HIGHWAY RESEARCH
RECORD

Number 82

Freight Transportation
9 Reports

Presented at the
43rd ANNUAL MEETING
January 13-17, 1964

and

44th ANNUAL MEETING
January 11-15, 1965

SUBJECT CLASSIFICATION
11 Transportation Administration

HIGHWAY RESEARCH BOARD
of the
Division of Engineering and Industrial Research
National Academy of Sciences--National Research Council
Washington, D. C.
1965

Department of Economics, Finance and Administration

Guilford P. St. Clair, Chairman
Chief, National Highway Planning Division
U. S. Bureau of Public Roads, Washington, D. C.

DIVISION OF ECONOMIC STUDIES

R. G. Hennes, Chairman
Department of Civil Engineering
University of Washington, Seattle

Carl C. Saal, Vice Chairman
Chief, Division of Traffic Operations
U. S. Bureau of Public Roads, Washington, D. C.

COMMITTEE ON INTERCITY HIGHWAY FREIGHT TRANSPORTATION

(As of December 31, 1963)

John C. Kohl, Chairman
Assistant Administrator, Office of Transportation
Housing and Home Finance Agency, Washington, D. C.

Malcolm F. Kent, Secretary
Transportation Economist, Traffic Systems Research Division
Office of Research and Development
U. S. Bureau of Public Roads, Washington, D. C.

Burton N. Behling, Association of American Railroads, Washington, D. C.

Donald E. Church, Chief, Transportation Division, U. S. Bureau of the Census, Washington, D. C.

Paul J. Claffey, Professor, Catholic University of America, Washington, D. C.

W. A. C. Connelly, Chief, Statistical and Service Division, Board of Engineers for Rivers and Harbors, Washington, D. C.

Alexander French, Chief, Planning Services Branch, U. S. Bureau of Public Roads, Washington, D. C.

Charles R. Haning, International Business Machines, Sherman, Texas

Earl N. Hoekenga, A. T. Kearney and Company, Management Consultants, Chicago, Illinois

Edward V. Kiley, Director, Department of Research and Transport Economics, American Trucking Associations, Inc., Washington, D. C.

Hoy Stevens, Highway Research Engineer, Traffic Systems Research Division, Office of Research and Development, U. S. Bureau of Public Roads, Washington, D. C.

Charles A. Taff, Head, Department of Business Organization and Administration, College of Business and Public Administration, University of Maryland, College Park

Charles V. Wootan, Associate Research Economist, Texas Transportation Institute, Texas A & M College System, College Station

Department of Economics, Finance and Administration

Guilford P. St. Clair, Chairman
Chief, National Highway Planning Division
U. S. Bureau of Public Roads, Washington, D. C.

DIVISION OF ECONOMIC STUDIES

R. G. Hennes, Chairman
Department of Civil Engineering
University of Washington, Seattle

Carl C. Saal, Vice Chairman
Chief, Traffic Systems Research Division
U. S. Bureau or Public Roads, Washington, D. C.

COMMITTEE ON INTERCITY HIGHWAY FREIGHT TRANSPORTATION
(As of December 31, 1964)

John C. Kohl, Chairman
Assistant Administrator, Transportation
Housing and Home Finance Agency, Washington, D. C.

Malcolm F. Kent, Secretary
Economist, Economic Research Division, Office of Research and Development
U. S. Bureau of Public Roads, Washington, D. C.

Burton N. Behling, Association of American Railroads, Washington, D. C.

Donald E. Church, Chief, Transportation Division, U. S. Bureau of the Census, Washington, D. C.

Paul J. Claffey, Catholic University of America, Washington, D. C.

W. A. C. Connelly, Chief, Statistical and Service Division, Board of Engineers for Rivers and Harbors, Washington, D. C.

Alexander French, Chief, Planning Services Branch, U. S. Bureau of Public Roads, Washington, D. C.

Earl N. Hoekenga, A. T. Kearney and Company, Management Consultants, Chicago, Illinois

Edward V. Kiley, Director of Research, American Trucking Association, Inc., Washington, D. C.

Hoy Stevens, Highway Research Engineer, Traffic Systems Research Division, Office of Research and Development, U. S. Bureau of Public Roads, Washington, D. C.

Charles A. Taff, Head, Department of Business Organization and Administration, College of Business and Public Administration, University of Maryland, College Park

Charles V. Wootan, Associate Research Economist, Texas Transportation Institute, Texas A & M University, College Station

Foreword

This Record offers the reader better understanding of the freight transportation characteristics and methods currently used by airline, highway, pipeline, railroad and inland waterway authorities to document the movement of freight. Knowledge of how ton-mile and other statistics are compiled will be especially useful to legislators in assessing overall transportation policy, to administrators in solving the financing and demand problems of their respective media, and to engineers seeking the optimum vehicle and roadway design that will provide maximum service at the least overall cost.

Four of the papers in this Record were given at the Board's 43rd Annual Meeting in 1964; the remainder were presented at the 44th Annual Meeting in 1965. Of those presented at the 43rd Annual Meeting, three discuss the characteristics of freight. The first paper presents new trucking data from the "1963 Census of Transportation" obtained through a sampling of selected motor carriers. The second report places a value on "Commercial Time Saved" as the result of shorter distances, fewer intersections and stop signs, easier curves and other improvements in highway construction. The third paper—"Intercity Freight Haulage"—is an outgrowth of a paper given at an earlier Annual Meeting.

The last paper given at the 43rd Annual Meeting, "Waterborne Commerce Statistics," and all of the papers given at the 44th Annual Meeting are concerned with the computing of ton-miles and other statistical measures.

The report entitled "Defining 'Intercity' for Transportation Purposes" sets the tone for the series. Although the changing character of urban America has added to the complexities of the term "intercity," this paper attempts to clarify it. "Air Cargo Ton-Miles" reports on the phenomenal growth in air freight and outlines the method for computing air ton-miles. Highway ton-miles, formerly computed by the Interstate Commerce Commission, are now being compiled by the Bureau of Public Roads as described in the paper "Highway Ton-Miles." They are based on a large sample of trucks weighed at loadometer stations.

The other papers included in this Record from the 44th Annual Meeting are concerned with pipeline statistics, a railroad carload waybill sample, and waterways statistics.

Contents

Intercity Freight Haulage, by Commodity, Shipping Density and Type of Transport, 1960

MALCOLM F. KENT
Economist, Traffic Systems Research Division, U.S. Bureau of Public Roads

•A STUDY of the pattern of weight demands for intercity freight transportation in 1954 (1) listed 260 categories of commodities hauled by highway. These commodities had been set forth in a code (2) published by the Interstate Commerce Commission (ICC). The Bureau of the Budget (BOB) published a more detailed code (3) in 1962 listing 1,315 commodities. Commodities transported in 1960, of course, were not reported under the BOB code. This study, however, attempts to allocate 1960 production and commodity data under this new code so that comparisons between past, present and future transport statistics can be made.

Shortly after the publication of the BOB code, the ICC compiled and published a revised ICC commodity code listing 369 different commodities. The new ICC code is compatible with the BOB code in that many of the commodities listed separately in the BOB code have been "collapsed" into the fewer and broader 369 ICC commodity codes. For instance, hay and forage 01191, hops (malt) 01192, potatoes, sweet 01194, straw 01196, sugar cane 01198 and field crops n.e.c. (not elsewhere classified) 01199 have been collapsed into field crops, miscellaneous 01190. The ICC code may be expanded at will and it is entirely possible that the 369 commodities may soon be increased if sufficient tonnages allocated to any of the collapsed codes warrant individual reporting. In the instance just cited, the more than 16 million tons of hay and forage, more than 17 million tons of straw, and 9 million tons of sugar cane would seem to warrant individual reporting.

The Census of Transportation is being conducted under the BOB code of 1,315 commodities. Notice was given (4) by the ICC on January 30, 1963, that commodity statistical data required for calendar year 1964 and annually or quarterly thereafter must be reported under the new ICC code by Class I and II railroads (other than switching and terminal companies), Class A and B carriers by water, maritime carriers, and Class I common and contract motor carriers of property operating in intercity service. The objectives of the revised ICC commodity code are stated in the Commission's order as follows:

> The "Proposed ICC Standard Commodity Code" has been designed so that statistics reported thereunder for use of the Commission may be related to existing and projected commodity data compiled and published by the Federal Government. It is an adaptation of the "Commodity Classification for Transportation Statistics" developed by the Office of Statistical Standards, Bureau of the Budget, for use in the planned Census of Transportation of 1963, which in turn was based on the Standard Industrial Classification (S.I.C.) prepared by the Bureau of the Budget and used generally by government agencies and others in the collection and presentation of data relating to business establishments. The "Proposed ICC Standard Commodity Code" is compatible with the "Proposed

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 43rd Annual Meeting.

Standard Transportation Commodity Code" developed also on the basis of the Bureau of the Budget "Commodity Classification for Transportation Statistics" by the Association of American Railroads and proposed for use within the railroad industry effective January 1, 1964.

STUDY PROCEDURES

In the Appendix are listed the commodities of the full commodity classification issued by BOB, to which produced and transported tonnages were assigned. References are shown by which the two most frequently used codes up to 1963 can be correlated with the BOB code. The letter P in the old code designations indicates that the code has been broken down into parts; e.g., barley and rye in the old code are now being shown separately. Three codes are shown for many commodities; for instance, rice under Farm Products was known by the Corps of Engineers as code 101, by the old ICC as code 11 and by the BOB as code 01134. Rice is one of the commodities shown by both the BOB and the new ICC code under the same number. The collapsing of codes by the ICC has been desirable because for many of the BOB codes there are few tons reported. The tonnages of the commodities have been listed in the Appendix essentially as they appear in the BOB code. Some wording of commodity names is rearranged so that significant words can appear at the beginning of the commodity classification. Numerals shown in parentheses represent tons or ton-miles which have been collapsed into a group commodity total. Addition of figures without parentheses gives the summation for each of the 29 two-digit commodity groups, such as 375,695,000 tons shown for FARM PRODUCTS 1960 production tons. Production tons given in the Appendix do not in all instances agree with production figures given in the ICC publication (5) as the ICC data did not include some of the waterborne tonnages.

Data on average length of haul were available for railroad tonnage (6) and for inland waterway tonnage (7, 8). This type of information was not available for highway tonnage and could not be reported. Pipeline and airline tonnages are shown at the end of the Appendix.

Every effort was made to allocate tonnage reported to the proper BOB code. In some instances this was impossible and the tonnage was, of necessity, listed in an n.e.c. code. As time goes on, especially with the reporting of commodity movements in the Census of Transportation, a better allocation of commodity tonnage to the BOB code can be made. In the meantime, this study will be of assistance in research into the optimum design of motor freight vehicles through the estimation of demand for the haulage of the various commodities. Also, the study compares 1960 tonnage in 5-lb increments of shipping density with similar data for 1954.

The Freight Commodity Statistics Classification in use up to 1963 was divided into five principal commodity groups as follows: I Products of Agriculture, II Animals and Products, III Products of Mines, IV Products of Forests, and V Manufactures and Miscellaneous (2). The 1,315 new Commodity Classifications for Transportation Statistics (3), published by BOB, are subdivided into 29 commodity groups and coded with a 2-digit numbering system from 01 to 40, eleven numbers being reserved for later expansion of the code. The 29 active commodity groups are listed in Table 1.

The steps used in determining the pattern of weight demand were generally similar to those used in the previous study (1). Briefly, these steps were as follows:

1. Data on the annual production of all commodities, both manufactured and not manufactured, were obtained. Original sources of data were obtained and used wherever possible. The main source was the ICC Statement No. 6301 (5) indicating the tonnage produced in 1960 which entered into transportation and showing the tonnage conveyed by railways. The other four types of transport are not included. The commodities were reported, of course, under the old ICC commodity code.

2. An estimation of the tonnages carried by each of the five principal types of transport was then made. Railway figures were obtained from the ICC report (5). Waterway figures came chiefly from U.S. Army Corps of Engineer publications (7, 8)

TABLE 1

TONS AND TON-MILES OF FREIGHT HAULED IN THE UNITED STATES IN 1960[a]

Group Number	Commodity Groups, BOB Classification	Railways		Inland Waterways		Domestic Coastlines	Highways	Pipelines	Airways
		Tons (thousands)	Ton-Miles (millions)	Tons (thousands)	Ton-Miles (millions)	(ton-mi, millions)	(tons, thousands)	(tons, thousands)	(tons, thousands)
01	Farm products	127,936	57,067	15,220	12,059	1,688	367,715	-	-
08	Forest products	6,040	2,503	4	0	78	10,301	-	-
09	Fresh fish and other marine products	48	38	23,136	1,194	84	86	-	-
10	Metallic ores	117,760	24,958	72,579	53,918	421	3,446	-	-
11	Coal	314,400	91,741	125,241	26,193	3,201	131,497	-	-
13	Crude petroleum, natural gas, and natural gasoline	1,888	855	35,251	8,630	60,167	27,996	334,105	-
14	Nonmetallic minerals, except fuels	188,413	32,943	85,562	16,984	6,164	1,043,834	-	-
19	Ordnance and accessories	0	0	0	0	0	0	-	-
20	Food and kindred products	84,104	54,591	5,834	2,130	13,452	122,049	-	-
21	Tobacco products	491	608	1	0	119	448	-	-
22	Basic textiles	772	764	40	23	109	5,984	-	-
23	Apparel and other finished textiles products, including knit apparel	395	327	4	0	78	768	-	-
24	Lumber and wood products, except furniture	81,720	49,038	24,637	957	10,332	181,551	-	-
25	Furniture and fixtures	1,174	1,149	0	0	0	4,541	-	-
26	Pulp, paper and allied products	41,360	27,614	2,434	446	1,405	57,849	-	-
27	Printed matter	540	689	0	0	0	1,491	-	-
28	Chemicals and allied products	55,363	29,890	11,109	6,664	10,812	92,301	-	-
29	Petroleum and coal products	48,197	18,112	114,867	26,094	193,395	303,552	118,027	-
30	Rubber and miscellaneous plastics products	1,484	1,087	20	1	45	1,483	-	-
31	Leather and leather products	102	108	2	0	29	765	-	-
32	Stone, clay and glass products	44,291	11,795	6,393	1,511	1,543	90,206	-	-
33	Primary metal products	37,603	16,237	9,993	6,551	7,108	59,618	-	-
34	Fabricated metal products, except ordnance, machinery, and transportation equipment	31,283	13,353	12	3	96	70,872	-	-
35	Machinery, except electrical	3,565	2,988	331	43	245	10,316	-	-
36	Electrical machinery, equipment and supplies	2,730	2,503	65	8	386	8,686	-	-
37	Transportation equipment	14,860	9,992	907	133	374	30,193	-	-
38	Instruments, photographic and optical goods, watches and clocks	0	0	0	0	0	0	-	-
39	Miscellaneous products of manufacturing	10,283	6,552	6,349	248	2,400	49,628	-	794
40	Waste and scrap materials	31,063	6,019	11,390	1,012	85	67,270	-	-
	Total	1,247,865	463,521	551,381	164,802	313,816	2,744,446	452,132	794

[a]Based on Appendix.

and from ICC reports (6). Pipeline and airways data came from "Minerals Yearbook" and from the "Statistical Handbook of Civil Aviation." Ton-miles, by commodity were available for the first time for domestic waterways and are included in the report, as are ton-miles for railways. Domestic coastline waterway data have been added because they represent a competitive mode of travel to freight movements inside the United States boundary. Coastwise shipments from New York to New Orleans, Baltimore via Panama Canal to the West Coast, etc., are in direct competition with rail, highway and pipeline shipments. These data have not been combined with inland waterway ton-miles because previous presentations of such statistics have not shown them together. They are shown, however, so that an overall domestic waterways ton-mile analysis can be made. Agricultural commodities are assumed to have been moved from their point of production by motor truck because few if any rail sidings or water terminals are convenient for initial farm transportation. Some estimates of line-haul tonnages by motor truck were obtained by subtracting the subtotal of the tons hauled by railroad, inland waterway and pipeline from the total tons moved. Airway tonnage increased from 464,000 tons in 1954 to 794,000 tons in 1960. Although this tonnage has a high intrinsic value, it represents only 0.015 percent of the total tonnage.

3. An important part of the study was the determination of the shipping density of each commodity. Products such as wheat and coal are not generally packaged for shipment, as their net weights are their shipping weights. Most products, however, are packaged and the weight of the commodity as it moves in commerce divided by the cubic content in feet, determines the shipping density, stated in pounds per cubic foot. This density may then be related to the cubic content of cargo bodies.

DISTRIBUTION OF HIGHWAY TONNAGE

To determine the demand for freight transportation, the various commodities have been arrayed in 5-lb intervals of shipping density for the five types of transport (Table 2). Figure 1 shows the distribution of the tons of freight moved by highway during 1954 and 1960. Of considerable interest is the close resemblance between the 1960 and the 1954 commodity distributions. The tonnage in most 5-lb intervals increased in 1960 as compared with 1954. The marked cessation in the demand for

TABLE 2

TONS OF FREIGHT HAULED IN THE UNITED STATES IN 1960[a]

Shipping Density (pcf)	Railways	Inland Waterways	Highways	Pipelines	Airways
5 - 9.9	5,640	60	35,693	-	-
10 - 14.9	11,219	1,428	86,314	-	-
15 - 19.9	4,883	609	15,974	-	-
20 - 24.9	15,177	694	46,991	-	-
25 - 29.9	36,643	9,102	119,006	-	794
30 - 34.9	63,905	2,719	103,973	-	-
35 - 39.9	122,302	9,497	145,251	-	-
40 - 44.9	97,837	96,319	253,821	92,462	-
45 - 49.9	112,498	33,333	286,448	-	-
50 - 54.9	328,190	126,246	146,578	-	-
55 - 59.9	34,718	101,300	237,409	359,670	-
60 - 64.9	2,521	1	2,952	-	-
65 - 69.9	9,541	1,196	30,686	-	-
70 - 74.9	4,588	527	13,247	-	-
80 - 84.9	7,225	-	4,520	-	-
85 - 89.9	141	-	671	-	-
90 - 94.9	69,226	5,310	81,807	-	-
100 - 104.9	102,656	78,137	919,948	-	-
105 - 109.9	10,606	-	7,455	-	-
110 - 114.9	2,114	-	7,134	-	-
115 - 119.9	658	-	13,791	-	-
120 - 124.9	-	1,798	-	-	-
130 - 134.9	10,351	2,193	39,853	-	-
135 - 139.9	-	171	-	-	-
145 - 149.9	27,118	3,368	53,813	-	-
155 - 159.9	1,866	-	427	-	-
160 - 164.9	76	283	2,181	-	-
165 - 169.9	1,029	-	997	-	-
170 - 174.9	7,590	198	-	-	-
180 - 184.9	4,615	343	2,865	-	-
185 - 189.9	36,300	-	60,476	-	-
190 - 194.9	-	34	-	-	-
195 - 199.9	1,529	1	352	-	-
215 - 219.9	1,201	-	1,183	-	-
220 - 224.9	9,795	4,743	6,631	-	-
225 - 229.9	4,902	1,213	15,167	-	-
250 - 254.9	941	7	-	-	-
290 - 294.9	96,847	70,551	-	-	-
310 - 314.9	1,417	-	632	-	-
Total	1,247,865	551,381	2,744,446	452,132	794

[a]Given in thousands of tons, based on Appendix.

haulage of packaged goods occurred in both years at 50 pcf. The bars for 50 to 54.9 lb and 55 to 59.9 lb represent the flowable commodities of coal, crude petroleum, and petroleum products other than gasoline, the cargoes of which can be limited by tank or hopper size. The tallest bar represents commodities in the 100- to 104.9-lb group of gravel, sand and crushed rock. These commodities do not move for long distances. The falloff in demand for packaged freight is, therefore, found at approximately 50 pcf.

Assuming that the empty weight of a 5-axle 40-ft van combination is about 30,000 lb (9, 10) and its cargo carrying capacity is approximately 2,200 cu ft, then this point of marked lessening of demand occurs at a possible gross vehicle weight of 140,000 lb (2,200 × 50 pcf + 30,000 lb). The present density of commodity at which such a combination can be loaded visibly full while still abiding by gross weight limitations is approximately 20 pcf. This is computed by subtracting the empty weight of 30,000 lb from the present gross weight limit set for the Interstate System, 73,280 lb, and dividing by the cargo capacity of 2,200 cu ft.

It is interesting to note at this point that the tonnage hauled by highway of densities less than 20 pcf represents only 5.0 percent of all highway tonnage and 11.1 percent of all highway tonnage less than pcf. This indicates not only that present gross weight

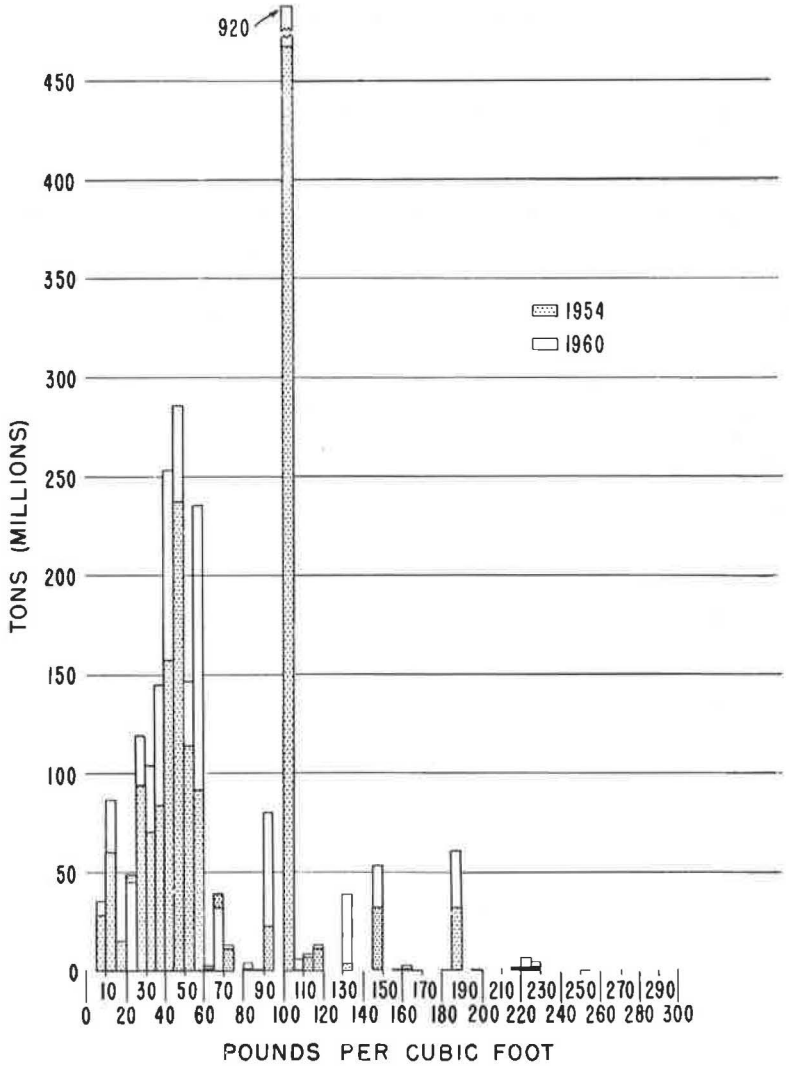

Figure 1. Highway freight tonnage by shipping densities, United States, 1954 and 1960.

limits permit little more than one-tenth of the trailer bodies to be stowed fully loaded, but also that the increase in trailer length from 35 to 40 ft, which has occured since 1958, can be used to advantage by only 11 percent of trailers hauling commodities of less than 50 pcf.

A considerable part of the increases in 1960 over 1954 (Fig. 1) are due to the increased commodity movements occasioned by both road and building construction work. Movements of gravel, sand and crushed rock increased from 460 to 920 million tons. Commodities in the 50- to 54.9-pcf interval, among which are fuel, road and petroleum residual oils, increased from 91 to 214 million tons. Similarly, there were increases in the weight intervals which include gasoline, cement, manufactured iron and steel and other commodities closely related to road and building construction.

DISTRIBUTIONS OTHER THAN HIGHWAY

The distribution of railroad freight tonnage is shown in Figure 2. Tonnages declined from 1954 to 1960 in the lighter weight intervals from 5 to 25 pcf as shown at the left

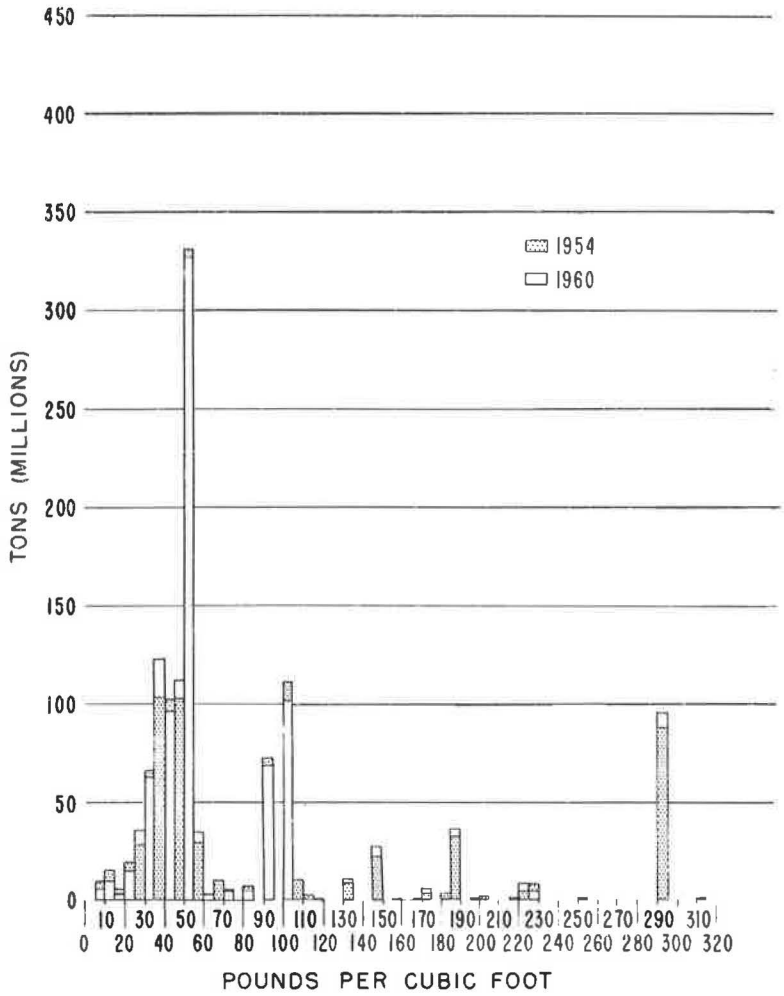

Figure 2. Railway freight tonnage by shipping densities, United States, 1954 and 1960.

of the chart. Tonnages in the 25- to 50-pcf weight intervals increased or remained nearly unchanged. The overall railroad tonnage increased 1.6 percent, from 1,228 million tons in 1954 to 1,248 million tons in 1960.

Inland waterway tonnage declined, partly due to reductions in gasoline, fuel, road and petroleum residual oils hauled. Other tonnages were found to be about the same as between 1954 and 1960, as shown in Figure 3. It should be noted that the combined total of inland waterway and domestic coastline ton-miles exceeds the ton-miles reported for railways, as shown in Table 1.

Pipeline tonnage (Fig. 4) increased from 378,000 tons in 1954 to 452,000 tons in 1960, an increase of 19.6 percent. A new form of pipeline haulage came into being during 1958 but ceased operations in 1963. This was the movement of coal slurry from Cadiz, Ohio, to the Cleveland Electric Illuminating Company in Cleveland, a distance of about 108 miles. In 1963, an adjustment of rates and the formation of dedicated coal trains enabled the transport of coal by railway at costs below those of the pipeline carrier.

An attempt was made to break down the airline tonnage by commodities, as has been done for the other four types of transport. However, airline freight traffic is so diversified and moves in such relatively small tonnages that this breakdown was not

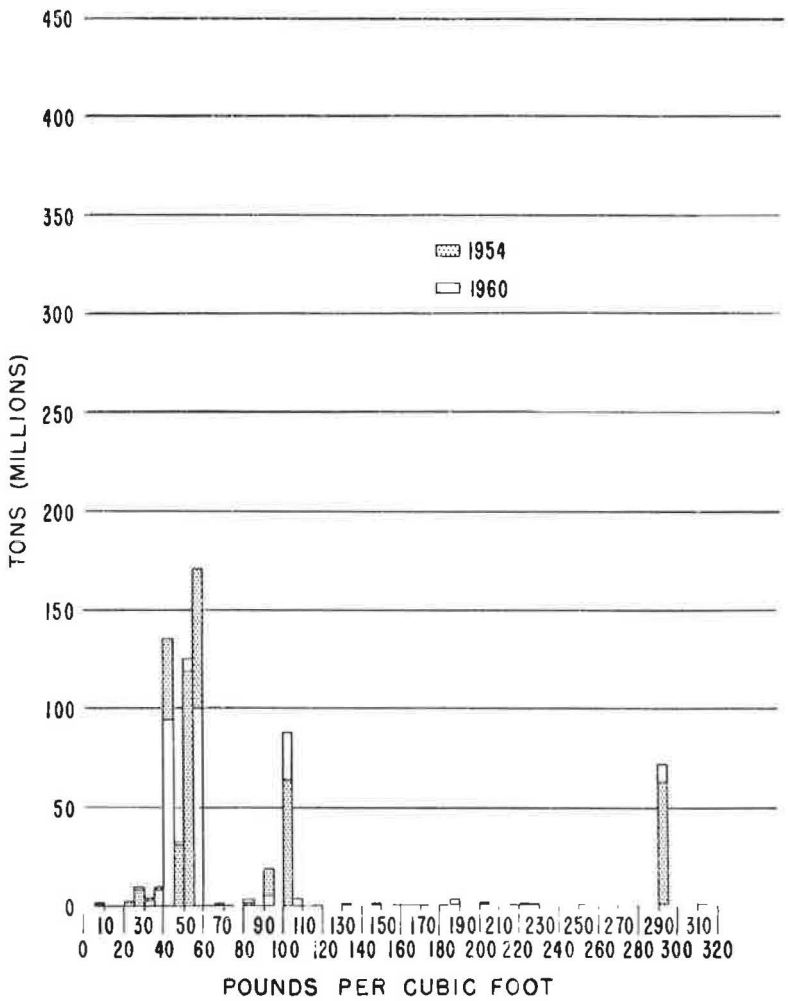

Figure 3. Inland waterway freight tonnage by shipping densities, United States, 1954 and 1960.

deemed feasible. Airline offices were visited and an estimate of 27 pcf was obtained of the weighted average shipping density of airfreight.

SUMMARY OF FINDINGS

1. The data herein presented indicate the proportion of commodities which may be hauled in visibly full loads under existing gross weight limitations. The data may be used to calculate the extent of usage which might be expected under any gross weight limitation.

2. Five-axle van combinations in 1960, to stay within legal limits, operated with less than a visibly full load when hauling commodities of shipping densities 20 pcf or more.

3. Tonnage with shipping densities of less than 20 pcf represented 11.1 percent of the tonnage with shipping densities less than 50 pcf and 5.0 percent of all commodities hauled.

4. Some commodities which have been collapsed by the new ICC code into summary codes have reported tonnages from 1,000,000 to 17,000,000 tons, and appear to warrant separate reporting.

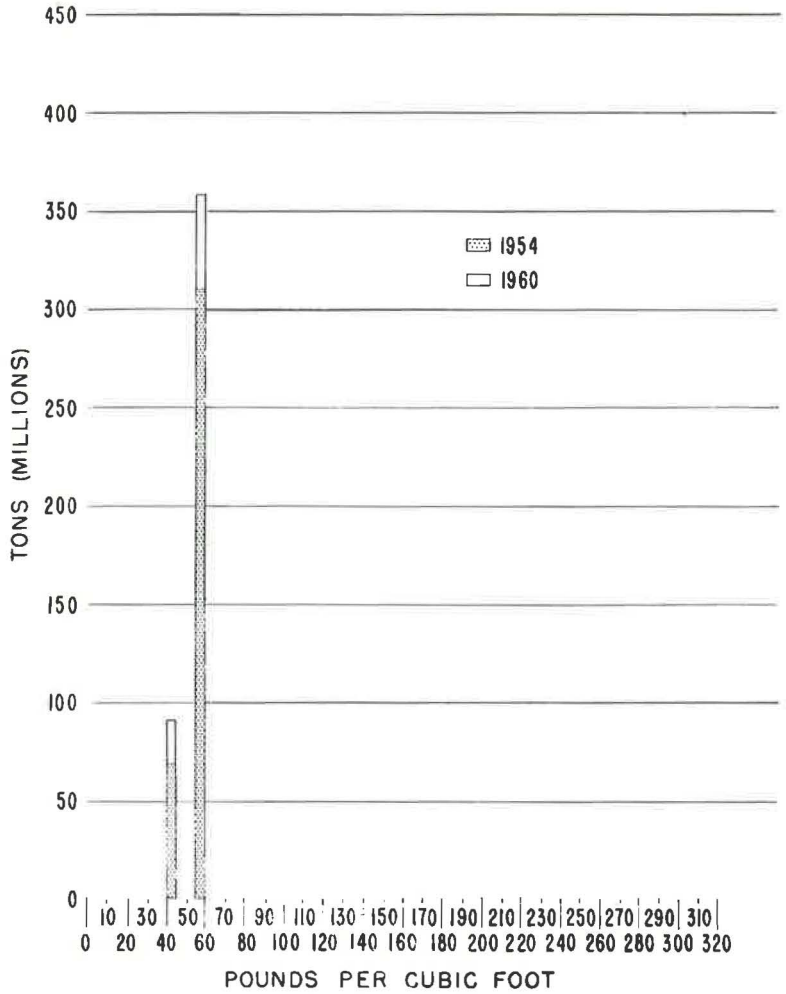

Figure 4. Pipeline freight tonnage by shipping densities, United States, 1954 and 1960.

5. The increase in trailer length from 35 to 40 ft could be used to advantage by 11 percent of the five-axle combinations hauling commodities with shipping densities of less than 50 pcf under gross weight limits presently set for the Interstate Highway System.

REFERENCES

1. Kent, M. F. The Freight's the Weight. Highway Research Board Proc., Vol. 37, pp. 21-43, 1958.
2. Interstate Commerce Commission. Freight Commodity Statistics Classification—1954 Edition. Assoc. of American Railroads, Washington, D.C., 1954.
3. Executive Office of the President, Bureau of the Budget. Commodity Classification for Transport Statistics. Washington, D.C., 1962.
4. Interstate Commerce Commission. Commodity Classification for Reporting Purposes, Docket No. 34206. Jan. 30, 1963. 25 pp.
5. Interstate Commerce Commission. Fluctuations in Railroad Freight Traffic Compared with Production. Statement No. 6301, Washington, D.C., Jan. 1963.
6. Interstate Commerce Commission. Carload Waybill Statistics, 1960. One Percent Sample of Terminations in the Year 1960. Washington, D.C., Oct. 1961.

7. U.S. Army Corps of Engineers. Waterborne Commerce of the United States. Calendar Year 1960. In Domestic Inland Traffic Areas of Origin and Destination of Principal Commodities, Suppl. to Pt. 5 National Summaries, Washington, D.C., 1961.
8. U.S. Army Corps of Engineers. Waterborne Commerce of the United States. Calendar Year 1961. In Water Carrier Ton-Miles, Suppl. 2 to Pt. 5 National Summaries, Washington, D.C., 1961.
9. Kent, M. F., and Stevens, Hoy. Dimensions and Weights of Highway Trailer Combinations and Trucks—1959. Highway Research Record No. 26, pp. 24-65, 1963.
10. Kent, M. F. AASHO Road Test Vehicle Operation Costs Related to Gross Weight. Highway Research Board Spec. Rept. 73, pp. 149-165, 1962.

Appendix

COMMODITY TONNAGES

On the following pages is a listing of commodity tonnages produced and transported in the United States by railways, domestic waterways and highways in 1960. The commodities are classified by old and new commodity codes. A new commodity code was issued in 1963 by BOB and was modified by (although compatible with) the ICC. Pipeline and airline commodity statistics are given at the end of the listing. Highway ton-miles are not reported.

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
FARM PRODUCTS					
300	33	01121	01121	Cotton, in bales	33
	35		01124	Cotton linters, noils, nubs, sweepings	15
		01120		Cotton, raw miscellaneous	15
102P	9P	01131	01131	Barley	40
100	3	01132	01132	Corn	45
104	7	01133	01133	Oats	30
101	11	01134	01134	Rice	44
102P	9P	01135	01135	Rye	45
108	5	01136	01136	Sorghum grains	45
103	1	01137	01137	Wheat	47
	13	01139	01139	Grain n.e.c.	43
231	43	01144	01144	Soybeans	25
	37		01141	Cottonseed	30
232	105		01142	Flax seed	28
	97		01143	Peanuts	22
235			01149	Oil seeds n.e.c.	29
		01140		Oil seeds, misc.	29
260	107		01159	Seeds, field n.e.c.	30
		01150		Seeds, field except oil seeds misc.	30
	29	01193	01193	Tobacco, leaf	21
	85	01195	01195	Potatoes, o/t sweet	35
	101	01197	01197	Sugar beets	42
	25		01191	Hay and forage	14
	103		01192	Hops (malt)	31
	27		01196	Straw	11
	199P		01198	Sugar Cane	27
		01190		Field crops, misc.	16
	59P		01212	Lemons	32
	61P		01214	Oranges (and grapefruit)	35
		01210		Fruits, Citrus	34
	49	01221	01221	Apples	26
	57	01224	01224	Grapes	33
	63P	01226	01226	Peaches	32
	65		01227	Pears	37
	71		01229	Fruits, Deciduous n.e.c.	43
		01220		Fruits, Deciduous	40
	51	01232	01232	Bananas	12
160	75	01295	01295	Coffee, green	29
	53		01291	Berries, cane and bush	20
161	199P		01294	Cocoa beans	29
140			01298	Nuts, edible, in shell except peanuts	29
130	69		01299	Fruits, fresh, n.e.c.	29
		01290		Fruits, fresh, misc. and tree nuts	28
	83	01318	01318	Onions, dry	19

1960 roduction . Tons housands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
875, 695	127, 936	57, 067		15, 220	12, 059		1, 688	367, 715
5, 586	4, 236	2, 817	665	5	1	150	9	1, 350
(789)	(557)	(424)	762					(232)
789	557	424	762					232
8, 127	5, 953	2, 316	389	491	446	909	31	8, 127
48, 110	21, 826	6, 460	296	4, 572	4, 193	917	245	48, 110
4, 356	2, 850	935	328	440	422	958	3	4, 356
2, 608	1, 807	660	365	158	16	100	904	2, 608
726	532	207	389	44	40	909	3	726
11, 858	9, 667	4, 292	444	529	230	434	9	11, 858
50, 326	40, 721	13, 804	339	5, 071	4, 559	899	128	50, 326
186	112	57	506					186
16, 985	9, 136	1, 644	180	2, 264	1, 820	804	23	16, 985
(5, 437)	(173)	(19)	107					(5, 264)
(1, 079)	(429)	(106)	246	(36)	(30)	831		(1, 079)
(864)	(284)	(199)	699					(864)
				(10)	(1)	108	*	
7, 380	886	324	364	46	31	674	*	7, 207
(1, 129)	(236)	(370)	1, 567	(3)	*	128	(31)	(1, 129)
1, 129	236	370	1, 567	3	*	128	31	1, 129
1, 311	633	215	340					1, 311
12, 860	3, 621	4, 490	1, 240					12, 860
16, 421	9, 888	574	58					16, 421
(16, 464)	(142)	(82)	574					(16, 464)
(1, 537)	(1, 340)	(60)	45					(1, 537)
(17, 070)	(63)	(19)	301					(17, 070)
(9, 047)	(2, 698)	(845)	313					(9, 047)
44, 118	4, 243	1, 006	237					44, 118
(611)	(214)	(577)	2, 697					(611)
(7, 208)	(826)	(1, 610)	1, 949					(7, 208)
7, 819	1, 040	2, 187	2, 103					7, 819
2, 706	309	696	2, 253					2, 706
3, 030	335	901	2, 689					3, 030
1, 818	118	196	1, 665					1, 818
(649)	(184)	(442)	2, 403					(649)
(741)	(284)	(641)	2, 257					(741)
1, 390	468	1, 083	2, 314					1, 390
1, 425	838	454	542					587
1, 462	748	498	666	235	2	8	35	714
(241)	(2)	(4)	1, 991					(241)
(516)	(154)	(48)	313	(2)	*	8	(12)	(362)
				(3)	(1)	209	(25)	
(1, 178)	(109)	(307)	2, 821	(12)	*	34	(148)	(1, 178)
1, 935	265	359	1, 357	17	1	62	185	1, 781
1, 327	259	479	1, 848					1, 327

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
FARM PRODUCTS (cont'd)					
	79	01334	01334	Celery	27
	81	01335	01335	Lettuce	19
	77		01333	Cabbage	20
		01330		Vegetables, leafy fresh	20
	91P	01341	01341	Beans	38
	93		01349	Veg. seeds used as food, dry ripe, n.e.c.	27
		01340		Veg. seeds used as food, dry ripe	27
	67	01392	01392	Watermelons	20
	87	01394	01394	Tomatoes	33
	55	01398	01398	Melons, except watermelons	28
	89		01399	Vegetables, fresh, n.e.c.	26
		01390		Vegetables, fresh, misc.	26
	203P	01411	01411	Cattle	11
	213	01413	01413	Hogs and pigs	10
	207P	01414	01414	Sheep and lambs	7
5			01419	Livestock, n.e.c.	10
		01410		Livestock	10
	233		01429	Diary farm products, n.e.c.	47
		01420		Diary farm products	47
340			01431	Wool	14
	237		01439	Animal fibers, n.e.c.	14
		01430		Animal fibers	14
	233		01519	Poultry, live, n.e.c.	7
		01520		Poultry, live	7
50	227	01521	01521	Eggs, market	26
90	201		01921	Horses, ponies, mules, asses, burros, live	10
95			01929	Animal specialties, n.e.c.	10
		01920		Animal specialties	10
297			01998	Farm products, n.e.c.	12
		01990		Farm products, n.e.c.	12
FOREST PRODUCTS					
200	523P	08423	08423	Latex and allied gums (crude nat. rub.)	36
	417		08422	Gums, crude exc. latex, all'd gums, cr'd rub.	38
		08420		Gums and barks, crude	38
	499		08619	Forest products, n.e.c.	30
		08610		Forest products, misc.	30
FRESH FISH AND OTHER MARINE PRODUCTS					
40	245		09121	Finfish	43
49			09122	Shellfish	43
		09120		Fish and Whale prdts, froz. unpkg. fish	43
94	299P	09131	09131	Shells; oyster, crab, etc.	40
METALLIC ORES					
600	309		10111	Ores, crude direct-shipping	293
		10110		Iron ores	293

1960 Production Tons (thousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
744	328	731	2,228					744
1,801	853	2,086	2,446					1,801
(1,280)	(143)	(227)	1,585					(1,280)
1,280	143	227	1,585					1,280
1,121	912	777	852					1,121
(118)	(57)	(174)	3,055					(118)
118	57	174	3,055					118
1,686	101	122	1,209					1,686
5,117	251	468	1,866					5,117
754	409	1,002	2,449					754
(6,760)	(707)	(1,317)	1,863					(6,760)
6,760	707	1,317	1,863					6,760
18,087	1,793	1,560	870					18,087
9,323	539	616	1,143					9,323
1,041	360	323	898					1,041
(1)				(1)	(*)	5	(6)	
1				1	*	5	6	
(61,412)	(9)	(4)	395					61,412
61,412	9	4	395					61,412
				(2)	*	50	(6)	
(593)	(179)	(200)	1,115					(593)
593	179	200	1,115	2	*	50	6	593
(4,206)	(1)	(1)	842					(4,206)
4,206	1	1	842					4,206
4,565	3	3	1,113		*		17	4,565
(32)	(7)	(8)	1,163					(25)
(1,266)				(1,266)	(295)	233	(35)	
1,298	7	8	1,163	1,266	295	233	35	25
				(76)	(3)	44	(18)	
				76	3	44	18	
10,301	6,040	2,503		4	*		78	10,301
2,466	1,926	1,292	671	4	*	60	78	2,466
(618)	(432)	(247)	572					(618)
618	432	247	572					618
(7,217)	(3,682)	(964)	286					(7,217)
7,217	3,682	964	286					7,217
23,270	48	38		23,136	1,194		84	86
(1,109)	(48)	(38)	794	(975)	(15)	15	(26)	(86)
(859)				(859)	(29)	34	(16)	
1,968	48	38	794	1,834	44	24	42	86
21,302				21,302	1,150	54	42	
305,085	117,760	24,958		72,579	53,918		421	3,446
(133,336)	(96,847)	(14,624)	151	(70,551)	(53,125)	753	(2)	
133,336	96,847	14,624	151	70,551	53,125	753	2	

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
METALLIC ORES (cont'd)					
620	313		10211	Copper ores, crude	170
		10210		Copper ores	170
640	315		10311	Lead ores, crude	251
		10310		Lead ores	251
670	317		10321	Zinc ores, crude	180
		10320		Zinc ores	180
617	311		10514	Aluminum ores, except bauxite	149
		10510		Bauxite and other aluminum ores	149
	319		10929	Metal ores, n.e.c.	188
		10920		Metal ores, misc.	188
COAL					
501	301	11112	11112	Anthracite, clnd. or predp. (cr. sc. sized)	54
502			11212	Bit. clnd. or prepd. (cr. scrnd. sized)	50
		11210		Bituminous Coal	50
CRUDE PETROLEUM, NATURAL GAS, AND NATURAL GASOLINE					
511	337	13111	13111	Petroleum, crude	55
522	507	13211	13211	Natural gasoline	41
NONMETALLIC MINERALS EXCEPT FUELS					
	335	14111	14111	Stone, dimension quarry	160
	333	14211	14211	Limestone, agricultural	155
551	329	14219	14219	Stone, crushed and brkn. incl., riprap, n.e.c.	100
	331		14214	Limestone, fluxing	93
		14210		Fluxing stone, furn. flux. lmst. and raw dolm.	93
554P	327P	14411	14411	Sand (aggregate and ballast)	100
554P	327P	14412	14412	Gravel (aggregate and ballast)	100
	325	14413	14413	Sand and gravel, industrial	105
540	323		14519	Clay, ceramic and refractory minrl. n.e.c.	130
		14510		Clay, ceramic and refractory minerals	130
	321	14711	14711	Barite	217
855		14713	14713	Potash, soda and borate	40
852	343	14714	14714	Phosphate rock	91
550	345	14716	14716	Sulphur	41
854			14719	Minerals, chem. and fertilizer, n.e.c.	41
		14710		Minerals, chemical and fertilizer	41
555	399		14919	Minerals, nonmet. exc. fuels n.e.c.	40
		14910		Minerals, nonmet. exc. fuels misc.	40
FOOD AND KINDRED PRODUCTS					
10	215		20119	Meat, fresh or chilled, n.e.c.	40
		20110		Meat, fresh or chilled, exc. salted 2/	40
17			20132	Meats and sausage, cooked, cured, smoked etc.	44
13			20134	Meat canned	44
20			20138	Animal oil, tallow, edible	41
55			20139	Meat products, n.e.c.	41
		20130		Meat products 2/	41

1960 Production Tons (thousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
(135,077)	(7,590)	(1,245)	164	(198)	(4)	18	(2)	
135,077	7,590	1,245	164	198	4	18	2	
(6,369)	(941)	(187)	199	(7)	(3)	430	(22)	
6,369	941	187	199	7	3	430	22	
(7,886)	(1,704)	(947)	556	(31)	(49)	1,587	(2)	(1,025)
7,886	1,704	947	556	31	49	1,587	2	1,025
(12,727)	(3,409)	(4,786)	1,404	(1,792)	(737)	411	(393)	
12,727	3,409	4,786	1,404	1,792	737	411	393	
(9,690)	(7,269)	(3,169)	436					(2,421)
9,690	7,269	3,169	436					2,421
421,311	314,400	91,741		125,241	26,193		3,201	131,497
13,006	9,900	2,218	224	633	150	237	*	8,668
(407,315)	(304,500)	(89,523)	294	(124,608)	(26,043)	209	3,201	(122,829)
407,315	304,500	89,523	294	124,608	26,043	209	3,201	122,829
500,777	1,888	855		35,251	8,630		60,167	27,996
500,489	1,888	855	453	34,963	8,601	246	59,817	27,996
288				288	29	101	350	
278,385	188,413	32,943		85,562	16,984		6,164	1,043,834
2,257	76	74	971					2,181
2,293	1,866	235	126					427
556,156	50,705	6,186	122	53,418	10,310	193	215	452,033
(35,392)	(16,765)	(2,179)	130					(18,627)
35,392	16,765	2,179	130					18,627
186,843	19,222	1,749	91	9,077	472	52	79	167,621
318,137	32,729	2,979	91	15,456	803	52	134	300,294
18,011	10,583	2,794	264					7,428
(49,422)	(9,376)	(5,391)	575	(2,014)	(93)	46	(16)	(38,032)
49,422	9,376	5,391	575	2,014	93	46	16	38,032
2,384	1,201	435	362					1,183
				5	*	71	118	
61,003	24,321	4,864	200	653	984	1,507	2,212	36,029
6,627	3,278	954	291	2,603	2,546	978	2,628	746
(287)				(287)	(366)	1,275	(268)	
287				287	366	1,275	268	
(39,573)	(18,291)	(5,103)	279	(2,049)	(1,410)	688	(494)	(19,233)
39,573	18,291	5,103	279	2,049	1,410	688	494	19,233
210,654	84,104	54,591		5,834	2,130		13,452	122,049
(24,039)	(3,735)	(4,135)	1,107	(25)	(2)	64	(109)	(20,279)
24,039	3,735	4,135	1,107	25	2	64	109	20,279
							(51)	
(2)				(2)	*	32	(5)	
(31)				(31)	(4)	117	(32)	
				*	*	*	(6)	
33				33	4	111	24	

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
FOOD AND KINDRED PRODUCTS (cont'd)					
60	239	20141	20141	Hides, skins, and pelts not tan'd (misc.)	41
	299P		20143	Grease and inedible tallow	37
		20140		Animal by-products inedible	37
	225		20151	Chickens, dressed fresh	26
		20150		Poultry dressed, small game fresh misc.	26
	229	20211	20211	Butter, creamery	44
35			20231	Milk products, dry	
33			20233	Milk prdts., evaportated and condensed	
		20230		Milk, condensed, evaporated and dry	
37			20251	Cheese, exc. cottage cheese	
39	231		20259	Spec. dairy prdts. and by-prdts. n.e.c.	38
		20250		Cheese and other spec. dairy prdts.	38
43			20311	Fish, canned et al. exc. soup, st. chowder	46
	763P	20310		Sea Food, canned and cured	46
135			20331	Fruits, canned	46
123			20332	Vegetables, canned	46
	763P		20339	Fruits, veg. by-prdts., canned	46
		20330		Fruits and vegetables, canned	46
133			20341	Fruits, dried and dehyd.	
127			20342	Veg. and soup mix, dried and dehyd.	35
		20340		Fruits, veg. and soup mix, dried and dehyd.	35
137			20359	Sauces and Seasoning, n.e.c.	
		20350		Fruits and veg. pickled, sauces, s. drg. etc.	
45	243		20361	Fish et al. seafood, frozen	38
		20360		Fish, packaged fresh or frozen	38
	765		20371	Fruits, frozen	45
136			20372	Juices and ades	46
120	95		20373	Vegetables, frozen	26
		20370		Fruits, fr. juices, and veg. spec., frozen	36
107	15	20411	20411	Flour, wheat exc. blend and prepared	36
	17		20413	Corn meal and flour exc. anim. and poul. feed	31
109	23		20419	Grain mill products, n.e.c.	40
		20410		Flour and other grain mill products	39
110	773		20423	Feeds, canned for animals and poultry	33
		20420		Feeds, prepared (animals and fowls)	33
	21		20452	Flour, prepared (cake, pie, biscuit, etc.)	25
		20450		Flour, blended and prepared	25
	755P	20461	20461	Corn sirup	55
	767P	20462	20462	Corn starch	38
185	757		20619	Sugar mill products, n.e.c.	55
		20619		Sugar mill products and by-products	55
290		20625	20625	Sugar refining by-products	55
180	759		20629	Sugar, refined, cane and beet, n.e.c.	53
		20620		Sugar, refined, cane and beet	53

1960 Production Tons (thousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
1,008	743	769	1,035	10	1	86	24	255
(3,075)	(1,371)	(587)	428					(1,704)
3,075	1,371	587	428					1,704
(3,751)	(142)	(207)	1,458					(3,609)
3,751	142	207	1,458					3,609)
664	305	259	849					359
(4)				(4)	*	84	(21)	
(24)				(24)	(2)	71	(53)	
28				28	2	73	74	
(27)				(27)	(2)	72	(4)	
(756)	(286)	(266)	931	(47)	(3)	63	(53)	(423)
783	286	266	931	74	5	66	57	423
(28)				(28)	(2)	84	(176)	
28				28	2	84	176	
(47)				(47)	(2)	43	(3,222)	
(82)				(82)	(7)	85	(580)	
(33,479)	(12,733)	(13,064)	1,026					(20,746)
33,608	12,733	13,064	1,026	129	9	70	3,802	20,746
				*	*	21	(204)	
(3)				(3)	*	85	(84)	
3				3	*	85	288	
							(214)	
							214	
(1,154)	(46)	(84)	1,822	(2)	*	48	(51)	(1,106)
1,154	46	84	1,822	2	*	48	51	1,106
(1,180)	(590)	(971)	1,645					(590)
				(3)	*	106	(752)	
(979)	(429)	(888)	2,071	(174)	(11)	65	(195)	(376)
2,159	1,019	1,859	1,824	177	11	65	947	966
12,769	10,458	6,400	612	231	134	581	113	2,080
(878)	(391)	(228)	583					(487)
(8,907)	(7,562)	(3,123)	413	(183)	(20)	112	(100)	(1,162)
9,785	7,953	3,351	421	183	20	112	100	1,649
(42,431)	(16,141)	(5,617)	348	(370)	(174)	471	(467)	(25,920)
42,431	16,141	5,617	348	370	174	471	467	25,920
(2,226)	(1,420)	(893)	629					(806)
2,226	1,420	893	629					806
1,061	1,423	1,059	744					
1,242	1,241	864	696					
(4,169)	(1,280)	(549)	429	(24)	(6)	245	(107)	(2,865)
4,169	1,280	549	429	24	6	245	107	2,865
606				606	646	1,066	861	
(9,873)	(6,355)	(3,788)	596	(928)	(612)	659	(4,071)	(2,590)
9,873	6,355	3,788	596	928	612	659	4,071	2,590)

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
FOOD AND KINDRED PRODUCTS (cont'd)					
	761		20711	Candy bars, bulk pkgd.	43
		20710		Candy and other confectionary products	43
	749	20821	20821	Beer, ale, porter, stout, bottled kegs, etc.	43
	747	20841	20841	Wines, brandy and brandy spirits	36
190	745	20851	20851	Liquors, distilled, rectified, blended	36
	535	20859	20859	Distilling liquors, by-prdts. of	37
925	751	20861	20861	Soft Drinks, bot., canned, carbon. min. wtr.	42
195	763P		20871	Flavoring extracts, emulsion compds.	46
		20870		Flavoring, misc. extracts, syps., compds.	46
	511	20911	20911	Cottonseed oil, crude refined	40
	39	20914	20914	Cottonseed, cake, meal, other by-prdts.	38
	515	20921	20921	Soybean Oil, crude, refined	46
	45	20923	20923	Soybean, cake, meal, flour, grits, by-prdts.	38
	513		20931	Linseed Oil, crude, refined	43
	517		20933	Veg. oil exc. cottonseed, soybean, linseed	39
240	47		20939	Veg. oil, seed cake, meal n.e.c.	40
		20930		Veg. and nut oils and by-prdts. exc. ctn. soy.	40
	521		20952	Marine oil mill-meal scrip by-prdts.	38
		20950		Marine fats and oils	38
	221		20963	Margarine	43
150	519		20969	Oils, salad and cooking exc. corn oil n.e.c.	43
		20960		Shortening, table oils et al. fats n.e.c.	43
926	753	20971	20971	Ice, natural or mfg.	57
170	199		20997	Spices	28
165			20998	Tea, including instant tea	46
199			20999	Food preparations, n.e.c.	46
		20990		Food preparations, misc.	46
TOBACCO PRODUCTS					
285	777	21111	21111	Cigarettes	22
280	775		21411	Tobacco, stemmed and redried	25
		21410		Tobacco, stemmed and redried	25
BASIC TEXTILES					
310	727P		22119	Fabric, cotton broad, woven n.e.c.	19
381	731		22211	Fabrics, man-made, fiber broad woven	19
350	733P		22311	Fabrics, wool broad woven	21
		22000		Woven fabrics	19
	713P		22799	Carpets, rugs, and mats n.e.c.	21
		22700		Carpet, rug, and textile	21
328			22991	Fabrics, bonded, nonwoven, fibre	28
331	723P		22992	Jute goods, exc. bags	28
335	733		22999	Textiles, basic n.e.c.	21
		22900		Textiles, basic misc.	21
	731	22961	22961	Tire cord and fabrics	26
326	735P		22981	Cordage, twine, hard fiber	27

1960 roduction Tons housands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
(1,937)	(457)	(555)	1,215					(1,480)
1,937	457	555	1,215					1,480
11,507	3,201	2,177	680					8,306
1,193	530	1,125	2,123					663
1,503	684	662	968	104	39	372	825	715
4,077	980	712	727					3,097
10,604	364	41	114	1,840	35	19	*	8,400
(28)				(28)	(5)	174	(12)	
28				28	5	174	12	
1,883	900	482	536					983
3,655	816	269	330					2,839
4,665	1,661	1,055	635					3,004
9,436	6,126	2,604	425					3,310
(304)	(175)	(146)	836					(129)
(1,547)	(568)	(544)	957					(979)
(646)	(359)	(136)	380	(647)	(384)	593	(117)	(287)
2,497	1,102	826	750	647	384	593	117	1,395
(139)	(107)	(90)	841					(32)
139	107	90	841					32
(849)	(40)	(37)	924					(809)
(542)	(297)	(192)	645	(66)	(24)	364	(84)	(245)
1,391	337	229	924	66	24	364	84	1,054
1,602	188	13	67	256	12	45	*	1,414
							(2)	
(1)				(1)	*	132	*	
(41)				(41)	(3)	77	(857)	
42				42	3	78	859	
939	491	608		1	*		119	448
738	464	579	1,248				91	274
(201)	(27)	(29)	1,058	(1)	*	20	(28)	(174)
201	27	29	1,058	1	*	20	28	174
6,796	772	764		40	23		109	5,984
(3,100)	(203)	(180)	888	(8)	*	43	(1)	(2,889)
(1)				(1)	*	175	(9)	
							(8)	
3,101	203	180	888	9	*	58	18	2,889
(891)	(293)	(355)	1,213					(598)
891	293	355	1,213					598
(2)				(2)	*		(1)	
(8)				(8)	(3)	318	(12)	
(623)	(75)	(87)	1,155	(20)	(20)	982	(77)	(528)
633	75	87	1,155	30	23	792	90	528
1,699	138	91	658					1,561
(472)	(63)	(51)	806	(1)	*	6	(1)	(408)

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
BASIC TEXTILES (cont'd)					
			22980	Cordage and twine	27
APPAREL AND OTHER FINISHED TEXTILE PRDTS. INCLUDING KNIT.					
	725		23031	Textile bags	36
	723		23949	Canvas products n.e.c.	31
320	729		23999	Textile prdts. fabricated n.e.c.	16
		23900		Textile prdts. fabricated, misc.	27
LUMBER AND WOOD PRDTS. EXCEPT FURNITURE					
440	409	24114	24114	Pulpwood logs	38
405	403	24116	24116	Woodposts, poles and piling	40
400	401		24111	Sawlogs	40
417	407		24112	Ties, hewn railroad and mine	50
401	401P		24113	Logs and bolts, short	45
	405		24117	Fuelwood and cordwood	40
408			24119	Primary forest prdts. n.e.c.	30
		24110		Primary forest prdts. logs etc.	45
	411		24211	Lumber	31
	679		24219	Lumber, n.e.c.	18
		24210		Lumber and dimension stock	30
413	413		24299	Sawmill and planing mill prdts. n.e.c.	31
		24290		Sawmill and planing mill prdts. shing. misc.	31
	677		24319	Millwork prdts., n.e.c.	13
		24310		Millwork	13
	415	24321	24321	Veneer and plywood	30
	681		24332	Buildings, prefab. wood	18
		24330		Buildings, prefab. wd. and structural members	18
416	781		24419	Containers and acces., wooden n.e.c.	7
		24410		Containers, wooden	7
430			24941	Cork products	27
421	703		24999	Wood prdts., n.e.c.	21
		24900		Wood prdts., misc.	21
FURNITURE AND FIXTURE					
	715P		25199	Furniture, household and office n.e.c.	8
		25100		Furniture, household and office	8
PULP, PAPER, AND ALLIED PRODUCTS					
441	653	26111	26111	Pulp	24
445	655	26112	26112	Pulp mill by-products	14
450	637	26211	26211	Newsprint	37
	661	26216	26216	Paper, coarse, incl. wrap. paper	41
457	659P		26219	Paper, exc. bldg. paper n.e.c.	40
		26210		Paper, exc. bldg. paper	40
	669	26311	26311	Paperbd, pulpbd, fiberbd, exc. insulbd.	25
	551		26459	Die cut paper and paperbd. prdts. cdbd. n.e.c.	20
	665		26499	Converted paper and paperbd. prdts. n.e.c.	20
		26400		Converted paper and paperbd. prdts.	20

1960 Production Tons (thousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
472	63	51	806	1	*	6	1	408
1,167	395	327		4	*		78	768
(214)	(31)	(15)	481					(183)
(609)	(135)	(102)	752					(474)
(344)	(229)	(210)	918	(4)	*	51	(78)	(111)
1,167	395	327	846	4	*	51	78	768
287,229	81,720	49,038		24,637	957		10,332	181,551
75,120	43,733	5,904	135	2,189	210	96	1	29,198
16,588	2,717	1,364	502	172	10	57	72	13,699
				658	(39)	59	*	
(1,822)	(1,103)	(251)	228	(15)	(2)	160	(10)	(704)
(101,165)	(6,268)	(627)	100	(19,943)	(618)	31	(266)	(74,954)
(11,861)	(86)	(19)	217					(11,775)
(588)				(588)	(19)	33	(8)	
115,436	7,457	897	120	21,204	678	32	284	87,433
(52,422)	(21,047)	(29,950)	1,423					(31,375)
(6,015)	(83)	(76)	915					(5,932)
58,437	21,130	30,026	1,421					37,307
(3,201)	(852)	(538)	632	(989)	(53)	54	(9,855)	(1,360)
3,201	852	538	632	989	53	54	9,855	1,360
(2,487)	(544)	(765)	1,407					(1,943)
2,487	544	765	1,407					1,943
11,788	5,050	9,358	1,853					6,738
(1,318)	(43)	(34)	785					(1,275)
1,318	43	34	785					1,275
(2,288)	(106)	(48)	449	(21)	(2)	80	(53)	(2,182)
2,288	106	48	449	21	2	80	53	2,182
(6)				(6)	*	12	*	
(560)	(88)	(104)	1,186	(56)	(4)	71	(67)	(416)
566	88	104	1,186	62	4	65	67	416
5,715	1,174	1,149						4,541
(5,715)	(1,174)	(1,149)	979					(4,541)
5,715	1,174	1,149	979					4,541
98,689	41,360	27,614		2,434	446		1,405	57,849
27,481	5,891	4,943	839	526	102	193	663	21,064
7				7	1	96	7	
7,420	5,053	3,128	619	218	72	328	29	2,149
3,984	2,094	1,571	750					1,890
(4,737)	(4,075)	(2,804)	688	(1,683)	(271)	161	(706)	(1,933)
4,737	4,075	2,804	688	1,683	271	161	706	1,933
15,903	8,640	6,566	760					7,263
(75)	(64)	(63)	977					(11)
(5,525)	(2,762)	(1,856)	672					(2,763)
5,600	2,826	1,919	679					2,774

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
PULP, PAPER, AND ALLIED PRDTS. (cont'd)					
	663		26439	Bags, paper, n.e.c.	22
		26430		Bags, paper	22
	783		26511	Boxes, containers, papbd., pulpbd., fiberbd.	20
	785		26559	Cans, tubes, fiber and sim. prdts., n.e.c.	6
		26500		Cont. and boxes, paperbd., fiberbd., pulpboard	18
	671	26613	26613	Hardboard, incl. wallboard	32
	673		26611	Board, insulating	57
	675		26619	Bldg. paper and bldg. board, n.e.c.	57
		26610		Bldg. board and bldg. paper	57
PRINTED MATTER					
	667		27419	Printed matter, n.e.c.	39
		27000		Printed matter	39
CHEMICAL AND ALLIED PRODUCTS					
827	533	28123	28123	Sodium comp. exc. sodium alkalies	45
	509		28139	Gases, industrial, n.e.c.	67
		28130		Gases, indust. (compressed liquefied)	67
826			28186	Cyclic chem. prdt. misc.	39
250			28188	Gases, chem. warfare	39
	545		28189	Chemicals, indust. organic	39
		28100		Dyes and cyclic intermediates, pigments	39
801			28141	Coal tar and prdts. crude exc. road tar	46
802			28143	Tar acids, coal inc. rel. prdt. o pet. raw	39
805			28149	Crude prdt. from c. tar, pet. nat. gas. n.e.c.	55
		28140		Crude prdt. from c. tar, pet. nat'l gas	55
	537		28169	Pigments, inorganic, n.e.c.	44
		28160		Pigments, inorganic	44
825	529	28193	28193	Acid, sulphuric	59
	531		28194	Acids, inorganic exc. nitric and sulphuric	37
829			28199	Chem. inorganic industrial, n.e.c.	37
		28190		Chem. inorganic industrial, misc.	37
201	523P	28212	28212	Rubber, synthetic	40
210	549		28211	Plastics materials, syn. resins, etc.	22
		28210		Plas. mat. resins., syn. rub. and fib. syn.	22
220			28331	Med. and Botanical drgs. uncompd. for humans	35
810	553		28342	Pharm. preparations for human use	35
		28300		Drugs, med. chem. bot. prod. phar. prep's.	35
	769		28419	Soap and detergents except syn. deter.	41
		28410		Soap et al. deterg. exc. spec. cleaners	41
848	547		28511	Paints, varnishes, laquers, enamels	50
518			28512	Thinners, solvents, and rel. prdts.	35
		28500		Paints, varnishes, lacq., enaml. and allid. prdts.	50
851	539	28711	28711	Fertilizers	37
	541		28799	Agricul. chem. n.e.c.	36
		28700		Pesticides et al. syn. organ. ag. chem.	36

1960 oduction Tons ousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
(2, 130)	(1, 146)	(887)	774					(984)
2, 130	1, 146	887	774					984
11, 436)	(1, 260)	(634)	503					(10, 176)
(1, 983)	(576)	(338)	586					(1, 407)
13, 419	1, 836	972	529					11, 583
8, 871	6, 651	3, 192	480					2, 220
(7, 299)	(2, 387)	(1, 134)	475					(4, 912)
(1, 838)	(761)	(498)	654					(1, 077)
9, 137	3, 148	1, 632	530					5, 989
2, 031	540	689						1, 491
(2, 031)	(540)	(689)	1, 275					(1, 491)
2, 031	540	689	1, 275					1, 491
58, 773	55, 363	29, 890		11, 109	6, 664		10, 812	92, 301
19, 438	9, 512	4, 452	468	1, 196	481	402	1, 063	8, 730
(9, 834)	(3, 395)	(1, 514)	446					(6, 439)
9, 834	3, 395	1, 514	446					6, 439
(973)				(973)	(929)	955	(1, 456)	
(1)				(1)	(1)	1, 416	(1)	
(156)	(61)	(25)	403					(95)
1, 130	61	25	403	974	930	955	1, 457	95
(561)				(561)	(243)	434	(127)	
(761)				(761)	(335)	440	(154)	
(875)				(875)	(698)	798	(1, 096)	
2, 197				2, 197	1, 276	581	1, 377	
(994)	(691)	(609)	881					(303)
994	691	609	881					303
17, 932	2, 834	558	197	1, 885	138	73	19	13, 213
(7, 633)	(1, 445)	(961)	665					(6, 188)
(3, 107)				(3, 107)	(2, 361)	760	(3, 713)	
10, 740	1, 445	961	665	3, 107	2, 361	760	3, 713	6, 188
61				61	98	1, 609	119	
(3, 199)	(1, 100)	(1, 011)	919	(53)	(95)	1, 795	(22)	(2, 046)
3, 199	1, 100	1, 011	919	53	95	1, 795	22	2, 046
1				(1)	*	80	(1)	
(1, 580)	(195)	(332)	1, 701	(1)	*	77	(59)	(1, 384)
1, 580	195	332	1, 701	2	*	79	60	1, 384
(2, 786)	(1, 191)	(802)	673					(1, 595)
2, 786	1, 191	802	673					1, 595
(5, 341)	(1, 053)	(822)	781	(61)	(85)	1, 398	(144)	(4, 227)
(642)				(642)	(523)	814	(2, 191)	
5, 983	1, 053	822	781	703	608	865	2, 335	4, 227
55, 014	19, 491	10, 720	550	690	661	958	511	34, 833
(1, 047)	(172)	(144)	837					(875)
1, 047	172	144	837					875

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
CHEMICAL AND ALLIED PRODUCTS (cont'd)					
	341	28991	28991	Salt	50
860	527		28999	Chemical products n.e.c.	45
		28990		Chemical products misc.	45
PETROLEUM AND COAL PRODUCTS					
507	501	29111	29111	Gas. jet. et al. vol. pet. fuels exc. nat. gas.	44
510	503	29112	29112	Kerosene, dist. and resid. fuel oil etc.	55
519	505P	29114	29114	Lubricating and sim. oils derivatives	40
516	339	29116	29116	Asphalt, tar, pitches	44
504	307	29117	29117	Petro., coke, breeze, carbon	35
520		29119	29119	Prdts. of petro. refining, n.e.c. 1216	40
503	799		29911	Coke and coal briquettes	40
		29910		Petro. and coal prdts., misc.	
RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS					
203		30311	30311	Rubber, reclaimed	24
207	525		30619	Fabricated rubber n.e.c. prdts.	24
		30000		Rubber ftwear and misc. fab. rubber prdts.	24
205	627P		30111	Tires, pneumatic	15
		30110		Tires and inner tubes	15
LEATHER AND LEATHER PRDTS.					
	737P		31312	Boot and shoe findings	20
	739P		31611	Luggage	7
65	241		31999	Leather goods, n.e.c.	25
		31000		Leather and leather goods	22
STONE, CLAY, AND GLASS PRODUCTS					
530	693P		32119	Glass, flat, n.e.c.	71
		32110		Glass, flat	71
	697	32211	32211	Containers, caps, covers, glass	14
	695		32299	Glass prdts. exc. flat gl. and gl. cont. n.e.c.	14
		32290		Glass prdts. exc. flat gl and gl. cont.	14
523	633	32411	32411	Cement, hyd. portld., nat. mas. pozzolan	94
	635	32412	34212	Cement, ready mix and dry concrete	73
	637	32511	32511	Brick, exc. ceramic, glaze, and refrect. brk.	119
543	639	32512	32512	Brick, glazed and struct, hollow tile	70
	641P		32551	Refractories, clay	111
		32550		Refractories, clay and nonclay	111
547	649P		32599	Clay prdts., structural n.e.c.	28
		32590		Clay prdts., structural misc.	28
	689P		32611	Plumbing fixtures, vitreous and semi-vit.	17
		32600		Plumbing Fixtures, vit. china and bath fixt's	17
	701	32621	32621	Vit. China and earthenware, tble and kit. art.	20
	643P		32719	Concrete prdts. n.e.c.	110
		32710		Concrete products misc.	110
	645	32741	32741	Lime	57
548			32752	Gypsum products, exc. bldg. materials	

1960 oduction Tons ousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
11, 625	5, 244	2, 140	408					6, 381
15, 212)	(8, 979)	(5, 800)	646	(241)	(16)	68	(136)	(5, 992)
15, 212	8, 979	5, 800	646	241	16	68	136	5, 992
83, 154	48, 197	18, 112		114, 867	26, 094		193, 395	303, 552
38, 981	7, 531	1, 273	169	47, 009	13, 257	282	73, 401	91, 979
78, 274	17, 018	8, 608	506	62, 522	9, 816	157	111, 483	173, 169
10, 826	2, 981	1, 672	561	1, 663	1, 483	892	5, 183	7, 671
24, 323	4, 214	1, 870	444	2, 007	1, 070	533	1, 959	18, 102
29, 518	16, 543	4, 689	285	434	174	402	24	12, 631
1, 216				1, 216	289	238	1, 345	
(16)				(16)	(5)	287	*	
16				16	5	287	*	
2, 987	1, 484	1, 087		20	1		45	1, 438
1				1	*	59	3	
(600)	(104)	(78)	747	(7)	*	71	(15)	(489)
600	104	78	747	7	*	71	15	489
(2, 386)	(1, 380)	(1, 009)	731	(12)	(12)	66	(27)	(994)
2, 386	1, 380	1, 009	731	12	1	66	27	994
869	102	108		2	*		29	765
(453)	(60)	(70)	1, 160					(393)
(29)	(9)	(12)	1, 307					(20)
(387)	(33)	(26)	784	(2)	*	94	(29)	(352)
869	102	108	1, 051	2	*	94	29	765
40, 422	44, 291	11, 795		6, 393	1, 511		1, 543	90, 206
(2, 626)	(656)	(470)	716	(59)	(8)	142	(94)	(1, 911)
2, 626	656	470	716	59	8	142	94	1, 911
8, 834	2, 052	903	440					6, 782
(1, 176)	(372)	(304)	817					(804)
1, 176	372	304	817					804
54, 948	28, 140	4, 080	145	4, 657	1, 043	224	1, 295	27, 151
7, 017	841	660	785					6, 176
14, 449	658	278	422					13, 791
8, 251	3, 091	1, 382	447	468	77	165	106	5, 160
(6, 351)	(1, 878)	(1, 179)	628					(4, 473)
6, 351	1, 878	1, 179	628					4, 473
(9, 496)	(211)	(116)	548	(4)	(1)	158	(28)	(9, 281)
9, 496	211	116	548	4	1	158	28	9, 281
(778)	(181)	(233)	1, 288					(597)
778	181	233	1, 288					597
395	51	59	1, 165					344
(2, 897)	(236)	(119)	504					(2, 661)
2, 897	236	119	504					2, 661
2, 983	4, 302	1, 286	299					
(922)				(922)	(353)	383	(4)	8, 681

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
STONE, CLAY AND GLASS PRODUCTS (cont'd)					
		32750		Gypsum products	
526			32810	Cut stone and stone products. n.e.c.	160
		32810		Cut stone and stone products	160
	721P		32919	Abrasive Prdt., n.e.c.	37
		32910		Abrasive products	37
	683		32929	Asbestos prdts., n.e.c.	52
	651		32959	Minerals and earth, other (grnd or otw. treat)	86
	647P		32994	Stucco	59
		32900		Min. prdts., asbes., abrasives, misc. Nonmet.	65
PRIMARY METAL PRODUCTS					
601	573	33111	33111	Pig iron	224
556	793	33112	33112	Slag	66
603	583P	33121	33121	Steel, ingot and semifinished shaped 1117	225
	577		33124	Steel bars, bar shapes rods	225
608			33126	Steel pipe and tube	
	609		33128	Railway trk. mat. (rails, crties, etc. rel. mat)	180
609	575		33129	Iron and steel, primary n.e.c.	223
		33120		Iron and st. pri. (exc. coke oven by-prdts)	223
613			33131	Ferromanganese	100
614			33132	Ferrochrome	138
615	569P		33139	Electrometallurgical, n.e.c.	184
		33130		Electrometallurgical products	184
	581		33152	St. nails and spikes (exc. rail. brads, st. tks)	61
		33150		Wire, nails, and spikes, steel	61
	587	33211	33211	Cast pipe fittings, iron and steel	80
605	585	33219	33219	Castings, iron and steel	58
632	559		33311	Copper, pri. pig slab or ingots, etc.	198
		33310		Copper smelter prdts., primary	198
672	563P		33331	Zinc smel. prdt. speltzer pig, slab, etc. 90	225
		33330		Zinc, pri. and zinc base alloys smelter prod.	225
	555		33341	Aluminum, pri, pig, slab, ing, billets, etc	82
		33340		Alum., pri, smelter products	82
	567		33391	Magnes and mag. base alloys, pig, ingot, etc.	108
662			33395	Tin and tin b. alloys, pig, etc. (ex. sold. bab.)	108
	563		33399	Base alloys non-feer, slag, pig n.e.c.	314
		33390		Base alloys n.f. anodes, cathodes, pig, misc.	310
622	561		33519	Cop. br. bronz. et al cop. b. alloy n.e.c.	130
		33510		Cop. br. bronz. et al cop. b. all (basic shap)	130
618	557		33529	Alum and al. b. alloy basic shapes n.e.c.	57
		33520		Al. and al. b. alloy basic shap. exc. al. foil	57
642			33562	Lead and ld. base all. ba. shapes (exc. sold. bab)	160
652			33563	Nickel and nickel base alloy, basic shapes 3	160
682	571		33569	Nonferrous (metal basic shapes) n.e.c.	180
		33560		Shapes, basic, n.f. metal, plates bars, etc.	180

1960 duction Tons usands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
922				922	353	383	4	
(283)				(283)	(29)	102	(16)	
283				283	29	102	16	
(369)	(108)	(81)	746					(261)
369	108	81	746					261
(169)	(9)	(17)	1,872					(160)
(812)	(141)	(51)	361					(671)
2,666)	(1,364)	(577)	423					(1,302)
3,647	1,514	645	426					2,133
8,448	37,603	16,237		9,993	6,551		7,108	59,618
5,943	3,357	890	265	932	426	457	42	2,305
8,798	6,086	797	131	1,190	156	131	*	22,712
1,117				1,117	207	185	70	
0,069)	(4,902)	(1,214)	247					(15,167)
1,798)				(1,798)	(1,519)	845	(1,249)	
1,383)	(696)	(363)	522					(687)
7,647)	(6,438)	(966)	150	(3,667)	(3,330)	908	(5,024)	(4,326)
0,897	12,036	2,543	211	5,465	4,849	887	6,273	20,180
(186)				(186)	(219)	1,178	*	
(171)				(171)	(221)	1,293		
2,219)	(1,241)	(735)	592	(116)	(92)	797	(1)	(862)
2,576	1,241	735	592	473	532	1,126	1	862
4,403)	(1,467)	(898)	612					(2,936)
4,403	1,467	898	612					2,936
9,365	5,955	3,805	639					3,410
2,144	746	560	751	141	59	417	14	1,398
1,882)	(1,529)	(1,639)	1,072	(1)	(1)	666	(24)	(352)
1,882	1,529	1,639	1,072	1	1	666	24	352
(90)				(90)	(134)	1,488	(43)	
90				90	134	1,488	43	
2,380)	(1,270)	(1,245)	980					(1,110)
2,380	1,270	1,245	1,443					1,110
(50)	(23)	(33)	1,443					(27)
(6)				(6)	(7)	1,140	(14)	
2,249)	(1,417)	(1,134)	800					(832)
2,305	1,440	1,167	810	6	7	1,140	14	859
2,975)	(975)	(1,203)	1,234	(179)	(17)	94	(1)	(1,821)
2,975	975	1,203	1,234	179	17	94	1	1,821
1,937)	(527)	(604)	1,146	(28)	(37)	1,332	(20)	(1,382)
1,937	527	604	1,146	28	37	1,332	20	1,382
(34)				(34)	(22)	637	(82)	
(3)				(3)	(1)	382	(6)	
1,281)	(974)	(151)	155	(16)	(7)	454	(37)	(291)
1,318	974	151	155	53	30	567	125	291

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
PRIMARY METAL PRODUCTS (cont'd)					
624		33621	33621	Castings, vr, bronz. cop. and cop. base, all. 144	180
612			33999	Metal prdts. primary n.e.c.	180
		33990		Metal prdts. primary	180
FABRICATED METAL PRDTS, EXCEPT ORDNANCE, MACH. & TRANSPORTATION EQUIP.					
	779	34111	34111	Cans, metal	9
	705		34211	Cutlery, tb. and kit. and rel. cut. app. exc. elec.	12
606	691P		34299	Hardware, n.e.c.	67
		34200		Metal prdts. fab. exc. ordn. mach. and trans.	60
	687		34321	Plumb. fixt. fittings, and trim (brass gds)	26
		34300		Plumb. fixt., and heat. appar. exc. electric	26
607	705P		34612	Utensils spun and stmpd, cooking, it. ect.	26
		34000		Met. stampings and wire prdts. fab. misc.	26
	589P		34435	Tanks, metal exc. pressure tanks	14
		34430		Plate prdts. fabricated (boiler shop prdts.)	14
	583		34999	Metal prdts., fabricated n.e.c.	189
		34900		Metal prdts., fabricated	189
MACHINE, EXCEPT ELECTRICAL					
710	595P		35112	Turbines, st. gas, hydr. and gen. set unit and pts.	
		35100		Stm. eng. turbines, turbine generator sets	
770	591P		35229	Farm machines, n.e.c.	24
		35220		Farm mach. and equip.	24
722	595P		35319	Construct. mach., equip, n.e.c.	34
		35310		Construct. machinery equipment	34
730	595P		35419	Mach. tools, metal cutting type, n.e.c.	51
		35400		Metalworking mach. and equipment	51
740	595P		35521	Machinery, textile	34
		35500		Ind. machinery, special exc. metal wkng. mch	34
742	595P		35699	Machinery and equip., gen'l n.e.c.	34
		35600		Machinery and equip. gen'l indust.	34
	601		35799	Machines, office, n.e.c.	20
		35700		Mach., office, computing, and accounting	20
	595P		35999	Machine and parts exc. electric n.e.c.	38
		35990		Machinery and parts exc. electric misc.	38
ELECTRICAL MACHINERY EQUIPMENT AND SUPPLIES					
	685P		36299	Electrical apparatus, industrial n.e.c.	38
		36000		Elect. Trans. equip. and indus. apparatus	38
	711	36311	36311	Ranges, oven, surface ch. eq. and pts. household	12
	707	36321	36321	Refrig. household and home, and freezers, farm	12
	709P		36331	Wash. mach., dryers, combinations, household	15
		36330		Household laundry equip.	15
700	685P		36999	Electr. machy. equip. and supplies n.e.c.	38
		36900		Elect. mach. equip. and supplies misc.	38
TRANSPORTATION EQUIPMENT					
	621P		37115	Passenger cars, knocked down or chassis	31

1960 roduction Tons housands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
144				144	12	82	52	
(174)				(174)	(84)	483	(429)	
174				174	84	483	429	
102, 167	31, 283	13, 353		12	3		96	70, 872
5, 805	1, 631	587	360					4, 174
(230)	(48)	(68)	1, 407					(182)
(1, 601)	(60)	(59)	979	(6)	(2)	410	(91)	(1, 535)
1, 831	180	127	1, 169	6	2	410	91	1, 717
(1, 302)	(297)	(310)	1, 044					(1, 005)
1, 302	297	310	1, 044					1, 005
(6)				(6)	(1)	107	(5)	
6				6	1	107	5	
(6, 137)	(216)	(165)	764					(5, 921)
6, 137	216	165	764					5, 921
(87, 086)	(29, 031)	(12, 164)	419					(58, 055)
87, 086	29, 031	12, 164	419					58, 055
13, 918	3, 565	2, 988		331	43		245	10, 316
(3)				(3)	*	84	(13)	
3				3	*	84	(13)	
(1, 910)	(651)	(481)	739	(27)	(3)	103	(13)	(1, 232)
1, 910	651	481	739	27	3	103	13	1, 232
(155)				(155)	(17)	108	(95)	
155				155	17	108	95	
(1, 046)	(26)	(36)	1, 403	(1)	*	105	(1)	(1, 019)
1, 046	26	36	1, 403	1	*	105	1	1, 019
(2)							(2)	
2							2	
(145)				(145)	(23)	160	(121)	
145				145	23	160	121	
(296)	(5)	(3)	691					(291)
296	5	3	691					291
(10, 361)	(2, 883)	(2, 468)	856					(7, 774)
10, 361	2, 883	2, 468	856					7, 774
11, 481	2, 730	2, 503		65	8		386	8, 686
(7, 342)	(1, 023)	(983)	961					(6, 319)
7, 342	1, 023	983	961					6, 319
414	261	247	948					153
2, 542	876	807	921					1, 666
(1, 118)	(570)	(466)	818					(548)
1, 118	570	466	818					548
(65)				(65)	(8)	128	(386)	
65				65	8	128	386	
45, 960	14, 860	9, 992		907	133		374	30, 193
(4, 173)	(203)	(44)	219					(3, 970)

Commodity Codes				Commodity Classification	Shpg Density (lb)
Corps Eng'r	Old ICC	New ICC	Bureau of Budget		
TRANSPORTATION EQUIPMENT (cont'd)					
	615		37116	Trucks, tr. trac. mtr. coaches FD kn chassis	5
780	617		37119	Vehicles, motor n.e.c.	19
		37110		Vehicles, motor	16
	613	37121	37121	Bodies and body parts, passenger cars	6
	611		37131	Bodies and body parts, truck	9
		37130		Bodies and body parts, truck and bus	9
782	723		37141	Mot. veh. parts, ex. gear fr. and int. comb. eng.	41
		37140		Parts and accessories, motor vehicles	41
790	625P		37299	Parts and aux. equip. aircraft n.e.c.	5
		37200		Aircraft and parts	5
783	799P		37329	Ships, boats, and parts, n.e.c.	
		37320		Ships and boats	
786	603P		37411	Locomotives and tenders	60
		37410		Locomotives and parts	60
	605		37423	Streetcars and self propelled cars railway	60
		37420		Railroad and streetcars	60
	607P	37428	37428	Railroad and stcars, parts and accessories for	165
796			37999	Transportation equip. n.e.c.	
		37900		Transport. equip. misc.	
MISCELLANEOUS PRODUCTS OF MANUFACTURING					
900	799		39999	Mfg. prdts., misc. n.e.c.	27
		39000		Mfg. products misc.	27
	743		39411	Games and toys, exc. dolls and child vehicles	7
		39400		Games, toys, dolls, chile. veh. exc. bicycles	7
	741		39499	Sporting and athletic gds. n.e.c.	25
		39490		Sporting and athletic goods	25
	771	39831	39831	Matches	17
WASTE AND SCRAP MATERIALS					
602	789	40111	40111	Scrap, iron and steel	148
	795		40129	Scrap, nonferr. met. exc. prec. met. n.e.c.	145
		40120		Scrap, nonferrous metal exc. precious metal	145
	655	40211	40211	Waste paper	14
930	797		40299	Scrap and wastes, n.e.c.	41
		40200		Waste and scrap materials miscellaneous	41
511	337	13111	13111	Petroleum crude	55
507	501	29111	29111	Gas, jet, et al. vol. pet. fuels ex. nat. gas	41
510	503	29112	29112	Kerosene, dist. and resid. fuel oil, etc.	55
900	799		39999	Misc. Products of Manufacturing	27

1960 Production Tons (thousands)	Railroad			Inland Waterways			Domestic Coastlines (ton-mi, millions)	Highways (Tons, thousands)
	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)	Tons (thousands)	Ton-Miles (millions)	Avg. Haul (mi)		
(5,612)	(127)	(120)	944					(5,485)
(1,158)	(485)	(477)	984	(585)	(107)	183	(308)	(88)
10,943	815	641	787	585	107	183	308	9,543
12,300	1,384	1,403	1,014					10,916
(1,113)	(155)	(104)	674					(958)
1,113	155	104	674					958
(17,894)	(10,393)	(7,005)	674	(212)	(17)	78	(17)	(7,289)
17,894	10,393	7,005	674	212	17	78	17	7,289
(505)	(30)	(41)	1,370	(1)	*	91	(1)	(474)
505	30	41	1,370	1	*	91	1	474
(70)				(70)	(5)	71	(27)	
70				70	5	71	27	
(1,025)	(1,024)	(287)	280	(1)	*	75	(1)	
1,025	1,024	287	280	1	*	75	1	
(46)	(30)	(8)	277					(16)
46	30	8	277					16
2,026	1,029	503	489					997
(38)				(38)	(4)	94	(20)	
38				38	4	94	20	
67,054	10,283	6,552		6,349	248		2,400	49,628
(66,317)	(10,132)	6,353	627	(6,349)	(248)	39	(2,400)	(49,042)
66,317	10,132	6,353	627	6,349	248	39	2,400	49,042
(376)	(87)	(120)	1,375					(289)
376	87	120	1,375					289
(141)	(24)	(36)	1,489					(117)
141	24	36	1,489					117
220	40	43	1,072					180
109,723	31,063	6,019		11,390	1,012		85	67,270
75,562	21,337	2,587	121	1,576	708	449	78	52,609
(3,536)	(2,332)	(1,206)	517					(1,204)
3,536	2,332	1,206	517					1,204
10,003	3,289	1,263	384					6,714
(20,622)	(4,065)	(963)	237	(9,814)	(304)	31	(7)	(6,743)
20,622	4,065	963	237	9,814	304	31	7	6,743
500,777	1,888	855	453	34,963	8,601	246	59,817	(27,996)
238,981	7,531	1,273	169	47,009	13,257	282	73,401	(91,979)
278,274	17,018	8,608	506	62,522	9,816	157	111,483	173,169[a]
66,317	10,132	6,353	627	6,349	248	39	2,400	49,042
							PIPE LINE	AIRWAYS
							Tons (1,000)	Tons (1,000)
							334,105	0
							92,462	0
							25,565	0
							0	794

Statistics on Waterborne Commerce Compiled by the Corps of Engineers, U. S. Army

W. A. C. CONNELLY
Chief, Statistical and Service Division, Board of Engineers for Rivers and Harbors

Information on the use of waterways and harbors by vessels, freight, and passengers has been collected and compiled by the Engineers for over 100 years. Compilation of data was begun on each waterway or harbor at the time navigation improvements were undertaken. Summarizations of the data on a national basis were started in 1920. Currently, vessel operators report all domestic freight and passenger vessel movements and tons of cargo and number of passengers carried between origins and destinations in the several traffics: coast, lake, internal, intraport, and local. Since 1920, ton-miles have been computed for all improved waterways and summarized for geographic areas and for the nation.

For 1961, ton-miles were also compiled on the basis of the regulatory status of the carriers under the terms of the Interstate Commerce Act: regulated and unregulated. Beginning with data for 1962, ton-miles will be compiled on the basis of the regulatory status of the carriage, i.e., regulated by the Interstate Commerce Commission; unregulated, for hire; and private.

•THE PURPOSE of this article is to describe and discuss statistical data on waterborne traffic collected, compiled, and published by the U. S. Army Corps of Engineers as a part of the Federal program for statistics on shipping.

Information on the use of the waterways by vessels, freight, and passengers is required by the Corps in connection with its responsibilities for the improvement, operation, and maintenance of the navigable waterways and harbors of the nation. The first River and Harbor Act of Congress assigning this type of work to the Corps was approved in 1824. Prior to 1920, each District Engineer in charge of the work collected whatever information he considered necessary to enable him to recommend improvements required by the developing waterborne traffic. Commodities were counted in customary units: tons, barrels, bushels, heads, and feet.

For calendar year 1920, the Chief of Engineers instituted a "new, uniform method" for collecting and compiling the data on the vessels, passengers, and freight using the improved waterways. The method encompassed domestic and foreign traffic and included standard forms for collection of the data, vessel and commodity nomenclature and classification, definitions for the types of traffic, and specified that quantities of freight be stated in tons of 2,000 pounds. It also provided for the compilation of ton-miles for each waterway. Collection and compilation of the data continued as a function of the District Engineers. This method remained in effect through calendar year 1946, after which the Federal program was put into operation.

In brief, the Federal Program for Statistics on Shipping was instituted in 1947 by the Office of Statistical Standards, Bureau of the Budget, under the terms of the Federal Reports Act of 1942. The purposes of the program are to reduce to the minimum

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 43rd Annual Meeting.

the reporting burden on the public, to eliminate duplication of effort in the government, to standardize terms and methodology, to improve the timeliness of the data, and to be responsive to the needs of the increasing number and variety of users. The Bureau of the Budget assigned the work to the several agencies on the basis of prime responsibilities of the agencies. Data on domestic waterborne traffic were assigned to the U. S. Army, Corps of Engineers; on foreign trade to the Bureau of the Census, Department of Commerce; on deep-draft shipping, domestic and foreign, to the Maritime Administration, Department of Commerce; and on passengers in the foreign trades, to the Immigration and Naturalization Service, Department of Justice. Data on domestic carriage subject to economic regulation by the Interstate Commerce Commission are collected by the Commission.

Subject to the terms of the Federal Reports Act, the compiling agency furnishes data to other Federal government agencies. The Army Engineers regularly supply data on domestic coastwise and lakewise traffic to Maritime Administration, and, on specific requests, on regulated carriers to the Interstate Commerce Commission. The Corps obtains data on foreign traffic from the Bureau of the Census and on passengers to and from foreign ports from Immigration and Naturalization Service.

For collection of data on domestic traffic, the Corps of Engineers uses one basic form. The vessel operator reports volume and description of commodities carried, ports and docks of origin and destination, name and draft of the vessel, dates of departure and arrival, and type of service in which the freight was moved: regulated by the ICC; unregulated, for hire; or private. Codes for vessel operators identify those operators who hold either certificates or permits to engage in common or contract carriage. The operator makes one report to one designated District Engineer's office, regardless of the area of operation.

The data are transferred to punch cards, with one punch card carrying generally one line of the vessel report, representing a commodity moved between two ports during one trip, one month, one quarter, or one year, depending on the period mutually agreed upon by the collecting office of the Corps of Engineers and the operator. Date of arrival of the commodity determines the year for which the data are reported. Data prior to 1961 are on a calendar year basis; beginning with data for 1961, a cut-off date of 28 February 1962 was established for the processing of reports of terminations in 1961. Reports received after that date were carried into the following year. This cut-off date will continue to be used as a means for expediting availability of published data. Foreign traffic data are obtained from the Bureau of the Census, Department of Commerce.

Enumerations are based on two items of the operator's report: commodities and vessels. Commodities are enumerated in tons (2,000 lb) and in ton-miles (statute mile); vessels are counted in trips and net register tons.

Commodities are classified in accordance with the Commodity Classification for Shipping Statistics, approved by the Bureau of the Budget. For ports and harbors, tonnages of commodities are summarized by types of traffic, foreign and domestic. Foreign traffic is divided into imports and exports, each of which is further divided in the Great Lakes Area into traffic with Canadian Ports and with overseas ports. Domestic traffic is separated into receipts and shipments for the following types: coastwise, lakewise, internal, intraport, local, and intraterritory.

For waterways, tons of commodities are summarized by traffics for the foreign and coastwise trades by inbound and outbound movements. For the inland traffic movements, the commodity tons are arrayed to portray the movement and direction in detail for each waterway or stretch of waterway: upbound; inbound, upbound; outbound, upbound; and through, upbound; and the reverse of these. These terms reveal the character of the waterway's traffic, whether it is principally a receiving waterway, or shipping, or both, or a "through" waterway for the kinds and tons of commodities carried.

Numbers of vessel trips are tabulated in feet of draft—the stub, and by direction and by type of vessel—the headings. Totals for net register tons are given for each of the types of vessels using the harbor and waterway.

A commodity table and vessel trip-and-draft table are prepared for each harbor

and waterway which has been improved by the Federal Government. For the long waterways, tables are prepared for segments, which are determined by the Congressional authorizations or by the characteristics of the traffic.

Harbors and segments of harbors are treated in the same manner as waterways. Large harbors may have many channels, each of which is a separate project, and on which a separate report or table is prepared. The terms "port" and "harbor" as used here are not synonymous: the harbor is the water area of a port; the latter also contains all the landward area, wharves, sheds, warehouses, roadways, railways and yards, and cargo handling facilities. Thus a port such as New York contains many harbors; and a harbor such as San Francisco Bay contains several ports.

In accordance with practice of long standing, the Corps of Engineers compiles and publishes in the public interest data on port and area complexes when requested by the port authorities. Such requests are made, of course, by those authorities whose port areas are not coterminous with project harbor limits. District Engineers also disseminate information of area interest, such as data on a single waterway and on vessels passing locks. Other data compiled and published in the public interest are areas of origin and destination of principal commodities (by tonnage), water carrier ton-miles, and water carriage ton-miles.

The compiled data are published annually in a five-part series of seven volumes titled Waterborne Commerce of the United States.

From punched cards furnished by the Corps of Engineers, the Maritime Administration periodically publishes annual data on the areas of origin and destination of commodities moving in deep-draft shipping. Only tonnages of those commodities moving in self-propelled vessels of 1,000 gross tons and more are included. Tonnages of commodities are presented separately for dry cargo ships and for tankers. The title of this report is Domestic Oceanborne and Great Lakes Commerce of the United States.

The total annual waterborne tonnage of the United States has exceeded one billion tons for the past eight years. The 1962 total of 1,129 million tons is almost double the 1939 total of 569 million tons. However, it is believed that the waterways' share of the total tons carried by all modes declined during the same period from 26 percent to 21 percent. The highways' share in 1961 is almost four and one-half times that of 1939. The Bureau of Public Roads' planned program for collection of data on tons and ton-miles of carriage by highways will remove the present uncertainty regarding highways' contribution to the nation's transportation volume. It is certain that the contribution is large; the question is "how large?"

Considering the diversity of water transportation, it is difficult to think of it as a single mode. When hovercraft and hydrofoils begin to operate on the waterways, they will further increase the diversity. A small tugboat towing logs or a small fishboat bringing in her catch and a modern freighter in the foreign trades are apparently a world apart, but they are in competition. The freighter brings in frozen fish, logs, lumber, and articles made of wood. The ships in the coastwise (deep-sea domestic) trade compete with the barges on the intracoastal waterway. The ships in the Great Lakes overseas trades are competing for grain cargoes with the barges on the Mississippi River. Competition is not restricted to that among the various water traffics; it also exists within each type of traffic, as coastwise ships compete with coastwise ships, barges with barges.

The Corps of Engineers also collects data on the number, horsepower, and capacity of the vessels engaged in transportation in the three main areas of the country: the seacoasts, the Mississippi River System and the Gulf Intracoastal Waterway, and the Great Lakes. Although the data for some years back are comparable figure for figure, they are not comparing comparable vessels. The same is true for the vehicles of all modes: to say that there are so many trucks today as against so many trucks in 1939 is, in fact, misleading. The trend in trucks, rail cars, and vessels is toward more and more specialization. The vehicle is tailored to the freight, and has a capability over and above any gains in size and speed of movement. Vessels are increasing in size and horsepower; full forms, rudders, propellers, shipboard machinery and controls, and navigation equipment are also vastly increasing the capacities of the various trades.

The improved inland waterway mileage is about 23,000. This amount includes the connecting channels of the Great Lakes and the deep channels in major rivers flowing into the sea. It does not include the open waters of the Great Lakes, of bays and sounds, and, of course, the ocean tracks of the coastwise trades. Inland channels for deep-draft shipping range from about 27 ft to about 45 ft in depth. Those for shallow draft are mainly 9 to 12 ft deep.

Probably every transportable commodity moves by water, with the greatest variety in the foreign trade and also in the coastwise trade in truck vans and in rail cars moving by ship. However, about 90 percent of the waterborne tonnage consists of commodities moving in bulk and in very large lots. In 1961, tonnages of 10 commodity groups made up 88.3 percent of the total waterborne traffic:

Petroleum and products	41.8%
Coal and coke	15.4
Iron ore and iron and steel	10.8
Sand, gravel, and stone	8.3
Grains	4.2
Logs and lumber	3.1
Chemicals	2.8
Seashells	1.9
Total	88.3%

The principal recent innovation in the Corps of Engineers' statistics on waterborne commerce is the compilation of ton-miles based on the vessel's itinerary. Since the legal conditions of carriage by water are comparable to those by road, and since the Bureau of Public Roads is launching a program for compilation of ton-miles by road, a description of the Engineers' ton-mile data may be of interest. Both modes have carriage (a) subject to economic regulation by the Interstate Commerce Commission, (b) for-hire carriage not regulated by the Commission, and (c) private carriage.

Ton-miles of freight carried on improved waterways of the United States have been compiled annually by the Corps of Engineers since about 1910. From that date until 1920, the compilations were made on an individual waterway basis for about half the waterways improved by the Corps at the direction of the Congress. Beginning with the data for 1920, ton-miles were compiled for virtually all the improved waterways for each year through 1924. The Introduction to the Annual Report of the Chief of Engineers, U. S. Army, Part 2 for 1925, has the statement: "A table has been incorporated in this report showing for the first time the total ton-miles of freight carried on the inland waterways of the United States." This total, however, included data for improved waterways only. Data for waterways used in their natural state have been added progressively in 1951, 1953, and 1954, and completed in 1959 with inclusion of Alaskan waters.

Further identification of ton-miles on a national basis was not made for the years prior to 1961. However, ton-miles by types of traffic--foreign, coastwise, lakewise, internal, intraport, and local--have been compiled for a number of years for the Great Lakes and the Mississippi River and these two systems. As mentioned above, the only basis for collection and compilation of ton-miles for the years through 1960 was the waterway, or right-of-way. The compilation of the ton-mile data on the basis of the vessel was begun in 1961 in response to a request of the Office of Statistical Standards, Bureau of the Budget. Since this larger total includes carriage on the open sea, these compilations produce a total more than double that based on the inland waterway.

For 1961, the ton-mile data on domestic carriage were distributed by type of traffic; regulatory status of the carrier: (a) carriers subject to economic regulation by the Interstate Commerce Commission, and (b) carriers not so regulated; and by commodity in terms of the Commodity Classification for Shipping Statistics. Ton-miles of carriage in foreign traffic were included only for that part of the carriage on inland waters and without commodity detail.

For 1962, ton-miles were compiled to reflect the regulatory status of the carriage, rather than of the carrier. Ton-miles by commodity and traffic are grouped into three categories of carriage: (a) regulated by the Commission, (b) unregulated, for hire, and (c) private. It is planned to continue annual compilations on the basis of carriage.

Thus, ton-miles by water are now compiled on two separate bases primarily to serve different purposes: (a) the inland waterway, to obtain--with data on numbers and types of vessels and tons of commodities and ton-miles--information on the use of harbors and waterways by traffic and (b) the vessel, to obtain broader economic information related to transportation, trade, and Federal regulation of carriage.

Since ton-miles by type of carrier are on a different basis from that by type of carriage, two views of the regulatory status of commodity ton-miles are provided. Those by carrier give the amount of participation by regulated and by unregulated carriers in the total traffic. The ton-miles by carriage give a somewhat closer view of the legal status of the carriage: regulated, unregulated for-hire, and private. Although technically correct, neither view gives the exact picture, since common and contract carriers may perform carriage not subject to economic regulation by the Intestate Commerce Commission. Consequently, the volume of regulated carrier ton-miles (1961 data) is larger than that of the regulated carriage (1962 data).

Ton-miles for foreign traffic are computed using the mileages for length of haul on inland waters only; no breakdown by commodity is made.

Tables 1 and 2 of Water Carrier Ton-Miles, Supplement 2 to Part 5, National Summaries of Waterborne Commerce of the United States, indicate the magnitude of the domestic water carrier industry's production and some of the intra- and inter-modal aspects of competition in both the domestic and the foreign trades. The total of 37.1 billion is many billions of ton-miles under the actual ton-miles of carriage produced by the carriers in the foreign trades. Thus a sector of the industry remains unmeasured. This "gap" also exists for air, rail, and highway carriers moving freight between the United States and foreign countries. Viewed from the broader (than transportation alone) standpoint of production and distribution, ton-miles of foreign carriage (and goods) are competing with domestic ton-miles (and goods). For example, barbed wire (and its ton-miles of carriage) from Belgium to the United States is competing with domestic barbed wire (and its ton-miles of carriage) moving by rail, highway, and water; and a recently exploited deposit of sulphur in Canada will affect the ton-miles of long-haul domestic sulphur.

Viewed from the narrower standpoint of intra- and inter-modal competion for the same tons of goods, the foreign-trade ship is competing with domestic carriers for every mile of the ship's haul in inland waters; the farther the haul, the greater the competion with the domestic carriers. The Saint Lawrence Seaway is an example of this type of competition.

The addition of the coastwise ton-mile data to those for inland filled the last remaining gap in ton-mile information on domestic waterborne traffic. The coastwise traffic, amounting in 1961 to 312 billion ton-miles, contributed more than 60 percent of the 1961 total of waterborne ton-miles, and carried about 20 percent of the total tons moved by water.

The coastwise ton-mile data, as in the case of the foreign traffic tonnage data, reflect some of the aspects of intra- and inter-modal competition. These ton-miles compete with the inland waterway ton-miles as well as those by pipeline, highway, and rail. The commodity details provide some insight into the prevailing distribution patterns and the competition of geographic areas of origin in the markets of the receiving areas.

Transportation, however, is but one part of the marketing complex, and cannot sensibly be viewed in terms of transportation only. Commodities appear in the several modes, disappear, perhaps reappear, or are replaced by entirely different commodities serving the same customer needs, for reasons not related to transportation services, yet with great effect on those services. For example, electricity and gas are directly competitive with other energy sources and their transportation, and as yet there are no published data in ton-mile equivalents for these commodities. This example illustrates the need to analyze the commodity markets in depth to obtain even a glimmer of

the forces affecting the current trends and future prospects of the various forms of transportation.

New Trucking Data from 1963 Census of Transportation

DONALD E. CHURCH
Chief, Transportation Division, Bureau of the Census

New data on trucks and trucking are being collected by three of the four major surveys in the 1963 Census of Transportation. The Truck Inventory and Use Survey will be the source of data showing the number of trucks and combinations classified by physical characteristics, occupational use, rough measures of the intensity of vehicle utilization, geographic distribution of vehicles, and related facts. The Bus and Truck Carrier Survey will produce data on for-hire carriers that are not subject to Interstate Commerce Commission economic regulation. Census information may be added to corresponding data collected from federally regulated carriers to estimate the national universe for all for-hire carriers. The Commodity Transportation Survey is designed primarily to measure the physical and geographic distribution of commodities shipped by manufacturing establishments. Because the basic data on shipments will be classified by means of transport, this survey will be a source of new data on the truck share of traffic originated by industrial plants.

Data will be published on a flow basis as significant segments of each survey are completed. The first reports will contain data for selected state or regions from the Truck Survey and probably truck traffic flow data from the Commodity Transportation Survey will be published last.

This report is concerned largely with the general tabulation plans and nature of data. However, the discussion is supplemented by copies of questionnaires, punch-card layouts, and related technical materials.

•THREE ASPECTS of the nation's trucking activities are being surveyed by the 1963 Census:

1. The Truck Inventory and Use Survey measures physical equipment.
2. The Commodity Transportation Survey is primarily concerned with the total volume and characteristics of shipments originated by the industrial sector and with the role played by each major type of carrier. For-hire motor carriers and private trucking are treated as two separate types of transportation. Additional categories include rail, air, water, and "other."
3. The Truck Carrier Survey collects information concerning business enterprises primarily engaged in rendering for-hire trucking services.

Whereas these three surveys are related in the sense that all deal with selected aspects of trucks and trucking activity, they differ strikingly in other respects such as sources of information, survey methods, timing, and kinds of data. Therefore, they will be discussed on the basis of methodology rather than subject matter.

TRUCK INVENTORY AND USE SURVEY

Data on the inventory and use of trucks are being collected by mail from owners of a sample of about 100,000 trucks and truck tractors. This probability sample, classified by vehicle size and state, was drawn from motor vehicle license records from

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 43rd Annual Meeting.

every state. In general, it consists of roughly 4,500 power units in large states, 3,000 in the intermediate states, and 1,500 in small states. This allocation was made to obtain a sufficient number of observations to support summary data on major aspects for each of the small states and to provide greater detail for larger states, regions of the country, and the nation as a whole (1). The sample also is classified by vehicle size, as indicated by the weight or size information on the registration record. In most states, two size classes are used, heavy and light, with roughly two-thirds of the observations drawn from the heavy vehicle category and one-third from the light. This allocation is made largely to meet the need for more detailed information on heavy vehicles.

The survey will provide a wide range of facts concerning the nation's trucking resources, as outlined in Appendix A. The data tend to fall into five subject-matter classes:

1. Physical characteristics of vehicles, such as body type, body size or capacity, and number of axles;
2. Major occupational use, such as for farming, lease or rental, for-hire trucking service, and use in connection with own business;
3. Rough indicators of intensity of vehicle utilization, such as annual mileage, lifetime miles, whether usually operated loaded in both directions or normally returned empty, and number of driver man-hours usually spent per week;
4. Geographic area of operation, such as mostly local, mostly over-the-road but within a 200-mile radius of home base, or mostly for longer hauls; and
5. Size and composition of fleets defined in terms of the number of vehicles operated out of a home base.

The data collection phase is nearing completion. The coding, editing and punching are in full operation. The computer programs are being tested with the expectation that preliminary reports will be prepared on a flow basis starting in the second quarter of 1964. These will be issued principally on a state or regional basis and will be followed by a national report.

COMMODITY TRANSPORTATION SURVEY

The main purpose of the 1963 Commodity Transportation Survey is to obtain traffic flow data showing the total volume of commodities shipped by the industrial sector of the national economy, classified by transport, length of haul, origin-destination areas, commodity description, and size of shipment.

Manufacturing establishments (in the Census of Manufactures) have been divided into 25 major classes corresponding to the major segments of the Federal Reserve Board index of industrial production. Each of these groups is further divided into two to five subgroups, called shipper groups, which are the smallest units for presenting traffic flow data on an industry or shipper basis. There are 87 such shipper groups.

The basic information for this survey will be obtained from a probability sample of manufacturing establishments by sampling bills of lading (or other shipper papers) normally kept by traffic departments (see Appendix B).

Shipments will be coded in terms of commodities using the new five-digit Commodity Classification for Transportation Statistics Code prepared by the Office of Statistical Standards of the Bureau of the Budget. This code is identical to the first five digits of the new Standard Transportation Commodity Code adopted by the Association of American Railroads and is compatible with the other codes now in use (or to be adopted shortly) by the Interstate Commerce Commission (ICC) and the Industry and Foreign Trade Divisions of the Bureau of the Census.

From the standpoint of trucking, the principal new data to be produced by this survey will be the relative share of total tonnage moved by for-hire motor carriers and private trucks as compared with the shares handled by rail, air, water and "other" types of transport. The principal tables will show distributions of traffic originated by each shipper group, classified by length of haul and means of transport, and by origin and destination areas. A similar set of tables will be prepared on a commodity basis.

The extent of geographic and commodity detail will be limited largely by sampling variability and the legal requirement to avoid disclosure of activities of individual shippers. The degree of detail doubtless will vary among shipper and commodity groups, depending on the distributions found in the preliminary tabulations of the actual survey results.

The collection of data for this report has just been started and will continue at least through October 1964. Although it is hoped that preliminary reports for some shipper groups can be completed before the end of the year, the main flow of shipper-group reports is scheduled for 1965 and will be followed by commodity tabulations.

TRUCK CARRIER SURVEY

Statistics on the business of trucking will be obtained through the Truck Carrier Survey (see Appendix C). The primary purpose of this phase is to obtain national aggregate measures of the total for-hire trucking industry. ICC collects annual data from carriers subject to its economic regulation. The Bureau of the Census' survey will collect corresponding statistics on key factors from carriers that are not subject to the Commission's reporting requirements.

The survey will be based on a probability sample of for-hire carriers drawn from businesses classified as being primarily engaged in trucking service under the Social Security program. Among the major items of information are the principal type of operation (common or contract carriage), principal type of service (local or intercity), form of ownership, type of carrier (general freight, household goods, carrier of exempt products, other), operating revenues, expenses, number of employees, number of vehicles owned or leased, and the following selected facts on intercity operations: freight revenue, truck and tractor miles operated, and tons of revenue freight carried. From the standpoint of geographic distributions, the form contains the location of the carrier's home office but no details on the geographic nature of its service area.

CONCLUSIONS

The Census program has been designed to collect information about selected aspects of trucking, and transportation in broader terms, for which available data are either wholly missing or are inadequate. The tabulation program is designed to produce tables of major general public interest within the limits of funds available for this project. We have not, by any means, exhausted the potential values that can be derived from the raw materials but will retain the schedules and computer tapes for later use in connection with research projects or for special tabulations under the Bureau's program for rendering special services.

REFERENCE

1. New Data on Trucks and Trucking in the 1963 Census of Transportation. U. S. Bureau of the Census, Transportation Div., Washington, D. C., April 1963.

Appendix A

SELECTED TECHNICAL ASPECTS OF TABULATION PROGRAM FOR TRUCK INVENTORY AND USE SURVEY

Raw Data

The basic information is being obtained from replies to Form TC-200 (Fig. 1) mailed to owners of a probability sample of trucks and truck tractors. Two punch cards are being prepared. One contains the details for the specified vehicle (Items 1 through 19), and the other contains fleet data (Item 20). Computer tapes are being

Budget Bureau No. 41-6262.1; Approval Expires June 30, 1964

CONFIDENTIAL - Response to this inquiry is required by Act of Congress (13 U.S.C.). The report you submit to the Census Bureau is confidential and may be seen only by sworn Census employees. It may not be used for purposes of taxation, investigation, or regulation. Copies retained in your files are also immune from legal process.

FORM TC-200-2 (1-24-63) — U.S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS

Return to Washington, D. C. not later than
TWENTY DAYS AFTER RECEIPT

(Please correct if name or address has changed)

1963 CENSUS OF TRANSPORTATION
TRUCK INVENTORY AND USE SURVEY

In correspondence pertaining to this report, please include State and License number.

GENERAL INSTRUCTIONS

COMPLETE ALL SECTIONS of this report if the license plates were on or assigned to a vehicle on July 1, 1963.

VEHICLE IDENTIFICATION and the information in the address box were obtained from the State Motor Vehicle Registration records. Please correct any errors in the vehicle identification or changes in name or address. If on July 1, 1963, the license plates were on a vehicle other than the one described, give the correct vehicle description.

If the license plates were not on or assigned to a vehicle, make this notation across the front of the form, sign in Item 21, and return it without further completion.

Return the form to the Bureau of the Census, Washington 25, D. C., in the enclosed envelope which requires no postage.

YOUR FILE COPY

PLEASE COMPLETE AND RETURN THE FORM WHICH SHOWS YOUR NAME AND ADDRESS

1. VEHICLE IDENTIFICATION

Make	Year model

Registered weight or capacity	State	License No.

If the make, year model, or weight of the vehicle is not shown above, please fill in the blank for the missing item.

2. TYPE OF VEHICLE *("X" ONE box)*

1 ☐ Truck
2 ☐ Truck-tractor
3 ☐ Truck-tractor and semi-trailer registered as a unit
4 ☐ Other *(Describe)* _____

3. TYPE OF FUEL *("X" ONE box)*

1 ☐ Gasoline
2 ☐ Diesel
3 ☐ Other *(Describe)* _____

4. NUMBER OF AXLES ON THE POWER UNIT (Truck or truck-tractor) *("X" ONE box in a, b, and c)*
(Do not include trailer. Report tandem axles as two axles.)

a. Total number of axles *("X" ONE box)*
1 ☐ Two axles
2 ☐ Three axles *(Also complete b)*
3 ☐ Four axles

b. Number of driving axles (powered) on front *("X" ONE box)*
1 ☐ None
2 ☐ One axle *(Also complete c)*
3 ☐ Two axles

c. Number of driving axles (powered) on rear *("X" ONE box)*
1 ☐ One axle
2 ☐ Two axles

5. UNLOADED WEIGHT OF THE TRUCK OR TRUCK-TRACTOR — Pounds

(Unloaded weight of truck or truck-tractor is the empty weight of the vehicle fully equipped for service, including fuel, water, accessories and equipment.) . . . . . .

6. NUMBER OF AXLES ON THE TRAILING UNIT(S) (Semi-trailer and full-trailer(s))
(If the vehicle is a truck-tractor (or a straight truck drawing a full trailer) mark a box for the number of axles on the trailing unit(s) most frequently used with the power unit.) *("X" ONE box only)*

a. Semi-trailer ONLY
1 ☐ One axle
2 ☐ Two axles
3 ☐ Three axles

b. Full-trailer ONLY
4 ☐ Two axles
5 ☐ Three axles
6 ☐ Four axles or more

c. Semi- and full-trailer, including converter dolly
7 ☐ Three axles
8 ☐ Four axles
9 ☐ Five axles or more

7. UNLOADED WEIGHT OF THE TRAILING UNIT(S) (Semi-trailer and full-trailer(s)) — Pounds

(Unloaded weight of the trailing unit, is the empty weight of the vehicle fully equipped for service, including accessories and equipment.) . . . . . .

USCOMM-DC 14956

Figure 1. Form TC-200-2.

8. TYPE AND SIZE OF BODY

Mark **one** box to describe the type of body of the truck or combination. If the power unit is a truck-tractor, report body type of the combination most frequently used with the power unit.

For all types **except winch or crane wreckers, pole or logging, or auto transport,** also mark a box to classify the size of the body. If the vehicle is a tank describe the kind of tank.

a. Body type *("X" ONE box in this column)*

- 01 ☐ Standard panel, sedan delivery, compact van
- 02 ☐ Station wagon
- 03 ☐ Pick-up
- 04 ☐ Multi-stop or walk-in
- 10 ☐ Platform, stake, grain, or other platform type
- 11 ☐ Cattle rack (hogs, calves, and other livestock)
- 12 ☐ Open top van
- 20 ☐ Furniture van
- 21 ☐ Closed top non-refrigerated van, other than furniture van
- 22 ☐ Refrigerated van
- 30 ☐ Low-bed
- 31 ☐ Depressed center
- 40 ☐ Winch or crane, other than wrecker
- 41 ☐ Wrecker
- 42 ☐ Pole or logging
- 43 ☐ Auto transport
- 50 ☐ Dump . . . . . .
- 60 ☐ Tank . . . . . .

  Kind of tank *(Describe, such as dry cargo, general purpose, insulated, refrigerated, stainless steel, glass lined, pressure vessel, etc.)*

  _____

  _____
- 70 ☐ Cement mixer . . . . . .
- 80 ☐ **Other** (If the above descriptions do not satisfactorily describe your vehicle, please enter identifying body type and size.)

  _____

b. Body size *("X" ONE box in this column to describe size of body)*

Length of load space *(Feet)*

- 1 ☐ Under 7
- 2 ☐ 7 to 9.9
- 3 ☐ 10 to 12.9
- 4 ☐ 13 to 15.9
- 5 ☐ 16 to 19.9
- 6 ☐ 20 to 24.9
- 7 ☐ 25 to 29.9
- 8 ☐ 30 to 34.9
- 9 ☐ 35 to 39.9
- 10 ☐ 40 and over

DO NOT SPECIFY BODY SIZE FOR THESE FOUR ITEMS

Capacity of dump (Water level without side boards) *(Cubic yds.)*

- 1 ☐ Under 5
- 2 ☐ 5 to 6.9
- 3 ☐ 7 to 9.9
- 4 ☐ 10 or over

Capacity of tank *(Gallons)*

- 1 ☐ Less than 1,000
- 2 ☐ 1,000 to 1,999
- 3 ☐ 2,000 to 2,999
- 4 ☐ 3,000 to 3,999
- 5 ☐ 4,000 to 5,999
- 6 ☐ 6,000 to 7,999
- 7 ☐ 8,000 and over

Capacity of mixer *(Cubic yds.)*

- 1 ☐ Less than 5
- 2 ☐ 5 to 5.9
- 3 ☐ 6 to 6.9
- 4 ☐ 7 or over

USCOMM-DC 14956

Figure 1. Continued.

MAJOR USE OF THIS TRUCK OR COMBINATION *("X" the ONE box that best describes your main use of this vehicle during the past 12 months. If owned less than 12 months, check the major use during the time you owned the vehicle.)*

1 ☐ **For your farming, ranching or other agricultural activities** - This use includes hauling your livestock, crops or products to market; bringing back supplies and equipment; hauling around farm, and perhaps occasional hauling for neighbors or others. *(Answer Question 12 next.)*

2 ☐ **Personal transportation** - This is using the vehicle in place of an automobile to go from home to work; doing odd jobs around home or summer place; going fishing or hunting, etc. *(Answer Question 12 next.)*

3 ☐ **Leased or rented to others without driver--for periods of less than 30 days.** *(Answer Question 12 next.)*

4 ☐ **Leased or rented to others without driver--for periods of 30 days or more.** *(Answer Question 11 next.)*

5 ☐ **State, county, municipal or other governmental operation.** *(Answer Question 12 next.)*

6 ☐ **For-hire transportation** - This use includes trucking services known as drayage, local cartage, household goods movers, common or contract motor carriers, commercial motor carriers, "Owner-operators" under lease or contract. *(Answer Question 10)*

7 ☐ **Operated in connection with own business or occupation not specified above.** *(Answer Question 11 next.)*

8 ☐ **Other** - If none of the above applies to the use you make of the vehicle, describe the main use of the vehicle here. *(Answer Question 12 next.)*

_____

(Answer this question if the "For-hire transportation" box has been marked in Question 9.)

10. TYPE OF SERVICE

a. Hauling in - *("X" ONE box)* 1 ☐ One State only 2 ☐ More than one State

b. Is this service under an Interstate Commerce Commission authorization (either granted or pending)? *("X" ONE box)*

3 ☐ No 4 ☐ Yes *(If "Yes," enter the Interstate Commerce Commission Docket Number (this number must begin with the letters MC-))* MC-

Answer this question if either the 4 box or the 7 box has been marked in Question 9.

11. BUSINESS OR OCCUPATION - *(Mark the ONE box below that most nearly describes your business or the business of the person to whom you leased the vehicle.)*

1 ☐ Mining or quarrying

2 ☐ Building or contract construction

3 ☐ Manufacturing -
(Describe class of industry such as furniture, petroleum, textile, etc.) _____

4 ☐ Wholesale -
(Describe class, such as groceries, machinery, hardware, etc.) _____

5 ☐ Retail -
(Describe class, such as drugs, apparel, etc.) _____

6 ☐ Service -
(Describe class, such as hotels, automobile repairs, laundries, etc.) _____

7 ☐ For-hire carrier -
(Describe major class or class of products carried) _____

8 ☐ Other *(Describe)* _____

12. VEHICLE LEASED TO OTHERS

Did you lease this vehicle **WITH DRIVER** to others any time during the past 12 months? *("X" ONE box)* No. of days

1 ☐ No 2 ☐ Yes *(If "Yes," estimate the total number of days leased)* . . . . . .

13. VEHICLE MILES Miles

a. **Total miles this vehicle was driven during the past 12 months.** If book figures are not available, estimate the total miles driven or if you have owned the vehicle less than 12 months, estimate the probable miles for a full year . . . . . .

b. Total miles this vehicle has **been driven since new.** If mileage shown on speedometer does not represent the life-time miles by this vehicle, estimate the total mileage . . . . . .

14. TYPICAL LOADS

On a round trip basis, how does the truck or combination usually move? *("X" ONE box)*

1 ☐ Loaded in one direction, but returns empty (or almost empty) in the other direction

2 ☐ Loaded in both directions

3 ☐ Comments *(If any)* _____

FORM TC-200-2 (1-24-63)

Figure 1. Continued.

15. EMPLOYMENT

About how many total DRIVER man-hours are usually spent per week by all persons in operation of this vehicle. Include both driving and riding time of relief and part-time drivers. If the driver helps load or unload the vehicle or is on duty include his time. Do not include time of non-driving employees. *("X" ONE box)*

1 ☐ Less than 15 hours
2 ☐ 15 to 30 hours
3 ☐ 31 to 40 hours
4 ☐ 41 to 60 hours
5 ☐ 61 hours or more

16. MAINTENANCE

When major repairs are needed on this vehicle, are they usually done by? - *("X" ONE box)*

1 ☐ Your own repair shop
2 ☐ Truck dealer or factory branch
3 ☐ Independent garage
4 ☐ Other *(Describe)* _____

17. BASE OF OPERATION

Where is the "home base" for this vehicle?
(Principal place from which this vehicle operates)

City or town

County

State

18. AREA OF OPERATION

Where is the vehicle operated? *("X" only ONE box)*

1 ☐ Mostly in the local area (in or around the city and suburbs, or within a short distance of farm, factory, mine, or "home base" shown in Question 17.)
2 ☐ Mostly over-the-road (beyond the local area) but usually not more than 200 miles one way from the "home base" shown in Question 17.
3 ☐ Mostly over-the-road trips that usually are more than 200 miles one way from "home base" shown in Ques. 17.

19. PERIOD OF OPERATION

a. What part of the week is vehicle usually used? *("X" ONE box)*

1 ☐ Five-day week (Monday through Friday)
2 ☐ Six-day week, including Saturday, but not Sunday
3 ☐ Six-day week, including Sunday, but not Saturday
4 ☐ Week-ends only (Saturday or Sunday)
5 ☐ Seven-day week

b. "X" one or more boxes to indicate the quarter in which the vehicle is used. If the vehicle is used during each quarter, "X" only the "all year" box.

1 ☐ All year
2 ☐ January - February - March
3 ☐ April - May - June
4 ☐ July - August - September
5 ☐ October - November - December

20. NUMBER OF TRUCKS, TRUCK-TRACTORS, AND TRAILERS OPERATED FROM "HOME BASE" AS OF JULY 1, 1963

All previous questions have been about the vehicle described on the front page of this report. This question is about OTHER trucks and combinations you may be operating from the HOME BASE shown in Question 17.

Were you operating ANY OTHER trucks, truck-tractors, semi-trailers or full trailers from this home base as of July 1, 1963? *("X" ONE box)*

☐ No ☐ Yes *(If "Yes," please enter below the number of trucks by each body type, the total number of truck-tractors, and the number of semi-trailers and full trailers. DO NOT INCLUDE THE VEHICLE DESCRIBED ON PAGE 1.)*

TRUCKS

Type	Number Owned	Number Leased
Standard panel, sedan delivery, compact van, station wagon, pick-up, multi-stop, walk-in	11	21
Platform, stake, grain, open top van or cattle rack	12	22
Closed top non-refrigerated or furniture van	13	23
Refrigerated van	14	24
Tank	15	25
Dump	16	26
Other trucks	17	27

TRUCK-TRACTORS

Total number of truck-tractors owned	30
Total number of truck-tractors leased	40

SEMI-TRAILERS AND FULL TRAILERS

Type	Number Owned	Number Leased
Platform, stake, grain, or open top van	52	62
Closed top non-refrigerated van	53	63
Refrigerated van	54	64
Tank	55	65
Dump	56	66
Other semi-trailer or full trailer	57	67

21. **CERTIFICATION**

Name and address of person who should be contacted regarding this report — Telephone No.

This report is substantially accurate.

Date | Title | Signature of authorized person

Figure 1. Continued.

prepared which combine the two related cards into a single record and supply additional information needed for estimating "universe" totals, sampling variability, etc.

Tabulation Program

The first step in the tabulation program will be the series of computer runs outlined in Table 1. These runs will be used to analyze the nature of the statistical distributions and relative magnitudes of sampling variability. They also will be used as a partial basis for judging the probable nature and extent of response errors.

The specifications for the published tables will be based largely on the results of these preliminary analyses. In general, national aggregates are expected to show essentially the full detail indicated by the "stubs" (Table 2) and "spreads" (Table 3) in the runs, except for some collapsing of small cells to higher levels of summarization. Since the size of samples for large states and major regions are smaller than for the nation as a whole, the tables for these areas will show considerably less detail than the national aggregates. Still less detail will be shown for smaller areas.

The degree of summarization will be governed largely by the results of the preliminary runs. However, since all tabulations will be obtained by summarizing the standardized computer accumulations outlined, data for any specified area will be comparable with each of the other areas at specified levels of summarization.

Selected Terms

The terms runs and computer accumulations are used to avoid possible confusion with the final tabulations. The runs represent the most detailed display of data (i.e., accumulations) that is currently planned to be developed from the basic reports. Fol-

TABLE 1

COMPUTER ACCUMULATIONS BY STATES FOR USE IN SUMMARIZING DATA FOR TABULATIONS BY STATES, REGIONS AND NATION[a]

Run	Description
Run 1.0[b]	By make (Stub 1) By year model (Spread 1)
Run 1.1	By weight class (Stub 2) By year model (Spread 1)
Run 1.2	By body and vehicle type (Stub 3) By length of load space or capacity (Spread 2)
Run 1.3	By body and vehicle type (Stub 3) By number of axles, inc. trailing unit and number of powered axles (Spread 3)
Run 1.4	By body and vehicle type (Stub 3) By type of fuel and vehicle weight class (Spread 4)
Run 2.1	By occupational use (Stub 4) By vehicle type and weight class (Spread 5)
Run 2.2	By body and vehicle type (Stub 3) By occupational use (Spread 6)
Run 2.3	By type of vehicle and weight class (Stub 5) By number of vehicles leased to others with driver and number of days leased (Spread 7)
Run 3.1	By year model and weight class (Stub 6) By annual mileage blocks (Spread 8)
Run 3.2	By occupational use and weight class (Stub 7) By driver man hours per week (Spread 9)
Run 3.3	By occupational use and weight class (Stub 7) By annual mileage blocks (Spread 8)
Run 3.4	By year model and weight class (Stub 6) By lifetime mileage blocks (Spread 10)
Run 3.5	By occupational use and weight class (Stub 7) By part of week and year operated (Spread 11)
Run 4.1	By occupation use (Stub 4) By area of operation and load factor (Spread 12)
Run 5.1	By weight class and maintenance (Stub 8) By number of vehicles in fleet (i.e., number operated out of home base) (Spread 13)
Run 5.2	By occupational use and area of operation (Stub 9) By number of vehicles in fleet (i.e., number operated out of home base) (Spread 13)

[a] All accumulations will show estimated number of trucks or combinations, except Run 2.3 which will show estimated number of vehicles and vehicle days.

[b] Run 1.0 is for Census edit and review of basic data for reasonableness—not for publication.

TABLE 2

DESCRIPTION OF STUBS

Stub	Description	Source on TC-200	Comment
1	Make	Item 1	Five major U. S. makes plus groups; for census use, not for publication
2	Weight class	See comment	Four classes: light, medium, light-heavy and heavy-heavy—based on combination of vehicle characteristics
3	Body type	Items 8-a, 2	Subclassified by trucks and combinations
4	Occupational use	Items 9, 11	Occupational classes consist of those with numbers preprinted on TC-200
5	Vehicle type and weight class	Item 2, Stub 2	
6	Year model and weight class	Item 1, Stub 2	Recent years separately; earlier years grouped
7	Occupational use and weight class	Stub 4, Stub 2	
8	Weight and maintenance	Stub 2, Item 16	
9	Occupational use and area of operation	Stub 4, Item 18	

TABLE 3

DESCRIPTION OF SPREADS

Spread	Description	Source on TC-200	Comment
1	Year model	Item 1	Recent years separately; earlier years grouped
2	Body length	Item 8-b	
3	Number of axles	Items 4, 6	
4	Fuel and weight class	Item 3, Stub 2	See stub sheet for description
5	Vehicle type and weight class	Item 2, Stub 2	See stub sheet for description
6	Occupational use	Item 9, 11	Same as Stub 4
7	Leased with driver	Item 12	Number of vehicles and vehicle days
8	Annual miles	Item 13-a	8 Broad mileage blocks
9	Man-hours	Item 15	
10	Lifetime miles	Item 13-b	9 Broad mileage blocks
11	Time period	Items 19-a, 19-b	
12	Area of operation	Items 18, 14	
13	Fleet size	Item 20	10 Size groups

lowing analysis of the detailed runs, the accumulations will be collapsed (if necessary) to produce state, region, and national tables. The stubs indicate the classifications to be used for the lines in the tables, whereas the spreads show the corresponding information for the column headings.

Sampling Variability

Since the survey is based on a probability sample of vehicles, the results are necessarily subject to sampling variability. Estimates of this variability will be produced as part of the output of the computer program.

Supplemental Tabulations

The tabulation program outlined is designed to produce the data believed to be of major public value. It does not exhaust the potential values that can be obtained by

additional cross-classifications and regroupings. A complete set of the basic computer tapes as well as the first stage summaries (computer accumulations) will be available for additional or special tabulations.

Appendix B

BRIEF SUMMARY OF METHOD AND TYPE OF DATA FROM COMMODITY TRANSPORTATION SURVEY

The purpose of this collection of statistics by the Bureau of the Census is to obtain traffic flow data, showing the relative volume of commodities shipped, classified by means of transport, length of haul, origin-destination areas, and size of shipment. Tables 4, 5 and 6 illustrate the main types of data produced by this method.

While some companies regularly summarize their traffic records, there is not sufficient uniformity to combine summary data from various shippers into useful industry or product totals. However, essentially all shippers maintain current files of bills of lading or other papers that show the essential information for each shipment—date, origin and destination towns, commodity description, weight, and mode of transport. Consequently, basic data are obtained from these files. Scientific samples are used because they give satisfactory results at only a small fraction of the time and cost that would be involved if all shipments were summarized.

A Census representative contacts appropriate company officials to request cooperation and prepares simple step-by-step instructions for drawing a systematic sample of about 100 to 200 bills of lading or other shipping papers. If requested, he will assist the company in selecting the sampled papers and recording the detailed information. This usually is most easily done by facsimile reproduction of the papers, but may be done by hand transcriptions. The sampling and recording in previous shipper surveys often was completed in three or four hours, and rarely took more than one man day for any plant.

Copies of records and other materials received by the Census Bureau are strictly confidential, as provided by the basic statutes governing the operations of the Bureau of the Census (Title 13, U. S. Code). Only sworn Census employees will have access to the reports or information obtained from the records. Furthermore, information received from any respondent cannot be used for purposes of taxation, investigation or regulation. It will be used solely for statistical purposes and will be released only in tabulated form that does not reveal the operations of any one company.

TABLE 4

PERCENT OF TONS ORIGINATED BY LARGE MANUFACTURING COMPANIES IN NORTHEASTERN UNITED STATES DURING RECENT YEAR[a]

Industry Class	Commodity Group	Total (%)	Percent by Type of Transport			
			Rail	Motor Carrier	Private Truck	Other
Agricultural implements and parts	Tractors and parts	100	34	62	4	-
	Other	100	60	33	6	1
Building products	Wallboard	100	54	46	-	-
	Insulating material	100	39	55	6	-
	Building and roofing materials	100	22	70	8	-
Construction and mining machinery	Tractors	100	48	47	5	-
	Power shovels	100	73	15	12	-
Electrical appliances	Small electrial appliances	100	19	59	3	19
	Other	100	74	20	1	5

[a]Mostly 1959 or 1960.

TABLE 5

PERCENT OF TONS ORIGINATED BY LARGE MANUFACTURING COMPANIES IN NORTHEASTERN UNITED STATES DURING A RECENT YEAR[a]

Commodity Group	Total (%)	Percent by Miles[b]				
		<100	100-299	300-499	500-999	≥1,000
Sulfuric acid	100	86	13	1	-	-
Fertilizers	100	59	38	3	-	-
Wallboard	100	36	40	17	6	1
Building and roofing materials	100	26	38	24	10	2
Lime	100	26	47	13	13	1
Small electrical appliances	100	10	10	15	40	25
Chinaware	100	6	19	27	25	23
Plate Glass	100	5	31	21	30	13
Transformers	100	2	26	26	25	21
Tractors	100	2	5	12	40	41

[a]Mostly 1959 or 1960.
[b]From plant to customer or redistribution point.

TABLE 6

PERCENT OF TONS OF CANNED FOODS ORIGINATED BY MANUFACTURING PLANTS IN UNITED STATES[a]

Origin[b]	Total (%)	Percent by Destination[b]					
		Official	Western Trunk	Southern	South-western	Mountain-Pacific	Foreign
Official	100	85	3	9	1	2	-
Western Trunk	100	25	56	4	10	4	1
Southern	100	18	1	63	5	6	7
Southwestern	100	3	3	4	89	1	-
Mountain-Pacific	100	6	19	6	7	56	6

[a]For year ended June 30, 1958.
[b]Approximate area equivalents: Official = Northeastern United States; Western Trunk = West North Central; Southern = Southern = South Atlantic and East South Central; and Southwestern = West South Central.

Appendix C

SELECTED ASPECTS OF TRUCK CARRIER SURVEY

Form TC-301 (Fig. 2) will be mailed in January 1964 to a probability sample of about 9,500 for-hire truck carriers drawn from all businesses in the Old Age and Survivors Insurance Program (Social Security) that are classified as being primarily engaged in rendering trucking service. The sample is stratified by carrier size, based on number of employees.

The sample includes all classes of for-hire motor carriers because no satisfactory basis was found for selecting only those that were not subject to ICC reporting requirements. However, since data for the federally regulated carriers will be collected by the Commission, those carriers are being requested to supply merely their ICC identification number (Item 2) to the Census, so that their names may be removed from the Census Survey.

The Census tabulation program will be coordinated with the ICC program to achieve maximum comparability. In general, the tables will show the total number of carriers, operating revenues, expenses, number of employees, and revenue freight carrying equipment, classified by principal type of operation and service and by form of ownership.

FORM TC-301

10. REVENUE FREIGHT CARRYING EQUIPMENT AS OF DECEMBER 31, 1963

		Number of vehicles owned	Key	Number of vehicles leased	Key
Show number of vehicles owned and leased in use or held for use in motor carrier operations, including those undergoing repairs, at the close of the year 1963.	a. Trucks		3–1		3–5
	b. Truck tractors		3–2		3–6
	c. Semitrailers		3–3		3–7
	d. Full trailers		3–4		3–8★

11. TOTAL NUMBER OF EMPLOYEES

		Persons on payroll for the payroll period ending nearest—			
		May 15, 1963	Key	Nov. 15, 1963	Key
Line a—Paid employees consist of all employees on the payroll during the specified payroll period, including those on paid sick leave, paid holidays and paid vacation. Corporations should include salaried officers and executives. Exclude owners and partners of unincorporated businesses.	a. Paid employees		2–4		2–6
Line b—Include owners and partners of unincorporated businesses.	b. Owners and partners of unincorporated businesses		2–5		2–7★

This space may be used for any explanations that may be helpful in understanding your report.

12.	Name and address of person who should be contacted if questions arise regarding this report.		Telephone No.
CERTIFICATION	This report is substantially accurate and covers the period from _____ to _____		
	Date	Title	Signature of authorized person

(Use additional sheets of paper, if necessary, to complete any item or to submit any explanation. Identify each sheet with the 11-digit file number appearing over your name.)

100 430—P.2

Figure 2. Form TC-301.

PENALTIES FOR FAILURE TO REPORT **DUE DATE—FEBRUARY 29, 1964** Form Approved: Budget Bureau No. 41-6?19

FORM TC-301

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

1963 CENSUS OF TRANSPORTATION

TRUCK CARRIER SURVEY

CONFIDENTIAL—Response to this inquiry is required by Act of Congress (13 U.S.C.). The report you submit to the Census Bureau is confidential and may be seen only by sworn Census employees. It may not be used for purposes of taxation, investigation, or regulation. Copies retained in your files are also immune from legal process.

GENERAL INSTRUCTIONS

Please complete and return this form in the envelope provided. If filing by the due date causes undue burden, a request for extension should be directed to the **Jeffersonville Census Operations Office, Jeffersonville, Indiana.**

Each carrier that renders services authorized by certificates or permits issued (or pending) by the Interstate Commerce Commission should answer only Items 1, 2, and 12. *All other carriers* should complete the entire report. If no operations were performed in 1963, answer only Item 12 and enter "No operations in 1963" in the Comments section.

If your Employer Identification Number (the number appearing on Employer's Quarterly Federal Tax Return—Form 941) was changed during 1963, submit a report for the entire period of operation in 1963 on one 1963 Census reporting form, and list all Employer Identification Numbers used during any part of 1963 in Item 1.

If calendar year records are not available, fiscal year reports for periods ending between October 31, 1963 and February 29, 1964 are acceptable.

If book figures are not available, enter your best estimates.

In correspondence pertaining to this report please refer to the 11-digit file number in the box above your name.

TC-301

(Do NOT make any entries on the above label.)

1. IDENTIFICATION NUMBER used for this establishment on Employer's Quarterly Federal Tax Return (U.S. Treasury Department Form 941).

☐☐ ☐☐☐☐☐☐☐

2. INTERSTATE COMMERCE COMMISSION DOCKET NUMBER

If the carrier (individual or company) in 1963 was engaged in a service under an Interstate Commerce Commission authorization (either pending or granted), enter the docket number in the space below and skip to Item 12.

Docket number ..... MC-

3. FORM OF OWNERSHIP a
(Check one box)

1 ☐ Individual proprietor

2 ☐ Partnership

0 ☐ Corporation (Do not include any form of cooperative association)

8 ☐ Cooperative association (corporate or non-corporate)

9 ☐ Other (*Specify*)

4. COMPANY AFFILIATION

Check this box ☐ if this business is owned or controlled by another company and enter the name, mailing address, and Employer Identification Number of owning or controlling company (if known).

Name of company

Mailing address

E.I. Number

5. PRINCIPAL TYPE OF OPERATION b
(Check one box)

1 ☐ Common carrier

2 ☐ Contract carrier

3 ☐ Other (*Specify*)

6. PRINCIPAL TYPE OF SERVICE c

Check the box pertaining to the principal type of service covered by this report. *(Check one box only)*

1 ☐ Local

2 ☐ Intercity

Local service means transportation performed within a city or town including the adjoining suburban area, whether or not a State line is crossed.

All other regular route service is classified as **intercity.**

7. TYPE OF CARRIER (*Check one box only*)

1 ☐ Carrier of general freight

2 ☐ Carrier of household goods

3 ☐ Carrier of agricultural products and other commodities that are exempt from Interstate Commerce Commission regulations

4 ☐ Other specific commodities

8. OPERATING REVENUES AND EXPENSES 1963

INCLUDE INTERSTATE, INTRASTATE, INTERCITY, AND LOCAL OPERATIONS

Line a—*Include* all revenues earned from the transportation of freight by motor vehicles. Include brokerage commissions and revenues from lease of vehicles with drivers.

Do not include revenues earned from noncarrier operations, such as dividends, interest received or miscellaneous revenues from: (a) sales of commodities, equipment, or real estate; (b) storage, packing, crating, and warehouse services for storage; (c) rentals of space, buildings, or equipment without service of drivers; and (d) furnishing other services indirectly related to motor carriers' operations.

Line b—Income received from others for the rental of vehicles *without drivers*, and for the rental of other motor carrier property.

Line c—*Include* all expenses incurred in the conduct of the motor carrier operations, i.e., costs of operating and maintaining vehicles, wages and salaries (including wages and salaries paid to owners for services in motor carrier operations), terminal expenses, insurance and safety, advertising, tariffs, rents, administrative expenses, etc. Include depreciation expense for all owned depreciable property used in the performance of motor carrier operations. Include taxes paid which are solely related to the motor carrier operations such as vehicle licenses and fees, real estate, social security and other taxes and licenses specifically required to conduct such operations.

Line d—*Include* all salaries, wages, bonuses and vacation allowances. Payments to salaried officers and executives of corporations should be included. Exclude payments to (or withdrawals by) owners or partners of unincorporated businesses.

Line e—*Include* payments to or withdrawals by owners or partners of unincorporated businesses.

	Dollars (*Omit cents*)	Key
a. Total operating revenues from motor carrier operations	$	1–1
b. Rental income from motor carrier property	$	1–2
c. Total expense of motor carrier operations	$	1–3
d. Total salaries and wages paid employees	$	1–4
e. Withdrawals and salaries paid owners and partners of unincorporated businesses	$	1–5★

9. INTERCITY OPERATING STATISTICS 1963

If services are entirely *local*, enter "None."

	Dollars (*Omit cents*)	Key
a. Freight revenue from intercity service	$	2–1
	Miles	
b. Owned and leased truck- and tractor-miles operated in intercity service (include loaded and empty).		2–2
	Tons	
c. Tons of revenue freight carried in intercity service		2–3 →

(*Use additional sheets of paper, if necessary, to complete any item or to submit any explanation. Identify each sheet with the 11-digit file number appearing over your name.*)

Please complete inquiries on reverse side

100 430—P.1

Figure 2. Continued.

Value of Commercial Motor Vehicle Time Saved

CHARLES R. HANING and C. V. WOOTAN
Respectively, International Business Machine Corporation and Texas Transportation Institute

The purpose of this paper is to explore the possibilities of determining reliable estimates of the dollar value that would accrue to commercial motor vehicle operators as a result of time savings occurring through use of improved highway facilities.

The estimates of the value of time developed in this report may possibly be compared and contrasted with the estimates of the value of time included in the final report of the Highway Cost Allocation Study. It was believed that a study of alternative approaches to the general problem and the development of estimates of the value of time saved to commercial truck operators in the Southwest would either (a) lend more credence to those values included in the cost allocation study; or (b) perhaps furnish evidence that more detailed studies would be desirable.

Any information developed by this study will supplement the several previous studies of vehicular travel time and fuel consumption rates under various operating conditions. The main purpose of these studies has been to provide reliable information for use in determining the benefits accruing to the users of the Federal Aid Highway System.

• DURING the early stage of this study, the decision was made to concentrate on determination of the value of time saved by commercial truck and bus operators in their intercity and over-the-road operations. It was felt that the local pickup and delivery operations of the commercial freight carriers were seldom benefited to any great extent by the urban freeway systems. Undoubtedly there are specific instances where urban arterial improvements are beneficial to the local carriers; however, the very nature of the pickup and delivery operations precludes any large usage of the urban freeways.

Records of the ICC regulated motor common carrier expenses and operating statistics were obtained for the years 1959 and 1960. These data were obtained from the report, "Transport Statistics in the United States, Part 7, Motor Carriers," which is compiled by the Interstate Commerce Commission from the annual reports of individual carriers and from an analysis of Class I and Class II motor carriers' reports, as published by Trinc Associates Ltd. These combined sources of data permitted a detailed analysis of the operations for the two-year period.

The data relating to the operating expenses and statistics of the intrastate carriers were obtained from the records on file at the Texas Railroad Commission. These records were verified, on a test basis, by mail questionnaires. The expense information for this group of carriers was for the year 1960. A limited check indicated that there were no significant differences in the expense relationships between the years 1959, 1960, and 1961.

As mentioned previously, one of the objectives of this study was to evaluate different methods of estimating the value of time to the commercial operators. Several alternative approaches were considered and their respective merits and disadvantages com-

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 43rd Annual Meeting.

pared. The following general methods received the most attention: (a) toll road approach, (b) specific point-to-point movement approach, (c) area of influence of market area approach, (d) case study approach, and (e) net operating profit approach.

After evaluating the advantages and disadvantages of each of these methods, it was decided that the net operating profit approach held the most promise under the limitations of the study. In addition, the logical consistancy of the area of influence of market area approach is such that it is considered to have potential usefulness in future studies. Therefore, although this paper deals primarily with the net profit approach, a cursory examination of the market area approach is included in order to investigate its potential. A brief description of the merits of these two methods will serve to clarify each, and will be included in the general discussion.

NET OPERATING PROFIT APPROACH

Methodology

The net operating profit approach is based on the assumption that if time savings accruing through the use of improved highways have an assignable value, this value will be reflected through the net operating profits of the commercial highway users. A further assumption is that time savings will be utilized whenever feasible to maximize profits.

The general hypothesis of this method is that as time is saved, the commercial operators will gain an advantage in these savings through productive use of both equipment and manpower. This added productive use will create a proportionate increase in gross operating revenues as well as a similar increase in variable vehicle expenses. For conservative purposes, it is assumed that other carrier expenses such as terminal, insurance and safety, and administrative expenses will also increase in proportion to the increased revenues. However, the vehicle and labor expenses that have a time function will remain constant under the theory that hours of service will be unchanged. The productive potential will be increased only as a result of increased average operating speeds.

Another possibility is that the total volume of freight handled would not increase as time savings became available. Under these conditions, the carriers should be able to transport the same volume with fewer units of line-haul operating equipment. The potential savings under these circumstances are evident. The reduction of driver expenses, fixed vehicular expenses and the capitalization of the cost of the eliminated operating units are perhaps the most important.

However, since the total tonnage and ton miles of intercity freight moved by motor trucks have been increasing each year, it seems more logical to assume that any additional equipment time (capacity) would be utilized by increased demand for truck transport services. For this reason, the computations presented in this report are based on the assumption that the availability of additional freight is not a limiting factor.

The application of this general approach to the determination of the value of time savings required the following procedures: (a) collection of operating cost and statistical data; (b) segregation of specific line-haul expenses; (c) collection and application of mileage and frequency of occurrence data for commercial trucks (axle and gross weight groups); and (d) analysis of the impediments to the utilization of time savings. The first two of these involve technical decisions only. A complete discussion of the problems involved can be found in TTI Bulletin 23. Since frequencies and impediments are of a more unique nature, they will be discussed in detail here.

Mileage and Frequency of Occurrence of Commercial Trucks

The distribution of vehicle mileage by axle classes and carrier groups was derived from data included in the unpublished study entitled "Value Characteristics in Motor Truck Transportation." This study was conducted by the Texas Transportation Institute in cooperation with the U. S. Bureau of Public Roads. The sample of commercial vehicles included in this study consisted of 13,663 tractor-trailer combinations as observed at various locations in the southwestern area of the United States. The number of obser-

vations, average miles per one-way trip, and percentage distribution of each axle class and each carrier group are shown in Table 1.

The distribution by relative total mileage for each group was utilized in the analysis of the mixed fleet costs. It is believed that these data are more reliable than the registration figures for each group. The registration data are sometimes difficult to segregate into either axle classes or carrier groups. For instance, in Texas the tractor and trailer are registered as separate units and there are no definite records of the registered weight, registration fee or the size of a particular combination.

Therefore, the number and type of units observed in the sample count appear to offer the best description of the units in operation within this area. The total registration fee for each combination unit was also recorded. Then the average for each axle class was computed. These average fees were used in determining the ratio of registration fees between the three major axle-class groups.

The relationships that exist between the different size units were important to this study in the allocation of composite fleet costs. The cost data that were obtained from the various carriers were applicable to the mixed line-haul fleet being operated by each particular firm. Therefore, to distribute these costs between the axle classes required an application of weighted ratios of relative costs. The development of the applicable ratios will be covered in a later section of this report.

Impediments to Utilization of Time Savings

The degree of utilization of time savings is certainly one of the major problem areas in determining the value of time saved to commercial operators. Time is definitely valuable, but the ultimate value cannot be realized unless the time is used productively. It was assumed in this study that all time would be utilized by the commercial carriers, "if the utilization of the added time would maximize profits." The determination of when to utilize the extra time is strictly a managerial decision.

The computation of the cost of operating a vehicle for an hour or per mile is basically a mechanical process. There are some differences of opinion as to the specific expenses that would remain constant under conditions of time savings. However, these differences and the resultant value of an hour's saving of time are rather minor when compared to the difference of opinion regarding the percent of time savings that can be profitably utilized. There is no general consensus among vehicle operators or researchers in the field of transportation with respect to the probable effect of the various impediments or barriers to the utilization of time. One barrier may be very significant to a general freight carrier but be of no consequence to a contract carrier and vice versa.

If each impediment could be assigned a weighting factor for each carrier, then a rather comprehensive and accurate utilization factor could be computed for each firm and for each carrier group. However, until detailed case studies of the utilization of time problem are conducted, the results of this study must rely on value judgment. Under these conditions, it should be emphasized that any projection of values derived by this study should be considered as estimates and are, therefore, expressed in terms of a range of probable upper and lower limits.

The utilization of time savings is a gradual process. This makes it difficult to segregate the savings because they tend to become obscured within the routine of business operations. Therefore, to determine the degree of utilization of time savings, it becomes necessary to view the problem from both a short-term and a long-term position.

In the short run, there are numerous barriers to the utilization of time savings. A majority of the intercity drivers are paid on a mileage basis, thereby eliminating any immediate savings through wage adjustments as a result of decreased trip time. Existing ICC and state regulatory agency route and area restrictions are rather rigid and tend to stifle a firm's expansion into new geographic areas. Route restrictions also sometimes hinder a carrier from taking advantage of new highway facilities. Therefore, if the objective is to determine the value of time savings to a particular group of firms, then it must be remembered that the utilization percentages for such firms are lowered due to these restrictions. However, if the value of time savings resulting from operations on a particular facility is the point of consideration, the consequent reduction in

TABLE 1

DISTRIBUTION OF VEHICLE MILEAGE BY AXLE CLASS AND CARRIER GROUPS[a]

Group	No. Observations	Avg. One-Way Trip Miles	Total Miles	Percentage Distribution	Total Miles by Axle Class	Total Miles by Carrier Groups
Axle class:						
2-S1	3,044	504	1,532,834	25.9		
2-S2	9,045	406	3,668,311	61.9		
3-S2	1,574	457	719,845	12.2		
Total	13,663	434	5,920,990	100.0		
Common carrier:						
2-S1	212	731	154,972	17.2	10.1	
2-S2	1,389	311	431,979	47.8	11.8	
3-S2	985	321	316,185	35.0	43.9	
Subtotal	2,584	349	903,136	100.0		15.3
Special hauler:						
2-S1	704	745	524,480	32.9	34.2	
2-S2	2,176	419	911,744	57.2	24.9	
3-S2	184	855	157,320	9.9	21.9	
Subtotal	3,064	520	1,593,544	100.0		26.9
Contract hauler:						
2-S1	87	472	41,064	45.5	2.7	
2-S2	122	301	36,722	40.6	1.0	
3-S2	55	342	12,540	13.9	1.7	
Subtotal	264	342	90,326	100.0		1.5
Private:						
2-S1	2,041	398	812,318	24.4	53.0	
2-S2	5,358	427	2,287,866	68.6	62.3	
3-S2	350	668	233,800	7.0	32.5	
Subtotal	7,749	430	3,333,984	100.0		56.3
Total			5,920,990			100.0

[a]Slater, J. Nelson, and Ray, Cadwell L. Determination of Value Characteristics in Motor Truck Transport. Unpublished report to U. S. Bureau of Public Roads, April 1961.

utilization percentages would not be the pertinent factor. It should be pointed out, however, that even when the value of time saved on a particular facility is the prime consideration, the value will sometimes be affected by a firm's inability to operate on other improved highways, particularly if such operation would facilitate the use of time saved on that particular facility. The utilization hindrances of this nature would be of little consequence in the short run and of no consequence in the long run.

The present location of terminal facilities and the existing trip schedules will both require adjustments in many instances before the time can be fully utilized. Therefore, it appears logical that a study such as this should be directed along two avenues. First, there would be the potential value that might accrue to the commercial users, assuming no external interference and a minimum amount of internal problems. This long-run approach assumes that all of the factors that act as present barriers to the utilization of time savings will have had sufficient time to adjust and be altered to the extent that they no longer operate as impediments to the firms.

The short-run approach will attempt to weigh the effect of the existing impediments and adjust the potential value of time savings accordingly.

Each class of carriers has different problems to cope with in the utilization of time saved. Practically all of the major common carriers of general freight base their driver wages on a combination of hourly and mileage rates. The hourly rate serves as a guaranteed minimum. However, the mileage pay scale is more prevalent since most trips can be completed within time limits that make the mileage rate basis more advantageous to the driver.

The specialized and contract carriers pay their drivers on either an hourly, mileage, fixed trip fee, or a percentage of revenue basis. The method of computing the pay varies greatly between individual carriers in this major group as well as between the major types of specialized and contract carriers.

There is a belief that wage considerations are fundamentally based on total take-home pay and the mileage basis or percent of revenue basis is only a means of attaining that end. If this premise is acceptable, then it appears logical that as trip travel time decreases, the fixed rate charges will be adjusted accordingly. This adjustment of per mile rates, etc., does not necessarily mean a downward revision of existing rates. This is highly improbable under current labor conditions. However, it is possible that the future rate increases might be smaller than they would have been if there had been no changes in trip time requirements. There is a psychological element involved that could be very important at the bargaining table.

With the savings of time accruing to the commercial highway users, it is feasible that the individual carriers could add a new service area to existing "runs." However, unless the firm has existing authority to serve that area, the carrier must obtain a certificate of necessity before it can add this area to its service route. Increasing competition within the motor transport industry is making it more difficult to obtain such certificates. Therefore, unless a firm can reschedule the trips within the existing framework of operating authority, there is a good possibility that much of the potential time savings will not be fully utilized.

The amount of time that can be saved per trip also plays an important role in determining the degree of possible utilization. For instance, a savings of 45 to 60 minutes on a one-way trip of 200 miles is not of great significance under normal conditions (although the dispatcher would undoubtedly welcome this leeway in his scheduling). A similar ratio of time savings to miles driven for a cross-country operation will frequently yield a more than proportionate savings in time as well as dollar savings. On long-distance trips, the time savings are cumulative and are often increased by elimination of layover periods. The ICC safety regulations stipulate that no driver may drive more than 10 hours at a time in any period of 24 consecutive hours unless such driver be off duty for 8 consecutive hours during or immediately following the 10 hours driving. This means that on trips that require more than 10 hours of driving time, layovers are required. Each layover period that is thus eliminated will add a minimum of 8 hours to the total saved. This amount of time is significant from the customer service standpoint and in the area of equipment utilization.

After considering the problems involved in the utilization of incremental time savings, certain conclusions and estimates have been made. All time saved as a result of highway improvements is valuable to the carriers whether it is used for additional preventative maintenance or for providing more freedom in the scheduling of trips.

To adjust the potential savings to reflect more closely current or short-term values, it became necessary to establish certain time utilization estimates for each carrier group. During the interviews with the respondent carriers, several questions regarding the time utilization problem were discussed. The answers, of course, were expressions of the respondents' informed judgments concerning the problem. The answers, as interpreted by the researchers, were converted to measurement and scaling techniques by use of scaling methods. The value of the scaling technique lies in its transformation of qualitative and noncomparable quantitative information into numerical rankings. Such rankings, moreover, permit the subsequent use of various quantitative techniques.

Based on the results of the scaling measurement and subjective judgment, the following ranges of probable utilization were established.

The common carriers of general freight, being the most heavily restricted as to the routes traveled and areas served, and operating predominantly with organized labor, received the lowest estimates, a range of 40 to 60 percent of potential value.

Within the specialized carrier group there are both regular and irregular route carriers, long- and short-haul carriers and carriers that have based their driver wages on a mileage, percent of revenue or hourly rate. Normally, these carriers have a greater degree of freedom in their operations than the general freight carriers. Accordingly, the specialized carrier group was estimated to be able to use approximately 60 to 80 percent of any time saved.

The private and contract haulers are less regulated and restricted in their operations than either of the preceding carrier groups. They have much more freedom in their scheduling, routing, and service areas. The major impediments to the complete utilization of time savings center around internal rather than external restrictions and problems. The private and contract carriers were assigned a utilization range of 80 to 100 percent.

Development of Value of Time Savings by Carrier Groups

The estimates of value for each group of commercial carriers are founded on several assumptions. It is assumed that, as additional time (equipment capacity) becomes available, the added capacity will be utilized through additional freight volume. This incremental volume will produce a proportionate increase in gross operating revenues as well as a similar increase in variable and semi-variable expenses. Therefore, the value accruing through this added capacity is the difference between the incremental gross revenues and the incremental expenses. The savings are thus an amount equal to the selected expenses (as described previously) which are not incurred in the incremental shipment plus the average net profit per unit of measure. The unit of measure employed in the tables and computations in this section is the "intercity mile." The revenue, expenses and potential value added are all expressed in terms of "per intercity miles." The potential value added per mile is expanded to the value per hour by multiplying by the average line-haul speed, expressed in miles per hour.

The average line-haul operating speed of 38 mph was used for all of the commercial freight carriers. This average speed was determined by sampling trip records and driver log sheets and was confirmed through conferences with dispatchers and other carrier officials.

The major variations in operating speeds appeared to be between specific routes and between different types of specialized and contract carriers. For instance, the heavy equipment haulers' average operating speed is not as high as the grain haulers'. However, the average for each group of carriers appears to be comparable for the general freight, specialized, contract and private carriers.

The revenues and variable expenses, that is, total expenses less the selected expenses, of each class of carriers were weighted according to the relative mileage of each class to the total mileage of the group. This weighting has the effect, of course, of giving prime importance to the revenues and expenses of the carrier class that has the greatest utilization of the highways in the southwestern region. The weighting factors were developed from sample Loadometer data and average miles per firm information for each study carrier.

The carriers are subgrouped in the various tables and computations into Class I, Class II, and Class III carriers (Table 2). These classifications conform to the Interstate Commerce Commission's designations. However, the Class III subgroup also includes intrastate carriers that are not included under the jurisdiction of the ICC. The terms intrastate and Class III carriers may, at times, be interchanged in this paper since they are both used to refer to the group of smaller carriers included in the study. These smaller carriers may be either intrastate or interstate in character.

TABLE 2

NUMBER OF CARRIERS INCLUDED IN STUDY

Carrier Group	Class I	Class II	Class III
Common carriers of general freight	35	25	19
Common carriers of passengers	23	--	7
Common carriers of commodities other than general freight	32	69	88
Contract carriers	3	7	29

TABLE 3

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CARRIERS OF GENERAL FREIGHT[a]

Factor	$ per Mile						
	Class I			Class II			Class III
	A[b]	B[c]	Total	A[b]	B[c]	Total	
Operating revenue	0.73244	0.78317	0.75289	0.91857	0.96028	0.92888	0.30788
Total expenses	0.68808	0.71985	0.70088	0.88652	0.96424	0.90573	0.30285
Selected line-haul expenses:							
Drivers' wages	0.10127	0.10449	0.10257	0.10683	0.08906	0.10244	0.03615
Employees' welfare	0.00273	0.00259	0.00267	--	--	--	--
Workmen's compensation	0.00161	0.00171	0.00165	0.00299	0.00251	0.00287	0.00078
Vehicle license and registration fees	0.00999	0.00980	0.00991	0.01279	0.01798	0.01407	0.00596
Real estate and personal property taxes	0.00223	0.00173	0.00206	0.00166	0.00050	0.00139	0.00084
Social security taxes	0.00177	0.00197	0.00185	0.00276	0.00260	0.00272	0.00097
Total	0.11960	0.12229	0.12071	0.12703	0.11265	0.12349	0.04470

[a]Engages in intercity operations, southwestern region and Texas, for year ending Dec. 31, 1959.
[b]Operating principally with owned equipment.
[c]Operating with owned and leased or purchased transportation.

Common Carriers of General Freight. —A summary of the revenues and selected expenses per mile is presented in Table 3. It is quite apparent that the major expense involved in determining the potential value of time saved is that of driver wages. It should be remembered that, under current conditions, this expense is primarily variable for this group of carriers.

The derivation of the potential value added per mile (as a result of time savings) for the common carriers of general freight is shown in Table 4. The Class I carriers had the greatest influence on this group since they accounted for approximately 88 percent of the total mileage.

When the value added per mile is converted to an hourly basis, the potential value of $6.17 per hr is obtained. Application of the probable utilization percentages yields a range of probable values of $2.47 to $3.70 per hr of time saved (see Table 10 for summary).

TABLE 4

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY MILE FOR COMMON CARRIERS OF GENERAL FREIGHT

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.88328	0.75289	0.66501	0.58017	0.51245
II	0.04123	0.92888	0.03830	0.78224	0.03225
III	0.07548	0.30788	0.02324	0.25815	0.01949
Total			0.72655		0.56419
Potential value added					0.16236[b]

[a]Total expenses less selected expenses.
[b]Difference of weighted revenue and weighted variable expenses.

TABLE 5

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CARRIERS OF COMMODITIES OTHER THAN GENERAL FREIGHT[a]

Factors	$ per Mile		
	Interstate		Class III[b]
	Class I	Class II	
Operating revenue	0.34942	0.42558	0.56734
Total expenses	0.33199	0.40739	0.52125
Selected line-haul expenses:			
Drivers' wages	0.05715	0.08027	0.10939
Employees' welfare	0.00142	--	--
Workmen's compensation	0.00246	0.00583	0.00737
Vehicle license and registration fees	0.00833	0.01012	0.01261
Real estate and personal property taxes	0.00069	0.00057	0.00205
Social security taxes	0.00051	0.00094	0.00199
Total	0.07056	0.09773	0.13341

[a]For carriers of commodities other than general freight, southwestern region, for year ending Dec. 31, 1959.
[b]All intrastate information for year ending Dec. 31, 1960.

Common Carriers of Commodities Other Than General Freight. — The group of common carriers of commodities other than general freight are generally considered specialized carriers. They include the haulers of petroleum products, household goods, heavy machinery, automobiles, exempt agricultural products, and various other specific commodities. It is within this group of carriers that the greatest variation in both physical operations and the cost of operation occurs.

Table 5 presents the pertinent revenue and expenses data for the three classes of specialized carriers. The derivation of the potential value added per mile is shown in Table 6. Classes I and III accounted for almost 86 percent of the total estimated mileage by the specialized group of carriers. This is apparent in the calculations of the weighted revenues per mile and the weighted variable expenses per mile as presented in Table 6.

The potential value added for the common carriers of commodities other than general freight is estimated to be slightly less than $0.13 per mile. This is approximately 20 percent lower than the estimate for the common carriers of general freight. However, the probable value added is greater than for the general freight haulers because the level of probable utilization is higher.

The potential value per hour of time saved for this group is estimated $4.86. The low value of the probable range is $2.91 and the high value is $3.89. This range is based on the estimated utilization of 60 to 80 percent.

Contract and Private Carriers. — The contract and private carriers' costs are assumed to be comparable for purposes of this study. Therefore, this subsection includes the derivation of estimated values of time savings for both groups.

The selected expenses and revenues for the three classes of contract carriers are listed in Table 7. The derivation of the potential value added per mile in Table 8 applies to both carrier groups and is weighted accordingly.

The smallest class of carriers in this group accounted for the highest percentage of total mileage. Therefore, their revenues and expenses were weighted the heaviest.

TABLE 6

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY MILE FOR COMMON CARRIERS OF COMMODITIES OTHER THAN GENERAL FREIGHT

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.46555	0.34942	0.16267	0.26143	0.12171
II	0.14253	0.42558	0.06066	0.30966	0.04414
III	0.39192	0.56734	0.22235	0.38784	0.15200
Total			0.44568		0.31785
Potential value added					0.12783[b]

[a] Total expenses less selected expenses.
[b] Difference of weighted revenue and weighted variable expenses.

TABLE 7

SUMMARY OF REVENUE AND SELECTED LINE-HAUL EXPENSES FOR CONTRACT CARRIERS[a]

Factors	$ per Mile		
	Interstate		Class III[b]
	Class I	Class II	
Operating revenue	0.32077	0.38622	0.33513
Total expenses	0.27863	0.36880	0.32294
Selected line-haul expenses:			
Drivers' wages	0.09316	0.07837	0.07057
Employees' welfare	0.00131	--	--
Workmen's compensation	0.00063	0.00210	0.00284
Vehicle license and registration fees	0.00776	0.01186	0.00934
Real estate and personal property taxes	0.00101	0.00047	0.00162
Social security taxes	0.00074	0.00066	0.00149
Total	0.10461	0.09346	0.08586

[a] Southwestern region, for year ending Dec. 31, 1959.
[b] All intrastate information for year ending Dec. 31, 1960.

The potential value added per mile for the contract and private carriers was estimated to be approximately $0.11 per mile. Converted to an hourly figure through use of the 38 mph average speed, the potential time savings are estimated to be valued at $4.32 per hour. Application of the utilization range of 80 to 100 percent yields a low value of $3.46 per hour and a high value of $4.32 per hour.

The estimated probable values accruing to these carriers are the highest of any of the commercial freight haulers. The validity of these figures is dependent on the accu-

TABLE 8

DERIVATION OF POTENTIAL VALUE ADDED PER INTERCITY FOR CONTRACT AND PRIVATE CARRIERS

Class	Class Mileage / Total Mileage	Revenue per Mile ($)	Weighted Revenue per Mile ($)	Expenses per Mile ($)[a]	Weighted Variable Expenses per Mile ($)
I	0.28060	0.32077	0.09001	0.17402	0.04883
II	0.15705	0.38622	0.06066	0.27534	0.04324
III	0.56235	0.33513	0.18846	0.23708	0.13332
Total			0.33913		0.22539
Potential value added					0.11374[b]

[a]Total expenses less selected expenses.
[b]Difference of weighted revenue and weighted variable expenses.

racy of the judgment values employed in determining the probable extent of time utilization by each class carrier.

Composite Commercial Freight Vehicle. — This subsection deals with the derivation of the values of time for a composite commercial freight vehicle. The composite vehicle is defined as an average vehicle, composed of the four freight carrier groups, operating in the southwestern region.

The value added per hour for a composite vehicle is derived through employment of the values developed in Tables 4, 6, and 8, together with the ratios in Table 1, in the following formula:

$$p_1(G) + p_2(S) + p_3(N) + p_4(P) = p_t(C_t) \quad (1)$$

where

p_1, p_2, p_3, p_4 = ratio of each of four carrier groups' miles operated to total miles operated by all carrier groups (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers);

p_t = ratio of miles operated by carrier groups used in a particular equation to total miles operated by carrier groups making up particular costs or revenues solved for (by this definition this ratio equal to one and added here simply for mathematical clarity);

G, S, N, P = value added per hour for, respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers as computed in Tables 4, 6, and 8; and

C_t = value added per hour for a composite vehicle composed of four carrier groups.

By using the values in Tables 1, 4, 6 and 8, three values may be developed for a composite vehicle:

1. Potential value (100% for all carriers)

$$0.153(\$6.16968) + 0.269(\$4.85754) + 0.015(\$4.32212) + 0.563(\$4.32212) = C_t$$
$$C_t = \$4.74803 \text{ per hour}$$

2. Low value

$$0.153(\$2.46787) + 0.269(\$2.91452) + 0.015(\$3.45770) + 0.563(\$3.45770) = C_t$$
$$C_t = \$3.16054 \text{ per hour}$$

3. High value

$$0.153(\$3.70181) + 0.269(\$3.88603) + 0.015(\$4.32212) + 0.563(\$4.32212) = C_t$$

$$C_t = \$4.11014 \text{ per hour}$$

Therefore, assuming a commercial freight traffic stream consisting of approximately 15 percent general freight carriers, 27 percent specialized carriers, and 58 percent private and contract carriers, the potential value of an hour of time saved would average $4.74 for all vehicles. The average low-high utilization values would be approximately $3.16 to $4.11 per hour of time saved.

It is readily apparent from the formula that the composite vehicle values are heavily weighted by the private carriers. Any shift in the composite traffic stream would automatically cause a change in the computed values for the composite vehicle.

It should be noted that the value range of $3.16 per hour to $4.11 is derived under assumptions that are based on the short-run period. However, this does not imply that these conditions and assumptions are currently operative. Therefore, the current values are probably somewhat lower than the value of $3.16 per hour. This will be true until adjustments are consummated in regard to driver wage payments since the possible savings that may accrue through this expense are responsible for the major portion of the estimated value of time savings.

Development of Value of Time Savings by Axle Classes within Carrier Groups

The purpose of this section is to develop the potential and probable values of time savings for each of the three major axle classes of commercial freight vehicles. The estimates are developed for each axle class within each major carrier group. Estimates of values are also derived for a composite vehicle of each axle class. The composite vehicles are composed of each carrier group weighted by the proportionate mileage factors as developed for the southwestern region.

The value added per mile for the various axle classes within each carrier group is developed using the following formula:

$$(R - E) + S = V \qquad (2)$$

where

R = total revenue per intercity mile for particular carrier group;
E = total expenses per intercity mile for particular carrier group;
S = selected expenses per intercity mile for particular axle class within carrier group; and
V = value added per mile for each axle class.

The values for (R - E) in Eq. 10 are taken from Column 1 of Tables 4, 6, and 8 and the values for S are taken from Table 10, which is a summary of the cost of selected line-haul expenses by axle class and carrier group.

Common Carriers of General Freight

1. Axle class 2-S1
   $0.04728 + $0.1107 = V
   V = $0.15798 per mile
2. Axle class 2-S2
   $0.04728 + $0.1157 = V
   V = $0.16298 per mile
3. Axle class 3-S2
   $0.04728 + $0.1162 = V
   V = $0.16348 per mile

Common Carriers of Commodities Other Than General Freight

1. Axle class 2-S1
   $0.02877 = $0.0960 = V
   V = $0.12477 per mile

TABLE 9

SUMMARY OF VALUE ADDED DERIVATIONS

Group	Value Added ($ per mi)	Average Speed (mph)	Potential Value Added ($ per hr)	Percent Range of Utilization	Range of Value ($)	
					Low	High
Common carriers of general freight	0.16236	38	6.16968	40-60	2.46787	3.70181
Common carriers of commodities other than general freight	0.12783	38	4.85754	60-80	2.91452	3.88603
Contract and private carriers	0.11374	38	4.32212	80-100	3.45770	4.32212
Composite vehicle	0.12485	38	4.74803	--	3.16054	4.11014

TABLE 10

COST OF SELECTED LINE-HAUL EXPENSES[a]

Group	Cost ($ per mi)			
	Axle Class			Group Avg.
	2-S1	2-S2	3-S2	
Common carriers of general freight	0.10954	0.11528	0.11751	0.1151
Common carriers of commodities other than general freight	0.09554	0.10051	0.10236	0.0991
Contract carriers	0.089420	0.09438	0.09573	0.0923
Private carriers	0.08881	0.09329	0.09496	0.0923
Composite vehicle	0.09323	0.09772	0.10653	0.09760

[a]From technical development of axle-class ratios by TTI.

2. Axle class 2-S2
   $0.02877 + $0.1004 = V
   V = $0.12917 per mile
3. Axle class 3-S2
   $0.02877 + $0.1008 = V
   V = $0.12957 per mile

Contract Carriers

1. Axle class 2-S1
   $0.02143 + $0.0900 = V
   V = $0.11143 per mile
2. Axle class 2-S2
   $0.02143 + $0.0941 = V
   V = $0.11553 per mile
3. Axle class 3-S2
   $0.02143 + $0.0945 = V
   V = $0.11593 per mile

Private Carriers

1. Axle class 2-S1
   $0.02143 + $0.0892 = V
   V = $0.11063 per mile

2. Axle class 2-S2
   $0.02143 + $0.0932 = V
   V = $0.11463 per mile
3. Axle class 3-S2
   $0.02143 + $0.0936 = V
   V = $0.11503 per mile

A summary of the potential and probable range of values is shown in Table 11. These hourly values are derived from the preceding mileage values. The average line-haul operating speed of 38 mph was used to determine the potential value per hour and the low-high ranges of probable values were computed, using the previously established estimates of time utilization factors for each carrier group.

The values, as developed in this section, are based on the assumption that each axle-class vehicle within a particular carrier group has an equal net operating profit potential. It is believed that the resultant error occurring as a result of the acceptance of this assumption will not be of major consequence, even though there is undoubtedly some variation. The major variation in net operating profit potential results from differences between carrier groups rather than axle classes. Since it is impossible to determine from available data the variation between both carrier groups and axle classes, the groups were segregated by carrier groups, the major source of variation.

Composite Axle Classes. —The value added per hour for composite axle-class groups may be developed from the information in Table 11, together with the values from Table 1, by the following equation:

$$p_1(G) + p_2(S) + p_3(N) + p_4(P) = p_t(C_a) \qquad (3)$$

where

p_1, p_2, p_3, p_4 = ratio of the number of miles operated by a particular axle class within a carrier group to the total miles operated by that axle class within the four carrier groups (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers);

p_t = ratio of miles operated by a particular axle class in all carrier groups, used in a particular equation, to total miles operated by that axle class within carrier groups making up costs or revenues solved for (equal to one in all following equations);

G, S, N, P = value added per hour for a particular axle class within each carrier group (respectively, common carriers of general freight, common carriers of commodities other than general freight, contract carriers, and private carriers); and

C_a = value added per hour for a composite axle-class vehicle composed of that axle class within each carrier group.

By using the values in Tables 1 and 11, three values may be developed for each composite axle class:

Composite 2-S1 axle class

1. Potential value
   0.101($6.00324) + 0.342($4.74126) + 0.027($4.23434) + 0.530($4.20394) = $4.57051 per hour
2. Low value
   0.101($2.40130) + 0.342($2.84476) + 0.027($3.38747) + 0.523($3.36315) = $3.08919 per hour
3. High value
   0.101($3.60194) + 0.342($3.79301) + 0.027($4.23434) + 0.530($4.20394) = $4.00329 per hour

Composite 2-S2 axle class

1. Potential value

0.118($6.19324) + 0.249($4.90846) + 0.010($4.39014) + 0.624($4.35594) = $4.70997 per hour

2. Low value
   0.118($2.47730) + 0.249($2.94508) + 0.010($3.51211) + 0.624($3.48475) = $3.23225 per hour
3. High value
   0.118($3.71594) + 0.249($3.92677) + 0.010($4.39014) + 0.623($4.35594) = $4.17424 per hour

Composite 3-S2 axle class

1. Potential value
   0.439($6.21224) + 0.219($4.92366) + 0.017($4.40534) + 0.325($4.37114) = $5.30117 per hour
2. Low value
   0.439($2.48490) + 0.219($2.95420) + 0.017($3.52427) + 0.325($3.49691) = $2.93426 per hour
3. High value
   0.439($3.72734) + 0.21855($3.93893) + 0.017($4.40534) + 0.325($4.37114) = $3.99449 per hour

A summary of the value added per hour for each composite axle-class commercial vehicle is shown in Table 12. It is interesting to note that the potential value added per hour increases with the number of axles but the probable range of values added per hour does not follow this pattern. The range of probable values for the 3-S2 axle class is less than for either of the other axle classes although the potential value is the greatest for the 3-S2 axle class. A combination of factors enters into the explanation of this apparent incongruity.

TABLE 11

SUMMARY OF VALUE ADDED DERIVATIONS

Group	Value Added ($ per hr)		
	Potential	Low Utilization	High Utilization
Common carriers of general freight:			
2-S1	6.00	2.40	3.60
2-S2	6.19	2.48	3.72
3-S2	6.21	2.48	3.73
Common carriers of commodities other than general freight:			
2-S1	4.74	2.84	3.79
2-S2	4.91	2.95	3.93
3-S2	4.92	2.95	3.94
Contract carriers:			
2-S1	4.23	3.39	4.23
2-S2	4.39	3.51	4.39
3-S2	4.41	3.52	4.41
Private carriers:			
2-S1	4.20	3.36	4.20
2-S2	4.36	3.48	4.36
3-S2	4.37	3.50	4.37

TABLE 12

SUMMARY OF VALUE ADDED DERIVATIONS

Composite Vehicle	Value Added ($ per hr)		
	Potential	Low Utilization	High Utilization
2-S1	4.57	3.09	4.00
2-S2	4.71	3.23	4.17
3-S2	5.30	2.93	3.99

The greatest use of the 3-S2 vehicles in the southwestern region study was by the common carriers of general freight, accounting for approximately 44 percent of the total mileage. This carrier group had the highest potential value of time savings but the lowest range of probable values. The private carriers accounted for the predominant usage of the 2-S1 and 2-S2 vehicles. These private carriers had the lowest potential values but the highest range of probable utilization. Therefore, the 2-S1 and 2-S2 axle classes are weighted more heavily by the higher utilization carrier groups, whereas the 3-S2 axle class is weighted more heavily by the lower utilization carrier groups.

This situation serves to illustrate the importance of the relative composure of the composite axle-class vehicles and the importance of the estimated range of probable utilization in the dollar value estimates of time savings.

AREA OF INFLUENCE OR MARKET AREA APPROACH

Methodology

The market area technique borrows from the field of location theory. The basic concept of this theory is that business locations can be determined rather scientifically by measuring each major locational factor and weighting each according to its relative importance to each specific business. Different businesses vary markedly in the extent to which they are transportation oriented. Therefore, costs of transportation and time requirements become decisive factors in the plant site selection.

Using certain facets of the plant location theory, it is possible to adapt the market area technique to the problem of determining the value of time savings. This concept may be utilized as an alternative process. Since it relies heavily on hypothetical assumptions, the measure of check that it provides is perhaps its most important potential. Since private trucking cost figures are rather difficult to obtain, the market area approach was tested using a large general merchandising firm that operates a private fleet of trucks in its distribution process.

Some of the basic hypotheses tested are as follows:

1. If a firm is operating with privately owned equipment, then time savings will enable the firm to expand its operations by an amount equal to the time savings.
2. If the transportation in question is used in supplying raw materials to the manufacturing sector, then the potential amount of raw materials carried will increase by an amount proportionate to the time savings. (The capacity of the manufacturing sector may be a limiting factor, however.) If the transportation in question is used in the supplying of marketing centers, then the firm may either increase the supply to existing centers by an amount proportionate to the time savings, or extend the radius of their distribution area thereby increasing their area of market influence.
3. Under certain circumstances, particularly when transportation costs represent a significant proportion of total costs, time savings may result in decreased costs which would enable the firm to benefit from existing operations or to expand into new areas that were previously unprofitable.

This general approach appears to be of most value in analyzing an individual firm's operations as opposed to an industry-wide study. For a single firm, this method would tend to provide insight into the value of time saved in relation to inventory costs, driver layover expenses, warehouse costs, flexibility of operations and customer service.

It appears to be of limited value when considering the regulated for-hire carrier operations. This is due mainly to the inflexibility created by regulatory restrictions. These restrictions affect both routes traveled and areas served in many cases. Under these conditions, the short-run opportunities for expanding the service area are rather limited for these carriers.

Generally speaking, each industry has three basic needs: (a) to accumulate its required raw materials and services at a manufacturing center; (b) to convert these resources into finished products at the manufacturing center; and (c) to distribute the finished products from the manufacturing center to the various market outlets. Transportation is required in the first and third of these processes.

In certain cases the distribution process may be carried out in separate stages. In these instances the products are first moved from the manufacturer to wholesalers, jobbers or other distribution centers from which they are then shipped to the retail outlets. Consumers then usually assume the burden of transporting the goods from the retail store to their final place of consumption.

The particular operation under consideration in this paper is a merchandising firm with a regional distribution center, located in Dallas, from which its products are distributed to retail outlets. This final movement may be either by way of common carriers of general freight or by the firm's private fleet of trucks.

The following discussion is divided into three parts, each showing a way in which time savings might be of value to such a firm. The first part shows how time savings might be of value to a firm if such savings allowed the firm to supply more of their retail outlets with their private fleet, rather than having to use for-hire carriers. The second part shows how the firm might use time savings to supply increased business to existing retail outlets. The third part shows how time savings might, in certain restricted cases, allow a firm to locate new retail outlets in previously unprofitable locations.

General Value of Time Savings Under Present Operations

Under present operations, time savings would be of value to the private fleet by allowing them (a) to increase the use of their own trucks (instead of for-hire carriers) in hauling products to their retail outlets, and (b) to operate this mileage at reduced costs. It is assumed that the number of miles operated by both for-hire carriers and by the private fleet, in serving the retail outlets, remains constant. That is, the amount of products carried to the retail outlets is assumed to remain constant, and the number of miles operated in carrying these products is likewise assumed to remain constant. The total transportation costs per year paid by the merchandising firm to serve its retail outlets are given by:

$$E_t = r(B) + c(D) \tag{4}$$

where

E_t = total transportation expenses per year;
r = common carrier rates per mile (although common carrier rates are not given in mileage figures, it is possible to develop such an average figure for known operations over a period of time);
c = private carrier costs per mile of operation;
B = miles operated by common carriers of general freight for the merchandising firm; and
D = miles operated by private fleet of the merchandising firm.

When the merchandising firm's potential miles operated by its private fleet increases (ΔD) due to time savings (due to increased speeds on the Interstate System) utilized, the

miles operated for the firm by common carriers of general freight will decrease by an equal amount ($\Delta B \equiv -\Delta D$, recalling the assumption that total miles operated per year remain constant). Furthermore, these changes in mileage will be accompanied by a change in total transportation expenses (ΔE_t), since r and c, or r and (c - s) below, are not equal:

$$E_t + \Delta E_t = r(B - \Delta D) + c(D + \Delta D) \tag{5}$$

Subtracting Eq. 4 from Eq. 5 gives Eq. 6 which shows the change in total expenses which results from the increase in miles operated by the private fleet and the decrease in miles operated by common carriers for the firm:

$$\Delta E_t = r(-\Delta D) + c(\Delta D) \tag{6}$$

However, since the additional mileage operated by the private fleet is accomplished with the same number of operating hours, the expenses for the private fleet on the additional mileage are not equal to c; rather, they are equal to the private carrier costs per mile before time savings occurred (c) less selected expenses per mile (designated hereafter as s) not occurring on the additional mileage. The reasoning used here is identical to that used in the discussion of commercial haulers. Using (c - s) to represent the expenses per mile on the additional private carrier miles operated, Eq. 7, showing the change in total transportation expenses from both the changeover from common carrier to the private fleet and the reduced expenses on the additional mileage, is obtained:

$$\Delta E_t = r(-\Delta D) + (c - s)(\Delta D) \tag{7}$$

There exist various impediments to changing from common carrier to the private fleet (such as rescheduling, route and load limitations) and other institutional factors prohibiting maximum savings of selected expenses on additional mileage (such as drivers paid on mileage basis and equipment utilization). Therefore, the total expense change will be less than ΔE_t. The actual change in total expenses ($\Delta E_t'$) will be represented as 50 percent of the potential change (ΔE_t), a percentage lower than that for private carriers in general[1] due to the particular institutional factors present in this firm's operation:

$$\Delta E_t' = \frac{\Delta E_t}{2} = \frac{r(-\Delta D)}{2} + \frac{(c - s)(\Delta D)}{2} \tag{8}$$

The change in the total miles operated by the private fleet (ΔD) may be derived from the following formula:

$$\Delta D = p(D)/S_o\,(S_i - S_o) \tag{9}$$

where

- D = total miles operated per year by the private fleet;
- p = ratio of miles operated in 1961 on roads which will be part of the Interstate Highway System to the total miles operated on all roads during 1961;
- S_o = the average speed of the private fleet during 1961;
- S_i = the estimated speed of the private trucks while operating on the Interstate System; and
- ΔD = the potential increase in total miles operated by the private fleet due to increased speed on the Interstate System, assuming the same number of driving hours by the private fleet.

Substituting the value for ΔD from Eq. 9 into Eq. 8 gives:

$$\Delta E_t' = \frac{r[(-pD/S_o)(S_i - S_o)]}{2} + \frac{(c - s)[(pD/S_o)(S_i - S_o)]}{2} \tag{10}$$

[1] See the discussion of private carriers in Net Operating Revenue Approach.

The total savings per year ($\Delta E_t'$) may be transformed into value per hour of time saved on Interstate highways (H_S) by Eq. 11 or into savings per potential mile saved on Interstate highways (M_S) by Eq. 12:

$$H_S = \Delta E_t'/(\Delta D/S_i) \quad (11)$$

$$M_S = H_S/S_i \quad (12)$$

The change in total transportation expenses per year due to increased speeds of operation ($\Delta E_t'$) may be obtained by using Eq. 10 together with the following information: r = \$0.46995; p = 0.6532; D = 4,517,824 miles; S_o = 38.011 mph; c = \$0.33144; and s = \$0.14187.

The common carrier rates per mile(r), obtained from the private firm under consideration, which has been developed from past years' operations. The firm has kept records showing the cost of using common carriers instead of the private fleet; the common carrier rates have averaged 1.4179 times as much per mile as the cost of hauling the same goods with the private fleet (1.4179 times \$0.33144 equals \$0.46995). All the other statistics are taken from the records of the firm under consideration for the year ended 1961. The p and S_o are taken from a sample of all trips dispatched during 1961. All other statistics cover the entire year's operation. The derivation of cost of selected expenses per mile is shown in Table 13.

Since the operating speed on the Interstate System may not yet be determined accurately, the values of time saved are computed for increased speeds varying from 39 to 45 mph. For each of these speeds, Table 14 gives a total yearly change in transportation expenses, value per hour or time saved on Interstate highways, and savings per potential mile saved on Interstate highways. After the average operating speed on the Interstate System has been ascertained, the value of time savings per year, hour, and mile may be approximated by simply referring to the speed in the table. (If the speed differs from the values shown in the table, then other values may be readily computed by use of their given formulas.) For example, the value of one hour of time saved on Interstate highways at an average speed of 42 mph is worth approximately \$5.89.

Extension of Market Area

The merchandising firm under consideration has a central distribution center located in Dallas from which it serves its many retail outlets located in Texas, Louisiana, Oklahoma, and New Mexico. In the previous section it was shown how the firm could utilize time savings and supply more of its retail outlets with its private fleet rather than having to use for-hire transportation. However, the firm does not necessarily have to utilize all of its time savings strictly in this manner, since there are other economically feasible means of using time savings.

One very significant way in which a private firm may utilize its time savings is through an extension of its area of influence or market area. Using the same amount of equipment, a firm benefiting from time savings may extend its market area by an amount equal to the distance traveled in the same time (which is equal to average speed on the improved highways times the amount of time saved). This extension of market area is possible at reduced costs and with the same amount of operating equipment. Since the firm may supply this extended market area at reduced costs, it may either take these reduced costs strictly in the form of profits or by reducing prices, sell more products (assuming more will be bought at lower prices) at reduced prices. Clearly, an economical decision would depend on the elasticity of demand and the economies of scale in any particular case. The firm's profits may be represented by the cost savings (the extra distance operated times the selected expenses not occurring on this additional mileage which is operated in the same amount of driving time with the same amount of equipment) and would also be determined by the demand conditions and economies of scale present in any particular case.

Figures 1 through 5 show the retail outlets of the large merchandising firm under consideration. All of the retail outlet locations shown are now served, at least par-

TABLE 13

SELECTED LINE-HAUL EXPENSES FOR LARGE MERCHANDISING FIRM OPERATING IN TEXAS, LOUISIANA, OKLAHOMA, AND NEW MEXICO PRIVATE FLEET RECORDS FOR YEAR ENDED DECEMBER 31, 1961

Expense	Selected Expense per Mile ($)	Line-Haul Percentage Allocated	Line-Haul Amount ($)
Drivers' wages	0.131506	100.00	0.131506
Workmens' compensation	0.000027	83.05	0.000022
Vehicle license and registration fees	0.008790	100.00	0.008790
Social security taxes	0.007846	19.72	0.001547
Total			0.141865

TABLE 14

VALUE OF TIME SAVINGS TO MERCHANDISING FIRM AT DIFFERENT SPEEDS

S_i (mph)	$\Delta E_t'$ ($)	H_S ($)	M_S ($)
39	10,764.14	5.4674	0.1401
40	21,648.00	5.6075	0.1401
41	32,531.86	5.7477	0.1401
42	43,415.72	5.8879	0.1401
43	54,299.58	6.0281	0.1401
44	65,183.44	6.1683	0.1401
45	76,067.31	6.3085	0.1401

tially, by the private fleet. Still other locations are served exclusively by common carrier. The light circular lines show the area within which the firm can now operate within designated layover-time distances. (Layover-time distances used here are defined most simply as the distance that can be driven in 10 hours.) The distance which may be traveled within a no-, one-, or two-layover period is determined by multiplying 10, 20, or 30 hours by the average speed for each region. The round trip distance traveled within any driving period is divided by two to determine the radius of market influence. The area of market extension, which may be served at reduced costs, is the area between the light and dark circular lines. The dark circular lines on the five maps are determined in a manner similar to the lighter lines; the dark lines merely represent a higher rate of speed (assumed to be 45 mph on the Interstate highways), whereas the lighter lines represent the average speed now being experienced in a particular operating region.

The foregoing relationship shows how a firm might choose to use its time savings in extending its market area and use the increased capacity of its private fleet to serve increased business. The firm may extend this area of influence by increasing the area as described, or it may simply increase the supply to the existing market area at reduced costs. Under conditions approaching pure competition, the former would have to be the more likely alternative, since in the absence of strong monopoly advantages, the firm would attempt to expand its operation to the point where marginal cost became equated with marginal revenue. This would mean, in effect, that a firm would continue to expand its area until the additional income derived from operating the last unit would be just equal to the additional costs incurred in its operation.

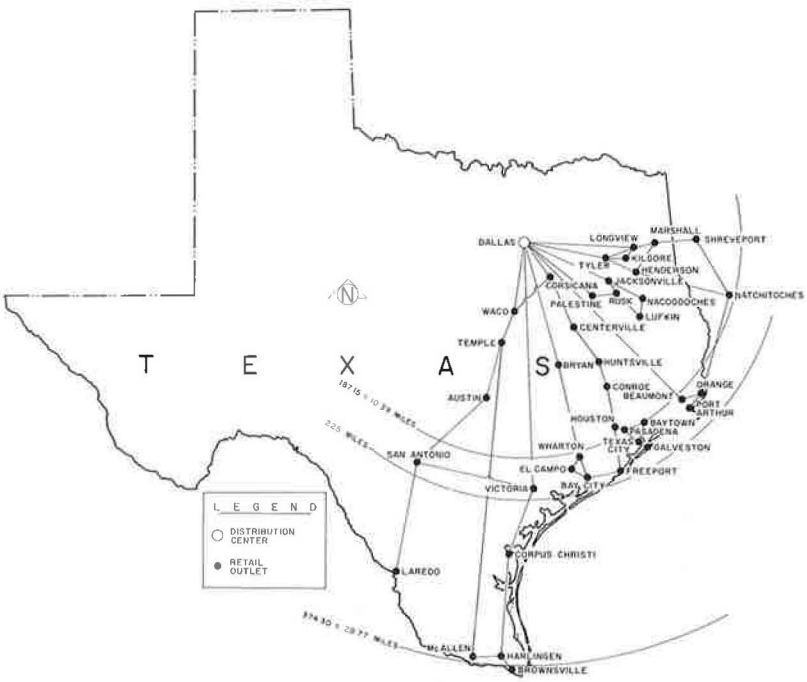

Figure 1. Existing and potential market area radius retail outlets of merchandising firm in east and south Texas.

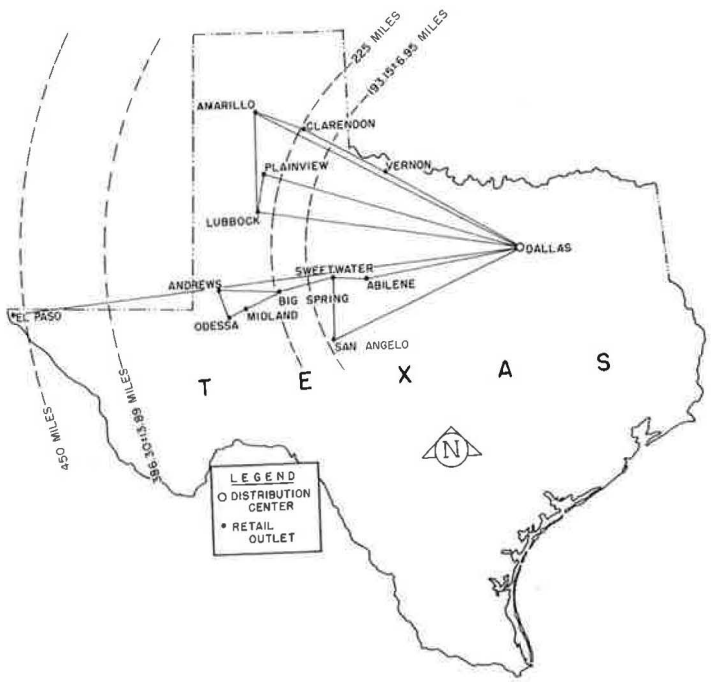

Figure 2. Existing and potential market area radius retail outlets of merchandising firm in north and west Texas.

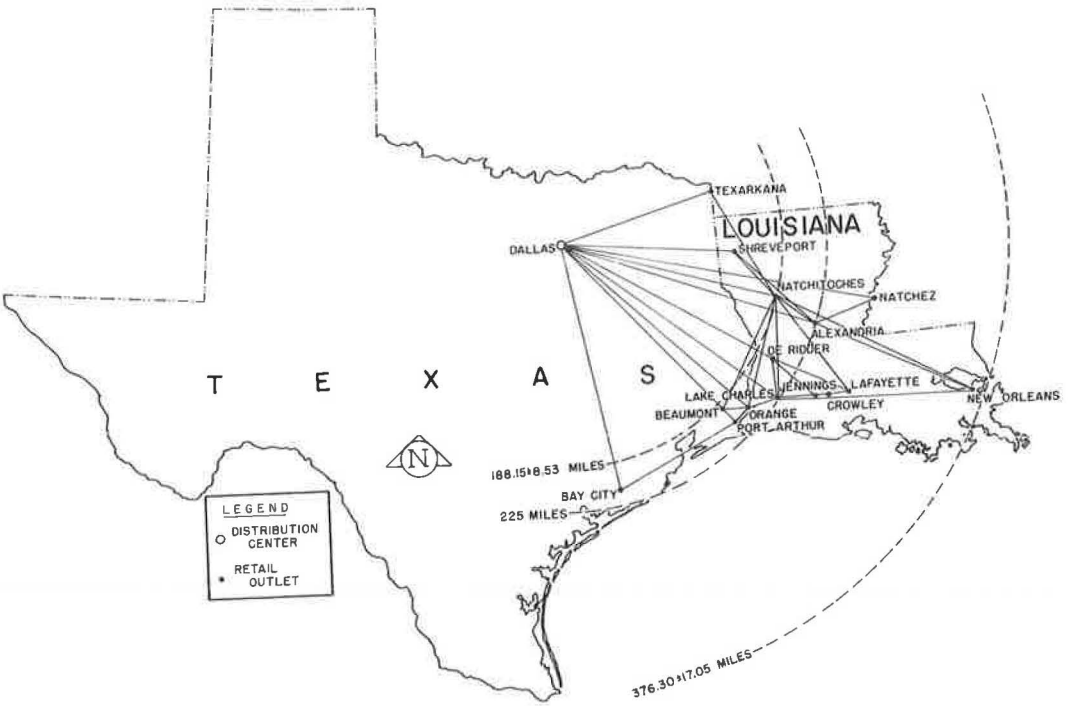

Figure 3. Existing and potential market area radius retail outlets of merchandising firm in Louisiana.

Market Area and Plant Location

Just as the market area served by the private fleet might be extended through increasing business in existing market areas, in some cases the market area served by the private fleet may be extended through new plant locations. These locations would be possible when time savings reduced costs to an extent where submarginal outlets became profitable.

The merchandising firm's marketing division determines the location of new retail outlets by determining the costs to serve a particular area and analyzing those factors which generally represent adequate demand, as shown by competitors, consumer purchasing power, etc. This firm has expanded its operations in the various regions to where all retail outlets now designated as profitable are served. Further expansion will be determined by whether either demand or costs change to an extent which will permit the location of new retail outlets. Such a possible change in costs could come through reduced transportation costs incurred in serving a particular location. In general, the total costs of the firm to supply a given product to a particular retail outlet is comprised of the costs of the product at the distribution center, the cost of transporting the product to the retail outlet (the distance from the distribution center to the retail outlet in miles times the transport costs per mile) and the costs of selling the good at the retail outlet. If the retail price that can be charged for the product is larger than total costs at a particular location, then this location is considered, from the cost situation, to be a suitable, profit-making location. Stated in more general terms, contemporary location theory states that if all costs other than transportation costs are constant, then location will be oriented toward points of minimum transport costs.

As was mentioned in the preceding analysis, Figures 1 through 5 show the various retail outlets served by the private trucking fleet of the firm under consideration.

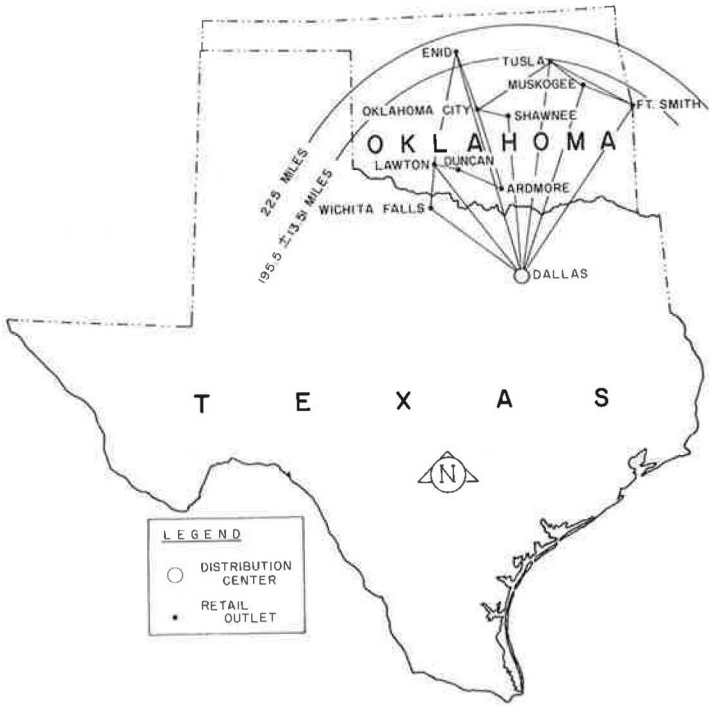

Figure 4. Existing and potential market area radius retail outlets of merchandising firm in Oklahoma.

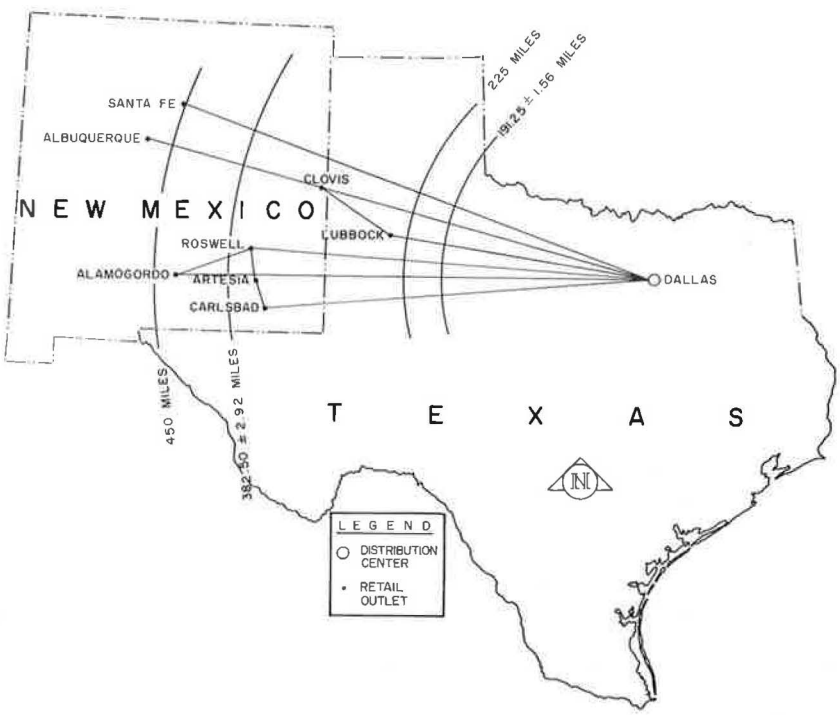

Figure 5. Existing and potential market area radius retail outlets of merchandising firm in New Mexico.

Also, it was shown how the firm might extend its market area served by private carriage through increasing the volume carried to existing stores. Other than the savings which would come from increasing the volume carried to existing stores, the firm might extend its market area by opening new outlets.

As was shown in the preceding analysis, time savings enable a firm to expand its operations at reduced costs. Whenever these costs are reduced enough to allow new retail outlet locations to become profitable, it may be said that the time savings take the value of the profits of these new outlets.

Clearly a variety of factors, many of which are somewhat intangible and have no readily assignable dollar value, must be taken into account in any decision on plant location. This report does not attempt to analyze all the various expenses of the potential retail outlets, but rather it outlines the conditions under which time savings might permit an extension of the market area of a firm.

ACKNOWLEDGMENTS

This paper is based on a study conducted by C. R. Haning and W. F. McFarland of the problems involved in determining the value of time saved to commercial motor vehicles through use of improved highways. The study was sponsored by the U. S. Bureau of Public Roads and was completed in 1963. A report was prepared and published in October 1963, as TTI Bulletin No. 23. The material in this paper was taken from that report.

REFERENCES

1. Aldrich, Lloyd. The Economy of Freeways. City of Los Angeles, Street and Parkway Design Division, June 1953.
2. Claffey, Paul J. Characteristics of Passenger Car Travel on Toll Roads and Comparable Free Roads. Highway Research Board Bull. 306, pp. 1-22, 1961.
3. Claffey, Paul J. Time and Fuel Consumption for Highway User Benefit Studies. Highway Research Board Bull. 276, pp. 20-34, 1960.
4. Fetter, Frank A. The Economic Law of Market Areas. Quarterly Jour. of Econ., Vol. 38, p. 525, May 1924.
5. Green, Forest H. The Value of Time Saved by Commercial Vehicles, as a Result of Highway Improvements. Unpublished report, U. S. Bureau of Public Roads, June 1960.
6. Hyson, C. D., and Hyson, W. P. The Economic Law of Market Areas. Quarterly Jour. of Econ., Vol. 64, p. 319, May 1950.
7. Isard, Walter. Location and Space Economy. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York and London, 1960.
8. Isard, Walter. Methods of Regional Analysis: An Introduction to Regional Science. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York and London, 1960.
9. Kent, Malcolm F. Fuel and Time Consumption Rates for Trucks in Freight Service. Highway Research Board Bull. 276, Jan. 1960.
10. Lang, A. S., and Robbins, D. H. A New Technique for Predicting Vehicle Operating Cost. Highway Research Board Bull. 308, pp. 19-35, 1962.
11. Lawton, Lawrence. Evaluating Highway Improvements on Mileage-and-Time-Cost Bases. Traffic Quarterly, pp. 102-125, Jan. 1950.
12. Saal, Carl C. Time and Gasoline Consumption in Motor Truck Operation. Highway Research Board Res. Rept. No. 9-A, 1950.
13. Sawhill, Roy B., and Firey, Joseph C. Motor Transport Fuel Consumption Rates and Travel Time. Highway Research Board Bull. 276, pp. 35-91, 1960.
14. Torgerson, Warren S. Theory and Methods of Scaling. New York, John Wiley and Sons, 1958.
15. Winfrey, Robley. Gasoline Consumption, Weight and Mileage of Commercial Vehicles. Highway Research Board Bull. 92, pp. 35-48, 1954.

Highway Ton-Miles

ALEXANDER FRENCH
Chief, Planning Services Branch, Current Planning Division, U.S. Bureau of Public Roads

Highway ton-mile estimates are used as a measure of highway use and service provided for goods movements by highway transportation. Comparisons are made between highway systems, with other modes of transportation, with previous years to determine trends, and between segments of the motor carrier industry. This paper describes the procedures for estimating highway ton-miles, discusses problems involved in analysis, and compares highway ton-miles with similar values for other modes of transportation. Additional information on truck travel obtained during 1963 is also presented for study in resolving some of the problems.

•ESTIMATES OF ton-miles of goods hauled on rural highways have been made by the U.S. Bureau of Public Roads since 1929. Until 1936, however, the estimates were limited to all rural roads and were made from a very small statistical sample with practically no information to indicate urban travel or the proportion on local rural roads separately from main rural roads. The initiation of the statewide highway planning studies in 1936 and the subsequent annual programs provided the necessary information to make separate estimates for main and local rural roads. It was not until 1957 that adequate information on urban streets was obtained for estimating ton-miles in urban as well as rural areas.

Since 1939 the Interstate Commerce Commission (ICC) has been making estimates of intercity ton-miles of truck travel as part of its responsibility of obtaining information concerning that segment of highway transportation in interstate commerce.

The need to determine the components of the highway cargo movement so that intercity ton-mile trends could be checked, compared with other modes, and carried forward with greater confidence was recognized by the U.S. Bureau of Public Roads, ICC, the Bureau of the Budget and other agencies involved in estimating and using data for annual ton-miles. The U.S. Bureau of Public Roads obtained additional special information as part of its responsibility for estimating highway ton-miles. The data were obtained during the 1963 annual truck weight study conducted in cooperation with state highway departments.

PROCEDURES FOR ESTIMATING HIGHWAY TON-MILES

The annual highway ton-mile estimates published by the U.S. Bureau of Public Roads (1) and ICC (2) are both based primarily on truck weight data obtained from roadside sample surveys conducted by the state highway departments as part of their highway planning programs. This roadside weighing of trucks involves the sampling of a statistical population of vehicle-miles of truck travel. For other modes, where practically all carriers are in the "regulated" category, intercity ton-mile estimates are based on samples from a statistical population of shipments.

The ton-mile estimates are based on three categories of data. Total vehicle-miles for all vehicle types combined are the first basic element. Vehicle type classification counts are next used in apportioning the total vehicle-miles to each vehicle type.

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 44th Annual Meeting.

Finally, the truck weight data are used to estimate the ton-miles hauled by each vehicle type. Since all three of these elements are interdependent, adjustment procedures have been developed to assure consistent relationships. The estimates of total vehicle-miles for all vehicle types are based on annual trends in highway traffic at over 2,000 locations on all classes of roads and streets at which traffic is counted continuously, highway motor fuel consumption determined from tax records, and motor vehicle registration data for each state. Vehicle type classification data are obtained by manual counts conducted at locations on rural roads and urban streets. Classification counts are conducted each year as a part of the annual truck weight operations, but in most states these counts represent only a small part of the classification count program. The scale weights of loaded and empty vehicles of each type are obtained at the roadside during the annual truck weight studies.

The ton-miles of cargo hauled by each vehicle type are estimated using the procedure indicated by the equation,

$$TM_v = VM_v \times P_l \times (\overline{W}_l - \overline{W}_e) \qquad (1)$$

where

TM_v = ton-miles of cargo hauled by vehicle type;
VM_v = total vehicle-miles of travel by vehicle type;
P_l = percentage of trucks of type loaded;
$\overline{W}_l$ = mean (average) weight of loaded vehicles for vehicle type (tons); and
$\overline{W}_e$ = mean weight of empty vehicles for vehicle type (tons).

The term $(\overline{W}_l - \overline{W}_e)$ is the average carried load. This factor, when multiplied by the percent loaded (P_l), is referred to as the loading factor $P_l (\overline{W}_l - \overline{W}_e)$ since multiplying this factor times vehicle-miles results in estimated ton-miles hauled.

The ICC estimates are based on the Public Roads main rural road ton-miles values adjusted to remove that portion resulting from entirely rural movements and to add the estimated ton-miles resulting from that portion of the intercity movement occurring within urban areas.

ANALYSIS AND PROBLEMS IN ANALYSIS

Tables 1 and 2 show 1962 data for truck vehicle-miles, percent loaded, average carried load, loading factor, and carried load in ton-miles by vehicle type for each census division. Similar estimates have been made each year in preparing ton-mile figures for all rural roads and all roads and streets since 1957. The United States total and census division values are first estimated from the individual state truck weight reports. Slight adjustments are sometimes necessary to bring the estimates of truck vehicle-miles into agreement with travel estimates of all vehicle types and with fuel consumption by vehicle types. The state volumes are then adjusted if necessary by a factor for each census division relating the sum of the state values to the estimated census division value. Because of this adjustment and since both loading and vehicle-mile estimates for a few states are based on rather limited data, individual state estimates are not considered statistically reliable and, hence, are not published.

The Public Roads ton-mile estimates for main rural roads since 1939 and for total rural and urban since 1957 are compared by years with the ICC intercity ton-mile values in Table 3 and Figure 1. The similarity in pattern between these estimates is evident. It is also significant that the intercity volume amounts to approximately 90 percent of the total rural and urban ton-miles since 1957 when the reliable urban estimates were first available.

Since 1957 when information was first available on haulage in urban areas, the urban proportion has approximated 25 percent of all highway freight transportation.

TABLE 1

TRAVEL, LOADING CHARACTERISTICS, AND TON-MILES HAULED ON MAIN RURAL ROADS, 1962[a]

Vehicle Classification	New England	Middle Atlantic	South Atlantic (North)	South Atlantic (South)	East North Central	West North Central	East South Central	West South Central	Mountain	Pacific	All Divisions Avg.	All Divisions Total[b]
(a) Travel, Loaded and Empty (veh-mi, millions)												
Single units:												
Panel and pickups	619	2,056	1,620	3,304	3,095	2,593	2,458	4,587	2,423	3,003	-	25,758
2 axle - 4 tire	191	520	286	199	406	160	293	37	200	92	-	2,384
2 axle - 6 tire	681	1,736	1,247	1,764	2,517	1,483	1,593	1,607	814	871	-	14,313
3 axle	107	299	237	253	320	216	133	214	112	207	-	2,098
Total	1,598	4,611	3,390	5,520	6,338	4,452	4,477	6,445	3,549	4,173	-	44,553
Semitrailer combinations:												
2S1 - 3 axle	212	579	158	368	1,049	274	251	421	193	183	-	3,688
2S2 - 4 axle	352	2,096	910	1,832	2,428	761	1,103	982	227	141	-	10,832
2S3 - 5 axle	47	76	113	83	953	822	214	1,248	947	748	-	5,251
Total	611	2,751	1,181	2,283	4,430	1,857	1,568	2,651	1,367	1,072	-	19,771
(b) Vehicles Carrying Loads (%)												
Single units:												
Panel and pickups	46.2	49.2	35.0	40.0	61.3	48.2	53.0	38.4	52.9	43.0	46.5	-
2 axle - 4 tire	62.3	64.0	62.0	64.9	72.0	65.3	71.2	61.8	56.8	67.5	65.5	-
2 axle - 6 tire	57.6	57.5	65.5	59.1	71.1	67.2	63.7	62.9	70.0	63.1	64.2	-
3 axle	54.8	56.6	52.9	54.1	64.5	60.8	58.5	66.8	56.1	46.9	57.6	-
Total	53.6	54.5	49.7	47.6	66.0	55.7	58.2	45.6	57.2	47.9	53.7	-
Semitrailer combinations:												
2S1 - 3 axle	61.7	65.6	69.8	62.9	60.4	66.4	68.5	60.0	73.1	78.2	64.4	-
2S2 - 4 axle	67.6	62.7	70.4	61.7	69.4	63.9	67.5	64.4	63.5	70.8	65.7	-
3S2 - 5 axle	58.2	63.7	50.3	58.3	69.1	72.4	69.5	71.1	75.8	72.5	71.1	-
Total	64.8	63.3	68.4	61.8	67.2	68.0	67.9	66.9	73.4	73.2	66.9	-
(c) Avg. Carried Load (tons)												
Single units:												
Panel and pickups	0.74	0.40	0.55	0.63	0.65	0.84	0.92	1.18	0.95	0.99	0.82	-
2 axle - 4 tire	1.41	0.84	0.61	0.93	0.91	1.01	0.96	2.22	1.46	1.02	0.98	-
2 axle - 6 tire	3.04	2.96	4.20	3.94	3.77	3.73	4.58	5.88	3.91	4.65	4.09	-
3 axle	8.53	10.79	12.04	12.66	12.10	11.23	13.97	12.59	11.58	10.46	11.72	-
Total	2.42	2.18	3.18	2.58	2.57	2.56	2.74	3.36	2.14	2.45	2.64	-
Semitrailer combinations:												
2S1 - 3 axle	6.10	5.76	6.92	6.12	6.68	6.34	6.72	6.32	6.67	5.80	6.34	-
2S2 - 4 axle	11.40	12.20	13.44	12.56	12.78	12.12	13.22	12.15	11.17	9.31	12.51	-
3S2 - 5 axle	16.50	11.38	15.04	15.08	19.08	16.77	16.42	14.39	15.21	17.40	16.27	-
Total	10.01	10.77	12.66	11.59	12.88	13.48	12.62	12.44	13.43	14.26	12.46	-
(d) Loading Factors (% vehicles carrying loads x avg. carried load)												
Single units:												
Panel and pickups	0.342	0.197	0.193	0.252	0.398	0.405	0.488	0.453	0.503	0.426	0.381	-
2 axle - 4 tire	0.878	0.538	0.378	0.604	0.655	0.660	0.684	1.372	0.829	0.689	0.642	-
2 axle - 6 tire	1.751	1.702	2.751	2.329	2.680	2.507	2.917	3.699	2.737	2.934	2.626	-
3 axle	4.674	6.107	6.369	6.849	7.805	6.828	8.172	8.410	6.496	4.906	6.751	-
Total	1.297	1.188	1.580	1.228	1.696	1.426	1.595	1.532	1.224	1.174	1.418	-
Semitrailer combinations:												
2S1 - 3 axle	3.764	3.779	4.830	3.849	4.035	4.210	4.603	3.792	4.876	4.536	4.083	-
2S2 - 4 axle	7.706	7.649	9.462	7.750	8.869	7.745	8.924	7.825	7.093	6.591	8.219	-
3S2 - 5 axle	9.603	7.249	7.565	8.792	13.184	12.141	11.412	10.231	11.529	12.615	11.568	-
Total	6.486	6.817	8.659	7.163	8.655	9.166	8.569	8.322	9.858	10.438	8.336	-
(e) Carried Load (ton-mi, millions)												
Single units:												
Panel and pickups	213	405	311	828	1,240	1,049	1,194	2,071	1,218	1,279	-	9,808
2 axle - 4 tire	169	278	108	120	265	106	201	50	165	64	-	1,526
2 axle - 6 tire	1,194	2,953	3,436	4,108	6,742	3,718	4,652	5,945	2,231	2,555	-	37,534
3 axle	501	1,829	1,511	1,733	2,498	1,473	1,081	1,800	730	1,013	-	14,169
Total	2,077	5,465	5,366	6,789	10,745	6,346	7,128	9,866	4,344	4,911	-	63,037
Semitrailer combinations:												
2S1 - 3 axle	796	2,187	761	1,415	4,239	1,152	1,156	1,596	941	829	-	15,072
2S2 - 4 axle	2,718	16,025	8,610	14,210	21,536	5,890	9,841	7,686	1,609	932	-	89,057
3S2 - 5 axle	451	551	854	730	12,572	9,976	2,442	12,771	10,918	9,432	-	60,697
Total	3,965	18,763	10,225	16,355	38,347	17,018	13,439	22,053	13,468	11,193	-	164,826

[a]Main rural roads consist of approximately 500,000 miles of roads of primary importance in the state highway system.
[b]For 48 states.

In rural areas where the information has been available over a longer period of time, there has been some change in the proportion of haulage over local and main rural roads. Before World War II, haulage on main rural roads amounted to about 80 percent of all rural road ton-mileage. By 1957 when extensive data were obtained for the Highway Cost Allocation Study, this had increased to about 88 percent. This reflects the increased proportion of intercity freight hauled by highway in the larger hauling units, the semitrailer, and full trailer combination, which largely operate on the main intercity routes. In terms of absolute volumes, ton-mile volumes on main and local

TABLE 2

TRAVEL, LOADING CHARACTERISTICS, AND TON-MILES HAULED ON URBAN STREETS, 1962[a]

Vehicle Classification	New England	Middle Atlantic	South Atlantic (North)	South Atlantic (South)	East North Central	West North Central	East South Central	West South Central	Mountain	Pacific	All Divisions Avg.	All Divisions Total[b]
(a) Travel, Loaded and Empty (veh-mi, millions)												
Single units:												
Panel and pickups	1,017	2,004	912	2,211	4,248	1,841	1,570	2,841	1,520	4,380	-	22,544
2 axle - 4 tire	340	566	654	397	941	116	125	139	228	352	-	3,858
2 axle - 6 tire	1,131	1,943	480	807	2,359	1,121	716	536	514	1,452	-	11,059
3 axle	157	267	171	107	220	203	45	35	82	228	-	1,515
Total	2,645	4,780	2,217	3,522	7,768	3,281	2,456	3,551	2,344	6,412	-	38,976
Semitrailer combinations:												
2S1 - 3 axle	185	464	81	84	441	98	105	63	60	151	-	1,732
2S2 - 4 axle	302	1,949	268	398	792	159	440	114	55	92	-	4,569
2S3 - 5 axle	6	130	27	36	270	211	46	173	194	175	-	1,268
Total	493	2,543	376	518	1,503	468	591	350	309	418	-	7,569
(b) Vehicles Carrying Loads (%)												
Single units:												
Panel and pickups	68.7	63.0	36.2	47.5	70.1	50.6	47.3	49.2	50.4	38.6	52.5	-
2 axle - 4 tire	61.9	72.9	56.9	68.7	70.3	65.0	58.7	55.8	61.7	75.3	66.4	-
2 axle - 6 tire	54.2	73.8	50.6	63.3	71.8	68.8	65.3	69.5	70.5	69.5	67.6	-
3 axle	58.1	68.5	41.0	50.0	69.5	63.4	68.5	61.7	55.9	51.0	59.0	-
Total	61.0	68.8	45.8	53.6	70.6	58.1	53.5	52.7	56.1	48.0	58.4	-
Semitrailer combinations:												
2S1 - 3 axle	51.5	66.3	64.3	64.9	65.6	70.1	73.2	64.5	60.5	71.9	65.2	-
2S2 - 4 axle	50.2	66.3	70.3	58.5	74.5	64.2	70.1	61.0	62.7	60.3	66.2	-
3S2 - 5 axle	69.9	66.0	59.3	45.2	60.6	67.1	69.5	67.2	73.2	62.6	65.2	-
Total	50.9	66.3	68.2	58.6	69.4	66.7	70.6	64.7	68.8	65.4	65.8	-
(c) Avg. Carried Load (tons)												
Single units:												
Panel and pickups	0.39	0.31	0.54	0.47	0.55	0.43	0.75	0.58	0.42	0.51	0.50	-
2 axle - 4 tire	0.37	0.58	0.85	0.54	0.75	1.04	0.92	1.98	1.04	0.67	0.74	-
2 axle - 6 tire	2.05	2.25	2.83	1.94	3.37	2.11	2.67	2.59	1.75	2.25	2.49	-
3 axle	7.98	7.53	8.45	6.83	7.75	8.67	8.39	10.22	7.36	6.81	7.80	-
Total	1.45	1.59	1.75	1.06	1.65	1.69	1.63	1.15	1.10	1.33	1.47	-
Semitrailer combinations:												
2S1 - 3 axle	5.53	5.00	5.66	3.42	4.89	5.24	6.78	4.99	5.80	4.09	5.05	-
2S2 - 4 axle	11.39	10.72	11.41	7.87	9.93	9.29	10.95	12.77	11.37	6.58	10.37	-
3S2 - 5 axle	5.88	12.73	14.76	12.98	15.28	13.35	13.69	13.53	13.57	13.70	13.77	-
Total	9.07	9.78	10.44	7.36	9.37	10.23	10.39	11.76	11.88	8.45	9.73	-
(d) Loading Factors (% vehicles carrying loads × avg. carried load)												
Single units:												
Panel and pickup	0.268	0.195	0.195	0.223	0.386	0.218	0.355	0.285	0.212	0.197	0.263	-
2 axle - 4 tire	0.229	0.423	0.484	0.371	0.527	0.676	0.540	1.105	0.642	0.505	0.491	-
2 axle - 6 tire	1.111	1.661	1.432	1.228	2.420	1.452	1.744	1.800	1.234	1.564	1.683	-
3 axle	4.636	5.158	3.465	3.415	5.386	5.497	5.747	6.306	4.114	3.473	4.602	-
Total	0.885	1.094	0.802	0.568	1.165	0.982	0.872	0.606	0.617	0.638	0.858	-
Semitrailer combinations:												
2S1 - 3 axle	2.848	3.315	3.639	2.220	3.208	3.673	4.963	3.219	3.509	2.941	3.293	-
2S2 - 4 axle	5.718	7.107	8.021	4.604	7.398	5.964	7.676	7.790	7.129	3.968	6.865	-
2S3 - 5 axle	4.110	8.402	8.753	5.867	9.260	8.958	9.515	9.092	9.933	8.576	8.978	-
Total	4.617	6.484	7.120	4.313	6.503	6.823	7.335	7.609	8.173	5.526	6.402	-
(e) Carried Load (ton-mi, millions)												
Single units:												
Panel and pickups	270	396	180	490	1,639	401	559	811	324	865	-	5,935
2 axle - 4 tire	78	240	315	147	498	78	68	153	146	177	-	1,900
2 axle - 6 tire	1,254	3,226	687	993	5,705	1,624	1,249	964	635	2,271	-	18,608
3 axle	731	1,378	590	364	1,184	1,115	260	223	339	790	-	6,974
Total	2,333	5,240	1,772	1,994	9,026	3,218	2,136	2,151	1,444	4,103	-	33,417
Semitrailer combinations:												
2S1 - 3 axle	525	1,536	297	185	1,413	361	524	203	212	443	-	5,699
2S2 - 4 axle	1,726	13,839	2,150	1,835	5,853	949	3,379	886	396	365	-	31,378
3S2 - 5 axle	25	1,097	232	214	2,502	1,886	434	1,573	1,922	1,501	-	11,386
Total	2,276	16,472	2,679	2,234	9,768	3,196	4,337	2,662	2,530	2,309	-	48,463

[a]Urban streets consist of approximately 470,000 miles of roads of primary importance in the state highway system or 13 percent of the total mileage.
[b]For 48 states.

rural roads have increased nearly 10 times in the last 30 years from an estimated 30 billion in 1933 to about 289 billion in 1963. The average annual increase in the last 10 years has been about 112 billion ton-miles or 6.1 percent. This is nearly twice the rate of increase in the economy of the nation as measured by the gross national product, which has been increasing, when adjusted to real values, about 3 to 4 percent per year.

TABLE 3

COMPARISONS OF HIGHWAY TON-MILE ESTIMATES[a]

Year	U.S. Bureau of Public Roads Estimates (ton-mi, millions)			ICC Estimate		
	Main Rural Rd.	All Rural Rd.	Total Rural Rd. and Urban St.	Intercity (ton-mi, millions)	Percent of Total Rural Ton-Miles	Percent of Total Rural and Urban Ton-Miles
1929	-	26,000	-	-	-	-
1930	-	24,000	-	-	-	-
1931	-	23,000	-	-	-	-
1932	-	26,000	-	-	-	-
1933	-	30,000	-	-	-	-
1934	-	33,000	-	-	-	-
1935	-	34,000	-	-	-	-
1936	28,005	34,863	-	-	-	-
1937	32,444	40,379	-	-	-	-
1938	35,696	44,728	-	-	-	-
1939	40,612	50,697	-	52,821	104.19	-
1940	46,264	57,783	-	62,043	107.37	-
1941	58,853	72,997	-	81,363	111.46	-
1942	45,839	55,722	-	59,896	107.49	-
1943	44,021	53,216	-	56,784	106.70	-
1944	44,838	54,418	-	58,264	107.07	-
1945	50,521	61,442	-	66,948	108.96	-
1946	61,084	73,706	-	81,992	111.24	-
1947	73,865	89,424	-	102,095	114.17	-
1948	83,487	100,508	-	116,045	115.46	-
1949	94,760	113,385	-	126,636	111.69	-
1950	121,091	145,488	-	172,860	118.81	-
1951	126,402	157,691	-	188,012	119.23	-
1952	132,009	163,934	-	194,607	118.71	-
1953	146,810	182,113	-	217,163	119.25	-
1954	143,901	180,270	-	213,225	118.28	-
1955	154,050	190,085	-	223,254	117.45	-
1956	171,249	210,666	-	248,846	118.12	-
1957	187,166	211,497	286,014	254,174	120.18	88.87
1958	187,886	212,904	288,307	255,544	120.03	88.64
1959	211,011	239,333	316,601	288,519	120.55	91.13
1960[a]	218,574	247,821	333,206	297,662	120.11	89.33
1961	230,455	259,527	344,423	313,141	120.66	90.92
1962	243,818	274,466	364,141	331,319	120.71	90.99
1963[b]	254,496	293,679	377,533	-	-	-

[a] Includes Alaska and Hawaii for 1960 and subsequent years.
[b] Preliminary.

TON-MILEAGE AND MODE OF TRANSPORTATION

Table 4 and Figure 2 compare estimates of ton-miles of goods movements and the percentage of the total carried by each principal mode of transportation. In this table, the highway ton-miles are those for all rural roads excluding movement on urban streets. Since World War II, although railroads have maintained approximately the same absolute volume of ton-miles, the railroad share of total ton-miles has decreased from 67 percent in 1945 to 45 percent in 1961. The highway and pipeline haulage has increased both in ton-miles and share of the total haulage. Waterways have increased total ton-miles hauled and have maintained about the same share of the total. The reliability of these comparisons, although satisfactory for an indication of general trends, is not as precise as might be desired for quantitative

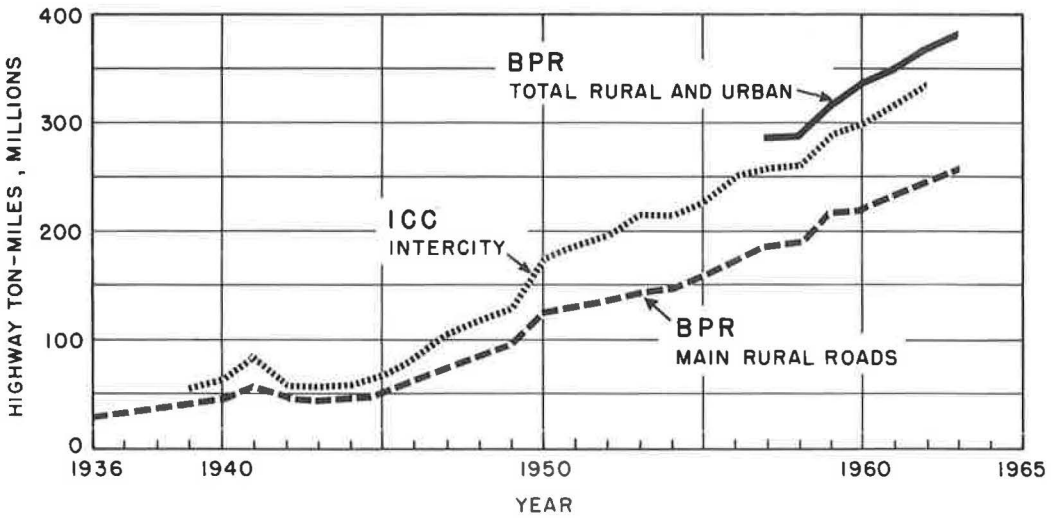

Figure 1. Comparison of trends in ton-miles hauled by highway as published by U.S. Bureau of Public Roads and ICC.

TABLE 4

TRANSPORT SERVICE BY EACH PRINCIPAL MODE OF FREIGHT TRANSPORTATION[a]

Year	Railways[b]		Highways[c]		Waterways[d]		Pipelines[e]		Airways[f]		Total (millions)
	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	Ton-Miles (millions)	Percent of Total	
1929	450,189	72.9	26,000	4.2	105,982	17.1	35,800	5.8	N.A.	<0.1	617,971
1930	385,815	73.1	24,000	4.5	86,454	16.4	31,800	6.0	0.1	<0.1	528,069
1931	311,073	73.7	23,000	5.4	56,905	13.5	31,200	7.4	0.2	<0.1	422,178
1932	235,309	72.8	26,000	8.1	32,639	10.1	29,200	9.0	0.3	<0.1	323,148
1933	250,651	68.0	30,000	8.1	55,189	15.0	33,000	8.9	0.4	<0.1	368,840
1934	270,292	68.6	33,000	8.4	57,690	14.6	33,132	8.4	0.6	<0.1	394,115
1935	283,637	67.7	34,000	8.1	68,096	16.2	33,517	8.0	1.1	<0.1	419,251
1936	341,182	66.1	34,863	6.8	92,651	18.0	47,013	9.1	1.9	<0.1	515,711
1937	362,815	64.1	40,379	7.1	110,127	19.5	52,462	9.3	2.2	<0.1	565,785
1938	291,866	64.4	44,728	9.9	66,747	14.7	49,950	11.0	2.7	<0.1	453,294
1939	335,375	62.4	50,697	9.4	96,249	17.9	55,602	10.3	3.3	<0.1	537,926
1940	375,369	61.5	57,783	9.5	118,057	19.3	59,277	9.7	4.4	<0.1	610,490
1941	477,576	62.9	72,997	9.6	140,454	18.5	68,428	9.0	6.7	<0.1	759,462
1942	640,992	69.6	55,722	6.1	148,565	16.1	75,087	8.2	14.1	<0.1	920,380
1943	730,132	71.4	53,216	5.2	141,652	13.8	97,867	9.6	18.8	<0.1	1,022,886
1944	740,586	68.7	54,418	5.1	150,155	13.9	132,864	12.3	20.9	<0.1	1,078,044
1945	684,148	67.4	61,442	6.0	142,737	14.1	126,530	12.5	26.6	<0.1	1,014,884
1946	594,943	67.0	73,706	8.3	123,973	13.9	95,727	10.8	44.8	<0.1	888,394
1947	657,878	65.8	89,424	9.0	146,714	14.7	105,161	10.5	71.6	<0.1	999,249
1948	641,104	62.7	100,508	9.8	161,846	15.8	119,597	11.7	108.1	<0.1	1,023,163
1949	529,111	59.0	113,385	12.6	139,396	15.6	114,916	12.8	130.2	<0.1	896,938
1950	591,550	57.5	145,488	14.1	163,344	15.9	129,175	12.5	159.7	<0.1	1,029,717
1951	649,831	56.9	157,691	13.8	182,216	16.0	152,115	13.3	153.5	<0.1	1,142,007
1952	617,942	55.8	163,934	14.8	168,367	15.2	157,502	14.2	172.6	<0.1	1,107,918
1053	608,954	52.3	182,113	15.7	202,439	17.4	169,884	14.6	191.9	<0.1	1,163,582
1954	552,197	50.9	180,270	16.6	173,679	16.0	179,203	16.5	204.8	<0.1	1,085,554
1955	626,893	50.7	190,085	15.4	216,508	17.5	203,244	16.4	247.4	<0.1	1,236,977
1956	651,188	49.6	210,666	16.1	219,978	16.8	229,959	17.5	268.5	<0.1	1,312,060
1957	621,907	48.3	211,497	16.4	231,792	18.0	222,728	17.3	295.0	<0.1	1,288,219
1958	554,534	47.5	212,904	18.2	189,016	16.2	211,289	18.1	319.9	<0.1	1,168,063
1959	578,637	46.6	239,333	19.3	196,559	15.8	226,991	18.3	372.7	<0.1	1,241,893
1960	575,360	45.2	247,821	19.5	220,253	17.3	228,626	18.0	414.4	<0.1	1,272,474
1961	566,295	44.6	259,527	20.5	209,706	16.5	233,172	18.4	482.1	<0.1	1,269,182
1962	595,774	44.7	274,466[g]	20.6	223,089	16.8	237,723	17.9	581.2	<0.1	1,331,633
1963	625,175	44.5	293,679[g]	20.9	234,172	16.7	250,319	17.8	629.1	<0.1	1,403,969

[a]Data for Alaska and Hawaii included beginning 1960.
[b]ICC, Statistics of Railways in the United States, Class I and II Railroads.
[c]U.S. Bureau of Public Roads; estimates include all travel of all kinds and sizes of trucks on rural roads.
[d]U.S. Army Board of Engineers for Rivers and Harbors; includes traffic on Great Lakes and inland waterways.
[e]Data from 1939 to present, ICC; from 1929 through 1938 by H. E. Hale using American Petroleum Institute data.
[f]Federal Aviation Agency, Statistical Handbook of Aviation; data include domestic freight, express, and excess baggage.
[g]Preliminary.

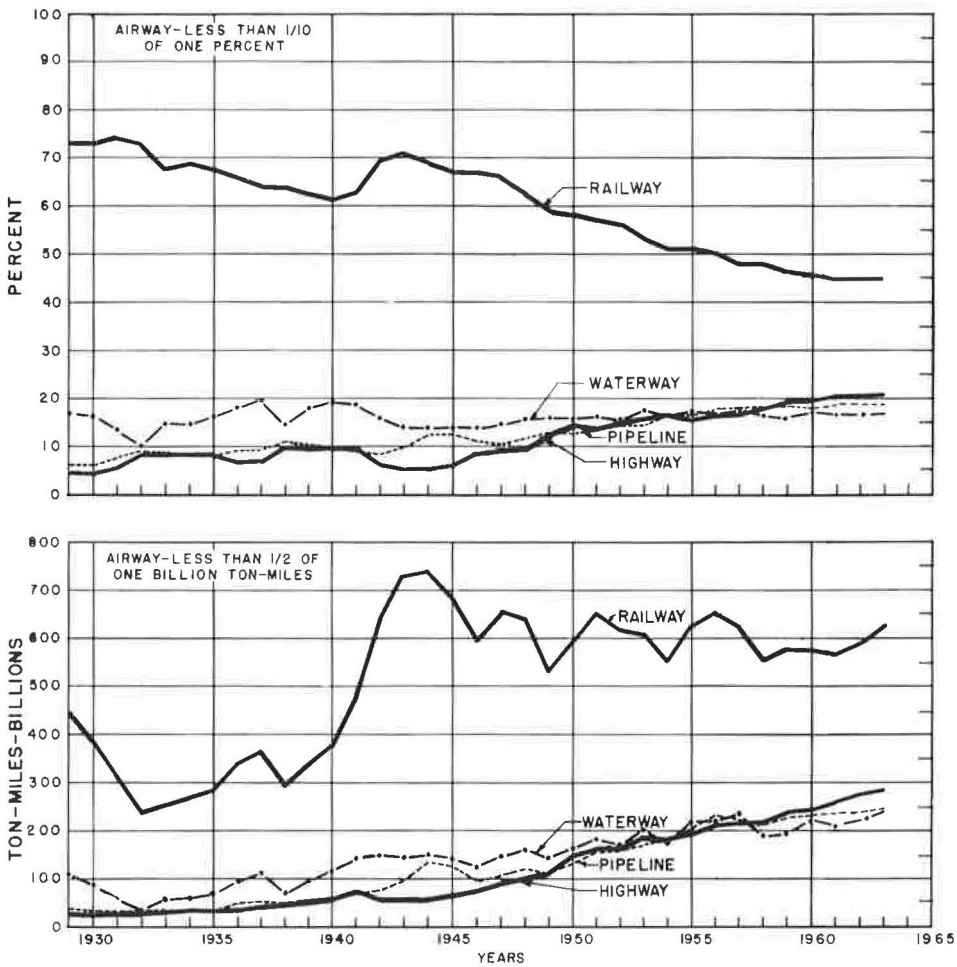

Figure 2. Transport service by mode.

measurement. This is due in part to the different characteristics of operation of each mode and in part to differences in methods used in obtaining source data and in subsequent analysis.

THE 1963 TRUCK WEIGHT SURVEY

In an effort to learn more about the nature of highway transportation—commodities hauled, trip lengths, class of operation, class of origin and destination, type of trip and loading—additional inquiries were made at the weighing of each vehicle and special tabulating cards were prepared by the state highway departments as a part of the annual 1963 truck weight survey (3). Table 5 shows the column arrangement and items of data coded in each card field. Detailed definitions and descriptions of the trip characteristics codes are given in the Appendix. Usage data for more than 217,000 cargo vehicles were obtained at a total of 778 locations in 50 states. Of these, 622 were on rural highways and 156 were in urban locations. Data for these special trip characteristics were subsequently tabulated and analyzed.

To obtain a reliable basis for comparisons, the data were grouped by census divisions and analyzed by vehicle type. Since the roadside weighing procedure involved sampling on the basis of vehicle-miles, the estimated vehicle-miles of travel by vehicle type, highway system, and state were used as the sampling strata to expand the

TABLE 5

ARRANGEMENT OF DATA IN NUMBER 7 TRUCK WEIGHT TABULATING CARD FOR SPECIAL TRUCK TRIP CHARACTERISTICS STUDY

Column	Item
1	Card No. 7, code 7.
2- 3	State.
4- 5	Station number.
6- 7	Highway system (01 thru 12 to indicate administrative system and rural or urban).
8-11	Date: month (columns 8-9), day (columns 10-11).
12-13	Hour of day (using 24-hr clock, 1:00 to 1:59 p. m., coded 13).
14	Direction of travel (1—northbound, 2—east, 3—south, 4—west, 5—NE, etc.).
→15-16	Vehicle type (based on axle and wheel arrangement, 12 principal types).
17-18	Body type.
19	Class of operation (0—not determined, 1—private, 2—ICC, 3—other for hire).
20-22	Commodity (Freight Commodity Statistics Classification, 1954, as amended).
→23	Loading and trip type (0 through 9 to indicate loaded or empty and line haul, pickup and delivery, etc.).
→24-27	Class of origin (columns 24-25) and destination (columns 26-27) (codes 00 through 13 to indicate transfer from other modes, warehouse, factory, mine, home, etc.).
28-29	Origin state.
30-32	Origin county.
33-35	Origin city.
36	Origin in or near the city.
37-38	Destination state.
39-41	Destination county.
42-44	Destination city.
45	Destination in or near the city.
46-49	Driver's estimate of trip length in miles.
50-52	Weight of axle A in hundreds of pounds.
53-55	Weight of axle B in hundreds of pounds.
56-58	Weight of axle C in hundreds of pounds.
59-61	Weight of axle D in hundreds of pounds.
62-64	Weight of axle E in hundreds of pounds.
65-67	Weight of axle F in hundreds of pounds.
68-70	Weight of axle G in hundreds of pounds.
71-74	Total weight of vehicle in hundreds of pounds.
75-79	Serial number.
80	Trailer card control.

data by vehicle type, class of operation, loading and trip type, and class of origin and destination for this part of the study. Analysis of data obtained in 1957 for the Highway Cost Allocation Study indicated that in most cases, differences in average carried load when related to type of service are small for a particular vehicle type. Therefore, differences in loading have small effects on the proportion of ton-miles hauled by a particular vehicle type in any category, and the proportion of ton-miles of commodities hauled by loaded vehicles of a particular type are proportional to vehicle-miles of travel. An indication of proportionate ton-miles can be obtained by multiplying

vehicle-miles of travel for loaded vehicles of a type by the average carried load for that vehicle type shown in Table 1. In this way, an indication of the approximate proportion of ton-miles in that particular category can be obtained for several vehicle types combined. The effects of differences in the average loads carried by each vehicle type related to category of service will be investigated in a subsequent analysis. Another simplification for the purpose of this report was the elimination of combinations larger than the 3S2. Figure 3 illustrates the vehicle types included in this analysis. Those combinations not included account for approximately 8 percent of all highway ton-miles hauled in the nation and will be analyzed later since their contribution is proportionately much greater in the areas where they are used and, in some cases, may provide a helpful indication of future trends.

CHARACTERISTICS OF TRIP AND LOADING

The rural and urban travel characteristics of the four types of single unit trucks and the three principal types of semitrailer combinations are summarized in Table 6 and Figures 4 through 7. In these figures, each bar represents the percentage of total rural or urban travel by a vehicle type having the characteristics indicated. Of particular interest are the very substantial differences between the vehicle types, compared to the great similarity in the pattern of usage of a particular vehicle type in both rural and urban areas. For example, vehicle type 2S, which is a 2-axle 4-tire truck of 1 ton or greater capacity, performs approximately one-third of its travel in delivery type service where it is the predominant vehicle type in both rural and urban areas. Vehicle type 2S includes many of the walk-in delivery bodies.

The panels and pickups, vehicle type 2P, perform more than 60 percent of their travel in personal transportation. Over 12 percent of their travel results from personal transportation while carrying a load. The 2-axle 6-tire truck, type 2D, is used for a variety of purposes. Although point-to-point hauling is its predominant usage, personal transportation in rural areas accounts for about 11 percent of the total. With the exception of type 2S, hauling from a single loading point to a single unloading point is the predominant usage for the other three types of single-unit trucks, with the 3-axle vehicles, usually concrete mixers or dump trucks, performing approximately 45 percent of their travel in this type of service.

The three types of semitrailer combinations—2S1, 2S2, and 3S2—included in Figures 6 and 7 account for approximately 68 percent of all highway ton-miles. Here again the similarity between rural and urban usage is evident. The point-to-point movement comprises a higher proportion of the total than is the case for single unit trucks, with two-thirds of the rural travel by 3S2's in this category. It is noteworthy that for the 3-axle 2S1 combination, over 16 percent of rural travel and over 20 percent of urban travel is in delivery service. This seems to confirm observations that these smaller combinations are used for distribution to cities, towns, and shopping areas from centralized terminals or other sources. For all vehicle types studied, the percentage of

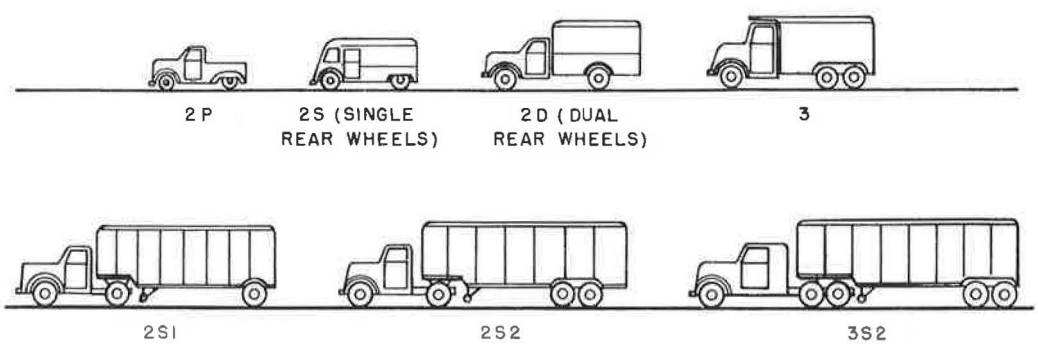

Figure 3. Principal vehicle types involved in highway commodity movements.

TABLE 6

PROPORTION OF TRAVEL

Trip and Loading Characteristics	Single-Unit Trucks			Semitrailer Combinations		
	Vehicle Type	Rural (%)	Urban (%)	Vehicle Type	Rural (%)	Urban (%)
Point to point (loaded and unloaded at single locations)	2P	21.07	16.78	2S1	41.42	40.48
	2S	22.26	20.14	2S2	57.44	54.34
	2D	37.55	31.71	3S2	66.11	53.87
	3	46.24	44.71	-	-	-
Delivery (loaded at single point and unloaded at 2 or more)	2P	6.05	8.06	2S1	16.91	21.50
	2S	32.95	34.75	2S2	7.94	11.71
	2D	20.76	26.34	3S2	5.84	8.14
	3	5.43	5.06	-	-	-
Collection (loaded at 2 or more and unloaded at single point).	2P	0.83	0.84	2S1	1.77	2.59
	2S	1.49	2.87	2S2	0.92	1.00
	2D	2.50	3.11	3S2	1.03	0.77
	3	1.13	1.38	-	-	-
Collection—delivery (loaded at 2 or more and unloaded at 2 or more)	2P	0.31	0.44	2S1	3.69	3.47
	2S	1.40	1.20	2S2	0.72	0.96
	2D	1.05	1.76	3S2	0.44	0.89
	3	0.19	0.29	-	-	-
Empty (to or from loading or unloading point)	2P	11.27	11.42	2S1	32.86	27.86
	2S	14.71	12.76	2S2	30.10	28.63
	2D	26.93	26.42	3S2	24.85	32.98
	3	39.39	41.69	-	-	-
Serve driver or passenger (empty vehicle not involved in a commodity movement)	2P	47.22	49.62	2S1	2.86	3.62
	2S	17.40	17.62	2S2	2.59	3.14
	2D	8.58	7.93	3S2	1.46	2.88
	3	6.35	6.10	-	-	-
Serve driver or passenger (loaded vehicle not involved in a commodity movement)	2P	13.25	12.84	2S1	0.49	0.48
	2S	9.79	10.66	2S2	0.29	0.22
	2D	2.63	2.73	3S2	0.27	0.47
	3	1.27	0.77	-	-	-
Total	2P	100.00	100.00	2S1	100.00	100.00
	2S	100.00	100.00	2S2	100.00	100.00
	2D	100.00	100.00	3S2	100.00	100.00
	3	100.00	100.00	-	-	-

travel involved in the collection and collection-delivery categories is quite small, generally below 5 percent of the total. For both rural and urban travel, the proportion of 2S1 collection-delivery travel is the highest of the three types of combinations with 3.7 percent of rural travel and 3.5 percent of urban travel in this category. Many household moving vans are of this vehicle type.

CHARACTERISTICS OF LOADING AND UNLOADING POINTS

The origin and destination characteristics are being analyzed as indicated by Table 7 and Figure 8 for one type of vehicle, the 2S2 combination, to determine the proportions of various components of the total highway cargo movements which may be

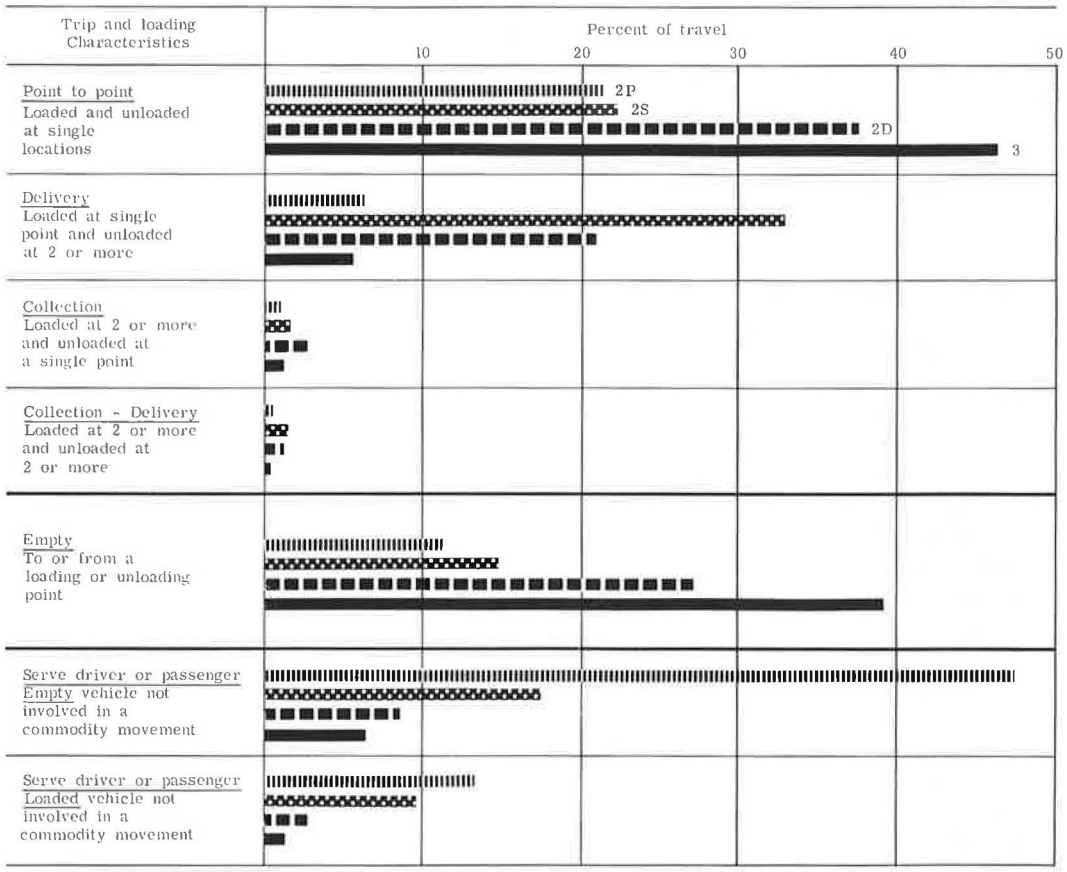

Figure 4. Rural travel distributed by trip and loading characteristics for each type of single-unit truck, travel percentages add to 100 percent for each vehicle type.

identified as complementary to or in competition with other modes of transportation. For example, the 6.1 percent from "Other modes" represents complementary movements, but the 0.83 percent from "Retail establishments" to "Final consumer" could probably not be diverted to another mode. The data in Figure 8 provide an example for one category, the 4-axle 2S2 combination, involved in cargo movements between single load and unload points as reported by the driver. This is the predominant category at the level of detail represented by a single vehicle type and trip movement characteristic and accounts for approximately 20 percent of all ton-miles hauled by highway.

Each vehicle type and category will be analyzed separately. As discussed previously, the percentage distribution of vehicle-miles within such a category will be essentially the same as the distribution of ton-miles, due to the similarity of loading of a given vehicle type. For these 2S2 combinations, movement between highway transfer points accounts for 16 percent of the total vehicle-miles of travel. This is a maximum for this category, since for long-haul movements where the driver picked up the vehicle at a truck terminal and was to drive it to another, this category was coded if he did not know the characteristics of the point where it was originally loaded or where it was to be unloaded.

Although the movements between highway transfer points are the largest single category, the "factory or packaging plant" is both the origin and the destination responsible for the greatest proportion of travel by 2S2 combinations transporting cargo

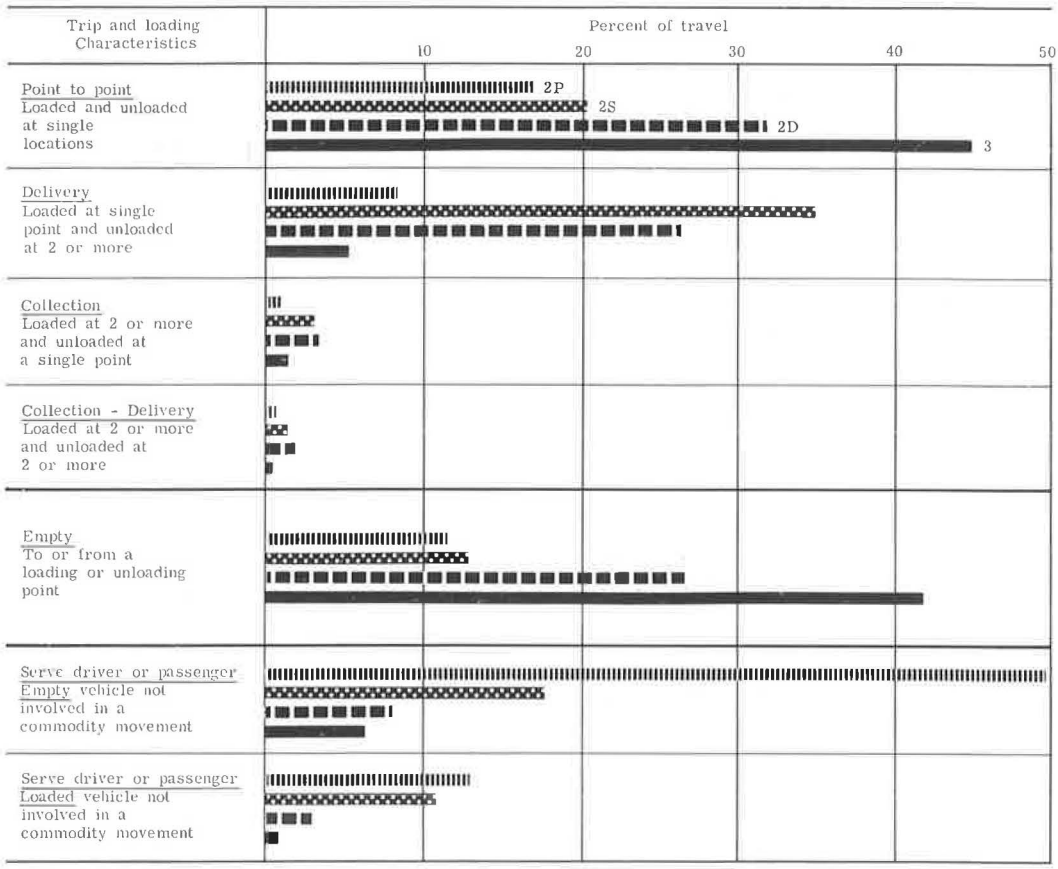

Figure 5. Urban travel distributed by trip and loading characteristics for each type of single-unit truck, travel percentages add to 100 percent for each vehicle type.

between a single loading point and a single unloading point. About 51.8 percent of the travel by this vehicle type has an origin or destination at a factory or packaging plant. Transfers from and to other modes are shown to be only 6.2 percent for origin and 3.5 percent for destination, respectively. Travel originating at the original or primary source of the commodity, such as a farm, forest, or mine, amounts to nearly 15 percent of the total, with just half going to a factory or processing plant.

Point-to-point travel by loaded 2S2's originating from a factory or packaging plant is destined about equally for other factories, wholesale warehouses, and retail establishments. A substantial proportion is also destined for the final consumer. The same is true for travel originating from wholesale warehouses. Travel originating at retail establishments is only 4.3 percent of the total for these 2S2 combinations with less than one-fifth going to the final consumer. Two items, the 3.6 percent of travel shown as originating from the final consumer and the 2.8 percent shown as destined for the primary source, seem puzzling. On reflection, the first seems a logical field interpretation applicable to household goods movement or the movement of machinery, equipment, or second-hand goods. Destinations shown as the primary source may involve returns of materials and possibly movement of agricultural commodities from farm to farm. The extent of reporting error for this item has not been determined. Subsequent analysis by commodity may clarify some of these items.

Preliminary review of data for other trip types and vehicle types indicates wide variation. For the same vehicle type, 2S2 in delivery trip type, 40 percent of the

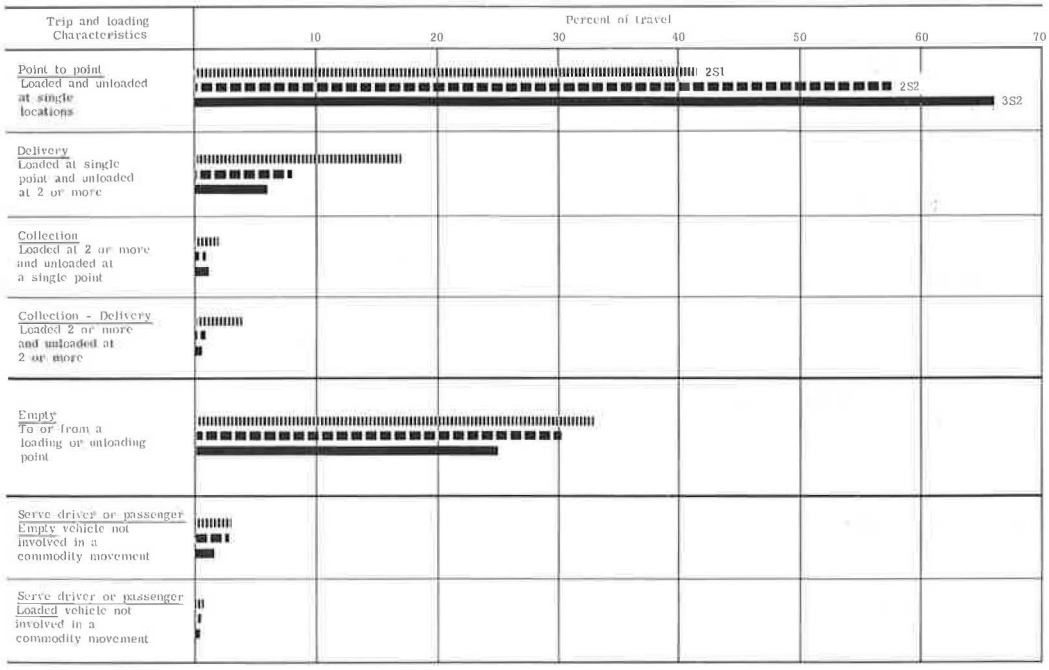

Figure 6. Rural travel distributed by trip and loading characteristics for each type of semitrailer combination, travel percentages add to 100 percent for each vehicle type.

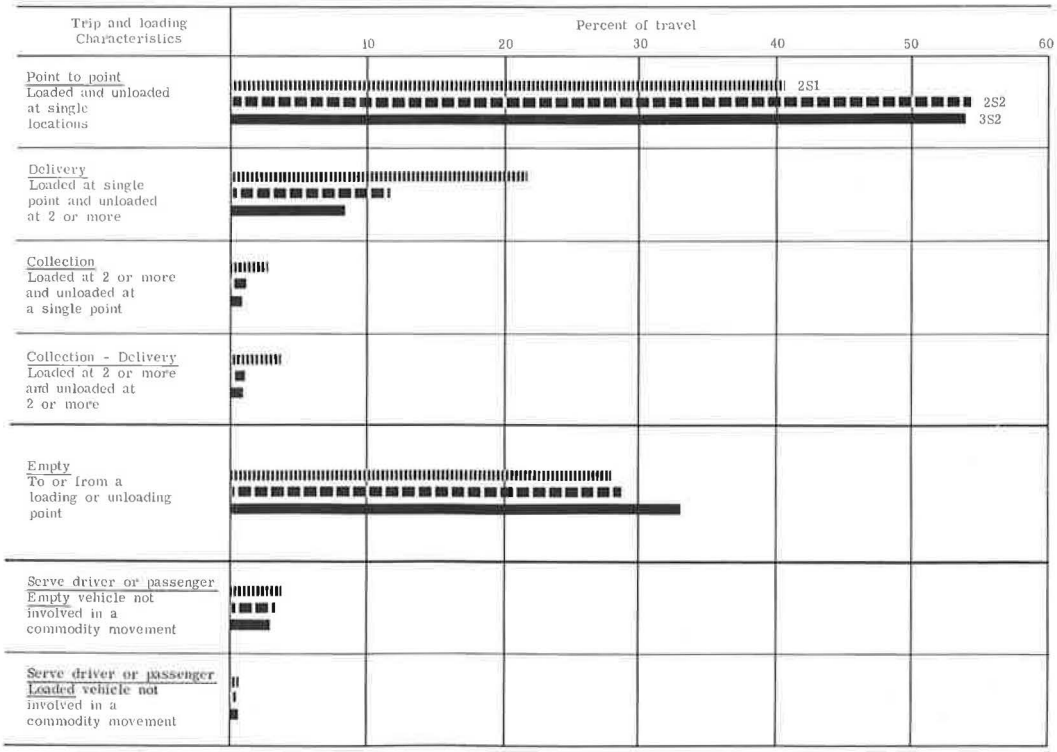

Figure 7. Urban travel distributed by trip and loading characteristics for each type of semitrailer combination, travel percentages add to 100 percent for each vehicle type.

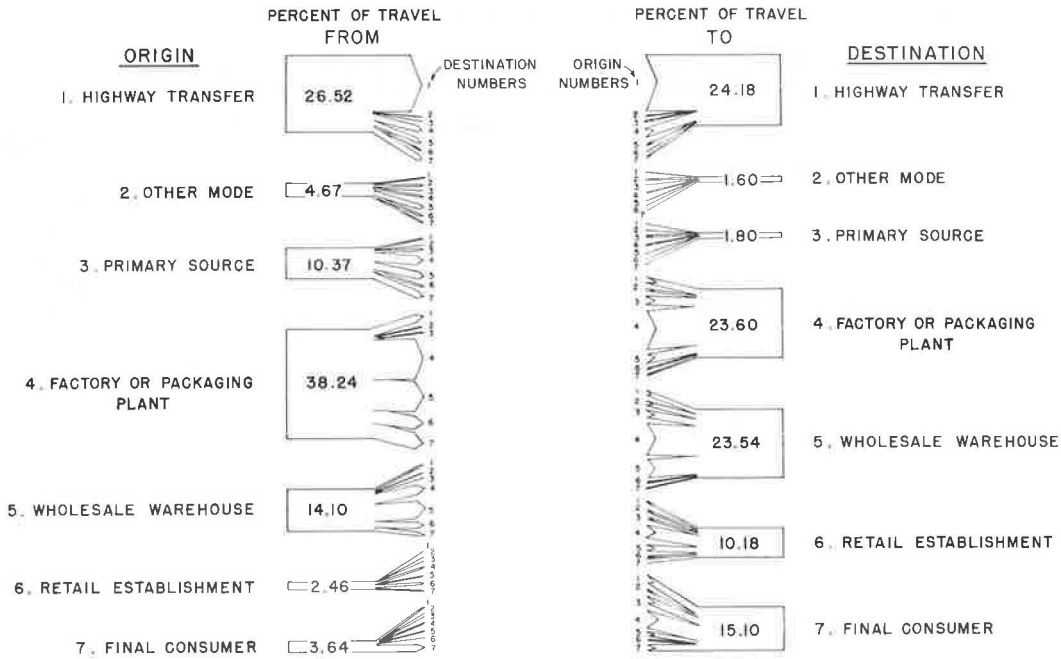

Figure 8. Distribution of rural travel by loaded 2S2 combinations loaded and unloaded at single location related to characteristics of origin and destination.

travel is related to other modes. For the 2-axle 4-tire trucks other than pickups, largely walk-in delivery trucks, nearly 20 percent of the rural travel is between manufacturing or packaging plants and retail establishments.

TABLE 7

PERCENTAGE DISTRIBUTION OF VEHICLE-MILES OF TRAVEL FOR LOADED 2S2 COMBINATIONS[a]

Origin Category	Destination Category							
	Highway Transfer	Other Mode	Primary Source	Factory or Packaging Plant	Wholesale Warehouse	Retail Establishment	Final Consumer	Total
Highway transfer	19.19	0.25	0.07	2.18	1.66	0.86	2.31	26.52
Other mode	0.35	0.48	0.15	0.54	1.75	0.84	0.56	4.67
Primary source	0.39	0.17	0.89	3.16	2.62	0.89	2.25	10.37
Factory or packaging plant	2.91	0.41	0.42	13.47	10.79	4.45	5.79	38.24
Wholesale warehouse	0.65	0.23	0.14	3.21	6.08	2.03	1.76	14.10
Retail establishment	0.14	0.01	0.05	0.57	0.36	0.95	0.38	2.46
Final consumer	0.55	0.05	0.08	0.47	0.28	0.16	2.05	3.64
Total	24.18	1.60	1.80	23.60	23.54	10.18	15.10	100.00

[a]Point to point, loaded and unloaded at single locations.

SUMMARY AND CONCLUSIONS

This study has shown that highway cargo vehicles serve a wide variety of uses. Although all categories of movements by loaded vehicles have been included in estimating ton-miles hauled by highway, these data indicate the proportions which are not true commodity haulage, for example, travel by a loaded vehicle to serve the driver. The proportions of all highway cargo movements by categories of trip type and origin-destination are shown. From this, proportions which can be well served only by highway, those which involve other modes, and those which could be served by other modes to varying degrees may be judged with increased assurance. These data serve to provide an indication of the dimensions of the elements, making up the total ton-miles of the highway cargo movement. Additional criteria, such as the interrelationship of commodity, place of origin and destination, and trip length, must be investigated to obtain as complete an understanding of highway transportation as possible.

Further Analysis

The differences in loading characteristics for each vehicle type will be analyzed to determine more precise ton-mile values for each category of movement. An analysis of trip length, origins and destinations within the same state, county and city, and commodity is being made for each vehicle type, class of operation, and category of trip loading characteristics to provide an indication of the relative proportion of highway commodity movements which are least competitive with other modes or which might be considered inappropriate for inclusion in the intercity highway ton-mile values.

Conclusions

1. The patterns and characteristics of usage of trucks and semitrailer combinations show considerable difference according to the type of vehicle.
2. For a given vehicle type, there are only moderate differences in proportions of travel related to trip and loading characteristics between rural and urban areas.
3. In the case of both single-unit trucks and semitrailer combinations, the larger truck types perform a higher proportion of their travel while loaded.
4. For all types of trucks except the 2-axle single-tire 2S, the greatest proportion of travel when loaded is from a single loading point to a single unloading point; for vehicle type 2S, delivery travel exceeds all other categories for both rural and urban travel.
5. For 4-axle 2S2 combinations loaded at a single point with unloading at a single point, more than one-third of all travel originates at a factory or packaging plant, one-fifth from a highway transfer point, and one-sixth at a primary source.
6. Similar factors when available for other vehicle types and origin and destination categories will be helpful in completing the appraisal of truck usage and service.

REFERENCES

1. U.S. Bureau of Public Roads. Highway Statistics, 1962. Table HT-1.
2. Interstate Commerce Commission. Transport Economics. p. 1, April 1964.
3. Instructions for Special Truck Trip Characteristics Study. IM 50-3-63, April 10, 1963.

Appendix

1963 SPECIAL TRUCK TRIP CHARACTERISTICS STUDY
(Excerpt from Coding Instructions)

*Loading and trip type, column 23.—The purpose of this item is to indicate whether loaded or empty and to obtain an indication of the type of service in which the vehicle

is engaged. Loaded and empty classifications reflect commodity movement and are consistent with the regular instructions.

Code	Description
* 1	Empty, not involved in commodity movement serving primarily as transportation for driver or passenger and travel to or from garage or parking area.
* 2	Empty, traveling to loading point or from unloading point.
3	Empty, service or repair vehicle not involved in commodity movement; may carry mounted equipment, tools, but no supplies of repair parts or other materials which are customarily unloaded.
4	Loaded service or repair vehicle not involved in commodity movement; may carry mounted equipment, tools, supplies, repair parts, or materials for use in service or repair activity which are not customarily all unloaded at a single location.
5	Loaded vehicle, loaded at a single location and to be completely unloaded at a single location.
6	Loaded vehicle, loaded at a single location and to be unloaded at two or more locations (delivery or distribution).
7	Loaded vehicle, loaded at two or more locations and to be unloaded at a single location (pickup or collection).
8	Loaded vehicle, loaded at two or more locations and to be unloaded at two or more locations (pickup-delivery or collection-distribution).
* 9	Loaded vehicle not involved in a commodity movement, including serving driver or passenger (travel to or from dwelling, garage or parking area).

*Class of origin and destination, columns 24-25 (origin) and columns 26-27 (destination). —This item is intended to reflect the point at which the highway movement of a commodity fits into the production-distribution process and should be recorded for both loaded and empty vehicles. Codes apply to origins and destinations in columns 28-45 and should be shown for both. In the case of a transfer from another vehicle or mode of transportation not involving processing, packaging or selling at the transfer point, the coding should indicate the other mode involved if this can be determined. If the other mode cannot be determined then the type of place at which the transfer was made should be indicated. For example, if a transfer between trucks is known to have occurred at a railroad warehouse, the correct coding is 01. A shipment which receives processing at a primary source from which it is transported direct to retail customers or ultimate customers, such as transit mixed concrete from a quarry or borrow pit, should be coded as from the processing plant (08) to the ultimate consumer (11). In the case of bank run gravel or borrow loaded directly into the transporting vehicle without washing, screening, or other processing, it should be coded as from the primary source (06). Similarly, a destination such as the distribution point for a chain of retail stores should be considered a wholesale distribution point (09), even though there may be a retail outlet at the same location where a small proportion (25 percent or less) may be sold at retail.

Code	Description
01	A loading point at which it is known that a transfer from or to another highway motor vehicle was or will be made, or a storage warehouse, yard, or area without processing, or selling facilities for goods of any nature served only by highway.
02	A loading point at which a transfer from or to rail was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by rail in addition to highway.
03	A loading point at which a transfer from or to water was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by water in addition to highway.
04	A loading point at which a transfer from or to air was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by air in addition to highway.
05	A loading point at which a transfer from or to pipeline was or will be made or a storage warehouse, yard, or area for goods of any nature served primarily by pipeline in addition to highway.
06	A loading point at the primary or original source of an agriculture product or raw material such as a farm, forest, mine, quarry, borrow pit, oil well, or in the case of rubble the site being cleared not including a residence or dwelling.
07	A loading point at the primary or original source which is a residence or dwelling (refuse, secondhand goods, etc.).
08	A loading point at a manufacturing, processing, assembling, or packaging establishment.
09	A wholesale distribution warehouse, store, supply yard, bulk storage tank, which may or may not have facilities for breaking down and reassembling packing and processing incidental to the wholesale activity.
10	A retail store, showroom, yard, service station, and associated warehouse from which retail sales or deliveries are made.
11	A store, office, commercial or nonprofit establishment, or construction site, not including a residence or dwelling, which is the location of the ultimate consumer, retail customers, or place of use.
12	A home, dwelling, or residence which is the location of the ultimate consumer, retail customer, or place of use.
* 13	A location other than a loading or unloading point.

Air Cargo Ton-Miles—A Statistic of Growing Importance

K. WILLIAM HORN
Research Analyst, Air Transport Association of America

This paper is designed to show the manner in which cargo ton-miles are reported by the airline industry and the growth of cargo traffic during recent years. It covers procedures used by the air carriers to report periodically to the Civil Aeronautics Board and the Air Transport Association of America. CAB and ATA reports on air cargo traffic are also discussed. The significant increase in cargo ton-miles is pointed out by charts showing the growth in airline freight traffic from 1939 to 1963 and comparing this traffic with that of other modes of transportation.

•AIR TRANSPORTATION had its beginning in the cargo transportation field. In 1911, the first U.S. airmail experiments began with a flight on Long Island, New York, of a total distance of 10 miles. From this early start, the airlines became familiar with the ton-mile statistic, and today it is a highly significant and much used figure in the aviation industry.

GROWTH OF THE INDUSTRY

During the early growth of air transportation, air freight played a secondary role to the carrying of passengers. In 1948, less than 300 million revenue ton-miles of cargo—freight, mail and express—moved by air. Since 1948 significant increases have been made in air cargo traffic, including international and domestic service, by the U.S. scheduled airlines (Fig. 1). In 1963, approximately 1.3 billion cargo ton-miles were flown in domestic service by the scheduled and supplemental air carriers (Table 1).

The certificated route air carriers transported 644,552,000 ton-miles of freight in scheduled domestic service in 1963, about 90 percent more than was carried in 1958 (Tables 2 and 3). According to the Civil Aeronautics Board, freight accounted for 16 percent of all revenue ton-miles flown, both cargo and passenger, and of this amount 43 percent was in all-cargo service. Based on estimated figures, the certificated route carriers accounted for 821,414,000 freight ton-miles in scheduled service in 1964, an increase of about 27 percent over the 1963 period.

In 1963, the scheduled airlines offered the public more than 10,000 flights a day, all of which carried some kind of cargo: mail, express, or freight. The eleven U.S. trunk and three all-cargo airlines flew 864 million ton-miles of cargo in scheduled domestic operations, a 10.5 percent increase over the 782 million ton-miles carried in 1962. Airfreight ton-miles in 1963 totaled 631 million, a 13.5 percent increase. Express ton-miles totaled 65.7 million, up 0.6 percent; mail volume climbed 4.7 percent to a total of 168.1 million ton-miles. The results for 1964 will show even more significant increases. Air cargo is expected to total 1.06 billion ton-miles for the trunks and all-cargo airlines.

The sharp growth rate and expectations by the airlines in regard to cargo potentials are reflected in the increase in the number of large turbo-fan jets and turboprop cargo aircraft being acquired. During 1963, cargo capacity of the airlines greatly increased

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 44th Annual Meeting.

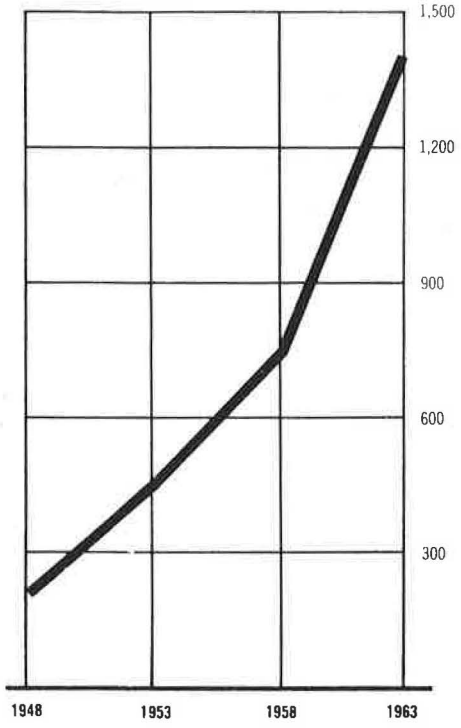

Figure 1. Revenue cargo ton-miles in millions per year carried by U.S. scheduled airlines.

TABLE 1

DOMESTIC INTERCITY FREIGHT BY MODES[a]

Year	Tons-Miles (billions)						
	Air[b]	Rail	Truck	Oil Pipeline	Great Lakes	Rivers and Canals	Total
1939	0.01	339	53	56	76	20	544
1940	0.02	379	62	59	96	22	618
1941	0.02	482	81	68	114	27	772
1942	0.04	645	60	75	122	26	928
1943	0.05	735	57	98	115	26	1,031
1944	0.07	747	58	133	119	31	1,088
1945	0.09	691	67	127	113	30	1,028
1946	0.08	602	82	96	96	28	904
1947	0.11	665	102	105	112	35	1,019
1948	0.15	647	116	120	119	43	1,045
1949	0.20	535	127	115	98	42	917
1950	0.30	597	173	129	112	52	1,063
1951	0.34	655	188	152	120	62	1,177
1952	0.34	623	195	158	105	64	1,145
1953	0.37	614	217	170	127	75	1,203
1954	0.38	557	213	179	91	83	1,123
1955	0.49	631	223	203	119	98	1,274
1956	0.58	656	249	230	111	109	1,356
1957	0.68	626	254	223	117	115	1,336
1958	0.70	559	256	211	80	109	1,216
1959	0.80	582	269	227	80	117	1,296
1960	0.89	579	299	229	100	123	1,331
1961	1.0	570	313	233	87	124	1,328
1962	1.3	600	331	238	90	133	1,393
1963	1.3	629	348	243	97	143	1,461

[a]Includes mail and express but not intercoastal and coastwise ton-miles; based on data from the Transportation Association of America, Interstate Commerce Commission, and Civil Aeronautics Board.
[b]Includes domestic scheduled and charter service of the U.S. scheduled airline industry, both passenger/cargo and all-cargo carriers, and the supplemental airlines.

as the first all-cargo jets were placed into U.S. scheduled airline service. At the beginning of 1964 about a dozen of these jets were being operated by U.S. carriers. Each jet freighter is capable of hauling a load of more than 40 tons nonstop from coast to coast.

Despite the gains made during recent years, however, the gross amount of domestic intercity cargo hauled by air is presently less than 1 percent of the total handled by all transport modes (Table 4). Although this amount is small in comparison to total freight haulage, it is still very important to the airlines.

TABLE 2

REVENUE FREIGHT TON-MILES FLOWN BY CERTIFICATED ROUTE AIR CARRIERS IN SCHEDULED DOMESTIC SERVICE, 1950-1963[a]

Year	Ton-Miles (thousands)
1950	173,102
1951	175,516
1952	202,472
1953	210,098
1954	206,598
1955	267,680
1956	298,495
1957	350,011
1958	337,898
1959	393,606
1960	417,550
1961	472,625
1962	567,720
1963	644,552

[a]Source: Civil Aeronautics Board

TABLE 3

REVENUE CARGO TON-MILES FLOWN BY CERTIFICATED ROUTE AIR CARRIERS IN SCHEDULED DOMESTIC SERVICE, 1963[a]

Traffic Category	Ton-Miles (thousands)
Freight	644,552
Express	70,017
Priority U.S. mail	145,929
Non-priority U.S. mail	29,518
Excess baggage	25,001
Total	915,017

[a]Source: Civil Aeronautics Board

TABLE 4

PERCENTAGE OF INTERCITY FREIGHT BY MODES[a]

Year	Air[b]	Rail	Truck	Oil Pipeline	Great Lakes	Rivers and Canals
1939	-	62.3	9.7	10.3	14.0	3.7
1940	-	61.3	10.0	9.5	15.5	3.6
1941	-	62.4	10.5	8.8	14.8	3.5
1942	-	69.5	6.5	8.1	13.1	2.8
1943	-	71.3	5.5	9.5	11.2	2.5
1944	0.01	68.7	5.3	12.2	10.9	2.8
1945	0.01	67.2	6.5	12.4	11.0	2.9
1946	0.01	66.6	9.1	10.6	10.6	3.1
1947	0.01	65.3	10.0	10.3	11.0	3.4
1948	0.01	61.9	11.1	11.5	11.4	4.1
1949	0.02	58.3	13.8	12.5	10.7	4.6
1950	0.03	56.2	16.3	12.1	10.5	4.9
1951	0.03	55.6	16.0	12.9	10.2	5.3
1952	0.03	54.4	17.0	13.8	9.2	5.6
1953	0.03	51.0	18.0	14.1	10.6	6.2
1954	0.03	49.6	19.0	15.9	8.1	7.4
1955	0.04	49.5	17.5	15.9	9.3	7.7
1956	0.04	48.4	18.4	17.0	8.2	8.0
1957	0.05	46.9	19.0	16.7	8.8	8.6
1958	0.06	46.0	21.1	17.4	6.6	9.0
1959	0.06	44.9	22.3	17.5	6.2	9.0
1960	0.07	43.5	22.5	17.2	7.5	9.2
1961	0.08	42.9	23.6	17.5	6.6	9.3
1962	0.09	43.1	23.8	17.1	6.5	9.5
1963	0.09	43.1	23.8	16.6	6.6	9.8

[a]Includes mail and express but not intercoastal and coastal ton-miles; based on data from Transportation Association of America, Interstate Commerce Commission, and Civil Aeronautics Board.

[b]Includes domestic scheduled and charter service of the U.S. scheduled airline industry, both passenger/cargo and all-cargo carriers, and the supplemental airlines.

TON-MILE REPORTS

For the industry to maintain an accurate accounting of the ton-miles of cargo carried, the airlines are required to compile and report to the government periodically the ton-miles of cargo being transported. The figures are used as an aid in analyzing the traffic and financial results of a particular carrier as well as those of the entire industry.

There are two groups primarily engaged in the collection and dissemination of airline statistical data: the Civil Aeronautics Board, which is charged with the regulation of commercial air transportation, and the Air Transport Association of America, which represents the vast majority of the carriers comprising the certificated airline industry. Both groups compile airline data on the financial and traffic status of the air carriers. The statistics compiled by ATA are consolidated industry figures and are not broken down by carriers, whereas the CAB reports the financial and traffic statistics of each of the U.S. certificated carriers, as as well as overall industry statistics.

Each certificated air carrier is required to report its ton-miles of freight handled per month on the Monthly Statement of Summarized Traffic and Capacity Statistics, CAB Form 41. The report is compiled and submitted every month to the CAB in accordance with the Board's Uniform System of Accounts and Reports for Certificated Route Air Carriers.

In general, the cargo ton-mile figures entered by the carriers on Form 41 are determined by computation from flight records. Total revenue ton-miles are entered on the report along with non-revenue ton-miles under the heading, Traffic on Revenue Flights. In addition, for reporting purposes, revenue cargo ton-miles are divided into the following categories: (a) U.S. mail-priority, (b) U.S. mail-non-priority, (c) foreign mail, (d) express, (e) freight, and (f) excess baggage. There is no breakdown by type of commodities hauled since the air carriers are not required to furnish this information on a regular basis to the Board.

The Board's Research and Statistics Division compiles and publishes the monthly figures in its booklet, Air Carrier Traffic Statistics. Consolidated industry figures and statistics covering each certificated route operator are included. At the end of the year the annual data, along with other statistical material covering the entire annual period, are computed and released in the Handbook of Airline Statistics.

With the submission of the report of Form 41 to the Board, a copy is furnished to the Air Transport Association by each of its member carriers. From these, ATA computes the industry totals on a quarterly basis and publishes them in a booklet entitled Quarterly Review—Airline Traffic and Financial Data. This publication contains a breakdown of revenue ton-miles carried, by passengers, priority mail, non-priority mail, express, freight, charter, excess baggage and foreign mail for the various classes of air carriers as well as the consolidated industry figures. Other traffic and financial information is included. Calendar year-end figures covering the twelve-month period in comparison with previous years are reported in an annual publication, Air Transport Facts and Figures (Table 5).

Generally speaking, the statistical data released by ATA are more current and preliminary in nature than those of the CAB. ATA is primarily concerned with processing

TABLE 5

REVENUE TON-MILES OF TRAFFIC CARRIED BY U. S. SCHEDULED AIRLINE INDUSTRY[a]

Carrier	Ton-Miles (thousands)							
	Passenger	Priority U.S. Mail	Non-Priority U.S. Mail	Express	Freight	Excess Baggage	Charter Flights	Total
Domestic trunk airlines:								
1959	2,672,087	98,487	17,929	53,107	282,472	29,419	13,271	3,166,772
1960	2,777,148	108,061	22,845	55,440	320,950	29,071	18,968	3,332,483
1961	2,806,469	117,929	26,762	56,745	384,161	26,881	16,270	3,435,218
1962	3,023,888	131,711	28,501	64,879	473,955	25,430	22,665	3,771,029
1963	3,456,932	138,661	28,402	64,915	520,631	23,797	24,227	4,257,565
Local service airlines:								
1959	97,516	1,693	503	2,211	3,125	711	3,061	108,820
1960	108,652	2,110	587	2,419	3,845	799	2,744	121,155
1961	127,602	2,771	584	3,019	5,492	875	2,084	142,428
1962	152,662	3,288	545	3,772	7,218	990	1,837	170,312
1963	177,555	3,766	587	4,312	9,026	1,004	2,096	198,346
Intra-Hawaiian airlines:								
1959	8,879	76	-	-	1,625	30	2,058	12,668
1960	10,156	82	5	-	1,806	31	5,605	17,685
1961	10,047	82	14	-	1,846	31	494	12,515
1962	10,308	90	19	-	2,100	51	10	12,578
1963	11,519	93	21	-	2,151	40	285	14,109
Helicopter airlines:								
1959	710	87	-	41	7	4	7	856
1960	901	91	-	40	7	5	10	1,053
1961	818	94	-	40	7	5	6	969
1962	779	65	-	44	6	3	10	907
1963	1,188	74	-	44	6	4	16	1,332
Intra-Alaskan airlines:								
1959	3,872	1,501	-	-	2,140	116	3,869	11,498
1960	4,434	1,796	-	-	2,422	127	1,844	10,625
1961	4,741	2,209	-	-	2,829	135	1,929	11,843
1962	4,874	2,576	-	-	2,620	147	3,211	13,428
1963	4,796	2,832	-	-	2,640	155	6,027	16,450
All-cargo airlines (domestic):								
1959	-	582	161	1,250	104,237	-	168,049	274,279
1960	-	674	233	1,050	88,516	-	159,224	249,697
1961	-	407	261	754	78,286	-	215,352	295,060
1962	-	175	146	417	81,816	-	389,536	472,090
1963	-	504	505	748	110,096	-	231,410	343,263
International and territorial airlines:								
1959	706,696	73,697	21	481	158,868	12,897	139,878	1,100,817
1960	831,066	82,626	12,233	520	191,065	13,922	78,350	1,218,245
1961	877,022	93,220	42,492	609	216,561	13,191	110,247	1,362,428
1962	1,017,184	108,987	52,760	798	263,931	15,125	150,848	1,619,903
1963	1,187,055	115,811	54,477	794	295,610	16,821	174,431	1,855,967
All-cargo airlines (international):								
1959	-	5,547	-	-	36,579	-	16,178	58,383
1960	-	6,567	2,658	-	34,853	-	28,796	73,091
1961	-	6,425	5,968	4	43,764	-	76,823	133,094
1962	-	4,441	6,602	14	66,537	-	99,759	177,497
1963	-	4,663	6,205	21	82,917	-	72,111	166,165
Consolidated industry:								
1959	3,489,760	181,670	18,614	57,090	589,053	43,177	346,371	4,734,093
1960	3,732,533	202,007	38,565	59,469	643,468	43,955	295,606	5,024,283
1961	3,827,038	223,139	76,087	61,167	732,951	41,118	423,231	5,393,933
1962	4,209,926	251,333	88,578	69,925	898,187	41,748	668,136	6,238,246
1963	4,839,045	266,404	90,197	70,834	1,023,077	41,821	510,603	6,880,845

[a]In some instances individual figures may not add to totals because of rounding; foreign mail ton-miles carried by international and territorial airlines and by all-cargo airlines in international operations are included only in the total ton-mile column.

and disseminating statistics of major importance to aviation interests as quickly and as rapidly as is feasibly possible.

The Bureau of the Census, since January 1962, has been publishing monthly reports by weight and value of commodities being transported by air in the U.S. foreign trade. Ton-miles, however, are not computed. The reports, which are compiled from export documents, contain a breakdown of some 60 commodities imported by air and 100 commodities exported by air. Items listed include auto, truck and bus parts, electronic computers, contracting and excavating machinery, and eggs.

The reports can be helpful to marketing specialists. For example, one recent report showed that 3,900 tons of machinery and vehicles were transported to the United Kingdom by air in 1963 along with 413 tons of man-made fibers and manufactures, 379 tons of photographic and projection equipment and 333 tons of electrical measuring and testing equipment.

Four reports are issued monthly and are followed by an annual summary. Two concern U.S. airborne exports of domestic merchandise, one with the commodities listed by the countries of destination and the other with the countries of destination by commodities. The other two pertain to imports involving origin countries.

TERMINOLOGY

The statistical data on air cargo have been somewhat misleading. The terminology used does not always indicate exactly what is meant by terms such as airfreight and air cargo. The broader definition of air cargo may include airmail, non-priority surface mail moving by air, parcel post, excess baggage, cargo tendered by the Railway Express Agency as air express, cargo tendered by the airfreight forwarders, and cargo tendered as airfreight under published airfreight tariffs. Writers using the terms air cargo or airfreight might have one or any possible combination of these items in mind. The industry provides passenger ton-mile data which may be included in certain overall ton-mile figures. Such total ton-mile figures can be misinterpreted. Also, in the interpretation of ton-miles there is some confusion as to what segment of the industry is included in a given stated figure.

Seven classes of air carrier operators in the United States have certificates of convenience and necessity authorizing them to conduct regularly scheduled services. These classifications are used by the CAB in connection with the economic regulation of the industry and, under the Federal Aviation Act, are based largely on the scope of operations authorized or allowed by the Act. These classes are as follows:

1. Domestic trunk carriers.—This category includes carriers with permanent operating rights within the continental United States. There are currently eleven trunk lines operating primarily over high-density traffic routes between principal traffic centers. These carriers conduct both scheduled and nonscheduled, or charter, service. In 1963, records were set by these airlines in all categories of cargo traffic in scheduled operations. Freight ton-miles were 520,631,000, a gain of 9.8 percent over 1962; mail ton-miles were 167,063,000, a gain of 4.3 percent; express rose to 64,915,000 ton-miles. In 1964, according to estimates, freight will be up 24.7 percent, mail 7.6 percent, and express 8.7 percent over 1963 figures.

2. Domestic local service carriers.—There are presently 13 of these carriers operating routes of lesser traffic density between the smaller traffic centers and between these and principal centers. In 1963, they carried 25.0 percent more freight, 13.6 percent more mail, and 14.3 percent more express than in 1962. In 1964, it is estimated freight will increase 32.1 percent, mail 16.2 percent and express 19.9 percent over the 1963 period.

3. Helicopter carriers.—Helicopters operate between airports, central post offices, and the suburbs of New York, Chicago, Los Angeles and San Francisco. Cargo volume of the four carriers in 1963 amounted to 74,000 ton-miles of air mail, an increase of 13.8 percent over 1962; also carried were 44,000 ton-miles of express and 6,000 ton-miles of freight, both of which matched 1962 achievements.

4. Intra-Hawaiian carriers.—The two airlines comprising this class operate between the several islands of Hawaii; they carried 2,151,000 ton-miles of freight in 1963, a gain of 2.4 percent over 1962, and 114,000 ton-miles of mail, an increase of 4.6 percent. They made substantial gains in 1964.

5. Intra-Alaskan carriers. —In 1963, the eight carriers which provide service in the State of Alaska carried 2,832,000 ton-miles of airmail for an increase of 9.9 percent over 1962, and 2,640,000 ton-miles of freight, a 1.0 percent increase. Estimates for 1964 point to further increases in cargo traffic transported by this group of carriers.

6. International and territorial carriers. —This service includes all U.S. Flag air carriers operating between the United States and foreign countries other than Canada and over international waters. These 18 carriers moved 295,600,000 ton-miles of freight in 1963, an increase of 12.0 percent over 1962, 170,288,000 ton-miles of mail, an increase of 5.3 percent, and 794,000 ton-miles of express, down about 1.0 percent. It is estimated that during 1964 freight ton-miles for this group of carriers jumped about 30 percent over 1963.

7. All-cargo carriers. —Scheduled flights carry freight, express and mail between designated areas in the U.S. and in one case to the Caribbean and in another to Europe. These carriers in domestic scheduled service carried a record of 110,096,000 ton-miles of freight in 1963, representing a 34.6 percent increase over 1962. Mail volume was 1,009,000 ton-miles, an increase of 8.3 percent; express volume was 748,000 ton-miles, an increase of 79.6 percent. Charter freight operations declined, however, by about 41 percent to 204,581,000 ton-miles.

In addition, supplemental air carriers conduct passenger and cargo charter service, as well as scheduled operations on a limited temporary basis. There were 15 such companies as of February 1, 1964. The supplemental carriers transported 171,067,000 ton-miles of freight in domestic service in 1963 compared to 115,171,000 in 1962.

A LOOK AHEAD

Although the airlines account for less than 1 percent of the total intercity ton-miles, the cargo they carry is of high value. This cargo, especially since it includes mail and express, is being considered more and more an indicator of business activity and economic growth.

There have been various predictions on the growth rate of domestic airfreight. It is, of course, difficult to say just what the figure will be. Airfreight, however, can be expected to increase by 20 percent or more in 1965 over 1964. Some foresee an increase of 120 percent by 1970 and an increase of 250 percent by 1975, bringing the total to more than 2.8 billion ton-miles in domestic scheduled service.

With the increased availability of the economical cargo jets and the improvement of handling methods, the cost of shipping by air will undoubtedly decrease in the future. Cargo ton-miles should expand at a faster rate than passenger miles, and it appears the air carriers will capture a larger share of the total freight market.

When compared to other modes of transportation, the airfreight business is still in an embryonic stage, but we can look forward to definite growth. As airfreight increases, more detailed reporting procedures will be required and eventually tonnage and ton-mile figures by commodity groups will be developed as in the other transport modes.

Shifts in Petroleum Transportation

WILLIAM L. MALONEY
Secretary, Association of Oil Pipe Lines

The oil industry uses all forms of transportation in its operations—pipelines, tankers, barges, tank cars and tank trucks. Pipelines are unique because the oil moves in one direction and there are no return pay loads. Thus, pipelines are a cheaper and faster means of transportation because they can operate all year. However, pipelines, trucks, tankers and railroads are all indispensable to the oil industry; in many cases they complement each other. Pipeline statistics are gathered by the Interstate Commerce Commission and the Department of Interior (Bureau of Mines and Geological Survey). Data from production and haulage reports by member companies of the Association of Oil Pipe Lines are included.

•TRANSPORTATION is an integral indispensable part of the oil industry. Without some form of transportation, crude oil could not be moved from the production areas to refineries and the refined products could not be delivered to ultimate points of consumption. The oil industry uses all forms of transportation in its operations: pipelines, tankers (both ocean and lake), barges, tank cars, and tank trucks. The predominant factor used in selecting the mode of transport is economics. Pipelines are unique because the oil moves generally in only one direction and, therefore, there are no return payloads.

DEVELOPMENT OF PIPELINES

The first successful commercial oil well was drilled at Titusville, Pa. It was brought in August 27, 1859, at 69½ feet. In late 1864, Samuel Van Syckle of New Jersey arrived in Titusville and immediately saw the problem of transporting by horse and wagon the large volume of crude produced in the Pithole region. Therefore, he built a 5-mi long 2-in. wrought iron pipe connecting Pithole with Miller's Farm station on the Oil Creek Railroad. After much difficulty and resistance by wagon drivers, the line was placed in operation on October 10, 1865. This first successful crude oil pipeline pumped about 81 bbl/hr at a pipage charge of $1.00/bbl as compared to the teamsters' charge of $3.00/bbl or more.

In 1878, Equitable Petroleum Company built a 7-mi common carrier line from Bradford, Pa., to Coryville, Pa. From there the oil went by railroad to Buffalo, N. Y., and then by Erie Canal barge to New York City. In 1879, the Tidewater Pipe Line Company became the first to pump oil successfully in pipelines over the Pennsylvania mountains. In June 1893, the first successful products pipeline from the Pennsylvania oil region refineries was completed by Lewis Emery, Jr., after much difficulty and opposition in securing a right-of-way. This 180-mi line brought the products from the independents' plants at Titusville, Oil City, Warren, and Bradford to Wilkes-Barre.

On January 10, 1901, the great oil field at Spindletop, a geological salt dome near Beaumont, Texas, was brought in. When the first six wells at Spindletop were drilled and went on stream, they produced more oil in one day than all the other wells then existing in the world. This event marked the real growth of the oil industry in the United States because now the public could have in abundance a cheap, clean, and con-

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 44th Annual Meeting.

TABLE 1

GROWTH IN PIPELINE MILEAGE AND TON-MILES

Year	Miles[a]	Ton-Miles[b] (billions)
1938	119,050	64.4
1943	132,149	96.3
1948	151,626	119.6
1953	179,023	169.9
1958	189,982	211.3
1962	204,064	237.7

[a]Of crude, crude gathering and products lines (4).
[b]ICC annual reports.

TABLE 2

PIPELINE MILEAGE, 1962

Type	ICC	All Lines
Crude trunk	61,702	70,368
Gathering	48,063	77,590
Products trunk	45,288	56,106
Total	155,053[a]	204,064

[a]Per 92 carriers.

venient source of liquid fuel energy. Before this, there was doubt that oil could seriously compete with coal as a primary source of energy.

The growth of crude gathering and trunk lines increased rapidly with the discovery of oil in other states as the frontier pushed south and west. This growth was necessary to keep pace with the growth in the oil industry and to meet economic demands for oil transportation from the producing areas to the refineries.

On May 2, 1901, the first piping of refined oil from the oil regions of Pennsylvania to the Atlantic was accomplished by the Pure Oil Company with the completion of its line from Wilkes-Barre to Marcus Hook on the Delaware River. The refined products lines developed more slowly than the crude lines. However, since 1930, their growth has increased rapidly. The main reason for this growth is the same as for the crude lines; i.e., shippers sought cheaper transportation for getting the products from the refineries to the large marketing and distribution terminals. Originally, the products lines only transported gasoline; now they handle all forms of liquid light products, including several grades of gasoline, kerosene, distillate fuel oil, diesel fuel, jet fuel, and liquified gases.

The first Federal regulation of oil pipelines began on June 29, 1906, with the enactment of the Hepburn Amendment to Section 1 of the Interstate Commerce Act of 1887. The Amendment stated, in effect, that the provisions of this Act shall apply to any corporation or person engaged in the transportation of oil by means of pipelines, and such corporation or person shall be considered and held to be a common carrier within the meaning and purpose of this Act. Accordingly, the common carrier lines are under the jurisdiction of the Interstate Commerce Commission (ICC) and are required by its regulations to file tariffs and annual reports and maintain a uniform system of accounts. The interstate carriers are not required to secure certificates of public convenience and necessity before construction of new lines, and they do not have to obtain prior permission to abandon properties. There are many intrastate and privately owned oil pipelines which do not come within the jurisdiction of the ICC but are subject to regulation by the state in which they are located.

Table 1 indicates the growth in pipeline mileage and ton-miles for the selected years. These data indicate an average growth of about 3,500 mi/yr for pipelines and about 7 billion ton-miles in oil pipeline transportation from 1938 to 1962. A breakdown of pipeline mileage for 1962 is given in Table 2.

Until 1941, the crude and products trunk line diameters were mostly in the 4- to 12-in. range and those of the gathering lines were 2 to 6 in.; now the range is up to 30 in. for crude, 36 in. for products, and 12 in. for gathering lines.

The Bureau of Mines monthly reports for the first 6 months of 1964 show that crude oil delivered by pipeline to U. S. refineries averaged about 6,683,000 bbl/day and that about 3,884,000 bbl/day of products were delivered from products lines. The latter quantity, comprised 2,394,000 bbl gasoline, 250,000 bbl kerosene, 806,000 bbl distillate fuel oil, 86,000 bbl military jet fuel and 348,000 bbl natural gas liquids. Those pipeline deliveries are compared with prior years in Table 3.

According to figures released by ICC for 1962 for oil pipelines, there were received into systems 3,791 million barrels of crude oil and 1,332 million barrels of refined oils, a total of 5,123 million barrels. Delivered out of systems were 3,781 million barrels of crude oil and 1,328 million barrels of refined oils, a total of 5,109 million barrels. Receipts and deliveries are almost equal because pipelines must be full at all times for operating purposes. Theoretically, what goes into a line must sooner or later be discharged. The same statistics show that 3,213 million barrels of crude oil and 1,322 million barrels of refined oils, or a total of 4,535 million barrels, received trunk-line movement. The crude oil had a barrel-mile movement of 998 billion and the refined oils had a movement of 347 billion for a total barrel-mile movement of 1,345 billion. Calculations show that the average haul for crude oil pipelines in 1962 was 311 miles and for refined oil lines was 263 miles.

Statistics developed by the Bureau of Mines for 1962 show that all oil pipelines delivered 2,279 million barrels of gasoline, kerosene, distillate, military jet fuel, and natural gas liquids to consuming areas. The difference between the ICC figures and those of the Bureau of Mines is that the latter includes only pipeline movements made directly to, or out of, refineries. A considerable quantity of oil terminates at deep-water terminals to be reshipped by tankers or other forms of transportation to final destinations. As a result, oil pipelines deliver only approximately 74 percent of the total crude oil delivered directly to refineries by all modes. To make the figures more comparable, about 173 million barrels of crude oil moving to Gulf Coast points by pipelines for transshipment to the East Coast refineries in tankers should be added to the Bureau of Mines total.

TABLE 3

PIPELINE DELIVERY

Year	Bbl per Day (thousands)	
	Crude	Products
1961	6,086	3,113
1962	6,242	3,401
1963	6,482	3,530
1964	6,683	3,884

ICC annually prepares statistics showing the volume of intercity ton-miles, public and private, carried by different modes of transportation. Table 4 is a comparison of these volumes for 1952 and 1962.

Aside from motor vehicles, the 3.27 percent increase in oil pipelines between 1952 and 1962 was the largest of other forms of transport.

TABLE 4

VOLUME OF INTERCITY TON-MILES TRANSPORTED

Mode	Ton-Miles (billions)		Percent of Annual Total	
	1952	1962	1952	1962
Railways, steam and electric including mail and express	623.373	599.977	54.98	43.04
Motor vehicles, for-hire and private use	184.106	331.900	16.24	23.81
Waterways, including Great Lakes	168.367	223.089	14.85	16.00
Pipeline (oil)[a]	157.502	237.723	13.89	17.06
Airways (domestic revenue service, including express mail)	0.415	1.182	0.04	0.09
Total	1,133.763	1,393.871	100.00	100.00

[a]Includes crude and product trunk lines and gathering lines.

ASSOCIATION OF OIL PIPE LINES

The Association of Oil Pipe Lines is a voluntary unincorporated organization of 85 oil pipeline companies, most of whom are common carriers. Its purpose is to consider, discuss, coordinate, and formulate action on matters affecting the common interests of the member companies. These matters generally pertain to taxation, valuation, safety, or other laws or regulations that already exist or may be enacted or promulgated under existing authority. The common carrier oil pipelines are under the jurisdiction of ICC. However, in areas outside this primary jurisdiction, and in the case of wholly intrastate oil pipelines, local and state authorities are involved.

The staff of the Association consists of a General Counsel, a Secretary and Research Assistant (myself), and an office Secretary. The policies and decisions of the Association are generally discussed, developed, and decided on through an Executive Committee consisting of a Chairman, Vice-Chairman, and ten members. The decisions are then introduced at the semiannual meetings for adoption by a majority vote. Once adopted, the policies and decisions are executed through the General Counsel. Other committees, organized to perform special functions during the year, assist the Executive Committee as may be appropriate. These include the Legislative, Legal Information and Educational Committees.

In view of the foregoing, it can be understood why the Association is able to function with a small Washington staff. This staff is not designed to furnish engineering or technological information on a request basis. Furthermore, this function is not necessary as it would duplicate reliable sources already in existence, such as the American Petroleum Institute, the oil pipeline companies themselves, and the numerous scientific and engineering firms specializing in oil pipeline problems. The staff is mainly concerned with keeping the Association members informed on current matters of immediate concern or interest to them as a group. In matters of special interest, it contacts, requests, gathers, and summarizes information, data, and statistics as may be required.

TABLE 5

SHIFTS IN DOMESTIC TRANSPORTATION OF CRUDE PETROLEUM AND PETROLEUM PRODUCTS[a]

Year	Total Crude and Products Carried	Pipelines		Water Carriers		Trucks[b]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	354,420,630	139,220,962	39.28	137,728,491	38.86	20,538,060	5.80	56,933,147	16.06
1939	377,204,272	147,534,686	39.11	148,054,469	39.25	21,557,680	5.72	60,057,437	15.92
1940	385,742,696	153,502,082	39.79	149,594,453	38.78	21,849,000	5.67	60,797,161	15.76
1941	421,133,971	170,684,472	40.53	152,430,794	36.20	28,695,020	6.81	69,323,685	16.46
1942	426,905,706	175,486,660	41.11	120,076,511	28.13	49,524,400	11.60	81,818,135	19.16
1943	473,733,623	196,391,443	41.46	115,995,425	24.49	76,471,500	16.14	84,875,255	17.91
1944	539,713,995	244,001,439	45.21	117,688,301	21.81	99,048,800	18.35	78,975,455	14.63
1945	546,386,683	240,749,492	44.06	142,498,332	26.08	96,135,600	17.60	67,003,259	12.26
1946	545,329,125	222,266,138	40.76	172,513,605	31.64	88,852,600	16.29	61,696,782	11.31
1947	619,209,392	237,879,554	38.42	209,087,669	33.77	105,603,500	17.05	66,638,669	10.76
1948	686,273,830	262,452,531	38.24	237,516,329	34.61	120,897,800	17.62	65,407,170	9.53
1949	665,368,815	261,023,757	39.23	229,928,665	34.56	126,217,294	18.97	48,199,099	7.24
1950	731,282,314	283,853,383	38.82	252,765,749	34.57	145,780,986	19.93	48,882,196	6.68
1951	805,457,356	324,631,081	40.30	267,417,940	33.20	163,566,274	20.31	49,842,061	6.19
1952	831,289,595	337,426,840	40.59	274,913,642	33.07	171,744,588	20.66	47,204,525	5.68
1953	862,695,394	359,142,335	41.63	273,476,440	31.70	184,625,431	21.40	45,451,188	5.27
1954	876,949,886	373,327,262	42.57	268,524,812	30.62	192,564,326	21.96	42,533,486	4.85
1955	960,808,391	412,533,395	42.94	284,007,134	29.56	222,604,360	23.17	41,663,502	4.33
1956	1,014,930,276	441,386,180	43.49	297,826,330	29.34	235,960,622	23.25	39,757,144	3.92
1957	1,019,854,162	441,078,169	43.25	299,800,463	29.40	242,331,559	23.76	36,643,971	3.59
1958	1,017,179,215	443,027,566	42.57	298,656,025	29.36	252,024,743	24.78	33,470,881	3.29
1959	1,074,375,041	464,290,959	43.22	310,098,034	28.86	266,642,261	24.82	33,343,787	3.10
1960	1,089,137,729	468,409,682	43.01	318,295,654	29.22	270,375,253	24.83	32,057,140	2.94
1961	1,110,450,480	484,170,055	43.60	322,695,527	29.06	273,619,665	24.64	29,964,233	2.70
1962	1,158,752,236	502,464,600	43.36	329,734,358	28.46	297,698,196	25.69	28,855,082	2.49

[a] In tons of 2,000 lb; data from Association of Oil Pipe Lines.
[b] Amounts carried by trucks are estimates.

TABLE 6

SHIFTS IN DOMESTIC TRANSPORTATION OF CRUDE OIL[a]

Year	Total Crude Oil Carried	Pipelines		Water Carriers		Trucks[b]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	180,508,947	128,175,000	71.01	46,173,283	25.58	2,115,000	1.17	4,045,664	2.24
1939	190,464,264	135,270,000	71.02	47,045,281	24.70	2,220,000	1.17	5,928,983	3.11
1940	196,197,117	140,985,000	71.86	47,927,090	24.43	2,250,000	1.14	5,035,027	2.57
1941	212,796,708	156,300,000	73.45	46,224,034	21.72	2,955,000	1.39	7,317,674	3.44
1942	220,834,215	159,255,000	72.12	35,299,423	15.98	5,100,000	2.31	21,179,792	9.59
1943	240,730,423	176,835,000	73.46	31,129,833	12.93	7,875,000	3.27	24,890,590	10.34
1944	267,468,834	208,560,000	77.98	32,371,496	12.10	10,200,000	3.81	16,337,338	6.11
1945	274,078,434	205,185,000	74.86	48,477,658	17.69	9,900,000	3.61	10,515,776	3.84
1946	265,601,728	193,545,000	72.87	56,287,368	21.19	9,150,000	3.45	6,619,360	2.49
1947	292,501,482	204,375,000	69.87	67,333,281	23.02	10,875,000	3.72	9,918,201	3.39
1948	322,991,312	221,198,250	68.48	75,126,140	23.26	12,450,000	3.86	14,216,922	4.40
1949	297,351,940	215,051,700	72.32	64,219,078	21.60	12,997,800	4.37	5,083,362	1.71
1950	318,280,275	231,198,150	72.64	67,551,132	21.22	15,012,459	4.72	4,518,534	1.42
1951	357,492,665	263,394,600	73.68	72,497,833	20.28	16,843,980	4.71	4,756,252	1.33
1952	365,081,250	269,105,100	73.71	74,812,548	20.49	17,686,179	4.85	3,477,423	0.95
1953	376,860,595	283,379,400	75.19	70,585,701	18.73	19,012,642	5.05	3,882,852	1.03
1954	372,447,048	284,438,700	76.37	64,572,121	17.34	19,830,186	5.32	3,606,041	0.97
1955	398,877,036	310,042,950	77.73	63,081,850	15.81	22,923,695	5.75	2,828,541	0.71
1956	421,673,677	327,846,900	77.75	67,335,912	15.97	24,299,117	5.76	2,191,748	0.52
1957	421,369,673	320,277,900	76.01	74,090,233	17.58	24,955,193	5.92	2,046,347	0.49
1958	402,173,215	307,059,000	76.35	67,965,254	16.90	25,953,401	6.45	1,195,560	0.30
1959	429,754,500	327,697,000	76.25	73,067,560	17.00	27,458,698	6.39	1,531,242	0.36
1960	432,318,282	328,449,000	75.97	74,137,775	17.15	27,843,120	6.44	1,888,387	0.44
1961	441,820,196	333,318,300	75.44	78,297,176	17.72	28,177,237	6.38	2,027,483	0.46
1962	452,024,545	338,642,644	74.92	80,969,520	17.91	30,656,834	6.78	1,755,547	0.39

[a] In tons of 2,000 lb; data from Association of Oil Pipe Lines.
[b] Amounts carried by trucks are estimates.

Often letter and telephone requests for information from companies, colleges, and individuals are handled.

The staff does not, except in a special case involving the member companies, originate statistics. The statistics needed are gathered on a periodic or annual basis from ICC and the Department of Interior (Bureau of Mines and Geological Survey). The information on current pipeline construction is obtained from the member companies, various dailies, newspapers, and periodicals that feature or specialize in oil transportation, oil industry, and oil pipeline information.

Annually the staff prepares sets of information on oil pipeline construction and volume of oil transportation. The statistics of oil pipelines are based on barrels of 42 gal, rather than on tons as used in other modes of transportation. The figures can be readily converted to tons by conversion factors. One set of volume transportation information published annually is called Shifts In Petroleum Transportation. The study was originated years ago by John E. Boice, former Secretary and Research Assistant in the Association.

METHODS OF TRANSPORTATION

Tables 5, 6 and 7 cover the volume of oil (crude, products, and combined totals) in short tons, hauled by each of the four principal modes of transportation: oil pipelines, water carriers, trucks, and railroads. The sources for the original statistics are for oil pipelines, Bureau of Mines Monthly Statements; for water carriers, U. S. Army Corps of Engineers Annual Compilation; for trucks, American Trucking Association Annual Report of Intercity Tonnages; and for railroads, ICC Annual Report of Freight Commodity Statistics. The data for the tonnage hauled by the truck have been estimated from original figures compiled some years ago and brought up to date by an annual percentage change reported by the American Trucking Association. The final figures to complete the 1963 study have not yet been received.

TABLE 7

SHIFTS IN DOMESTIC TRANSPORTATION OF REFINED PRODUCTS[a]

Year	Total Refined Products Carried	Pipelines[b]		Water Carriers		Trucks[c]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	173,911,713	11,045,962	6.35	91,555,208	52.65	18,423,060	10.59	52,887,483	30.41
1939	186,740,008	12,264,686	6.57	101,009,188	54.09	19,337,680	10.36	54,128,454	28.98
1940	189,545,579	12,517,082	6.60	101,667,363	53.64	19,599,000	10.34	55,762,134	29.42
1941	208,337,263	14,384,472	6.90	106,206,760	50.98	25,740,020	12.36	62,006,011	29.76
1942	206,071,491	16,231,660	7.88	84,777,088	41.14	44,424,400	21.56	60,638,343	29.42
1943	233,003,200	19,556,443	8.39	84,865,592	36.42	68,596,500	29.44	59,984,665	25.75
1944	272,245,161	35,441,439	13.02	85,316,805	31.34	88,848,800	32.63	62,638,117	23.01
1945	272,308,249	35,564,492	13.06	94,020,674	34.53	86,235,600	31.67	56,487,483	20.74
1946	279,727,397	28,721,138	10.27	116,226,237	41.55	79,702,600	28.49	55,077,422	19.69
1947	326,707,910	33,504,554	10.26	141,754,388	43.39	94,728,500	28.99	56,720,468	17.36
1948	363,282,518	41,254,281	11.36	162,390,189	44.70	108,447,800	29.85	51,190,248	14.09
1949	368,016,875	45,972,057	12.49	165,709,587	45.03	113,219,494	30.76	43,115,737	11.72
1950	413,002,039	52,655,233	12.75	185,214,617	44.85	130,768,527	31.66	44,363,662	10.74
1951	447,964,691	61,236,481	13.67	194,920,107	43.51	146,722,294	32.76	45,085,809	10.06
1952	466,208,345	68,321,740	14.66	200,101,094	42.92	154,058,409	33.04	43,727,102	9.38
1953	485,834,799	75,762,935	15.59	202,890,739	41.76	165,612,789	34.09	41,568,336	8.56
1954	504,502,838	88,888,562	17.62	203,952,691	40.43	172,734,140	34.24	38,927,445	7.71
1955	561,931,355	102,490,445	18.24	220,925,284	39.32	199,680,665	35.53	38,834,961	6.91
1956	593,256,599	113,539,280	19.14	230,490,418	38.85	211,661,505	35.68	37,565,396	6.33
1957	598,484,489	120,800,269	20.19	225,710,230	37.71	217,376,366	36.32	34,597,624	5.78
1958	615,006,000	125,968,566	20.48	230,690,771	37.51	226,071,342	36.76	32,275,321	5.25
1959	644,620,541	136,593,959	21.19	237,030,474	36.77	239,183,563	37.10	31,812,545	4.94
1960	656,819,447	139,960,682	21.31	244,157,879	37.17	242,532,133	36.93	30,168,753	4.59
1961	668,630,284	150,851,755	22.56	244,399,351	36.55	245,442,428	36.71	27,936,750	4.18
1962	706,727,691	163,821,956	23.18	248,764,838	35.20	267,041,362	37.78	27,099,535	3.84

[a] In tons of 2,000 lb; data from Association of Oil Pipe Lines.
[b] Products pipelines move light oils only—gasoline, kerosene, distillate, jet fuel and L.P.G.
[c] Amounts carried by trucks are estimates.

Practically all of the oil demands of the heavily populated and industralized East Coast states—both crude for processing in area refineries and products—have for many years been met by means of tankers. This has proved the cheapest method of transportation for the area. There is, after all, no crude oil production in the Atlantic Coast states themselves. What is produced in the Appalachian area is largely consumed there by local refineries. Refineries in the Atlantic Coast area have a combined capacity of approximately 1,433,000 bbl/day and must bring in 1,080,000 bbl/day of crude oil if they are to stay on stream. Since the major refineries are in the Philadelphia, New York, Baltimore, and Boston harbor areas, all of which have access to deep-water terminals, the oil naturally comes from the Gulf Coast, California, and foreign countries by tanker. In addition, the East Coast needs 2,345,000 bbl/day of finished products that it cannot produce itself. That too, comes in largely by tanker from the Gulf Coast, California or foreign areas.

Figure 1 shows in millions of tons the combined volume of crude and products carried by each mode of transportation from 1938 to 1962. The tonnages carried by pipelines, water carriers, and trucks show substantial increases, whereas the tonnage carried by the railroads decreased. All media of transportation together moved more than 354 million tons of crude oil and products during 1938, whereas in 1962 they moved approximately 1,159 million tons, an increase of 805 million tons or 227 percent. The peak years were 1956 to 1962. The overall increases in movement show progressively the rise in United States oil demands.

Figure 1 shows the critical transportation situation that existed during World War II. Ocean-tanker movements then were practically eliminated because of the submarine menace to shipping lanes. Tanker movements on the coast alone declined from 1,472,000 bbl/day in June 1941 to 57,000 bbl/day in January 1943, a decrease of more than 96 percent. During this period overland transportation had to be developed to offset the loss of water movements. Tank cars were relied on primarily and their performance in long-haul movements was remarkable. Tank-car movements for short hauls were prohibited during the war. Instead, tank trucks took over the short hauls and performed so efficiently

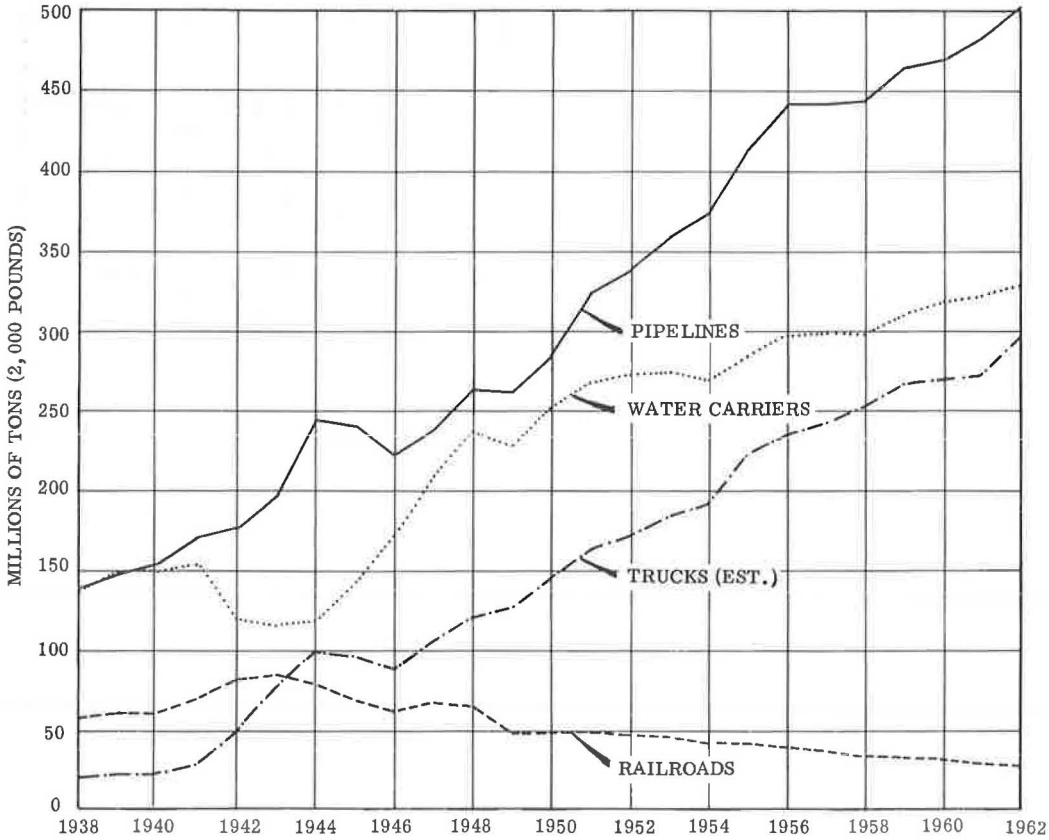

Figure 1. Volume of crude petroleum and petroleum products carried by each mode of transportation.

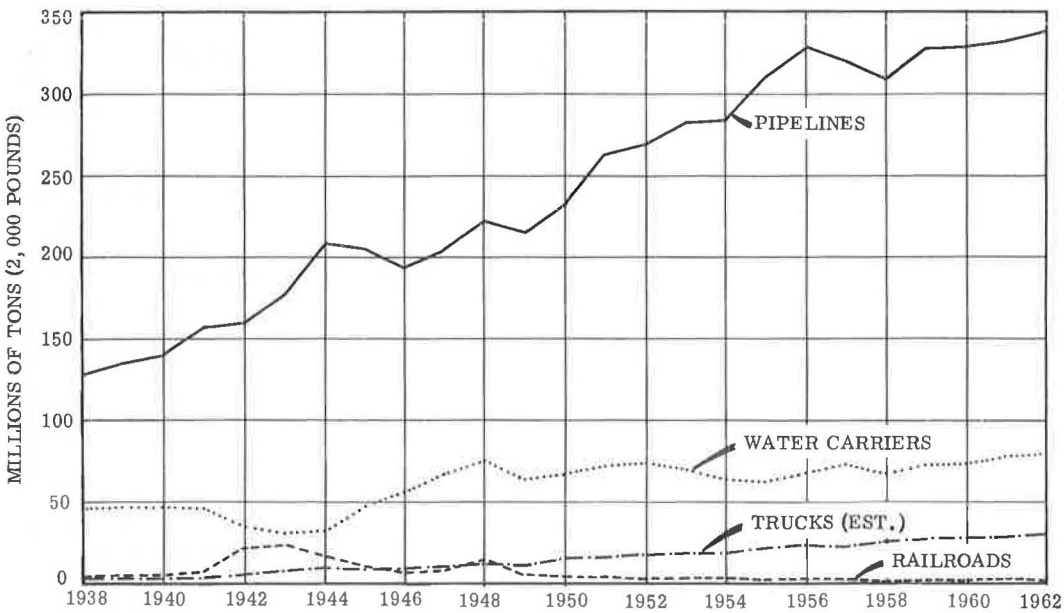

Figure 2. Volume of crude petroleum carried by each mode of transportation.

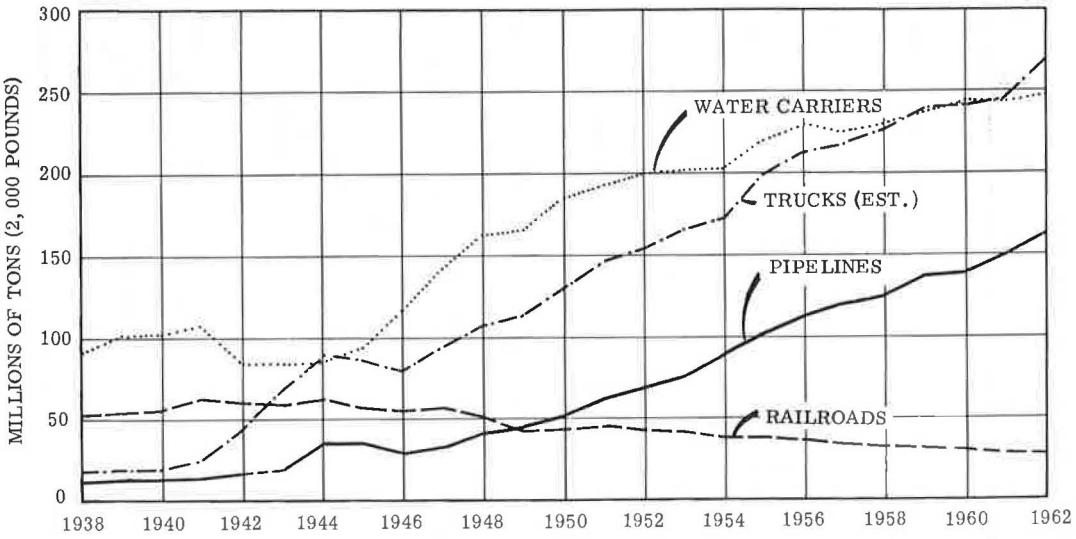

Figure 3. Volume of refined products carried by each mode of transportation.

much of this lost business. The rail movements between 1941 and 1944 show only the net gain; the increase would have been more pronounced had it not been for the loss of the short-haul business to the tank trucks. Barge movements on the inland waterways and on the Great Lakes were greatly increased during the war. They held the figures for water movements above the 1-million-ton mark in spite of the large decline in ocean-tanker movements.

During the struggle to overcome deficiencies caused by the loss of ocean-tanker movements, new pipelines were being developed, converted, and flow-reversed to move more oil in a general northeasterly direction. The large increase shown in Figure 1 between 1943 and 1945 reflects the movement made through the Government-owned war-emergency Big Inch and Little Big Inch pipelines, which were rushed to completion. The combined capacity of these 24- and 20-in. lines was more than 500,000 bbl/day. The sale of these large systems after the war for the transmission of natural gas accounts for the indicated decline in pipeline movements of a short period after 1945. However, extensive construction of new lines since then has more than compensated for the loss of these two giant lines for petroleum transportation. It might be mentioned that the Little Big Inch line has been reconverted to products service in the post-war period but only part way to the East Coast.

Figure 2 shows the total crude oil carried by each mode of transportation from 1938 to 1962. In spite of the 227 percent increase in total tonnage carried by all modes of transport, the percentage carried by pipelines increased only 3.91 percent between 1938 and 1962, disregarding intervening years. The water carriers moved 25.58 percent of the total tonnage in 1938 as against 17.91 percent in 1962, a decline of 7.67 percentage points. Railroad movements were off 1.85 percent during the 24 years, the figure indicating almost a constant decline since 1948. On the other hand, during the same years tank trucks increased their movement of crude oil by estimated 5.61 percent, with the greatest rise since 1942, precisely when rail movements were declining. Pipelines have for a long time been the principal means of moving crude oil from producing areas to refineries, as evidenced by the fact that they handled 74.92 percent of the total in 1962.

Figure 3 corresponds to Figure 2 except that it shows the movement of refined products exclusively between 1938 and 1962. The tonnage moved by trucks increased 27.19 percent and by pipelines, 16.83; that moved by the railroads decreased 25.67 and by water carriers, 17.45.

All four methods of transportation obviously are indispensable to the oil industry and, in many instances, complement one another. For instance, crude produced in

West Texas will move by pipeline to a Gulf Coast tidewater terminal and then be shipped by tanker to a refinery on the Atlantic Seaboard. After processing, the refined products will move to consuming areas by pipeline, truck, rail, or a combination of several modes. Naturally, each carrier reports its participation in the movement. There is, therefore, to some undeterminable extent a duplication in the reporting insofar as total tonnage carried is concerned. Therefore, this study can be regarded only as depicting the trend that has taken place in the shift in petroleum transportation over the number of years indicated.

Statistics clearly show the importance of adequate transportation for moving petroleum. As previously stated, pipelines are the most reliable because they operate around the clock all year, regardless of weather or other delaying factors that usually affect the other modes. They deliver nearly 75 percent of the crude oil reaching refineries. Refined oil pipelines have existed mainly since 1930 but their development in recent years has been phenomenal. In 1930 there were only 1,050 mi of such lines whereas of January 1, 1962 there were 53,200 mi.

In 1938 refined oil pipelines delivered 16.31 percent of domestic demands for gasoline, kerosene and distillate, the principal light products handled, whereas in 1962 this had increased to 44.90 percent. With the building each year of additional products line mileage, the volume moved is bound to grow. The 30- to 36-in. Colonial pipeline from Texas to the New York area is expected to be placed in operation shortly. This should make a major contribution to increased volume and will also result in further changes in the "shifts" study.

The pipelines as now constituted form a well-developed method of transportation that will continue to grow with future economic demands.

REFERENCES

1. Johnson, A. M. The Development of American Petroleum Pipelines: A Study in Private Enterprise and Public Policy, 1862-1906. Cornell Univ. Press, 1956.
2. Williamson, Harold F., and Daum, Arnold R. The American Petroleum Industry: The Age of Illumination, 1859-1899. Northwestern Univ. Press, 1959.

Defining "Intercity" for Transportation Purposes

JOHN NOLEN, JR.
Director of Transportation Planning, Office of Transportation, Housing & Home Finance Agency

The changing character and extent of urban America and particularly the growth of the metropolitan complex, together with concomitant changes in travel patterns and modes, have confounded the meaning of the term "intercity" as applied to transportation since the turn of the century. The basis of the dilemma is not only in the form of transportation provided but also in the form and extent of the urban communities which are served.

The evolution of the problem is traced and the concepts used to define and measure intercity and other travel are discussed. It is concluded that the problem is to find a series of common denominators or criteria that would take into account and identify the extent of the urban or metropolitan complex and the travel of a daily character associated with that complex in order to distinguish this type of travel and the service provided from that which is characteristic of movement between separated urban centers or aggregates. The SMSA is suggested as the geographical unit with which to associate metropolitan statistical compilations on travel.

•THE DAYS when the American city was a well-defined geographic or physical entity contained within its own political boundaries have long passed. Gone also are the days when the suburbs of the city were recognized as distinct communities, separated by distance and open space from the central city, though economically dependent on it. In their places compact metropolitan urban complexes have appeared in which city and suburb are physically amalgamated, with the daily activities of each dominated by interlocking streams of transportation in every form. Now the megalopolis is developing as a chain of metro complexes.

In this evolving environment, transportation facilities and service have been seeking to meet the changing requirements for moving both people and goods throughout and between these expanding urban complexes. Clearly, urban economic and social activities are highly interdependent, generating a wide variety of transportation needs which are increasingly difficult to define, separate, and measure. This paper is directed principally to a discussion of the changing factors which bear on the problem and to a review of the criteria used to distinguish or identify the so-called intercity passenger travel from urban travel in general.

GENESIS OF PROBLEM

The problem of defining intercity for transportation purposes has its roots in the successive changes which have taken place in the form and extent of urban settlements, whether they be large or small cities, suburban communities, isolated towns, or nonfarm sprawl and scattering. These changes, which have transpired over a period of more than half a century, have to a large extent been made possible, if not actually been caused by, progressive changes in the forms of transportation and the patterns of travel within and between urban areas of varied size and complexity.

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 44th Annual Meeting.

Until shortly before the turn of the century, travel within cities, as they were then constituted, depended on the carriage and the horsecar. Intercity travel was almost entirely by steam railroad which in the larger cities provided the beginnings of commutation service. After the turn of the century, the electric interurban railway became a system reality, reaching development on a statewide basis about a decade before the rise of the motor vehicle as a means of both urban and interurban transportation. During the 20 years of effective operation of the interurban railways, the groundwork was laid for the spread of urbanization around the larger cities and dispersion into smaller communities which the Federal-Aid Highway System later accelerated and extended.

The flexibility of the motor vehicle and its improvement as an economic means of both individual and mass transportation began to have its effect in consolidating urbanization around cities as centers of metropolitan development in the decades following World War I and the depression. Transportation routes and services, originally conceived as intercity or interurban, soon became so dominated by wholly metropolitan movements that the statistical basis for measuring and comparing travel became confused and even completely changed.

While these changes in the form of urbanization and in transportation were taking place, governmental interests in regulating and controlling public transportation were also changing. As motor bus routes and service began to replace the interurban electrics and new systems and services were organized, the states took over the regulation of intercity and, at first, even interstate operations. Indeed, much of the city-suburban movement was included whenever cities were not given control of operations beyond their boundaries. For a decade or more, as service and systems evolved, the need for and practice of regulation increased. The Motor Carrier Act of 1935 settled the question for the carriers in interstate service but the intercity vs local service issue was left undefined, with operations subject to varied classification.

This is the basis of the present problem of defining intercity for transportation purposes. Its roots are not only in the type of transportation service provided but also in the form and extent of the urban communities being served.

DEFINING URBAN COMPLEX

Since the political boundaries of a city constitute too limited a concept to identify intercity travel, some other basis of demarcation is needed which will take the city as a nucleus and group together the closely populated areas associated with it. A review of the methods developed to define and measure these urban complexes or aggregations may be of value in helping to differentiate between intercity operations and those associated with the internal life of the metropolitan community.

In 1910, the U. S. Bureau of the Census established the metropolitan district in an attempt to embrace an urban aggregate that was larger than the city and an appropriate unit for demographic and ecological analysis. By 1940, the limited criteria of size and density for creating a census metropolitan district had become outmoded and quite inadequate to delimit the expanding metropolitan community.

Two changes were made for the 1950 census in an effort to define and measure the population within the areas of continuous urban settlement. First, criteria were established for mapping and compiling statistics for urbanized areas. Each urbanized area so classified had to have at least one city of 50,000 inhabitants or more in 1940 and the surrounding closely settled incorporated places and unincorporated areas had to meet certain size, density and contiguity criteria. Since the boundaries by the definition could not always conform to political subdivisions, and would change from census to census, statistics pertaining to these urbanized areas were extremely limited and were only related to one point in time.

In an effort to eliminate this inherent weakness and broaden the basis of statistical comparison, the Bureau of the Budget created the Standard Metropolitan Statistical Area (SMSA). As constituted in 1960, there were 212 SMSA's, embracing 112,885,178 people or about 63 percent of the population of the United States at the time.

The general concept of an SMSA is one of an integrated economic and social unit with a large population nucleus. Each must contain at least one city with 50,000 or more in-

TABLE 1

URBAN POPULATION CLASSIFICATIONS

Area	Number	Population	% of Total
Urban	5445[a]	125,268,750	69.9
Urbanized	213	95,848,487	53.5
SMSA	212	112,885,178	63.0

[a]Includes only places of 2,500 or more representing 63.9 percent of total population.

habitants and include the county of the central city and adjacent counties found to be metropolitan in character and economically and socially integrated with the county of the central city. In New England, towns rather than counties are used as the basic statistical unit. The criteria of metropolitan character relate primarily to the attributes of the county as a place of work or as a home for concentration of nonagricultural workers. The criteria of integration relate primarily to the extent of economic and social communication between the outlying counties and the central county.

Table 1 gives the relative number of places and people in the several census classifications or groupings of the urban population. It indicates that the SMSA is a possible successor unit to the city for distinguishing intercity travel from that which primarily serves the metropolitan area. The SMSA meets the requirement of including all the contiguous urban area associated with the central city and has a definite and generally fixed legal boundary which might be satisfactory from a regulatory standpoint and is certainly statistically significant.

DEFINITIONS IN CURRENT USE

As previously indicated, the present definitions have been developed largely for separate regulatory purposes and have no intended coordinate relationships. The most important sources of these are: (a) the Interstate Commerce Commission (ICC), (b) decisions of the courts relating to jurisdiction and the applicability of Federal and state laws, and (c) exemptions from the Highway Revenue Act of 1956.

In its annual reports, the ICC gives the following definitions:

> Local service for the purpose of accounting and compiling statistical data means transportation performed within a city or town including the suburban area contiguous thereto.
>
> Intercity service means transportation performed beyond the limits defined for local service.

Obviously, these general definitions leave indeterminate the statistical boundary line between local and intercity service with regard to both periodic comparisions and the applicability of the definition territorially.

In its quarterly reports, the ICC gives the following slightly different definitions:

> Local and suburban schedules shall include schedules (other than charter or special service) operated within a municipality and the trading and suburban residential area thereto.
>
> Intercity schedules shall include all schedules (other than charter or special service) operated beyond the limits defined for local and suburban schedules.

In reporting operations for Class I motor carriers (i.e., those having gross operating revenues of $200,000 or more annually), the ICC tabulates statistics for both intercity schedules and local and suburban schedules according to these schedule definitions, but when the carrier reports operating both schedules it classifies the carrier as intercity if the average revenue per passenger is in excess of $0.20. This arbitrary fixed limit has not been changed for many years in spite of rising fares; therefore, some Class I carriers performing essentially a local service in a metropolitan area would be classified as intercity though reporting divided operations according to the definition.

The National Association of Motor Bus Owners, which annually publishes Bus Facts, states that approximately half of the 1,450 intercity bus companies are in interstate service, but that there are no comprehensive data available for those intercity carriers operating intrastate service only, presumably because these are not covered uniformly by any single agency such as the ICC. Thus, the available statistics for intercity travel are probably not complete or entirely comparable for lack of a generally accepted definition and a single official source of compilation. Further elaboration of the definition issue will clarify this phase of the problem.

Oklahoma statutes provide the following often quoted definition under Title 47, Chapter 56, §161, paragraph (d):

> The term 'intercity' as used in this Act is defined as describing transportation of either passengers or property, when such transportation is from one incorporated city or town to or through another incorporated city or town or through two or more incorporated cities or towns, regardless of the point of origin or destination.

In a Florida decision, quoting Webster's New International definition and the Oklahoma statute, the court termed the Oklahoma statute definition as adequately reflecting the commonly accepted understanding of the word intercity. Interestingly enough, it also states that the word most often used to describe this type of transportation is interurban.

Seemingly contrary in its effect, if not actually so, is a decision of the Circuit Court of Appeals in Ohio involving the Valley Motor Transit Company which was engaged in interstate commerce between Steubenville, Ohio, and Beaver, Pa. It involved an exemption from the requirements of Section 13 of the Fair Labor Standards Act of 1938. The decision of the Court was that, in spite of the fact the service was provided over a 42-mile route between cities in different states, the Valley Motor Transit Company was a local motor bus carrier because it rendered a local service along the route involving 239 stops and charged fares according to zones. Furthermore, only three passengers of the 12,000 carried per day traveled the entire distance. The court stated that the distinguishing characteristics between local and long-distance carriers were fivefold: (a) traffic, (b) service, (c) equipment, (d) fare structure, and (e) wages and working conditions. Notable in this decision is the fact that neither the termini of the route nor its length nor the character of the territory traversed were the distinguishing characteristics.

Federal highway legislation deals with intercity problems in connection with the Highway Revenue Act of 1956. As in all revenue legislation the provisions of the law are complicated. For the purpose of this discussion it is sufficient to say that exemptions from the imposition of a portion of the gasoline tax and of the tax on the transportation of persons are provided in the case of the use of any bus which is of a transit type (rather than of the intercity type). Here again the distinction between local and intercity is in the type of service rendered (as exemplified by the transit bus) rather than any direct relation to the route.

A valuable contribution to this subject, including impact of the term intercity on freight transportation, are the following separate definitions of intercity travel for passenger and freight provided by the former Deputy Undersecretary for Transportation of the Department of Commerce, E. G. Plowman.

> By intercity personal transportation is meant those travel movements that are not patterned on a daily commuter basis and that are between urban centers rarely less than 40 miles apart, measured between their downtown 'central business districts'. Since this definition excludes daily commuter travel, data collection is complicated by such movements up to, but rarely beyond 100 miles. Furthermore, automobile, bus, rail and air transportation may serve both commuter and intercity travel needs within each urban area.

By intercity freight transportation is meant all shipments except those that are handled by a private or for-hire truck that is operated on a planned daily route pattern and that returns to its base each evening. In general, daily truck route patterns do not extend beyond about 150 miles for the round trip. Within this radius of any urban center there are both intercity and local movements, sometimes in the same vehicle, complicating the statistical problem.

INTERCITY TRAVEL MODES AND PATTERNS

Total intercity travel has been estimated by The National Association of Motor Bus Owners and the Transportation Association of America to comprise some 841 billions of passenger miles in 1963, of which almost 90 percent was by automobile. Excluding travel by automobile, intercity movement is now dominated by the airlines which carry about 50 percent of the passengers; the other 50 percent is almost equally divided between the railroads and the intercity bus, the latter having remained nearly constant at 25 or 26 percent of the total for the last five years.

Of particular interest in the definition problem is the fact that for the Class I intercity bus industry, two-thirds of the passengers carried in regular route service are classified as intercity and one-third as local and suburban. These figures apply to only 161 of the 1,450 companies estimated by The National Association of Motor Bus Carriers as in intercity service.

The 1963 census of transportation covering national travel during the first six months of 1963 provides some recent statistics on the distribution of travel by method of transportation and the distance and duration of trip. Trips were counted if they involved being out of town overnight or on a one-day trip 100 miles or more from home. This was not intended to represent the dividing line between intercity and local travel, however, but only to serve as a basis for measuring the travel industry. Of bus trips, 29 percent were under 50 miles, 16 percent were 50 to 99 miles and 55 percent were more than 100 miles. Trips by auto had higher proportions only for the 50- to 199-mile distances.

More directly related to the definition problem is the fact that the survey also showed that for all trips of more than one day duration, the bus was used less than the auto for one or two overnight trips, but for longer durations the bus had increasing use. This again emphasizes a dominant characteristic of its intercity service.

SUMMARY

The foregoing discussion singles out some of the many variables in need of reconciliation or evaluation in order to define the term intercity for transportation purposes. The difficulty is to find a series of common denominators or criteria that would take into account and identify the extent of the urban or metropolitan complex and the travel of a daily character associated with that complex in order to distinguish this type of travel and the service provided from that which is characteristic of movement between separated urban centers or aggregates. Clearly, the term intercity is outmoded and, in lieu of interurban, perhaps the concept of extra-urban is more applicable. And, for travel within or between the complex metro-urban aggregations, perhaps the SMSA should be the geographical unit most practical for statistical compilations.

Obtaining Acceptable Quality Data from Carload Waybill and Other Samples

A. C. ROSANDER
Chief, Mathematics and Statistics Staff, Bureau of Transport Economics and Statistics, Interstate Commerce Commission

The purpose of this paper is to describe the various factors that determine the quality of data obtained from a probability sample study, to explain what is meant by "quality," to give examples illustrating quality of data with special reference to the Interstate Commerce Commission's continuous carload sample, and to describe steps that can be taken in the planning, implementation and presentation of a probability sample study to control the quality of the data obtained.

•STATISTICAL PROGRAMS and sample studies are planned not simply for the purpose of compiling numerical data which may be useful sometime, but as an integral part of an information system which aids management to make better decisions, exert closer control, appraise operations more accurately, and set policy more intelligently. This means that close attention is paid to the early stages of the study, to detailed analysis of the problem, definition of the population, isolation of basic characteristics, and enumeration of significant classes and subclasses for which data are required. In other words, close attention is paid to the purpose for which the information is needed, so that only the most significant information is collected.

There are many reasons for stressing analyzed purpose, but the most important is to collect the minimum amount of data required to meet a specified need, thereby saving time, money and personnel. The older notions that facts speak for themselves, that there is virtue in large masses of data, and that data collected for no specific purpose might sometime prove beneficial have been found to be wasteful guidelines. Simply collecting or compiling a mass of data is no longer enough.

Experience with applied probability sampling during the past 25 years has substantiated the following important ideas:

1. The quality of the information is as important as, if not more important than, the quantity of data.
2. Redundancy exists in numerical data (and, therefore, justifies sampling).
3. Numerical data have to be interpreted in terms of how they are collected or, to use an expression coined by R. A. Fisher, in terms of the logical structure. An efficient logical structure is one which can be expressed in terms of probability and mathematical statistics.
4. Data collected on a probability sample basis can be analyzed by mathematical statistics, thereby aiding both research and management to make more accurate and meaningful decisions about operations, planning, and policy.
5. A properly planned, designed, and managed probability sample can give quality data rapidly at a minimum cost.
6. Sources of nonsampling variation may equal or even exceed variations due to random sampling. A very important information problem is that of getting quality data at the source since the source is often the major cause of nonsampling variations, due to the respondent, the collector of the data, or to both. This means that a prob-

Paper sponsored by Committee on Intercity Highway Freight Transportation and presented at the 44th Annual Meeting.

ability sample properly designed and managed may actually prove better (have less total error) than a census or 100 percent tabulation that is not carefully planned and controlled.

7. Neither a purely inductive (statistical data) nor a purely deductive (model building) approach to information is most effective, but some combination of the two is required.

CHARACTERISTICS OF ACCEPTABLE QUALITY DATA

Some of the major characteristics of acceptable quality data derived from a probability sample are as follows:

1. The standard error of an estimate is known.
2. Since the variation due to sampling is known, assignable causes can usually be separated from random variations. Therefore, differences due to sampling can be distinguished from those arising from other sources. Therefore, statistical techniques, such as analysis of variance, can be applied to the data to clarify the meaning of differences.
3. Nonsampling variation is controlled so as to minimize or measure its effect, e.g., nonresponse or loss of sample elements due to cutoff date. This means that the sample study is properly managed and controlled, and that techniques such as a sample audit are used to measure nonsample variation.
4. If nonsampling error can be estimated, the magnitude of the total error can be computed.
5. The sample data answer specific questions of magnitude, level, control, comparison, and frequency of occurrence.
6. Basic concepts and terms are explained in enough detail that the user can distinguish them from slightly different concepts or terms. This is a problem of exposition.
7. Basic concepts and terms, including any questions on a questionnaire or items on a data sheet, are explained in operational terms so they can be distinguished from other concepts and so that answers to questions and data entries are additive. This comparability is facilitated by pre-tests, pilot studies, and written and oral instructions. Where many persons are involved in collecting the data, it is imperative that they have a common understanding of the information desired; hence, written as well as oral instructions are needed, with follow-up on questions and problems, statistical quality control techniques, and other controls designed to insure that the information is additive and not a function of some characteristic of those collecting the data.
8. Acceptable quality data also imply an adequate technical sample designed in terms of purpose and population, and adequate management of the sample so that the plan will be properly implemented. At every stage, the integrity of the data must be maintained so that the use of the powerful methods of statistical interpretation will be justified.
9. The data are relevant to the questions to be answered or the problems to be solved.

EXAMPLES ILLUSTRATING QUALITY IN DATA

The following examples illustrate what is meant by quality in data:

1. A careful probability area sample showed that about 25 percent of the businesses had been omitted in the French census of business for 1947. Therefore, the census data was of no value and was never published.
2. Revenue per ton-mile for railroads as obtained from annual reports is less than revenue per ton-mile obtained from the carload waybill sample because the former is derived from actual miles and the latter is derived from short-line miles. This means that in the expression $v = u/(xy)$, where u is total revenue, x is tons, and y is miles, the value of y is greater in the annual reports than in the carload sample. Hence, the ratio v is less. There is no problem here if the term miles is clearly defined in both instances.

3. On some piggyback-type waybills, the term net weight may mean the same as gross weight on other waybills. Furthermore, the concept of weight may include actual commodity weight in some instances and an arbitrary minimum weight in others. We "make" these weights additive by calling them billed weight. Obviously, this does not help the person who is interested in the total actual tonnage of commodities hauled. A correction factor could be obtained and applied to billed weight to get actual commodity weight in the same way as a circuity factor is applied to short-line miles to get actual miles.

4. In a proceeding before the Interstate Commerce Commission (ICC), a cost formula of the form $C = (Mcy)/x$ was presented where values for M and c came from accounting records, and x and y from a sample. Sampling errors were confined to y; x was ignored as were the possible errors in M and c. In this case, the standard error of C was needed, but this computation was not made. Considerable time was spent by the parties in the case discussing the sampling error in y when this magnitude was really not the error required.

5. The applicability of sample data collected for one day or one week to longer periods such as an entire year is questionable. Usually it is assumed, rather than proven, that data from a short-time population are applicable to a much longer-time population. The solution lies in using the time population inherent in, or applicable to, the problem.

6. In one of the carload waybill publications, the revenue per car-mile for all movements was shown as $0.60 for each of the years 1959 and 1960. The standard error of these estimates is about 0.01, and using one more digit gave $0.601 for the 1959 value and $0.598 for the 1960 value. A very significant difference of $0.003 existed between the two years but too much rounding off eliminated it.

7. In a random time study of personnel activity during one week, 25 random minutes are selected and one group of workers is observed each minute. The total number of persons for which a record is made is 225. The sample size is 25, not 225, and the standard error should be based on 25 values, not 225; otherwise, the standard error is one-third as large as it ought to be.

8. The waybill sample shows 25 carloads of a certain commodity movement for one year and 36 for the same commodity the next year. The probability is very high that this difference is due to sampling, not to a change in the commodity movement. In sample data, differences must be tested to determine whether or not they could be explained in terms of random sampling or its equivalent.

CARLOAD WAYBILL SAMPLE

The ICC's sample of waybills of carloads terminating on Class I railroads in the United States illustrates the problems which arise in connection with the quality of the data on the waybills, and the steps taken to insure acceptable quality:

1. Control over sample receipts by railroads is necessary to secure timely and complete shipment of the sample bills. A follow-up system is applied monthly and at the end of the calendar year to keep missing sample bills at a very low level.

2. A quick review of sample waybills is made on receipt to screen out those obviously in error or defective (such as those wholly or partially illegible).

3. Form letters are used to return waybills found in error to railroads for correction. These errors include missing stations, wrong station numbers, questionable commodity codes, inconsistency of type of car and commodity carried, and uncertain type of rate.

4. Consistency checks are programmed on the computer to read out waybills containing inconsistent information such as weight of car in relation to type of car.

5. About 90 percent of the waybills are miled mechanically, thus eliminating a major source of error. About 2,500 waybills are still manually miled monthly.

6. Statistical quality control techniques are now being developed or applied to commodity coding, to other coding operations, and to manual miling to maintain control over the error rate on waybills before they go to the punch room. This program is not fully operative but tests to date indicate that it is needed and would be effective.

Additional checks are made after the tabulations are run. Cell-by-cell comparisons are made with the tabulation for the previous year. In a few instances this review has detected some tabulation errors. Finally, the publications are reviewed to check for missing or illegible pages and omission of commodity identification. In the publications the limitations of the data are described and the limits of the population are drawn.

MAJOR FACTORS AFFECTING QUALITY OF DATA

Source

One of the major factors affecting quality is the source of the data. The respondent may not answer accurately or completely; he may misunderstand what is wanted or he may deliberately slant, withhold or distort the information. The collector of the data may not ask clearly worded questions, the right questions, or nonleading questions. The questionnaire and the data sheet may have deficiencies which affect the information. Very careful and complete planning is necessary to obtain quality of data at the source. For example, pre-testing data sheets, instructions, questionnaires, and even sample plans help to weed out unwanted and unwarranted deviations.

Analysis of Problem

Many times the crucial factor in determining the quality of the data is the analysis of the problem itself. This includes phrasing of specific questions, defining the population, identifying basic characteristics to be measured, and listing classes and subclasses for which data are required. When specific questions are formulated, effort is concentrated on collecting only those data giving unambiguous answers to these questions. Implicit assumptions should be made explicit, and subject to test by means of the data. Otherwise, the entire study may rest on an assumption or conjecture which may seriously impair the validity of the entire project.

Some years ago, a sample study of American families was made eliminating the foreign-born because it was assumed that they were different from native-born families. Before the study was over, however, estimates for all U. S. families were necessary and the foreign-born had to be included. Therefore, the original position was reversed and it was assumed the foreign-born were like the native-born at the same income class! These inconsistencies and unnecessary truncations of the population can be avoided by a careful analysis of the problem and the population at the outset.

Definition of Terms

Numerical data, whether derived from sample or census, are subject to semantic problems. These problems arise at some critical points: (a) in analyzing the problem; (b) in phrasing instructions, data sheets, etc., for collecting the data so that the respondents know what is wanted (part of this job is to explain clearly the various units of measurement); and (c) in explaining what these terms mean in various reports and publications. Much of the trouble lies in the fact that the terms are not explained carefully enough that the respondent, the reader, or the user knows what they mean. The carload waybill publications contain sections defining all major terms used in the tables, including ton-mile, carload, car-mile, revenue, and billed weight.

Use of Probability Sampling

A very effective way of obtaining data of acceptable quality is to take full advantage of probability sampling and the associated statistical analysis. This assumes, of course, that the probability sample is carefully designed and effectively managed when put into operation.

Probability sampling has the following merits:

1. It provides a way of measuring and controlling sampling variability (the standard error of an estimate);
2. It provides a built-in method of estimation;
3. It forces a better control over nonsampling errors;

4. It forces a more detailed analysis of the problem;
5. It provides data for its own progressive improvement;
6. It eliminates the need to assume that a sample is representative, a judgment often hard to defend; and
7. Mathematical statistics can be used to interpret the data.

The last point is of special importance because it allows us to use the sciences of probability and statistics to interpret the data, to distinguish real differences and relationships from apparent ones. The Shewhartian chart used for statistical quality control is an excellent example of how theory and practice of mathematical statistics are combined into a simple, yet very effective, device for decision making and control.

Random Time Sampling

A very important type of probability sampling found in work measurement, cost accounting, and other cost work is random time sampling. This method is used where operations must be observed as they are taking place. A suitable time frame is established and units of time, either instants or durations, are selected at random. At these random instants or durations, observations are made of workers or machines, of street or road traffic, or of persons entering supermarkets. In this way, accurate estimates of work performance, traffic density, and similar characteristics can be obtained. The randomly selected time unit may be a minute, an hour, a day, or some other unit, depending on the problem.

Design of Sample

The technical design of the sample is another factor in determining the quality of the data, but it is often the easiest problem to solve. Established standards of practice will be followed in designing the sample. Many different designs are possible, all of which may be valid, but the problem is to design that sample which is most efficient and most feasible, yet meets the specifications of variation imposed on the final results or the risks imposed on the final decisions. It is the statistician's responsibility to make clear what kinds of information the sample can provide and what kinds of data it is not designed to furnish.

Control Over Sampling Variability

This can be exerted in a number of different ways: (a) by the size of the sample, (b) by the method of estimation, (c) by stratification, and (d) by type of sampling unit. Usually, this control is not difficult to exert. Although control by size of sample is most common, the other methods can be very effective.

Pilot Studies and Pre-Testing

A sample survey can be greatly improved by making use of pilot studies including pre-testing of data sheets, forms and questionnaires. These exploratory tests or studies enable one to:

1. Test a questionnaire for ambiguity, misunderstanding, inconsistencies;
2. Estimate standard deviations and other quantities needed for determination of size of sample and efficiency of stratification;
3. Test personnel reaction, whether favorable or unfavorable;
4. Determine areas, questions, and operations that need to be emphasized when preparing instructions;
5. Test data recording forms;
6. Test control forms;
7. Examine possible frames for use in selecting the sample; and
8. Appraise the type of personnel available to implement the sample.

Example of Pilot Study

A good example of a pilot study was the five-day random time sample used by the Internal Revenue Service preparatory to introducing a continuous random time sample to determine salary costs of various projects for purposes such as of budget planning and work scheduling. The five-day test yielded information which was used to improve instructions and sample design and to simplify operations. The pilot study data in this instance were studied and procedures changed so that about four months elapsed before the final random time sample was put into effect. Much of this time was spent redesigning the sample, revising instructions, preparing activity code books, and otherwise improving procedures.

Management of Sample

The implementation of a probability sample study requires careful management of the entire project. This is done to keep nonsampling errors under control and to see that the technical sample design is carried out as planned. Careful management calls for detailed planning, design of various data sheets and control forms, preparation of instructions and any other necessary materials, and the effective implementation of these plans and controls.

Control Over Nonsampling Variability

Quality of data is preserved chiefly by controlling nonsampling variability, and here the major problem lies in getting acceptable quality data at the source. The problem does not arise primarily because some data involve opinions or judgments and others do not; it can arise even if the information is objective and subject to measurement. The problem consists of getting accurate and unambiguous data from the source, and this holds true whether we deal with income tax returns where most of the basic data are money figures, with carload waybills filled out by a railroad station agent, with freight bills filled out by a motor carrier (truck line), or with a cost-of-living study where all data are money figures or quantities furnished by a member of the household.

Statistical Analysis

Statistical analysis is needed to give logical quantitative meaning to the data; otherwise, misleading inferences may be drawn. We may conclude that a difference is due to economic factors, when it could very easily be due to sampling variations. This statistical analysis needs to be made before other specialists attempt to interpret the data in terms of their own subject matter fields. Some statistical analysis is now included in the carload waybill publications, and this will probably be in forthcoming issues.

CONCLUSION

To summarize, the quality of data depends on careful execution of the following procedures:

1. Define problem and terms;
2. Analyze problem into details;
3. Phrase questions carefully;
4. Use pre-testing and pilot study, and study the source;
5. Train personnel;
6. Prepare written instructions and other materials;
7. Design adequate probability sample and use random time sampling as needed;
8. Manage probability sample properly;
9. Apply statistical analysis implied in collection procedure;
10. Compute standard errors of estimates and functions;
11. Control nonsampling error;
12. Estimate total error;

13. Explain basic terms so the reader knows what they mean and distinguish them from similar or identical terms used elsewhere; and
14. Use sample audit and other control methods.