

INSTALLATION REPORT ON POROUS FRICTION COURSE  
HOT PLANT MIX

by

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Highway Research Engineer

Virginia Highway Research Council  
(A Cooperative Organization Sponsored Jointly by the Virginia  
Department of Highways and the University of Virginia)

Charlottesville, Virginia

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### INTRODUCTION

An investigation was initiated in the spring of 1972 to develop surface mixes with high skid resistance for use at special locations. The porous friction course will hopefully provide high skid coefficients where water drainage and hydroplaning may be problems. The porous friction course has sufficient voids and channels to allow water to drain to the bottom of the layer and out to the shoulder.

### INSTALLATION OF POROUS FRICTION COURSES

Two sections of a porous friction course (pop-corn) hot plant mix were installed during 1972. The initial installation was on Route 60 in Appomatox County on May 24, 1972 and a second section was installed at an accident prone location on Route 23 in Scott County on September 18 and 19, 1972 (see Figure 1 attached).

### MATERIALS

Two aggregates were utilized in separate test sections on Route 60: one a crushed stone from Rockydale Stone of Lynchburg, and the other a lightweight aggregate from the Hercules plant at Snowden, Virginia.

A No. 8 crushed gravel from Vulcan Materials, Erwin, Tennessee, was used in the Route 23 installation.

The gradations of all materials are listed in Table 1.

Approximately 0.07 gal/sy of AP-3 was used as a tack coat on Route 60 and 0.1 gal/sy residual asphalt CAE-2 emulsion was applied to Route 23.

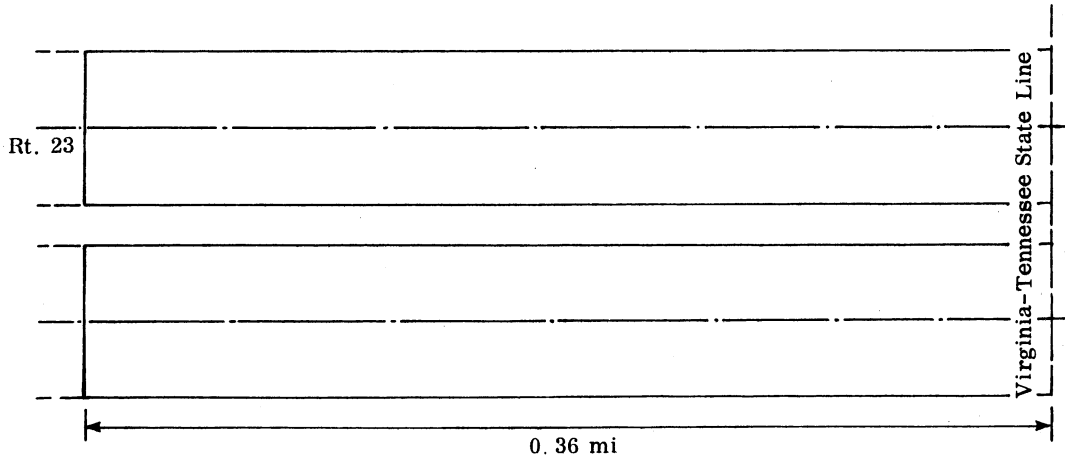
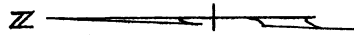
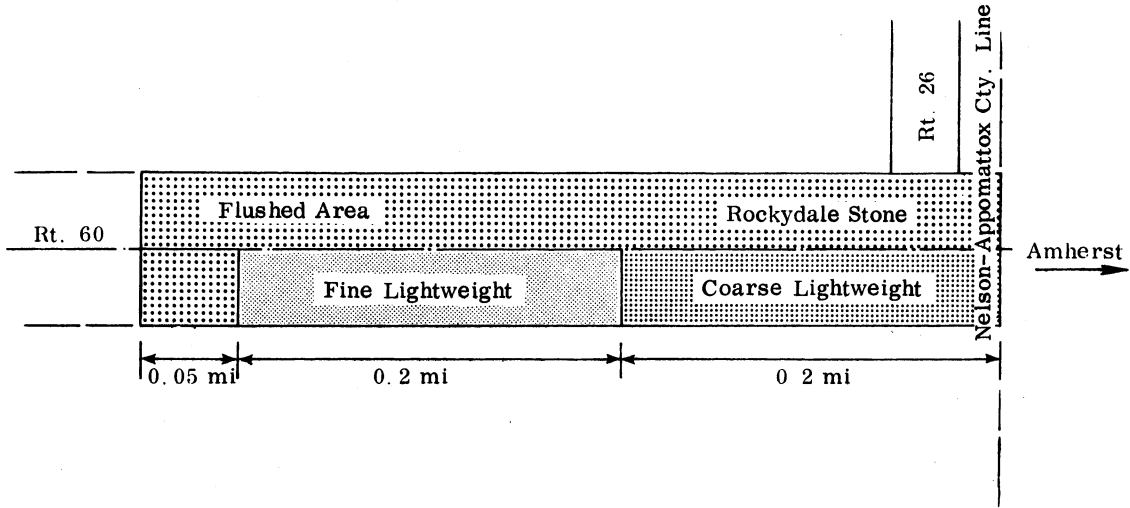


Figure 1. Installation Locations.

**CONTAINERIZATION:  
SOME TRENDS AND PROBLEMS**

by

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CONTAINERIZATION:  
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INTRODUCTION

The information presented in this report is the result of data compiled for an HPR study entitled "A Forecast of the Effects of Containerization on the Transportation System in the State of Virginia", due for completion by June 30, 1973. The purpose of the study is to determine the impact of the growing use of containers for freight shipments on the state's transportation system. It involves water, highway, and rail transportation and, most importantly, their inter-relations.

This brief report focuses on some of the problems facing the Port Authority in the transportation of containers over highways and speculates upon the methods the Authority might employ in seeking solutions.

CONCLUSIONS

Twenty (20) foot containers are entering the ports in growing numbers and when combined with the fact that economic drawbacks cause reluctance of motor carriers to move them, a congestion problem can be anticipated in the ports.

The Port Authority, in an attempt to solve this problem, may move to modify sections of the Virginia Code which deals with the movement of freight over the highways.

Judging from the trends of other states the sections "§46.1-335, Vehicles having more than one trailer, etc., attached thereto," and "§46.1-339, Weight of vehicles and loads," would be ones in which modifications would be sought.

If the move is made to modify these laws the modifications should be viewed in terms other than either/or. The alternatives should be viewed in terms of containerized freight vs. breakbulk, small container movement (the problem) vs. general twin-trailer movement (a generalized issue) or imported containers (more difficult to control) vs. domestic containers.

Table I

Port of Hampton Roads  
General Cargo Tonnage Movement  
Short Tons of 2,000 lb.

<u>Year</u>	<u>Breakbulk</u>	<u>Container</u>	<u>Total</u>	<u>%Container</u>
1970 (actual)	1,297,463	868,601	2,166,064	40.1
1971 (Jan. to Nov.)	1,203,816	1,051,291	2,255,107	46.6

Projections made by the Virginia Port Authority and given in table 2 indicate an increase of the container breakbulk ratio to 70/30 in favor of containerized freight by 1981. This rapid increase in container freight is not only dependent on the tendency of the shipping industry toward containerization but also upon the expansion of the ports facilities to handle the increased volume containerized cargo.

Table 2

Port of Hampton Roads  
General Cargo Tonnage Movement  
Short Tons of 2,000 lb.

<u>Year</u>	<u>Breakbulk</u>	<u>Container</u>	<u>Total</u>	<u>%Container</u>
1972	1,144,011	1,304,151	2,448,182	53.3
1973	1,069,271	1,588,818	2,658,089	59.8
1974	973,760	1,912,631	2,886,391	66.3
1975	923,776	2,210,935	3,134,711	70.5
1976	1,005,317	2,399,522	3,404,839	70.5
1977	1,005,951	2,517,516	3,573,467	70.5
1978	1,109,158	2,641,373	3,570,531	70.4
1979	1,165,074	2,771,383	3,936,457	70.4
1980	1,223,835	2,907,859	4,131,694	70.4
1981	1,285,590	3,051,122	4,336,712	70.4



All sizes of containers enjoy the benefits of intermodal transit, limited handling, and generally reduced costs (see appendix I). Because of the ease with which a container can be moved from one mode of travel to another the time expended on a 40 foot box is no more than that spent on a 20 foot box. The 40 foot box being larger contains more cargo and thus returns more profit for time expended. Motor carriers feel that since the ton-mile cost decreased with the increase in Loaded Gross weight (see table 4) the 40 footers are much more profitable to handle than the 20 footers. In fact the marginal distance within which it is profitable to haul a 20 footer is about 150 miles.

Table 4

Payload Ton - Mile and Gross Ton - Mile Costs by Loaded Gross Weight - All Trailer Combinations.

Payload Ton - Mile Costs

<u>Loaded Gross wt. (lb)</u>	<u>Loaded in both directions</u>	<u>Loaded in one direction with empty return</u>
27,500	0.0410	0.0820
44,000	0.0230	0.0460

20 foot containers in this area.

58,000	0.0183	0.0366
65,000	0.0170	0.0340

40 foot containers in this area.

73,000	0.0160	0.0320
82,000	0.0152	0.0304
91,000	0.0147	0.0294

Table 5 shows the number of loaded and empty containers that entered the Norfolk International Terminal in 1971.

Table 5

Norfolk International Terminal  
Import

<u>Loaded</u>	<u>Empty</u>
20' - 7,380	20' - 3,363
40' - 13,977	40' - 10,536

It can be seen that a substantial number of 20 foot containers are entering the Norfolk port; of the total, about 46% are empty and would present no weight problem. There are various reasons why empty containers are shipped into the country. Primarily, they have been unloaded at their foreign destinations and are being returned to the owner. Secondly, they have been manufactured overseas and are being shipped to the consumer in this country.

One of the largest problems within the container industry is that there has been almost no use of the pooling concept. The interuse of containers by different owners has only recently been a serious objective.

As the problems inhibiting the growth of pooling are resolved, the ~~growth~~ more efficient use of these boxes will be realized and the number of empty containers will be reduced; conversely the

## ALTERNATIVE I

This is the most obvious of the alternatives, to load the 20 foot box to capacity.

The 20 foot box loaded to capacity would in all probability not exceed the maximum weight allowed by law. The carrying capacity is 20 long tons or 38,080 lb. This weight, combined with the tare weight of 15,000 lb. for the tractor, 3,600 lb. for the container, and 7,000 lb. for the chassis, equals 63,680 lb., or 9,820 lb. lighter than the 73,500 lb. (70,000 + 5% tolerance) allowed by law.

However, the weight allowable on the highways is not solely dependent on gross weight alone, but on the numbers of axles on the combination tractor and chassis used to haul the container and the distance between these axles as prescribed in the follow-in provisions of section 46. 1 - 339 of the Code of Virginia (see appendix II of this report):

- (c) "single axle weight on any vehicle or combination shall not exceed eighteen thousand pounds....."
- (d) "The total gross weight imposed upon the highway by a vehicle or combination shall not exceed the maximum weight given for the respective distance between the first and last axle of the group of axles measured longitudinally to the nearest foot as set forth in the following table:

some intermediate location they must be separated. The separation requires special equipment (i. e., a crane) and thus entails additional handling and expense.

(b) Twin 20 foot containers coupled, (marriage)

Two 20 foot containers can be coupled to form a single unit that can be transported over the road on a specially designed chassis. The coupling is inserted in the circular openings of the bottom corner fittings of abutting containers and twist - locks in place. This coupling remains in tension and a top - fitting serves as a compression member.

This method presents the same problem as the previous one; i. e., often the units must be separated. However, a crane is not needed for the separation, but it is desirable to have a level platform so the couplings do not bind when being removed. Additional expense is incurred in the uncoupling, but when compared with economics of hauling a single unit this cost may not be significant.

This method is preferable to alternative (a), however, it is probably not legal in Virginia. 46. 1 - 335 of the code states:

**No motor vehicle shall be driven upon a highway drawing or having attached thereto more than one motor vehicle, trailer or semitrailer unless such vehicle is being operated under special permit from the State Highway Commission. . . . (see appendix II for complete context).**

Possible Courses of Action for the Port Authority

The port states of New York, New Jersey, and Maryland along with many other states have modified their laws in recent years to permit the hauling of the double bottom trailer (see Appendix 3 and 4). More recently the State of Maryland has dropped the "bridge law" requirement on containers of foreign origin. Many states including the port state of South Carolina have never used the bridge formula.

It therefore seems that one course of action which might be sought is to modify existing sections of the Virginia Code dealing with vehicle weight, sizes and combinations using these other states as precedent.

the container movement will be shared between the industry which moves containers and governments having jurisdiction over the laws governing their movement.

## APPENDIX I

## DEFINITIONS

## 1. Container

The container is a box-like structure made of steel, aluminum, fiberglass — reinforced-plywood sandwiches, or combinations of these materials. The dimensions of the container have not been standardized throughout the shipping industry. However, the MH5 Committee of the United States of America Standards Institute (now the America National Standards Institute) has suggested the following:

Group I Demountable Containers — 8 by 8 by 40 feet, 8 by 8 by 30 feet, 8 by 8 by 20 feet, and 8 by 8 by 10 feet; Group II Demountable Cargo Containers — 8 by 6.5 feet, and 8 by 5 feet containers now in use are 20 feet, 24 feet, 35 feet, and 40 feet in length.

The container has a tare weight of approximately four pounds per cubic foot. This loading weight is necessary to enable the stacking of fully loaded containers and to withstand heavy weather at sea when loaded above deck. Although the containers are intermodal in concept, this heavy weight restricts shipment by air. (A lightweight aluminum container has been developed; this container is 8 by 8 by 10 feet in dimension.)

The containers can be transferred between different types of transportation (e.g., rail, highway, or sea).

## 2. Advantages of Container Method

The main advantage of containerized freight is the savings due to repeated use of one shipping package, reduction in time and reduced cost of insurance.

The alternative shipping method that can be used in place of containerization is "breakbulk." "Breakbulk" refers to stowing freight loose rather than in containers.

With the "breakbulk" method each freight package must be strong enough to withstand repeated handling and pressure from other freight placed upon it. This packaging is often expensive not only in material, labor charges to construct and dispose of such packaging, but in time spent in getting goods to the consignee. The container method eliminates these extra costs plus utilizes extra space taken up by these packages, thus increasing profits to the shipper. Since many costs are passed on to the consumer, the savings of container movement is realized in general.

## 5. Containerizable Cargo

Cargo suitable for containerization falls into two categories. One class is composed of goods that will fit into a container and that are valuable enough to justify the use of a container for overseas movement. The other class is composed of goods that will fit into a container but are not of sufficient value to warrant, by themselves, the more expensive shipment by container. This latter category can be used as filler once the primary cargo has been loaded.



## APPENDIX II

VEHICLE SIZE AND WEIGHT LIMITATIONS  
VIRGINIA LAW

§46.1-327 Limitations applicable throughout State;  
Alteration by Local Authorities - The maximum size and weight of vehicles herein specified shall apply throughout the state. Local authorities shall not alter such limitations except as expressly authorized in this title.

§46.1-328 Width of Vehicles and Exceptions as to Size

a) No vehicle, including any load thereon, but excluding the mirror required by §46.1-289, shall exceed a total outside width as follows: (1) Farm tractor - 108 inches; (2) passenger bus operated in an incorporated city or town when authorized under §46.1-180--102 inches; (3) other vehicles - 96 inches.

b) Provided, however, that upon application by the governing body of any county having a population of more than five thousand inhabitants per square mile, the State Highway Commission may by general or special order, which may be amended or rescinded from time to time, permit the operation of passenger buses in excess of ninety six inches but not exceeding one hundred and two inches on certain highways or parts thereof designated by the Commission in such county.

c) And provided further, that upon application by the governing body of any county contiguous to an incorporated city or town or which is contiguous to a county having a population of more than five thousand inhabitants per square mile, the State Highway Commission may by general or special order, which may be amended or rescinded from time to time permit the operation of passenger buses of a total outside width in excess of ninety-six inches, but not exceeding one hundred and two inches, which passenger buses have been authorized for operation within such city or town in the manner provided in subsection (a)(2) of this section or within such county in the manner provided in subsection (b) of this section, on certain highways or parts thereof designated by the Commission in such contiguous county and within ten miles of the corporate limits of the aforesaid city, town, or county.

d) In the event federal law and regulations thereunder permit the operation of passenger buses of widths in excess of ninety-six inches on the system of interstate and defense highways, the State Highway Commission may, by general or special order, which may be amended or rescinded from time to time, permit the operation of passenger buses of a total outside width, excluding the mirror required by §46.1-289, in

§46.1-330 Length of vehicles; generally; special permits--

Except for passenger buses, no motor vehicle exceeding a length of thirty-five feet shall be operated upon a highway of this State. No passenger bus exceeding a length of forty feet shall be operated upon a highway of this State. The actual length of any combination of vehicles coupled together including any load thereon shall not exceed a total of fifty-five feet; and no tolerance shall be allowed thereon. Provided, however, that the State Highway Commission when good cause is shown, may issue a special permit for combinations in excess of fifty-five feet including any load thereon where the object or objects to be carried cannot be moved otherwise; and passenger buses in excess of thirty-five feet, but not exceeding forty feet, may be operated on the streets of incorporated cities and towns when authorized pursuant to §46.1-180. (Code 1950, §46-328; 1950, p. 665; 1952, c. 342; 1956, cc. 476, 483; 1958, c. 541; 1962, c. 113; 1966, c. 59.)

§46.1-331 Same; mobile homes or house trailers

§46.1-332 Size limitations inapplicable to farm machinery and firefighting equipment.

§46.1-333 Extension of loads beyond front of vehicles

§46.1-334 Extension of loads beyond line of fender or body.

§46.1-335 Vehicles having more than one trailer, etc., attached thereto — No motor vehicle shall be driven upon a highway drawing or having attached thereto more than one motor vehicle, trailer or semitrailer unless such vehicle is being operated under a special permit from the State Highway Commission, but this limitation shall not apply between sunrise and sunset to such farm trailers or semitrailers being moved from one farm to another farm owned or operated by the same person within a radius of ten miles, provided that this limitation shall not apply to a combination of vehicles coupled together by a saddle mount device to transport motor vehicles in a drive-away service from factory to dealer when not more than two saddle mounts are used and such use is in conformity with safety regulations adopted by the Superintendent of State Police; provided, further however, that in the cities of this Commonwealth, the councils may, in their discretion, by general ordinance, permit motor vehicles to be driven upon streets of their respective cities drawing or having attached thereto more than one other vehicle, trailer, or semitrailer.

§46.1-336 Connection between vehicles — The connection between any two vehicles one of which is towing or drawing the other on a highway shall consist of a fifth wheel, drawbar or other similar device not to exceed ten feet in length from one vehicle to the other and such two vehicles shall in addition to such drawbar or other similar device be equipped at all times when so operated on the highway with an emergency chain.

Distance in feet between  
the extremes of any  
groups of axles

Maximum weight in  
pounds on any group  
of axles

4	. . . . .	.32,000
5	. . . . .	.32,000
6	. . . . .	.32,000
7	. . . . .	.32,000
8	. . . . .	.33,500
9	. . . . .	.35,000
10	. . . . .	.36,500
11	. . . . .	.38,000
12	. . . . .	.39,500
13	. . . . .	.41,000
14	. . . . .	.42,000
15	. . . . .	.43,000
16	. . . . .	.44,000
17	. . . . .	.45,000
18	. . . . .	.46,000
19	. . . . .	.47,000
20	. . . . .	.48,000
21	. . . . .	.49,000
22	. . . . .	.50,000
23	. . . . .	.51,000
24	. . . . .	.52,000
25	. . . . .	.53,000
26	. . . . .	.54,000
27	. . . . .	.55,000
28	. . . . .	.56,000
29	. . . . .	.57,000
30	. . . . .	.58,000
31	. . . . .	.59,000
32	. . . . .	.60,000
33	. . . . .	.61,400
34	. . . . .	.62,800
35	. . . . .	.64,000
36	. . . . .	.65,000
37	. . . . .	.65,800
38	. . . . .	.66,600
39	. . . . .	.67,400
40	. . . . .	.68,200
41	. . . . .	.69,000
42	. . . . .	.70,000

of State highways.

b) Any officer authorized to make arrests and weigh vehicles under the provisions of this chapter may for a period of twenty-four hours without a court order and thereafter upon a written order of the court either before or after conviction hold the vehicle involved in the overweight violation, provided the same is not registered with the Division of Motor Vehicles, until the amount assessed, if after conviction, or subject to be assessed, if before conviction, together with the cost of holding or storing of the vehicle, be paid, or until a bond by or on behalf of the offending person is given for payment as the court may direct of the amount assessed or to be assessed with surety approved by the court or its clerk.

c) In the event the amount so assessed be not paid or not bond be given as provided hereinabove, the vehicle in the overweight violation shall be stored in a place of security, as may be designated by the owner or operator of the vehicle. If no place be designated, the officer making the arrest shall designate the place of storage. The owner or operator shall be afforded the right of unloading and removing the cargo from such vehicle. The risk and cost of such storage shall be borne by the owner or operator of such vehicle. (1968, c. 184)

d) If within sixty days from the time of the conviction for the overweight violation, the offending party does not pay the assessment imposed by this section, together with the cost of storing such vehicle and cargo, if the cargo is not removed as herein provided, the vehicle and cargo shall be forfeited to the Commonwealth and sold to satisfy the assessment and cost of storage.

e) Upon notification of the failure of such person to pay the amount assessed, together with the payment of cost of holding such vehicle under this section, the Division or the Department of State Police may thereafter deny the offending person the right to operate a motor vehicle or vehicles upon the highways of this State until such assessment has been paid.

f) The Department of State Police is vested with the same powers with respect to the enforcement of this section as it has with respect to the enforcement of the criminal laws of the Commonwealth.

g) The charge hereinabove specified shall be in addition to any other liability which may be legally fixed against such owner or operator for damage to a highway or a bridge attributable to such weight violation (Code 1950 (Suppl.) §46-388.2; 1956, c. 215; 1958, cc. 541, 612).

§46.1-342.1 - County ordinances fixing weight limits on roads which have been withdrawn from secondary system - The governing body of any county which has withdrawn its roads from secondary system of State highways in accordance with chapter 415 of the Acts of 1932, may adopt ordinances providing weight limits in accordance with the weight limits established by §46.1-339 for any vehicle or combination of vehicles passing over any such roads under the jurisdiction of such county, and providing

c) Provided further, the State Highway Commission and local authorities of cities and towns in their respective jurisdictions, upon application in writing, made by the owner or operator of vehicles used exclusively for the hauling of coal from a mine or other place of production to a preparation plant, loading dock or railroad shall issue to such owner or operator, without cost, a permit in writing authorizing the operation of three axle vehicles having a gross weight not exceeding fifty thousand pounds, a single axle weight not exceeding twenty-four thousand pounds and a tandem axle weight not exceeding forty thousand pounds, and shall issue such permit for two axle vehicles having a gross weight not exceeding thirty-six thousand pounds and a single axle weight not exceeding twenty-four thousand pounds; provided, however, that no such permit shall be valid for the operation of any such vehicle for a distance of more than twenty-five miles from such preparation plant, loading dock or railroad. However, no permit issued under this section providing for a single axle weight in excess of eighteen thousand pounds or a tandem axle weight in excess of thirty-two thousand pounds shall be issued to include travel on the Federal Interstate System of Highways.

c) Provided, however, that upon the application in writing of any county which has withdrawn its roads from the secondary system of State highways and which owns or operates three axles refuse collection trucks, a single axle weight not exceeding eighteen thousand pounds, and a tandem axle weight not exceeding thirty-six thousand pounds, the State Highway Commission and local authorities of counties, cities, and towns in their respective jurisdictions shall issue to such county, without cost, a permit in writing authorizing the operation of such vehicles upon the highways. Permits may be issued only for the operation of the four refuse collection trucks which the county owned or had ordered prior to March one, nineteen hundred sixty-eight. No such permit shall designate the route to be traversed nor contain restrictions or conditions not applicable to other vehicles in their general use of the highways. No permit issued under this section providing for a single axle weight in excess of eighteen thousand pounds or a tandem axle weight in excess of thirty-two thousand pounds shall be issued to include travel on the Federal Interstate System of Highways. (1968, c. 203).

d) Every such permit shall be carried in the vehicle to which it refers and shall be open to inspection by any officer and it shall be a misdemeanor for any person to violate any of the terms or conditions of such special permit. (Code 1950, §46-339; 1956, c. 541; 1959, Ex. Sess., c. 91; 1960, c. 233; 1962, cc. 35, 162.)

The local authorities of cities, towns and counties, where the highways or streets are under their jurisdiction, may adopt rules and regulations or pass ordinances, as the case may be, decreasing the weight limits prescribed in this title for a total period not to exceed ninety days in any calendar year, when an engineering study discloses that operation over such highways or streets by reason of deterioration, rain, snow, or other climatic conditions will seriously damage such highways or streets unless such weights are reduced.

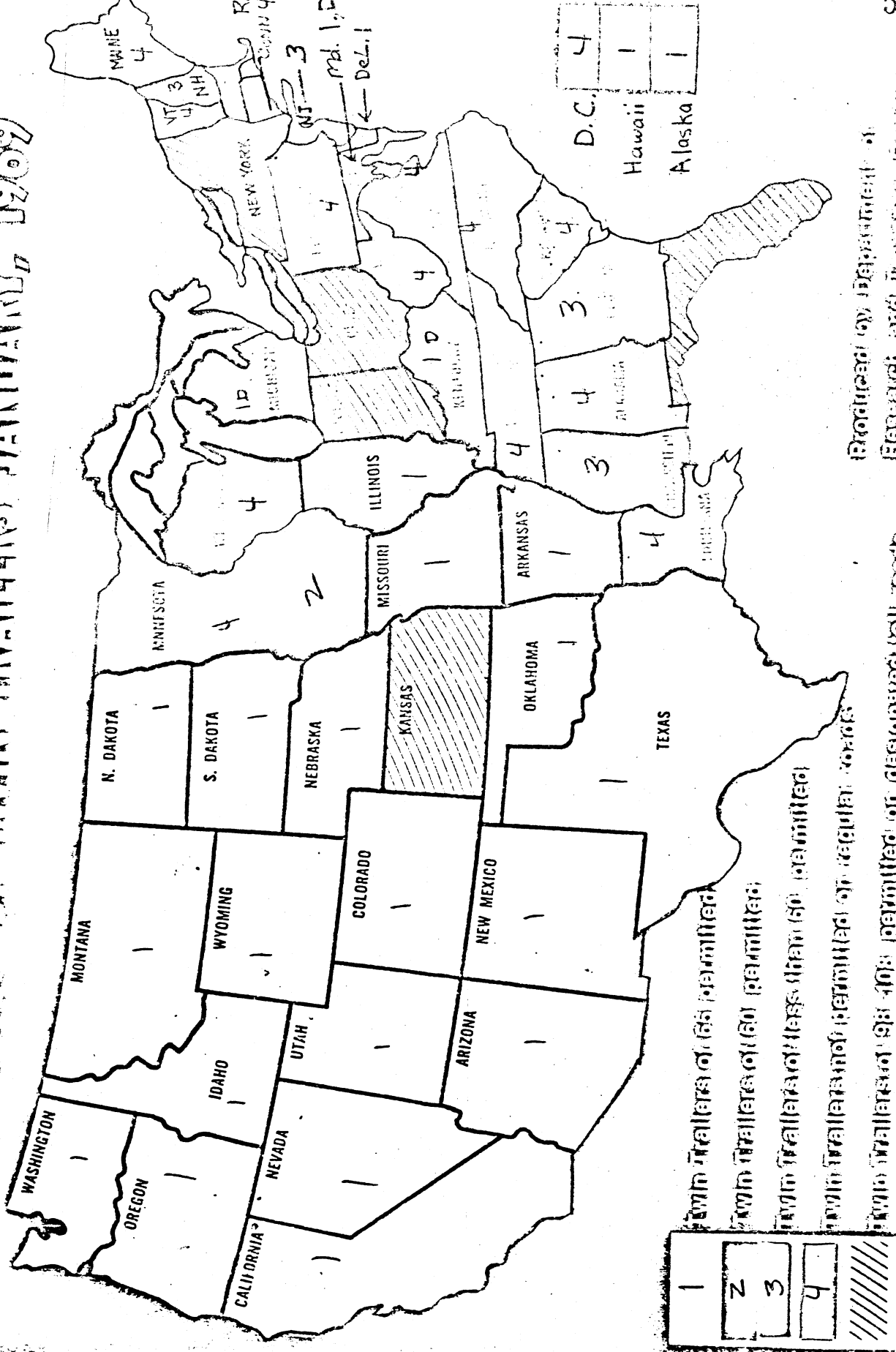
In all instances where the limits for weight, size or speed have been reduced by the State Highway Commissioner or the weights have been reduced by local authorities, pursuant to this section, signs stating the weight, height, width, length or speed, as the case may be, permitted on such highway or street, shall be erected at each end of the section of highway or street affected and no such reduced limits shall be effective until such signs have been posted.

It shall be unlawful to operate a vehicle or combination of vehicles over or upon any public highway, street or section thereof when the weight, size or speed thereof exceeds the maximum posted by authority of the State Highway Commissioner or local authorities pursuant to this section.

Any person convicted of a violation of any provision of this section shall be punished by a fine of not less than ten dollars nor more than five hundred dollars or be confined in jail for not less than one day nor more than six months, or both, and the vehicle or combination of vehicles involved in such violation may be held upon an order of the court until all fines and cost have been satisfied. (Code 1950, §46-340, 46-341; 1952, cc. 137, 237; 1958, c. 600; 1966, c. 85; 1968, c. 218).

APPENDIX III

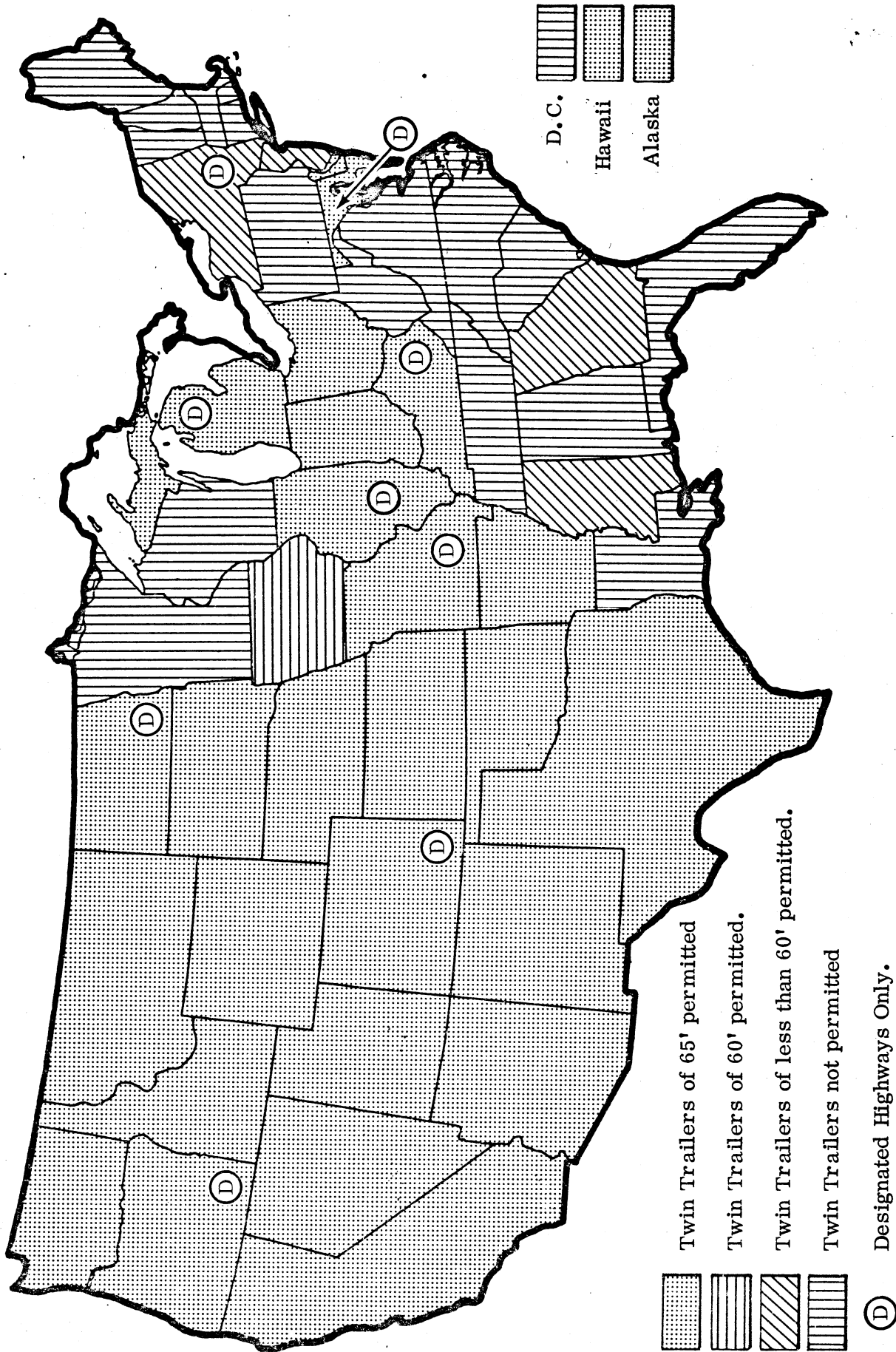
# STATUS OF TWIN TRAILERS JANUARY, 1969



Produced by Department of  
 Research and Statistics, Economics  
 American Trucking Association, Inc.  
 Washington, D. C. 20004



## APPENDIX IV



Status of twin trailers on public roads, January 1972.

SOURCE: Department of Research and Transport Economics, American Trucking Associations, Inc. Washington, D. C. 20036