MICHIGAN
STATE HIGHWAY DEPARTMENT
Charles M. Ziegler
State Highway Commissioner

THE 1951 PROPOSED AASHO POLICY

ON MOTOR VEHICLE OPERATION

This is a review, in light of Michigan's Vehicle
Code, of the proposed revision of section (5)(b) of the
1946 AASHO policy concerning maximum dimensions, weights, and
speeds of motor vehicles to be operated over the highways of the
United States. The revision has been prepared by the AASHO Committee
on Highway Transport for consideration by all of the states and the AASHO
Committee on Bridges and Structures.

Highway Research Project 51 F-23

Research Laboratory
Testing and Research Division
Report No. 171
February 1, 1952

EFFECT OF PROPOSED REVISION OF SECTION (5)(b)
OF THE 1946 POLICY ON MOTOR TRANSPORT OPERATION

This review is based on information submitted by AASHO Committee on Highway Transport, R. C. Keeling, Chairman, C. F. Rogers, Secretary.

The Proposal: Permissible loads on heavy vehicles shall be governed by the formula:

$$W = 500 \left(\frac{L N}{N-1} + 12N + 32 \right)$$

where W = Max. load in lb. per group of two or more axles

L = Distance in feet between extremes of axle groups

N = Number of axles in the group

Purpose: To encourage economic heavy vehicle operation without excessive axle load.

SUMMARY OF
DISCUSSION IN LETTER FROM AASHO COMMITTEE ON HIGHWAY TRANSPORT

General Benefits: The proposal benefits the road structure which is about 75 percent of the highway investment with some sacrifice of the bridge structure, which is 25 percent of the investment.

Specific Benefits over 1946 Policy:

1. Inclusion of factor "N" in the formula gives advantage in gross vehicle weight for larger number of axles.

2. Formula provides operators with incentive to use longer wheelbase vehicles having greater number of axles.

Detriments: Operation permitted under the proposed revision will require the use of some of the reserve capacity of existing bridges of prevailing standard.

Comparisons Drawn:

1. Proposed loadings are somewhat in excess of those permitted in eastern states.

2. Proposal is substantially in line with present western states' practices.

   (a) Arizona, California, Nevada, Oregon limits agree with the proposed AASHO formula for N = 4.

   (b) Utah limits approach AASHO proposal for N = 5.

Bridge Loadings:

1. Under AASHO proposal, bridge loadings on 60-ft. spans produced by common carriers give moments equivalent to the following H-design loadings:

TABLE I

MOMENTS IN BRIDGES UNDER AASHO PROPOSAL

Carrier Type	Equivalent H-design	Percent Overstress Above H-15 (44)
2-S 1	H-16	5
3	H-18	12
2-S 2, 3-S 2	H-20	18
3-3	H-22	24

COMPARISON WITH PRESENT MICHIGAN PRACTICE

The Michigan law permits gross loads considerably in excess of the AASHO proposal. Tables and graphs have been prepared to show these differences. A study of these data brings out the following:

Gross Load for Axle Groups:

Table II has been prepared for comparing the allowable gross loads which may be carried under the Michigan law with those under the AASHO proposal. Figures 1 and 2 present these data graphically for all highways and for Class A highways. The outstanding differences in the allowable gross load limits under the two systems are listed below.

TABLE II

COMPARISON OF ALLOWABLE GROSS LOADS ON AXLE GROUPS
UNDER MICHIGAN LAW AND AASHO PROPOSAL

No. of Axles in group	Michigan Law		AASHO Load at same Wheelbase (kips)	Advantage of Michigan Law (percent)
	Gross (kips)	Wheelbase (ft.)		
3	54	18	47.5	14
4	72	27	58.0	24
5	90	36	68.5	31
6	108	45	79	37
7	126	54	89.5	41

TABLE 3

DISTANCE IN FT. BETWEEN THE EXTREMES OF ANY GROUP OF AXLES	1946 AASHO	2 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	3 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	4 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	5 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	6 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	7 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	8 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.	9 AXLES PROP 1951 AASHO	AXLE ORDER	MICH. NORM.	MICH. SPC'L.
4	32.0	32	0-2	26	32																												
5	"	33	"	"	"																												
6	"	34	"	"	"																												
7	"	35	"	"	"	40	0-3	39	45																								
8	32.6	36	"	"	"	40.7	"	"	"																								
9	33.6		1-1	36	36	41.5	"	"	"																								
10	34.6					42.2	"	"	"		2-2	52	58																				
11	35.5					43.0	"	"	"			"	"																				
12	36.5					43.0	1-2	44	50	48.0		"	"																				
13	37.4					43.7	"	"	"	46.7		"	"																				
14	38.4					44.5		"	"	49.3		"	"	56.0	2-3	65	71																
15	39.3					45.2		"	"	50.0		"	"	56.6		"	"																
16	40.2					46.0		"	"	50.7	1-3	57	63	57.2		"	"																
17	41.2					46.7		"	"	51.3	"	"	"	57.9		"	"																
18	42.1					47.5	1-1-1	54	54	52.0	"	"	"	58.5		"	"	64.0	2-2-2	78	84												
19	43.0					48.2				52.7	"	"	"	59.1	1-2-2	70	76	64.6		"	"												
20	43.9					49.0				53.3	"	"	"	58.5		"	"	65.2		"	"												
21	44.8					49.7				54.0	"	"	"	59.1		"	"	65.8	1-2-3	83	89												
22	45.7					50.5				54.7	1-1-2	62	68	59.7		"	"																
23	46.6					51.2				55.3	"	"	"	60.4		"	"																
24	47.5					52.0				56.0	"	"	"	61.0		"	"	66.4		"	"	72.0		"	"	80.0	2-2-2-2	104	110				
25	48.4					52.7				56.7	"	"	"	61.6	1-1-3	75	81	67.0		"	"	72.6		"	"			"	"				
26	49.2					53.5				57.3	"	"	"	62.2	"	"	"	67.6		"	"	73.1		"	"			"	"				
27	50.1					54.0				58.0	1-1-1-1	72	72	62.9	"	"	"	68.2		"	"	73.7	1-2-2-2	96	102			"	"				
28	51.0									58.7		"	"	63.5	"	"	"	68.8		"	"	74.2		"	"		1-2-2-3	109	115		2-2-2-3	117	123
29	51.8									59.3		"	"	64.1	"	"	"	69.4	1-1-2-2	88	94	74.9		"	"	80.6		"	"		"	"	"
30	52.7									60.0		"	"	64.7	"	"	"	70.0		"	"	75.5		"	"	81.1		"	"		"	"	"
31	53.5									60.7		"	"	65.4	1-1-1-2	80	85	70.6		"	"	76.1		"	"	81.7		"	"		"	"	"
32	54.3									61.3		"	"	66.0	"	"	"	71.2		"	"	76.7		"	"	82.3		"	"	88.0	"	"	"
33	55.2									62.0		"	"	66.6	"	"	"	71.8		"	"	77.2	1-1-2-3	101	107	82.9		"	"	88.6	"	"	"
34	56.0									62.7				67.2		"	"	72.4	1-1-1-3	93	99	77.8		"	"	83.4		"	"	89.1	1-2-2-2-2	122	128
35	56.8									63.3				67.9	1-1-1-1-1	90	90	73.0		"	"	78.4		"	"	84.0	1-1-2-2-2	114	120	89.7		"	"
36	57.6									64.0	1-1-1-1-1			68.5		"	"	73.6		"	"	79.0		"	"	84.6	"	"	"	90.2		"	"
37	58.4									64.7				69.1		"	"	74.2		"	"	79.6		"	"	85.1	"	"	"	90.8		"	"
38	59.2									65.3				69.7		"	"	74.8		"	"	80.2	1-1-1-2-2	106	112	85.7	"	"	"	91.4		"	"
39	60.0									66.0				70.4		"	"	75.4		"	"	80.7		"	"	86.3	"	"	"	91.9	1-1-2-2-3	127	133
40	60.8									66.7				71.0	1-1-1-1-2	98	104	76.0	1-1-1-1-2	98	104	81.3		"	"	86.9		"	"	92.5		"	"
41	61.6									67.3				71.6		"	"	76.6		"	"	81.9		"	"	87.4	1-1-2-2-3	119	125	93.1		"	"
42	62.4									68.0				72.2		"	"	77.2		"	"	82.5		"	"	88.0	"	"	"	93.6		"	"
43	63.1									68.7				72.9		"	"	77.8		"	"	83.1	1-1-1-1-3	111	117	88.6	"	"	"	94.2		"	"
44	63.9									69.3				73.5				78.4	1-1-1-1-1-1	108	108	83.7		"	"	89.1		"	"	94.7	1-1-1-2-2-2	132	138
45	64.7									70.0				74.1				79.0		"	"	84.2		"	"	89.7		"	"	95.3		"	"
46	65.4									70.7				74.7				79.6		"	"	84.8		"	"	90.3		"	"	95.9		"	"
47	66.2									71.3				75.4				80.2		"	"	85.4		"	"	90.9	1-1-1-2-2-2	124	130	96.4		"	"
48	66.9									72.0				76.0				80.8		"	"	86.0		"	"	91.4		"	"	97.0		"	"
49	67.6													76.6				81.4		"	"	86.6	1-1-1-1-1-2	116	122	92.0		"	"	97.6	1-1-1-1-2-3	137	143
50	68.4													77.2				82.0		"	"	87.2		"	"	92.6		"	"	98.1		"	"
51	69.1													77.9				82.6		"	"	87.7		"	"	93.1	1-1-1-1-2-3	129	135	98.7		"	"
52	69.8													78.5				83.2		"	"	88.3		"	"	93.7	1-1-1-1-1-3	129	135	99.2		"	"
53	70.5													79.1				83.8		"	"	88.9		"	"	94.3		"	"	99.8		"	"
54	71.2													79.7				84.4				89.5	1-1-1-1-1-1-1	126	126	94.9		"	"	100.4		"	"
55	71.9													80.4				85.0				90.1		"	"	95.4		"	"	100.9		"	"
56	72.6													81.0				85.6				90.7		"	"	96.0		"	"	101.5	1-1-1-1-2-2	148	148

NOTE: ALL LOADS IN KIPS—DISTANCES IN FEET.
AXLE ARRANGEMENT:
NUMBER ① INDICATES AXLE 9 FT. OR MORE FROM NEAREST AXLE.
NUMBER ② OR ③ INDICATES GROUP OF AXLES CLOSE-SPACED FROM A MINIMUM OF 3 1/2 FT. BETWEEN ADJACENT AXLES TO A MAXIMUM OF 9 FT. BETWEEN ADJACENT AXLES.
MICHIGAN SPECIAL:
ONE TANDEM SET OF A GROUP OF AXLES MAY CARRY 32,000 POUNDS ON CLASS 'A' HIGHWAYS.

COMPARISON OF AASHO 1951 TRUCK LOADING PROPOSAL WITH MICHIGAN PRACTICE
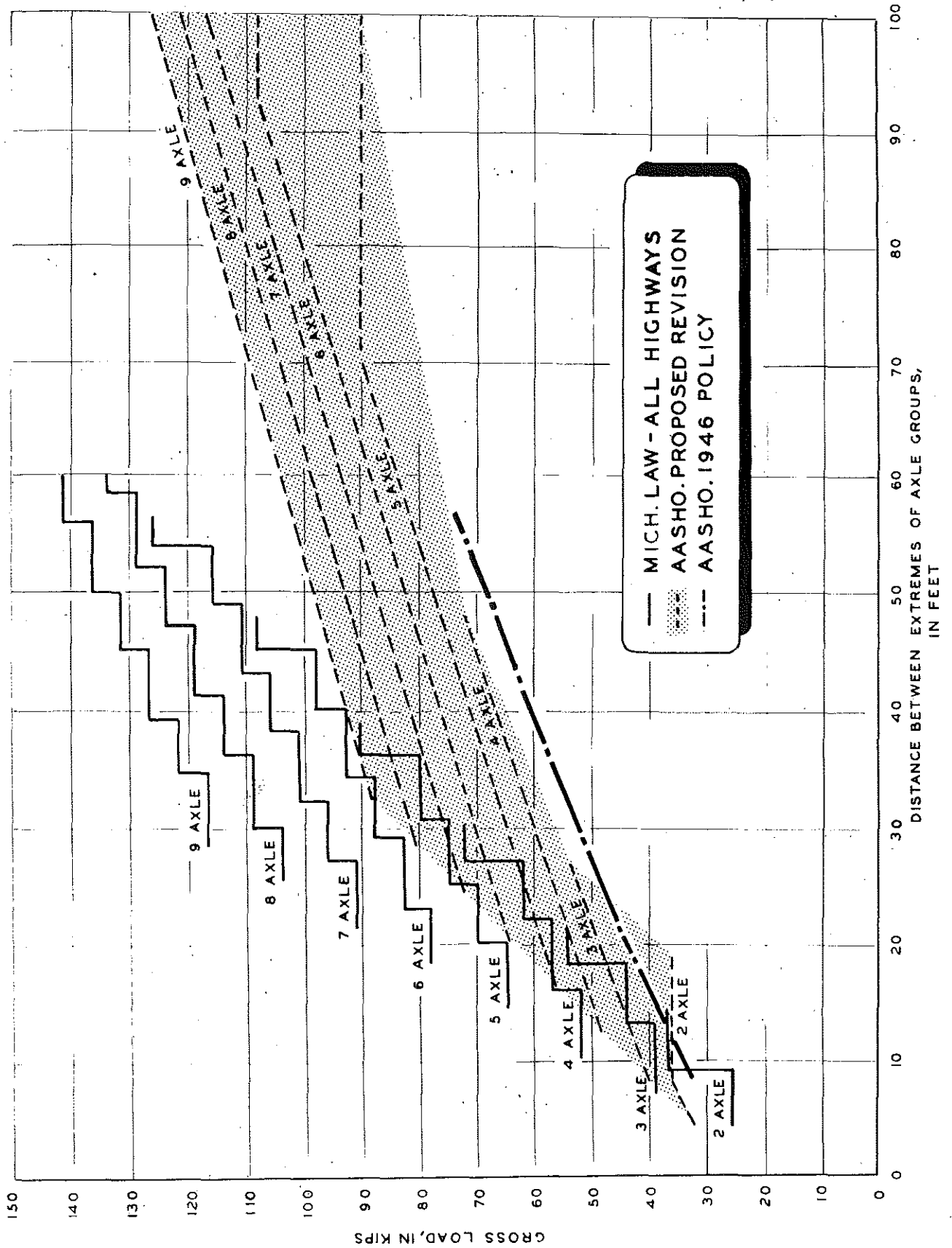
AXLE GROUP LOADS—AASHO. 1951 PROPOSAL VERSUS MICHIGAN LAW—ALL HIGHWAYS
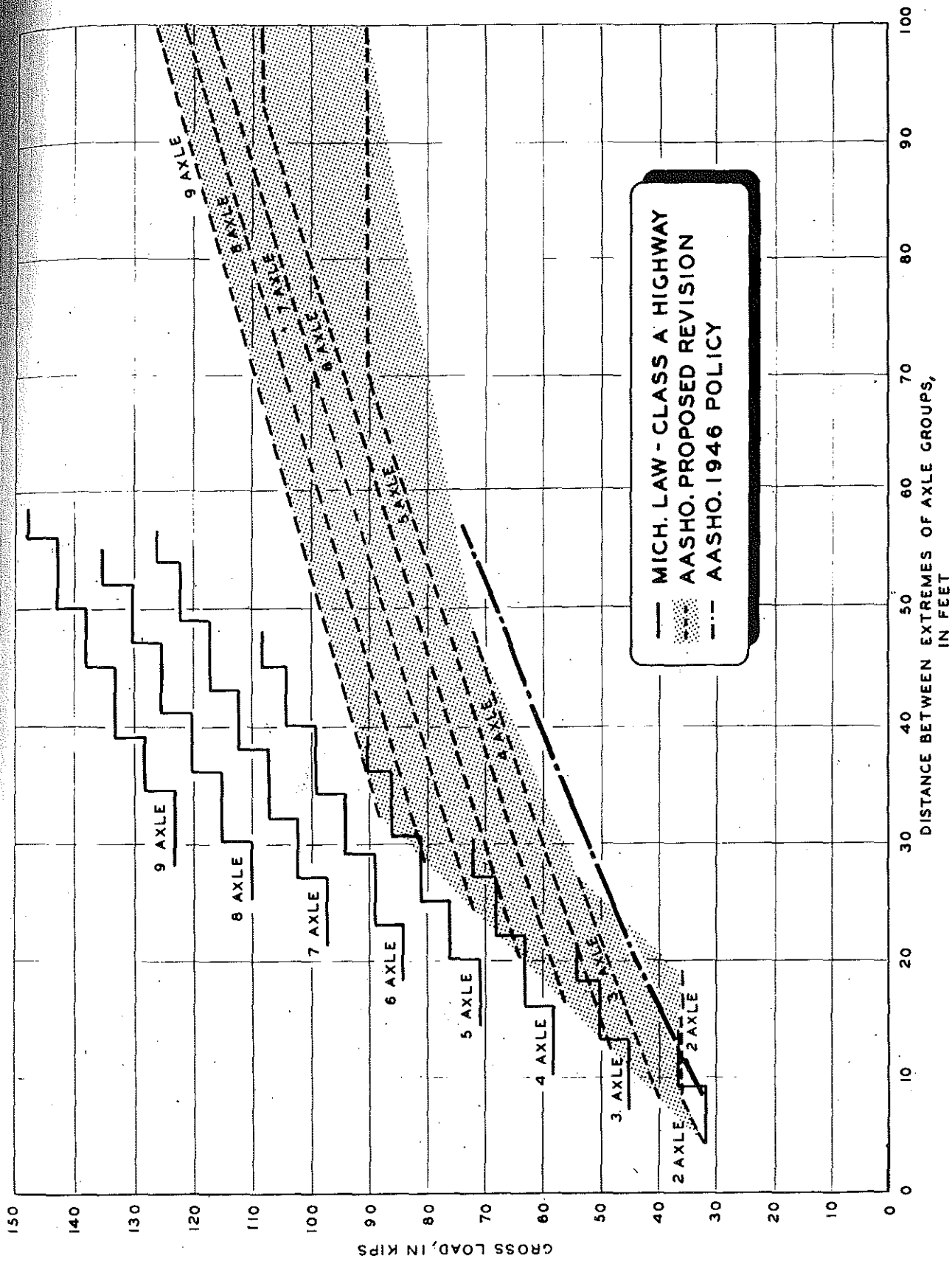
FIGURE 1

AXLE GROUP LOADS—AASHO 1951 PROPOSAL VERSUS MICHIGAN LAW·CLASS A HIGHWAYS

FIGURE 2

Figures 3 and 4 show the common types of carriers encountered in Michigan. The loads allowed on these units under the Michigan law are listed for all highways and also for the Class A highway group. In Figure 3, the column headed "AASHO 1951 Proposal" should be compared with Michigan legal loading. The "Normal" column restricts the front axle to 9000 lbs.

From the standpoint of gross loads, the AASHO and Michigan formulas agree substantially through the two-unit vehicles but the Michigan law permits larger loads on the three-unit vehicles. Also, there is considerable difference in vehicle length under the two policies.

The tabulation below has been prepared to show the differences in extreme axle distances under the two systems when the loads carried are the maximum allowed on all Michigan highways. The data is extracted from Table I and extended by formula.

TABLE IV

COMPARISON OF EXTREME AXLE DISTANCES
TO CARRY SAME GROSS LOAD

Axles in Group	Distance Between Extremes (ft.) Michigan	AASHO	Excess of AASHO over Michigan (ft.)
3	18	27	9
4	27	48	21
5	36	70.4	34.4
6	45	93.3	48.3
7	54	116.6	62.6

TYPE	VEHICLE DESIGNATION ②	GROSS WEIGHT IN KIPS				
		CLASS A HIGHWAYS ③		ALL HIGHWAYS ③		AASHO 1951 PROPOSAL
		LEGAL ④	NORMAL ⑤	LEGAL	NORMAL	
TRUCK CLASS I	2	36	27	36	27	36
	3	50	41	44	35	50
TRACTOR & SEMI-TRAILER CLASS II	2S1	54	45	54	45	54
	2S2	68	59	62	53	68
	3S1	68	59	62	53	68
	3S2	76	67	70	61	82
TRUCK & TRAILER CLASS III	2-2	72	63	72	63	72
	3-2	86	77	80	71	81
	2-3	86	77	80	71	81
	3-3	94	85	88	79	85.6
TRACTOR, SEMI-TRAILER & TRAILER CLASS IV	2S1-2	90	81	90	81	81
	2S1-3	104	95	98	89	85.6
	2S2-2	104	95	98	89	85.6
	2S2-3	112	103	106	97	90.7
	3S1-2	104	95	98	89	85.6
	3S1-3	112	103	106	97	90.7
	3S2-2	112	103	106	97	90.7
	3S2-3	120	111	114	105	96
	3S2-4	128	119	122	113	101.5

1. CLASS DESIGNATION BY BRIDGE DIVISION.
2. VEHICLE DESIGNATION BY PLANNING AND TRAFFIC DIVISION.
3. NORMAL VEHICLES OPERATING UNDER MICHIGAN LAW:

CLASS A HIGHWAYS { 18,000 POUNDS ON SINGLE AXLES, 16,000 POUNDS ON TANDEM AXLES WHEN TRAIN CONTAINS ONE TANDEM GROUP. FOR MORE THAN ONE TANDEM GROUP, IN A TRAIN 16 000 POUNDS PER AXLE ON ONE TANDEM AXLE GROUP, 13,000 POUNDS PER AXLE ON ALL OTHER TANDEM AXLE GROUPS.

ALL HIGHWAYS { 18,000 POUNDS ON SINGLE AXLES, 13,000 POUNDS ON ALL TANDEM AXLE GROUPS.

4. LEGAL LOADING – 18 000 POUNDS ON FRONT AXLE.
5. NORMAL LOADING – 9 000 POUNDS ESTIMATED FRONT AXLE.

CLASSIFICATION and GROSS WEIGHTS
of MOTOR TRANSPORT UNITS

FIGURE 3
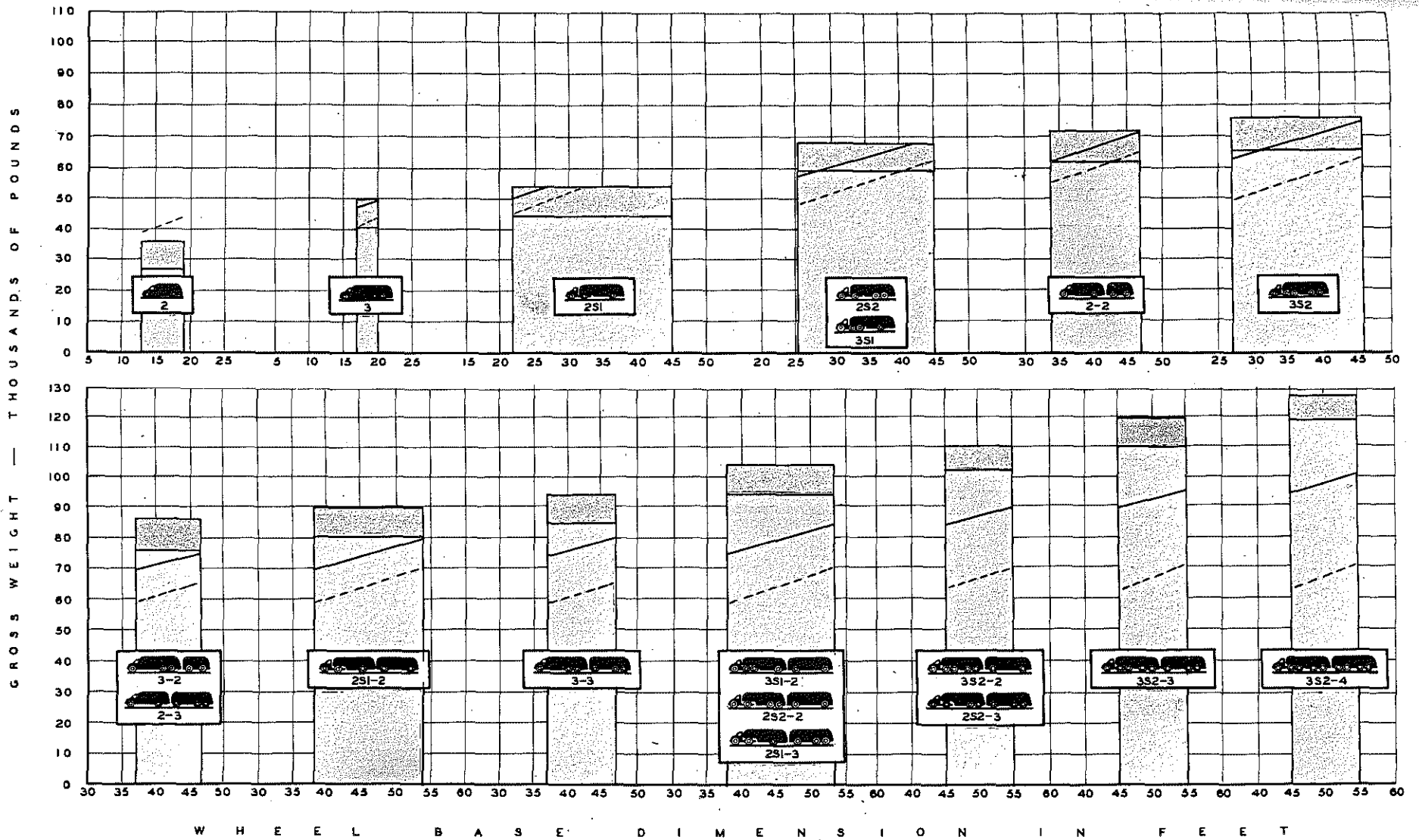
LEGEND: 1. TOP OF RED IS PRACTICAL LOAD LIMIT IN MICHIGAN ON CLASS A PAVEMENT WITH 9000 POUNDS ON FRONT AXLE.
2. TOP OF BROWN IS MICHIGAN LEGAL LIMIT.
3. SLANT BLACK IS PROPOSED AASHO REVISION
4. SLANT RED – AASHO 1946 POLICY.

EFFECT OF AASHO LOAD LIMIT POLICIES ON GROSS LOADS IN MICHIGAN

A Comparison of Practical Vehicles

Typical vehicle lengths based upon field observations are listed below:

TABLE V

ASSUMED WHEEL BASES USED IN TABLE VI

Vehicle Type	Wheelbase in feet		
	2-axle	3-axle	4-axle
Truck	16	18	--
Tractor	10	14	--
Semi-trailer	14(1-axle)	16(2-axle)	--
Trailer	12	13	14

Based upon these lengths, computations of gross loads have been made and listed. In all cases where a full trailer was used, the distance from the front trailer axle to the rear axle of the preceding section was assumed to be nine feet.

TABLE VI

ALLOWABLE LOADS ON PRACTICAL VEHICLES*

Type	**Frequency %	Wheel-base (ft.)	Mich. Gross Load (kips)	AASHO Load for Wheelbase Shown (kips)	Diff. in pay-load (kips)
2	16	16	27	27	0
3	0.7	18	35	41	-6
2-S1	40	24	45	45	0
2-S2	27.6	26	53	55	-2
2-2	1.7	37	63	58.7	4.3
3-S2	0.8	30	61	62.3	-1.3
3-2	1.1	39	71	65.7	5.3
3-S1-2	7.1	49	89	79.4	9.6
3-3	0.2	40	79	76	3
2-S1-3	3.7	46	89	77.5	11.5
2-S1-4	0.5	47	97	83.2	13.8
3-S2-3	0.2	52	105	91.5	13.5

* Max. load on front axle assumed to be 9000 lbs.

** Average frequency of heavy trucks based on 1951 loadometer survey.
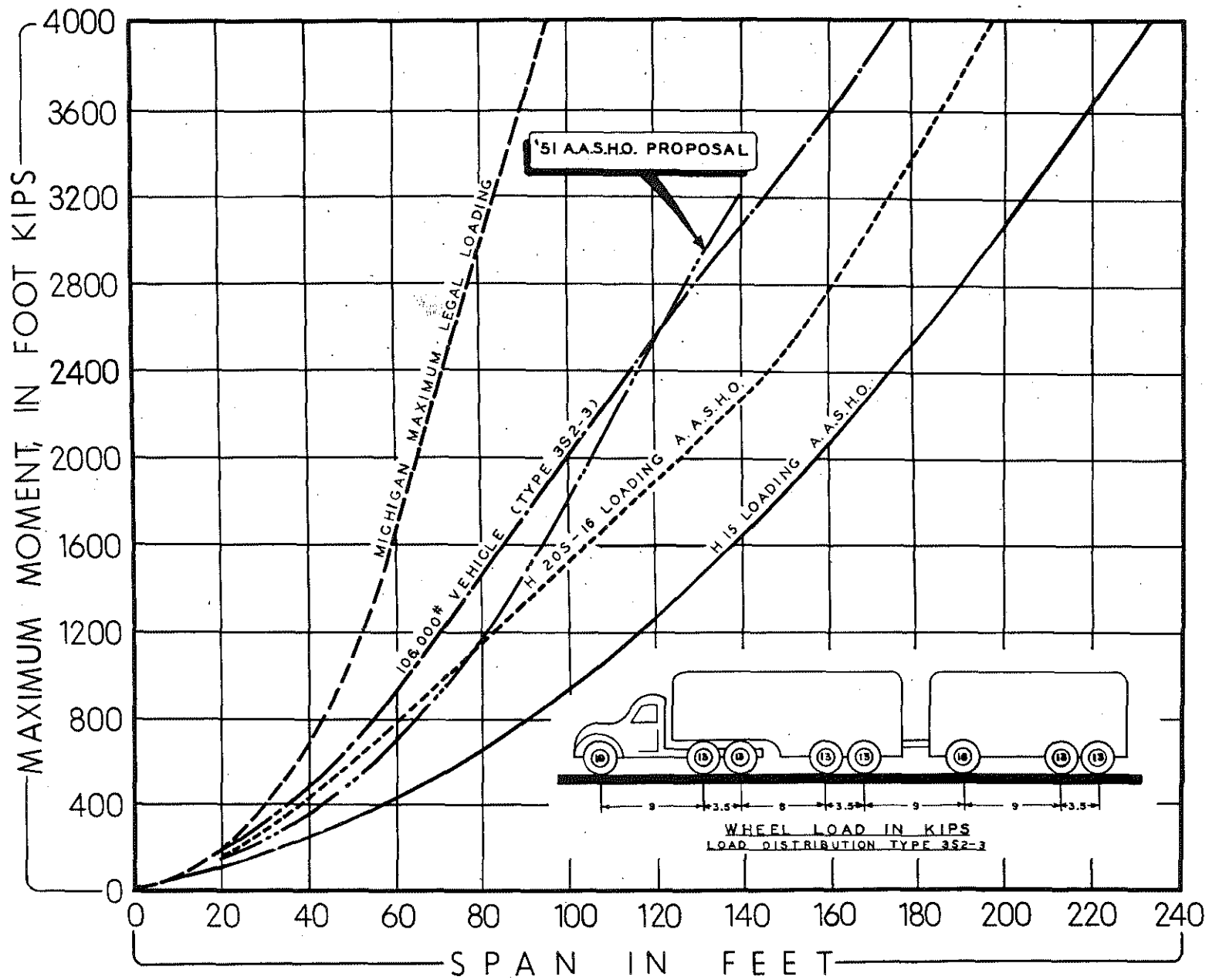
MAXIMUM MOMENT CURVES

FIGURE 5

Bridge Loadings

Several maximum moment curves for bridge loading are shown on Figure 5. The moment produced by the AASHO formula is seen to be less severe than that for an H-20 - S-16 design vehicle for spans up to 80 ft. From 80-ft. to 120-ft. spans, the AASHO policy produces moments exceeding the H20-S16 loading but less than the 106,000-lb. close-spaced load pictured.

Special Butler-Built Vehicle

A photo, Figure 6, of a heavy 11,600 gallon transport tank train is attached. Under Michigan law, this vehicle with an extreme axle spacing of 42 ft. can carry a gross load of 122,000 lb. It is likely, however, that the front axle would be loaded to 9000 lbs., instead of the allowable 18,000 lbs. This would make a gross load of 113,000 lbs.

Under the AASHO proposal, a 42-ft. vehicle with nine axles could carry 93,600 lbs., and in order to carry 113,000 lbs. the length would have to be extended to 76.4 ft.
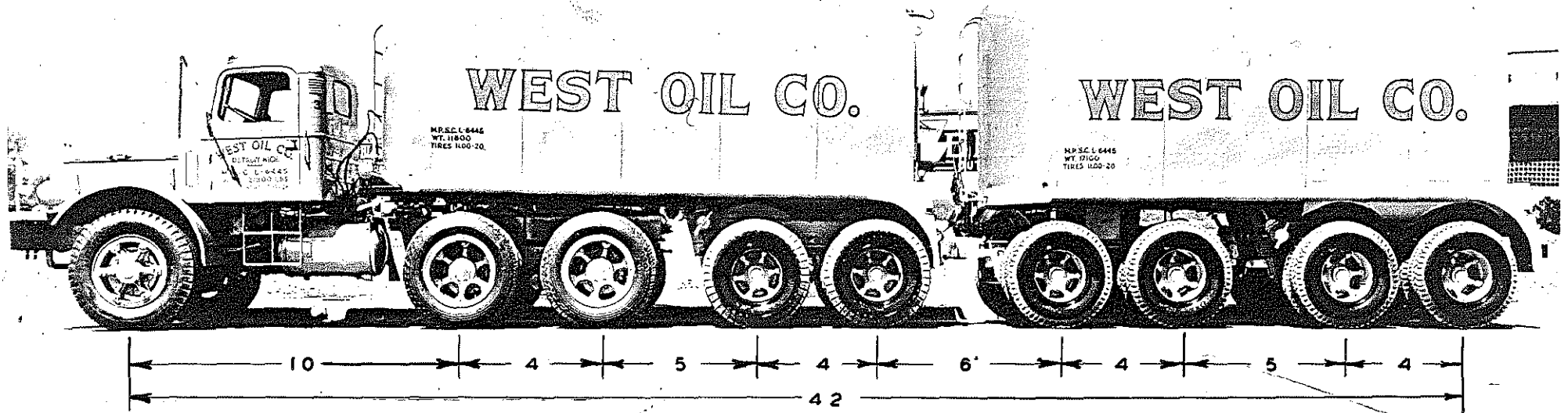
11,600 Gallon Transport Tank Train

BUTLER BUILT

GM-745

050645

FIGURE 6

SUMMARY

The AASHO Committee proposal would regulate loads which could be carried on any combinations of axles from two to the total number on the vehicle. The formula should be supplemented by a statement that the limit on any single axle is 18,000 lbs.

The proposal would allow slightly greater loads than those permitted in Michigan on tandem axle groups and on 3-axle combinations with wheel base less than 18 ft. On all other combinations of axles the Michigan law allows higher gross loads than the AASHO formula. Figure 1 presents these facts graphically.

The moments produced on structures under the AASHO plan are less than the design moments resulting from H20-S16 vehicle loadings for spans under 80 ft. in length. For longer spans the AASHO proposal yields bridge moments which exceed design load moments by amounts almost proportional to span length, until at 140 ft. the excess moment is more than one-third of that resulting from the design load.

Practical gross load limits in Michigan are about 9000 lbs. less than the legal limits because trucks are not constructed so that the front axle shares any portion of the pay load. Figure 4 shows Michigan legal and practical limits and proposed AASHO restrictions for vehicles operating on Michigan highways. It is evident that the AASHO proposal is more lenient than the Michigan practical limit on vehicles with five axles or less, whereas truck trains with more than five axles would suffer load reductions under the new formula.

From Table VI it can be seen that vehicles of types 2, 2-S1, and 2-S2 comprise 84% of the operating units. These would suffer no penalty under the new AASHO formula. However, certain two-unit and all three-unit trains which constitute about 12% of the total vehicles would incur reductions in the loads they are now permitted to carry on Michigan highways.

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