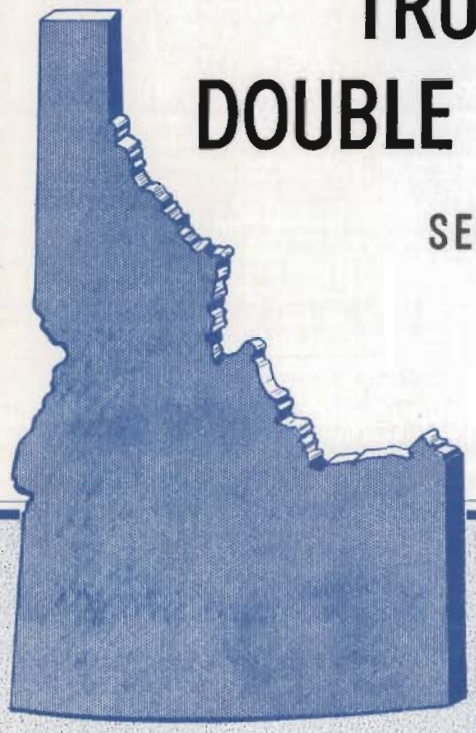
HIGHWAY OPERATIONS WITH

TRUCK TRAILER DOUBLE & TRIPLE UNITS

SEPTEMBER, 1964

RESEARCH PROJECT NO. 35



STATE OF IDAHO DEPARTMENT OF HIGHWAYS

A STUDY OF HIGHWAY OPERATIONS WITH TRUCK TRAILER DOUBLE AND TRIPLE UNITS

SEPTEMBER, 1964

RESEARCH DIVISION
IDAHO DEPARTMENT OF HIGHWAYS

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INTRODUCTION

The Idaho Motor Transport Association requested permission of the Idaho Board of Highway Directors to conduct research by making several round trips between Boise and Pocatello and Boise and Salt Lake City with combinations of vehicles commonly known as doubles and triples. These combinations consist of a truck tractor with semi-trailer pulling a full trailer or a double unit and a tractor with a semi-trailer pulling two full trailers or a triple unit.

The triple units had 27' trailers and the double units had 40' trailers. The overall length of these units ranged from 94' to a total of 96'. The purpose of the research by the Idaho Motor Transport Association was to determine operating costs and operational conditions using these units over Idaho Highways. The Idaho Department of Highways is concerned with safety to the traveling public. The Board of Highway Directors authorized the Department of Highways to participate in this research to permit the Department to observe conditions affecting safe operating conditions and to obtain additional information on performance of large truck-trailer combinations climbing hills, etc.

COOPERATING AGENCIES

Several highway users, members of the Idaho Motor Transport Association, supplied vehicles and loads for performance of this test, namely, Boise Cascade Corporation, Garrett Freightlines, Pacific Intermountain Express and Consolidated Freightways. Each of these companies furnished

truck-tractors, trailers, operators, as well as pilot cars and observers, when required during the performance of this test. The Idaho Department of Highways furnished observers with a car for the test. Observers from the Western Highway Institute at San Francisco also accompanied the test. The Idaho Motor Transport Association obtained aerial photographs and movies of the operation of the various units at various locations throughout Southern Idaho.

ROUTE LOCATION AND HIGHWAY SECTIONS

Table I gives schedules for the various trips, origin and destination of trip and owners of units conducting the trip. Figure 1 shows location of the routes in Idaho.

Typical geometric cross sections are given in Figure 2 for portions of the Route. Interstate and climbing lane sections are noted on the trip log profiles of Appendix C. The old 2-lane sections are between Jerome and the Junction of Highway 50 and the Minidoka - Jerome County Line and Paul. Other sections would generally be in the 2-lane width with shoulders 5 to 10 feet in width with the majority of the mileage having 5-7 foot shoulder widths.

TYPE OF TRUCK UNITS IN TEST

The units used in this test were either five axle or three axle semi-trailer combinations pulling full trailers. The five axle semi-trailer pulled a three or four axle full trailer, whereas the three axle semi-trailer pulled 2 two axle full trailers. Figures 3 and 4 are photographs of a typical 3S2-3 and a 2S1-2-2 or double and triple units used in the experiment. Figures 6-11, Appendix A give essential data for each of the truck tractor units used in the experiment.

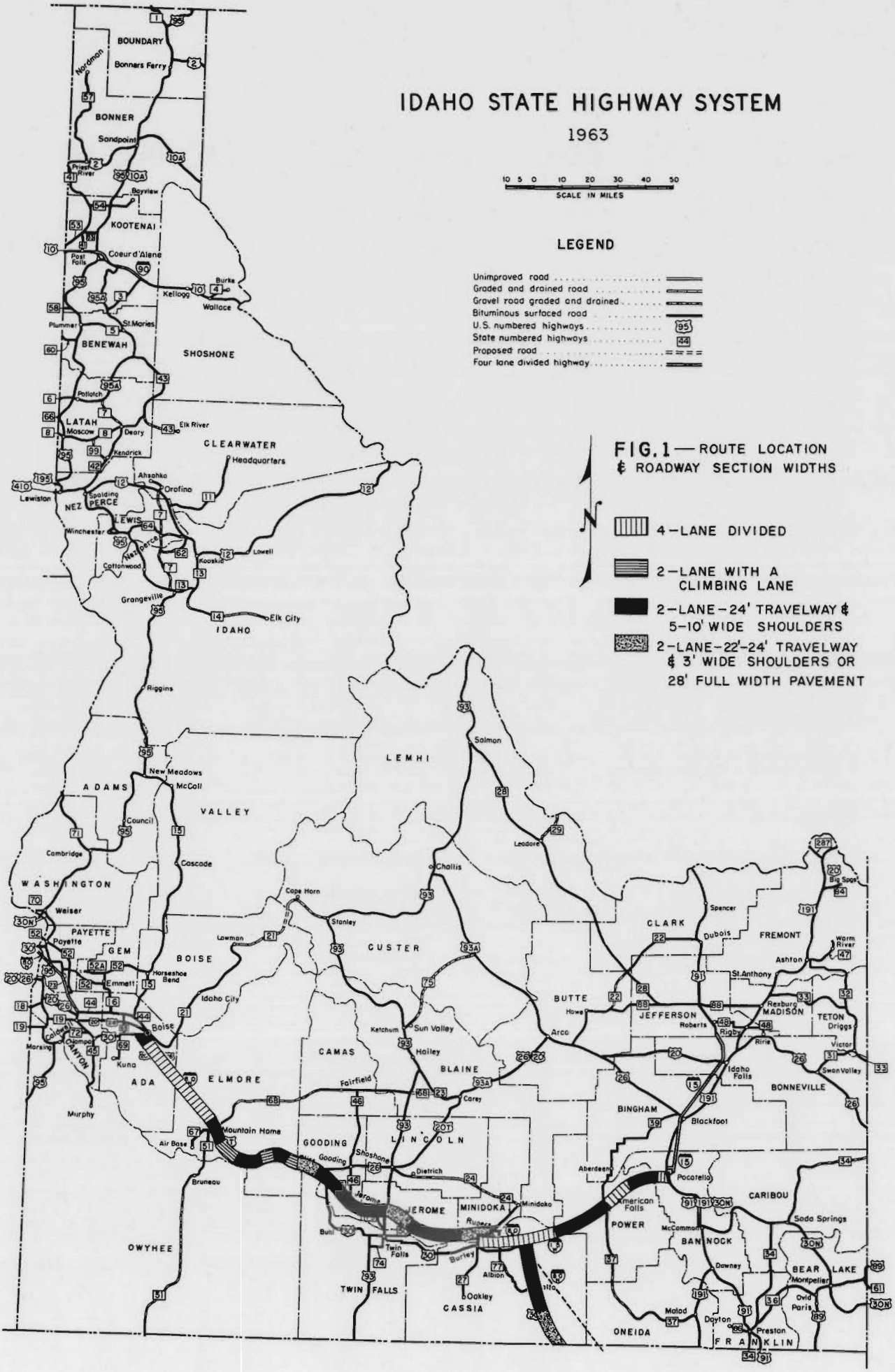
LOADS CARRIED

All units were loaded to approximately the Idaho legal load limit for the individual axle loadings normally permitted on our highways, i.e.,

TABLE I

TRIP SCHEDULE

Trip No.	Origin	Destination	Date	Owner	Unit Description
1	Boise	Strevell	6/8/64	Boise Cascade	3S2-4
2	Strevell	Boise	6/9/64	Boise Cascade	3S2-4
3	Boise	Pocatello	6/15/64	Pacific Intermountain Express	3S2-3
4	Pocatello	Boise	6/16/64	Pacific Intermountain Express	3S2-3
5	Boise	Pocatello	6/17/64	Garrett Freightlines	3S2-3
6	Pocatello	Boise	6/17/64	Garrett Freightlines	3S2-3
7	Boise	Pocatello	6/18/64	Garrett Freightlines	2S1-2-2
8	Pocatello	Boise	6/19/64	Garrett Freightlines	2S1-2-2
9	Boise	Pocatello	6/22/64	Consolidated Freightways	2S1-2-2
10	Pocatello	Boise	6/23/64	Consolidated Freightways	2S1-2-2
11	Boise	Pocatello	6/24/64	Pacific Intermountain Express	2S1-2-2
12	Pocatello	Boise	6/24/64	Pacific Intermountain Express	2S1-2-2


IDAHO STATE HIGHWAY SYSTEM
1963
10 5 0 10 20 30 40 50
SCALE IN MILES
LEGEND
Unimproved road
Graded and drained road
Gravel road graded and drained
Bituminous surfaced road
U.S. numbered highways
State numbered highways
Proposed road
Four lane divided highway
FIG. 1 — ROUTE LOCATION & ROADWAY SECTION WIDTHS
4-LANE DIVIDED
2-LANE WITH A CLIMBING LANE
2-LANE-24' TRAVELWAY & 5-10' WIDE SHOULDERS
2-LANE-22'-24' TRAVELWAY & 3' WIDE SHOULDERS OR 28' FULL WIDTH PAVEMENT
BOUNDARY
Bonners Ferry
BONNER
Sandpoint
KOOTENAI
Coeur d'Alene
Kellogg
Wallace
Burke
Bayview
Post Falls
Plummer
St. Maries
BENEWAH
SHOSHONE
Pollatch
LATAH
Moscow
Deary
Elk River
CLEARWATER
Headquarters
Kendrick
Ahsahka
Orofino
Lewiston
NEZ PERCE
Spalding
LEWIS
Winchester
Nez Perce
Kooskia
Lowell
Cottonwood
Grangeville
Elk City
IDAHO
Riggins
LEMHI
Salmon
Leadore
Challis
New Meadows
McCall
ADAMS
VALLEY
Council
Cambridge
Cascade
WASHINGTON
Weiser
Cape Horn
Stanley
Lowman
PAYETTE
Payette
GEM
BOISE
Horseshoe Bend
Emmett
Idaho City
Boise
Marsing
Caldwell
Nampa
CANYON
Kuna
ADA
ELMORE
Murphy
Mountain Home
Air Base
Bruneau
OWYHEE
CUSTER
Ketchum
Sun Valley
Hailey
CAMAS
BLAINE
Fairfield
Carey
GOODING
Gooding
Shoshone
LINCOLN
Dietrich
JEROME
Jerome
Buhl
Twin Falls
TWIN FALLS
MINIDOKA
Minidoka
Rupert
Burley
Albion
Oakley
CASSIA
BUTTE
Howe
Arco
CLARK
Spencer
Dubois
FREMONT
Ashton
St. Anthony
Warm River
Big Spot
JEFFERSON
Roberts
Rigby
Rexburg
MADISON
Ririe
TETON
Driggs
Victor
Swan Valley
Idaho Falls
BONNEVILLE
BINGHAM
Blackfoot
Aberdeen
Pocatello
American Falls
POWER
McCammon
BANNOCK
CARIBOU
Soda Springs
Downey
BEAR LAKE
Montpelier
Ovid
Paris
Malad
Dayton
Preston
ONEIDA
FRANKLIN

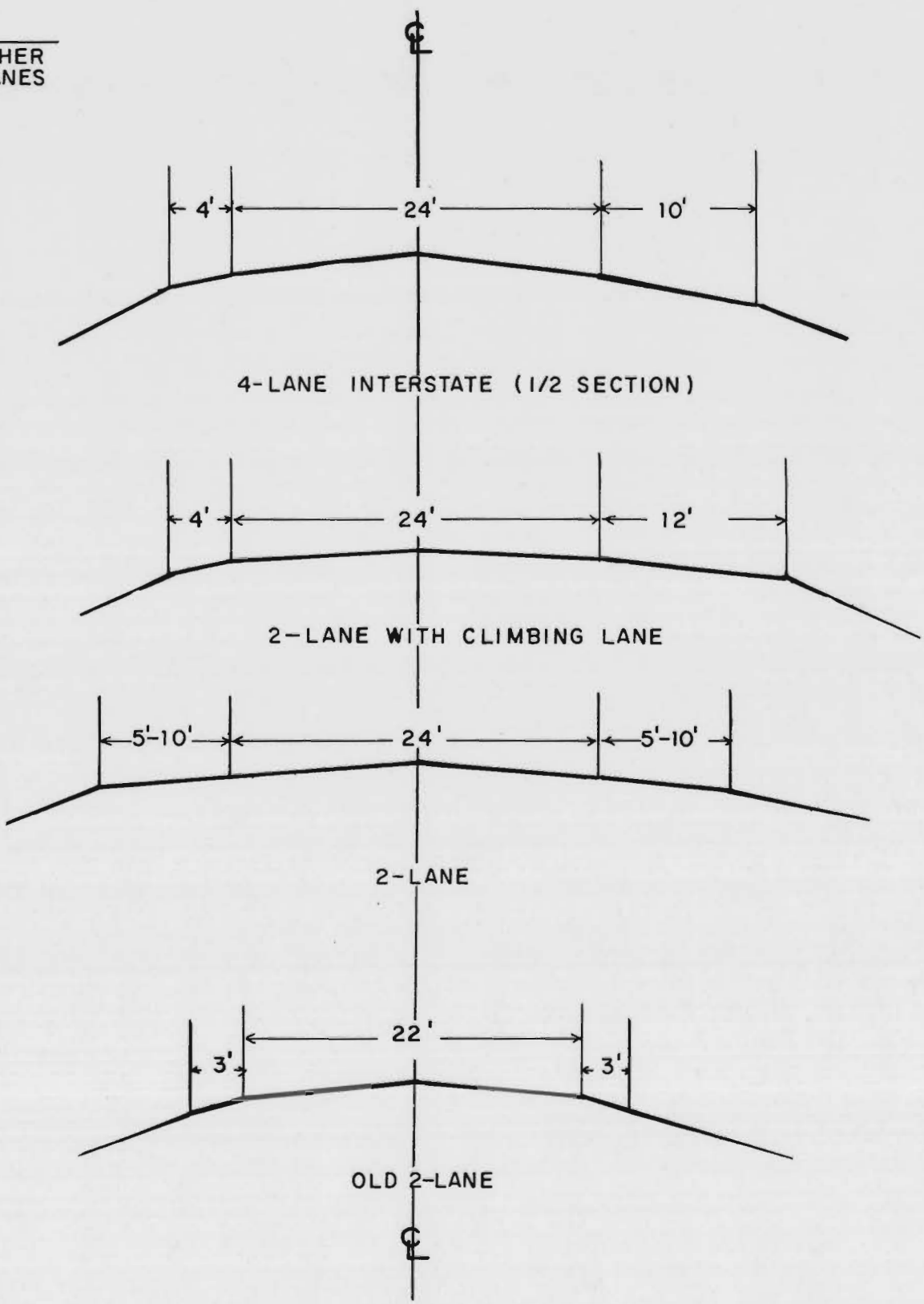


FIG. 2.— TYPICAL CROSS SECTIONS OF HIGHWAYS USED IN STUDY.

FIG. 3— TYPICAL TRUCK, TRAILER & FULL TRAILER UNIT

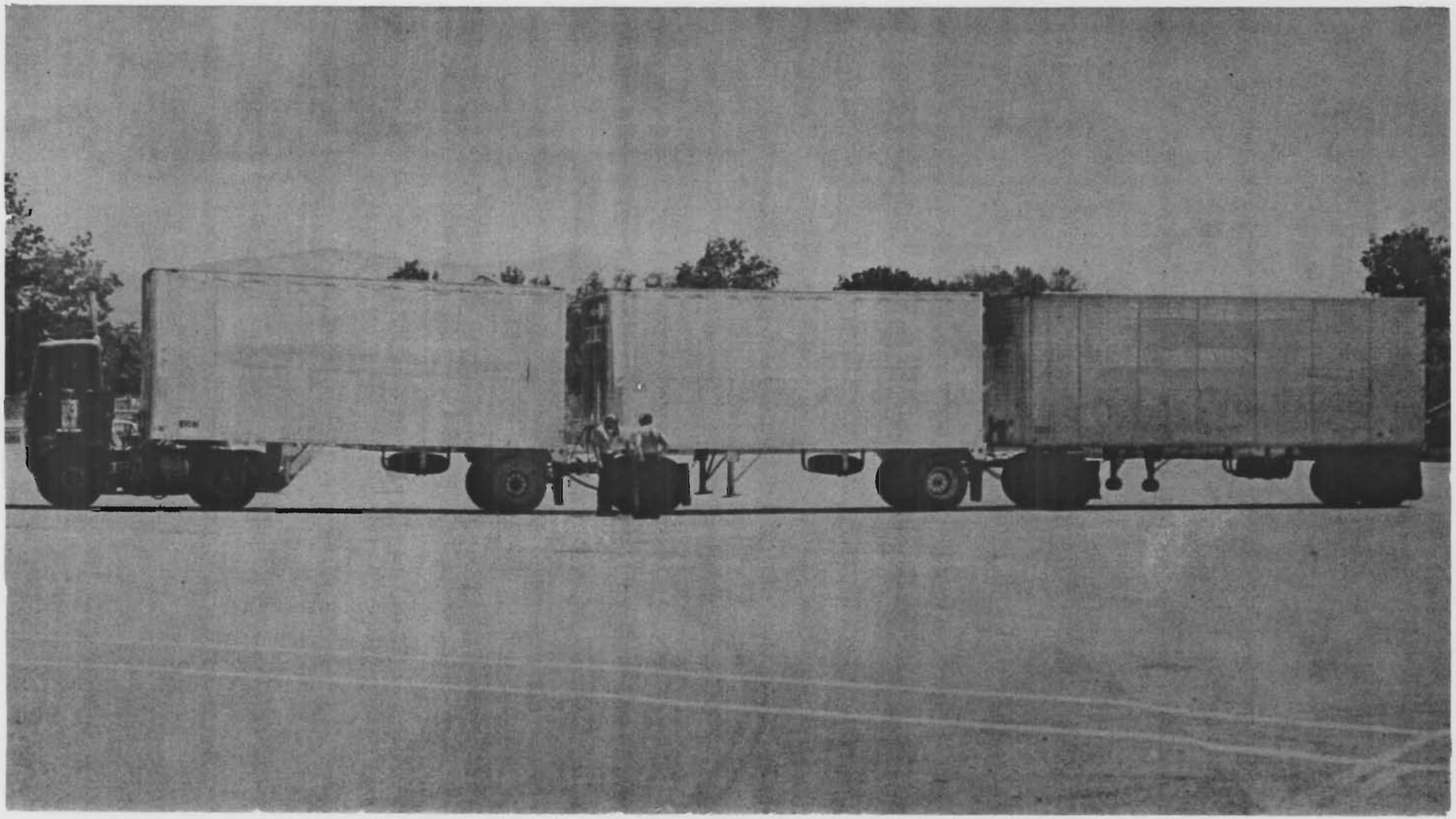


FIG. 4 — TYPICAL TRUCK, TRAILER & TWO FULL TRAILER UNIT

approaching 32,000 pounds on tandem axles and 18,000 pounds on single axles. Two groups of four axles, because of the distance between the first and last axle of the group, exceeded the total gross weight for a group of consecutive axles normally allowed by overload permits by 4,000 pounds. All other axle groups were within such load restrictions and all single and tandem axles were within legal load limits. The maximum gross load hauled was 134,900 pounds on the five axle semi with the four axle trailer. The same unit on the return trip had a load of 130,000 pounds. The five axle semi with a three axle trailer had loads ranging from 112,900 pounds to 115,300 pounds. The two axle semis pulling 2 two axle trailers had loads ranging from 104,000 to about 105,000 pound gross loads.

A record was made of each axle group weight for each of the units on each trip made and is given in Table II.

TABLE II

Axle Weights - Gross Loads
(Port of Entry - King Hill)

3S2-4, 5 Axle Semi and 4 Axle Full Trailer

Trip No.	AXLES -1-	2-3	4-5	6-7	8-9	Gross Load	Net Load
1	10,550	30,450	30,150	29,950	29,450	130,550	-
2	10,150	30,050	31,850	30,500	32,350	134,900	-

3S2-3, 5 Axle Semi and 3 Axle Full Trailer

Trip No.	AXLES -1-	2-3	4-5	-6-	7-8		
3	10,050	26,900	27,500	17,700	31,150	113,300	79,840
4	10,200	26,350	27,650	17,450	31,300	112,950	-
5	9,500	28,450	28,100	17,350	31,200	114,600	81,110
6	9,350	28,350	28,150	17,700	30,900	114,450	-

2S1-2-2, 3 Axle Semi and Two 2 Axle Full Trailers

Trip No.	AXLES -1-	-2-	-3-	-4-	-5-	-6-	-7-		
7	9,900	16,450	16,500	15,590	16,150	16,050	13,700	104,340	64,948
8	9,800	15,800	16,500	16,150	15,800	16,200	13,700	103,950	-
9	8,900	16,000	16,900	15,400	16,550	14,900	15,550	104,200	65,950
10	8,900	16,250	16,950	15,500	16,650	14,900	15,650	104,800	-
11	9,650	15,600	17,100	15,700	16.050	15,300	15,600	105,000	-
12	9,650	15,600	17,100	15,600	16,100	15,000	15,650	104,700	-

The engine horsepower and dynamometer or brake horsepower for each of the units used is given in Table III.

TURNING RADII AND OFF TRACKING

Measurements were make of the off tracking distances for turns of 45 degrees, 90 degrees, 135 degrees and for turning radii of 50 feet, 75 feet and as sharp as possible for 90 degree and 135 degree turns. Table IV and Figures 12-27 in Appendix B give the results of these measurements.

RECORDS MADE DURING EXPERIMENTAL TRIPS

The following records were made during the experimental runs of the various test units:

1. Time records were kept of time of departure, arrival at various key locations enroute and destination as well as time and duration of any stops during the trip.
2. Speed of the vehicle at several locations enroute and climbing speeds on various long hills. Some trips had a mile by mile record made of running speed over part of the route.
3. Traffic behavior was observed to determine what adverse effects these long units had on traffic, i. e., delays, congestion due to inability to pass, and passing times for passenger cars and trucks.
4. Operational problems, particularly turning movements of the test vehicles were observed and recorded.
5. Pictures of the units operating were obtained showing their performance in making 90 degree turns and also were to be taken to show other problems involving the test units.

Results of these records are given in Figures 28-39 in Appendix C by trip number. These figures show the roadway profile, percent grade on selected hills, location of towns, junctions and other landmarks

TABLE III

Weight - Horsepower Ratios

Trip No.	Owner	Type Unit	Gross Weight Lbs.	Horsepower Engine	Horsepower Brake	Lbs./H.P. Engine	Lbs./H.P. Brake
1	Boise Cascade	3S2-4	130,500	250	174	522	750
2	Boise Cascade	3S2-4	134,900	250	174	538	774
3	Pacific Intermountain Express	3S2-3	113,800	235	170	484	670
4	Pacific Intermountain Express	3S2-3	112,950	235	170	480	665
5	Garrett Freightlines	3S2-3	114,600	335	265	342	432
6	Garrett Freightlines	3S2-3	115,260	335	265	344	435
7	Garrett Freightlines	2S1-2-2	104,340	335	265	312	394
8	Garrett Freightlines	2S1-2-2	103,950	335	265	310	392
9	Consolidated Freightways	2S1-2-2	104,800	270	219	388	478
10	Consolidated Freightways	2S1-2-2	104,800	270	219	388	470
11	Pacific Intermountain Express	2S1-2-2	105,000	235	170	445	617
12	Pacific Intermountain Express	2S1-2-2	104,700	235	170	445	615

TABLE IV

Turning Radii and Off Tracking Distances

Tests were conducted using typical 3S2-4 and 2S1-2-2 units for steering radii of 50 feet, 75 feet for each of 90° and 135° turns. In addition, a turn as sharp as possible was made for the 90° and 135° turns.

The amount of off tracking in feet was measured for each turn for the last axle of the test unit together with the last axle of the semi-trailer for the 3S2-3 units and the last axle of the second trailer of the 2S1-2-2 units. These axles were numbers 5 and 8 on the 3S2-3 and numbers 5 and 7 on the 2S1-2-2 units. Figures 12-27 show these results.

MAXIMUM OFF TRACK DISTANCE FROM FRONT WHEEL

Unit	Radius Steer	Radius Wheel	45° Axle (5)	45° Axle (8)	90° Axle (5)	90° Axle (8)	135° Axle (5)	135° Axle (8)
3S2-4	50	46	6	8.2	12	19.6	13.6	24.8
	75	71	6.5	10.3	10	16	6.5	15.0
	Hard Left							
	30±	25.5			15.5	25		
	30±	25.5					19.2	32
			(5)	(7)	(5)	(7)	(5)	(7)
2S1-2-2	50	46	6.0	8.8	15.0	19.0	8.5	13.0
	75	71	6.0	9.5	5.5	9.0	5.6	9.0
	Hard Left							
	20±	15.5			15.0	21.5		
	20±	15.5					18.0	25.5

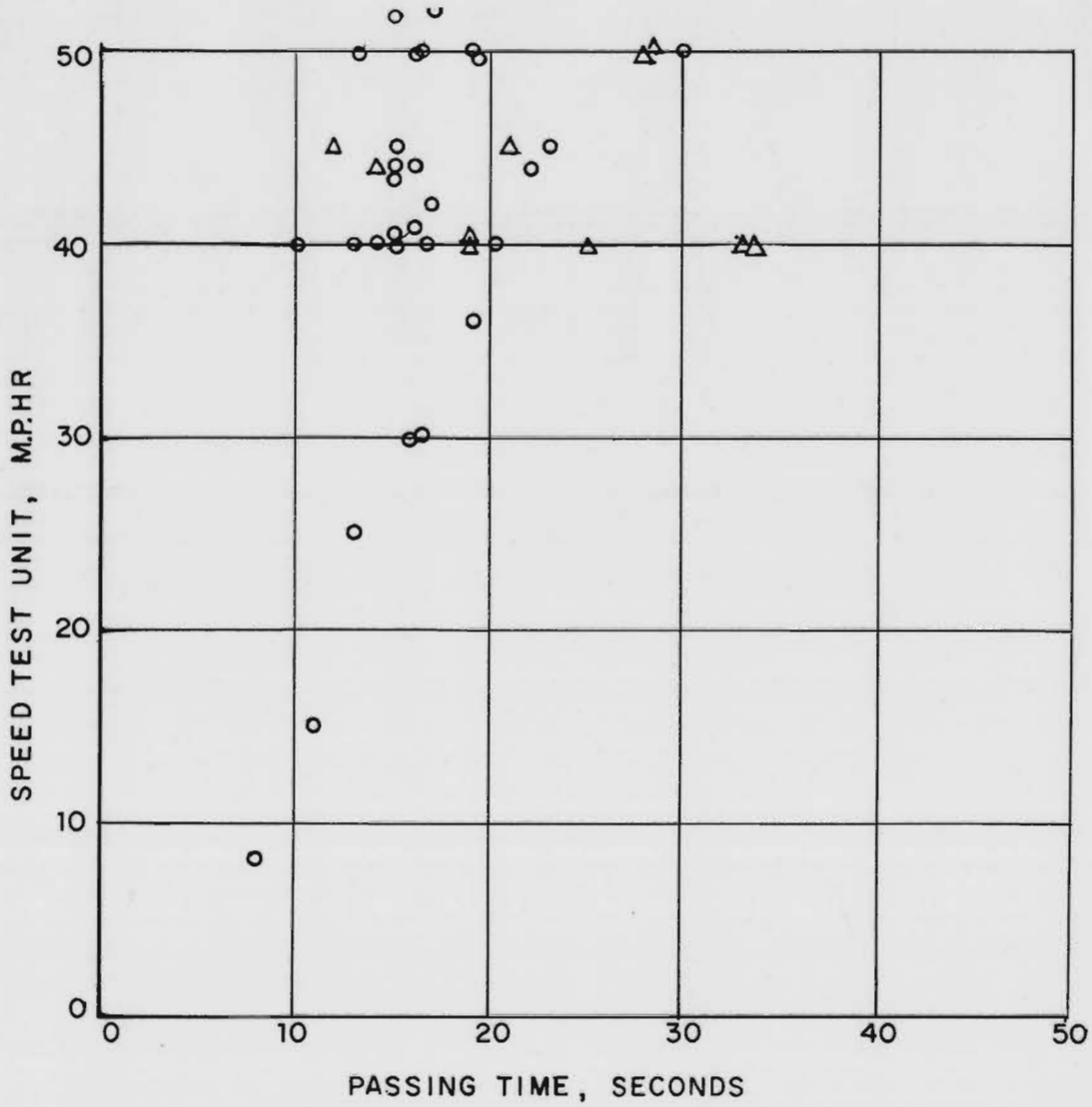
and location of four-lane sections, passing lanes, and distance from point of origin of the trip. In addition, spot speed checks and speed distance checks are noted and data for some trips of number of vehicles met passing test unit and delayed because of the test unit. Time for passing the test units is reported in Figure 5.

Travel time, miles per hour for the trip and fuel consumption in miles per gallon are given in Table V. The average speed on short sections of the route is given in Table VI and the slowest climbing speed checked on the various hills is given in Table VII.

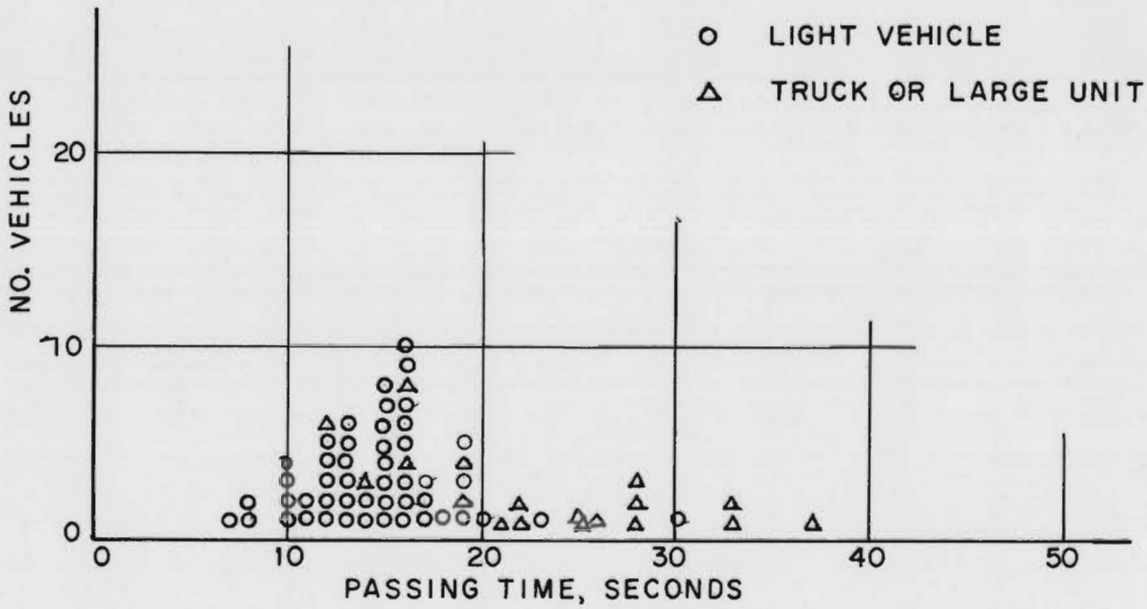
Table VIII is included to show actual traffic volume for the day and also the hour the test unit passed one of the Highway Department automatic counters. The volumes given are for totals of both directions.

Passing times were recorded at numerous locations during the several trips. These were taken at the observer's option and many were taken during the slower travel speeds of the test unit and often the unit speed was not noted. Figure 5 shows the results of these measurements. Approximately 70% of the traffic checked passed the unit in less than 16 seconds, with 95% of the light vehicles passing in less than 20 seconds. The heavier units, trucks and house trailers, etc., took from 12 to 40 seconds with nearly all requiring more than 25 seconds to pass. The number of vehicles checked was limited in number, but it is believed they are indicative of the time required normally to pass the unit.

Tracking of the trailers was noted to be smooth except for the triple units having a pintle hook hitch. The last or third trailer had a tendency to weave back and forth causing some swaying of the cab. Braking of the unit stopped this sway. The air lock hitch held the units firm under all conditions and no swaying was observed. The double units gave no indication of swaying.



PASSING TIME AS RELATED TO SPEED OF TEST UNIT.



NO. OF VEHICLES TAKING VARIOUS PASSING TIME.

FIG.- 5

TABLE V

Travel Time, Miles Per Hour, Fuel Miles Per Gallon

Trip No.	Date	Time Start	Time Finish	Elapse Time Hour	Elapse Time Minute	Stop Minutes	Travel Time Hour	Travel Time Minute	Trip Miles	Gallons Fuel	Miles Per Gallon
1	6/8/64	5:03 A.M.	11:52 A.M.	6	49	36	6	13	221.4	112**	3.29**
2	6/9/64	1:30 P.M.	7:53 P.M.	6	23	29*	5	54	221.4	102**	3.60**
3	6/15/64	5:17 A.M.	12:43 P.M.	7	26	47	6	39	237.1	80	3.39
4	6/16/64	7:00 A.M.	2:24 P.M.	7	24	55	6	29	237.1	70	3.40
5	6/17/64	5:03 A.M.	11:00 A.M.	5	57	43*	5	14	237.1	67	3.54
6	6/17/64	1:04 P.M.	6:50 P.M.	5	46	10	5	36	237.1	71	3.34
7	6/18/64	5:05 A.M.	10:26 A.M.	5	21	15	5	06	237.1	65	3.65
8	6/19/64	7:15 A.M.	1:14 P.M.	5	59	10	5	49	237.1	75	3.16
9	6/22/64	5:07 A.M.	11:16 A.M.	6	09	32	5	37	237.1	70	3.39
10	6/23/64	7:05 A.M.	12:55 P.M.	5	50	39*	5	11	237.1	-	-
11	6/24/64	4:52 A.M.	11:47 A.M.	6	55	31	6	24	237.1	73	3.24
12	6/24/64	12:13 P.M.	7:14 P.M.	7	01	83	5	38	237.1	63	3.76

* Estimated time on one stop
** Trip to Salt Lake City - 368 Miles
Power dolly burned 40 gallons - did not provide power.

TABLE VI

Average Speed on Test Sections
Eastbound

Section	Trip Number 1	3	5	7	9	11
Boise - Mountain Home	43	35	49	44	41	44
Mountain Home - King Hill	39.5	41	47	45	52	45.5
King Hill - Bliss	31.4	25.3	48	-	36.5	29
Bliss - Jerome	39.4	35.8	43	-	45	38
U.S. 93 - Paul	31	36	42	46	44	37
Jct. I-80N - S.H. 27 - Raft River	-	42	48	46	50	41
Raft River - Pocatello	-	38	48	46	45	41.5
Jct. I-80N - S.H. 27 - Malta	43	-	-	-	-	-
Malta - Strevell	32.5	-	-	-	-	-

Average Speed on Test Sections
Westbound

Section	Trip Number 2	4	6	8	10	12
Strevell - Malta	45.5	-	-	-	-	-
Malta - Jct. I-80N - S.H. 27	40	-	-	-	-	-
Pocatello - Raft River	-	38.6	45	-	51.5	42.5
Raft River - Jct. I-80N - S.H. 27	-	41.8	46	-	46	54.5
Paul - Jct. S.H. 25 - U.S. 93	34.4	36	41	-	45	40
Jerome - Bliss	45	44	45	48	54	52
Bliss - King Hill	48	44	45	46	51	43.5
King Hill - Mountain Home	26.5	32	44	38	36	40
Mountain Home - Boise	43	38	44	44	51	49

TABLE VII

Slow Climbing Speed on Hills
Eastbound

Section	Trip Mile	% Grade	Trip Number 1	3	5	7	9	11
LB/BHP			750	670	432	394	478	617
Milepost 140	78-80	4.982	12	10	15-20	18	12	11-15
U.S. 93 East	121	5.26	5	8	-	-	-	-
Jct. S.H 50 - Eden	133	4.08	15	18-25	40-50	40	30	-
Raft R. E. US 30-I-15W	191	3.97	-	15	30	28	20	-
Hill S. Salt Lake I.C.	181		22	-	-	-	-	-

Slow Climbing Speed on Hills
Westbound

Section	Trip Mile	% Grade	Trip Number 2	4	6	8	10	12
LB/BHP			774	665	435	392	470	615
Coldwater	42	3.964	-	10	25	25	20	-
Eden - S.H. 50	101	4.86	8	10	20	27	18	-
Barrymore - U.S. 93	112	4.9	8-12	10-15	15-20	25	12	-
Bennett Creek West	180	4.66	8	7-15	15-30	17	10	11

TABLE VIII

Traffic Volumes Permanent Station Hourly Volume
During Hour Unit Passed Station
(Volumes Total Both Directions)

		Station 2			Station 7			Station 18			Station 20		
Trip No.	Date	24 Hr. Count	Hour	Volume	24 Hr. Count	Hour	Volume	24 Hr. Count	Hour	Volume	24 Hr. Count	Hour	Volume
1	6/8	5,191	5-6 A.M.	117	3,995	8-9 A.M.	193	-	-	-	1,561	11-12 A.M.	113
2	6/9	5,058	7-8 P.M.	239	4,047	4-5 P.M.	314	-	-	-	1,567	1-2 P.M.	100
3	6/15	6,329	5-6 A.M.	123	4,260	9-10 A.M.	228	2,566	11-12 A.M.	179			
4	6/16	6,269	8-9 A.M.	147	4,631	10-11 A.M.	295	2,781	2-3 P.M.	447			
5	6/17	6,091	5-6 A.M.	82	4,250	7-8 A.M.	177	2,821	9-10 A.M.	214			
6	6/17	6,091	6-7 P.M.	327	4,250	4-5 P.M.	286	2,821	2-3 P.M.	198			
7	6/18	5,836	5-6 A.M.	80	4,169	7-8 A.M.	181	2,587	9-10 A.M.	162			
8	6/19	6,800	12-1 P.M.	378	4,763	8-9 A.M.	192	2,990	8-9 A.M.	127			
9	6/22	5,787	5-6 A.M.	124	4,146	8-9 A.M.	200	2,378	10-11 A.M.	188			
10	6/23	5,482	12-1 P.M.	295	4,234	9-10 A.M.	266	2,369	8-9 A.M.	118			
11	6/24	5,594	5-6 A.M.	109	4,068	8-9 A.M.	222	2,372	10-11 A.M.	175			
12	6/24	5,594	7-8 P.M.	181	4,068	4-5 P.M.	261	2,372	1-2 P.M.	154			

Station No. 2 - 8 Miles Southeast of Boise - U.S. 30
Station No. 7 - 1.5 Miles West of Jerome - S.H. 25
Station No. 18 - Raft River - East End of I-15W
Station No. 20 - South Limits of the Village of Strevell

The power dolly used with the 3S2-4 was to have provided an additional 140 horsepower to the first axle of the full trailer whenever desired. Unfortunately this unit had a mechanical failure in the torque converter or transmission and although the engine ran, no power was transmitted to the wheels.

OBSERVATIONS

Operation of the test units for the 12 trips involved no serious incidents. Traffic flow on the 4 lane sections of Interstate appeared to be effected not at all for the traffic volumes encountered. Modern two lane sections having adequate sight distances and climbing lanes on the longer hills caused only slight delays and rarely caused anyone to follow more than two or three minutes before a passing opportunity would occur. Old sections having limited sight distance and no climbing lanes on longer hills did create delays and often several vehicles would be delayed until sight distances permitted passing. The worst areas for delay to traffic occurred on SH 25 between Hazelton and US 93 and also on US 30 between the Elmore County Line and Bliss. If the vehicle possessed sufficient horsepower to maintain a higher rate of speed (in excess of 25 mph on hills) the number of vehicles held up was reduced. Slow climbing speeds of 8-15 mph caused greatest delay.

Observer's comments were that police and pilot car escorts caused many people to be overly cautious and not take passing opportunities. This caused further delays to traffic as anyone wishing to pass often had to pass a string of several vehicles without opportunity to return to his driving lane.

Truck trailers having pintle hook hitches on the triple trailer units swayed as much as a foot on hills apparently because of the loose fit of the pintle and hook. Trailers having air lock hitches and the double trailer units showed no evidence of the swaying.

The variation in effective horsepower was very apparent in maintaining uniform speeds. Short hills that effectively slowed down the trucks with low horsepower or a high ratio of pounds per horsepower had only slight effect on the more powerful trucks. Speeds on the long hills were sometimes more than double the speed of the less powerful trucks.

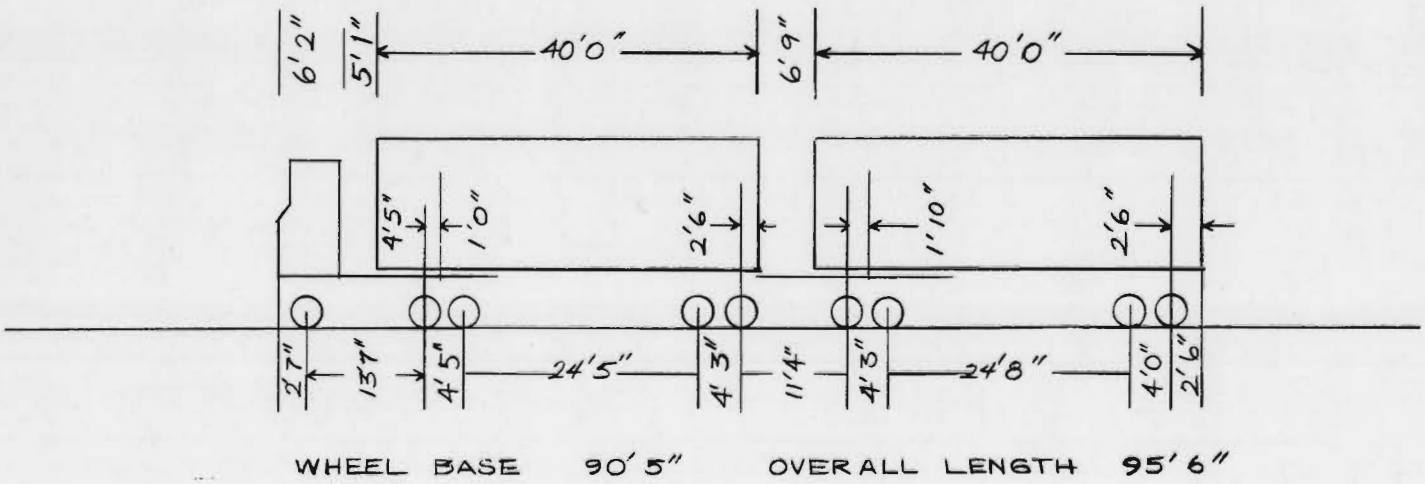
Turning radii and off tracking distances make it doubtful that units could be expected to satisfactorily negotiate turns in excess of 90 degrees and then only where wide shoulders (10 feet) or extra lanes permit a wide turn.

Present interchange ramp turning radii will not normally permit turning movements when the turn exceeds 90°, and for the less experienced driver, will frequently involve hitting the guard rail for 90° turns. Use of these units would necessitate revision of on or off ramp connections at the crossroad.

APPENDIX A

Figures 6 - 11 contain basic data for each of the vehicle combinations used in the study.

FIGURE 6 - 3S2-4 Unit - Trip No. 1 and 2



TRACTOR

Owner - Boise Cascade Corporation Unit No. 406
Make-Model - Kenworth
Engine - Cummins Mfg. HP 250 at wheels 174 HP
Transmission - Dana Spicer, No. forward speeds - 5

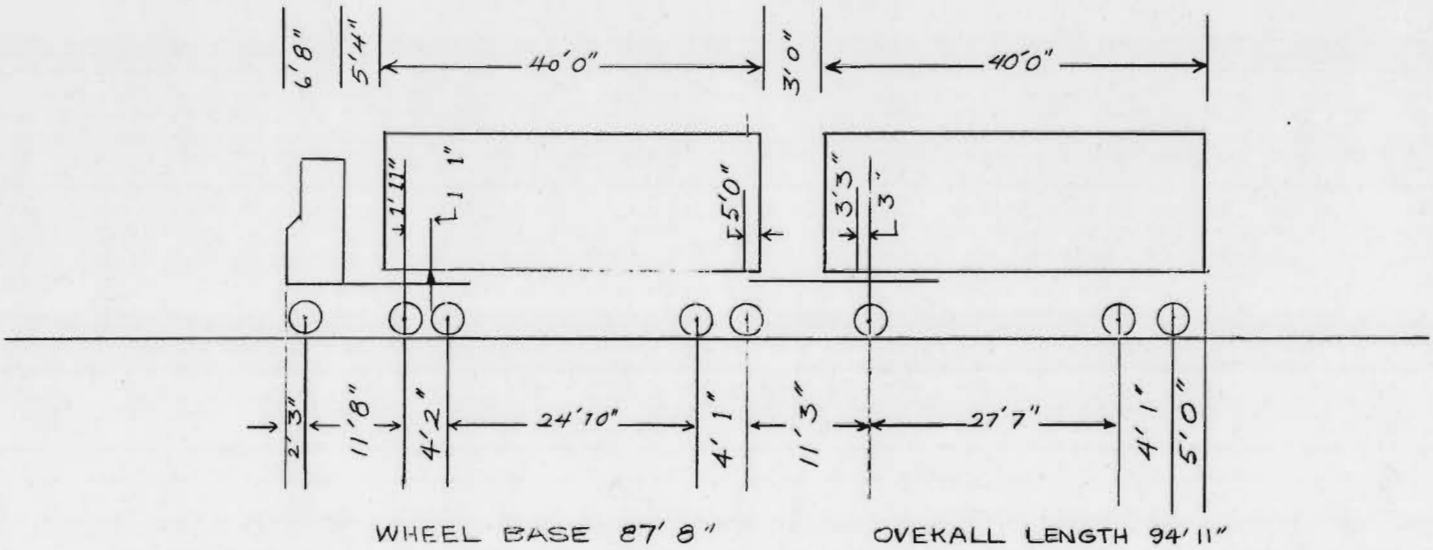
TRAILER NO. 1

Owner - Boise Cascade Unit T-405
Make-Model - Peerless
Body - Flat Bed
Type Hitch - Pintle Hook

TRAILER NO. 2

Owner - Boise Cascade Unit T-107
Make-Model - Peerless
Body - Flat Bed
Special Equipment - Front axle powered - Freightliner Experimental power dolly with 4 x 6 auxiliary axle - Rating Engine 140 HP. Unit failed to operate due to failure in power transmission.

FIGURE 7 - 3S2-3 Unit - Trip No. 3 and 4



TRACTOR

Owner - Pacific Intermountain Express - Unit B-3669
Make-Model - Kenworth
Engine - 265 HP Mfg rating at wheel 177 HP
Transmission - Fuller R-96 No. forward speeds - 10

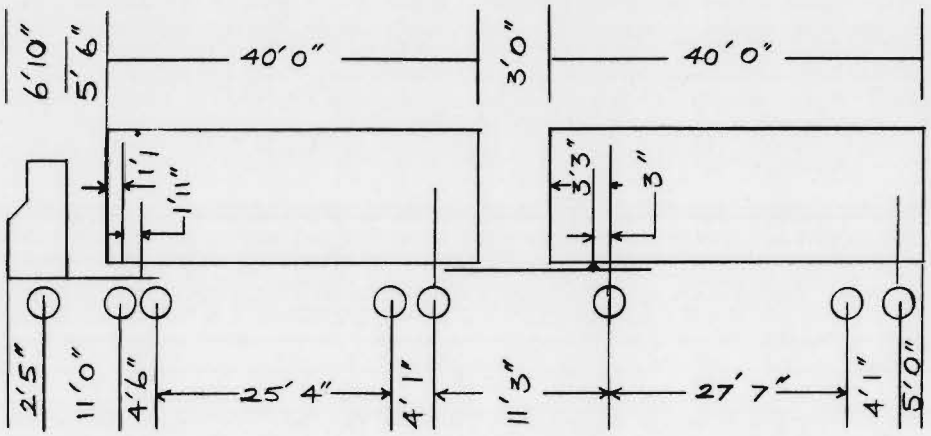
TRAILER NO. 1

Owner - Pacific Intermountain Express Unit V-4249
Make-Model - Brown 40 MVA
Body - Closed Van
Type Hitch - Pintle Hook

TRAILER NO. 2

Owner - Pacific Intermountain Express Unit V-2473
Make-Model - Brown 40 MVA-AR 204
Body - Closed Van
Dolly - Single Axle - Trailmobile WTX-66

FIGURE 8 - 3S2-3 Unit - Trip No. 5 and 6



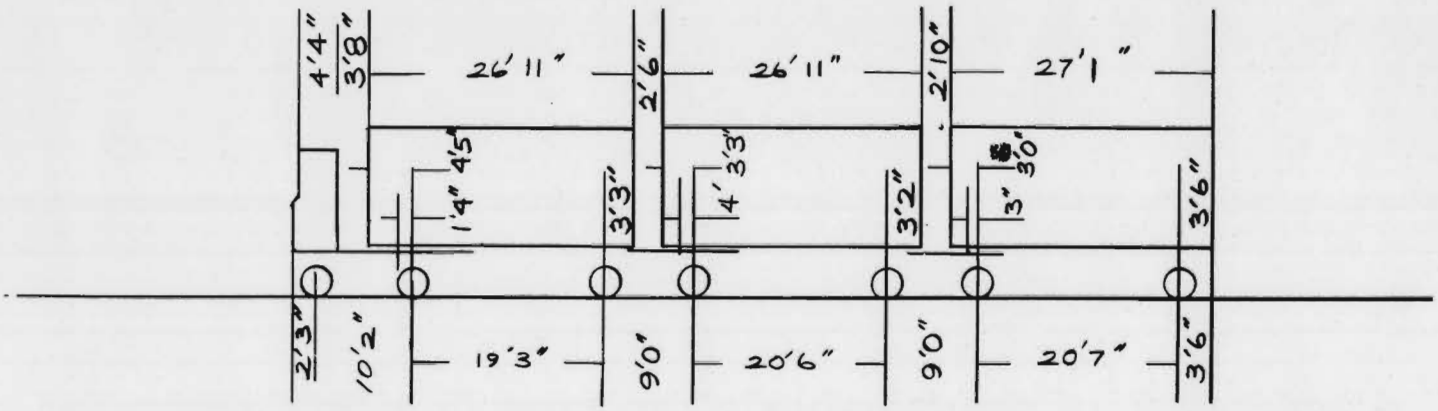
WHEEL BASE 87'10" OVERALL LENGTH 95'3"

TRACTOR

Owner - Garrett Freightlines, Inc.
Make-Model - Kenworth - K-125
Engine - Cummins Mfg Rate HP - 335 HP at wheel 265
Transmission - Fuller RT 910 No. forward speeds - 10
(NOTE: Engine with Cummins T-590 Turbocharger.)

Trailer No. 1 and Trailer No. 2 were Pacific Intermountain Express Units used on Trips 3 and 4 - Different tractor to determine effects of horsepower on operations.

FIGURE 9 - 2S1-2-2 Unit - Trip No. 7 and 8



WHEEL BASE 88'6" OVERALL LENGTH 94'3"

TRACTOR

Owner - Garrett Freightlines, Inc. Unit 12-756
Make-Model - Kenworth K-121
Engine - Cummins Mfg rate HP 335 HP at wheel 265
Transmission - Fuller RT 910 No. of forward speeds - 10
Note: Engine with Cummins T-590 Turbocharger

TRAILER NO. 1

Owner - Garrett Freightlines, Inc. Unit 42-2739
Make-Model - Brown 272 WC VD-W-HLU
Body - Closed Van
Type Hitch - Air Lock

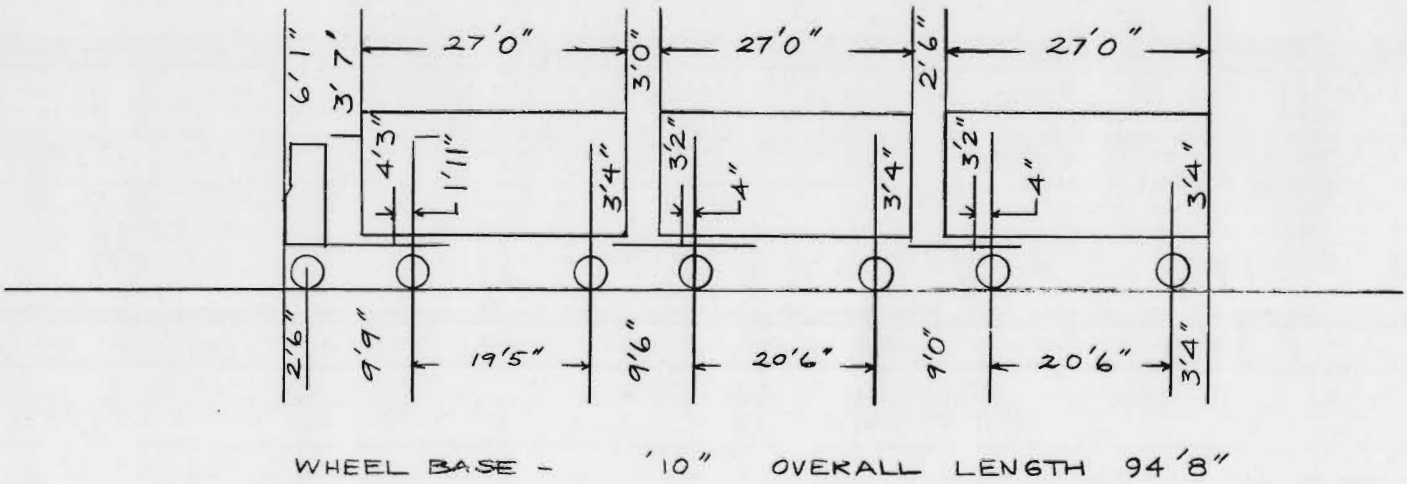
TRAILER NO. 2

Owner - Garrett Freightlines, Inc.
Make-Model - Pike
Body - Closed Van
Type Hitch - Air Lock
Dolly - Single Axle - Pike No. 333

TRAILER NO. 3

Owner - Garrett Freightlines, Inc., Unit No. 42-2970
Make-Model - Fruehauf VVD-248130 - VDDX FI 27-E
Body - Closed Van
Dolly - Single Axle - Garrett

FIGURE NO. 10 - 2S1-2-2 - Trip No. 9 and 10



TRACTOR

Owner - Consolidated Freightways Unit 18-120
Make-Model - Freightliner WF 7245
Engine - GMC Mfg rate HP 265 HP at wheels 219
Transmission - Dana Spicer 8054B Forward speeds - 5

TRAILER NO. 1

Owner - Consolidated Freightways, Inc. Unit 29-841
Make-Model - Utility No. 35266
Body - Closed Van
Type Hitch - Pintle Hook

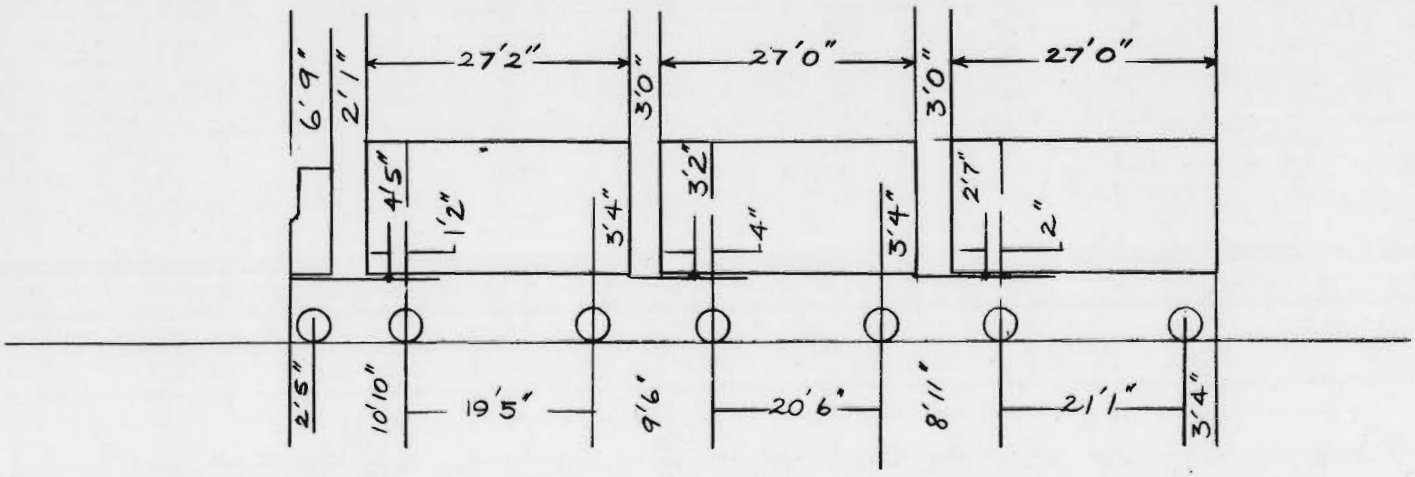
TRAILER NO. 2

Owner - Consolidated Freightways, Inc. Unit 29-576
Make-Model - Trailmobile No. 209676
Body - Closed Van
Type Hitch - Pintle Hook
Dolly - Single axle Freightlines No. 421

TRAILER NO. 3

Owner - Garrett Freightlines, Inc. Unit 42-2739
Make-Model - Brown 272-WCVD-W-HIU
Body - Closed Van
Dolly - Single Axle Garrett

FIGURE NO. 11 2S1-2-2 Trip No. 11 and 12



WHEEL BASE 90'3" OVERALL LENGTH 96'0"

TRACTOR

Owner - Pacific Intermountain Express, Inc. Unit D-347
Make-Model - Peterbilt - 282M
Engine - Cummins Mfg rate HP 265 at wheel 170 HP
Transmission - Dana Spicer 8016-5B Forward Speeds - 12

TRAILER NO. 1

Same units as used in Trip No. 9

APPENDIX C

Figures 28-39 show roadway profile of route and data from trip records for each of the trips in the study.

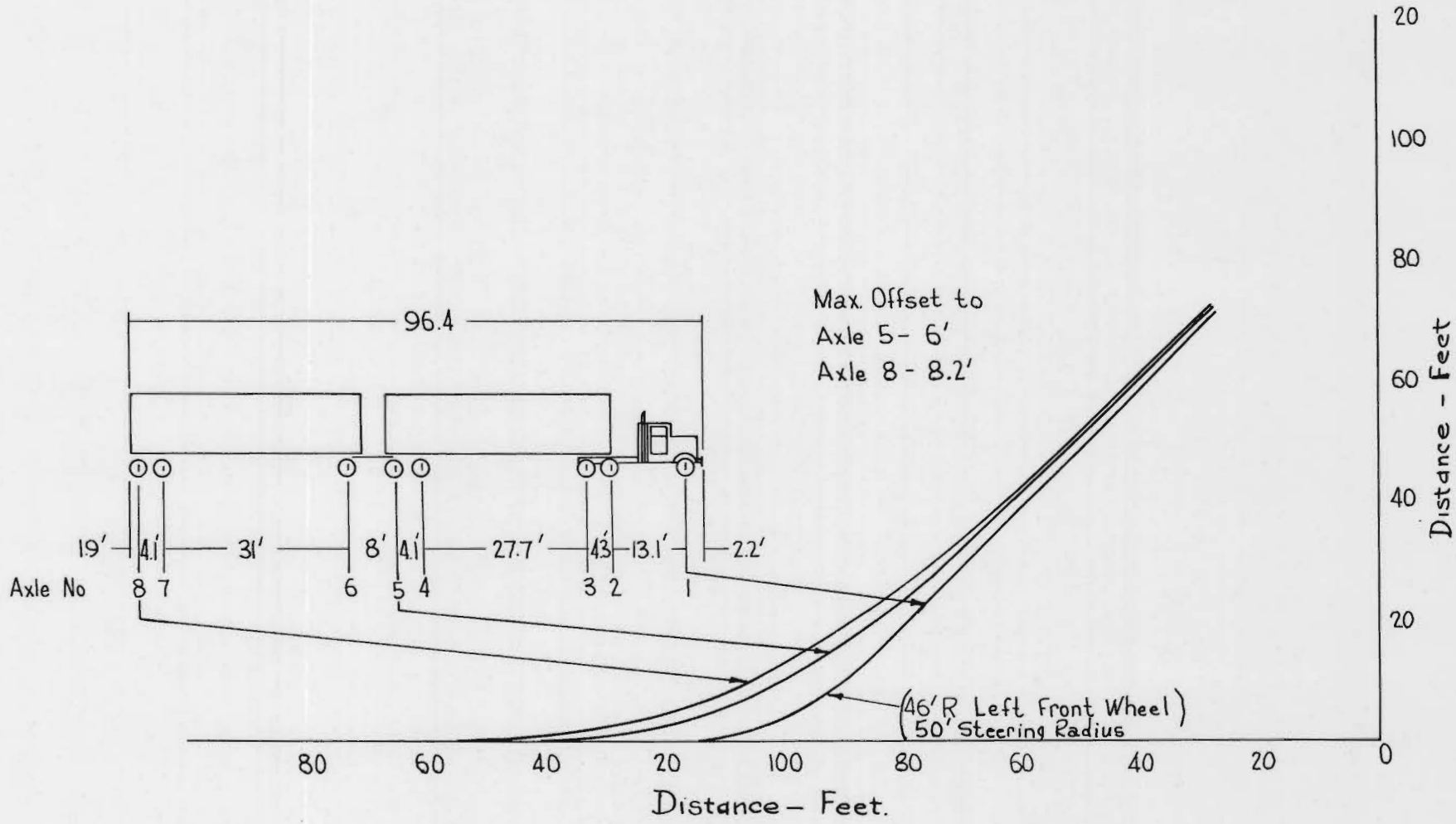


FIG. 12 - 45° Turn 46' R
2 Trailer Unit

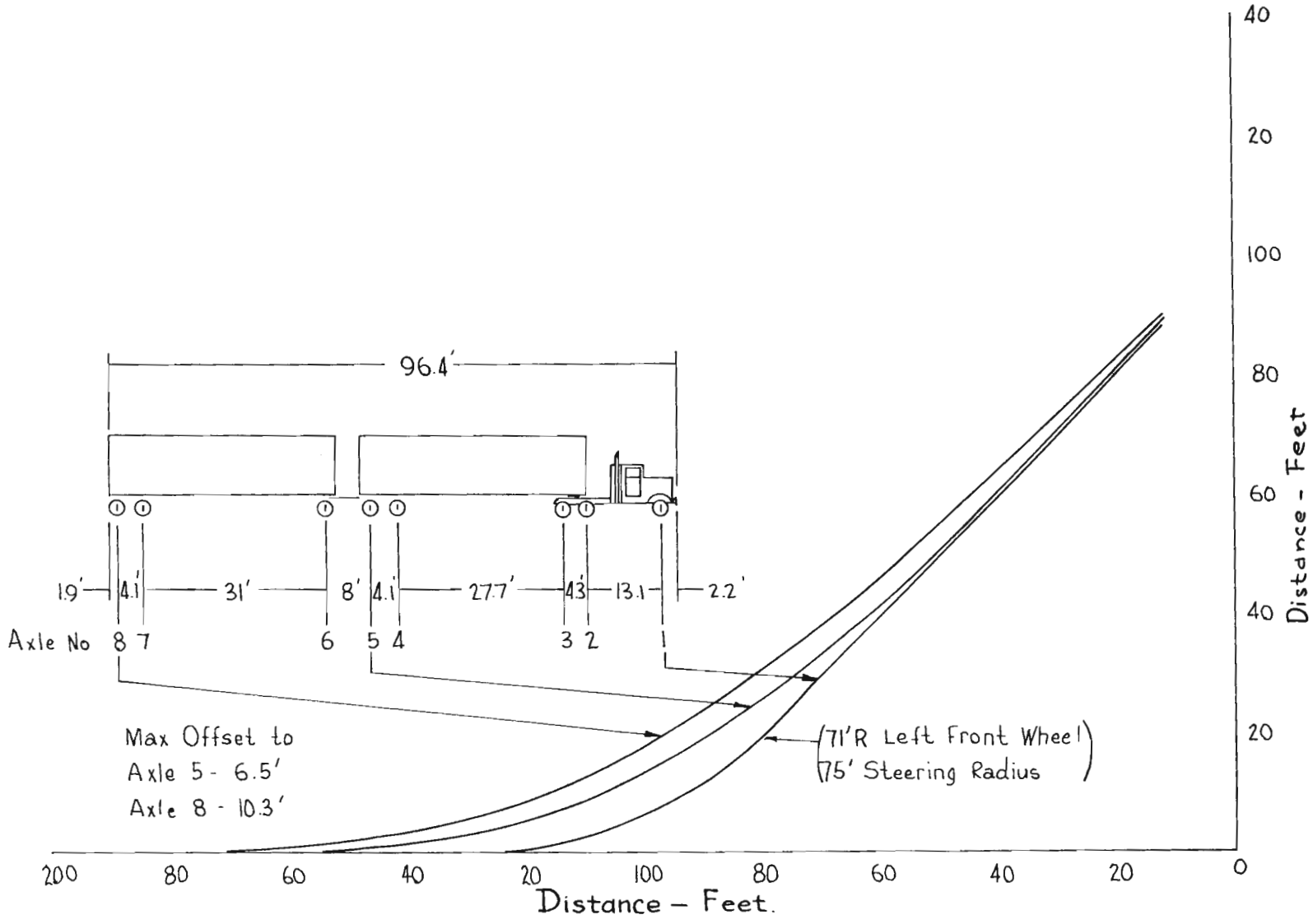


FIG 13. —45° Turn 71'R
2 Trailer Unit

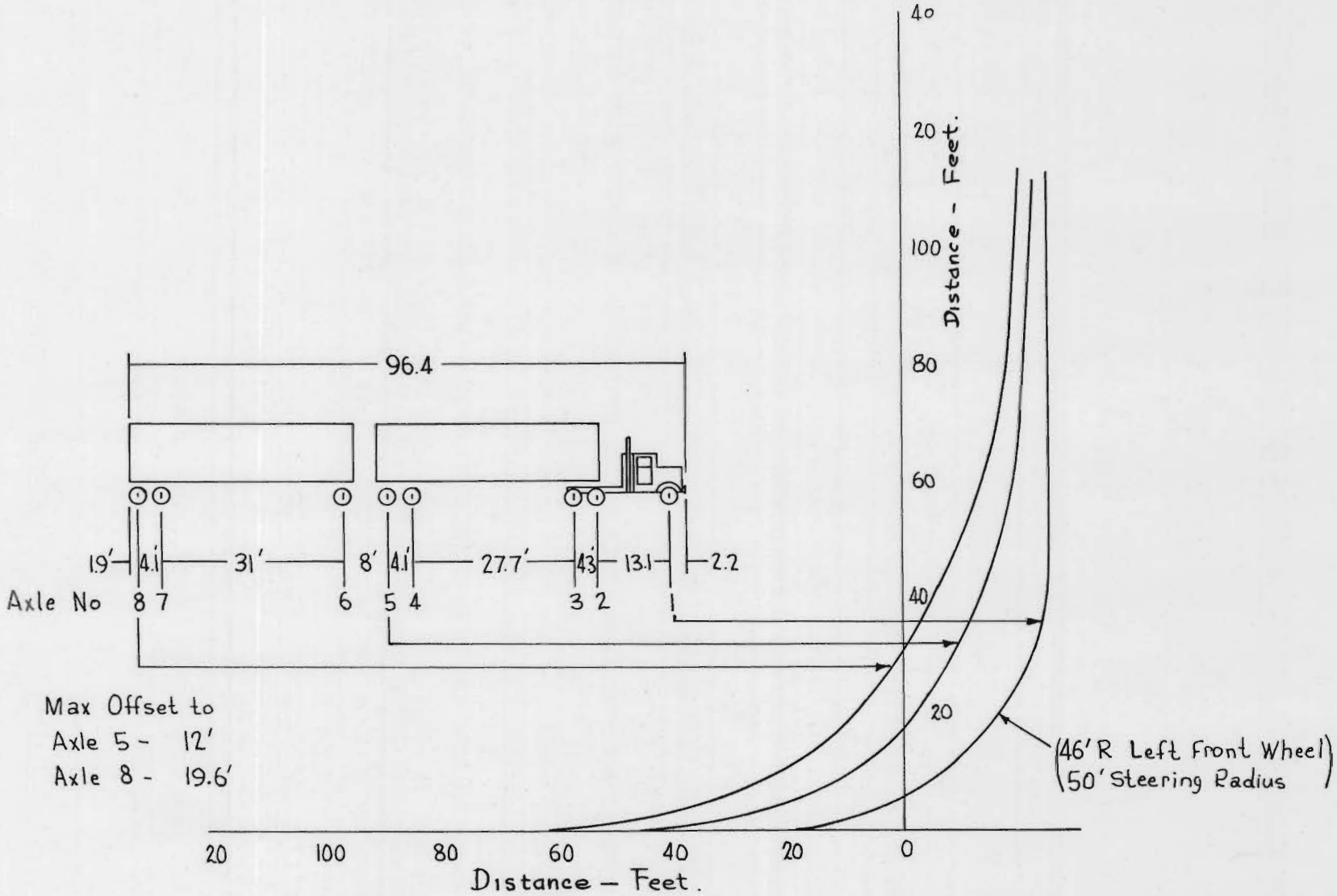


FIG. 14 – 90° Turn 46'R
2 Trailer Unit

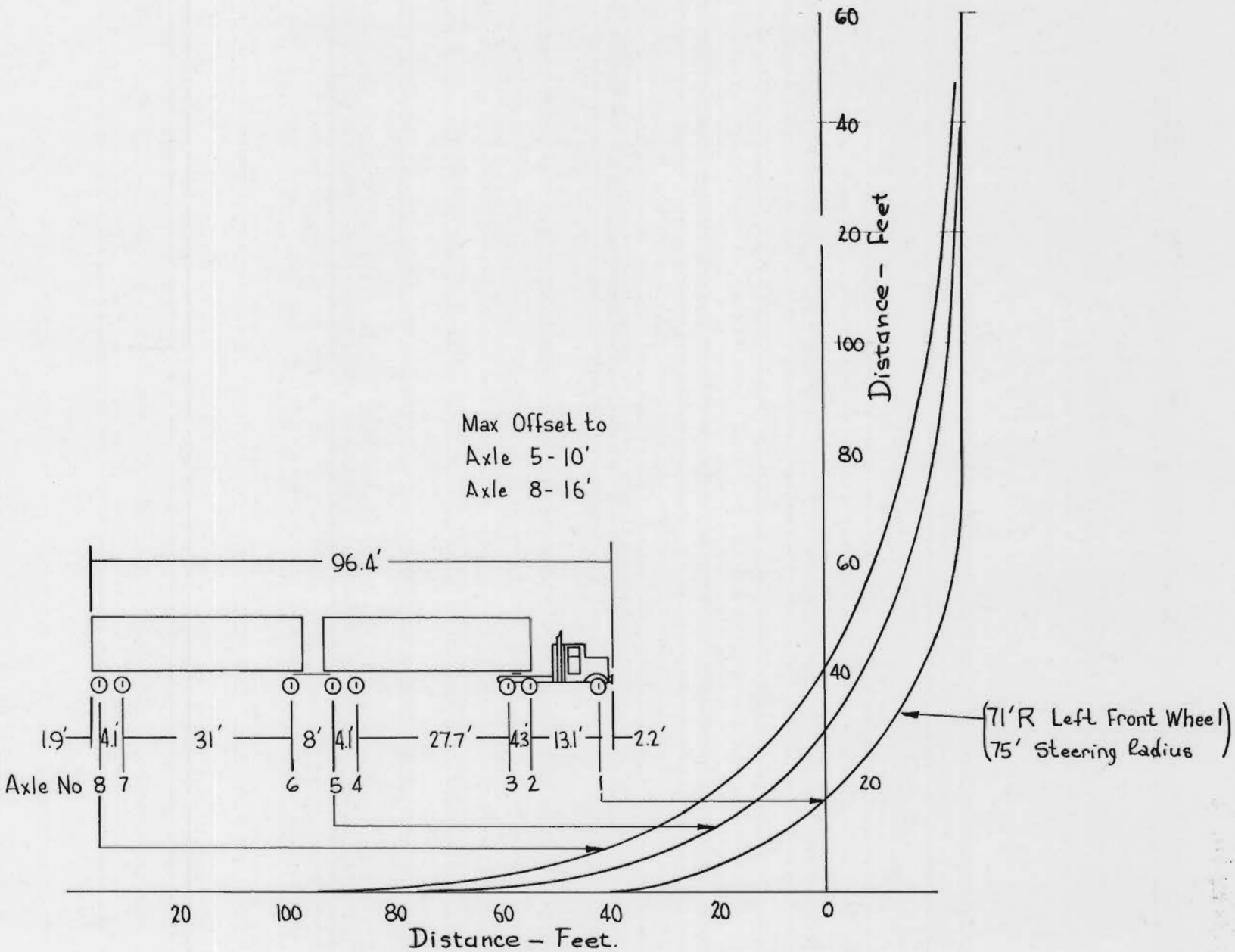


FIG. 15. — 90° Turn 71' R
2 Trailer Unit

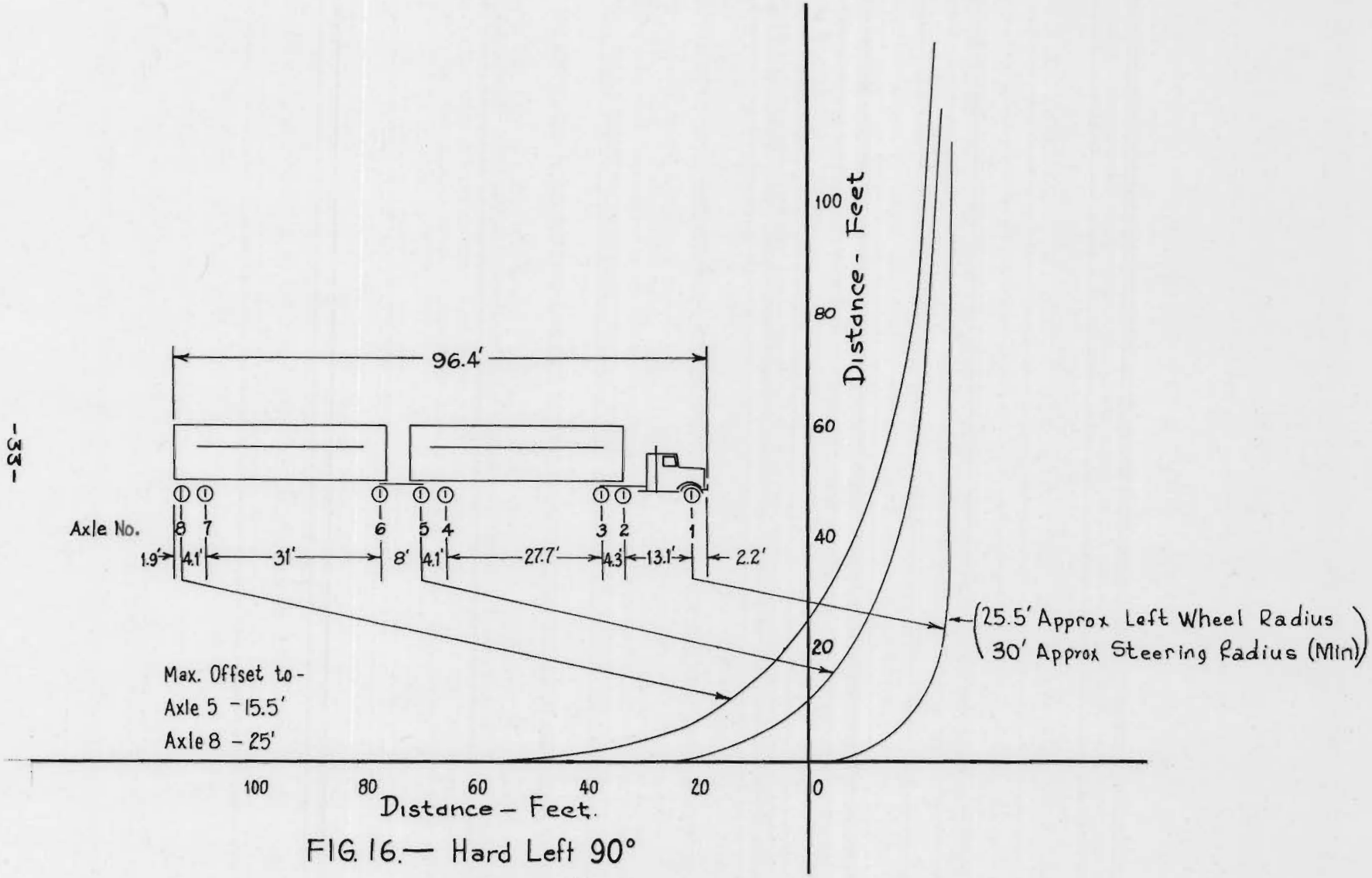


FIG. 16.— Hard Left 90°
2 Trailer Unit

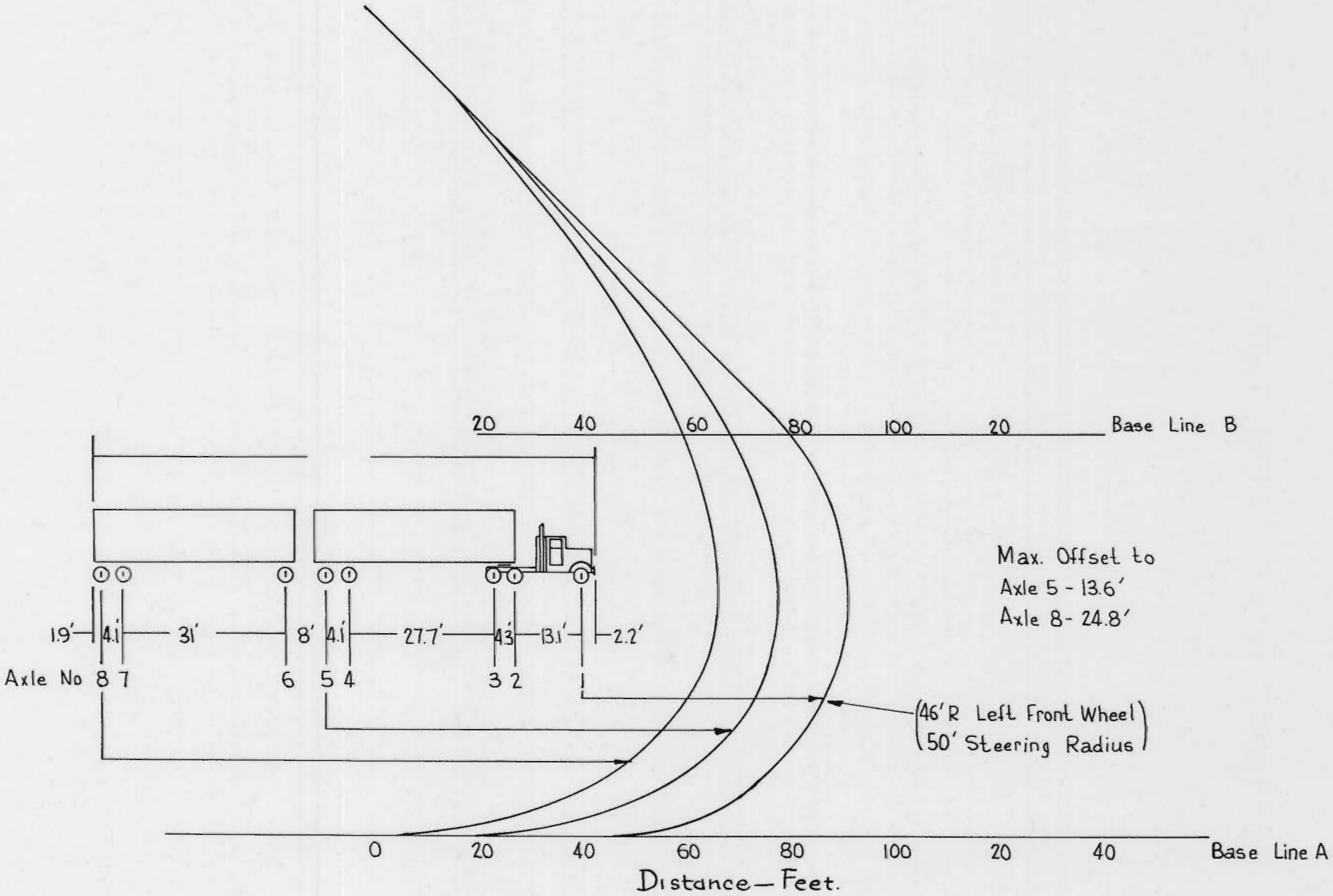


FIG. 17. — Left Turn 135° 46′ R
2-Trailer Unit

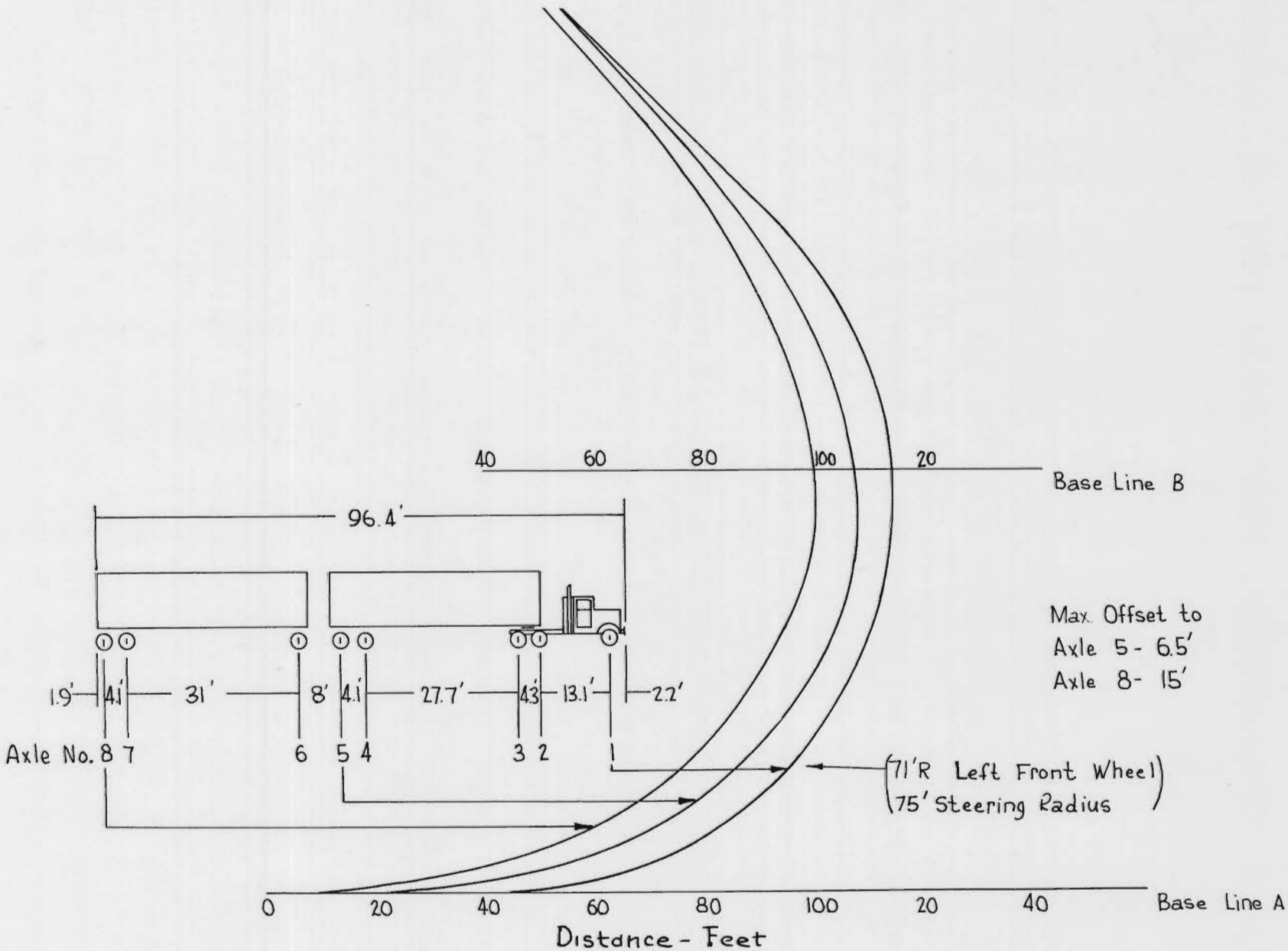


FIG. 18. — Left Turn 135° 71'R
2 Trailer Unit

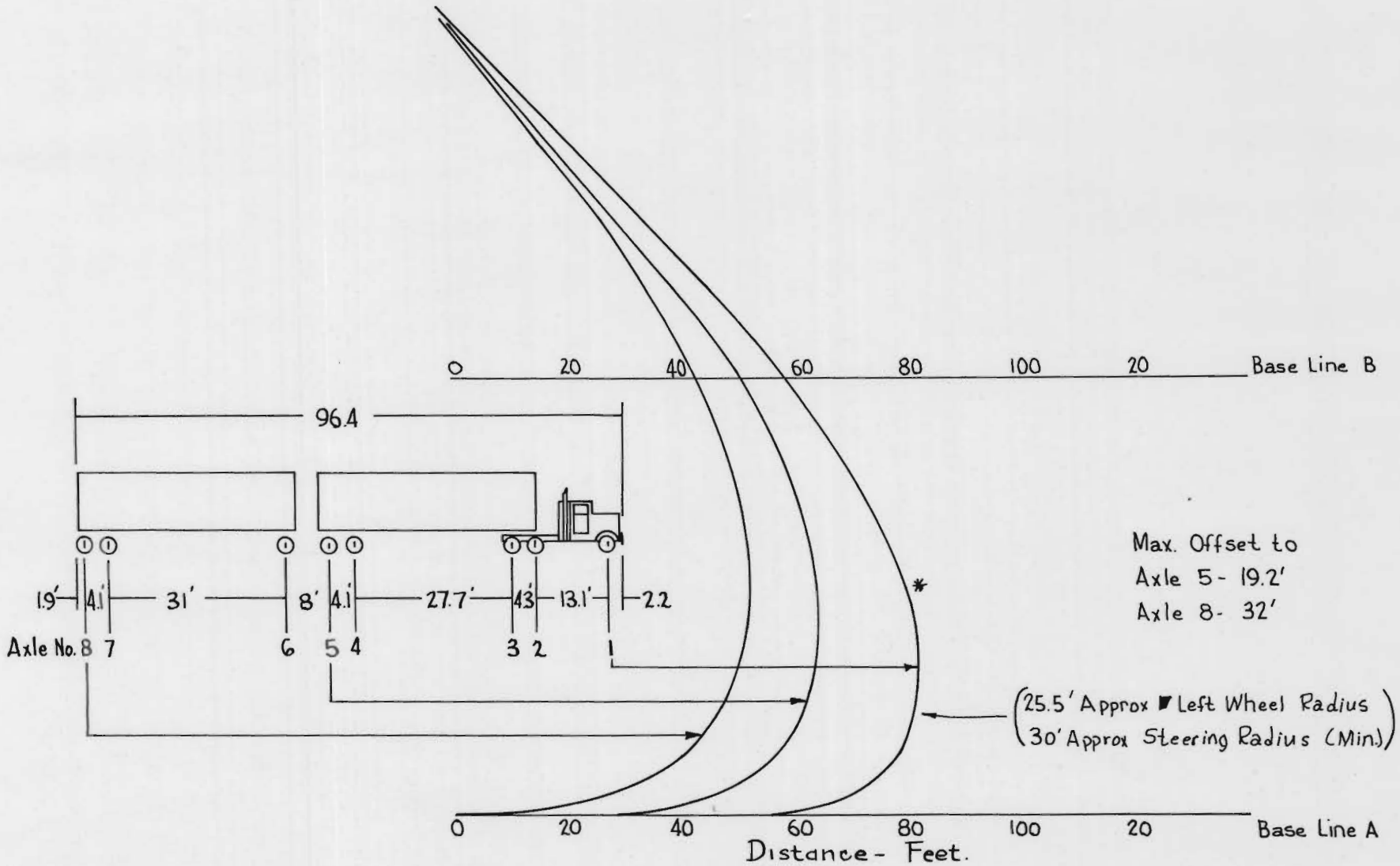


FIG. 19. — Hard Left 135°
2 Trailer Unit

* Min turning radius of vehicle

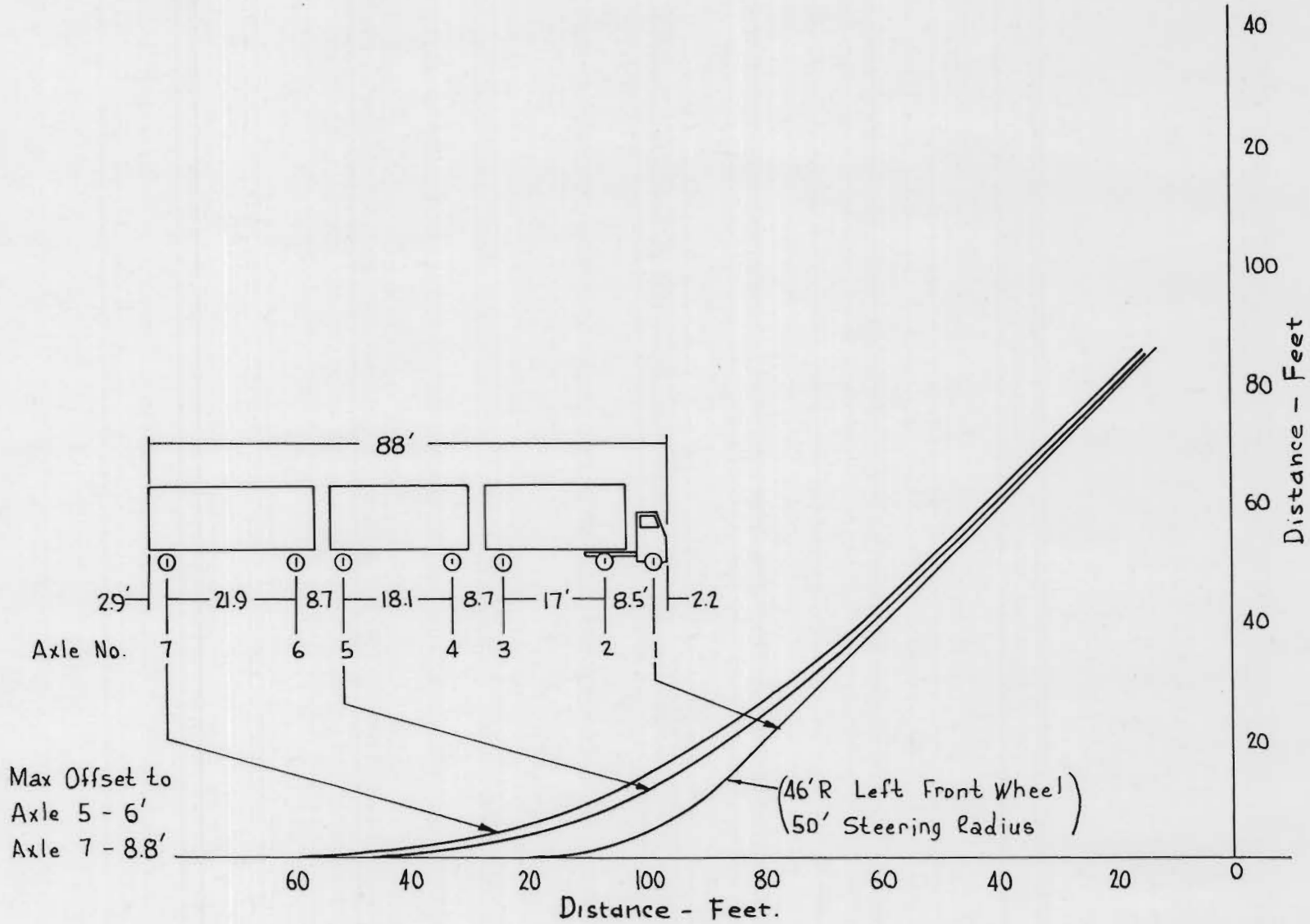


FIG.20 — 45° Turn 46'R
3 Trailer Unit

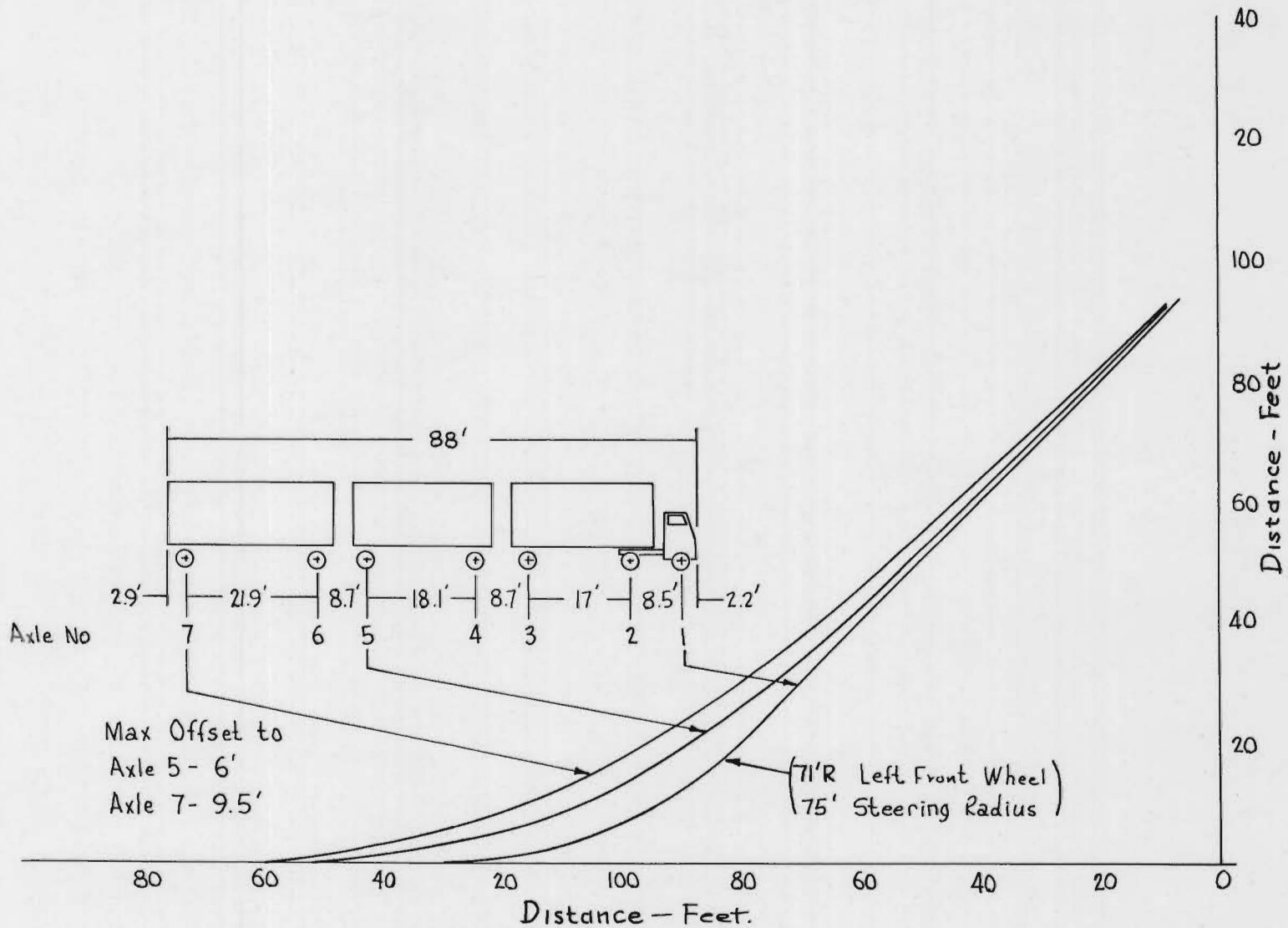


FIG. 21.- 45° Turn 71'R
3 Trailer Unit

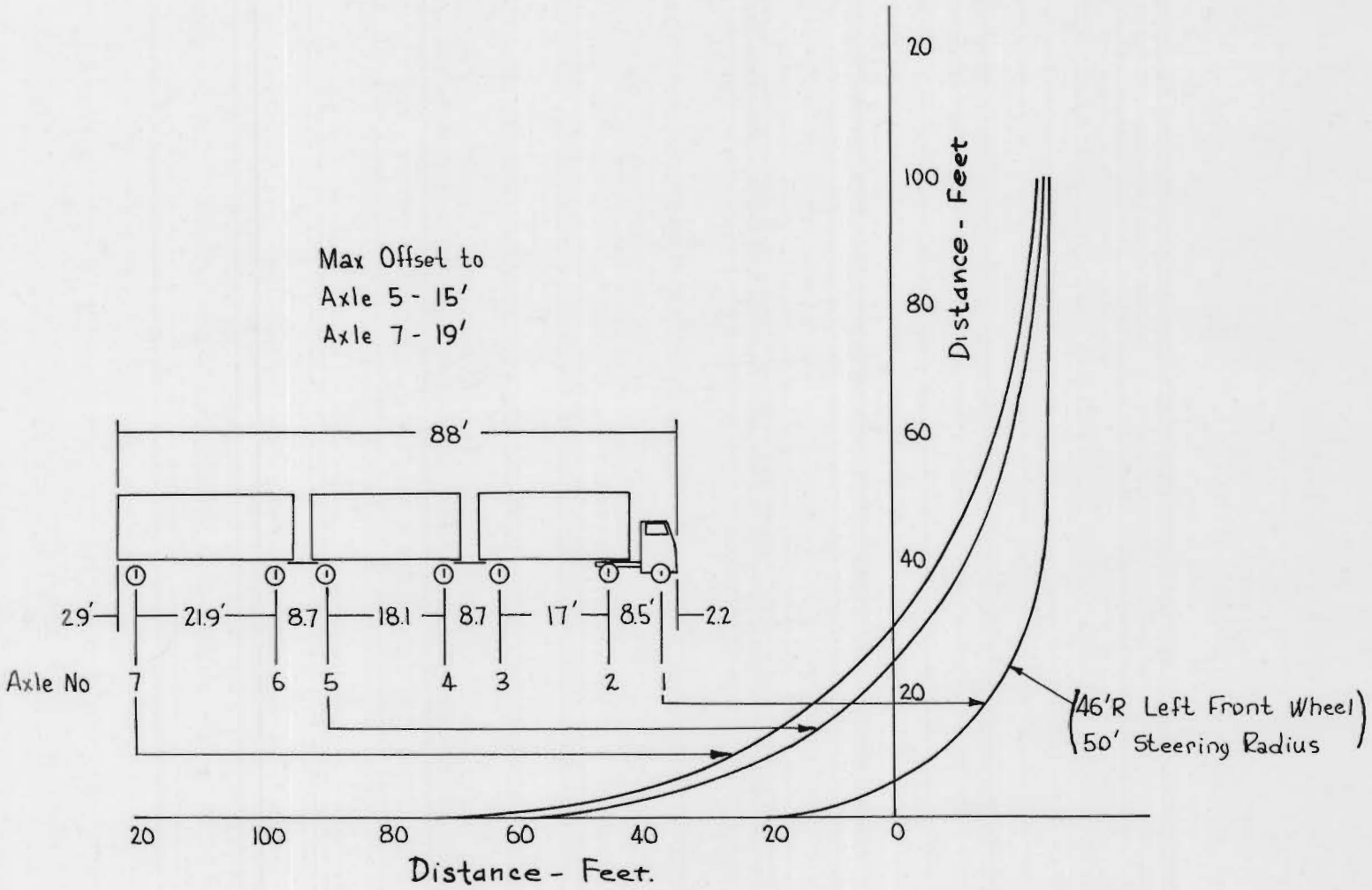


FIG. 22 – 90° Turn 46' R
3 Trailer Unit

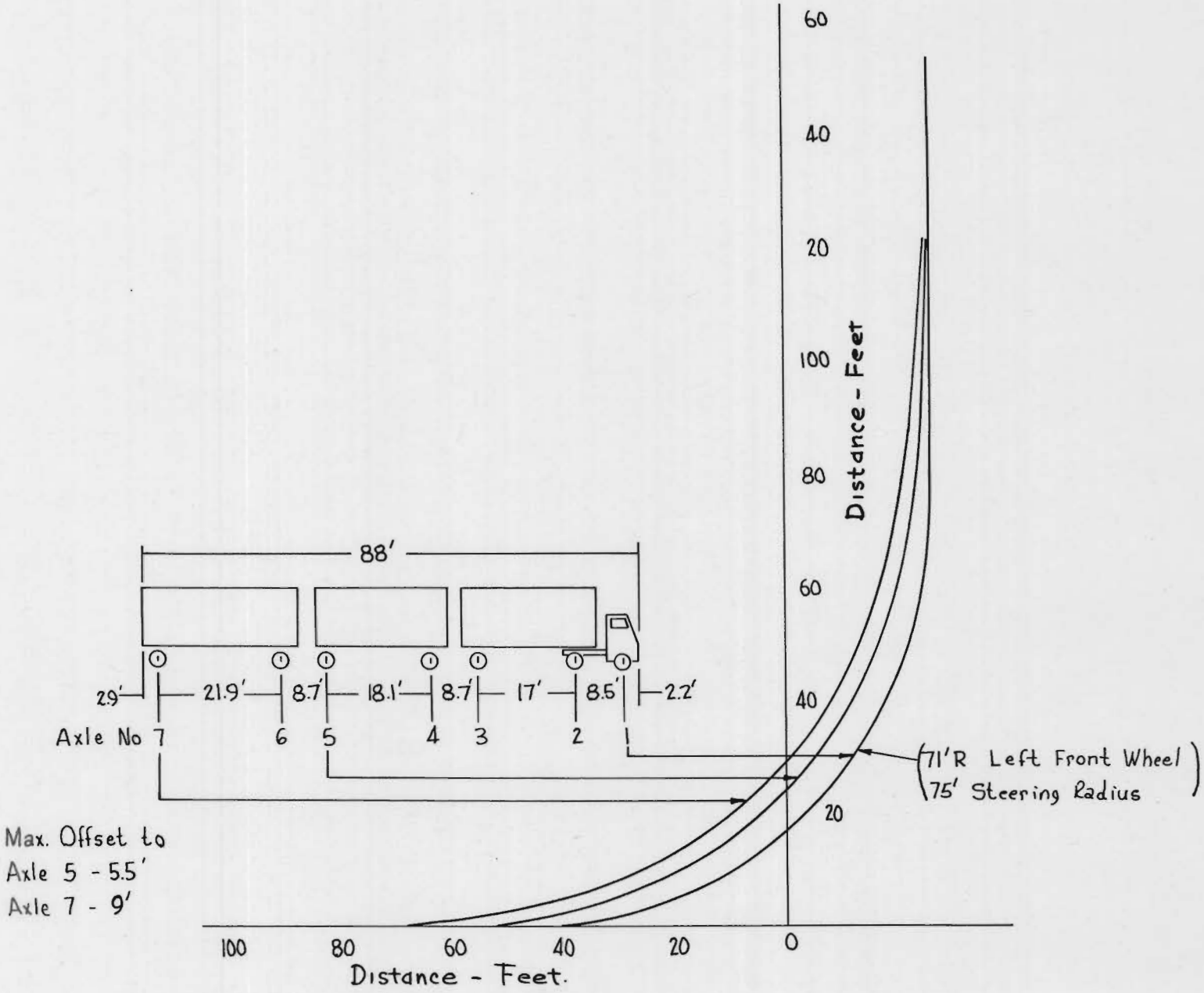


FIG 23 — 90° Turn 71'R
3 Trailer Unit

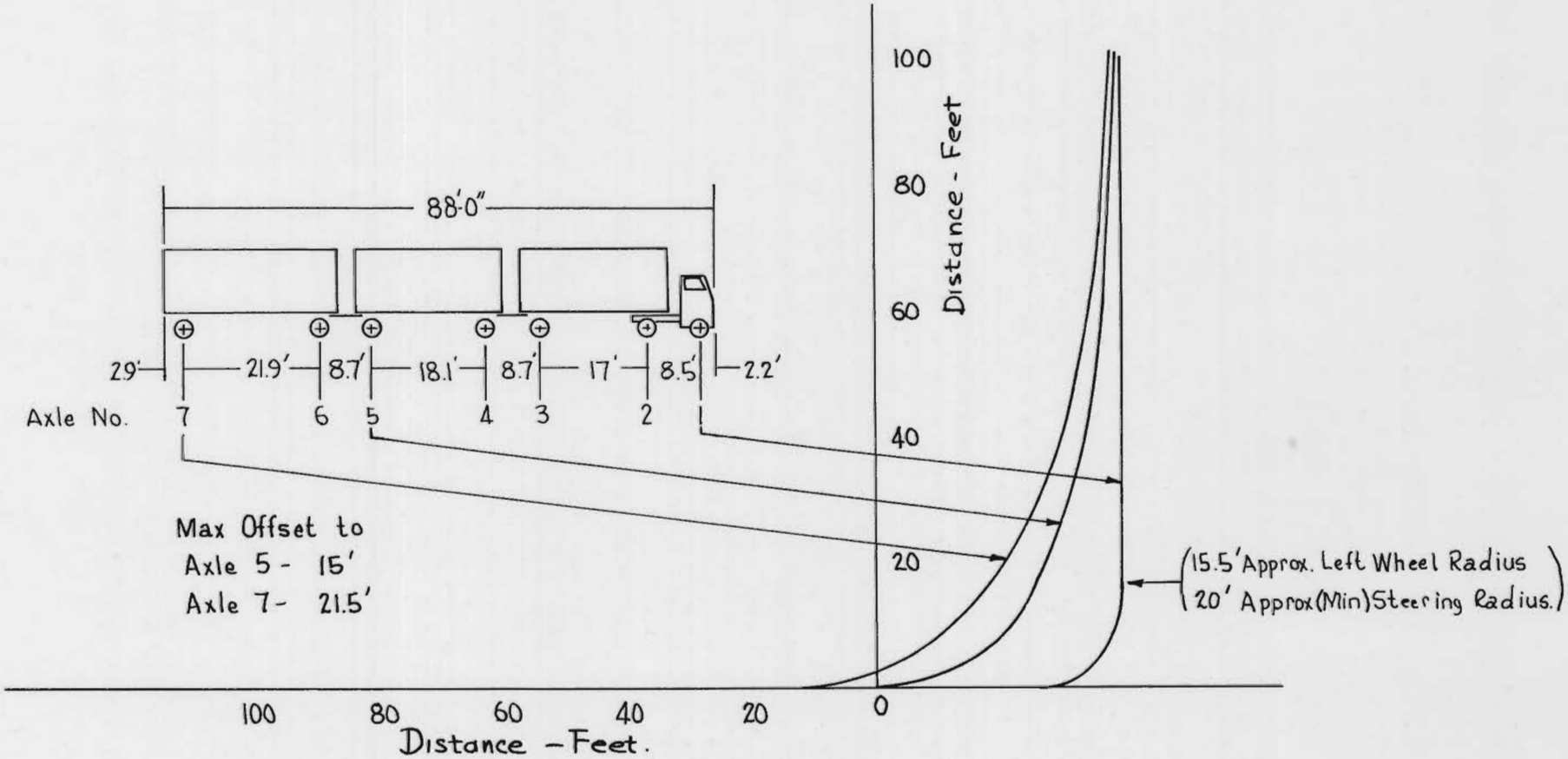


FIG.24.— Hard Left 90°
3 Trailer Unit

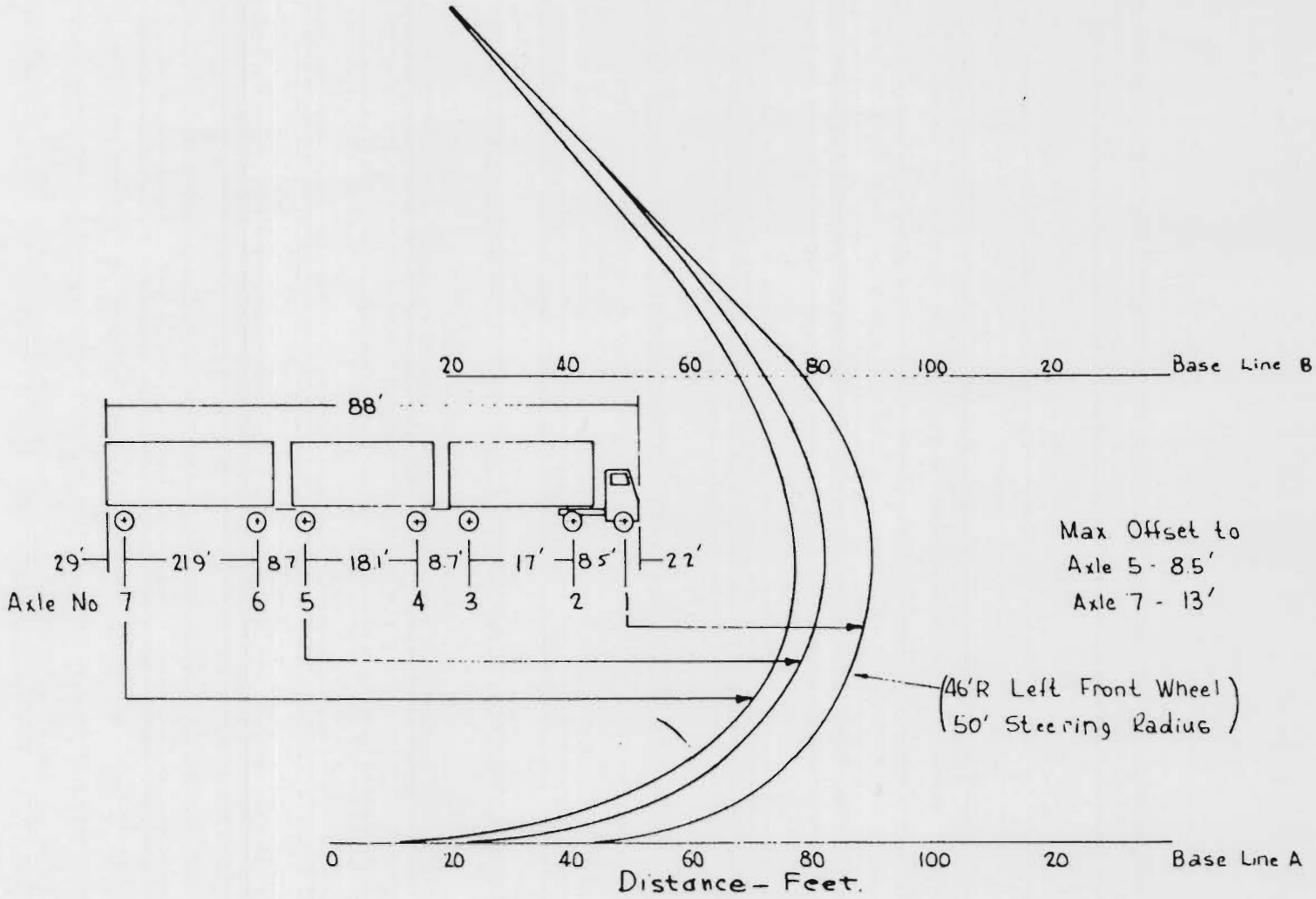


FIG. 25 — Left Turn 135° 46'R
3 Trailer Unit

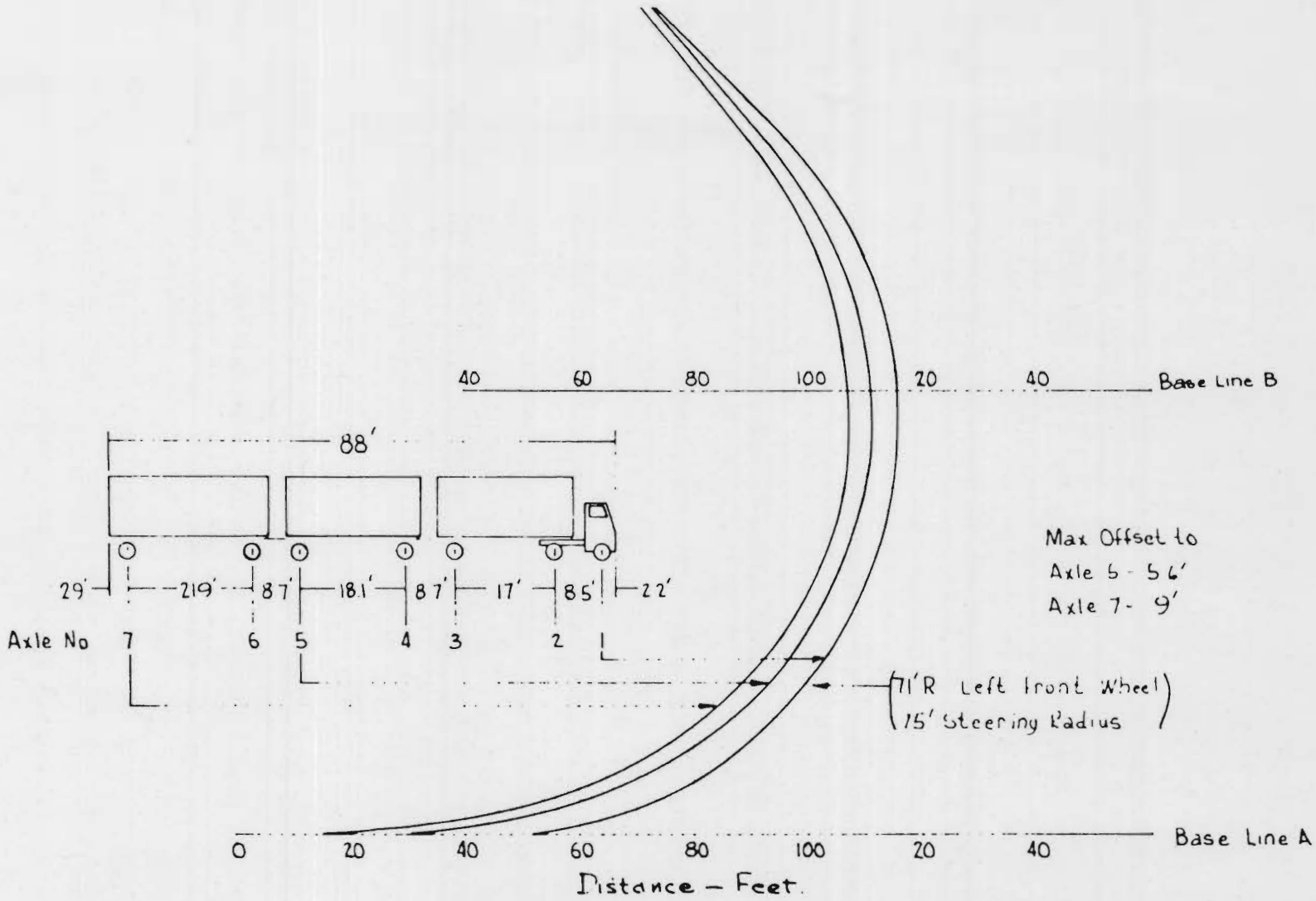


FIG. 26 — Left Turn 135° 71'R
3 Trailer Unit

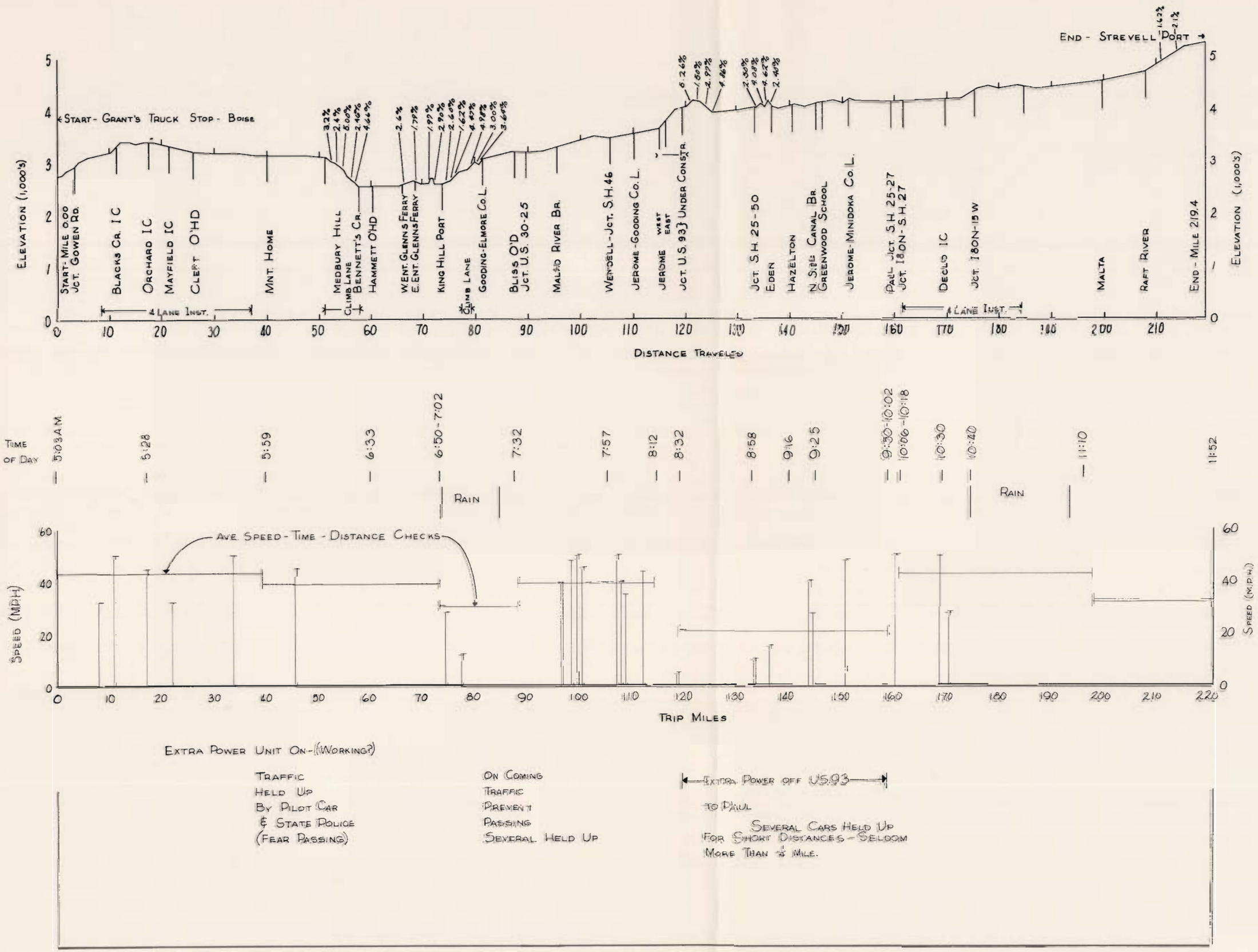


FIG. 28 — TRIP Nº 1, JUNE 8, 1964
BOISE - STREVELL
BOISE-CAS. -3S2-4 LB/BHP. 750

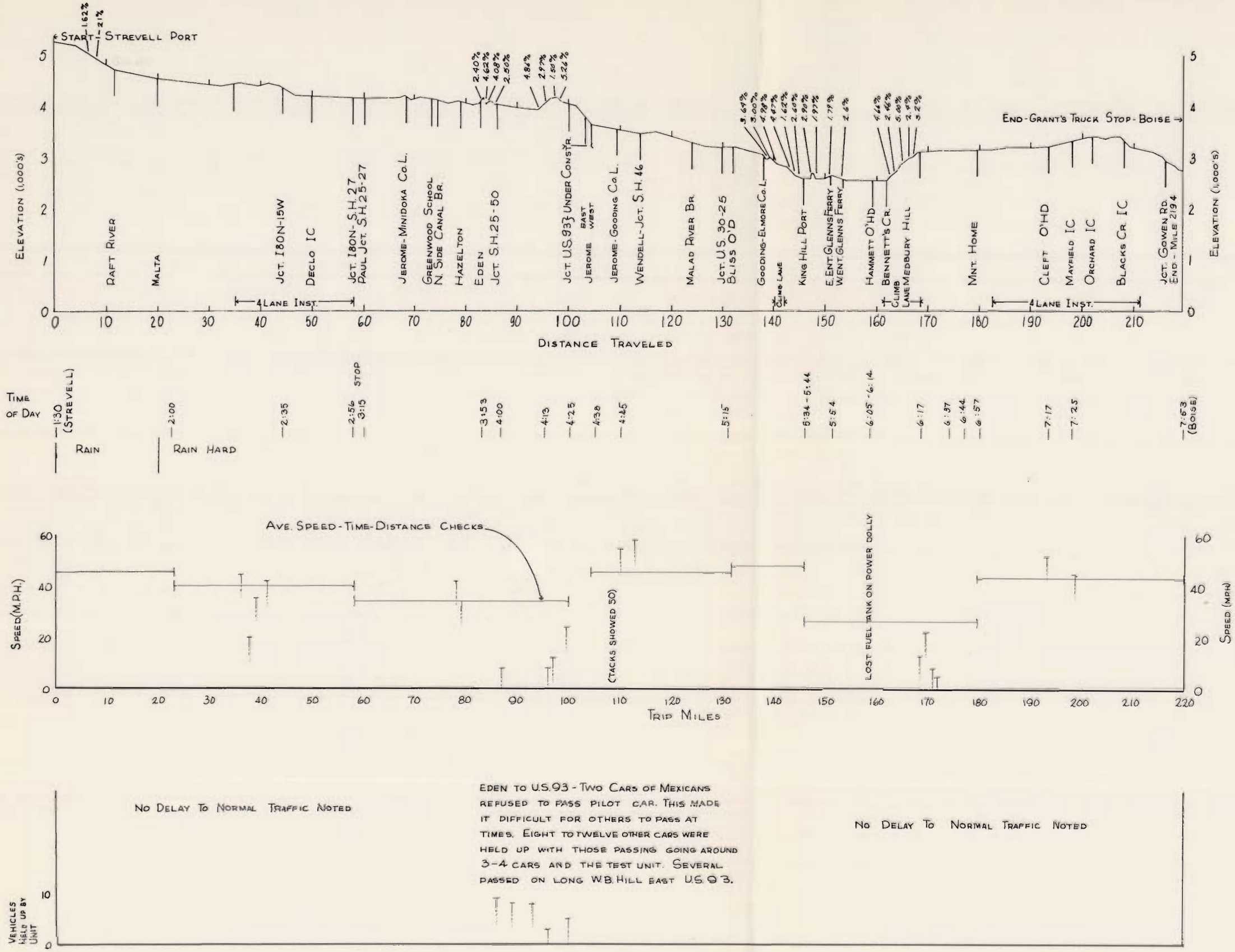


FIG. 29—TRIP Nº 2, JUNE 9, 1964
STREVELL - BOISE
BOISE-CAS. - 3S2-4 LB/BHP. 774

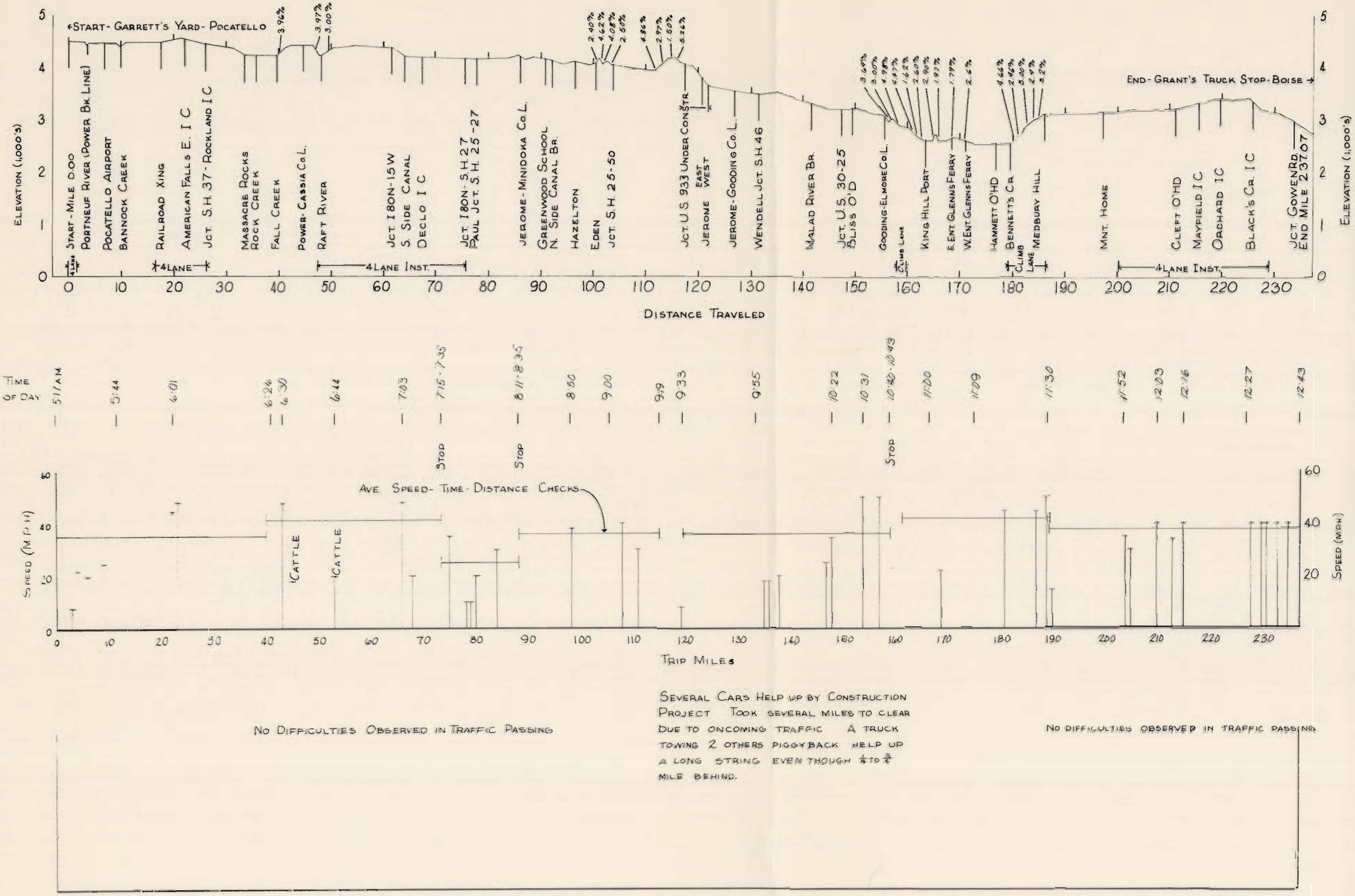
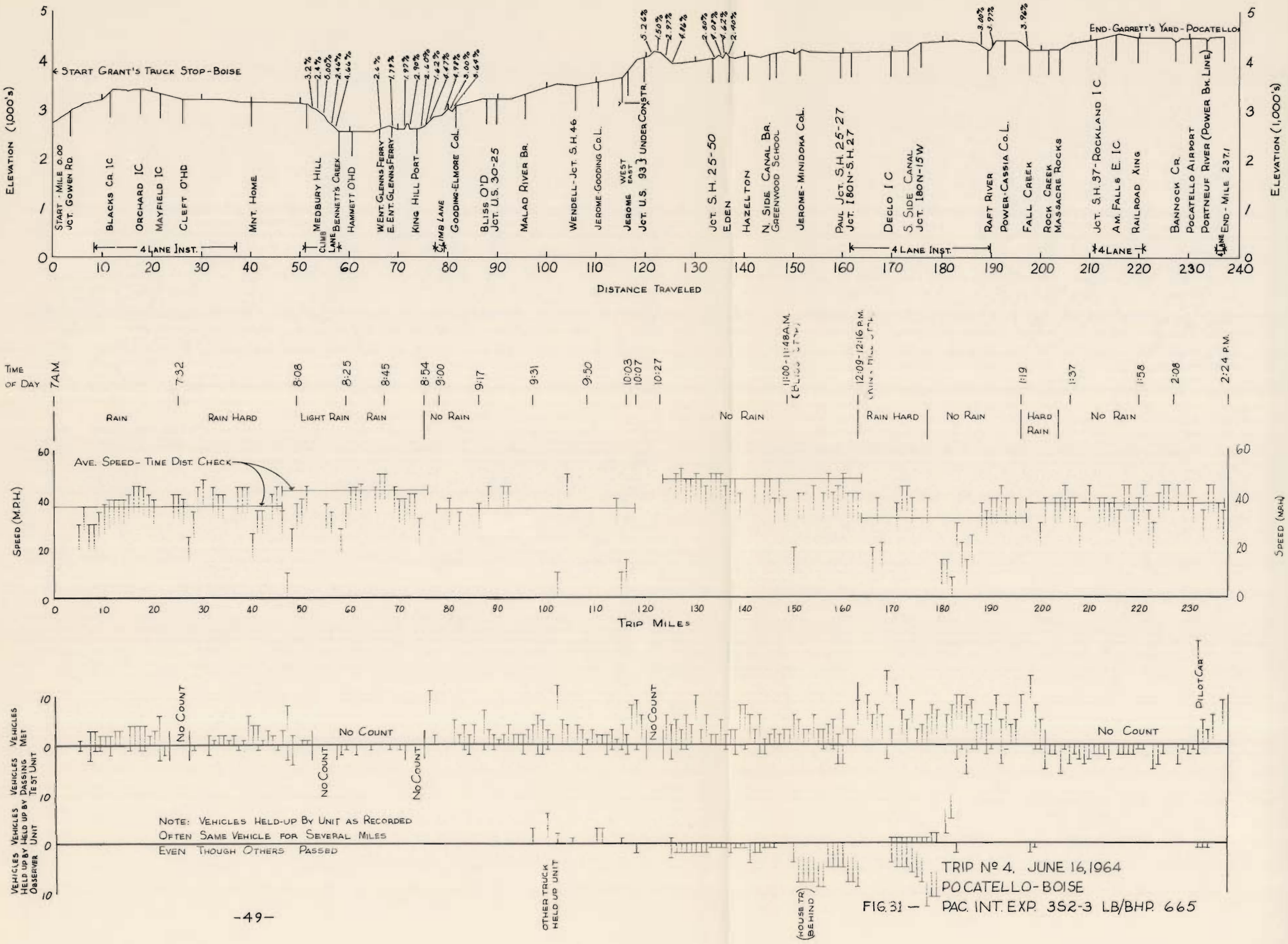


FIG. 30 — TRIP Nº 3 JUNE 15, 1964
BOISE-POCATELLO
PAC. INT. EXP. - 3S2-3 LB/BHP 670



Trip No. 4, June 16, 1964
Pocatello - Boise
Fig. 31 — Pac. Int. Exp. 3S2-3 LB/BHP 665

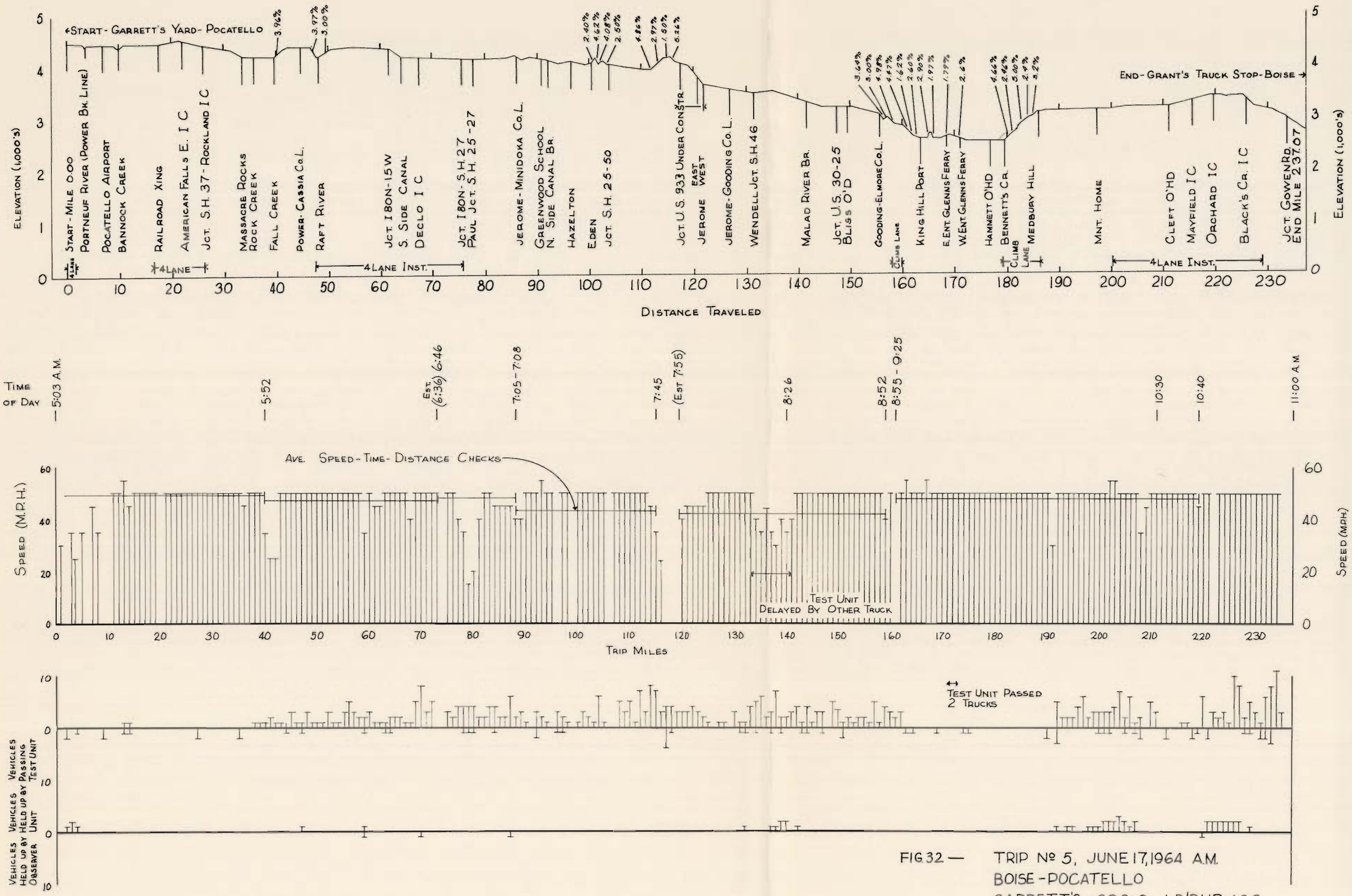


FIG. 32 — TRIP Nº 5, JUNE 17, 1964 A.M.
BOISE - POCATELLO
GARRETT'S - 3S2-3 LB/BHP. 432

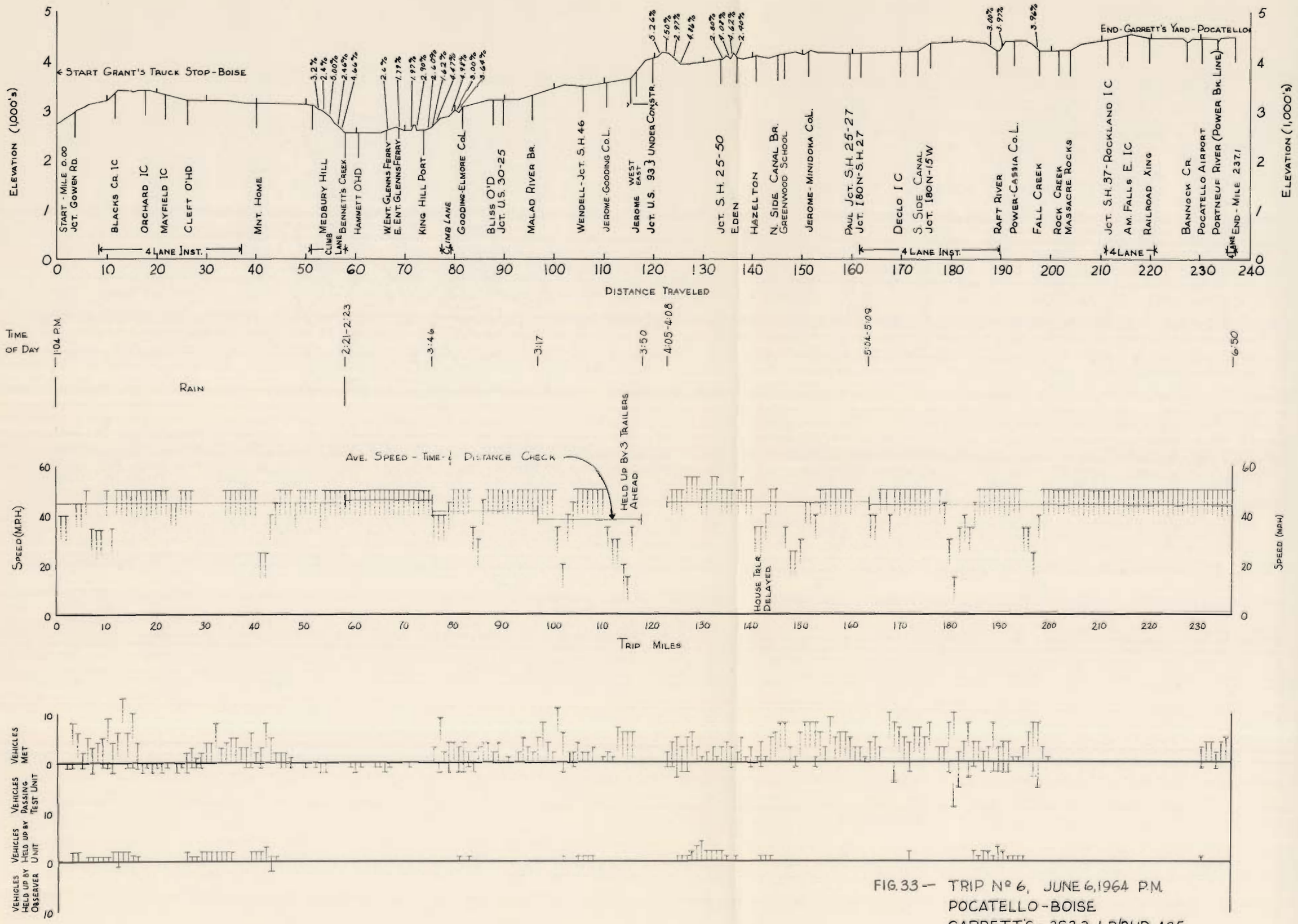


FIG. 33 — TRIP Nº 6, JUNE 6, 1964 P.M.
POCATELLO - BOISE
GARRETT'S - 3S2-3 LB/BHP. 435

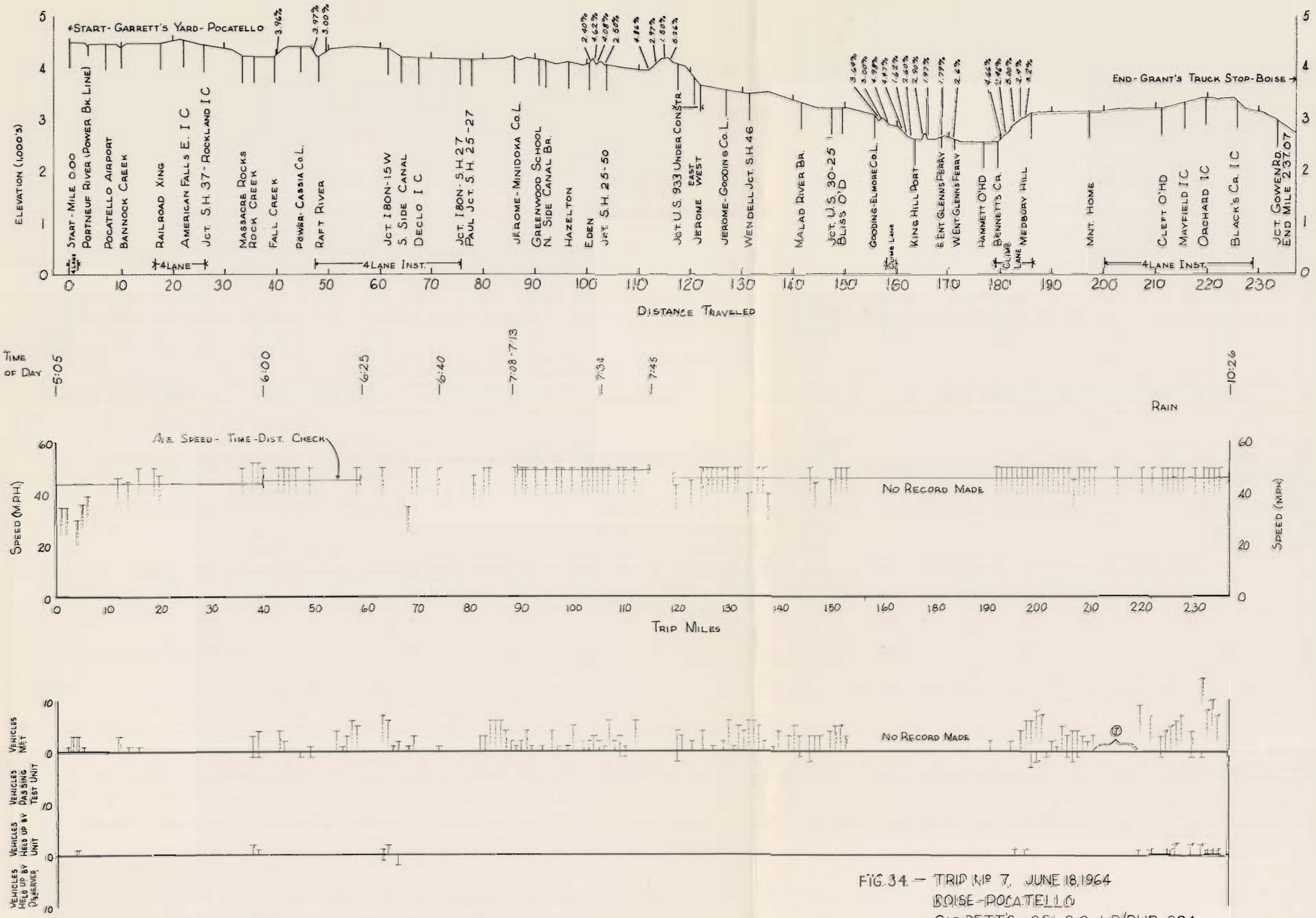
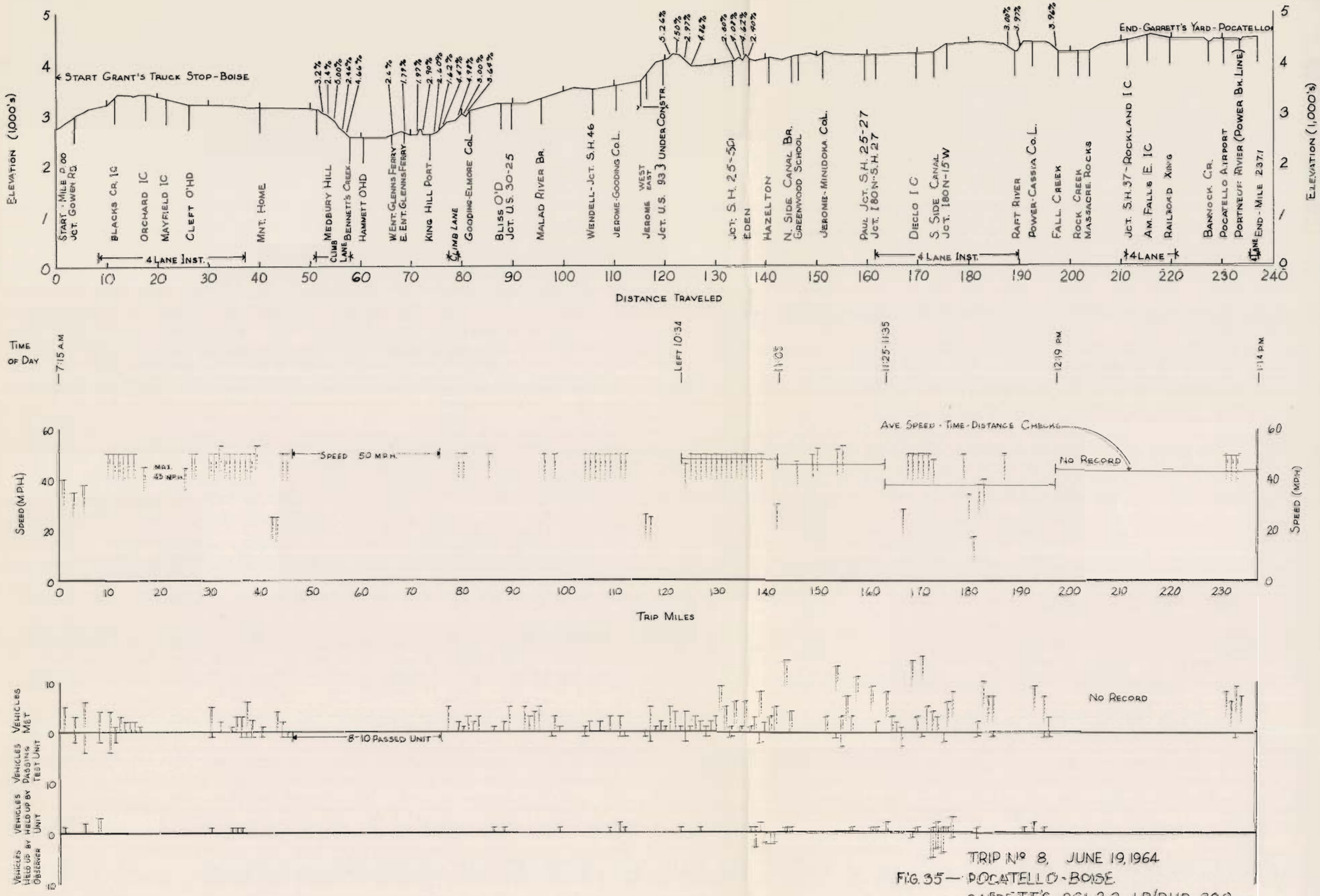


FIG. 34. — TRIP Nº 7, JUNE 18, 1964
BOISE - POCATELLO
GARRETT'S - 2S11-2-2 LB/BHP. 394



TRIP Nº 8, JUNE 19, 1964

FIG. 35 — POCATELLO - BOISE

GARRETT'S - 2S1-2-2 LB/BHP 392

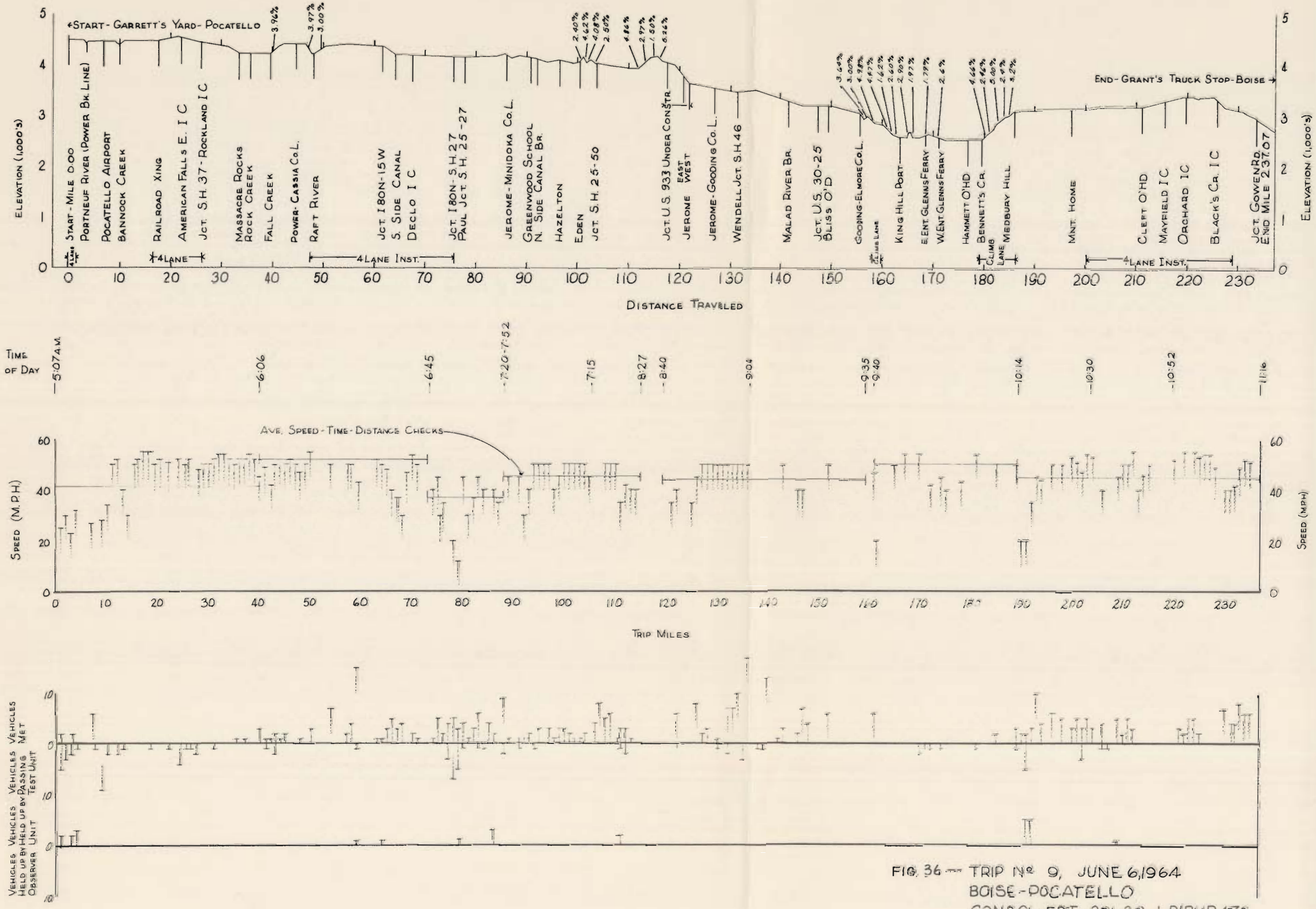


FIG. 36 — TRIP Nº 9, JUNE 6, 1964
BOISE - POCATELLO
CONSOL-FRT-291-22 LB/BHP 478

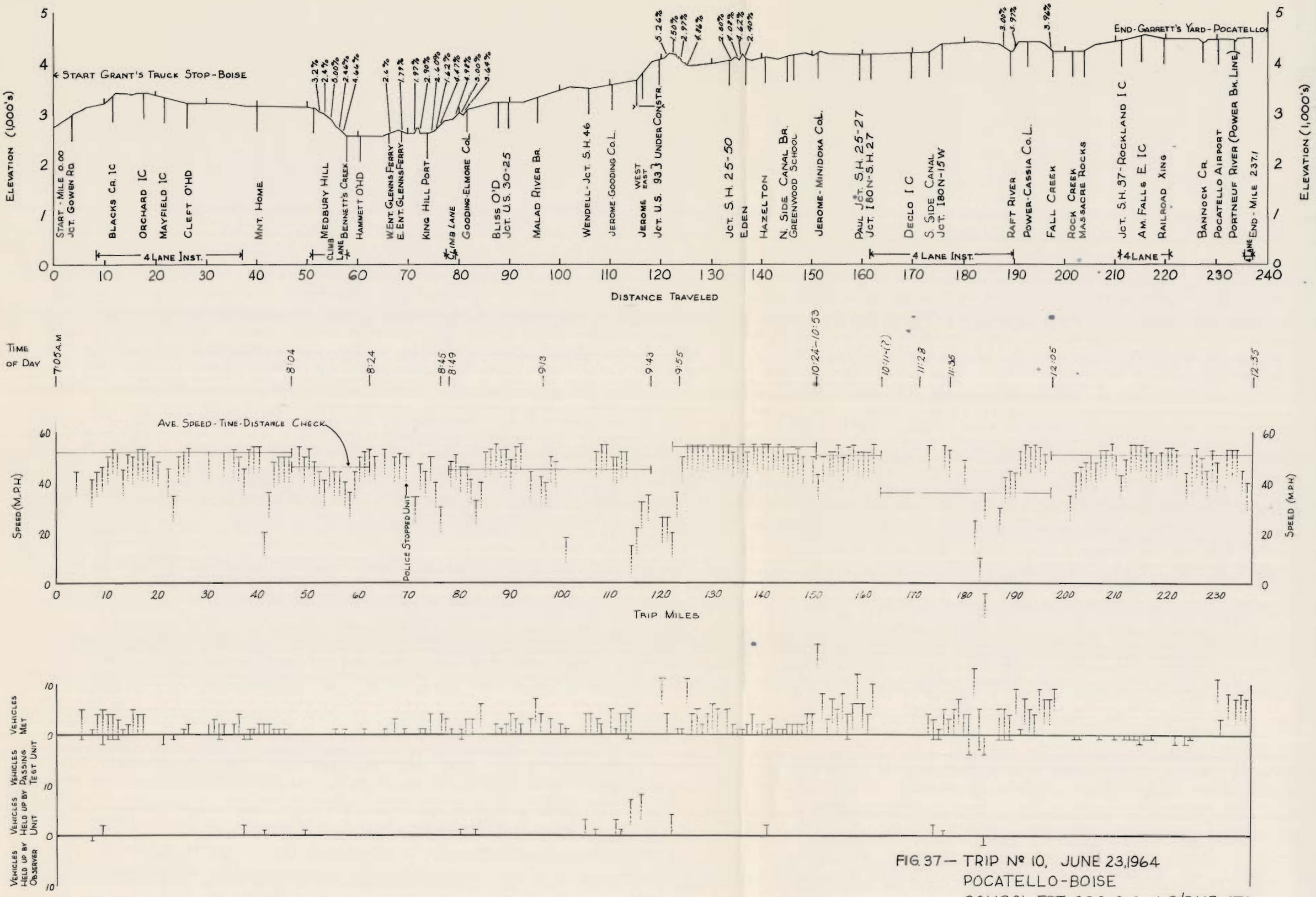


FIG. 37 — TRIP Nº 10, JUNE 23, 1964
POCATELLO-BOISE
CONSOL-FRT. 2S2-2-2 LB/BHP 470

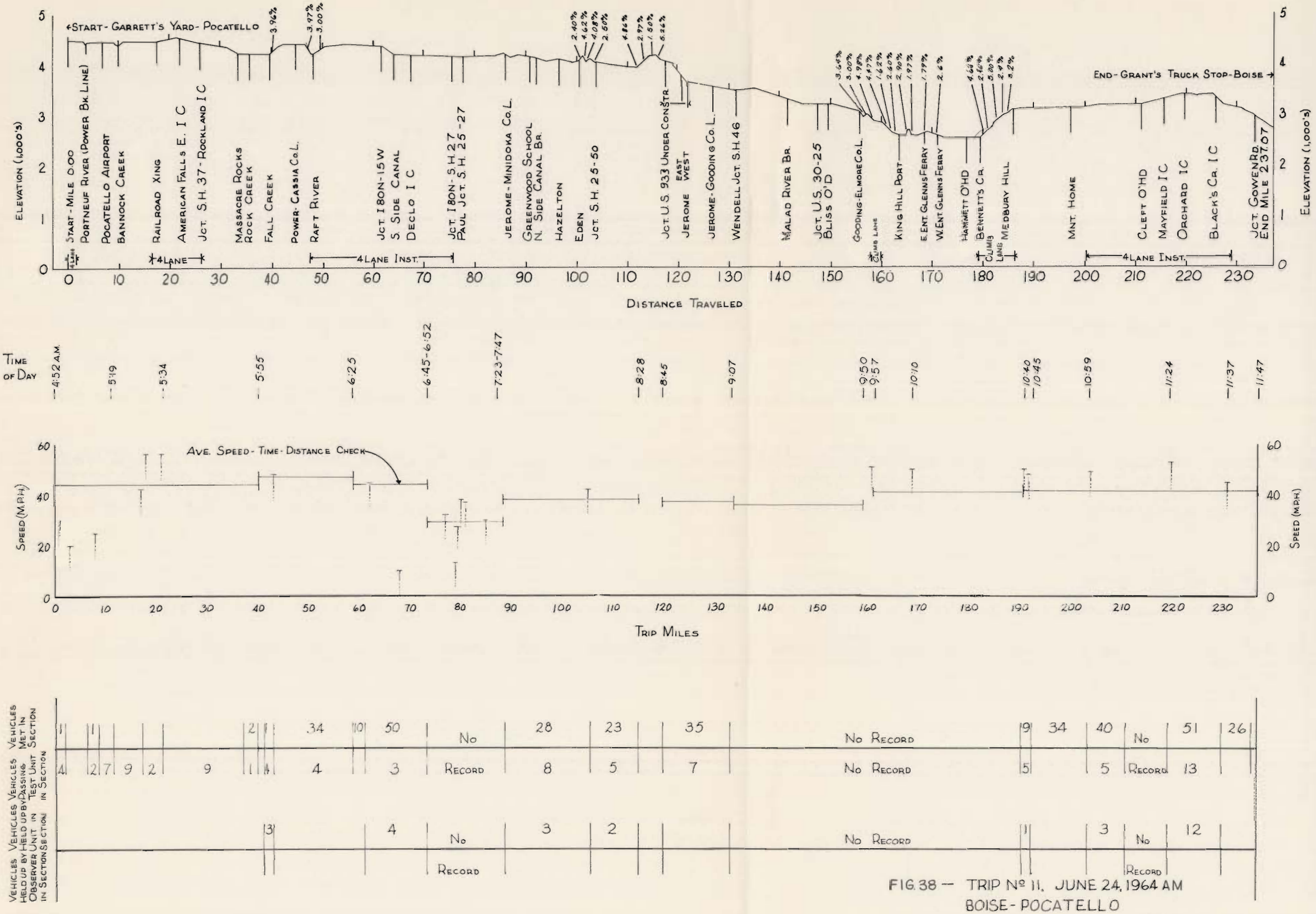


FIG. 38 — TRIP Nº 11, JUNE 24, 1964 AM
BOISE - POCATELLO
PAC. INT. EXP. - 2S1-2-2 LB/BHP 617