UMTRI-83-10-3

INFLUENCE OF SIZE AND WEIGHT VARIABLES ON THE STABILITY AND CONTROL PROPERTIES OF HEAVY TRUCKS

Final Report

Contract Number FH-11-9577

Volume III

Appendices

R.D. Ervin
R.L. Nisonger
C.C. MacAdam
P.S. Fancher

May 1983

Prepared for the Department of Transportation, Federal Highway Administration under Contract FH-11-9577. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Federal Highway Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/RD-83/031		

4. Title and Subtitle	5. Report Date
INFLUENCE OF SIZE AND WEIGHT VARIABLES ON THE STABILITY AND CONTROL PROPERTIES OF HEAVY TRUCKS	May 1983
	6. Performing Organization Code
7. Author(s) R.D. Ervin, R.L. Nisonger, C.C. MacAdam, P.S. Fancher	8. Performing Organization Report No. UMTRI-83-10/3
9. Performing Organization Name and Address Transportation Research Institute The University of Michigan 2901 Baxter Road Ann Arbor, Michigan 48109	10. Work Unit No. 31U4 044 11. Contract or Grant No. FH-11-9577
12. Sponsoring Agency Name and Address Federal Highway Administration U.S. Department of Transportation Washington, D.C. 20590	13. Type of Report and Period Covered Final 4/5/79-5/18/83 14. Sponsoring Agency Code

15. Supplementary Notes

Contract Manager - Dr. R. Hegmon (HNR-20)

16. Abstract

This study has determined the influence of variations in truck size and weight constraints on the stability and control properties of heavy vehicles. The size and weight constraints of interest include axle load, gross vehicle weight, length, width, type of multiple-trailer combinations, and bridge formula allowances. Variations in location of the center of gravity of the payload were also considered as a separate subject. The influence of these parametric variations on stability and control behavior was explored by means of both full-scale vehicle tests and computer simulations.

In Volume I, the findings of the study were presented in a manner which is intended to inform the non-technical reader and, specifically, the persons concerned with formulating policies and laws regarding truck size and weight.

Volume II presents the methodology and summary results from the full-scale test program. The test findings relating size and weight variables to vehicle dynamic behavior are compared with those derived from simulation results. Volume II also presents the results of a special set of experimental measurements showing the dynamic loads which heavy trucks impose on the pavement. Volume III contains appendices of test and simulation data.

17. Key Words	18. Distribution Statement
size and weight, heavy trucks, stability and control, traffic safety, pavement loading, dynamic wheel load tests, simulation	UNLIMITED

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
NONE	NONE	232	

TABLE OF CONTENTS

Introduction

This document constitutes a volume of data obtained in support of the major report entitled "The Influence of Size and Weight Variables on the Stability and Control Properties of Heavy Trucks." The project involved both computerized simulations and full-scale test methods for studying how changes in truck dimensions and loading influenced the properties which determine vehicle response to steering and braking. This volume of the report presents plots of simulation results which are arranged according to the types of analyses which were conducted. Within each set of simulations, various vehicles are represented and each is considered with varying values of size and weight variables.

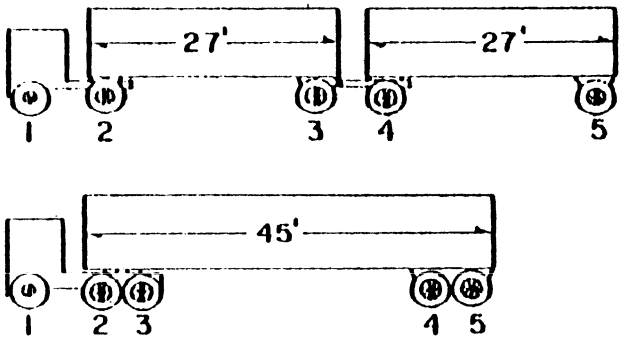
The test results are presented in groups corresponding to individual test vehicle configurations. For each configuration, various plots are presented showing braking, cornering, roll stability, and rearward amplification information measured under differing size and weight conditions.

In general, single measures of performance were employed for summarizing the influence of size and weight variables in the reporting of study findings in Volumes I and II. The measures in question were derived from plots illustrated in this volume.

Results of Simplified Braking Calculations

The following plots present the normalized longitudinal force, F_x/F_z, at each axle of the vehicle during steady braking, as well as longitudinal deceleration, in g's, versus the brake input pressure at the treadle valve. Each plot shows individual curves for each of the vehicle's axles, numbered according to axle position, from front to rear. For a given value of line pressure, the value of F_x/F_z on a given curve represents the brake force at that axle (given the proportioning scheme) and the total vertical load on the axle (given the load transfer mechanisms and the pertinent height and length parameters of the vehicle). The measures of F_x/F_z for a given value of applied pressure can be interpreted as reflecting the level of tire/road friction at which the axle in question would achieve lockup. Thus, the axle curve which is the "highest" on a given plot identifies the limiting axle, from a lock-up point of view. For any combinations of tire/road friction and applied brake pressure falling below this "highest" curve, the vehicle's braking performance would be said to be "lockup limited."

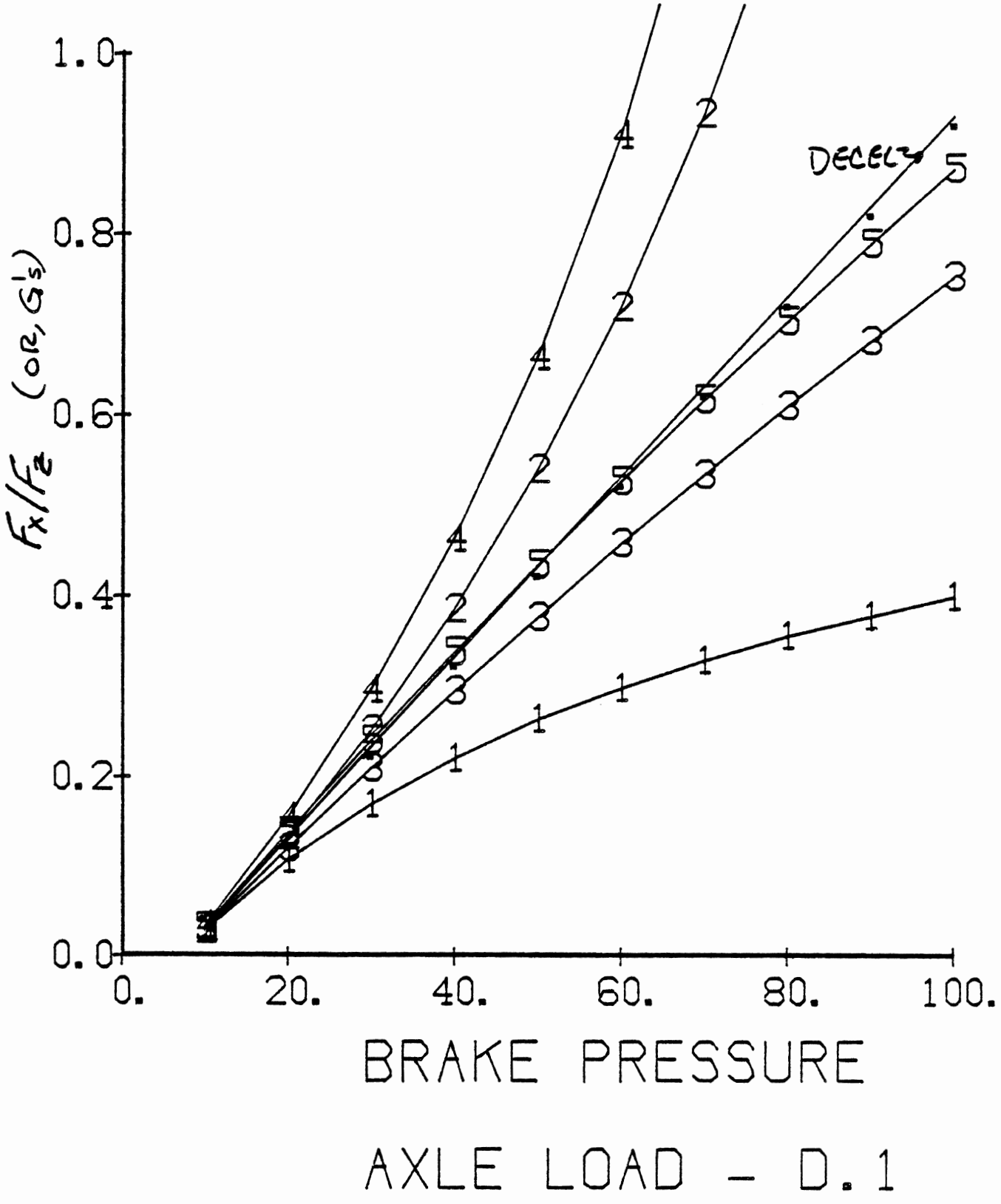
Although approximately 100 such plots were produced to examine the various size and weight cases in this study, only the plots representing the sensitivities of the five-axle tractor-semitrailer and five-axle double to variations in axle loading are included in this appendix. These plots provide example illustrations of the manner in which the braking performance analyses were finally established.

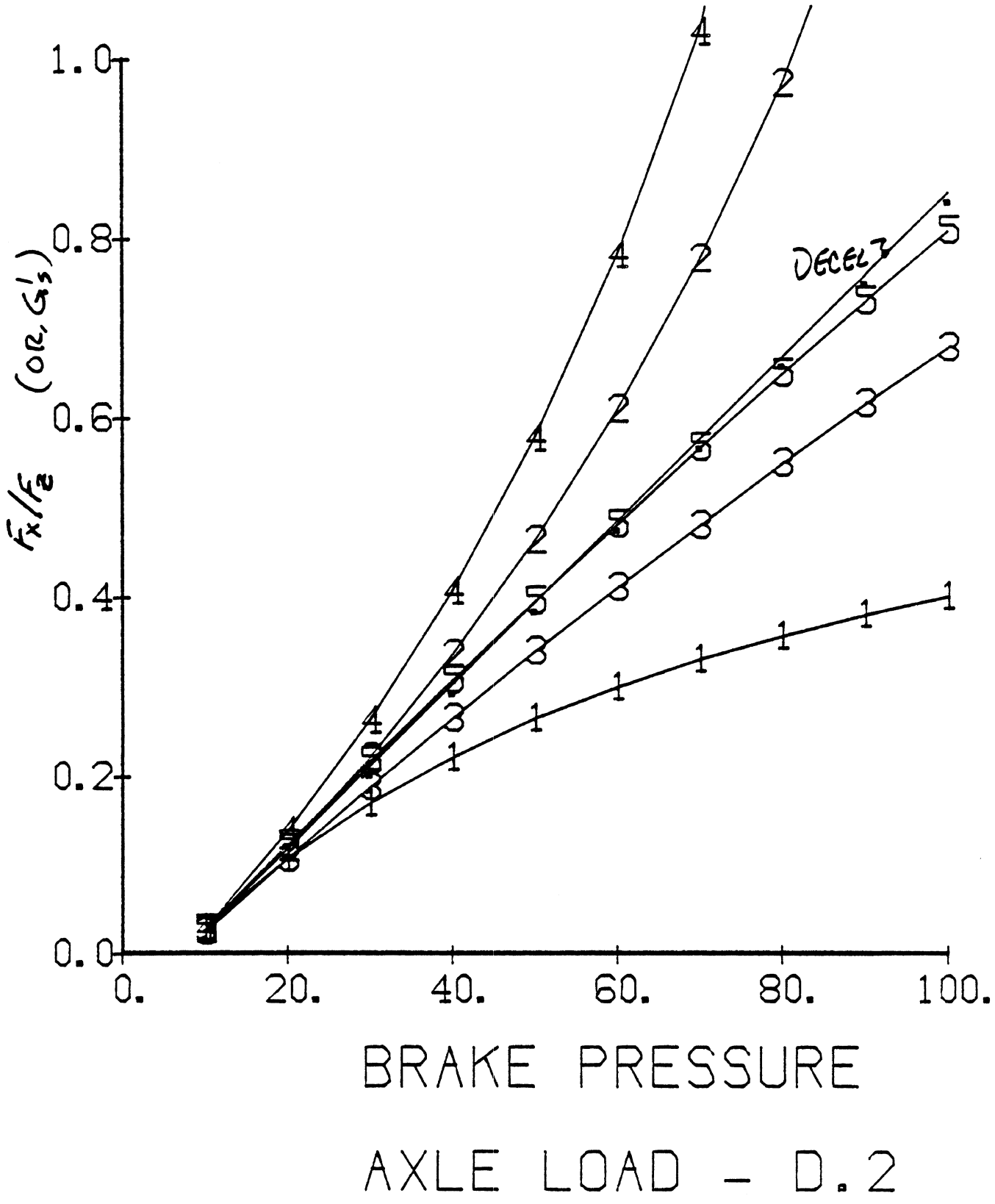


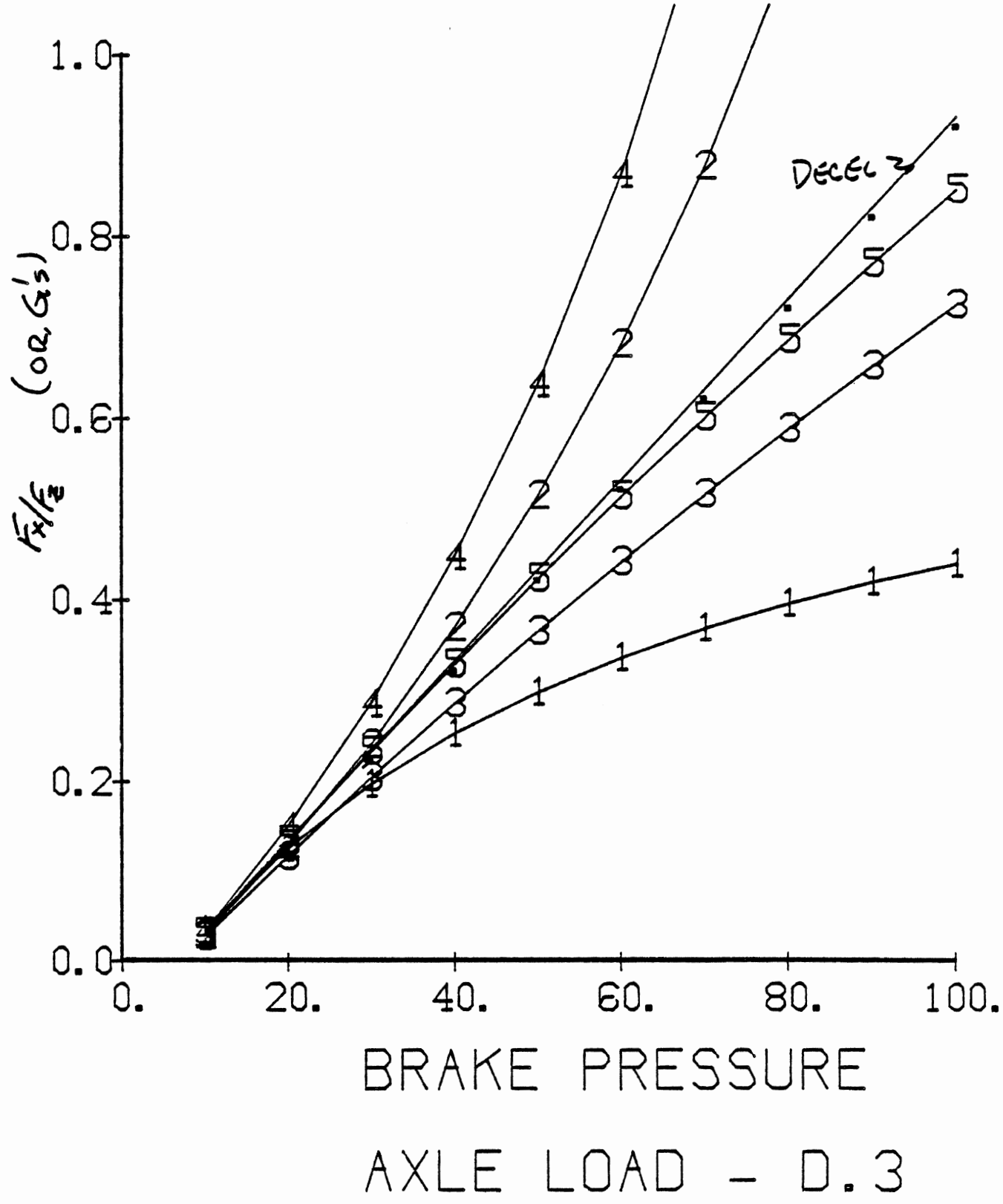
Axle Loads/1000 lb

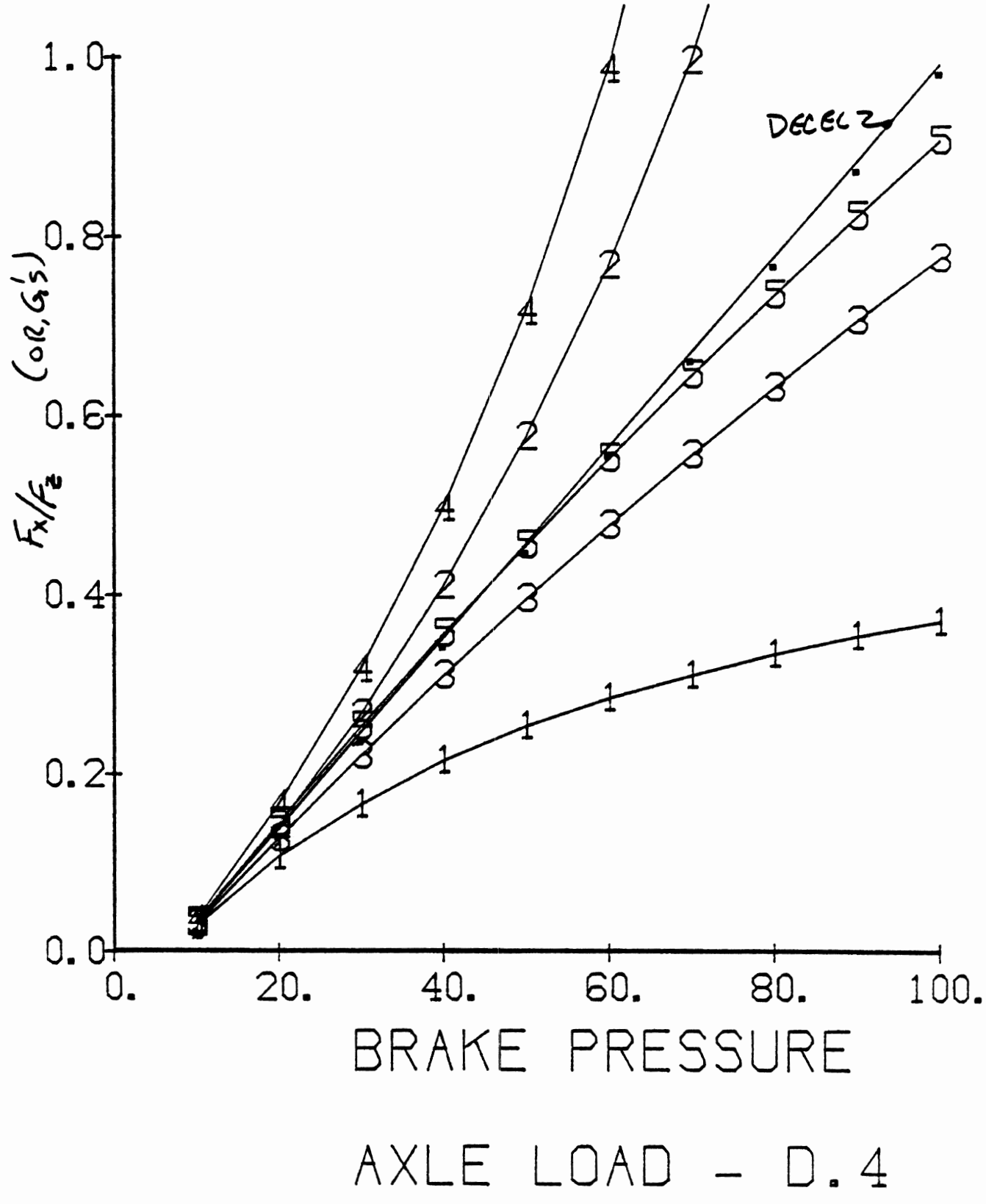
		Axle Number →	1	2	3	4	5
F	1	(Baseline)	10	17.5	17.5	17.5	17.5
	2		10	20	15	20	15
	3		10	15	15	20	20
	4		10	15	20	15	20
	5		10	15	22	15	22
D	1	(Baseline)	12	17	17	17	17
	2		12	19	19	19	19
	3		10	17.5	17.5	17.5	17.5
	4		9.3	16	16	16	16
	5		10	20	20	19	19

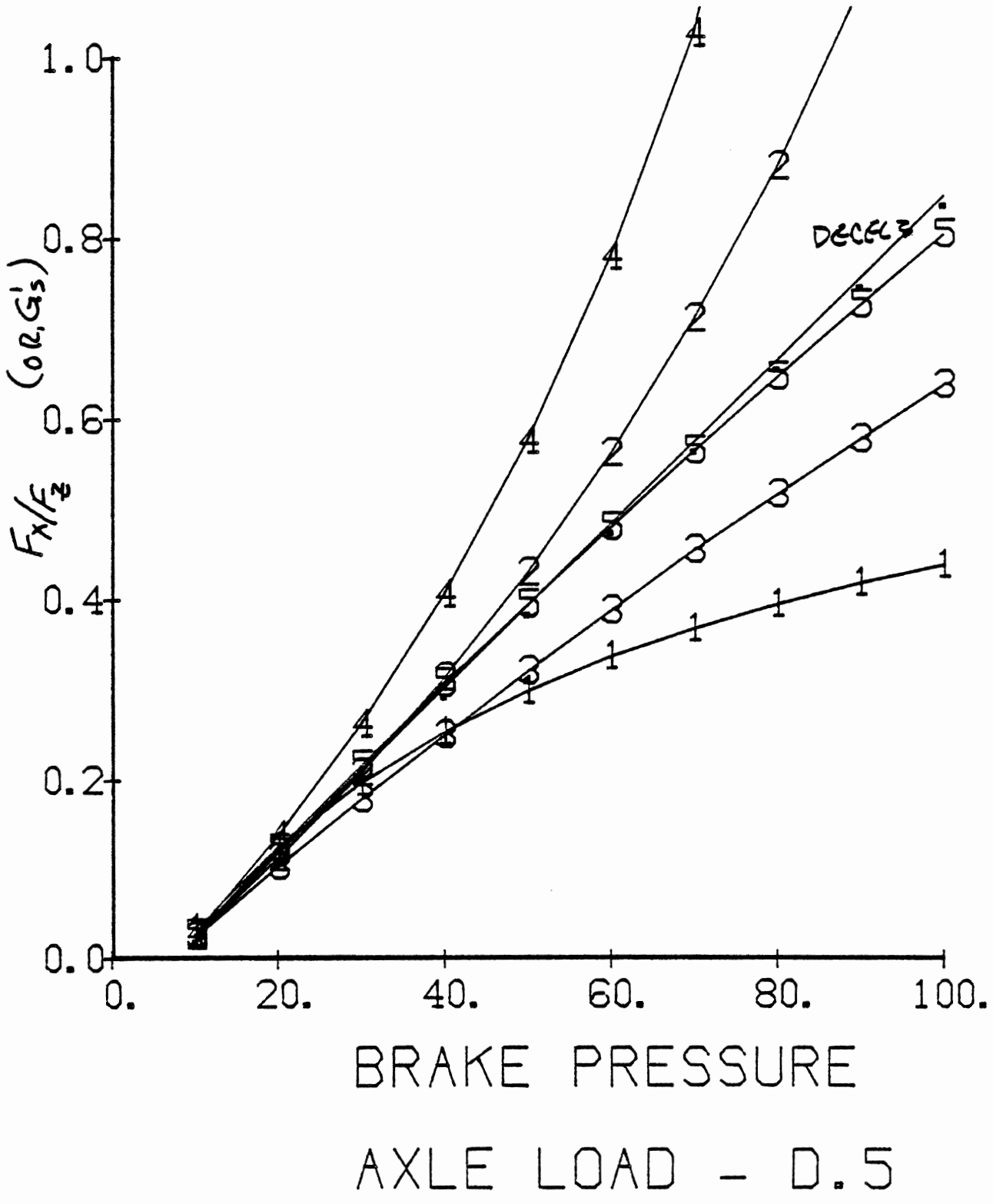
Loading Cases Covered in the Following Plots of Straight-Line Braking

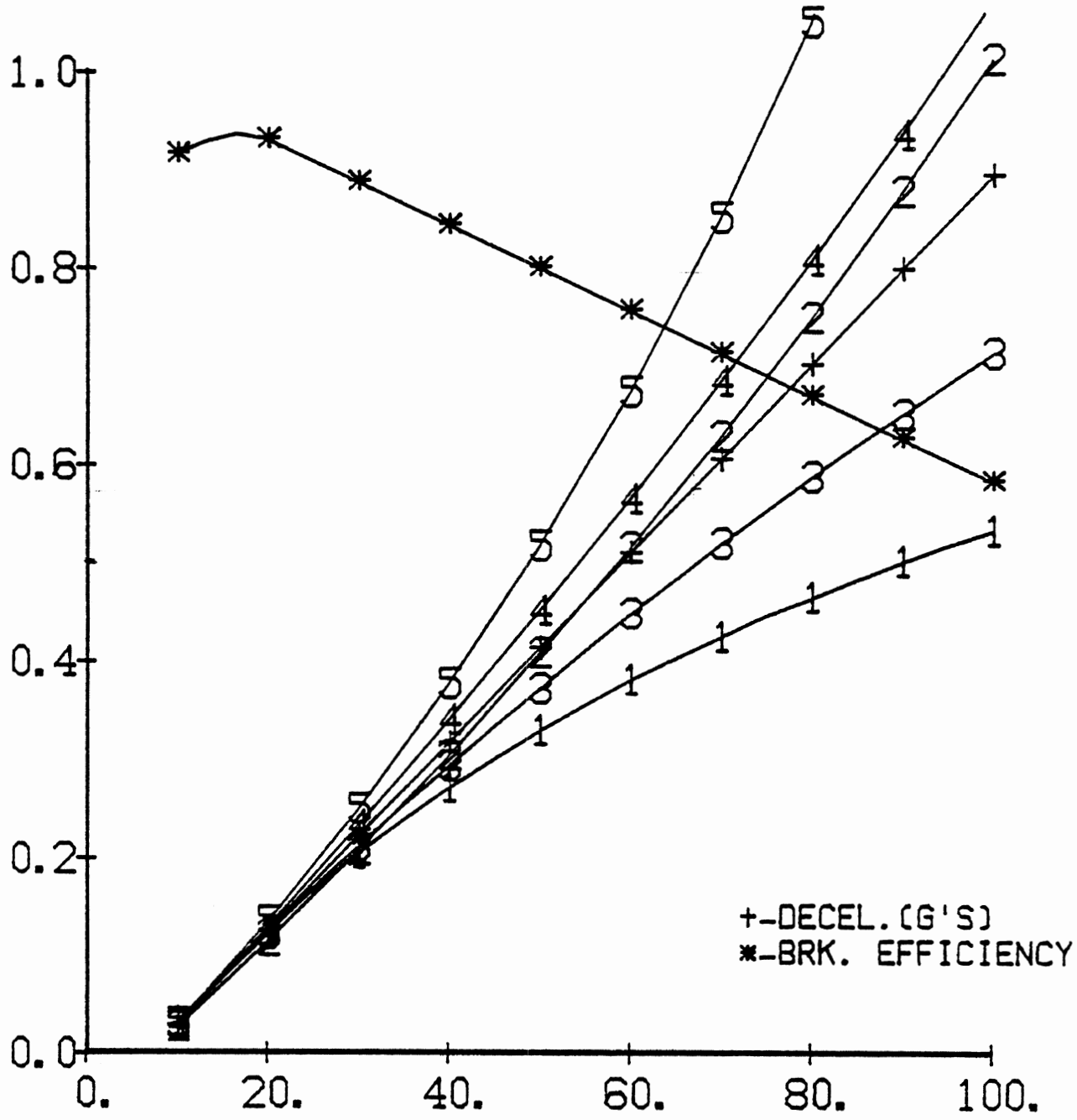

1.0
0.8
0.6
0.4
0.2
0.0
F_x/F_z (OR, G's)
DECEL
0.
20.
40.
60.
80.
100.
BRAKE PRESSURE
AXLE LOAD - D.1


1.0
0.8
0.6
0.4
0.2
0.0
Fx/Fz (OR, Gs)
DECEL?
0.
20.
40.
60.
80.
100.
BRAKE PRESSURE
AXLE LOAD - D.2

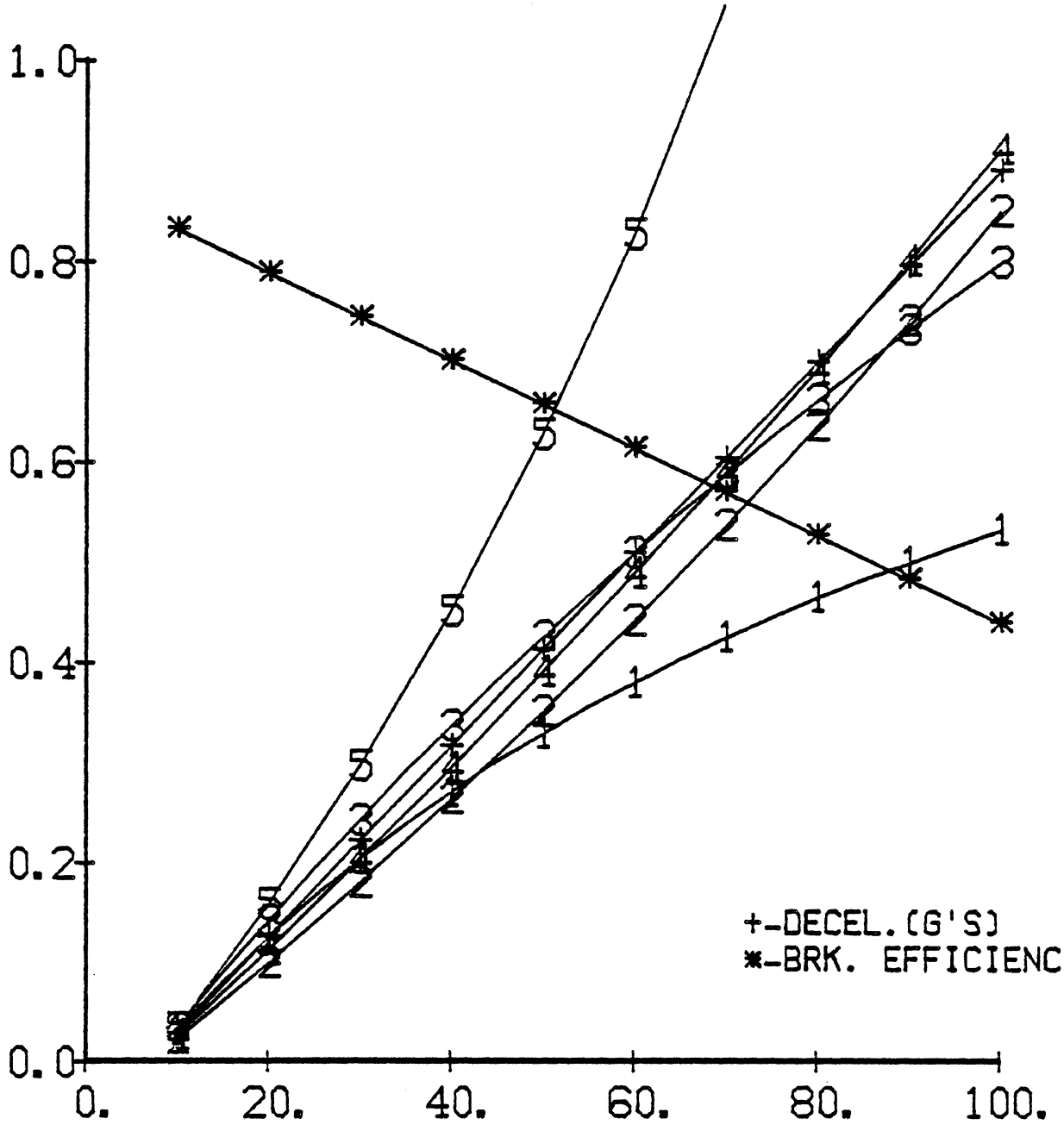

1.0
0.8
0.6
0.4
0.2
0.0
0.
20.
40.
60.
80.
100.
Fx/Fz (or Gs)
Decel
BRAKE PRESSURE
AXLE LOAD - D.3


1.0
0.8
0.6
0.4
0.2
0.0
F_x/F_z (or, G's)
DECEL
0.
20.
40.
60.
80.
100.
BRAKE PRESSURE
AXLE LOAD - D.4


1.0
0.8
0.6
0.4
0.2
0.0
F_x/F_z (OR, Gs)
DECEL
0.
20.
40.
60.
80.
100.
BRAKE PRESSURE
AXLE LOAD - 0.5

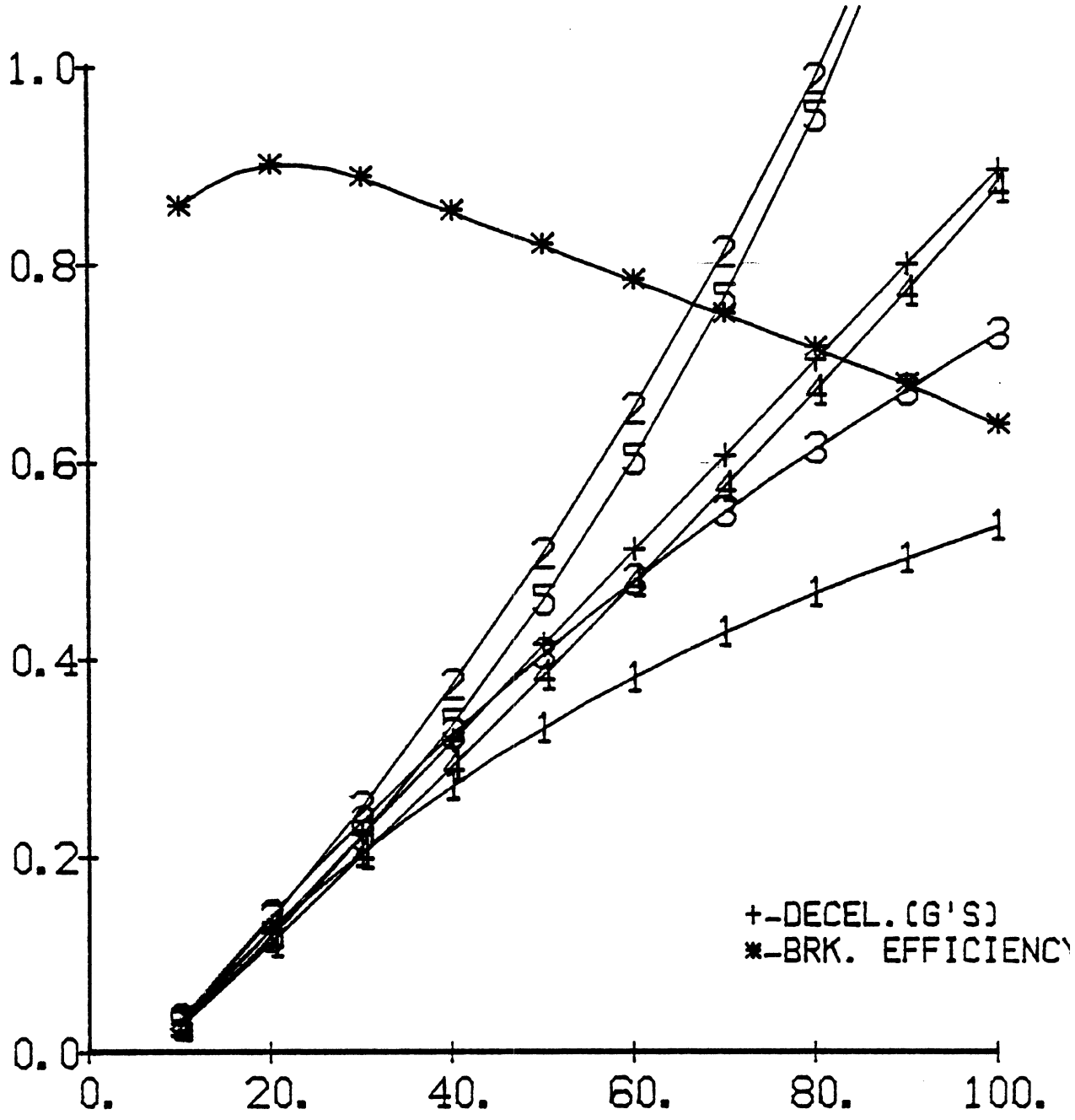


SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 1
STRAIGHT LINE BRAKING

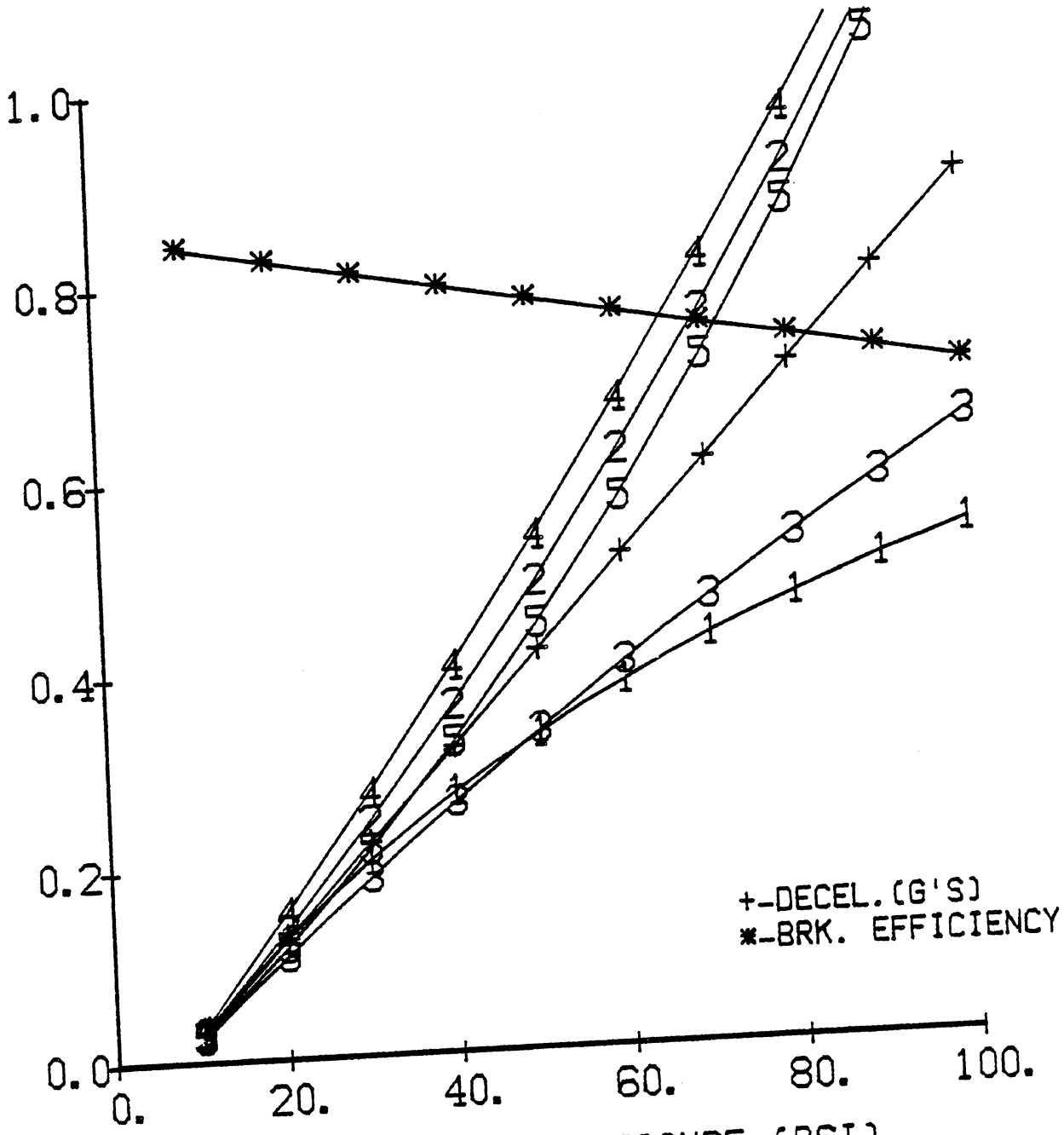


APPLIED PRESSURE (PSI)

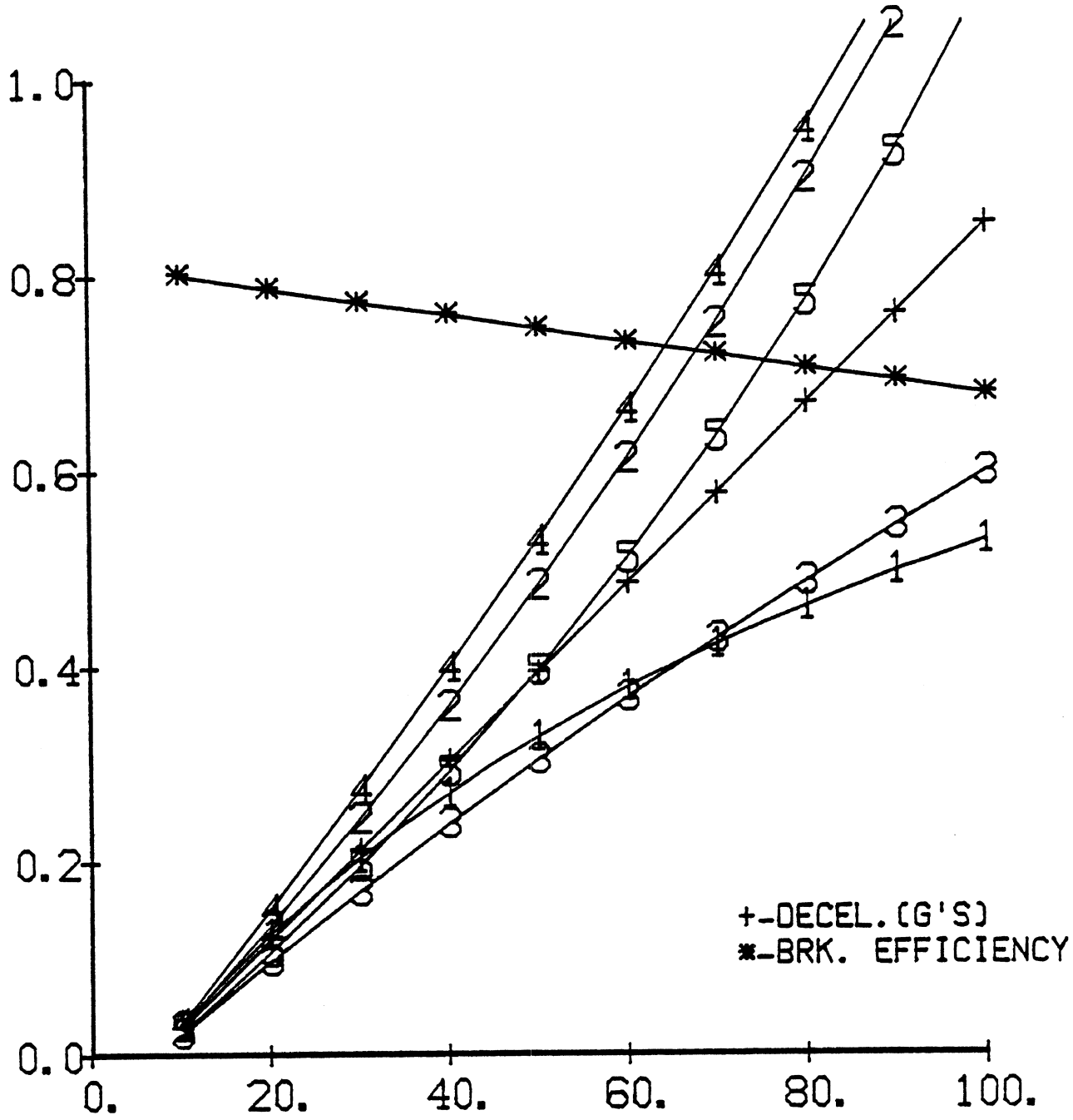
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 2
STRAIGHT LINE BRAKING



SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 3
STRAIGHT LINE BRAKING



SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 4
STRAIGHT LINE BRAKING



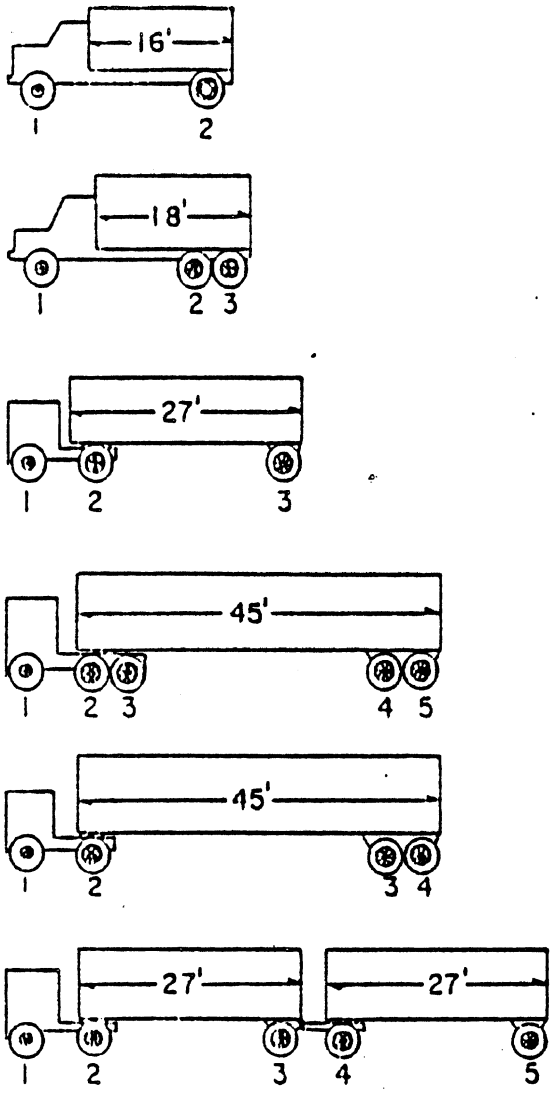
SINGLE AXLE DOUBLES
AXLE LOAD VARIATION - CASE 5
STRAIGHT LINE BRAKING

Handling Diagrams - Axle Load Variations

Maneuver: Ramp steer - 0.5 deg/sec steering-wheel angle

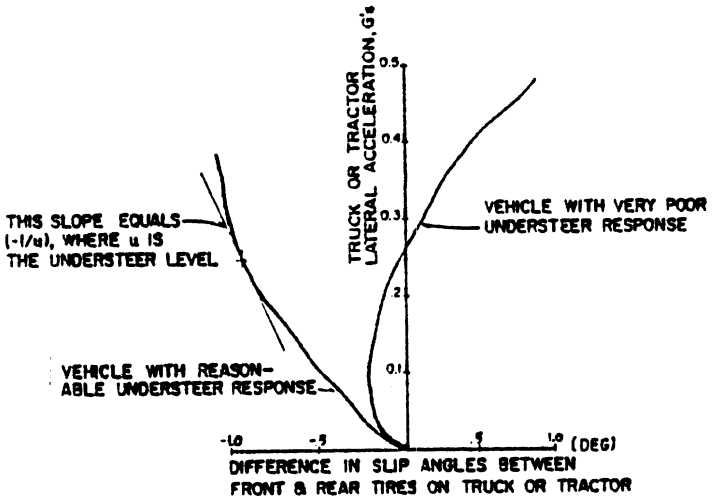
Speed: 55 mph (88 km/h)

Loading and Vehicles:



Case	Axle Number →	Axle Loads/1000 lb 1	2	3	4	5
1	(Baseline)	12	20			
2		12	22			
3		12	18			
4		12	24			
1	(Baseline)	12	34			
2		12	38			
3		12	32			
4		12	36			
1	(Baseline)	10.5	20	20		
2		10.5	22	22		
3		10.5	18	18		
4		10.5	24	24		
1	(Baseline)	12	17	17	17	17
2		12	19	19	19	19
3		10	17.5	17.5	17.5	17.5
4		9.3	16	16	16	16
5		10	20	20	19	19
1	(Baseline)	10.5	20	17	17	
2		10.5	22	19	19	
3		10.5	18	19	19	
1	(Baseline)	10	17.5	17.5	17.5	17.5
2		10	20	15	20	15
3		10	15	15	20	20
4		10	15	20	15	20
5		10	15	22	15	22

Format for Handling Diagram Plots



Handling Diagram Showing the Understeer Measure

The handling diagram is a plot of the steady-state cornering behavior of the power unit (straight truck or tractor) of a vehicle combination. The plot readily illustrates the trend toward understeer (sloping up toward the left) or oversteer (sloping toward the right).

The lateral acceleration of the power unit is scaled along the vertical axis, while the horizontal axis is scaled according to the composite term

$$[L \cdot R/V - \frac{DSW}{NG}] \text{ (degrees)}$$

where

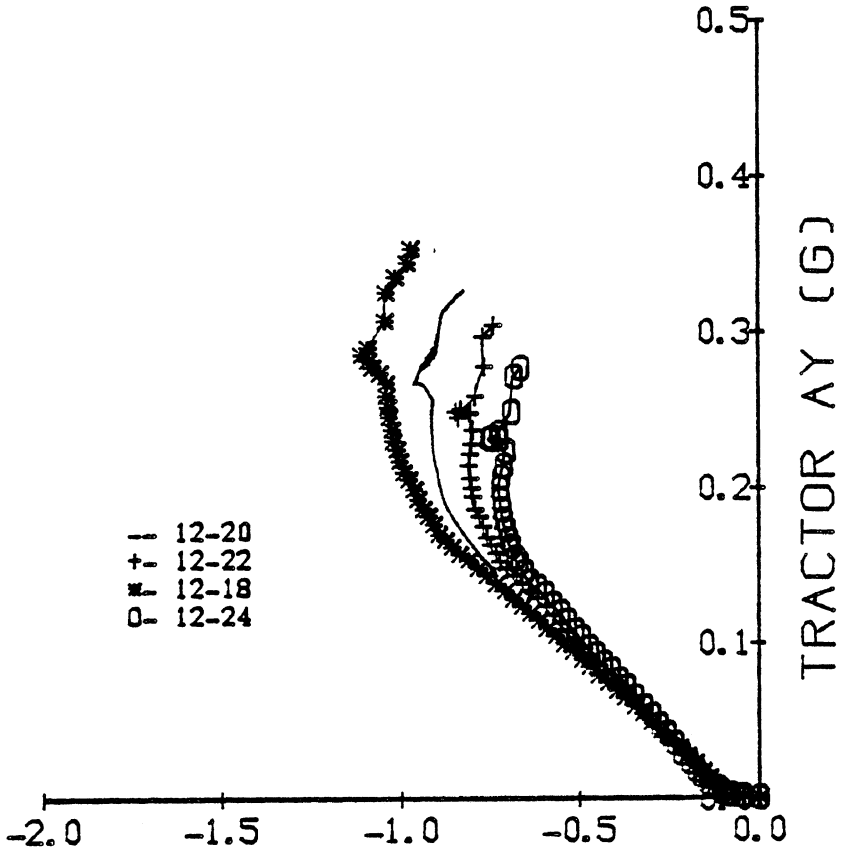
L = tractor (or truck) wheelbase

R = path radius

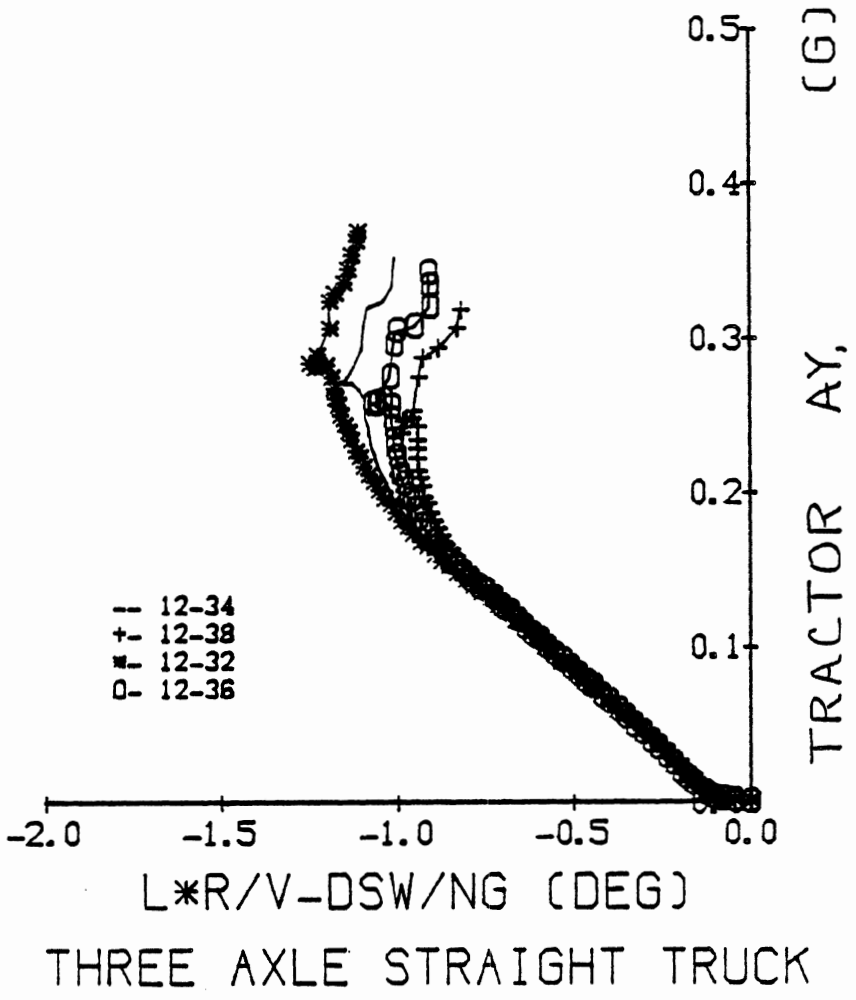
V = vehicle velocity

DSW = steering wheel angle

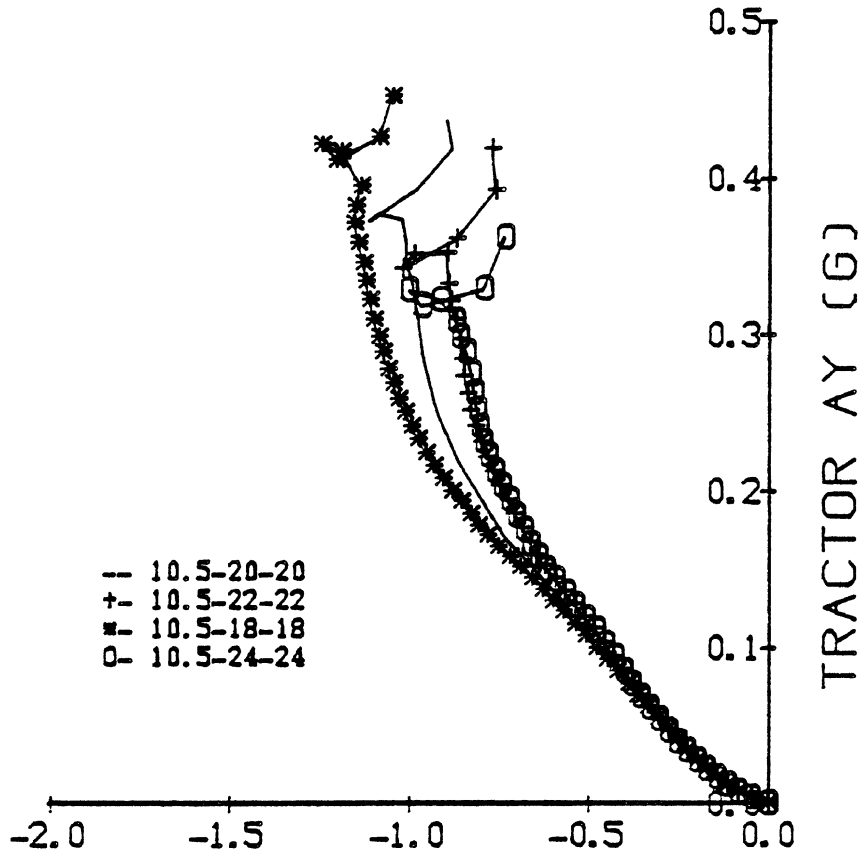
NG = effective steering ratio, steering wheel to front wheels



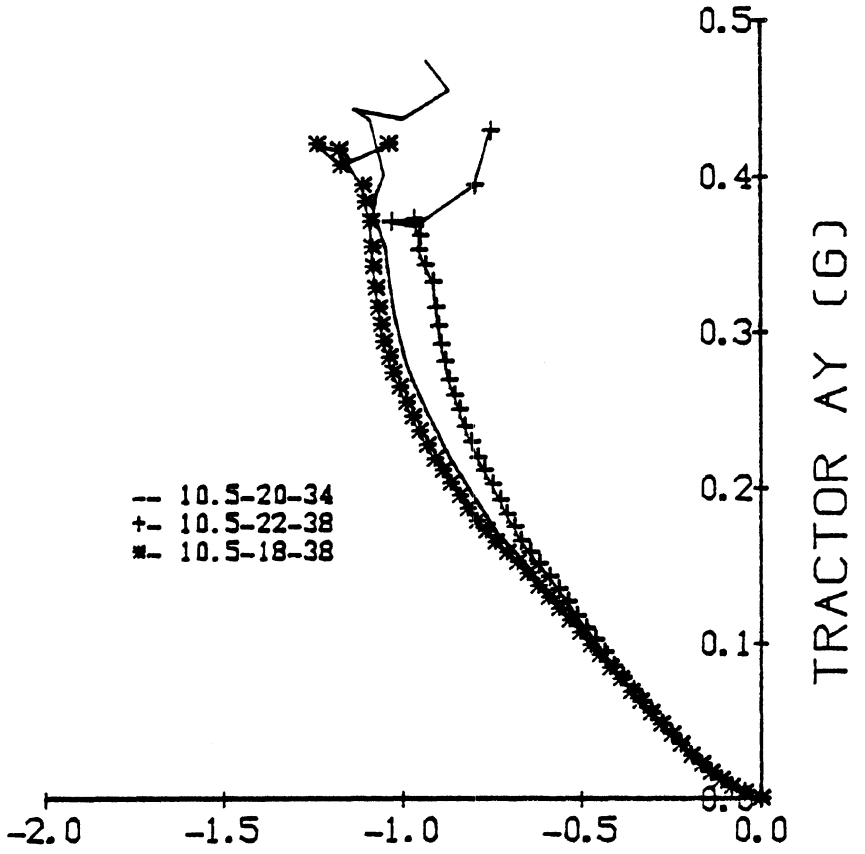
TWO AXLE STRAIGHT TRUCK

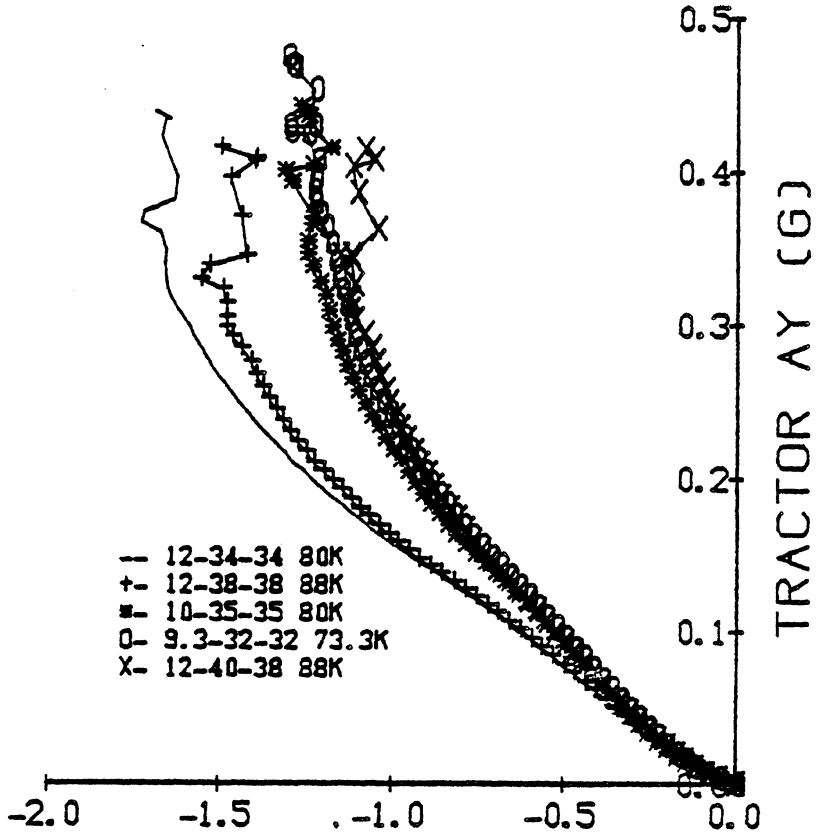


THREE AXLE STRAIGHT TRUCK

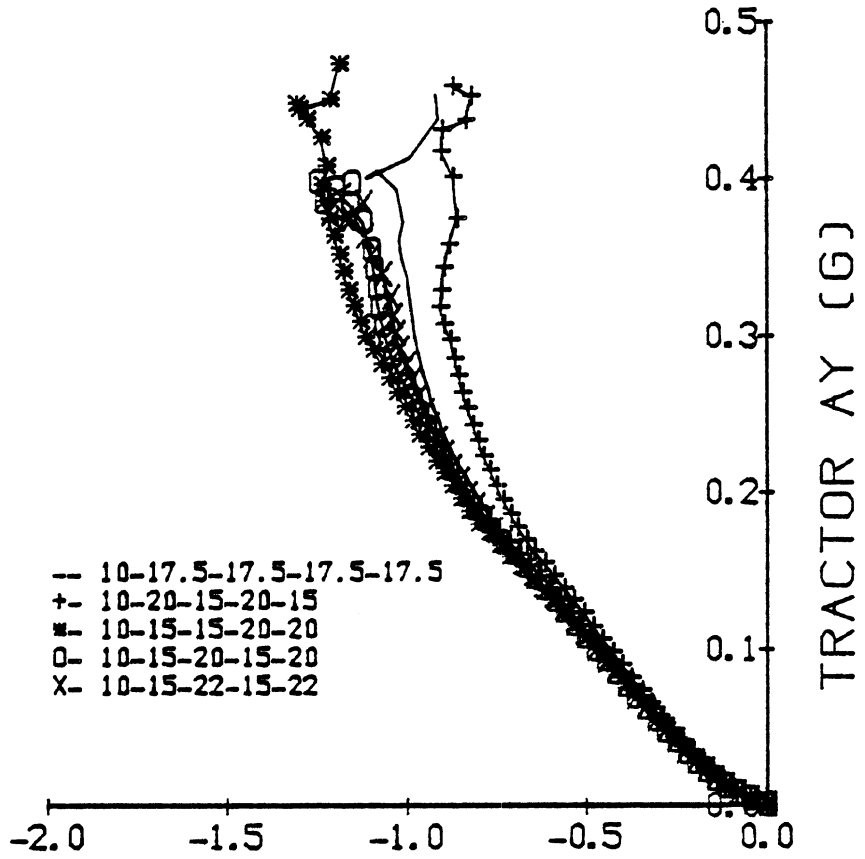


THREE AXLE TRACTOR-SEMI


0.5
0.4
0.3
0.2
0.1
0.0
TRACTOR AY (G)
-- 10.5-20-34
+- 10.5-22-38
*- 10.5-18-38
-2.0
-1.5
-1.0
-0.5
0.0
L*R/V-DSW/NG
FOUR AXLE TRACTOR-SEMI



FIVE AXLE TRACTOR-SEMI



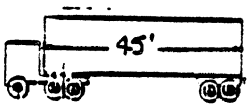
FIVE AXLE DOUBLE

Handling Diagrams - Gross Weight Variations

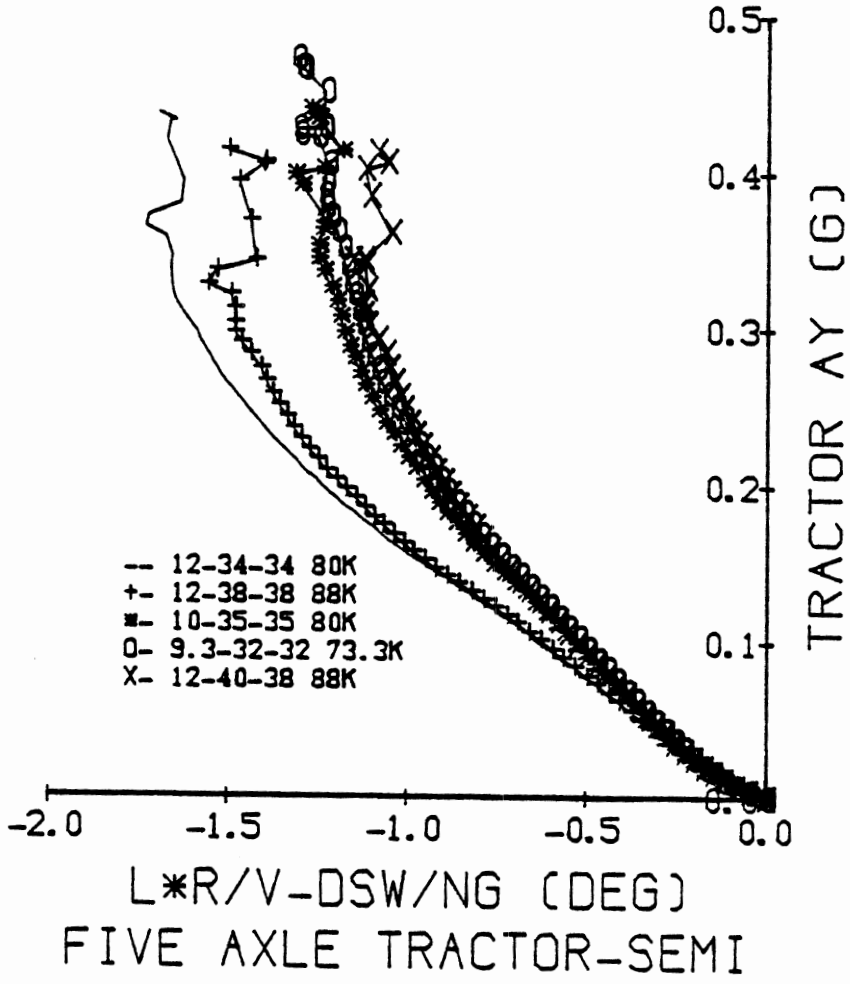
Maneuver: Ramp steer - 0.5 deg/sec steering-wheel angle

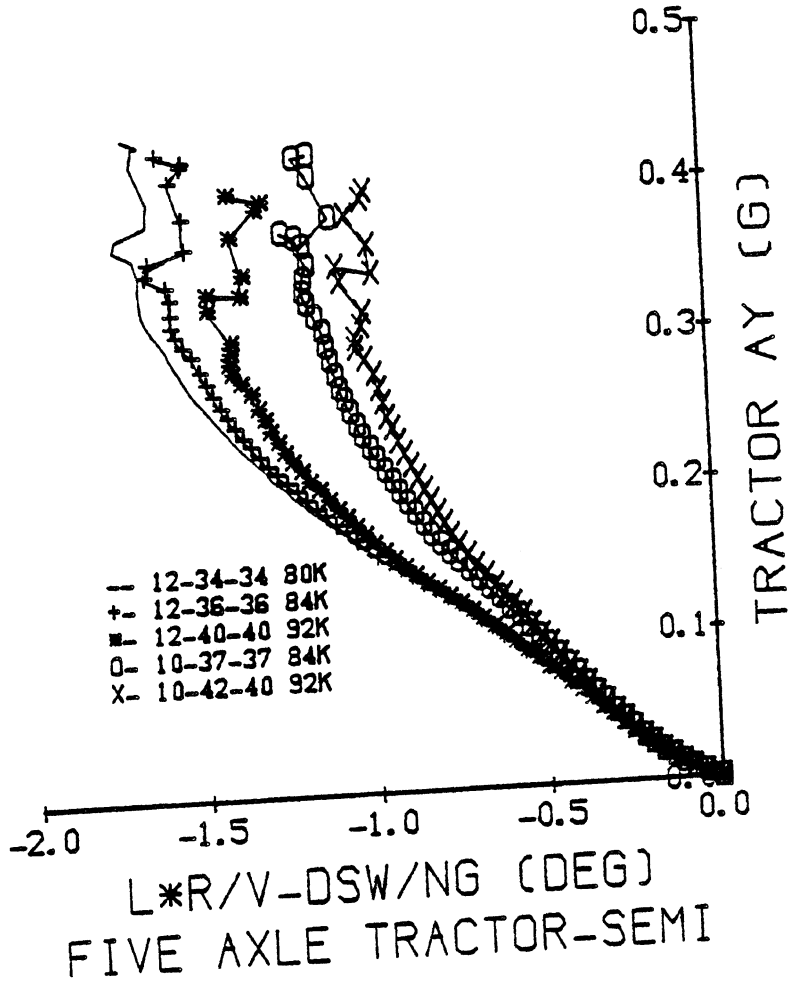
Speed: 55 mph (88 km/h)

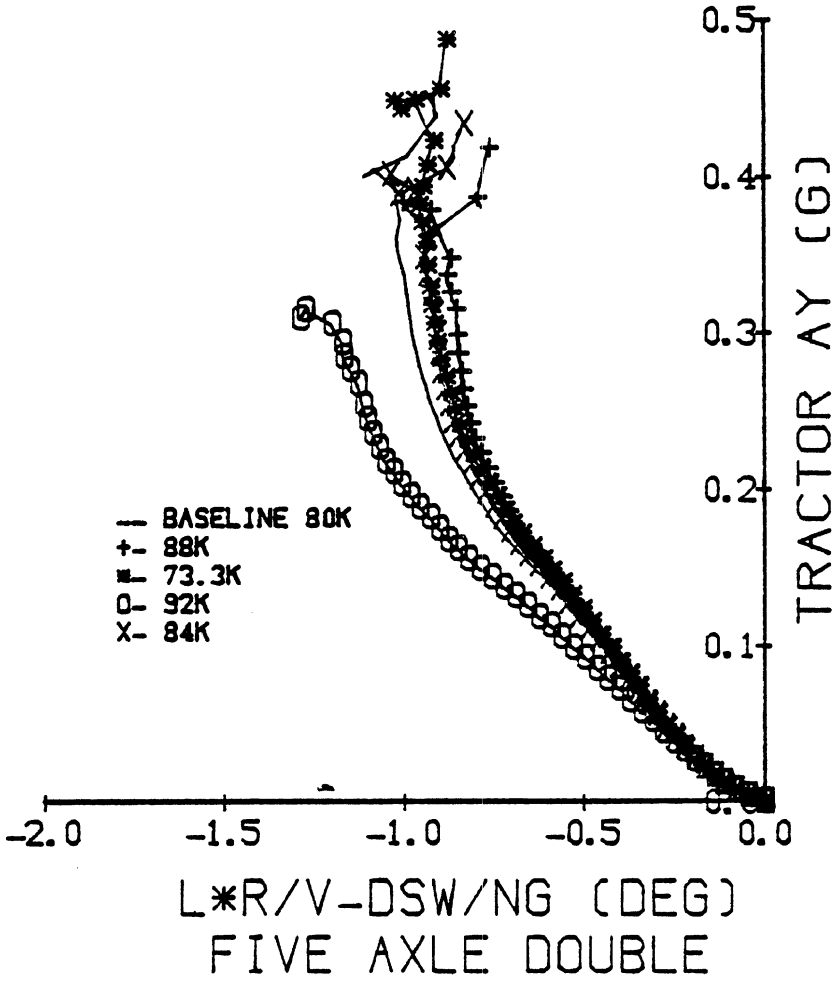
Loading and Vehicles:



Vehicle / Case		Axle No. →	Axle Loads/1000 lb. 1	2	3	4	5	GV
A (Tractor Semitrailer)	1	(Baseline)	12	17	17	17	17	(80
	2		12	19	19	19	19	(8
	3		9.3	16	16	16	16	(73.3
	4		10	17.5	17.5	17.5	17.5	(80
	5		10	20	20	19	19	(88
	6		12	18	18	18	18	(84)
	7		12	20	20	20	20	(92
	8		10	18.5	18.5	18.5	18.5	(84
	9		10	21	21	20	20	(92)
B (Conventional Double)	1	(Baseline)	10	17.5	17.5	17.5	17.5	(80
	2		10	19.5	19.5	19.5	19.5	(88)
	3		9.3	17	15	17	15	(73.
	4		12	20	20	20	20	(92
	5		10	18.5	18.5	18.5	18.5	(84)


0.5
0.4
0.3
0.2
0.1
TRACTOR AY (G)
-- 12-34-34 80K
+- 12-38-38 88K
*- 10-35-35 80K
O- 9.3-32-32 73.3K
X- 12-40-38 88K
-2.0
-1.5
-1.0
-0.5
0.0
L*R/V-DSW/NG (DEG)
FIVE AXLE TRACTOR-SEMI


0.5
0.4
0.3
0.2
0.1
0.0
TRACTOR AY (G)
-2.0
-1.5
-1.0
-0.5
0.0
L*R/V-DSW/NG (DEG)
FIVE AXLE TRACTOR-SEMI
— 12-34-34 80K
+- 12-36-36 84K
■- 12-40-40 92K
O- 10-37-37 84K
X- 10-42-40 92K

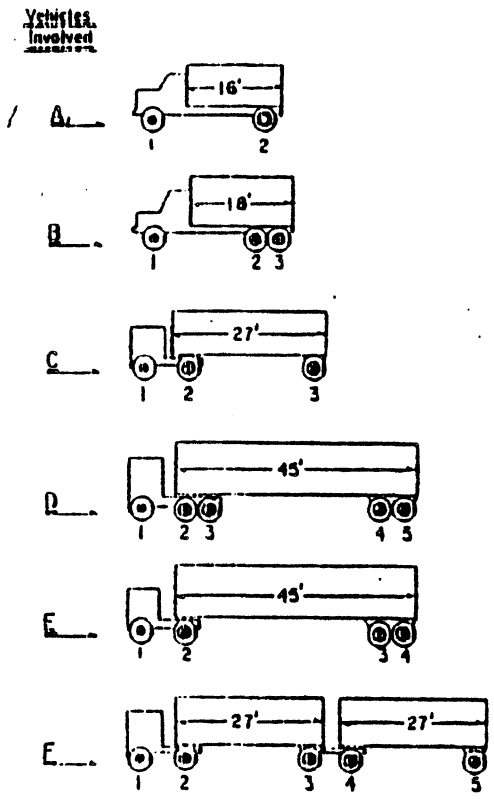

0.5
0.4
0.3
0.2
0.1
0.0
TRACTOR AY (G)
— BASELINE 80K
+- 88K
■- 73.3K
O- 92K
X- 84K
-2.0
-1.5
-1.0
-0.5
0.0
L*R/V-DSW/NG (DEG)
FIVE AXLE DOUBLE

Handling Diagrams - Mixed Tire Installation

Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

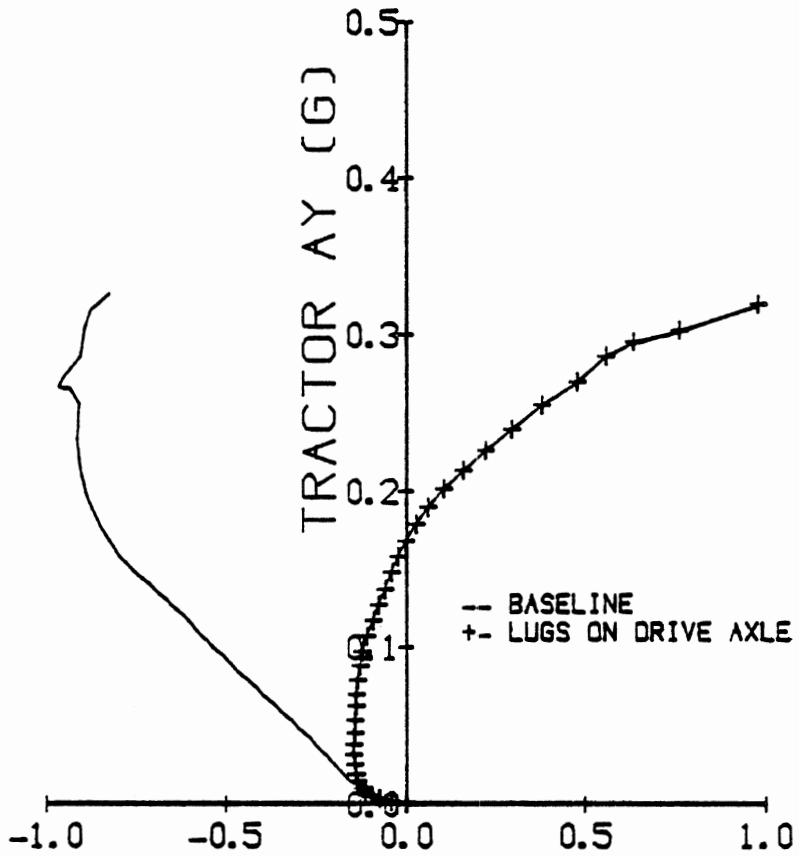
Loading and Vehicles:



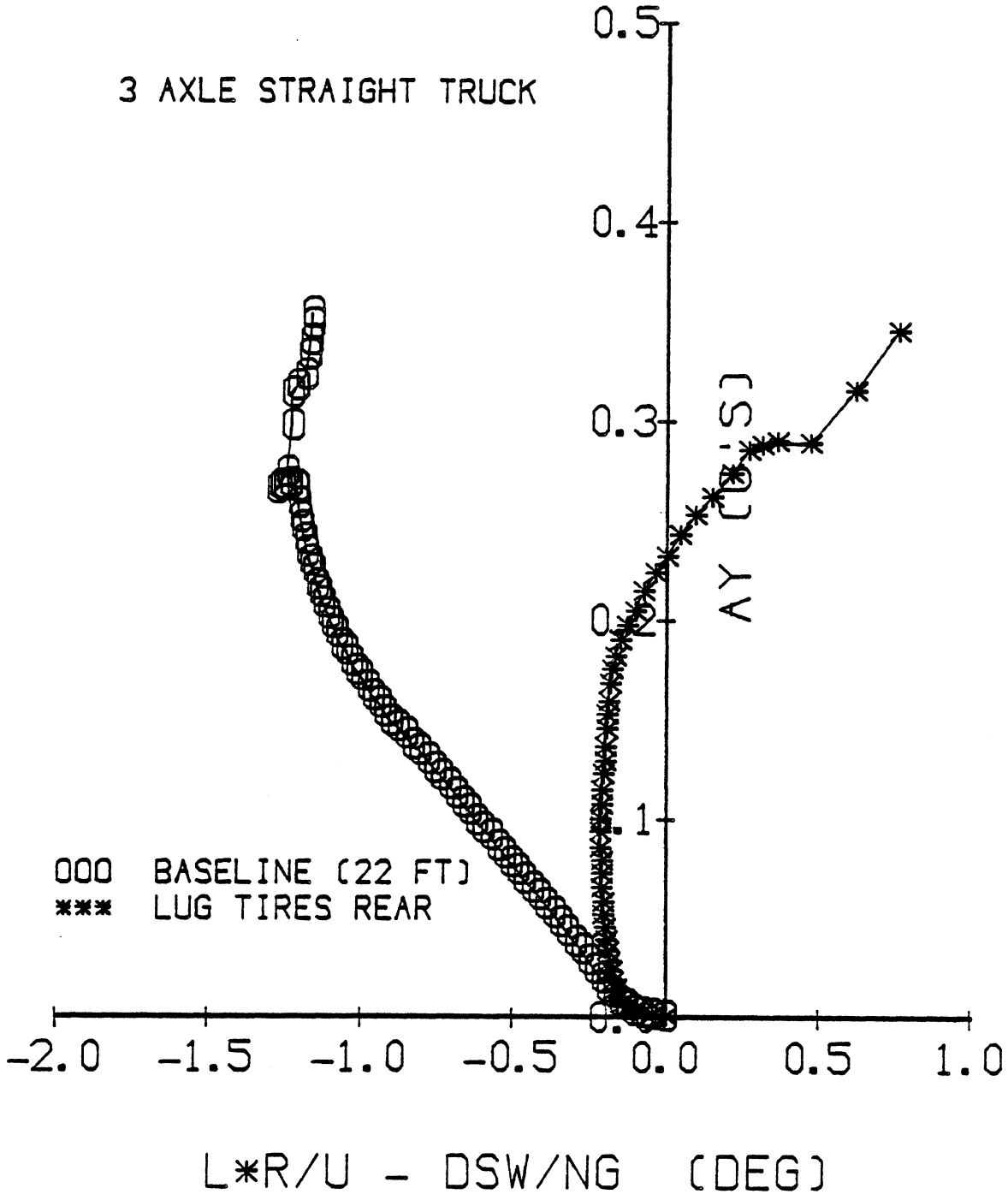
Vehicles / Case		Axle Loads/1000 lb: Axle Number - 1	2	3	4	5
A	1					
	2					
	3	12	20			
	4					
B	1					
	2					
	3	12	34			
	4					
C	1					
	2					
	3	10.5	20	20		
	4					
D	1					
	2					
	3	12	34		34	
	4					
	5					
E	1					
	2					
	3	10.5	20	34		
E	1					
	2					
	3					
	4	10	17.5	17.5	17.5	17.5
	5					

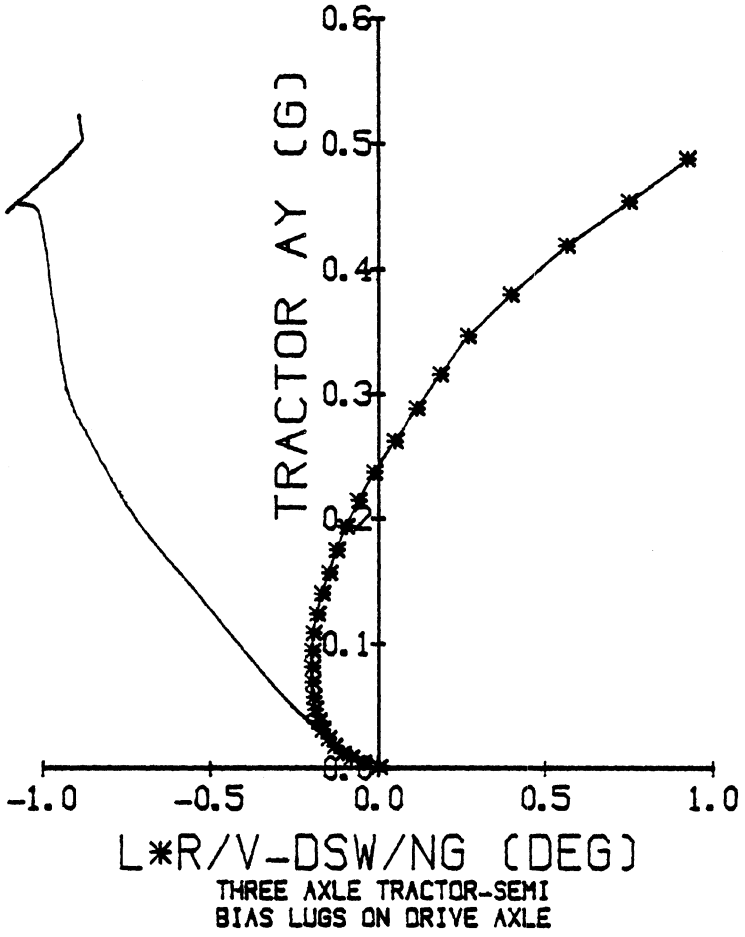
Tire Installation: Baseline - all radials

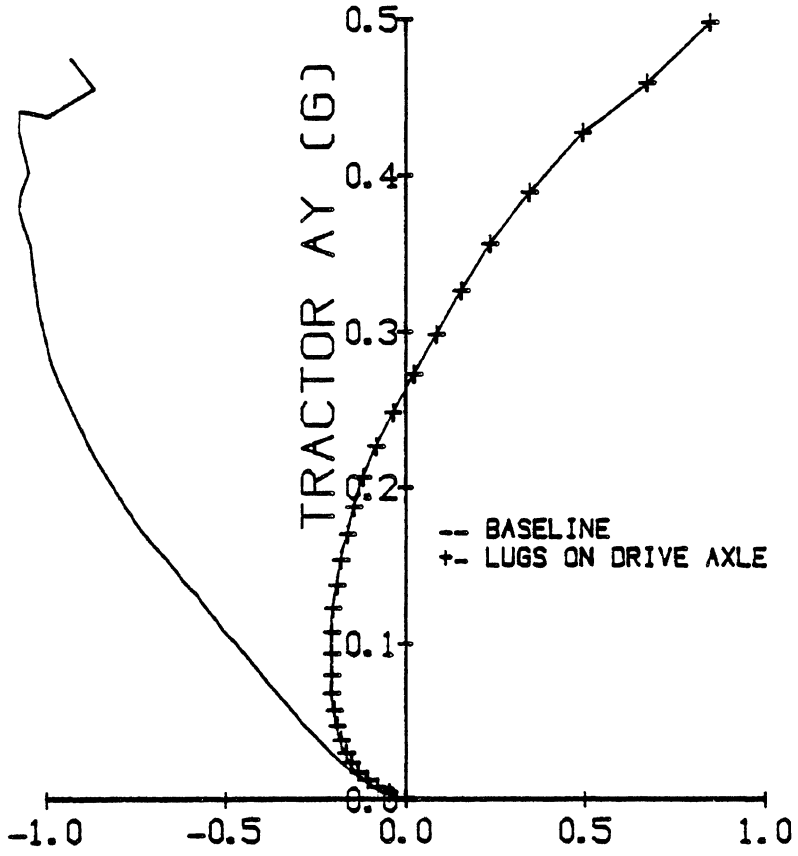
Mix - radials, steering axle; bias-ply lug tires, drive axle(s)



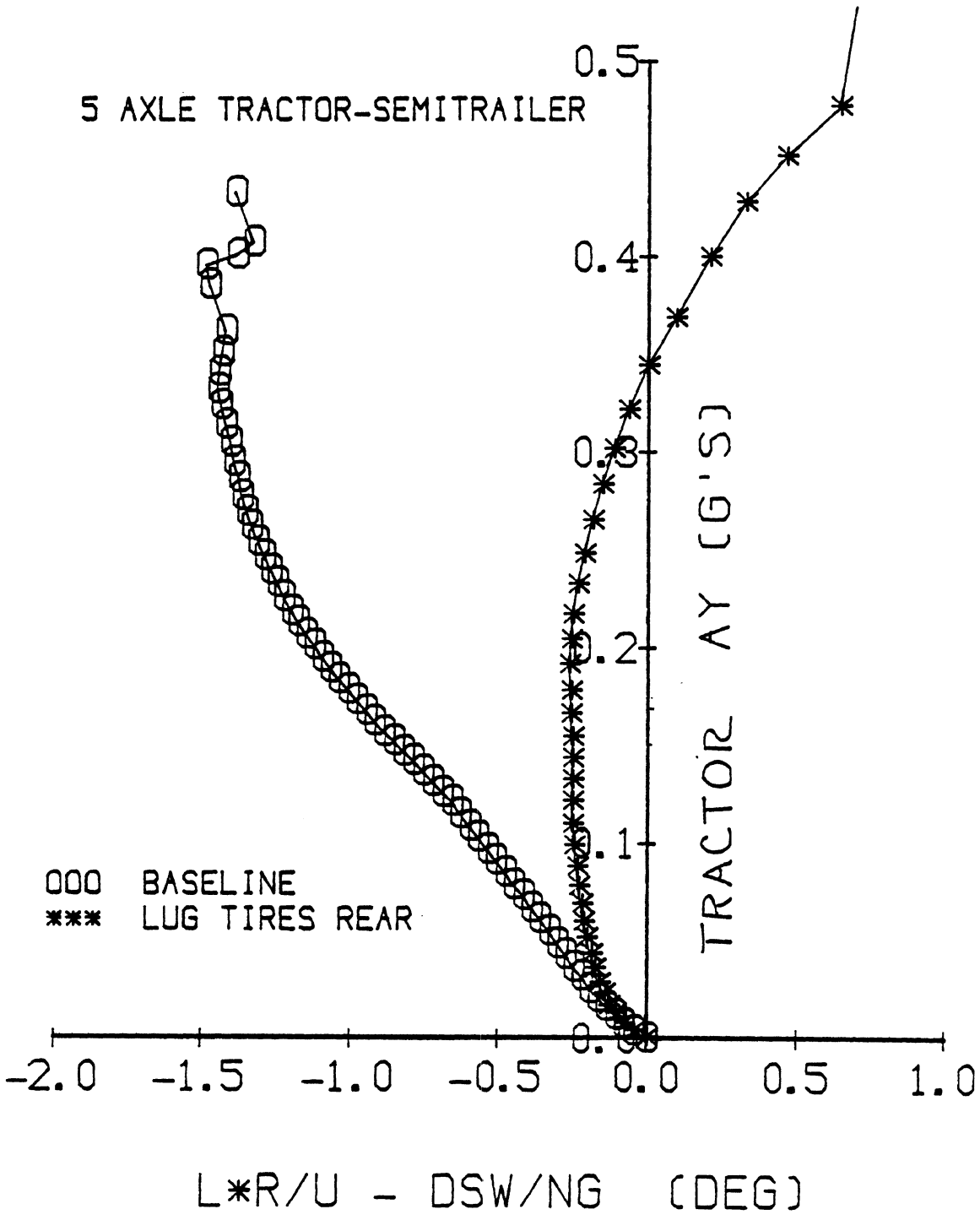
TWO AXLE STRAIGHT TRUCK

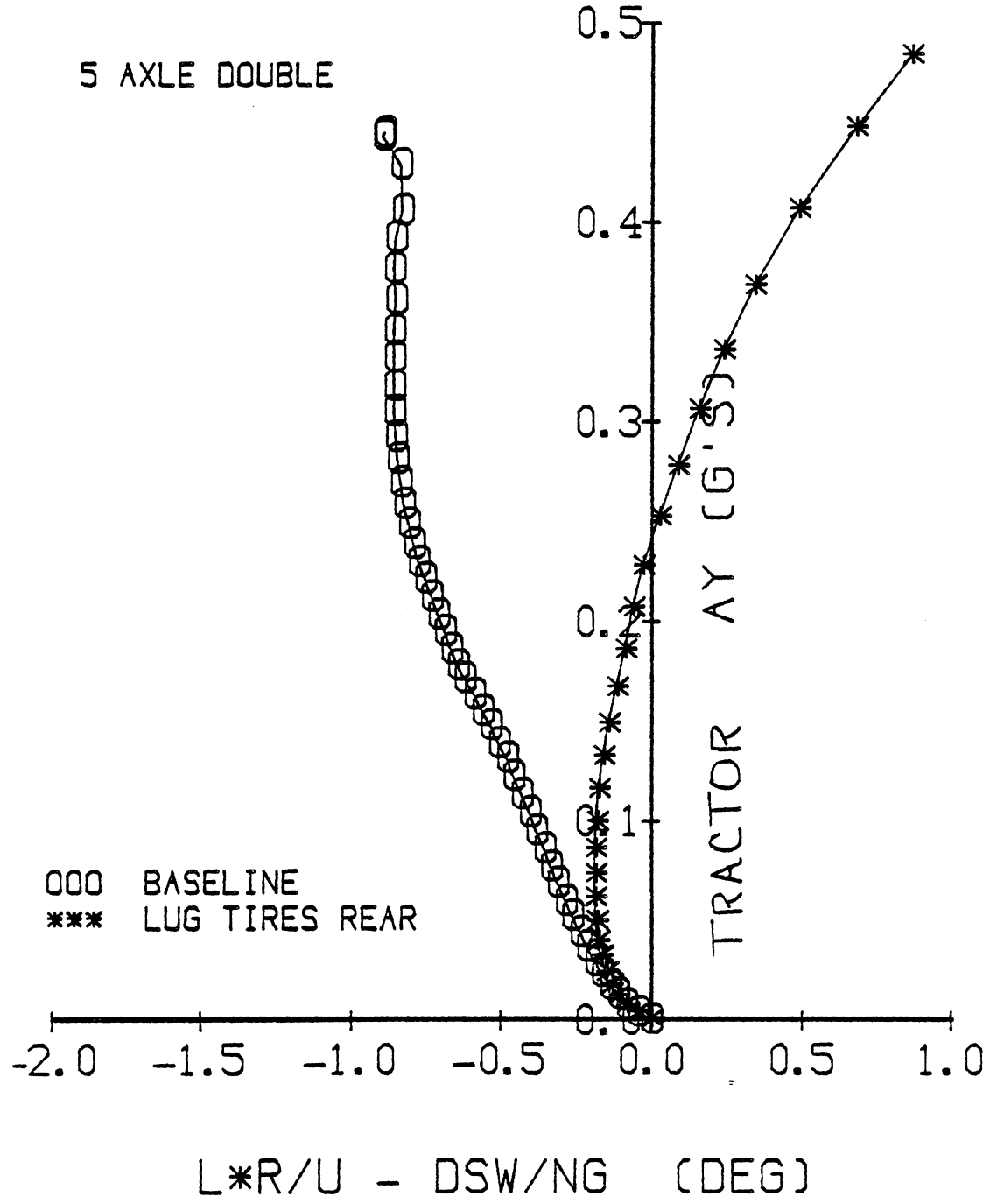

3 AXLE STRAIGHT TRUCK
0.5
0.4
0.3
0.2
.1
0.
AY (D-S)
000 BASELINE (22 FT)
*** LUG TIRES REAR
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
L*R/U - DSW/NG (DEG)


TRACTOR AY (G)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-1.0
-0.5
0.0
0.5
1.0
L*R/V-DSW/NG (DEG)
THREE AXLE TRACTOR-SEMI
BIAS LUGS ON DRIVE AXLE



FOUR AXLE TRACTOR-SEMI


5 AXLE TRACTOR-SEMITRAILER
000 BASELINE
*** LUG TIRES REAR
TRACTOR AY (G'S)
0.5
0.4
0.3
0.2
0.1
0.0
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
L*R/U - DSW/NG (DEG)


5 AXLE DOUBLE
0.5
0.4
0.3
0.
0.1
0.
TRACTOR AY (G'S)
000 BASELINE
*** LUG TIRES REAR
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
L*R/U - DSW/NG (DEG)

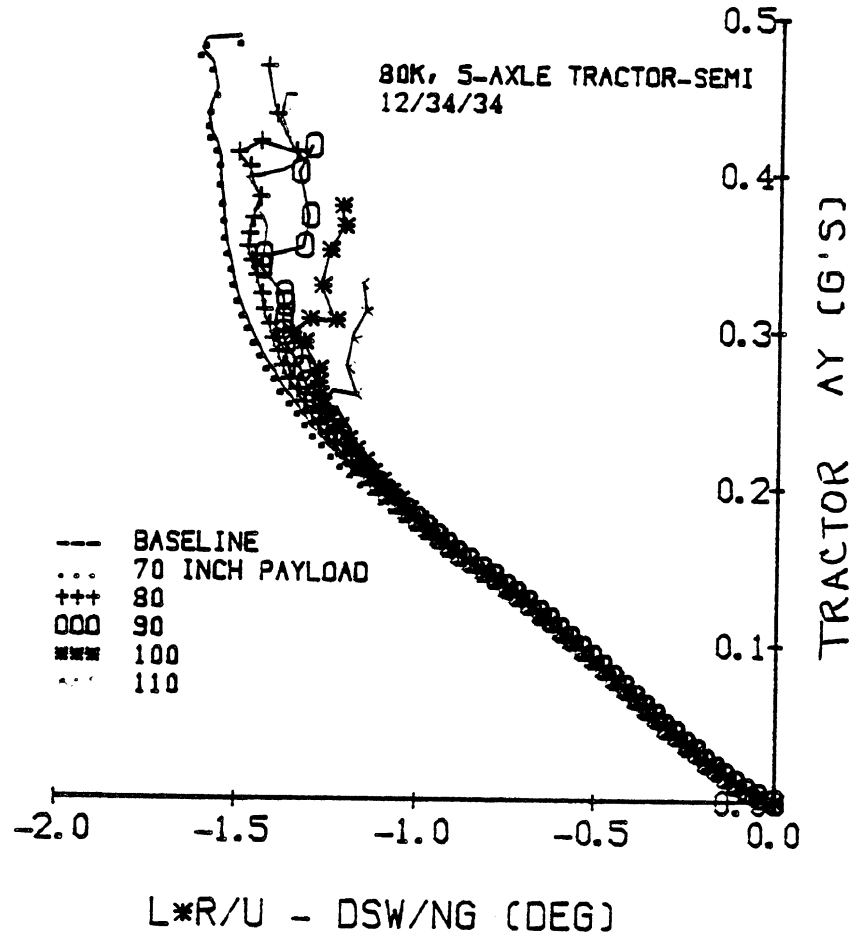
Handling Diagrams - C.G. Height Variations

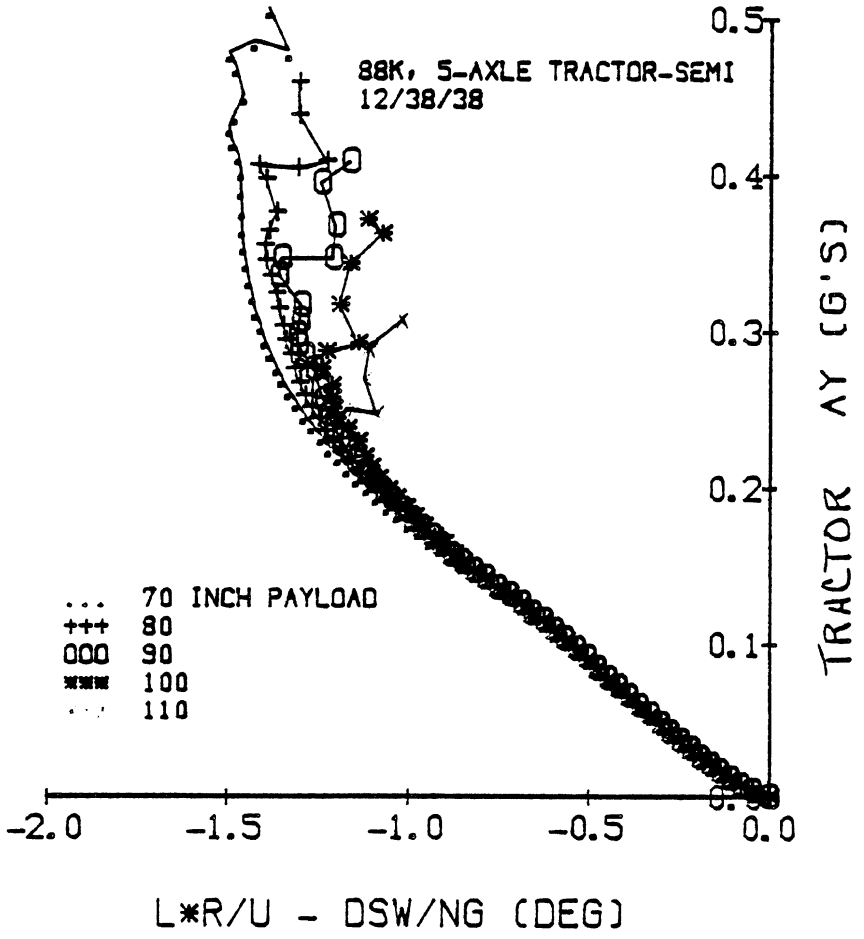
Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

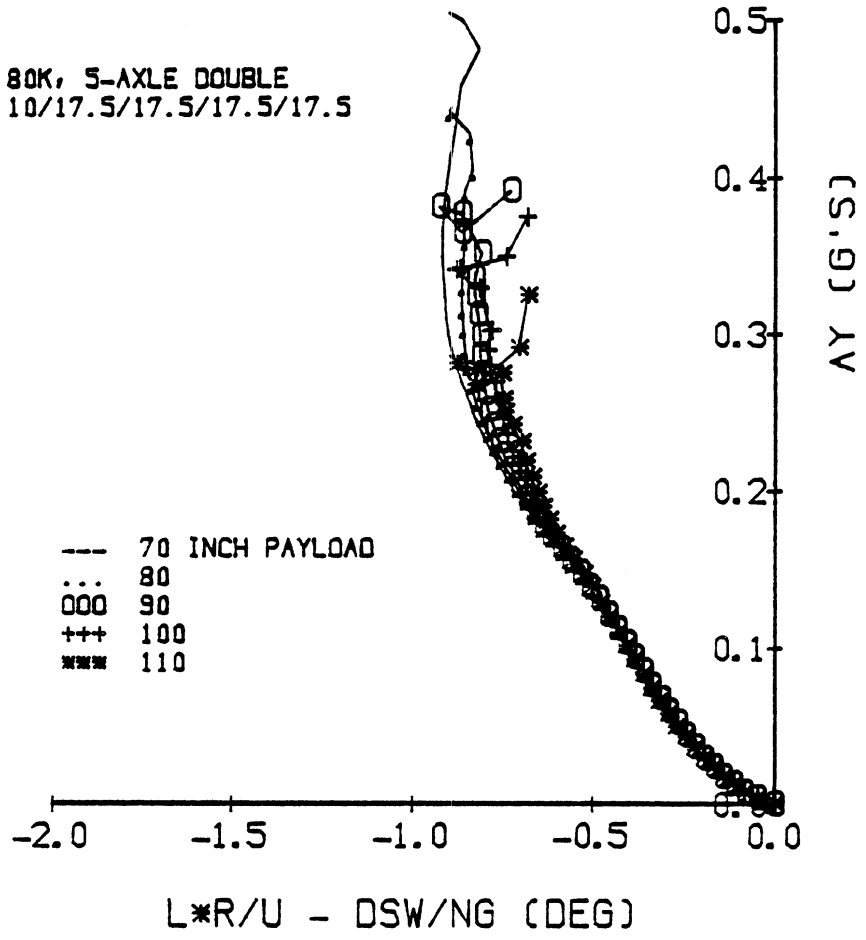
Speed: 55 mph (88 km/h)

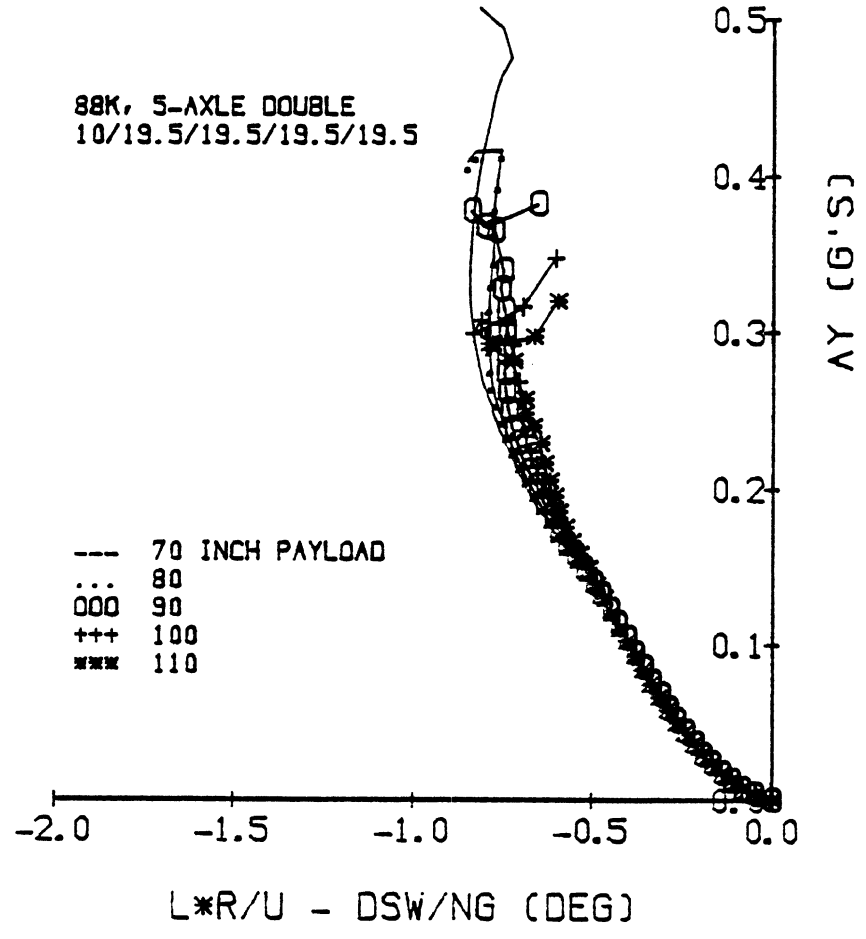
Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW
Payload c.g. height varies as labeled

Vehicles: five-axle tractor-semitrailer (with 45' trailer)
five-axle double (with 27' trailers)


80K, 5-AXLE TRACTOR-SEMI
12/34/34
--- BASELINE
... 70 INCH PAYLOAD
+++ 80
000 90
*** 100
110
0.5
0.4
0.3
0.2
0.1
0.0
-2.0
-1.5
-1.0
-0.5
0.0
TRACTOR AY (G'S)
L*R/U - DSW/NG (DEG)


88K, 5-AXLE TRACTOR-SEMI
12/38/38
... 70 INCH PAYLOAD
+++ 80
000 90
*** 100
110
0.5
0.4
0.3
0.2
0.1
0.0
-2.0
-1.5
-1.0
-0.5
0.0
TRACTOR AY (G'S)
L*R/U - DSW/NG (DEG)


80K, 5-AXLE DOUBLE
10/17.5/17.5/17.5/17.5
--- 70 INCH PAYLOAD
... 80
000 90
+++ 100
*** 110
0.5
0.4
0.3
0.2
0.1
0.0
AY (G'S)
-2.0
-1.5
-1.0
-0.5
0.0
L*R/U - DSW/NG (DEG)


88K, 5-AXLE DOUBLE
10/19.5/19.5/19.5/19.5
--- 70 INCH PAYLOAD
... 80
000 90
+++ 100
*** 110
0.5
0.4
0.3
0.2
0.1
0.0
AY (G'S)
-2.0
-1.5
-1.0
-0.5
0.0
L*R/U - DSW/NG (DEG)

Handling Diagrams - C.G. Lateral Offset

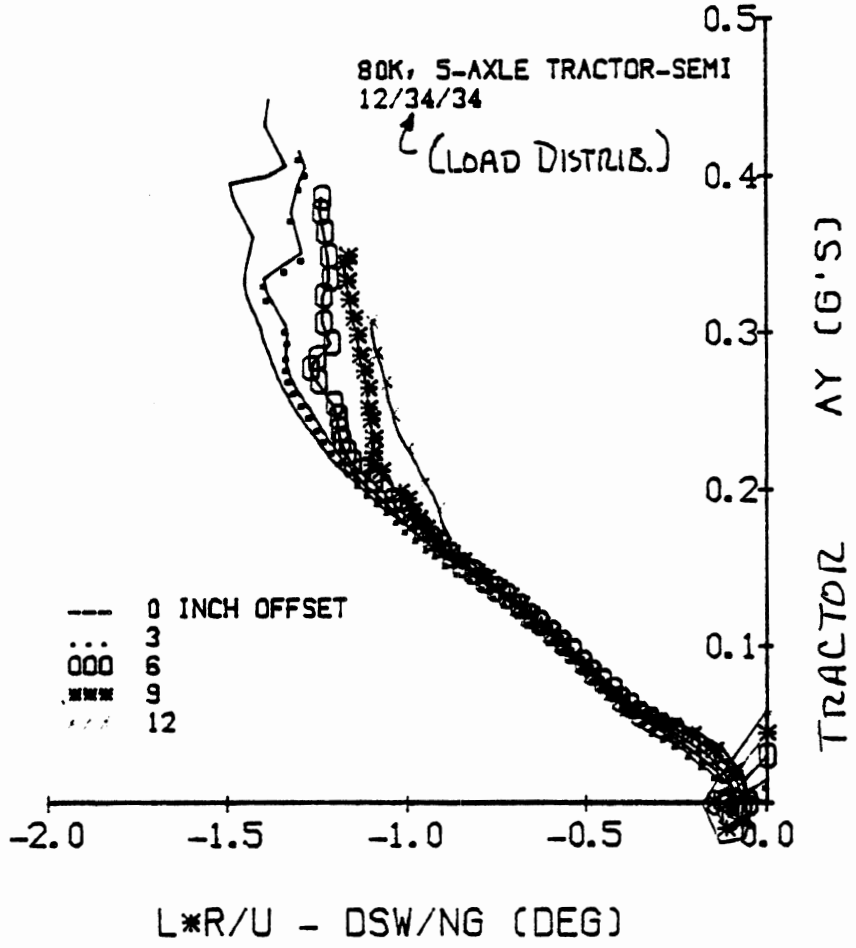
Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

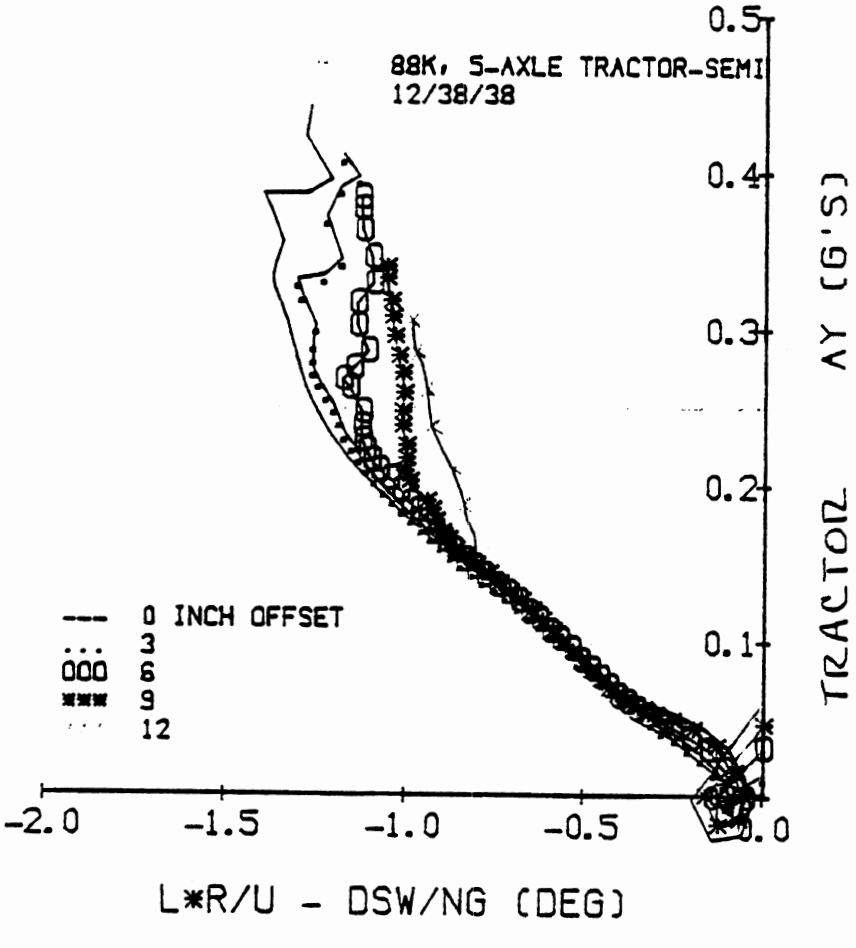
Speed: 55 mph (88 km/h)

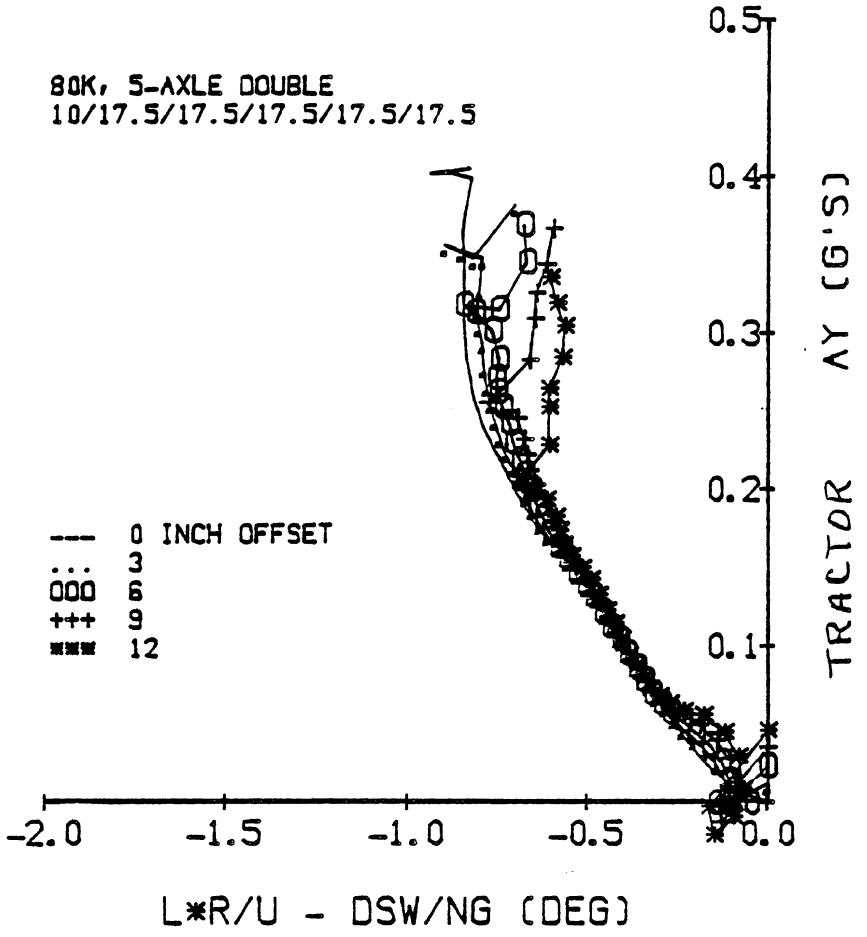
Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW
Payload c.g. offset laterally as labeled
(Note the offset is always toward the outside of the turn)

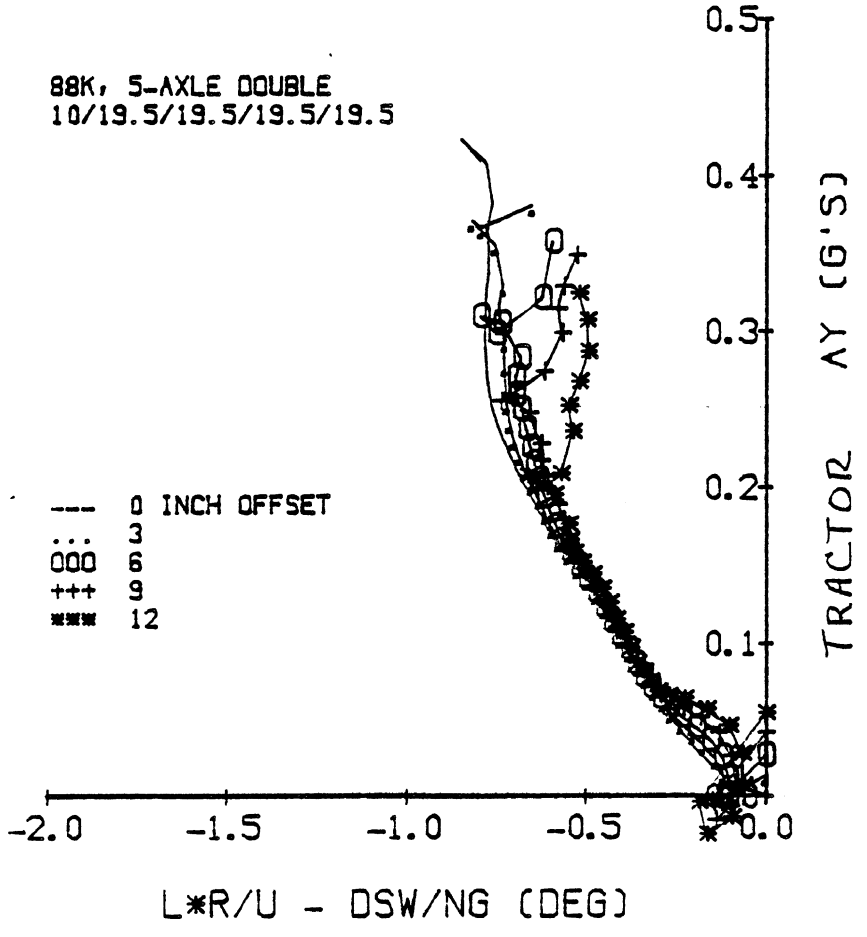
Vehicles: five-axle tractor-semitrailer (with 45' trailer)

five-axle doubles (with 27' trailers)


80K, 5-AXLE TRACTOR-SEMI
12/34/34
(LOAD DISTRIB.)
0 INCH OFFSET
3
6
9
12
0.5
0.4
0.3
0.2
0.1
0.0
-2.0
-1.5
-1.0
-0.5
TRACTOR AY (G'S)
L*R/U - DSW/NG (DEG)


88K, 5-AXLE TRACTOR-SEMI
12/38/38
0 INCH OFFSET
3
6
9
12
0.5
0.4
0.3
0.2
0.1
0.0
-2.0
-1.5
-1.0
-0.5
TRACTOR AY (G'S)
L*R/U - DSW/NG (DEG)


80K, 5-AXLE DOUBLE
10/17.5/17.5/17.5/17.5/17.5
--- 0 INCH OFFSET
... 3
000 6
+++ 9
*** 12
0.5
0.4
0.3
0.2
0.1
TRACTOR AY (G'S)
-2.0
-1.5
-1.0
-0.5
0.0
L*R/U - DSW/NG (DEG)


88K, 5-AXLE DOUBLE
10/19.5/19.5/19.5/19.5
--- 0 INCH OFFSET
... 3
000 6
+++ 9
*** 12
0.5
0.4
0.3
0.2
0.1
TRACTOR AY (G'S)
-2.0
-1.5
-1.0
-0.5
0.0
L*R/U - DSW/NG (DEG)

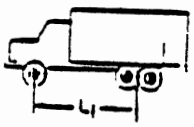
Handling Diagram - Truck Wheelbase Variation

Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

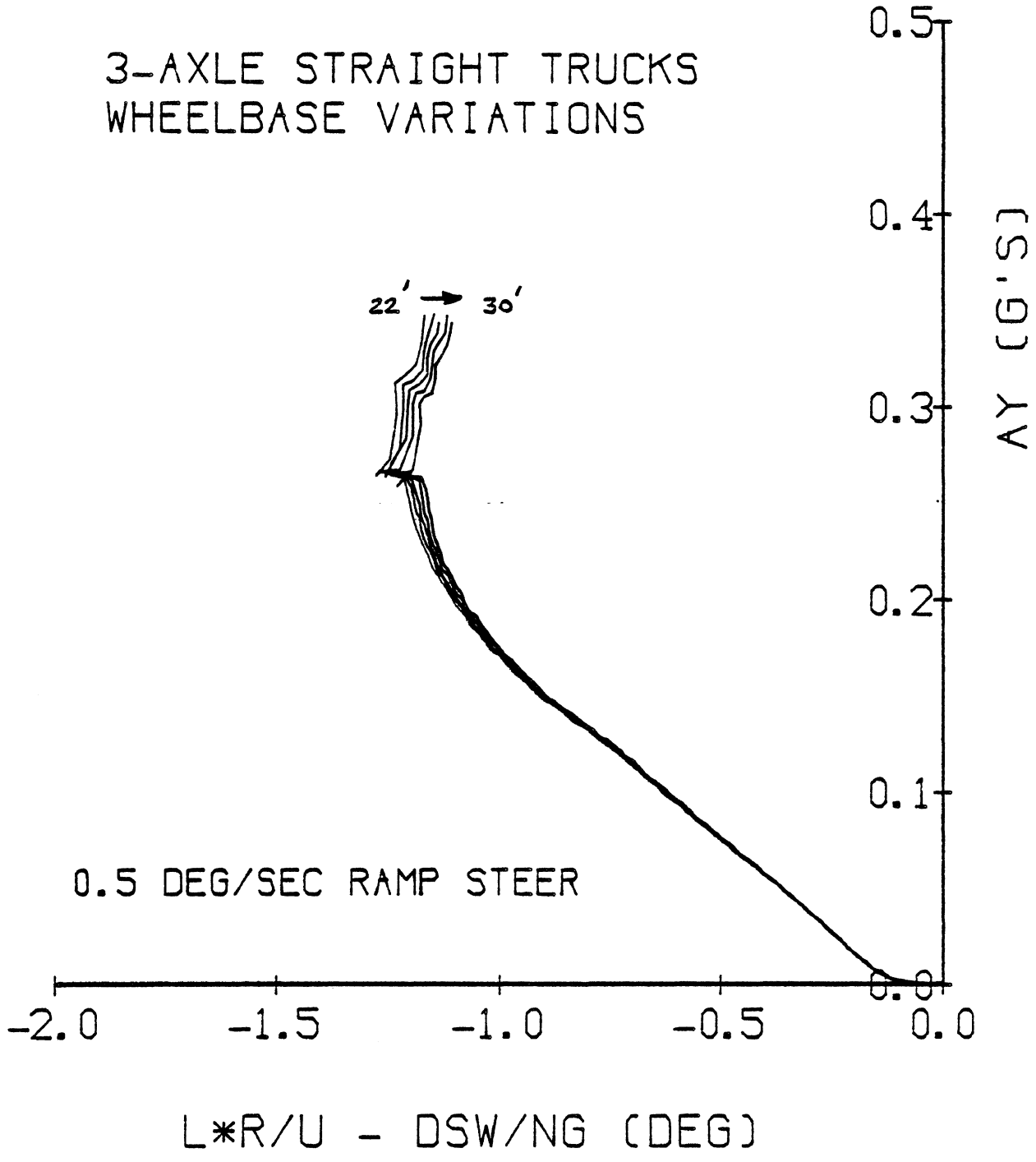
Speed: 55 mph (88 km/h)

Loading Condition: 12,000 lbs (5.4 m tons) - front axle
34,000 lbs (15.4 m tons) - rear tandem

Vehicle:



Vehicle / Case		Length, ft L_1	L_2	L_3	L_4	L_5
A. Straight Truck	1	22				
	2	24				
	3	26				
	4	28				
	5	30				


3-AXLE STRAIGHT TRUCKS
WHEELBASE VARIATIONS
22'
30'
0.5
0.4
0.3
0.2
0.1
0.0
AY (G'S)
0.5 DEG/SEC RAMP STEER
-2.0
-1.5
-1.0
-0.5
0.0
L*R/U - DSW/NG (DEG)

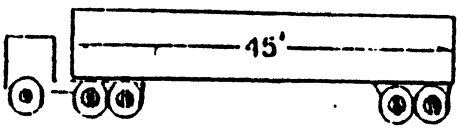
Handling Diagrams - Width Variations

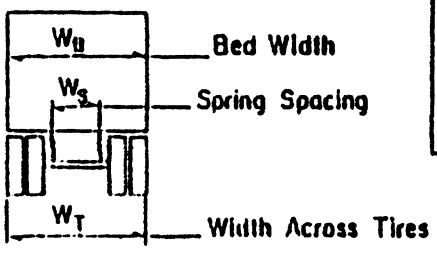
Maneuver: Ramp steer input - 0.5 deg/sec steering-wheel angle

Speed: 55 mph (88 km/h)

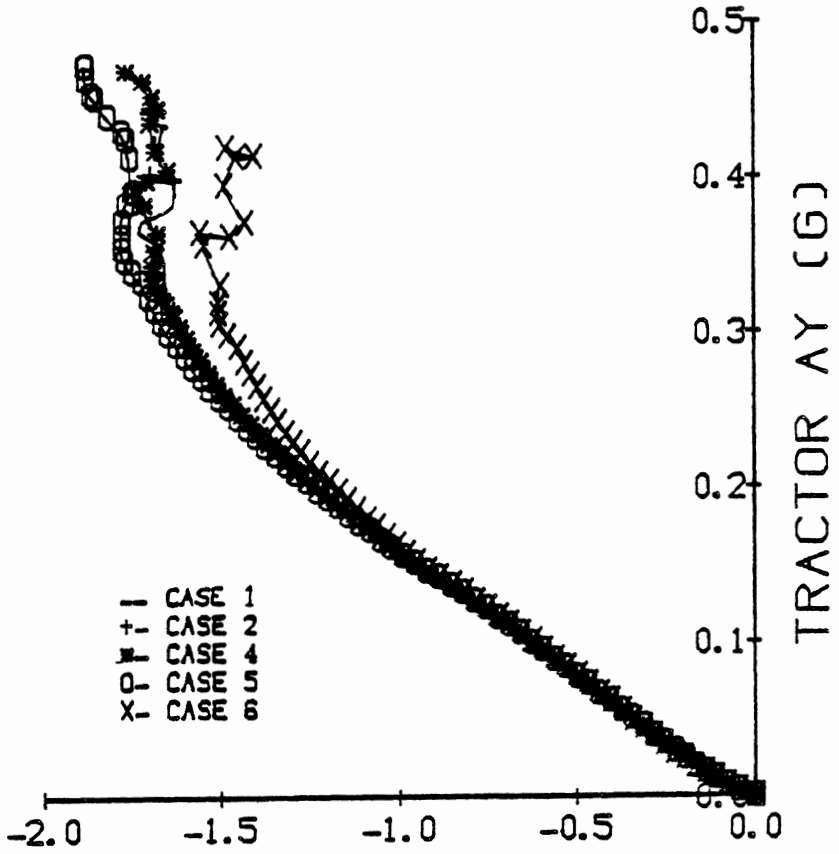
Loading: 80,000 and 88,000 lbs (36.3 and 39.9 m tons) GCW as per table below

Width Dimension Variations:

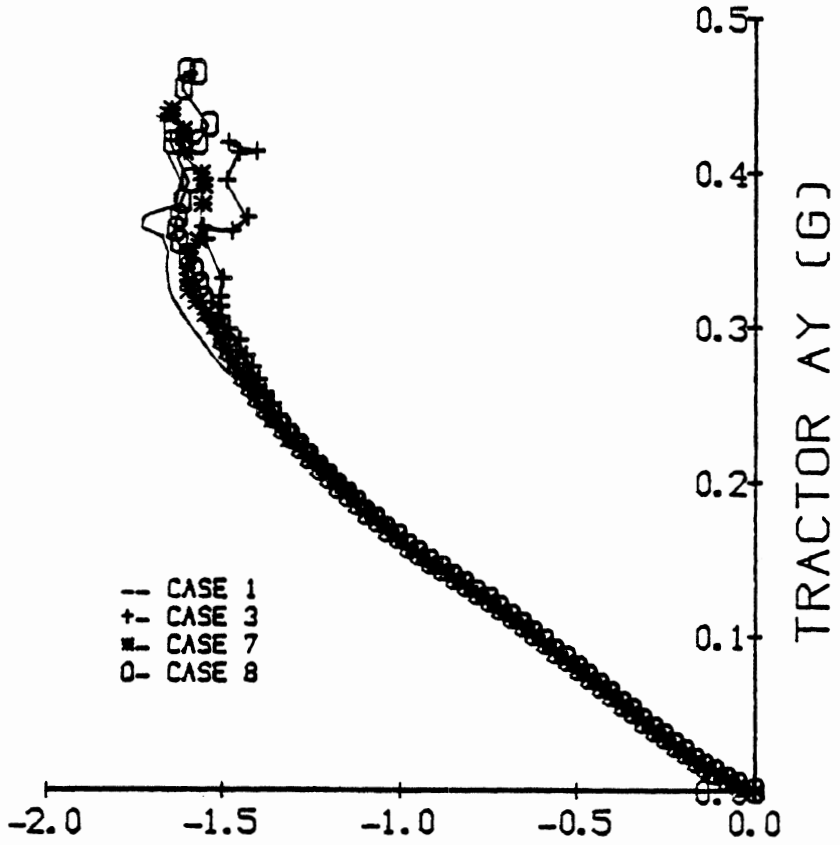




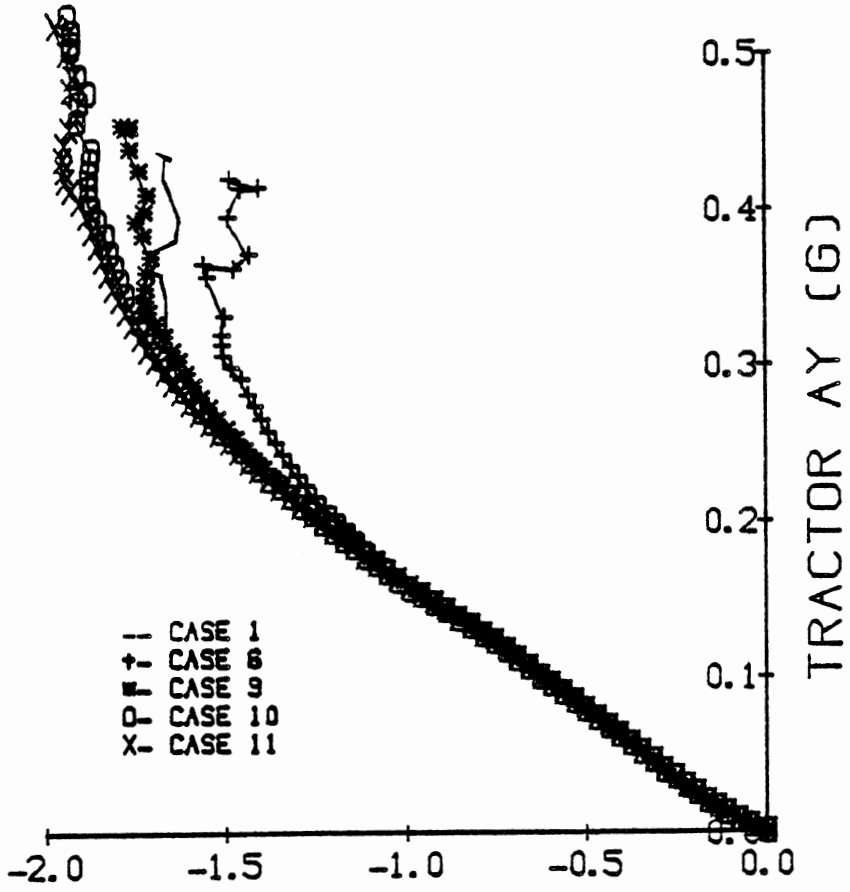
Cases	(INCHES) W_B	W_S	W_T	Gross Wgt (LBS)	Tractor Width(IN)
1* (Baseline)	96	38	96	80k	96
2*	102	38	96	80k	96
3	102	38	96	88k	96
4*	102	38	102	80k	96
5*	102	44	102	80k	96
6*	102	44	102	80k	102
7	102	44	102	88k	96
8	102	44	102	88k	102
9	99	41	99	80k	96
10	105	47	105	80k	102
11	108	50	108	80k	102



FIVE AXLE TRACTOR-SEMI
WIDTH VARIATIONS



FIVE AXLE TRACTOR-SEMI
WIDTH VARIATIONS



FIVE AXLE TRACTOR-SEMI
WIDTH VARIATIONS

Jackknife Dynamics - Tractor Wheelbase Variations

Maneuver: Braking in a steady turn - tractor drive axles are locked up and the ensuing jackknife divergency is characterized

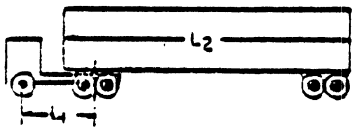
The following four plots present the time histories of the yaw rate and articulation angle responses of the tractor, showing how the jackknife motion ensues following wheel lockup at approximately Time = 3.25 seconds.

Initial Speed: 55 mph (88 km/h)

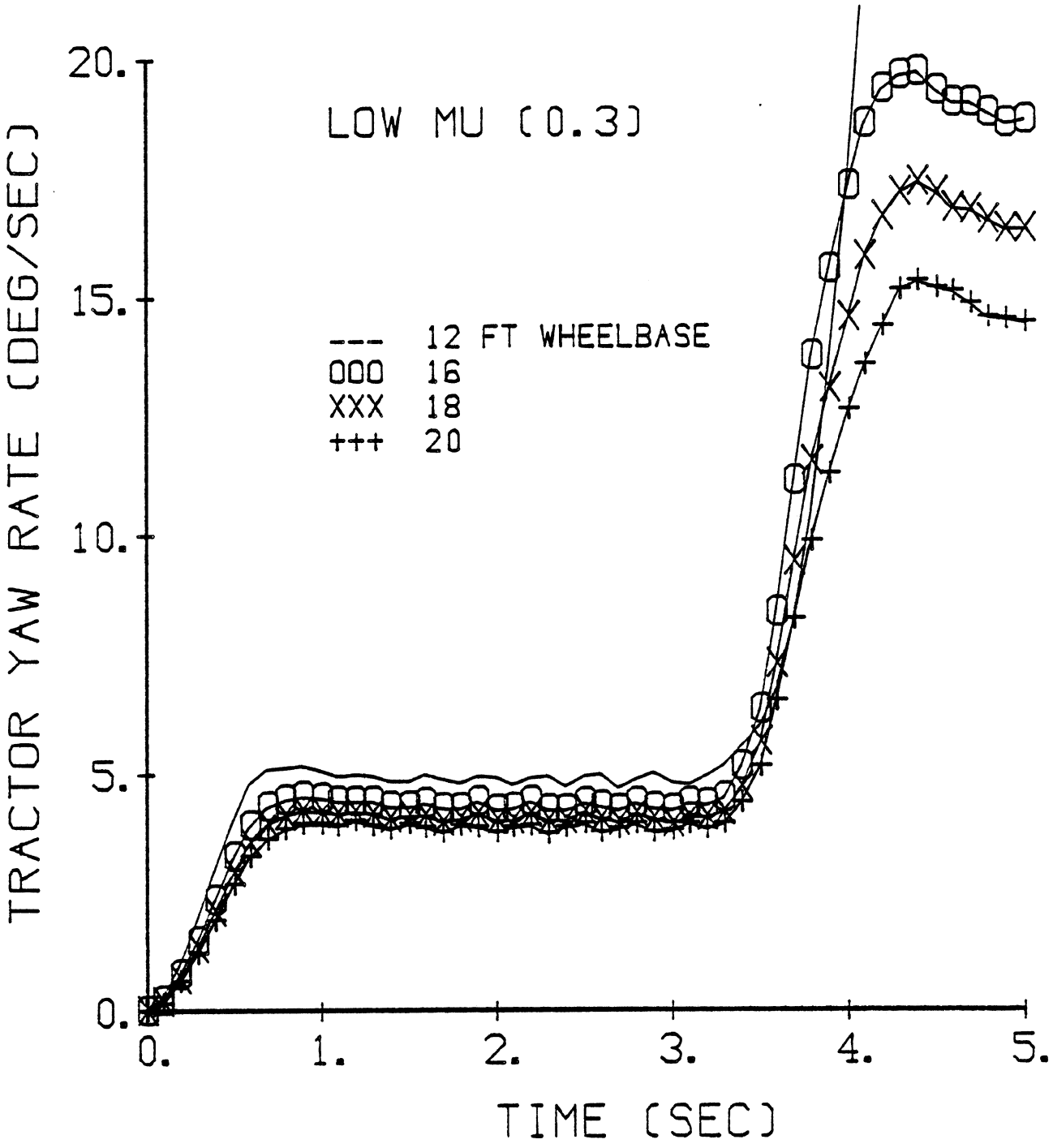
Initial Lateral Acceleration: ~0.17 g's

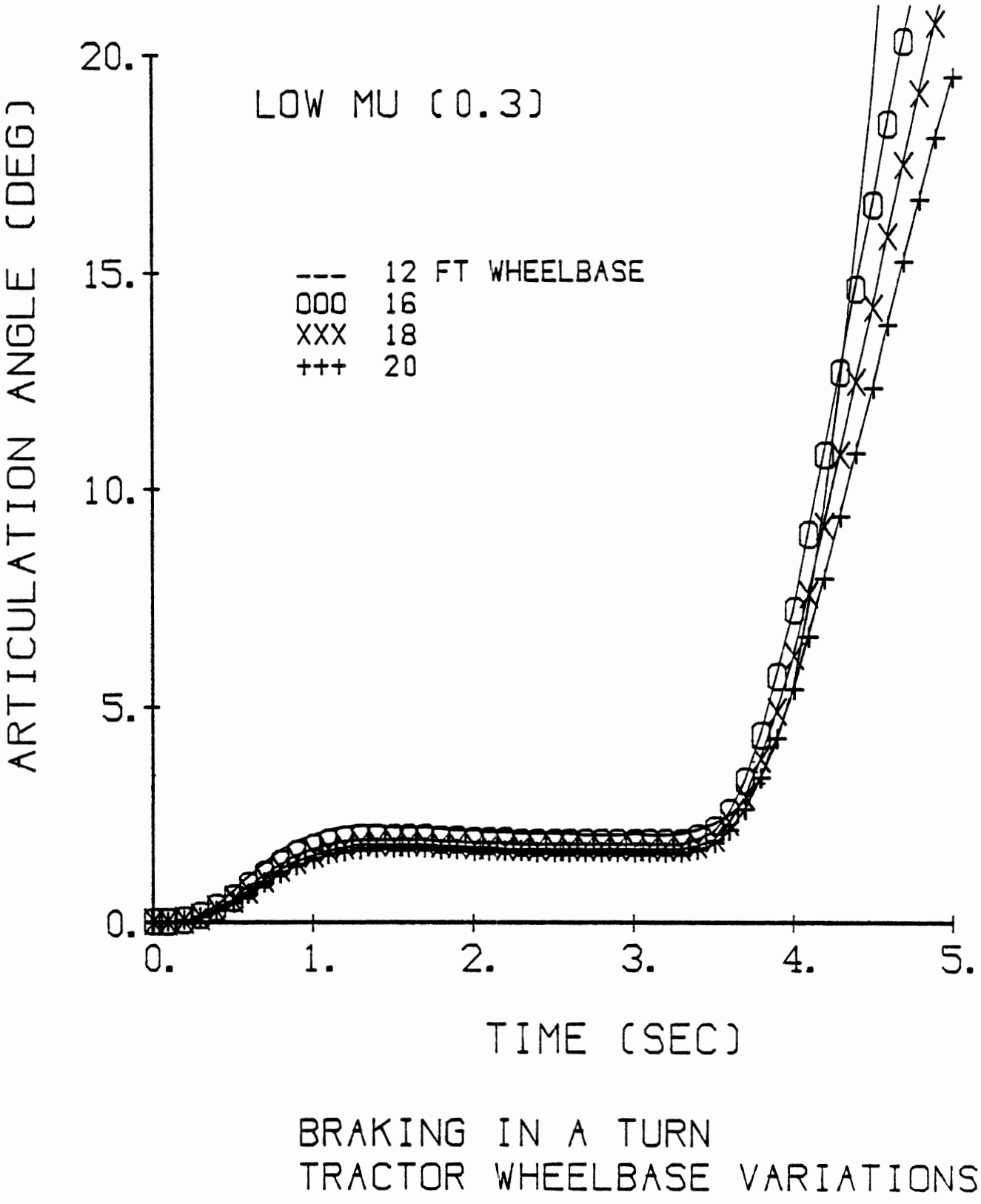
Surface Friction Levels: μ = 0.3 and 0.8

Vehicle:

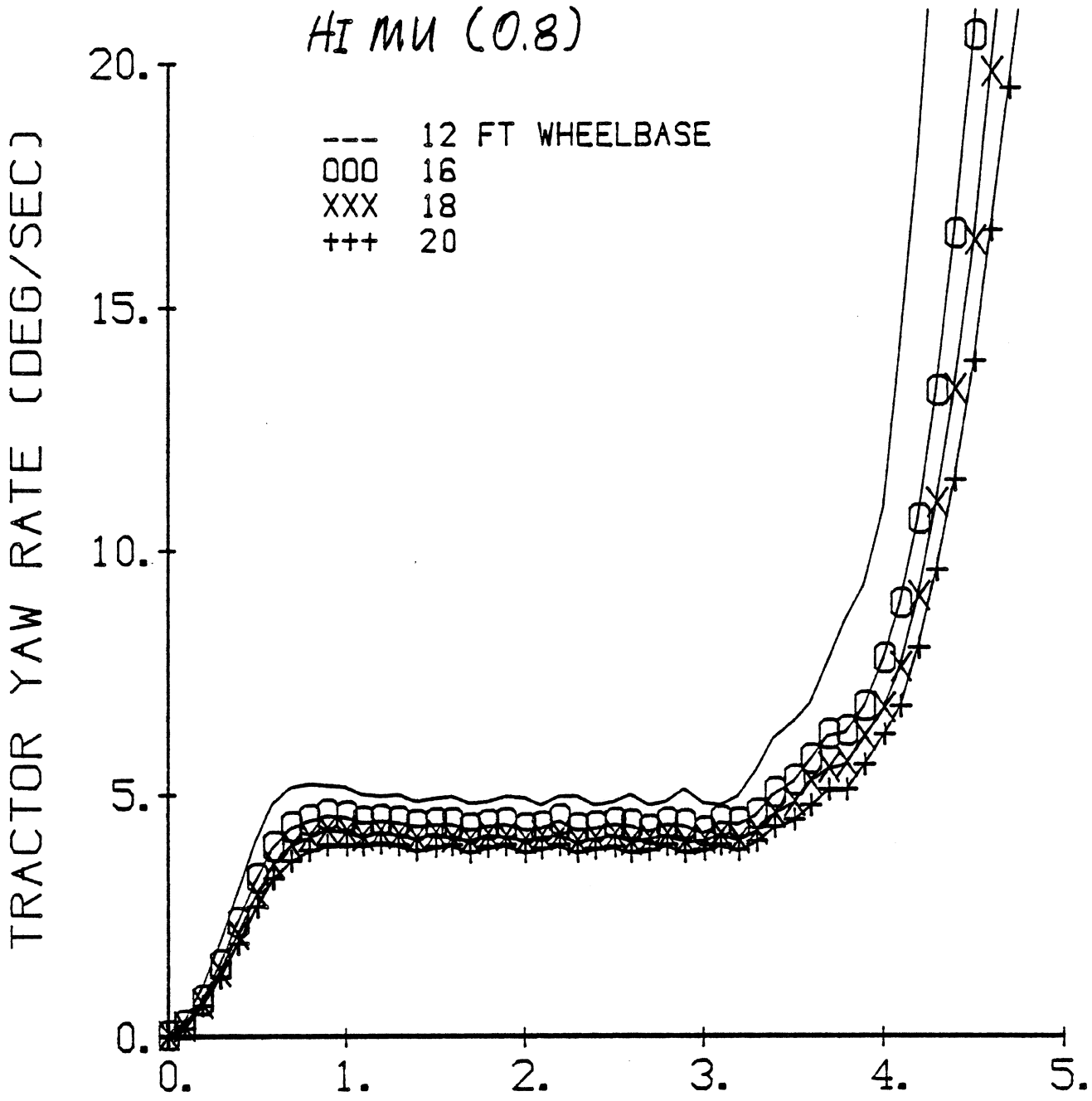


C. Tractor	1	12	45
Semitrailer	2	16	45
	3	18	45
	4	20	45

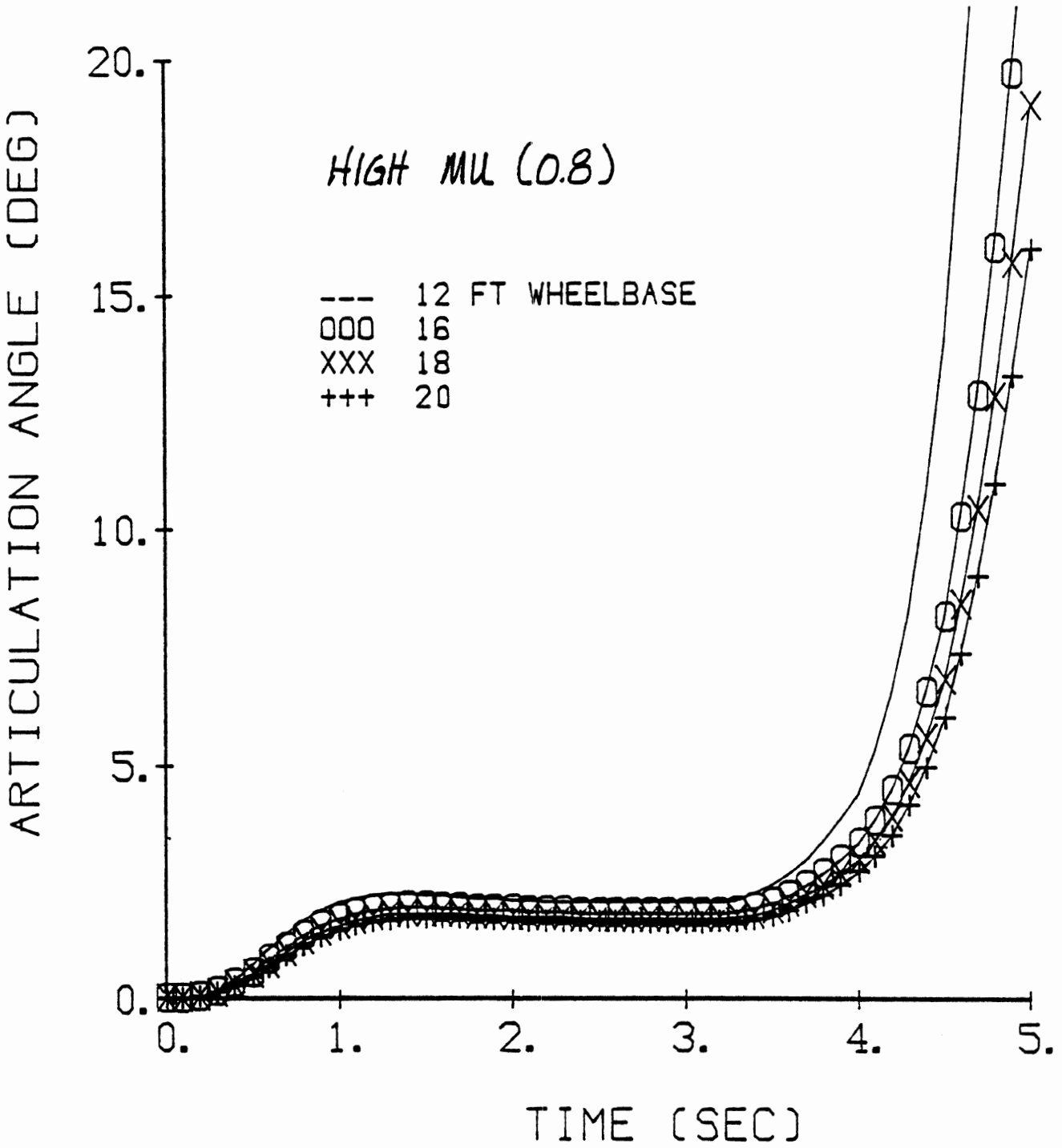

LOW MU (0.3)
--- 12 FT WHEELBASE
000 16
XXX 18
+++ 20
TRACTOR YAW RATE (DEG/SEC)
20.
15.
10.
5.
0.
0.
1.
2.
3.
4.
5.
TIME (SEC)



BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS



BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS



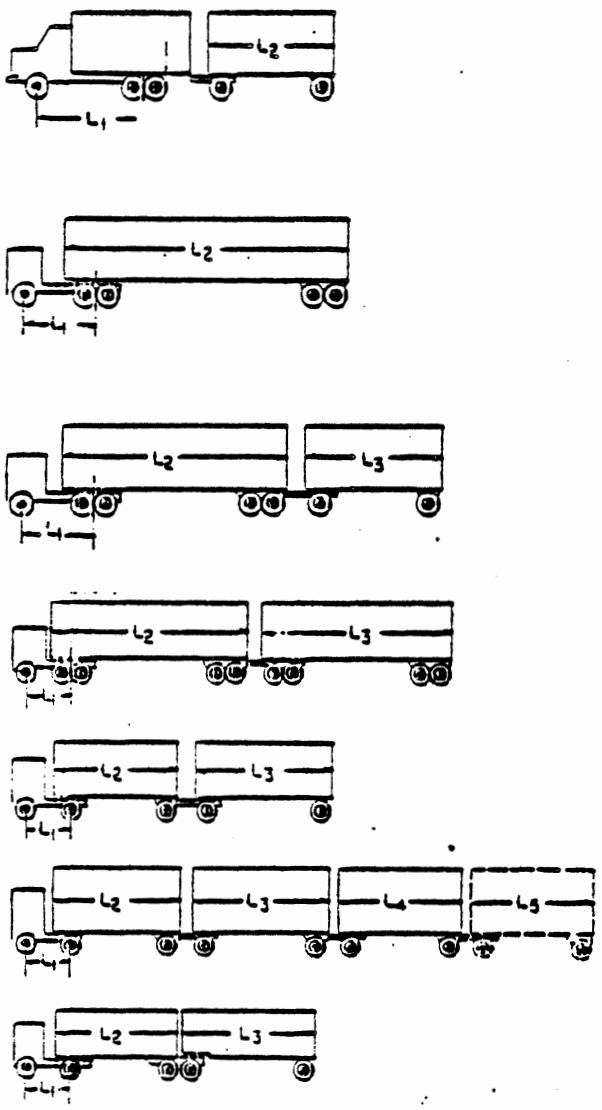
BRAKING IN A TURN
TRACTOR WHEELBASE VARIATIONS

Low-Speed Offtracking - Length Variations

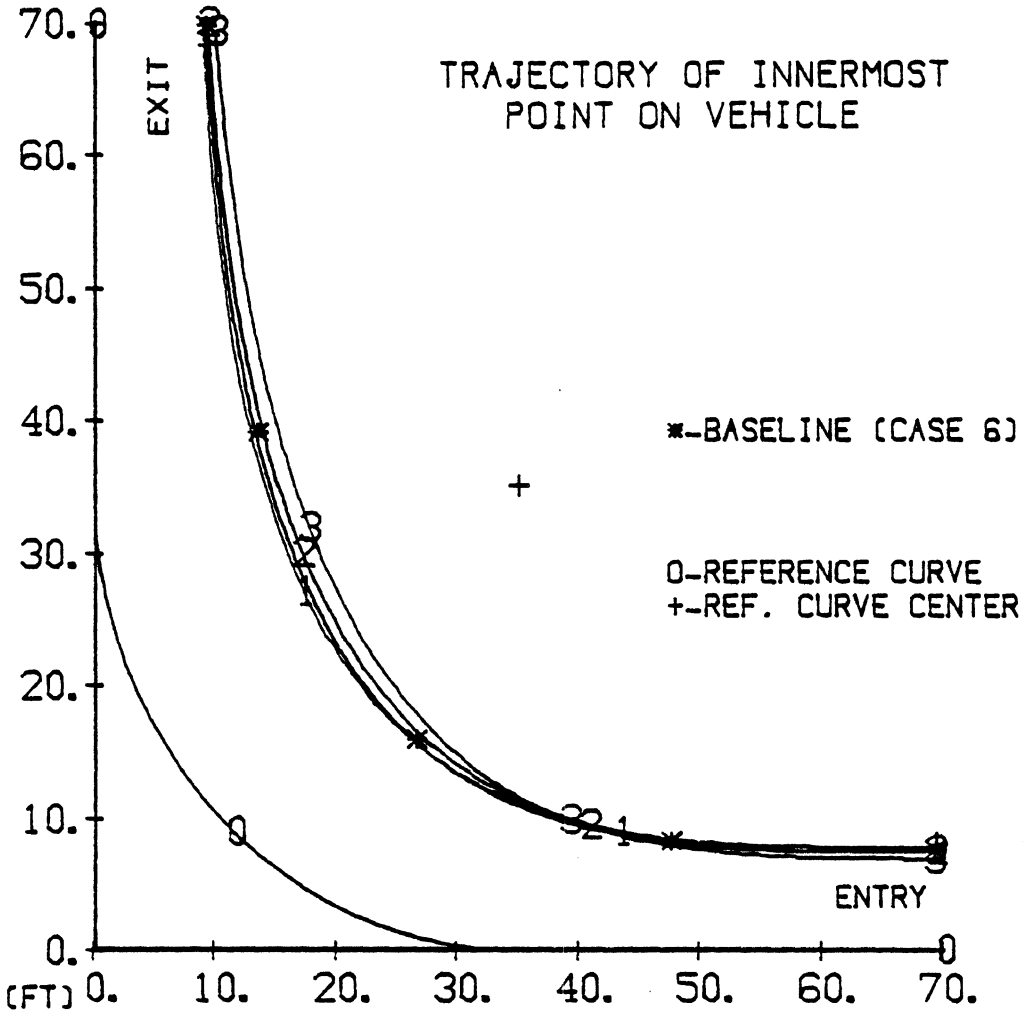
Maneuver: 90-degree intersection turn
Reference curve - 35-foot (10.7-m) radius
(tracked by outside steering tire on tractor)

Speed: ~0 mph (0 km/h)

Vehicles:

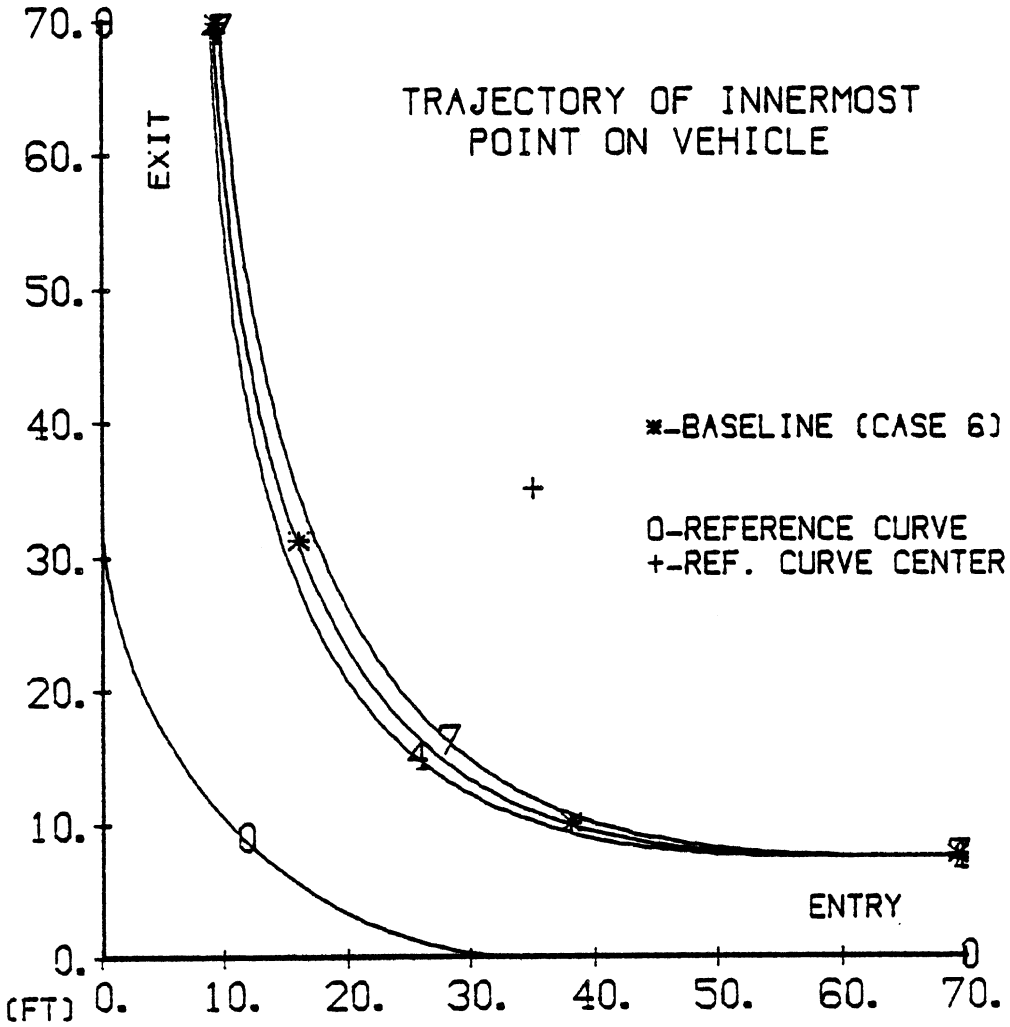


B. Truck/ Full Trailer	1	16	22				
	2	20	22				
	3	24	22				
	4	20	16				
	5	20	18				
	6	20	20				
	7	20	24				
C. Tractor Semitrailer	1	12	45				
	2	16	45				
	3	18	45				
	4	20	45				
	5	18	21				
	6	18	27				
	7	18	35				
	8	18	55				
D. Rocky Mtn. Doubles	1	12	35	21			
	2	12	35	27			
	3	12	40	21			
	4	12	40	27			
	5	12	45	21			
	6	12	45	27			
	7	12	27	45—(Single axle trailer first, tandem dolly on 2nd trailer)			
E. Turnpike Doubles	1	12	35	35			
	2	12	40	40			
	3	12	45	45			
	4	12	50	50			
F. Single Axle Doubles	1	11	21	21			
	2	11	24	24			
	3	11	27	27			
	4	11	30	30			
	5	11	35	35			
G. Single Axle Triples (& Quadruples)	1	11	27	27	27		
	2	11	35	35	35		
	3	11	21	21	21		
	4	11	24	24	24		
	5	11	27	27	27	27	
H. B-Train	1	11	27	27			
	2	11	30	30			
	3	11	35	35			

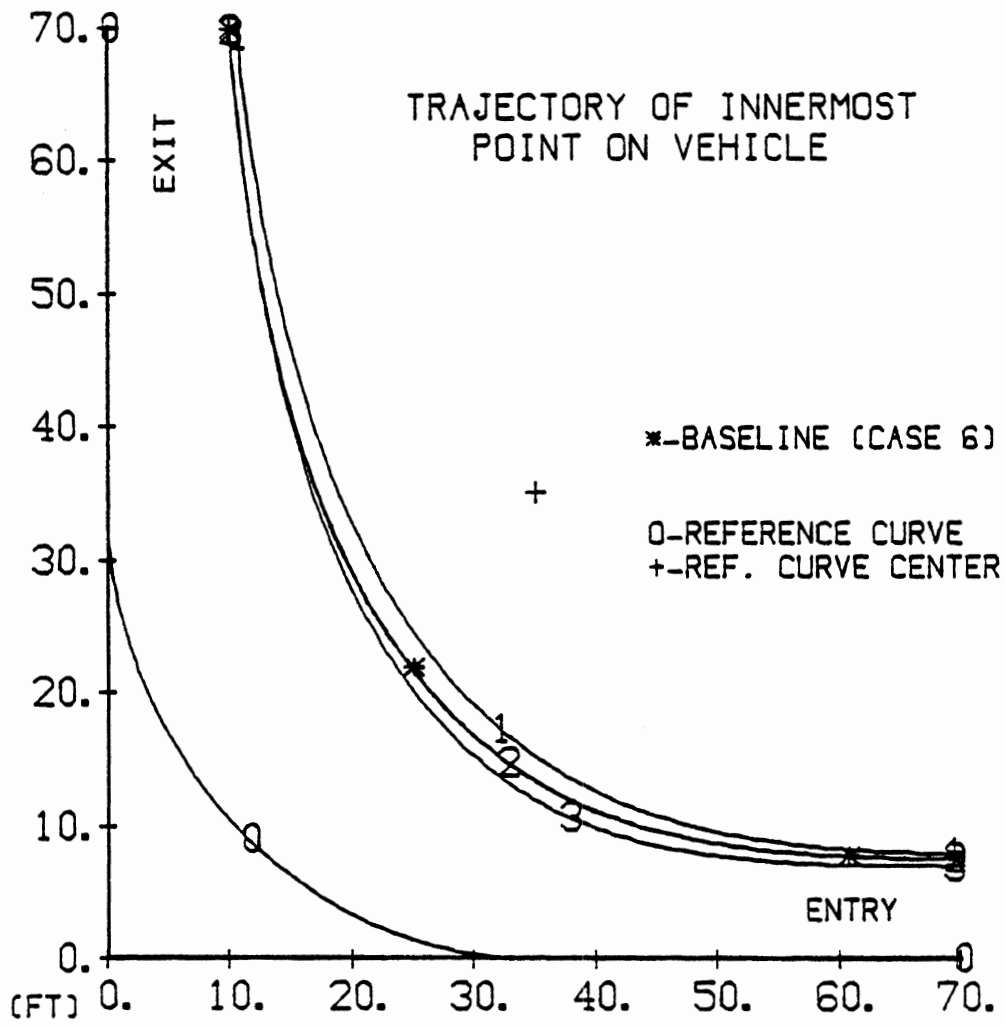


OFF-TRACKING
90 DEG TURN, 35 FT RADIUS

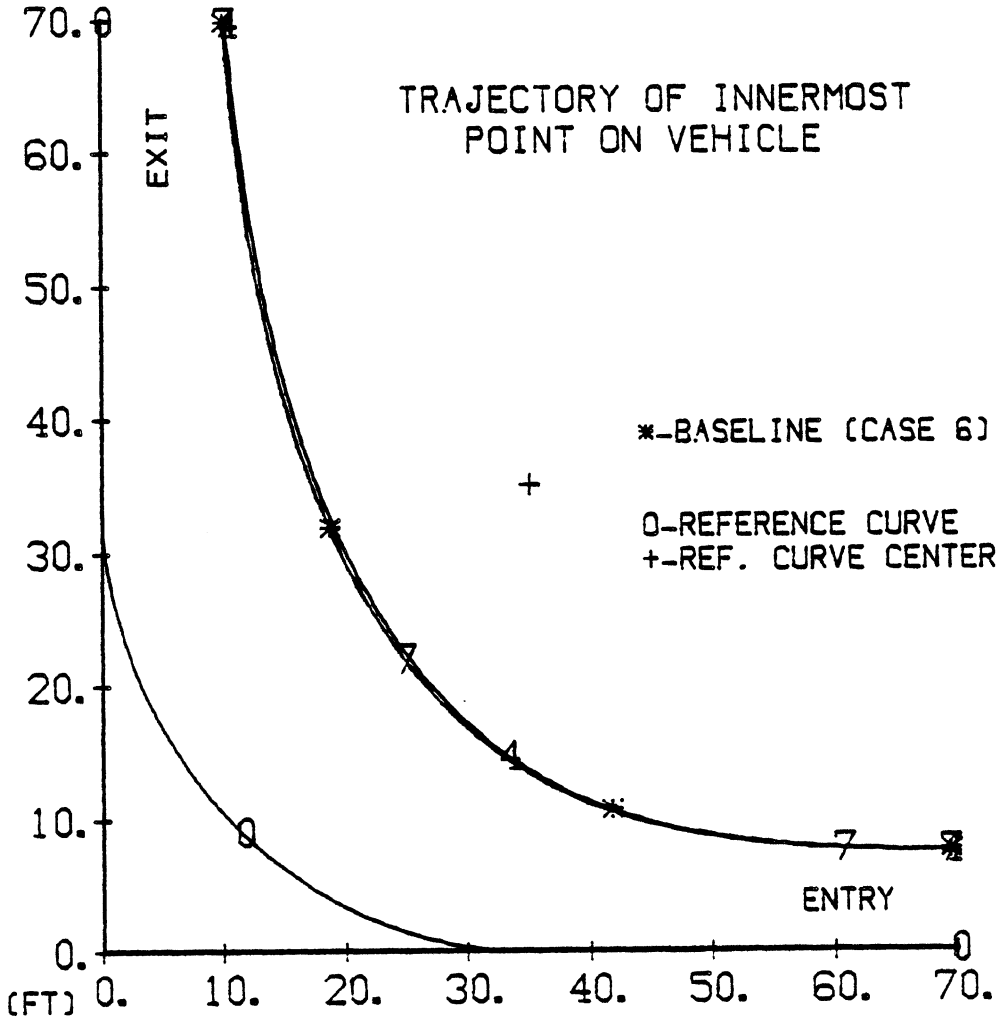
TRUCK/FULL TRAILER - SHORT TONGUE
(TRUCK WHEELBASE VARIATION)



TRUCK/FULL TRAILER - SHORT TONGUE
(TRAILER LENGTH VARIATION)

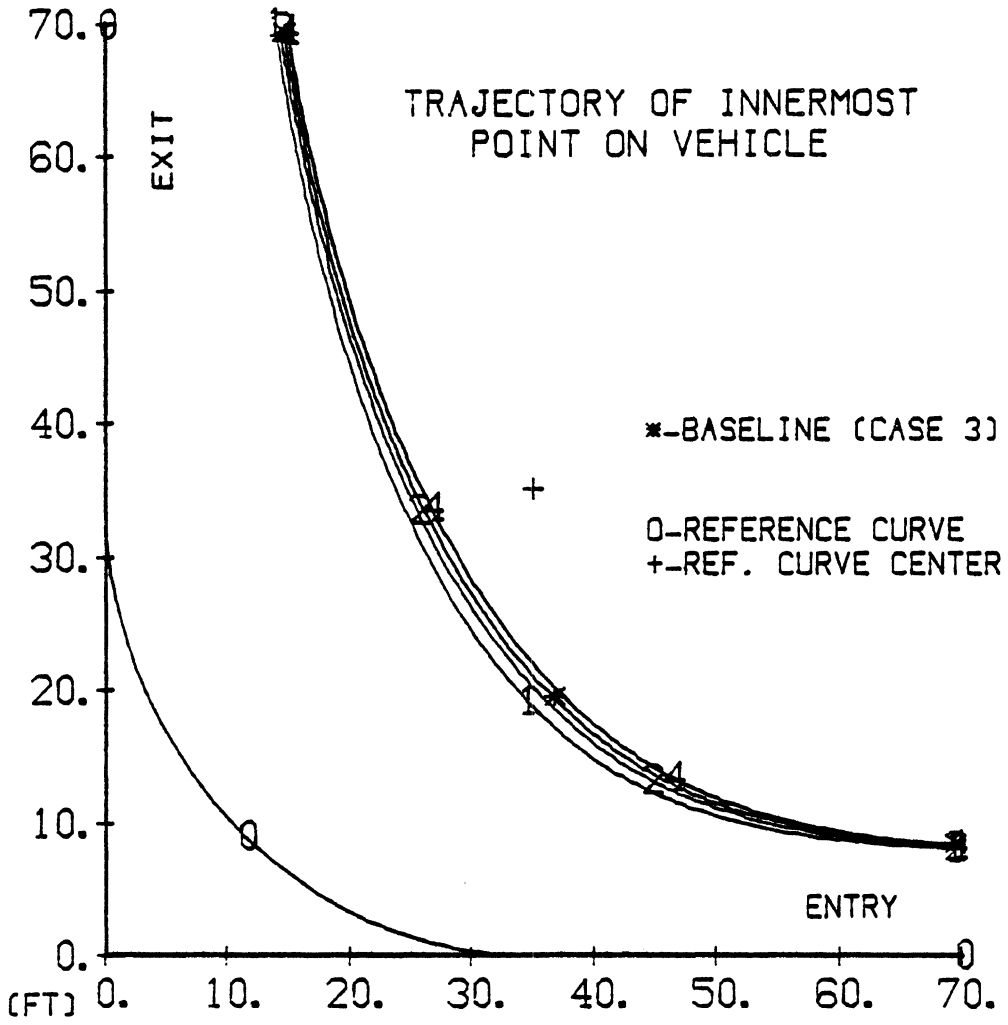


TRUCK/FULL TRAILER - LONG TONGUE
(TRUCK WHEELBASE VARIATION)



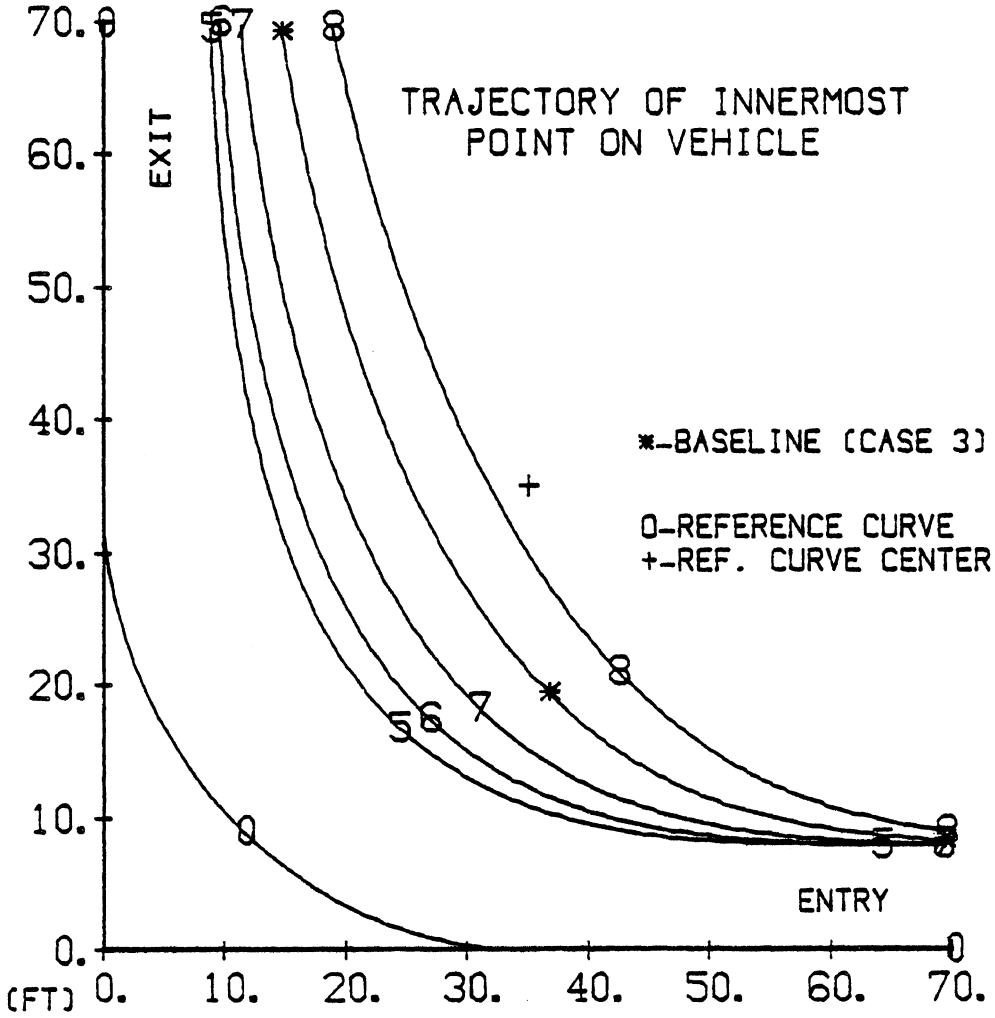
OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

TRUCK/FULL TRAILER - LONG TONGUE
(TRAILER LENGTH VARIATION)



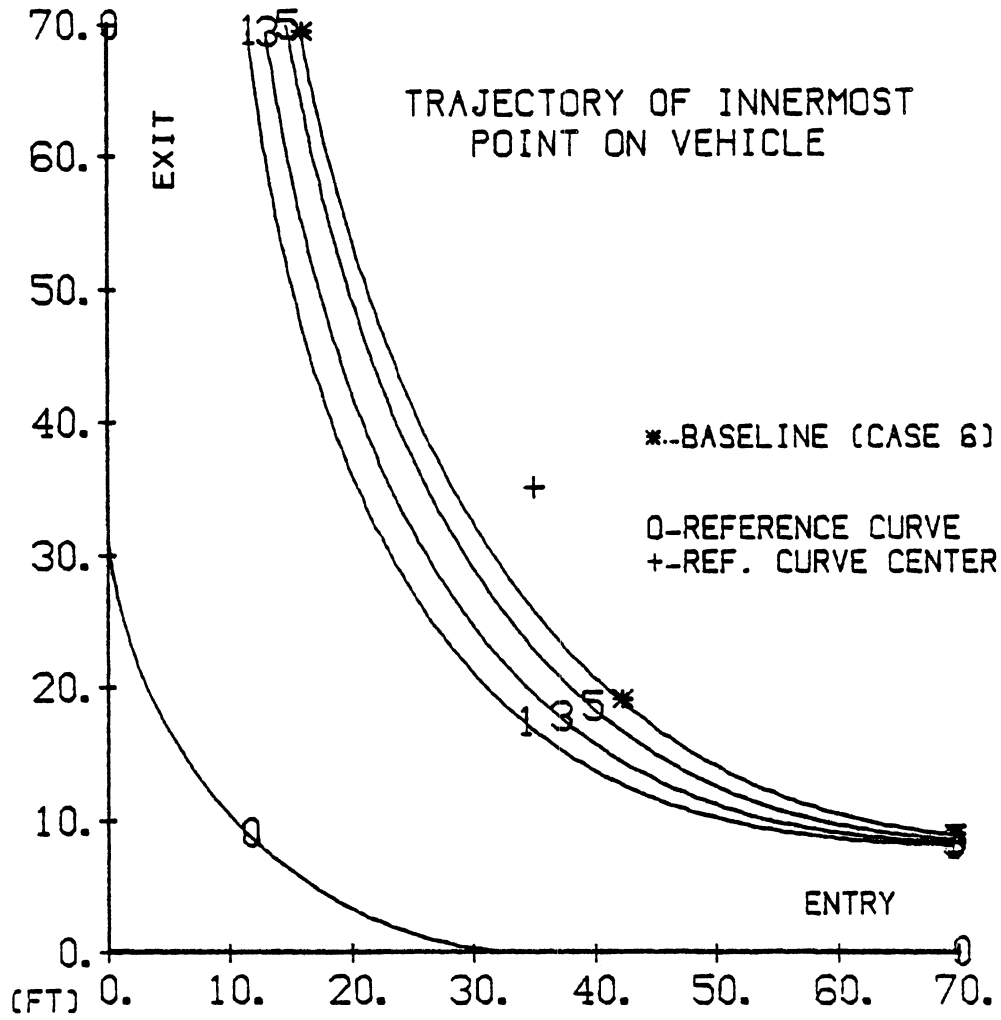
OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

TRACTOR+45 FT SEMITRAILER
(TRACTOR WHEELBASE VARIATION)

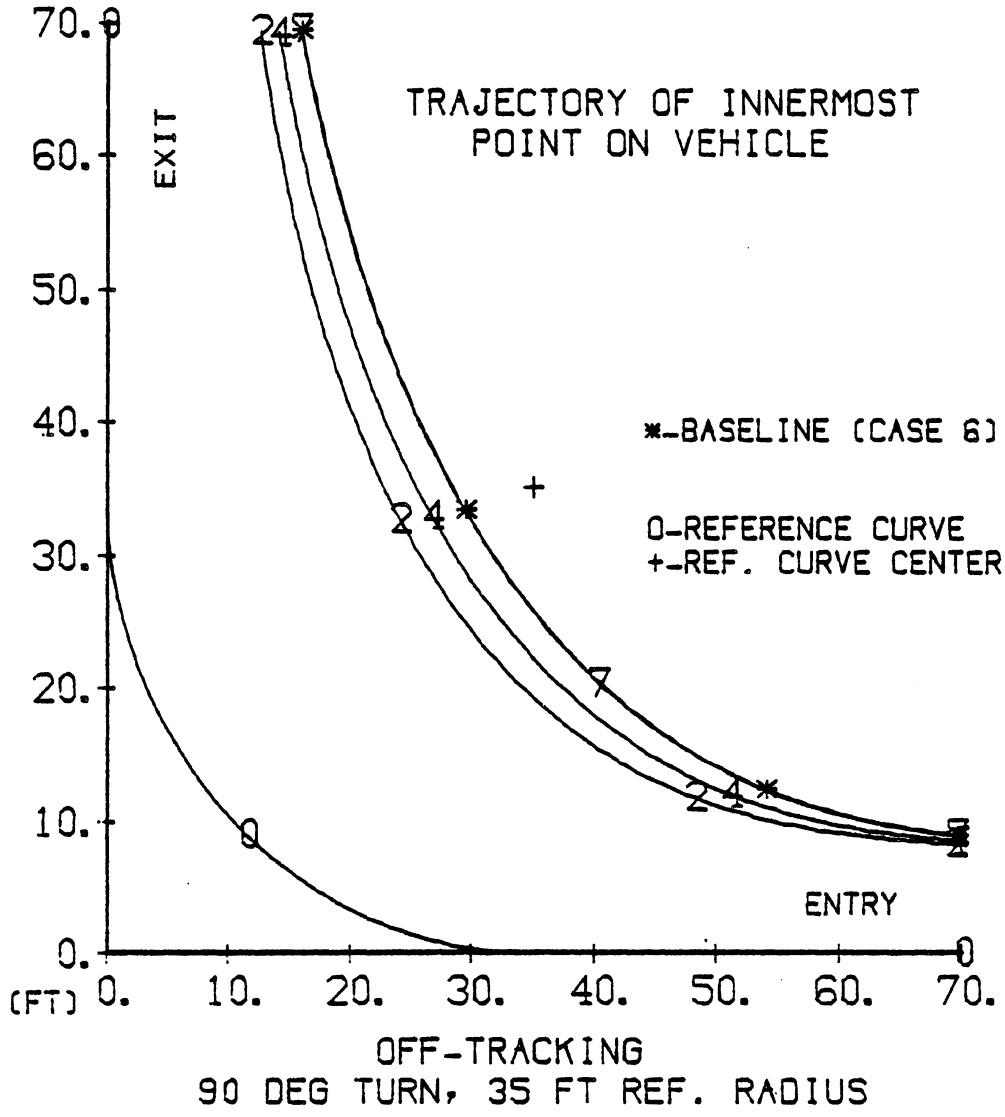


OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

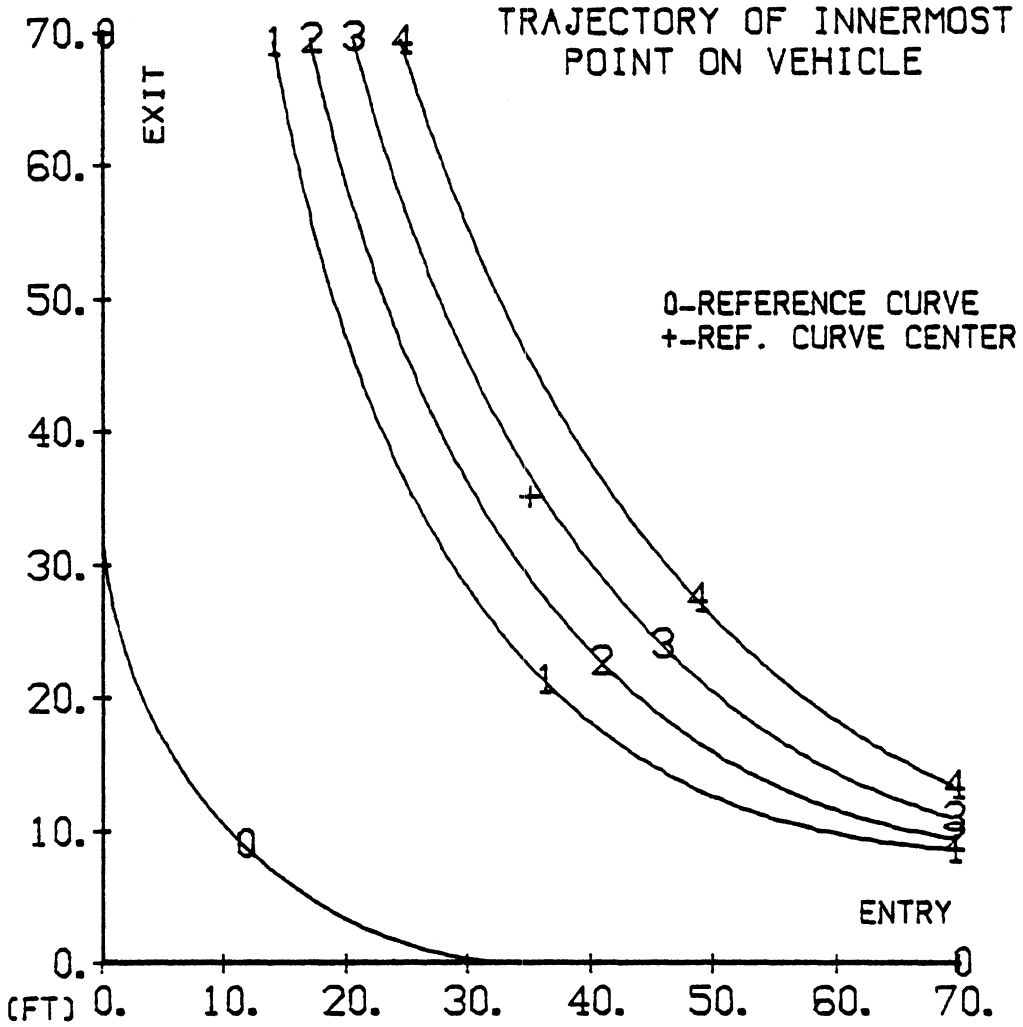
TRACTOR (18 FT WB) + SEMITRAILER
(SEMITRAILER LENGTH VARIATION)



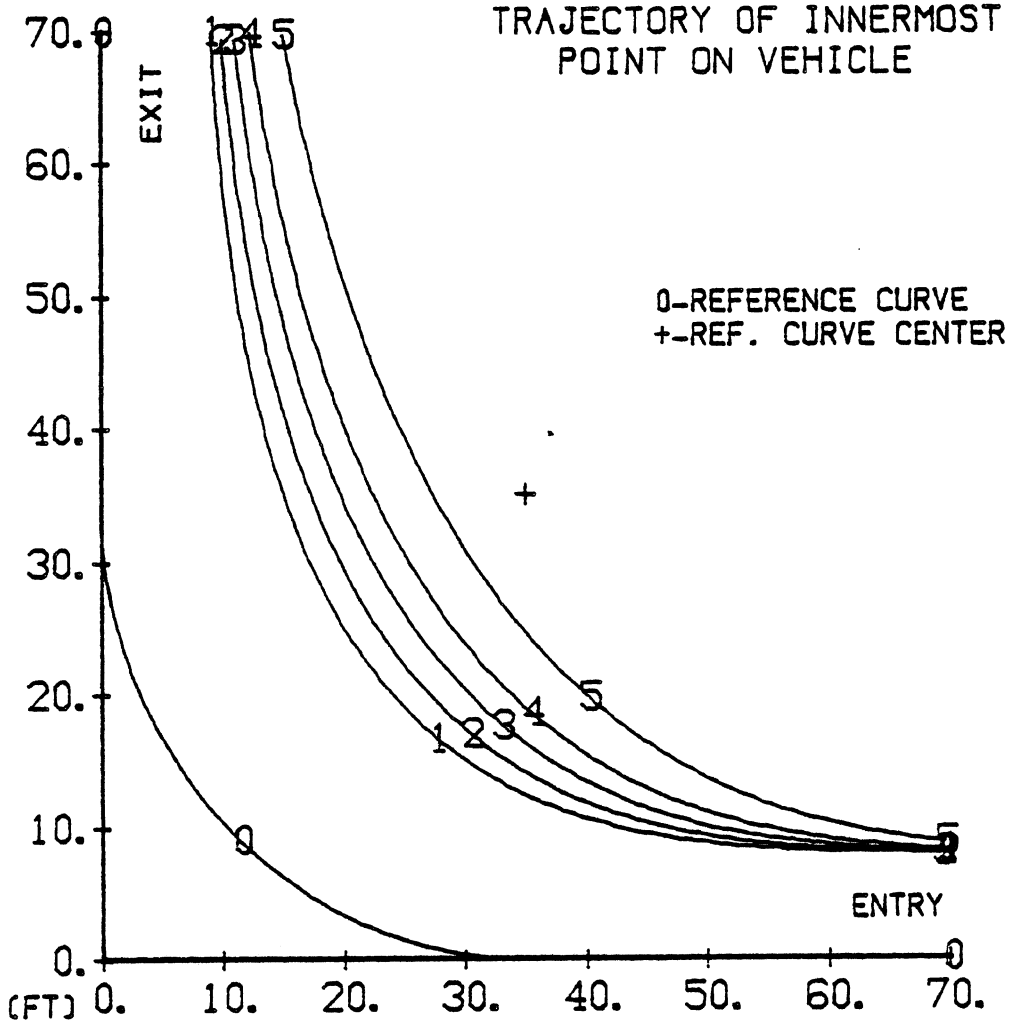
ROCKY MOUNTAIN DOUBLES



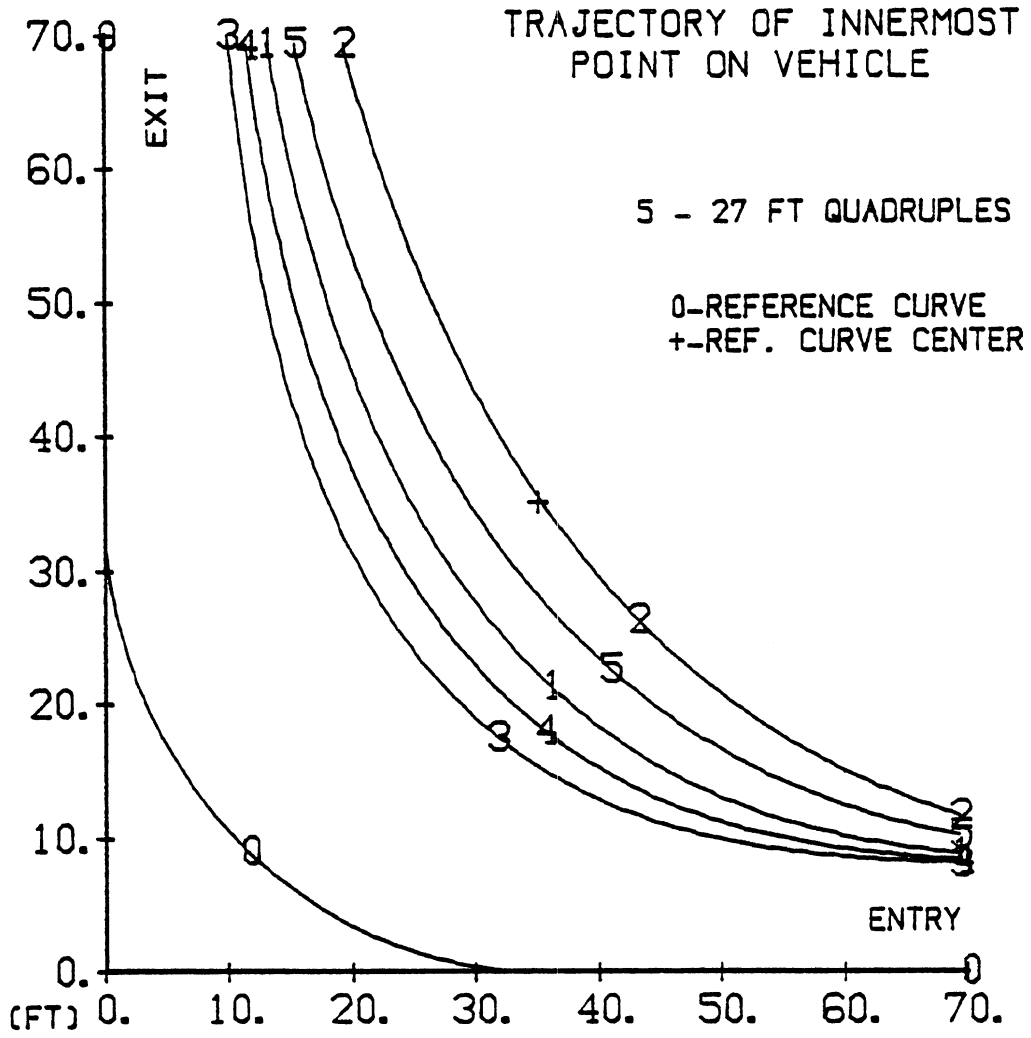
ROCKY MOUNTAIN DOUBLES

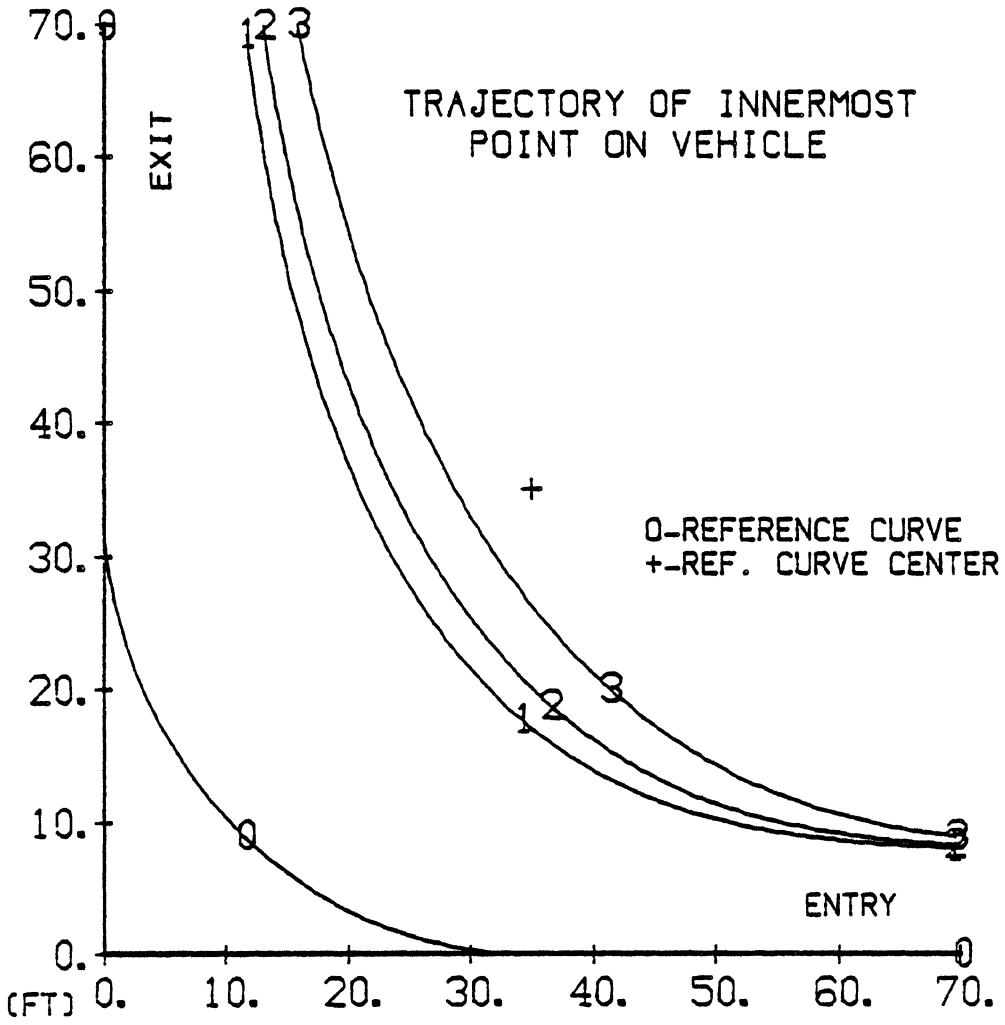


TURNPIKE DOUBLES



SINGLE AXLE DOUBLES


TRAJECTORY OF INNERMOST
POINT ON VEHICLE
5 - 27 FT QUADRUPLES
0-REFERENCE CURVE
+-REF. CURVE CENTER
EXIT
ENTRY
70.
60.
50.
40.
30.
20.
10.
0.
(FT) 0.
10.
20.
30.
40.
50.
60.
70.
OFF-TRACKING
90 DEG TURN, 35 FT RADIUS
SINGLE AXLE TRIPLES
(AND QUADRUPLES)


70.
60.
50.
40.
30.
20.
10.
0.
EXIT
TRAJECTORY OF INNERMOST
POINT ON VEHICLE
0-REFERENCE CURVE
+-REF. CURVE CENTER
ENTRY
(FT) 0. 10. 20. 30. 40. 50. 60. 70.
OFF-TRACKING
90 DEG TURN, 35 FT REF. RADIUS

B-TRAIN

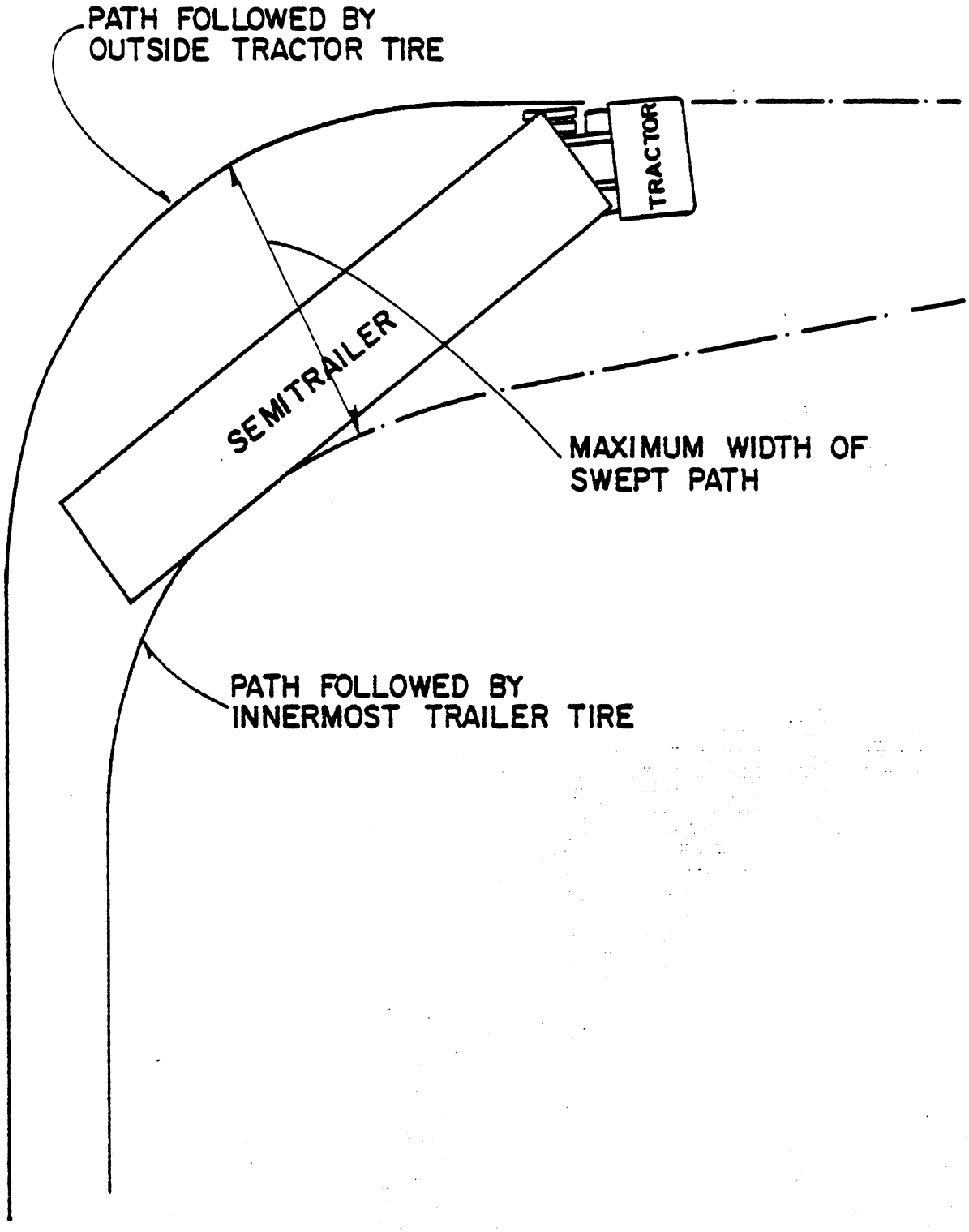
Low- and High-Speed Offtracking -- Numerical Results

On the following pages are presented tabular values of measures depicting specific low- and high-speed offtracking performance for all of the vehicle configurations examined under the "length" issue. The "low-speed offtracking" performance measure represents a zero-speed turning maneuver through a 90-degree intersection. The outside front tire on the tractor steering axle is caused to track along a reference curve of 35-foot radius. The measure of offtracking, called Maximum Path Width, describes the maximum projected width of the vehicle occurring during the turn, measured from the outside edge of the front tire on the tractor steering axle to the inside edge of the inside tire on the rearmost trailer axle. The maximum path width is listed for each vehicle case, measured in feet.

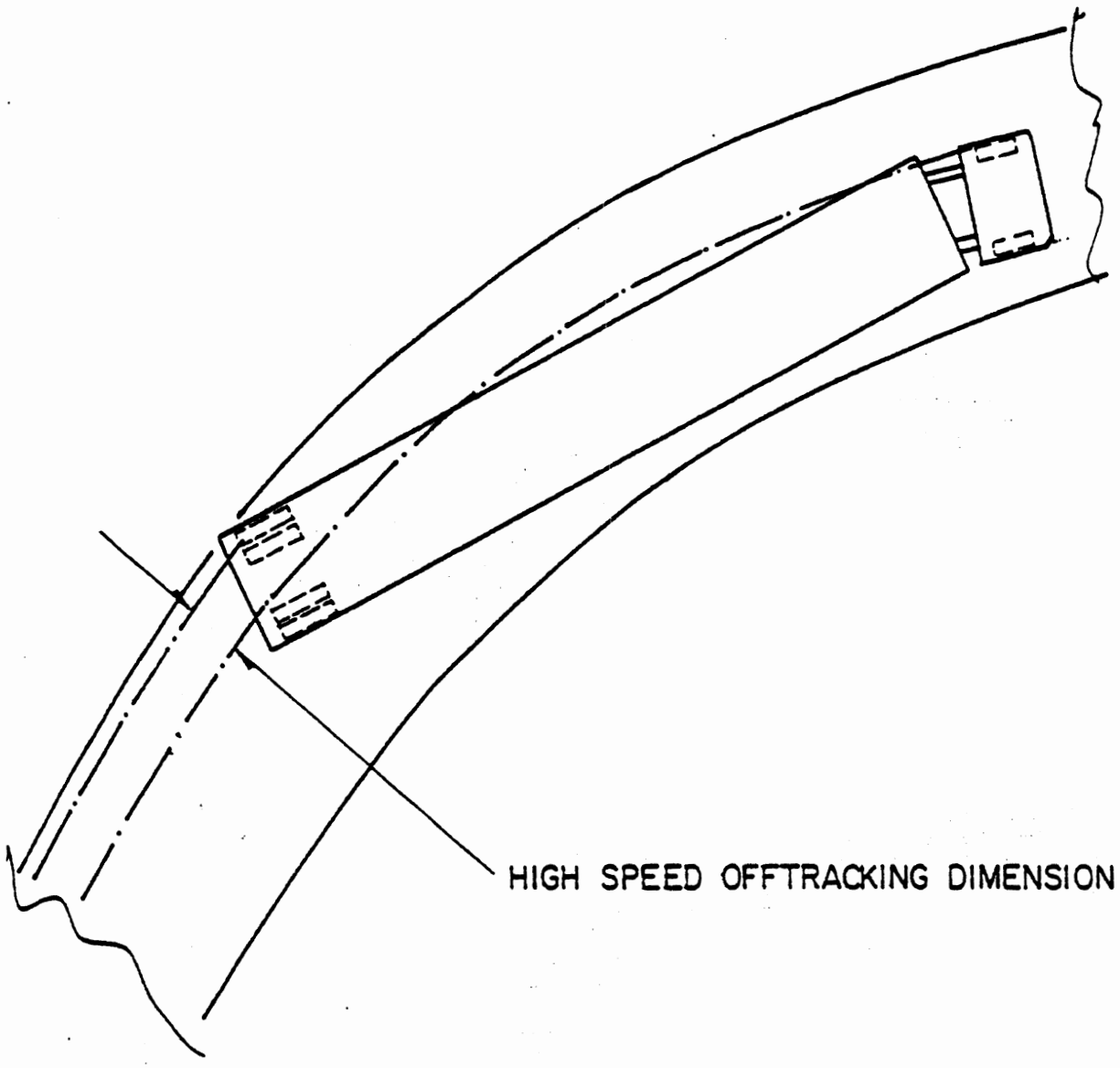
For each vehicle case, the number of the vehicle unit (tractor, trailer, or dolly) is listed, together with the dimensions, in inches, of the nominal wheelbase of each unit and the longitudinal distance from the center of the rearmost axle (or tandem center, in the case of a tandem pair) to the next hitch point. This distance pertains, for example, to kingpin offsets on tractors and dollies and to the overhang distance to the pintle hook at the rear of a straight truck or trailer. The longitudinal distance to the hitch is expressed as positive if the hitch is ahead of the rear axle (or tandem) center.

The same geometric input data defining the vehicles were used in calculations of high-speed offtracking. The reference turn employed in the high-speed offtracking cases involved a 600-foot (183-m) curve at a speed of 55 mph (88 km/h). The resulting high-speed offtracking measure is defined as the radial distance from the reference curve (which is tracked, in this case, by the center of the tractor steering axle) to the center of the rearmost trailer axle (or tandem center). The high-speed offtracking measures are listed at the right side of the sheet adjacent to the computer-printed results from the low-speed offtracking calculations.

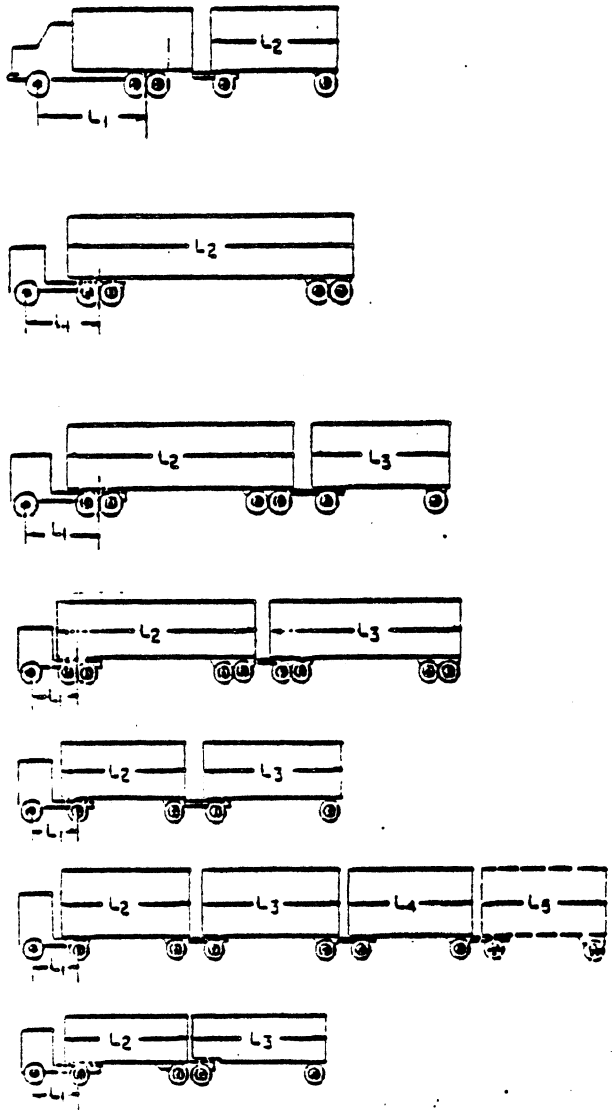
The low- and high-speed offtracking measures are illustrated, respectively, in the next two figures.



Low Speed Offtracking in a 90° Intersection Turn



High Speed Offtracking in a Steady Turn



Vehicle / Case		Length, ft L_1	L_2	L_3	L_4	L_5
B. Truck/ Full Trailer	1	16	22			
	2	20	22			
	3	24	22			
	4	20	16			
	5	20	18			
	6	20	20			
	7	20	24			
C. Tractor Semitrailer	1	12	45			
	2	16	45			
	3	18	45			
	4	20	45			
	5	18	21			
	6	18	27			
	7	18	35			
	8	18	55			
D. Rocky Mtn. Doubles	1	12	35	21		
	2	12	35	27		
	3	12	40	21		
	4	12	40	27		
	5	12	45	21		
	6	12	45	27		
	7	12	27	45	(Single axle trailer first, tandem daily on 2nd trailer)	
E. Turnpike Doubles	1	12	35	35		
	2	12	40	40		
	3	12	45	45		
	4	12	50	50		
F. Single Axle Doubles	1	11	21	21		
	2	11	24	24		
	3	11	27	27		
	4	11	30	30		
	5	11	35	35		
G. Single Axle Triples (& Quadruples)	1	11	27	27	27	
	2	11	35	35	35	
	3	11	21	21	21	
	4	11	24	24	24	
	5	11	27	27	27	27
H. B-Train	1	11	27	27		
	2	11	30	30		
	3	11	35	35		

Length Variations

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	192.000	-63.726
2	73.000	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	15.686	
MIN. INSTANTAENOUS RADIUS	44.299	
LAST UNIT HEADING ANGLE	60.442	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	18.195	25.480
- MIN. TURNING CENTER	53.249	45.359

HIGH-SPEED OFFTRACKING, FT

1.213

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	16.838	
MIN. INSTANTAENOUS RADIUS	49.068	
LAST UNIT HEADING ANGLE	60.980	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	19.125	26.178
- MIN. TURNING CENTER	58.535	48.041

1.403

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	288.000	-140.589
2	73.000	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	18.105	
MIN. INSTANTAENOUS RADIUS	55.045	
LAST UNIT HEADING ANGLE	61.769	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	20.110	27.017
- MIN. TURNING CENTER	65.083	51.162

1.582

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	130.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	14.792	
MIN. INSTANTAENOUS RADIUS	46.160	
LAST UNIT HEADING ANGLE	63.513	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	16.921	25.973
- MIN. TURNING CENTER	54.656	44.776

1.314

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	154.000	0.0

1.350

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	15.404	
MIN. INSTANTAENOUS RADIUS	46.746	
LAST UNIT HEADING ANGLE	62.457	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	17.635	25.919
- MIN. TURNING CENTER	55.536	45.685

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 6.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	178.000	0.0

1.380

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	16.090	
MIN. INSTANTAENOUS RADIUS	47.837	
LAST UNIT HEADING ANGLE	61.685	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	18.349	26.036
- MIN. TURNING CENTER	56.942	46.829

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 7.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	226.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	17.641	
MIN. INSTANTANEOUS RADIUS	50.686	
LAST UNIT HEADING ANGLE	60.529	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF TRACKING POINT	19.878	26.476
- MIN. TURNING CENTER	60.523	49.444

1.419

70

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, SHORT TONGUE, CASE 8.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	73.000	1.000
3	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	18.931	
MIN. INSTANTANEOUS RADIUS	53.115	
LAST UNIT HEADING ANGLE	59.844	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF TRACKING POINT	21.131	26.885
- MIN. TURNING CENTER	63.599	51.558

1.431

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	192.000	-63.726
2	269.274	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	20.868	
MIN. INSTANTAENOUS RADIUS	53.367	
LAST UNIT HEADING ANGLE	56.828	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	23.155	27.292
- MIN. TURNING CENTER	64.477	54.303

1.443

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	182.843	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.088	
MIN. INSTANTAENOUS RADIUS	51.375	
LAST UNIT HEADING ANGLE	58.069	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	21.488	26.598
- MIN. TURNING CENTER	61.694	51.655

1.586

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

1.633

TRUCK/FULL TRAILER, LONG TONGUE, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	288.000	-140.589
2	96.411	1.000
3	202.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	18.406	
MIN. INSTANTAENOUS RADIUS	54.754	
LAST UNIT HEADING ANGLE	61.162	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF TRACKING POINT	20.450	27.021
- MIN. TURNING CENTER	64.909	51.502

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

1.542

TRUCK/FULL TRAILER, LONG TONGUE, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	254.843	1.000
3	130.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.567	
MIN. INSTANTAENOUS RADIUS	52.611	
LAST UNIT HEADING ANGLE	58.339	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF TRACKING POINT	21.891	26.856
- MIN. TURNING CENTER	63.267	52.372

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 5.

INPUT GEOMETRY OF COMBINATION (IN.) :

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	230.843	1.000
3	154.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.266	
MIN. INSTANTANEOUS RADIUS	51.755	
LAST UNIT HEADING ANGLE	58.107	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	21.653	26.668
- MIN. TURNING CENTER	62.199	51.898

1.570

73

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 6.

INPUT GEOMETRY OF COMBINATION (IN.) :

E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	206.843	1.000
3	178.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.106	
MIN. INSTANTANEOUS RADIUS	51.280	
LAST UNIT HEADING ANGLE	57.955	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	21.544	26.541
- MIN. TURNING CENTER	61.620	51.627

1.585

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 7.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	158.843	1.000
3	226.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.214	
MIN. INSTANTANEOUS RADIUS	51.801	
LAST UNIT HEADING ANGLE	58.243	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	21.573	26.699
- MIN. TURNING CENTER	62.218	51.857

1.574

74

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRUCK/FULL TRAILER, LONG TONGUE, CASE 8.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	-102.157
2	122.843	1.000
3	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.675	
MIN. INSTANTANEOUS RADIUS	53.371	
LAST UNIT HEADING ANGLE	58.730	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	21.899	27.049
- MIN. TURNING CENTER	64.099	52.676

1.531

>>>>> >> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	25.101	
MIN. INSTANTAENOUS RADIUS	68.237	
LAST UNIT HEADING ANGLE	60.244	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	26.425	30.055
- MIN. TURNING CENTER	82.193	61.936

0.5285

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	192.000	19.137
2	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	26.034	
MIN. INSTANTAENOUS RADIUS	68.603	
LAST UNIT HEADING ANGLE	59.283	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	27.300	30.406
- MIN. TURNING CENTER	82.840	63.406

0.572

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	216.000	21.529
2	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	26.589	
MIN. INSTANTAENOUS RADIUS	69.239	
LAST UNIT HEADING ANGLE	58.860	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	27.791	30.667
- MIN. TURNING CENTER	83.630	64.403

0.584

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	240.000	23.921
2	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	27.196	
MIN. INSTANTAENOUS RADIUS	70.027	
LAST UNIT HEADING ANGLE	58.443	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	28.338	30.936
- MIN. TURNING CENTER	84.601	65.491

0.590

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	216.000	21.529
2	166.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	15.100	
MIN. INSTANTAENOUS RADIUS	42.429	
LAST UNIT HEADING ANGLE	60.884	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	17.628	25.294
- MIN. TURNING CENTER	51.201	43.992

0.710

77

>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 6.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	216.000	21.529
2	238.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	17.501	
MIN. INSTANTAENOUS RADIUS	47.821	
LAST UNIT HEADING ANGLE	59.647	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	19.915	26.131
- MIN. TURNING CENTER	57.729	48.275

0.768

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 7.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	216.000	21.529
2	334.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	21.283	
MIN. INSTANTANEOUS RADIUS	56.781	
LAST UNIT HEADING ANGLE	59.153	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	23.204	27.999
- MIN. TURNING CENTER	68.519	55.062

0.753

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TRACTOR SEMITRAILER, CASE 8.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	216.000	21.529
2	574.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	32.291	
MIN. INSTANTANEOUS RADIUS	82.867	
LAST UNIT HEADING ANGLE	58.726	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	32.675	33.610
- MIN. TURNING CENTER	100.082	74.552

0.249

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TURNPIKE DOUBLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	334.000	-50.000
3	73.000	1.000
4	334.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	26.990	
MIN. INSTANTANEOUS RADIUS	65.402	
LAST UNIT HEADING ANGLE	55.840	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	28.369	30.505
- MIN. TURNING CENTER	79.178	64.983

1.473

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TURNPIKE DOUBLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	394.000	-50.000
3	73.000	1.000
4	394.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	31.417	
MIN. INSTANTANEOUS RADIUS	74.596	
LAST UNIT HEADING ANGLE	65.475	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	32.083	32.920
- MIN. TURNING CENTER	90.245	72.931

1.346

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TURNPIKE DOUBLES, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	454.000	-50.000
3	73.000	1.000
4	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	35.964	
MIN. INSTANTAENOUS RADIUS	84.128	
LAST UNIT HEADING ANGLE	55.236	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	35.821	35.508
- MIN. TURNING CENTER	101.647	81.197

1.135

80

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

TURNPIKE DOUBLES, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L. = POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	514.000	-50.000
3	73.000	1.000
4	514.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	40.594	
MIN. INSTANTAENOUS RADIUS	93.953	
LAST UNIT HEADING ANGLE	55.099	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	39.548	38.258
- MIN. TURNING CENTER	113.322	89.726

0.847

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE DOUBLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	190.000	-26.000
3	73.000	1.000
4	190.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	17.124	
MIN. INSTANTAENOUS RADIUS	44.306	
LAST UNIT HEADING ANGLE	56.868	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	20.053	25.194
- MIN. TURNING CENTER	53.806	47.224

1.313

81

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE DOUBLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	226.000	-26.000
3	73.000	1.000
4	226.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	19.391	
MIN. INSTANTAENOUS RADIUS	49.287	
LAST UNIT HEADING ANGLE	56.699	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	21.927	26.472
- MIN. TURNING CENTER	59.778	51.336

1.3666

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

1.390

SINGLE AXLE DOUBLES, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	262.000	-26.000
3	73.000	1.000
4	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	21.795	
MIN. INSTANTAENOUS RADIUS	54.261	
LAST UNIT HEADING ANGLE	56.306	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	24.016	27.670
- MIN. TURNING CENTER	65.834	55.553

82

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

1.384

SINGLE AXLE DOUBLES, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	298.000	-26.000
3	73.000	1.000
4	298.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	24.302	
MIN. INSTANTAENOUS RADIUS	59.598	
LAST UNIT HEADING ANGLE	56.078	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	26.119	29.036
- MIN. TURNING CENTER	72.255	60.063

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE DOUBLES, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	358.000	-26.000
3	73.000	1.000
4	358.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	28.648	
MIN. INSTANTAENOUS RADIUS	68.771	
LAST UNIT HEADING ANGLE	55.722	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	29.755	31.417
- MIN. TURNING CENTER	83.275	67.897

1.307

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	262.000	-26.000
3	73.000	1.000
4	262.000	-26.000
5	73.000	1.000
6	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	26.495	
MIN. INSTANTAENOUS RADIUS	61.704	
LAST UNIT HEADING ANGLE	53.781	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	28.132	29.984
- MIN. TURNING CENTER	74.686	64.079

2.101

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	358.000	-26.000
3	73.000	1.000
4	358.000	-26.000
5	73.000	1.000
6	358.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	35.371	
MIN. INSTANTAENOUS RADIUS	79.459	
LAST UNIT HEADING ANGLE	53.334	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	35.291	35.231
- MIN. TURNING CENTER	95.819	80.292

1.976

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	190.000	-26.000
3	73.000	1.000
4	190.000	-26.000
5	73.000	1.000
6	190.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	20.327	
MIN. INSTANTAENOUS RADIUS	49.375	
LAST UNIT HEADING ANGLE	54.275	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF TRACKING POINT	23.082	26.441
- MIN. TURNING CENTER	59.918	52.936

1.985

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE TRIPLES, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	226.000	-26.000
3	73.000	1.000
4	226.000	-26.000
5	73.000	1.000
6	226.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	23.337	
MIN. INSTANTAENOUS RADIUS	55.429	
LAST UNIT HEADING ANGLE	54.047	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	25.534	28.188
- MIN. TURNING CENTER	67.166	58.383

2.066

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

SINGLE AXLE QUADRUPLES (CASE 5).
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	262.000	-26.000
3	73.000	1.000
4	262.000	-26.000
5	73.000	1.000
6	262.000	-26.000
7	73.000	1.000
8	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	30.606	
MIN. INSTANTANEOUS RADIUS	68.444	
LAST UNIT HEADING ANGLE	52.238	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	31.562	32.263
- MIN. TURNING CENTER	82.509	71.727

2.812

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

B-TRAIN, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	302.000	-50.000
3	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	22.764	
MIN. INSTANTANEOUS RADIUS	57.651	
LAST UNIT HEADING ANGLE	56.900	
INSTANTANEOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	24.743	28.328
- MIN. TURNING CENTER	69.687	57.627

1.276

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

B-TRAIN, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	338.000	-50.000
3	298.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	25.353	
MIN. INSTANTAENOUS RADIUS	63.118	
LAST UNIT HEADING ANGLE	56.554	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	26.925	29.722
- MIN. TURNING CENTER	76.254	62.304

1.253

87

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

B-TRAIN, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	132.000	21.345
2	398.000	-50.000
3	358.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	29.804	
MIN. INSTANTAENOUS RADIUS	72.401	
LAST UNIT HEADING ANGLE	56.055	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	30.660	32.142
- MIN. TURNING CENTER	87.404	70.336

1.148

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 1.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	334.000	-50.000
3	73.000	1.000
4	190.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	22.431	
MIN. INSTANTAENOUS RADIUS	56.087	
LAST UNIT HEADING ANGLE	56.858	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	24.459	28.155
- MIN. TURNING CENTER	68.073	56.632

1.456

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 2.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	334.000	-50.000
3	73.000	1.000
4	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	24.536	
MIN. INSTANTAENOUS RADIUS	60.318	
LAST UNIT HEADING ANGLE	56.152	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	26.288	29.203
- MIN. TURNING CENTER	73.061	60.572

1.494

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 3.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	394.000	-50.000
3	73.000	1.000
4	190.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	24.925	
MIN. INSTANTANEOUS RADIUS	61.490	
LAST UNIT HEADING ANGLE	56.970	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF TRACKING POINT	26.536	29.536
- MIN. TURNING CENTER	74.734	60.872

1.392

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 4.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	394.000	-50.000
3	73.000	1.000
4	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	26.919	
MIN. INSTANTANEOUS RADIUS	65.391	
LAST UNIT HEADING ANGLE	56.146	
INSTANTANEOUS LOCATION OF: -	X	Y
- MAX. OFF TRACKING POINT	28.261	30.540
- MIN. TURNING CENTER	79.244	64.740

1.431

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 5.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	454.000	-50.000
3	73.000	1.000
4	190.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	27.552	
MIN. INSTANTAENOUS RADIUS	67.208	
LAST UNIT HEADING ANGLE	57.089	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	28.736	30.971
- MIN. TURNING CENTER	81.800	65.314

1.287

90

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 6.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	454.000	-50.000
3	73.000	1.000
4	262.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	29.440	
MIN. INSTANTAENOUS RADIUS	70.708	
LAST UNIT HEADING ANGLE	56.175	
INSTANTAENOUS LOCATION OF:	X	Y
- MAX. OFF-TRACKING POINT	30.368	31.924
- MIN. TURNING CENTER	85.785	69.057

1.325

>>>>>>>> ZERO SPEED OFF-TRACKING CALCULATION <<<<<<<<

ZERO SPEED OFF-TRACKING - 90 DEGREES, 35.0 FT. RADIUS.

ROCKY MOUNTAIN DOUBLES, CASE 7.
INPUT GEOMETRY OF COMBINATION (IN.) :
E = DISTANCE FROM REAR AXLE/S C.L. TO ARTICULATION JOINT
FOR NEXT UNIT (AHEAD OF AXLE/S C.L.= POSITIVE SIGN).

UNIT	WHEELBASE	E
1	144.000	14.353
2	262.000	-26.000
3	73.000	1.000
4	454.000	0.0

CONDITION OF MAXIMUM OFF-TRACKING (FT. ; DEG.) :

REFERENCE :	OUTPUT TRAJECTORY	
MAXIMUM PATH WIDTH	29.456	
MIN. INSTANTAENOUS RADIUS	70.717	
LAST UNIT HEADING ANGLE	56.382	
INSTANTAENOUS LOCATION OF: -	X	Y
- MAX. OFF-TRACKING POINT	30.418	31.878
- MIN. TURNING CENTER	85.977	68.815

1.239

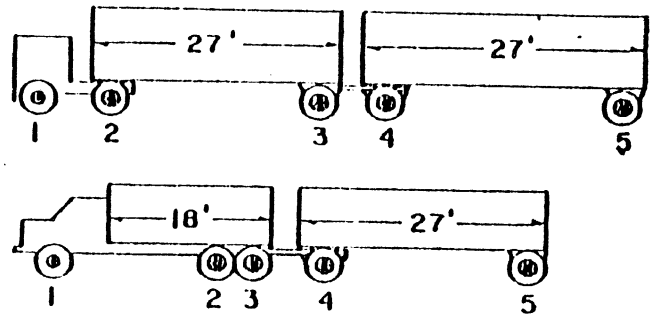
Rearward Amplification - Gross Weight Variation

Maneuver: Continuous steering sinusoid (simplified, linear amplification model)

Speed: 55 mph (88 km/h)

Vehicles: Identified on data sheets by vehicle letter (B,C) and case number (1,2,3, etc.)

(For each case, the maximum numerical values of rearward amplification are first listed as evaluated within the range of steering input frequency from 0 to 3.15 radians/sec (.5 Hz). The term, GM, is used to depict this maximum amplification "gain" exhibited by the overall vehicle combination. Additional "gain components" are also listed, representing the contribution to the total amplification gain attributed to each portion of the vehicle combination (such as that portion of the semitrailer existing between the tractor c.g. and the semitrailer c.g.). Following the numerical data, plots are presented showing the spectrum of rearward amplification levels for each vehicle configuration over a broad range of steering input frequencies.



	CASE	AXLE #	AXLE LOAD, LBS/1000 1	2	3	4	5	GVW
B (Conventional Double)	1	(Baseline)	10	17.5	17.5	17.5	17.5	(80)
	2		10	19.5	19.5	19.5	19.5	(88)
	3		9.3	17	15	17	15	(73.3
	4		12	20	20	20	20	(92)
	5		10	18.5	18.5	18.5	18.5	(84)
C (Truck, Full Trailer)	1	(Baseline)	12	17	17	17	17	(80)
	2		12	17	17	21	21	(88)
	3		10	19	19	20	20	(88)

VEHICLE IENTIFICATION: B1-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.99 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.382

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.256

VEHICLE IENTIFICATION: B2-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.06 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.407

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.277

VEHICLE IENTIFICATION: B3-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.96 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.362

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.256

VEHICLE IENTIFICATION: B4-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.09 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.424

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.282

VEHICLE IENTIFICATION: B5-GW

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

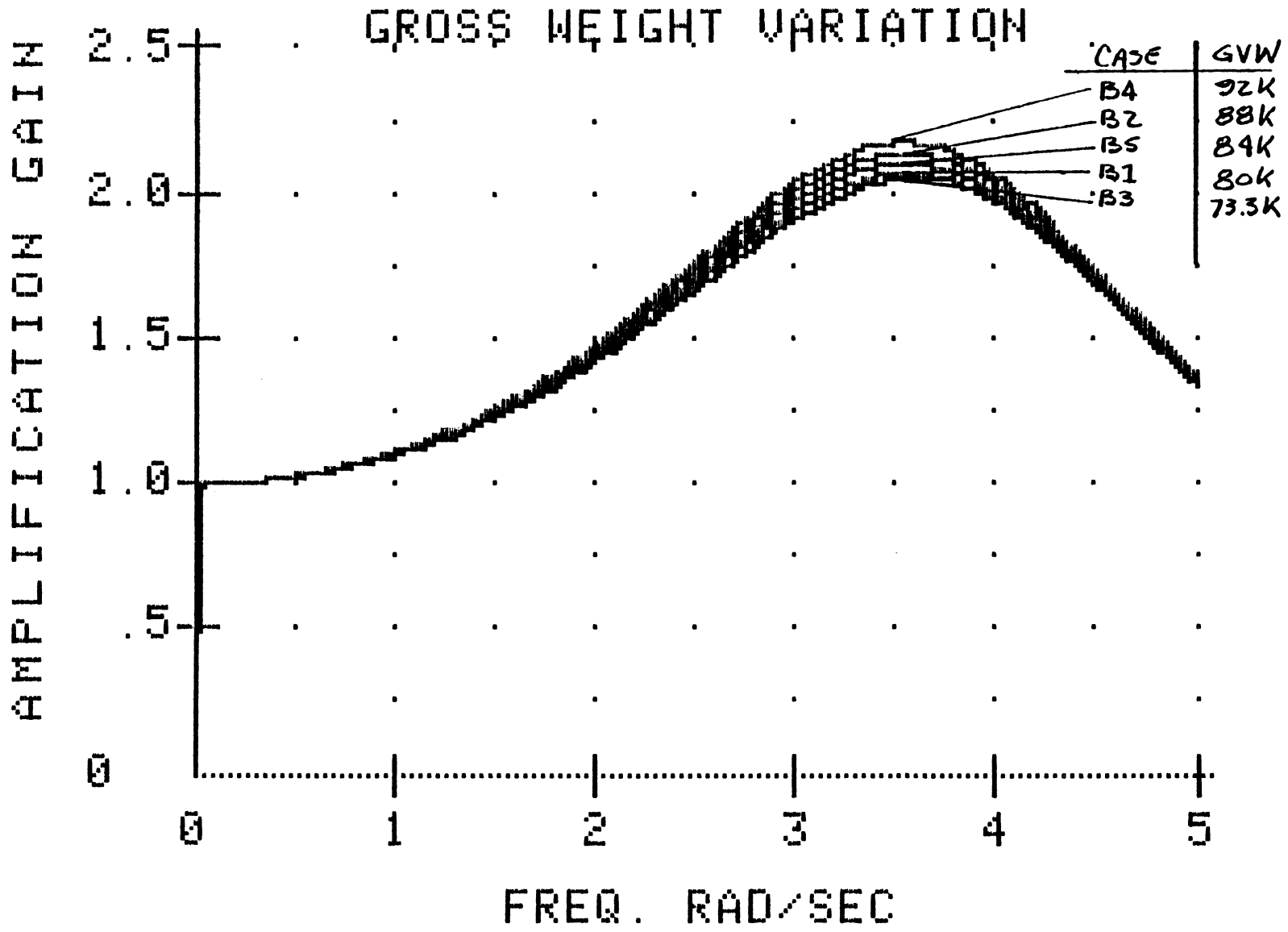
GM= 2.02 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.394

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.266


GROSS WEIGHT VARIATION
AMPLIFICATION GAIN
2.5
2.0
1.5
1.0
.5
0
0
1
2
3
4
5
FREQ. RAD/SEC
CASE
GVW
B4
92K
B2
88K
B5
84K
B1
80K
B3
73.3K

VEHICLE IENTIFICATION: C1-GW

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.95 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.558

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.251

VEHICLE IENTIFICATION: C2-GW

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 2.01 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.558

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.293

VEHICLE IENTIFICATION: C3-GW

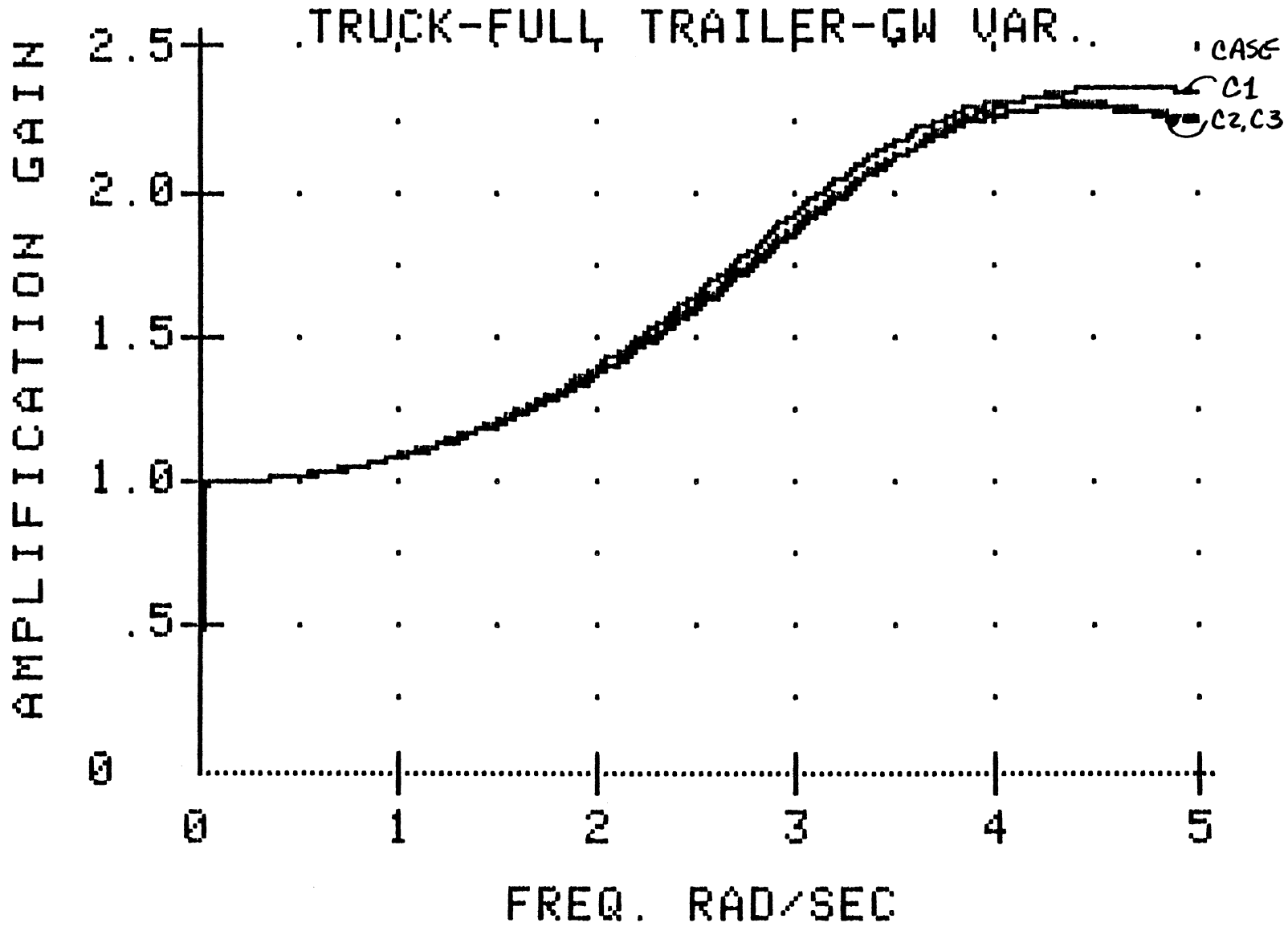
MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.96 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.532

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.282

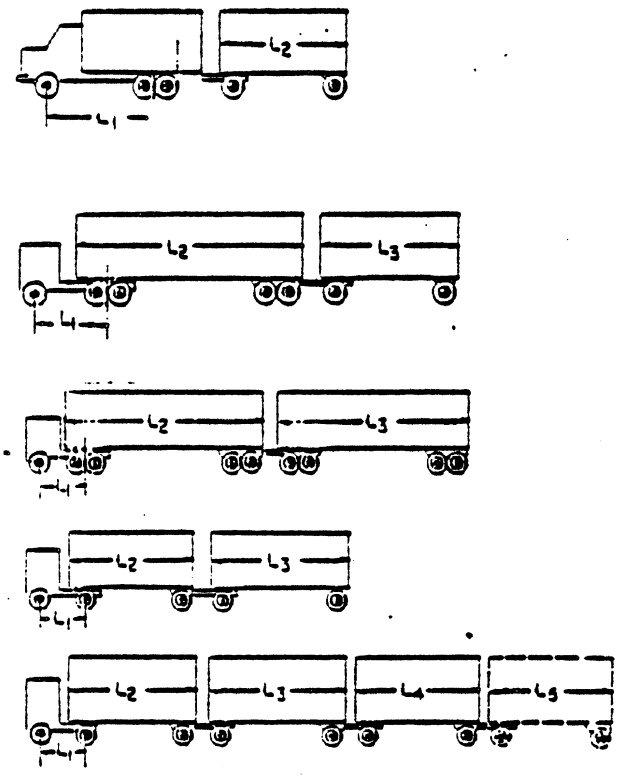

TRUCK-FULL TRAILER-GW VAR..
CASE
C1
C2,C3
AMPLIFICATION GAIN
2.5
2.0
1.5
1.0
.5
0
0
1
2
3
4
5
FREQ. RAD/SEC

Rearward Amplification - Length Variations

Maneuver: Continuous steering sinusoid (using simplified, linear amplification model)

Speed: 55 mph (88 km/h)

Vehicles: All multiply-articulated vehicles except for B-train (vehicles identified by vehicle letter (B,D,E, etc.) and case number (1,2,3, etc.). Note that truck/full trailers are represented in two sets, namely, the set (B1-LEN through B7-LEN) having a fixed drawbar length of 6.1 feet (1.86 m) and the set (B1-LEN-65 through B7-LEN-65) having variable drawbar length and fixed overall length of 65 feet (19.8 m).



Vehicle / Case		Length, ft L_1	L_2	L_3	L_4	L_5
B. Truck/ Full Trailer	1	16	22			
	2	20	22			
	3	24	22			
	4	20	16			
	5	20	18			
	6	20	20			
	7	20	24			
D. Rocky Mtn. Doubles	1	12	35	21		
	2	12	35	27		
	3	12	40	21		
	4	12	40	27		
	5	12	45	21		
	6	12	45	27		
	7	12	27	45—(Single axle trailer first, tandem dolly on 2nd trailer)		
E. Turnpike Doubles	1	12	35	35		
	2	12	40	40		
	3	12	45	45		
	4	12	50	50		
F. Single Axle Doubles	1	11	21	21		
	2	11	24	24		
	3	11	27	27		
	4	11	30	30		
	5	11	35	35		
G. Single Axle Triples (& Quadruples)	1	11	27	27	27	
	2	11	35	35	35	
	3	11	21	21	21	
	4	11	24	24	24	
	5	11	27	27	27	27

TRUCK/FULL TRAILER

VEHICLE IENTIFICATION: B1-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.77 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.366
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.301

VEHICLE IENTIFICATION: B2-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 2.04 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.301

VEHICLE IENTIFICATION: B3-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 2.33 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.794
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.301

VEHICLE IENTIFICATION: B4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.05 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.31

VEHICLE IENTIFICATION: B5-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.06 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.313

VEHICLE IENTIFICATION: B6-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.05 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.569

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.31

VEHICLE IENTIFICATION: B7-LEN

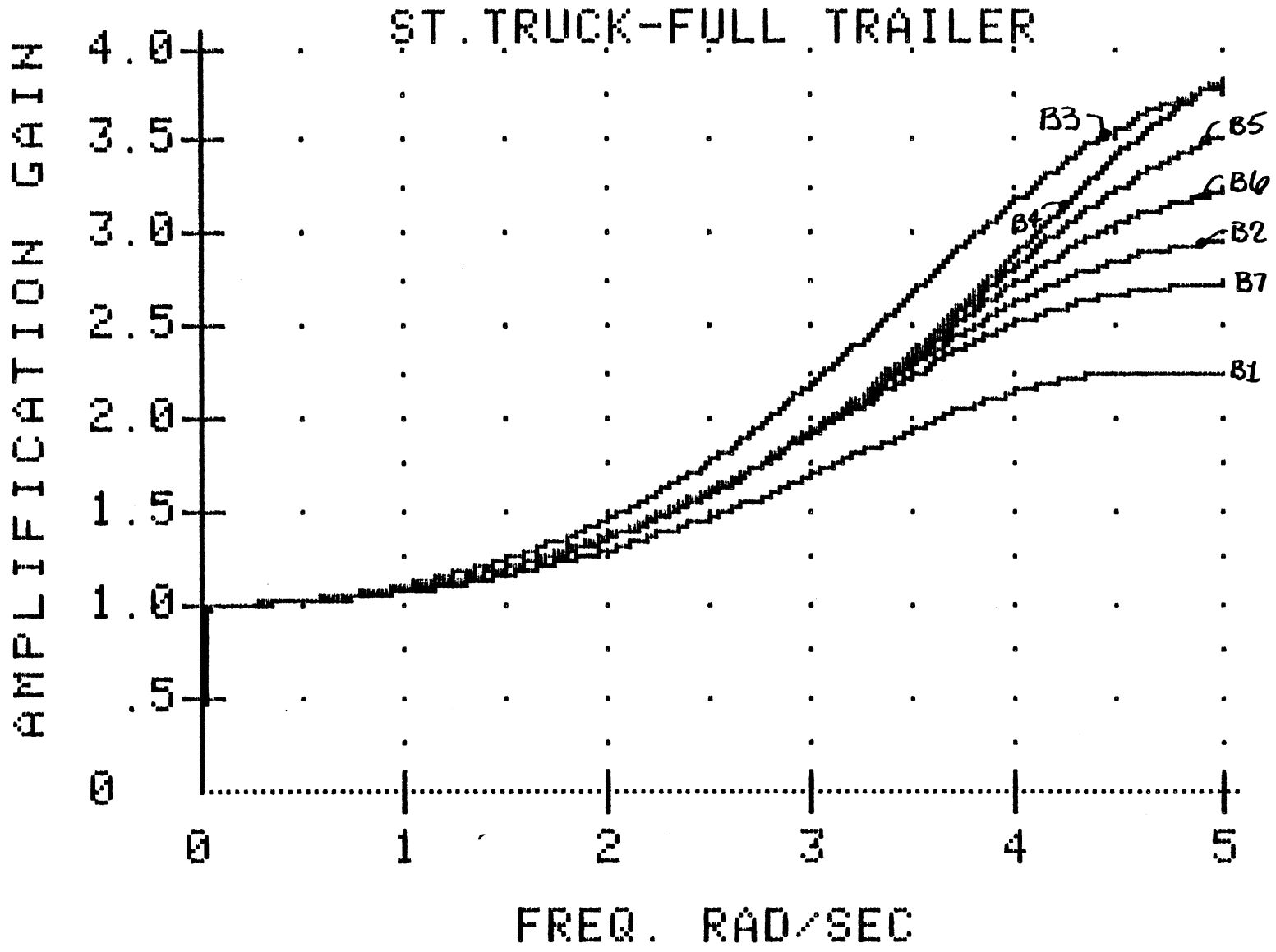
MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.02 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.569

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.287


ST.TRUCK-FULL TRAILER
AMPLIFICATION GAIN
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
0
1
2
3
4
5
FREQ. RAD/SEC
B3
B5
B6
B4
B2
B7
B1

VEHICLE IENTIFICATION: B1-LEN-65

TRUCK/FULL TRAILER

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.21 AT W= 2.45 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 2.45 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.213

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= .999

VEHICLE IENTIFICATION: B2-LEN-65

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.68 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.569

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.072

VEHICLE IENTIFICATION: B3-LEN-65

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 2.3 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK, G2= 1.794

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.282

VEHICLE IENTIFICATION: B4-LEN-65

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.52 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= .971

VEHICLE IENTIFICATION: B5-LEN-65

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.57 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.004

VEHICLE IENTIFICATION: B6-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.62 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.037

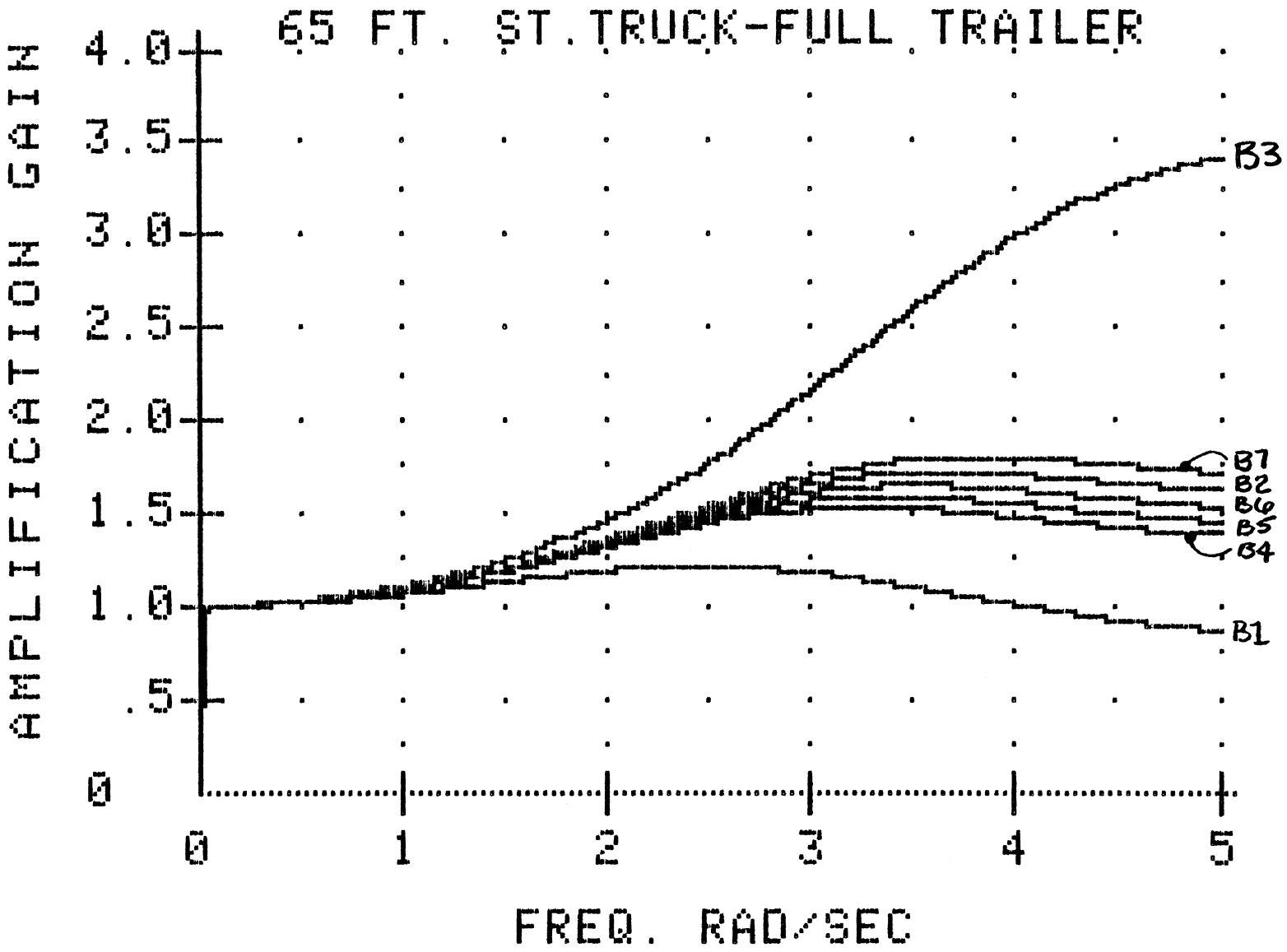
VEHICLE IENTIFICATION: B7-LEN-65

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.73 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

STRAIGHT TRUCK, CG.TO PINTLE HOOK,	G2= 1.569
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.106


65 FT. ST.TRUCK-FULL TRAILER
AMPLIFICATION GAIN
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
0
1
2
3
4
5
FREQ. RAD/SEC
B3
B7
B2
B6
B5
B4
B1

ROCKY MTN. DOUBLES

VEHICLE IENTIFICATION: D1-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.88 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .96

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.509

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.301

VEHICLE IENTIFICATION: D2-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.81 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .96

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.509

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.251

VEHICLE IENTIFICATION: D3-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.68 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .858

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.508

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.301

VEHICLE IENTIFICATION: D4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.61 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .858

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.508

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.251

VEHICLE IENTIFICATION: D5-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.47 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .756

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.495

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.301

VEHICLE IENTIFICATION: D6-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.41 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .756

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.495

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.251

VEHICLE IENTIFICATION: D7-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

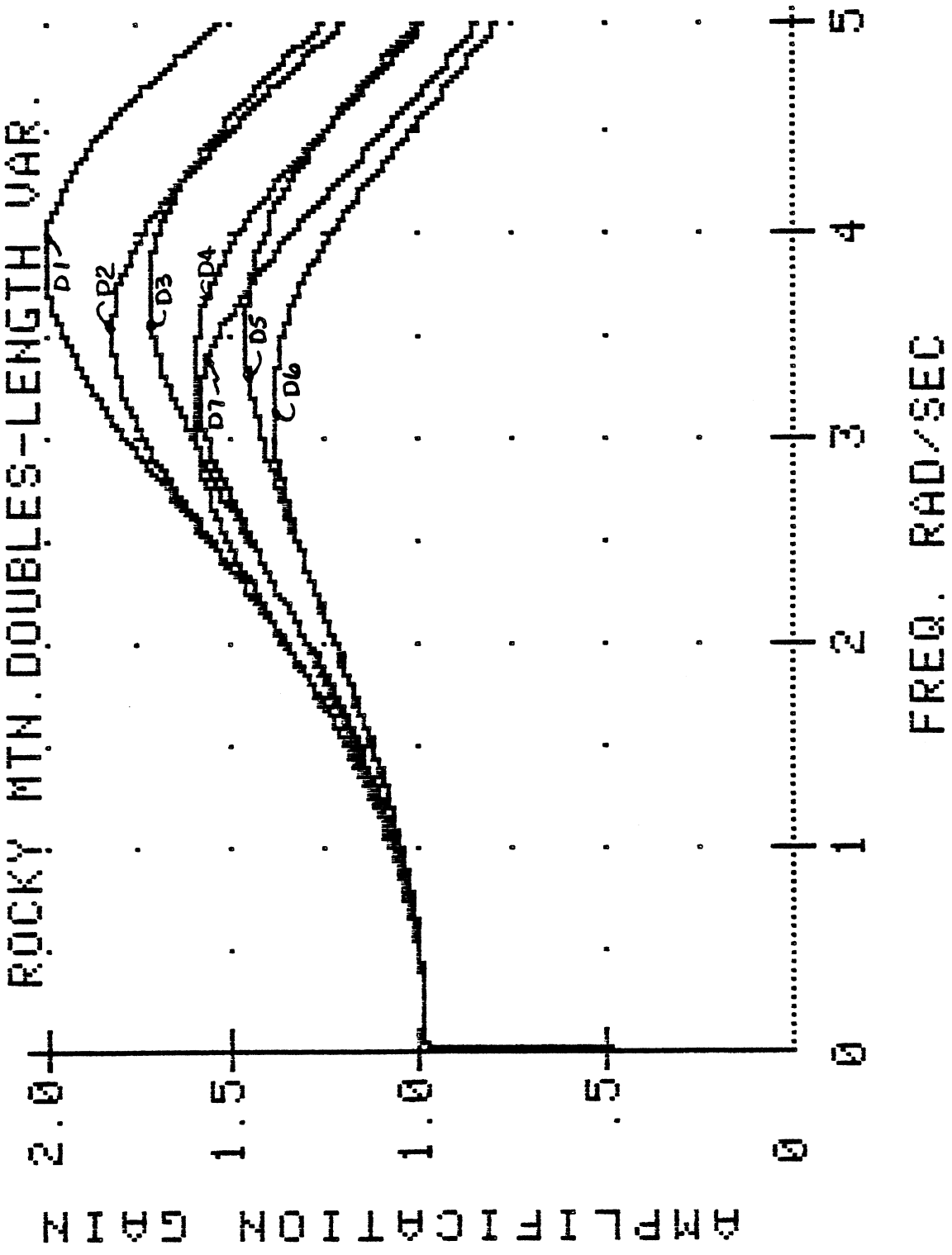
GM= 1.62 AT W= 3.05 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.05 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.152

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.353

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.04


ROCKY MTN. DOUBLES-LENGTH VAR.
AMPLIFICATION GAIN
FREQ. RAD/SEC
2.0
1.5
1.0
.5
0
1
2
3
4
5
D1
D2
D3
D4
D5
D6
D7

TURNPIKE DOUBLES

VEHICLE IENTIFICATION: E1-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.67 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .96

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.5

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.164

VEHICLE IENTIFICATION: E2-LEN

MAX. AMPLIFICATION GAIN FOR WK=3.15 RAD/SEC:

GM= 1.41 AT W= 2.9 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 2.9 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .891

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.426

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.114

VEHICLE IENTIFICATION: E3-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.22 AT W= 2.45 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 2.45 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .86

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.306

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.087

VEHICLE IENTIFICATION: E4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

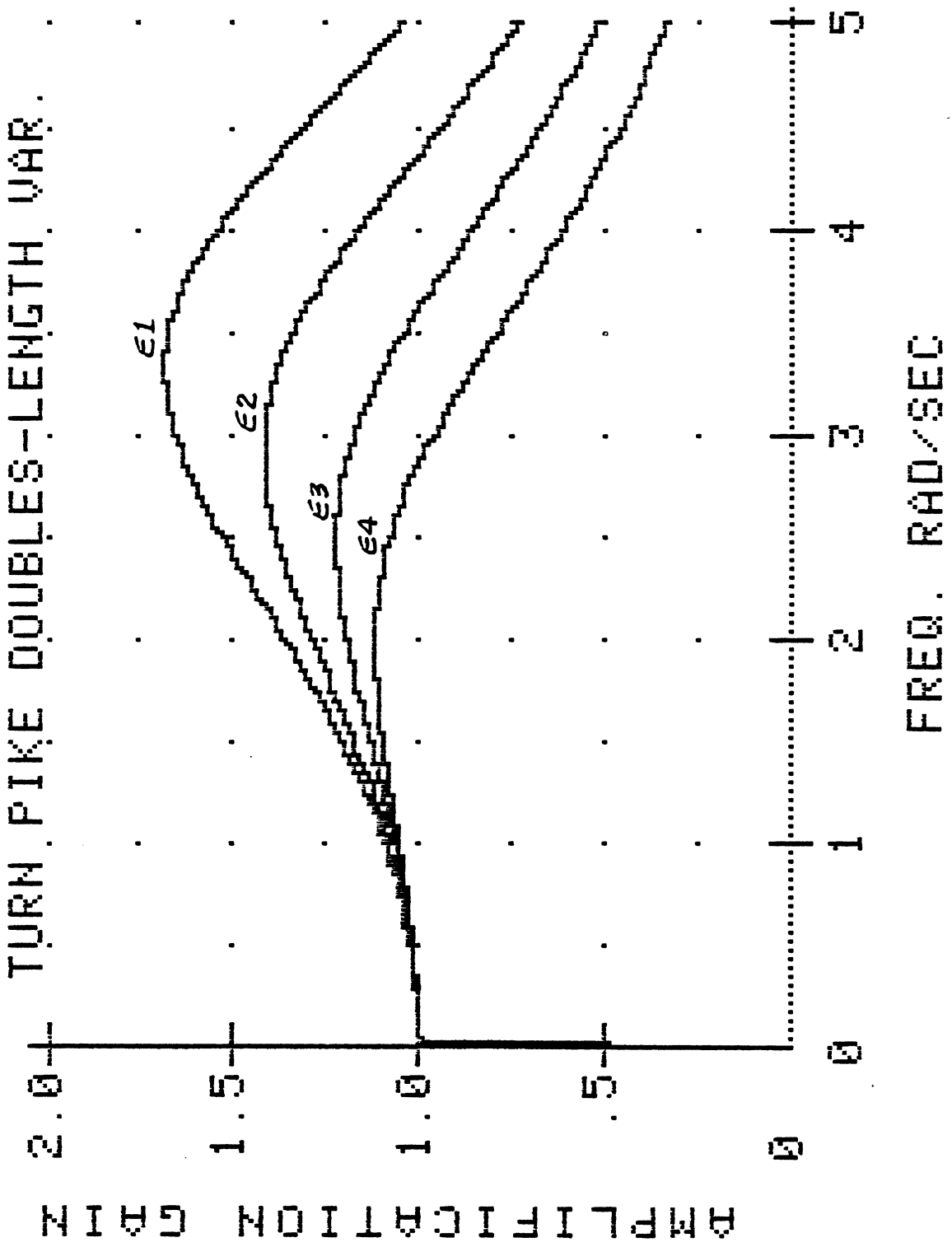
GM= 1.11 AT W= 1.95 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 1.95 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .878

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.195

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.062


TURN PIKE DOUBLES-LENGTH VAR.
AMPLIFICATION GAIN
2.0
1.5
1.0
.5
0
1
2
3
4
5
FREQ. RAD/SEC
ε1
ε2
ε3
ε4

SINGLE AXLE DOUBLES

VEHICLE IENTIFICATION: F1-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.24 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.287

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.332

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.306

VEHICLE IENTIFICATION: F2-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.14 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.222

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.359

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.287

VEHICLE IENTIFICATION: F3-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.99 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.148

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.382

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.256

VEHICLE IENTIFICATION: F4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 1.84 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= 1.08

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.4

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.217

VEHICLE IENTIFICATION: F5-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

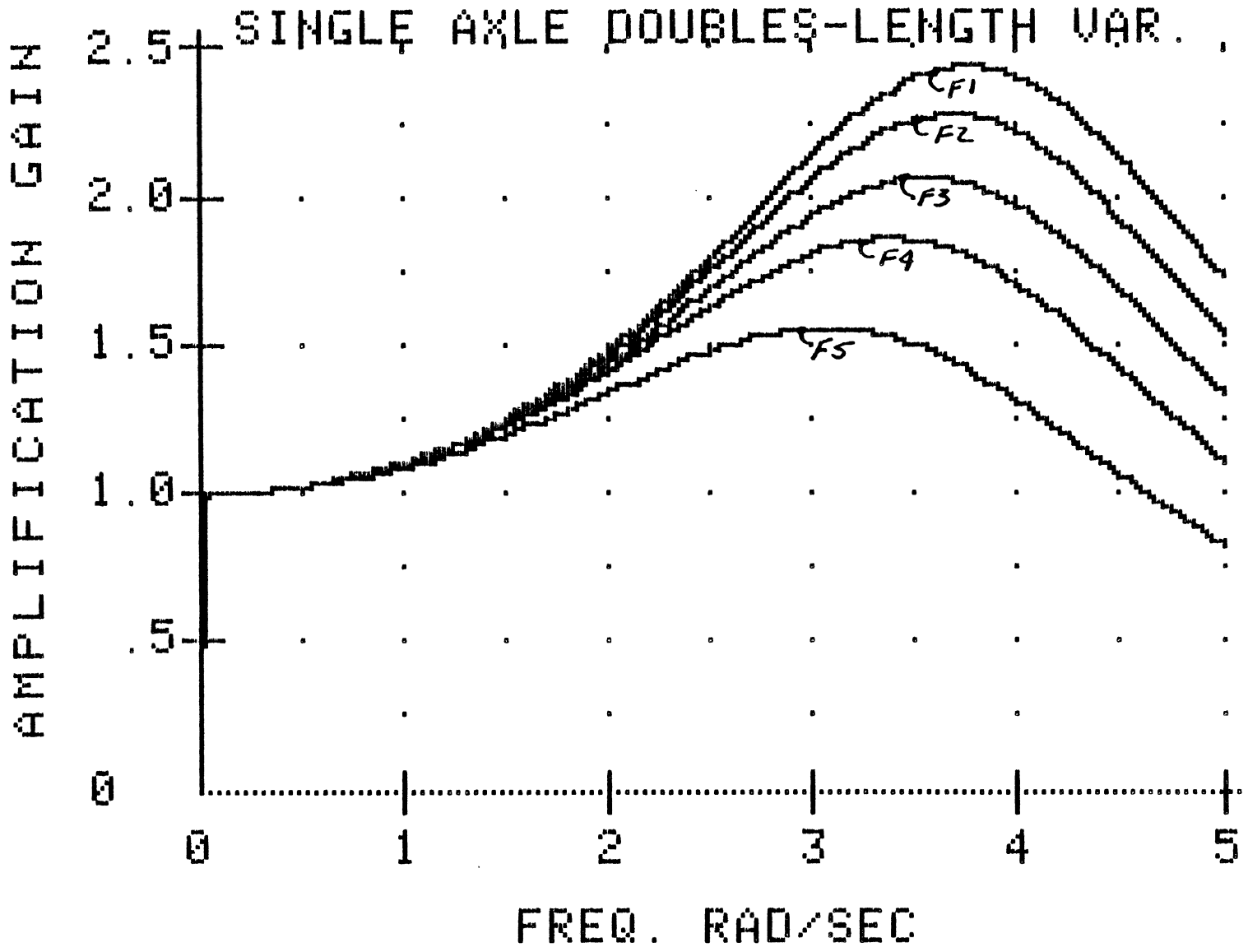
GM= 1.55 AT W= 3.05 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.05 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG., G1= .971

SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK, G2= 1.392

1ST.FULL TRAILER, PINTLE EYE TO CG., G3= 1.15


SINGLE AXLE DOUBLES-LENGTH VAR.
AMPLIFICATION GAIN
2.5
2.0
1.5
1.0
.5
0
F1
F2
F3
F4
F5
0
1
2
3
4
5
FREQ. RAD/SEC

SINGLE AXLE TRIPLES & QUAD

VEHICLE IENTIFICATION: G1-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 3.51 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG.,	G1= 1.148
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK,	G2= 1.382
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.256
1ST. FULL TRAILER, CG.TO PINTLE HOOK,	G4 = 1.402
2ND.FULL TRAILER, PINTLE EYE TO CG.,	G5= 1.256

VEHICLE IENTIFICATION: G2-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 2.52 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG.,	G1= .96
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK,	G2= 1.417
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.139
1ST. FULL TRAILER, CG.TO PINTLE HOOK,	G4 = 1.426
2ND.FULL TRAILER, PINTLE EYE TO CG.,	G5= 1.139

VEHICLE IENTIFICATION: G3-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 3.96 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG.,	G1= 1.287
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK,	G2= 1.332
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.306
1ST. FULL TRAILER, CG.TO PINTLE HOOK,	G4 = 1.354
2ND.FULL TRAILER, PINTLE EYE TO CG.,	G5= 1.306

VEHICLE IENTIFICATION: G4-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 3.8 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG.,	G1= 1.222
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK,	G2= 1.359
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.287
1ST. FULL TRAILER, CG.TO PINTLE HOOK,	G4 = 1.381
2ND.FULL TRAILER, PINTLE EYE TO CG.,	G5= 1.287

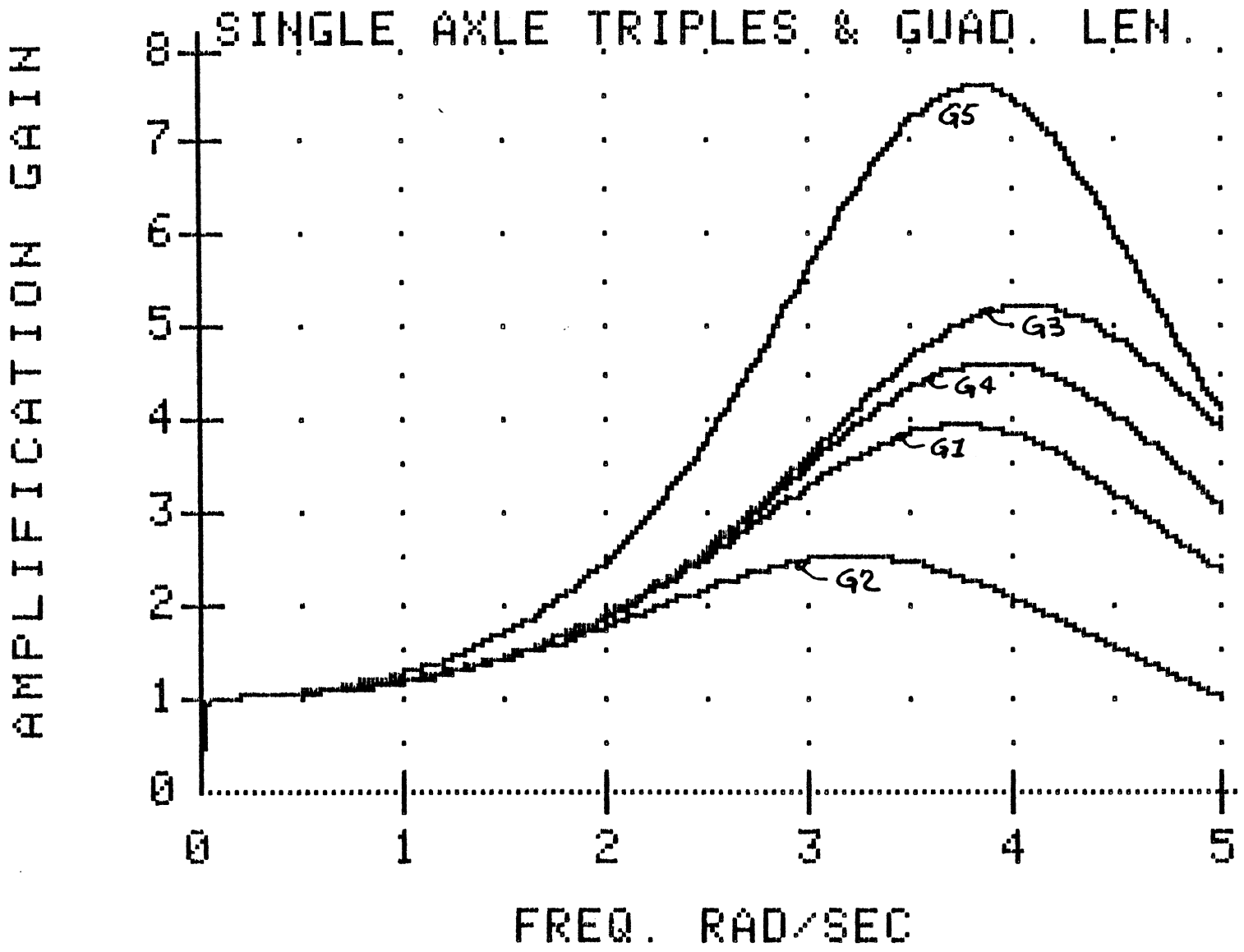
VEHICLE IENTIFICATION: G5-LEN

MAX. AMPLIFICATION GAIN FOR W<=3.15 RAD/SEC:

GM= 6.19 AT W= 3.15 RAD/SEC

AMPLIFICATION GAIN COMPONENTS AT W= 3.15 RAD/SEC

SEMI-TRAILER, TRACTOR CG.TO TRAILER CG.,	G1= 1.148
SEMI-TRAILER, TRAILER CG.TO TRAILER PINTLE HOOK,	G2= 1.382
1ST.FULL TRAILER, PINTLE EYE TO CG.,	G3= 1.256
1ST. FULL TRAILER, CG.TO PINTLE HOOK,	G4 = 1.402
2ND.FULL TRAILER, PINTLE EYE TO CG.,	G5= 1.256
2ND.FULL TRAILER, CG.TO PINTLE HOOK,	G6= 1.402
3RD.FULL TRAILER, PINTLE EYE TO CG.,	G7= 1.256

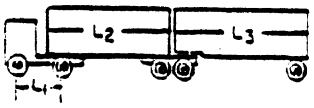

SINGLE AXLE TRIPLES & QUAD. LEN.
AMPLIFICATION GAIN
FREQ. RAD/SEC
G5
G3
G4
G1
G2
0
1
2
3
4
5
6
7
8

Rearward Amplification - Length Variation, B-Trains

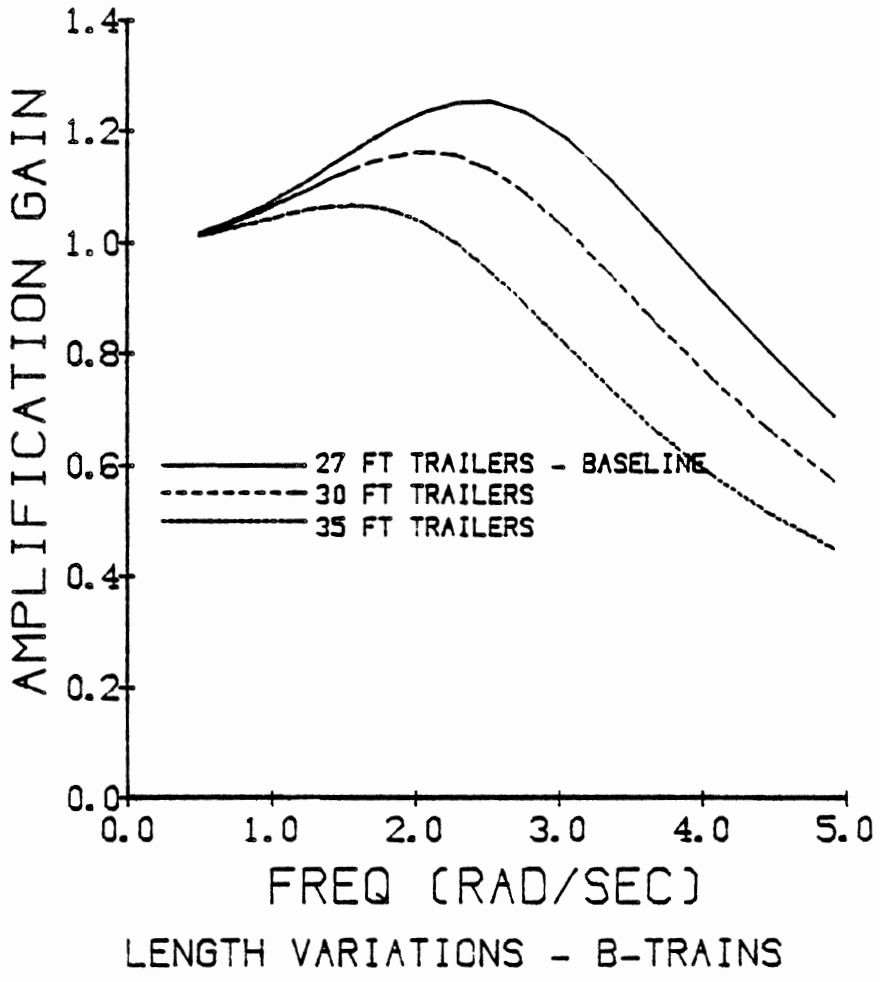
Maneuver: Continuous steering sinusoid (using linear yaw plane model)

Speed: 55 mph (88 km/h)

Vehicle: B-train doubles - curves identified by trailer lengths as listed below



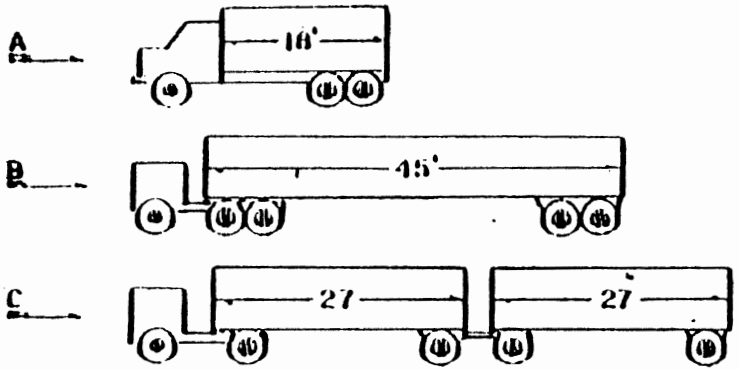
		LENGTHS, FT		
CASE #		L_1	L_2	L_3
H. B-Train	1	11	27	27
	2	11	30	30
	3	11	35	35

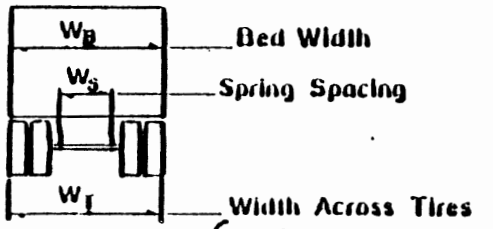


LENGTH VARIATIONS - B-TRAINS

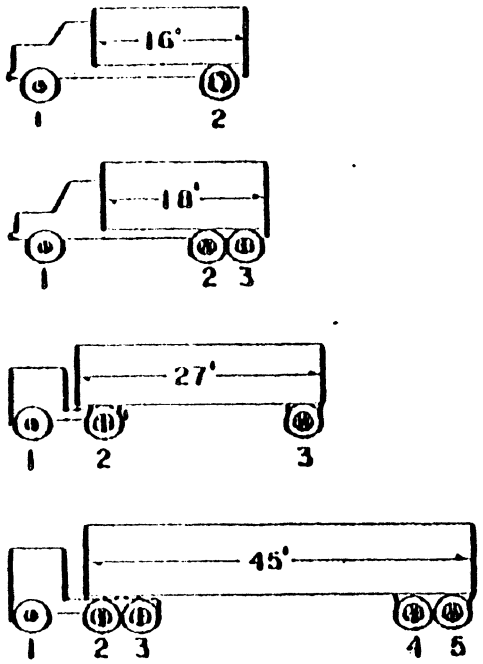
Rollover threshold values for cases involving variation in width and loading parameters. See Volume I for identification of load distributions.

Cases	W_B	W_S	W_T	Gross Wgt Veh. B & C	Gross Wgt Vehicle A	Tractor (or Truck Steering Axle) Width	Rollover Threshold, G's: Veh A	Vehicle B: Med. Dens. Freight	Vehicle B: Lo Dens. Freight	Vehicle C: Front	Vehicle C: Rear
1* (Baseline)	96	38	96	80k	46k	96	.322	.348	.244	.376	.376
2*	102	38	96	80k	46k	96	.332	.358	.238	.385	.386
3	102	38	96	88k	50k	96	.300	.316		.345	.347
4*	102	38	102	80k	46k	96	.362	.381	.253	.407	.422
5*	102	44	102	80k	46k	96		.379	.261	.404	.438
6*	102	44	102	80k	46k	102	.390	.412	.281	.441	.438
7	102	44	102	88k	50k	96		.335		.363	.399
8	102	44	102	88k	50k	102	.359	.383		.402	.399
9	99	41	99	80k	46k	96	.357	.364		.390	.408
10	105	47	105	80k	46k	102	.421	.429		.455	.467
11	108	50	108	80k	46k	102	.451	.445		.470	.496



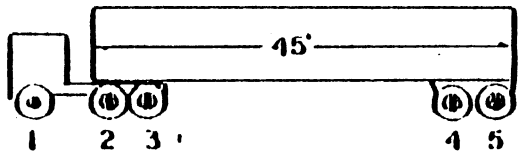


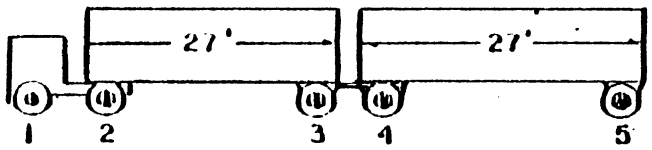
Rollover threshold values obtained for cases involving axle load variation:



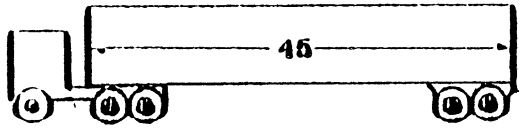
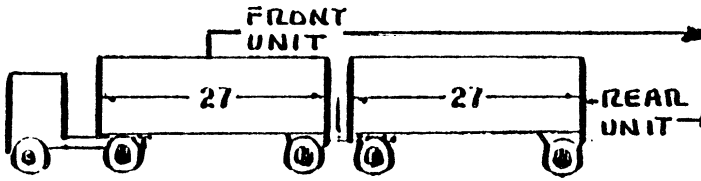
Vehicles	/ Case	Axle Number →	Axle Loads/1000 lb 1	2	3	4	5	Rollover Threshold G's
A	1	(Baseline)	12	20				.308
	2		12	22				.286
	3		12	18				.332
	4		12	24				.264
B	1	(Baseline)	12	17	17			.322
	2		12	19	19			.290
	3		12	16	16			.338
	4		12	18	18			.306
C	1	(Baseline)	10.5	20	20			.318
	2		10.5	22	22			.282
	3		10.5	18	18			.357
	4		10.5	24	24			.250
D	1	(Baseline)	12	17	17	17	17	.348
	2		12	19	19	19	19	.316
	3		10	17.5	17.5	17.5	17.5	.353
	4		9.3	16	16	16	16	.397
	5		10	20	20	19	19	.321

Rollover threshold values for cases involving gross weight variations: (Results for the doubles combination show values for both the front unit—the tractor-semitrailer—and the rear unit—the full trailer)





Case'	Axle No. →	Axle Loads/1000 lb. 1	2	3	4	5	GVW	Rollover Threshold G's
1	(Baseline)	12	17	17	17	17	(80)	.348
2		12	19	19	19	19	(88)	.316
3		9.3	16	16	16	16	(73.3)	.397
4		10	17.5	17.5	17.5	17.5	(80)	.353
5		10	20	20	19	19	(88)	.321
6		12	18	18	18	18	(84)	.325
7		12	20	20	20	20	(92)	.276
8		10	18.5	18.5	18.5	18.5	(84)	.331
9		10	21	21	20	20	(92)	.283
								Front / Rear
1	(Baseline)	10	17.5	17.5	17.5	17.5	(80)	.376 / .376
2		10	19.5	19.5	19.5	19.5	(88)	.345 / .347
3		9.3	17	15	17	15	(73.3)	.419 / .405
4		12	20	20	20	20	(92)	.295 / .331
5		10	18.5	18.5	18.5	18.5	(84)	.356 / .356

Gross Vehicle Wgt. (lbs	80,000					88,000				
Payload C.G. Hgt. (in)	70	80	90	100	110	70	80	90	100	110
	.435	.369	.309	.263	.215	.422	.350	.292	.231	.183
	.457	.394	.343	.299	.261	.443	.379	.326	.280	.242
	.463	.399	.347	.303	.265	.448	.384	.330	.285	.247

Rollover threshold values for cases involving variations in payload c.g. height and gross vehicle weight. Axle load distributions for these cases are tabulated below.

	Axle Loads/1000 lb					
Axle No.	1	2	3	4	5	GVW
Tractor-Semitrailer	12	17	17	17	17	(80)
	12	19	19	19	19	(88)
Double	10	17.5	17.5	17.5	17.5	(80)
	10	19.5	19.5	19.5	19.5	(88)

Results from Full-Scale Tests

- Configuration: 3 Axle Straight Truck ("ST-2").

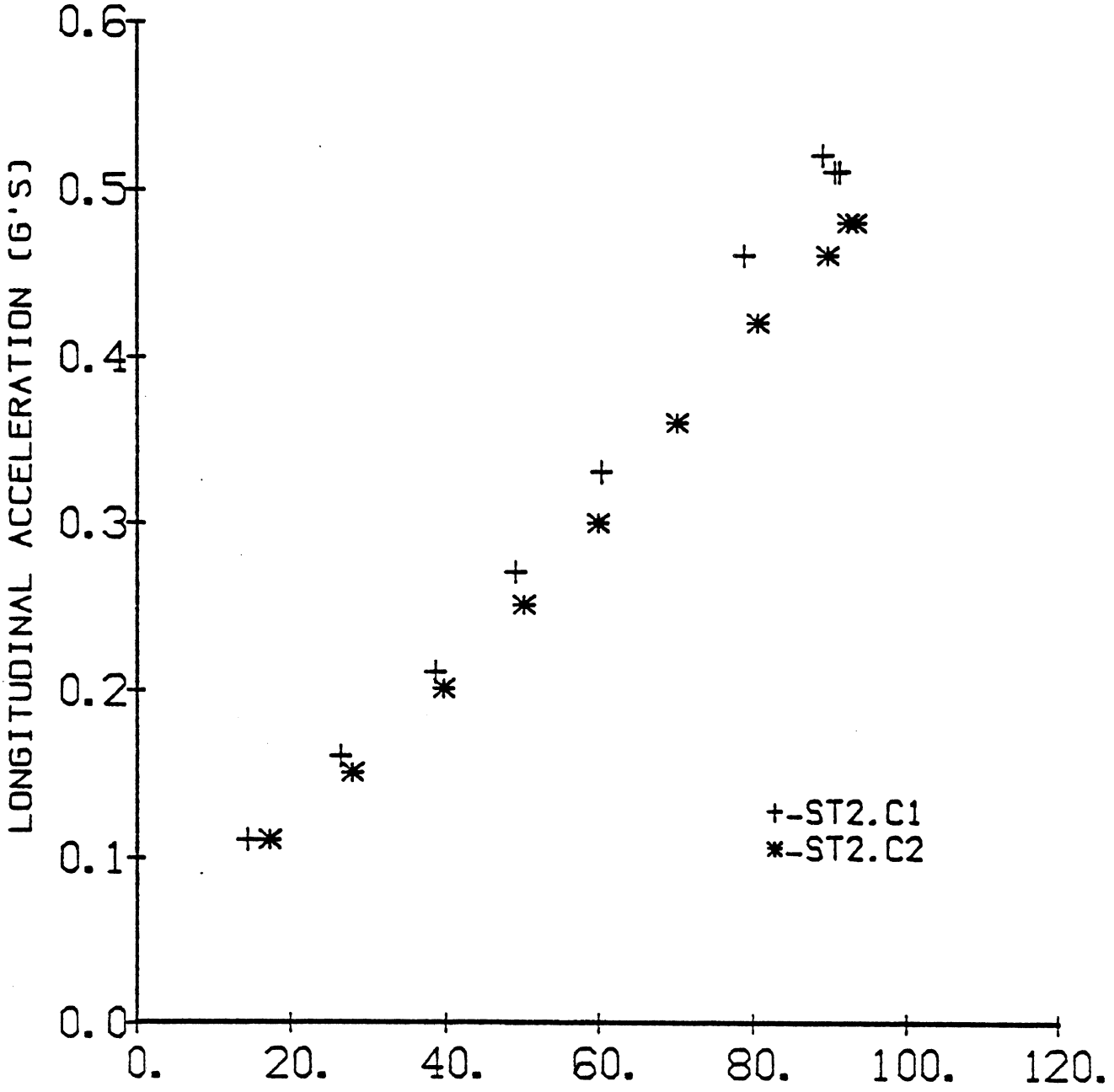
- Power Unit: Wheelbase: 209 in.
  Axle-group Rated Capacities:
  front - 12,000 lb; rear - 38,000 lb.

- Trailer(s): None.

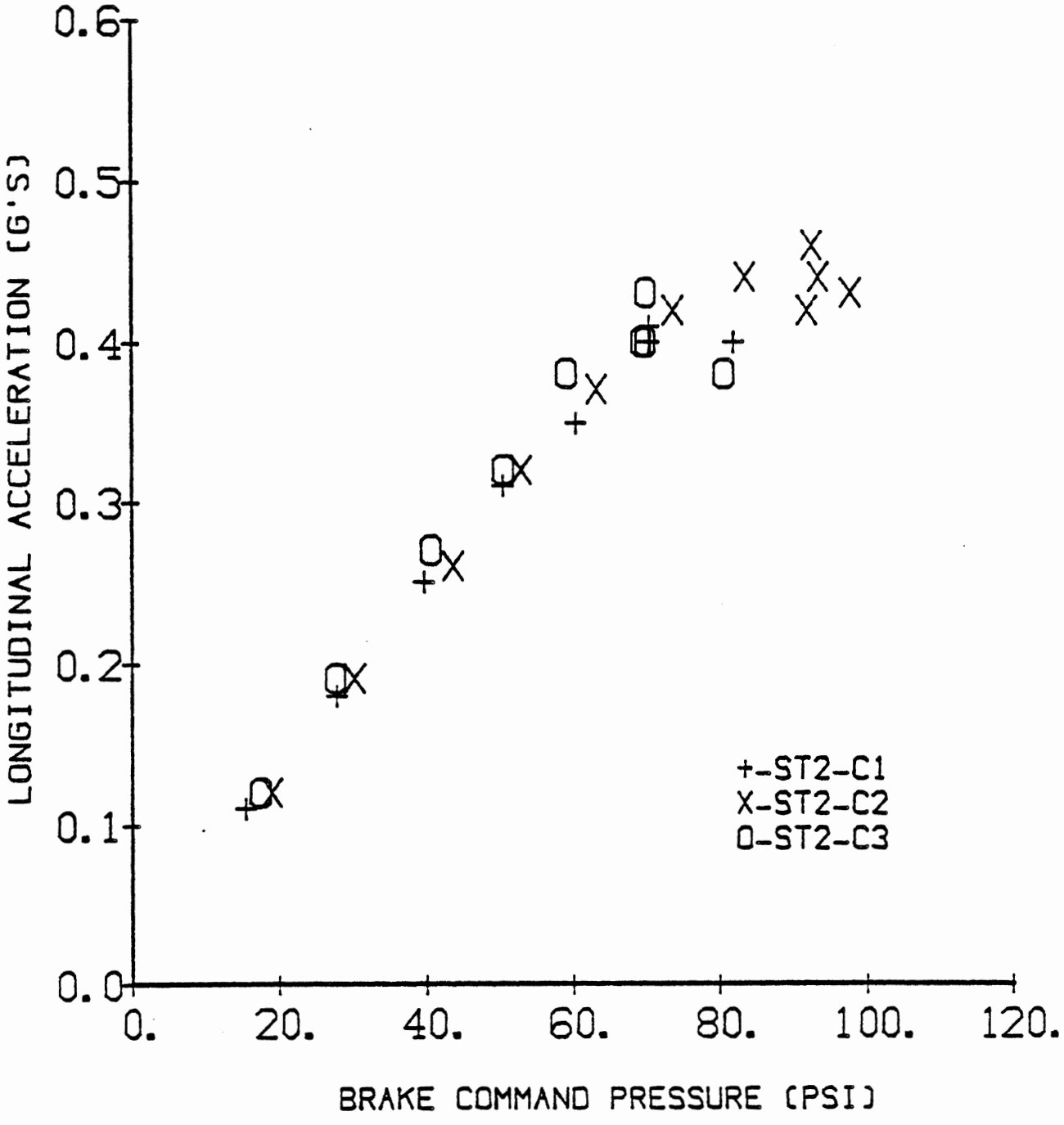
- Test Conditions and Codes:

Code	Payload CG Height(in.)	Axle Loads/1000 lb. 1	2	3	GCW 1000 lbs.	Notes
ST2-C1	70.5	12	34		46	baseline
ST2-C2	79.0	12	38		50	
ST2-C3	93.0	12	34		50	high C.G.
ST2-C4	70.5	12	34		50	radials fr., bias rear

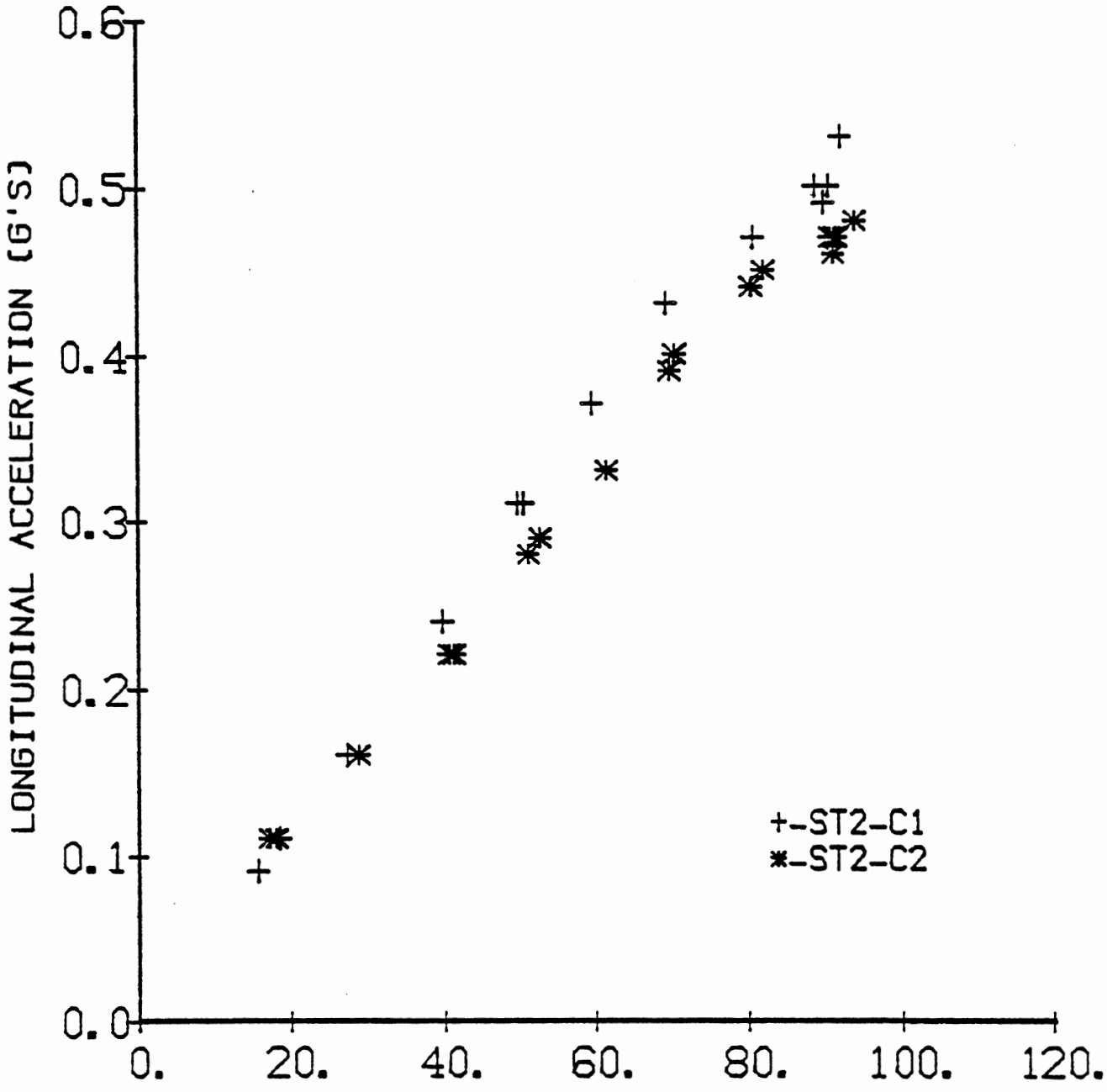
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	C1 & C2-dry & wet, C3-wet only.
2. Braking in a turn	C1 & C2-dry & wet, C3-wet only.
3. Trapezoidal Steer	all
4. Sinusiodal Steer	none



STRAIGHT TRUCK
STRAIGHT LINE BRAKING - DRY

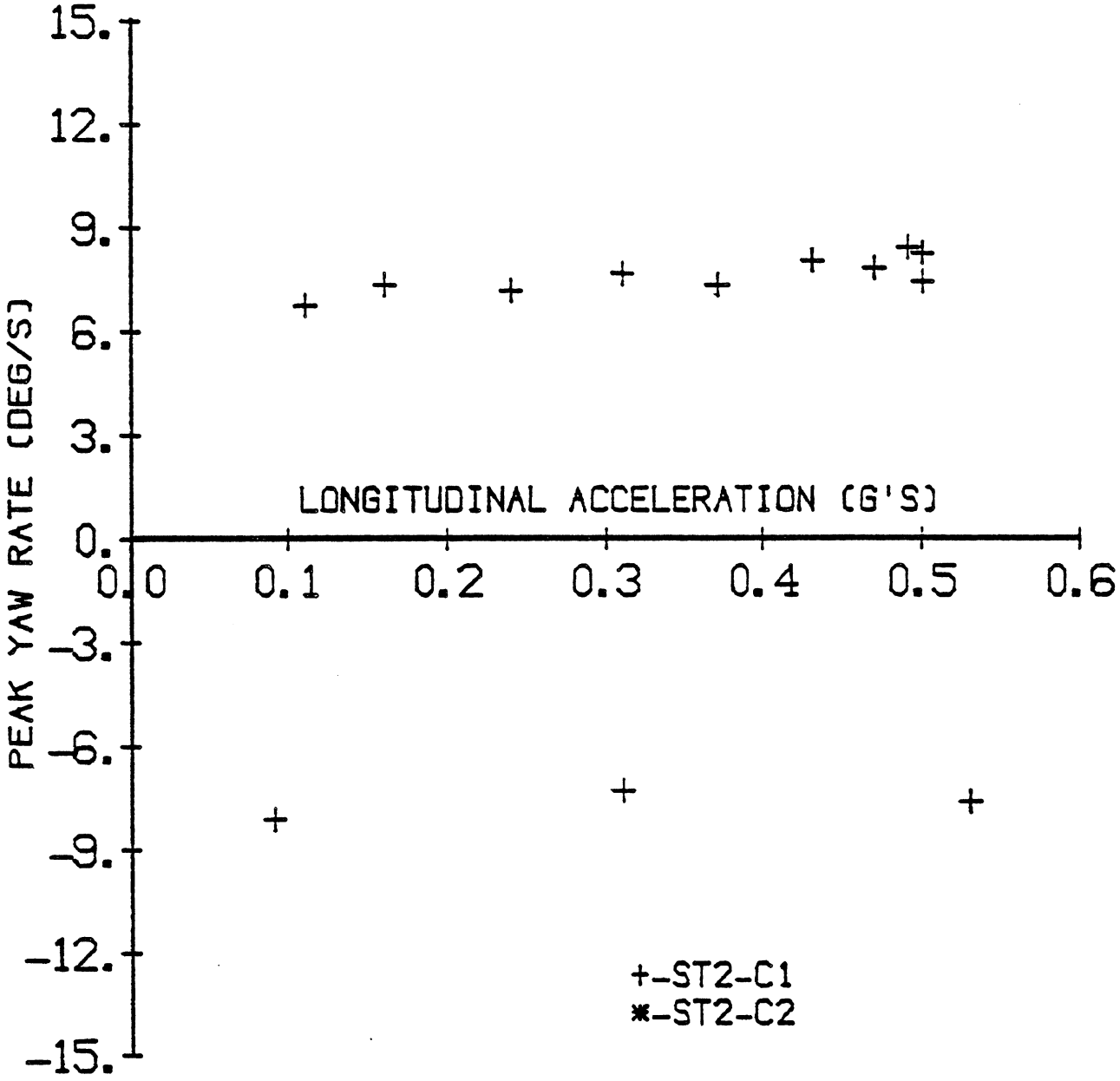


STRAIGHT TRUCK
STRAIGHT LINE BRAKING - WET



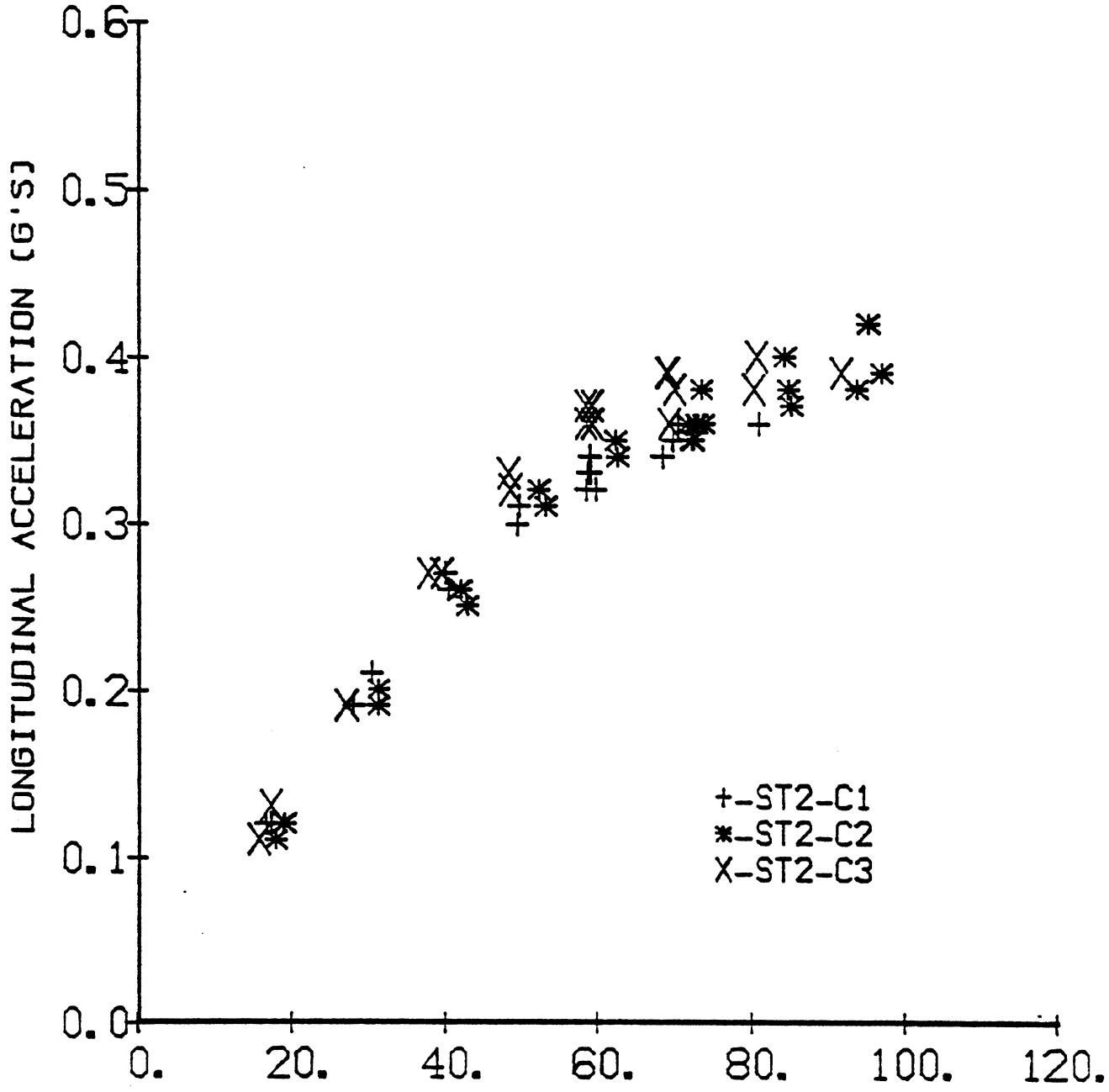
STRAIGHT TRUCK

BRAKING IN A TURN - DRY



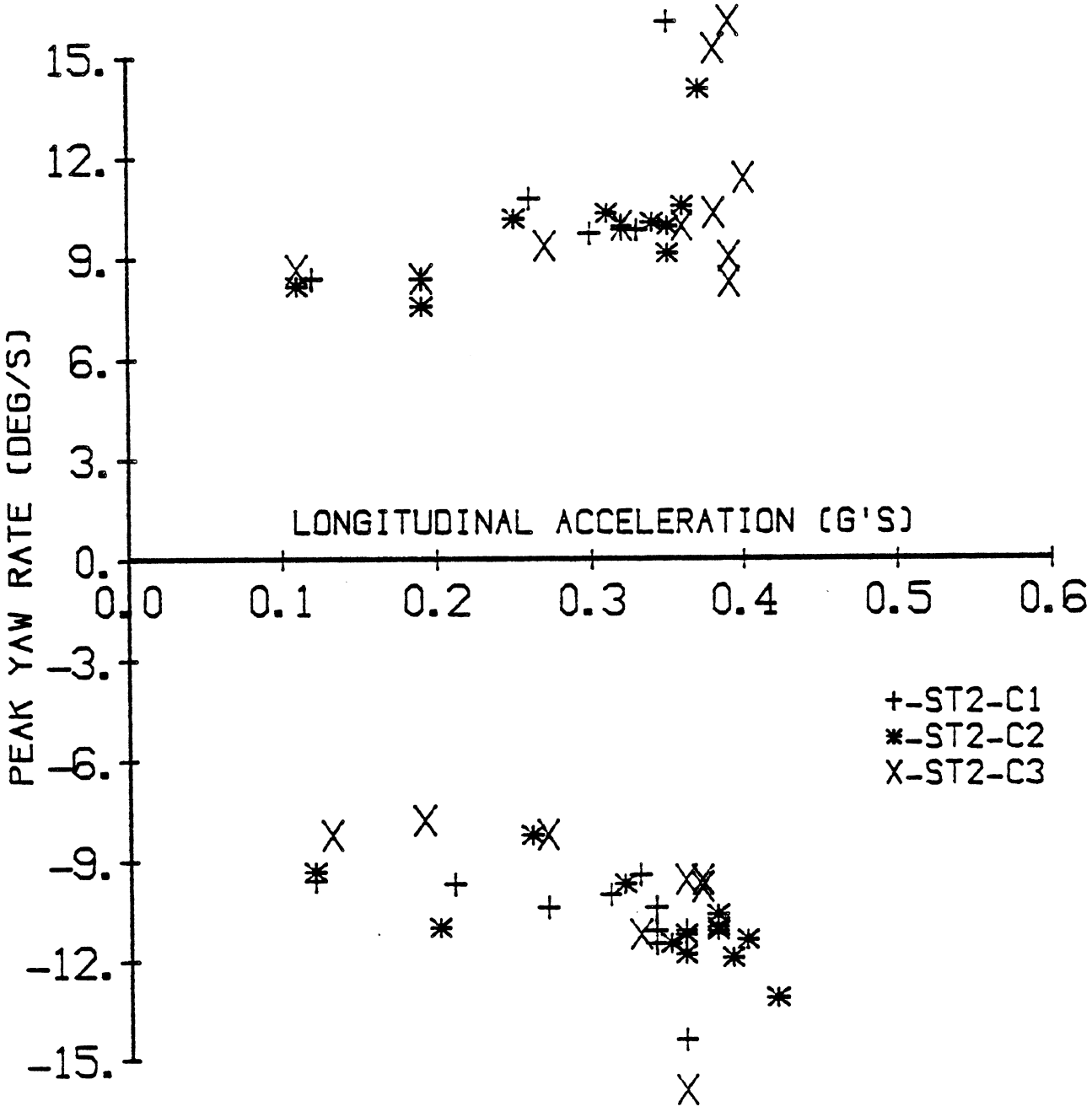
STRAIGHT TRUCK

BRAKING IN A TURN - DRY

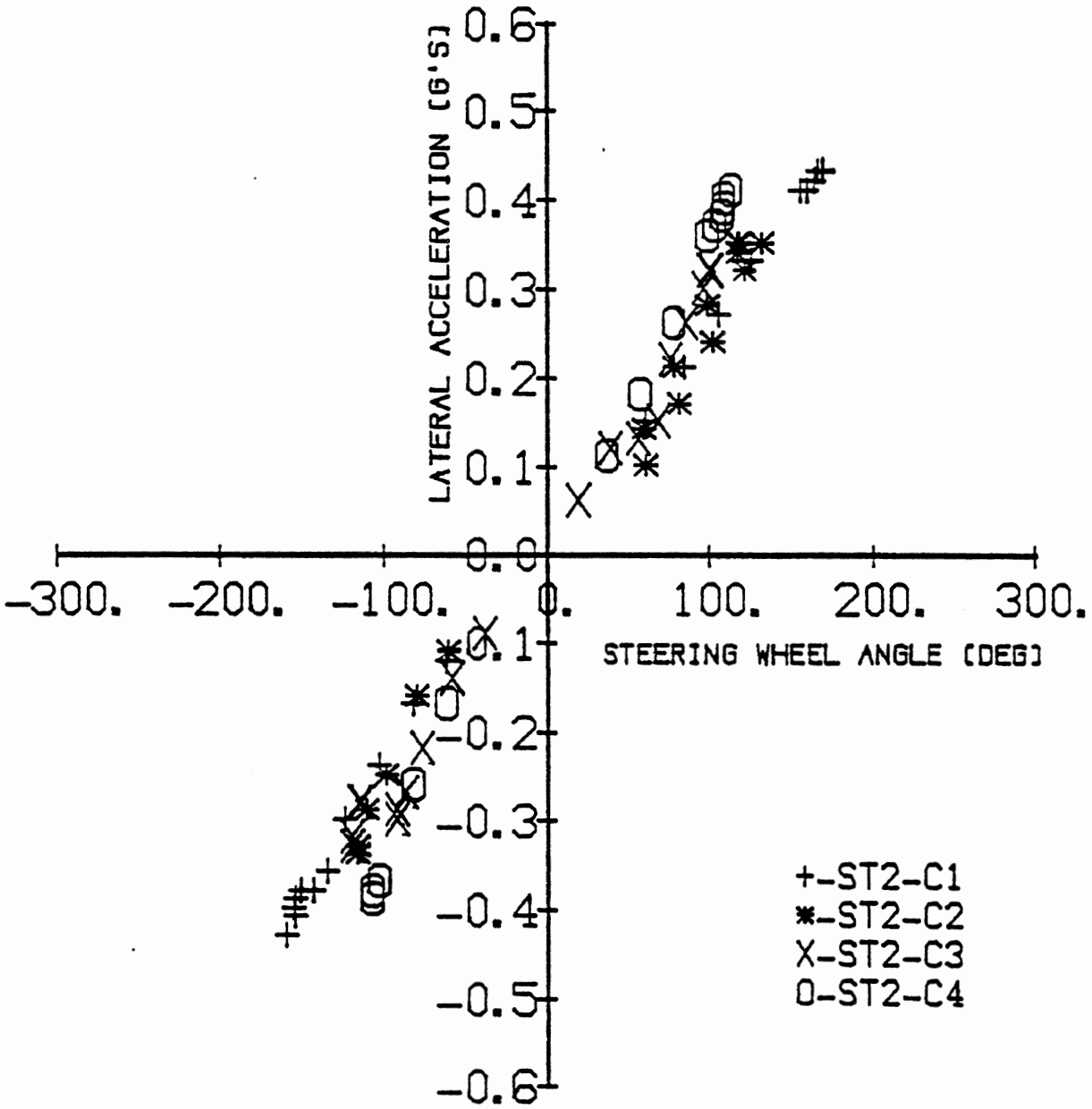


STRAIGHT TRUCK

BRAKING IN A TURN - WET

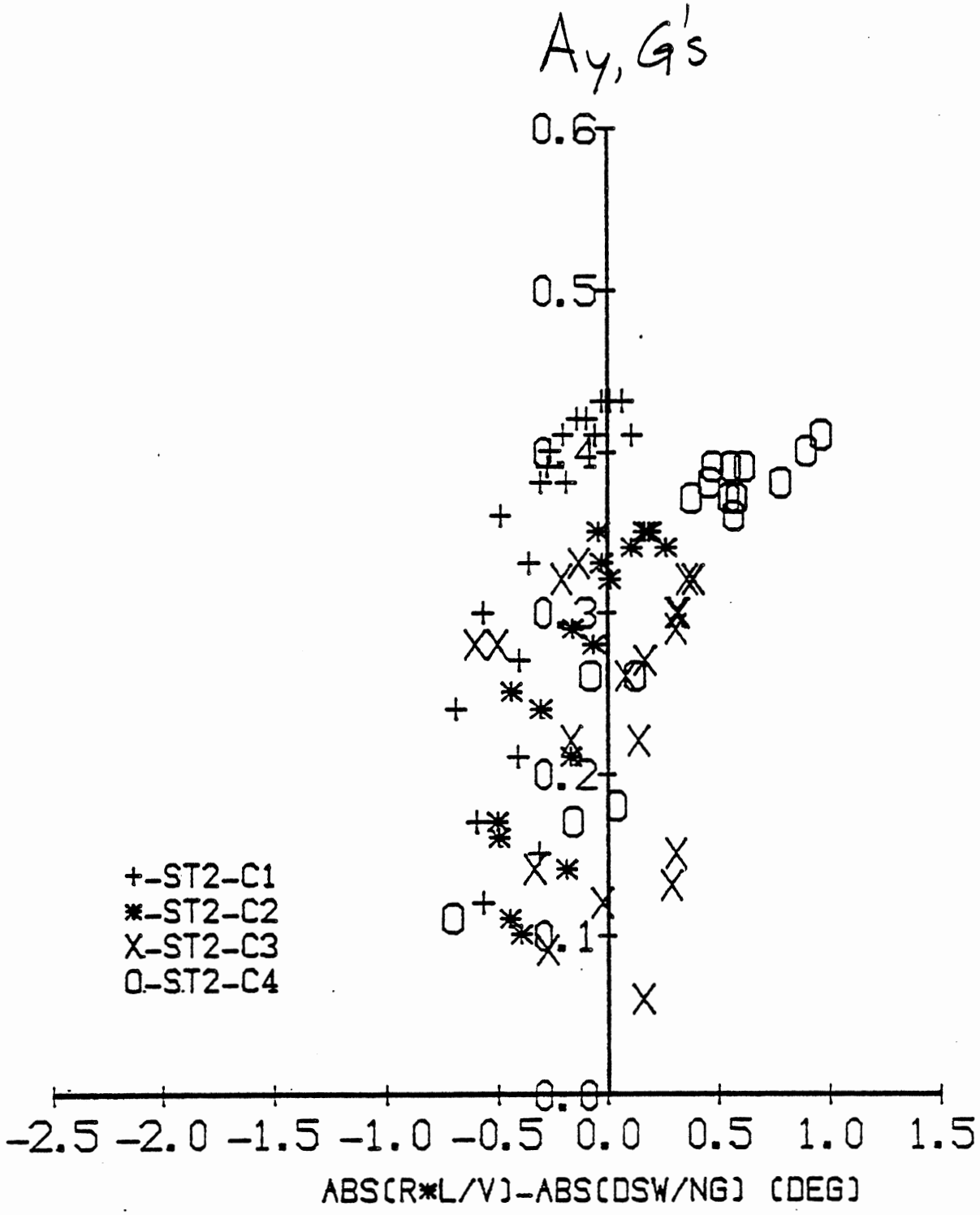


STRAIGHT TRUCK
BRAKING IN A TURN - WET

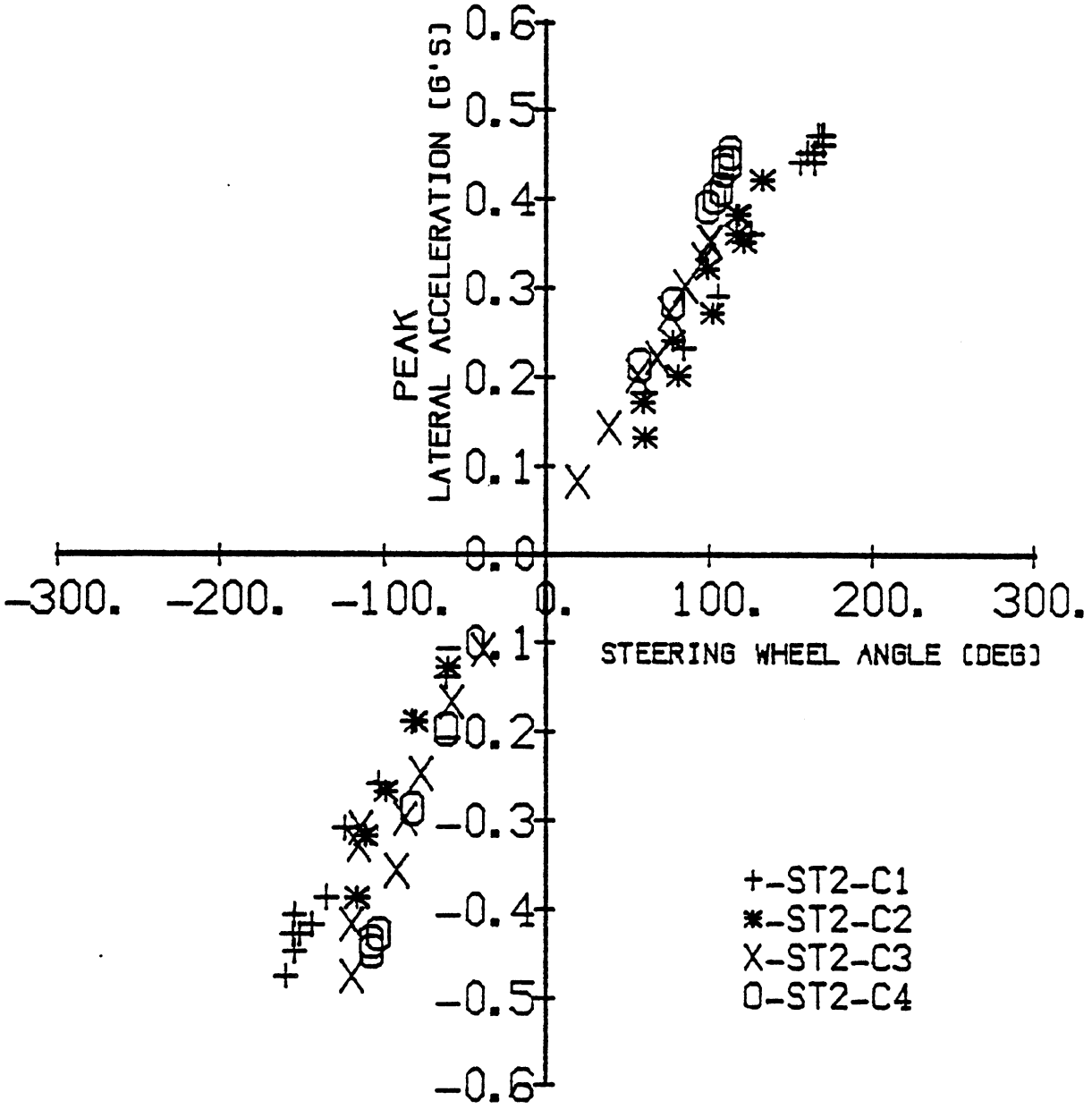


TRAPEZOIDAL STEER

STRAIGHT TRUCK

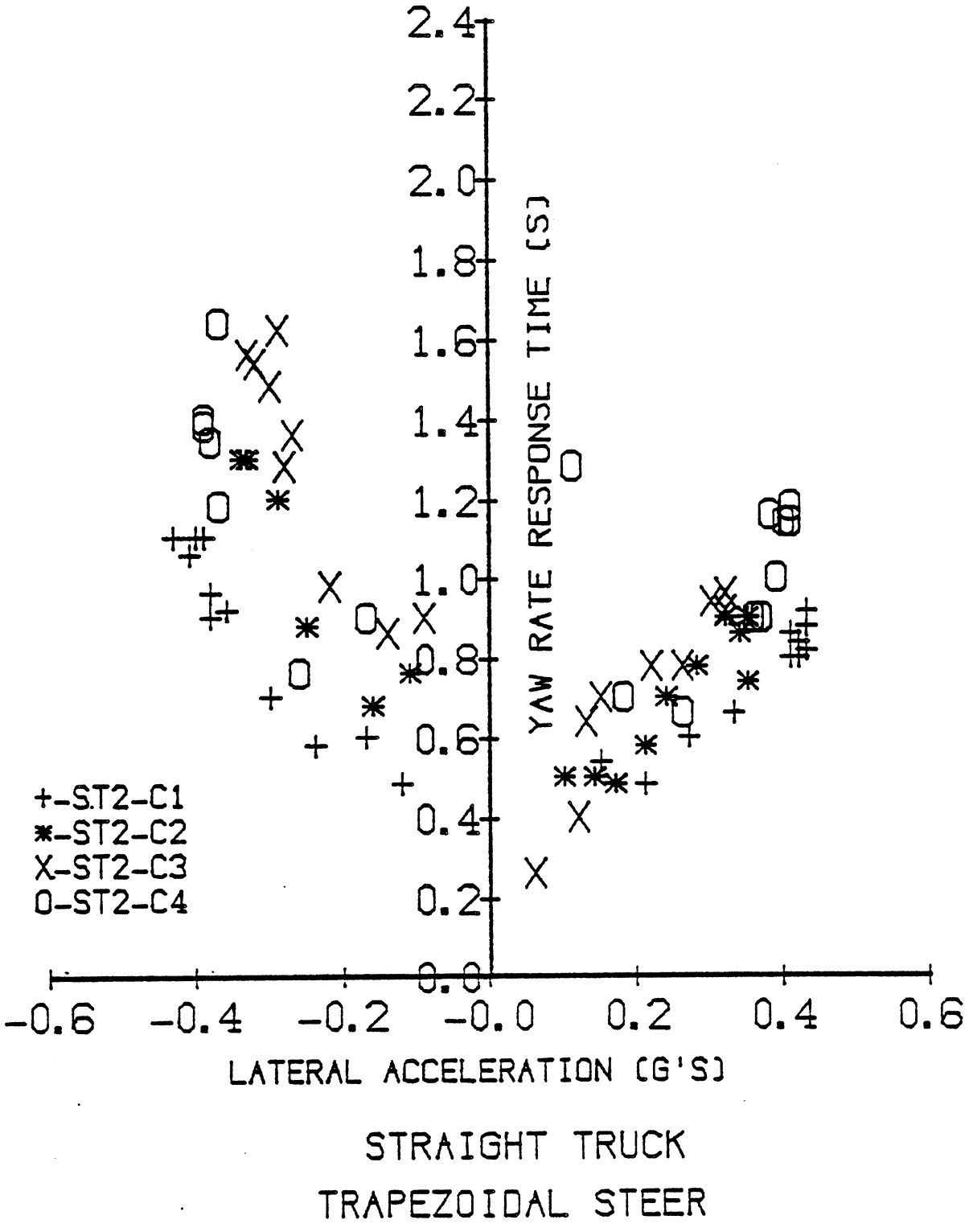


STRAIGHT TRUCK



TRAPEZOIDAL STEER

STRAIGHT TRUCK



STRAIGHT TRUCK

TRAPEZOIDAL STEER

- Configuration: 3 Axle Tractor-Semitrailer ("T1-TR1").

- Power Unit: Wheelbase: 135 in.
  Axle-group Rated Capacities:
  front-12,000 lb; rear-23,000 lb.

- Trailer(s):

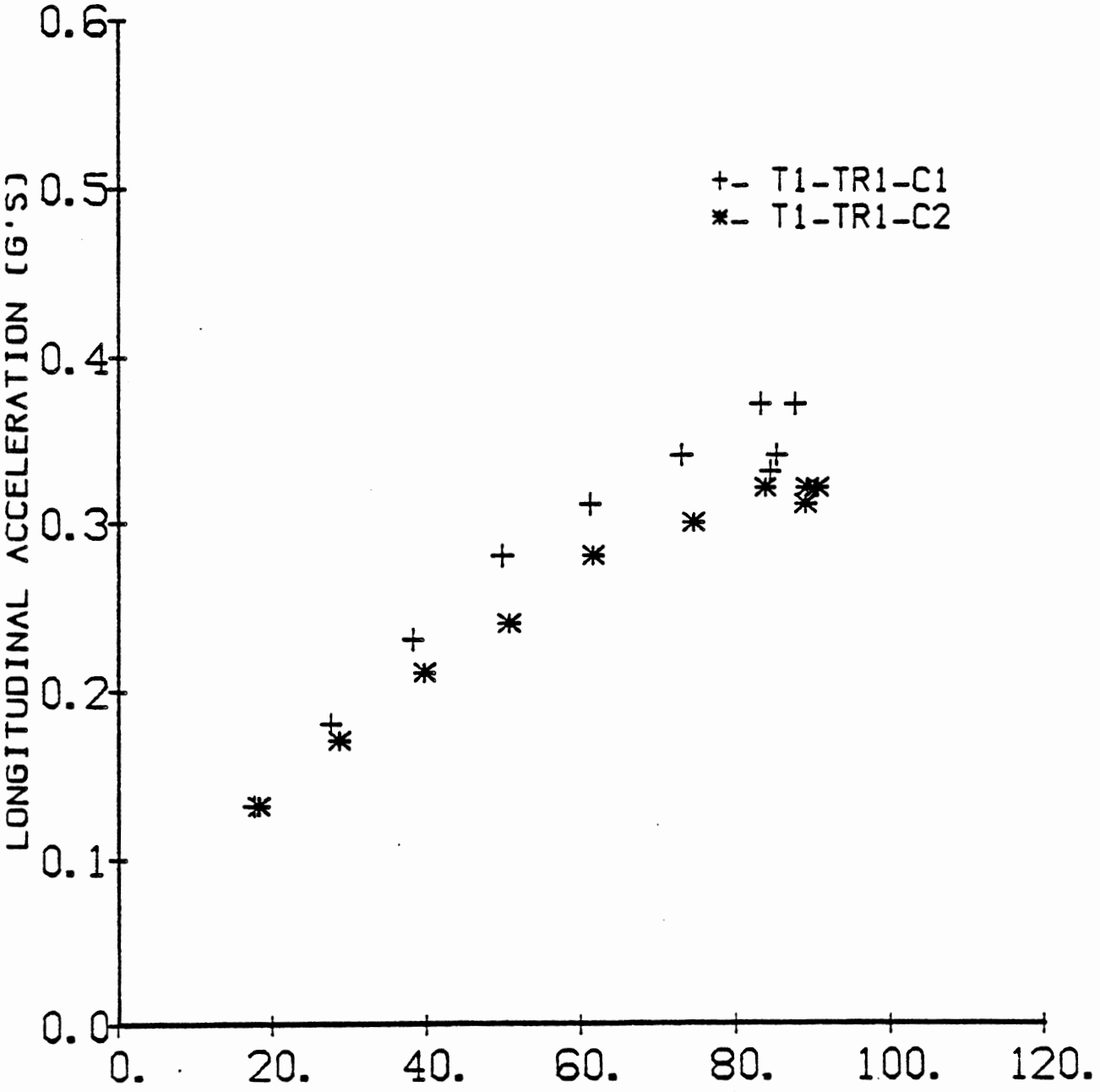
	No. of axles in group	Length (ft)
#1:	1	27

- Test Conditions and Codes:

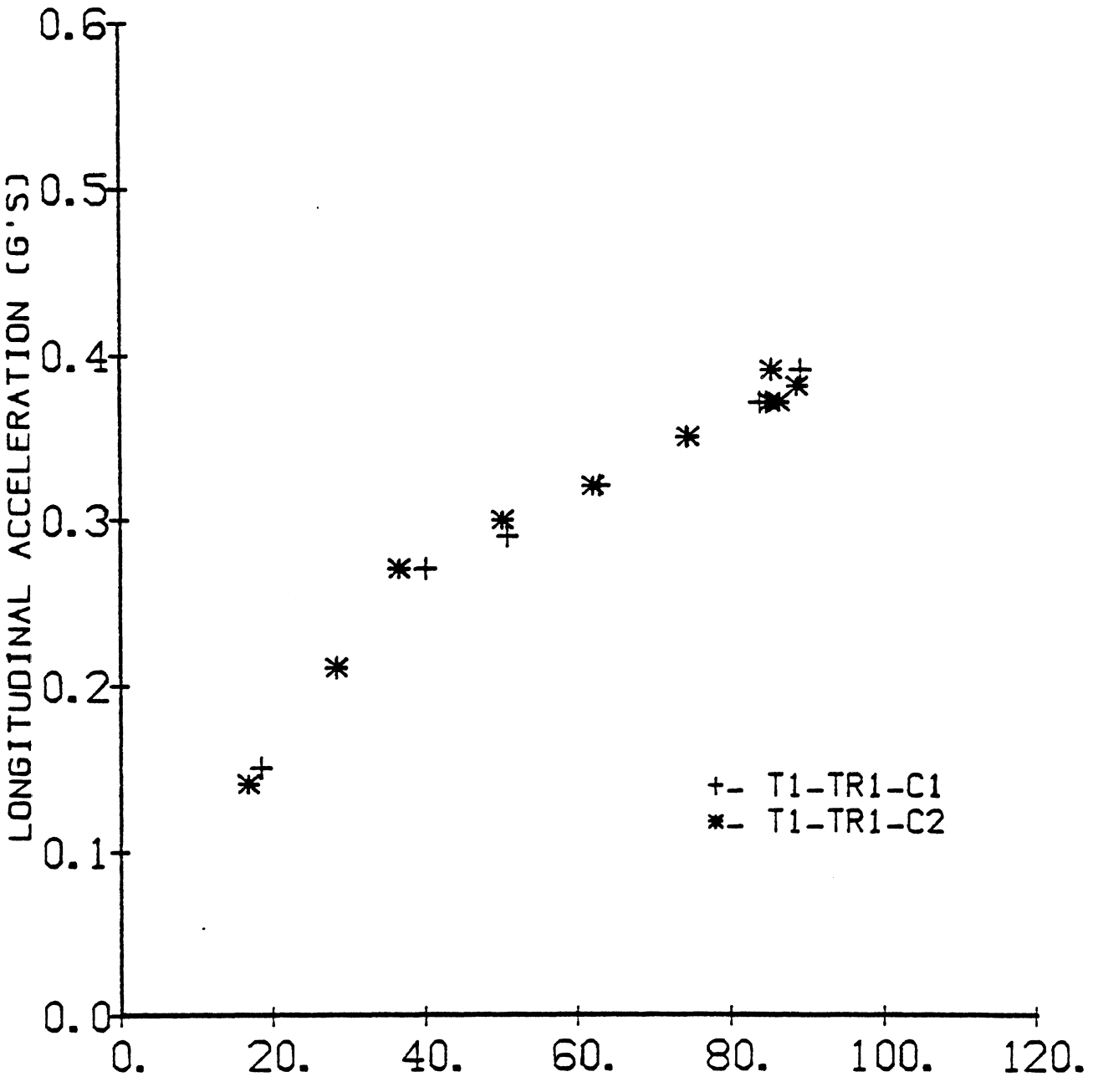
Code	CG Height(in.)	Axle Loads/1000 lb. 1	2	3	GCW 1000 lb.	Notes
T1-TR1-C1	72	11	20	20	52	baseline
T1-TR1-C2	80	11	22	22	56	
T1-TR1-C3	80	11	22	22	56	radials fr., bias rear

- Test Procedure Plots — Test Conditions:

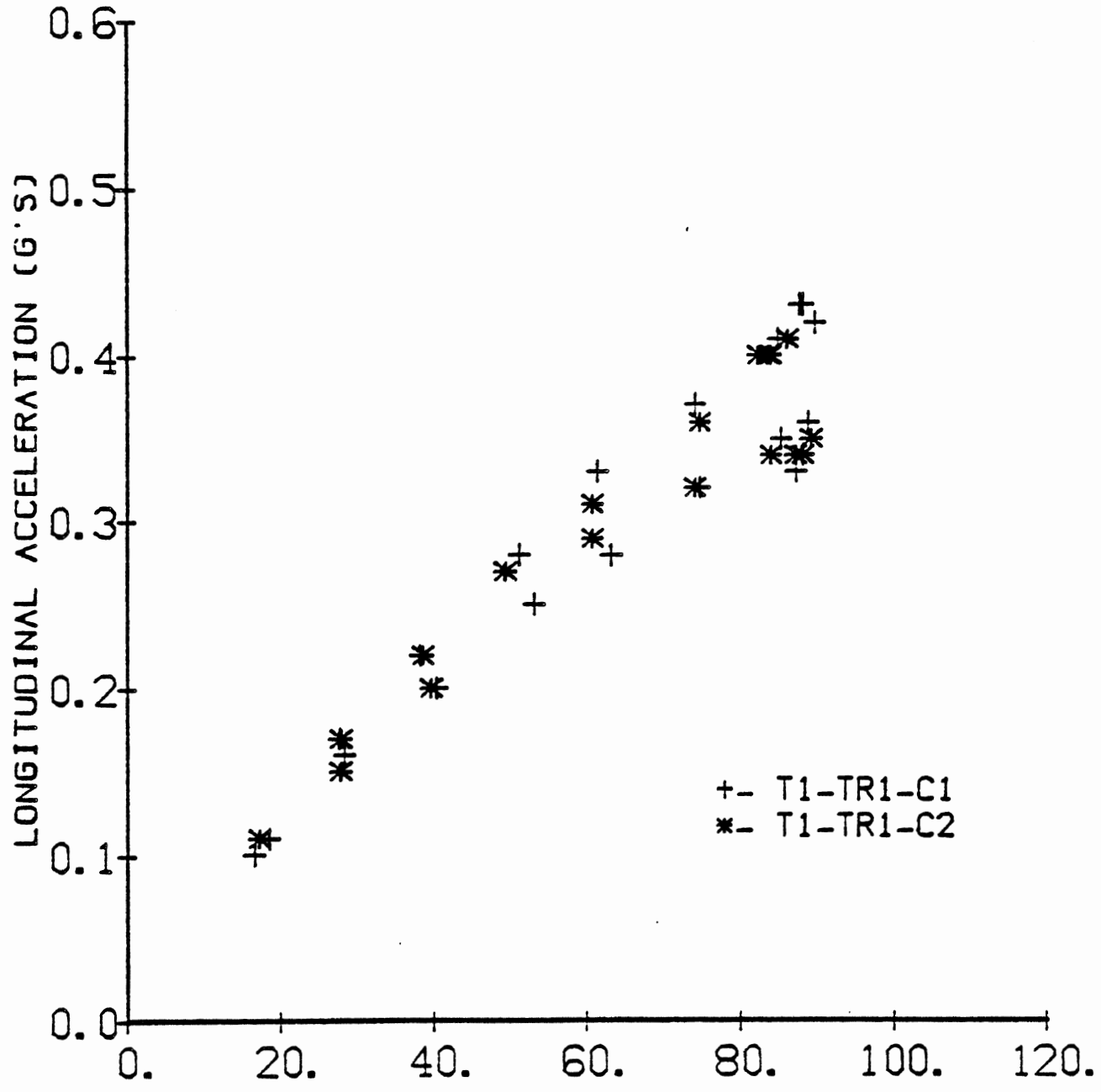
1.	Straight Line Braking	C1 & C2
2.	Braking in a Turn	C1 & C2
3.	Trapezoidal Steer	all
4.	Sinusiodal Steer	C1 only



TWO AXLE TRACTOR- 27 FT TRAILER
STRAIGHT LINE BRAKING
DRY SURFACE

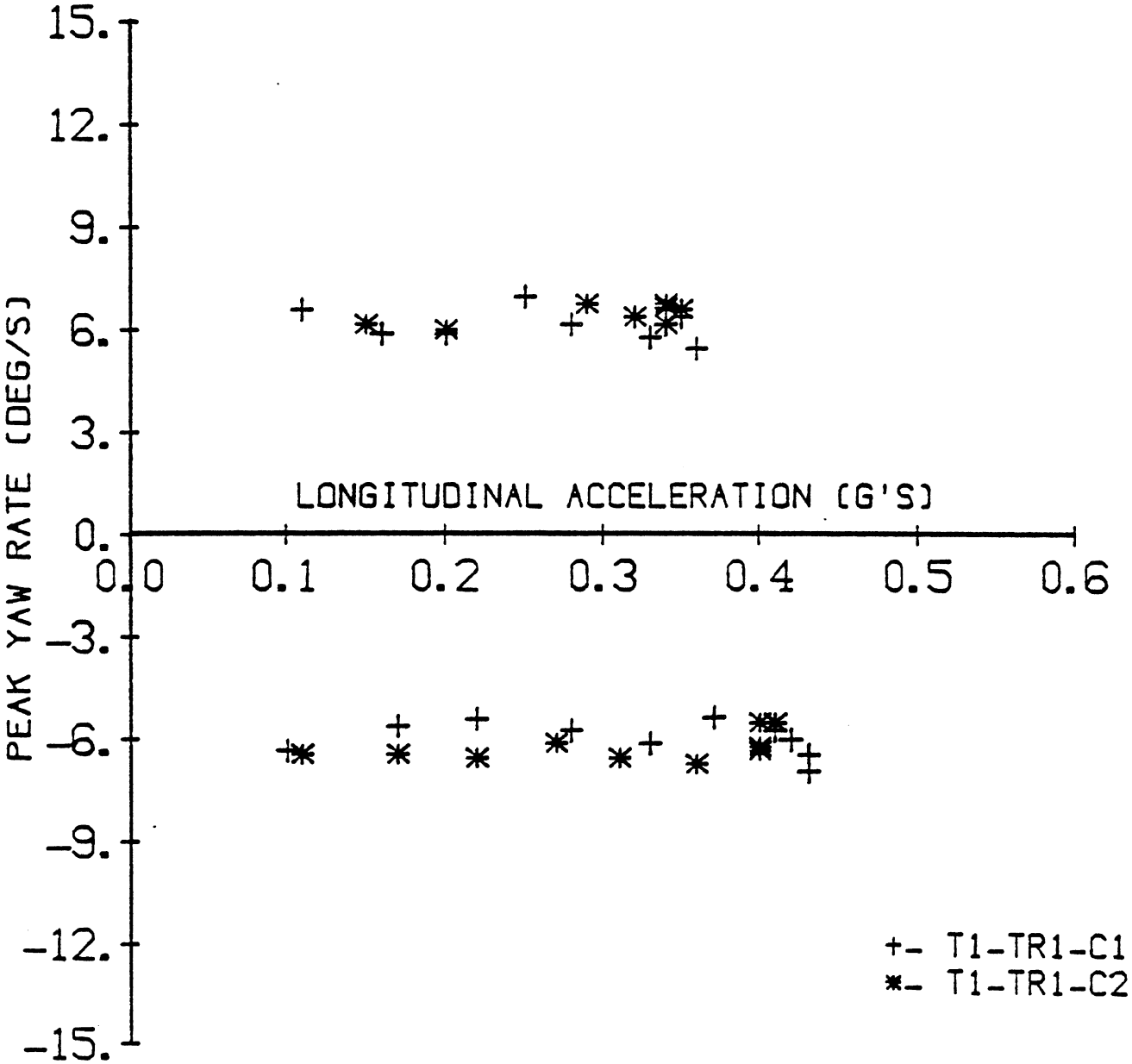


TWO AXLE TRACTOR- 27 FT TRAILER
STRAIGHT LINE BRAKING
WET SURFACE

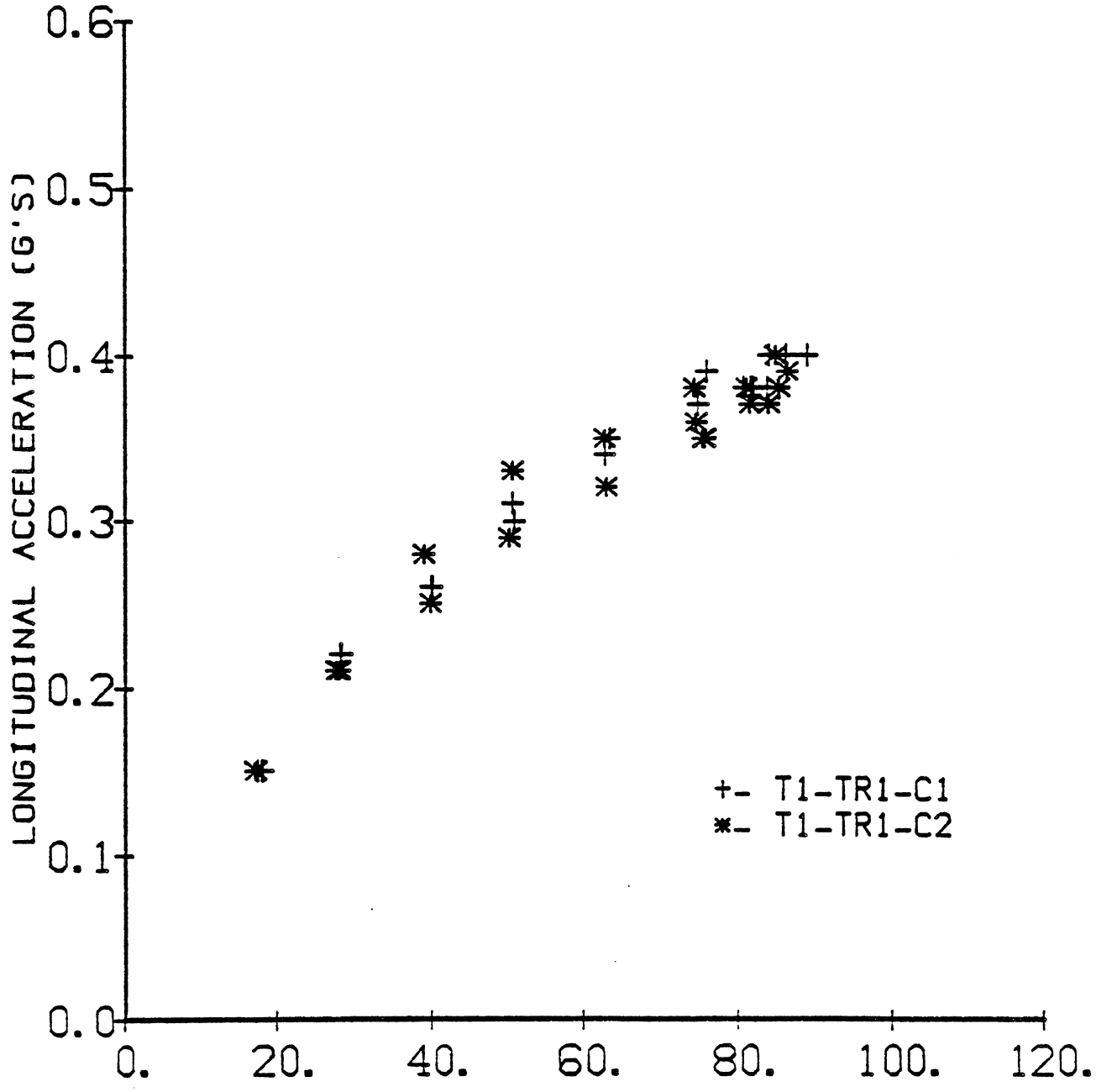


TWO AXLE TRACTOR- 27 FT TRAILER
BRAKING IN A TURN

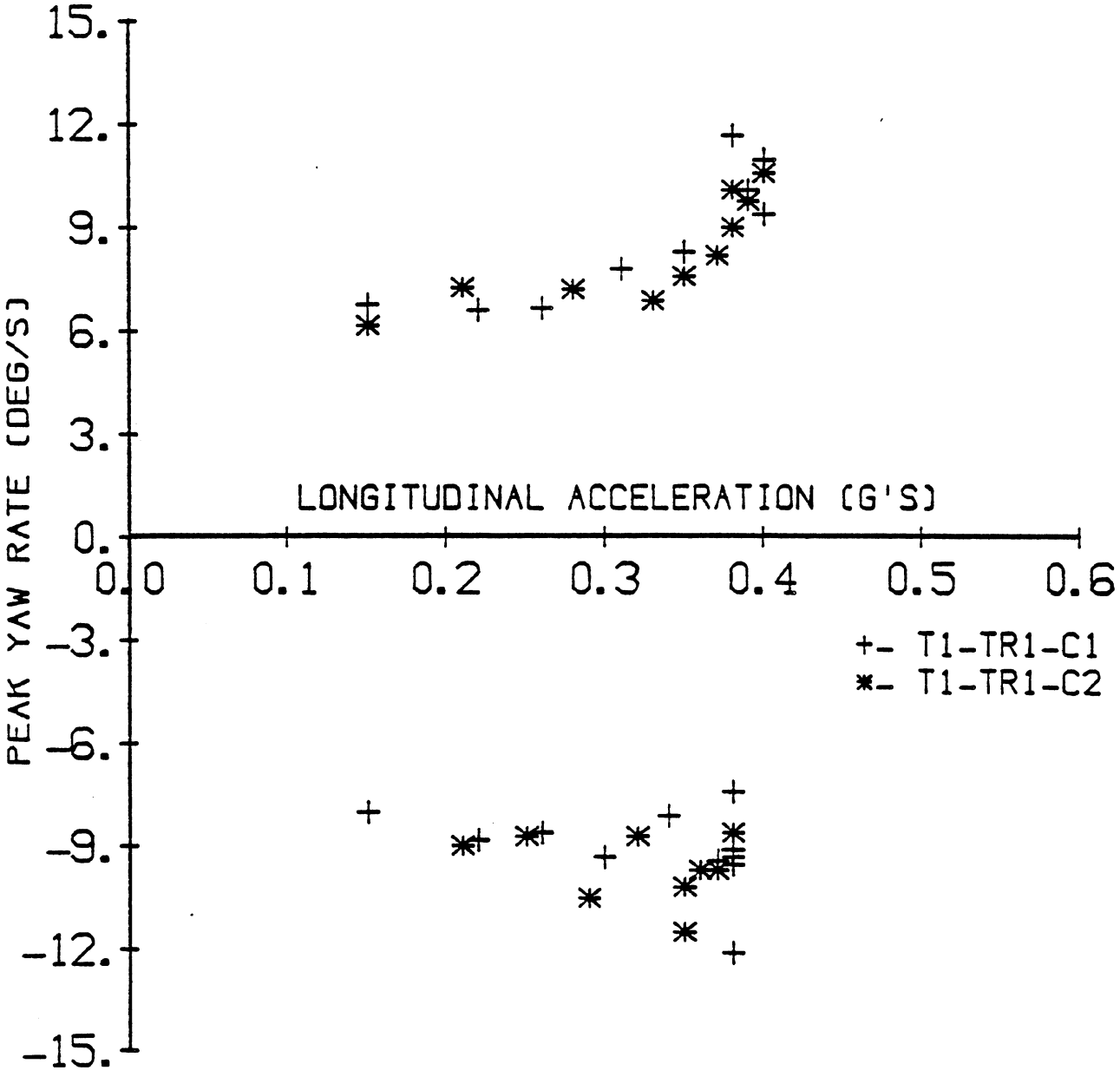
DRY SURFACE



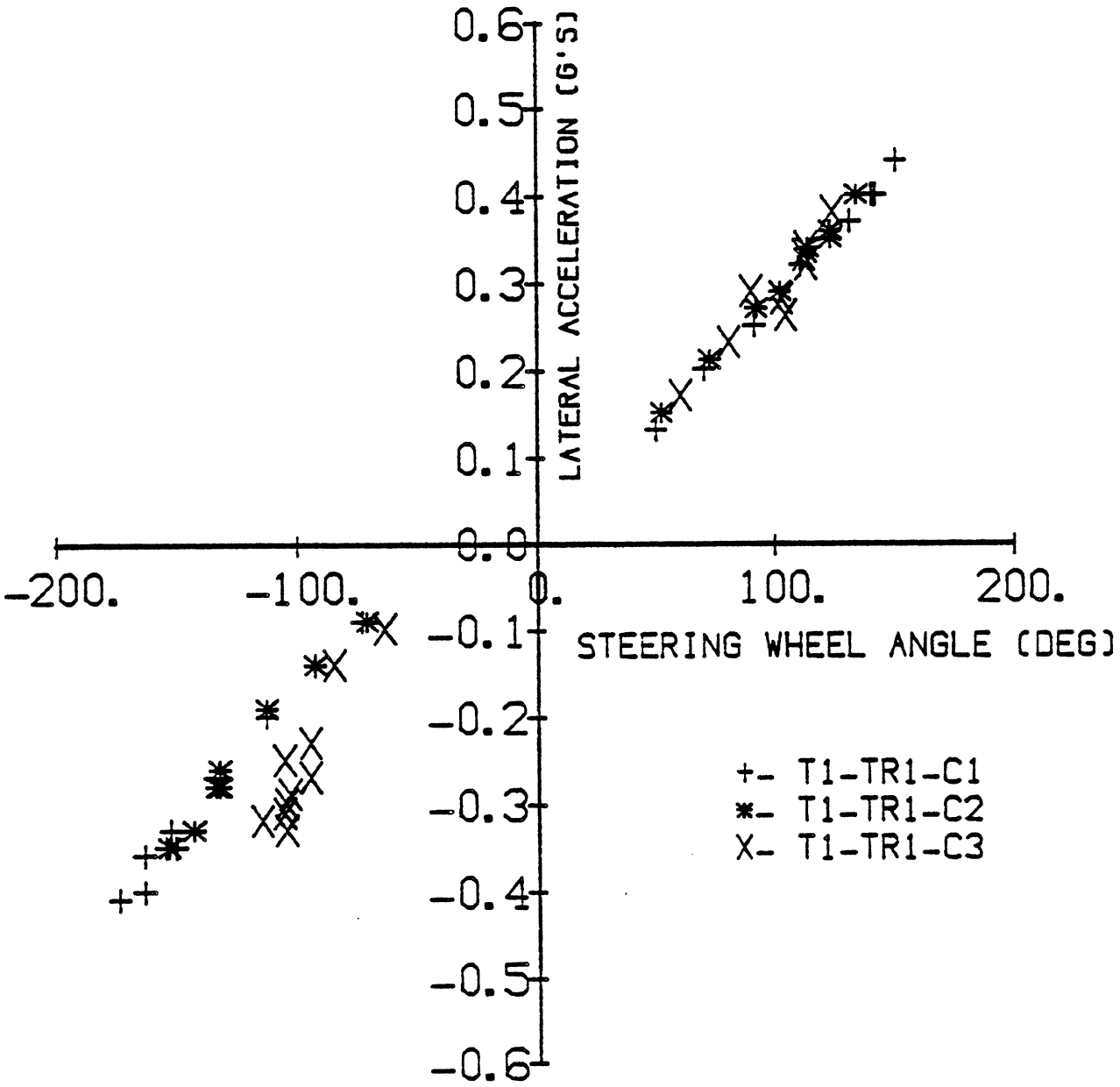
TWO AXLE TRACTOR- 27 FT TRAILER
BRAKING IN A TURN
DRY SURFACE



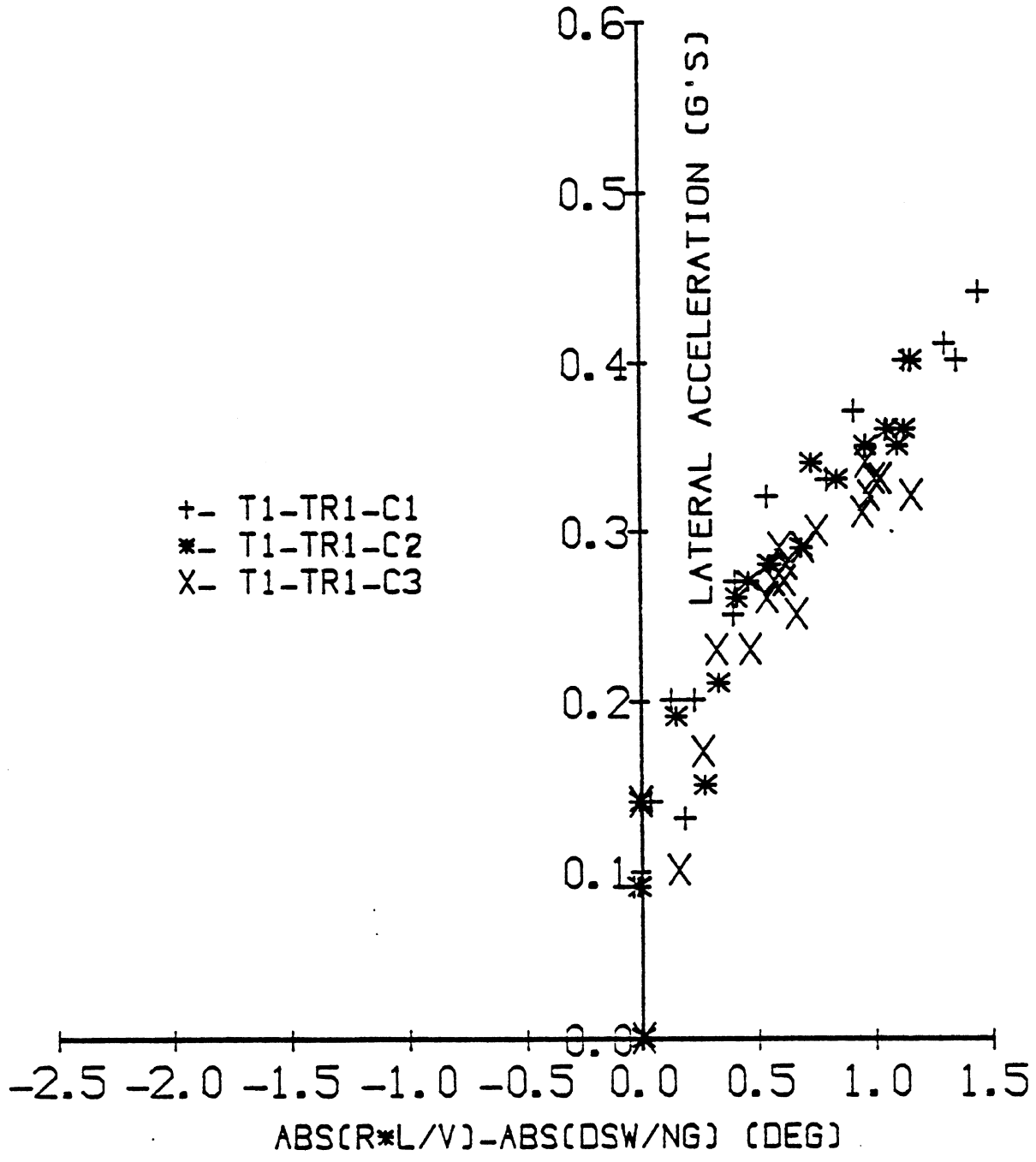
TWO AXLE TRACTOR- 27 FT TRAILER
BRAKING IN A TURN
WET SURFACE



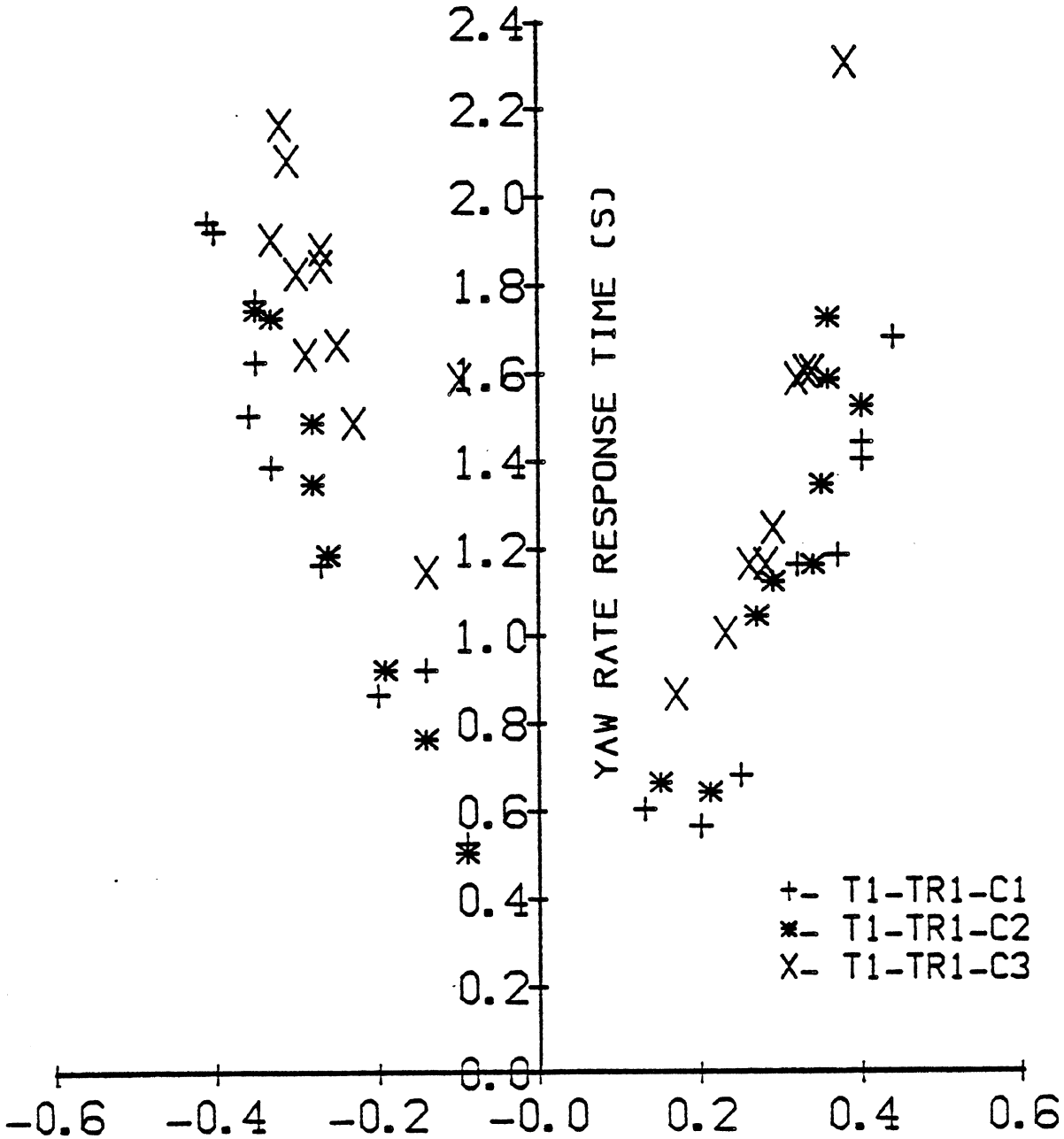
TWO AXLE TRAILER- 27 FT TRAILER
BRAKING IN A TURN
WET SURFACE



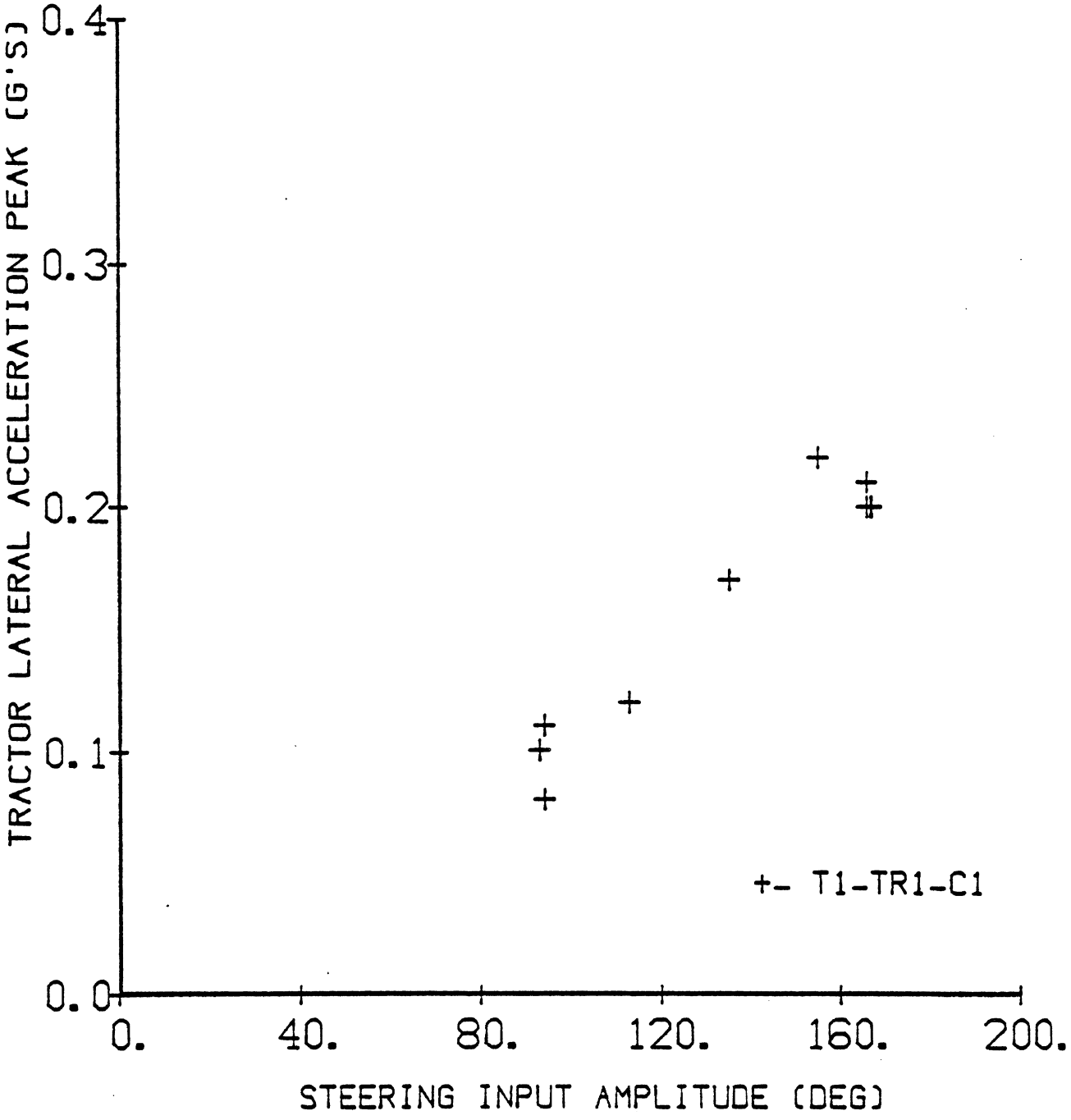
TWO AXLE TRACTOR- 27 FT VAN TRAILER



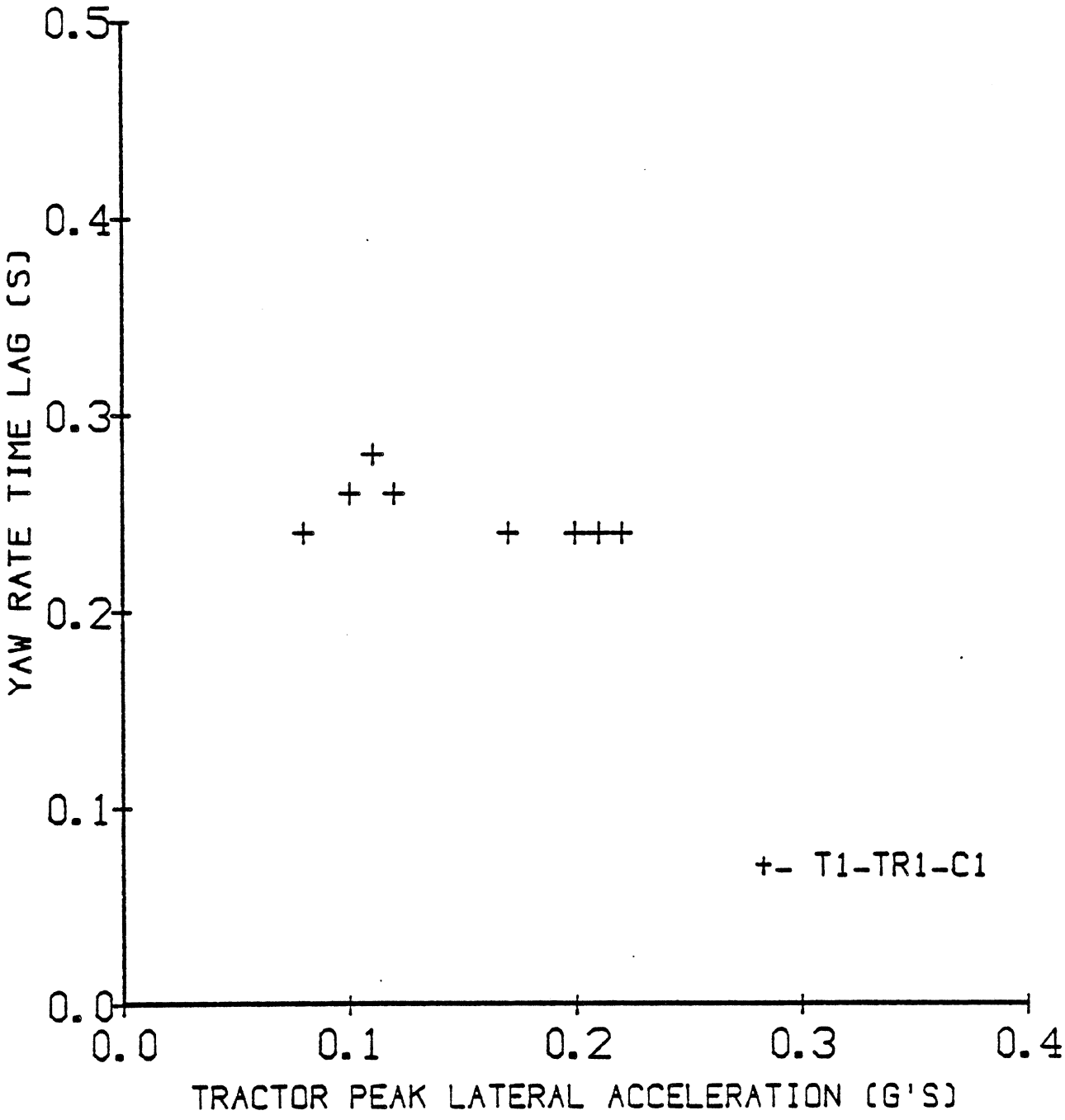
TWO AXLE TRACTOR- 27 FT VAN TRAILER



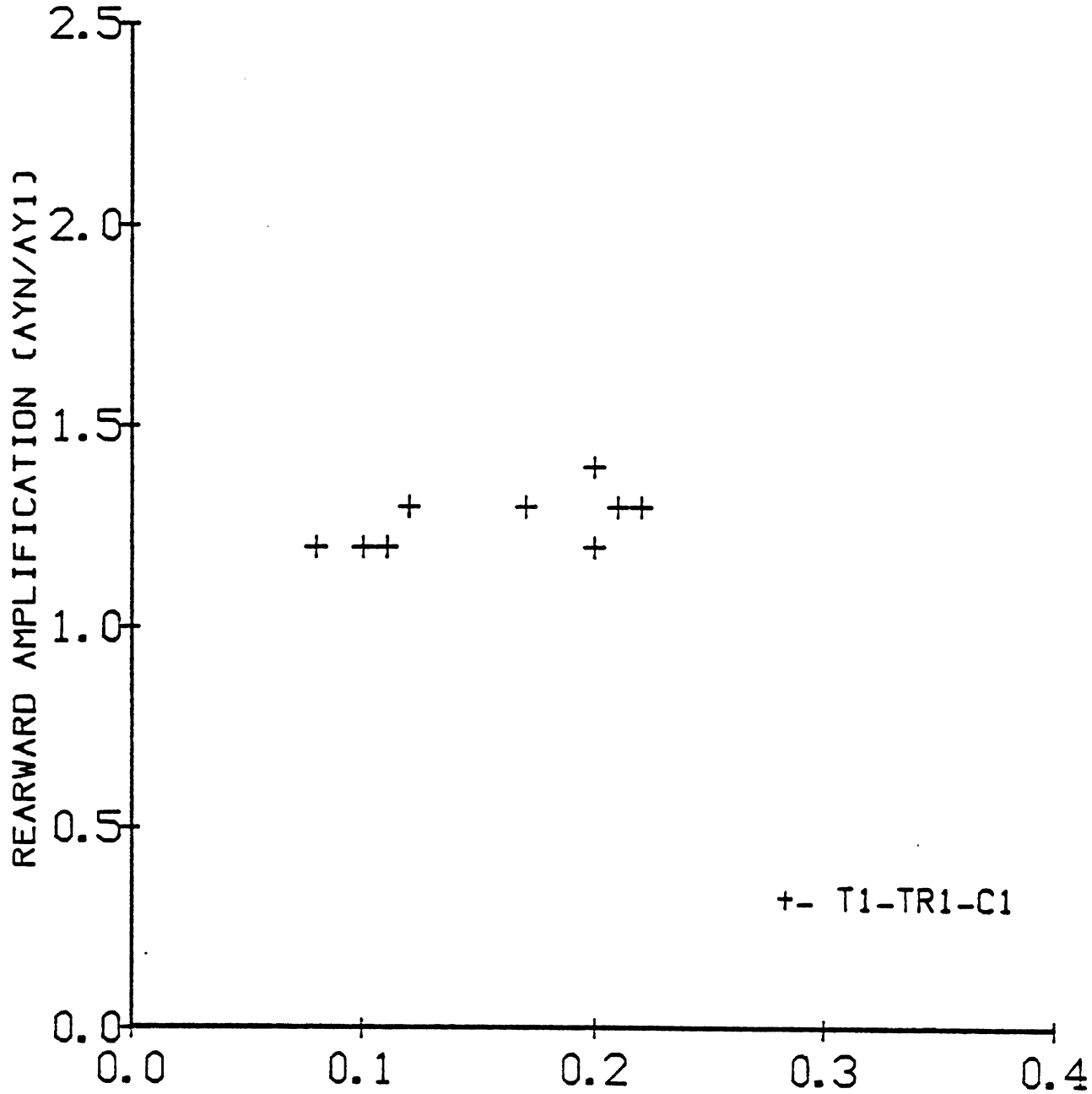
TWO AXLE TRACTOR- 27 FT VAN TRAILER



TWO AXLE TRACTOR- 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

- Configuraton: 5 Axle Tractor-Semitrailer ("T3-TR6").

- Power Unit: Wheelbase: 142 in.
  Axle-group Rated Capacities:
  front-12,000 lb; rear-34,000 lb.

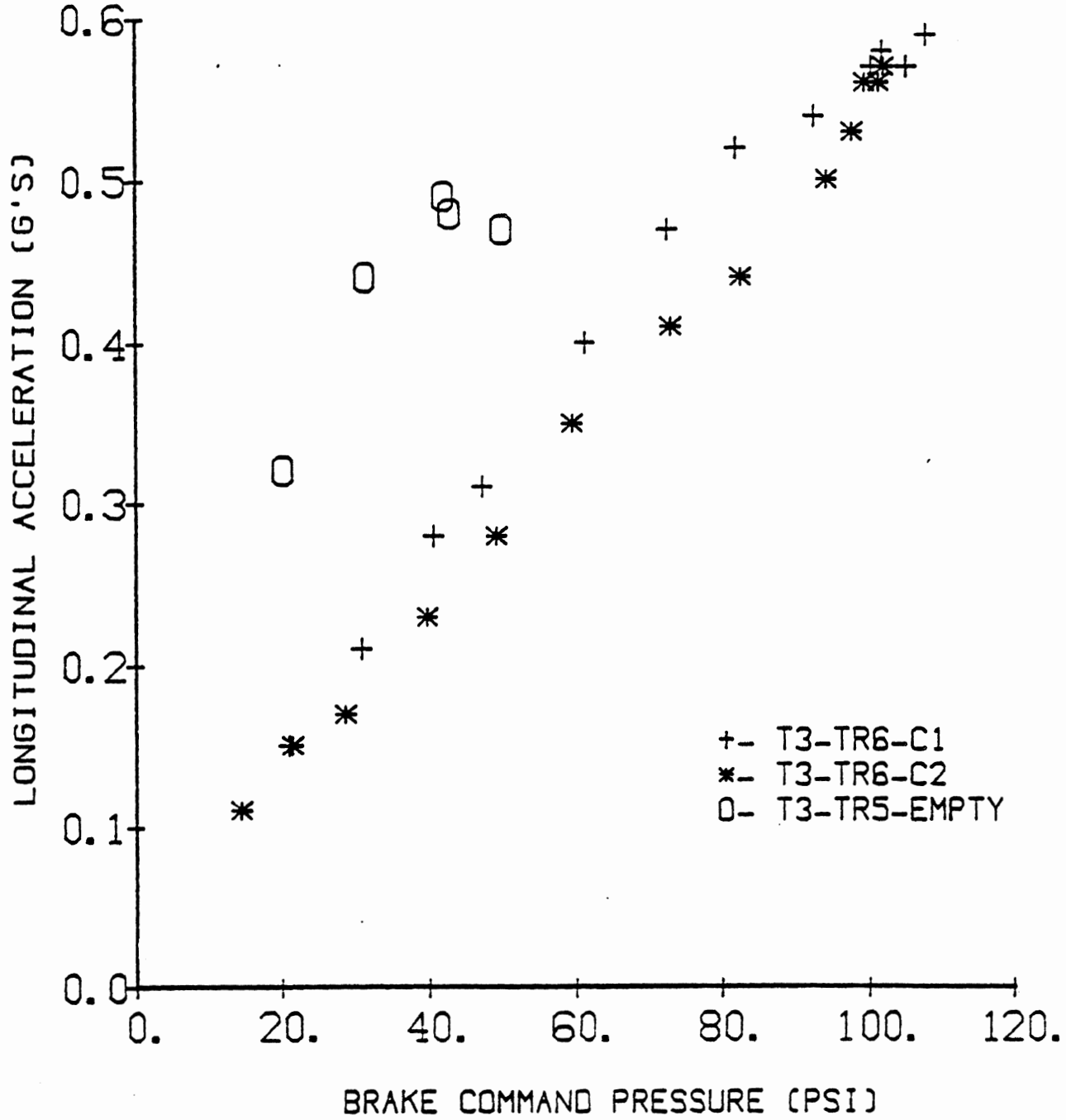
- Trailer(s):

	No. of axles in group	length (ft.)
#1:	2	45

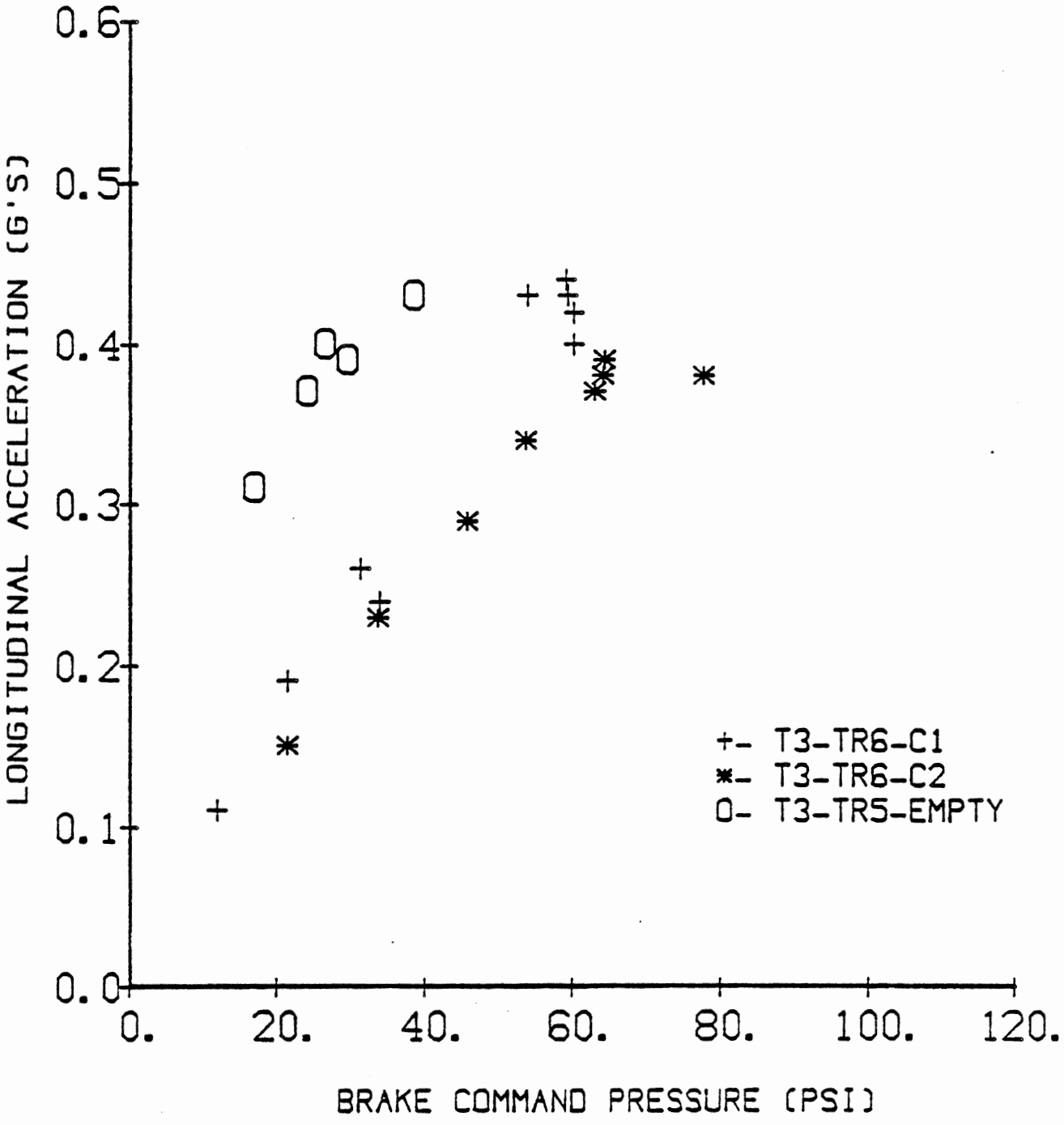
- Test Conditions and Codes:

Code	Payload CG Height(in.)	Axle Loads/1000 lbs. 1	2	3	4	5	GCW 1000 lb.	Notes
T3-TR6-C1	70	12	34		34		80	Baseline
T3-TR6-C2	78.5	12	38		38		88	
T3-TR6-C3	70	10	35		35		80	
T3-TR6-C4	70	10	35		35		80	Radials fr, Bias rear
T3-TR5-Empty	-							Empty

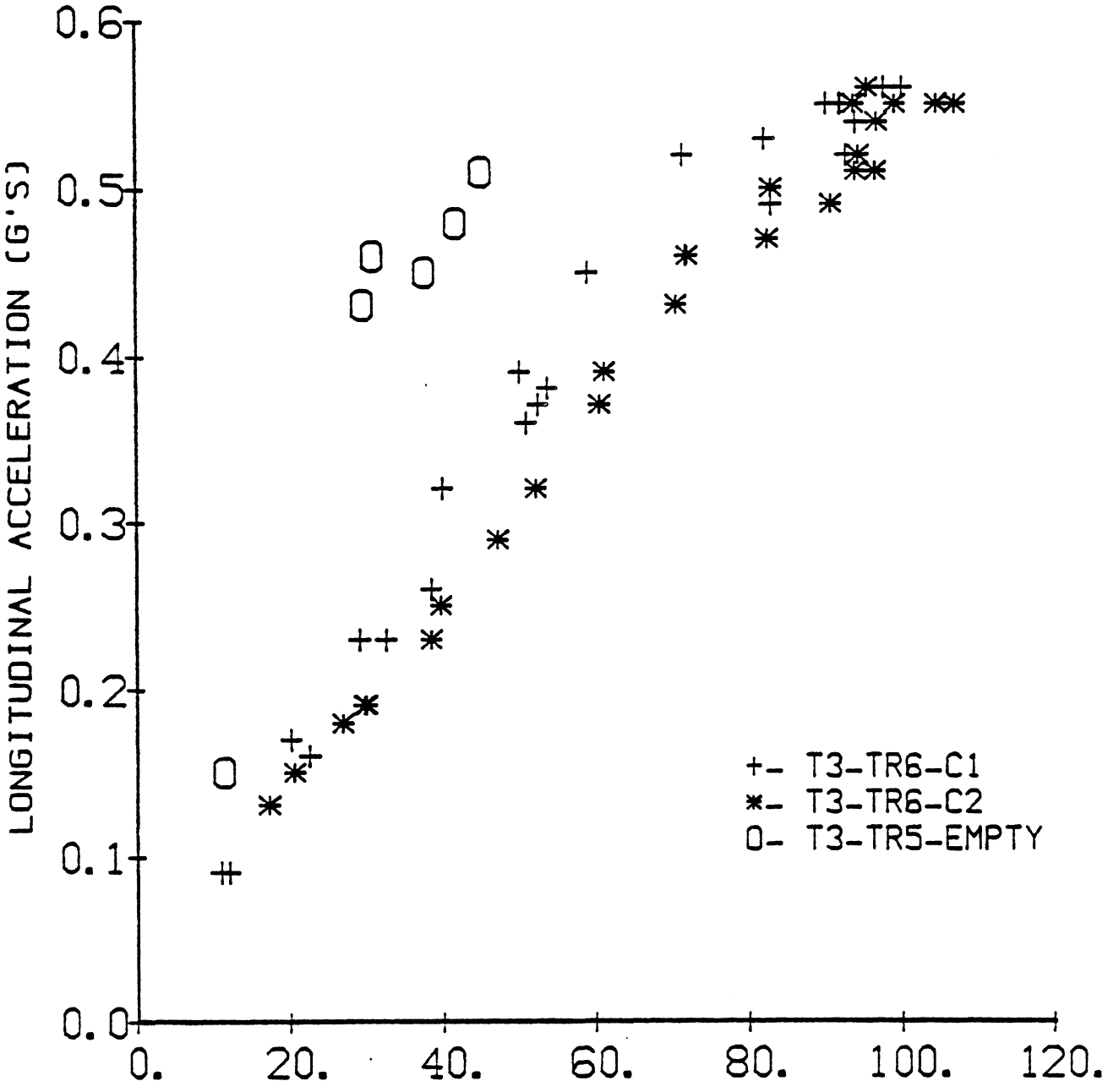
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	C1, C2 & Empty
2. Braking in a Turn	C1, C2 & Empty
3. Trapezoidal Steer	All
4. Sinusoidal Steer	C1 only



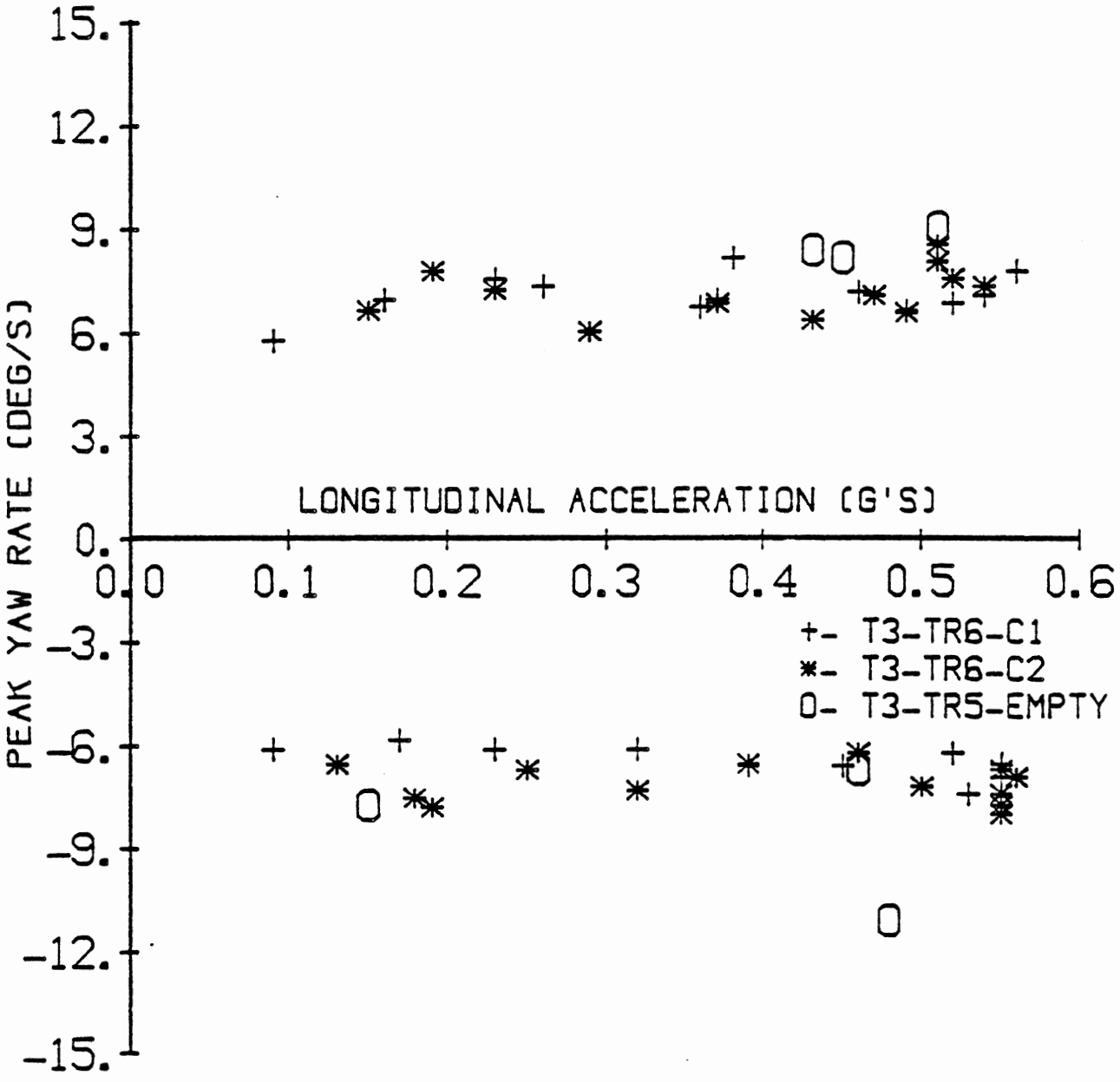
THREE AXLE TRACTOR- 45 FT TRAILER
STRAIGHT LINE BRAKING
DRY SURFACE



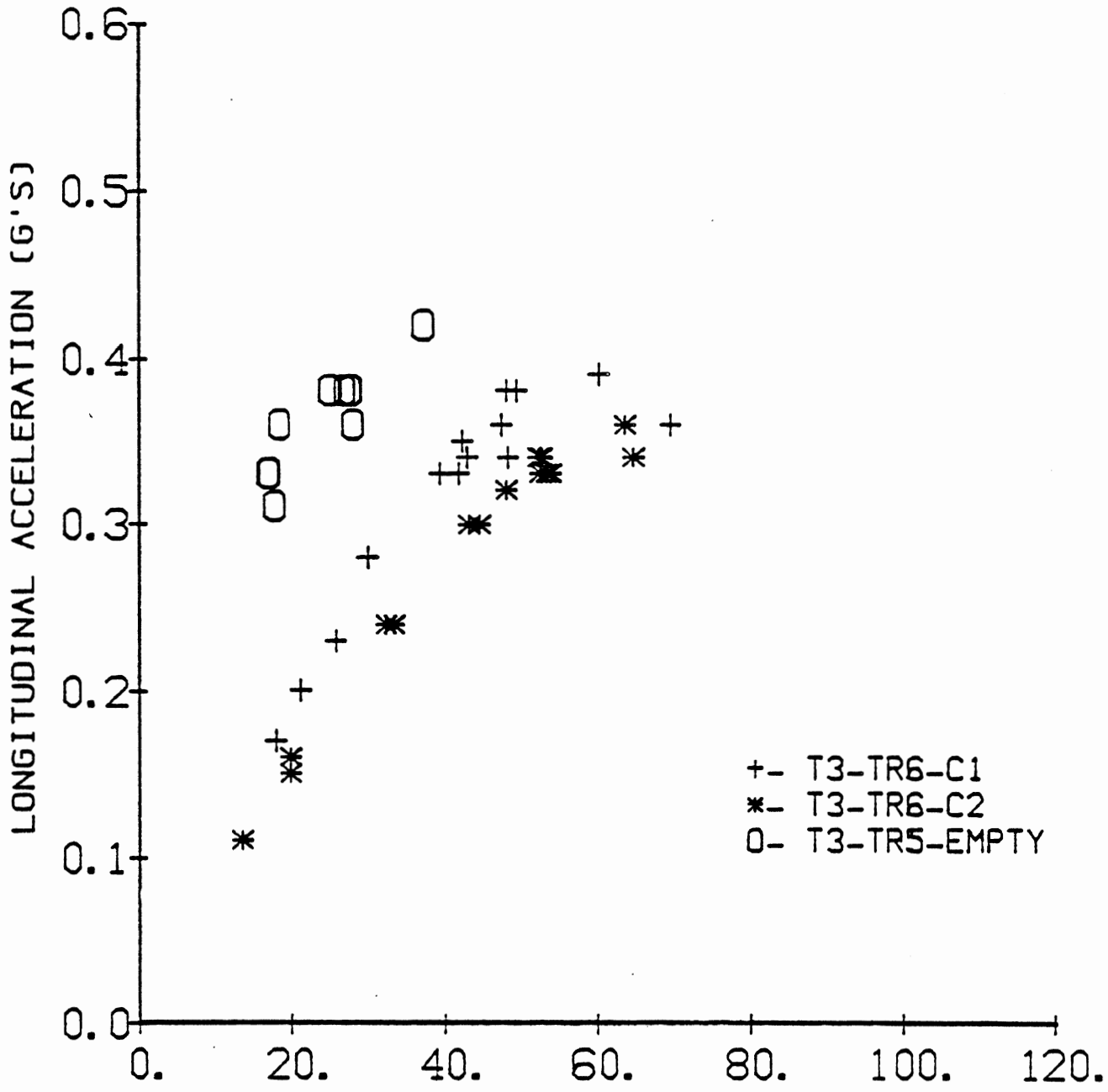
THREE AXLE TRACTOR- 45 FT TRAILER
STRAIGHT LINE BRAKING
WET SURFACE



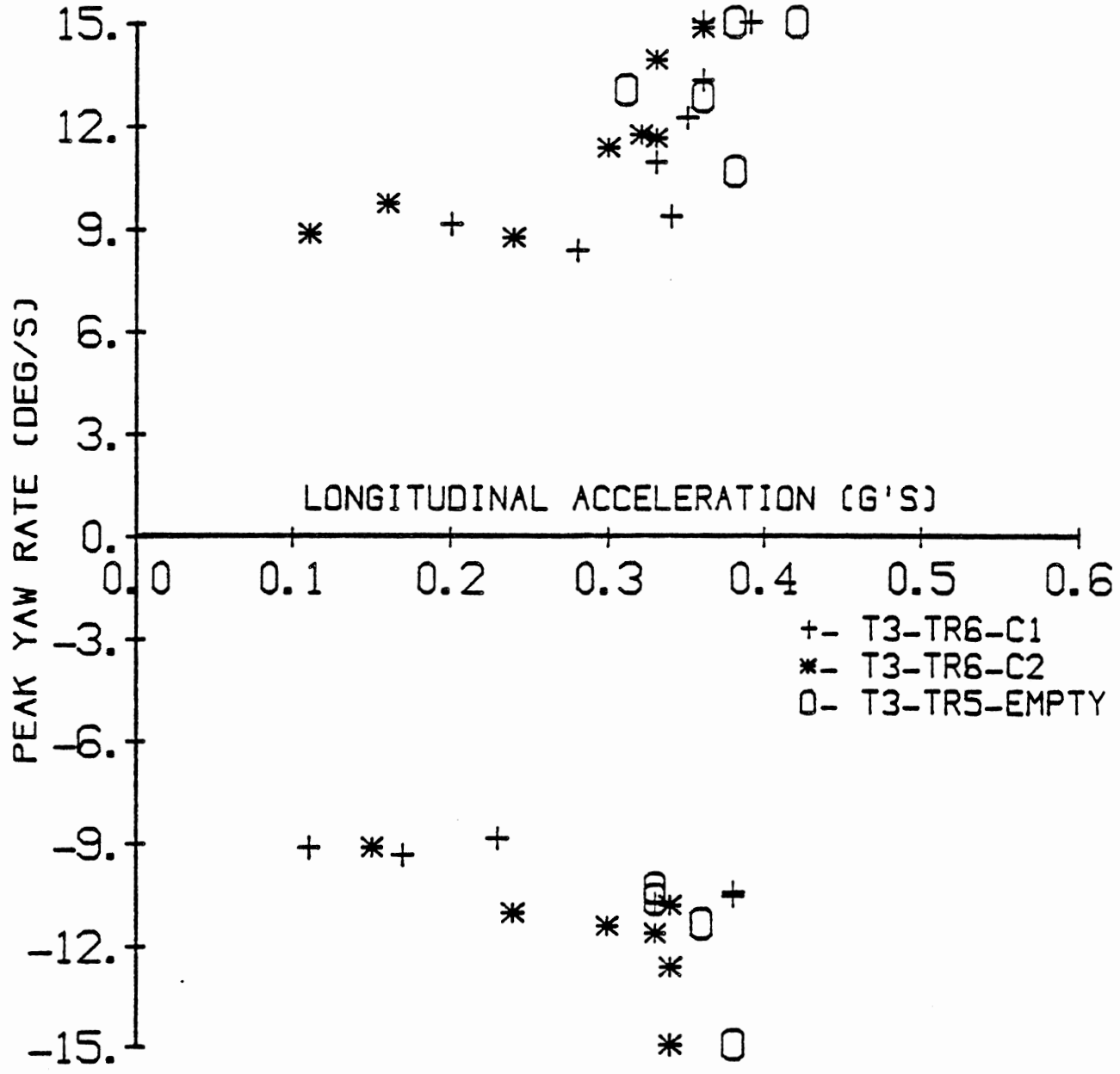
THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
DRY SURFACE



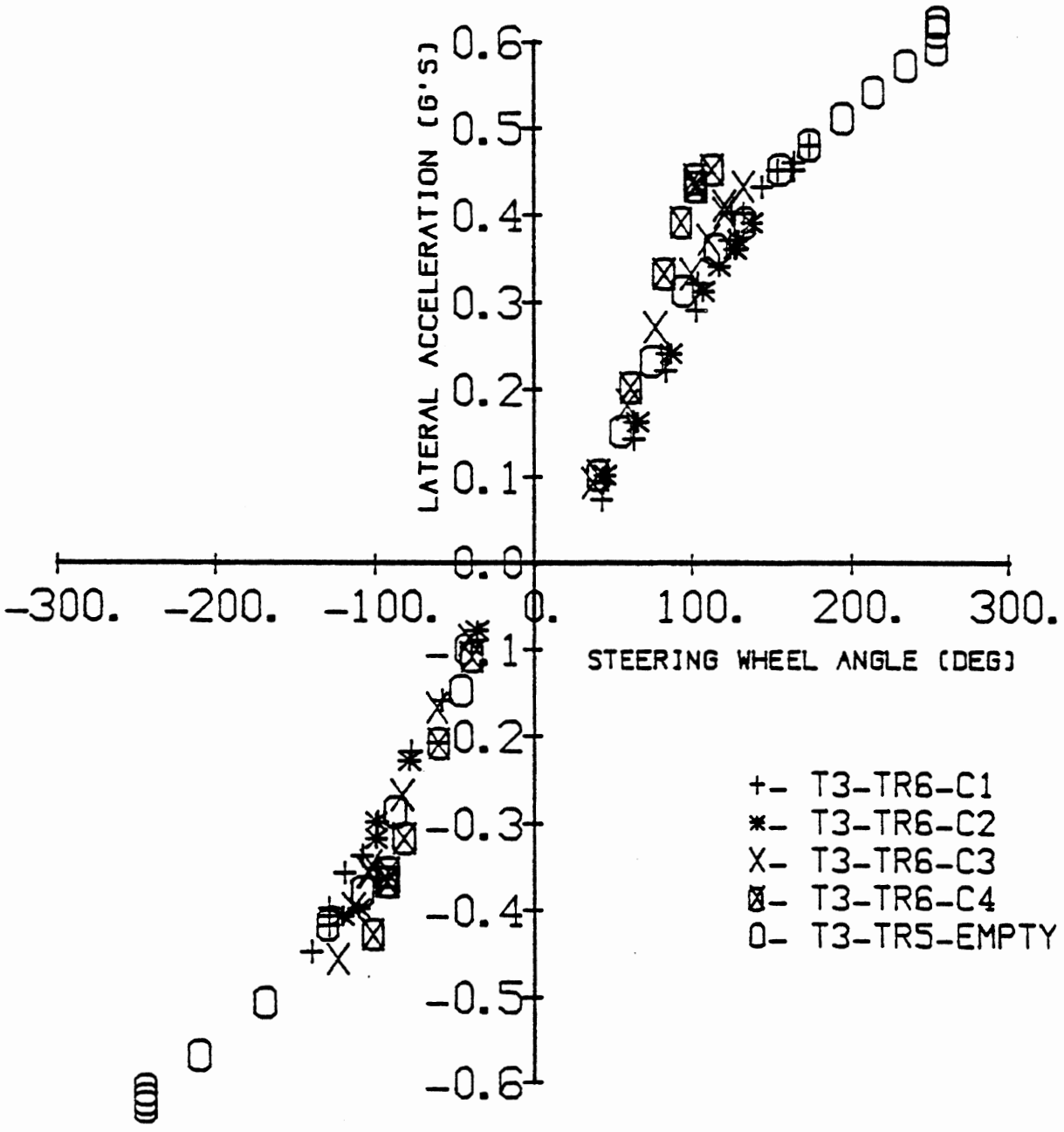
THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
DRY SURFACE



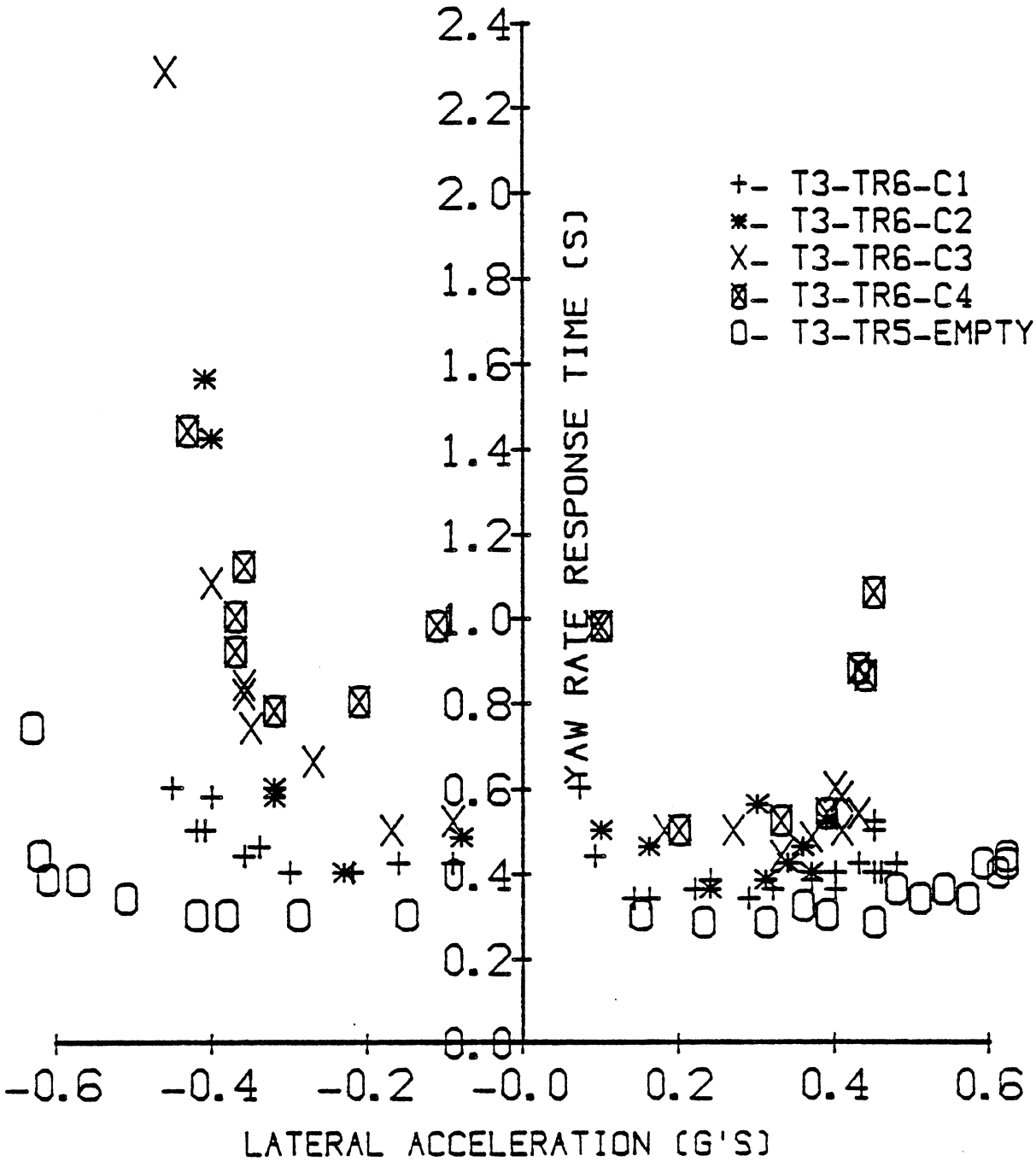
THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
WET SURFACE



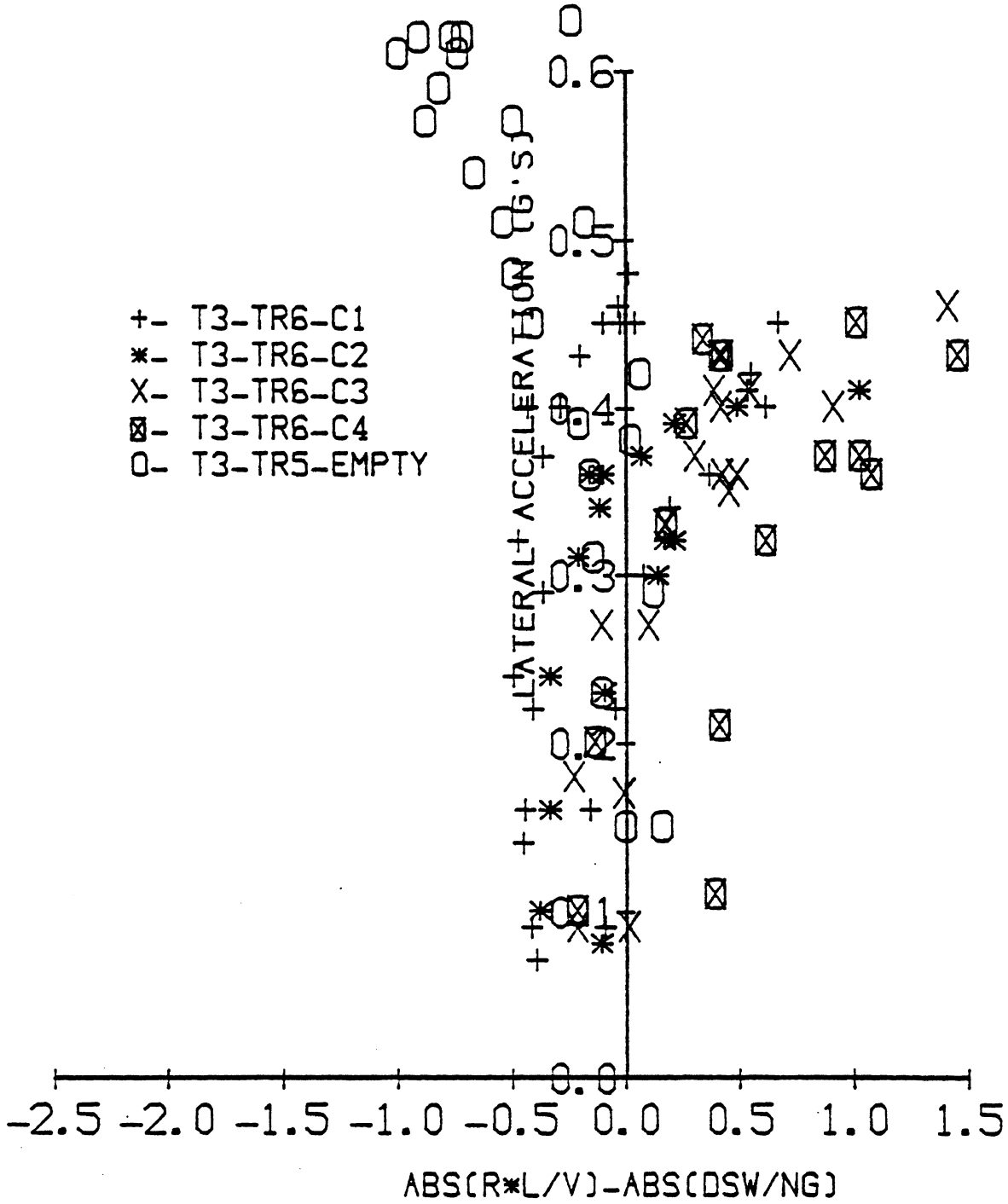
THREE AXLE TRACTOR- 45 FT TRAILER
BRAKING IN A TURN
WET SURFACE



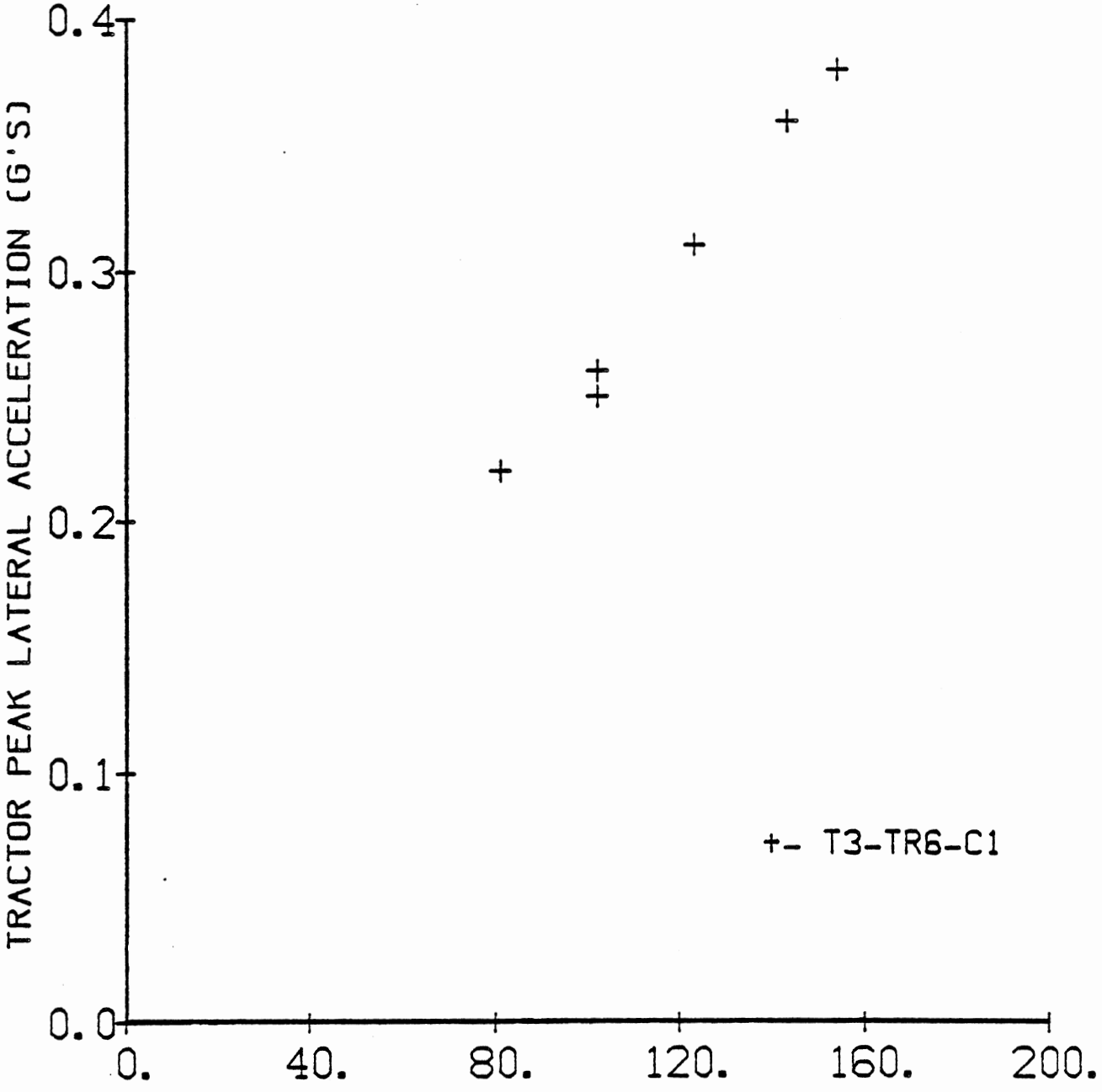
THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER



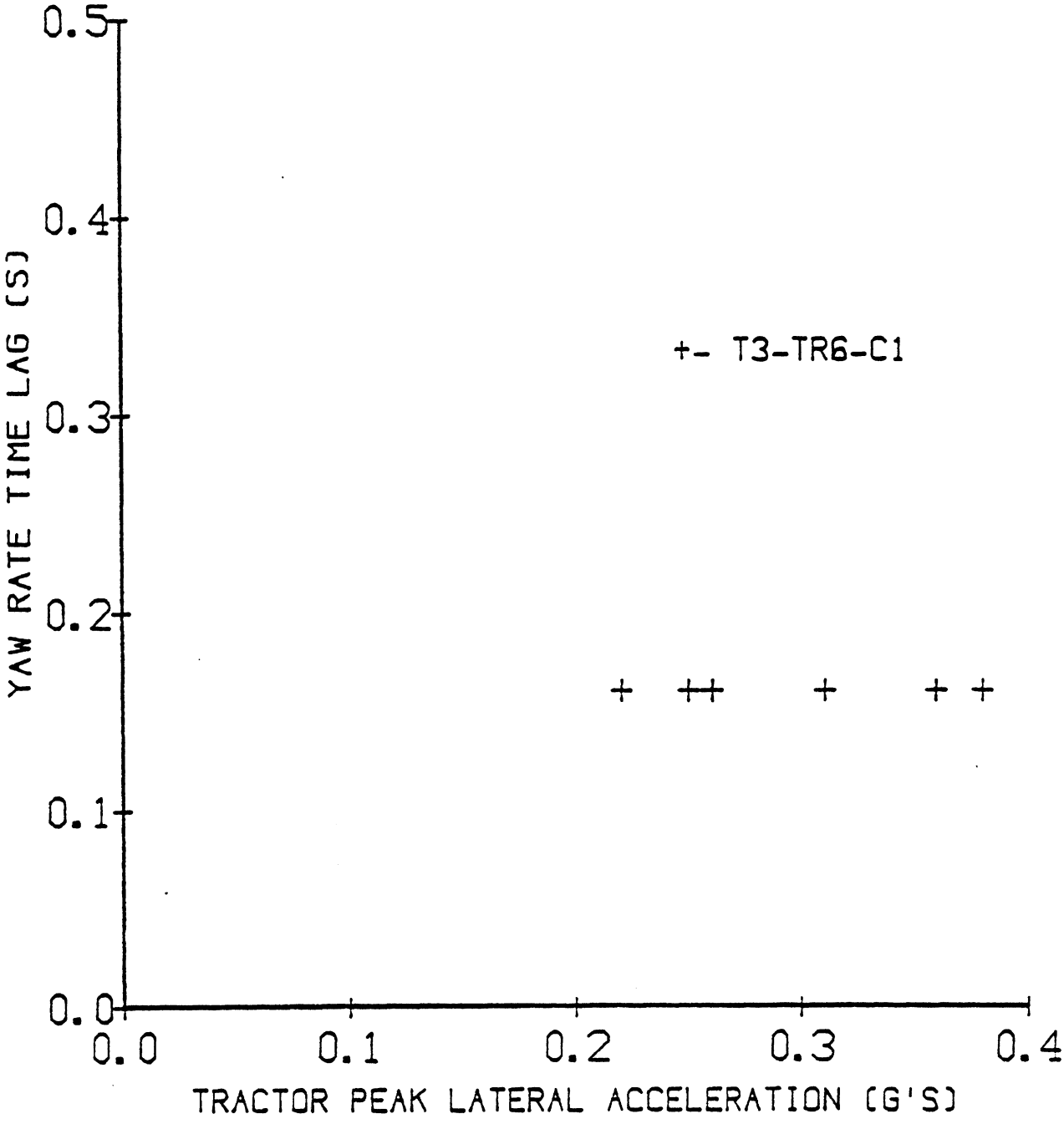
THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER



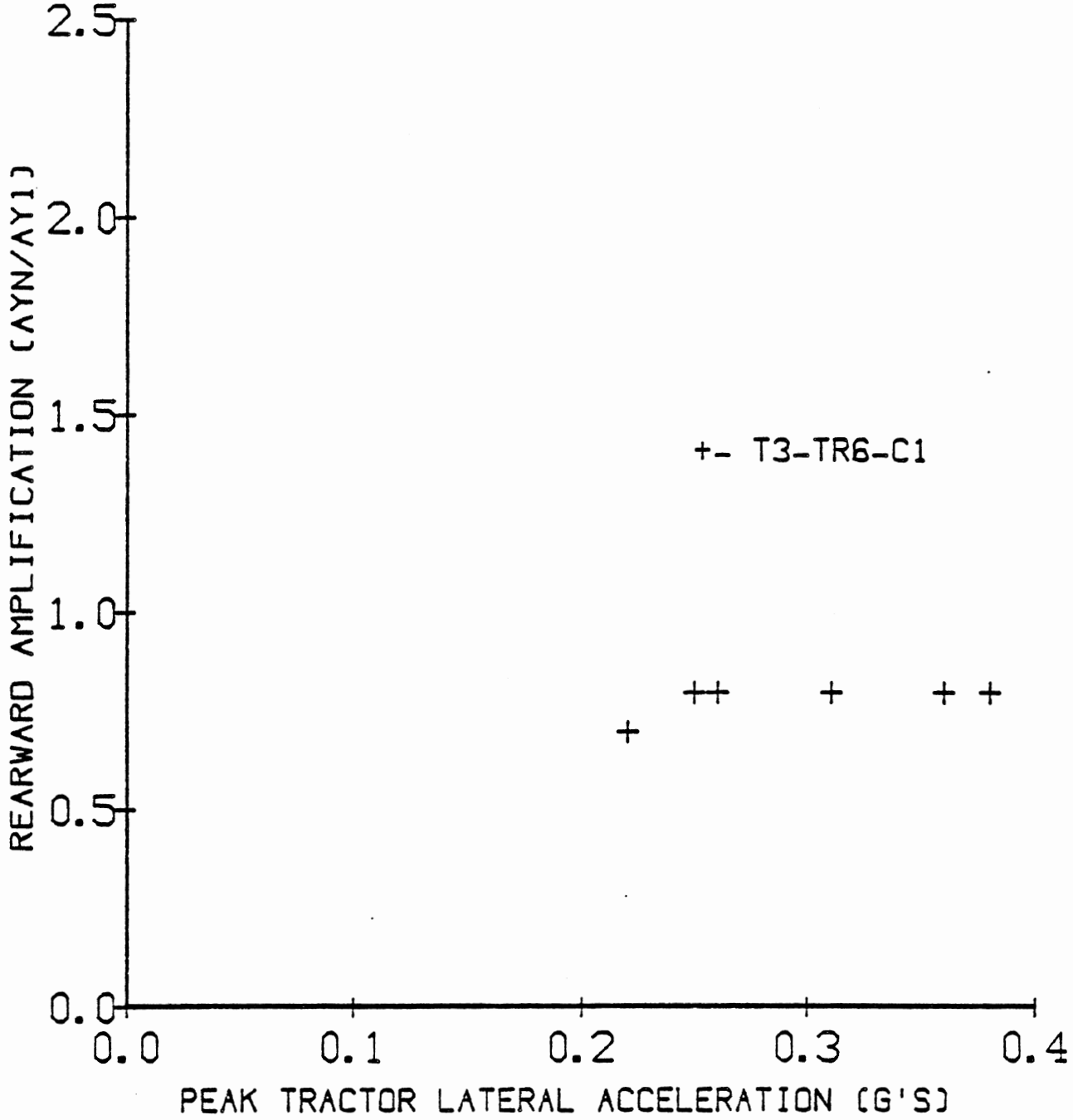
THREE AXLE TRACTOR- 45 FT TRAILER
STEERING RATIO= 50



THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR- 45 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

- Configuration: 5 Axle Tractor-Semitrailer ("T7-TR6").

- Power Unit: Wheelbase: 145 in.
Axle-group Rated Capacities:
front - 12,000 lb; rear - 38,000 lb.

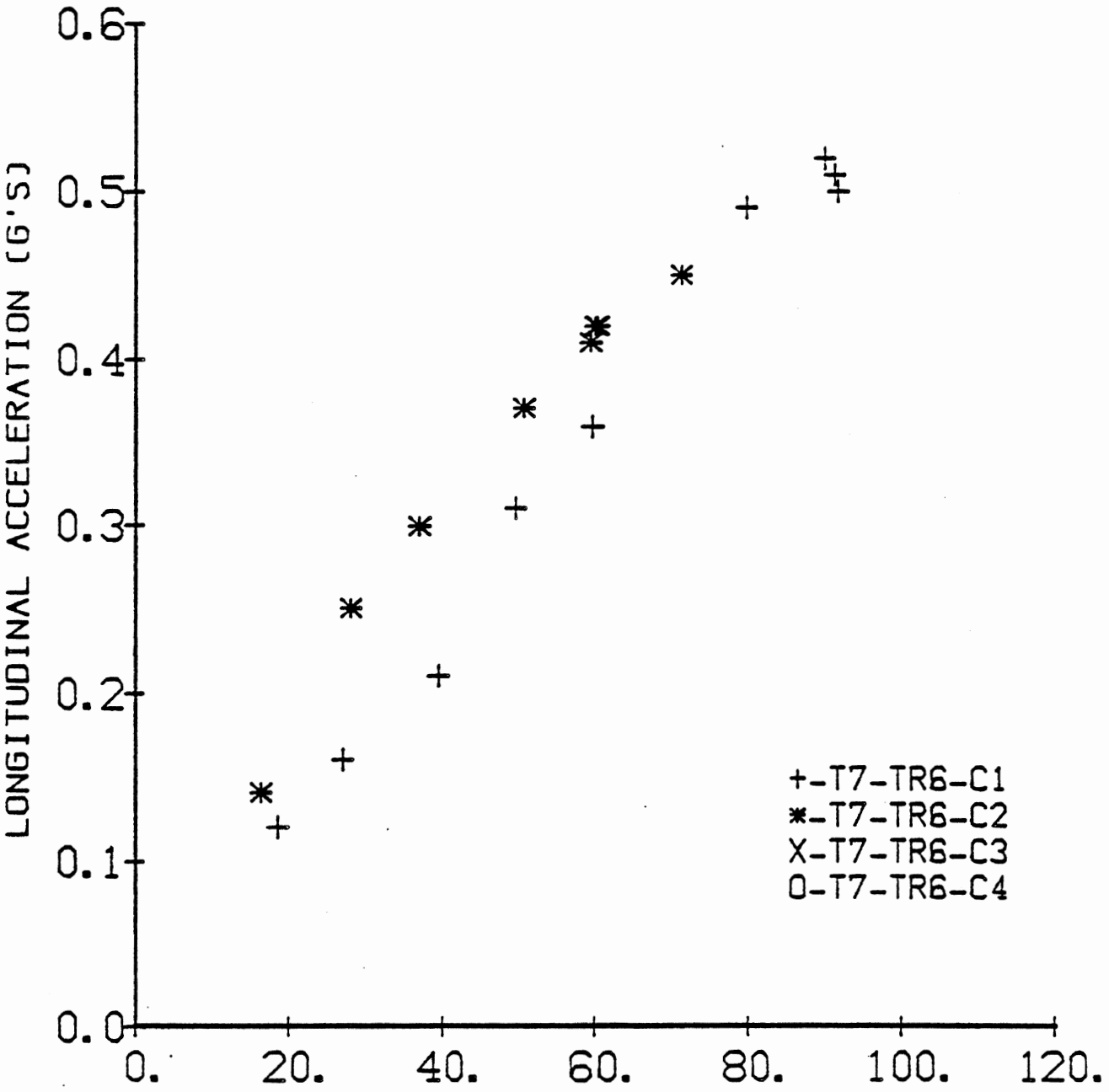
- Trailer(s):

No. of Axles in group	length (ft).
2	45

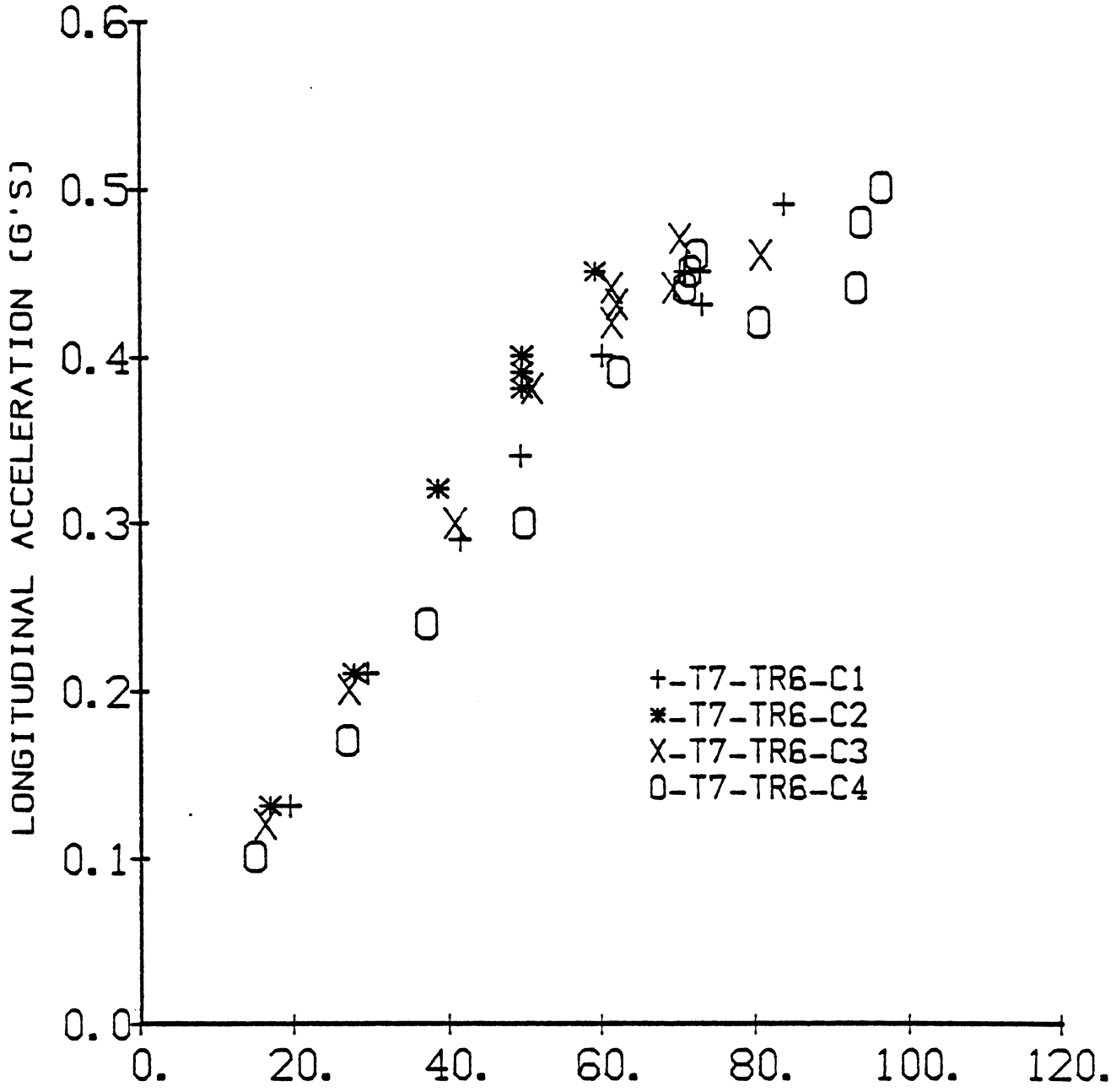
- Test Conditions and Codes:

Code	Payload CG Height(in)	Axle Loads/1000 lb. 1	2	3	4	5	GCW 1000 lb.	Notes
T7-TR6-C1	70	12	34		34		80	Baseline
T7-TR6-C2	70	12	30		16		58	Partial loading
T7-TR6-C3	95	12	34		34		80	High CG, 80 K
T7-TR6-C4	99	12	38		38		88	High CG, 88 K

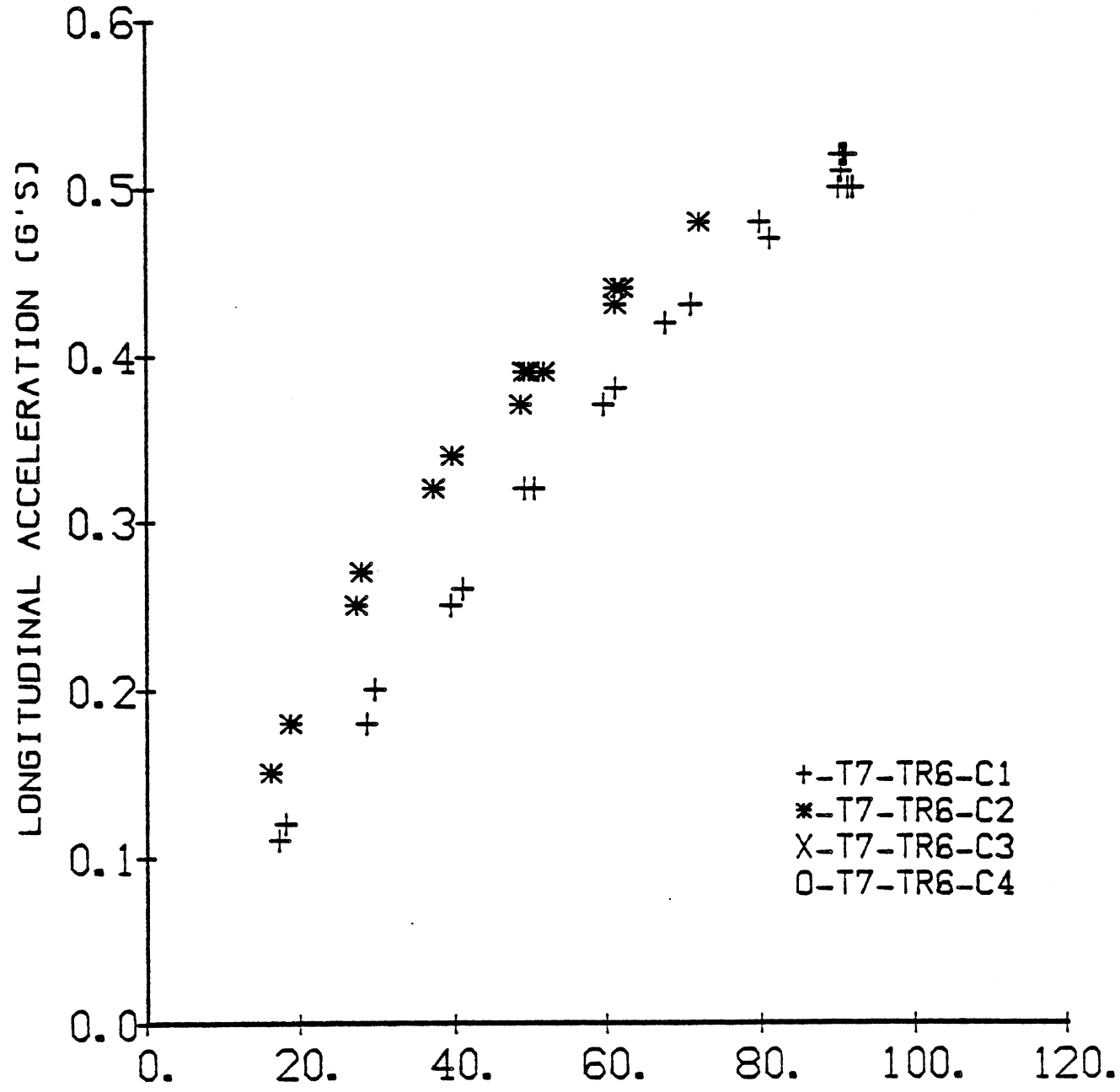
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	C1 & C2-dry & wet, C3 & C4-wet only.
2. Braking in a Turn	C1 & C2-dry & wet, C3 & C4-wet only.
3. Trapezoidal Steer	All.
4. Sinusoidal Steer	C1 only.



THREE AXLE TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - DRY

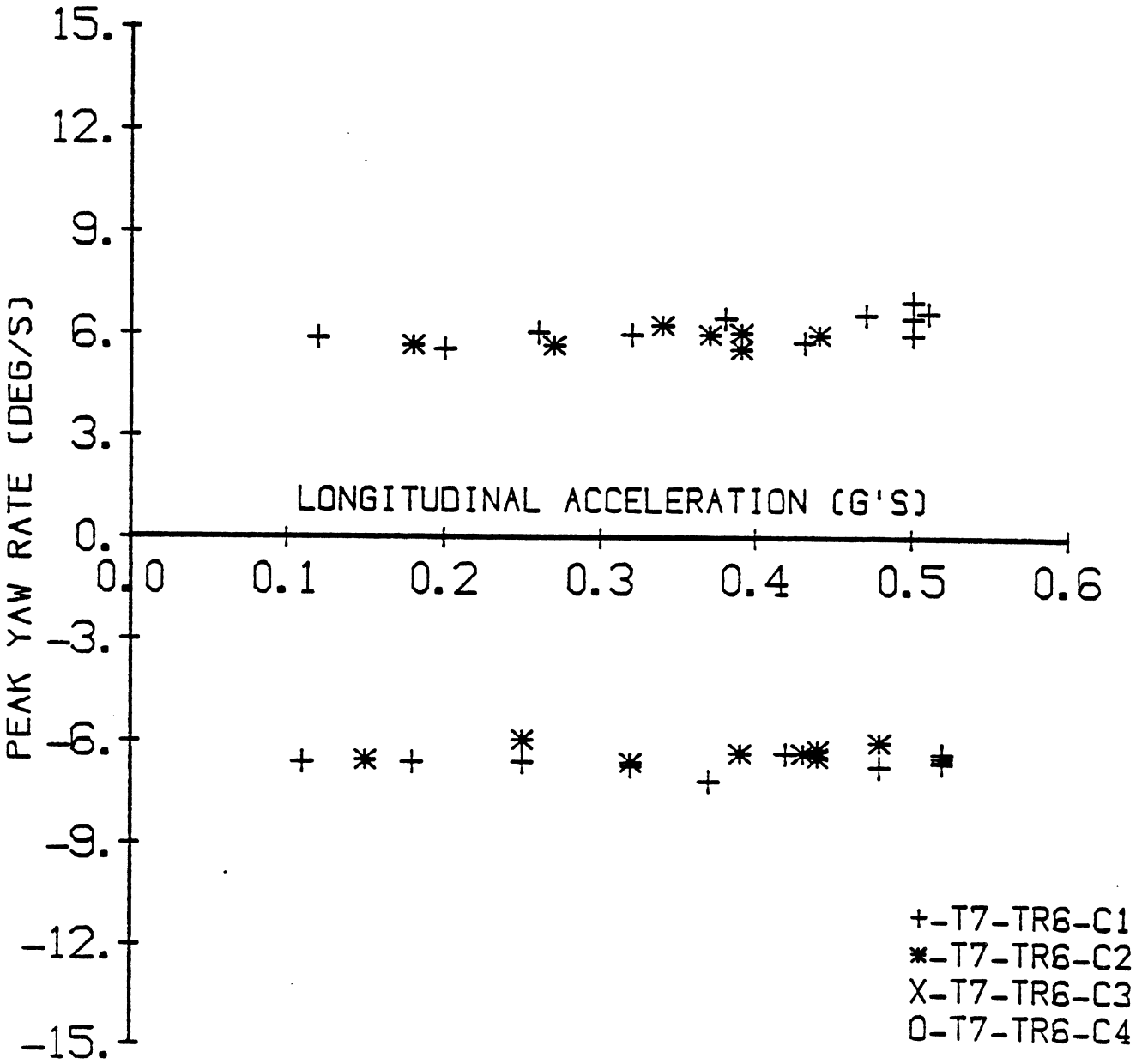


THREE AXLE TRACTOR-45 FT TRAILER
STRAIGHT LINE BRAKING-WET



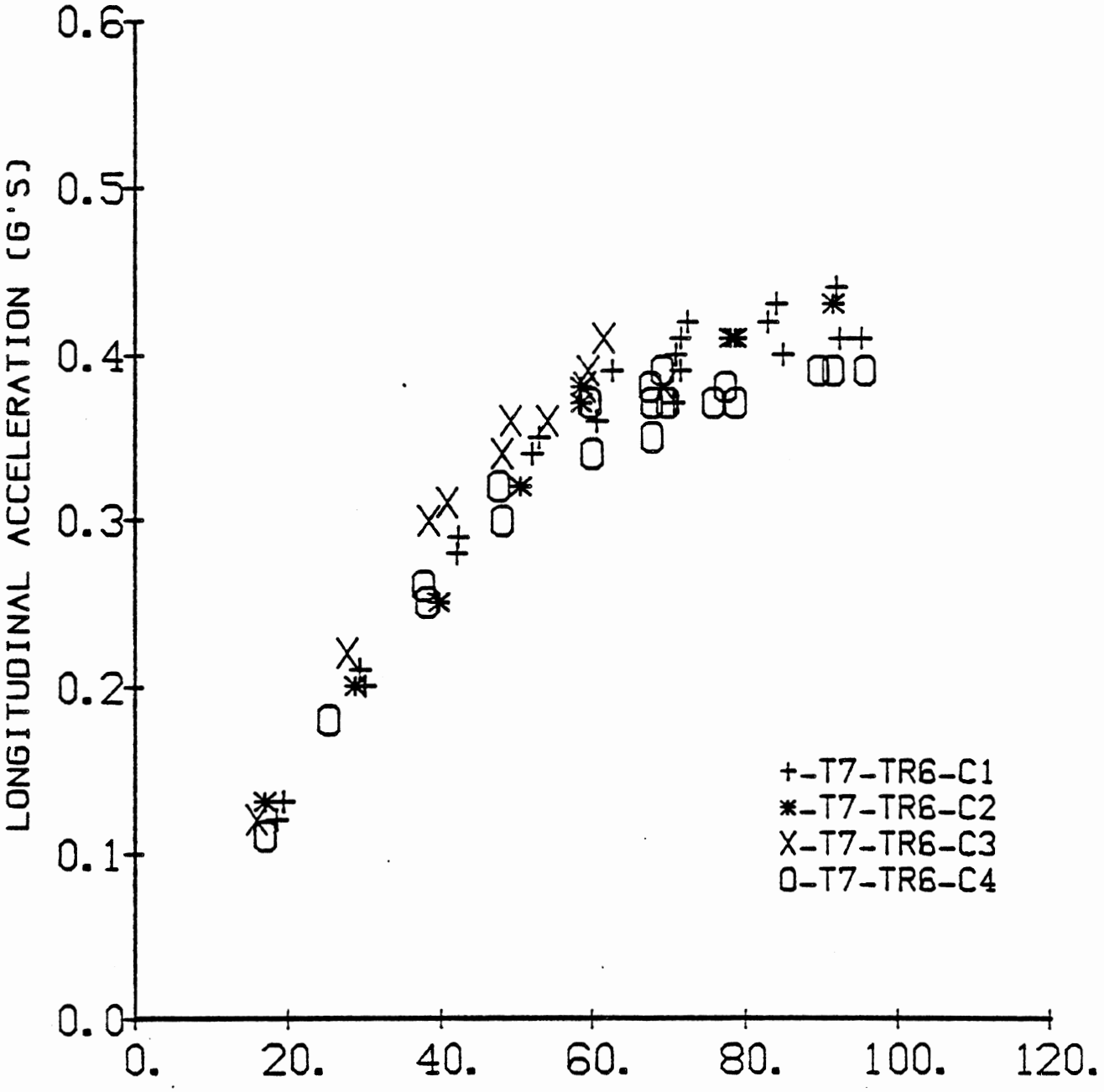
THREE AXLE TRACTOR-45 FT TRAILER

BRAKING IN A TURN - DRY



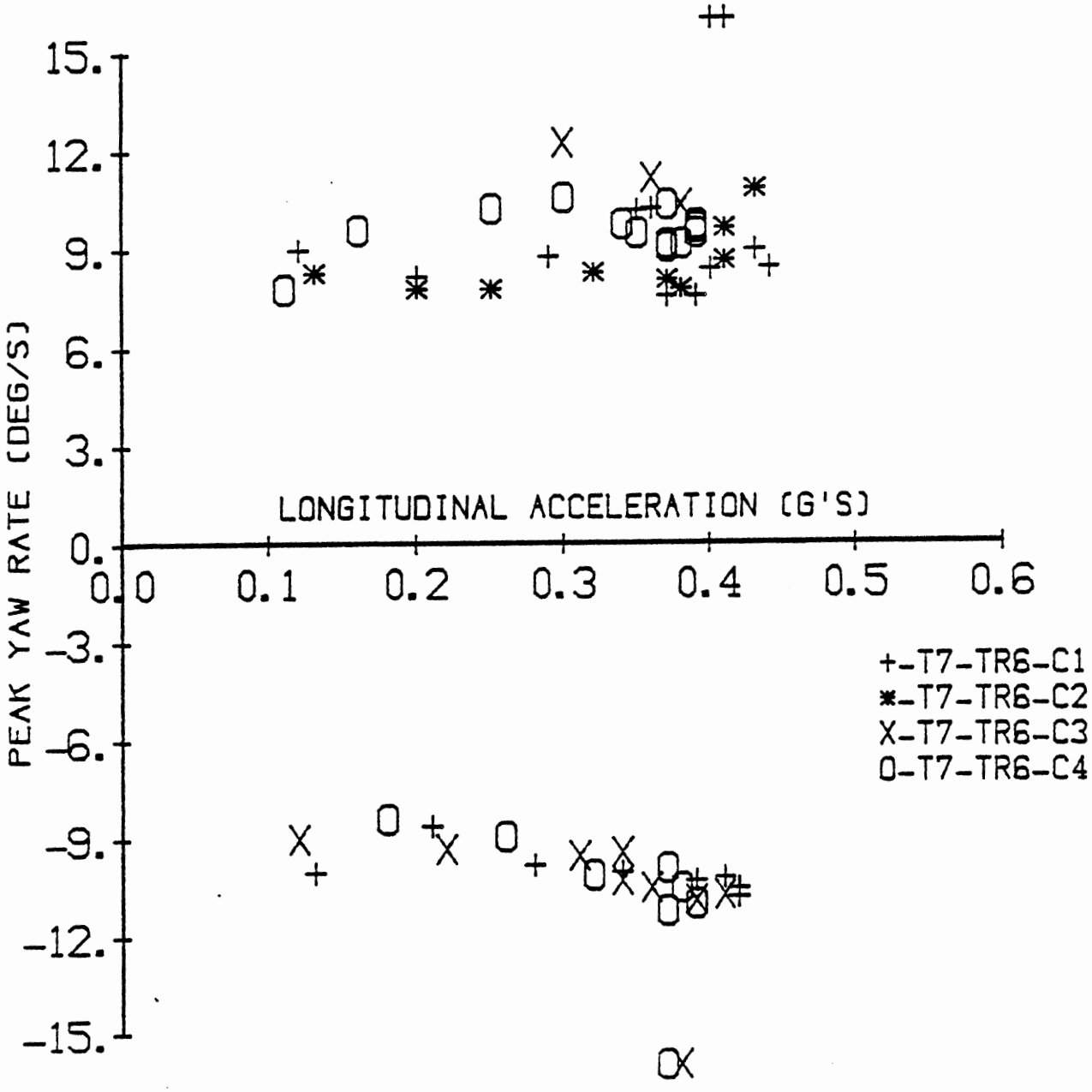
THREE AXLE TRACTOR - 45 FT TRAILER

BRAKING IN A TURN - DRY

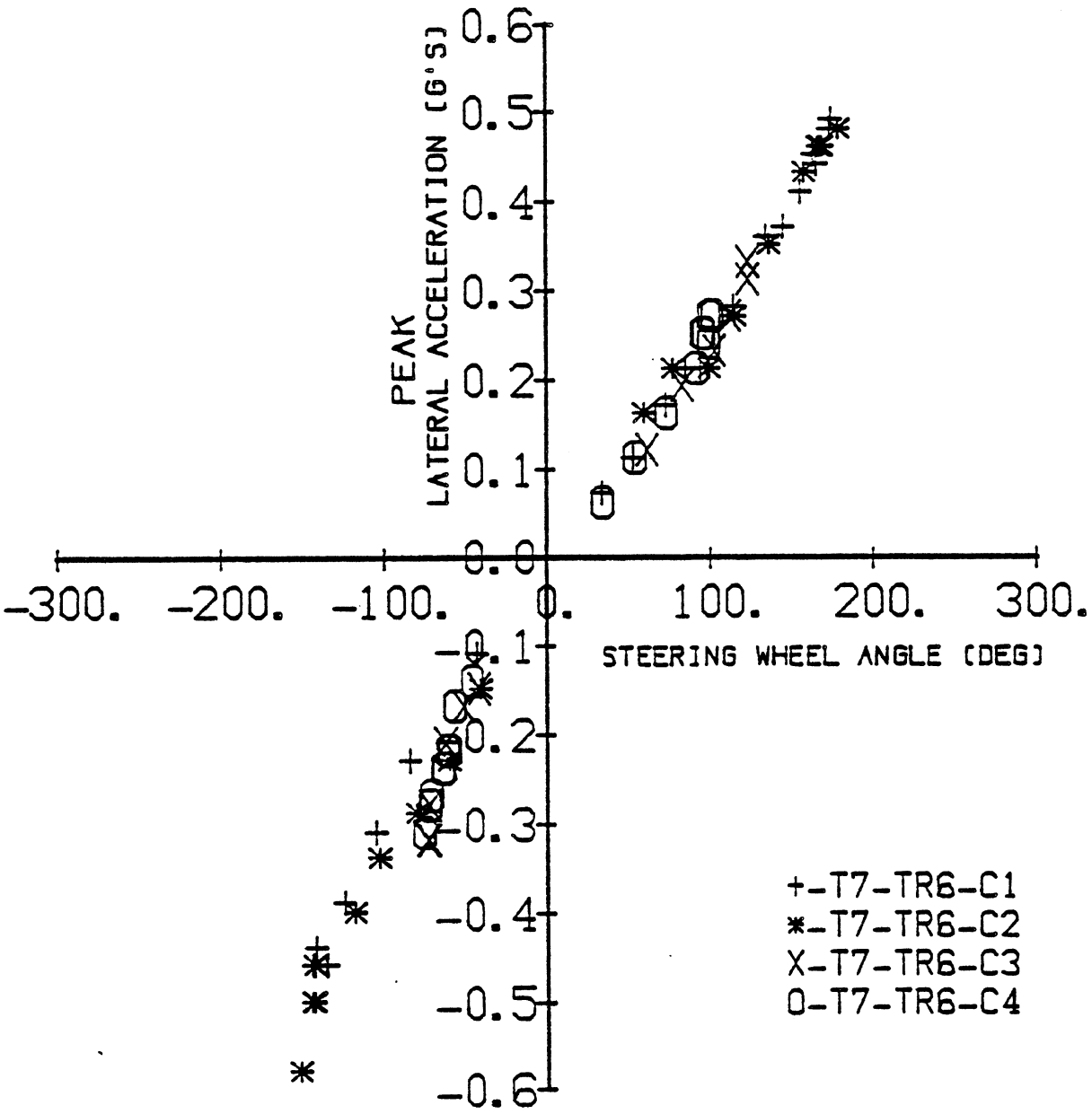


THREE AXLE TRACTOR-45 FT TRAILER

BRAKING IN A TURN - WET

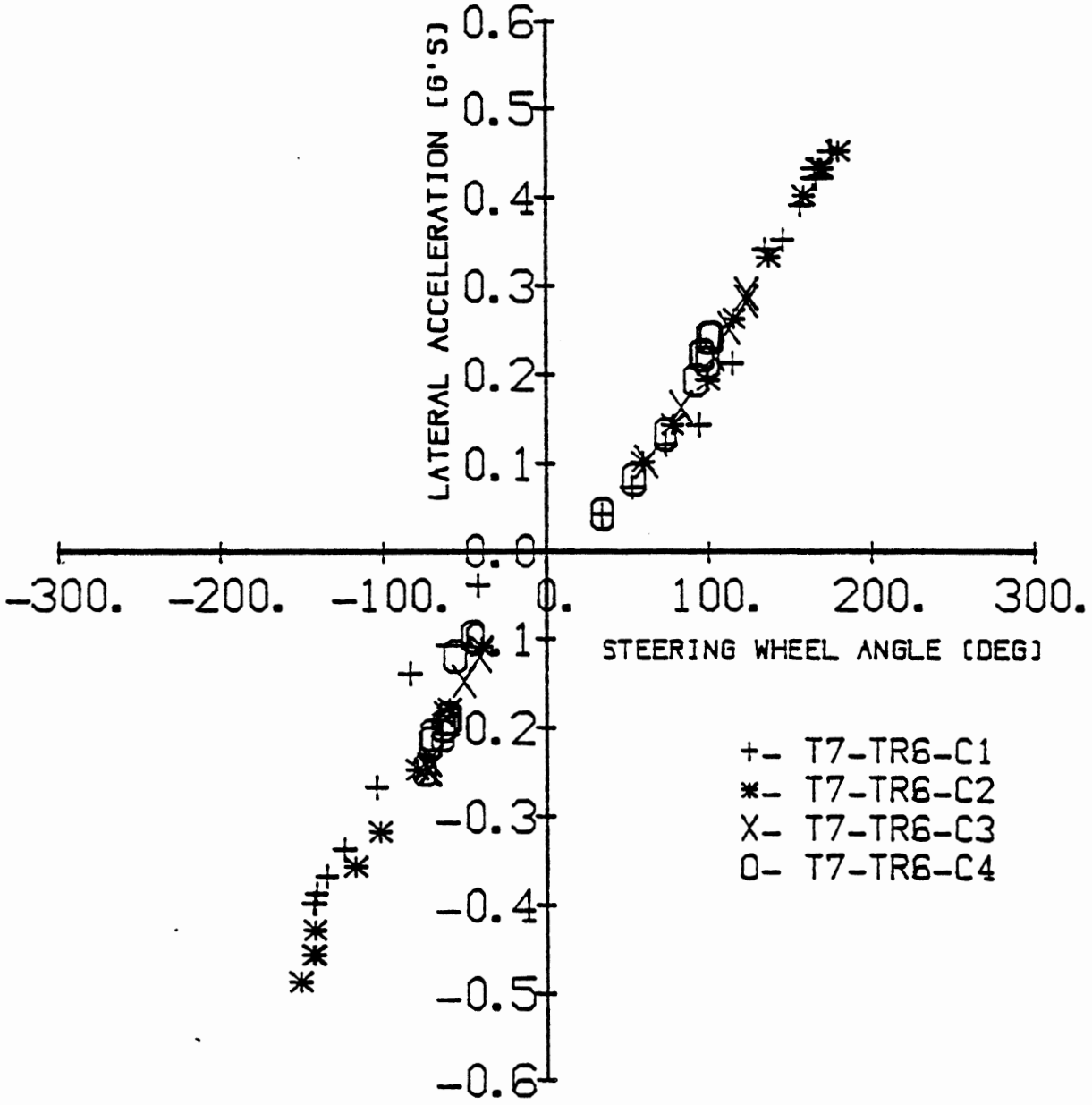


THREE AXLE TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET

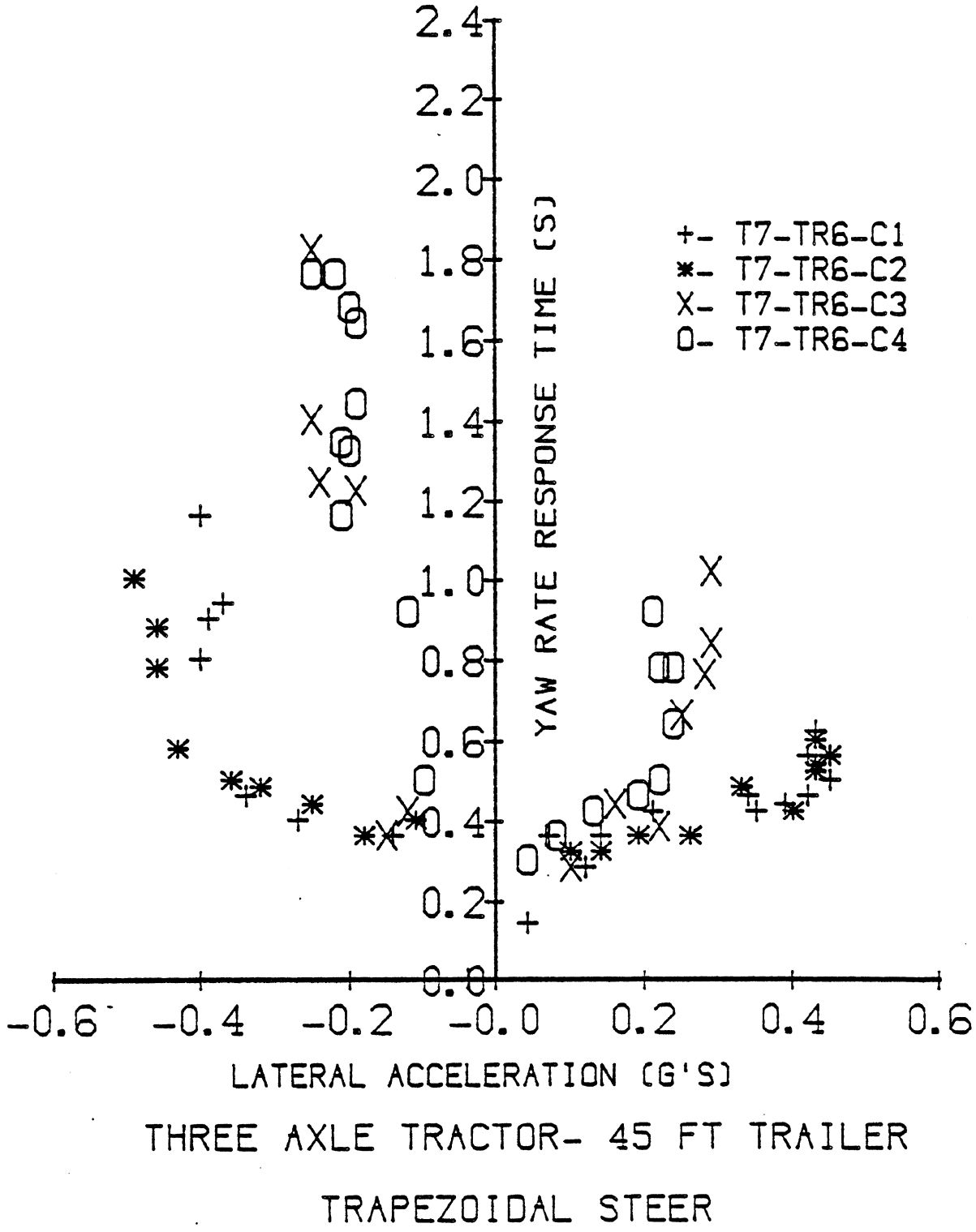


TRAPEZOIDAL STEER

THREE AXLE TRACTOR - 45 FT TRAILER

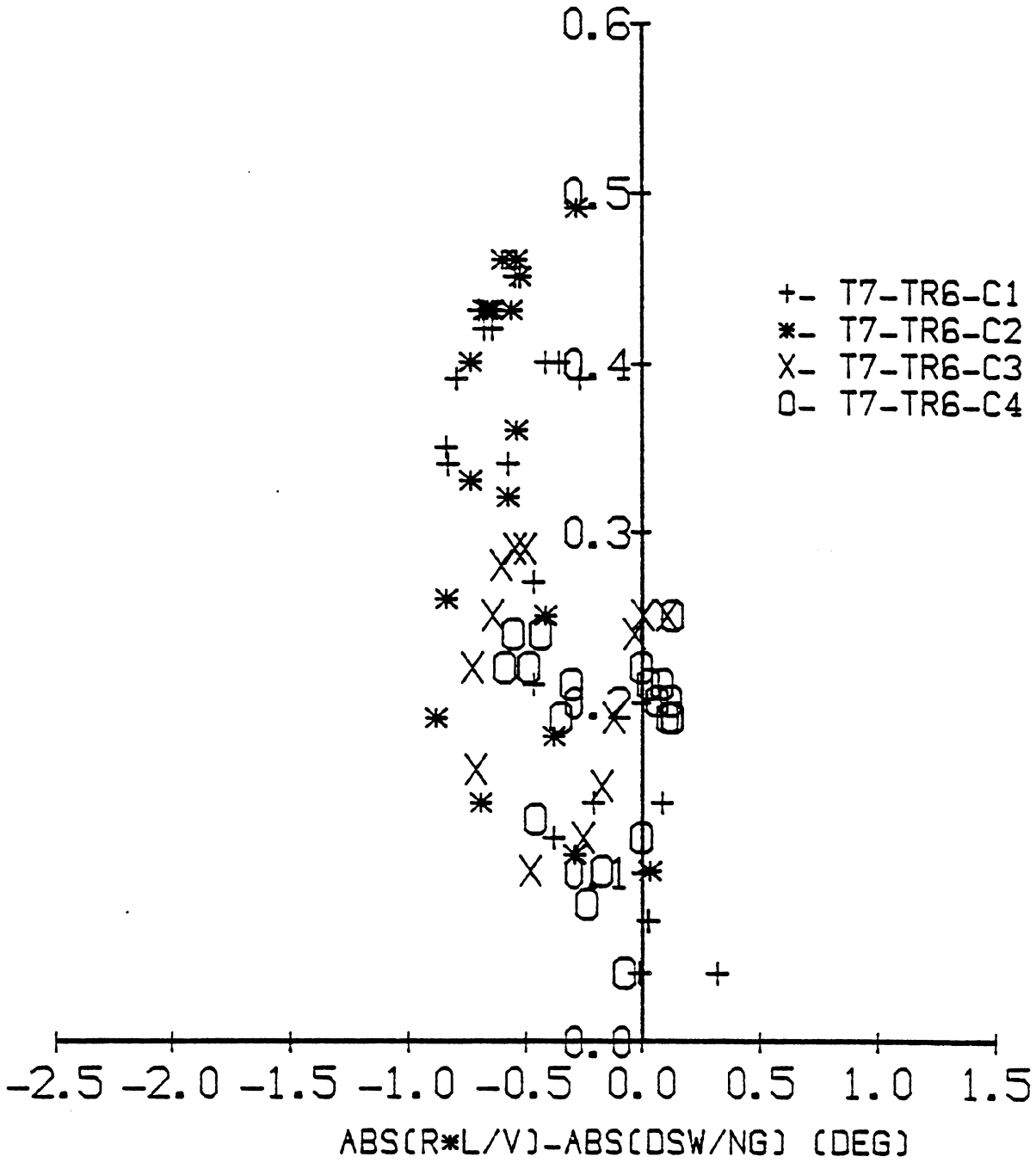


THREE AXLE TRACTOR- 45 FT TRAILER
TRAPEZOIDAL STEER

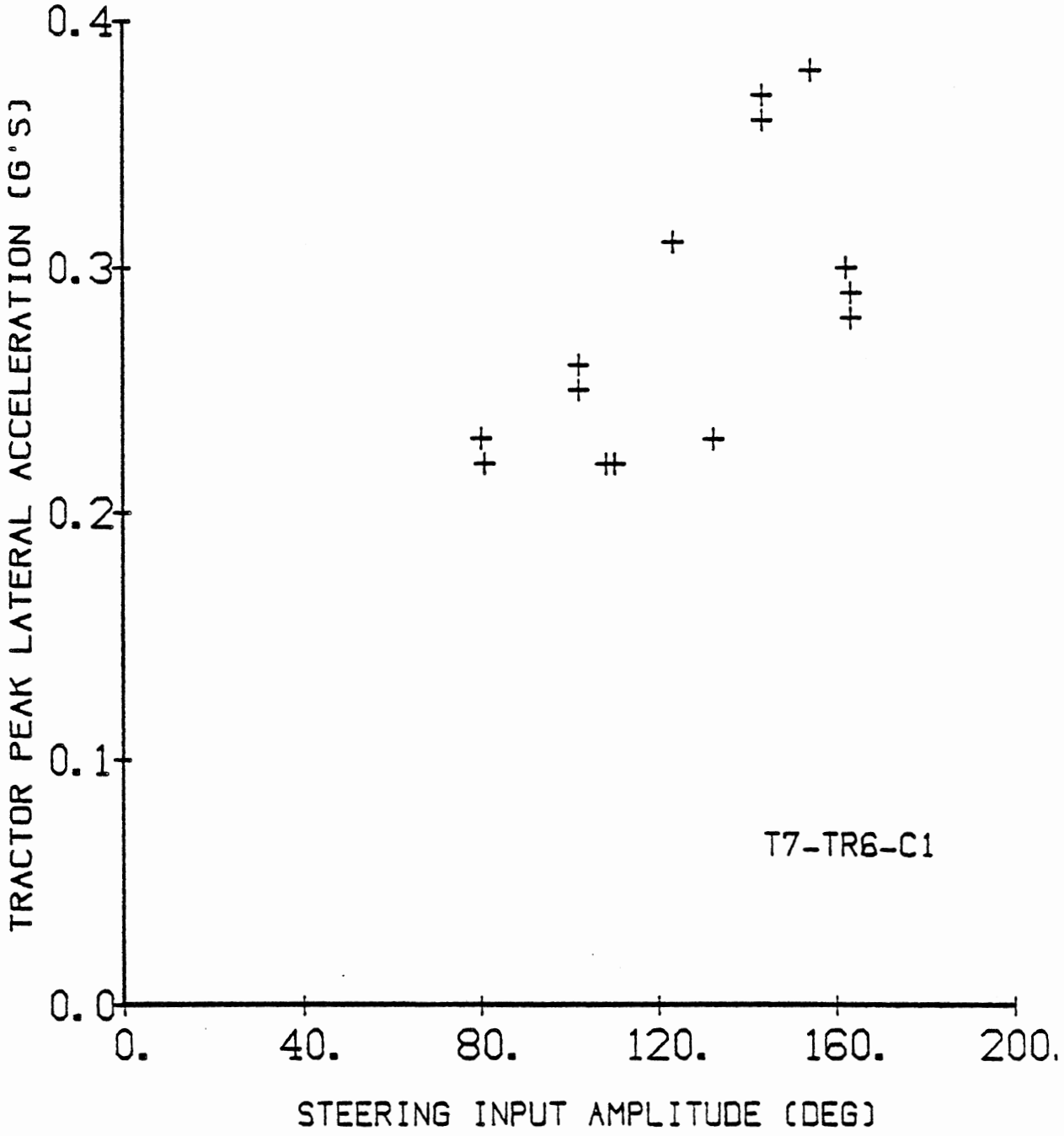


THREE AXLE TRACTOR- 45 FT TRAILER

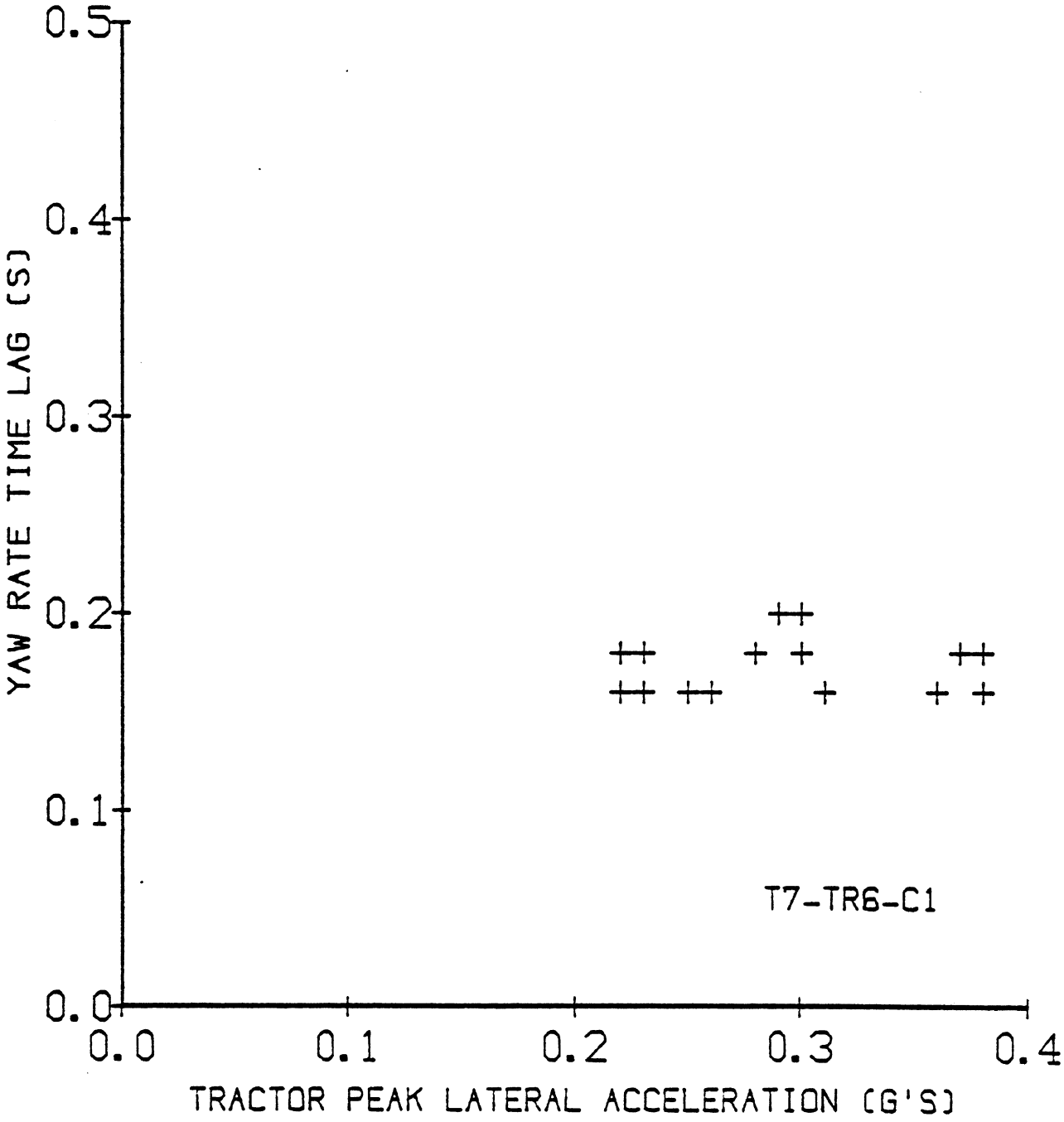
TRAPEZOIDAL STEER



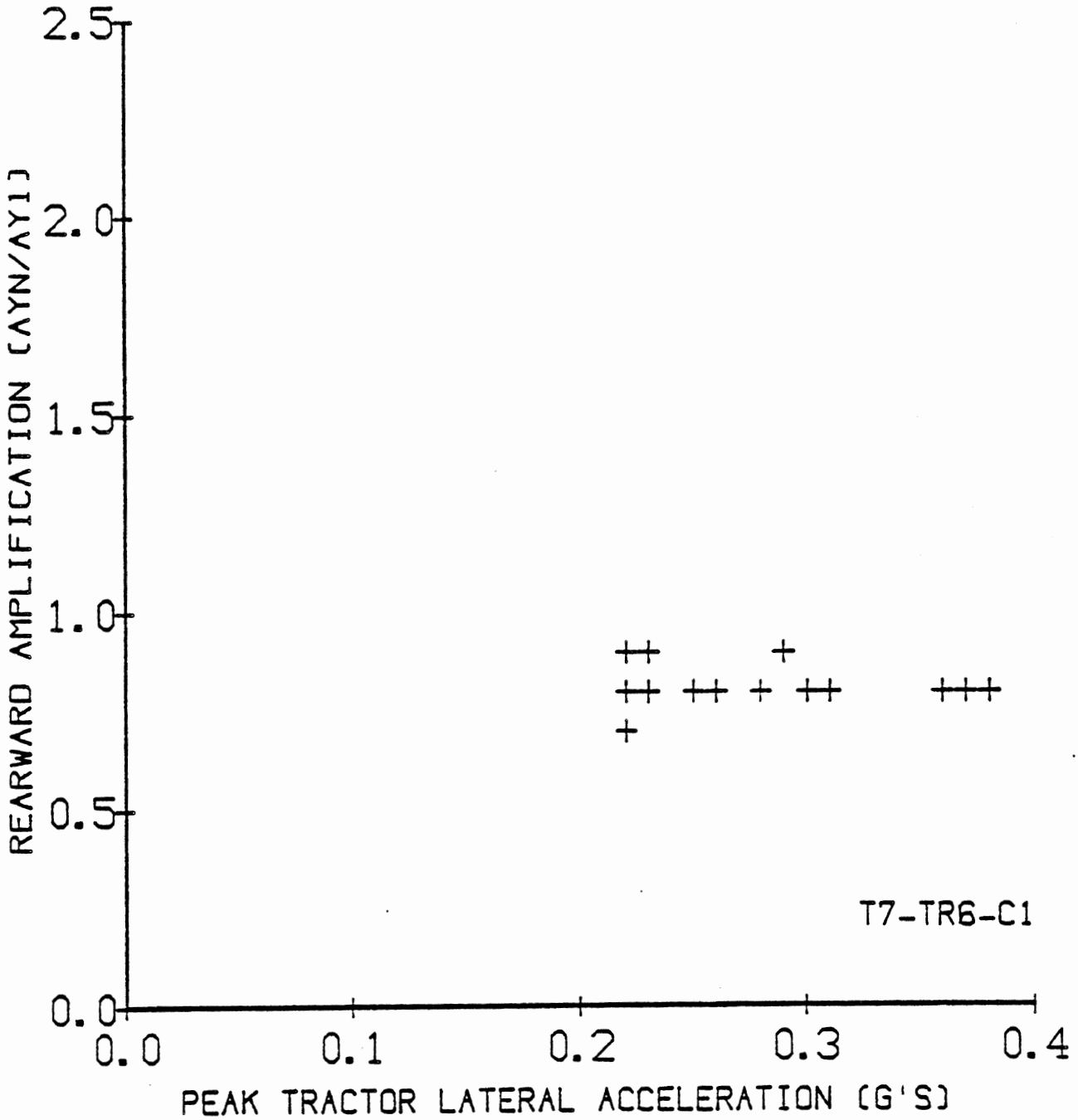
THREE AXLE TRACTOR-45 FT TRAILER



SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER



SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER



SINUSOIDAL STEER
TWO SEC PERIOD

THREE AXLE TRACTOR-45 FT TRAILER

- Configuration: 5 Axle Tractor-Semitrailer ("T5-TR6").

- Power Unit: Wheelbase: 209 in.
  Axle-group Rated Capacities:
  front - 12,000 lb; rear - 38,000 lb.

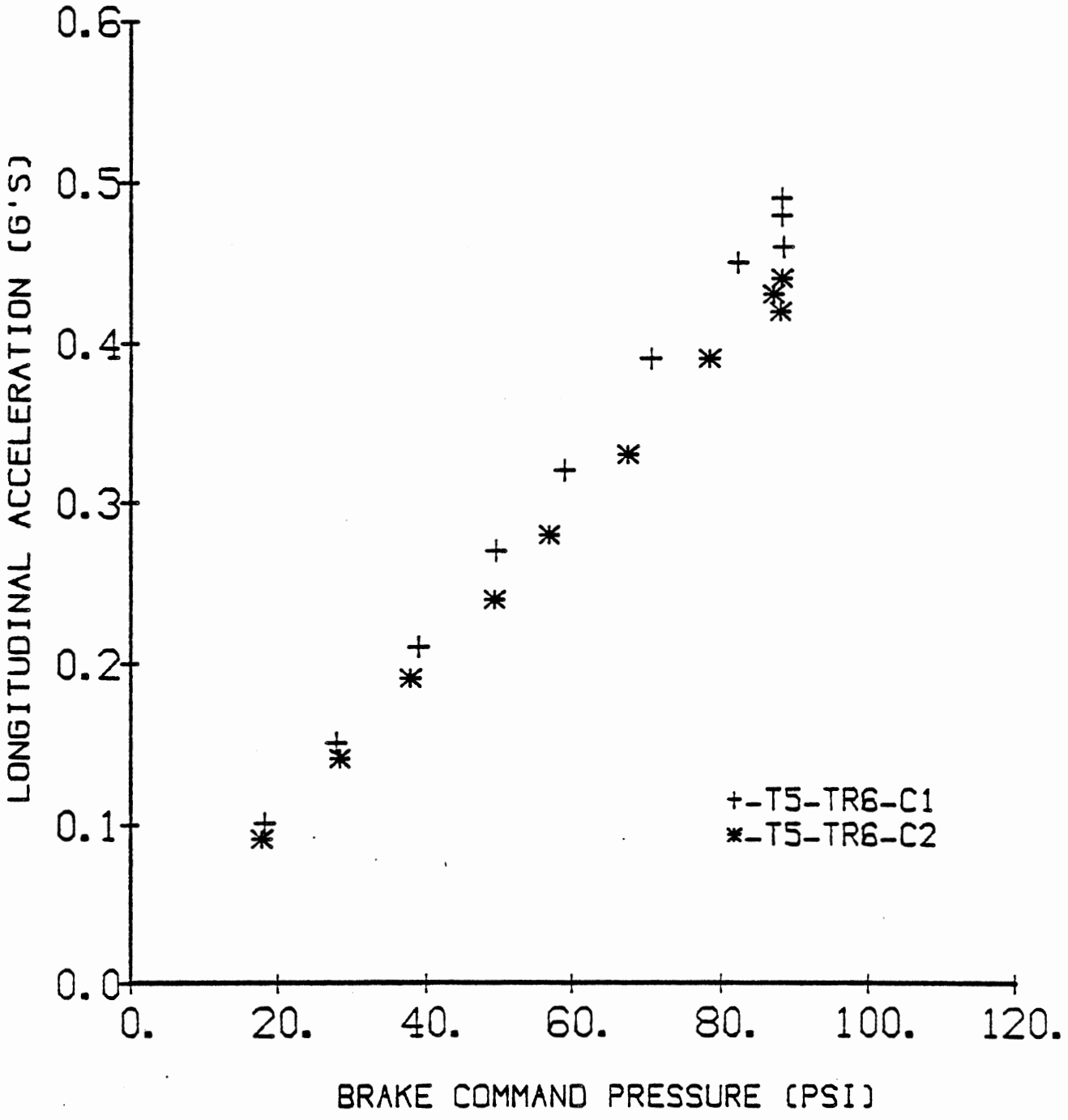
- Trailer(s):

	No. of axles in group	length (ft.)
#1:	2	45

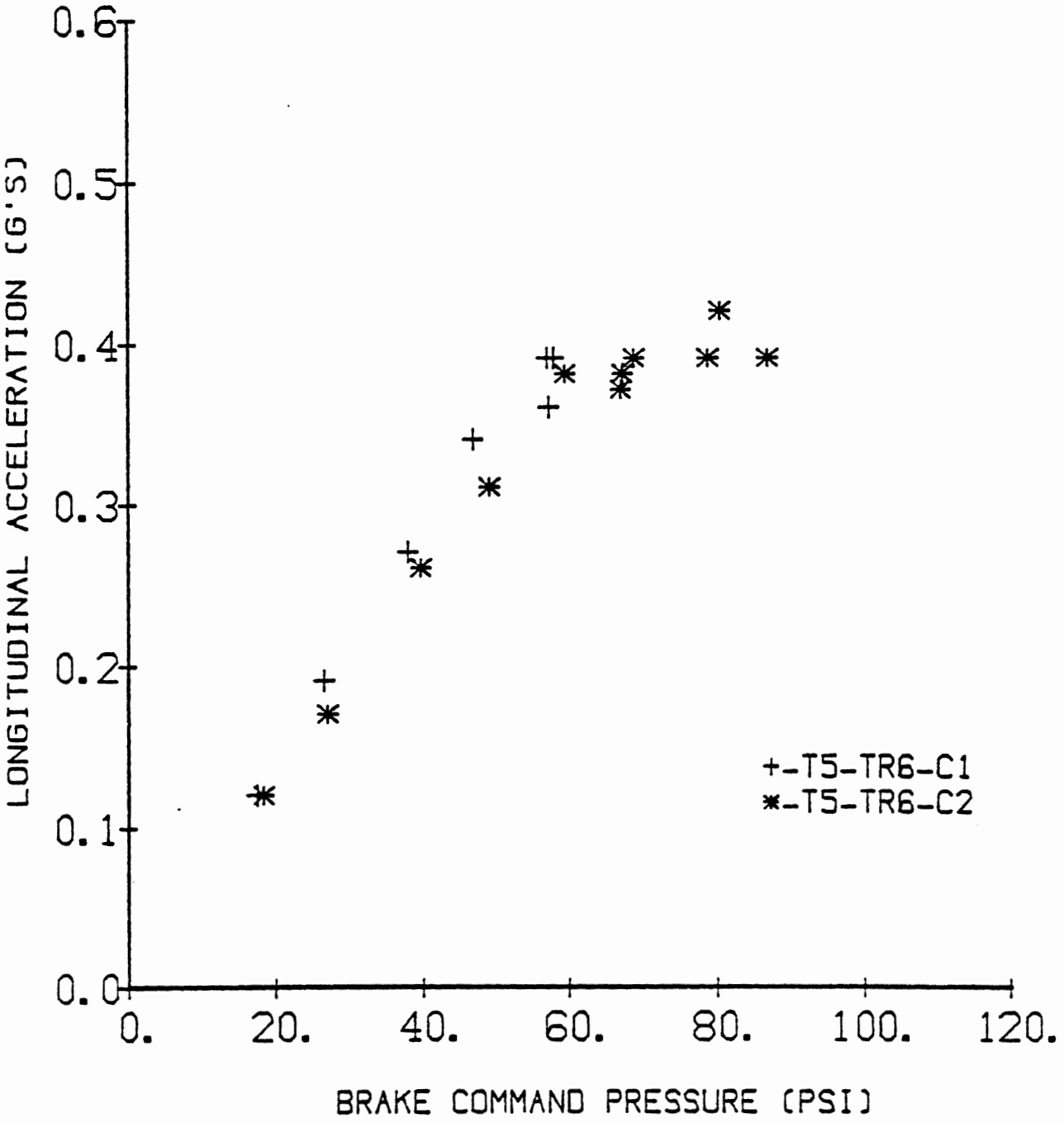
- Test Conditions and Codes:

Code	Payload CG Height (in.)	Axle Loads/1000 lb. 1	2 3	4 5	GCW 1000 lb.	Notes
T5-TR6-C1	70	12	34	34	80	Baseline
T5-TR6-C2	78.5	12	38	38	88	
T5-TR6-C3	70	10	35	35	80	
T5-TR-6-C4	70	10	35	35	80	Radials fr., Bias rear

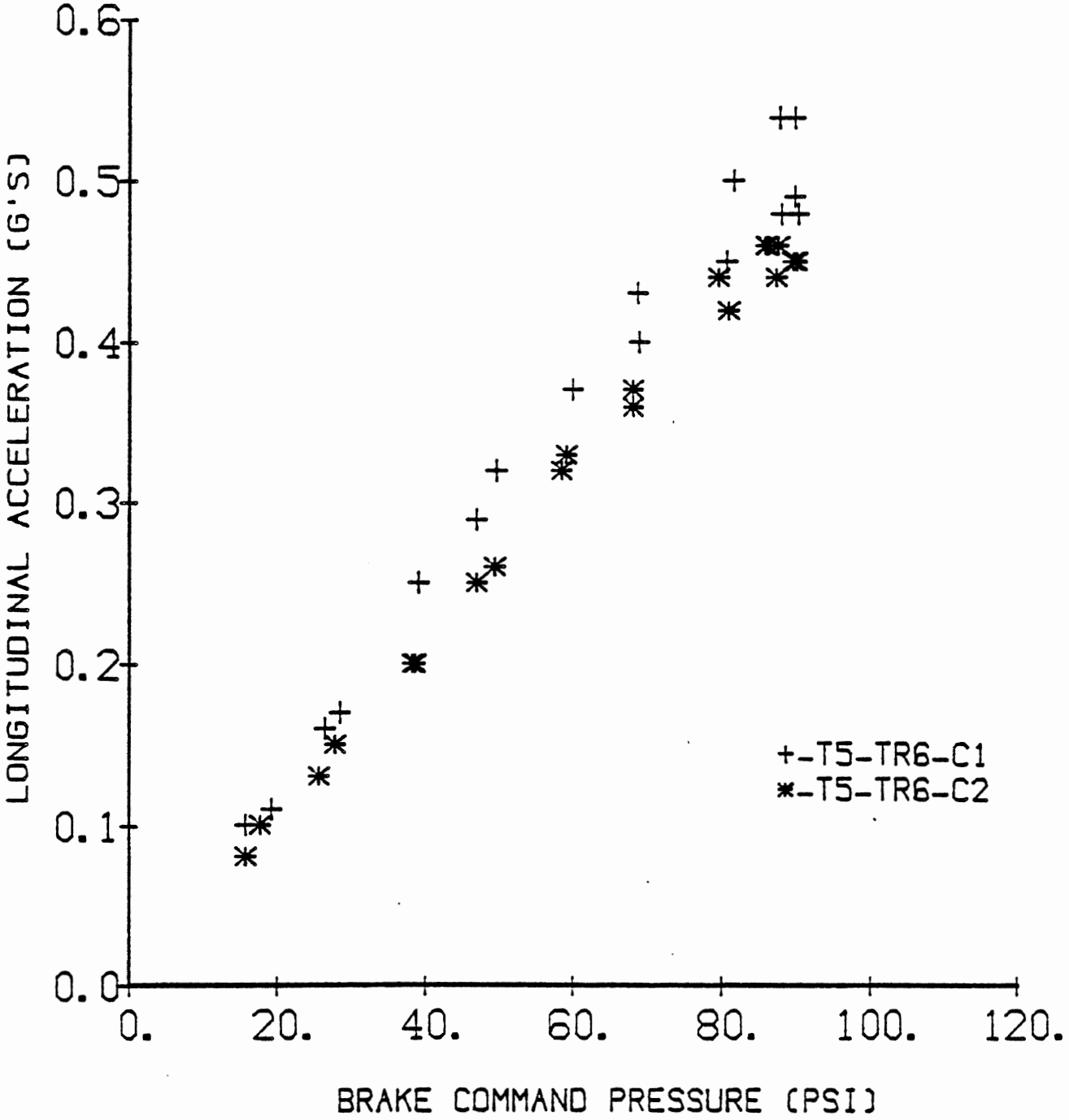
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	C1 & C2.
2. Braking in a Turn	C1 & C2.
3. Trapezoidal Steer	All.
4. Sinusoidal Steer	C1 only.



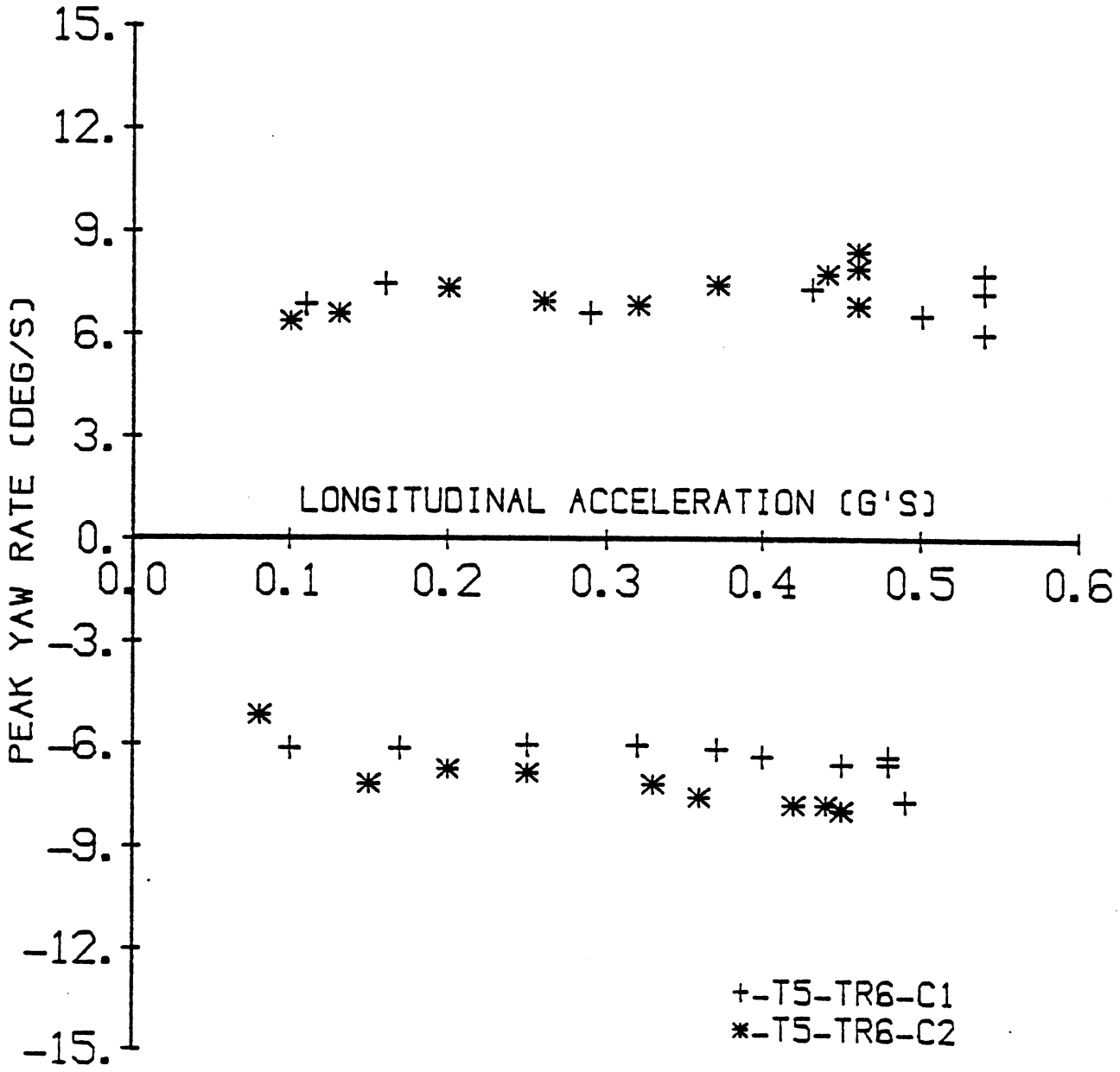
LWB TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - DRY



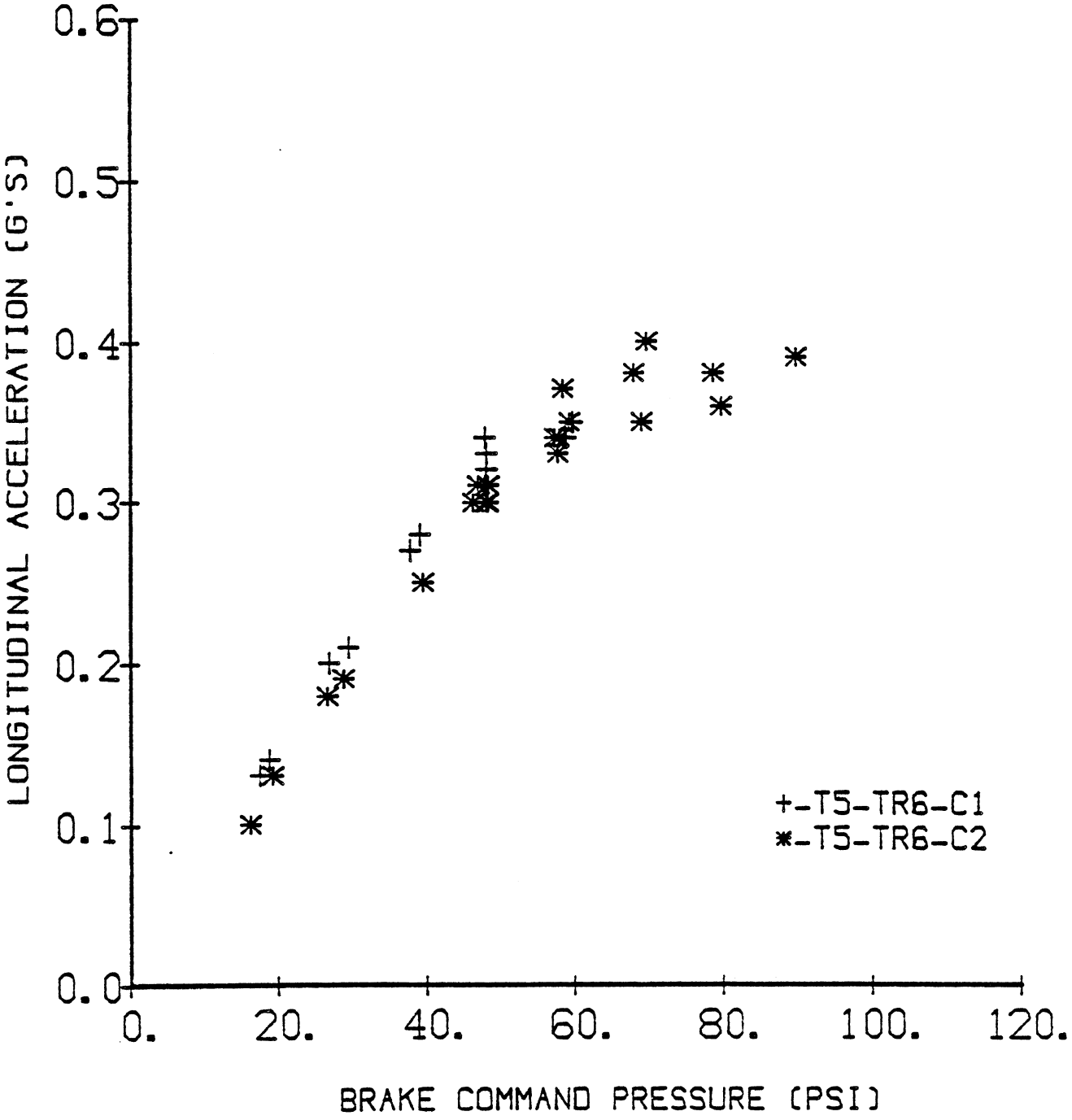
LWB TRACTOR - 45 FT TRAILER
STRAIGHT LINE BRAKING - WET



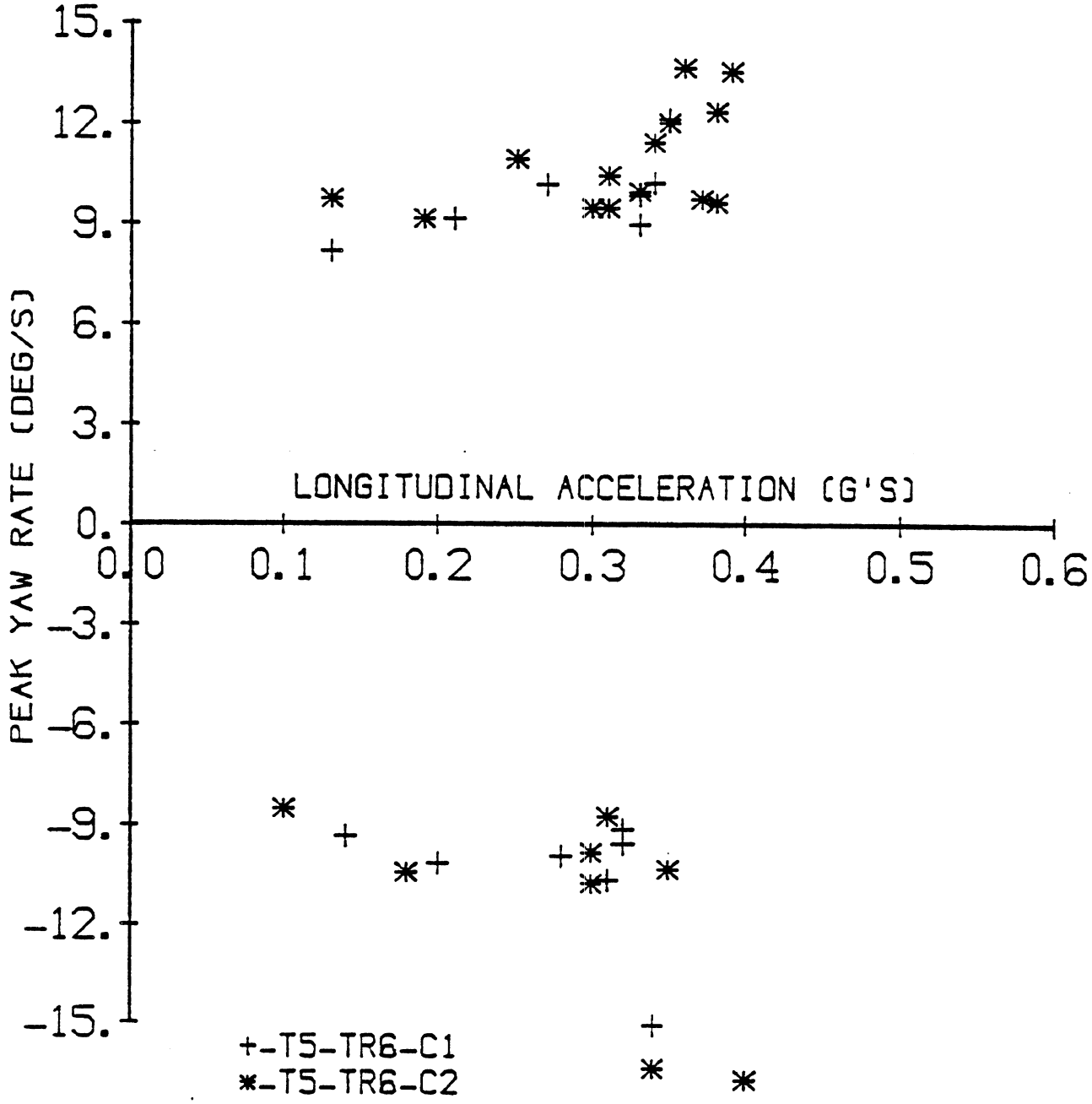
LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - DRY



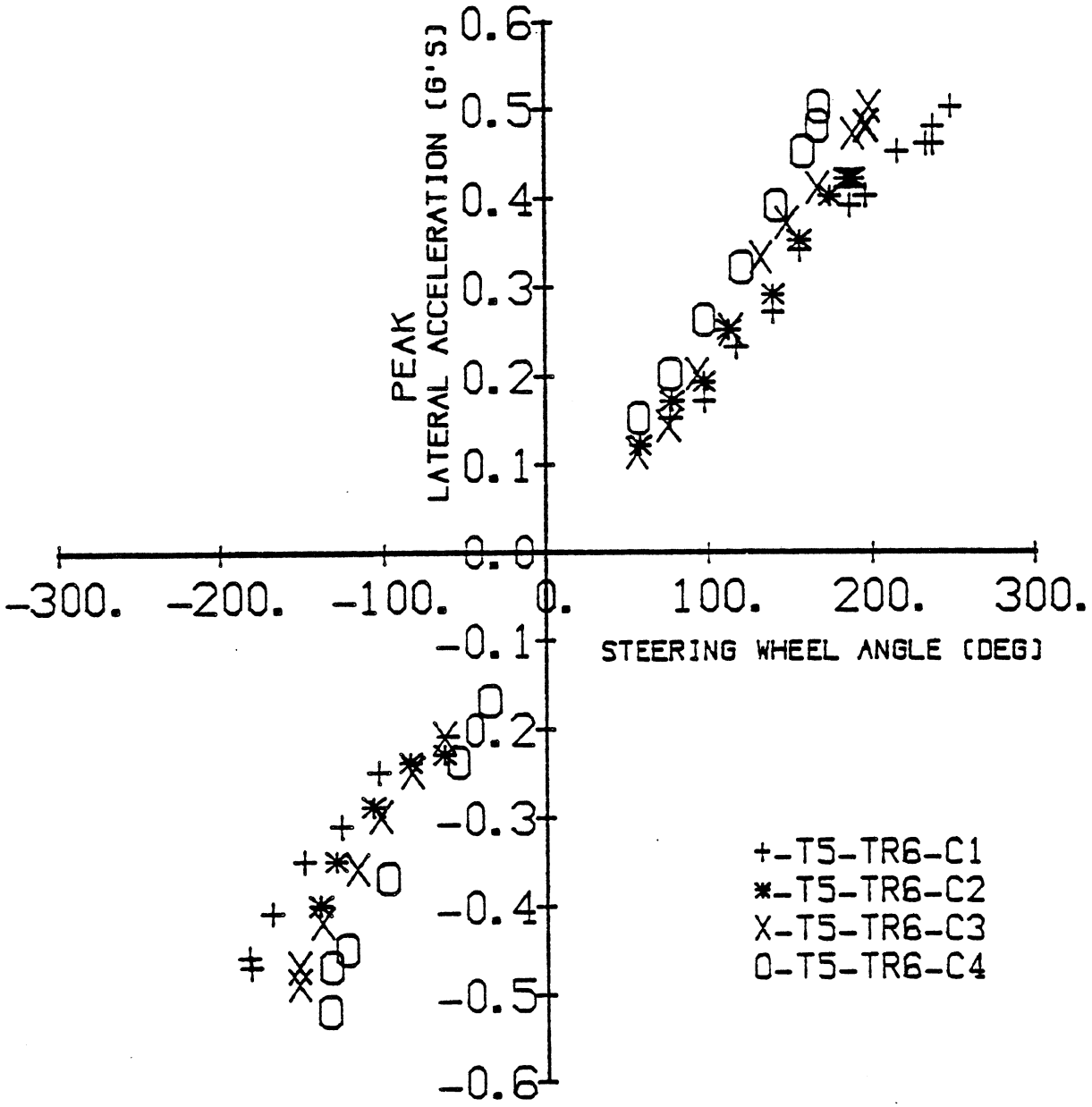
LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - DRY



LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET

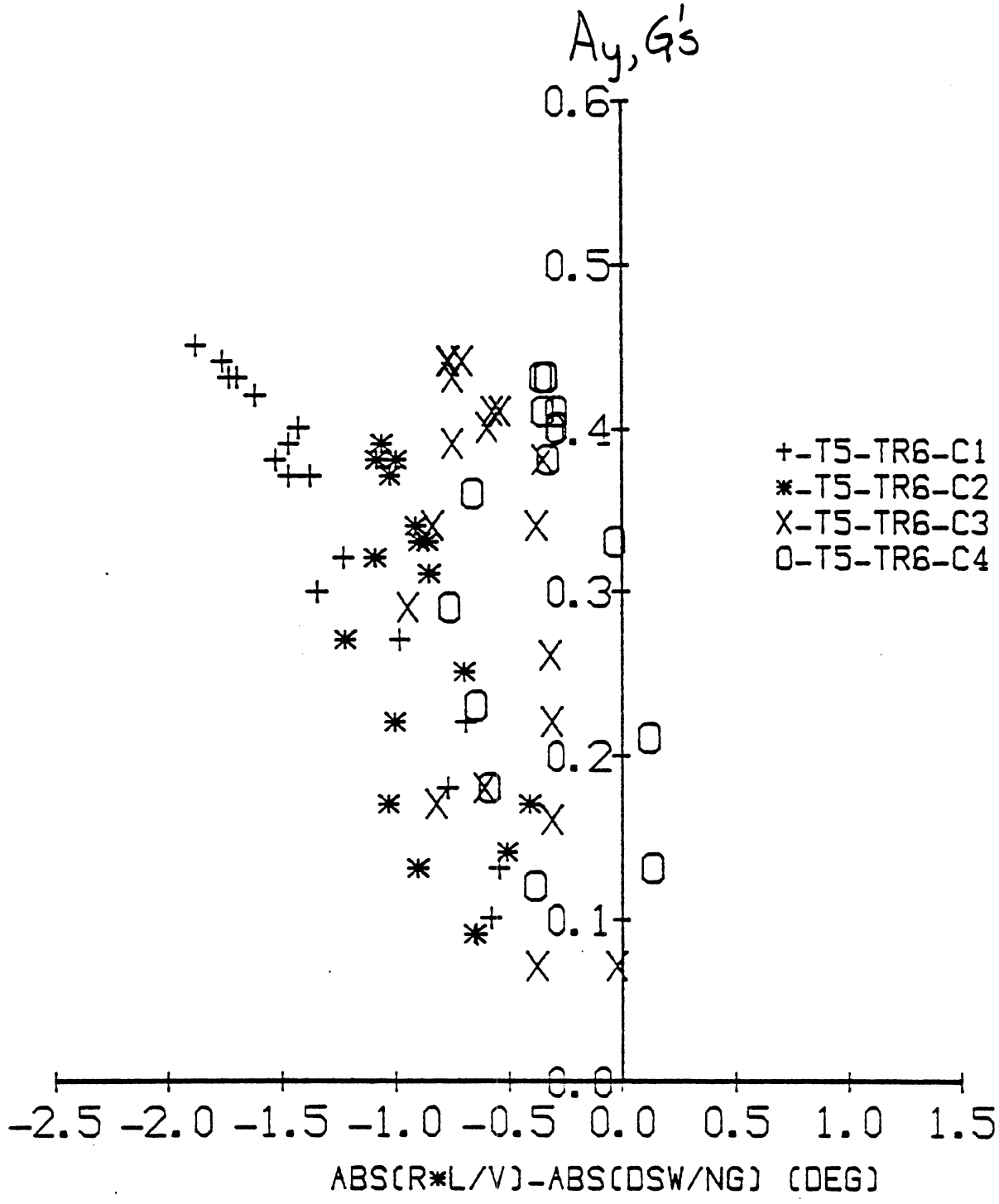


LWB TRACTOR - 45 FT TRAILER
BRAKING IN A TURN - WET

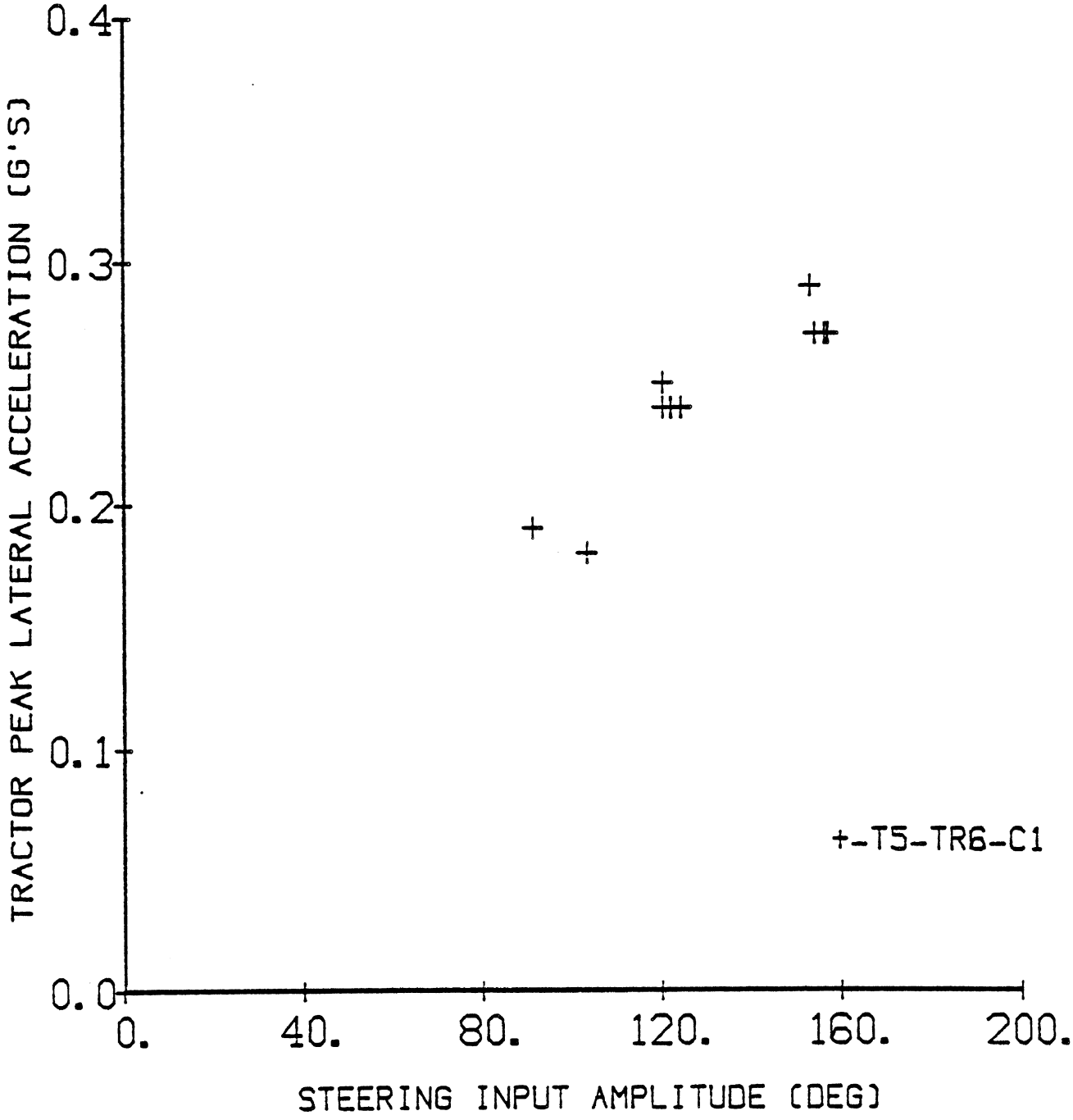


TRAPEZOIDAL STEER

LWB TRACTOR - 45 FT TRAILER

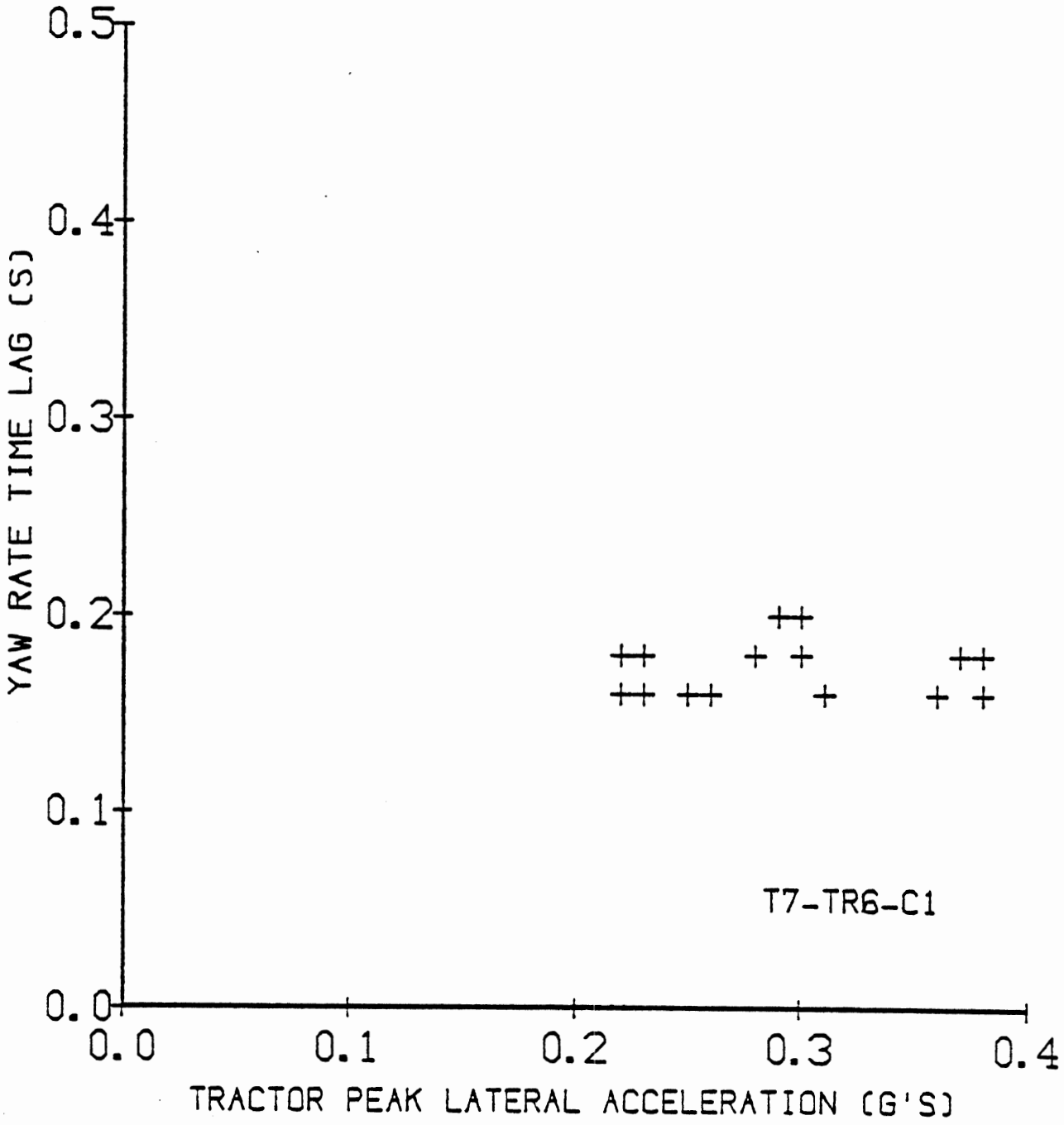


LWB TRACTOR - 45 FT TRAILER

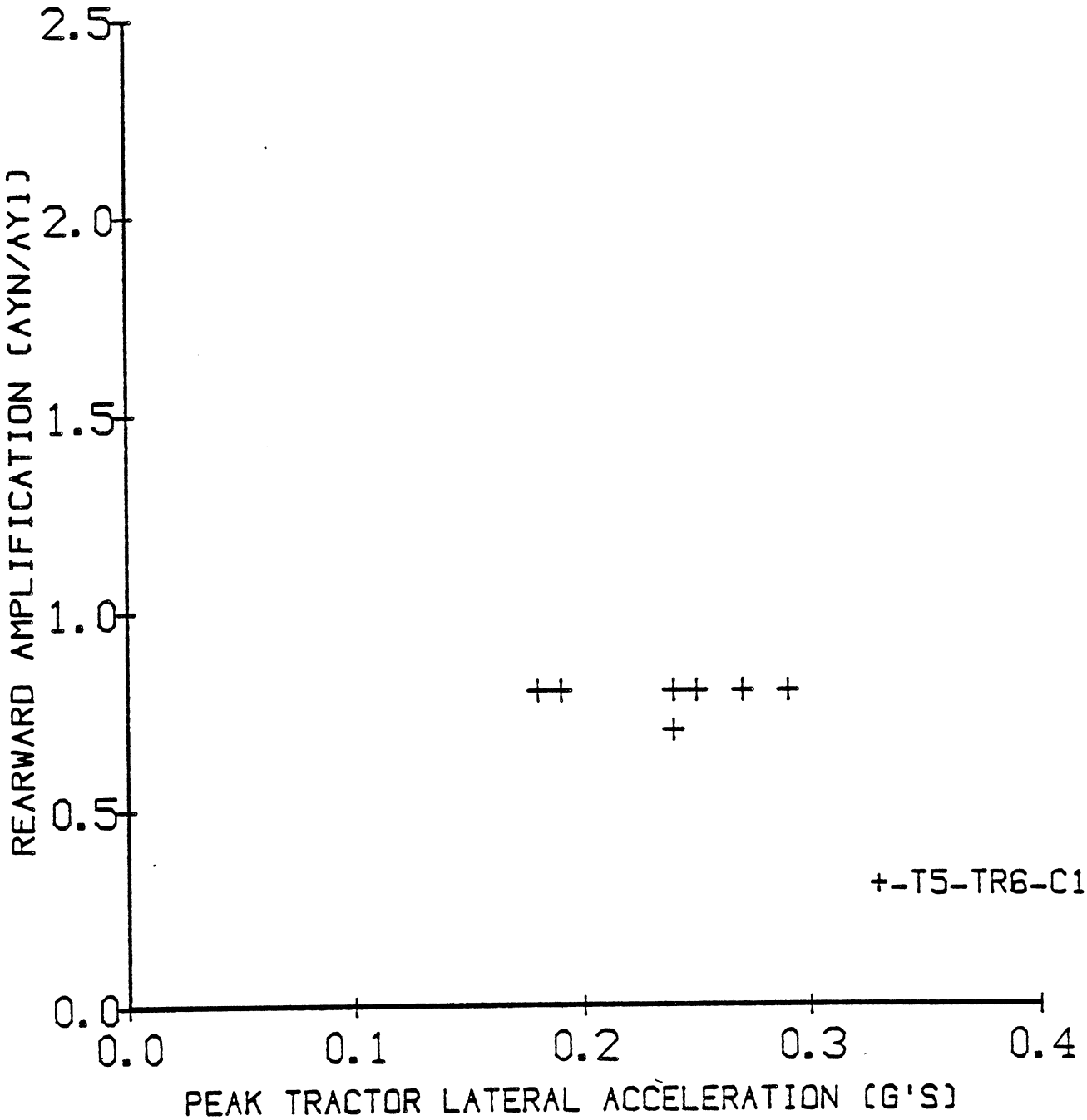


SINUSOIDAL STEER
TWO SEC PERIOD

LWB TRACTOR - 45 FT TRAILER



SINUSOIDAL STEER
TWO SEC PERIOD
THREE AXLE TRACTOR-45 FT TRAILER



SINUSOIDAL STEER
TWO SEC PERIOD

LWB TRACTOR - 45 FT TRAILER

- Configuration: 5 Axle Double ("T1-TR1-TR2")

- Power Unit: Wheelbase: 135 in.
Axle-group Rated Capacities:
front - 12,000 lb; rear - 23,000 lb.

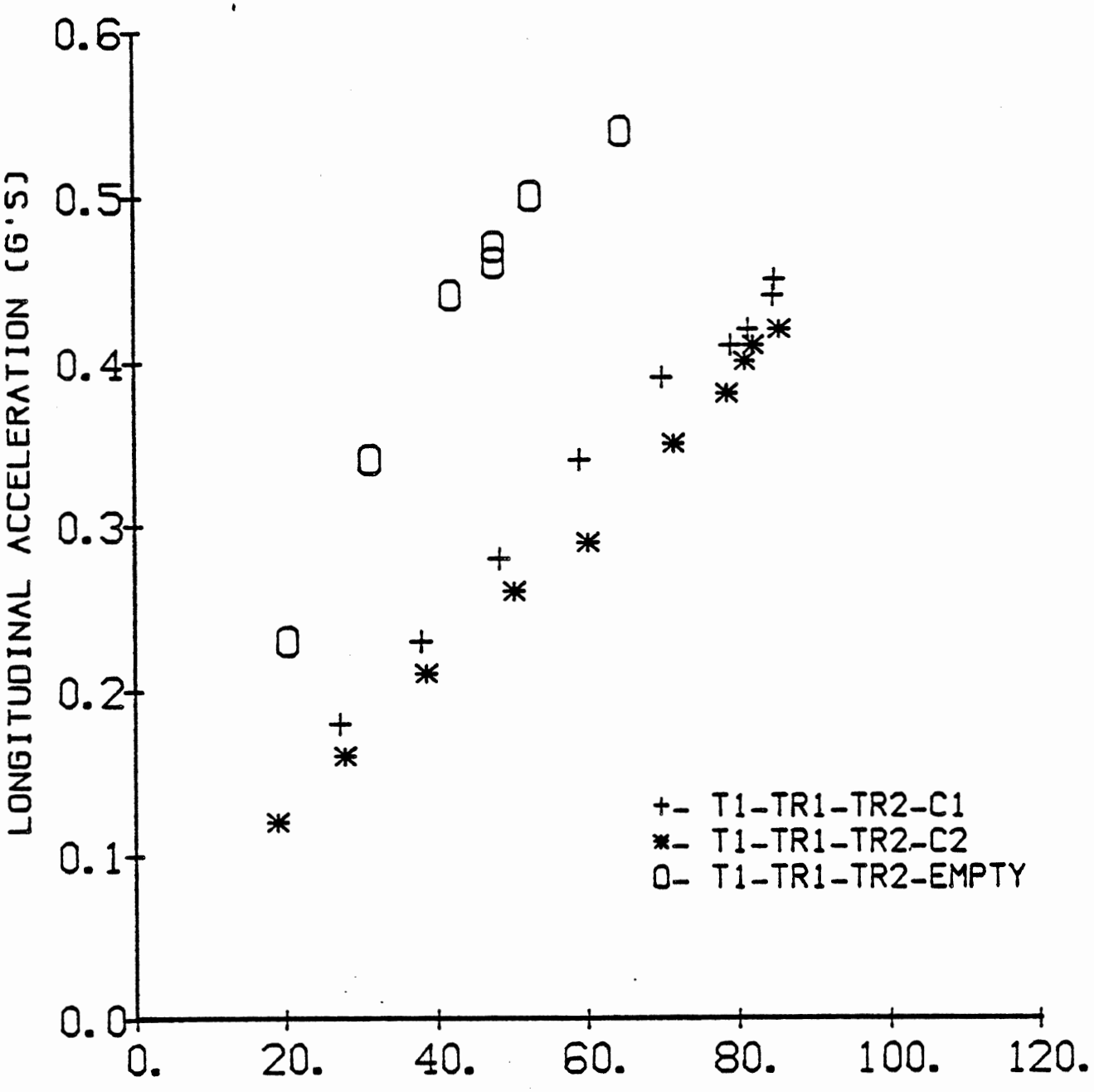
- Trailer(s):

	No. of axles in group	length (ft.)
#1:	1	27
#2:	1	27

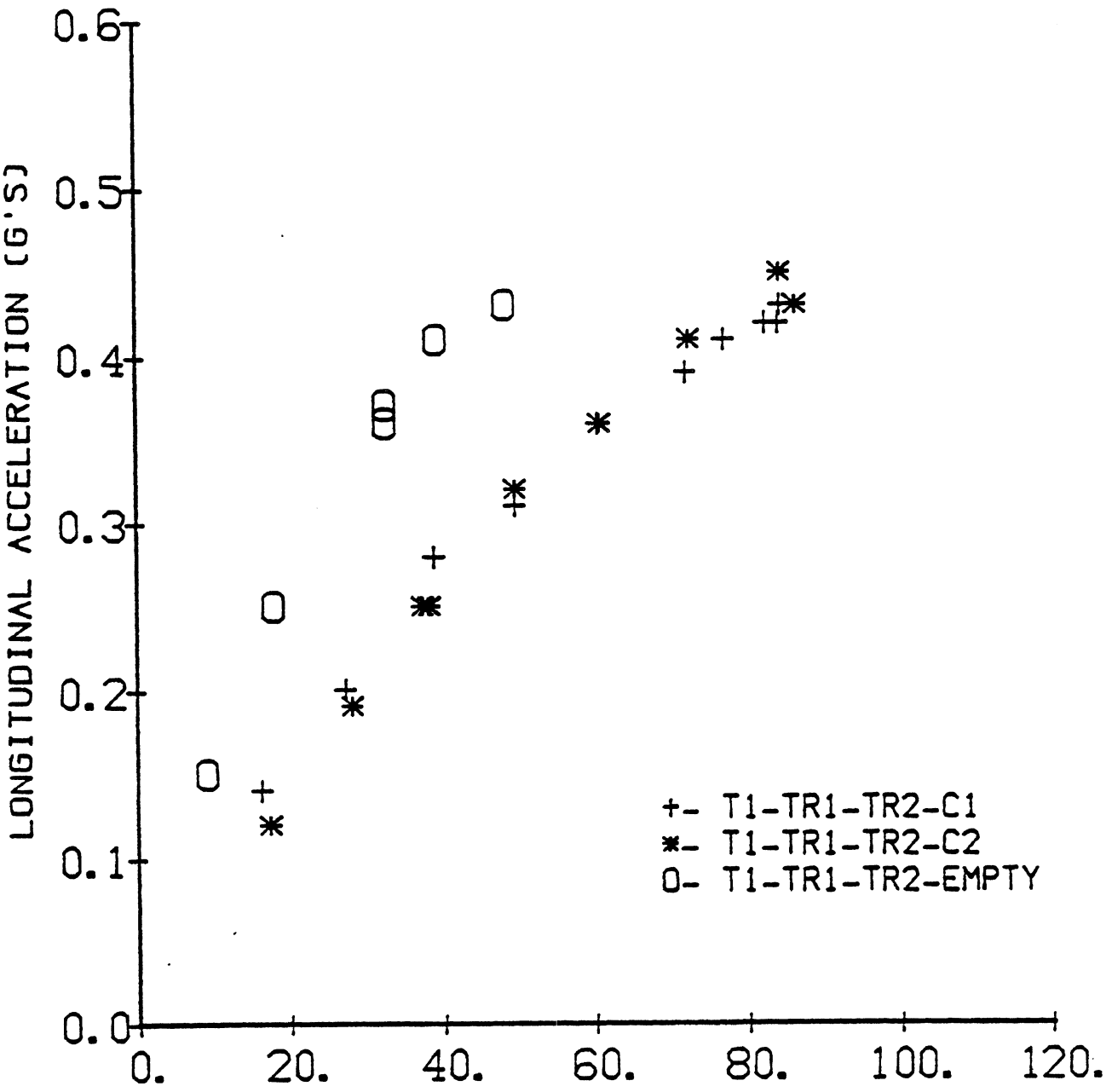
- Test Conditions and Codes:

Code	Payload CG Height(in)	Axle Loads/1000 lbs. 1	2	3	4	5	GCW 1000 lb.	Notes
T1-TR1-TR2-C1	73	9.5	18	17.5	17.5	17.5	80	Baseline
T1-TR1-TR2-C2	80	9.5	20	19.5	19.5	19.5	88	
T1-TR1-TR2-Empty	-							Empty

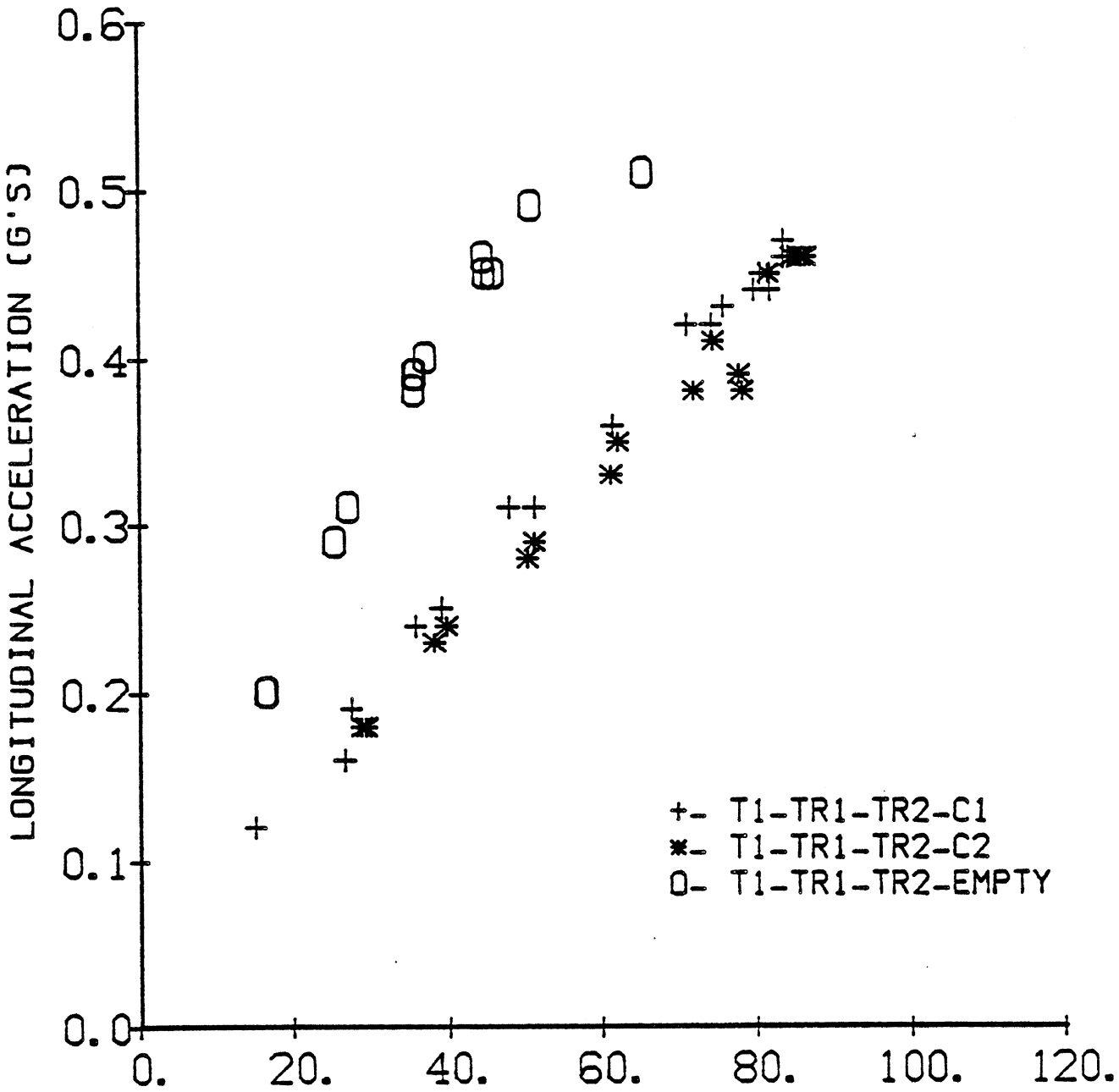
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	All
2. Braking in a Turn	All
3. Trapezoidal Steer	All
4. Sinusoidal Steer	All



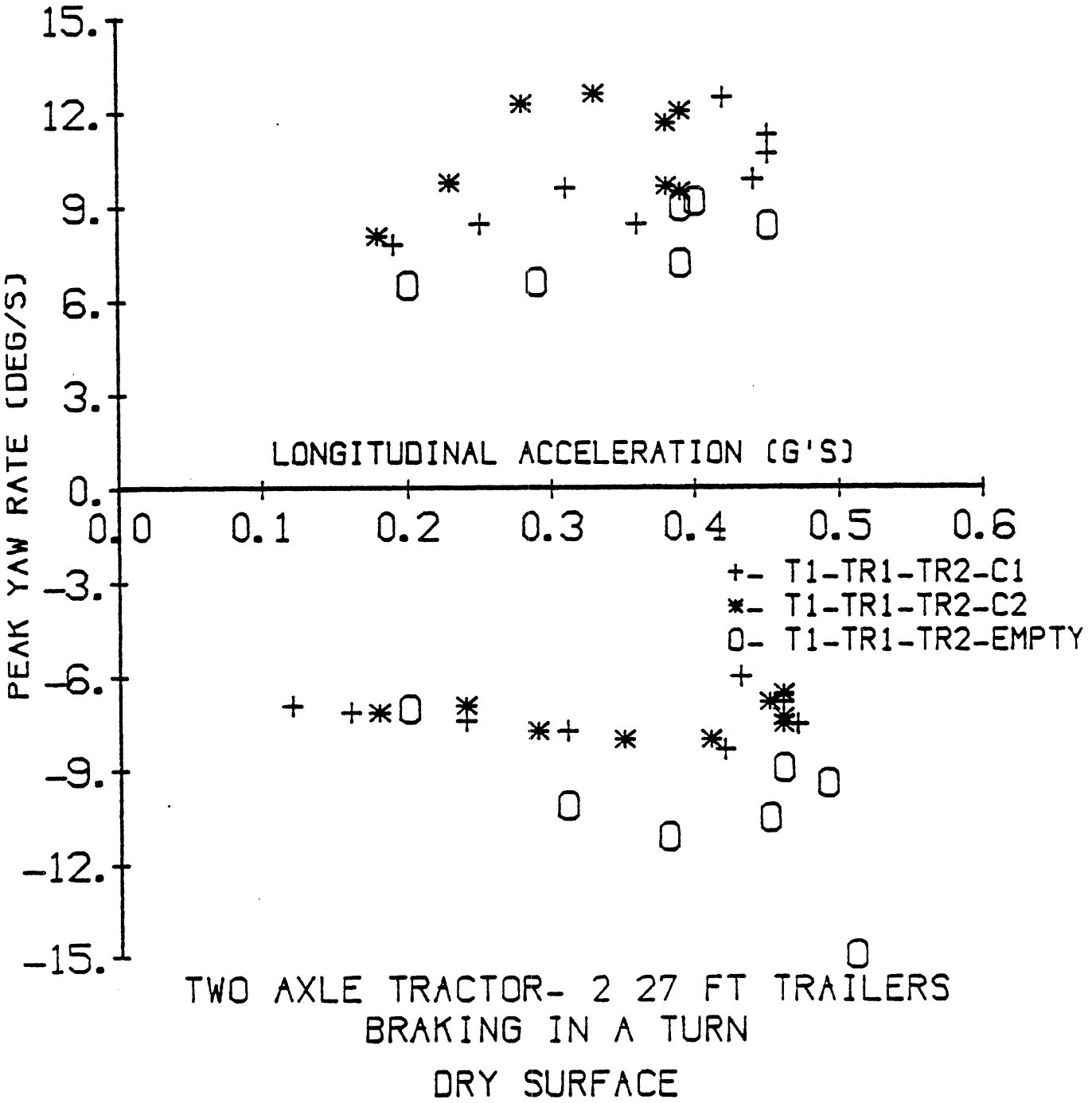
TWO AXLE TRACTOR- 2 27 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE

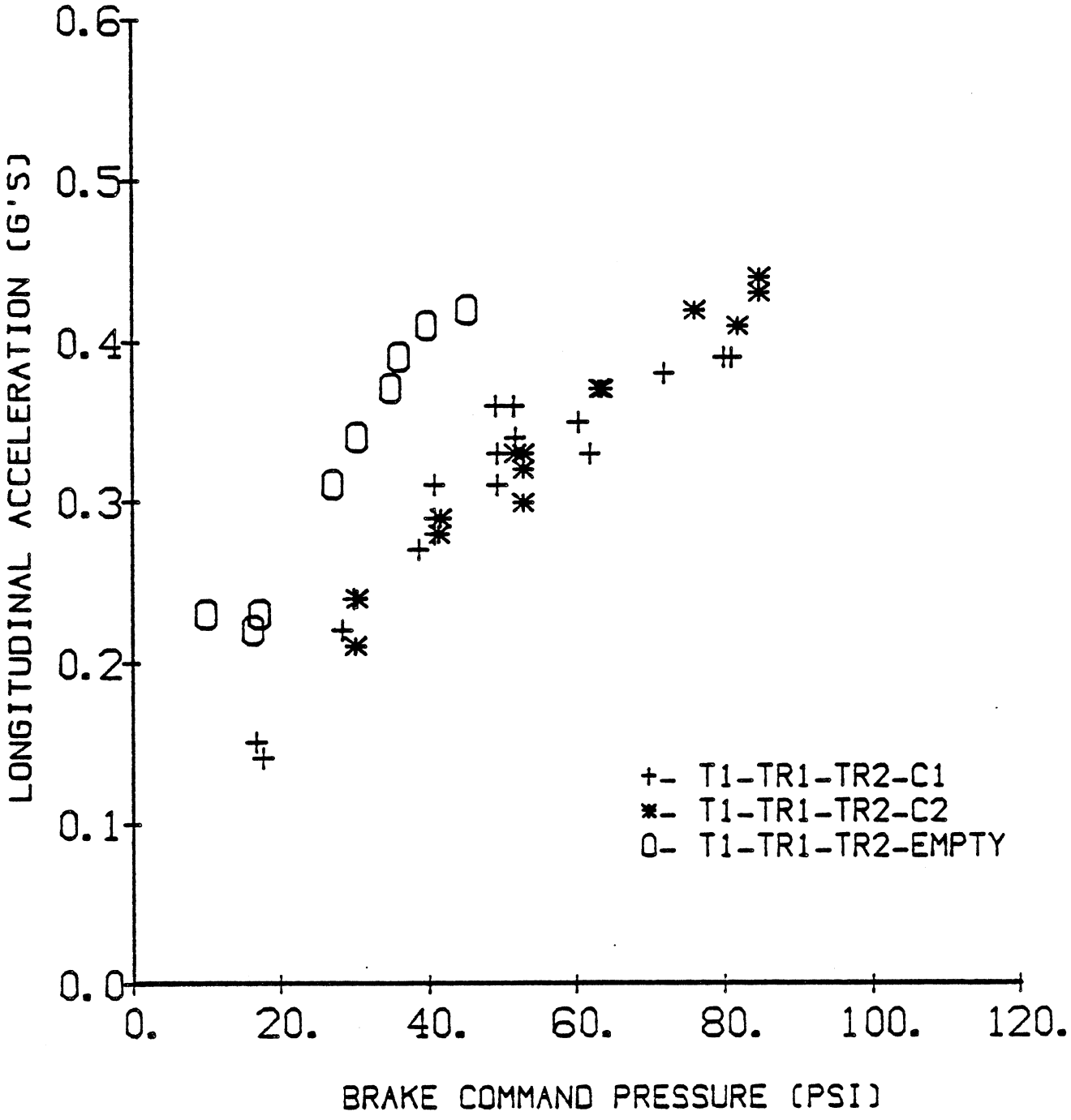


TWO AXLE TRACTOR- 2 27 FT TRAILERS
STRAIGHT LINE BRAKING
WET SURFACE

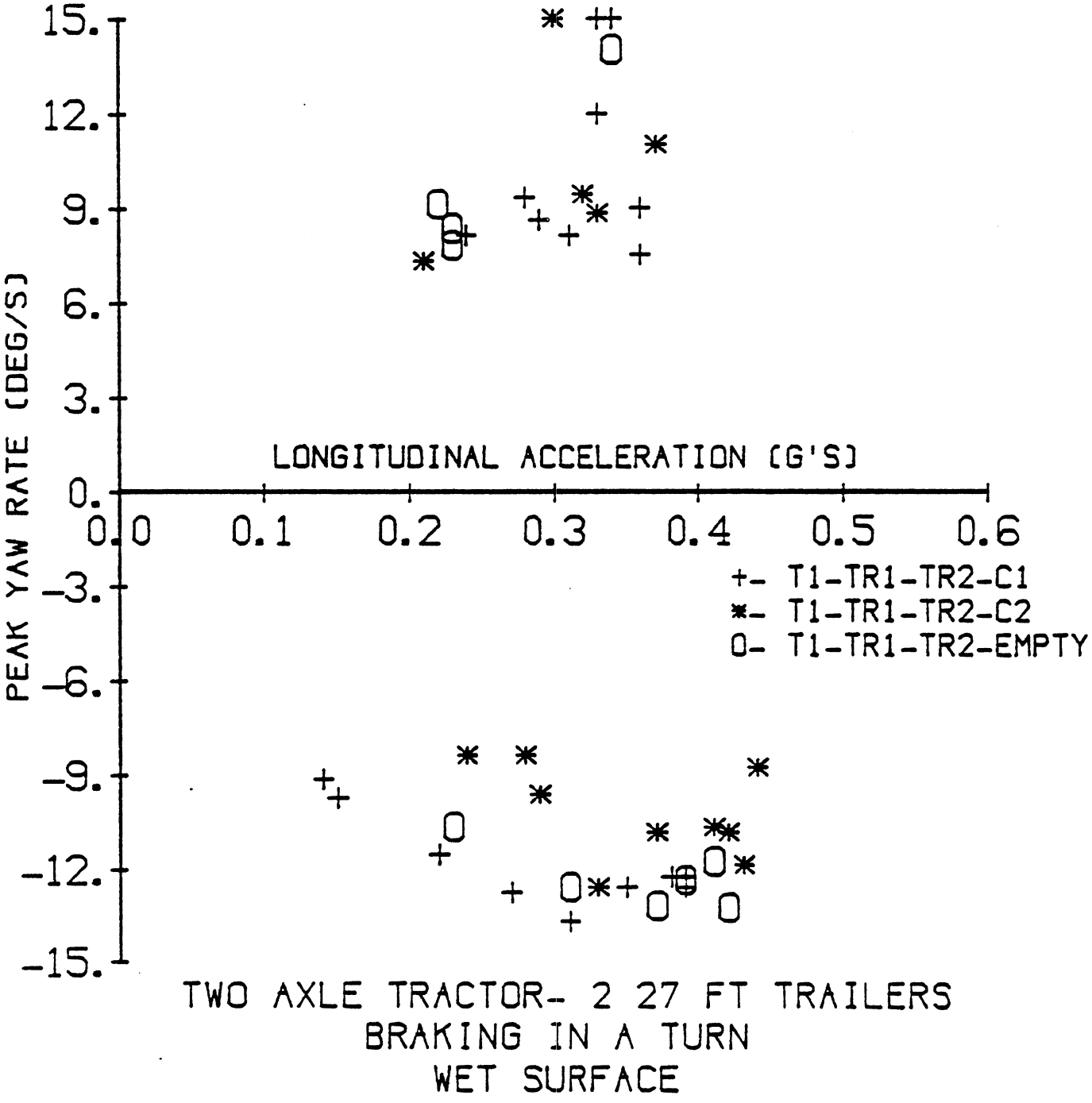


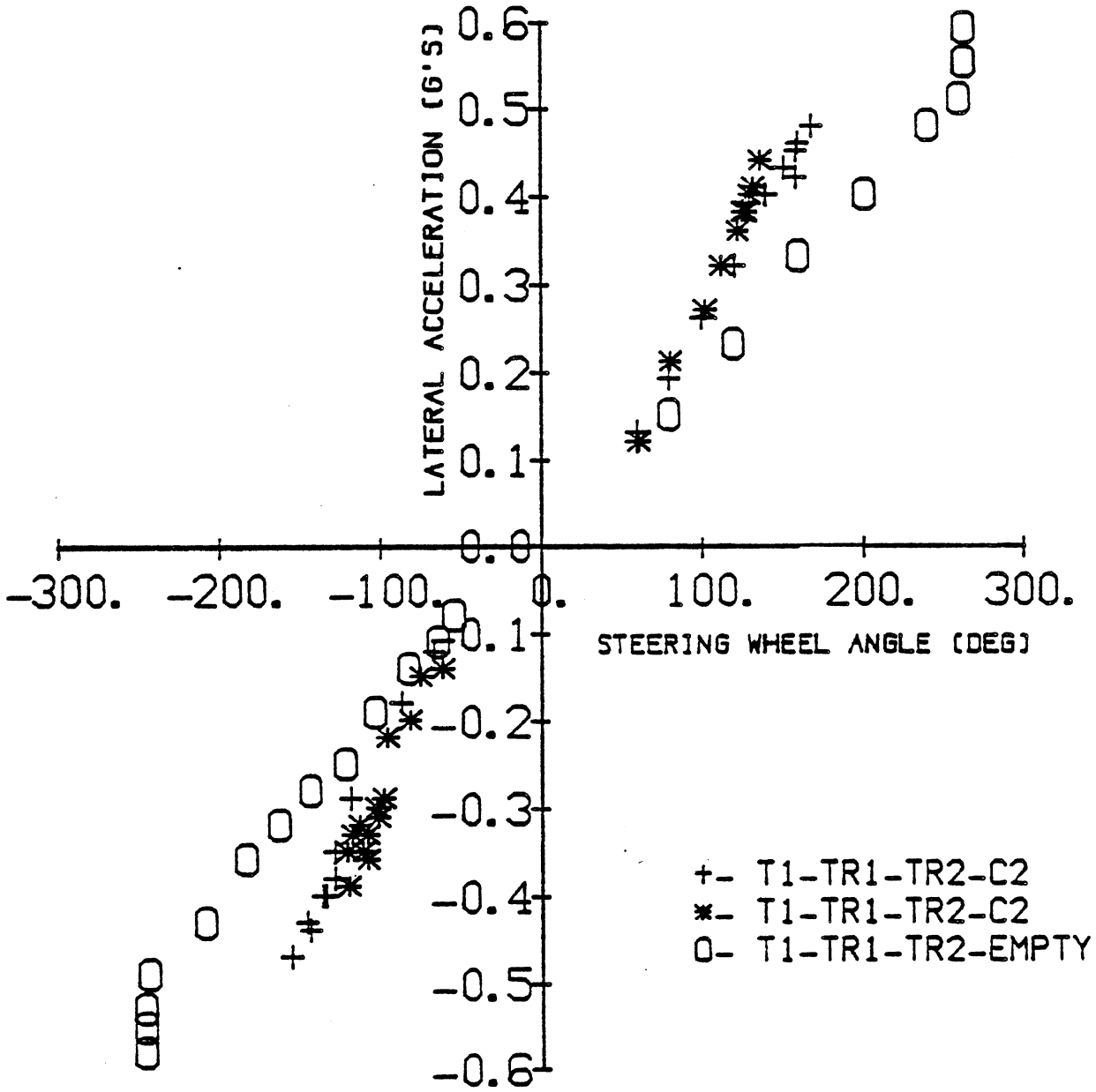
TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE


15.
12.
9.
6.
3.
0.
-3.
-6.
-9.
-12.
-15.
PEAK YAW RATE (DEG/S)
LONGITUDINAL ACCELERATION (G'S)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
+- T1-TR1-TR2-C1
*- T1-TR1-TR2-C2
O- T1-TR1-TR2-EMPTY
TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE

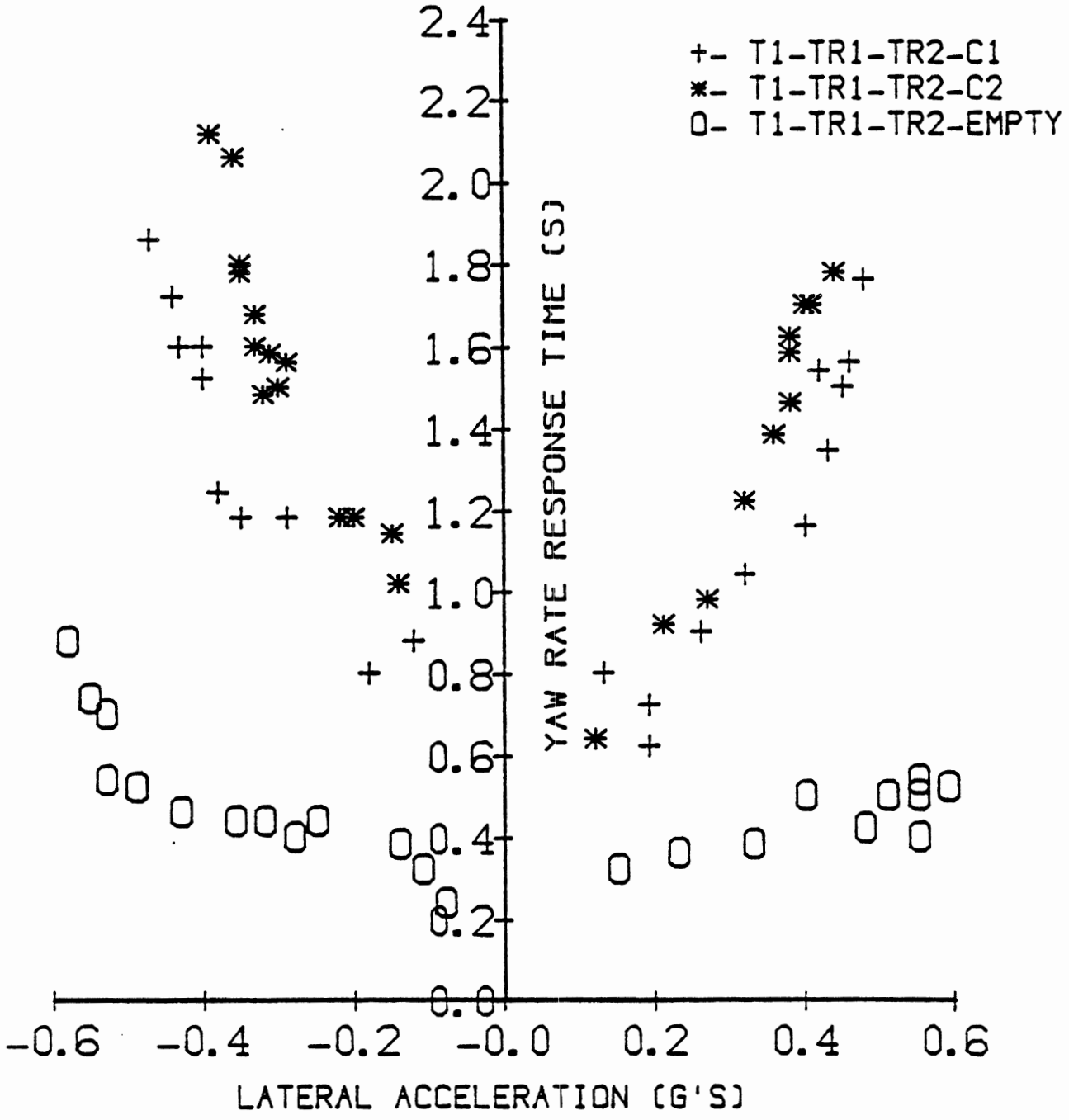


TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE

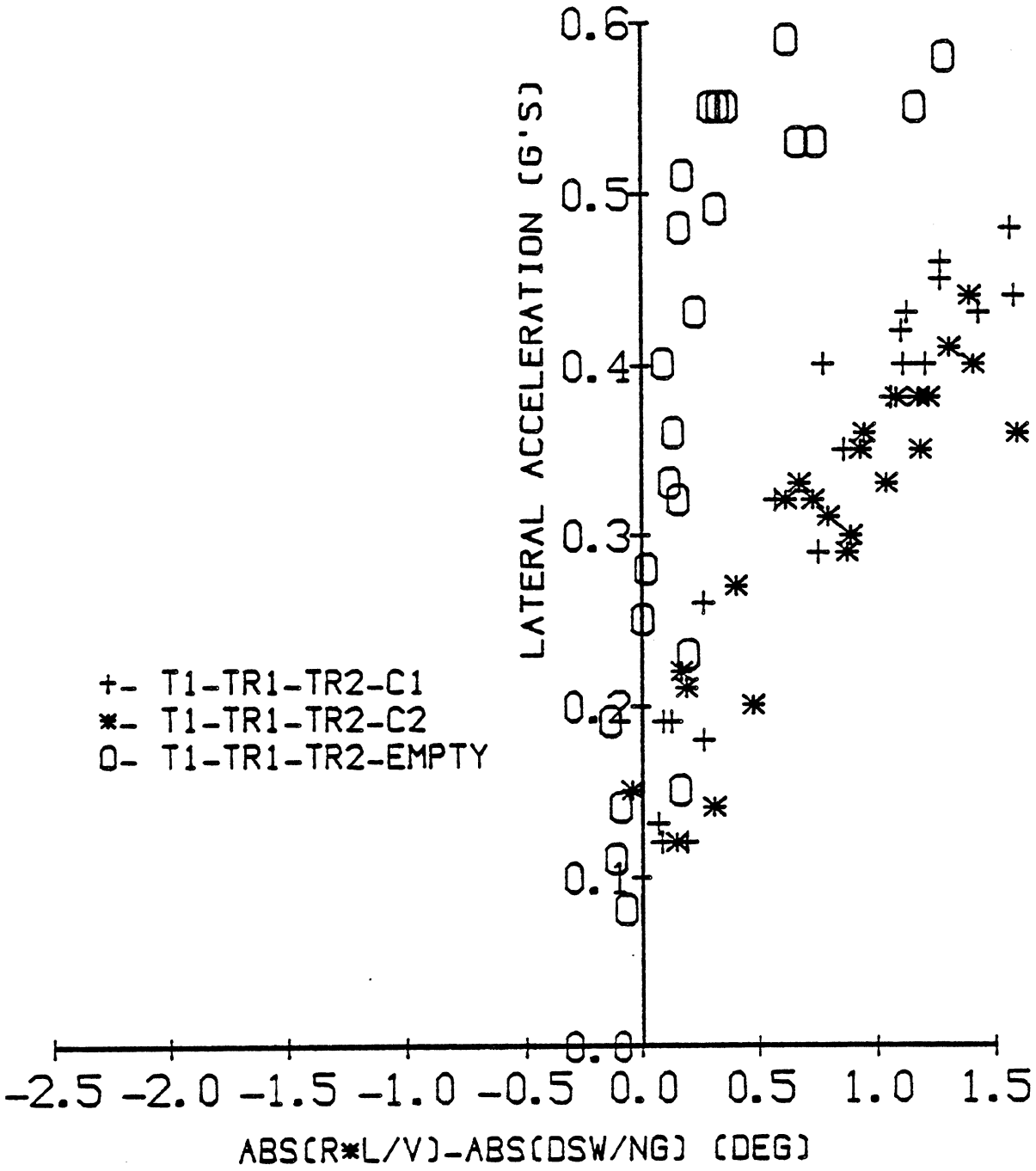

15.
12.
9.
6.
3.
0.
-3.
-6.
-9.
-12.
-15.
PEAK YAW RATE (DEG/S)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
LONGITUDINAL ACCELERATION (G'S)
+- T1-TR1-TR2-C1
*- T1-TR1-TR2-C2
O- T1-TR1-TR2-EMPTY
TWO AXLE TRACTOR- 2 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE



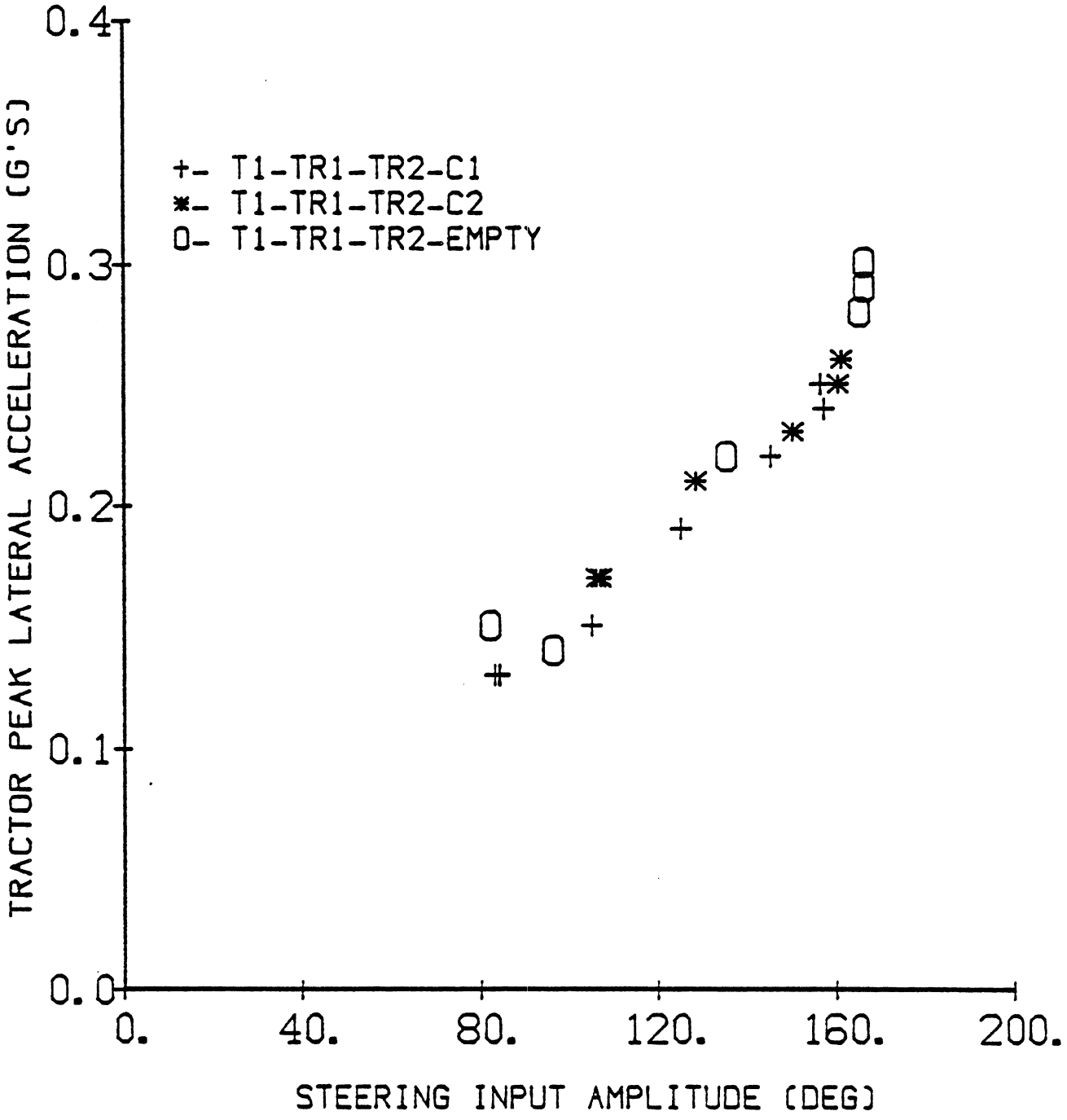
TWO AXLE TRACTOR- 2 27 FT TRAILERS
TRAPEZOIDAL STEER



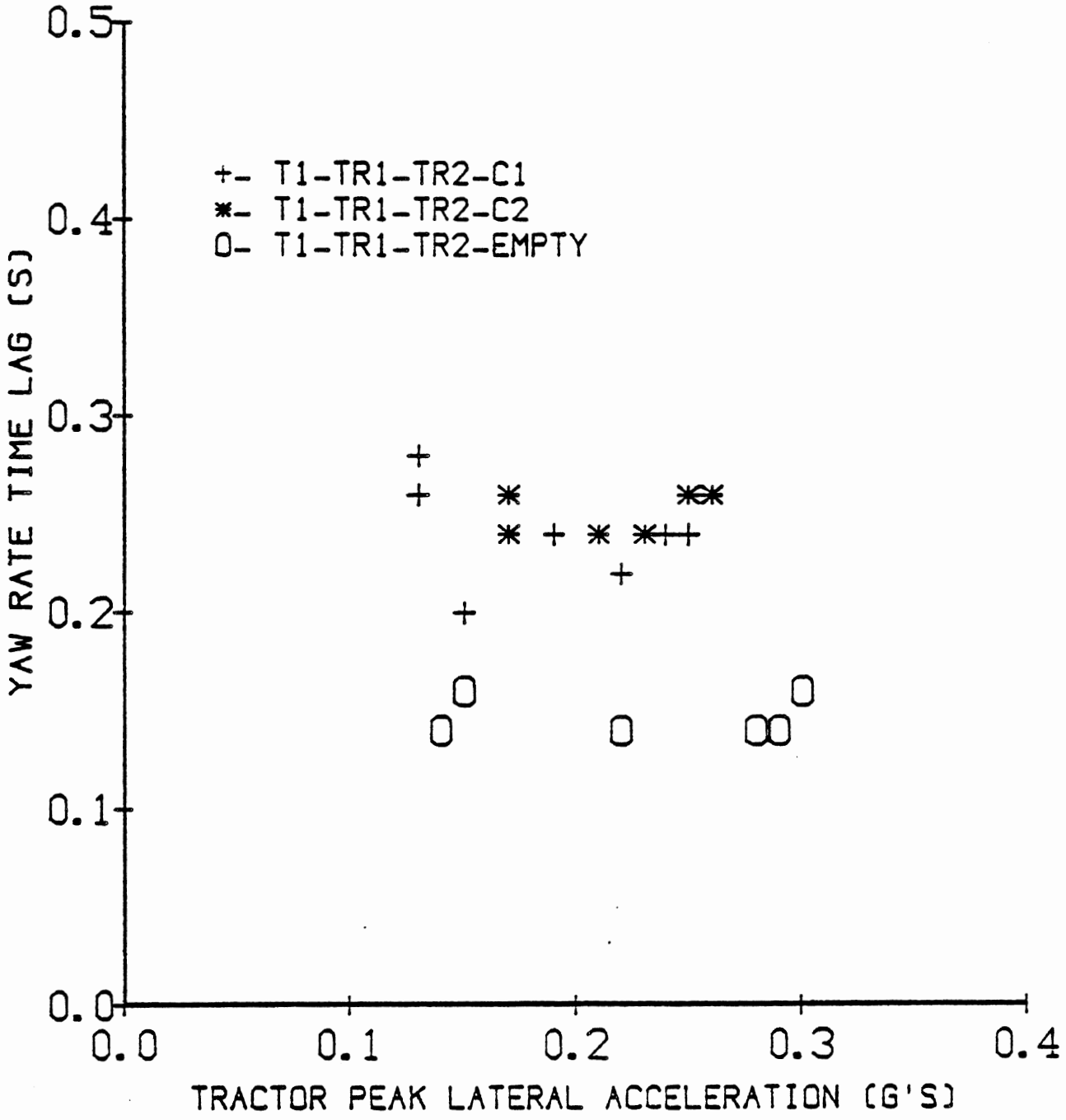
TWO AXLE TRACTOR- 2 27 FT TRAILERS
TRAPEZOIDAL STEER



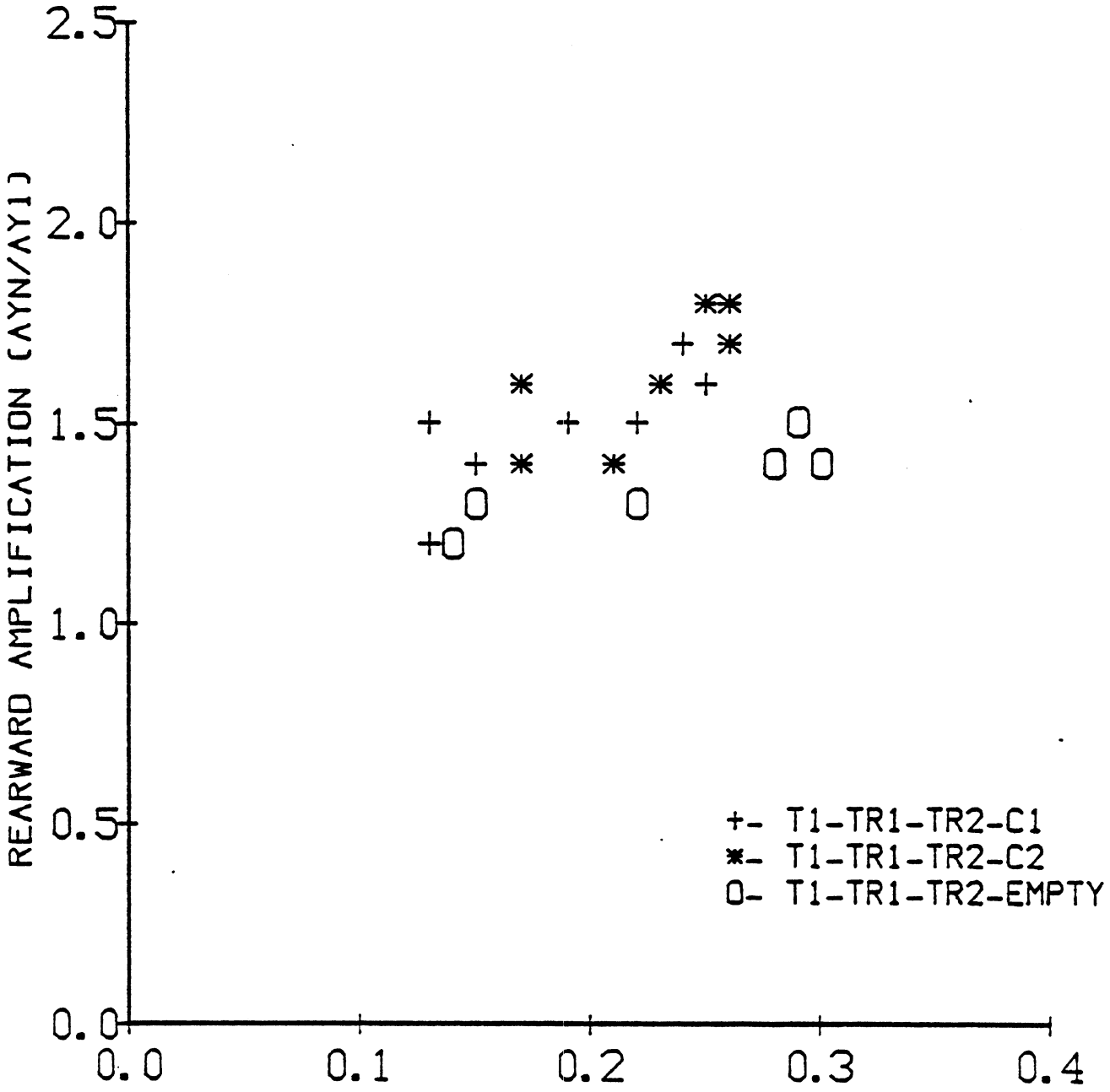
TWO AXLE TRACTOR- 2 27 FT TRAILERS
TRAPEZOIDAL STEER



TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 2 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

- Configuration: 7 Axle Triple ("T1-TR1-TR2-TR3")

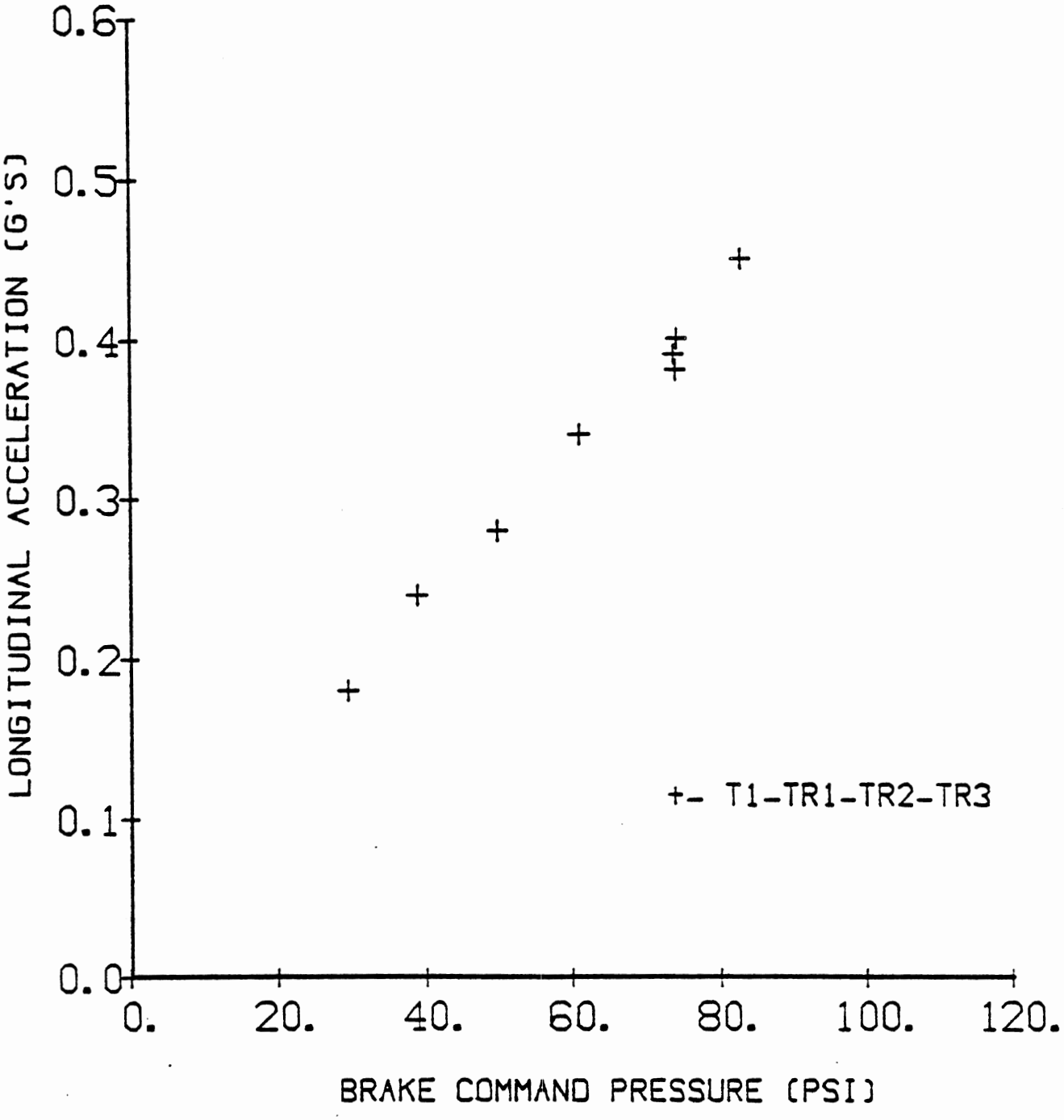
- Power Unit: Wheelbase: 135 in.
Axle-group Rated Capacities:
front - 12,000 lb; rear - 23,000 lb.

- Trailer(s):	No. of axles in group	length (ft)
#1:	1	27
#2:	1	27
#3:	1	27

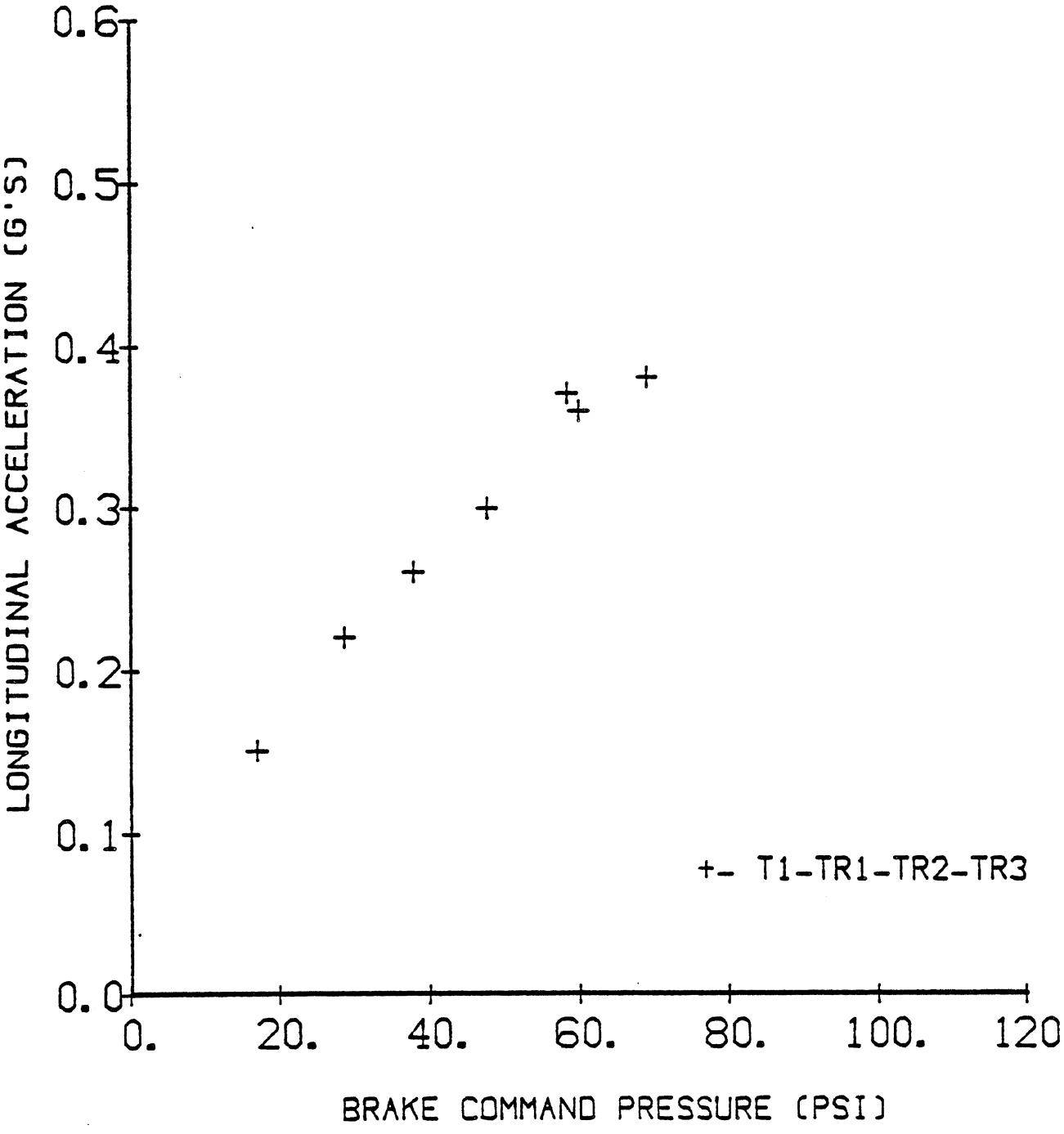
- Test Conditions and Codes:

Code	Payload CG Height(in.)	Axle Loads/1000 lb 1	2	3 thru 7	GCW 1000 lb.	Notes
T1-TR1-TR2-TR3-C1		9.5	16	15.5 each	103	Baseline

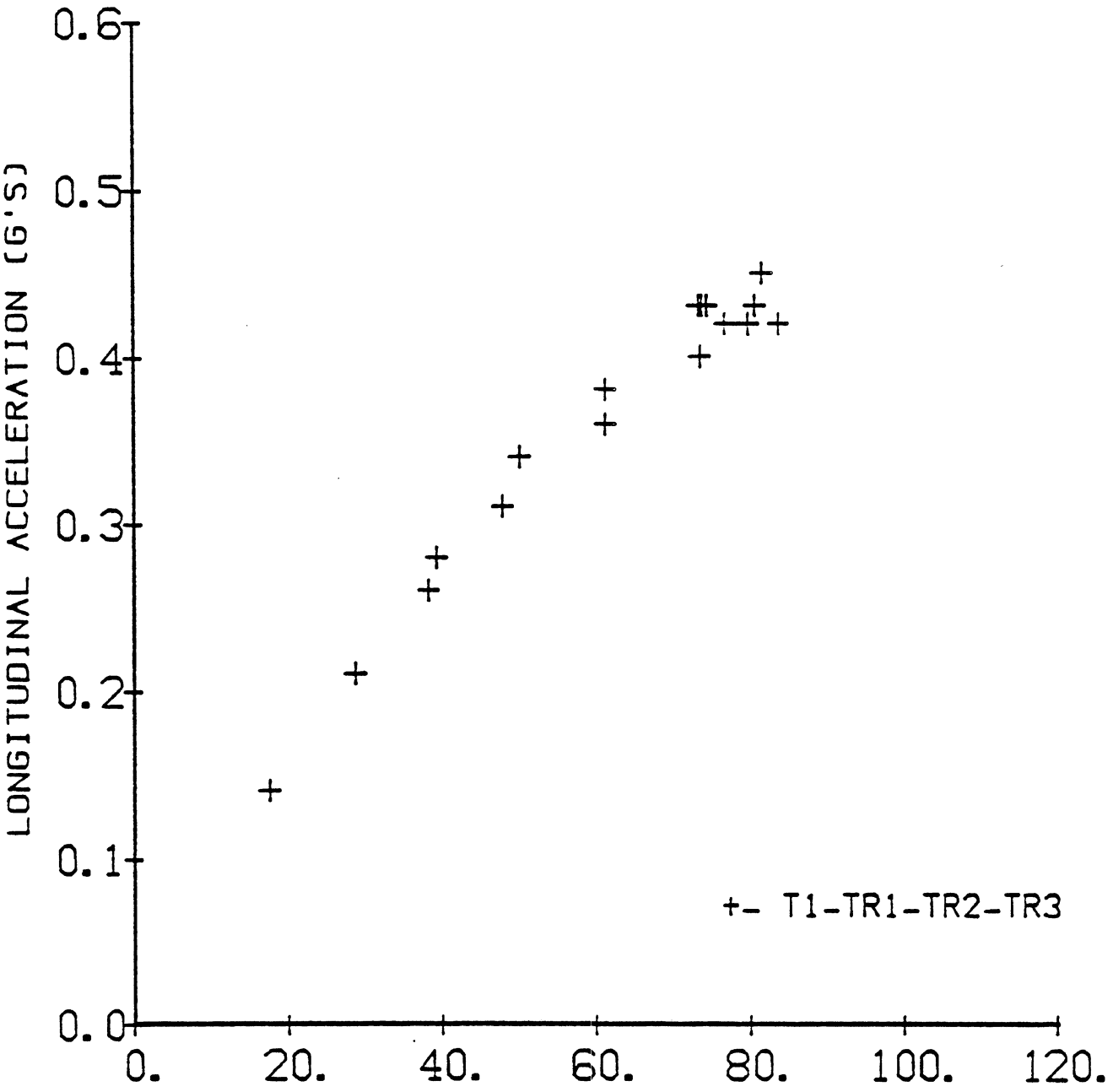
- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	C1
2. Braking in a Turn	C1
3. Trapezoidal Steer	No
4. Sinusoidal Steer	C1



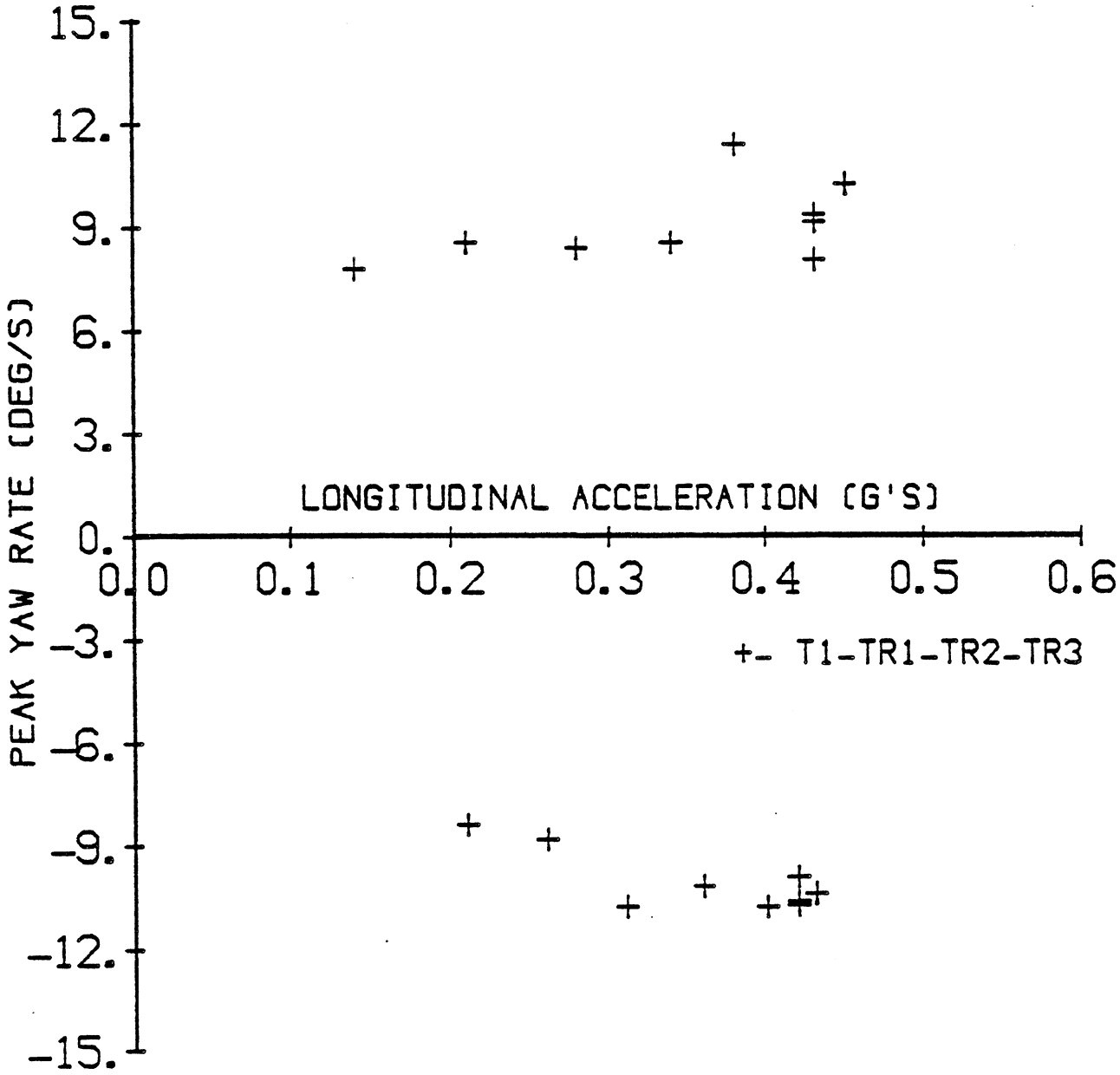
TWO AXLE TRACTOR- 3 27 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE



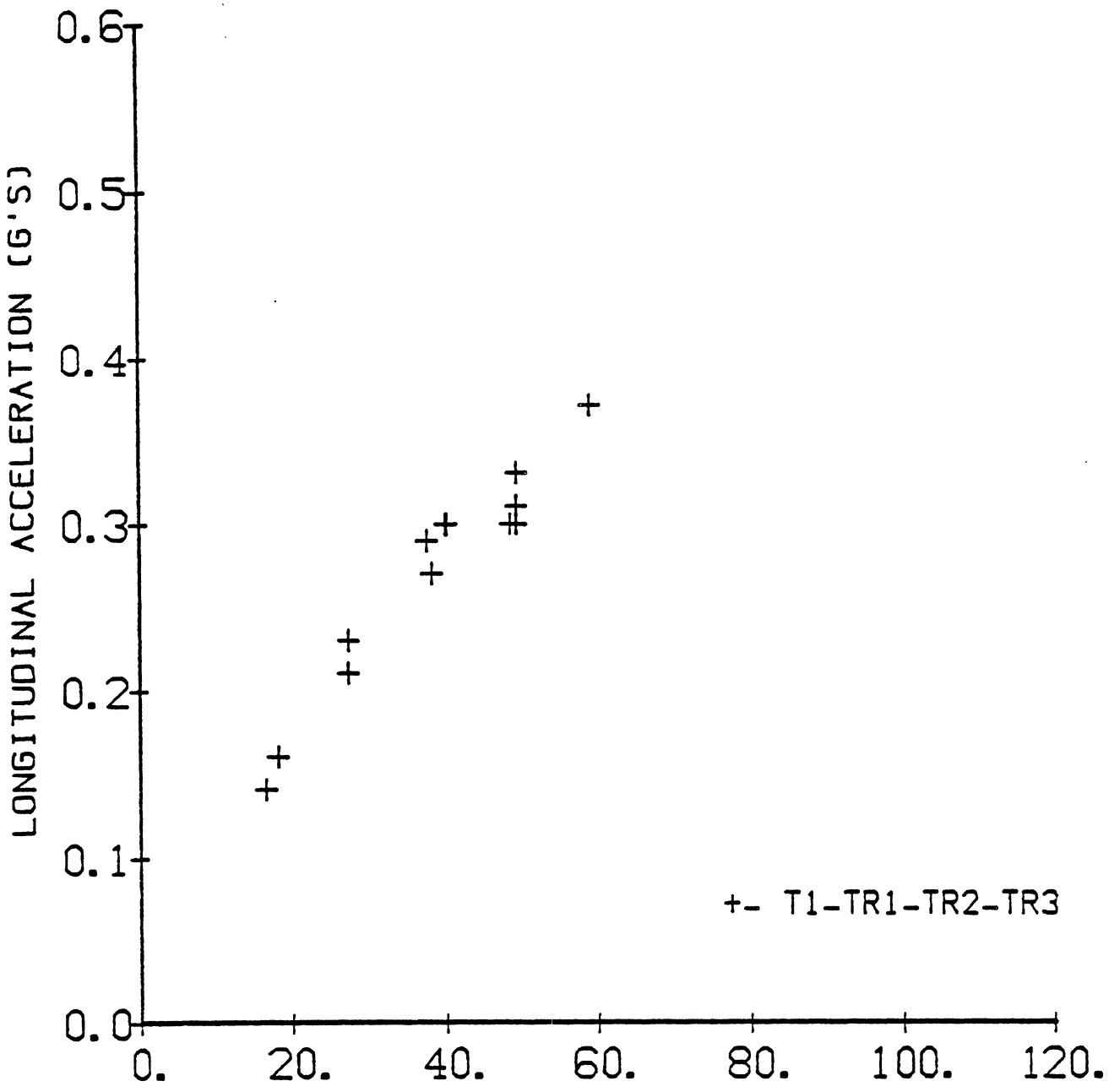
TWO AXLE TRACTOR- 3 27 FT TRAILERS
STRAIGHT LINE BRAKING
WET SURFACE



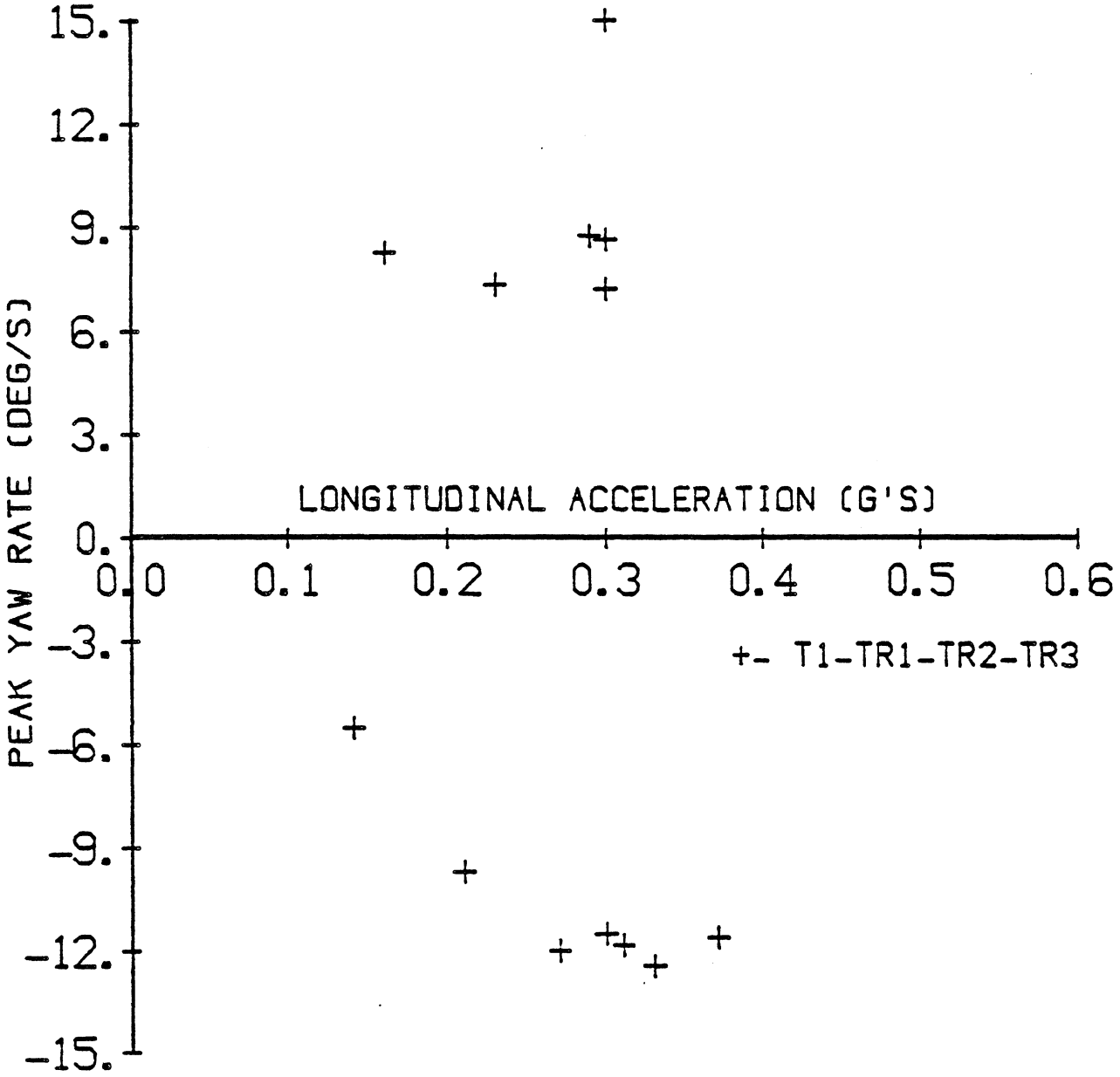
TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE



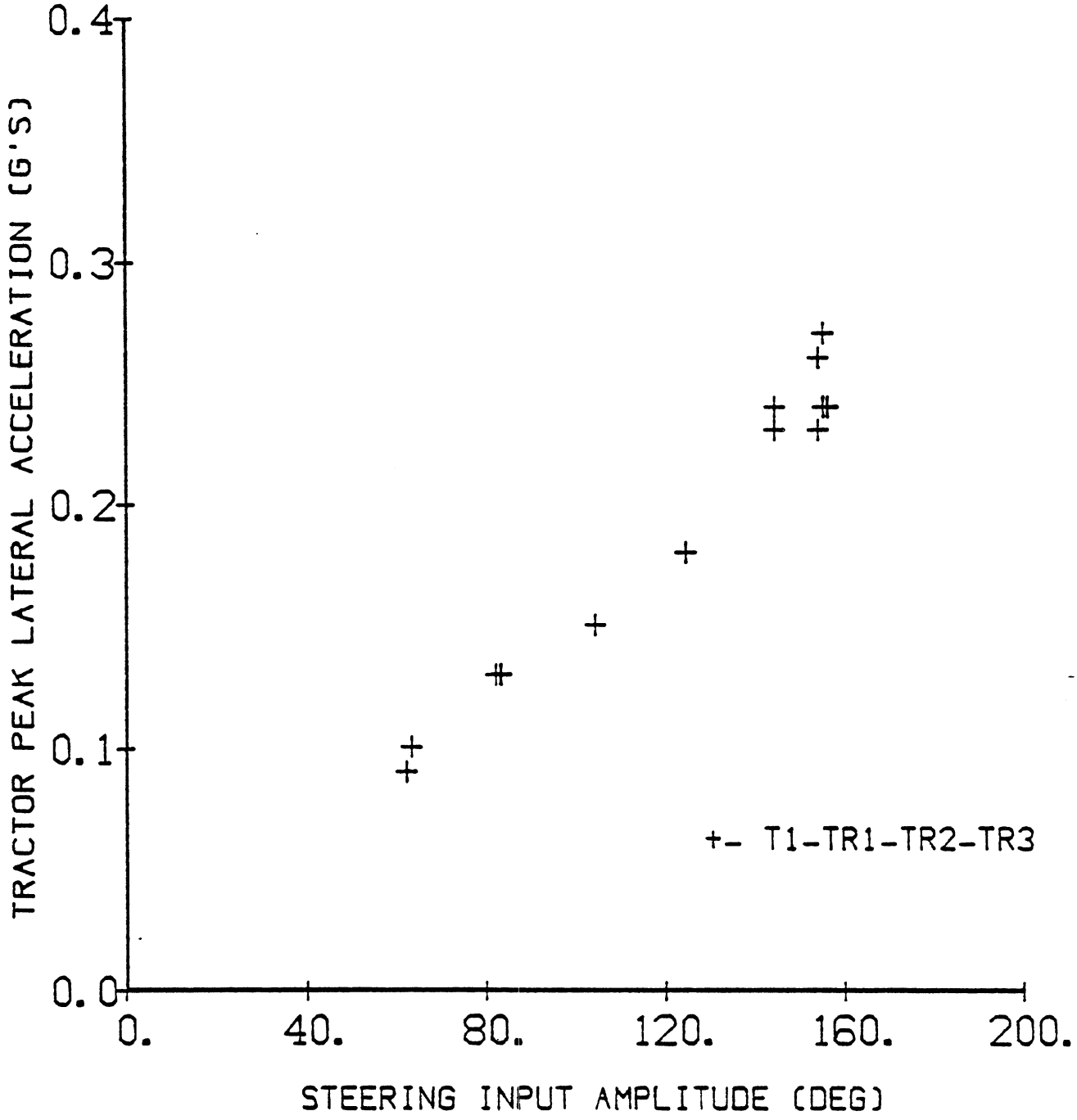
TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE



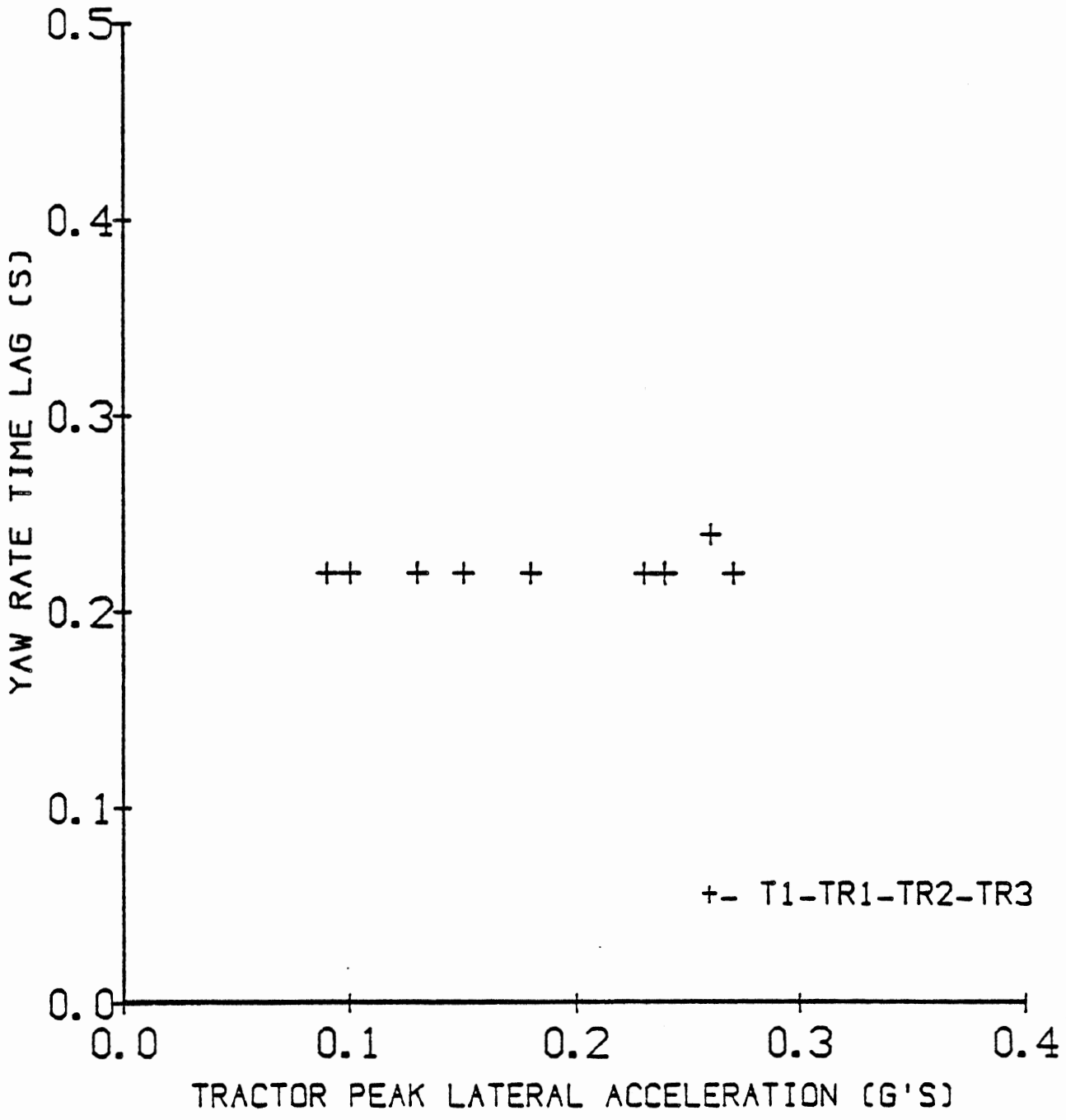
TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE



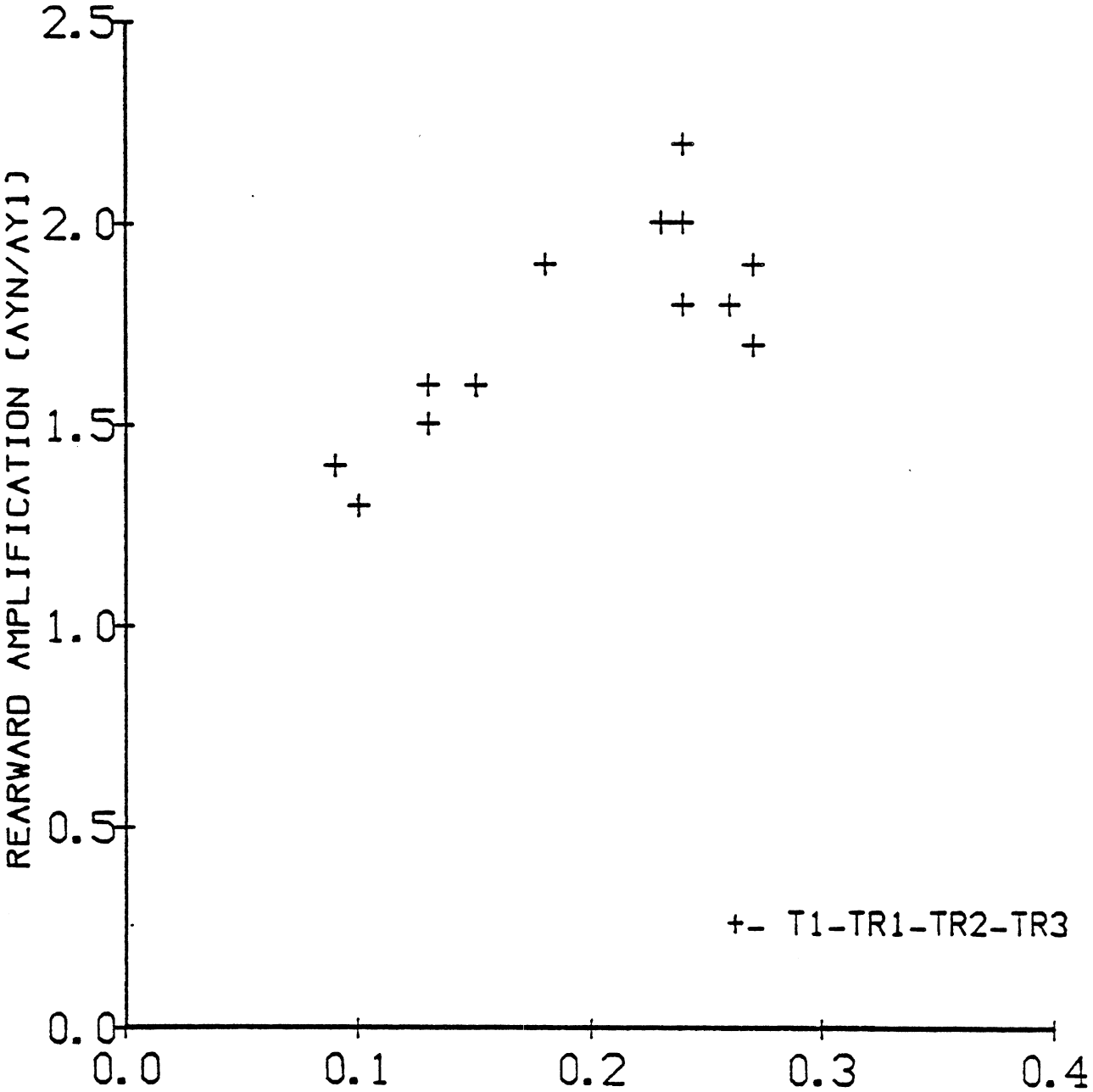
TWO AXLE TRACTOR- 3 27 FT TRAILERS
BRAKING IN A TURN
WET SURFACE



TWO AXLE TRACTOR- 3 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 3 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



TWO AXLE TRACTOR- 3 27 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD

- Configuration: Rocky Mountain Double ("T7-TR6-TR8")

- Power Unit: Wheelbase: 145 in.
Axle-group Rated Capacities:
front - 12,000 lb; rear - 38,000 lb.

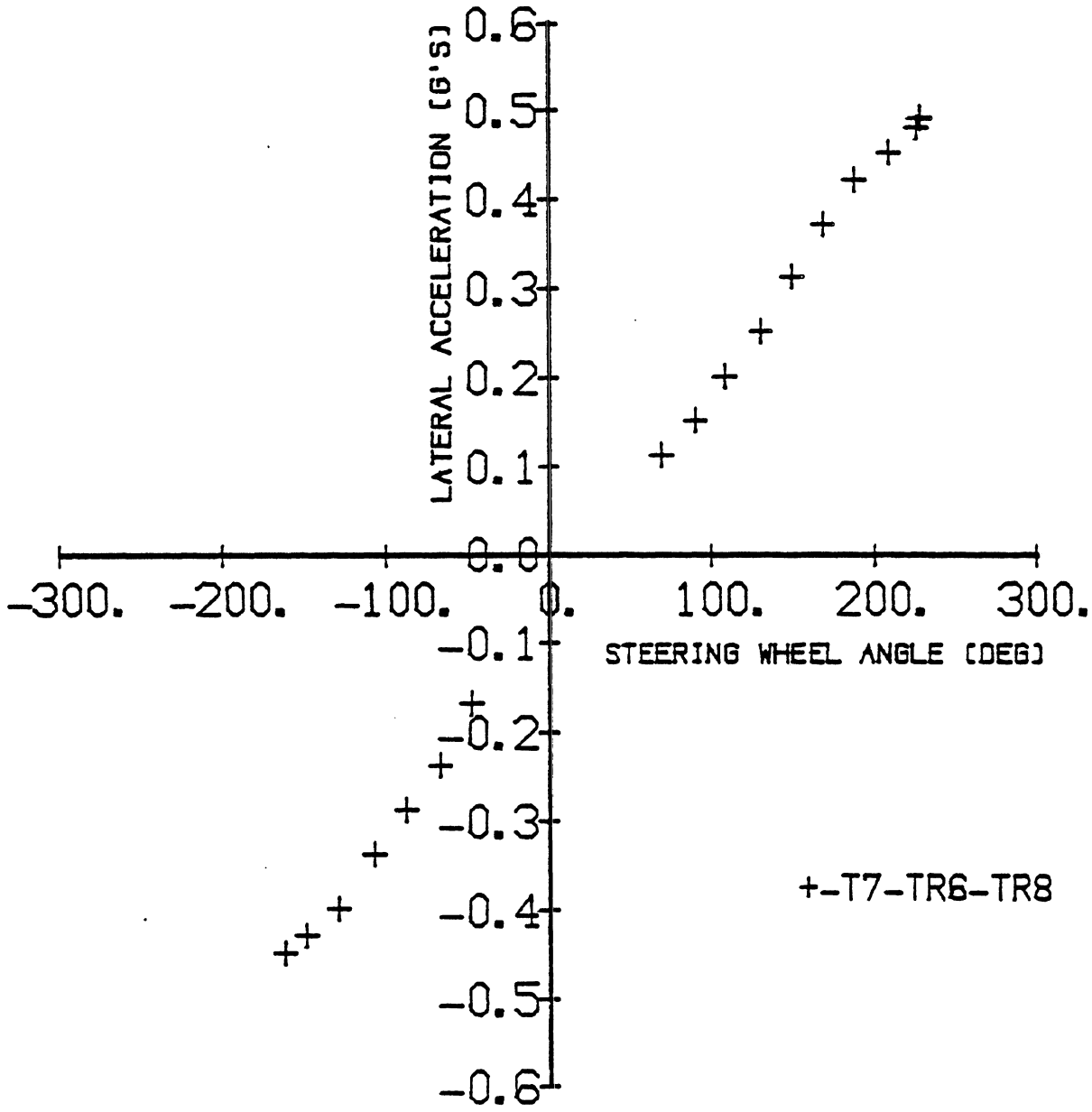
- Trailer(s):

	No. of axles in group	length (ft)
#1:	2	45
#2:	1	27

- Test Conditions and Codes:

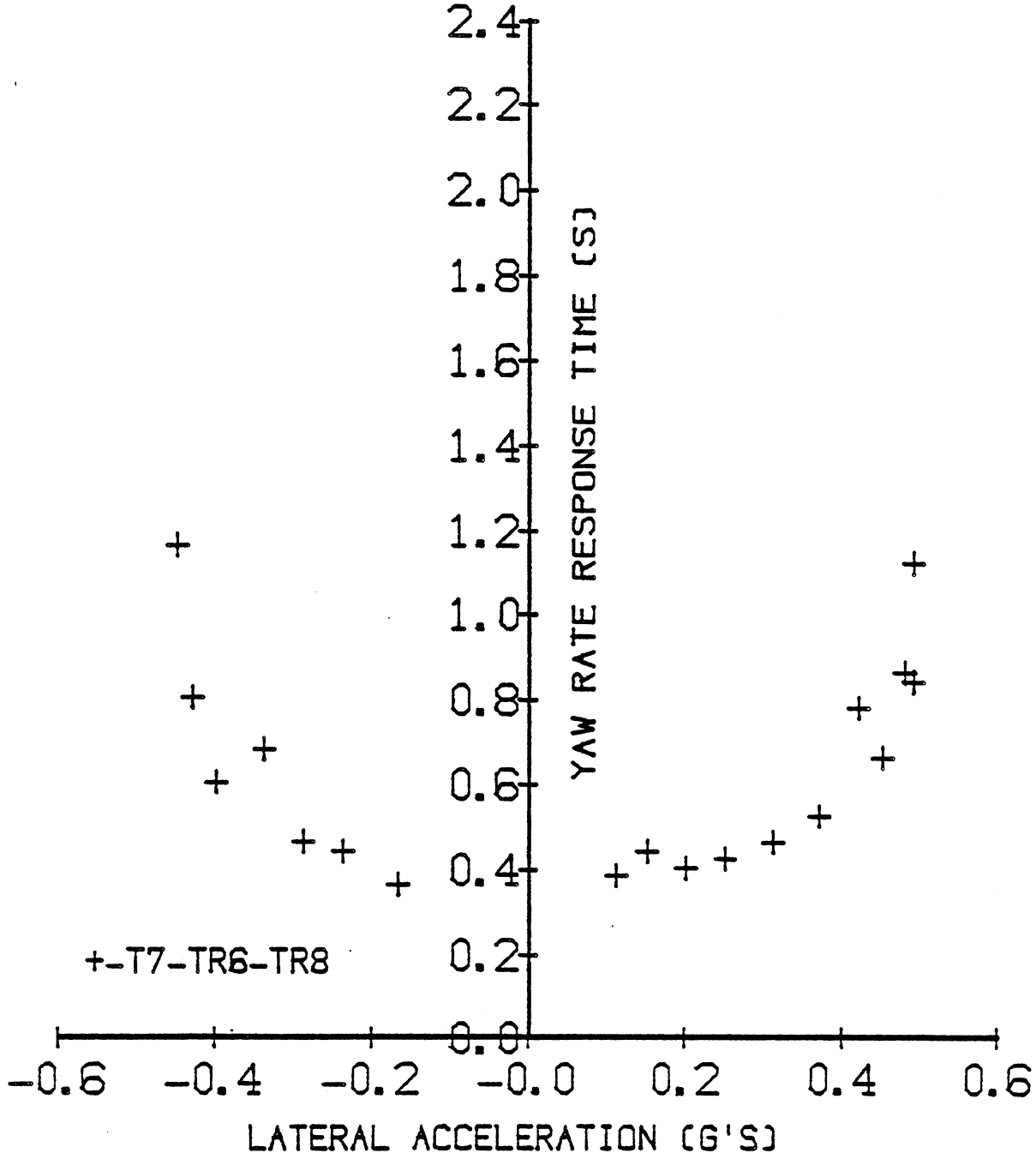
Code	Payload CG Height(in)	Axle Loads/1000 lb. 1	2	3	4	5	6	7	GCW 1000 lb.	Notes
T7-TR6-TR8-C1	68	10	32		30		15	15	102	Baseline

- Test Procedure Plots	Test Conditions:
1. Straight Line Braking	no
2. Braking in a Turn	no
3. Trapezoidal Steer	C1
4. Sinusoidal Steer	C1



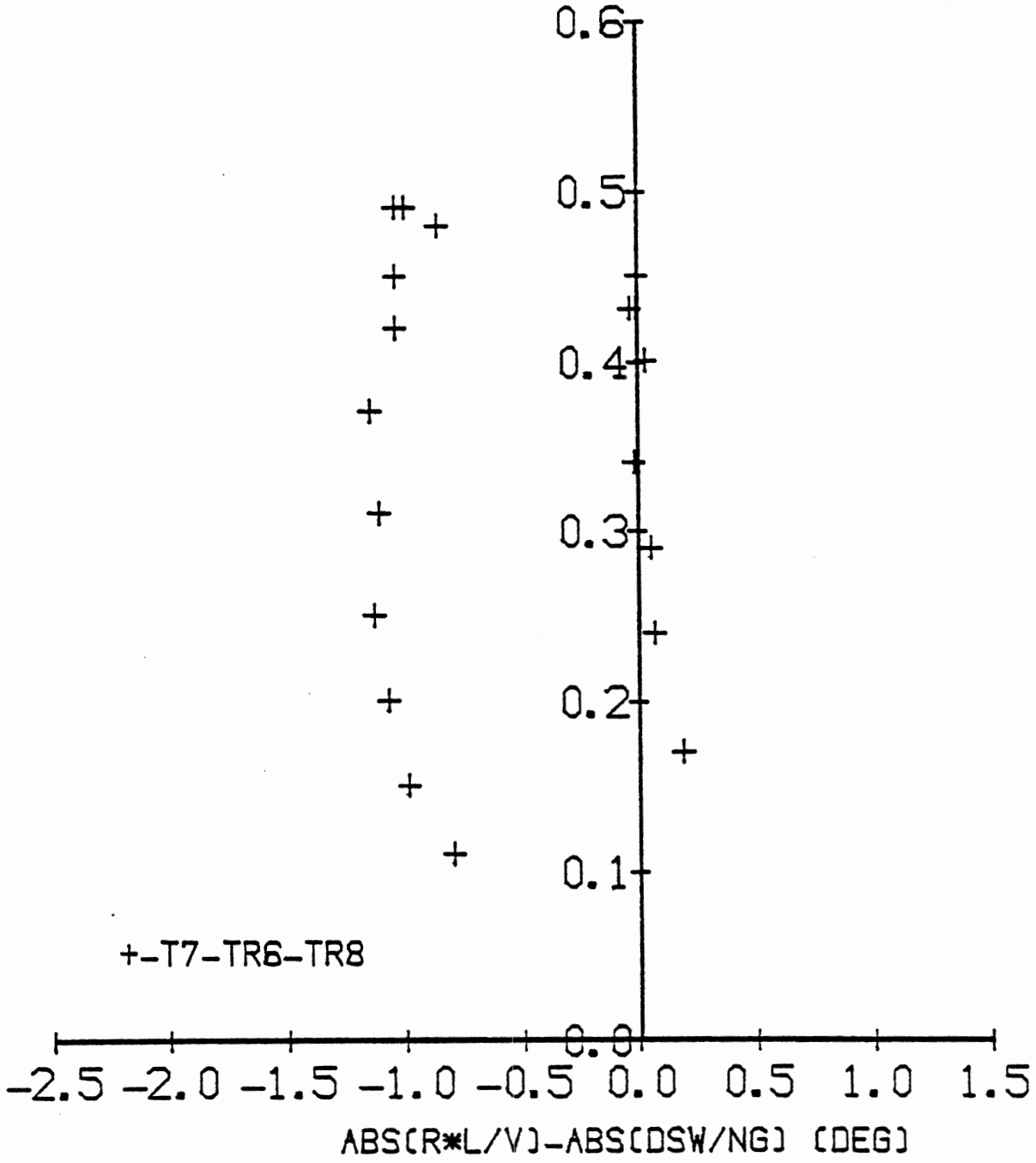
TRAPEZOIDAL STEER

THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER

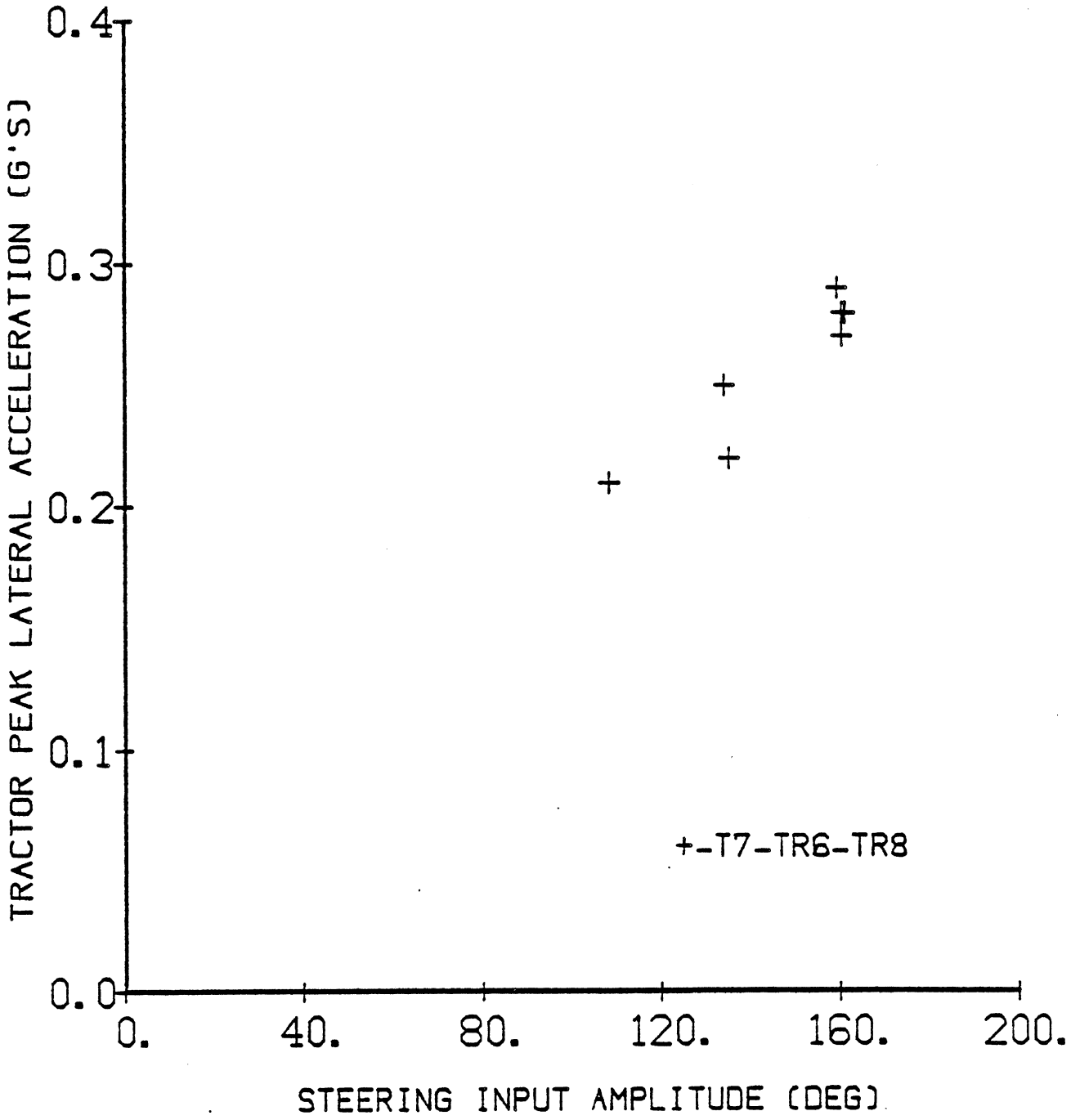


THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER

TRAPEZOIDAL STEER

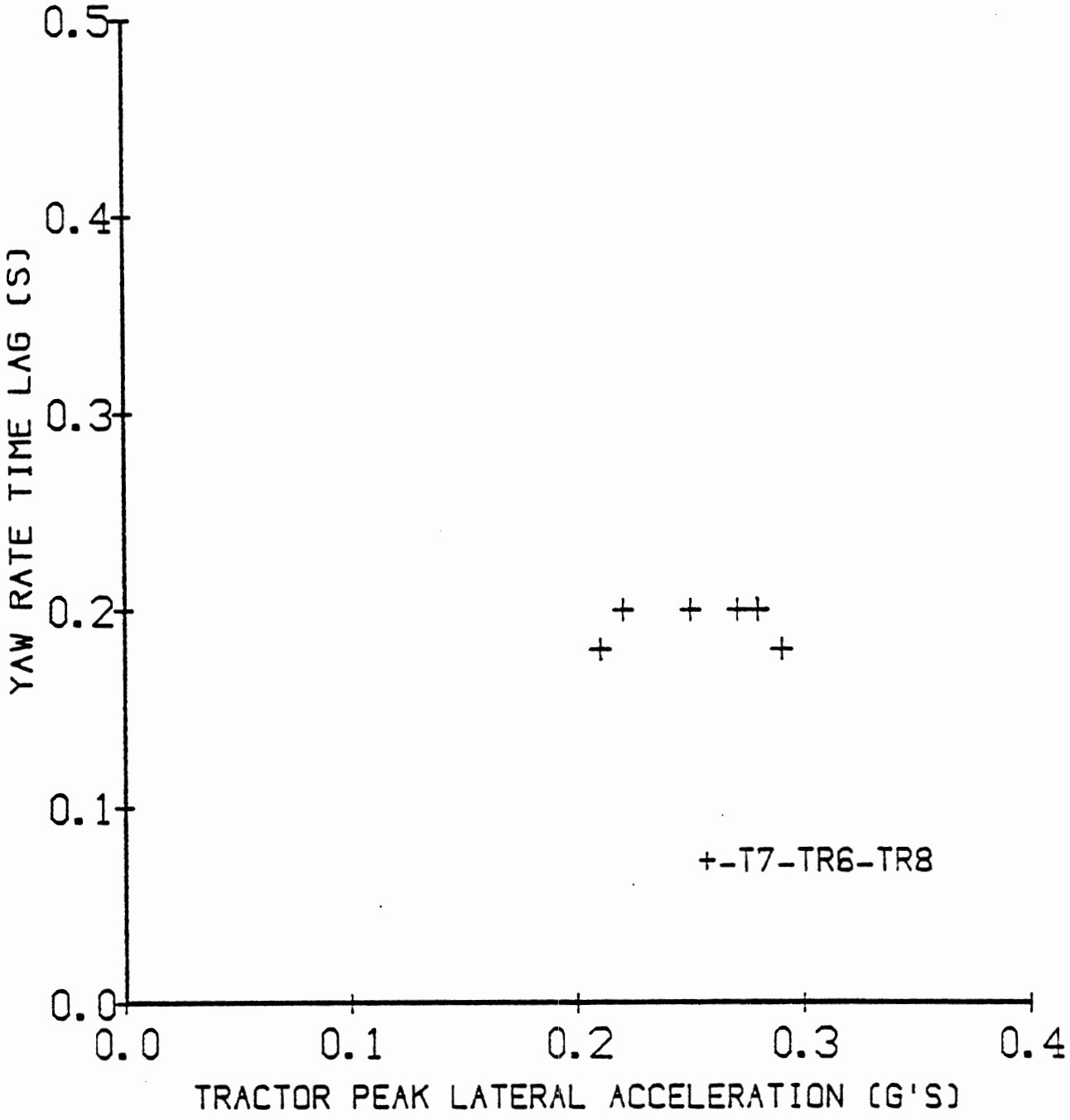


THREE AXLE TRACTOR + 45 FT TRAILER + 27 FT TRAILER



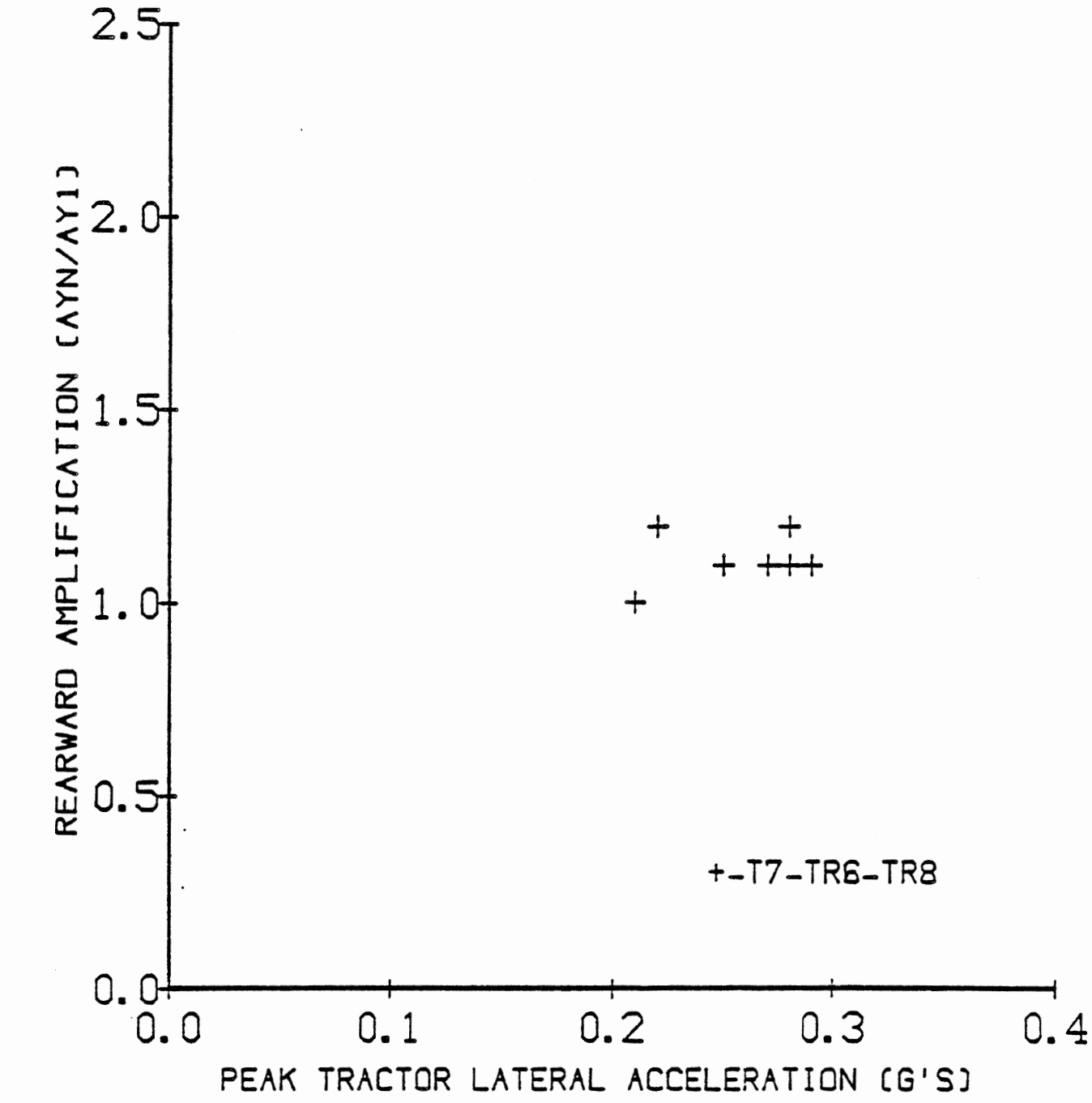
THREE AXLE TRACTOR+45 FT TRAILER+27 FT TRAILER

SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR+45 FT TRAILER+27 FT TRAILER

SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR+45 FT TRAILER+27 FT TRAILER
SINUSOIDAL STEER
TWO SEC PERIOD

- Configuration: Turnpike Double ("T3-TR5-TR6")

- Power Unit: Wheelbase: 142 in.
  Axlegroup Rated Capacities:
  front - 12,000 lb; rear -34,000 lb.

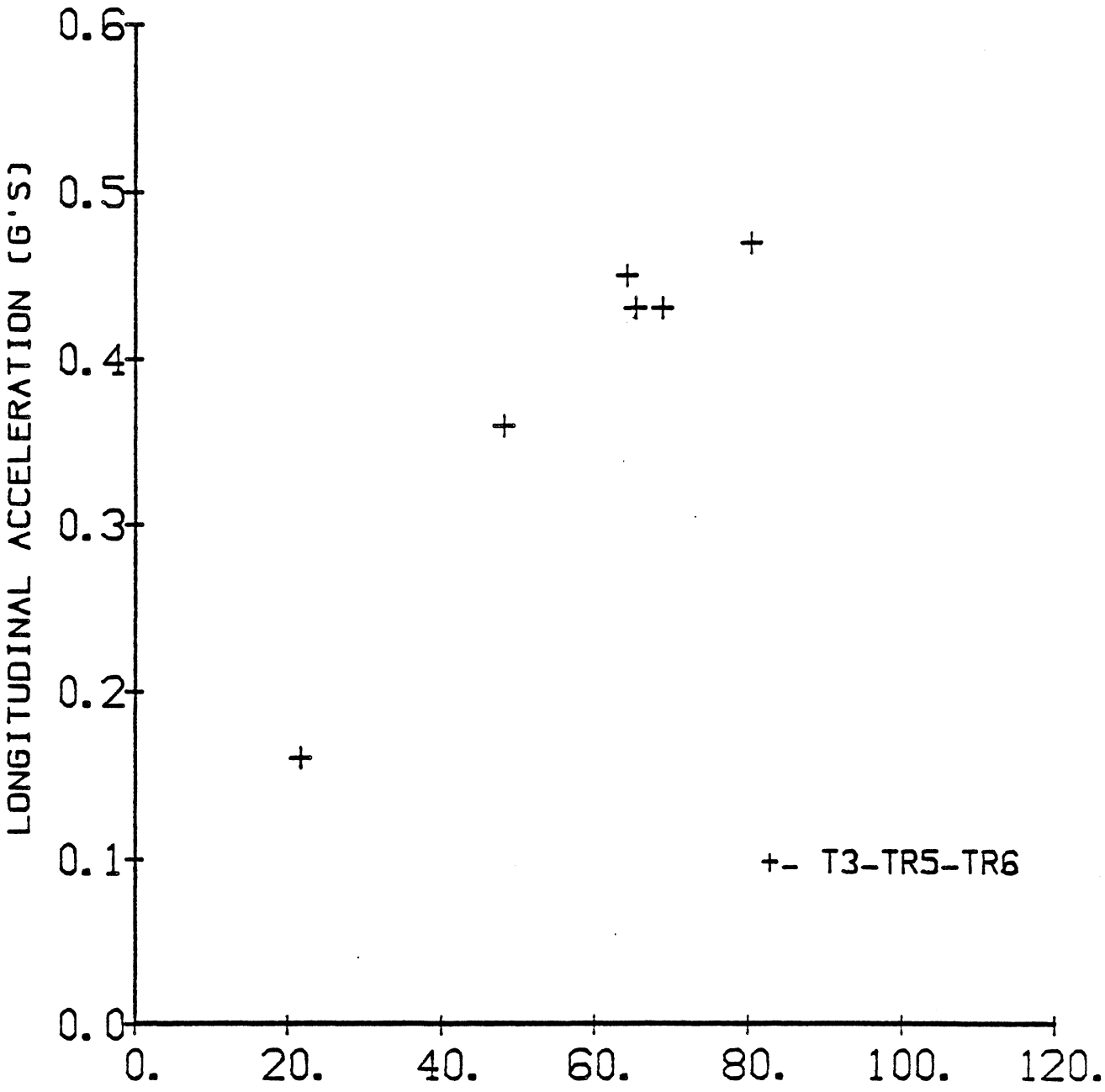
- Trailer(s):	No. of axles in group	length (ft)
#1:	2	45
#2	2	45

- Test Conditions and Codes:

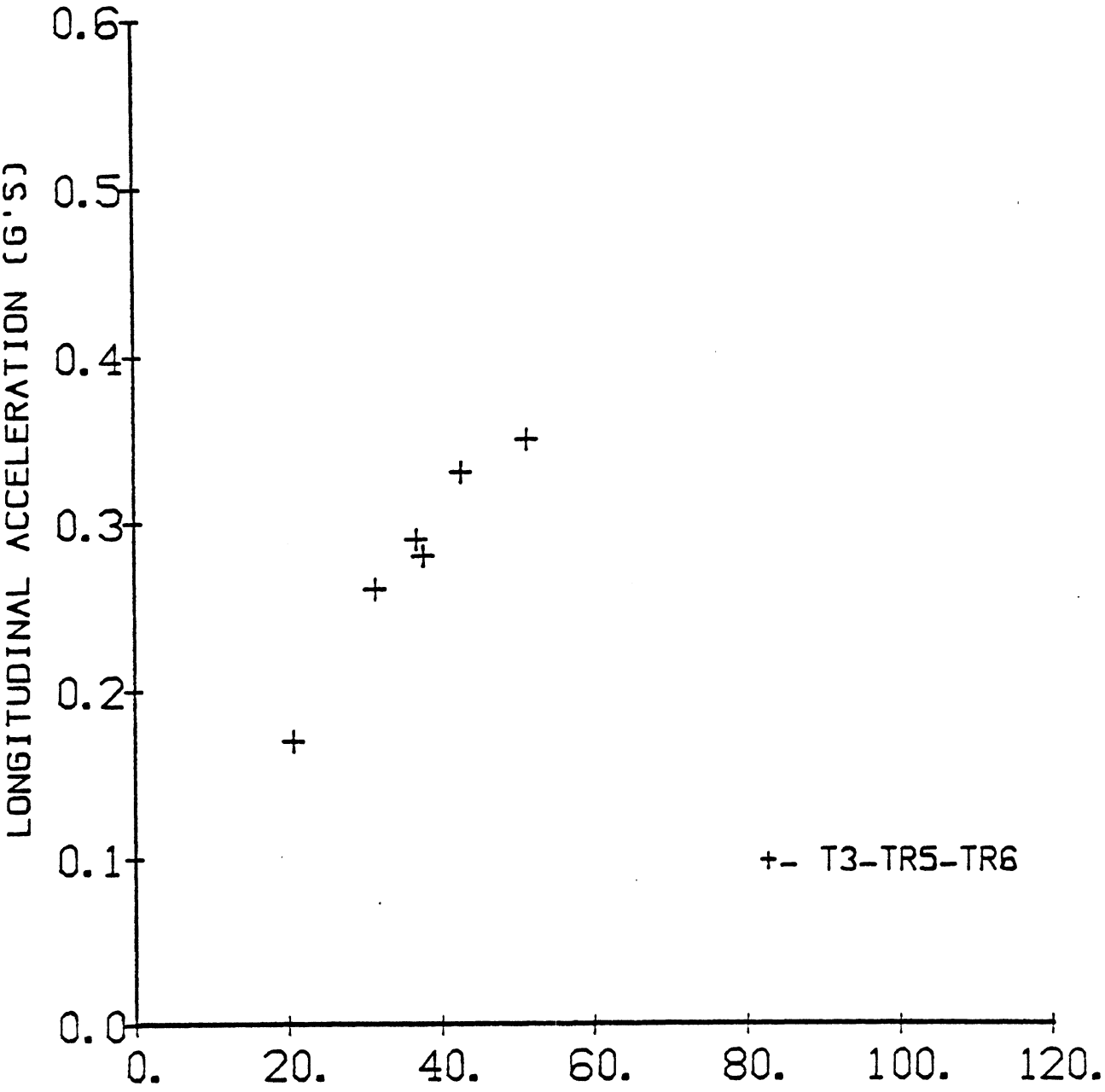
Code	Payload CG Height(in)	Axle Loads/1000 lb 1	2	3	4	5	6	7	8	9	GCW 1000 lb.	Notes
T3-TR5-TR6	67	10	28		25		25		25		113	Baseline

- Test Procedure Plots

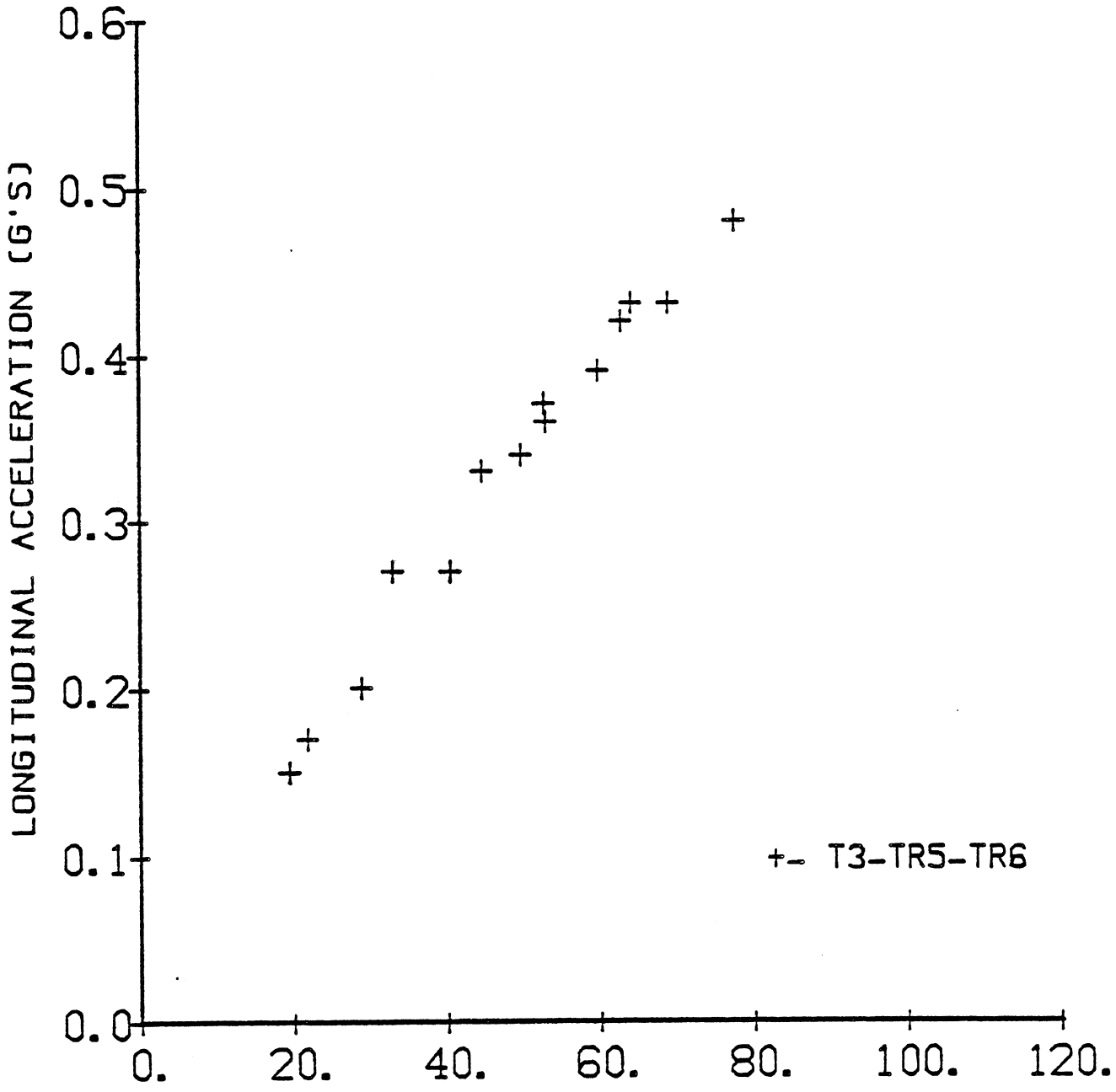
1. Straight Line Braking - Yes
2. Braking in a Turn - Yes
3. Trajezoidal Steer - Yes
4. Sinujoidal Steer - Yes



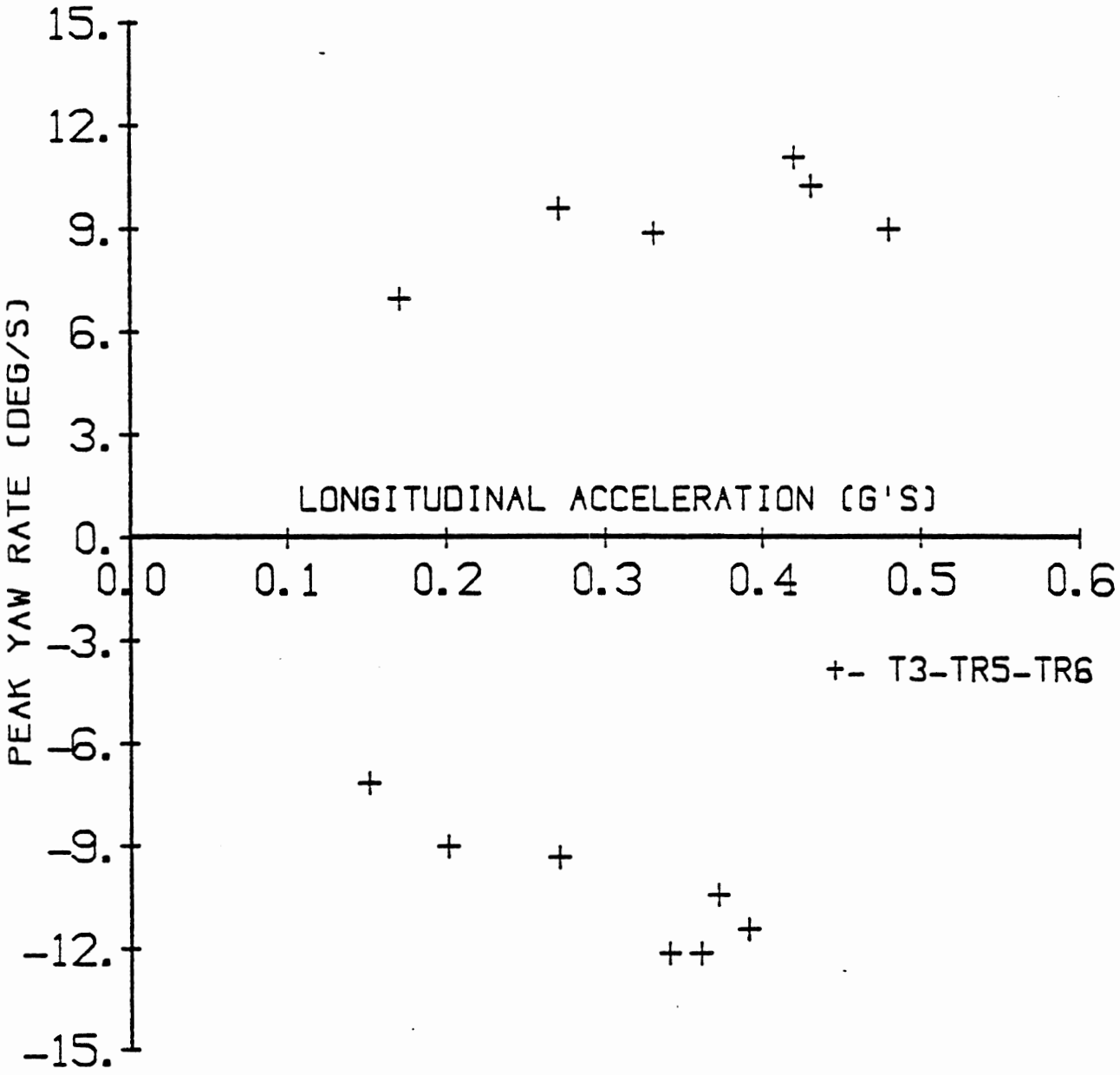
THREE AXLE TRACTOR- 2 45 FT TRAILERS
STRAIGHT LINE BRAKING
DRY SURFACE



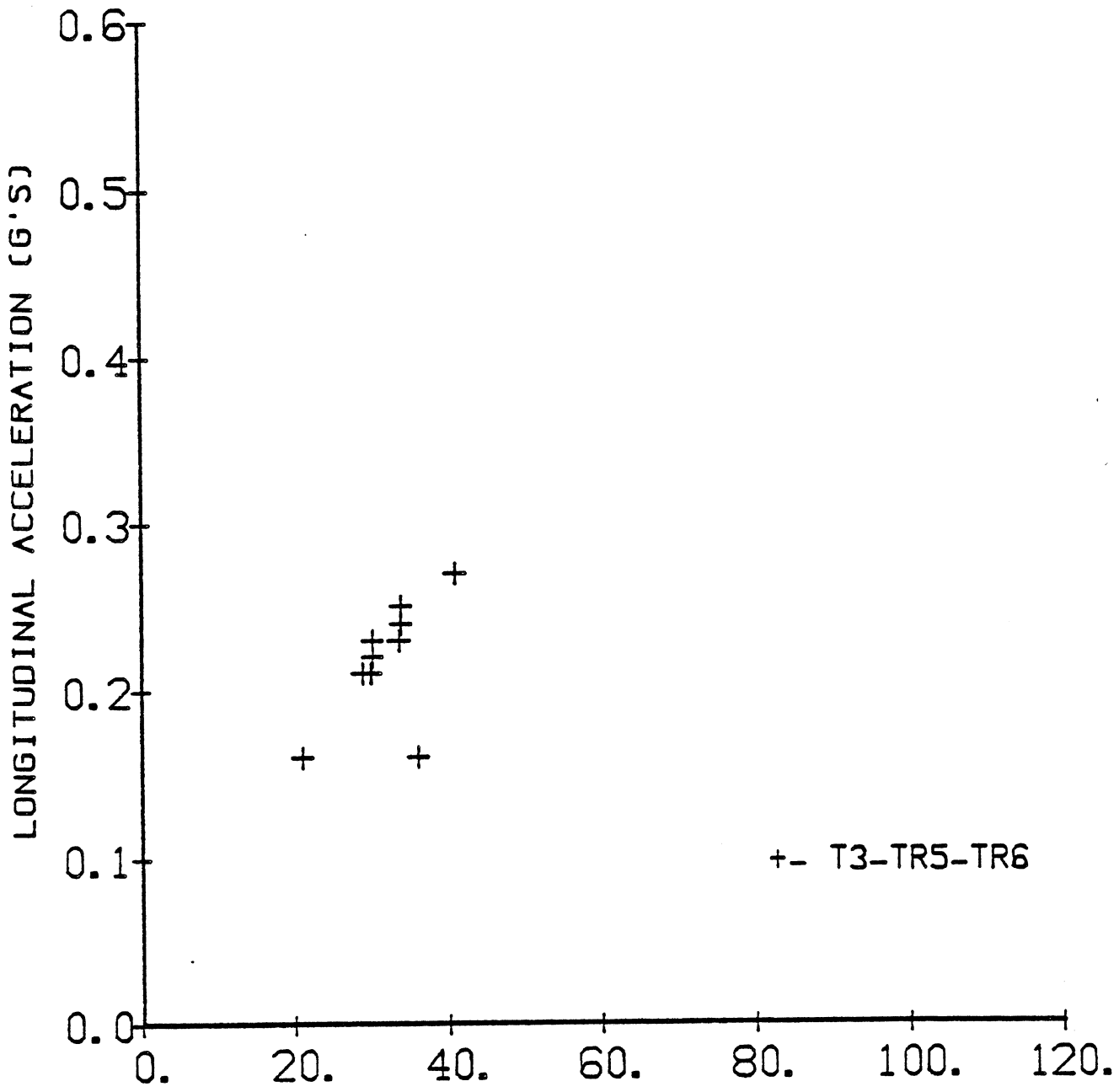
THREE AXLE TRACTOR- 2 45 FT TRAILERS
STRAIGHT LINE BRAKING
WET SURFACE



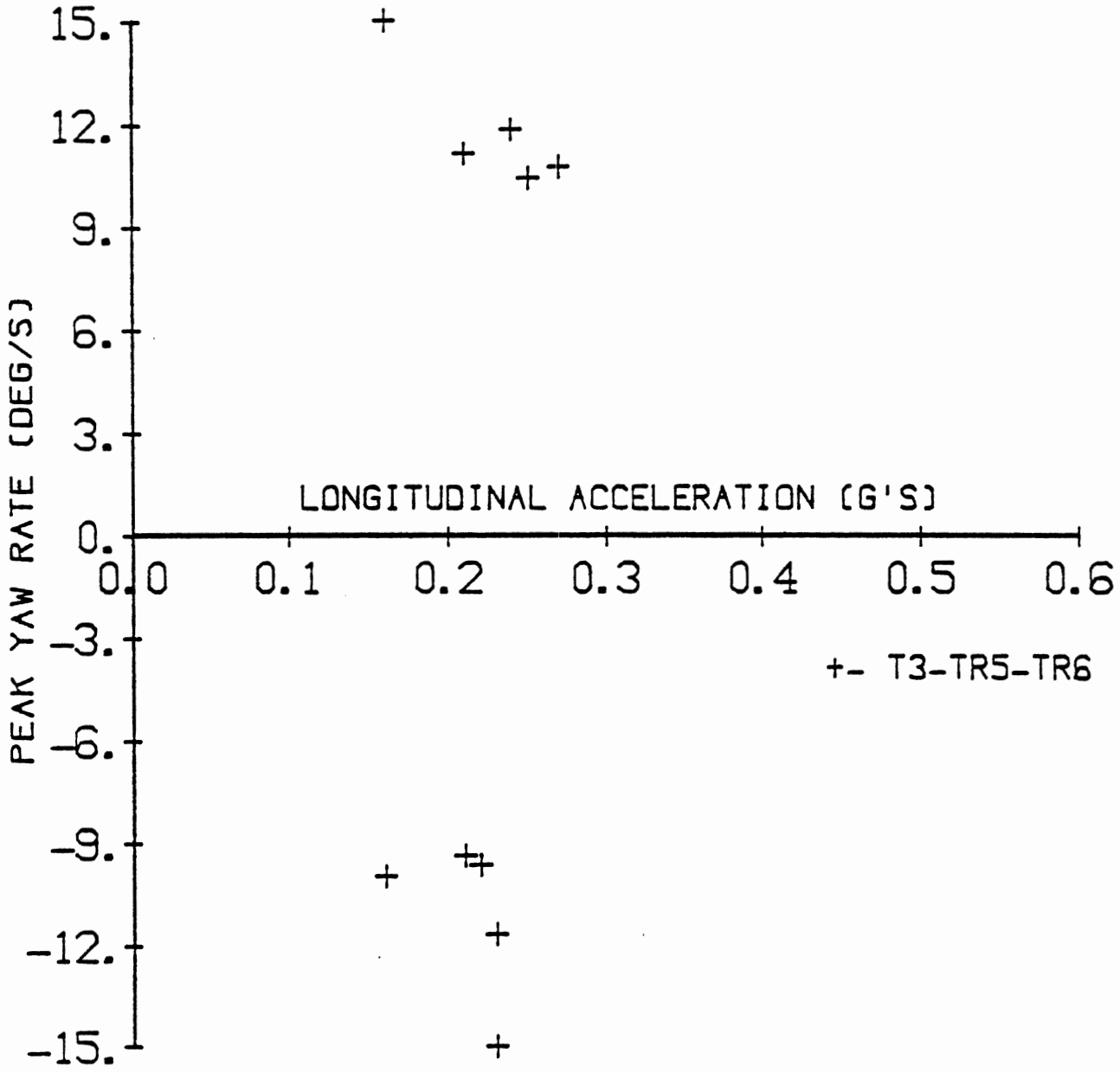
THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE



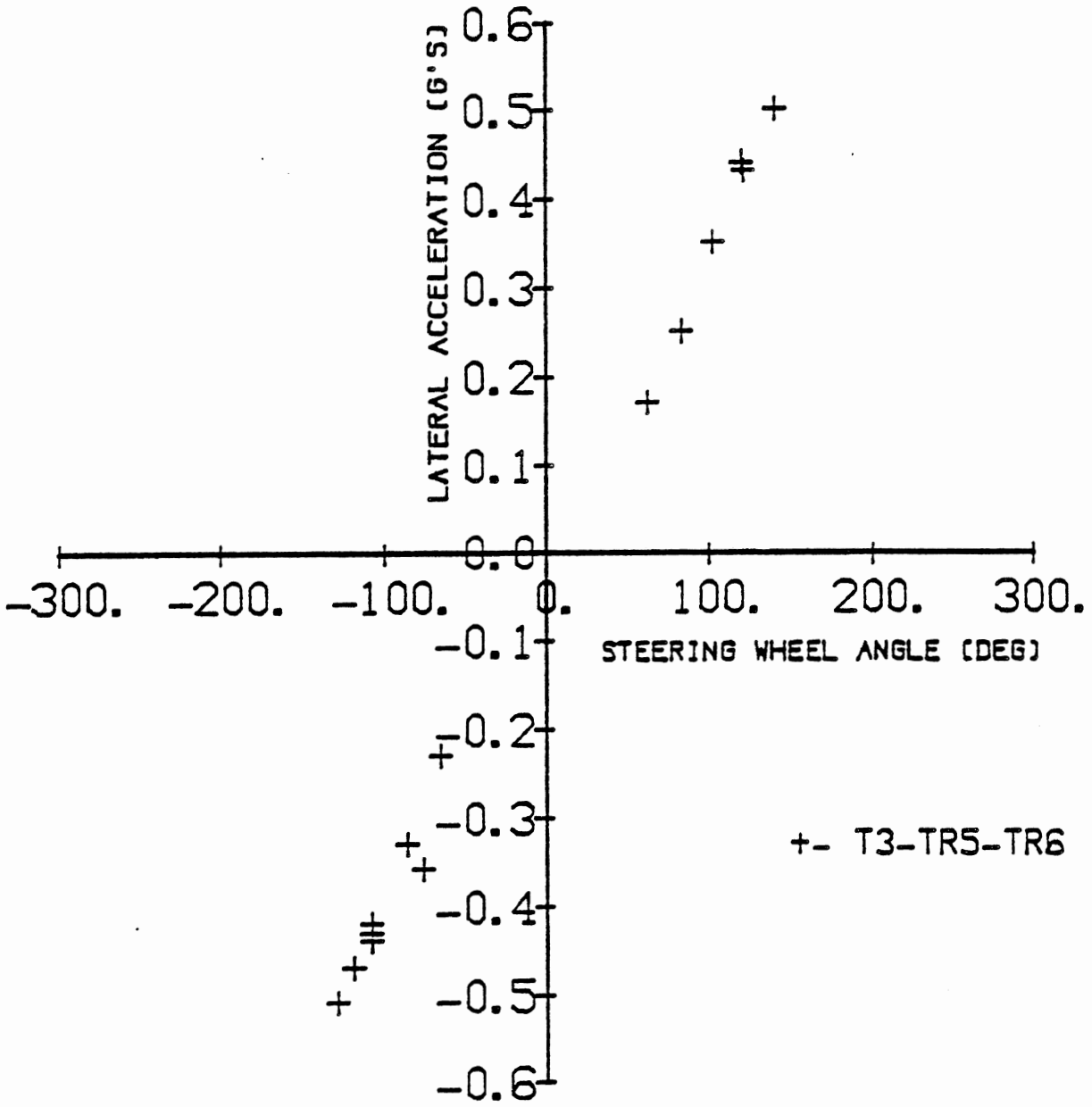
THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
DRY SURFACE



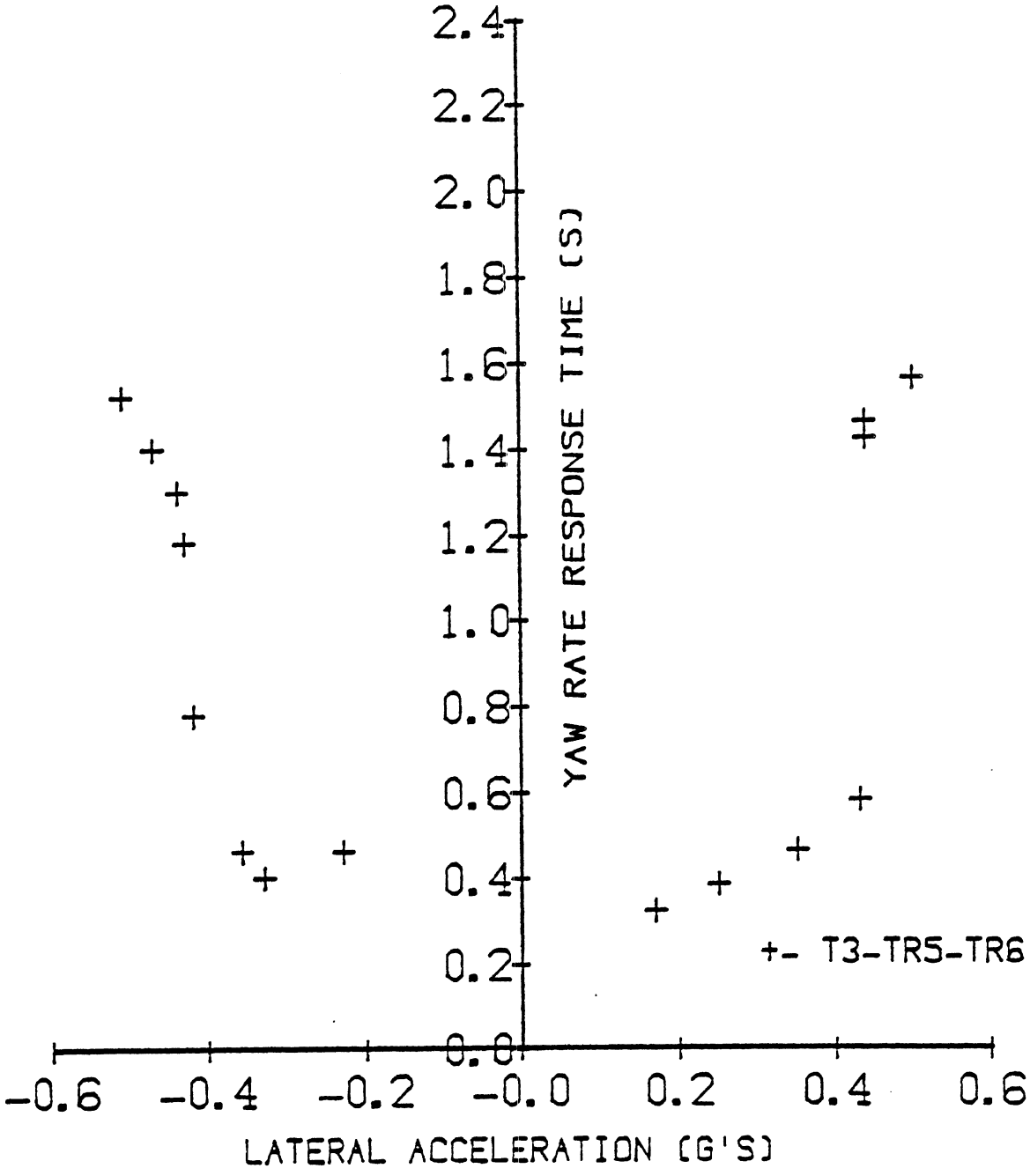
THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
WET SURFACE



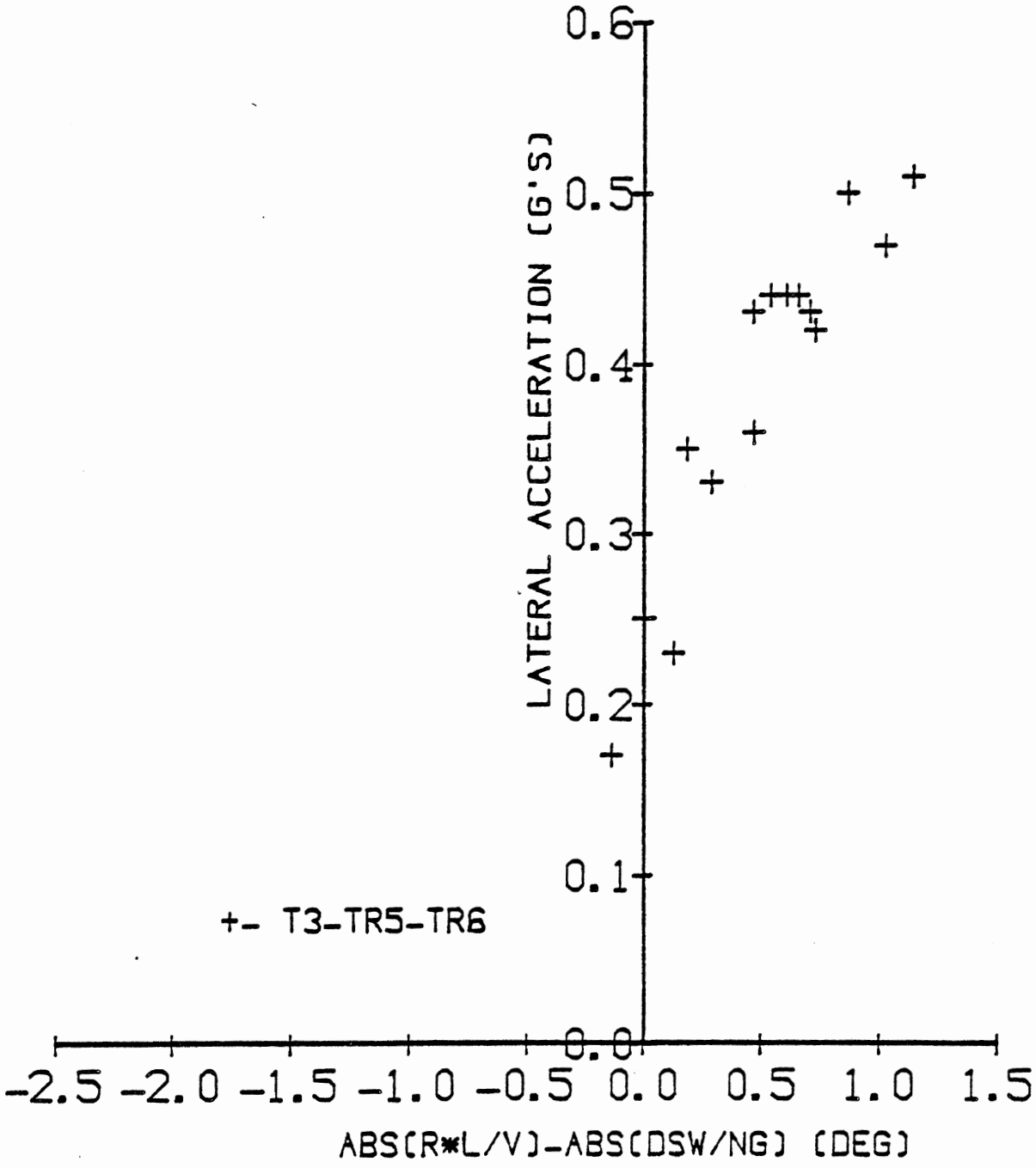
THREE AXLE TRACTOR- 2 45 FT TRAILERS
BRAKING IN A TURN
WET SURFACE



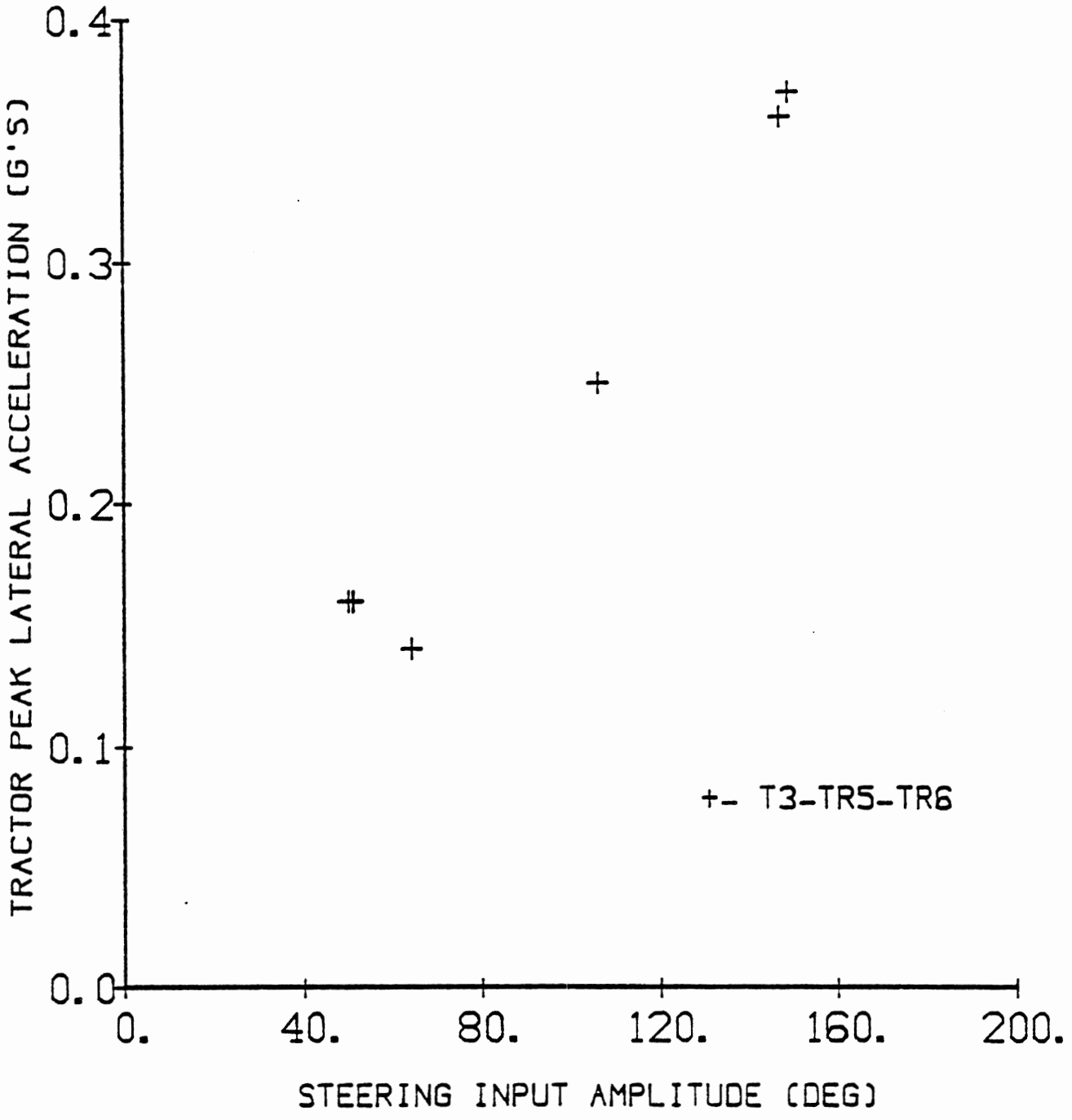
THREE AXLE TRACTOR- 2 45 FT TRAILERS
TRAPEZOIDAL STEER



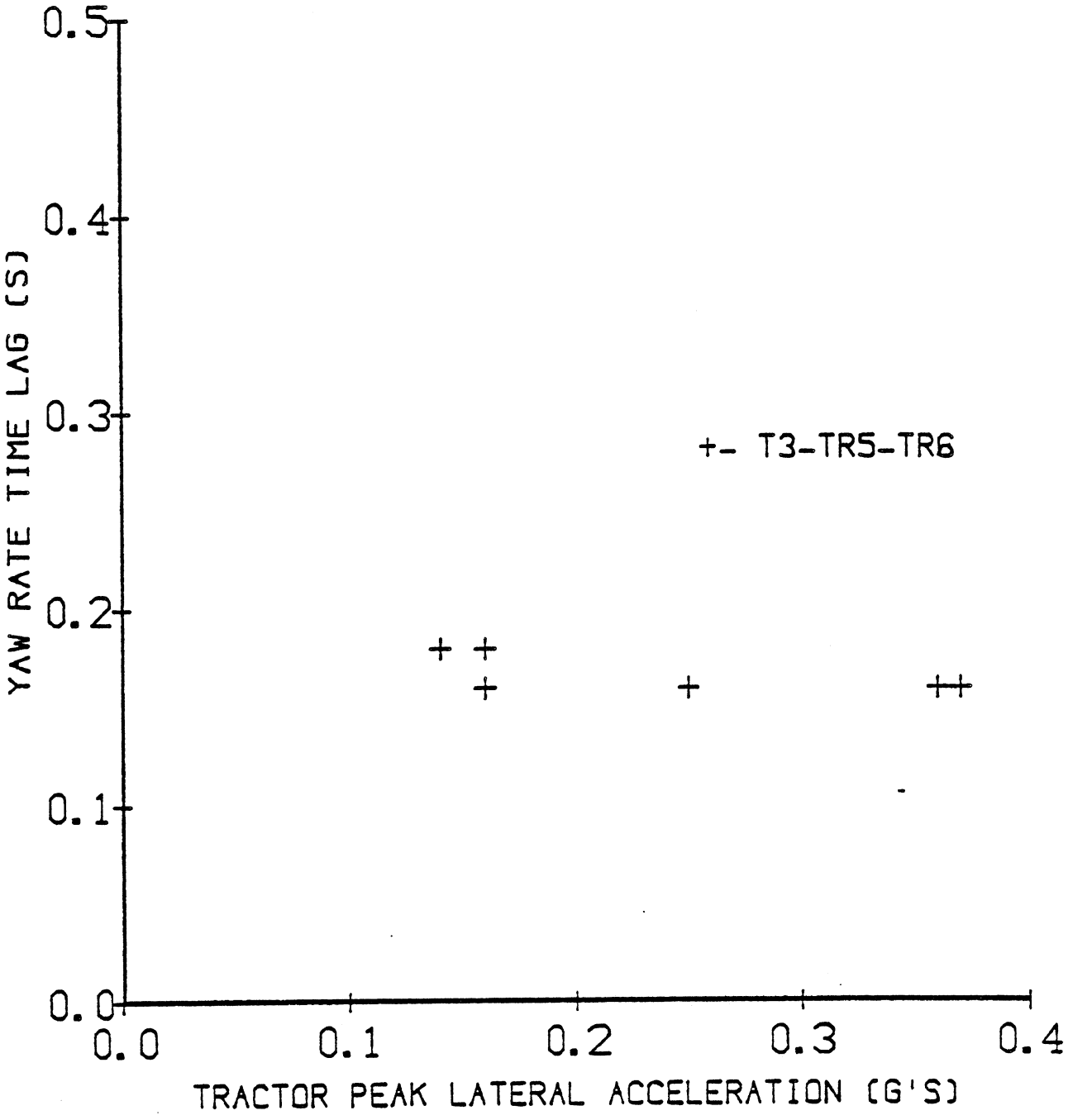
THREE AXLE TRACTOR- 2 45 FT TRAILERS
TRAPEZOIDAL STEER



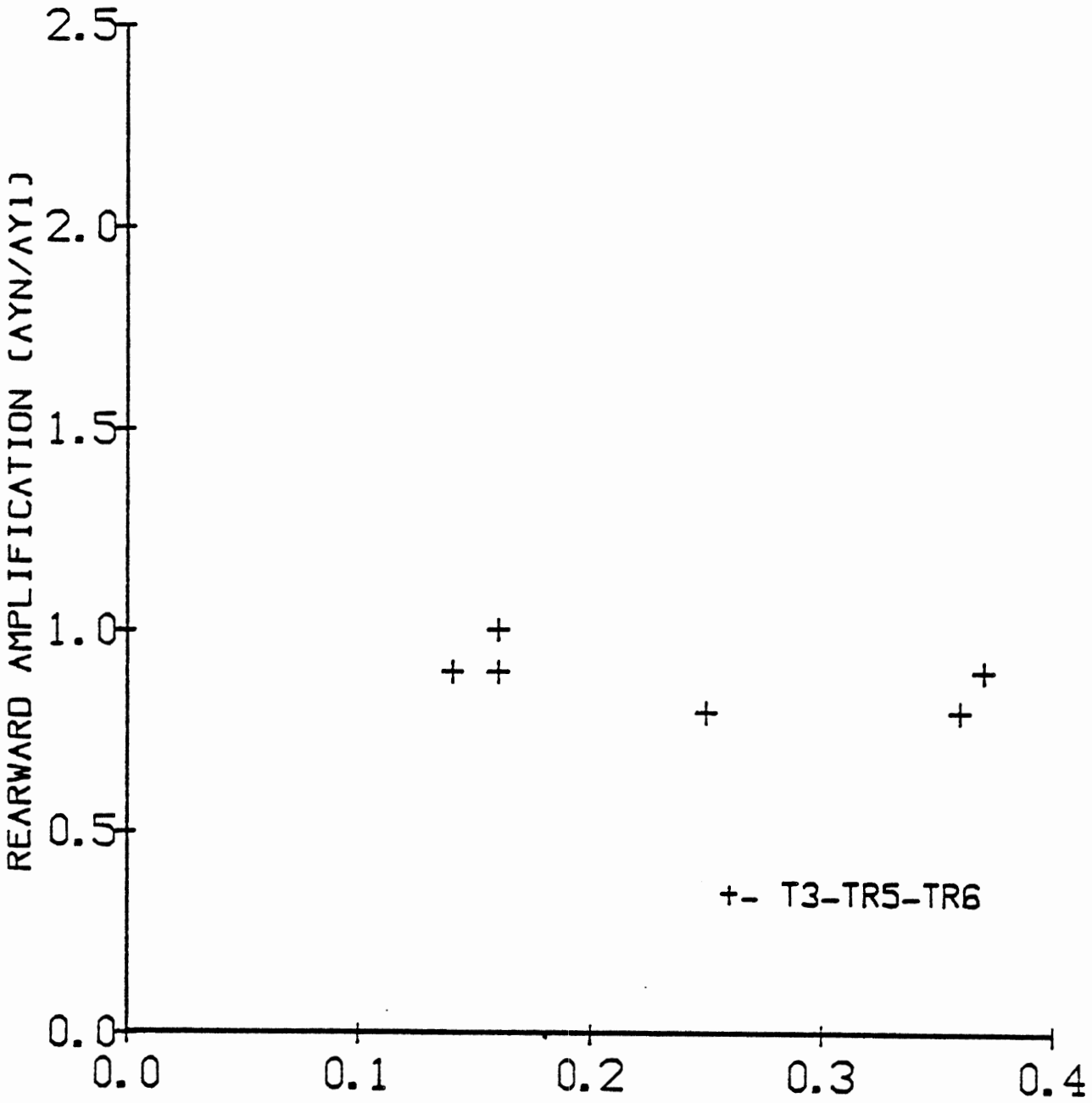
THREE AXLE TRACTOR- 2 45 FT TRAILERS
TRAPEZOIDAL STEER
NG=50.



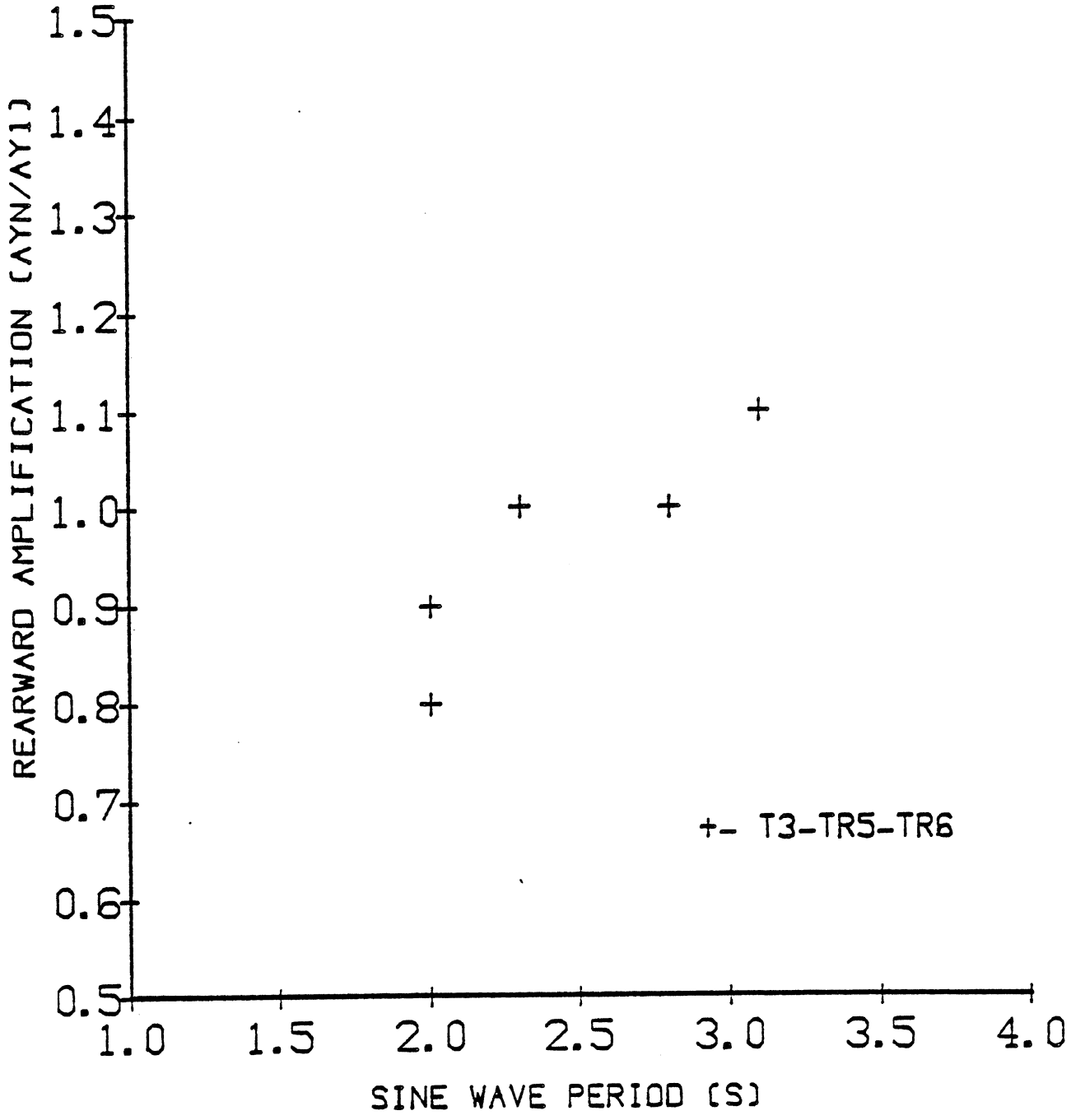
THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER
TWO SEC PERIOD



THREE AXLE TRACTOR- 2 45 FT TRAILERS
SINUSOIDAL STEER