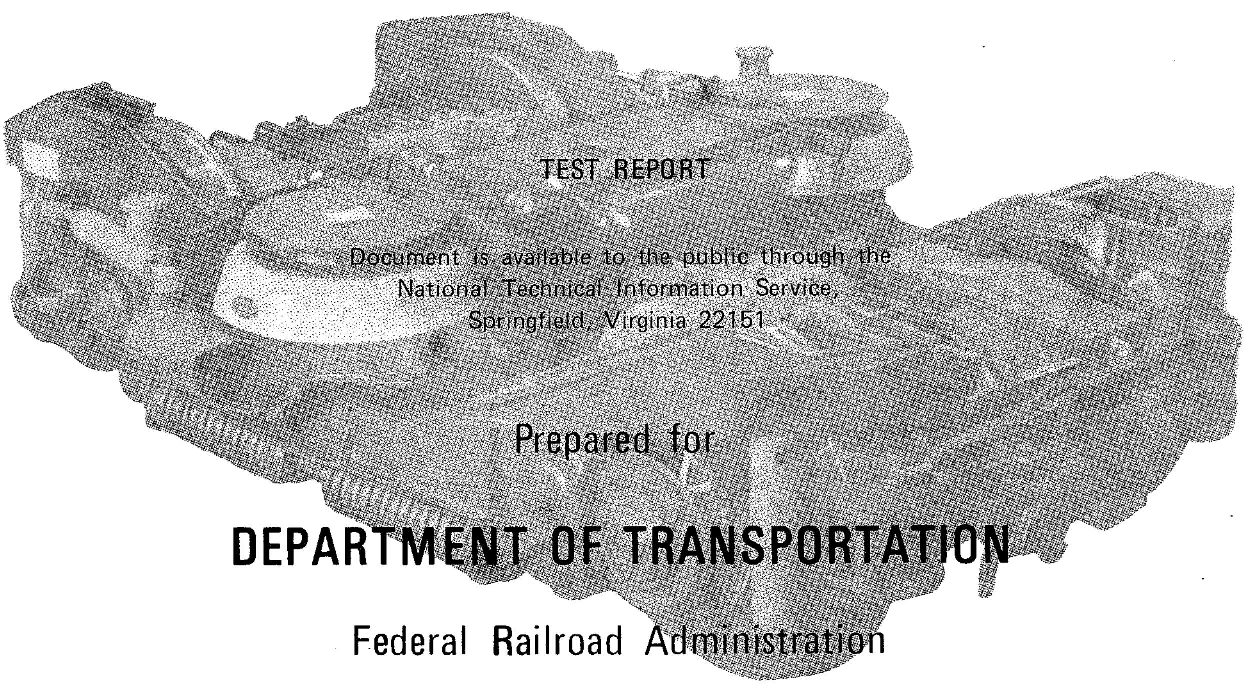
REPORT NO. FRA-OR&D 76-252

LTV/SIG METROLINER TRUCK TEST—VOLUME II

(SUSPENSION PARAMETER VARIATION TEST REPORT)

AUGUST 1975



TEST REPORT

Prepared for

DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

Office of Research & Development

Washington, D. C. 20590

03 - Rail Vehicles &
Components

NOTICE

Technical Report Documentation Page

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16. Abstract

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A test train comprised of snack bar coach 850 and the fleet car, snack bar coach 855, was operated for a distance of 3657 miles. Test operations were conducted on 18 days, and a total of 65 runs was made. Three hundred and sixty-eight tests were conducted within the 65 runs. Tests were conducted with 21 different suspension system configurations.

The final suspension system, tuned for optimum ride quality, demonstrated that Car 850 had a ride superior to Car 855. Test data also showed that Car 850 had a lower onboard noise level than Car 855.

Data obtained during the test were sufficient to generate a load spectrum for the trucks and components when operated under the current Metroliner speed profile. In addition, load-to-speed relationships were obtained for the trucks and components.

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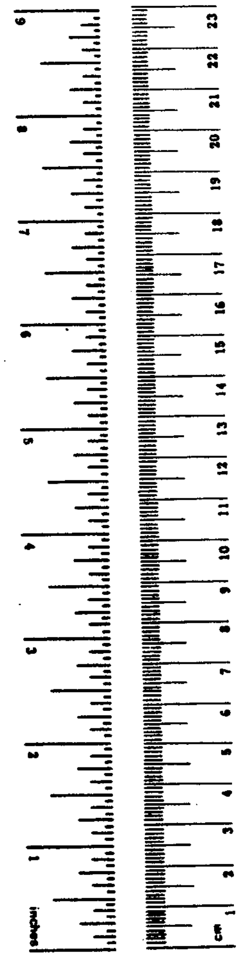
METRIC CONVERSION FACTORS

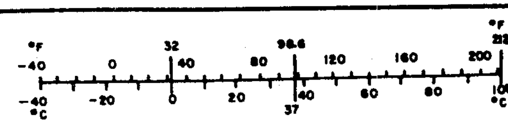
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares ($10,000\ m^2$)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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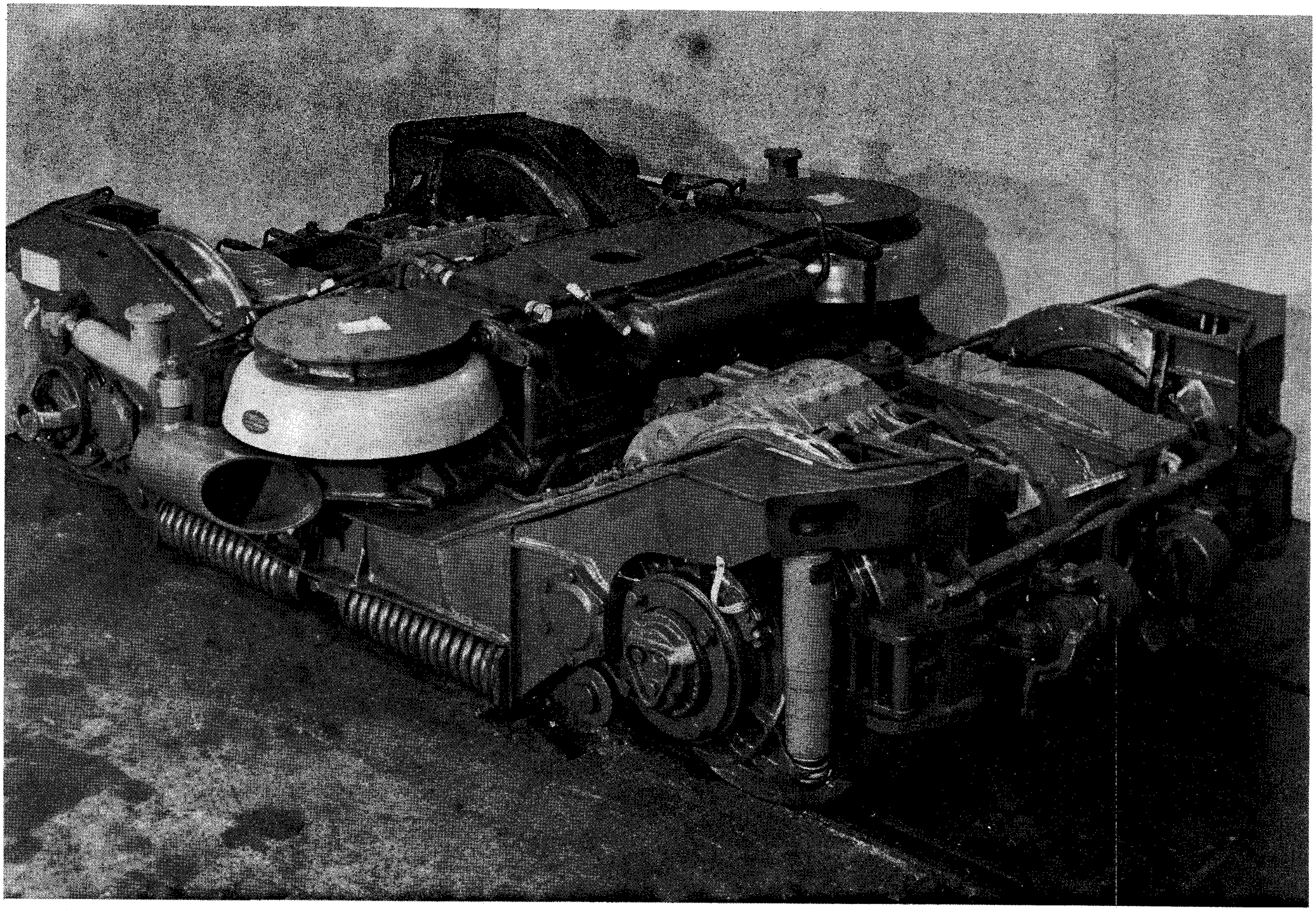


PHOTOGRAPH NO. 1 GENERAL VIEW OF LTV/SIG METROLINER TRUCK

1.0 INTRODUCTION

This report is submitted to DOT/FRA in compliance with the requirements of Contract No. DOT-FR-20049 Mod 3 dated April 18, 1975. The test program conducted was a continuation of the Phase II test program performed under the basic contract. The purpose of these Additional Running Tests was to tune the trucks for optimum ride quality and to generate load spectrum data.

The design of the truck was such that several of the parameters influencing ride quality, such as damping and spring rates, were adjustable. The basic tests were conducted during Phase II, Reference (a), with the adjustable parameters at the initial settings. This report documents running tests performed to examine the effect on ride quality and loads of the variation of these parameters.

The test program described in this report required the effort and cooperation of many different persons and organizations. Some of those who were key in accomplishing the task were:

DEPARTMENT OF TRANSPORTATION

Mr. M. C. Gannett, Chief of Passenger Equipment Division who had overall responsibility for direction of the program. Mr. J. M. Herring of the Budd Company, Mr. J. W. Marchetti of J. W. Marchetti, Inc., and Mr. R. B. Watson of Klauder and Associates who were technical consultants to DOT.

PENN CENTRAL TRANSPORTATION COMPANY

Mr. T. N. Butler - Coordinator Northeast Corridor, Mr. F. N. DeLozier - Assistant to the Coordinator, Mr. R. C. Elliott - General Foreman of the Wilmington Heavy Repair Shops and Mr. H. G. Zeithan - Special Duty Engineman.

AMTRAK

Mr. A. D. Bradford and Mr. T. E. Brunner.

2.0 SUMMARY OF RESULTS

An additional running test program of the LTV/SIG Metroliner trucks was conducted with the objective of defining suspension system characteristics. The tests were conducted on revenue tracks of the Penn Central Railroad in the Northeast corridor between Washington, D.C. and Hudson, N.J. Testing began on February 28, 1975 and ended on May 7, 1975.

A test train comprised of snack bar coach 850 and the fleet car, snack bar coach 855, was operated for a distance of 3657 miles. Test operations were conducted on 18 days, and a total of 65 runs was made. Three hundred and sixty-eight tests were conducted within the 65 runs. Tests were conducted with 21 different suspension system configurations.

The final suspension system, tuned for optimum ride quality, demonstrated that Car 850 had a ride superior to Car 855. Test data also showed that Car 850 had a lower onboard noise level than Car 855.

Data obtained during the test were sufficient to generate a load spectrum for the trucks and components when operated under the current Metroliner speed profile. In addition, load-to-speed relationships were obtained for the trucks and components.

3.0 DESCRIPTION OF TESTS

3.1 TEST REQUIREMENTS

3.1.1 Requirements for the tests described in this report are established by Modification No. 3 to Metroliner Contract DOT-FR-20049 - Additional Running Tests.

3.2 PERTINENT DATA

3.2.1 Test Site - The tests were conducted on the revenue tracks of the Penn Central Railroad between Washington, D.C. and Hudson, New Jersey.

3.2.2 Date - The tests were conducted between February 28, 1975 and May 7, 1975.

3.2.3 Witnesses

Mr. M. C. Gannett - Chief of Passenger Equipment Division, Department of Transportation/Federal Railroad Association

Mr. J. M. Herring - Consultant - The Budd Co., Inc.

Mr. J. W. Marchetti - Consultant - J. W. Marchetti, Inc.

Mr. R. B. Watson, Consultant - Klauder and Associates

3.2.4 Test Conducted by -

Mr. R. W. Burford - LTV Instrumentation Engineer

Mr. G. R. Courtney - LTV Test Engineer

Mr. F. E. Dean - LTV Dynamics Engineer

Mr. A. W. Johnston - LTV Test Engineer (Test Director)

Mr. N. H. Sandlin - LTV Loads Engineer

3.3 TEST SPECIMEN

The test specimen was a set of prototype railcar trucks which were installed under Metroliner Snack Bar Coach Number 850. The trucks were designed by Vought Systems Division of LTV Aerospace Corporation, Dallas, Texas and the Swiss Industrial Company (SIG), Neuhausen, Switzerland.

The trucks were fabricated in Switzerland in accordance with SIG drawing 205 932 and installed on Car 850 by personnel of the Penn Central Railroad under the supervision of LTV and SIG.

The specimen trucks are equipped with adjustable suspension system elements which permit the variation of dynamic characteristics of the primary and secondary suspension systems. The following dynamic characteristics are adjustable:

<u>Primary Suspension</u>

- Primary Vertical Damping

<u>Secondary Suspension</u>

- Roll Stiffness
- Lateral Stiffness
- Vertical Stiffness
- Lateral Damping
- Vertical Damping
- Yaw Damping

The isometric drawings Figures 3.3-1 and 3.3-2, pages 14 and 15, show the location of adjustable elements. The truck is also shown in the photographs nos. 2, 3, and 4, pages 91, 92, and 93.

A complete description of the truck and components is given in the Design Report, Reference (b).

Modified Car 850 was put into a test consist with snack bar coach 855, a fleet car which had just gone through an interim rework program. The interim rework of 855 included refurbishment of the suspension systems of its trucks. Such items as primary and secondary springs, shock absorbers, wheels and rubber stop elements were replaced with new or reconditioned parts. Thus, Car 855 was in a new truck condition. This should be kept in mind when comparisons of ride data are presented in Section 3.5.1. That is, Car 855 is not representative of the Metroliner revenue cars. All tests were conducted using consist 850/855. The test cars were ballasted to normal seated passenger load, 10,600 pounds.

3.4 INSTRUMENTATION AND DATA SYSTEM

The data system and instrumentation were the same as described in Reference (a).

3.5 TEST PROCEDURE AND RESULTS

3.5.1 Suspension System Variation Tests

3.5.1.1 Test Procedure

The test objective was to define suspension system characteristics over the adjustable range of the primary and secondary system elements. The approach to testing was parametric with test conditions and all suspension elements held constant except one for a given set of tests.

The tests were designed to optimize the ride quality of Car 850 through successive adjustments in the suspension system of its prototype trucks. Optimization was approached by obtaining comparative measures of ride quality both for the various suspension configurations of Car 850 and for the corresponding tests of Car 850 and Car 855. In addition, the response of the new suspension system to several specific conditions of track quality was examined.

The tests were conducted over a standard test route which permitted repeated train operation at increments of stabilized speed over the various track conditions existing between Wilmington, Delaware and Baltimore, Maryland. The track conditions of the test route are described in Table 3-1, pages 60 and 61.

A baseline run was conducted first, and a set of baseline data was obtained. Subsequently, the suspension system configuration was changed, and the test train was operated over the standard test route.

Ride quality data were recorded during all tests and compared to baseline data to evaluate the effect of adjusting various suspension system elements. In addition, subjective evaluations of the effect on ride quality were made by personnel on board the test train.

All rail operations were conducted by personnel of Penn Central and were under the control of the Northeast Corridor coordinator.

Specific test procedure was as follows: The suspension system of the trucks on Car 850 was set to a predetermined configuration. Power was applied to the onboard data system, and the data system was "warmed up" for 2 hours before departure. "In-place" calibrations were performed on all data channels before moving the train. Postrun calibrations were also performed at the end of each day of operation.

Detail test plans were prepared for each day's operation, and a copy was given to the special duty engineman who used it as a guide for test operation. Figure 3.5-1, pages 16 and 17, is the plan used on April 18, 1975 for runs 38 and 39 and is a typical run plan.

All southbound movement of the test train was assigned even run numbers while northbound moves were given odd numbers. Tests were numbered consecutively within a given run.

For a given test the train was balanced at a preselected speed and data recorders turned on and off as directed by the test director. Tests were begun and ended at preselected mileposts.

Test conditions were duplicated as closely as possible with each suspension system configuration. Table 3-2, pages 62 through 75, gives details of all tests as run. The table includes test numbers, test locations, and suspension system configuration number as well as comments. Suspension system configurations are described in Table 3-3, pages 76, 77, and 78. Table 3-4, page 79, presents suspension component variations in engineering units.

Instrumentation for the measurement of comparative ride quality consisted of tape recorded accelerations and noise levels. Reference (a) includes a detail description of instrumentation.

For each of the two test cars, the following carbody accelerations were measured and recorded on magnetic tape:

- "A" end lateral
- "A" end vertical
- Carbody center vertical
- Carbody center lateral (discontinued early in the program)

Noise level measurements were taken with two microphones placed at corresponding locations in the two cars.

In addition, oscillographic recordings of forces and displacements were made. The complete set of data recorded on oscillograph is listed under Oscillograph No. 1, Table 3-5, page 86.

The tape recorded acceleration data were air shipped to Dallas at the end of each day of testing where the LTV Acoustics Lab performed data reduction. Spectral analyses were provided in two forms:

- a narrowband spectrum of RMS acceleration occurring in each 0.2 Hz bandwidth from 0 to 25 Hz

- a compilation of the narrowband spectrum into a spectrum of 5 Hz bandwidths

Corresponding cases of acceleration spectra for the two cars were then overlaid. Examples of the data are displayed in this report.

The data recorded on oscillograph were reduced manually. A detail discussion of resulting test data follows in paragraph 3.5.1.2.

3.5.1.2 Results

3.5.1.2.1 Stroking Performance of Suspension Elements

Figure 3.5-2, page 18, displays an example of the worst case situation with respect to suspension element strokes. This was the "rock and roll" test number 1, conducted as the train left the Wilmington yards on the "O" track. The case shown is taken from run 36, the first run with the new bellcrank pivot bearings.

Run 36 provides a worst case for primary vertical stroke, a double amplitude of 2.2 inches and a clear case of stop bottoming in extension and compression. At this speed the track excites the "lower roll" resonance of the vehicle at 0.6 Hz. The secondary lateral strokes, D-8 and D-9 (for A and B trucks), show a large amplitude in-phase oscillation while the left and right combinations of vertical strokes, primary and secondary, are out-of-phase.

The worst case secondary lateral stroke was found in the "rock and roll" test of run 18, with a double amplitude of 3.2 inches out of a possible 4 inches. The remaining suspension element stroke involving transition stops is the secondary vertical. With the exception of the failure mode tests, no secondary vertical stop contact occurred.

Figure 3.5-3, page 19, shows a segment of run 36, test 3, conducted at 40 mph on bolted rail. A dominant frequency of 1.6 Hz is caused by the 39-foot rail length with staggered construction. The secondary lateral traces, D-8 and D-9, show by their out-of-phase relationship that the car is oscillating in a yaw mode.

Figure 3.5-4, page 20, shows a segment of test 4, run 36, conducted at 20 mph on very poor quality bolted rail. Traces D-8 and D-9 show that the car is oscillating laterally with much greater amplitude at the leading A-end than at the trailing B-end. Two effects were identified as a result of early runs of this test. Both the direction of travel, whether leading or trailing, and the presence or lack of coupling between cars significantly affects the low speed roll performance.

3.5.1.2.2 Sound Level Measurements

The single most striking difference in ride quality of the two cars was found in the comparative sound levels. Measured data are summarized as a function of speed in Figure 3.5-7(a), page 23. Data were taken at corresponding locations in the two cars and at stabilized speeds. Because of frequent interruptions, such as the opening of doors and loud conversations, each sample necessarily represents only a few minutes of data.

Figure 3.5-7(b) summarizes the octave band spectral content of sound pressure level in the two cars. It can be seen that in the range below 250 Hz, where noise is primarily transmitted through the structure, a significant reduction is achieved by the LTV/SIG trucks.

3.5.1.2.3 Carbody Accelerations

Typical acceleration spectra, comparing corresponding cases for Car 850 and Car 855, are shown in Figure 3.5-8, page 24.

The single-most significant acceleration parameter was found in the root-mean-square (RMS) acceleration of the 0-5 Hz bandwidth. This region included all of the "rigid-body" vibration frequencies of both carbodies. Summaries of this parameter for a selected number of tests from each run are presented in Figures 3.5-9 through 3.5-12, pages 25 through 28. The suspension configuration for each run is defined in Table 3-3 and 3-4, pages 76 and 79.

Lateral and vertical accelerations are presented for both southbound and northbound tests with runs assembled into "consist-leading" and "consist-trailing" tests for Car 850. For Car 855, the average of corresponding consist-leading or consist-trailing tests is presented in each case. This provides a constant target for the results of Car 850, showing the trend as suspension parameters are varied.

One continuing difficulty during the course of the program was the correlation of the acceleration data with the subjective responses of those riding the train. In an effort to improve this relationship, the acceleration spectra for certain runs were multiplied by weighting functions for equivalent human sensitivity, derived from References (c) and (d). The weighting functions are shown in Figure 3.5-13.

Weighting significantly affected only the vertical response from certain tests, while exerting relatively little influence on the lateral response. As seen in Figure 3.5-13, lateral accelerations are not attenuated in the frequency range from 0.6 to 2 Hz where all of the "rigid carbody" frequencies lie. Vertical response is heavily attenuated in this range, but attenuated very little in the range from 2.5 to 10 Hz. Within this range lie the carbody bending frequency and the frequency of track forcing for speeds above 70 mph. The most significant effect was found for southbound test 6 at 70 mph and is shown in Figure 3.5-14, page 30. The two runs involved, numbers 36 and 44, were made with the "improved baseline" configuration.

The relative dominance of the track forcing and carbody bending frequencies after weighting of the vertical acceleration tend to verify a conclusion commonly reached among the test crew: heavy vertical damping produced objectionable harshness. Heavy damping increases the response at frequencies above the "rigid carbody" natural frequencies.

In summary, Figures 3.5-9 and 3.5-10 demonstrate a clear and consistent improvement in vertical axis accelerations for Car 850 as compared to Car 855. The lateral results of Figures 3.5-10 and 3.5-11 are not as consistent, although a positive trend can definitely be seen in the results of the last series of runs, numbers 66-69.

3.5.1.2.4 Final Suspension Configuration

Tables 3-3 and 3-4 define the final suspension configuration. The following discussion explains the choice of the most important parameters.

(1) Roll bar stiffness was changed from "standard" to "intermediate" stiffness as a result of tests conducted on the yard track. Conducted at a top speed of 13 mph, these tests were called "rock and roll" tests because of the violent oscillations they could induce at 12 mph in either car. All riders uniformly agreed that the stiffer roll bar provided a significant improvement although acceleration data actually showed no improvement. This phenomena could only be attributed to a greater sense of positive control provided by the stiffer roll bars.

(2) Midway in the test program, the main bellcrank pivot bearing was changed from a bushing type bearing to a roller bearing. The change was designed to improve wheel-load equalization by elimination of the friction of the bushing bearing. The effect of this change on ride quality was minimal, except that more hydraulic damping was required to replace the frictional damping in the control of carbody roll.

(3) Final primary vertical damping was set at 150% (504 lb-sec/in) of its baseline value. This provided very good control of carbody roll while not increasing the harshness of higher frequency vibrations.

(4) Final value of secondary lateral damping was 150% (445 lb-sec/in) of its baseline value. This provided the best compromise in the smoothing of transients while avoiding harshness at higher frequencies.

(5) Final secondary vertical damping of 207 lb-sec/in was obtained by using a 20 mm (large diameter, minimum damping) orifice with no hydraulic augmentation. This provided the smoothest vertical ride while preventing any contact of secondary suspension stops.

(6) Final auxiliary airspring volume was that provided by the largest air tank (85 liters per airspring). A definite reduction in vertical vibration level could be seen between this tank and the intermediate tank which provided 74 liters of auxiliary volume.

(7) Yaw damping contributed not merely to stability but also to control of carbody lateral/yaw oscillation.

(8) Lateral ride was measurably improved by removal of the shims behind one of the contoured secondary lateral rubber springs per side. This verifies the importance of the tradeoff between available suspension stroke and the smoothness of ride.

3.5.2 Load Measurement Tests

3.5.2.1 Test Procedure

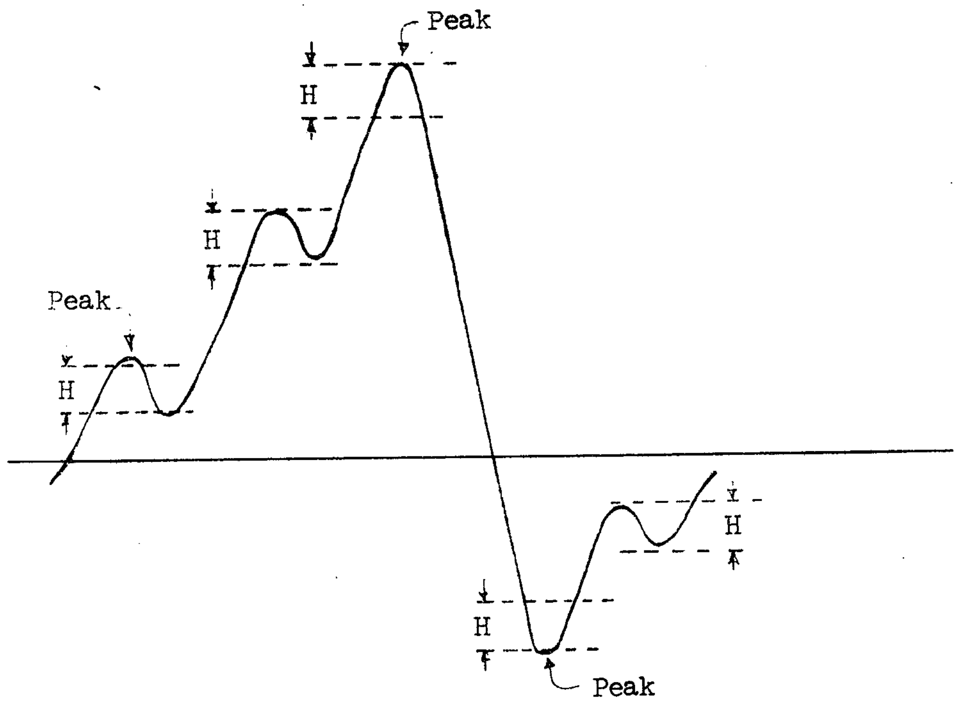
Loads data were recorded during all of the tests described in paragraph 3.5-1. Recording was on direct print oscillograph for "quick look" evaluation of selected channels to assure that safe operating loads were not exceeded. In addition, specific runs were made to establish a load spectrum. Some load spectrum runs were made during Phase II tests, Reference (a), but are reported here along with runs conducted during the Additional Running Tests. A description of load spectrum runs follows:

Three load spectrum runs were made during Phase II. Those runs were conducted between Baltimore, Maryland and Landover, Maryland; Landover, Maryland and Baltimore, Maryland; Baltimore, Maryland and Wilmington, Delaware. During these runs, loads data were recorded continuously on magnetic tape and oscillograph while the test train was operated under normal Metroliner speed profile. The test runs are summarized in Table 3-8, pages 86 and 87. The data recording setup was as shown in Table 3-5, page 83. The loads data are described in Reference (a).

During the additional tests, load spectrum runs were made on April 24 and 25, 1975. On April 24, 1975 the test train was operated from Wilmington, Delaware to Washington, D.C. On April 25 the test route was Washington, D.C. to Hudson, N.J. to Wilmington, Delaware. The data were again recorded continuously as the train was operated under a Metroliner speed profile. The detail run plan is presented in Table 3-9, pages 88 and 89. The data setup is presented in Table 3-6, page 84.

On May 2, 1975 the test train was operated between Wilmington, Delaware and Northeast, Maryland for three round trips with one round trip between Wilmington, Delaware and Perryville, Maryland. These runs traversed track 3 between MP37 - 39 - 37 (through Davis Interlocking) at balance speeds in increments of 50, 70, 90 and 105 miles per hour. The test runs are summarized in Table 3-10, page 90, while the data recording setup was as shown in Table 3-7, page 85.

The loads data recorded on magnetic tape during Metroliner speed profile operation were reduced in the Acoustics Laboratory as follows: Each data channel was filtered (100 Hz bandwidth), digitized (500 samples/sec) and input to a Hewlett Packard model 5451 Fourier Analyzer System for peak count operations. The criterion for determining when a peak load is counted is: if a relative maximum has a preceding rise and a following fall greater than a present value, H, then that maximum is counted as a peak. This is illustrated by the following sketch:



This moving threshold (or hysteresis, H) constant is in engineering units and is calculated for each load variable such that oscillations of double amplitude less than H produce no damage for infinite cycles. This technique throws out the many cycles of insignificant loads as well as instrumentation noise.

The peak counts for each variable are lumped into discrete load intervals such that a histogram with the familiar "bell-shaped" frequency of occurrence distribution can be constructed. Each positive and negative tail of this distribution is then accumulated from the extreme toward the mean (or static) load. This accumulation is then normalized on a per one hundred mile distance by multiplying 100 and the inverse of the test mileage traveled. The results of this procedure are illustrated by Figure 3.5-15, page 31, a curve which indicates the number of load peaks expected to occur greater than a given load level for each one hundred miles traveled. This accentuates the extremes and allows statistical extrapolation to less frequent occurrences.

In addition to data reductions for operation under Metroliner speed profile, the data from the May 2, 1975 (speed variation) runs were reduced and analyzed to obtain load-to-speed relationships. The load-to-speed data provide insight to the changing load environment by determining the sensitivity of each truck and component to varying speed.

3.5.2.2 Results

The data obtained during runs where Metroliner revenue speed profile was maintained were used to prepare the load spectra graphs Figures 3.5-15 through 3.5-27, pages 31 through 43. These curves present the load spectrum for each measured truck and component load. See Reference (a), Sections 5.1.6.2 and 5.2.2.2.4 for a description of the code numbers used in the above listed graphs. Furnished with each spectrum is the threshold value (H) used in determining peaks and the static (balance condition) load about which the peak loads act. Also stated is the number of miles the spectrum is based on. The "few occurrence" extreme of each solid line curve ends at the maximum load value actually measured during the running test sample. The dashed line portion is extended out to a frequency of occurrence corresponding to one peak per five hundred miles traveled. This can be realistically considered the maximum value expected to occur since there is approximately five hundred miles of Metroliner track for revenue operations.

The data obtained during the May 2, 1975 (speed variation runs) are presented graphically in Figures 3.5-28 through 3.5-43, pages 44 through 62. These curves show the sensitivity of each truck or component maximum load-to-speed variations.

The curves are also identified according to whether the test truck was the leading or trailing truck in a two car consist.

The loads data presented in this report provide the structural analyst with an indication of maximum loads as well as the complete spectrum of lower loads. Data also show the effect of train speed on loads and permit life prediction for the trucks and components.

If the Metroliner Operator (Penn Central) should decide to run the trains at consistently higher or lower speeds than now used, the loads data presented in this report provide the structural analyst a means to expand or contract the measured load environment for life prediction or redesign purposes.

4.0 CONCLUSIONS

The suspension system characteristics were defined within the adjustable range of the suspension system elements. The final suspension system configuration provided:

- o Good control of carbody roll
- o A smooth vertical ride without any contact or secondary stops
- o A definite reduction in vertical vibration level
- o Yaw stability and control of carbody lateral/yaw oscillation
- o A quieter and smoother ride in Car 850 than in Car 855

Although loads measurements were made, no conclusions are presented here. Refer to the Final Design Report, Reference (b), Section 11.6 for analysis of the loads data. The design report includes data comparing measured loads in the truck frame, bellcranks and rollbars to the loads used for truck design and fatigue tests.

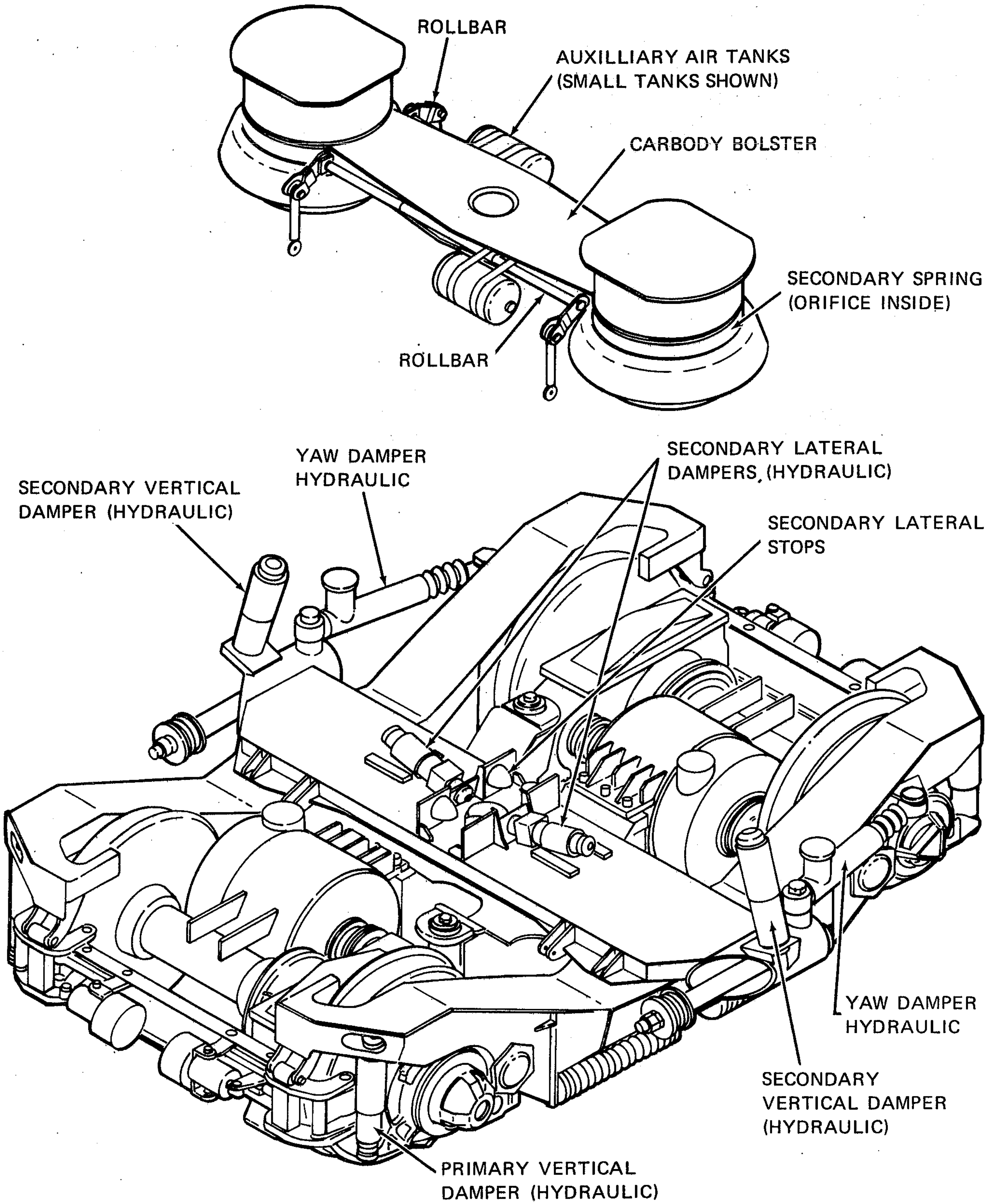


FIGURE 3.3-1

SPECIMEN TRUCK - LOCATION
OF ADJUSTABLE COMPONENTS

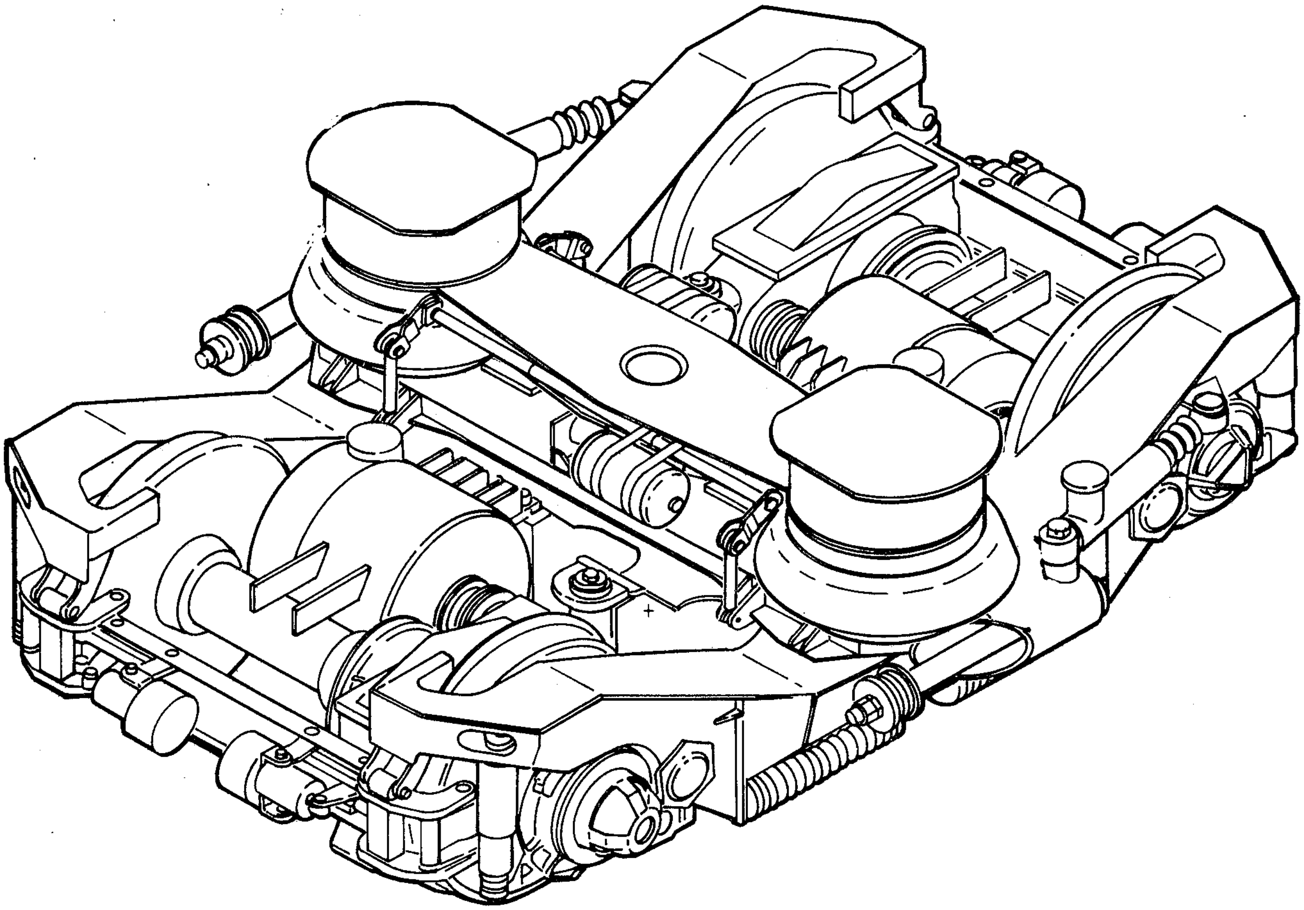


FIGURE 3.3-2

SPECIMEN TRUCK - GENERAL ARRANGEMENT

FIGURE 3.5-1 (Sht 1 of 2)

TYPICAL RUN PLAN

- PARAMETER VARIATIONS TESTS

DATE: 18 April 1975

VARIATION: Improved Configuration plus inc. vertical damping by one full turn, plus four hydraulic dampers in the secondary spring system.

ROUTE: Wilmington - Baltimore

CONSIST: [855]-[850] → Southbound

RUN NO. 38

1. Leave Wilmington Yards - Conduct Rock and Roll Test on the "O" track while approaching Landlith. Balance at 4, 8 and 12 mph. (Test #1)

2. Run track speed to RAGAN.

3. Run Track #4, RAGAN to DAVIS, track speed at all times except:

   Stop between MP29 and MP30. Accelerate to 70 mph and balance. Record data between MP31 and MP33. (Test #2)

   40 mph balance, MP34-36 (Test #3)

4. Run track #3, DAVIS to PRINCIPIO, at track speed at all times EXCEPT:

   50 mph Balance, MP44-47 (Test #3a)

5. Run track #4, PRINCIPIO to PERRYVILLE

   20 mph Balance, MP57-59. Record data between MP58 and MP59. (Test #4)

6. Run track #4, HAVRE DE GRACE to BUSH, track speed at all times EXCEPT:

   90 mph Balance, MP62-66 (Test #5)

7. Run track #3, BUSH to GUNPOW, as follows:

   Track speed at all times EXCEPT:

   105 mph Balance, MP77-78 (Test #6)

8. Run track #4, GUNPOW to BALTIMORE, as follows:

   Track speed at all times EXCEPT:

   105 mph Balance, MP83-85 (Test #7)

COMMENTS:

FIGURE 3.5-1 (Sht 2 of 2)

TYPICAL RUN PLAN

- PARAMETER VARIATIONS TESTS

DATE: 18 April 1975

ROUTE: Baltimore - Wilmington

CONSIST: [850]—[855]→ Northbound

RUN NO: 39

VARIATION: Improved configuration plus inc. vertical damping by one full turn, plus four hydraulic dampers in the secondary spring system.

1. Run track #2, Baltimore to "Oak" at track speed EXCEPT:

   40 mph Balance, MP88-87 (Test #1)

   40 mph Balance, MP85-84 (Test #2)

   70 mph Balance, MP78-76 (Test #3)

   Stop at MP69, accelerate to 105 (Test #3a)

2. Run track #1 Oak to Havre de Grace at track speed EXCEPT:

   70 mph Balance, MP62-66 (Test #4)

3. Run track #2, "Havre de Grace" to Wilmington, at track speed EXCEPT:

   90 mph Balance, MP55-52 (Test #5)

   105 mph Balance, MP48-46 (Test #6)

   105 mph Balance, MP37-35 (Test #7)

   80 mph Balance, MP30-29 (Test #8)

COMMENTS:

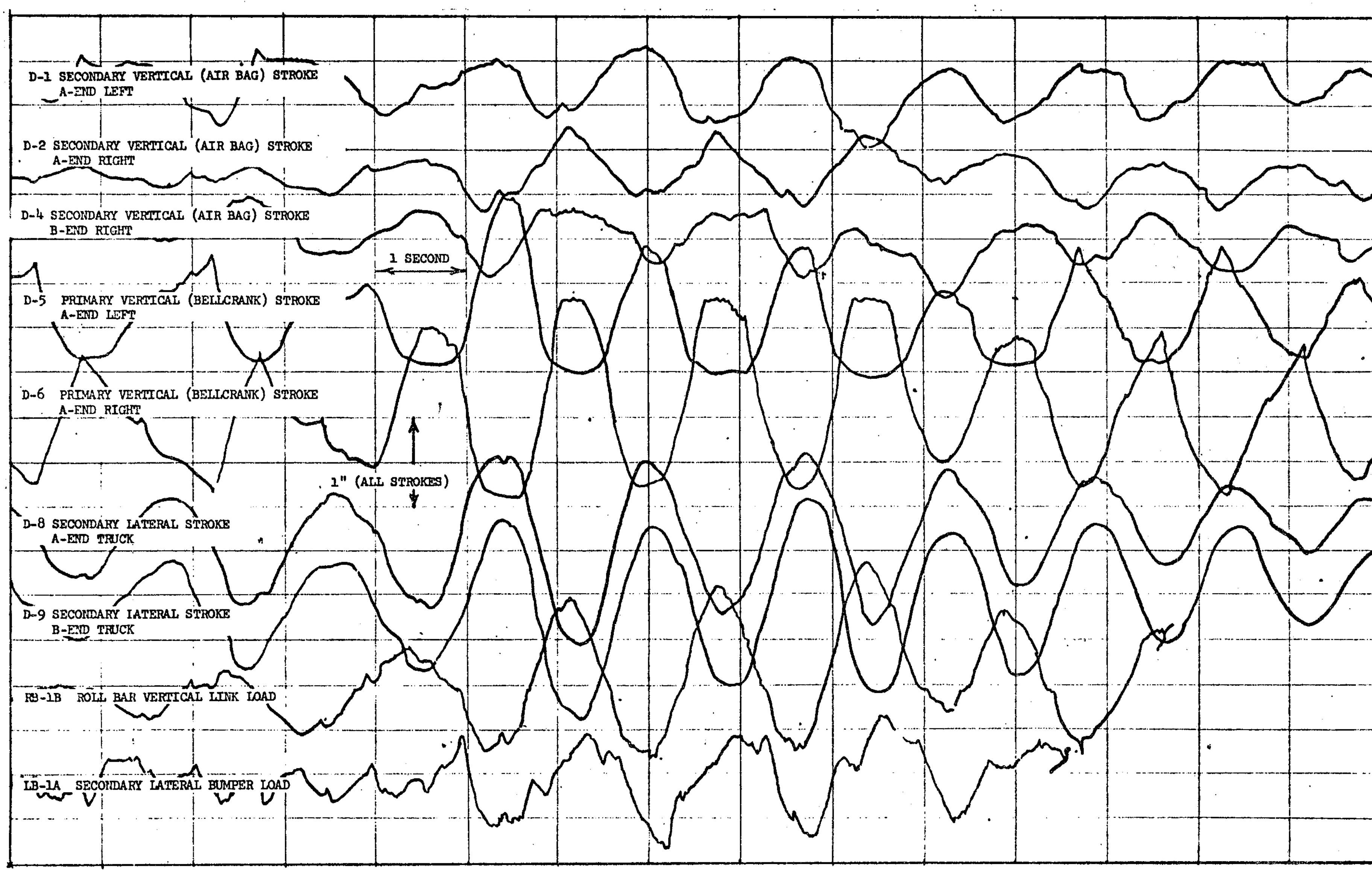


Figure 3.5-2 Suspension Element Strokes and Loads, Run 36, Test 1, 12 MPH - "Rock and Roll" Test

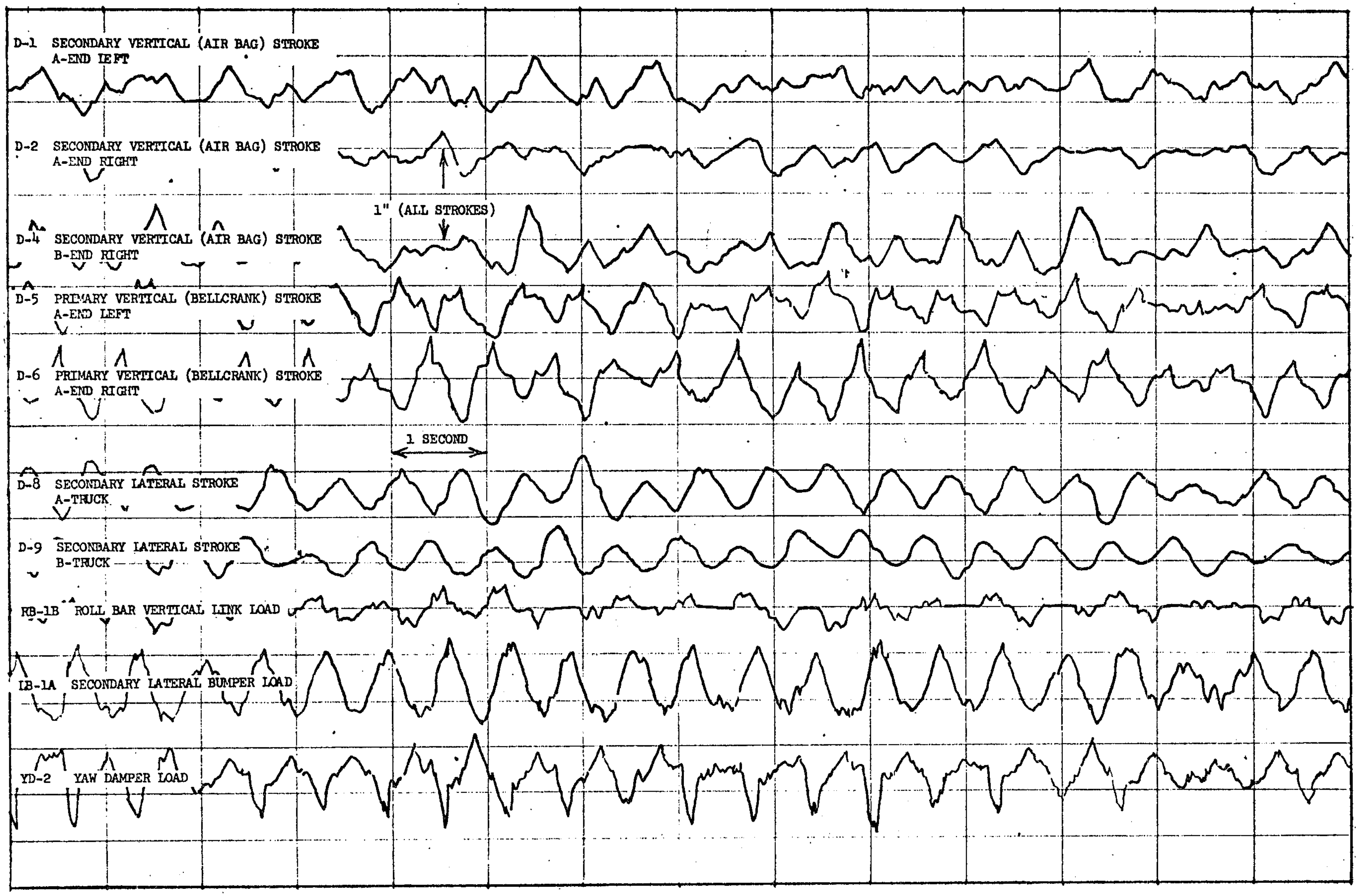


Figure 3.5-3 Suspension Element Strokes and Loads, Run 36, Test 3, 40 MPH

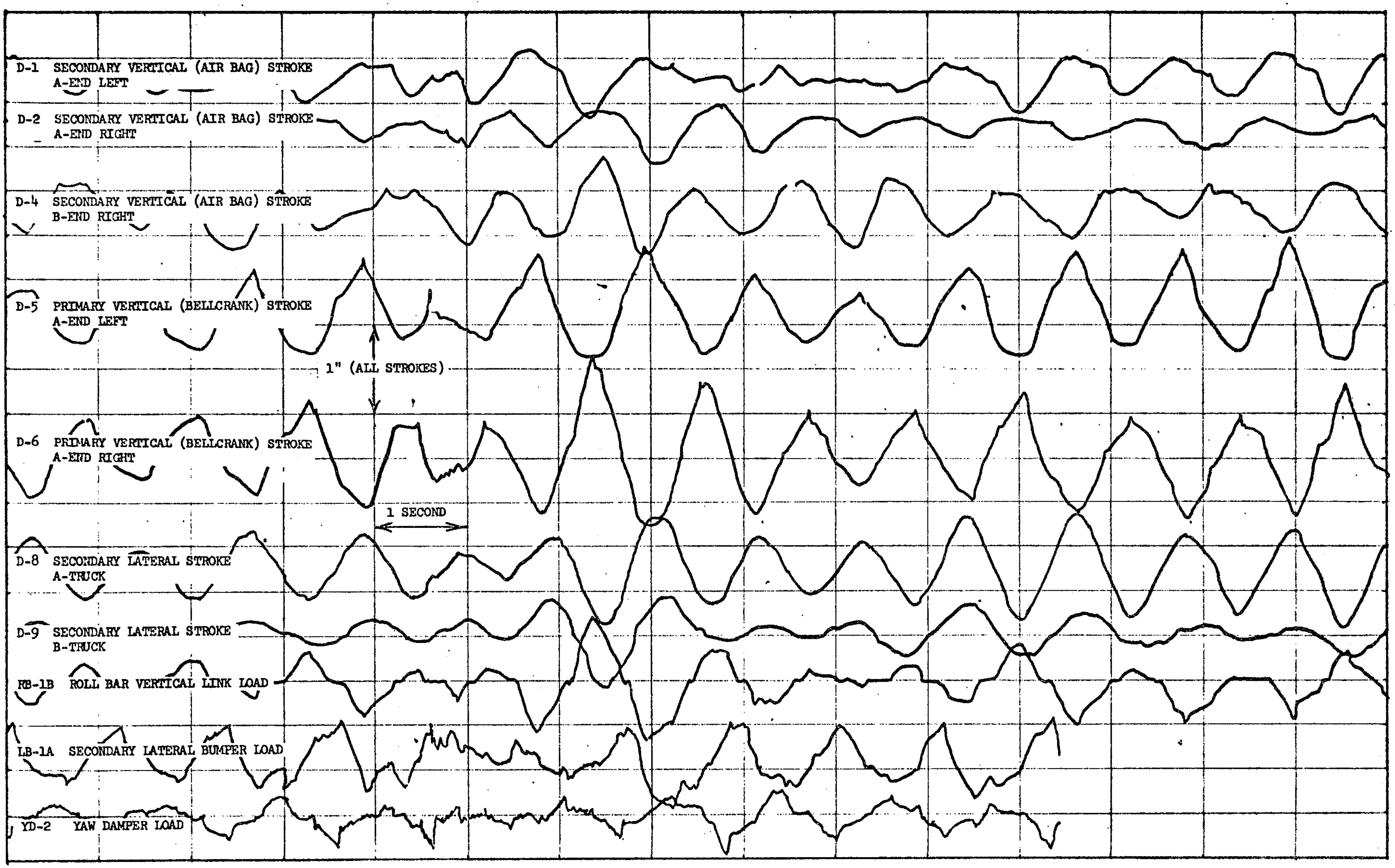
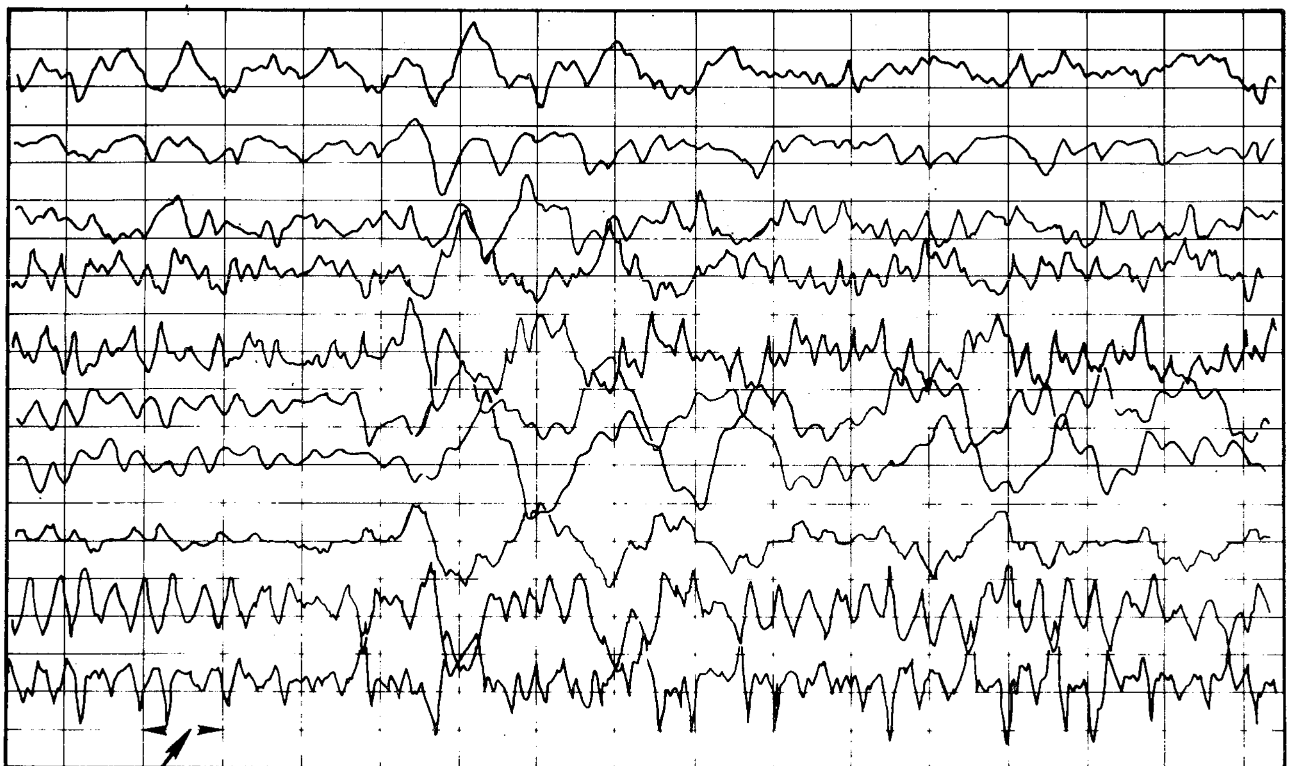


Figure 3.5-4 Suspension Element Strokes and Loads, Run 36, Test 4, 20 MPH



Run 36, Test 2 - 70 MPH - Poor Quality Track

Run 36, Test 5 - 90 MPH - Good Quality Track

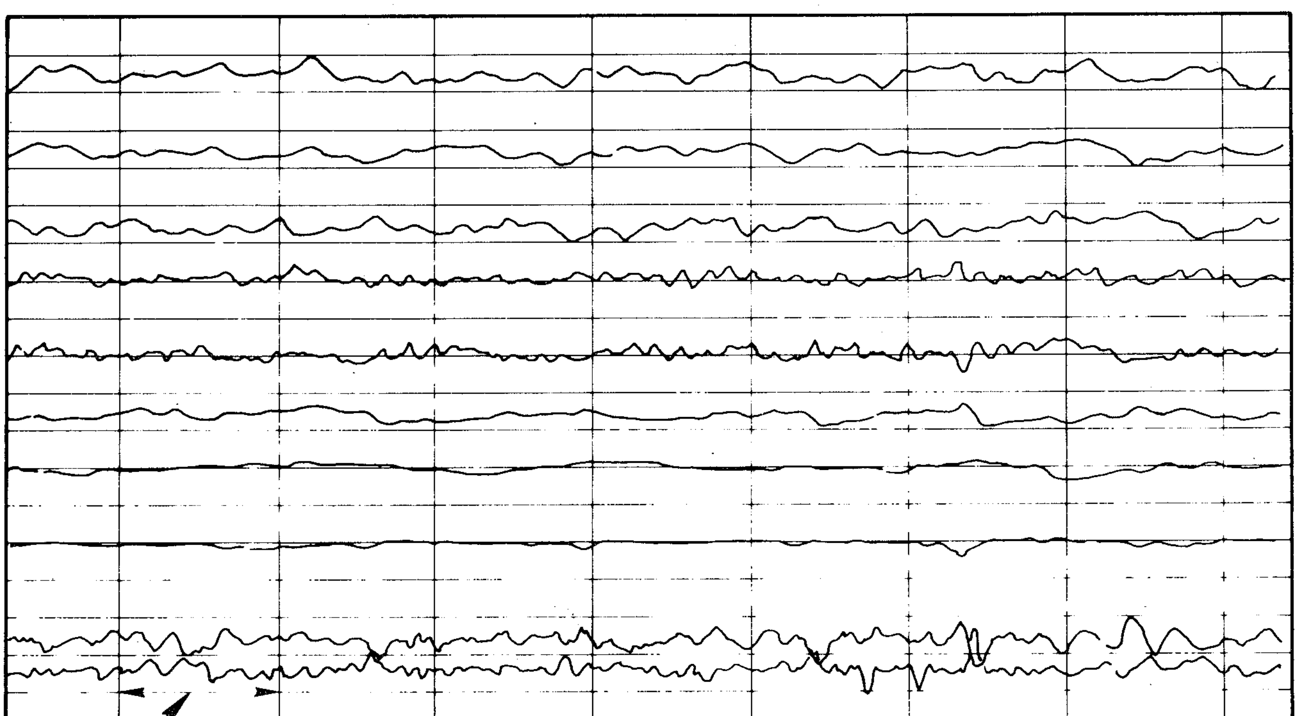


Figure 3.5-5 Effect of Track Quality on Suspension Performance

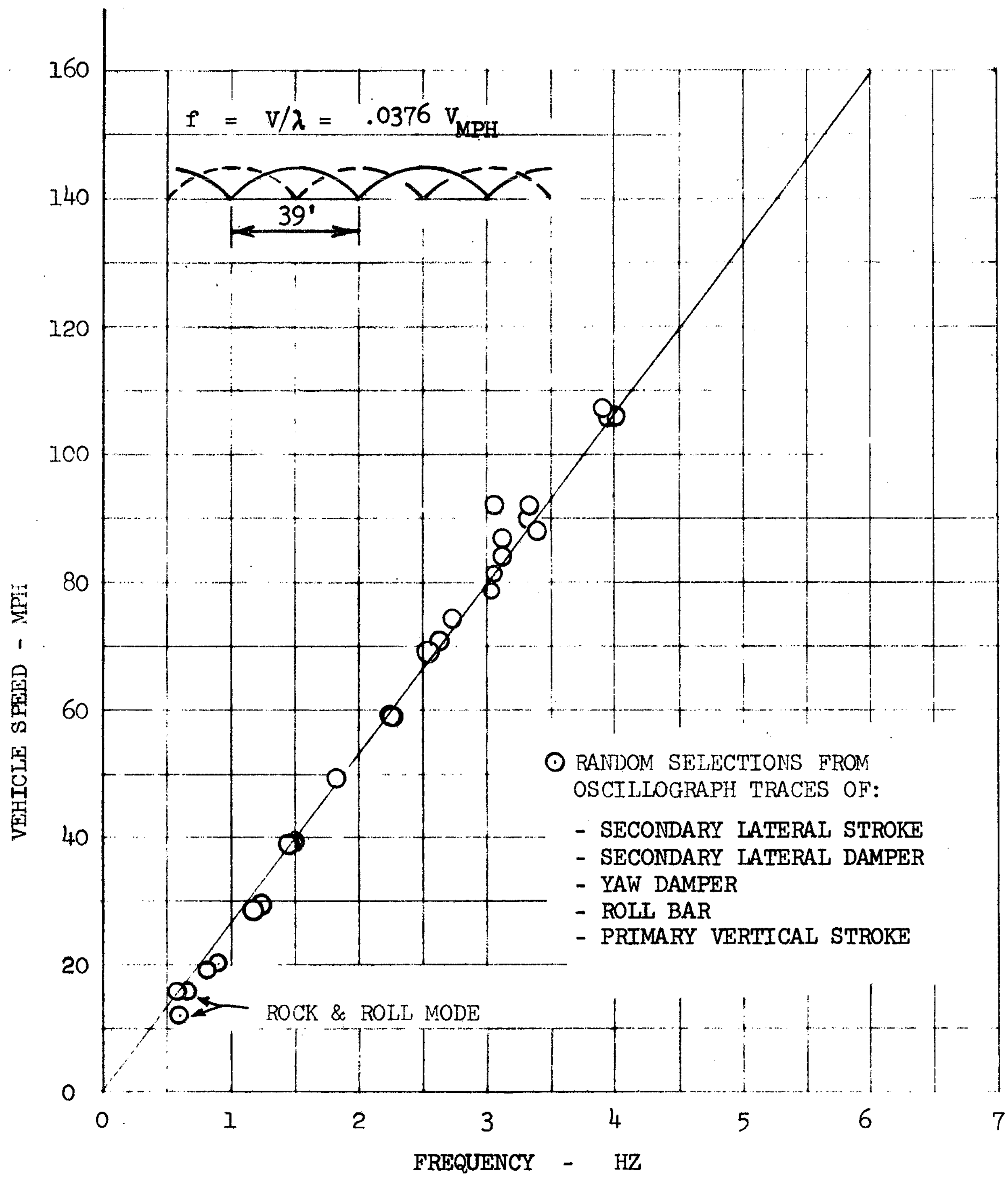


Figure 3.5-6 Comparison of Dominant Oscillation Frequencies with the Driving Frequency of Staggered, Bolted Rail

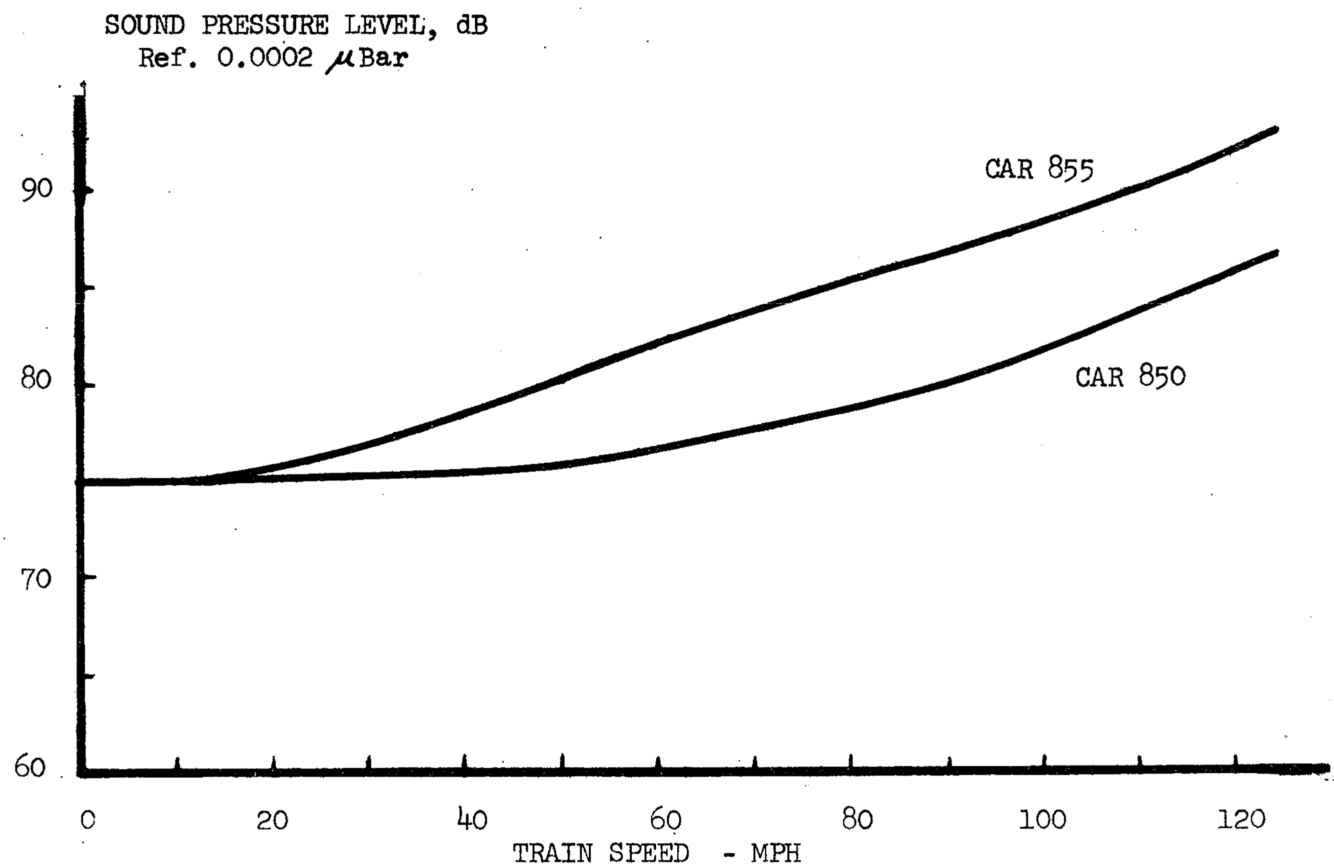


Figure 3.5-7(a) Comparative Overall Noise Levels vs. Speed

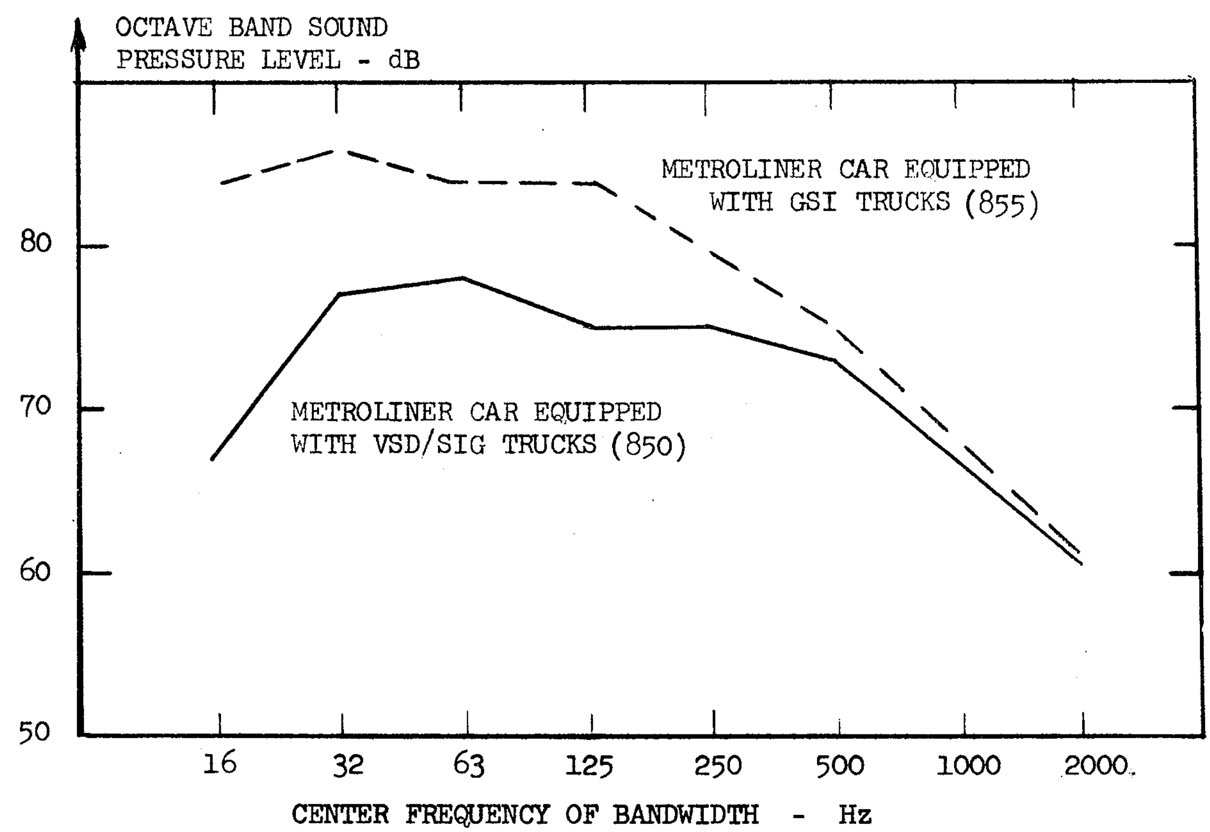


Figure 3.5-7(b) Comparative Noise Levels In Octave Bandwidths

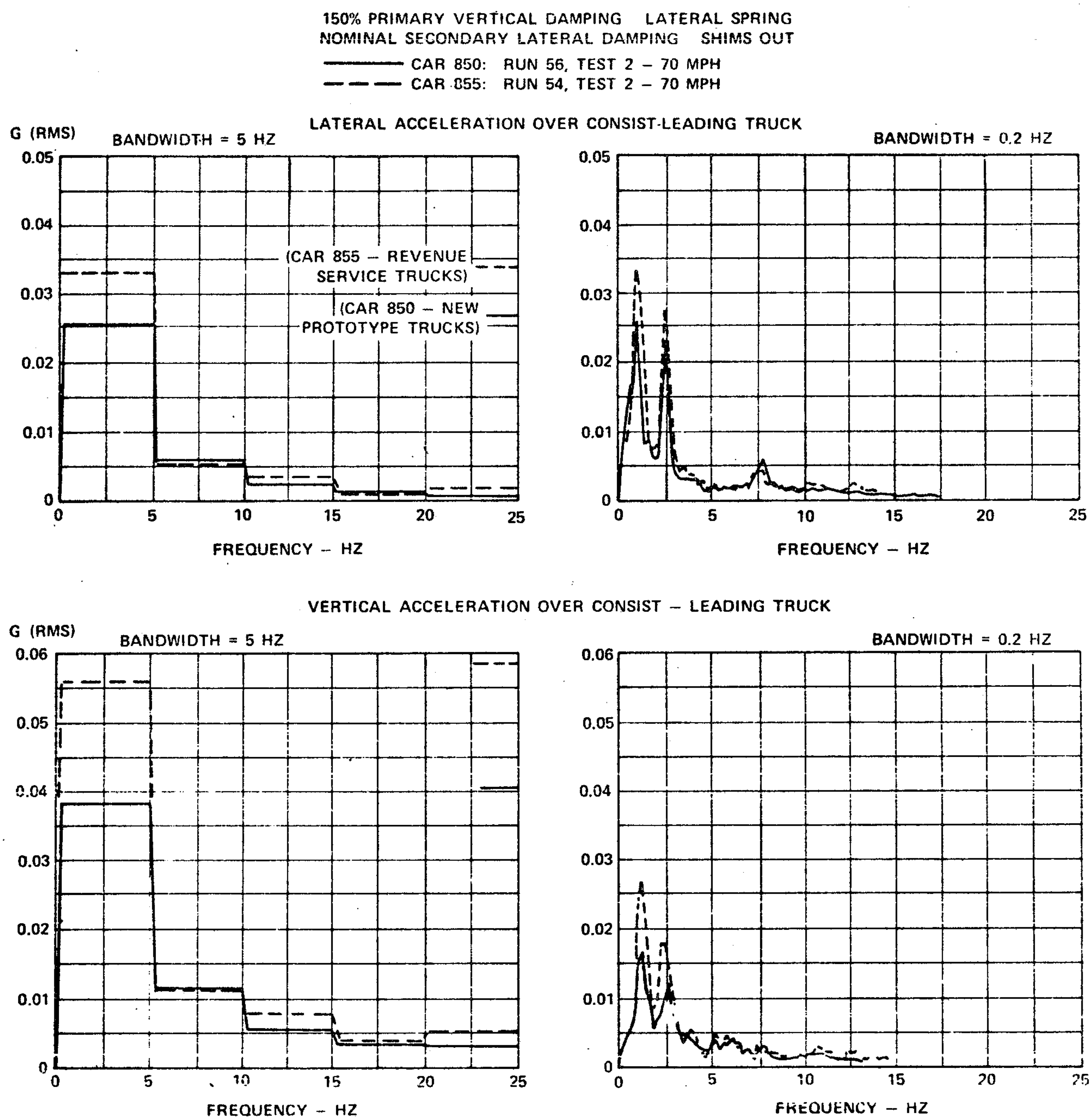


Figure 3.5-8 Comparative Acceleration Spectra for the Two Running Test Cars

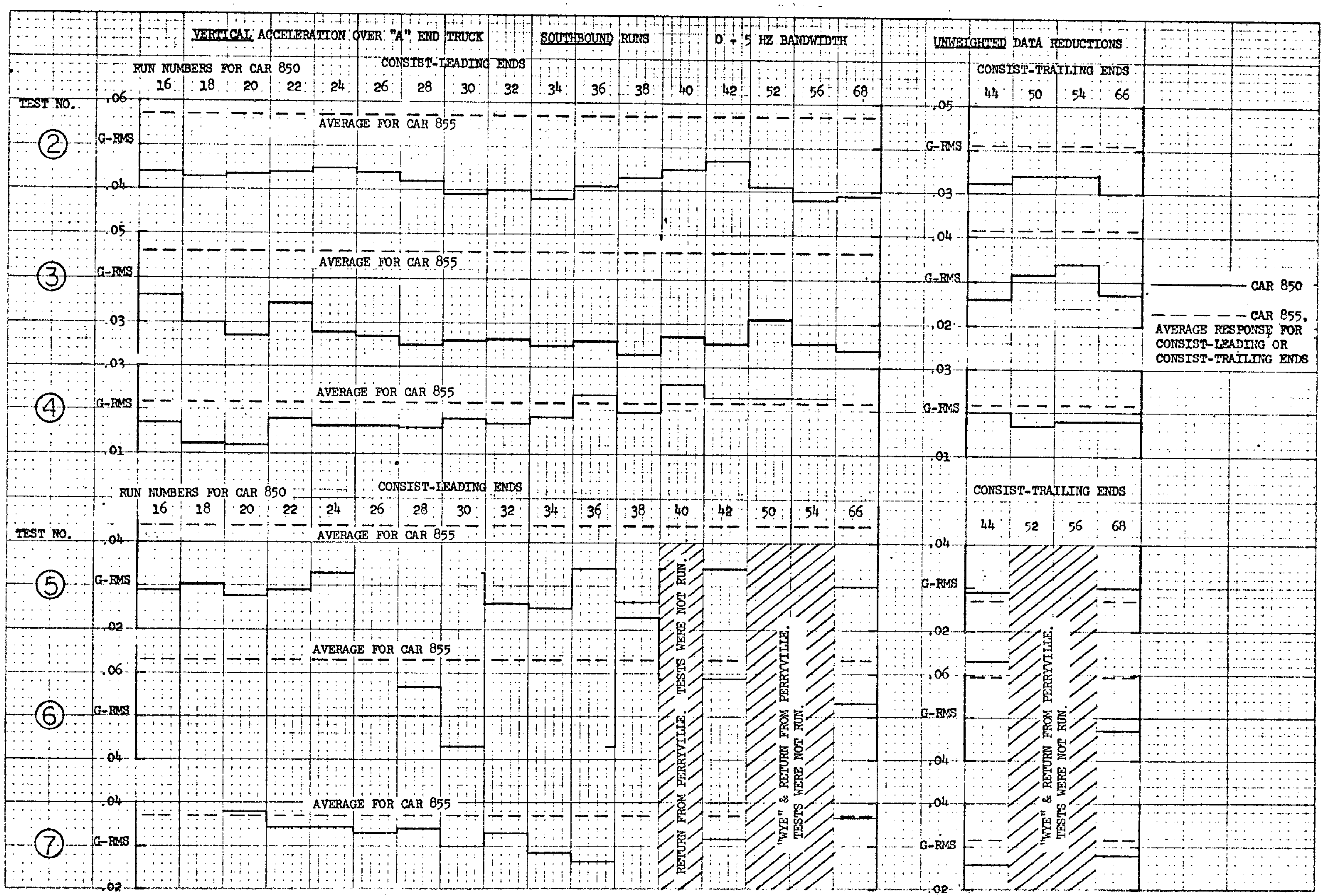


Figure 3.5-9 Vertical RMS Acceleration over "A" End Truck, Southbound Runs

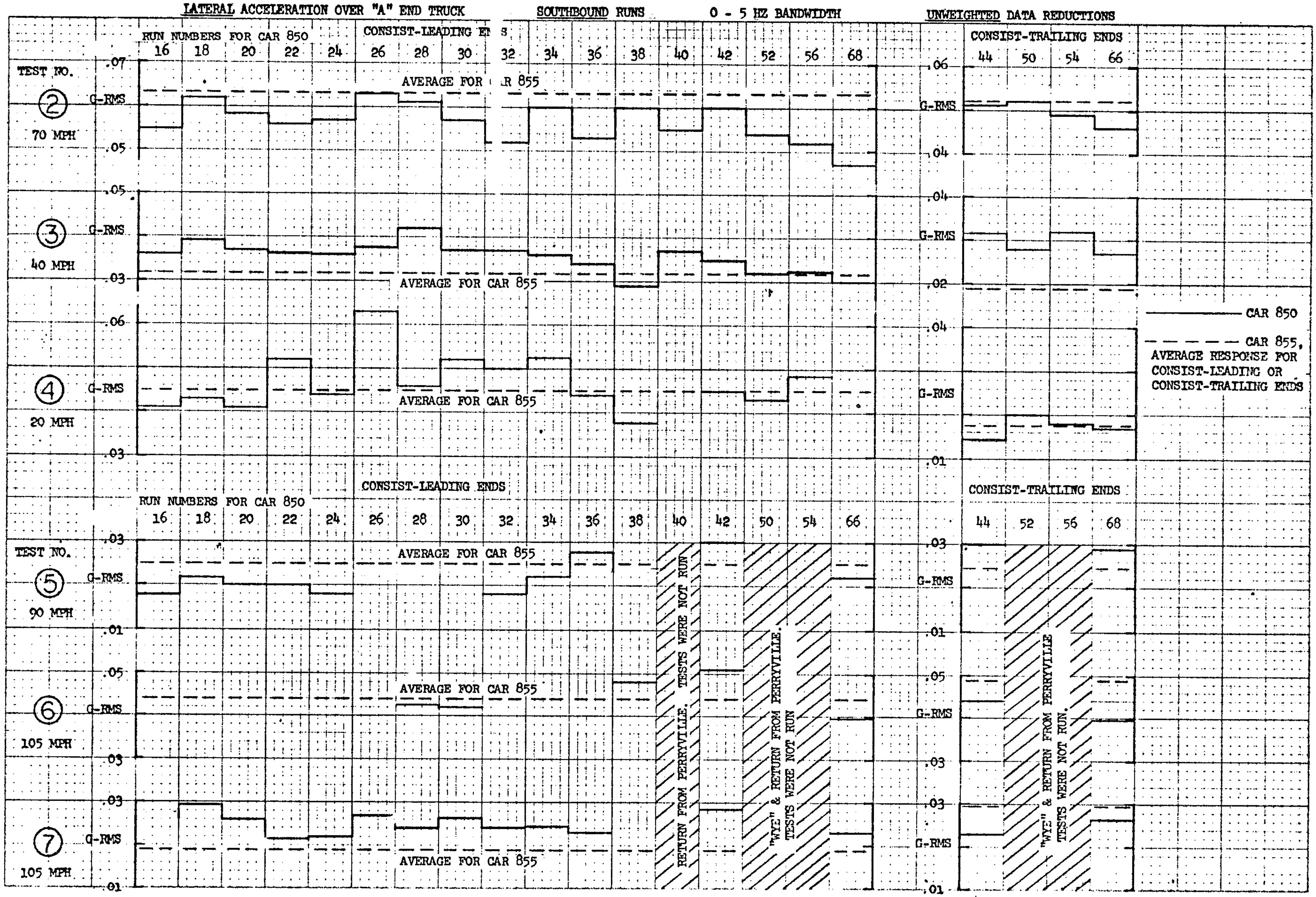


Figure 3.5-10 Lateral RMS Acceleration over "A" End Truck, Southbound Runs

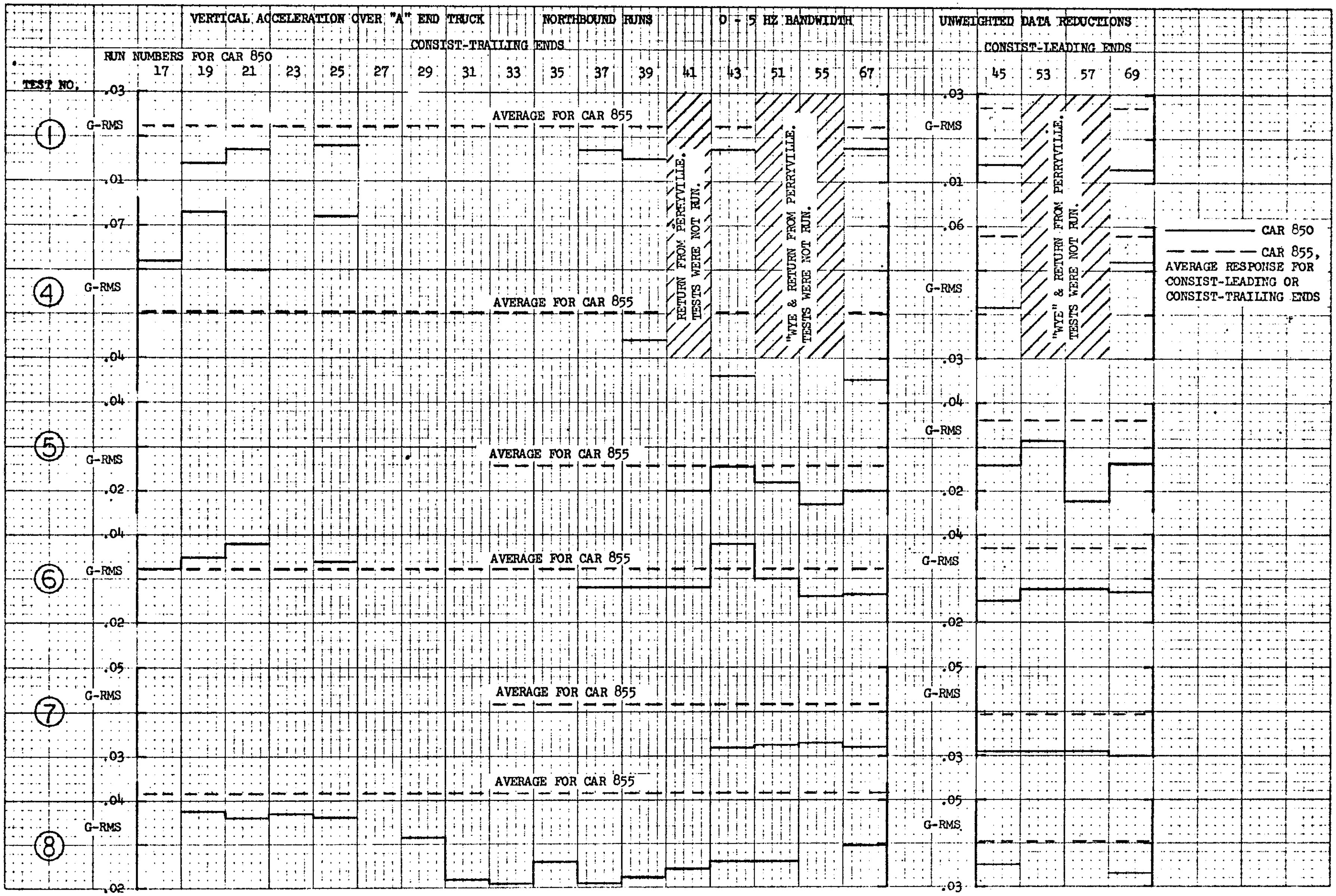


Figure 3.5-11 Vertical RMS Acceleration over "A" End Truck, Northbound Runs

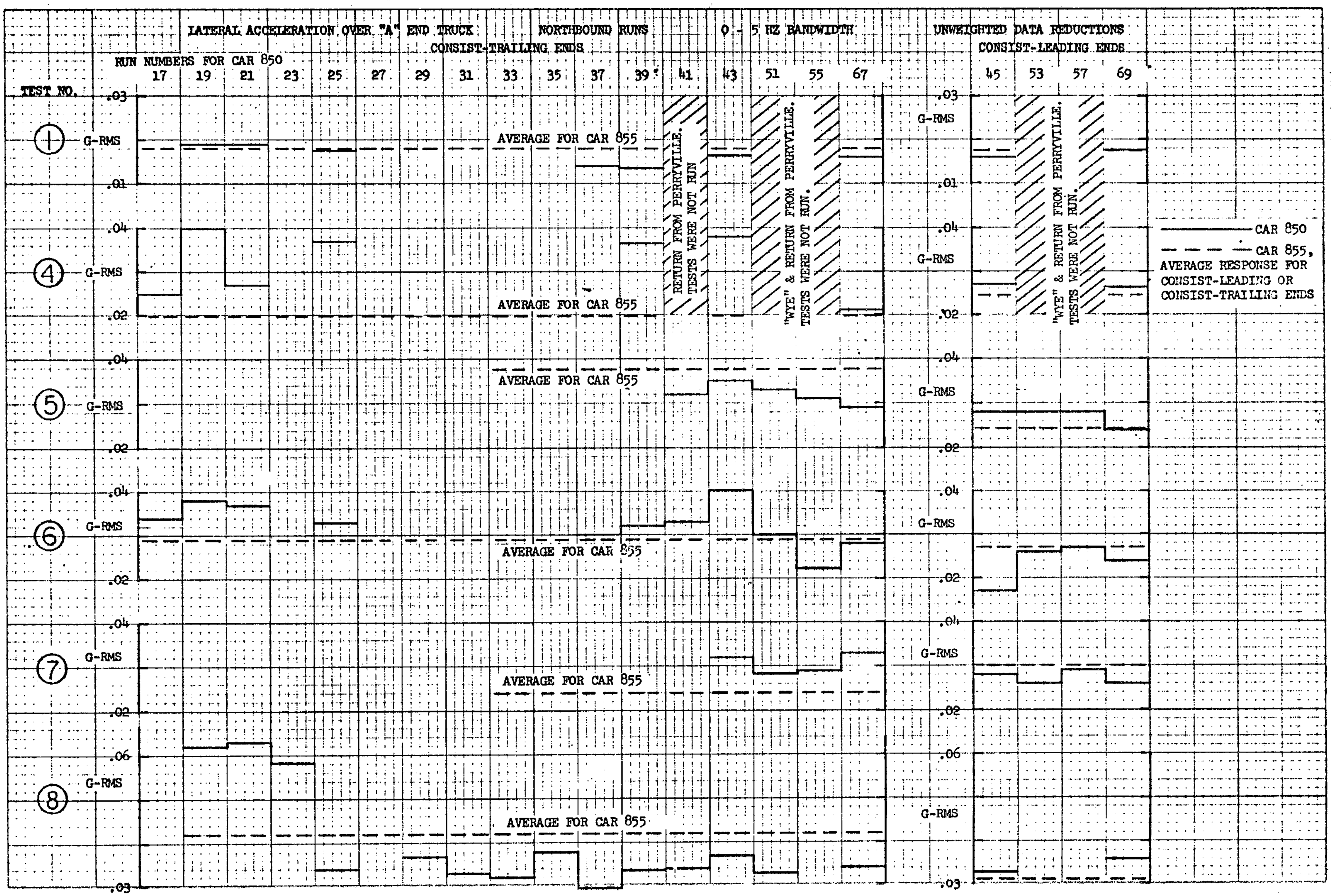


Figure 3.5-12 Lateral RMS Acceleration over "A" End Truck, Northbound Runs

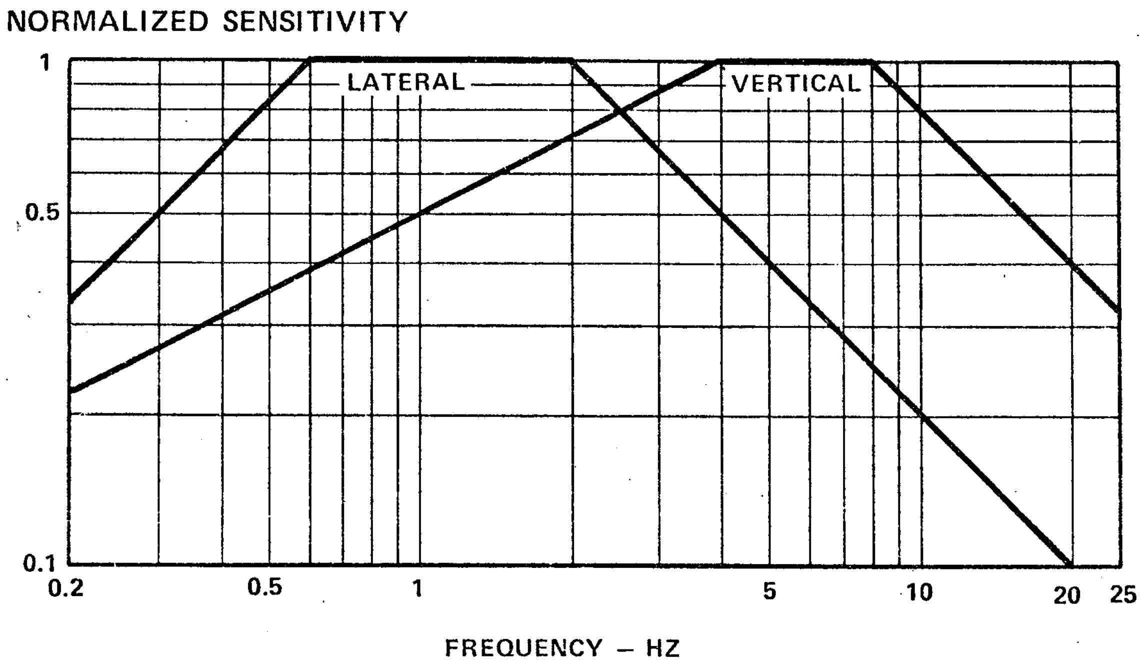


Figure 3.5-13 Curves for Equivalent Human Sensitivity to Vertical and Lateral Vibration

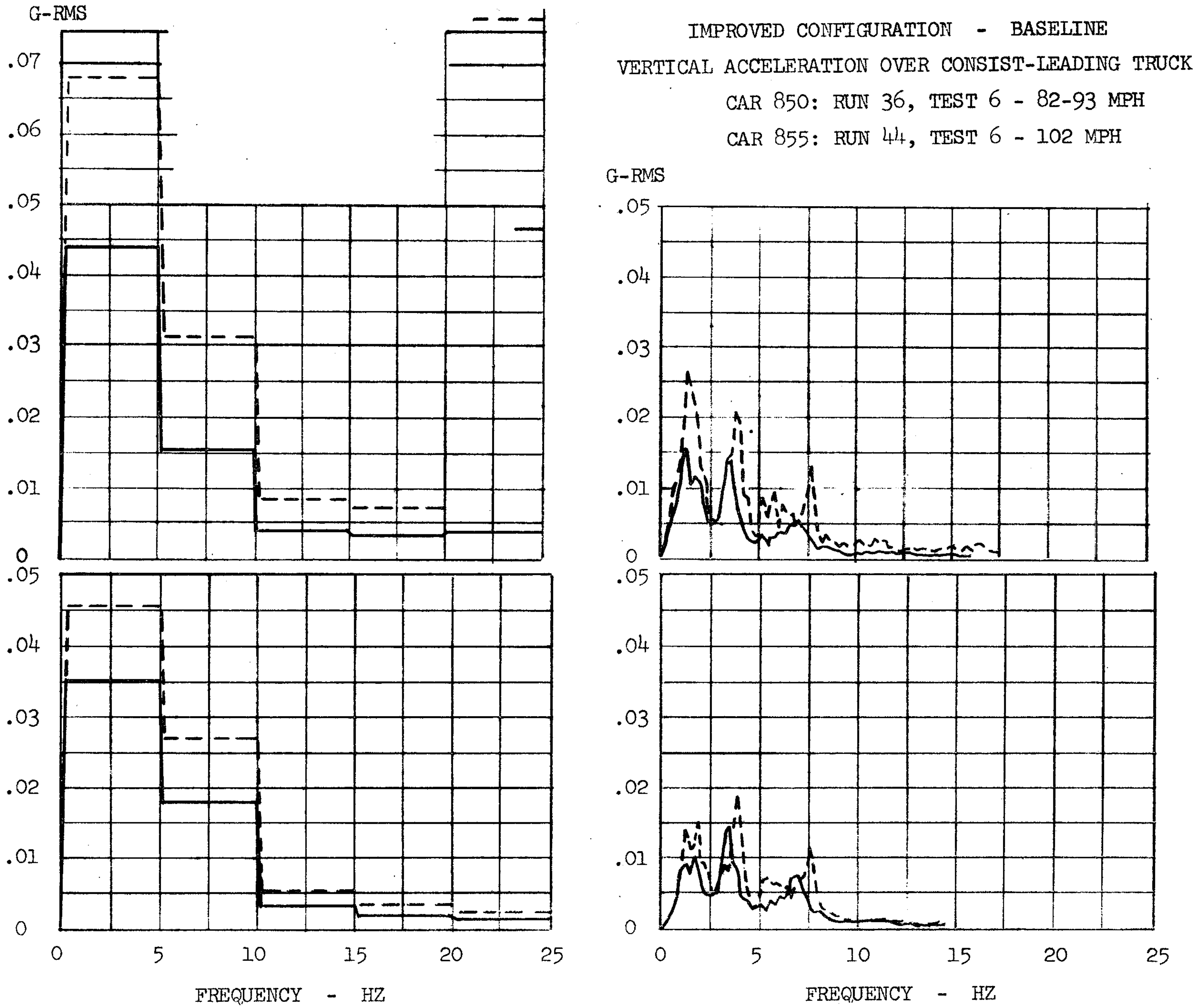


Figure 3.5-14 Comparison of Weighted vs. Unweighted Vertical Acceleration Spectra

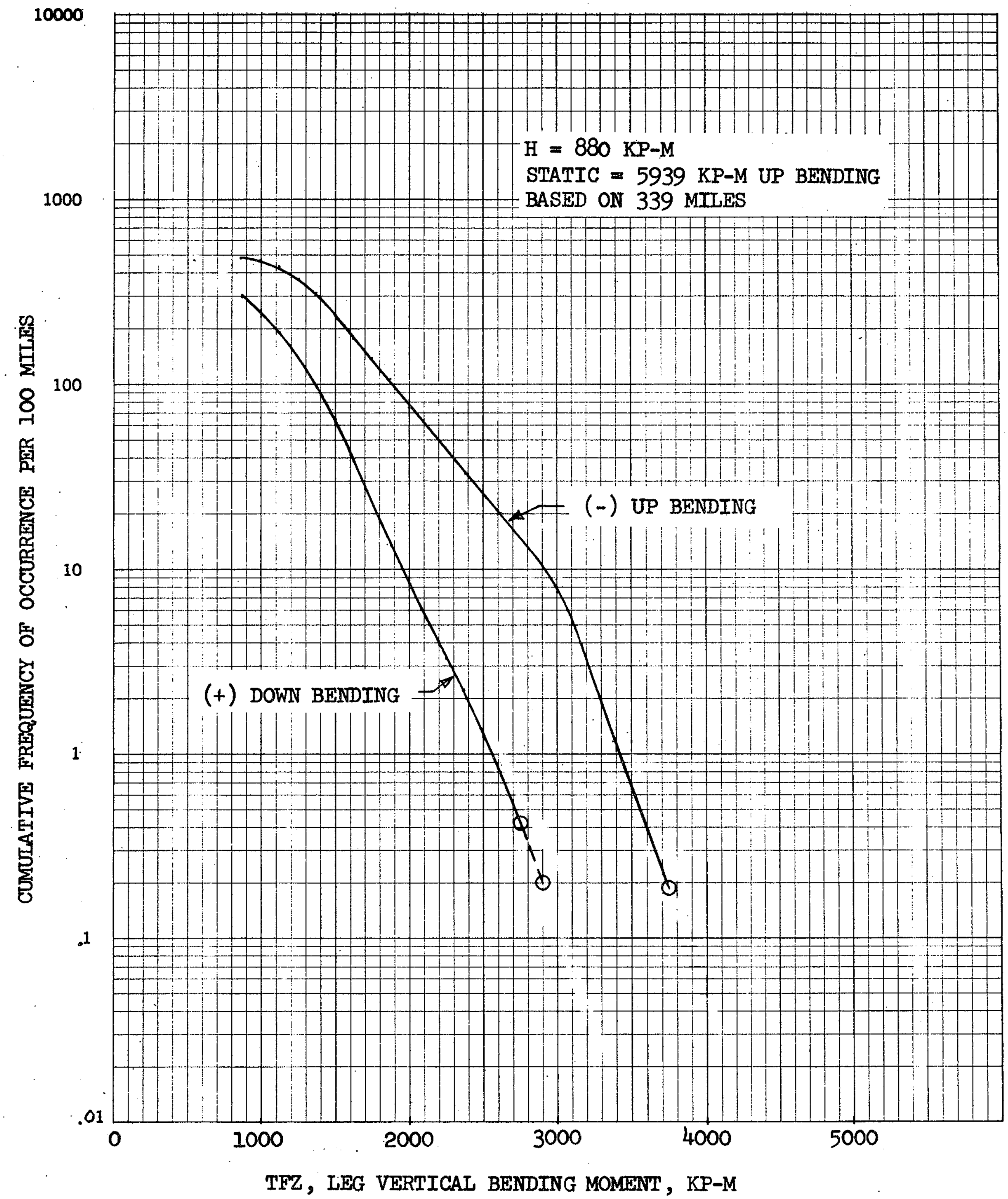


FIGURE 3.5-15 TRUCK FRAME VERTICAL LOAD SPECTRUM

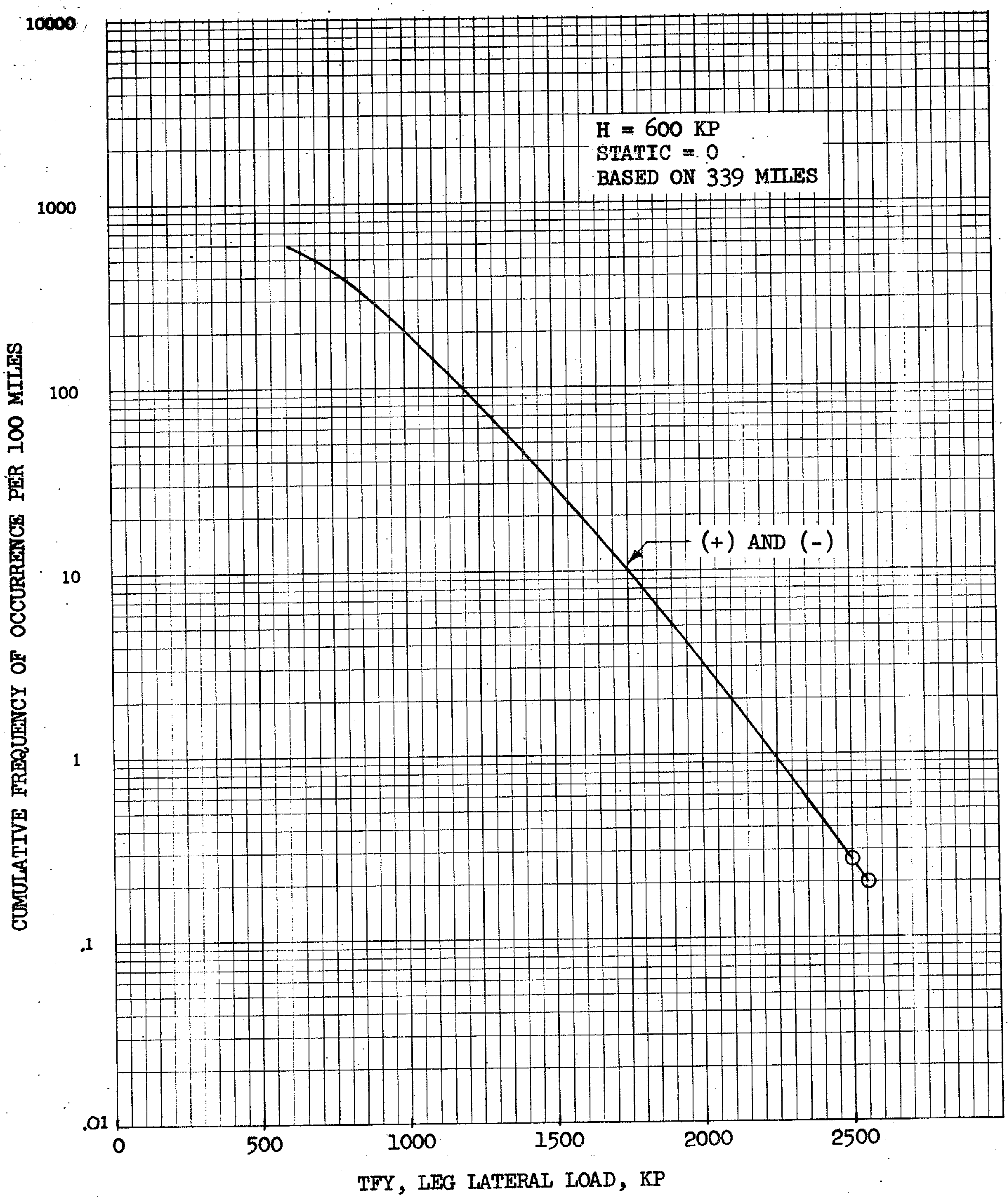


FIGURE 3.5-16 TRUCK FRAME LATERAL LOAD SPECTRUM

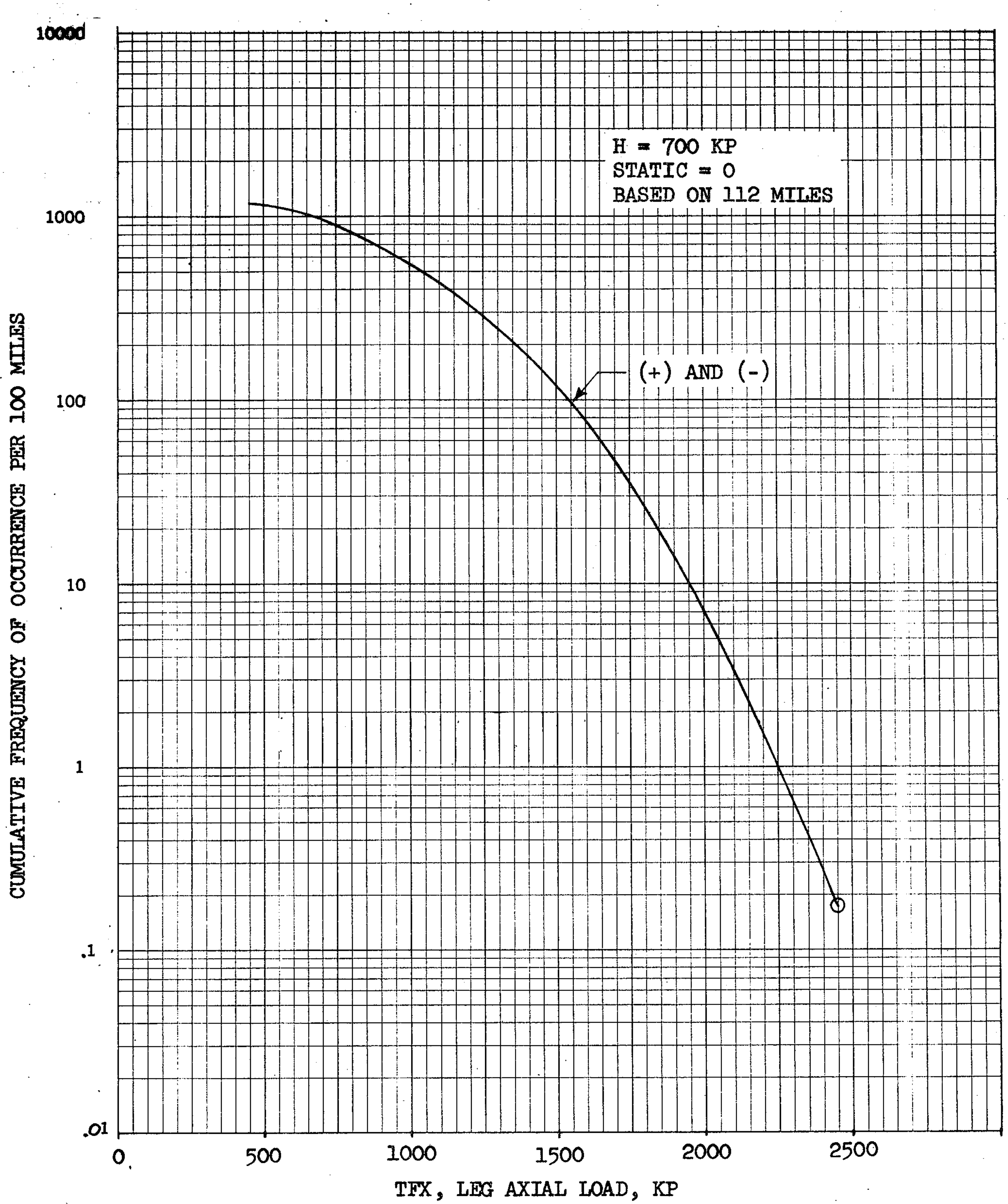


FIGURE 3.5-17 TRUCK FRAME LONGITUDINAL LOAD SPECTRUM

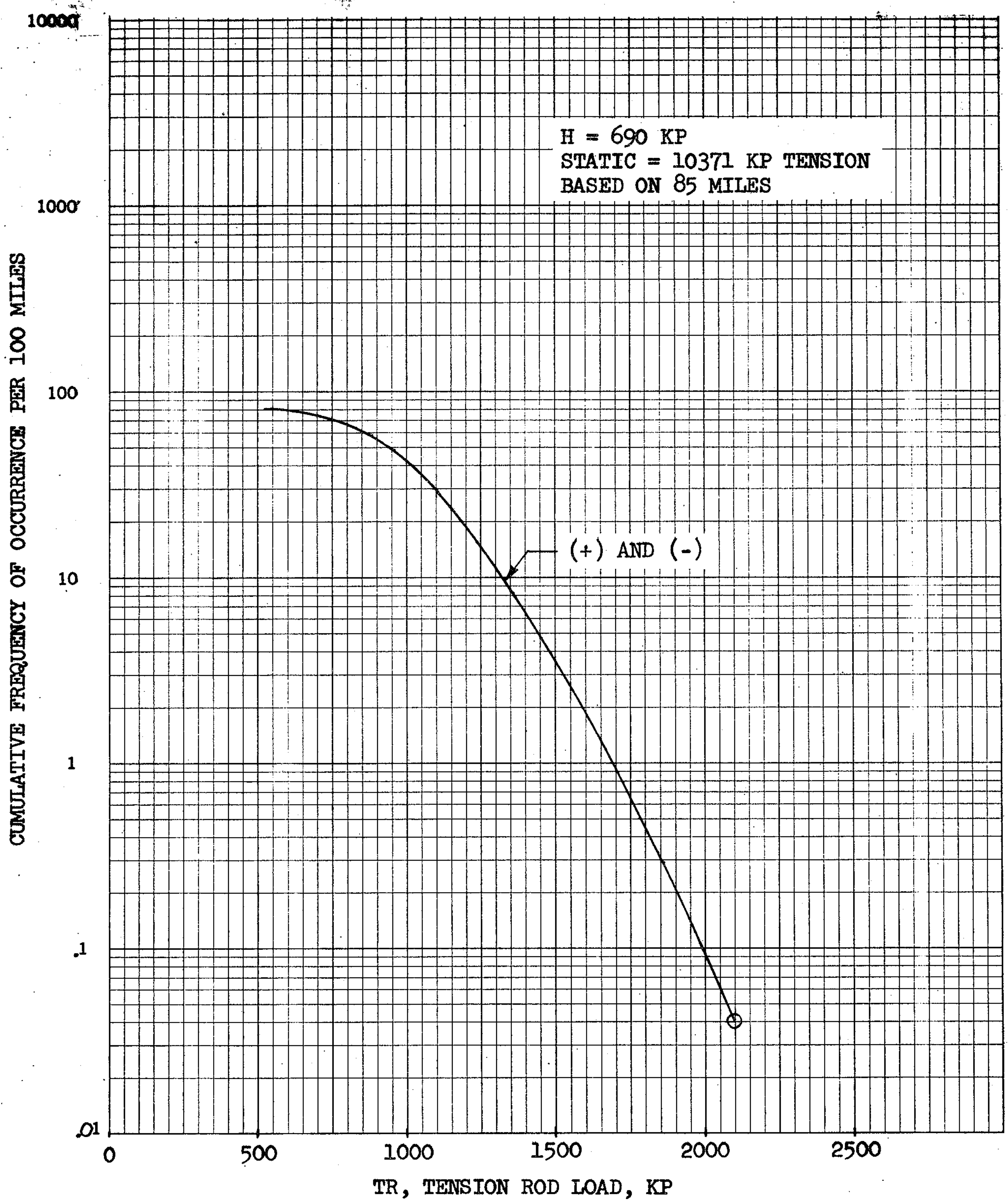


FIGURE 3.5-18 TENSION ROD LOAD SPECTRUM

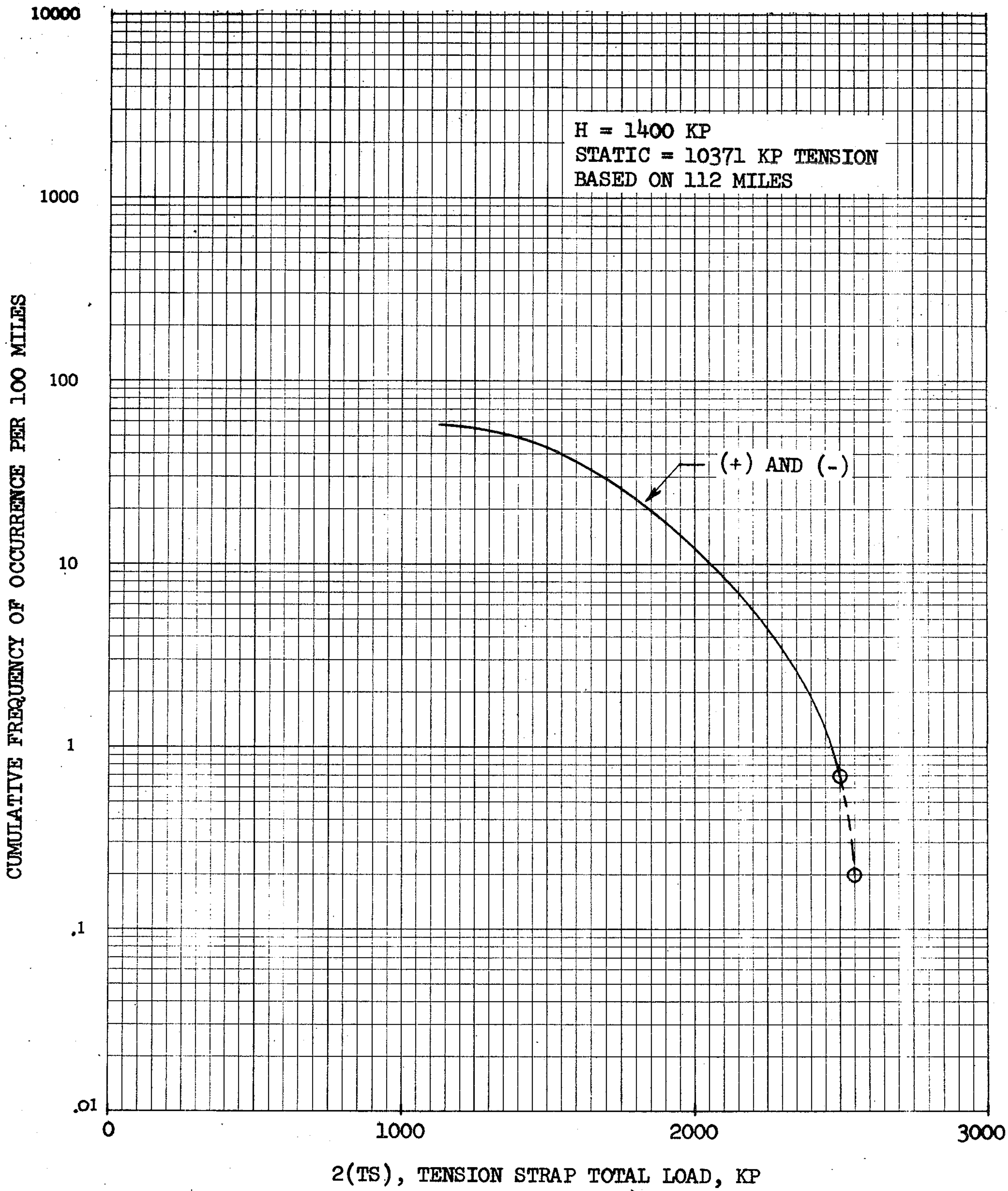


FIGURE 3.5-19 TENSION STRAP LOAD SPECTRUM

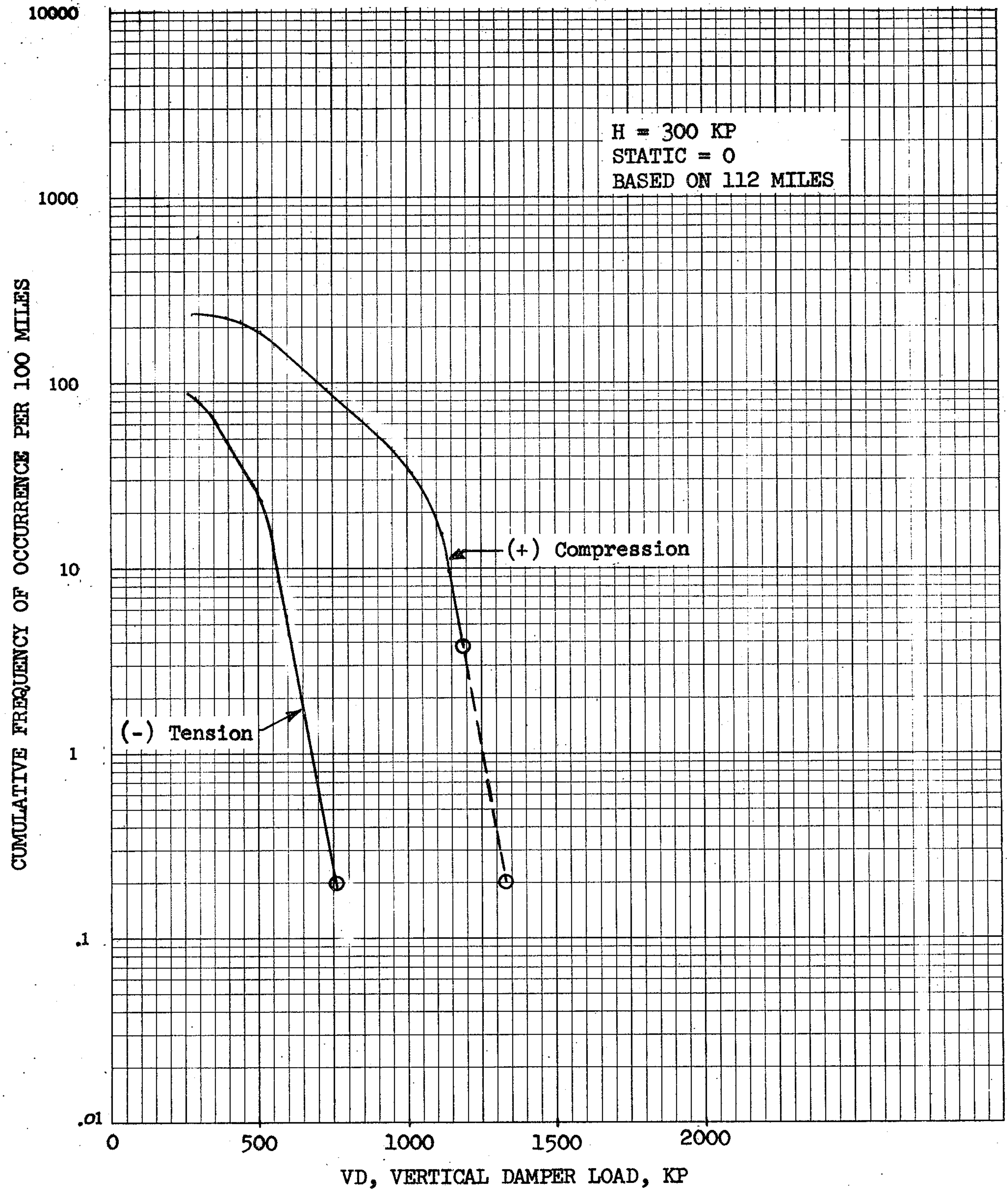


FIGURE 3.5-20 VERTICAL DAMPER LOAD SPECTRUM

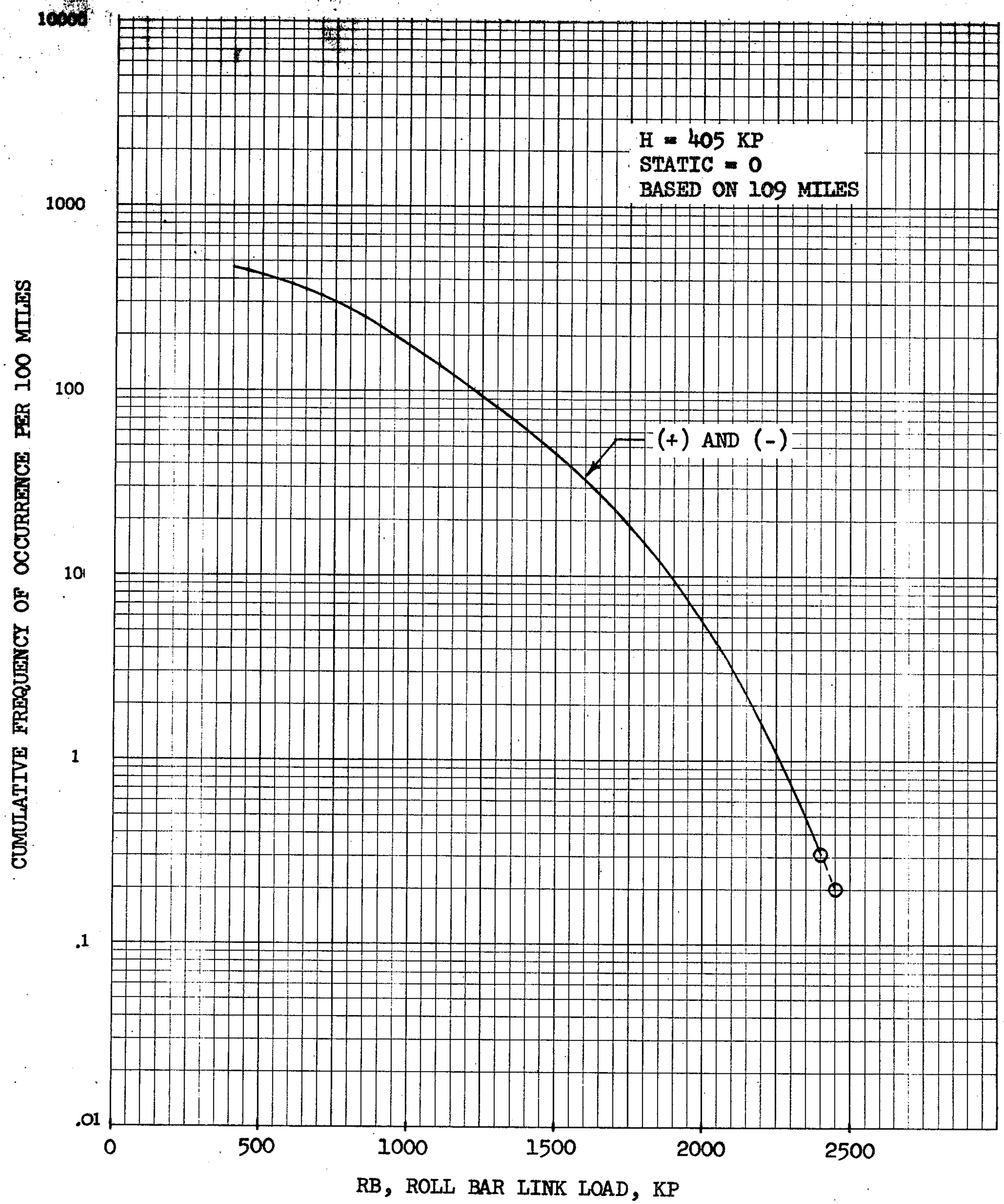


FIGURE 3.5-21 ROLL BAR LINK LOAD SPECTRUM

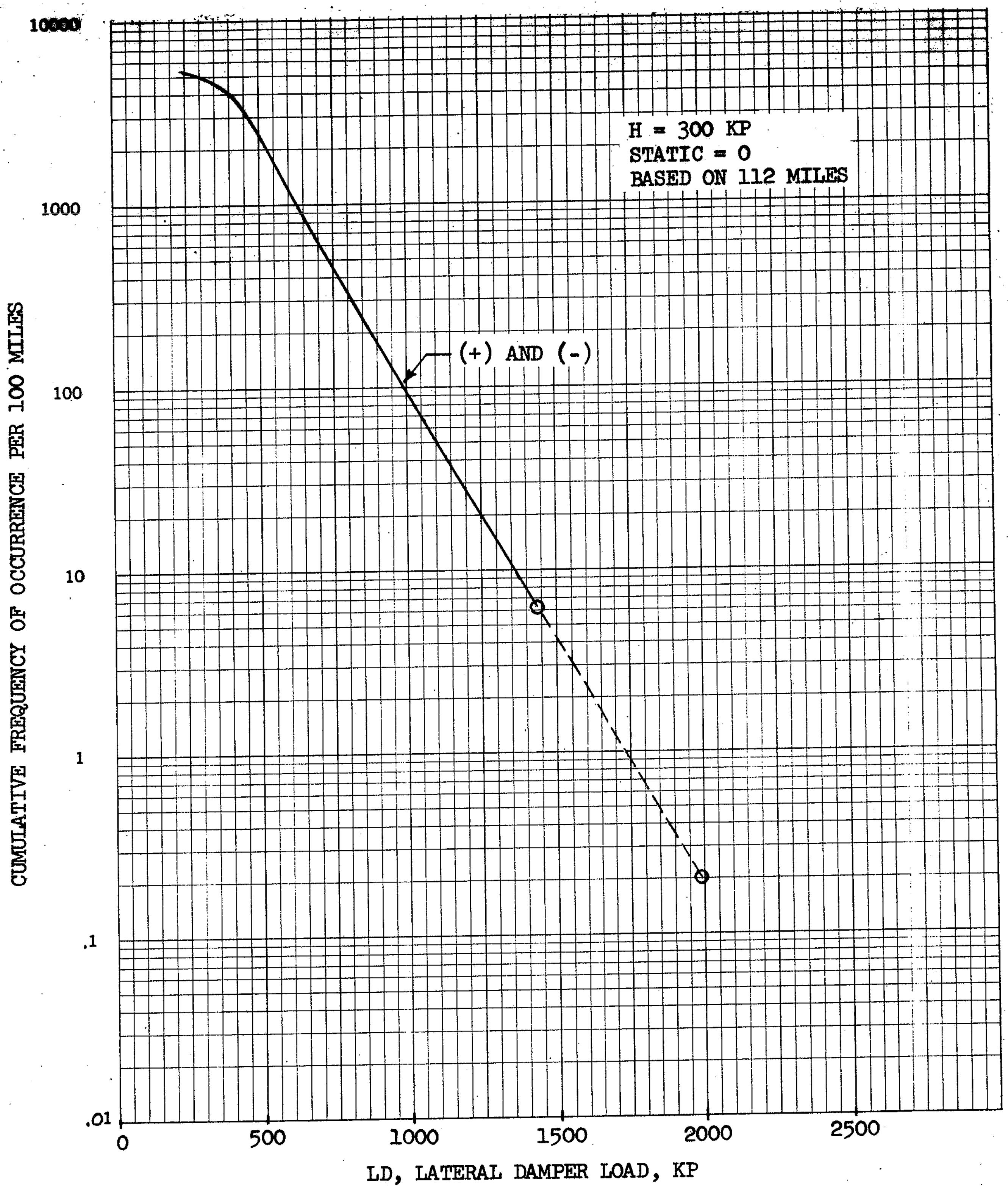


FIGURE 3.5-22 LATERAL DAMPER LOAD SPECTRUM

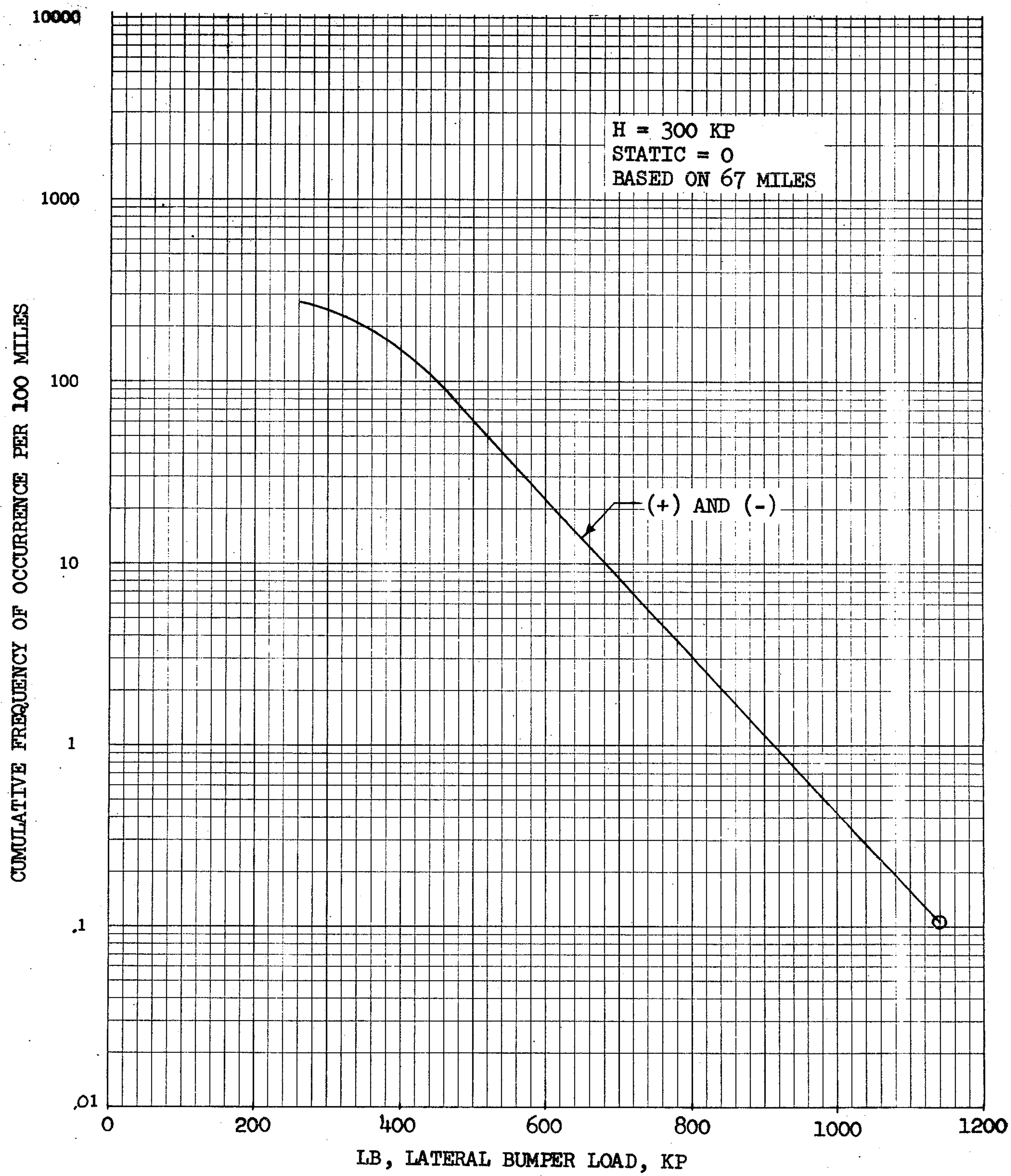


FIGURE 3.5-23 LATERAL BUMPER LOAD SPECTRUM

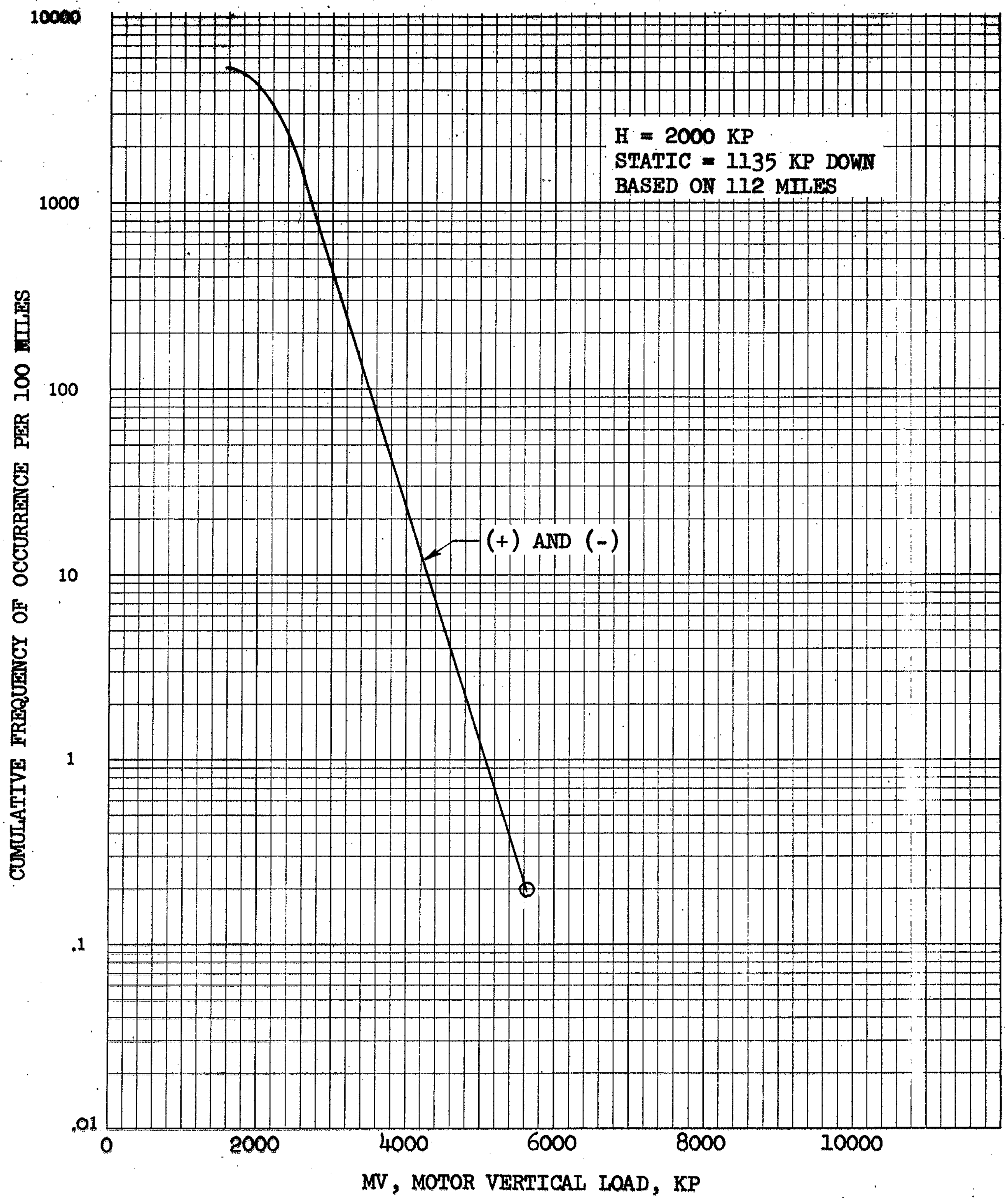


FIGURE 3.5-24 MOTOR LOAD SPECTRUM

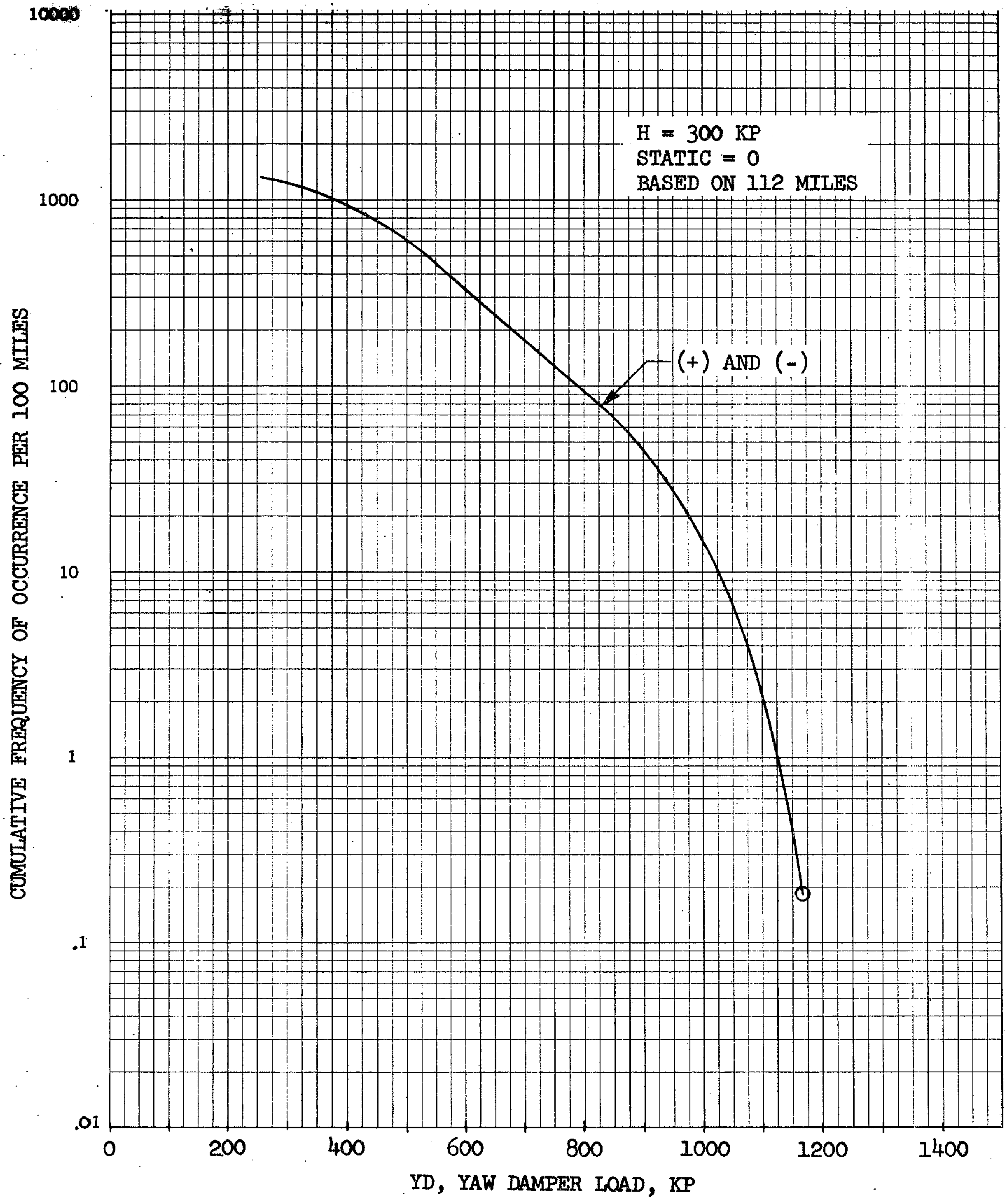


FIGURE 3.5-25 YAW DAMPER LOAD SPECTRUM

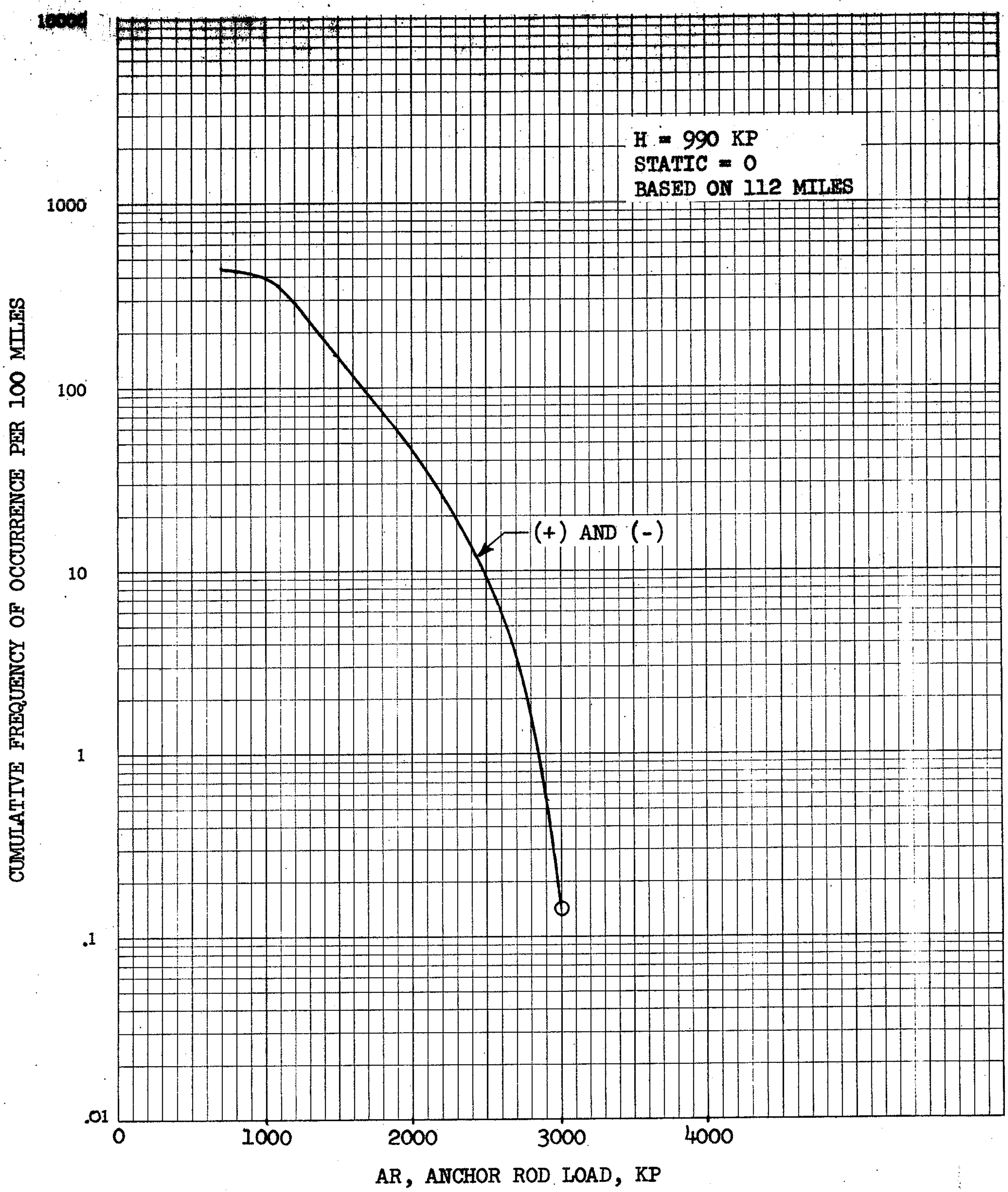


FIGURE 3.5-26 ANCHOR ROD LOAD SPECTRUM

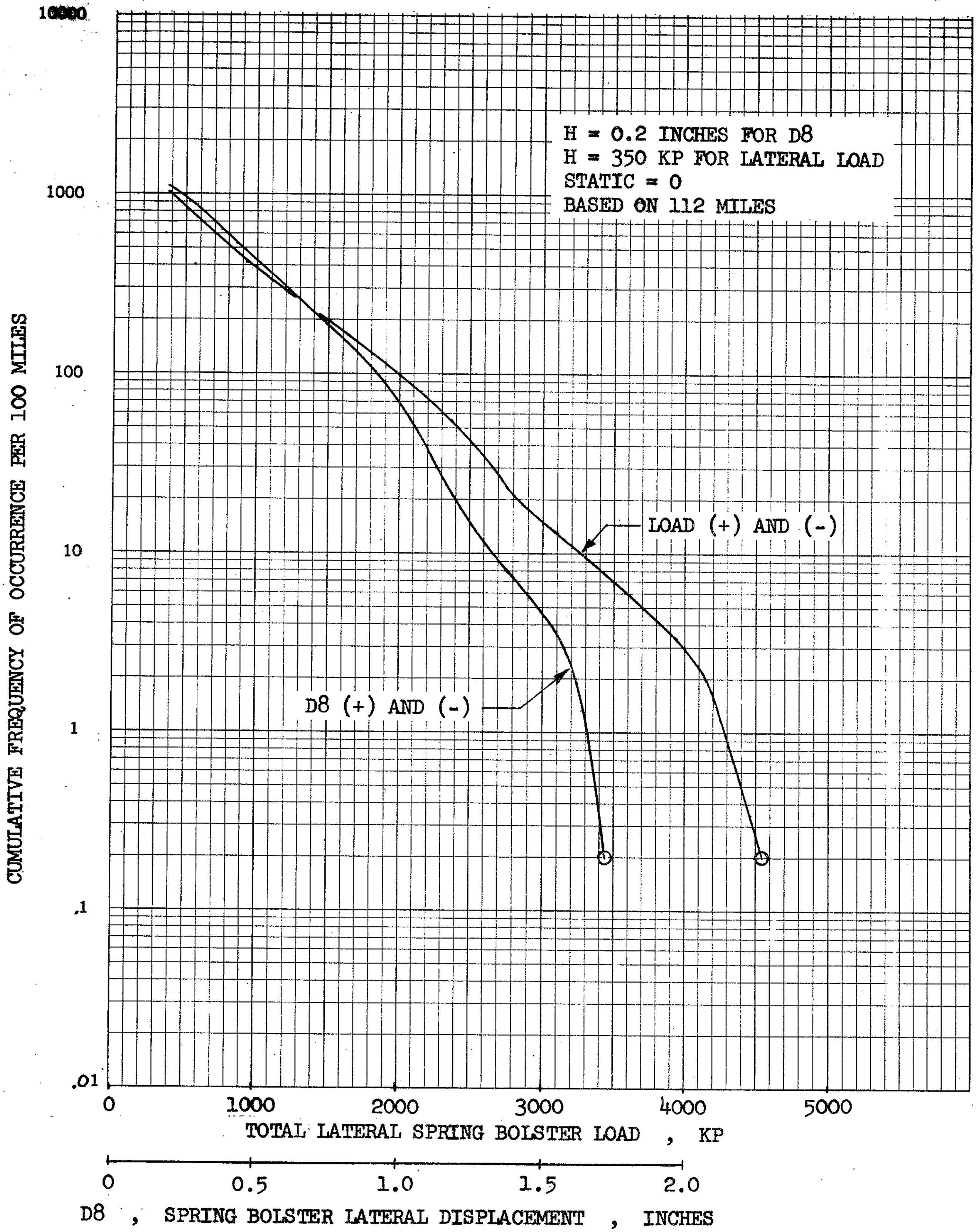


FIGURE 3.5-27 SPRING BOLSTER LATERAL LOAD SPECTRUM

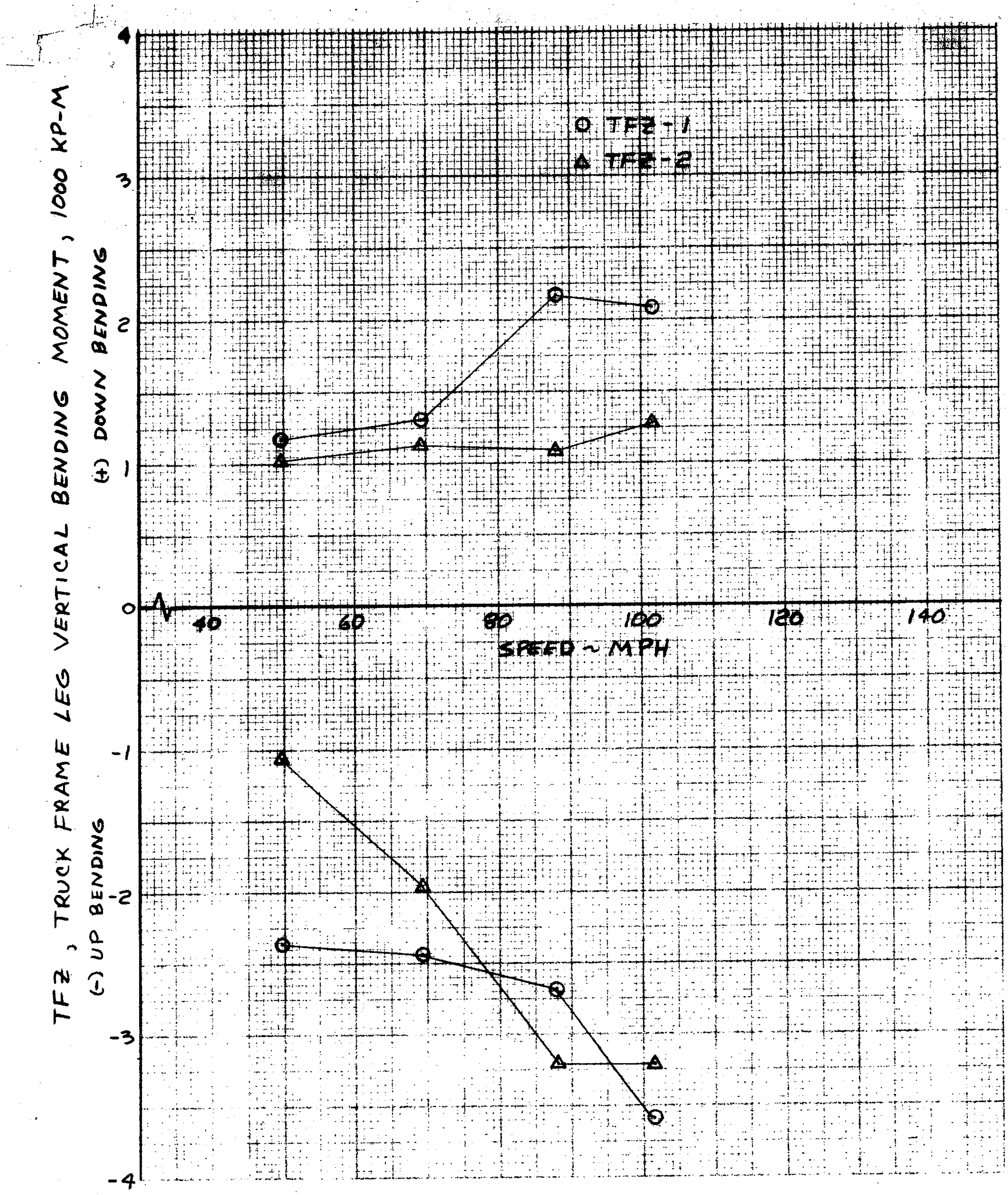


FIGURE 3.5-28 FRAME VERTICAL LOAD SENSITIVITY, TRAILING TRUCK

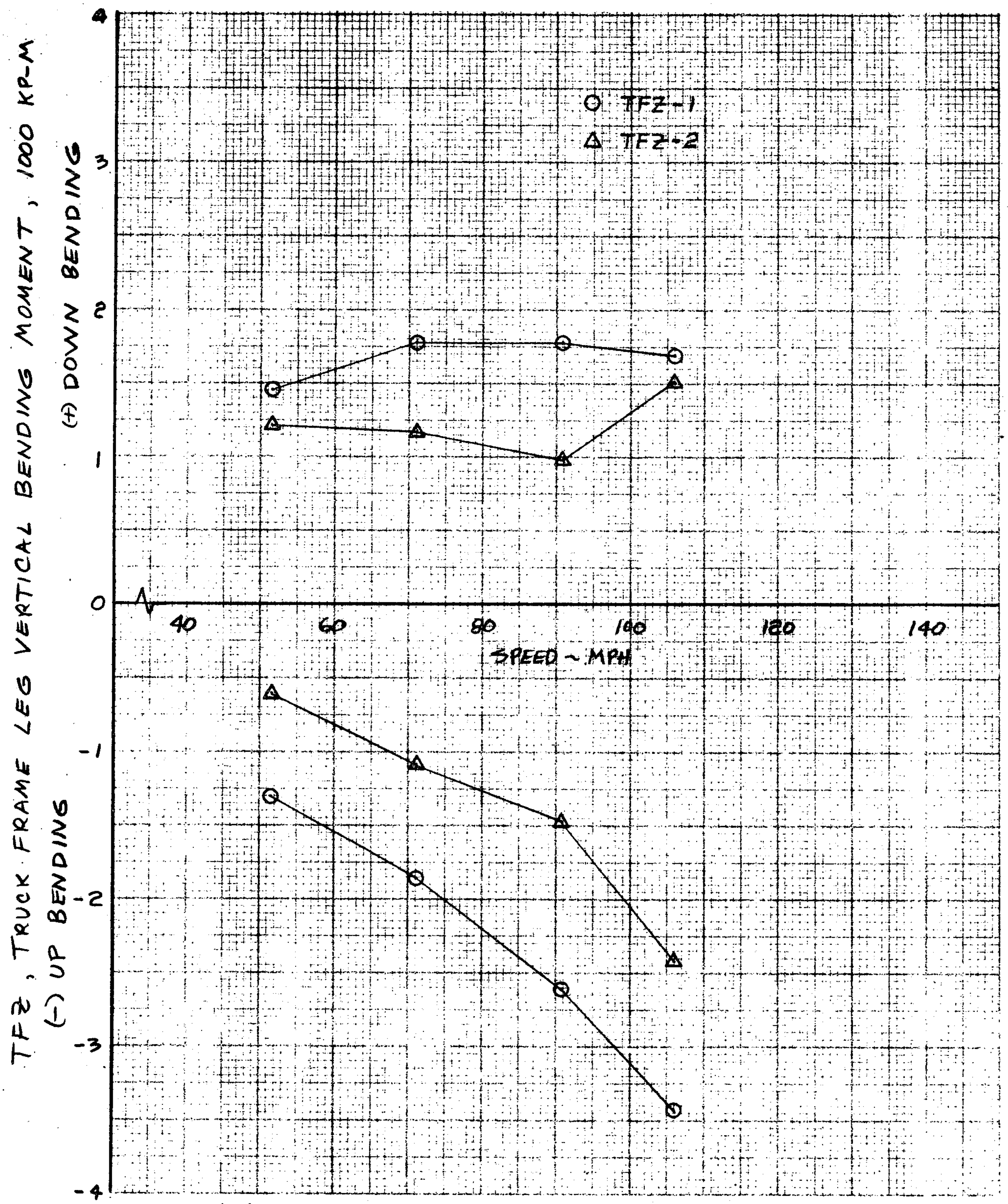


FIGURE 3.5-29 FRAME VERTICAL LOAD SENSITIVITY,
LEADING TRUCK

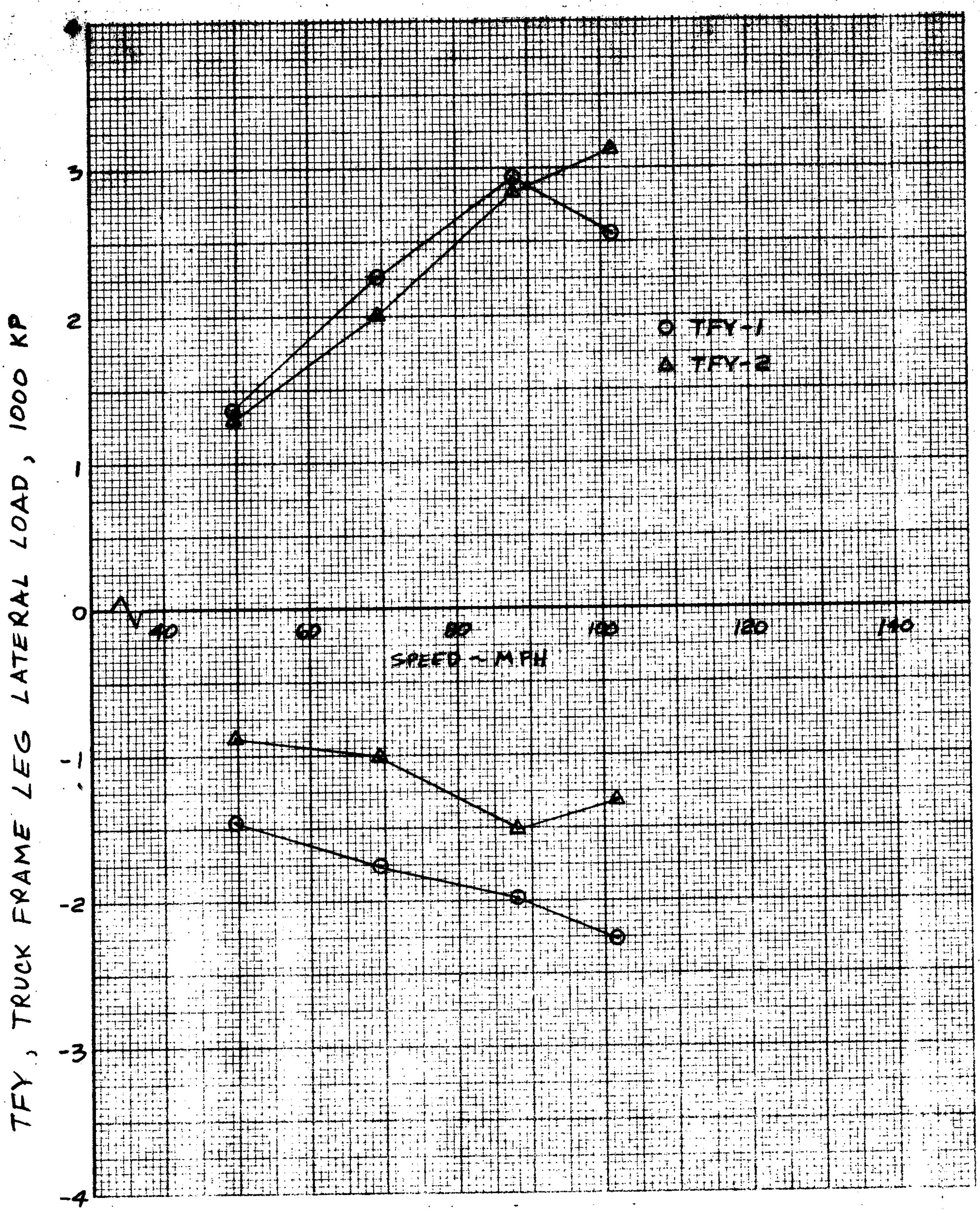


FIGURE 3.5-30 FRAME LATERAL LOAD SENSITIVITY, TRAILING TRUCK

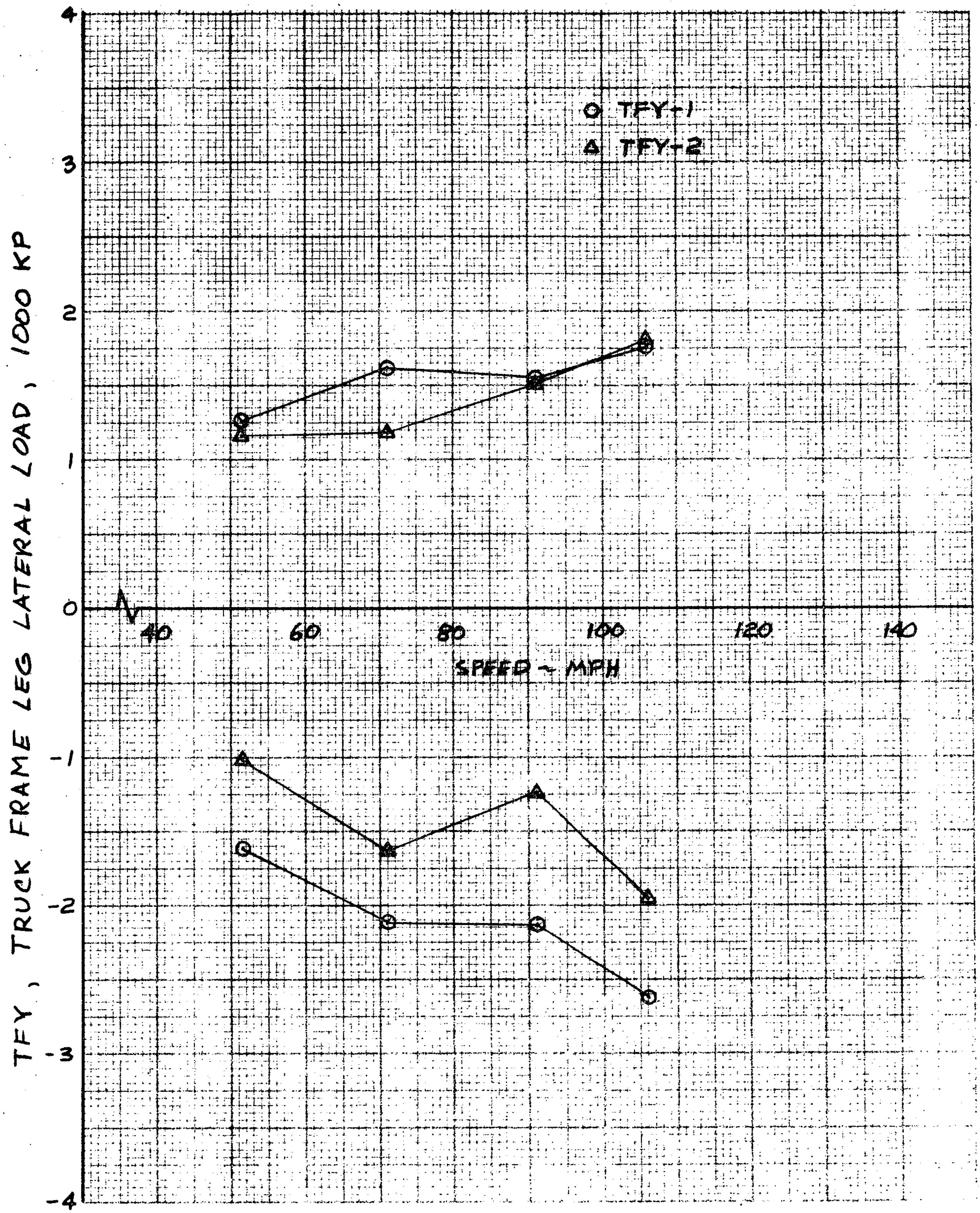


FIGURE 3.5-31 FRAME LATERAL LOAD SENSITIVITY, LEADING TRUCK

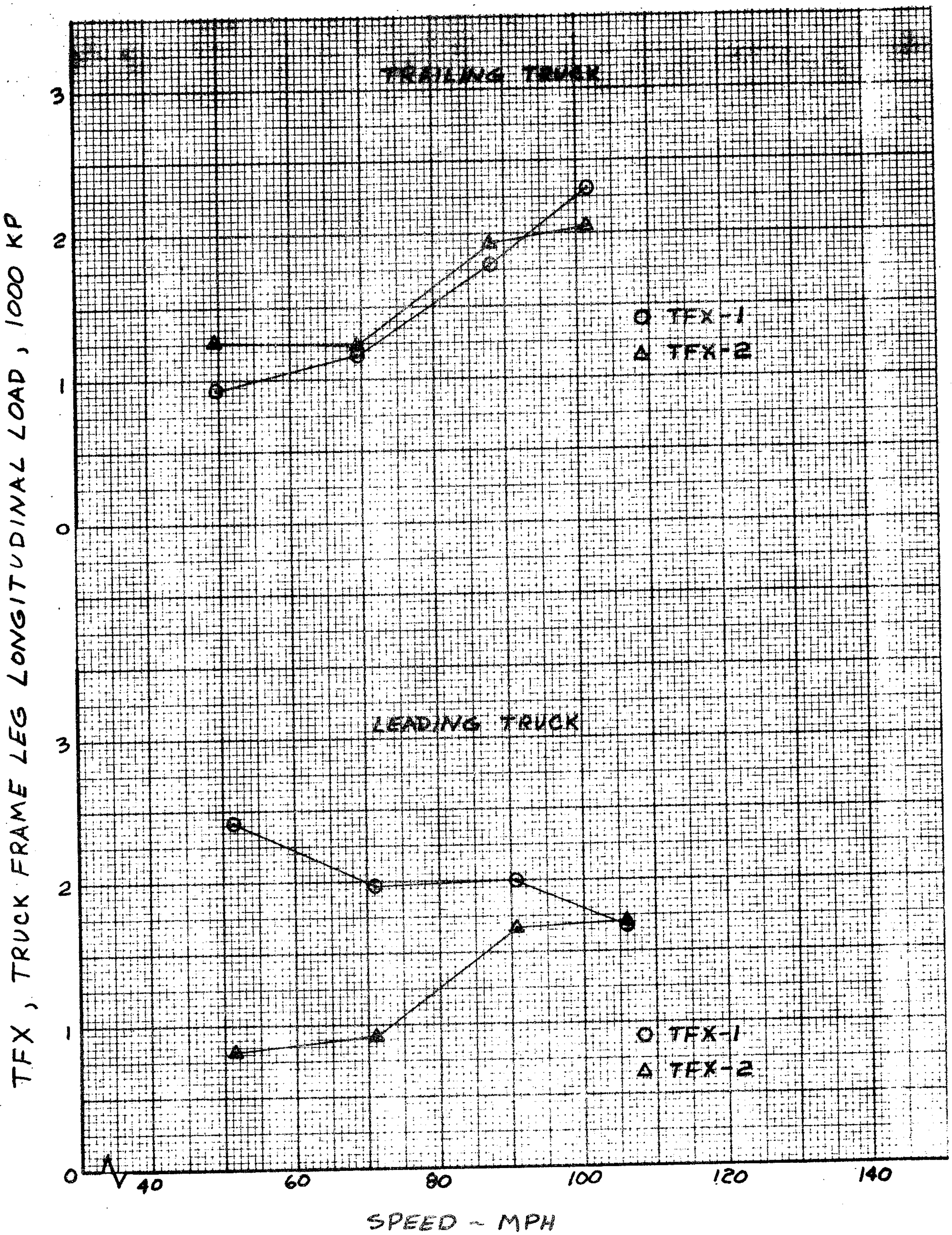


FIGURE 3.5-32 FRAME LONGITUDINAL LOAD SENSITIVITY

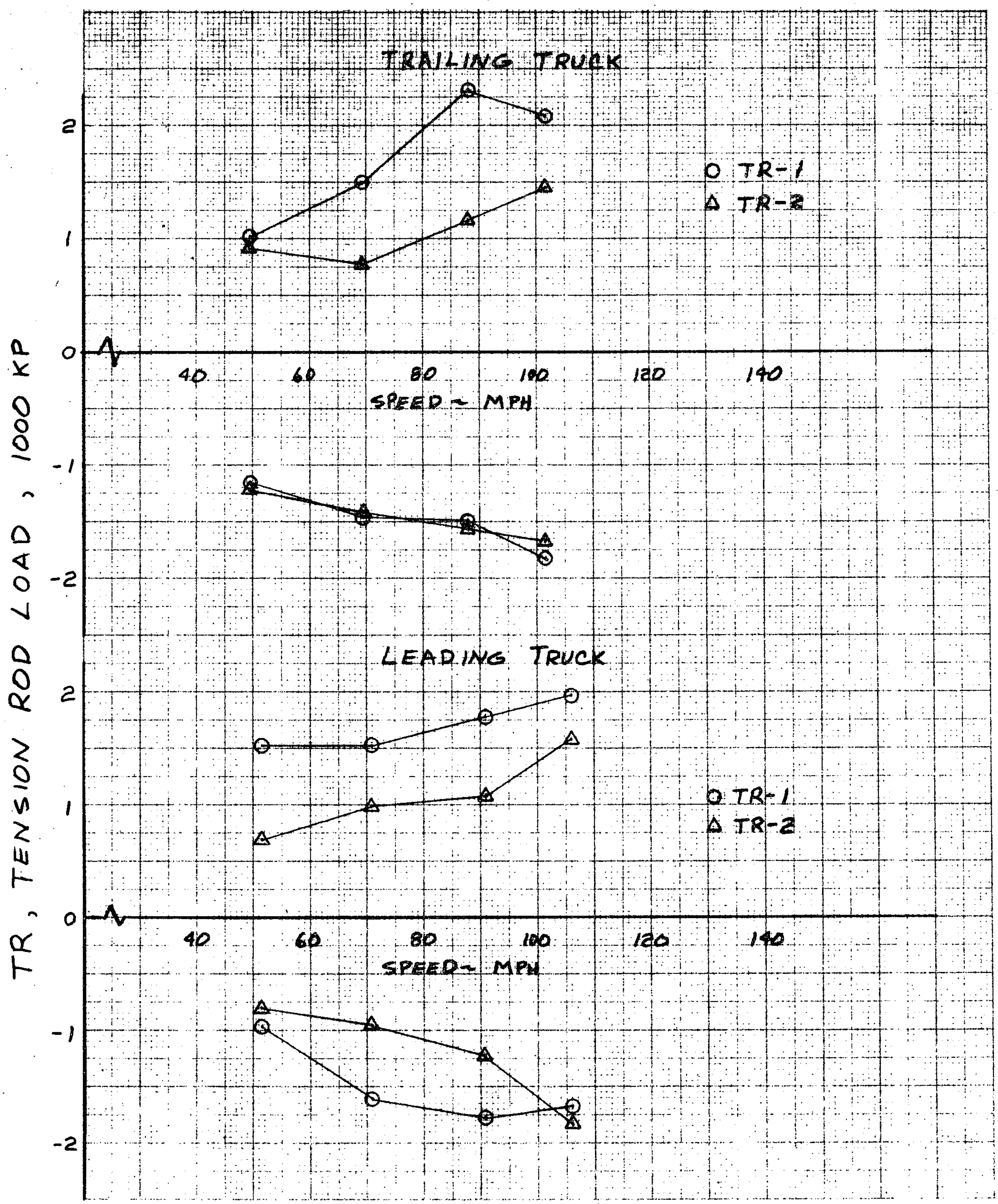


FIGURE 3.5-33 TENSION ROD LOAD SENSITIVITY

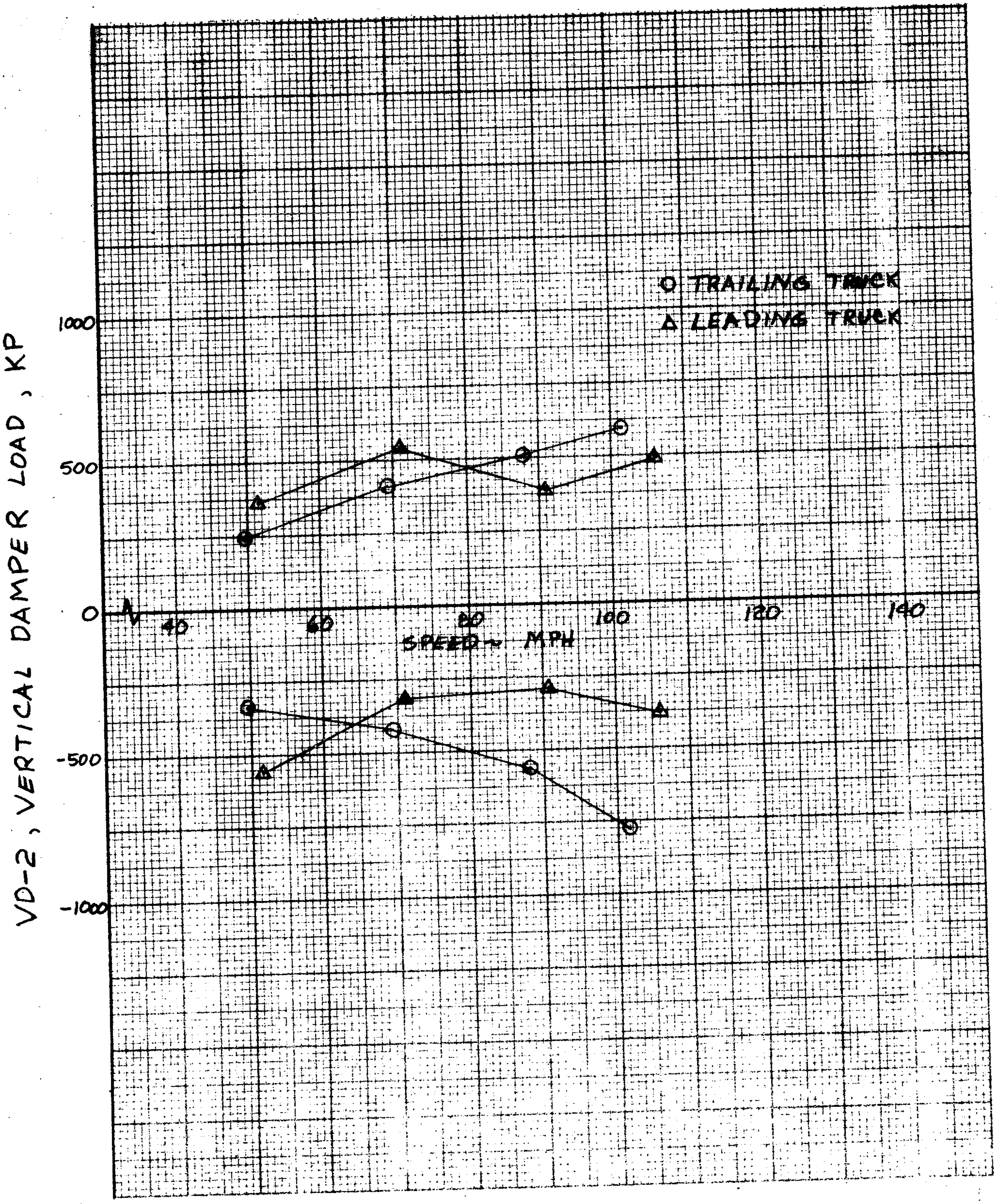


FIGURE 3.5-34 VERTICAL DAMPER LOAD SENSITIVITY

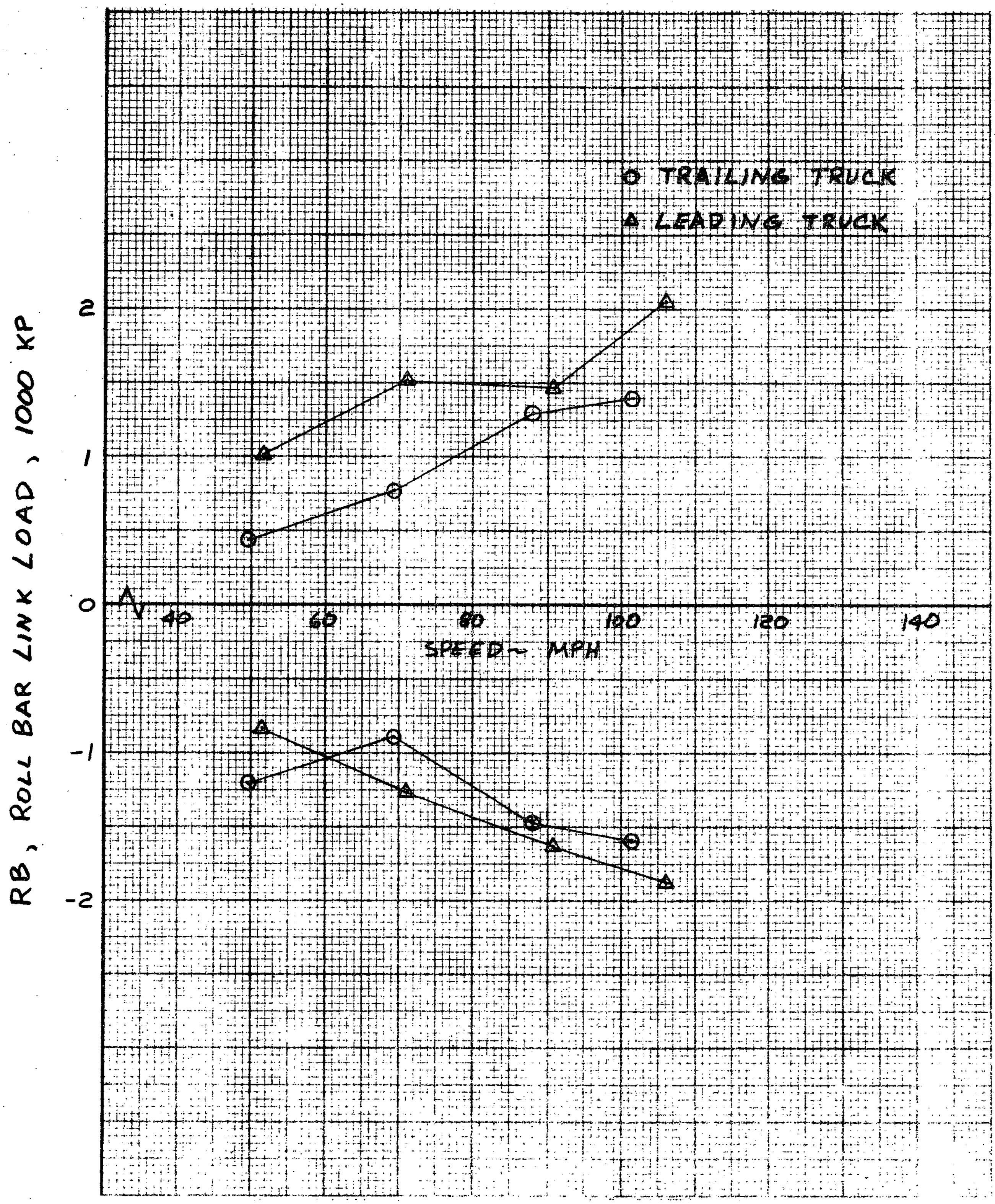


FIGURE 3.5-35 ROLL BAR LINK LOAD SENSITIVITY

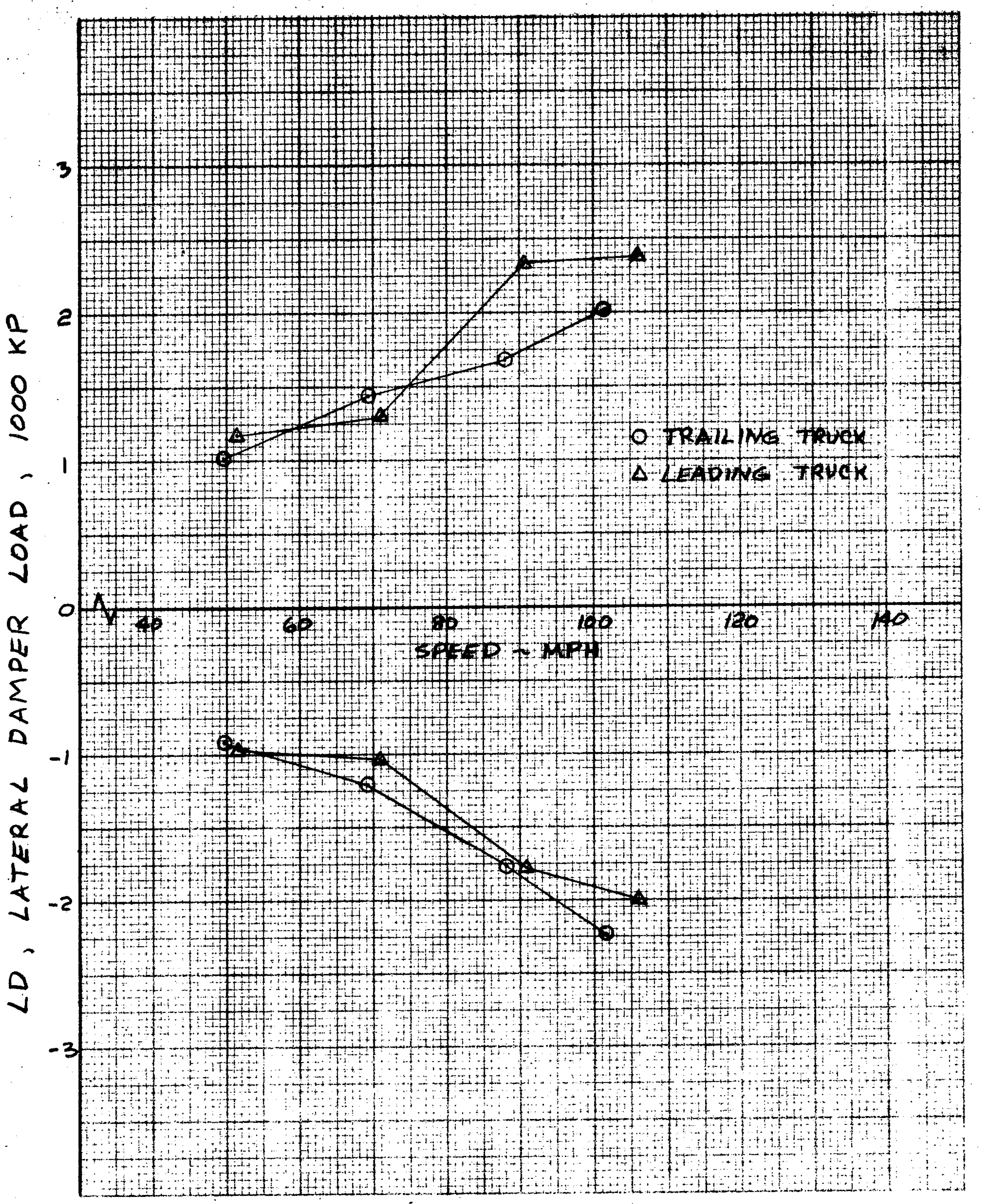


FIGURE 3.5-36 LATERAL DAMPER LOAD SENSITIVITY

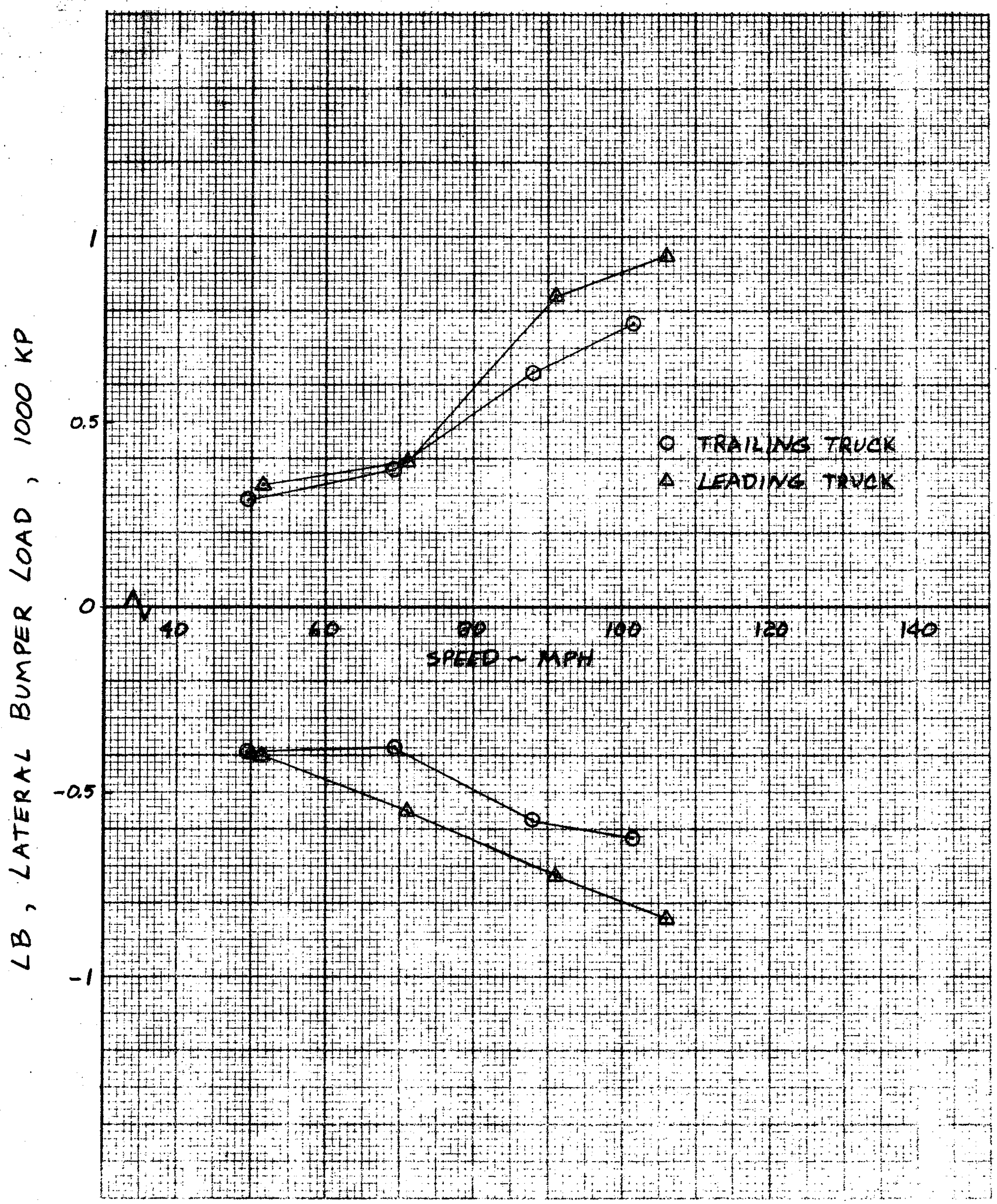


FIGURE 3.5-37 LATER BUMPER LOAD SENSITIVITY

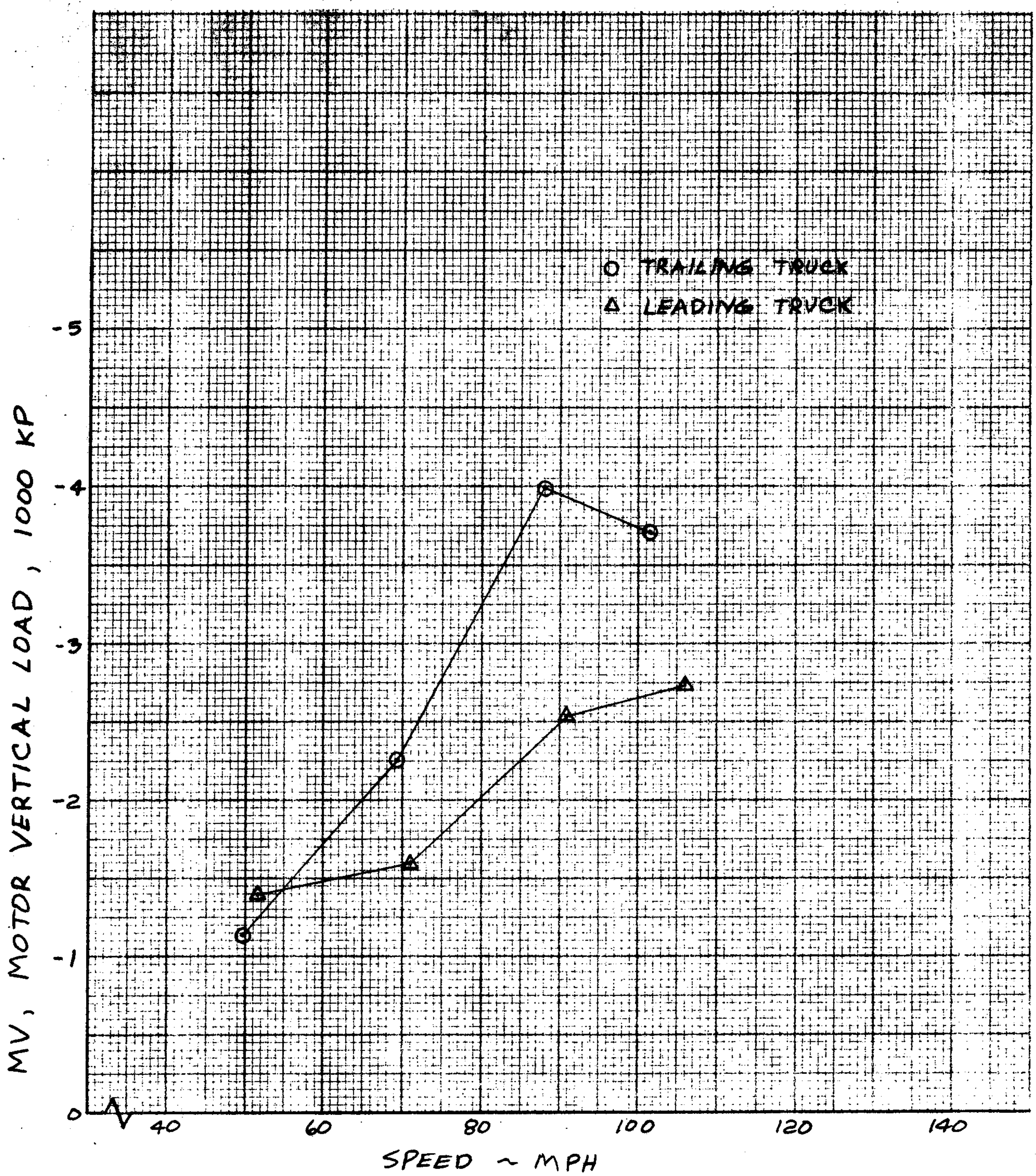


FIGURE 3.5-38 MOTOR LOAD SENSITIVITY

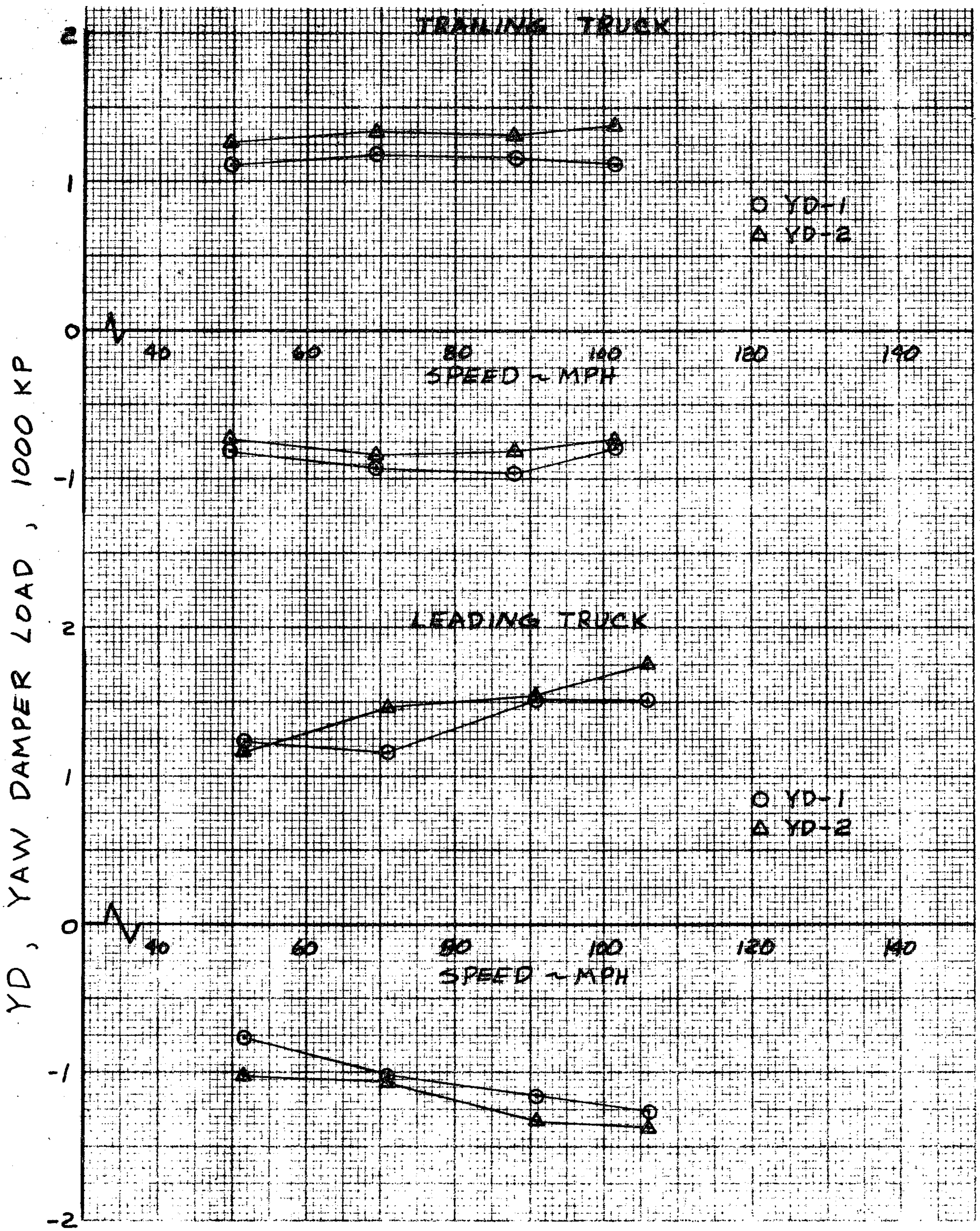


FIGURE 3.5-39 YAW DAMPER LOAD SENSITIVITY

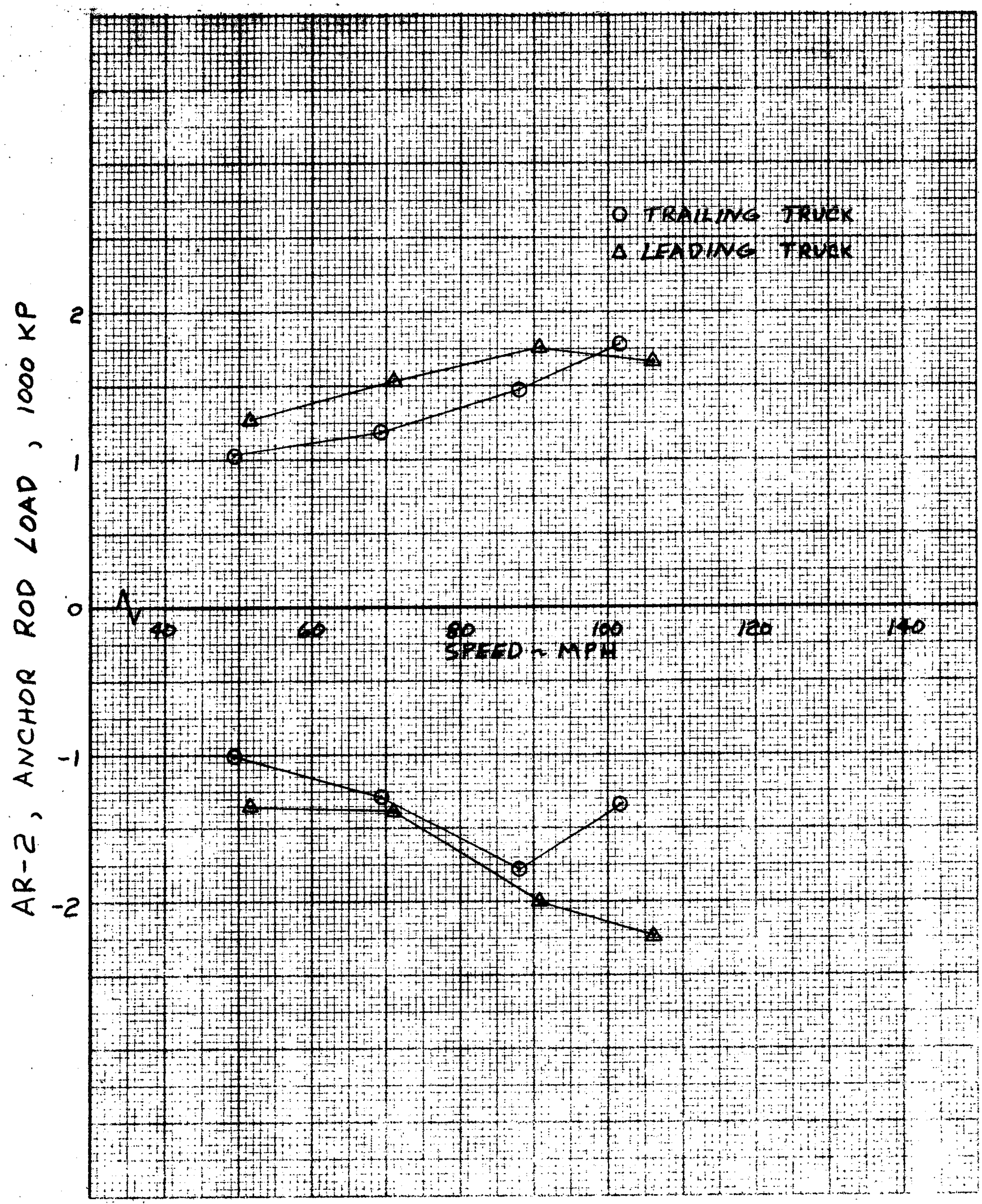


FIGURE 3.5-40 ANCHOR ROD LOAD SENSITIVITY

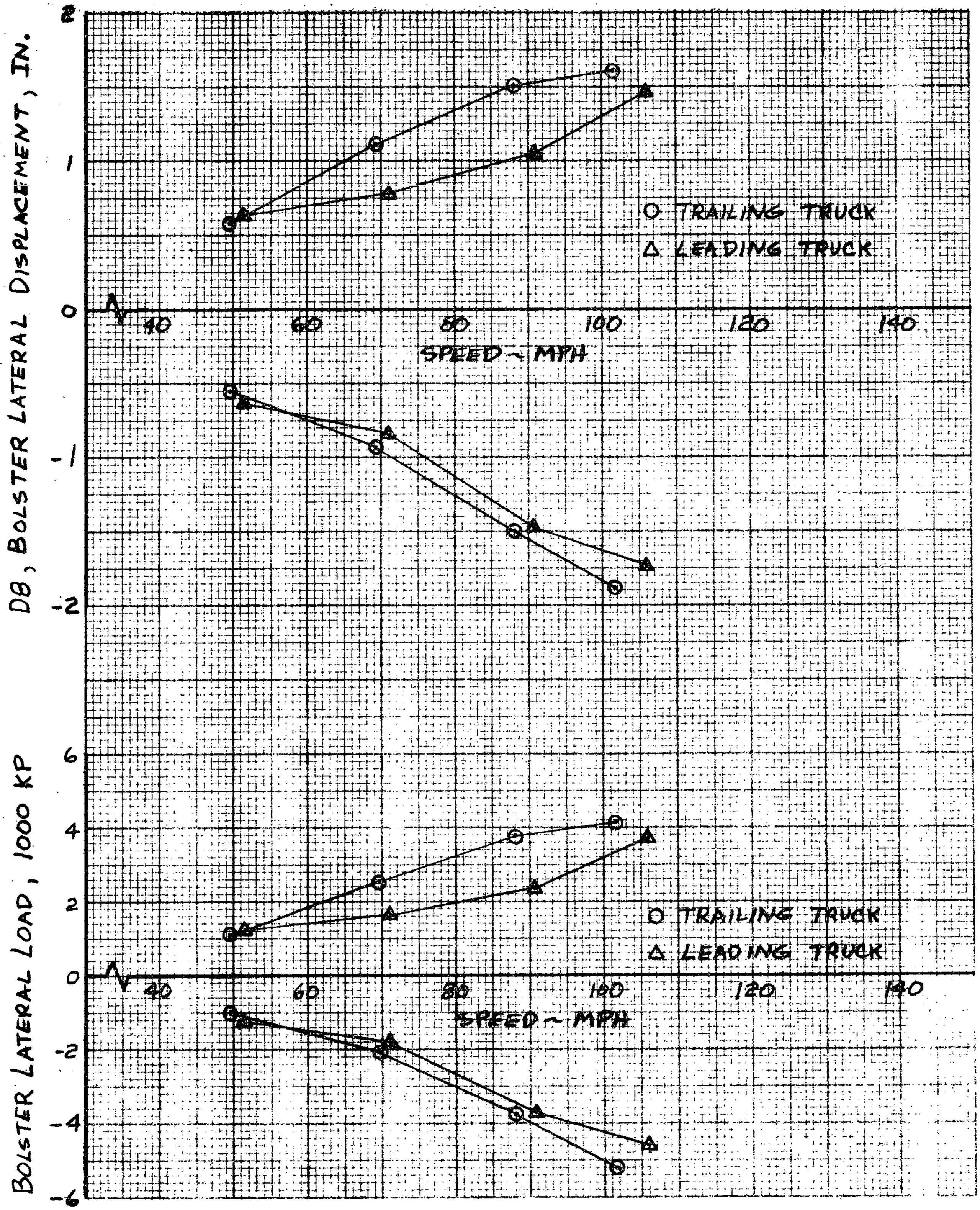


FIGURE 3.5-41 SPRING BOLSTER LATERAL DISPLACEMENT AND TOTAL LATERAL LOAD SENSITIVITY

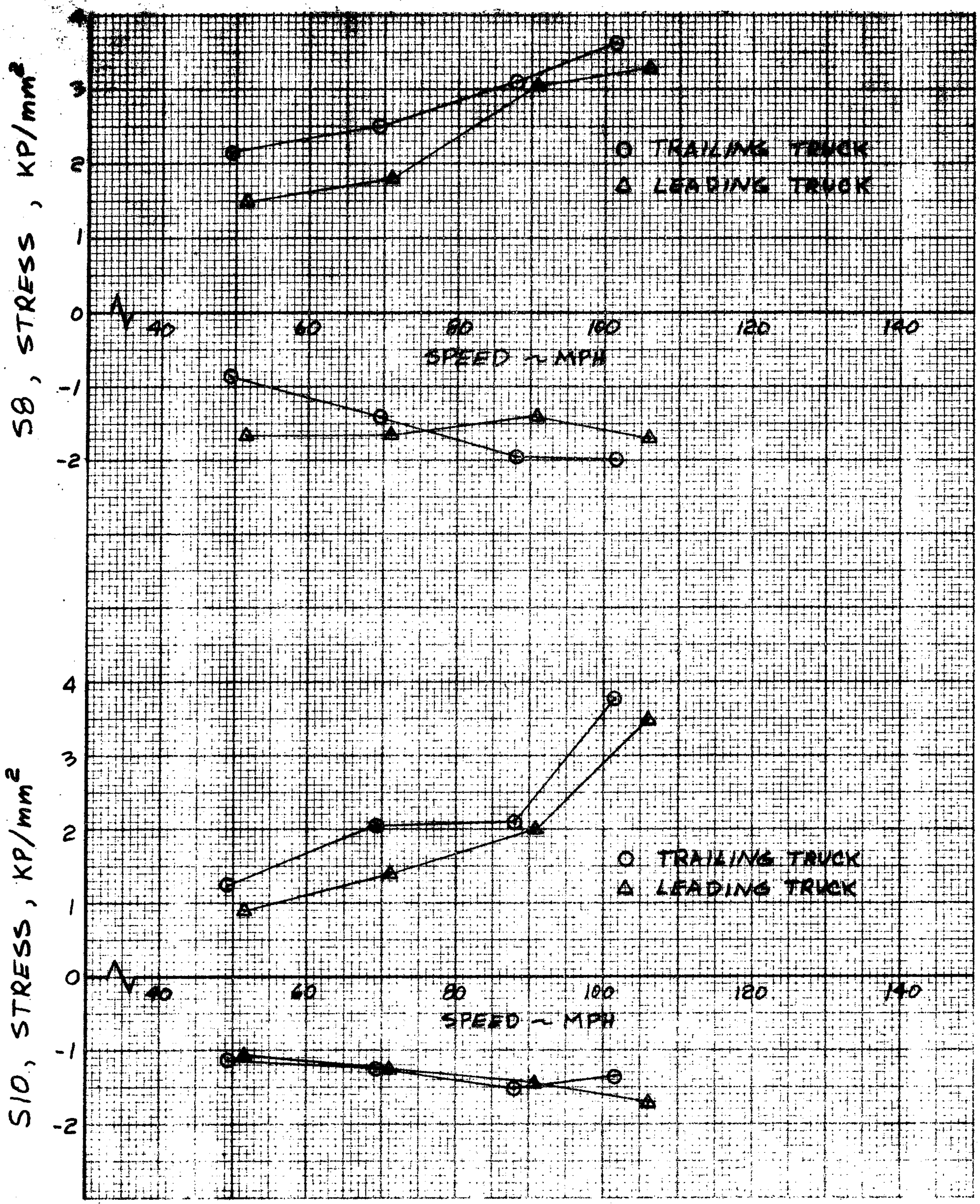


FIGURE 3.5-42 CANTED WEBB STRESS SENSITIVITY

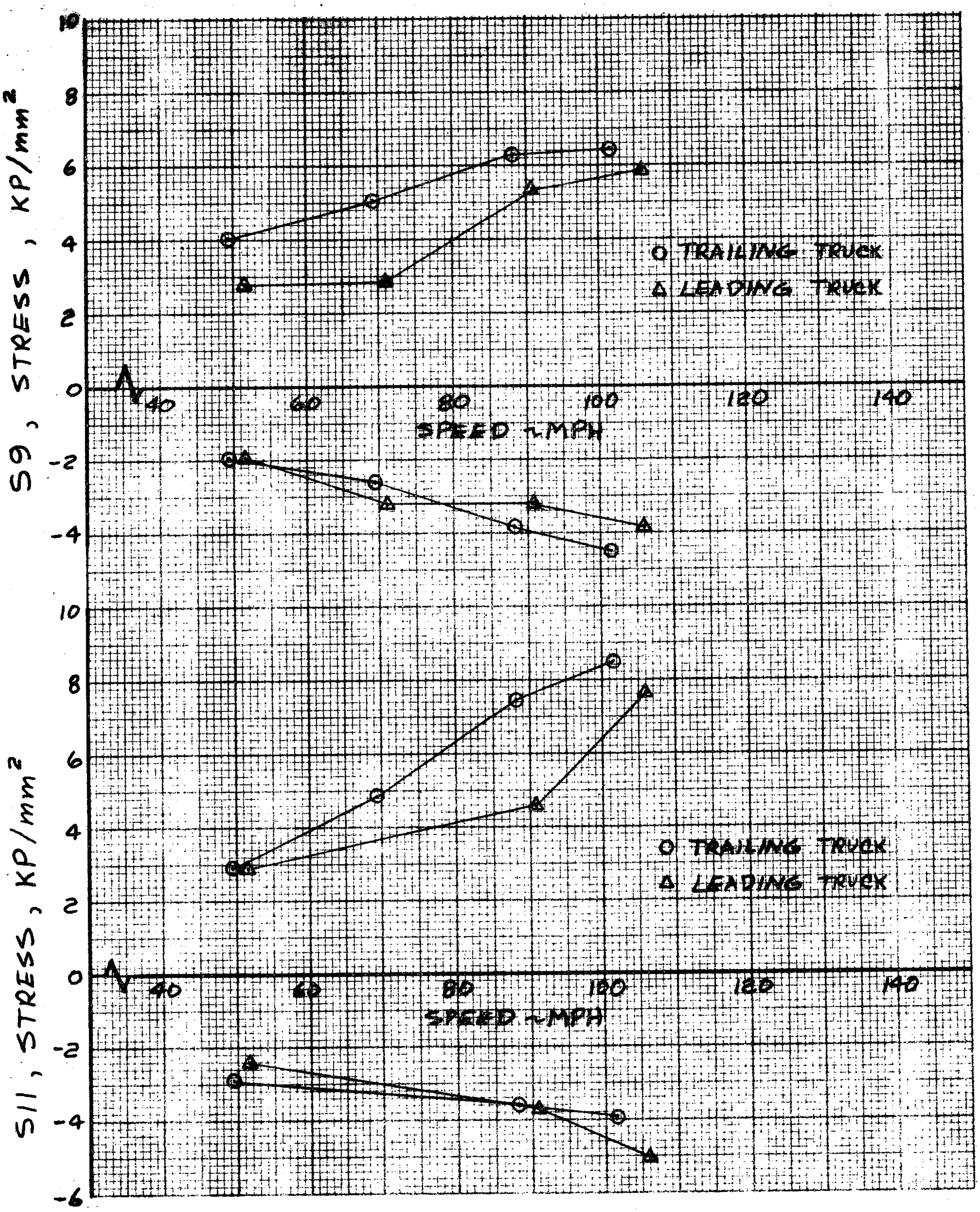


FIGURE 3.5-43 RADIUS STRESS SENSITIVITY

TABLE 3-1

TRACK CONDITIONS (Sht 1 of 2)

ROUTE: Wilmington - Baltimore

TEST NO.	MILEPOSTS	TRACK DESCRIPTION	TRACK #	TRACK TYPE
1	Yard Track	Straight	"0"	Bolted
2	31 - 33	Straight	4	Bolted
3	34 - 36	30' Curve, 1" Superel.- Straight - 20' curve, 2 1/2" Superelevation.	4	Bolted
3a	44 - 47	14' curve 1.0 superel.- straight.-34' curve 1 1/2" superelevation- straight.-1.0° curve 5 1/2" superel.	3	Bolted
4	58 - 59	Straight		Bolted
5	62 - 66	40' curve. 2 1/2" superelev. - straight- 1° curve. 5" superel.- straight.	4	Welded
6	77 - 78	Straight - 30° curve 1" superelev. - straight	3	Welded
7	83 - 85	Straight	4	Welded

TABLE 3-1

TRACK CONDITIONS (Sht 2 of 2)

ROUTE: Baltimore - Wilmington

TEST NO.	MILEPOSTS	TRACK DESCRIPTION	TRACK #	TRACK TYPE
1	88 - 87	57' curve 5 1/2" superel.	2	Welded
2	85 - 84	Straight	2	Welded
3	78 - 76	Straight - 30' curve 1" superel. - thru Magnolia Interlock on straight track.	2	Welded
3a	69 - 66.5	Straight - 32' curve, 2" superelevation.	2	Welded
4	62 - 60	Straight - 45' curve 2" superelevation - straight thru Havre de Grace Interlock	1	Welded
5	55 - 52	10' curve 1" superelevation - 34' curve 2" superelevation - 1° 08' curve 6" superelevation.	2	Welded
6	48 - 46	Straight - 1° curve, 5" superelevation - straight.	2	Welded
6a	39 - 38	Straight through Davis Interlocking	2	Welded
7	37 - 35	Straight - 20' curve 1" superelevation- Straight.	2	Welded
8	30 - 29	Straight - thru Ragan Interlock - 52' curve 5" superelevation.	2	Welded

TABLE 3-2 **(Sht 1 of 14)**
DESCRIPTION OF TEST OPERATIONS
ADDITIONAL RUNNING TESTS

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
2-28-75	15	1	Yard Track	"0"	4,8,&12	Baseline Suspension System
		2	Yard Track	"0"	4,8,&12	Baseline Suspension System
		3	Yard Track	"0"	4,8,&12	Baseline Suspension System
		4	Yard Track	"0"	4,8,&12	Baseline Suspension System
		5	Yard Track	"0"	4,8,&12	Suspension System Configuration No. 2
		6	Yard Track	"0"	4,8,&12	Suspension System Configuration No. 2
3-3-75	16	1	31-33	4	70	Baseline Suspension System Configuration
		2	34-36	4	40	Run 16: Route - Wilmington to Baltimore, Consist 855 —— 850 → Southbound
		3	57-59	4	20	
		4	62-66	4	90	
		5	77-78	3	105 △	△ These two tests cancelled because of poor train operation.
		6	83-85	4	105 △	
	17	1	88-87	2	40	Run 17: Route - Baltimore to Wilmington, Consist 850 —— 855 → Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		4	62-59	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	105	
3-5-75	18	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 3
		2	31-33	4	40	Run 18: Route - Wilmington to Baltimore, Consist 855 —— 850 → Southbound
		3	34-36	4	70	
		4	57-59	4	20	
		5	62-66	4	90	*Did not attain 105 mph because train accelerated too slowly.
		6	77-78	3	105*	
		7	83-85	4	105	

TABLE 3-2 (Sht 2 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
3-5-75	19	1	88-87	2	40	Run 19: Route - Baltimore to Wilmington Consist 850 — 855 → Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		3a	Accelerated to 105 mph from a standing stop. Began this test at MP69.			
		4	62-59	1	70	
		4a	Stopped between milepost 59 and milepost 58 and measured the carbody roll angle on superelevated track.			
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	105	
3-7-75	20	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 4
		2	31-33	4	70*	*Speed was low at MP31
		3	34-36	4	40	Run 20: Route - Wilmington to Baltimore Consist 855 — 850 → Southbound
		4	57-59	4	20	
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	
	21	1	88-87	2	40	Run 21: Route - Baltimore to Wilmington Consist 850 — 855 → Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105 Δ	Δ Acceleration test from a standing stop at milepost 69.
		4	62-60	1	70*	* This test was aborted due to a speed restricting signal.
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	105	

TABLE 3-2 (Sht 3 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
3-11-75	22	1	Yard	"0"	4,8,&12	
		2*	31-33	4	70	Suspension System Configuration No. 5
		3	34-36	4	40	Run 22: Route - Wilmington to Baltimore Consist [855]——[850]→Southbound
		3a	44-47	3	50	* Speed was low at the beginning of this test (58 mph).
		4	57-59	4	20	
		5	62-66	4	90	
		6 Δ	77-78	3	105	Δ Speed was 94 mph at the beginning of this test.
		7	83-85	4	105	
	23	1	88-87	2	40	Run 23: Route - Baltimore to Wilmington Consist [850]——[855]→Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105Δ	Δ Acceleration run - slow to accelerate, low on final speed - one traction motor inoperable on car 850.
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	105	

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
						Suspension System Configuration No. 6
3-14-75	24	1	In Yard	"0"	4,8,&12	**Run 24: Route - Wilmington to Baltimore** **Consist [855]—[850]—Southbound**
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90 △	△ **Test was begun at 80 mph**
		6	77-78	3	105 □	□ **Test was begun at 90 mph**
		7	83-85	4	105 ○	○ **Test was started at MP 83.5 instead of 83 as planned**
	25	1	88-87	2	40	**Run 25: Route - Baltimore to Wilmington** **Consist [850]—[855]→Northbound**
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105 ○	○ **Acceleration run from a standing stop. Started this test from MP69.**
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
3-18-75	26	1	In Yard	"0"	4,8,&12	Suspension System Configuration No. 7
		2	31-33	4	70	
		3	34-36	4	40	Run 26: Route - Wilmington to Baltimore Consist [855]—[850]→Southbound
		3a	44-47	3	50	
		4	58-59	4	20	
		5 ■	62-66	4	90	■ This test was deleted because right of way maintenance was in progress.
		6 ▲	77-78	3	105	▲ Speed was low at the beginning of this test; 97 mph

TABLE 3-2 (Sht 5 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
3-18-75	26	7	83-85	4	105	
	27	1	88-87	2	40	Run 27: Route - Baltimore to Wilmington Consist [850]——[855]→ Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a	69---	2	0-105	△ Acceleration run beginning at MP69 Test data recording began just past milepost 62.
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
3-21-75	28	1	In Yard	"0"	4,8,&12	Suspension System Configuration No. 8
		2	31-33	4	70	Run 28: Route - Wilmington to Baltimore Consist [855]——[850]→ Southbound
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5○	62-66	4	90	○ Test cancelled because of road repairs.
		6	77-78	3	105	
		7□	83-85	4	105	□ Speed was low (95 mph) at the beginning of this test
	29	1	88-87	2	40	Run 29: Route - Baltimore to Wilmington Consist [850]——[855]→ Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105	
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	

TABLE 3-2 (Sht 6 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
3-21-75	29	7	37-35	2	105	
	"	8	30-29	2	80	
3-21-75	30	1*	Yard	"0"	4&8	Suspension System Configuration No. 9 Run 30: Route - Wilmington to Baltimore Consist [855]——[850]→ Southbound * Test Conducted going north.
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90	Test cancelled because of road repairs
		6	77-78	3	105	
		7	83-85	4	105	
	31	1	88-87	2	40	Run 31: Route - Baltimore to Wilmington Consist [850]——[855]→ Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105	
		4	62-60	1	70	
		△ 5	55-52	2	90	△ Speed high at start of test
		□ 6	48-46	2	105	□ Speed varied between 98 and 110 mph during test
		7	37-35	2	105	
		8	30-29	2	80	
3-25-75	32	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 10 Run 32: Route - Wilmington to Baltimore Consist [855]——[850]→ Southbound
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	

TABLE 3-2 (Sht 7 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
3-25-75	33	1	88-87	2	40	Run 33: Route - Baltimore to Wilmington Consist 850 —— 855 → Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a	69---	2	0-105	△ Cancelled because of road repairs.
		□ 4	62-60	1	70	□ Cancelled because of road repairs.
		○ 5	55-52	2	90	○ Continued data recording to MP51.
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
3-25-75	34	1	West Yard	22	8	Run 34: Route - Wilmington to Baltimore Consist 855 —— 850 → Southbound Suspension System Configuration No. 11
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	
	35	1	88-87	2	40	
		2	85-84	2	40	Run 35: Route - Baltimore to Wilmington Consist 850 —— 855 → Northbound
		3	78-76	2	70	
		3a	69---	2	0-105	
		▲ 4	62-60	1	70	▲ Speed was low at the beginning of this test.
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
		■ 8a	Yard	"0"	6&12	■ Test conducted going north.

TABLE 3-2 (Sht 8 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
						Suspension System Configuration No. 12 (Improved)
4-15-75	36	1	Yard	"0"	4,8,&12	Run 36: Route Wilmington to Baltimore Consist [855]—[850]→Southbound
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	Speed was low during this test
	37	1	88-87	2	40	Run 37: Route - Baltimore to Wilmington Consist [850]—[855]→Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a	69---	2	0-105	△ These tests were not conducted because of road repair.
		△ 4	62-59	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		7	37-35	2	105	
		□ 8	30-29	2	80	□ Speed varied during this test due to operator error.
4-18-75	38	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 13
		2	31-33	4	70	
		3	34-36	4	40	Run 38: Route - Wilmington to Baltimore Consist [855]—[850]→Southbound
		3a	44-47	3	50	
		4	58-59	4	20	
		▲ 5	62-66	4	90	▲ Speed low going into this test.
		6	77-78	3	105	
		7	83-85	4	105	

TABLE 3-2 (Sht 9 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
4-18-75	39	1	88-87	2	40	Run 39: Route - Baltimore to Wilmington Consist [850]——[855]→Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a				△ Deleted because of road repairs
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		6a	39-38	2	105	
		7	37-35	2		
		8	30-29	2	80	
4-18-75	40	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 14 Run 40: Route - Wilmington to Perryville Consist [855]——[850]→Southbound
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5 ⬡				
		6 ⬡				
		7 ⬡				
	41	1 ⬡				⬡ These tests were not conducted since Runs 40 and 41 were terminated and begun at Perryville.
		2 ⬡				
		3 ⬡				
		3a ⬡				
		4 ⬡				
		4a	59-58	4	20	Run 41: Route - Perryville to Wilmington Consist [850]——[855]→Northbound
		5	55-52	2	90	
		6	48-46	2	105	
		6a	39-38	2	105	
		7	37-35	2	105	
		8	30-29	2	80	

TABLE 3-2 (Sht 10 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
4-18-75	41	8a	In Yard	"0"	4,8,&12	This test conducted going north
4-22-75	42	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 15
		2	31-33	4	70	
		3	34-36	4	40	Run 42: Route - Wilmington to Baltimore Consist [855]——[850]→Southbound
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	Speed was 93 mph going into this test
	43	1	88-87	2	40	Run 43: Route - Baltimore to Wilmington Consist [850]——[855]→Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a				△ This test was not conducted because of road repairs.
		4	62-60	1	70	
		5	55-52	2	90	
		6	48-46	2	105	
		6a	39-38	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
4-22-75	44	□ 1				Suspension System Configuration No. 16 □ Test was not conducted since run 44 was begun from west yard.
		2	31-33	4	70	Run 44: Route - Wilmington to Baltimore Consist [850]——[855]→Southbound
		3	34-36	4	40	
		3a	44-47	3	50	
		4	57-59	4	20	
		5	62-66	4	90	

TABLE 3-2 (Sht 11 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
4-22-75	44	6	77-78	3	105	
	"	7	83-85	4	109	
	45	1	88-87	2	40	Run 45: Route - Baltimore to Wilmington Consist [855]—[850]→Northbound
		2	85-84	2	40	
		3	78-76	2	70	
		△ 3a				△ This test was aborted due to speed restrictions.
		4	62-60	2	70	
		5	55-52	2	90	
		6	48-46	1	105	
		6a	39-38	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
4-29-75	50	1	Yard	"0"	4,8,&12	Run 50: Route - Wilmington to Perryville Consist [850]—[855]→Southbound
		2	31-33	4	70	
		3	34-36	4	40	⬡ Conducted a braking test from 105 mph at MP44 zero brake
		⬡				
		4	58-59	4	20	
	51	5	55-52	2	90	Run 51: Route - Perryville to Wilmington Consist [850]—[855]→Northbound
		6	48-46	2	105	
		6a	39-38	2	105	Suspension System Configuration No. 17 for runs 50, 51, 52, 53.
		7	37-35	2	105	
		8	30-29	2	80	
4-29-75	52	2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	2	50	Run 52: Route - Wilmington to Perryville Consist [855]—[850]→Southbound
		4	58-59	4	20	
	53	5	55-52	2	90	Run 53: Route - Perryville to Wilmington Consist [855]—[850]→Northbound

TABLE 3-2 (Sht 12 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
4-29-75	53	6	48-46	2	105	✱Test was aborted due to a speed restriction
		6a	39-38	2	105	
		7	37-36	2	105	
		8	30-29	2	✱	
4-30-75	54	1	Yard	"0"	4,8,&12	Suspension System Configuration No. 18 Run 54: Route - Wilmington to Perryville Consist 850 —— 855 → Southbound
		2	31-33	4	70	
		3	34-36	4	40	Run 55: Route - Perryville to Wilmington Consist 850 —— 855 → Northbound
		3a	44-47	3	50	
		4	58-59	4	20	
	55	5	55-52	3	Note 1	
		6	48-46	3	105	Note 1: The train was turned on the Perryville "Wye" between runs 54 & 55.
		6a	39-38	2	105	
		*7	37-35	2	105	*Aborted test due to speed restriction.
		8	30-29	2	80	
4-30-75	56	1	Note 2			Suspension System Configuration No. 18
		2	31-33	4	70	Note 2: Test 1 was not conducted since run 56 began from west yard.
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
	57	*5	55-52	3	Note 3	
	"	6	48-46	3	105	Note 3: The train was turned on the Perryville "Wye" between runs 56 & 57.
	"	6a	39-38	2	105	Run 56: Route - Wilmington to Perryville Consist 855 —— 850 → Southbound

TABLE 3-2 (Sht 13 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
4-30-75	57	7	37-36	2	105	
	"	8	30-29	2	80	Run 57: Route - Perryville to Wilmington Consist 855 - 850 Northbound
5-5-75	66	1	Yard	"0"	4,8,&12	Suspension System in Final Configuration - Runs 66, 67, 68 & 69. * The train was turned on the "Wye" at Perryville between tests 4 and 5 of runs 66 and 68.
		2	31-33	4	70	
		3	34-36	4	40	
		3a	44-47	3	50	
		4	58-59	4	20	
		5	62-66	4	90*	
		6	77-78	3	105	
		7	83-85	4	105	
5-6-75	67	1	88-87	2	40	Run 66: Route - Wilmintong to Washington Consist [850]—[855]→ Southbound To Perryville
		2	85-84	2	40	Consist [855]—[850]→ Southbound Perryville to Washington
		3	78-76	2	70	
		△ 3a	69---	2	0-105	△ Acceleration Run
		4	62-59	1	70	
		5	55-52	2	90	Run 67: Route - Baltimore to Wilmington Consist [855]—[850]→ Northbound
		6	48-46	2	105	
		6a	39-38	2	105	
		7	37-35	2	105	Run 68: Route - Wilmington to Baltimore Consist [855]—[850]→ Southbound To Perryville
		8	30-29	2	80	
	68	2	31-33	4	70	
	"	3	34-36	4	40	Consist [850]—[855]→ Southbound Perryville to Baltimore

TABLE 3-2 (Sht 14 of 14)

DATE	RUN #	TEST #	TEST CONDUCTED BETWEEN MP AND MP	TRACK #	BALANCE SPEED MPH	COMMENTS
5-6-75	68	3a	44-47	3	50	Run 69: Route - Baltimore to Wilmington
		4	58-59	4	20 *	Consist 850 —— 855 → Northbound
		5	62-66	4	90	
		6	77-78	3	105	
		7	83-85	4	105	
	69	1	88-87	2	40	
		2	85-84	2	40	
		3	78-76	2	70	
		3a	69---	2	0-105	
		4	62-60	2	70	
		5	55-52	2	90	
		6	48-46	1	105	
		6a	39-38	2	105	
		7	37-35	2	105	
		8	30-29	2	80	
5-7-75	70	1	38-42	3	20	Suspension System Configuration No. 20
		2	42-44	3	70	
		3	47-49	3	90	Run 70: Route - Wilmington to Perryville Consist 850 —— 855 → Southbound
		4				Minimum braked to a stop from 90 mph
	71	1	38-34	2	70	
		2	38-36	2	90	Run 71: Route - Perryville to Wilmington Consist 855 —— 850 → Northbound
		3	36---	2	105	
5-7-75	72	1	38-44	2	50	Suspension System Configuration No. 21
		2	42-44	2	70	
		3	47-49	2	70	Run 72: Route - Wilmington to Perryville
		4	Min brake stop	2		
	73	1	38-44	2	90	Run 73: Route - Perryville to Wilmington Consist 855 —— 850 → Northbound
	"	2	36---	2	105	

TABLE 3-3

DESCRIPTION OF SUSPENSION SYSTEM CONFIGURATIONS

ADDITIONAL RUNNING TESTS

CONFIGURATION NO. 1 BASELINE
Used on run nos 15, 16, and 17
Roll bar - standard
Secondary lateral springs - 2 metallastic
2 batague (unshimmed)
Secondary lateral damping - (1) damper set at nominal damping
Secondary vertical damping - 16 mm orifices
Secondary vertical stiffness - Intermediate air tank
Bellcrank pivot bearing - Bushing (high friction)
Primary vertical damping - dampers set at nominal (baseline)
Yaw damping - baseline

CONFIGURATION NO. 2
Used on run no 15
Roll bar - none
Other parameters - baseline

CONFIGURATION NO. 3
Used on run nos. 18 and 19
Roll bars - Stiff
Other parameters - baseline

CONFIGURATION NO. 4
Used on run nos. 20 and 21
Roll bars - Stiff roll bars
Secondary lateral stops - all metallastic
Other parameters - baseline

CONFIGURATION NO. 5
Used on run nos. 22 and 23
Roll bars - stiff
Secondary lateral stops - all batague (shimmed)
Other parameters - baseline

CONFIGURATION NO. 6
Used on run nos 24 and 25
Roll bars - Stiff
Secondary lateral stops - 2 metallastic
2 batague (shimmed)
Secondary lateral damping - doubled
All other parameters - baseline

NOTE: All configurations are on a per truck basis.

TABLE 3-3 (Cont'd)

CONFIGURATION NO. 7
Used on run nos. 26 and 27
Roll bars - stiff
Secondary lateral stops - same as configuration 6
Secondary lateral damping - minimum
All other parameters - baseline

CONFIGURATION NO. 8
Used on run nos 28 and 29
Secondary lateral stops - same as configuration 7
Roll bars - stiff
Secondary vertical damping - 20 mm orifices hydraulic damping
All other parameters - baseline

CONFIGURATION NO. 9
Used on run nos. 30 and 31
Roll bars - stiff
Secondary lateral stops - same as configuration 8
Secondary vertical damping - 20 mm orifices
All other parameters - baseline

CONFIGURATION NO. 10
Used on run nos 32, 33
Roll bars - Stiff
Secondary lateral stops - same as configuration 9
Secondary vertical damping - 20 mm orifices
Secondary vertical stiffness - large air tank
All other parameters - baseline

CONFIGURATION NO. 11
Used on run nos 34 and 35
Same as configuration no 10 except
Primary vertical damping - none

CONFIGURATION NO. 12 (Improved)
Used on run nos 36, 37, 44 and 45
Roll bars - Stiff
Secondary lateral stops - 2 metallastic (per truck)
2 batague (shimmed)
Secondary lateral damping - doubled
Secondary vertical damping - 20 mm orifices
Secondary vertical stiffness - large air tank
Bellcrank pivot bearing - low friction
Primary vertical damping - baseline
Yaw damping - baseline

CONFIGURATION NO. 13
Used on run no. 38 and 39
Same as improved configuration (No. 12)except:
Secondary vertical damping - hydraulic dampers installed
Primary vertical damping - Tripled

TABLE 3-3 (Cont'd)

CONFIGURATION NO. 14
Used on runs 40 and 41
Same as improved configuration (No. 12) except:
Primary vertical damping - Tripled

CONFIGURATION NO. 15
Used on runs 42 and 43
Same as improved configuration (No. 12) except:
Yaw damping - None

CONFIGURATION NO. 16
Used on run nos 46, 47 and 48
Same as improved configuration (No. 12) except:
Batague lateral stops were unshimmed
Primary vertical damping - doubled

CONFIGURATION NO. 17
Used on run nos. 50, 51, 52 and 53
Same as improved configuration (No. 12) except:
Primary vertical damping - baseline X 1.5

CONFIGURATION NO. 18
Used on run nos 54 through 65
Same as configuration 17 except:
Secondary lateral damping - baseline

CONFIGURATION NO. 19 (Final)
Used on runs 66, 67, 68 and 69
Roll bars - Stiff
Secondary lateral stiffness - 1/2 metallastic
1/2 batague (unshimmed)
Secondary lateral damping - baseline X 1.5
Secondary vertical damping - 20 mm orifices
Secondary vertical stiffness - large air tank
Bellcrank pivot bearing - low friction
Primary vertical damping - baseline X 1.5
Yaw damping - baseline

CONFIGURATION NO. 20
Used on run nos 70 and 71 (failure mode runs)
Same as final configuration (No. 19)
with secondary springs on the "A" truck fully
inflated (safety hooks engaged)

CONFIGURATION NO. 21
Used on run nos. 72 and 73 (failure mode runs)
Same as final configuration (No. 19) with
secondary springs on the "A" truck deflated.

TABLE 3-4 (Sht 1 of 4)
SUSPENSION COMPONENT VARIATIONS - PER TRUCK

	COMPONENT	SUSPENSION SYSTEM CONFIGURATION NUMBER 1 BASELINE	2	3	4	5
PRIMARY	Vertical Stiffness Lb/In	17,800 ←	—	—	—	→ 17,800
PRIMARY	Vertical Damping Lb-Sec/In	336 ←	—	—	—	→ 336
PRIMARY	Lateral Stiffness Lb/In	347,200 ←	—	—	—	→ 347,200
PRIMARY	Lateral Damping Ratio	0.05 ←	—	—	—	→ 0.05
PRIMARY	Longitudinal Stiffness Lb/In	336,000 ←	—	—	—	→ 336,000
SECONDARY	Vertical Stiffness Lb/In	6,412 ←	—	—	—	→ 6,412
SECONDARY	Aux. Volume Liters	74 ←	—	—	—	→ 74
SECONDARY	Vertical Damping Lb-Sec/In	550 ←	—	—	—	→ 550
SECONDARY	Low Amplitude Lateral Stiffness Lb/In	4,760 3,750	4,760 3,750	4,760 3,750	3,696 3,750	6,076 6,050
SECONDARY	Lateral Damping Lb-Sec/In	297 ←	—	—	—	→ 297
SECONDARY	Longitudinal Stiffness Lb/In	53,800 ←	—	—	—	→ 53,800
SECONDARY	Longitudinal Damping Ratio	0.05 ←	—	—	—	→ 0.05
SECONDARY	Roll Bar Stiff-ness Lb/In/Radian	24.0×10^6	None	46.0×10^6	46.0×10^6	46.0×10^6
SECONDARY	Yaw Damper Load at 0.4 m/sec	3,087 ←	—	—	—	→ 3,087

TABLE 3-4 (Sht 2 of 4)

SUSPENSION COMPONENT VARIATIONS - PER TRUCK

	COMPONENT	SUSPENSION SYSTEM CONFIGURATION NUMBER 6	7	8	9	10
PRIMARY	Vertical Stiffness Lb/In	17,800 ←	—	—	—	→ 17,800
PRIMARY	Vertical Damping Lb-Sec/In	336 ←	—	—	—	→ 336
PRIMARY	Lateral Stiffness Lb/In	347,200 ←	—	—	—	→ 347,200
PRIMARY	Lateral Damping Ratio	0.05 ←	—	—	—	→ 0.05
PRIMARY	Longitudinal Stiffness Lb/In	324,800 ←	—	—	—	→ 324,800
SECONDARY	Vertical Stiffness Lb/In	6,412 ←	—	—	→ 6,412	5,852
SECONDARY	Aux. Volume Liters	74 ←	—	—	→ 74	85
SECONDARY	Vertical Damping Lb-Sec/In	550	550	550	207	207
SECONDARY	Low Amplitude Lateral Stiffness Lb/In	4,900 ←	—	—	—	→ 4,900
SECONDARY	Lateral Damping Lb-Sec/In	594	594	594	594	594
SECONDARY	Longitudinal Stiffness Lb/In	53,800 ←	—	—	—	→ 53,800
SECONDARY	Longitudinal Damping Ratio	0.05 ←	—	—	—	→ 0.05
SECONDARY	Roll Stiffness Lb/In/Radian	46.0×10^6 ←	—	—	—	→ 46.0×10^6
SECONDARY	Yaw Damper Load at 0.4 m/sec	3,087 ←	—	—	—	→ 3,087

TABLE 3-4 (Sht 3 of 4)
SUSPENSION COMPONENT VARIATIONS - PER TRUCK

	COMPONENT	SUSPENSION SYSTEM CONFIGURATION NUMBER 11	12 IMPROVED	13	14	15
PRIMARY	Vertical Stiffness Lb/In	17,800 ←				→ 17,800
	Vertical Damping Lb-Sec/In	None	336	1,008	1,008	336
	Lateral Stiffness Lb/In	347,200 ←				→ 347,200
	Lateral Damping Ratio	0.05 ←				→ 0.05
	Longitudinal Stiffness Lb/In	329,800 ←				→ 329,800
SECONDARY	Vertical Stiffness Lb/In	5,852 ←				→ 5,852
	Aux. Volume Liters	85 ←				→ 85
	Vertical Damping Lb-Sec/In	207	207	550	207	207
	Low Amplitude Lateral Stiffness Lb/In	4,900 ←				→ 4,900
	Lateral Damping Lb-Sec/In	594 ←				→ 594
	Longitudinal Stiffness Lb/In	53,800 ←				→ 53,800
	Longitudinal Damping Ratio	0.05 ←				→ 0.05
	Roll Stiffness Lb-In/Radian	46.0×10^6 ←				→ 46.0×10^6
	Yaw Damper Load @ 0.4 m/sec	3,087	3,087	3,087	3,087	None

TABLE 3-4 (Sht 4 of 4)
SUSPENSION COMPONENT VARIATIONS - PER TRUCK

	COMPONENT	SUSPENSION SYSTEM CONFIGURATION NUMBER 16	17	18	19 FINAL	20 *	21 *
PRIMARY	Vertical Stiffness Lb/In	17,800 ←			→ 17,800		
PRIMARY	Vertical Damping Lb-Sec/In	672	504	504	504		
PRIMARY	Lateral Stiffness Lb/In	347,200 ←			→ 347,200		
PRIMARY	Lateral Damping Ratio	0.05 ←			→ 0.05		
PRIMARY	Longitudinal Stiffness Lb/In	324,800 ←			→ 324,800		
SECONDARY	Vertical Stiffness Lb/In	5,852 ←			→ 5,852		
SECONDARY	Aux. Volume Liters	85 ←			→ 85		
SECONDARY	Vertical Damping Lb-Sec/In	207 ←			→ 207		
SECONDARY	Low Amplitude Lateral Stiffness Lb/In	4,760 ← 3,750			→ 4,760 3,750		
SECONDARY	Lateral Damping Lb-Sec/In	594	594	297	445		
SECONDARY	Longitudinal Stiffness Lb/In	53,800 ←			→ 53,800		
SECONDARY	Longitudinal Damping Ratio	0.05 ←			→ 0.05		
SECONDARY	Roll Stiffness Lb-In/Radian	46.0×10^6 ←			→ 46.0×10^6		
SECONDARY	Yaw Damper Load @ 0.4 m/sec	3,087 ←			→ 3,087		

* No data are included for configurations 20 and 21 since they were special for failure mode runs. Refer to Table 5.5-3 for a description of 20 and 21.

C.L.= CENTERLINE
A-TRUCK } CAR 850
B-TRUCK

TABLE 3-5
RECORDING SETUP - LOADS MEASUREMENT TESTS

DATES: February 24 and 26 1975

CHANNEL	TAPE RECORDER			OSCILLOGRAPH NO. 1			OSCILLOGRAPH NO. 2		
	ITEM	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION
1	1	TFZ-1B	*	1	P-1	*	1	TFZ-1B	*
2	2	TFY-1A		2	D-1		2	RB-1B	
3	3	TFX-1B		3	D-2		3	RB-2A	
4	4	TR-1A		4	D-4		4	TS-3	
5	5	TS-2		5	D-5		5	TS-4	
6	6	VD-1		6	D-6		6	TFZ-3B	
7	7	RB-1A		7	D-6A		7	TFY-3B	
8	8	LD-1B		8	D-8		8	TFX-3A	
9	9	LB-2B		9	D-7		9	S-8	
10	10	MV-1B		10	AR-2A		10	S-9	
11	11	YD-1		11	TR-2A		11	S-10	
12	12	AR-2A		12	TR-4B		12	S-11	
13	13	D-8		13		Analog of Train Speed	13	TSS	Train Speed
14	14	T/C	Time Code	14	TSS	Train Speed			
15	15		Voice on Side Track	15					
16									

* Refer to pages 55, 56, 57 and 99 of reference 4.1.1 for a description of these data.

CL = CENTERLINE
A - TRUCK } CAR 850
B - TRUCK }

TABLE 3-6

RECORDING SETUP - LOADS MEASUREMENT TESTS

DATES: April 24 and 25 1975

CHANNEL	TAPE RECORDER			OSCILLOGRAPH NO. 1			OSCILLOGRAPH NO. 2		
	ITEM	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION
1	1	TFZ-1B	*	1	P-1	*	1	TFZ-2A	*
2	2	TFY-1A		2	D-1		2	TFY-2A	
3	3	TFX-1B		3	D-2		3	TFX-2B	
4	4	TR-1A		4	D-3		4	TR-2A	
5	5	A-1		5	D-5		5	TS-4	
6	6	VD-2		6	D-7		6	D-6	
7	7	RB-1A		7	D-6		7	YD-2	
8	8	LD-1B		8	D-8		8	S-10	
9	9	LB-2B		9	D-6A		9	S-11	*
10	10	MV-1B		10	D-9		10	TSS	Train Speed
11	11	YD-1		11	RB-1B				
12	12	AR-2A		12	LB-1A				
13	13	D-8	*	13	YD-2	*			
14	14	T/C	Time Code	14	------	Analog of Train Speed			
15	15		Voice on Side Track	15	------	Wheel Revolutions			
16									

* See reference 4.1.1 pages 55, 56, 57 and 99 for a description of these data.

•CL=CENTERLINE
-A-TRUCK } CAR 150
B-TRUCK }

TABLE 3-7
RECORDING SETUP - LOAD MEASUREMENT TESTS

DATE: May 2 1975

CHANNEL	TAPE RECORDER			OSCILLOGRAPH NO. 1			OSCILLOGRAPH NO. 2		
	ITEM	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION	TRACE	CODE	DESCRIPTION
1	1	TFZ-1B	*	1	P-1	*	1	TFZ-2A	*
2	2	TFY-1A		2	D-1		2	TFY-2A	
3	3	TFX-1B		3	D-2		3	TFX-2B	
4	4	TR-1A		4	D-3		4	TR-2A	
5	5	A-1		5	D-5		5	YD-2	
6	6	VD-2		6	D-7		6	D-6	
7	7	RB-1A		7	D-6		7	S-8	
8	8	LD-1B		8	D-8		8	S-9	
9	9	LB-1B		9	D-6A		9	S-10	
10	10	MV-1B		10	D-9		10	S-11	*
11	11	YD-1		11	RB-1B		11	TSS	Train Speed
12	12	AR-2A	*	12	LB-1A				
13	13	D-8		13	YD-2	*			
14	14	T/C		14		Analog of Train Speed			
Side 15			Voice Track	15		Wheel Revolutions R2 Wheel			
16									

* Refer to pages 55, 56, 57 and 99 of reference 4.1.1 for a description of these data.

TABLE 3-8

SUMMARY OF LOAD SPECTRUM TEST RUNS
PHASE II TESTS

DATE: February 24 1975

ROUTE: Baltimore, Maryland to Landover, Maryland

CONSIST: [855]—[850]→ Southbound

Voice logged on tape all mileposts and the following interlockings (at track speed).

Interlock	Milepost
"GWYNNS"	99
"ODENTON"	113
"BOWIE"	120

DATE: February 24 1975

ROUTE: Landover, Maryland to Baltimore, Maryland

CONSIST: [850]—[855]→ Northbound

Voice logged on tape all mileposts and the following interlockings (at track speed).

Interlock	Milepost
"BOWIE"	121
"ODENTON"	114
"GWYNNS"	100

DATE: February 26 1975

ROUTE: Baltimore, Maryland to Wilmington, Delaware

CONSIST: [850]—[855]→ Northbound

Voice logged on tape all mileposts and the following interlockings (at track speed).

Interlock	Milepost
"CANTON JUNCTION"	93
"GUNPOW"	80

TABLE 3-8
(Continued)

Interlock	Milepost
"EDGEWOOD"	76
"OAK"	63
"PRINCIPIO"	58
"NORTHEAST"	52
"DAVIS"	39

TABLE 3-9

LOAD SPECTRUM TEST RUNS-
ADDITIONAL TEST PROGRAM

DATE: April 24 1975

ROUTE: Wilmington, Delaware to Washington, D.C.

CONSIST: [850]—[855]→ Southbound

RUN NO. 46

Voice logged on tape all mileposts and conducted the following tests while running at track speed.

TEST NO.	MILEPOSTS	INTERLOCK	TRACK
1	31 - 33		3
2	34 - 36		3
3	38 - 39	"DAVIS"	3
4	44 - 47		3
5	58 - 59		3
6	62 - 66		4
7	75 - 78	"EDGEWOOD"	3
8	83 - 85		4
9	111 -112	"VERN"	-
10	120 -121	"BOWIE"	-

DATE: April 25 1975

ROUTE: Washington, D.C. to Hudson, N. J.

CONSIST: [855]—[850]→ Northbound

RUN NO. 47

Voice logged on tape all mileposts and conducted the following tests while running at track speed.

TEST NO.	MILEPOSTS	INTERLOCK	TRACK
1	121 - 120	"BOWIE"	3
2	112 - 111	"VERN"	1
3	88 - 87		
4	85 - 84		3
5	78 - 75	"EDGEWOOD"	3
6	62 - 60	"HAVRE DE GRACE"	1
7	55 - 52		2
8	48 - 46		2
9	39 - 35	"DAVIS"	2

TABLE 3-9

(Continued)

TEST NO.	MILEPOSTS	INTERLOCK	TRACK
10	30 - 29	"RAGAN"	2
11	12 - 11	"BALDWIN"	2
12	66 - 65	"GRUNDY"	1
13	47 - 46	"NASSAU"	1
14	26 - 25	"LINCOLN"	2
15	13 - 12	"LANE"	1

DATE: April 25 1975

ROUTE: Hudson, N. J. to Wilmington, Delaware

CONSIST: [830]—[855]→ Southbound

RUN NO. 48

Voice logged on tape all mileposts and conducted the following tests while running at track speed.

TEST NO.	MILEPOSTS	INTERLOCK	TRACK
1	12 - 13	"LANE"	3
2	25 - 26	"LINCOLN"	3
3	46 - 48	"NASSAU"	3
4	65 - 66	"GRUNDY"	3
5	11-12	"BALDWIN"	3

TABLE 3-10
LOAD SPECTRUM TEST RUNS-
ADDITIONAL TEST PROGRAM

DATE: 2 May 1975

CONSIST: [850]—[855] → Southbound

Northbound ← [850]—[855]

Conducted three round trips RAGAN - NORTHEAST - RAGAN on track #3, and one round trip RAGAN - PERRYVILLE - RAGAN

RUN NO. 58 (RAGAN - NORTHEAST)

Balance at 105 mph, MP37 to MP39

RUN NO. 59 (NORTHEAST - RAGAN)

Balance at 105 mph, MP39 to MP37

RUN NO. 69 (RAGAN - NORTHEAST)

Balance at 90 mph, MP37 to MP39

RUN NO. 61 (NORTHEAST - RAGAN)

Balance at 90 mph, MP39 to MP37

RUN NO. 62 (RAGAN - NORTHEAST)

Balance at 70 mph, MP37 to MP39

RUN NO. 63 (NORTHEAST - RAGAN)

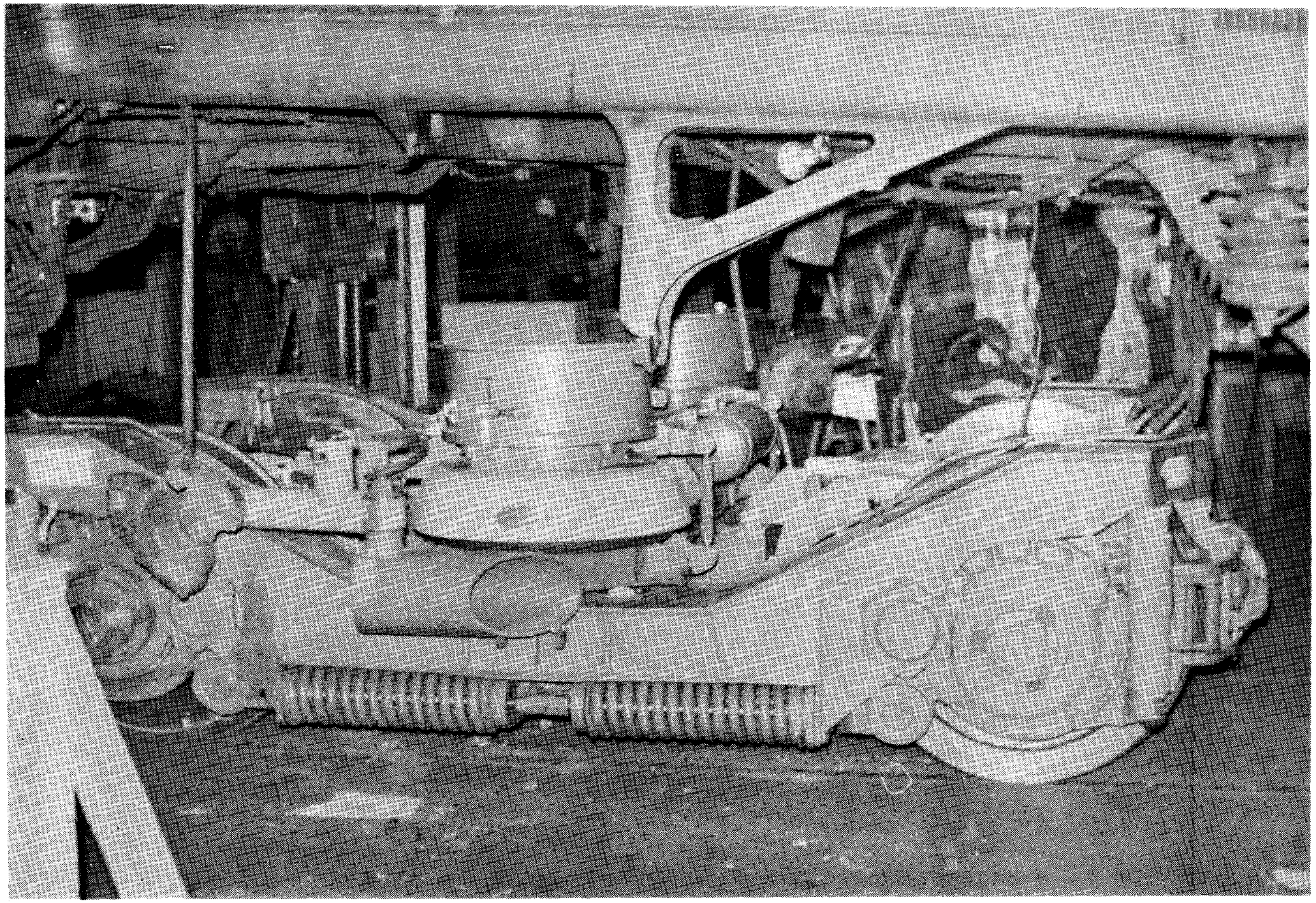
Balance at 70 mph, MP39 to MP37

RUN NO. 64 (RAGAN - PRINCIPIO)

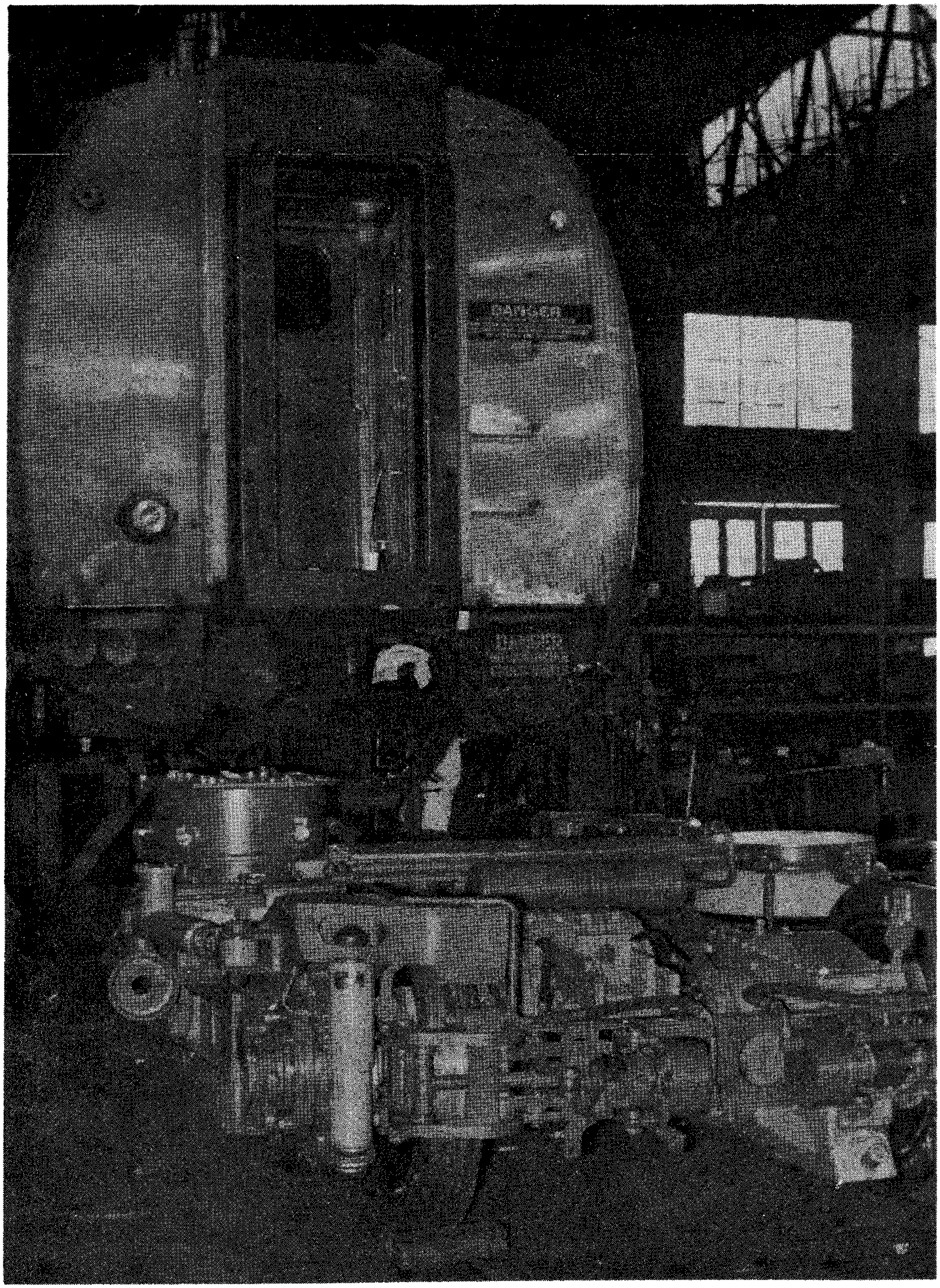
Balance at 50 mph, MP37 to MP39

RUN NO. 65 (PRINCIPIO - RAGAN)

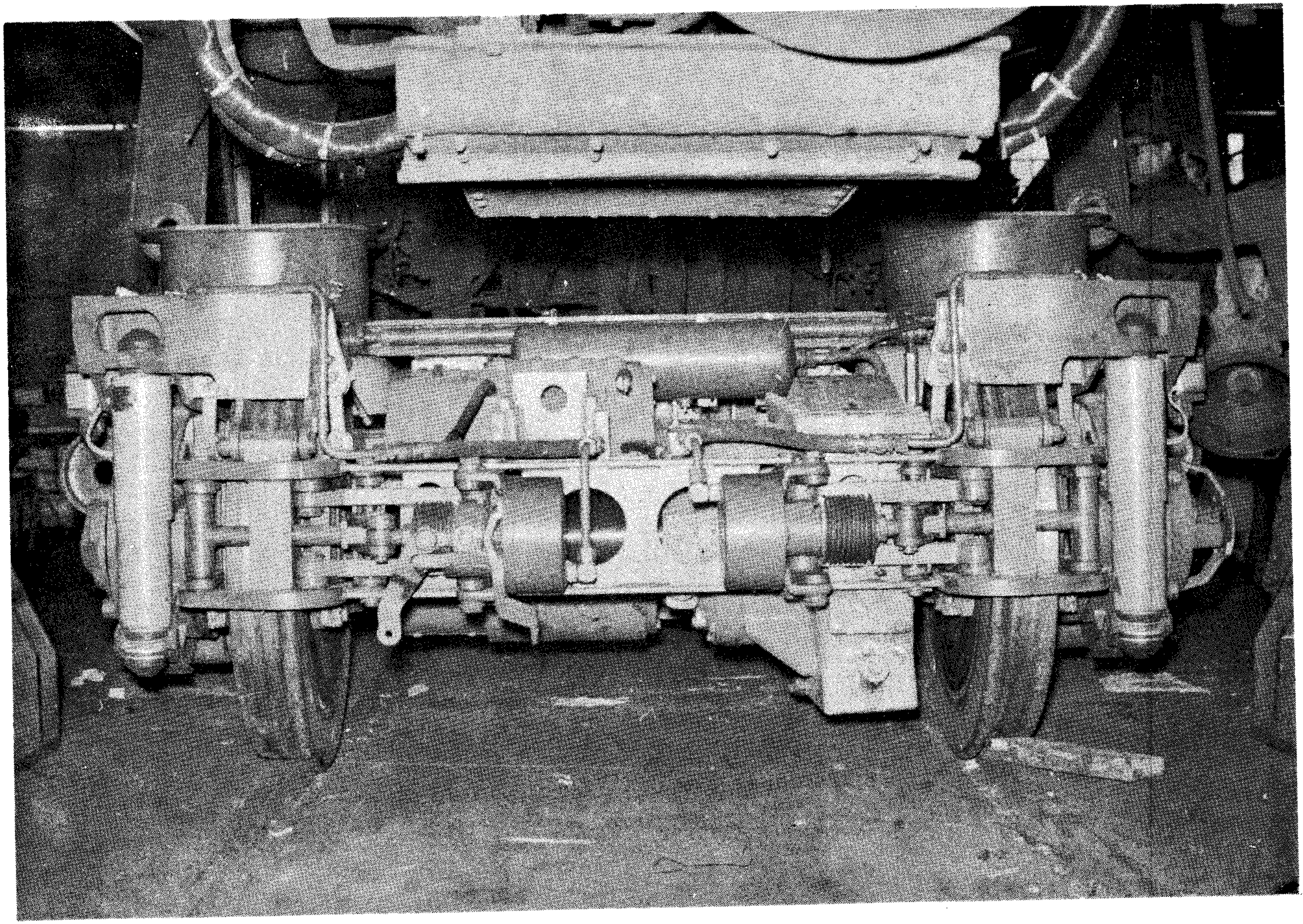
Balance at 50 mph, MP39 to MP37



PHOTOGRAPH NO. 2
PROTOTYPE TRUCK - SIDE VIEW



PHOTOGRAPH NO. 3
PROTOTYPE TRUCK - QUARTER VIEW



PHOTOGRAPH NO. 4
PROTOTYPE TRUCK - END VIEW

5.0 REFERENCES

5.1 REPORTS

(a) FRA-OR&D 76-251, LTV/SIG Metroliner Truck Test - Volume I (Test Report).

(b) FRA-OR&D 76-250, LTV/SIG Metroliner Truck Test - Final Design Report.

(c) "Guide for the Evaluation of Human Exposure to Whole-Body Vibration," International Standard ISO 2631-1974 (E), International Organization for Standardization, 1974.

(d) Lee, R. A. and Pradko, F., "Analytical Analysis of Human Vibration," SAE Paper No. 680091.