TARDEC

---TECHNICAL REPORT---

THE NATION'S LABORATORY FOR ADVANCED AUTOMOTIVE TECHNOLOGY

WINNER OF THE 1994 FEDERAL QUALITY IMPROVEMENT PROTOTYPE AWARD

No. 13681

FINAL REPORT
FOR THE
3,600 MILE DURABILITY TEST
ON THE
M1061A1 5-TON FLATBED TRAILER

MARCH 1996

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NOTICES

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
March 1996

3. REPORT TYPE AND DATES COVERED
Final, Aug 1995 - Jan 1996

4. TITLE AND SUBTITLE
Final Report for the 3,600 Mile Durability Test on the M1061A1 5-Ton Flatbed Trailer

5. FUNDING NUMBERS

6. AUTHOR(S)
Mark J. Brudnak

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Tank-automotive & Armaments Command
Research, Development and Engineering Center
Warren, MI 48397-5000

8. PERFORMING ORGANIZATION REPORT NUMBER
13681

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Tank-automotive & Armaments Command
Research, Development and Engineering Center
Warren, MI 48397-5000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
*See distribution page

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This report presents the results of the full-scale motion base durability testing of a M106A1 5-ton flatbed trailer. The test was conducted using the Pintle Motion Base Simulator (PMBS), simulating the dynamic response on four different APG terrains for a total of 3,600 miles. The objective was to evaluate the durability of this first production item. Twenty-two channels of instrumentation were recorded for use by the customer in determining the functionality and performance of this system.

14. SUBJECT TERMS

Laboratory test	Trailer	DADS
Simulation	M1061A1	Model
PMBS	RPC	

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

PREFACE

This report describes the full-scale motion-base testing of the M1061A1 5-ton flatbed trailer. The test was conducted using the Pintle Motion Base Simulator (PMBS). Questions regarding motion base simulation of trailers using the Pintle Motion Base Simulator are to be referred to the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), ATTN.: Physical Simulation Team, AMSTA-TR-D, Bldg. 215, MS: 157, Warren, MI 48397-5000, Telephone: AUTOVON/DSN 786-7583, Commercial (810)574-7583, FAX (810)574-8667.

The author would like to acknowledge the contributions of several people whose hard work and skill made this test effort a success: Mr. Thomas Ashworth, electrical technician, who did most of the instrumentation work, Mr. Nick Coleman, mechanical technician, who helped with inspections and test monitoring, Mr. Aleksander Kurec, mechanical engineer, who advised on the project, Mr. Terry Hoist, electrical engineer, who was instrumental in preparing the simulator for the test and running the test, Mr. Michael Reininger, lead technician, who coordinated the effort among the technicians, Mr. Elmer Donajkowski and Mr. George Norkus, mechanical technicians, who configured and ran the hydraulics, Mr. Ronald Smith, mechanical technician, who helped with test execution, Mr. John Weller, mechanical engineer, who created and ran the DADS model of the trailer. The author would also like to acknowledge the efforts of Joe Sullivan of Optim Electronics, who provided the data acquisition system used for the validation test, and Martin Craig of nCode International, who aided in the data acquisition process during the validation test. There are many others who aided this test effort who are not mentioned here, who were very necessary in the completion of this test.

TABLE OF CONTENTS

Section | Page

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

Figure | Title | Page

LIST OF FIGURES (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

Table | Title | Page

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

1.0. INTRODUCTION

1.1. General

The Program Manager (PM) for trailers (AMSTA-PM-T) directed the Physical Simulation Team (PST) at TARDEC to perform a durability test on a M1061A1 5-ton flatbed trailer. The Physical Simulation Team responded by performing the test described below.

This report describes and documents the work performed by the Physical Simulation Team to complete 3,600 miles of durability testing on the M1061A1 5-ton flatbed trailer. It documents the test procedure, any problems found, and the recommendations for possible improvements. The test was conducted in the Physical Simulation Laboratory (PSL), Building 215, at TARDEC from 6 December 1995 to 19 January 1996.

1.2. Background

The trailer which was tested is an initial production item (one of the first five) of the M1061A1 trailer. The improvements incorporated in the M1061A1 included reshaping the main longitudinal frame rails, changing the welds on the frame and superstructure, and the addition of bias ply tires. These changes resulted in a weight reduction of several hundred pounds over the previous version.

A prototype M1061A1 trailer, with all of the above changes, was subjected to a 6,000 mile durability test at Nevada Automotive Test Center (NATC) during the summer of 1994. (For a description of this test see reference [1]). Late in the test at NATC, a crack was found in the weld which held the drawbar to the superstructure of the trailer. Also, several of the spring bumper pads had split and failed. Finally, the spare tire carrier cable failed, allowing the spare tire to fall from the trailer. Most of these problems were corrected before the production item was made and shipped to TARDEC for laboratory testing.

At TARDEC, this initial production item was tested to verify that the changes and modifications made after the NATC test were able to survive in a vibration environment. Particular attention was paid to the weld between the drawbar and the superstructure. This portion of the trailer was heavily instrumented and frequently inspected.

1.3. Testing of the System

The trailer test commenced on 6 Dec 1996 and completed on 19 Jan 1996. The test consisted of six 600-mile cycles modeled after the requirements of Military Specification MIL-T-62073E. This specification calls for durability testing on paved highway, secondary roads, level cross-country, hilly cross-country, and Belgian Block for six cycles of 1,000 miles each. The test at TARDEC conformed to this specification with two exceptions: (1) paved road was not simulated, and (2) the entire test was performed with the 5-ton payload installed. Aberdeen Proving Ground (APG) courses were used to represent these terrains, Munson Gravel for secondary roads, Perryman A for level-cross country, and Churchville B for hilly cross-country. A 2,000 foot section of each APG course was used to represent the whole terrain.

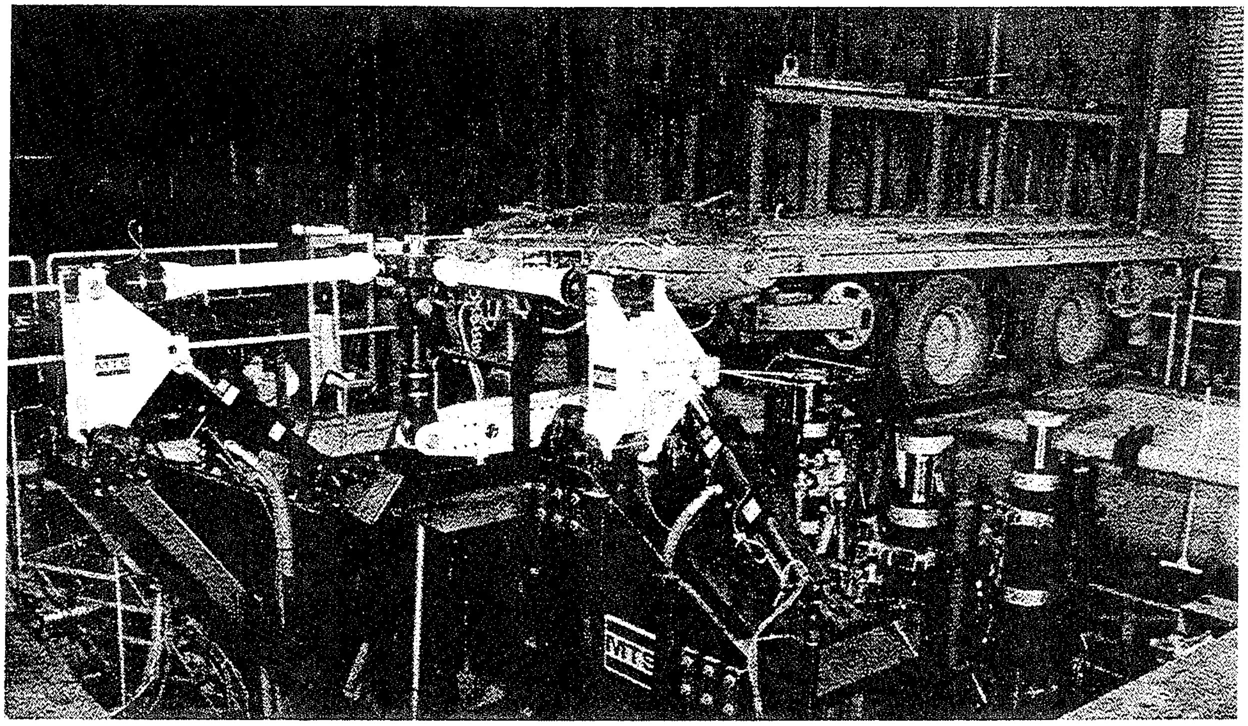

Figure 1-1. M1061A1 5-Ton Flatbed Trailer on the Pintle Motion Base Simulator.

The trailer was subjected to vibrations induced by the above mentioned terrain inputs by means of the Pintle Motion Base Simulator (PMBS). A picture of the M1061A1 trailer attached to the PMBS can be seen in Figure 1-1. The PMBS is capable of inputting vertical, lateral, and longitudinal forces and motions into the lunette of the attached trailer. It also has a vertically oriented actuator on which each of the four trailer tires rest. The motion of these actuators into the tires along with the motion imparted to the lunette of the trailer are the only means by which motion is imparted to the trailer. The goal of this simulation was to make these motions (accelerations) equivalent to those experienced in an actual field test (i.e. realistic). The PMBS uses a control method called Remote Parameter Control™ (RPC[1]) to achieve this realism. Since the motions measured in the laboratory and in the field are equivalent, the field vibration environment is being realistically reproduced in the laboratory. RPC, unfortunately, requires that field response data be recorded to achieve this realism. In this case, a field test was not feasible thus a Dynamic Analysis Design System (DADS) model was generated to produce these response data instead. Since a degree of realism is sacrificed when model data are used instead of field data, the realism of the resulting motion base simulation is limited.

The trailer was instrumented with 22 channels of data acquisition which were continuously monitored throughout the test. Also, the trailer was inspected every morning during the test and any problems found were immediately reported to the PM.

There were three major failures that occurred during testing. Three of the bolts which attach the right trunnion bracket to the leaf spring failed. Each of these failures occurred in a fatigue mode and are documented in the failure reports given in Appendix I. Some other minor failures were also found prior to and during the test. These regarded the leveling jacks (three problems found)

[1] Remote Parameter Control and RPC III are registered trademarks of MTS Systems Corporation.

and one of the tarp tie-down hooks. See Section 5.6 and Appendix A for a description of all of the failures.

1.4. Specimen Description

The specimen that was tested is a M1061A1 5-ton flatbed lunette trailer. It is a double-axle flatbed trailer with a bogie suspension. Its intended use is in the support of M876 laundry units, ANJQR 30 generator sets, the Tank Unit, Liquid Dispensing for Trailer Mounting (TULDTUM), and other systems. Table 1-1 shows other pertinent details about the system tested. A drawing of the trailer can be seen in Figure 1-2.

Table 1-1. Description of the Item Under Test.

Model Number	M1061A1
Identification Number	2413
Part Number	8750137
NSN	2330-01-207-3533
Manufacturer	Utility Tool and Body Company, Inc.
Curb Weight	5,850 lbs.
Maximum Payload	10,000 lbs.
Total Weight	15,850 lbs.
Technical Manual	TM 9-2330-376-14&P
Tires	Goodyear 12-16.5LT Custom Hi-Miler

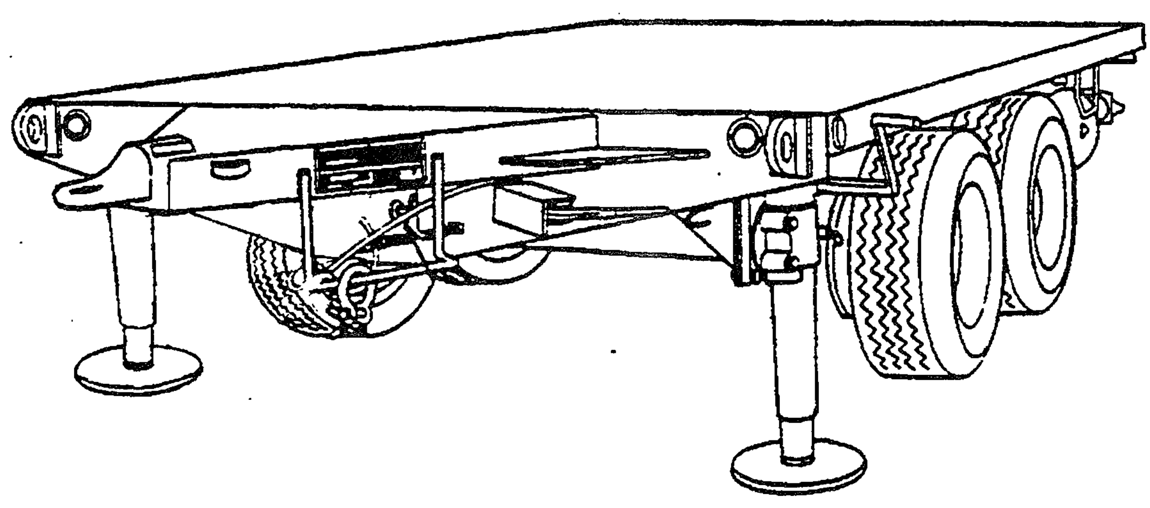

Figure 1-2. M1061A1 5-ton Flatbed Trailer.

2.0. TEST OBJECTIVES

The primary objective for this test was to determine if this initial production item was capable of enduring in a vibration environment representative of its service life. This evaluation primarily related to the vibration induced failures which occurred in the NATC test. These are summarized as follows:

1. Determine the structural integrity of the M1061A1 trailer in a typical vibration environment per the requirements stated in MIL-T-62073E.
2. Specifically determine if the problems which were found in the test at NATC have been adequately corrected.

3.0. CONCLUSIONS

3.1. Major Failures and Problems

The test specimen completed the test with seven incidents that occurred which would limit or prohibit the operation or use of the trailer. First, there were three failures of the bolts holding the right trunnion bracket to the leaf spring (TIR # 006, 008, 009). Second, there were three problems found with the leveling jacks. In one case the right-front leveling jack was found to be inoperable before the start of the test (TIR #002). In another case, this same leveling jack extended while under test and had to be retracted and restrained (TIR #005). Also, the lubrication of the leveling jack swivel locks interferes with normal operation (TIR #007). Finally, a tarp hook failed prior to the start of the test while being used improperly (TIR #004).

3.2. Trunnion Bracket Bolts

The failure of the three bolts on the right hand side of the trailer would interfere with the normal use of the trailer, since the failure of one of these bolts may accelerate the failure of the others. The analysis conducted on one of the broken bolts found that they were <u>not</u> manufactured to surface hardness standards (SAE J429) for a grade 5 bolt. A locally procured grade 5 replacement bolt endured 2,477 miles while two grade 8 replacement bolts (supplied by the trailer manufacturer) endured 1,594 and 1,204 miles respectively. The fourth original bolt on the right side (rear outer) endured the entire test (3,610 miles). For more information on the bolt failures see Section 5.6.1 and Appendices A and I.

3.3. Leveling Jacks

The spot weld on the crank shaft of the right-front leveling jack was not sufficient to allow the extension/retraction of the jack. This, as far as can be determined, was a result of the manufacturing process (as this was the trailer's condition upon arrival). All other leveling jacks functioned properly upon arrival.

The extension of the same leveling jack, while under test, did not cause any permanent damage. The jack, however, did have to be restrained throughout the remainder of the test. Additionally, impact with the tire while under normal use could conceivably cause permanent damage to the tire and/or the jack. Although the leveling jack was restrained, this failure requires the repair or replacement of the leveling jack.

When the swivel locks on the leveling jacks were lubricated, the pressure of the grease locked them in place, rendering them inoperable. Sufficient outlets were not available for the grease to escape.

3.4. Trunnion Axle Wear

The lubrication design for the trunnion axle is not sufficient to properly lubricate the trunnion axle, as evidenced by the wear found on the trunnion axle. The current design allows grease to access the load-bearing portion of the bushing (bottom), but due to the heat generated, the bottom channel eventually became clogged with hardened dried grease. This forced all of the grease through the top channel. This caused wear to occur on the trunnion axle. Metal shavings by the trunnion bracket were first noticed at 789 miles. The clogging of the bottom grease channel was first noticed at 1,375 miles into the test.

3.5. Miscellaneous

Although the spare tire did not separate during the test as it did in the test at NATC, the slack in the spare tire cable allowed for cyclic loading and possible wear of the cable. The cable was inspected after the laboratory test and was found to be in good condition.

The tarp hook (right side, third from the front) that failed was not being used for its intended purpose when the failure occurred, but was being used as a handle instead. Although not intended for this purpose, it is certainly possible that these hooks will be used as handles in the field.

All of the spring bumper pads survived the test intact.

4.0. RECOMMENDATIONS

4.1. Trunnion Bracket Bolts

It is recommended that the current grade 5 bolts, used to hold the trunnion bracket to the spring, be evaluated with regard to strength and quality. It is not clear that upgrading these to grade 8 will solve the failure problem. It is also recommended that the torque values specified in the Technical Manual be reconsidered so that they comply with SAE standards.

4.2. Leveling Jacks

It is recommended that the manufacturing process be checked on the leveling jack assemblies to assure that the crank shaft is properly welded and in working order. It is also recommended that the leveling jacks be operated prior to delivery.

It is recommended that the manufacturing process and/or design be evaluated to address the extension of the leveling jack during operation.

It is recommended that the grease zerks on the swivel locks for the leveling jacks be removed or modified to prevent the "grease pressure lock" that was observed during the test. The Technical Manual [8] states "Do not lubricate the springs and leveling jacks", so these zerks are not required.

4.3. Trunnion Axle Wear

It is recommended that the grease channels for the trunnion axle and bushing be redesigned to force the grease into the load bearing portion of the trunnion bracket bushing. The grease channels should be changed to a spiral type which would allow the bushing to be better lubricated.

4.4. Miscellaneous

To correct for the slack in the spare tire cable, it is recommended that the ratchet gear be replaced with one which has more teeth (the current one has four). This will allow the cable slack to be reduced when the spare tire is in its stowed position.

It is recommended that the manufacturer address the tarp hook failure by either strengthening them, or by providing another grasp point that soldiers may use when inspecting the under carriage of the trailer.

5.0. DISCUSSION/TESTING

5.1. General

This test was intended to determine the durability of the M1061A1 trailer in a vibration environment induced by the simulated traversal over four different terrains. These terrains were chosen to conform to MIL-T-62073E and to the terrains chosen for the test at NATC. These terrains were combined to form six equivalent cycles of 600 miles each. The test was conducted using the PMBS to provide the motion inputs to the trailer and using RPC III™ to develop the simulator drive commands. Trailer performance was monitored using 22 channels of data acquisition. In addition to this, the trailer was periodically inspected, paying particular attention to those areas that had failed at NATC. Testing commenced on December 6, 1995 and took 6 weeks and 3 days to complete, ending on January 19, 1996. Several problems were found which were primarily confined to the leveling jacks and the suspension.

5.2. Motion Simulator

The PMBS is a hydraulically powered simulator specifically designed to impart motion to an attached lunette trailer. It can move the trailer lunette in three independent directions (longitudinal, lateral, vertical), and it can input vertical motion into the trailer tires. The lunette is rigidly clamped to the simulator, while the wheels rest in platens which are attached to the vertical hydraulic actuators. For a four-wheeled trailer such as the M1061A1, it has seven degrees of freedom. The bandwidth of control for this test was 0.6 - 20 Hz at the lunette and 0.6 to 50 or 60 Hz at the wheels/spindles (depending on the terrain). The physical capabilities of the PMBS are shown in Table 5-1.

Table 5-1. Capabilities of the PMBS.

Parameter	Maximum Value or Range
Trailer payload:	20,000 lbs
Displacement:	
Lateral	+- 5.25 inch
Longitudinal	+- 5 inch
Vertical	+- 8.62 inch
Pitch (passive)	+- 10 deg
Roll (passive)	+- 15 deg
Velocity:	
Lateral	+- 60 in/sec
Longitudinal	+- 51 in/sec
Vertical	+- 78 in/sec
Acceleration:	
Lateral	16.7g (@700 lbs)
Longitudinal	16.1g (@1700 lbs)
Vertical	26.4g (@700 lbs)
Force:	
Lateral	11,700 lbs
Longitudinal	27,300 lbs
Vertical	18,480 lbs
Bandwidth: *	
Lateral	40 Hz
Longitudinal	40 Hz
Lunette vert	40 Hz
Spindle vert	40 Hz

* partly dependent on Trailer specimen and quality of desired response data.

The PMBS is controlled by a test method called Remote Parameter Control™ (RPC). RPC™ is capable of controlling a response (e.g. acceleration, strain. etc.) on the specimen itself (i.e. at the lunette or wheel spindle). Through an iterative process, RPC™ derives the correct position command from existing trailer response data (desired response), resulting in the correct trailer response. For this test, the desired response was derived from a computer-based DADS model. (RPC™ normally uses field acquired data as the desired response to achieve maximum realism of the simulation.) RPC™ will strive to reproduce these desired response data on the specimen in the laboratory. (i.e. it will try to match the wheel spindle accelerations from the model to those measured on the simulator.) RPC™ first characterizes the trailer and simulator by inputting shaped noise into the position commands of the simulator and then measuring the responses coming back from the trailer. The software uses these data to calculate a linear characterization of the entire system in the form of a Frequency Response Function (FRF). The FRF is then used to calculate the simulator position commands based on the desired response. By performing this process iteratively for the same desired response, the data which are being measured from the simulator and the desired response data should eventually match. This RPC™

process was used to derive simulator position commands from the response data recorded from the DADS model for each of the five terrains. See Appendix H for a more in depth description of the RPC™ process.

5.3. Terrain Profile Selection

The terrains and speeds used for this test were chosen according to the requirements in MIL-T-62073E. In the areas that this specification was not strictly defined, the NATC test report was used to clarify the test requirements, such as the speeds on the different terrains. Table 5-2 summarizes the terrains used for this test. Paved road miles were omitted from the schedule so that more cycles of the rougher terrains could be run instead. Since the likely failures would be structural in nature and the rougher terrains contribute highly to the structural damage (see Section 5.8 and Table 5-8), deleting the milder terrains, such as Paved Road, was justified. The length chosen for a typical terrain was 2,000 feet. (Two sections were taken from Churchville B to represent both the mild and severe portions.) The Churchville B (mild) and Belgian Block terrains are less than 2,000 feet in length. Twenty feet of data were deleted from Churchville B (mild) to remove an unrealistic spike in the data. The Belgian Block terrain was limited to a two-minute run time so it did not complete the entire 2,000 foot length. Due to time constraints, these data were used to represent the Belgian Block terrain.

Table 5-2. Terrain/Speed Scenarios.

Terrain	RMS (in.)	Speed (mph)	Run Length (feet)	Run Length (sec.)*	Reps. per Cycle	Distance Cycle/Total (miles)	Time Cycle/Total (hours)
Munson Gravel	0.27	25	2,000	60	660	250.0 / 1,500	11.0 / 66.0
Perryman A	0.36	16	2,000	90	607	229.9 / 1,379.5	15.2 / 91.1
Churchville B (mild)	1.2	15	1,980	95	189	70.9 / 425.3	5.0 / 29.9
Churchville B (rough)	3.2	10	2,000	145	81	30.7 / 184.1	3.3 / 19.6
Belgian Block	0.74	10	1,687	120	63	20.1 / 120.8	2.1 / 12.6
Total	-	-	-	-		**601.6 / 3,609.7**	**36.5 / 219.2**

* These times include 5 seconds of fade time per repetition.

The individual segments from each course were repeated to attain the required miles for a specific course. These repetitions per cycle are shown in column six of Table 5-2. The terrains were run in the order shown in Table 5-2 for each of the six cycles, with the exception of Churchville B, which mixed the mild and the rough segments in the test sequence. The sections from the Churchville B course were run in a ratio of 30% rough and 70% mild to simulate the distribution of the actual APG course. The simulator was setup to run seven segments of mild and three segments of rough. The RPC™ software requires that a signal be faded to zero at the beginning and end of each run. It takes 5 seconds per run to do this, and is why the time per run in column five is five seconds longer than the length and speed would dictate.

5.4. Test Conduct

5.4.1. Pre-test.

In order to build an accurate model of the trailer, the trailer was characterized and subjected to a brief field test for the purposes of model validation. The characterization measured the stiffness of the springs and tires, the horizontal center of gravity, and the weights of the trailer, wheels, and axles. The validation sought to quantify the trailer's response while being towed over a discrete bump. These response data would then be compared with the model output. The modeler can then adjust parameters in his model so that the model response matches the field recorded response more closely. This characterization and validation work is further detailed in Section 5.10.

When the DADS model was completed, validated and run, and the trailer was instrumented properly, it was placed on the simulator and the simulator was tuned. Then the iterations were ready to begin.

5.4.2. Iterations.

When the desired responses (DADS model outputs) were known, the next step involved deriving the position (drive) commands for the simulator. These drive commands were developed from the DADS model responses using the RPC™ process. (The RPC™ process is described in more detail in Appendix H.) Five different position command sets were derived (one for each terrain) using the DADS response data from that terrain as input. This process is a necessary step in developing commands for the simulator. Unfortunately, these iterations add miles to the trailer before the start of the test. A total of 51 miles were accumulated on the trailer during the iteration phase. These miles, however, cannot be added to the test miles because most of these runs were not at the appropriate energy level. They are noted here but the test is considered to have started at 0 accumulated miles. Table 5-4 summarizes the accuracy of these iterations for each of the control channels and each terrain.

The control bandwidth chosen for each of the courses was initially as high as 60 Hz for the vertical spindle accelerations and 40 Hz for the lunette accelerations. As the iterations progressed, some problems were found at particular frequencies, primarily in the lunette channels. Due to the low level of the signal for the lunette accelerations, the simulator response diverged from the desired result at high frequencies. To correct for this problem the control bandwidth for all three lunette control channels was cut to 20 Hz. Additionally, there was a resonance problem found at 55 Hz for the spindle accelerations which could not be corrected, so the bandwidth was cut to 50 Hz for these terrains. The final bandwidth for each of the terrains is given in Table 5-3.

Table 5-3. Control Bandwidth for the Five Terrains Used in the Test.

Terrain	Lunette Bandwidth	Spindle Bandwidth
Munson Gravel @ 25 mph	0.6 - 20 Hz	0.6 - 60 Hz
Perryman A @ 16 mph	0.6 - 20 Hz	0.6 - 60 Hz
Churchville B (mild) @ 15 mph	0.6 - 20 Hz	0.6 - 50 Hz
Churchville B (rough) @ 10 mph	0.6 - 20 Hz	0.6 - 50 Hz
Belgian Block @ 10 mph	0.6 - 20 Hz	0.6 - 60 Hz

Table 5-4. Iteration Accuracy Statistics.

Terrain/Channel	RMS			Maximum			Minimum		
(All data in g's)	Desired	Achieved	Error (%)	Desired	Achieved	Error (%)	Desired	Achieved	Error (%)
Munson Gravel @ 25 mph									
1) Accel. Lat. - Lunette	0.06	0.09	53.91	0.32	0.67	109.72	-0.32	-0.81	157.78
2) Accel. Vert. - Lunette	0.06	0.06	2.22	0.50	0.46	6.67	-0.39	-0.42	7.36
3) Accel. Long. - Lunette	0.02	0.03	35.71	0.20	0.18	10.10	-0.09	-0.13	38.38
4) Accel. Vert. - LF Spindle	1.78	1.77	0.56	8.58	8.20	4.43	-9.93	-9.31	6.24
5) Accel. Vert. - RF Spindle	1.54	1.54	0.00	8.41	9.12	8.44	-9.23	-9.48	2.71
6) Accel. Vert. - LR Spindle	1.72	1.73	0.58	8.84	8.86	0.23	-8.16	-8.01	1.84
7) Accel. Vert. - RR Spindle	1.52	1.48	2.63	9.14	9.95	8.86	-7.43	-7.62	2.56
Perryman A @ 16 mph									
1) Accel. Lat. - Lunette	0.07	0.08	14.99	0.87	0.95	8.71	-0.62	-0.59	4.83
2) Accel. Vert. - Lunette	0.07	0.07	3.03	0.70	0.71	0.85	-0.76	-0.76	0.66
3) Accel. Long. - Lunette	0.02	0.03	26.94	0.25	0.24	0.82	-0.11	-0.14	31.48
4) Accel. Vert. - LF Spindle	1.51	1.51	0.00	6.74	6.98	3.56	-6.30	-6.19	1.75
5) Accel. Vert. - RF Spindle	1.33	1.33	0.00	7.73	7.78	0.65	-8.01	-7.80	2.62
6) Accel. Vert. - LR Spindle	1.43	1.44	0.70	5.96	6.23	4.53	-6.17	-6.08	1.46
7) Accel. Vert. - RR Spindle	1.26	1.27	0.79	6.69	6.88	2.84	-7.01	-6.91	1.43
Churchville B (mild) @ 15 mph									
1) Accel. Lat. - Lunette	0.08	0.09	12.87	0.74	0.77	5.17	-0.58	-0.71	21.97
2) Accel. Vert. - Lunette	0.08	0.08	1.40	0.76	0.72	5.78	-0.90	-0.87	2.68
3) Accel. Long. - Lunette	0.03	0.04	41.25	0.25	0.26	4.02	-0.17	-0.17	2.99
4) Accel. Vert. - LF Spindle	1.04	1.05	0.96	5.17	5.45	5.42	-5.70	-5.12	10.18
5) Accel. Vert. - RF Spindle	1.01	1.03	1.98	6.09	6.09	0.00	-5.70	-5.36	5.96
6) Accel. Vert. - LR Spindle	0.99	1.02	3.55	6.53	6.76	3.52	-7.81	-7.44	4.74
7) Accel. Vert. - RR Spindle	0.95	1.04	9.59	7.35	7.12	3.13	-6.18	-5.94	3.88
Churchville B (rough) @ 10 mph									
1) Accel. Lat. - Lunette	0.11	0.12	9.52	0.60	0.71	19.50	-0.74	-0.71	4.21
2) Accel. Vert. - Lunette	0.13	0.13	1.57	0.82	0.79	4.25	-0.94	-0.95	1.82
3) Accel. Long. - Lunette	0.05	0.05	10.14	0.33	0.34	0.60	-0.42	-0.44	3.77
4) Accel. Vert. - LF Spindle	1.03	1.05	1.94	6.35	6.94	9.29	-7.04	-6.34	9.94
5) Accel. Vert. - RF Spindle	0.96	0.99	3.46	7.20	7.48	3.89	-7.13	-6.77	5.05
6) Accel. Vert. - LR Spindle	1.01	1.04	2.97	6.00	5.90	1.67	-5.89	-6.10	3.57
7) Accel. Vert. - RR Spindle	0.94	0.97	3.29	8.09	8.89	9.89	-6.41	-5.23	18.41
Belgian Block @ 10 mph									
1) Accel. Lat. - Lunette	0.17	0.19	10.65	0.81	0.89	9.24	-0.87	-0.89	2.77
2) Accel. Vert. - Lunette	0.18	0.18	1.10	0.94	0.91	2.56	-0.94	-0.90	4.67
3) Accel. Long. - Lunette	0.06	0.07	5.50	0.39	0.40	2.60	-0.26	-0.28	6.90
4) Accel. Vert. - LF Spindle	1.22	1.22	0.00	5.72	5.75	0.52	-5.51	-5.64	2.36
5) Accel. Vert. - RF Spindle	1.11	1.12	0.90	4.84	4.85	0.21	-5.56	-5.37	3.42
6) Accel. Vert. - LR Spindle	1.17	1.16	0.85	5.33	5.51	3.38	-5.14	-5.04	1.95
7) Accel. Vert. - RR Spindle	1.07	1.10	2.80	5.01	5.11	2.00	-5.00	-5.18	3.60

5.4.3. Test execution.

Once the iterations were complete and the most accurate drive file was derived for each terrain, one repetition of each of the terrains was run to establish a baseline and to gain the approval of those involved in the test to proceed. The approval was attained and testing began on 6 December 1995.

The trailer was tested under the following conditions:

1. A payload of 10,010 pounds was installed with the center of gravity centered on the deck, 16.5 inches above the deck surface.
2. The tires were maintained at a pressure of 65 psi throughout the test.
3. All four leveling jacks were in the stowed (horizontal) and retracted position throughout the test.
4. The right-front leveling jack was restrained from extending for all testing after 53 accumulated miles.
5. The wheels did not rotate appreciably during the test. Therefore the wheel bearings, tires, brakes, and other parts associated with forward motion were not tested.
6. At ride position the trailer was slightly pitched up (approximately 0.9 degrees).

The test progressed at a rate of roughly one cycle per week and lasted 6 weeks and 3 days. The trailer was usually tested approximately 9 hours per day. There were some brief periods of down time when failures were found or when other simulators required the laboratory hydraulics. The test was completed on 19 January 1996. For a chronology of the test please see Appendix G.

When testing was complete, the trailer was thoroughly inspected and there were no problems found with the frame. The trunnion axle was disassembled and found to be worn due to a lack of lubrication. Measurements were made of the amount of wear and the results are reported in Section 5.6 and Appendix A (TIR # 010). No other discrepancies were found.

5.5. <u>Inspections</u>

The trailer was inspected every morning before testing began for the day. With each inspection, the inspector(s) were required to complete a checklist on which they would confirm that they had inspected all areas of concern. An example of this checklist can be found in Appendix E. Those areas which had problems during the test at NATC were inspected every morning. Some of these areas include the A-frame toe welds, the spring bumper pads, and the spare tire cable. Other areas that were inspected daily concerned the simulator condition with regards to safety. The trailer's general condition was also examined daily; this included all welds on the trailer, cables, leveling jacks, and the trunnion axle.

After testing began for the day, strip chart recorders were used to check the simulator response, the condition of the data acquisition system, and the general condition of the trailer. These served as an additional check on the validity of the test and the integrity of the trailer.

In addition to the regular inspections, the trailer was periodically lubricated and the operation of the leveling jacks was verified. The lubrication was conducted in accordance with the TM 9-2330-376-14&P. The operational check on the leveling jacks consisted of rotating the jacks to the vertical position, extending and retracting them, and then rotating them back to the stowed (horizontal) position. The actual times and accumulated mileage at the time of the lubrications and leveling jack inspections can be found in the test chronology in Appendix G.

5.6. Test Incidents

There were several notable incidents that were observed prior to, during, and after the test. These incidents will be described here, grouped according the part that failed. A summary of all of the incidents can be found in Table 5-5.

5.6.1. Trunnion bracket bolts.

Three of the trunnion bracket bolts on the right side of the trailer failed during the test. They failed at 1133, 2016, and 2406 miles into the test. The sequence in which they failed was rear-inner, front-inner, and front-outer. The rear-outer bolt did not fail and endured the entire test. The first two bolts to fail fractured in the threaded portion and appeared to fail in a fatigue mode. The third bolt failed just under the head, also in a fatigue mode.

The first two bolts that failed were shipped to the trailer manufacturer (Utility Tool and Body Company, Inc.) for analysis. The manufacturer conducted a chemical analysis, tensile test, and hardness test and found that the bolts conformed to the SAE J429 specification for Grade 5 bolts.

The third bolt that failed was analyzed at the TARDEC Metallurgical Laboratory. The tests conducted were chemical composition, surface and core hardness, microstructure examination, visual examination. The analysis found that that the failure was in a fatigue mode. The chemical composition met the standards for a Grade 5 bolt, but was found to have some alloying elements present. The bolt also passed the core hardness specification for a Grade 5 bolt. The surface hardness was, however, found to be too low (approx. 20 Rc, SAE J429 requires a minimum of 25). After examining the microstructure a decarburized layer of 0.01 inch was found at the surface. This was the probable cause of the bolt failure.

The bolts were also found to be rotating while in use as witnessed by score marks caused by impact with the springs. The failed bolts had marks indicating that they had been rotating during the test. The bolts, however, did not fail at these score markings. It is noted that the Technical Manual for the trailer requires a torque of 150-175 lb-ft which is well below the SAE recommendation of 435 lb-ft.

Both the manufacturer's report and the TARDEC failure report can be found in Appendix I.

Table 5-5. Test Incidents.

Incident Number	Cycle / Miles	Terrain	Description
001	0 / 0	Pre-test / upon arrival	Upon arrival of the trailer at TARDEC the spare tire cable was found to have some slack in it. The slack could not be removed by turning the hand crank. The cable was tightened as well as possible, but some slack remained.
002	0 / 0	Pre-test / during characterization	The right-front leveling jack hand crank shaft was found to be rotating freely (the square ended sleeve was not firmly attached to the shaft). In this condition the jack could not be extended or retracted. The problem was corrected and the jack operated normally.
003	0 / 0	Pre-test / during validation	While backing the trailer during the validation test the trailer "jack-knifed" and impacted with the prime mover (FMTV). This caused no significant damage, but did remove some paint and gouge the metal on the right A-frame.
004	0 / 0	Pre-test / during test preparation	While inspecting the trailer a person grasped a tarp hook to maintain his balance which caused the tarp hook to break off. The hook that failed was on the right side, third from the front. The hook was not repaired.
005	1 / 52	Munson Gravel	The right-front leveling jack was found to be extended rearward (towards tire) and impacting both the tire and the frame. The jack was retracted and restrained in the retracted position and remained restrained throughout the test. Note: This is the same jack that was found to be inoperable in incident #002 mentioned above.
006	2 / 1133	Churchville B	The right-rear inner bolt which holds the right leaf spring to the trunnion bracket failed. The bolt was replaced with a bolt of equal grade and testing continued.
007	3 / 1375	Munson Gravel / during operational check	It was found that when the swivel pins on the leveling jacks were lubricated, the pressure of the added grease locked the swivel pin in the engaged position. This prevented the swivel motion of the leveling jacks from the horizontal to the vertical position or visa-versa. The grease fittings were removed and the pressure was released. The swivel pin then operated normally.
008	4 / 2016	Munson Gravel	The right-front inner bolt which holds the right leaf spring to the trunnion bracket failed. The bolt was replaced with a grade 8 bolt and testing continued.
009	4 / 2406	Belgian Block	The right-front outer bolt which holds the right leaf spring to the trunnion bracket failed. The bolt was replaced with a grade 8 bolt and testing continued.
010	6 / 3610	Post-test / during final inspection	Upon completion of the test the trunnion axle was removed and inspected. It was found to be worn on both the right and left where it contacts the trunnion bracket bushing. The axle was replaced with a new part.

5.6.2. Leveling jacks.

There were two problems found with the right-front leveling jack:

1. Upon arrival, during initial checkout of the system, the square ended piece on the hand-crank shaft was found to be loose. This rendered the leveling jack inoperable. The problem was corrected by center punching the shaft to peen the material on the shaft causing the needed interference between square piece and the shaft.

2. During the first day of testing (52 miles into the test), this same leveling jack (RF) was found to be extended and impacting the right front tire and the frame. (At the start of testing, the leveling jack was fully retracted.) The leveling jack was then retracted and restrained from extending throughout the remainder of the test. The other three leveling jacks remained in their retracted position unrestrained throughout the test. The bed of the trailer was pitched up 0.9 degrees during the test.

Another problem found on all of the leveling jacks was that the swivel locks seized when lubricated. The pressure of the grease held the swivel lock in place. The only way that the lock could be released was to remove the grease zerk, releasing the pressure of the grease. The swivel locks were not lubricated from that point forward (1375 miles).

5.6.3. Trunnion axle.

During maintenance, while lubricating the trunnion, it was noted that the grease was not flowing through the bottom of the trunnion axle. It was also noted that the trunnion bearing got hot to the touch during testing. It was clear that the trunnion was not being lubricated properly, so upon completion of the test, the trunnion axle was removed, disassembled, and inspected; it was found to be worn. The amount of the wear was measured and found to be 0.038 inch in the worst case.

5.6.4. Miscellaneous incidents.

Upon arrival the spare tire was found to be loose. The cable holding it could not be fully retracted. This problem was not corrected and the minimum slack was allowed in the cable during the test.

During the validation test, the prime mover "jack-knifed" the trailer while backing up, causing the frame of the trailer to impact the prime mover, gouging the metal. This damage was not significant.

Prior to the start of the test, a person was examining the under carriage of the trailer. When they grasped one of the tarp hooks to maintain their balance, the hook broke off in their hand. No action was taken to repair the hook.

5.7. Data Acquisition and Instrumentation

A total of 22 channels of instrumentation were mounted on the trailer for the entire the test. This consisted of 16 accelerometers, 4 strain gages, and 2 rotational rate transducers.(See Figure 5-1 for the locations of all of the transducers.) These transducers were mounted for a number of different reasons.

Seven of the accelerometers were mounted on the trailer as control transducers for the RPC III™ software. These were mounted on each of the four spindles (1 each) and at the lunette (3 channels). The other transducers were mounted to monitor the test progress and determine the accelerations and forces at critical points on the trailer. Both the tri-axial accelerometer at the trunnion and the two rotational rate transducers were mounted for test monitoring and documentation purposes. There were ten channels (five on each side) of instrumentation mounted at the location on the frame where cracks were found during the test at NATC. These were two tri-axial accelerometers (six channels) and four single-axis strain gages. The accelerometers were located near both of the toe-welds, and the strain gages were located at the points where it was suspected a crack would likely initiate if one were to occur.

All 22 channels were sampled using an MTS 498 Automated Site Controller (ASC). This data acquisition system was configured to sample the data at 204.8 Hz. Prior to sampling the 498 ASC digitally low-pass filtered each channel at 82 Hz to prevent aliasing. Each channel was also connected to a thermal strip chart recorder so that it could be monitored without disrupting the test.

These 22 data channels were sampled for each terrain prior to the start of testing to establish a baseline against which subsequent data recordings could be compared. Time-domain and frequency-domain plots of these baseline data can be found in Appendix D. Data were recorded at least twice for each terrain during each cycle of testing, primarily for monitoring purposes. They would typically be sampled at the start and end of the terrain for a particular cycle. Additionally, if the running of a terrain spanned more than one day, data would be recorded either at the start of the day or at the end of the day. Statistical summaries of all of the data that were recorded can be found in Appendix C.

The orientations for each of the transducers can be found in Table 5-6. Also, a list of transducers used for the motion-base test can be found in Table 5-7.

Table 5-6. Instrumentation Orientations.

Measurement	Positive	Negative
Lateral Acceleration	Right, Curb-Side	Left, Road-Side
Vertical Acceleration	Up	Down
Longitudinal Acceleration	Forward	Rearward
Axial Strain	Tension	Compression
Pitch Rate	Rear-up, Front-down	Front-up, Rear-down
Roll Rate	Right-up, Left-down	Left-up, Right-down

Table 5-7. Durability Test Instrumentation Channels.

Channel	Axis	Eng. Unit	Manufacturer	Model	Serial No.	Due for cal	Bandwidth (Hz)	Range	Resolution
Accelerometers									
1. LF Spindle	Vert.	g	Setra	141B	412812	July 1996	dc - 80	± 20	0.61×10^{-3}
2 RF Spindle	Vert.	g	Setra	141B	412815	July 1996	dc - 80	± 20	0.61×10^{-3}
3. LR Spindle	Vert.	g	Setra	141B	412817	July 1996	dc - 80	± 20	0.61×10^{-3}
4. RR Spindle	Vert.	g	Setra	141B	412821	July 1996	dc - 80	± 20	0.61×10^{-3}
5. Frame @ c.g.	Lat.	g	Setra	141A	597849	June 1998	dc - 80	± 10	0.31×10^{-3}
6. Frame @ c.g.	Vert.	g	Setra	141A	597852	June 1998	dc - 80	± 10	0.31×10^{-3}
7. Frame @ c.g.	Long.	g	Setra	141A	597857	June 1998	dc - 80	± 10	0.31×10^{-3}
8. Lunette	Lat.	g	Setra	141B	153770	July 1998	dc - 80	± 10	0.31×10^{-3}
9. Lunette	Vert.	g	Setra	141B	153771	July 1998	dc - 80	± 10	0.31×10^{-3}
10. Lunette	Long.	g	Setra	141B	153774	July 1998	dc - 80	± 10	0.31×10^{-3}
11. A-Frame @ RF corner	Lat.	g	Setra	141A	597856	June 1998	dc - 80	± 10	0.31×10^{-3}
12. A-Frame @ RF corner	Vert.	g	Setra	141A	597851	June 1998	dc - 80	± 10	0.31×10^{-3}
13. A-Frame @ RF corner	Long.	g	Setra	141B	298504	Jan. 1998	dc - 80	± 10	0.31×10^{-3}
14. A-Frame @ LF corner	Lat.	g	Setra	141A	597853	June 1998	dc - 80	± 10	0.31×10^{-3}
15. A-Frame @ LF corner	Vert.	g	Setra	141A	597854	June 1998	dc - 80	± 10	0.31×10^{-3}
16. A-Frame @ LF corner	Long.	g	Setra	141A	597855	June 1998	dc - 80	± 10	0.31×10^{-3}
Strain Gages (Single)									
17. L A-Frame In-board	Long.	ue	Micro-Measurements	CEA-06-250UW-350	Lot # Q-A21AD149	-	dc - 80	± 2000	61.0×10^{-3}
18. L A-Frame Out-board	Long.	ue	Micro-Measurements	CEA-06-250UW-350	Lot # Q-A21AD149	-	dc - 80	± 2000	61.0×10^{-3}
19. R A-Frame In-board	Long.	ue	Micro-Measurements	CEA-06-250UW-350	Lot # Q-A21AD149	-	dc - 80	± 2000	61.0×10^{-3}
20. R A-Frame Out-board	Long.	ue	Micro-Measurements	CEA-06-250UW-350	Lot # Q-A21AD149	-	dc - 80	± 2000	61.0×10^{-3}
Rotational Rate Transducers									
21. Left side frame above axle	Pitch	°/s	Humphrey	RT02-0201-1	129	N/A	dc - 25	± 60	7.32×10^{-3}
22. Left side frame above axle	Roll	°/s	Humphrey	RT02-0201-1	129	N/A	dc - 25	± 360	43.9×10^{-3}

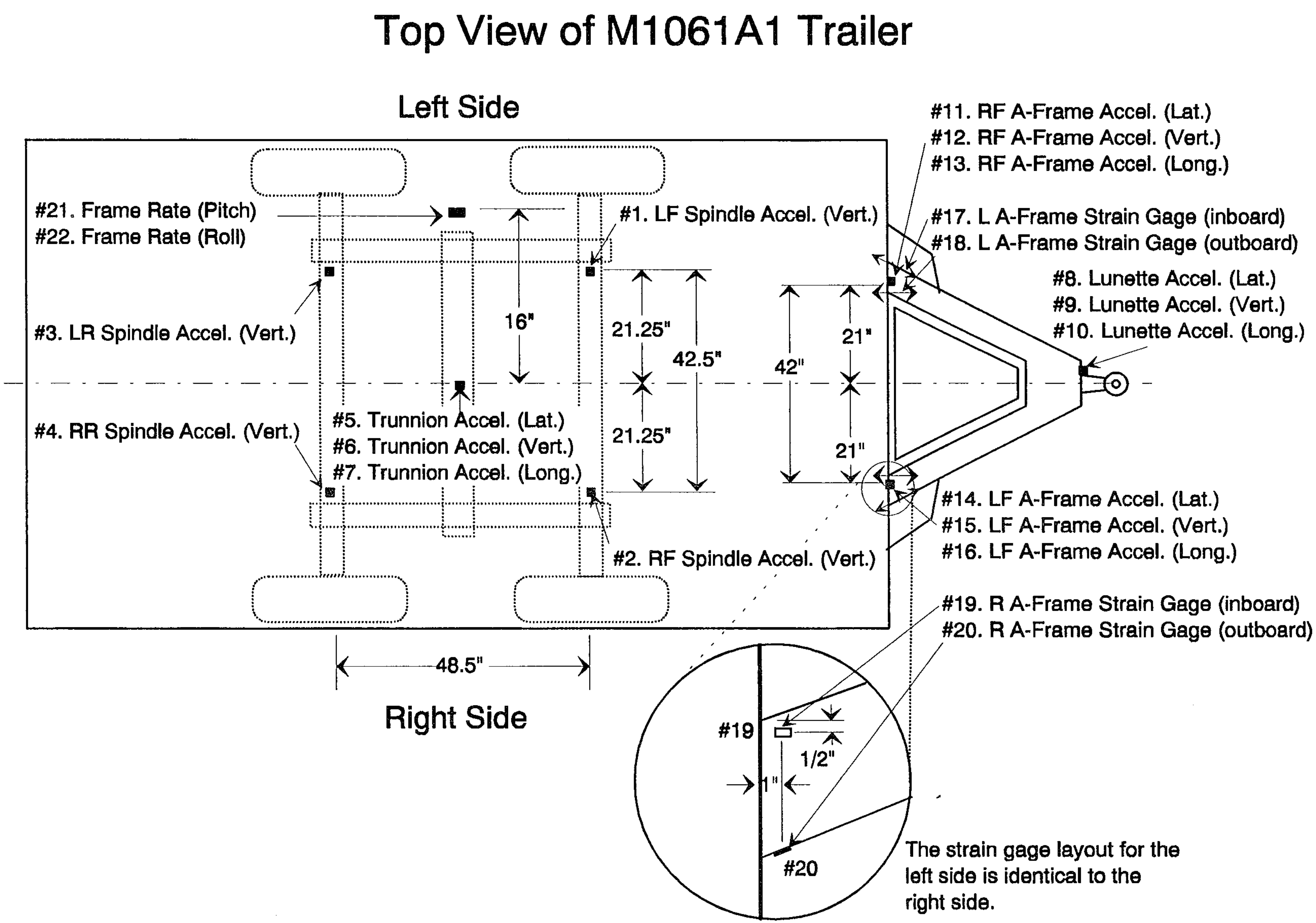

Figure 5-1. Instrumentation Locations.

5.8. Data Analysis

When data were periodically recorded, they were processed to determine if the simulator and trailer were being subjected to the same vibration environments. This process consisted of first removing the mean or average value from each channel of the data file. This was necessary for further processing, because varying mean values will cause arbitrary variations in the statistics which are not attributable to the dynamics of the trailer or performance of the simulator. Once the mean was removed, the statistics of the data were calculated. These statistics included maximum, minimum, RMS, mean, standard deviation, and variance. The next step was to compare these statistics to those calculated for the base line data. This was done by taking the ratio of the RMS values of the recorded data and the base line data. These values were then plotted over time to measure and monitor the variations in the response data with respect to the baseline data. The acceleration channels were found to vary most and the strain channels varied least. Variations as large as 70 percent were seen at times on the acceleration channels. These large variations were reduced by lubricating the simulator. Other large variations were attributable to low acceleration levels in the base line data. In these cases the variance, although large in percentage, was small in terms of absolutes.

Since one of the objectives of this test was to determine the structural integrity of the welds between the drawbar and superstructure, some fatigue analysis was conducted on the strain data recorded in channels 17 to 20. The model used for this fatigue analysis was a strain-life model. It was discovered from the manufacturer that the drawbar material is SAE 1021 steel, but fatigue parameters were not available for SAE 1021 steel. The analysis was conducted for two other steels that are close in their properties to SAE 1021 (SAE 1022 and SAE 1025). Since the fatigue parameters for SAE 1021 are not known, the analysis conducted here will not provide reliable fatigue life properties and can only be used for comparative purposes. This comparative analysis gives an indication of the relative amount of damage at this weld, caused by the different terrains. Both steels yield similar results.

The results of this analysis are shown in Table 5-8. The columns of primary interest are columns 8 through 11 in which the comparative numbers are shown. Column 8 shows the percentage of the total damage that is caused by all of the miles from a specific terrain. From these data it is clear that both Perryman A and Belgian Block are equally as damaging to the drawbar weld, each contributing approximately one third of the total damage. It is also seen that Churchville B (mild) contributes little to the damage of the drawbar weld (approx. 4%).

It appears that Belgian Block and Perryman A are equally as damaging. Belgian Block is, however, considerably more damaging because it accumulates its damage in a total of 12.6 hours while Perryman A takes 91.1 hours to accumulate the same amount of damage. To gain a sense of the damage accumulated in one time unit (hour) the accumulated damage is normalized by the amount of time spent on that course yielding the results in column 9. These values are then compared to each other in columns 10 and 11. It is apparent from column 10 that Belgian Block has the highest "damage efficiency" as these values are normalized with the sum of damage efficiencies. Column 11 presents the damage efficiency of the other four terrains with respect to Belgian Block. Now it is clear that Belgian Block is approximately seven times more damaging than Perryman A. From this analysis, it is apparent that the two most damaging courses happen to be the two roughest (Belgian Block and Churchville B rough) and that the least damaging is still Churchville B (mild).

Although the milder terrains do not cause much damage at the drawbar weld, they may cause damage in some other part of the trailer. Since these milder courses did not efficiently cause damage, one would think that additional time could be saved by deleting these miles from the test. This, however, is not the case because they may very well be contributing enormously to the damage in the suspension for instance. If it could be shown that a particular terrain does not contribute to the damage in all parts of the trailer, then the terrain could be removed from the schedule to realize a time and cost savings. Unfortunately, sufficient strain data were not recorded to allow this analysis to be made. Since the trunnion bracket mounting bolts failed on three different courses, it is clear that mild terrains do significantly damage some suspension components.

Table 5-8. Comparative Fatigue Analysis

Terrain/Channel	Average Damage	Average Life	Repetitions	Seconds per Rep.	Total Time (hours)	Accumulated Damage	Percent Damage	Damage Efficiency (Damage/Hour)	Percent Damage Efficiency	Relative Efficiency (to Blg. Blk.)
Munson Gravel										
17. Left Inboard A-frame	3.76E-08	2.71E+07	3960	60	66.00	1.49E-04	12.5	2.25E-06	4.6	7.2
18. Left Outboard A-frame	1.90E-09	5.33E+08	3960	60	66.00	7.51E-06	12.2	1.14E-07	4.4	6.9
19. Right Inboard A-frame	3.19E-07	3.14E+06	3960	60	66.00	1.26E-03	17.8	1.92E-05	6.9	11.1
20. Right Outboard A-frame	2.24E-09	4.48E+08	3960	60	66.00	8.89E-06	17.3	1.35E-07	6.4	10.0
Perryman A										
17. Left Inboard A-frame	1.16E-07	8.66E+06	3642	90	91.05	4.22E-04	35.3	4.63E-06	9.5	14.9
18. Left Outboard A-frame	5.83E-09	1.72E+08	3642	90	91.05	2.12E-05	34.4	2.33E-07	9.1	14.2
19. Right Inboard A-frame	6.43E-07	1.56E+06	3642	90	91.05	2.34E-03	33.0	2.57E-05	9.2	14.9
20. Right Outboard A-frame	4.54E-09	2.22E+08	3642	90	91.05	1.65E-05	32.1	1.81E-07	8.7	13.5
Churchville B (mild)										
17. Left Inboard A-frame	4.43E-08	2.33E+07	1134	95	29.93	5.03E-05	4.2	1.68E-06	3.4	5.4
18. Left Outboard A-frame	2.18E-09	4.75E+08	1134	95	29.93	2.47E-06	4.0	8.24E-08	3.2	5.0
19. Right Inboard A-frame	2.95E-07	3.47E+06	1134	95	29.93	3.35E-04	4.7	1.12E-05	4.0	6.5
20. Right Outboard A-frame	1.75E-09	6.08E+08	1134	95	29.93	1.98E-06	3.8	6.62E-08	3.2	4.9
Churchville B (rough)										
17. Left Inboard A-frame	3.71E-07	2.70E+06	486	145	19.58	1.80E-04	15.1	9.22E-06	18.8	29.6
18. Left Outboard A-frame	2.00E-08	5.02E+07	486	145	19.58	9.71E-06	15.7	4.96E-07	19.3	30.1
19. Right Inboard A-frame	1.99E-06	5.02E+05	486	145	19.58	9.69E-04	13.7	4.95E-05	17.8	28.6
20. Right Outboard A-frame	1.47E-08	6.84E+07	486	145	19.58	7.13E-06	13.8	3.64E-07	17.4	27.0
Belgian Block										
17. Left Inboard A-frame	1.04E-06	9.71E+05	378	120	12.60	3.93E-04	32.9	3.12E-05	63.7	100.0
18. Left Outboard A-frame	5.49E-08	1.84E+07	378	120	12.60	2.08E-05	33.7	1.65E-06	64.0	100.0
19. Right Inboard A-frame	5.76E-06	1.74E+05	378	120	12.60	2.18E-03	30.7	1.73E-04	62.1	100.0
20. Right Outboard A-frame	4.49E-08	2.25E+07	378	120	12.60	1.70E-05	33.0	1.35E-06	64.3	100.0
Total										
17. Left Inboard A-frame	1.61E-06	6.27E+07	9600		219.15	1.19E-03	100.0	4.89E-05	100.0	
18. Left Outboard A-frame	8.48E-08	1.25E+09	9600		219.15	6.17E-05	100.0	2.57E-06	100.0	
19. Right Inboard A-frame	9.01E-06	8.85E+06	9600		219.15	7.09E-03	100.0	2.78E-04	100.0	
20. Right Outboard A-frame	6.81E-08	1.37E+09	9600		219.15	5.15E-05	100.0	2.09E-06	100.0	
Average										
17. Left Inboard A-frame	3.21E-07	1.25E+07				2.39E-04		9.79E-06		
18. Left Outboard A-frame	1.70E-08	2.50E+08				1.23E-05		5.15E-07		
19. Right Inboard A-frame	1.80E-06	1.77E+06				1.42E-03		5.57E-05		
20. Right Outboard A-frame	1.36E-08	2.74E+08				1.03E-05		4.19E-07		

5.9. DADS model

The DADS computer program is a highly detailed, general-purpose modeling and simulation method for determining the spatial, transient-dynamic response of controlled, articulated multi-body mechanical systems to excitation by irregular external and internal forces and disturbances.

The methodology consists of a library of subroutines defining primitive rigid-body, kinematic joint, control-element, and force building blocks that can be combined in numerous ways to assemble complex system models to the level of detail and accuracy deemed necessary for a given problem. The DADS program consists of three main parts, a preprocessor, main processor, and post processor. The preprocessor allows much of the system's parametric and topological properties to be defined in an interactive environment without being concerned with the supporting equations. The preprocessor then sends this information to the main processor, which uses it to assemble the equations of kinematics and dynamics. The main processor also has several user interface subroutines which allow more detail to be added to the model than possible with the primitive building blocks. This Feature makes the representation of highly nonlinear vehicle system properties possible and yields more accurate models. The main processor also automatically integrates the resulting equations of motion for a specified period of time and outputs state variables at regular specified time intervals. The postprocessor allows these state variables to be output to an external file.

The computer model of the M1061A1 was generated with the DADS software system, which models all the bodies as rigid. The suspension was modeled as a six degree-of-freedom spring mass damper system. The lunette was modeled as a translational spring damper actuator (TSDA) with a total translational slop of ¼ inch in all directions. The tires were modeled with a sliced tire model and all of the terrains were two track terrains with a sample rate of 3 inches. The 5-ton FMTV prime mover was also modeled in DADS.

The model was built using characterization data measured at TARDEC. Once the model was built it was validated against field data that were also acquired at TARDEC. These data were compared against model outputs and the model was iteratively modified until the responses matched as well as possible. Parameters that were typically adjusted include the moments of inertia and the damping characteristics of the springs and tires. This characterization and validation are described in the next section.

5.10. Trailer Characterization and Model Validation

Since the desired response data were generated by a DADS model (rather than by performing a road load data acquisition), the accuracy of this model is of extreme importance. This being the case, it was decided that the physical properties of the trailer should be measured and that the model should be validated.

The characterization measured various physical properties of the trailer. The properties that were measured are those properties which are necessary to obtain an accurate model. These properties include the horizontal center of gravity, the spring stiffness, the tire stiffness, the masses of the axles and tires. These data were then given to the modeler to be entered into the model as known fixed values. The characterization yielded the results shown in Table 5-9.

Even with the trailer characterization data incorporated into the model, there are still a number of unknown parameters which must be estimated before a working model can be generated. Since these estimated parameters are not as easily determined as the measured characterization data, and since they also have an effect on the accuracy of the model, a comparison of the model response to the actual trailer response was necessary.

Table 5-9. Trailer Characterization Results.

Parameter	Measured Value
Longitudinal location of center of gravity	5.9 inches forward of the trunnion
Lateral location of center of gravity	On center line of the trailer
Leaf-spring stiffness	2,765 pounds/inch (per corner)
Tire stiffness (@ 65 psi)	4,801 pounds/inch
Tire mass (wheel and tire)	122 pounds[1]
Axle mass (axle, hub, drum)	400 pounds[1]

[1]These parameters were not measured but were given by the manufacturer.

This comparison took the form of a brief field test in which the trailer was towed over a discrete 6-inch bump at different speeds. Eleven channels of data were recorded for each run, 8 accelerometers and 3 rotational rate transducers.

When these data were recorded, the DADS model of the trailer was run over the same discrete bump. The model data were then compared to those that were recorded in the field. When differences occurred, the modeler used this information to tune his model by intelligently adjusting those parameters that were estimated (primarily the moments of inertia and the damping). The modeler would then rerun the simulation and compare his results to the field data. Using this iterative process the modeler tuned his model so that it closely matched the field data.

Knowing that the model matches the field responses closely for a discrete bump gives increased confidence that the model will also yield accurate results on random terrains such as those used for this test. The test plan for the trailer characterization and validation can be found in Appendix F.

The Model validation test was performed on September 14, 1995 and consisted of eight runs over a 6-inch discrete bump. Eight uni-axial accelerometers and a three-axis rate transducer were attached to the trailer for a total of eleven data channels. The accelerometers were placed on each of the spindles, in the center of the trunnion, and one on the rear spindle of the prime mover. The rate transducer was placed on the frame near the center of gravity. Table 5-10 details the channels recorded for this validation.

Table 5-10. Validation Test Instrumentation Channels.

Channel	Axis	Eng. Unit	Manufacturer	Model	Serial No.	Due for cal	Bandwidth (Hz)	Range (E.U.)	Resolution (E.U.)
Accelerometers									
1. LF Spindle	Vert.	g	Setra	141A	597853	June 1996	dc - 80	± 20	0.61×10^{-3}
2 RF Spindle	Vert.	g	Setra	141A	597854	June 1996	dc - 80	± 20	0.61×10^{-3}
3. LR Spindle	Vert.	g	Setra	141A	597855	June 1996	dc - 80	± 20	0.61×10^{-3}
4. RR Spindle	Vert.	g	Setra	141A	597856	June 1996	dc - 80	± 20	0.61×10^{-3}
5. Frame @ c.g.	Lat.	g	Setra	141A	597849	June 1998	dc - 80	± 10	0.31×10^{-3}
6. Frame @ c.g.	Vert.	g	Setra	141A	597852	June 1998	dc - 80	± 10	0.31×10^{-3}
7. Frame @ c.g.	Long.	g	Setra	141A	597857	June 1998	dc - 80	± 10	0.31×10^{-3}
8. LR Spindle of Prime Mover	Vert.	g	Setra	141A	597851	June 1998	dc - 80	± 10	0.31×10^{-3}
Rotational Rate Transducers									
9. Roll of trailer frame	-	°/s	Humphrey	RT02-0201-1	129	N/A	dc - 25	± 360	43.9×10^{-3}
10. Pitch of trailer frame	-	°/s	Humphrey	RT02-0201-1	129	N/A	dc - 25	± 60	7.32×10^{-3}
11. Yaw of trailer frame	-	°/s	Humphrey	RT02-0201-1	129	N/A	dc - 25	± 60	7.32×10^{-3}

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4. Paul, Victor J.; Berger, AnnMarie; Zywiol, Harry J. Jr., "M2-A2 Bradley Fighting Vehicle Traverse Drive Motor Base Line Test on TARDEC's Crew Station/Turret Motion Base Simulator Final Report", No. 13602, U.S. Army Tank-Automotive Command Research, Development, and Engineering Center, Warren, MI, November 1993.

5. "RPC™ III Software Manual", Volume 1, MTS Systems Corporation, Minneapolis, MN, 1994.

6. "RPC™ III Software Operation", MTS Systems Corporation, Minneapolis, MN, 1992.

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8. TM 9-2330-376-14&P, "TECHNICAL MANUAL FOR TRAILER, FLATBED: 5-TON, 4-WHEEL M1061A1 (NSN 2330-01-207-3533)", Headquarters, Department of the Army, Washington D.C., 31 March 1992.

APPENDIX A

TEST INCIDENT REPORTS

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	15 September 1995	TIR Number:	001

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

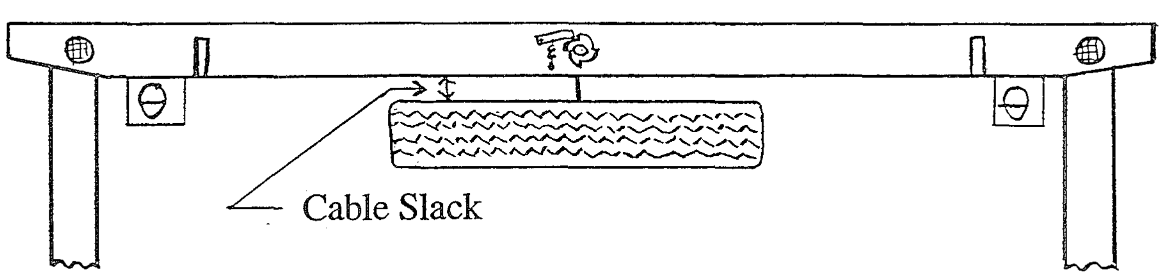
Title:	loose spare tire cable	Date:	10 August 1995
Subsystem:	Spare Tire Mounting	Time:	Upon arrival at TARDEC
Part:	N/A	Terrain:	N/A
Part #:	N/A	Miles:	0
Observed During:	Inspection upon arrival	Cycle:	N/A
Action Taken:	Winch tightened, PM Notified		

Incident Description

Upon arrival of the trailer at TARDEC there was found to be slack in the cable which holds the spare tire under the trailer. The amount of this slack was approximately 3 to 4 inches.

Action:
The slack was taken out by turning the handcrank until it was gone.

Drawing



Rear View of Trailer

Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: Mark J. Brudnak

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	15 September 1995	TIR Number:	002

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

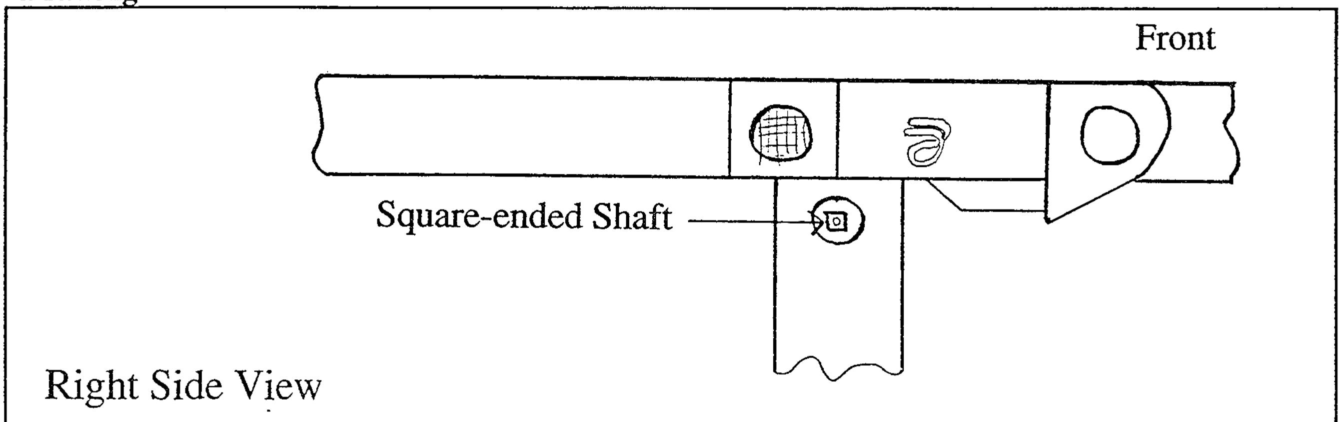
Title:	inoperable RF leveling jack	Date:	16 August 1995
Subsystem:	Leveling Jacks	Time:	Upon arrival at TARDEC
Part:	Jack Assembly	Terrain:	N/A
Part #:	PB000 19207 12355851	Miles:	0
Observed During:	After arrival	Cycle:	N/A
Action Taken:	Repaired, PM Notified		

Incident Description

When attempting to operate the right-front leveling jack, the jack could not be raised or lowered. The square-ended shaft that the hand crank would attach. This square-ended piece was turning freely on the shaft. The square-ended piece is supposed to be firmly attached to the shaft to transmit the torque of the handcrank. This failure rendered the right-front leveling jack inoperable.

Action:
Per the PM's direction, the failure was repaired.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: Michael Reininger

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	15 September 1995	TIR Number:	003

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

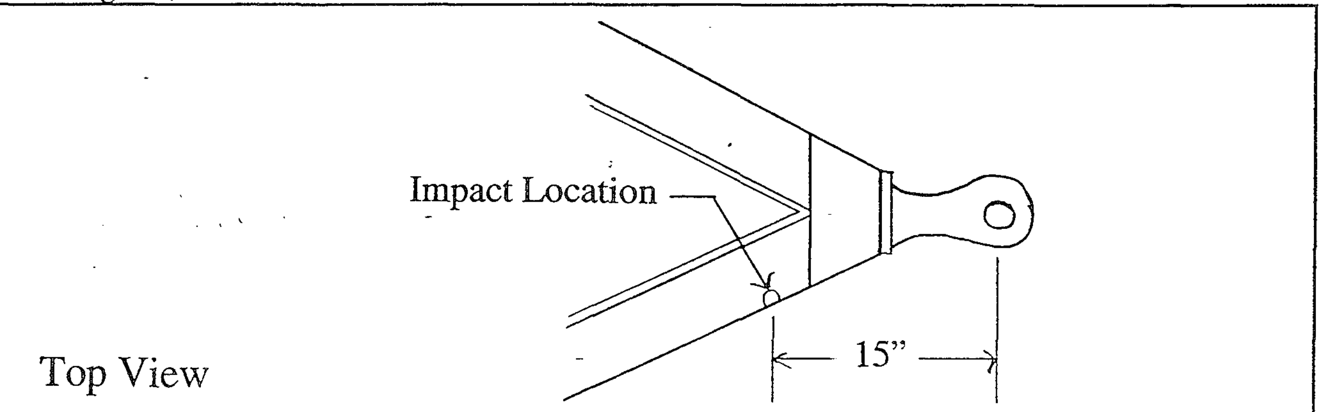
Title:	jack-knife of trailer	Date:	14 September 1995
Subsystem:	frame, drawbar	Time:	1000 hours
Part:	drawbar	Terrain:	N/A
Part #:	N/A	Miles:	0
Observed During:	After field test	Cycle:	N/A
Action Taken:	None		

Incident Description

When the field test was completed and the driver was attempting to back the trailer into the shop area, the trailer jack-knifed to the right and contacted the prime mover. The point at which the contact was made was on the right side of the drawbar approximately 15 inches behind the center of the lunette. The damage was minor and consisted of scratched paint gouged metal.

Action:
None was taken.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: Michael Reininger

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	20 September 1995	TIR Number:	004

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

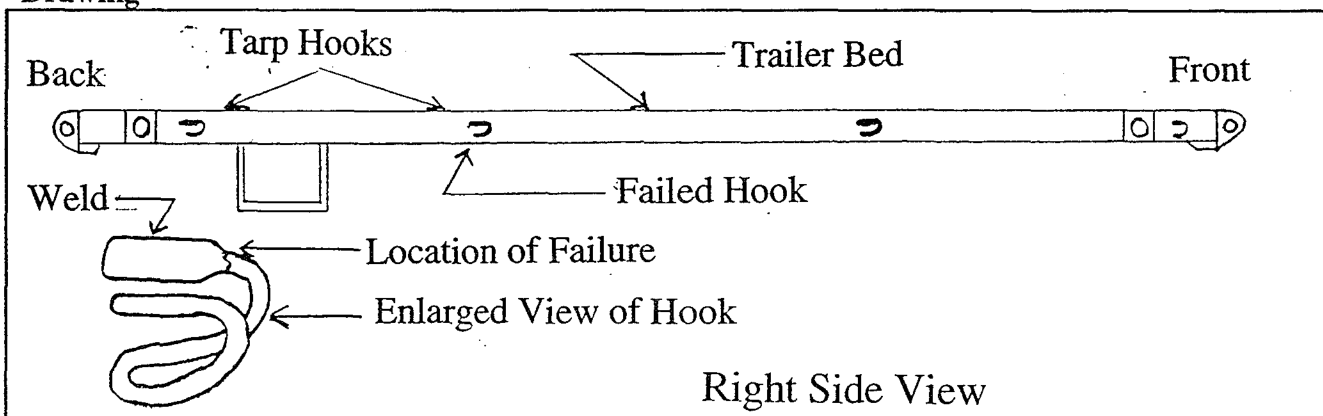
Title:	tarp hook failure	Date:	20 September 1995
Subsystem:	deck	Time:	1300 hours
Part:	tarp hook	Terrain:	N/A
Part #:	N/A	Miles:	0
Observed During:	During test preparation	Cycle:	N/A
Action Taken:	None		

Incident Description

While inspecting the trailer, the person inspecting held a tarp hook to keep his balance while looking under the trailer. Due to the forces exerted by this the tarp hook failed. It failed at the location where the weld ends (flat cross-section) and the hook begins (round cross-section). The hook that failed was on the right (curb) side, third from the front.

Action:
None was taken.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: Mark J. Brudnak

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	6 December 1995	TIR Number:	005

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

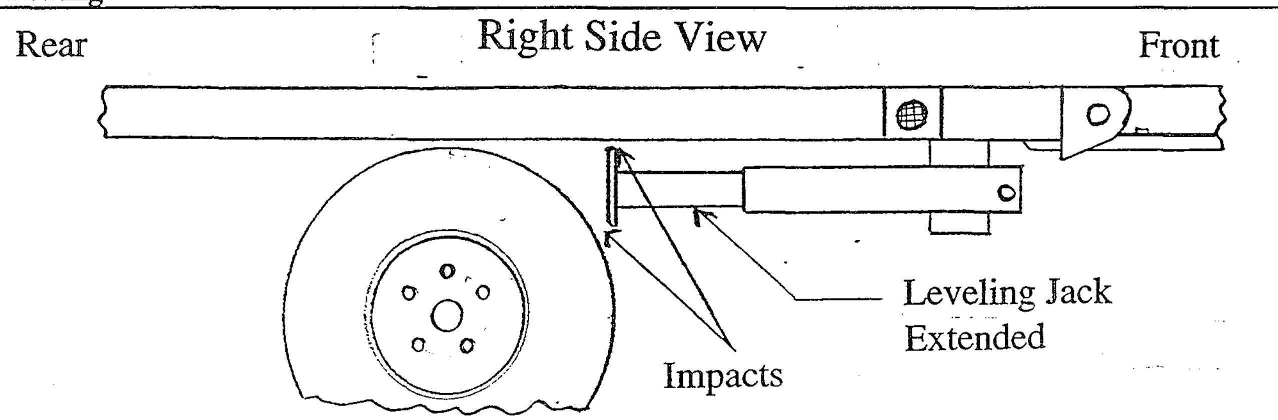
Title:	Extension of RF Jack	Date:	6 December 1995
Subsystem:	Leveling Jacks	Time:	1145 hours
Part:	Jack Assembly	Terrain:	Munson Gravel @ 25 mph
Part #:	PB000 19207 12355851	Miles:	52
Observed During:	During test	Cycle:	1
Action Taken:	Jack retracted and secured		

Incident Description

When testing on the Munson Gravel course at 25 mph during cycle 1 the right-front leveling jack was found to be fully extended rearward. It was stowed in the horizontal position at the time. In this extended position, the shoe on the end of the jack was impacting the right-front tire and was also impacting the under side of the frame. No permanent damage was observed.

Action:
The jack was retracted and restrained with a cable. Testing continued.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: George Norkus

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	18 December 1995	TIR Number:	006

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

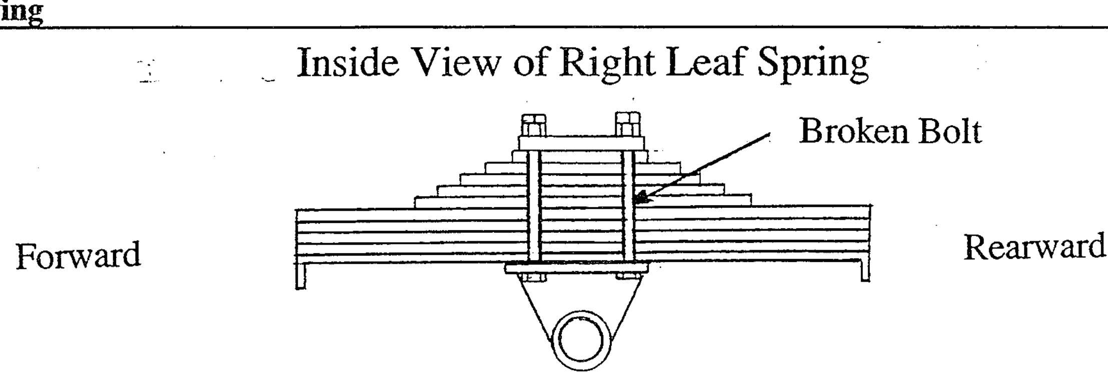
Title:	Leaf spring bolt failure	Date:	15 December 1995
Subsystem:	Spring assembly	Time:	1422 hours
Part:	Hexagon cap screw	Terrain:	Churchville B @ 13 mph
Part #:	PAFZZ 19207 12259791-1	Miles:	1133
Observed During:	During test	Cycle:	2
Action Taken:	Problem corrected/resumed testing		

Incident Description

When testing on Churchville B during cycle 2 the right rear inner bolt which holds the leaf spring to the trunnion failed. The bolt failed in the threaded portion. Other bolts were observed to have been turning.

Action:
The bolt was replaced and torqued to 175 ft-lb. per TM 9-2330-376-14&P. Also torqued remaining 7 bolts to 175 ft-lb. Resumed testing.

Drawing



Points of Contact

Prepared By: Terry Hoist / Mark J. Brudnak (810)574-6676	Noticed By: R. Smith / T. Ashworth

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date: 21 December 1995	TIR Number: 007

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

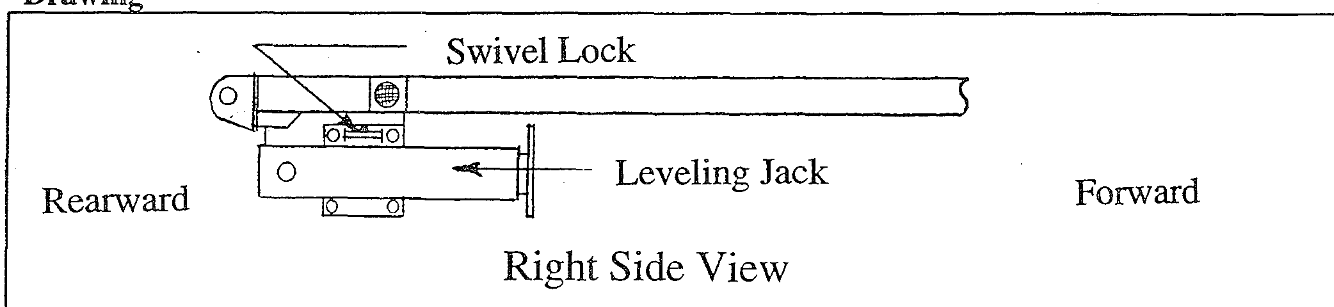
Title:	leveling jack swivel pin lockup	Date:	21 December 1995
Subsystem:	Leveling jack	Time:	0600 hours
Part:	Jack assembly / Swivel pin	Terrain:	Munson Gravel @ 25 mph
Part #:	PB000 19207 12355851	Miles:	1375
Observed During:	During maintenance	Cycle:	3
Action Taken:	Problem corrected/resumed testing		

Incident Description

While performing maintenance procedures on the left-front and right-rear leveling jacks, the jacks had to be lowered to the vertical position to access the grease fittings for the swivel pins for lubrication. When the swivel pins were lubricated, the pressure of the grease locked the swivel pin in place. This prevented the leveling jack from being rotated to the stowed position from the vertical position.

Action:
The grease fittings were removed and the pressure was released. The swivel pin then operated normally.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: G. Norkus / N. Coleman

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	29 December 1995	TIR Number:	008

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

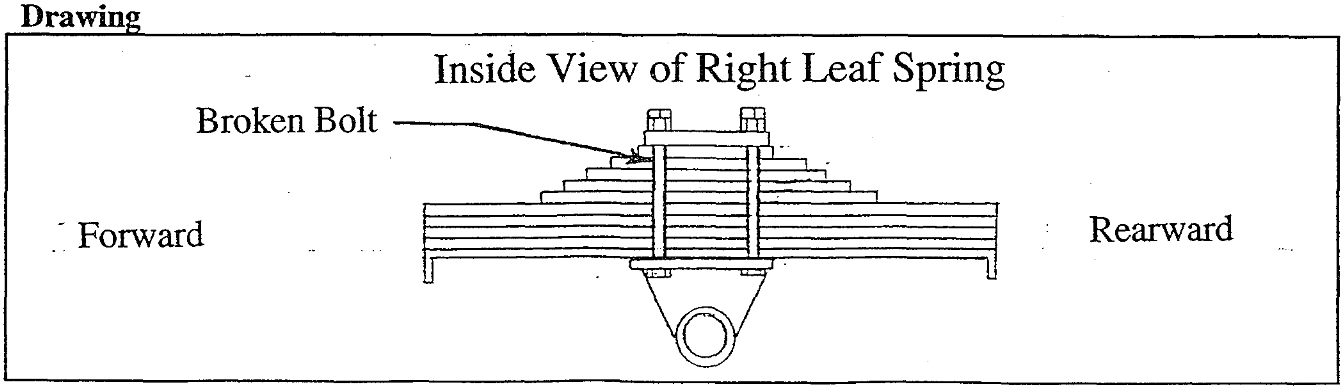
Title:	Leaf spring bolt failure	Date:	29 December 1995
Subsystem:	Spring assembly	Time:	1130 hours
Part:	Hexagon cap screw	Terrain:	Munson Gravel @ 25 mph
Part #:	PAFZZ 19207 12259791-1	Miles:	2016
Observed During:	During test	Cycle:	4
Action Taken:	Problem corrected/resumed testing		

Incident Description

When testing on Munson Gravel during cycle 4 the right front inner bolt which holds the leaf spring to the trunnion failed. The bolt failed in the threaded portion. All eight (8) bolts were tightened to 160 ft-lb. 3 hours prior to failure. This was done because some were found to be loose.

Action:
The broken bolt (grade 5) was replaced with a grade 8 bolt (supplied by the manufacturer) and torqued to 160 ft-lb. per TM 9-2330-376-14&P.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: N. Coleman

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	5 January 1995	TIR Number:	009

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

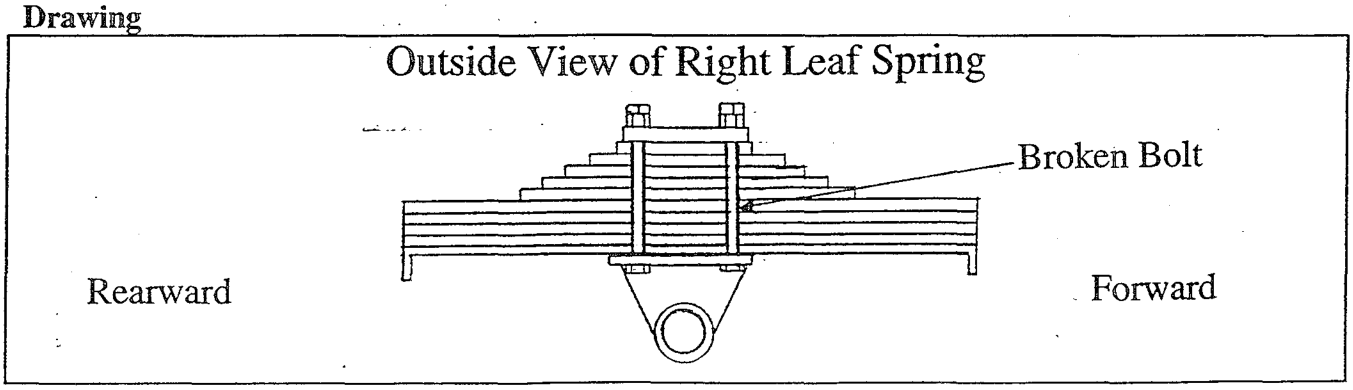
Title:	Leaf spring bolt failure	Date:	5 January 1995
Subsystem:	Spring assembly	Time:	0605 hours
Part:	Hexagon cap screw	Terrain:	Belgian Block @ 10 mph
Part #:	PAFZZ 19207 12259791-1	Miles:	2406
Observed During:	Daily inspection	Cycle:	4
Action Taken:	Problem corrected/resumed testing		

Incident Description

When inspecting the trailer the right front outer bolt which holds the leaf spring was found to be broken. The bolt failed where the head of the bolt meets the shaft. There was evidence on the bolt that it had been turning prior to failure.

Action:
The broken bolt (grade 5) was replaced with a grade 8 bolt (supplied by the manufacturer) and torqued to 160 ft-lb. per TM 9-2330-376-14&P.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: M. Reininger

Test Incident Report
Physical Simulation Team
AMSTA-TR-D

Date:	24 January 1995	TIR Number:	010

Item Description

Test Article:	M1061A1 5 ton, flatbed trailer	Manufacturer:	Utility Tool and Body Company
Part #:	8750137 NSN 2330-01-207-3533	Serial #:	N/A
Ident. #:	2413		

Incident Data

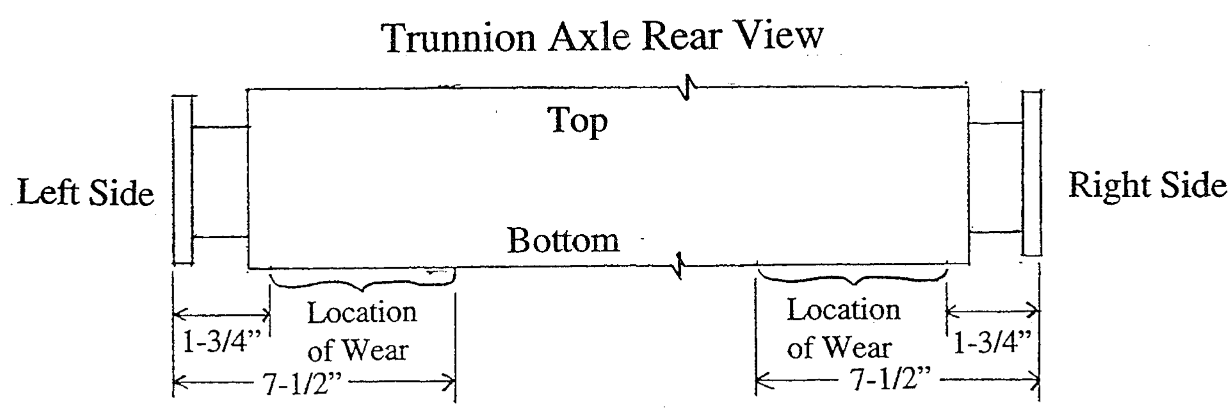
Title:	Trunnion Axle Wear	Date:	24 January 1995
Subsystem:	Suspension	Time:	-
Part:	Trunnion Axle	Terrain:	Test Complete
Part #:	PBFZZ 19207 12269927	Miles:	3610
Observed During:	Final Inspection	Cycle:	Test Complete
Action Taken:	Trunnion axle replaced		

Incident Description

After completion of the test the trunnion axle was removed from the trailer and inspected because it was suspected that the part was wearing. The part was found to have worn on the bottom side. The amount of wear was measured to be approximately 0.038 inch in the worst case.

Action:
The trunnion axle was replaced with a new one and the trailer was reassembled.

Drawing



Points of Contact

Prepared By: Mark J. Brudnak (810)574-6676	Noticed By: N. Coleman

APPENDIX B

TEST PLAN

Test Plan

for a

3,600 Mile Durability Test

for the

M1061A1 5-ton Flatbed Trailer

Prepared by:

Mark J. Brudnak
Physical Simulation Team
AMSTA-TR-D
U.S. Army Tank-Automotive Research Development and Engineering Center

September 18, 1995

Introduction

The Program Manager for Trailers has modified the M1061A1 trailer, making changes to the frame, decking and tires. The contractor responsible for manufacturing this trailer, Utility Tool and Body Co., has completed the production of five of these modified trailers. PM Trailers has instructed the Physical Simulation Team to conduct a 3, 600 mile durability test on one of these initial production models. This test will be conducted to verify the quality of production and to affirm that previously occurring problems have been adequately corrected before the bulk of the trailers are built.

The M1061A1 was endurance tested for 6,000 miles in 1994 at the Nevada Automotive Test Center (NATC) for Utility Tool and Body Company, Inc. The durability test to be conducted at TARDEC will be modeled after the test at NATC in the choice of the courses and speeds (with the exception that paved road will not be simulated). One of the major failures encountered in the test at NATC was the crack of a weld between the A-frame (drawbar) and the bed (superstructure) of the trailer. One objective of this test will be to determine if this same failure occurs.

The test will be conducted using the Pintle Motion Base Simulator (PMBS). This will allow motions to be imparted to the lunette of the trailer in all three directions. Since the failure that occurred at NATC was near the lunette of the trailer, the motion of the lunette will figure prominently in the accuracy and validity of this test.

The Remote Parameter Control™ (RPC[1]) process will be used to generate drive commands for the PMBS. The input data for the RPC™ process will be derived from a computer based model. This model will use characterized trailer parameters and will be validated against a field test.

Motion Simulator

As mentioned previously the simulator to be used for this test will be the PMBS. It will be configured with 4 vertical tire-coupled actuators, each positioned under one of the wheels. The 458 servo-hydraulic controller will need to have channels 6 and 7 configured for operation with the two additional rear actuators. Also, the axles of the trailer should be tethered to the platens of the actuators as a safeguard against the trailer hopping off of the simulator.

The lunette of the trailer will be attached to the PMBS so that it can be independently moved in three directions. The PMBS configured with four vertical actuators has seven degrees of freedom (DOF). The seven actuator command signals for this simulator will be generated by the 498 automated site controller (ASC). The 498 ASC will also be used for the acquisition of the response data throughout the test.

[1] Remote Parameter Control and RPC are registered trademarks of the MTS Systems Corporation.

The output of analog drive signals will be controlled by the RPC™ software. These analog drive signals will be fed into the 458 controller which will perform the closed-loop servo-hydraulic control. All seven control channels of the 458 should be tuned prior to the start of the test.

Profile Scenario

The profiles and speeds were selected to resemble the courses and speeds used for the test at NATC, which were based on MIL-T-62073E. The NATC report and MIL-T-62073E specify courses in generic terms such as "hilly cross-country", and "secondary road". This test will use standard Aberdeen Proving Ground (APG) terrains as substitutes for this generic set of courses. The substitutes made are shown in Table 1.

Table 1. APG Course Substitutions for Generic Terrain Types.

Generic Terrain Type	APG Course Used
Paved or Hard-surfaced Roads	None
Secondary or Gravel Roads	Munson Gravel
Level Cross-country Roads	Perryman A
Hilly Cross-country Roads	Churchville B
Belgian Block Roads	Belgian Block

The distribution of the mileage will be in accordance with MIL-T-62073E. (Zero payload mileage will be simulated with full payload). The test will be conducted in six cycles of 600 miles each for a total of 3,600 miles. The distribution of mileage will be as shown in Table 2.

Table 2. Mileage Distribution.

Terrain	Speed (mph)	Cycle Dist. (miles)	Cycle Time (hours)	Total Dist. (miles)	Total Time (hours)
Munson Gravel	25	250	10	1,500	60
Churchville B (rough)	10	30	3	180	18
Churchville B (mild)	15	70	4.7	420	28
Perryman A	16	230	14.4	1,380	86.3
Belgian Block	10	20	2	120	12
Total	-	**600**	**34.1**	**3,600**	**204.3**

It should be noted that paved road will not be simulated in this test. The reasons for this are as follows:

1. The Physical Simulation Team does not have a representation of Perryman Paved in our terrain library.
2. Paved highway is the mildest of the terrains specified in Table 1.

3. Replacing the paved highway portion of the test with more cycles as specified in Table 2 will better approximate the 6,000 mile test done at NATC.

The PM originally requested a 3,000 mile test consisting of three complete cycles of 1,000 miles each. This would emulate half of the NATC test. Since paved road is relatively mild, the Physical Simulation Team suggested that the entire 6,000 mile test be replicated with the exception of the 2,400 miles of paved road. This resulted in six cycles of 600 miles each for 3,600 miles total. Although the 2,400 miles of paved road will not be simulated, all of the more severe terrains will be simulated for all six cycles. This will represent a more complete test than the originally proposed 3,000 mile test. By examining data from a past field test (M149A2), it was found that paved road is 2 to 10 times less severe than Belgian Block and that it is the mildest of the courses examined. Although the miles deleted from paved roads may have caused small amounts of vibration related fatigue, the paved road miles are abundantly compensated for by adding three cycles of the harsher courses to the test.

If the trailer endures the schedule in Table 2, additional testing may take place (at the discretion of the PM) using a more severe schedule containing harsher courses. These courses will be Belgian Block, radial washboard and 3 inch spaced bumps. The scenario for this schedule will be as shown in Table 3. This scenario is modeled after a test performed on a M1048 flatbed trailer performed in 1992.

Table 3. Mileage Distribution for Harsher Scenarios

Terrain	Speed (mph)	Distance (miles)	Time (hours)
Belgian Block	10	120	12
Radial Wash Board	15	30	2
3" Spaced Bumps	20	10	0.5
Total	-	**160**	**14.5**

This scenario may be modified if the need arises. A decision will be made whether to perform this test after the completion of the original durability test.

Data Acquisition

Although this test is primarily intended to determine the durability of the trailer, some instrumentation will be installed on the trailer. The trailer will be instrumented for (1) monitoring purposes (2) later reference (2) and to better understand the cause of any failures. Particular attention will be given to the drawbar toe-weld.

Table 4. M1061A1 Instrumentation Channels.

Channel	Scale Factor	Full Scale Value (RPC)	Bandwidth
Accelerometers			
1. LF Spindle (vert.)	0.667 V/g	15 g	dc - 80 Hz
2 RF Spindle (vert.)	0.667 V/g	15 g	dc - 80 Hz
3. LR Spindle (vert.)	0.667 V/g	15 g	dc - 80 Hz
4. RR Spindle (vert.)	0.667 V/g	15 g	dc - 80 Hz
5. Frame @ c.g. (lat.)	1.0 V/g	10 g	dc - 80 Hz
6. Frame @ c.g. (vert.)	1.0 V/g	10 g	dc - 80 Hz
7. Frame @ c.g. (long.)	1.0 V/g	10 g	dc - 80 Hz
8. Lunette (lat.)	1.0 V/g	10 g	dc - 80 Hz
9. Lunette (vert.)	1.0 V/g	10 g	dc - 80 Hz
10. Lunette (long.)	1.0 V/g	10 g	dc - 80 Hz
11. A-Frame @ RF corner (lat.)	1.0 V/g	10 g	dc - 80 Hz
12. A-Frame @ RF corner (vert.)	1.0 V/g	10 g	dc - 80 Hz
13. A-Frame @ RF corner (long.)	1.0 V/g	10 g	dc - 80 Hz
14. A-Frame @ LF corner (lat.)	1.0 V/g	10 g	dc - 80 Hz
15. A-Frame @ LF corner (vert.)	1.0 V/g	10 g	dc - 80 Hz
16. A-Frame @ LF corner (long.)	1.0 V/g	10 g	dc - 80 Hz
Strain Gages (Single)			
17. L A-Frame In-board (long.)	0.01 V/ue	1,000 ue	dc - 80 Hz
18. L A-Frame Out-board (long.)	0.01 V/ue	1,000 ue	dc - 80 Hz
19. R A-Frame In-board (long.)	0.01 V/ue	1,000 ue	dc - 80 Hz
20. R A-Frame Out-board (long.)	0.01 V/ue	1,000 ue	dc - 80 Hz
Rotational Rate Transducers			
21. Pitch of trailer frame	0.0417 V/deg/sec	240 deg/sec	dc - 25 Hz
22. Roll of trailer frame	0.00694 V/deg/sec	1,440 deg/sec	dc - 25 Hz

Test Execution

Upon completion of the model validation field test, the trailer should be placed up on the PMBS. The instrumentation should be installed. The wheels of the trailer tethered to the actuator platens. The trailer should be lubricated and the tires inflated IAW the TM if this was not done previously.

Once this is done the simulator should be tuned with the trailer attached. When this is done the trailer is ready to begin iterations.

Next, iterations will be performed on the trailer using the DADS model data as input. This will take approximately 3 days for all five terrains listed above. If problems arise, this time may be extended.

Before the start of the test the trailer should be inspected to determine if it was damaged during iterations. Jury runs will then be made in the presence of Physical Simulation

Engineers, PM Trailer personnel, and possibly representatives from the manufacturer. These jury runs will be run to gain the approval of other engineers and the PM prior to the start of the test. Once the jury runs are completed and all of the data acquisition channels are working and are in order, the test can begin.

As seen in Table 2, the test will be approximately 6 weeks long. This allows for one cycle per week. This equates to 34 hours of testing at 600 miles per week. Also the trailer will be periodically lubricated IAW the TM. All of the data acquisition channels should be monitored through strip chart recorders. Data will be recorded periodically using the RPC™ system.

The test will be operated using the RPC™ system. The execution of the test will be automated using command files. The operating technicians will be briefed on how to start and shut down the test using the RPC™ system.

Inspections

The trailer should be inspected periodically throughout the test. The purpose of these inspections will be to detect broken or failing parts and other abnormalities. The inspections will generally overview the trailer systems and components with particular attention called to the areas that are likely or expected to fail. Inspection sheets will be provided which will serve as a checklist of items that must be inspected.

Inspections should be performed at the following intervals:

1. Prior to the start of iterations.
2. After iterations, before the start of testing.
3. During testing, every morning.
4. After the completion of the 3,600 mile test, before extended testing starts.
5. During extended testing, every morning.
6. After the completion of the extended test.

When an inspection discovers a problem, failure, or abnormality, the person who noticed it should complete a Test Incident Report (TIR) form. This provides a way of tracking and documenting problems when they occur. Also, the project engineer (or his representative) should be notified immediately. He will in-turn notify the PM. If the problem would interfere in the normal operation of the trailer, the test should be stopped. No corrective action should be done until the project engineer has been notified. This will assure that every incident is documented and that the PM has the chance to observe the problem before it is fixed or compounded by further testing.

References

1. Cox, Robert A., "Final Report for Utility Tool and Body Company, Inc. - 6,000 Mile Endurance Test and Lifting and Tiedown Evaluation of One M1061A1 Flatbed Trailer", Nevada Automotive Test Center, Proj. No. 20-14-311, August 1994.

2. MIL-T-62073E, "Military Specification, Trailer: 4-, 5-, and 7.5-ton, 4-Wheel (Tandem) Cart Type; Trailer, Bolster: 4-ton, 4-wheel (Tandem)", Army - AT, April 1992.

APPENDIX C

STATISTICAL SUMMARIES OF THE RECORDED DATA

(Plots are arranged chronologically.)

Table C-1. Statistics from Munson Gravel @ 25 mph, Cycle 0, 0000 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	10.0	-10.4
2	Accel. Vert. - RF Wheel Spindle	g	1.8	9.9	-9.8
3	Accel. Vert. - LR Wheel Spindle	g	1.8	11.7	-8.0
4	Accel. Vert. - RR Wheel Spindle	g	1.6	11.2	-7.5
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	0.9	-1.9
7	Accel. Long. - Frame at the CG	g	0.2	1.3	-1.3
8	Accel. Lat. - Lunette	g	0.3	2.0	-2.7
9	Accel. Vert. - Lunette	g	0.3	1.8	-1.6
10	Accel. Long. - Lunette	g	0.1	1.3	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.5	2.6	-2.3
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.2	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.4	-1.9
15	Accel. Vert. - A-frame at LF Corner	g	0.5	2.5	-2.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.1	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	93.4	406.0	-435.0
18	Strain Long. - A-frame, Left Outboard	ue	56.8	253.0	-260.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	502.0	-683.0
20	Strain Long. - A-frame, Right Outboard	ue	55.0	226.0	-316.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.1	8.9	-9.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.8	6.9	-8.3

Table C-2. Statistics from Perryman A @ 16 mph, Cycle 0, 0000 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.5	6.9	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.4	8.0	-8.1
3	Accel. Vert. - LR Wheel Spindle	g	1.4	6.6	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.3	6.9	-6.8
5	Accel. Lat. - Frame at the CG	g	0.3	1.7	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	0.9	-1.5
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.8
8	Accel. Lat. - Lunette	g	0.3	1.8	-1.5
9	Accel. Vert. - Lunette	g	0.3	1.4	-1.7
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.3	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-2.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.3	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.5	2.6	-2.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	108.0	462.0	-646.0
18	Strain Long. - A-frame, Left Outboard	ue	64.5	266.0	-400.0
19	Strain Long. - A-frame, Right Inboard	ue	144.0	641.0	-813.0
20	Strain Long. - A-frame, Right Outboard	ue	60.9	297.0	-363.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.5	-9.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	10.0	-11.7

Table C-3. Statistics from Churchville B (mild) @ 15 mph, Cycle 0, 0000 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	5.6	-5.6
2	Accel. Vert. - RF Wheel Spindle	g	1.1	6.5	-5.9
3	Accel. Vert. - LR Wheel Spindle	g	1.0	6.8	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.0	7.1	-5.5
5	Accel. Lat. - Frame at the CG	g	0.2	1.8	-1.6
6	Accel. Vert. - Frame at the CG	g	0.2	0.9	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.8
8	Accel. Lat. - Lunette	g	0.3	1.8	-2.2
9	Accel. Vert. - Lunette	g	0.2	2.1	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.4	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.5	-2.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.4	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.3	-3.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	93.4	412.0	-400.0
18	Strain Long. - A-frame, Left Outboard	ue	56.0	256.0	-244.0
19	Strain Long. - A-frame, Right Inboard	ue	125.0	546.0	-559.0
20	Strain Long. - A-frame, Right Outboard	ue	52.8	242.0	-261.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.2	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	13.3	-10.4

Table C-4. Statistics from Churchville B (rough) @ 10 mph, Cycle 0, 0000 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.6	-6.6
2	Accel. Vert. - RF Wheel Spindle	g	1.0	7.5	-7.2
3	Accel. Vert. - LR Wheel Spindle	g	1.0	5.7	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.0	9.7	-5.7
5	Accel. Lat. - Frame at the CG	g	0.2	3.2	-4.9
6	Accel. Vert. - Frame at the CG	g	0.1	2.5	-3.8
7	Accel. Long. - Frame at the CG	g	0.1	1.9	-1.7
8	Accel. Lat. - Lunette	g	0.2	1.2	-1.5
9	Accel. Vert. - Lunette	g	0.2	2.3	-2.4
10	Accel. Long. - Lunette	g	0.1	0.7	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.1	0.8	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.1	-5.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.1	0.8	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	4.5	-4.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	112.0	447.0	-785.0
18	Strain Long. - A-frame, Left Outboard	ue	65.5	268.0	-486.0
19	Strain Long. - A-frame, Right Inboard	ue	152.0	648.0	-908.0
20	Strain Long. - A-frame, Right Outboard	ue	62.8	280.0	-387.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.4	-16.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	13.9	-16.8

Table C-5. Statistics from Belgian Block @ 10 mph, Cycle 0, 0000 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.3	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.2	5.0	-5.4
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.3	-5.0
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.3	-5.0
5	Accel. Lat. - Frame at the CG	g	0.3	3.0	-2.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.3	-1.3
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.1
9	Accel. Vert. - Lunette	g	0.4	2.3	-2.5
10	Accel. Long. - Lunette	g	0.1	0.7	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.3	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.5
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.6	-3.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.8	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	153.0	500.0	-774.0
18	Strain Long. - A-frame, Left Outboard	ue	90.8	300.0	-466.0
19	Strain Long. - A-frame, Right Inboard	ue	210.0	707.0	-1030.0
20	Strain Long. - A-frame, Right Outboard	ue	89.0	312.0	-490.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	10.3	-11.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.4	18.8	-17.8

Table C-6. Statistics from Munson Gravel @ 25 mph, Cycle 1, 0175 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.5	-9.6
2	Accel. Vert. - RF Wheel Spindle	g	1.7	8.5	-9.3
3	Accel. Vert. - LR Wheel Spindle	g	1.7	7.8	-7.6
4	Accel. Vert. - RR Wheel Spindle	g	1.6	9.4	-7.2
5	Accel. Lat. - Frame at the CG	g	0.3	1.7	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	1.4	-1.7
8	Accel. Lat. - Lunette	g	0.3	1.9	-2.8
9	Accel. Vert. - Lunette	g	0.3	1.7	-2.0
10	Accel. Long. - Lunette	g	0.1	0.9	-1.3
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.3	-1.9
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.5	-2.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.1	-1.1
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.2	-1.9
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-3.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-1.1
17	Strain Long. - A-frame, Left Inboard	ue	93.8	401.0	-447.0
18	Strain Long. - A-frame, Left Outboard	ue	56.6	243.0	-265.0
19	Strain Long. - A-frame, Right Inboard	ue	128.0	538.0	-690.0
20	Strain Long. - A-frame, Right Outboard	ue	55.1	230.0	-324.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	8.0	-9.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.8	8.0	-7.0

Table C-7. Statistics from Munson Gravel @ 25 mph, Cycle 1, 0250 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.4	-9.6
2	Accel. Vert. - RF Wheel Spindle	g	1.7	8.0	-9.7
3	Accel. Vert. - LR Wheel Spindle	g	1.7	8.5	-7.9
4	Accel. Vert. - RR Wheel Spindle	g	1.6	9.5	-7.4
5	Accel. Lat. - Frame at the CG	g	0.3	1.7	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.4
7	Accel. Long. - Frame at the CG	g	0.2	1.5	-2.1
8	Accel. Lat. - Lunette	g	0.4	1.8	-3.2
9	Accel. Vert. - Lunette	g	0.3	1.7	-1.7
10	Accel. Long. - Lunette	g	0.1	0.8	-1.0
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-2.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.3	-1.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.0	-1.1
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-2.1
15	Accel. Vert. - A-frame at LF Corner	g	0.5	2.1	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.9
17	Strain Long. - A-frame, Left Inboard	ue	93.7	397.0	-455.0
18	Strain Long. - A-frame, Left Outboard	ue	56.8	242.0	-272.0
19	Strain Long. - A-frame, Right Inboard	ue	128.0	530.0	-691.0
20	Strain Long. - A-frame, Right Outboard	ue	55.2	219.0	-325.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	8.5	-9.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.8	8.0	-7.0

Table C-8. Statistics from Perryman A @ 16 mph, Cycle 1, 0260 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.5	7.7	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.4	-8.1
3	Accel. Vert. - LR Wheel Spindle	g	1.5	6.9	-6.5
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.5	-7.1
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.6
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	0.7	-0.8
8	Accel. Lat. - Lunette	g	0.3	1.4	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.5	-1.9
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.0	-1.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.5	2.5	-2.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	107.0	462.0	-631.0
18	Strain Long. - A-frame, Left Outboard	ue	64.5	255.0	-386.0
19	Strain Long. - A-frame, Right Inboard	ue	145.0	624.0	-819.0
20	Strain Long. - A-frame, Right Outboard	ue	61.5	287.0	-367.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.8	-9.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	9.7	-11.4

Table C-9. Statistics from Perryman A @ 16 mph, Cycle 1, 0327 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.5	7.5	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.4	-7.9
3	Accel. Vert. - LR Wheel Spindle	g	1.4	6.6	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.3	6.3	-7.0
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	0.6	-0.7
8	Accel. Lat. - Lunette	g	0.3	1.3	-1.5
9	Accel. Vert. - Lunette	g	0.3	1.5	-1.8
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.0	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.0	-1.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.0	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.7	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	107.0	458.0	-630.0
18	Strain Long. - A-frame, Left Outboard	ue	64.4	252.0	-384.0
19	Strain Long. - A-frame, Right Inboard	ue	145.0	638.0	-822.0
20	Strain Long. - A-frame, Right Outboard	ue	61.2	291.0	-366.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.5	-8.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	9.8	-11.8

Table C-10. Statistics from Perryman A @ 16 mph, Cycle 1, 0434 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	7.6	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.9	-7.9
3	Accel. Vert. - LR Wheel Spindle	g	1.5	6.7	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.7	-7.1
5	Accel. Lat. - Frame at the CG	g	0.3	1.9	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.6
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.3	1.5	-1.4
9	Accel. Vert. - Lunette	g	0.3	1.5	-1.8
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.1	-1.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-2.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	107.0	457.0	-629.0
18	Strain Long. - A-frame, Left Outboard	ue	64.7	254.0	-383.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	625.0	-826.0
20	Strain Long. - A-frame, Right Outboard	ue	61.5	287.0	-367.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.5	-8.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	9.8	-11.8

Table C-11. Statistics from Perryman A @ 16 mph, Cycle 1, 0480 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.5	7.1	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.6	-7.7
3	Accel. Vert. - LR Wheel Spindle	g	1.4	6.9	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.3	6.4	-6.9
5	Accel. Lat. - Frame at the CG	g	0.3	1.9	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.7
8	Accel. Lat. - Lunette	g	0.3	1.4	-1.4
9	Accel. Vert. - Lunette	g	0.3	1.6	-1.9
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.4	1.9	-1.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.4	-2.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	107.0	456.0	-640.0
18	Strain Long. - A-frame, Left Outboard	ue	64.5	252.0	-388.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	632.0	-832.0
20	Strain Long. - A-frame, Right Outboard	ue	61.3	288.0	-367.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.5	-8.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-12.1

Table C-12. Statistics from Churchville B (rough) @ 10 mph, Cycle 1, 0483 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.0	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.0	7.0	-6.8
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.6	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.0	9.7	-5.2
5	Accel. Lat. - Frame at the CG	g	0.2	4.4	-2.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.8	-2.7
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.7
8	Accel. Lat. - Lunette	g	0.2	1.2	-1.2
9	Accel. Vert. - Lunette	g	0.2	2.1	-2.1
10	Accel. Long. - Lunette	g	0.1	0.5	-0.8
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.8	-0.8
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.8	-4.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.8	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.3	-3.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	111.0	450.0	-779.0
18	Strain Long. - A-frame, Left Outboard	ue	65.6	268.0	-486.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	668.0	-879.0
20	Strain Long. - A-frame, Right Outboard	ue	63.6	291.0	-367.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.4	-16.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.3	-16.1

Table C-13. Statistics from Churchville B (mild) @ 15 mph, Cycle 1, 0485 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.3	-5.5
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.7	-6.7
3	Accel. Vert. - LR Wheel Spindle	g	1.1	6.9	-5.7
4	Accel. Vert. - RR Wheel Spindle	g	1.1	7.4	-5.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.6
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.9
8	Accel. Lat. - Lunette	g	0.3	2.1	-2.4
9	Accel. Vert. - Lunette	g	0.2	2.1	-1.7
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.7	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.4	-4.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.7	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.7	-3.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	93.1	410.0	-391.0
18	Strain Long. - A-frame, Left Outboard	ue	55.8	245.0	-237.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	537.0	-578.0
20	Strain Long. - A-frame, Right Outboard	ue	53.3	233.0	-258.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	9.9	-10.3
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.0	-10.9

Table C-14. Statistics from Churchville B (mild) @ 15 mph, Cycle 1, 0513 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	5.3	-5.5
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.5	-6.3
3	Accel. Vert. - LR Wheel Spindle	g	1.1	6.9	-5.7
4	Accel. Vert. - RR Wheel Spindle	g	1.1	7.2	-5.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.5
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-1.0
8	Accel. Lat. - Lunette	g	0.3	2.2	-2.4
9	Accel. Vert. - Lunette	g	0.2	1.9	-1.5
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.7	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.2	-3.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.7	-1.7
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.7	-3.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	92.5	412.0	-388.0
18	Strain Long. - A-frame, Left Outboard	ue	55.4	246.0	-235.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	538.0	-574.0
20	Strain Long. - A-frame, Right Outboard	ue	52.9	237.0	-257.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	9.9	-10.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.4	-10.6

Table C-15. Statistics from Churchville B (rough) @ 10 mph, Cycle 1, 0513 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.1	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.0	7.1	-6.9
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.2	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.0	9.6	-5.2
5	Accel. Lat. - Frame at the CG	g	0.2	3.8	-3.1
6	Accel. Vert. - Frame at the CG	g	0.1	1.5	-2.2
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.7
8	Accel. Lat. - Lunette	g	0.2	1.2	-1.2
9	Accel. Vert. - Lunette	g	0.2	2.4	-2.6
10	Accel. Long. - Lunette	g	0.1	0.5	-0.7
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.9	-0.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.0	-4.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.8	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.5	-3.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	112.0	449.0	-774.0
18	Strain Long. - A-frame, Left Outboard	ue	66.0	273.0	-480.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	673.0	-888.0
20	Strain Long. - A-frame, Right Outboard	ue	63.5	295.0	-374.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.4	-16.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.8	-16.4

Table C-16. Statistics from Churchville B (mild) @ 15 mph, Cycle 1, 0548 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	5.4	-5.5
2	Accel. Vert. - RF Wheel Spindle	g	1.1	6.4	-6.4
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.1	-5.8
4	Accel. Vert. - RR Wheel Spindle	g	1.1	6.9	-5.7
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.5
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-1.1
8	Accel. Lat. - Lunette	g	0.3	2.1	-2.5
9	Accel. Vert. - Lunette	g	0.2	2.0	-1.8
10	Accel. Long. - Lunette	g	0.1	0.4	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.6	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.3	-3.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.6	-1.8
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.7	-3.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	92.9	415.0	-393.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	244.0	-236.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	544.0	-584.0
20	Strain Long. - A-frame, Right Outboard	ue	53.3	238.0	-259.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	9.8	-10.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.4	-11.0

Table C-17. Statistics from Churchville B (rough) @ 10 mph, Cycle 1, 0548 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.0	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	0.9	7.2	-6.7
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.4	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.0	9.4	-5.0
5	Accel. Lat. - Frame at the CG	g	0.2	3.8	-3.5
6	Accel. Vert. - Frame at the CG	g	0.1	1.7	-2.5
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.7
8	Accel. Lat. - Lunette	g	0.2	1.3	-1.3
9	Accel. Vert. - Lunette	g	0.3	2.1	-2.8
10	Accel. Long. - Lunette	g	0.1	0.5	-0.7
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.9	-0.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.0	-4.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.8
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.9	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.6	-3.0
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	112.0	444.0	-786.0
18	Strain Long. - A-frame, Left Outboard	ue	66.2	266.0	-489.0
19	Strain Long. - A-frame, Right Inboard	ue	154.0	683.0	-896.0
20	Strain Long. - A-frame, Right Outboard	ue	63.8	298.0	-375.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.3	-16.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.0	-16.2

Table C-18. Statistics from Churchville B (mild) @ 15 mph, Cycle 1, 0581 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.7	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.6	-6.7
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.1	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.1	7.4	-5.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-2.3
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.9
8	Accel. Lat. - Lunette	g	0.3	2.4	-2.2
9	Accel. Vert. - Lunette	g	0.2	2.2	-1.7
10	Accel. Long. - Lunette	g	0.1	0.4	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.8	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.3	-3.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.8	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.6	-3.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	93.2	421.0	-390.0
18	Strain Long. - A-frame, Left Outboard	ue	56.2	250.0	-239.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	552.0	-569.0
20	Strain Long. - A-frame, Right Outboard	ue	53.3	241.0	-251.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	10.0	-10.3
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.0	-10.4

Table C-19. Statistics from Churchville B (rough) @ 10 mph, Cycle 1, 0582 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.3	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.0	7.3	-6.8
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.6	-6.0
4	Accel. Vert. - RR Wheel Spindle	g	1.0	9.9	-5.2
5	Accel. Lat. - Frame at the CG	g	0.2	4.0	-3.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.6	-2.6
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.4
8	Accel. Lat. - Lunette	g	0.2	1.3	-1.3
9	Accel. Vert. - Lunette	g	0.3	2.4	-2.5
10	Accel. Long. - Lunette	g	0.1	0.5	-0.7
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.9	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.8	-5.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.8
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.9	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.7	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	112.0	454.0	-780.0
18	Strain Long. - A-frame, Left Outboard	ue	66.6	268.0	-487.0
19	Strain Long. - A-frame, Right Inboard	ue	154.0	687.0	-893.0
20	Strain Long. - A-frame, Right Outboard	ue	63.9	297.0	-376.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.4	-16.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.1	-16.7

Table C-20. Statistics from Belgian Block @ 10 mph, Cycle 1, 0586 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.3	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.1	4.5	-5.4
3	Accel. Vert. - LR Wheel Spindle	g	1.2	4.8	-5.2
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.2	-5.1
5	Accel. Lat. - Frame at the CG	g	0.3	2.3	-3.4
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-2.1
7	Accel. Long. - Frame at the CG	g	0.2	1.3	-0.7
8	Accel. Lat. - Lunette	g	0.3	1.9	-1.9
9	Accel. Vert. - Lunette	g	0.4	2.5	-2.5
10	Accel. Long. - Lunette	g	0.1	0.7	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.1	-2.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.4	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.5	-4.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	153.0	532.0	-766.0
18	Strain Long. - A-frame, Left Outboard	ue	92.5	331.0	-469.0
19	Strain Long. - A-frame, Right Inboard	ue	213.0	706.0	-1060.0
20	Strain Long. - A-frame, Right Outboard	ue	89.9	304.0	-512.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	10.1	-10.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	5.0	20.5	-16.8

Table C-21. Statistics from Belgian Block @ 10 mph, Cycle 1, 0599 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.3	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.1	4.6	-5.4
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.1	-4.9
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.2	-5.2
5	Accel. Lat. - Frame at the CG	g	0.3	2.5	-3.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.3	-1.8
7	Accel. Long. - Frame at the CG	g	0.2	1.3	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.2	-1.9
9	Accel. Vert. - Lunette	g	0.4	2.7	-2.5
10	Accel. Long. - Lunette	g	0.1	0.7	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.0	-2.3
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.5	-4.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.8	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	153.0	534.0	-779.0
18	Strain Long. - A-frame, Left Outboard	ue	92.5	332.0	-463.0
19	Strain Long. - A-frame, Right Inboard	ue	213.0	702.0	-1070.0
20	Strain Long. - A-frame, Right Outboard	ue	89.9	311.0	-508.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	10.0	-11.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.7	19.8	-17.9

Table C-22. Statistics from Belgian Block @ 10 mph, Cycle 1, 0602 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.1	-5.6
2	Accel. Vert. - RF Wheel Spindle	g	1.1	4.4	-5.0
3	Accel. Vert. - LR Wheel Spindle	g	1.2	4.9	-5.0
4	Accel. Vert. - RR Wheel Spindle	g	1.1	4.9	-5.0
5	Accel. Lat. - Frame at the CG	g	0.3	3.1	-2.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-1.4
7	Accel. Long. - Frame at the CG	g	0.2	1.2	-0.9
8	Accel. Lat. - Lunette	g	0.3	2.0	-2.1
9	Accel. Vert. - Lunette	g	0.4	2.9	-2.5
10	Accel. Long. - Lunette	g	0.1	0.6	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.2	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.7	-3.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.8	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	153.0	536.0	-766.0
18	Strain Long. - A-frame, Left Outboard	ue	92.3	328.0	-471.0
19	Strain Long. - A-frame, Right Inboard	ue	213.0	686.0	-1060.0
20	Strain Long. - A-frame, Right Outboard	ue	89.4	303.0	-505.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	9.4	-10.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	19.7	-18.6

Table C-23. Statistics from Munson Gravel @ 25 mph, Cycle 2, 0603 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.0	-9.7
2	Accel. Vert. - RF Wheel Spindle	g	1.7	8.6	-9.1
3	Accel. Vert. - LR Wheel Spindle	g	1.7	8.2	-7.6
4	Accel. Vert. - RR Wheel Spindle	g	1.6	8.6	-7.1
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	1.0	-1.6
8	Accel. Lat. - Lunette	g	0.3	1.9	-2.9
9	Accel. Vert. - Lunette	g	0.3	1.7	-1.6
10	Accel. Long. - Lunette	g	0.1	0.6	-1.1
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.2	-2.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.0	-1.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-1.1
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.2	-2.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.3	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.7	-1.0
17	Strain Long. - A-frame, Left Inboard	ue	91.6	387.0	-435.0
18	Strain Long. - A-frame, Left Outboard	ue	55.3	229.0	-262.0
19	Strain Long. - A-frame, Right Inboard	ue	129.0	538.0	-681.0
20	Strain Long. - A-frame, Right Outboard	ue	54.7	227.0	-317.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.1	-9.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.8	7.7	-7.1

Table C-24. Statistics from Munson Gravel @ 25 mph, Cycle 2, 0789 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.8	-9.4
2	Accel. Vert. - RF Wheel Spindle	g	1.7	9.1	-9.6
3	Accel. Vert. - LR Wheel Spindle	g	1.7	8.2	-7.4
4	Accel. Vert. - RR Wheel Spindle	g	1.7	9.2	-8.0
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-1.8
6	Accel. Vert. - Frame at the CG	g	0.3	1.1	-1.4
7	Accel. Long. - Frame at the CG	g	0.2	1.2	-1.4
8	Accel. Lat. - Lunette	g	0.3	2.1	-3.1
9	Accel. Vert. - Lunette	g	0.3	2.1	-2.0
10	Accel. Long. - Lunette	g	0.1	0.8	-0.9
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.3	-2.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.0	-2.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.9	-0.9
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.3	-2.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.8	-2.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.8	-1.0
17	Strain Long. - A-frame, Left Inboard	ue	91.7	378.0	-430.0
18	Strain Long. - A-frame, Left Outboard	ue	55.2	234.0	-257.0
19	Strain Long. - A-frame, Right Inboard	ue	130.0	543.0	-685.0
20	Strain Long. - A-frame, Right Outboard	ue	55.2	227.0	-319.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	8.1	-9.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.8	7.2	-7.5

Table C-25. Statistics from Munson Gravel @ 25 mph, Cycle 2, 0852 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	8.2	-10.1
2	Accel. Vert. - RF Wheel Spindle	g	1.9	9.2	-10.0
3	Accel. Vert. - LR Wheel Spindle	g	1.8	8.4	-8.0
4	Accel. Vert. - RR Wheel Spindle	g	1.9	9.4	-8.2
5	Accel. Lat. - Frame at the CG	g	0.4	2.1	-2.4
6	Accel. Vert. - Frame at the CG	g	0.3	1.1	-1.6
7	Accel. Long. - Frame at the CG	g	0.2	1.5	-1.5
8	Accel. Lat. - Lunette	g	0.4	2.5	-3.6
9	Accel. Vert. - Lunette	g	0.3	1.8	-2.3
10	Accel. Long. - Lunette	g	0.1	0.9	-0.9
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-2.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.1	-1.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.0	-1.0
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-2.5
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.0	-2.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.9
17	Strain Long. - A-frame, Left Inboard	ue	91.9	394.0	-438.0
18	Strain Long. - A-frame, Left Outboard	ue	55.6	229.0	-269.0
19	Strain Long. - A-frame, Right Inboard	ue	131.0	533.0	-690.0
20	Strain Long. - A-frame, Right Outboard	ue	55.6	226.0	-312.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.5	-9.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.7	8.4	-6.7

Table C-26. Statistics from Perryman A @ 16 mph, Cycle 2, 0856 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.0	-6.4
2	Accel. Vert. - RF Wheel Spindle	g	1.6	8.0	-9.3
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.8	-6.9
4	Accel. Vert. - RR Wheel Spindle	g	1.6	7.3	-7.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.7
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.3	1.6	-1.7
9	Accel. Vert. - Lunette	g	0.3	1.4	-1.9
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.0	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	1.8	-1.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.4	1.8	-1.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	105.0	485.0	-640.0
18	Strain Long. - A-frame, Left Outboard	ue	63.1	278.0	-392.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	641.0	-830.0
20	Strain Long. - A-frame, Right Outboard	ue	61.5	274.0	-362.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.6	7.0	-8.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	9.9	-10.2

Table C-27. Statistics from Perryman A @ 16 mph, Cycle 2, 0899 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	6.9	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.5	8.0	-9.1
3	Accel. Vert. - LR Wheel Spindle	g	1.5	6.6	-7.3
4	Accel. Vert. - RR Wheel Spindle	g	1.5	7.3	-7.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.6
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.4	1.5	-1.8
9	Accel. Vert. - Lunette	g	0.3	1.5	-2.0
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.1	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.3	1.7	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.1	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	1.9	-1.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	105.0	473.0	-626.0
18	Strain Long. - A-frame, Left Outboard	ue	62.9	274.0	-383.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	628.0	-823.0
20	Strain Long. - A-frame, Right Outboard	ue	61.2	271.0	-359.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.6	7.1	-8.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-10.7

Table C-28. Statistics from Perryman A @ 16 mph, Cycle 2, 1081 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	7.3	-6.7
2	Accel. Vert. - RF Wheel Spindle	g	1.6	8.9	-9.3
3	Accel. Vert. - LR Wheel Spindle	g	1.6	7.1	-7.1
4	Accel. Vert. - RR Wheel Spindle	g	1.5	7.9	-7.6
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.8
7	Accel. Long. - Frame at the CG	g	0.2	1.1	-0.9
8	Accel. Lat. - Lunette	g	0.3	1.7	-2.0
9	Accel. Vert. - Lunette	g	0.3	1.5	-2.0
10	Accel. Long. - Lunette	g	0.1	0.5	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.2	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	1.9	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.3	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	1.7	-2.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	107.0	481.0	-633.0
18	Strain Long. - A-frame, Left Outboard	ue	64.7	280.0	-386.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	628.0	-841.0
20	Strain Long. - A-frame, Right Outboard	ue	61.0	270.0	-369.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.6	7.2	-8.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.8	-11.1

Table C-29. Statistics from Churchville B (mild) @ 15 mph, Cycle 2, 1084 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.0	-6.5
2	Accel. Vert. - RF Wheel Spindle	g	1.3	7.7	-8.0
3	Accel. Vert. - LR Wheel Spindle	g	1.2	7.8	-7.3
4	Accel. Vert. - RR Wheel Spindle	g	1.3	9.0	-6.7
5	Accel. Lat. - Frame at the CG	g	0.3	2.4	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.3
8	Accel. Lat. - Lunette	g	0.3	2.4	-2.4
9	Accel. Vert. - Lunette	g	0.2	2.1	-1.9
10	Accel. Long. - Lunette	g	0.1	0.7	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.8	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.3	1.9	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.8	-1.8
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.6	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.8	-0.8
17	Strain Long. - A-frame, Left Inboard	ue	91.7	415.0	-381.0
18	Strain Long. - A-frame, Left Outboard	ue	55.8	250.0	-248.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	556.0	-554.0
20	Strain Long. - A-frame, Right Outboard	ue	52.8	251.0	-245.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	9.8	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	11.7	-10.7

Table C-30. Statistics from Churchville B (rough) @ 10 mph, Cycle 2, 1085 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.1	6.5	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.5	-7.1
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.9	-6.0
4	Accel. Vert. - RR Wheel Spindle	g	1.1	10.4	-5.2
5	Accel. Lat. - Frame at the CG	g	0.3	2.2	-3.6
6	Accel. Vert. - Frame at the CG	g	0.2	1.5	-2.4
7	Accel. Long. - Frame at the CG	g	0.1	1.6	-1.1
8	Accel. Lat. - Lunette	g	0.3	1.6	-1.3
9	Accel. Vert. - Lunette	g	0.3	2.2	-1.9
10	Accel. Long. - Lunette	g	0.1	0.7	-0.9
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.4	-2.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.9
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.9	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-1.0
17	Strain Long. - A-frame, Left Inboard	ue	111.0	466.0	-777.0
18	Strain Long. - A-frame, Left Outboard	ue	66.7	272.0	-487.0
19	Strain Long. - A-frame, Right Inboard	ue	154.0	690.0	-885.0
20	Strain Long. - A-frame, Right Outboard	ue	64.0	295.0	-364.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.3	11.4	-16.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.8	-17.8

Table C-31. Statistics from Churchville B (rough) @ 10 mph, Cycle 2, 1156 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.7	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.2	-6.8
3	Accel. Vert. - LR Wheel Spindle	g	1.1	6.0	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.0	10.5	-5.3
5	Accel. Lat. - Frame at the CG	g	0.2	4.5	-3.1
6	Accel. Vert. - Frame at the CG	g	0.2	2.5	-2.9
7	Accel. Long. - Frame at the CG	g	0.1	1.4	-1.4
8	Accel. Lat. - Lunette	g	0.2	1.5	-1.3
9	Accel. Vert. - Lunette	g	0.2	2.1	-2.1
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.0	-0.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.8	-4.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.0	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	4.5	-3.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	444.0	-797.0
18	Strain Long. - A-frame, Left Outboard	ue	66.1	263.0	-498.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	703.0	-945.0
20	Strain Long. - A-frame, Right Outboard	ue	63.3	306.0	-390.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	10.8	-16.3
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.9	-17.3

Table C-32. Statistics from Churchville B (mild) @ 15 mph, Cycle 2, 1158 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.5	-5.4
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.7	-6.3
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.2	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.0	6.0	-6.1
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.4	-2.8
9	Accel. Vert. - Lunette	g	0.2	1.8	-1.7
10	Accel. Long. - Lunette	g	0.1	0.6	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.8	-2.1
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.5	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.8	-2.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.6	-2.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	91.1	400.0	-367.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	241.0	-229.0
19	Strain Long. - A-frame, Right Inboard	ue	125.0	520.0	-539.0
20	Strain Long. - A-frame, Right Outboard	ue	52.2	239.0	-243.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	9.9	-11.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	16.1	-11.0

Table C-33. Statistics from Churchville B (mild) @ 15 mph, Cycle 2, 1180 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.6	-5.5
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.8	-6.6
3	Accel. Vert. - LR Wheel Spindle	g	1.2	7.4	-6.7
4	Accel. Vert. - RR Wheel Spindle	g	1.1	6.3	-5.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-1.0
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.6
9	Accel. Vert. - Lunette	g	0.2	1.7	-1.4
10	Accel. Long. - Lunette	g	0.1	0.8	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.4	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.8
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.4	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	91.5	394.0	-372.0
18	Strain Long. - A-frame, Left Outboard	ue	56.2	236.0	-231.0
19	Strain Long. - A-frame, Right Inboard	ue	125.0	535.0	-547.0
20	Strain Long. - A-frame, Right Outboard	ue	52.5	248.0	-246.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	9.9	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.9	-11.3

Table C-34. Statistics from Churchville B (rough) @ 10 mph, Cycle 2, 1182 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.8	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.1	-6.9
3	Accel. Vert. - LR Wheel Spindle	g	1.2	6.0	-6.5
4	Accel. Vert. - RR Wheel Spindle	g	1.0	10.7	-5.3
5	Accel. Lat. - Frame at the CG	g	0.2	4.9	-3.2
6	Accel. Vert. - Frame at the CG	g	0.2	2.4	-3.1
7	Accel. Long. - Frame at the CG	g	0.1	1.6	-1.0
8	Accel. Lat. - Lunette	g	0.2	1.4	-1.2
9	Accel. Vert. - Lunette	g	0.2	1.9	-2.1
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.0	-0.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.8	-4.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.9	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	4.2	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	454.0	-791.0
18	Strain Long. - A-frame, Left Outboard	ue	66.4	271.0	-496.0
19	Strain Long. - A-frame, Right Inboard	ue	152.0	689.0	-938.0
20	Strain Long. - A-frame, Right Outboard	ue	63.1	298.0	-391.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	10.8	-16.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	14.3	-17.1

Table C-35. Statistics from Belgian Block @ 10 mph, Cycle 2, 1196 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.3	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.2	4.8	-5.6
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.1	-5.3
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.3	-4.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.5	-3.1
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-2.1
7	Accel. Long. - Frame at the CG	g	0.2	1.0	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.3	-1.9
9	Accel. Vert. - Lunette	g	0.4	3.3	-2.5
10	Accel. Long. - Lunette	g	0.1	0.8	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.0	-2.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.4	-5.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	151.0	525.0	-765.0
18	Strain Long. - A-frame, Left Outboard	ue	91.7	316.0	-465.0
19	Strain Long. - A-frame, Right Inboard	ue	210.0	695.0	-1050.0
20	Strain Long. - A-frame, Right Outboard	ue	88.4	306.0	-487.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	9.7	-11.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.7	19.5	-19.3

Table C-36. Statistics from Belgian Block @ 10 mph, Cycle 2, 1202 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.5	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.2	5.0	-5.5
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.2	-5.2
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.2	-4.9
5	Accel. Lat. - Frame at the CG	g	0.4	2.0	-2.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.5	-2.1
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.0
9	Accel. Vert. - Lunette	g	0.4	2.9	-2.3
10	Accel. Long. - Lunette	g	0.1	0.8	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.0	-2.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.5
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.4	-4.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	150.0	516.0	-754.0
18	Strain Long. - A-frame, Left Outboard	ue	91.2	310.0	-467.0
19	Strain Long. - A-frame, Right Inboard	ue	210.0	693.0	-1060.0
20	Strain Long. - A-frame, Right Outboard	ue	88.5	303.0	-489.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.7	10.1	-11.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.7	20.0	-19.1

Table C-37. Statistics from Munson Gravel @ 25 mph, Cycle 3, 1219 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	2.0	9.0	-10.3
2	Accel. Vert. - RF Wheel Spindle	g	1.8	10.0	-10.4
3	Accel. Vert. - LR Wheel Spindle	g	1.9	9.0	-9.2
4	Accel. Vert. - RR Wheel Spindle	g	1.6	11.1	-7.3
5	Accel. Lat. - Frame at the CG	g	0.4	2.2	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.2	-1.9
7	Accel. Long. - Frame at the CG	g	0.2	1.8	-2.0
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.4
9	Accel. Vert. - Lunette	g	0.3	2.0	-1.9
10	Accel. Long. - Lunette	g	0.1	1.4	-1.2
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-1.9
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.8	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.5	-1.2
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.9
15	Accel. Vert. - A-frame at LF Corner	g	0.5	2.9	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.4	-1.3
17	Strain Long. - A-frame, Left Inboard	ue	89.8	380.0	-401.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	232.0	-253.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	528.0	-686.0
20	Strain Long. - A-frame, Right Outboard	ue	53.9	223.0	-322.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.5	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.0	8.6	-8.8

Table C-38. Statistics from Munson Gravel @ 25 mph, Cycle 3, 1330 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	8.5	-10.0
2	Accel. Vert. - RF Wheel Spindle	g	1.9	10.3	-10.5
3	Accel. Vert. - LR Wheel Spindle	g	1.8	9.9	-9.0
4	Accel. Vert. - RR Wheel Spindle	g	1.7	12.7	-8.8
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-3.0
6	Accel. Vert. - Frame at the CG	g	0.3	1.5	-2.3
7	Accel. Long. - Frame at the CG	g	0.2	1.7	-2.1
8	Accel. Lat. - Lunette	g	0.4	2.2	-2.2
9	Accel. Vert. - Lunette	g	0.3	2.2	-2.2
10	Accel. Long. - Lunette	g	0.1	1.0	-1.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.5	2.7	-2.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.1	-1.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.5	3.9	-3.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-1.5
17	Strain Long. - A-frame, Left Inboard	ue	89.4	360.0	-396.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	220.0	-256.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	509.0	-685.0
20	Strain Long. - A-frame, Right Outboard	ue	54.3	225.0	-320.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	12.1	-10.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.0	9.5	-9.2

Table C-39. Statistics from Munson Gravel @ 25 mph, Cycle 3, 1375 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	2.0	8.7	-10.0
2	Accel. Vert. - RF Wheel Spindle	g	1.9	9.7	-10.1
3	Accel. Vert. - LR Wheel Spindle	g	1.9	10.3	-9.5
4	Accel. Vert. - RR Wheel Spindle	g	1.7	12.3	-8.5
5	Accel. Lat. - Frame at the CG	g	0.4	2.4	-2.7
6	Accel. Vert. - Frame at the CG	g	0.3	1.7	-2.0
7	Accel. Long. - Frame at the CG	g	0.2	1.4	-1.7
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.1
9	Accel. Vert. - Lunette	g	0.3	1.8	-2.1
10	Accel. Long. - Lunette	g	0.1	1.1	-1.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.5	2.7	-2.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.2	-1.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.8	-1.5
15	Accel. Vert. - A-frame at LF Corner	g	0.5	4.1	-3.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-1.5
17	Strain Long. - A-frame, Left Inboard	ue	89.3	370.0	-398.0
18	Strain Long. - A-frame, Left Outboard	ue	55.8	225.0	-250.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	518.0	-685.0
20	Strain Long. - A-frame, Right Outboard	ue	54.3	221.0	-320.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	12.0	-11.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.0	8.8	-9.2

Table C-40. Statistics from Munson Gravel @ 25 mph, Cycle 3, 1452 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	8.6	-9.8
2	Accel. Vert. - RF Wheel Spindle	g	1.9	10.0	-10.8
3	Accel. Vert. - LR Wheel Spindle	g	1.8	10.5	-9.3
4	Accel. Vert. - RR Wheel Spindle	g	1.8	17.4	-8.9
5	Accel. Lat. - Frame at the CG	g	0.4	2.4	-2.3
6	Accel. Vert. - Frame at the CG	g	0.3	1.2	-1.9
7	Accel. Long. - Frame at the CG	g	0.2	1.6	-1.8
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.3
9	Accel. Vert. - Lunette	g	0.3	2.2	-2.0
10	Accel. Long. - Lunette	g	0.1	1.1	-1.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.5	3.2	-3.3
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.2	-1.3
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.8
15	Accel. Vert. - A-frame at LF Corner	g	0.5	4.6	-3.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-1.4
17	Strain Long. - A-frame, Left Inboard	ue	89.4	357.0	-405.0
18	Strain Long. - A-frame, Left Outboard	ue	55.6	214.0	-256.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	516.0	-676.0
20	Strain Long. - A-frame, Right Outboard	ue	54.6	217.0	-315.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	12.0	-11.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	8.7	-8.1

Table C-41. Statistics from Perryman A @ 16 mph, Cycle 3, 1457 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	7.1	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.5	7.9	-8.6
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.6	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.7	-7.0
5	Accel. Lat. - Frame at the CG	g	0.3	1.8	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	0.9	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	0.6	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.6	-1.5
9	Accel. Vert. - Lunette	g	0.3	1.5	-2.0
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-1.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.3	-2.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	105.0	459.0	-656.0
18	Strain Long. - A-frame, Left Outboard	ue	63.9	252.0	-403.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	632.0	-848.0
20	Strain Long. - A-frame, Right Outboard	ue	61.7	282.0	-367.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.0	-9.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	10.1	-11.7

Table C-42. Statistics from Perryman A @ 16 mph, Cycle 3, 1563 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.5	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.5	7.9	-8.4
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.2	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.9	-7.1
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.9
7	Accel. Long. - Frame at the CG	g	0.2	0.8	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.6	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.4	-1.9
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.3	-2.1
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	105.0	471.0	-653.0
18	Strain Long. - A-frame, Left Outboard	ue	64.6	261.0	-397.0
19	Strain Long. - A-frame, Right Inboard	ue	148.0	633.0	-850.0
20	Strain Long. - A-frame, Right Outboard	ue	62.1	282.0	-368.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.6	-8.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.8	-12.3

Table C-43. Statistics from Churchville B (rough) @ 10 mph, Cycle 3, 1684 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.6	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.3	-6.6
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.9	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.1	10.3	-5.3
5	Accel. Lat. - Frame at the CG	g	0.2	4.1	-3.4
6	Accel. Vert. - Frame at the CG	g	0.2	2.4	-3.1
7	Accel. Long. - Frame at the CG	g	0.1	1.3	-1.5
8	Accel. Lat. - Lunette	g	0.3	1.3	-1.3
9	Accel. Vert. - Lunette	g	0.2	1.9	-2.0
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.9	-0.9
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.0	-3.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.9	-0.9
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.6	-3.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	109.0	446.0	-780.0
18	Strain Long. - A-frame, Left Outboard	ue	66.0	272.0	-490.0
19	Strain Long. - A-frame, Right Inboard	ue	152.0	681.0	-900.0
20	Strain Long. - A-frame, Right Outboard	ue	63.2	293.0	-370.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.1	-16.3
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.5	-17.6

Table C-44. Statistics from Churchville B (mild) @ 15 mph, Cycle 3, 1685 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.3	-5.5
2	Accel. Vert. - RF Wheel Spindle	g	1.3	6.6	-5.9
3	Accel. Vert. - LR Wheel Spindle	g	1.1	6.9	-5.5
4	Accel. Vert. - RR Wheel Spindle	g	1.2	6.2	-5.9
5	Accel. Lat. - Frame at the CG	g	0.3	1.9	-1.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	1.2	-1.1
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.4
9	Accel. Vert. - Lunette	g	0.2	2.1	-1.5
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.4	-3.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.9	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.7
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.2	-2.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	92.3	413.0	-379.0
18	Strain Long. - A-frame, Left Outboard	ue	56.9	248.0	-240.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	534.0	-575.0
20	Strain Long. - A-frame, Right Outboard	ue	53.5	240.0	-262.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	10.0	-10.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.5	-11.2

Table C-45. Statistics from Churchville B (mild) @ 15 mph, Cycle 3, 1782 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.5	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.2	6.8	-6.4
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.1	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.1	6.3	-6.1
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-2.0
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.2	-2.3
9	Accel. Vert. - Lunette	g	0.2	1.8	-1.6
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.4	-2.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.4	-2.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	92.4	401.0	-374.0
18	Strain Long. - A-frame, Left Outboard	ue	57.1	237.0	-232.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	534.0	-566.0
20	Strain Long. - A-frame, Right Outboard	ue	53.5	239.0	-255.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	10.1	-10.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	14.4	-10.5

Table C-46. Statistics from Churchville B (rough) @ 10 mph, Cycle 3, 1783 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	7.0	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.7	-6.7
3	Accel. Vert. - LR Wheel Spindle	g	1.2	6.0	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.1	11.1	-5.3
5	Accel. Lat. - Frame at the CG	g	0.2	3.7	-3.7
6	Accel. Vert. - Frame at the CG	g	0.2	2.2	-2.8
7	Accel. Long. - Frame at the CG	g	0.1	1.3	-1.8
8	Accel. Lat. - Lunette	g	0.3	1.5	-1.4
9	Accel. Vert. - Lunette	g	0.3	2.1	-2.1
10	Accel. Long. - Lunette	g	0.1	0.5	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.0	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.7	-4.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.0	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.9	-4.0
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	450.0	-776.0
18	Strain Long. - A-frame, Left Outboard	ue	66.2	254.0	-486.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	674.0	-912.0
20	Strain Long. - A-frame, Right Outboard	ue	63.3	289.0	-378.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	11.4	-16.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.9	-17.5

Table C-47. Statistics from Belgian Block @ 10 mph, Cycle 3, 1784 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.8	-5.8
2	Accel. Vert. - RF Wheel Spindle	g	1.2	4.9	-6.2
3	Accel. Vert. - LR Wheel Spindle	g	1.3	5.4	-5.4
4	Accel. Vert. - RR Wheel Spindle	g	1.2	6.1	-5.6
5	Accel. Lat. - Frame at the CG	g	0.3	2.6	-2.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-1.7
7	Accel. Long. - Frame at the CG	g	0.2	1.2	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.2	-1.8
9	Accel. Vert. - Lunette	g	0.4	2.4	-2.0
10	Accel. Long. - Lunette	g	0.1	0.9	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.6	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.7	-5.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.1	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	149.0	486.0	-739.0
18	Strain Long. - A-frame, Left Outboard	ue	90.9	285.0	-455.0
19	Strain Long. - A-frame, Right Inboard	ue	210.0	684.0	-1040.0
20	Strain Long. - A-frame, Right Outboard	ue	87.9	301.0	-478.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	9.6	-11.3
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	18.5	-18.3

Table C-48. Statistics from Belgian Block @ 10 mph, Cycle 3, 1805 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.4	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.3	4.8	-6.2
3	Accel. Vert. - LR Wheel Spindle	g	1.3	5.1	-5.0
4	Accel. Vert. - RR Wheel Spindle	g	1.2	6.1	-5.6
5	Accel. Lat. - Frame at the CG	g	0.4	2.7	-2.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.5	-2.0
7	Accel. Long. - Frame at the CG	g	0.2	1.1	-1.0
8	Accel. Lat. - Lunette	g	0.4	2.2	-1.9
9	Accel. Vert. - Lunette	g	0.4	2.4	-2.6
10	Accel. Long. - Lunette	g	0.1	0.9	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.0	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.5	-5.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	149.0	487.0	-748.0
18	Strain Long. - A-frame, Left Outboard	ue	90.4	285.0	-458.0
19	Strain Long. - A-frame, Right Inboard	ue	209.0	688.0	-1040.0
20	Strain Long. - A-frame, Right Outboard	ue	87.7	299.0	-474.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	9.8	-11.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	19.2	-18.3

Table C-49. Statistics from Munson Gravel @ 25 mph, Cycle 4, 1815 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	8.4	-9.5
2	Accel. Vert. - RF Wheel Spindle	g	1.8	10.2	-10.4
3	Accel. Vert. - LR Wheel Spindle	g	1.8	8.9	-9.2
4	Accel. Vert. - RR Wheel Spindle	g	1.7	13.8	-8.2
5	Accel. Lat. - Frame at the CG	g	0.4	2.2	-2.6
6	Accel. Vert. - Frame at the CG	g	0.3	1.3	-1.9
7	Accel. Long. - Frame at the CG	g	0.2	1.5	-1.9
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.7
9	Accel. Vert. - Lunette	g	0.3	2.0	-2.5
10	Accel. Long. - Lunette	g	0.1	1.7	-1.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-2.0
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.8	-3.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.8	-1.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-2.0
15	Accel. Vert. - A-frame at LF Corner	g	0.5	3.7	-2.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.4	-1.6
17	Strain Long. - A-frame, Left Inboard	ue	88.5	366.0	-401.0
18	Strain Long. - A-frame, Left Outboard	ue	55.1	228.0	-245.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	519.0	-704.0
20	Strain Long. - A-frame, Right Outboard	ue	54.0	220.0	-325.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.3	12.1	-10.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	9.0	-7.7

Table C-50. Statistics from Munson Gravel @ 25 mph, Cycle 4, 1946 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	8.5	-9.4
2	Accel. Vert. - RF Wheel Spindle	g	1.8	10.0	-10.5
3	Accel. Vert. - LR Wheel Spindle	g	1.8	10.6	-9.4
4	Accel. Vert. - RR Wheel Spindle	g	1.7	15.8	-9.0
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-2.2
6	Accel. Vert. - Frame at the CG	g	0.3	1.4	-2.1
7	Accel. Long. - Frame at the CG	g	0.2	1.5	-1.8
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.3
9	Accel. Vert. - Lunette	g	0.3	1.8	-1.9
10	Accel. Long. - Lunette	g	0.1	1.1	-1.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.3	-3.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.0	-1.2
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.7
15	Accel. Vert. - A-frame at LF Corner	g	0.5	3.0	-2.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-1.2
17	Strain Long. - A-frame, Left Inboard	ue	88.1	364.0	-402.0
18	Strain Long. - A-frame, Left Outboard	ue	54.8	231.0	-243.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	505.0	-696.0
20	Strain Long. - A-frame, Right Outboard	ue	53.8	215.0	-329.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.3	12.1	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	8.1	-7.7

Table C-51. Statistics from Munson Gravel @ 25 mph, Cycle 4, 2055 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.9	-9.2
2	Accel. Vert. - RF Wheel Spindle	g	1.8	9.3	-11.4
3	Accel. Vert. - LR Wheel Spindle	g	1.8	9.3	-8.7
4	Accel. Vert. - RR Wheel Spindle	g	1.7	10.9	-8.3
5	Accel. Lat. - Frame at the CG	g	0.4	2.0	-2.2
6	Accel. Vert. - Frame at the CG	g	0.3	2.0	-1.8
7	Accel. Long. - Frame at the CG	g	0.2	1.4	-1.6
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.7
9	Accel. Vert. - Lunette	g	0.3	2.3	-1.9
10	Accel. Long. - Lunette	g	0.1	1.2	-1.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.1	-3.3
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.2	-1.3
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.4	-1.9
15	Accel. Vert. - A-frame at LF Corner	g	0.5	3.5	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-1.4
17	Strain Long. - A-frame, Left Inboard	ue	87.9	358.0	-410.0
18	Strain Long. - A-frame, Left Outboard	ue	54.5	219.0	-249.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	502.0	-683.0
20	Strain Long. - A-frame, Right Outboard	ue	53.6	215.0	-322.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.3	10.6	-10.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	8.3	-8.2

Table C-52. Statistics from Perryman A @ 16 mph, Cycle 4, 2056 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.0	-5.8
2	Accel. Vert. - RF Wheel Spindle	g	1.5	8.3	-8.8
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.8	-6.1
4	Accel. Vert. - RR Wheel Spindle	g	1.4	7.2	-7.6
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.6
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-2.2
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.4	1.5	-1.9
9	Accel. Vert. - Lunette	g	0.3	1.5	-1.9
10	Accel. Long. - Lunette	g	0.1	0.4	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.1	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.1	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.1	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.4	-2.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	103.0	473.0	-641.0
18	Strain Long. - A-frame, Left Outboard	ue	63.2	266.0	-395.0
19	Strain Long. - A-frame, Right Inboard	ue	144.0	634.0	-823.0
20	Strain Long. - A-frame, Right Outboard	ue	60.5	276.0	-355.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.8	-9.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.8	-11.1

Table C-53. Statistics from Perryman A @ 16 mph, Cycle 4, 2195 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.8	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.4	8.0	-8.6
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.5	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.2	-7.0
5	Accel. Lat. - Frame at the CG	g	0.3	2.2	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	1.2	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.6	-1.8
9	Accel. Vert. - Lunette	g	0.3	1.4	-2.2
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.4	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-2.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	104.0	471.0	-652.0
18	Strain Long. - A-frame, Left Outboard	ue	63.7	265.0	-401.0
19	Strain Long. - A-frame, Right Inboard	ue	145.0	636.0	-843.0
20	Strain Long. - A-frame, Right Outboard	ue	60.6	272.0	-363.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.0	-9.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-11.8

Table C-54. Statistics from Perryman A @ 16 mph, Cycle 4, 2285 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.2	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.5	8.5	-8.7
3	Accel. Vert. - LR Wheel Spindle	g	1.7	6.7	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.5	-7.3
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.9
6	Accel. Vert. - Frame at the CG	g	0.3	1.5	-2.1
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.6	-1.9
9	Accel. Vert. - Lunette	g	0.3	1.5	-2.0
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.6	-1.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.3	-2.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	105.0	473.0	-657.0
18	Strain Long. - A-frame, Left Outboard	ue	64.5	267.0	-404.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	629.0	-831.0
20	Strain Long. - A-frame, Right Outboard	ue	61.0	277.0	-356.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.2	-9.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-11.6

Table C-55. Statistics from Churchville B (rough) @ 10 mph, Cycle 4, 2297 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	7.3	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.6	-7.2
3	Accel. Vert. - LR Wheel Spindle	g	1.2	6.0	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.1	9.9	-5.4
5	Accel. Lat. - Frame at the CG	g	0.2	2.6	-3.5
6	Accel. Vert. - Frame at the CG	g	0.2	2.4	-2.0
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-1.1
8	Accel. Lat. - Lunette	g	0.3	1.2	-1.5
9	Accel. Vert. - Lunette	g	0.3	2.0	-2.4
10	Accel. Long. - Lunette	g	0.1	0.5	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	0.9	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.0	-3.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.2	0.9	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.3	4.4	-3.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	108.0	444.0	-756.0
18	Strain Long. - A-frame, Left Outboard	ue	65.5	281.0	-468.0
19	Strain Long. - A-frame, Right Inboard	ue	151.0	688.0	-907.0
20	Strain Long. - A-frame, Right Outboard	ue	62.8	298.0	-379.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.3	-16.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.5	-17.6

Table C-56. Statistics from Churchville B (mild) @ 15 mph, Cycle 4, 2298 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.3	-5.4
2	Accel. Vert. - RF Wheel Spindle	g	1.3	7.3	-6.9
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.3	-6.1
4	Accel. Vert. - RR Wheel Spindle	g	1.2	7.1	-6.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.6	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.6	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.4
9	Accel. Vert. - Lunette	g	0.3	2.1	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.8	-1.8
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.9	-2.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.9	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.8	-1.7
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.7	-2.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	91.1	399.0	-372.0
18	Strain Long. - A-frame, Left Outboard	ue	56.6	242.0	-232.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	508.0	-582.0
20	Strain Long. - A-frame, Right Outboard	ue	52.7	228.0	-266.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	10.2	-9.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	13.3	-10.3

Table C-57. Statistics from Churchville B (mild) @ 15 mph, Cycle 4, 2385 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.5	-5.1
2	Accel. Vert. - RF Wheel Spindle	g	1.3	5.3	-5.3
3	Accel. Vert. - LR Wheel Spindle	g	1.2	4.6	-4.2
4	Accel. Vert. - RR Wheel Spindle	g	1.2	5.5	-4.4
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.4
6	Accel. Vert. - Frame at the CG	g	0.2	0.9	-1.1
7	Accel. Long. - Frame at the CG	g	0.1	0.5	-0.6
8	Accel. Lat. - Lunette	g	0.4	1.3	-2.0
9	Accel. Vert. - Lunette	g	0.2	1.1	-1.2
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.0	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.3	1.7	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.3
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.0	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.1	-2.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.3	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	89.6	340.0	-382.0
18	Strain Long. - A-frame, Left Outboard	ue	55.1	210.0	-233.0
19	Strain Long. - A-frame, Right Inboard	ue	124.0	494.0	-484.0
20	Strain Long. - A-frame, Right Outboard	ue	51.2	208.0	-199.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.1	-10.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	12.1	-10.0

Table C-58. Statistics from Churchville B (rough) @ 10 mph, Cycle 4, 2386 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	7.2	-6.7
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.8	-7.1
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.6	-6.5
4	Accel. Vert. - RR Wheel Spindle	g	1.2	10.4	-5.4
5	Accel. Lat. - Frame at the CG	g	0.2	2.4	-3.8
6	Accel. Vert. - Frame at the CG	g	0.2	2.2	-2.0
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-0.9
8	Accel. Lat. - Lunette	g	0.3	1.4	-1.5
9	Accel. Vert. - Lunette	g	0.3	1.8	-2.0
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.0
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.9	-3.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.0
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.8	-3.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	109.0	465.0	-763.0
18	Strain Long. - A-frame, Left Outboard	ue	65.8	282.0	-477.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	666.0	-906.0
20	Strain Long. - A-frame, Right Outboard	ue	63.3	281.0	-381.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	11.5	-16.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.2	-17.3

Table C-59. Statistics from Belgian Block @ 10 mph, Cycle 4, 2392 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.4	5.6	-6.0
2	Accel. Vert. - RF Wheel Spindle	g	1.3	5.1	-6.1
3	Accel. Vert. - LR Wheel Spindle	g	1.3	5.3	-5.2
4	Accel. Vert. - RR Wheel Spindle	g	1.2	6.0	-5.6
5	Accel. Lat. - Frame at the CG	g	0.4	2.7	-2.3
6	Accel. Vert. - Frame at the CG	g	0.3	1.9	-2.0
7	Accel. Long. - Frame at the CG	g	0.2	1.0	-1.0
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.0
9	Accel. Vert. - Lunette	g	0.4	2.6	-2.5
10	Accel. Long. - Lunette	g	0.1	0.9	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.7	-2.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.4	-4.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-0.8
17	Strain Long. - A-frame, Left Inboard	ue	149.0	485.0	-723.0
18	Strain Long. - A-frame, Left Outboard	ue	90.3	286.0	-452.0
19	Strain Long. - A-frame, Right Inboard	ue	210.0	702.0	-1020.0
20	Strain Long. - A-frame, Right Outboard	ue	87.8	301.0	-458.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	9.7	-11.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	18.5	-18.9

Table C-60. Statistics from Munson Gravel @ 25 mph, Cycle 5, 2413 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	7.9	-9.9
2	Accel. Vert. - RF Wheel Spindle	g	1.8	9.0	-10.8
3	Accel. Vert. - LR Wheel Spindle	g	1.8	9.0	-8.4
4	Accel. Vert. - RR Wheel Spindle	g	1.7	10.3	-7.9
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-2.3
6	Accel. Vert. - Frame at the CG	g	0.3	1.6	-1.7
7	Accel. Long. - Frame at the CG	g	0.2	1.8	-1.7
8	Accel. Lat. - Lunette	g	0.4	1.9	-1.9
9	Accel. Vert. - Lunette	g	0.3	3.1	-1.8
10	Accel. Long. - Lunette	g	0.1	1.7	-1.0
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	3.0	-2.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.8	-1.2
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.1	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.3	-1.2
17	Strain Long. - A-frame, Left Inboard	ue	88.0	373.0	-415.0
18	Strain Long. - A-frame, Left Outboard	ue	54.7	230.0	-253.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	517.0	-701.0
20	Strain Long. - A-frame, Right Outboard	ue	53.3	216.0	-310.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.3	10.3	-10.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	8.1	-8.0

Table C-61. Statistics from Munson Gravel @ 25 mph, Cycle 5, 2585 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.3	-10.0
2	Accel. Vert. - RF Wheel Spindle	g	1.7	8.7	-9.8
3	Accel. Vert. - LR Wheel Spindle	g	1.7	9.1	-8.1
4	Accel. Vert. - RR Wheel Spindle	g	1.6	10.5	-8.4
5	Accel. Lat. - Frame at the CG	g	0.4	2.1	-1.8
6	Accel. Vert. - Frame at the CG	g	0.3	1.7	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	1.9	-1.4
8	Accel. Lat. - Lunette	g	0.4	1.9	-2.3
9	Accel. Vert. - Lunette	g	0.3	2.1	-1.9
10	Accel. Long. - Lunette	g	0.1	1.1	-1.7
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.6	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.3	-1.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.7	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-1.4
17	Strain Long. - A-frame, Left Inboard	ue	89.3	378.0	-406.0
18	Strain Long. - A-frame, Left Outboard	ue	54.9	229.0	-259.0
19	Strain Long. - A-frame, Right Inboard	ue	128.0	533.0	-699.0
20	Strain Long. - A-frame, Right Outboard	ue	53.6	220.0	-318.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.2	9.5	-10.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.0	7.7	-9.3

Table C-62. Statistics from Munson Gravel @ 25 mph, Cycle 5, 2656 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.6	-9.9
2	Accel. Vert. - RF Wheel Spindle	g	1.8	8.8	-11.2
3	Accel. Vert. - LR Wheel Spindle	g	1.8	8.9	-8.0
4	Accel. Vert. - RR Wheel Spindle	g	1.7	9.9	-8.4
5	Accel. Lat. - Frame at the CG	g	0.4	2.7	-1.8
6	Accel. Vert. - Frame at the CG	g	0.3	1.9	-1.6
7	Accel. Long. - Frame at the CG	g	0.2	2.1	-1.9
8	Accel. Lat. - Lunette	g	0.4	2.2	-2.9
9	Accel. Vert. - Lunette	g	0.3	2.2	-2.1
10	Accel. Long. - Lunette	g	0.1	1.3	-1.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-2.0
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.4	-2.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.3	-1.3
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-2.0
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.8	-2.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.2	-1.3
17	Strain Long. - A-frame, Left Inboard	ue	89.0	378.0	-425.0
18	Strain Long. - A-frame, Left Outboard	ue	54.6	227.0	-257.0
19	Strain Long. - A-frame, Right Inboard	ue	128.0	528.0	-702.0
20	Strain Long. - A-frame, Right Outboard	ue	53.7	213.0	-319.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.1	11.3	-11.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	7.4	-8.7

Table C-63. Statistics from Perryman A @ 16 mph, Cycle 5, 2660 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.1	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.5	8.0	-9.2
3	Accel. Vert. - LR Wheel Spindle	g	1.7	6.8	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.5	7.2	-7.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-2.0
7	Accel. Long. - Frame at the CG	g	0.1	0.7	-1.0
8	Accel. Lat. - Lunette	g	0.4	1.9	-1.7
9	Accel. Vert. - Lunette	g	0.3	1.4	-2.3
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-1.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	104.0	492.0	-650.0
18	Strain Long. - A-frame, Left Outboard	ue	63.7	282.0	-399.0
19	Strain Long. - A-frame, Right Inboard	ue	145.0	638.0	-844.0
20	Strain Long. - A-frame, Right Outboard	ue	60.2	276.0	-369.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.7	8.2	-8.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.7	-10.2

Table C-64. Statistics from Perryman A @ 16 mph, Cycle 5, 2720 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	7.2	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.8	-8.2
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.6	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.3	6.1	-6.9
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.4
7	Accel. Long. - Frame at the CG	g	0.1	0.8	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.7	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.4	-1.9
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	1.8	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-1.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	105.0	496.0	-658.0
18	Strain Long. - A-frame, Left Outboard	ue	64.0	285.0	-407.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	630.0	-847.0
20	Strain Long. - A-frame, Right Outboard	ue	60.2	268.0	-369.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.7	7.8	-8.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.6	-11.4

Table C-65. Statistics from Perryman A @ 16 mph, Cycle 5, 2886 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.6	7.2	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.4	7.9	-8.6
3	Accel. Vert. - LR Wheel Spindle	g	1.5	5.9	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.4	-7.2
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.3	-1.6
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.8	-1.9
9	Accel. Vert. - Lunette	g	0.3	1.4	-1.8
10	Accel. Long. - Lunette	g	0.1	0.4	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.1	-1.7
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.0	-2.0
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	106.0	494.0	-647.0
18	Strain Long. - A-frame, Left Outboard	ue	64.4	284.0	-399.0
19	Strain Long. - A-frame, Right Inboard	ue	145.0	626.0	-840.0
20	Strain Long. - A-frame, Right Outboard	ue	59.6	268.0	-365.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.9	-8.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	10.0	-10.8

Table C-66. Statistics from Churchville B (rough) @ 10 mph, Cycle 5, 2890 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	7.1	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.8	-7.3
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.6	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.1	10.2	-5.3
5	Accel. Lat. - Frame at the CG	g	0.2	2.3	-3.4
6	Accel. Vert. - Frame at the CG	g	0.2	2.0	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	1.5	-1.2
8	Accel. Lat. - Lunette	g	0.3	1.6	-1.7
9	Accel. Vert. - Lunette	g	0.2	1.7	-2.1
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.2	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.3	-3.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.2	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.6	-3.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	462.0	-799.0
18	Strain Long. - A-frame, Left Outboard	ue	65.8	271.0	-496.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	696.0	-934.0
20	Strain Long. - A-frame, Right Outboard	ue	62.6	297.0	-384.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.4	-16.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.0	-18.0

Table C-67. Statistics from Churchville B (mild) @ 15 mph, Cycle 5, 2891 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.3	-5.3
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.4	-6.3
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.9	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.1	7.1	-5.6
5	Accel. Lat. - Frame at the CG	g	0.3	2.2	-2.0
6	Accel. Vert. - Frame at the CG	g	0.2	1.3	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-0.8
8	Accel. Lat. - Lunette	g	0.4	2.2	-2.6
9	Accel. Vert. - Lunette	g	0.2	1.9	-1.5
10	Accel. Long. - Lunette	g	0.1	0.7	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.7	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.9	-2.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.0	-0.6
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.7
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.3	-2.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	92.0	397.0	-375.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	232.0	-229.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	531.0	-591.0
20	Strain Long. - A-frame, Right Outboard	ue	52.0	235.0	-264.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.0	-10.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	13.0	-11.2

Table C-68. Statistics from Churchville B (mild) @ 15 mph, Cycle 5, 2960 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.5	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.3	7.5	-6.4
3	Accel. Vert. - LR Wheel Spindle	g	1.2	8.0	-6.4
4	Accel. Vert. - RR Wheel Spindle	g	1.2	7.0	-5.7
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.5	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.3
9	Accel. Vert. - Lunette	g	0.2	1.7	-1.7
10	Accel. Long. - Lunette	g	0.1	0.6	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.8	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.0	-2.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.8	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.3	2.1	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.7	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	92.2	399.0	-364.0
18	Strain Long. - A-frame, Left Outboard	ue	56.2	234.0	-231.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	524.0	-586.0
20	Strain Long. - A-frame, Right Outboard	ue	52.4	234.0	-263.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.2	-10.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	13.6	-11.3

Table C-69. Statistics from Churchville B (rough) @ 10 mph, Cycle 5, 2969 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.7	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.1	8.2	-7.4
3	Accel. Vert. - LR Wheel Spindle	g	1.1	5.1	-6.0
4	Accel. Vert. - RR Wheel Spindle	g	1.1	11.0	-5.5
5	Accel. Lat. - Frame at the CG	g	0.2	2.6	-2.8
6	Accel. Vert. - Frame at the CG	g	0.2	2.3	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-1.0
8	Accel. Lat. - Lunette	g	0.3	1.4	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.7	-2.1
10	Accel. Long. - Lunette	g	0.1	0.5	-0.8
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.0	-3.0
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.1	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.3	4.0	-2.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.8
17	Strain Long. - A-frame, Left Inboard	ue	109.0	459.0	-779.0
18	Strain Long. - A-frame, Left Outboard	ue	65.2	271.0	-483.0
19	Strain Long. - A-frame, Right Inboard	ue	152.0	673.0	-924.0
20	Strain Long. - A-frame, Right Outboard	ue	62.2	283.0	-384.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.1	-16.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.4	-18.3

Table C-70. Statistics from Churchville B (mild) @ 15 mph, Cycle 5, 2970 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.4	-5.3
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.4	-6.0
3	Accel. Vert. - LR Wheel Spindle	g	1.1	7.6	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.1	6.1	-5.3
5	Accel. Lat. - Frame at the CG	g	0.3	2.3	-1.6
6	Accel. Vert. - Frame at the CG	g	0.2	1.1	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.4
9	Accel. Vert. - Lunette	g	0.2	1.6	-1.6
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.9	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.8	-1.8
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.9	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.3	1.7	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	91.6	388.0	-367.0
18	Strain Long. - A-frame, Left Outboard	ue	55.8	229.0	-228.0
19	Strain Long. - A-frame, Right Inboard	ue	126.0	523.0	-562.0
20	Strain Long. - A-frame, Right Outboard	ue	51.8	234.0	-249.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.0	-9.6
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.8	-10.6

Table C-71. Statistics from Churchville B (mild) @ 15 mph, Cycle 5, 2987 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	5.4	-5.4
2	Accel. Vert. - RF Wheel Spindle	g	1.2	7.6	-6.2
3	Accel. Vert. - LR Wheel Spindle	g	1.1	8.1	-6.3
4	Accel. Vert. - RR Wheel Spindle	g	1.1	6.4	-5.6
5	Accel. Lat. - Frame at the CG	g	0.3	2.3	-1.8
6	Accel. Vert. - Frame at the CG	g	0.2	1.2	-1.7
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.4	2.4	-2.5
9	Accel. Vert. - Lunette	g	0.2	2.0	-1.4
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.8	-1.6
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.7	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.8	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.3	1.9	-2.5
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	91.9	397.0	-369.0
18	Strain Long. - A-frame, Left Outboard	ue	55.9	236.0	-231.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	518.0	-580.0
20	Strain Long. - A-frame, Right Outboard	ue	52.0	232.0	-255.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.0	-9.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.9	-10.8

Table C-72. Statistics from Churchville B (rough) @ 10 mph, Cycle 5, 2988 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.2	6.7	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.1	7.9	-7.1
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.2	-5.9
4	Accel. Vert. - RR Wheel Spindle	g	1.1	10.6	-5.4
5	Accel. Lat. - Frame at the CG	g	0.2	3.4	-3.3
6	Accel. Vert. - Frame at the CG	g	0.2	2.7	-2.0
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-1.0
8	Accel. Lat. - Lunette	g	0.3	1.6	-1.7
9	Accel. Vert. - Lunette	g	0.3	1.8	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.8
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.1	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.8	-2.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.0	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.6	-2.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	109.0	473.0	-782.0
18	Strain Long. - A-frame, Left Outboard	ue	65.5	282.0	-487.0
19	Strain Long. - A-frame, Right Inboard	ue	152.0	668.0	-923.0
20	Strain Long. - A-frame, Right Outboard	ue	62.4	285.0	-379.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	11.1	-16.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.5	13.1	-17.9

Table C-73. Statistics from Belgian Block @ 10 mph, Cycle 5, 2989 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.3	-5.8
2	Accel. Vert. - RF Wheel Spindle	g	1.2	4.5	-5.9
3	Accel. Vert. - LR Wheel Spindle	g	1.2	4.8	-5.1
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.3	-5.6
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.8	-1.3
7	Accel. Long. - Frame at the CG	g	0.2	1.1	-0.9
8	Accel. Lat. - Lunette	g	0.4	1.8	-2.0
9	Accel. Vert. - Lunette	g	0.4	2.1	-2.1
10	Accel. Long. - Lunette	g	0.1	0.7	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.5	-2.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.4	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.1	-4.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.9	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	150.0	480.0	-737.0
18	Strain Long. - A-frame, Left Outboard	ue	90.4	289.0	-452.0
19	Strain Long. - A-frame, Right Inboard	ue	211.0	688.0	-1020.0
20	Strain Long. - A-frame, Right Outboard	ue	87.3	301.0	-457.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	9.4	-11.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.5	19.3	-19.6

Table C-74. Statistics from Belgian Block @ 10 mph, Cycle 5, 3008 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.2	-5.9
2	Accel. Vert. - RF Wheel Spindle	g	1.2	4.9	-5.8
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.2	-5.0
4	Accel. Vert. - RR Wheel Spindle	g	1.1	5.7	-5.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-2.4
6	Accel. Vert. - Frame at the CG	g	0.2	1.6	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	1.1	-0.8
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.2
9	Accel. Vert. - Lunette	g	0.4	2.8	-2.2
10	Accel. Long. - Lunette	g	0.1	0.8	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.6	-2.9
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.8	-5.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	150.0	496.0	-728.0
18	Strain Long. - A-frame, Left Outboard	ue	90.7	297.0	-451.0
19	Strain Long. - A-frame, Right Inboard	ue	211.0	694.0	-1020.0
20	Strain Long. - A-frame, Right Outboard	ue	87.0	304.0	-457.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	9.6	-11.5
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	19.3	-19.2

Table C-75. Statistics from Munson Gravel @ 25 mph, Cycle 6, 3014 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.9	-9.9
2	Accel. Vert. - RF Wheel Spindle	g	1.8	9.4	-11.4
3	Accel. Vert. - LR Wheel Spindle	g	1.8	8.3	-8.1
4	Accel. Vert. - RR Wheel Spindle	g	1.7	9.2	-8.4
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-2.2
6	Accel. Vert. - Frame at the CG	g	0.3	1.7	-1.6
7	Accel. Long. - Frame at the CG	g	0.2	2.3	-1.8
8	Accel. Lat. - Lunette	g	0.4	2.1	-2.1
9	Accel. Vert. - Lunette	g	0.3	2.4	-1.7
10	Accel. Long. - Lunette	g	0.1	1.7	-1.2
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.4	-1.5
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.8	-1.1
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.4	-1.5
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.5	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.5	-1.3
17	Strain Long. - A-frame, Left Inboard	ue	89.3	358.0	-430.0
18	Strain Long. - A-frame, Left Outboard	ue	54.6	213.0	-264.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	526.0	-699.0
20	Strain Long. - A-frame, Right Outboard	ue	53.2	214.0	-312.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	9.1	-10.7
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	7.9	-7.5

Table C-76. Statistics from Munson Gravel @ 25 mph, Cycle 6, 3095 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.8	7.3	-9.2
2	Accel. Vert. - RF Wheel Spindle	g	1.8	8.4	-11.0
3	Accel. Vert. - LR Wheel Spindle	g	1.7	7.5	-8.1
4	Accel. Vert. - RR Wheel Spindle	g	1.7	10.3	-8.0
5	Accel. Lat. - Frame at the CG	g	0.4	2.0	-2.4
6	Accel. Vert. - Frame at the CG	g	0.3	1.6	-1.6
7	Accel. Long. - Frame at the CG	g	0.2	1.4	-1.6
8	Accel. Lat. - Lunette	g	0.4	2.2	-2.3
9	Accel. Vert. - Lunette	g	0.3	2.2	-2.0
10	Accel. Long. - Lunette	g	0.1	1.4	-1.8
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.5	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.5	-1.7
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.4	-3.0
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.1	-1.7
17	Strain Long. - A-frame, Left Inboard	ue	88.4	374.0	-423.0
18	Strain Long. - A-frame, Left Outboard	ue	53.9	221.0	-254.0
19	Strain Long. - A-frame, Right Inboard	ue	127.0	541.0	-680.0
20	Strain Long. - A-frame, Right Outboard	ue	53.1	217.0	-315.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.2	11.4	-10.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	8.5	-8.1

Table C-77. Statistics from Munson Gravel @ 25 mph, Cycle 6, 3258 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.9	8.1	-9.9
2	Accel. Vert. - RF Wheel Spindle	g	1.9	9.9	-12.3
3	Accel. Vert. - LR Wheel Spindle	g	1.8	7.6	-8.5
4	Accel. Vert. - RR Wheel Spindle	g	1.8	10.6	-8.4
5	Accel. Lat. - Frame at the CG	g	0.4	2.5	-2.3
6	Accel. Vert. - Frame at the CG	g	0.3	1.9	-2.0
7	Accel. Long. - Frame at the CG	g	0.2	1.6	-1.4
8	Accel. Lat. - Lunette	g	0.4	2.4	-2.9
9	Accel. Vert. - Lunette	g	0.3	2.4	-1.8
10	Accel. Long. - Lunette	g	0.1	1.5	-1.3
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.6	-2.1
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.6	-3.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	1.8	-1.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-2.2
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.1	-2.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.3	-1.4
17	Strain Long. - A-frame, Left Inboard	ue	88.7	364.0	-438.0
18	Strain Long. - A-frame, Left Outboard	ue	54.5	220.0	-253.0
19	Strain Long. - A-frame, Right Inboard	ue	128.0	510.0	-690.0
20	Strain Long. - A-frame, Right Outboard	ue	53.7	211.0	-308.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.2	11.5	-11.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	1.9	7.7	-7.5

Table C-78. Statistics from Perryman A @ 16 mph, Cycle 6, 3263 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.2	-6.2
2	Accel. Vert. - RF Wheel Spindle	g	1.5	8.4	-9.1
3	Accel. Vert. - LR Wheel Spindle	g	1.7	6.8	-6.6
4	Accel. Vert. - RR Wheel Spindle	g	1.5	7.5	-7.5
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.9
6	Accel. Vert. - Frame at the CG	g	0.3	1.3	-2.0
7	Accel. Long. - Frame at the CG	g	0.2	1.0	-0.9
8	Accel. Lat. - Lunette	g	0.4	1.6	-2.0
9	Accel. Vert. - Lunette	g	0.3	1.4	-2.2
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.1	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.1	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.1	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.2	-2.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.5
17	Strain Long. - A-frame, Left Inboard	ue	105.0	489.0	-664.0
18	Strain Long. - A-frame, Left Outboard	ue	64.1	277.0	-413.0
19	Strain Long. - A-frame, Right Inboard	ue	147.0	652.0	-835.0
20	Strain Long. - A-frame, Right Outboard	ue	60.7	282.0	-353.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.2	-8.9
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	10.2	-10.1

Table C-79. Statistics from Perryman A @ 16 mph, Cycle 6, 3352 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.5	-6.3
2	Accel. Vert. - RF Wheel Spindle	g	1.5	7.9	-8.7
3	Accel. Vert. - LR Wheel Spindle	g	1.7	6.6	-6.6
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.4	-7.3
5	Accel. Lat. - Frame at the CG	g	0.3	1.9	-2.1
6	Accel. Vert. - Frame at the CG	g	0.2	1.3	-1.6
7	Accel. Long. - Frame at the CG	g	0.2	0.9	-0.8
8	Accel. Lat. - Lunette	g	0.4	1.8	-1.8
9	Accel. Vert. - Lunette	g	0.3	1.6	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.2	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.2	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.4	1.9	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	106.0	491.0	-654.0
18	Strain Long. - A-frame, Left Outboard	ue	64.9	279.0	-405.0
19	Strain Long. - A-frame, Right Inboard	ue	147.0	646.0	-849.0
20	Strain Long. - A-frame, Right Outboard	ue	60.0	279.0	-365.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.3	-8.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-11.2

Table C-80. Statistics from Perryman A @ 16 mph, Cycle 6, 3389 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.8	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.5	7.7	-8.2
3	Accel. Vert. - LR Wheel Spindle	g	1.6	6.8	-6.2
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.1	-6.8
5	Accel. Lat. - Frame at the CG	g	0.3	2.1	-1.7
6	Accel. Vert. - Frame at the CG	g	0.2	1.2	-1.4
7	Accel. Long. - Frame at the CG	g	0.2	0.7	-0.7
8	Accel. Lat. - Lunette	g	0.4	1.8	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.3	-1.7
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.0	-1.6
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.2	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.4	1.8	-2.6
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	107.0	490.0	-668.0
18	Strain Long. - A-frame, Left Outboard	ue	65.2	277.0	-412.0
19	Strain Long. - A-frame, Right Inboard	ue	148.0	623.0	-855.0
20	Strain Long. - A-frame, Right Outboard	ue	60.6	270.0	-369.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	7.7	-9.0
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.6	-11.3

Table C-81. Statistics from Perryman A @ 16 mph, Cycle 6, 3488 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.7	7.8	-6.4
2	Accel. Vert. - RF Wheel Spindle	g	1.6	8.1	-8.9
3	Accel. Vert. - LR Wheel Spindle	g	1.7	6.8	-6.8
4	Accel. Vert. - RR Wheel Spindle	g	1.4	6.7	-7.4
5	Accel. Lat. - Frame at the CG	g	0.3	2.0	-1.9
6	Accel. Vert. - Frame at the CG	g	0.2	1.2	-1.8
7	Accel. Long. - Frame at the CG	g	0.2	0.8	-0.8
8	Accel. Lat. - Lunette	g	0.4	1.8	-1.9
9	Accel. Vert. - Lunette	g	0.3	1.3	-2.1
10	Accel. Long. - Lunette	g	0.1	0.5	-0.4
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.3	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	1.8	-1.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.5	-0.4
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.3	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.0	-2.4
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	106.0	490.0	-651.0
18	Strain Long. - A-frame, Left Outboard	ue	65.2	281.0	-403.0
19	Strain Long. - A-frame, Right Inboard	ue	146.0	629.0	-848.0
20	Strain Long. - A-frame, Right Outboard	ue	59.8	269.0	-365.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.8	8.3	-8.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	9.9	-10.4

Table C-82. Statistics from Churchville B (mild) @ 15 mph, Cycle 6, 3518 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	5.7	-5.1
2	Accel. Vert. - RF Wheel Spindle	g	1.3	5.8	-4.9
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.0	-4.5
4	Accel. Vert. - RR Wheel Spindle	g	1.2	5.4	-4.3
5	Accel. Lat. - Frame at the CG	g	0.3	1.7	-1.5
6	Accel. Vert. - Frame at the CG	g	0.2	1.0	-1.1
7	Accel. Long. - Frame at the CG	g	0.1	0.6	-0.5
8	Accel. Lat. - Lunette	g	0.4	1.4	-1.8
9	Accel. Vert. - Lunette	g	0.2	1.1	-1.3
10	Accel. Long. - Lunette	g	0.1	0.4	-0.3
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.0	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.1	-1.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.4	-0.3
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.0	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.3	1.9	-1.8
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.4	-0.3
17	Strain Long. - A-frame, Left Inboard	ue	90.1	343.0	-382.0
18	Strain Long. - A-frame, Left Outboard	ue	55.2	214.0	-235.0
19	Strain Long. - A-frame, Right Inboard	ue	124.0	491.0	-477.0
20	Strain Long. - A-frame, Right Outboard	ue	50.3	206.0	-194.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	1.9	10.1	-9.8
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.3	12.2	-10.3

Table C-83. Statistics from Churchville B (rough) @ 10 mph, Cycle 6, 3519 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	7.4	-6.5
2	Accel. Vert. - RF Wheel Spindle	g	1.2	8.7	-7.2
3	Accel. Vert. - LR Wheel Spindle	g	1.2	5.8	-6.5
4	Accel. Vert. - RR Wheel Spindle	g	1.1	11.0	-5.8
5	Accel. Lat. - Frame at the CG	g	0.2	2.8	-3.0
6	Accel. Vert. - Frame at the CG	g	0.2	2.5	-1.9
7	Accel. Long. - Frame at the CG	g	0.1	1.1	-1.1
8	Accel. Lat. - Lunette	g	0.3	1.8	-1.6
9	Accel. Vert. - Lunette	g	0.3	1.9	-2.0
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.2	-1.1
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.3	-2.4
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.2	-1.1
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.7	-3.3
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	448.0	-780.0
18	Strain Long. - A-frame, Left Outboard	ue	66.1	272.0	-484.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	657.0	-936.0
20	Strain Long. - A-frame, Right Outboard	ue	62.2	283.0	-384.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.4	10.9	-16.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.5	-17.1

Table C-84. Statistics from Churchville B (mild) @ 15 mph, Cycle 6, 3588 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.4	6.1	-5.7
2	Accel. Vert. - RF Wheel Spindle	g	1.4	8.1	-7.1
3	Accel. Vert. - LR Wheel Spindle	g	1.3	8.8	-7.4
4	Accel. Vert. - RR Wheel Spindle	g	1.3	7.3	-6.3
5	Accel. Lat. - Frame at the CG	g	0.3	2.5	-2.2
6	Accel. Vert. - Frame at the CG	g	0.2	1.4	-1.6
7	Accel. Long. - Frame at the CG	g	0.1	0.9	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.3	-2.2
9	Accel. Vert. - Lunette	g	0.3	1.9	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.8	-1.7
12	Accel. Vert. - A-frame at RF Corner	g	0.3	3.5	-2.3
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.6	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.7	-1.6
15	Accel. Vert. - A-frame at LF Corner	g	0.4	2.1	-2.7
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.5	-0.4
17	Strain Long. - A-frame, Left Inboard	ue	93.0	393.0	-373.0
18	Strain Long. - A-frame, Left Outboard	ue	57.3	233.0	-231.0
19	Strain Long. - A-frame, Right Inboard	ue	129.0	525.0	-570.0
20	Strain Long. - A-frame, Right Outboard	ue	52.7	235.0	-249.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.0	10.1	-10.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.4	12.2	-10.7

Table C-85. Statistics from Churchville B (rough) @ 10 mph, Cycle 6, 3589 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.3	7.4	-6.8
2	Accel. Vert. - RF Wheel Spindle	g	1.2	8.5	-7.4
3	Accel. Vert. - LR Wheel Spindle	g	1.3	6.1	-6.7
4	Accel. Vert. - RR Wheel Spindle	g	1.2	11.3	-5.8
5	Accel. Lat. - Frame at the CG	g	0.2	3.4	-2.8
6	Accel. Vert. - Frame at the CG	g	0.2	2.6	-1.8
7	Accel. Long. - Frame at the CG	g	0.1	1.0	-0.9
8	Accel. Lat. - Lunette	g	0.3	1.9	-1.7
9	Accel. Vert. - Lunette	g	0.3	1.7	-1.8
10	Accel. Long. - Lunette	g	0.1	0.6	-0.6
11	Accel. Lat. - A-frame at RF Corner	g	0.2	1.3	-1.2
12	Accel. Vert. - A-frame at RF Corner	g	0.3	2.2	-2.2
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.7	-0.7
14	Accel. Lat. - A-frame at LF Corner	g	0.2	1.3	-1.2
15	Accel. Vert. - A-frame at LF Corner	g	0.3	3.8	-3.0
16	Accel. Long. - A-frame at LF Corner	g	0.1	0.6	-0.6
17	Strain Long. - A-frame, Left Inboard	ue	110.0	459.0	-771.0
18	Strain Long. - A-frame, Left Outboard	ue	66.2	282.0	-470.0
19	Strain Long. - A-frame, Right Inboard	ue	153.0	673.0	-918.0
20	Strain Long. - A-frame, Right Outboard	ue	62.4	285.0	-379.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.5	11.5	-16.2
22	Rot. Rate Roll - Frame at the CG	deg/sec	2.6	13.3	-17.7

Table C-86. Statistics from Belgian Block @ 10 mph, Cycle 6, 3592 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.4	6.2	-6.5
2	Accel. Vert. - RF Wheel Spindle	g	1.3	5.4	-5.9
3	Accel. Vert. - LR Wheel Spindle	g	1.3	5.4	-4.9
4	Accel. Vert. - RR Wheel Spindle	g	1.2	6.0	-5.7
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-2.0
6	Accel. Vert. - Frame at the CG	g	0.3	1.4	-1.5
7	Accel. Long. - Frame at the CG	g	0.2	1.0	-1.2
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.2
9	Accel. Vert. - Lunette	g	0.4	2.2	-2.8
10	Accel. Long. - Lunette	g	0.1	0.9	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.4
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.9	-2.1
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.6	-1.4
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.1	-4.9
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	149.0	494.0	-711.0
18	Strain Long. - A-frame, Left Outboard	ue	90.3	324.0	-451.0
19	Strain Long. - A-frame, Right Inboard	ue	209.0	681.0	-1010.0
20	Strain Long. - A-frame, Right Outboard	ue	86.2	301.0	-441.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	9.9	-11.1
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	18.2	-18.9

Table C-87. Statistics from Belgian Block @ 10 mph, Cycle 6, 3610 Miles

#	Channel	Unit	RMS	Maximum	Minimum
1	Accel. Vert. - LF Wheel Spindle	g	1.4	5.3	-6.1
2	Accel. Vert. - RF Wheel Spindle	g	1.3	5.5	-6.0
3	Accel. Vert. - LR Wheel Spindle	g	1.3	5.4	-4.9
4	Accel. Vert. - RR Wheel Spindle	g	1.2	5.9	-5.5
5	Accel. Lat. - Frame at the CG	g	0.4	2.3	-2.8
6	Accel. Vert. - Frame at the CG	g	0.3	1.4	-1.8
7	Accel. Long. - Frame at the CG	g	0.2	1.3	-0.9
8	Accel. Lat. - Lunette	g	0.4	2.0	-2.0
9	Accel. Vert. - Lunette	g	0.4	2.2	-2.0
10	Accel. Long. - Lunette	g	0.1	0.9	-0.5
11	Accel. Lat. - A-frame at RF Corner	g	0.3	1.5	-1.3
12	Accel. Vert. - A-frame at RF Corner	g	0.4	2.7	-2.5
13	Accel. Long. - A-frame at RF Corner	g	0.1	0.8	-0.5
14	Accel. Lat. - A-frame at LF Corner	g	0.3	1.5	-1.3
15	Accel. Vert. - A-frame at LF Corner	g	0.4	3.1	-5.2
16	Accel. Long. - A-frame at LF Corner	g	0.1	1.0	-0.7
17	Strain Long. - A-frame, Left Inboard	ue	149.0	483.0	-718.0
18	Strain Long. - A-frame, Left Outboard	ue	90.0	301.0	-447.0
19	Strain Long. - A-frame, Right Inboard	ue	209.0	670.0	-1020.0
20	Strain Long. - A-frame, Right Outboard	ue	85.9	302.0	-442.0
21	Rot. Rate Pitch - Frame at the CG	deg/sec	2.6	10.2	-11.4
22	Rot. Rate Roll - Frame at the CG	deg/sec	4.6	18.8	-18.5

APPENDIX D

SELECTED DATA PLOTS

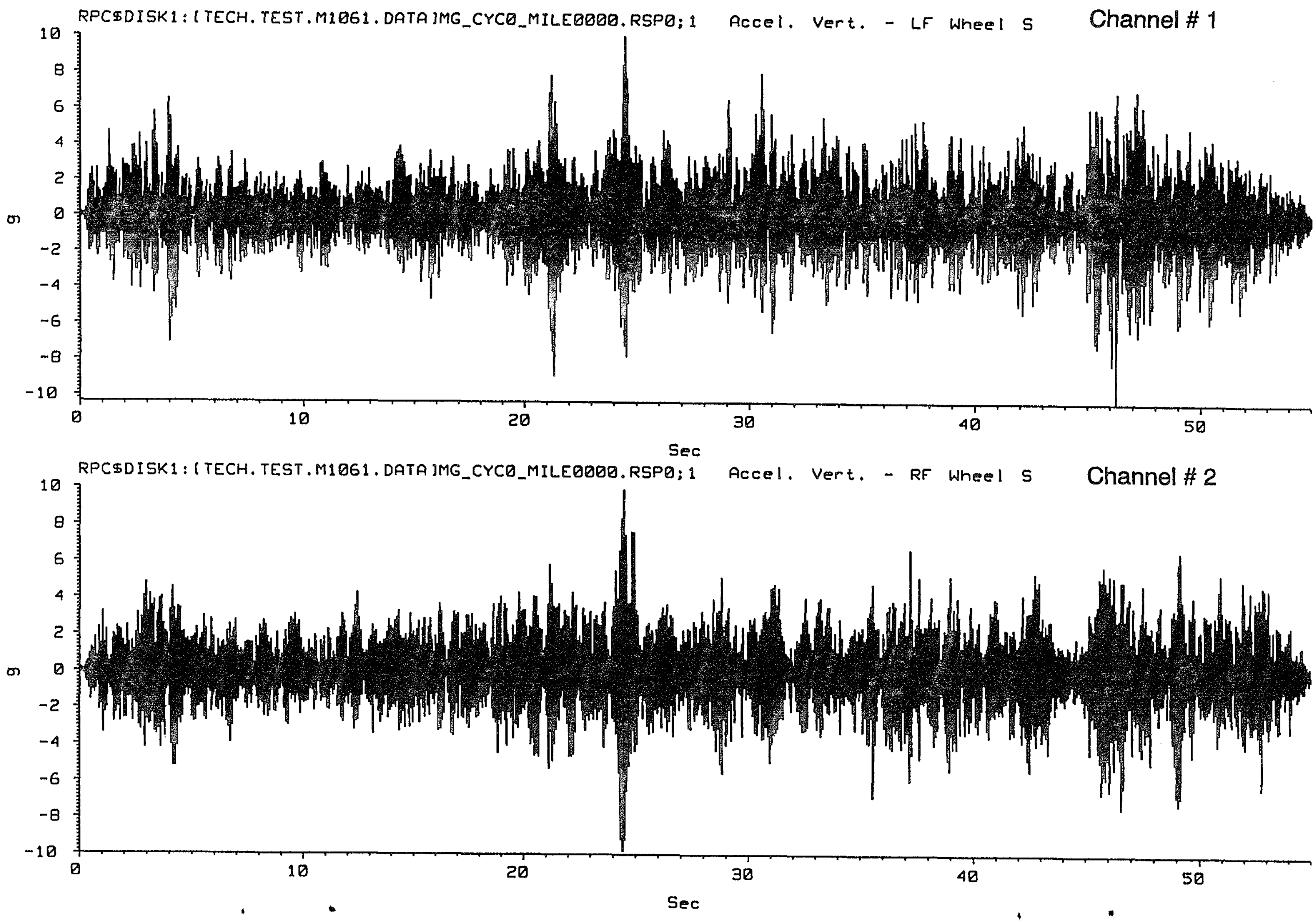
TIME HISTORY PLOTS

FROM

MUNSON GRAVEL AT 25 MPH

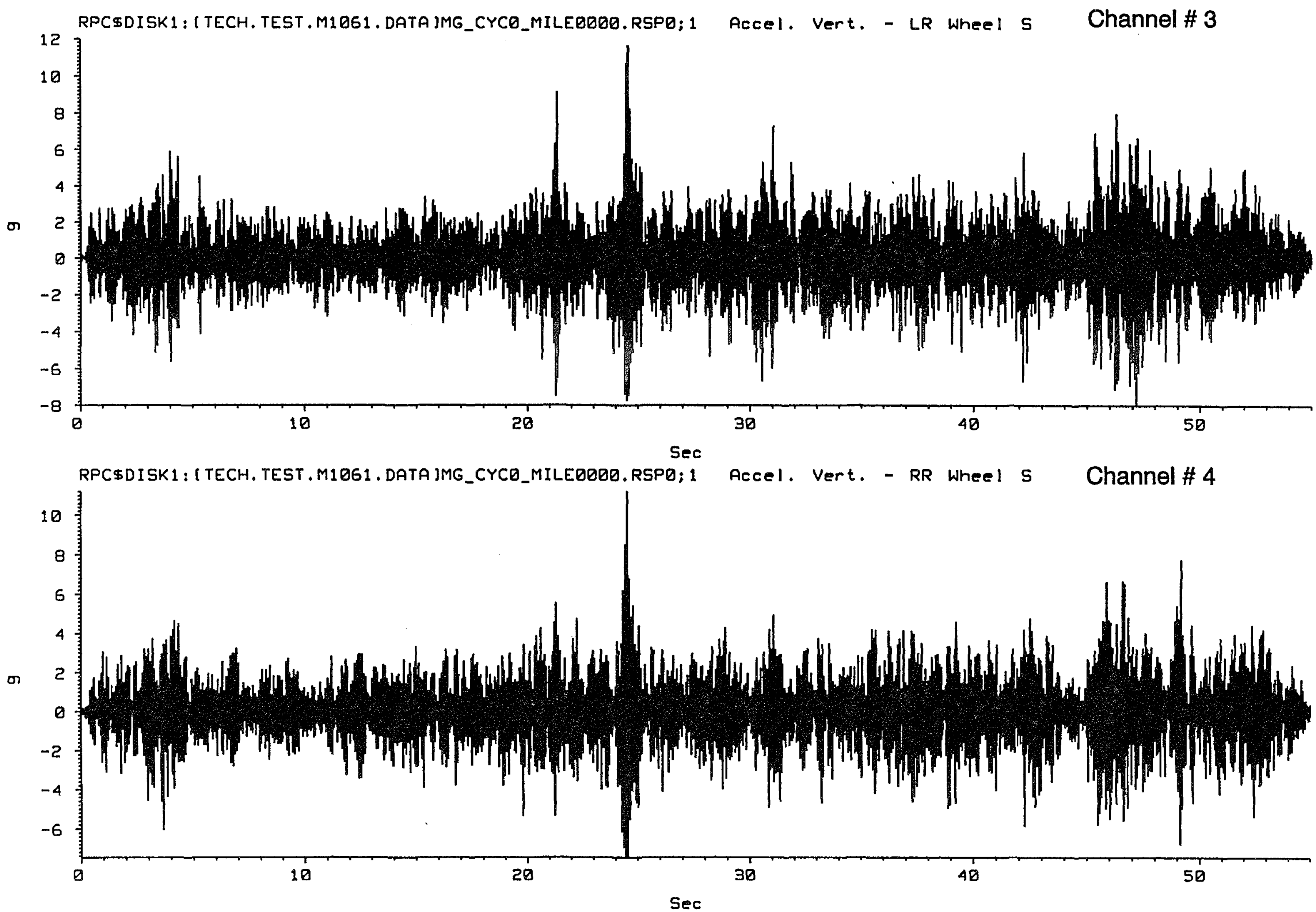
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:02:10

Figure D-1 LF & RF Wheel Spindle Accelerations from Munson Gravel at 25 mph



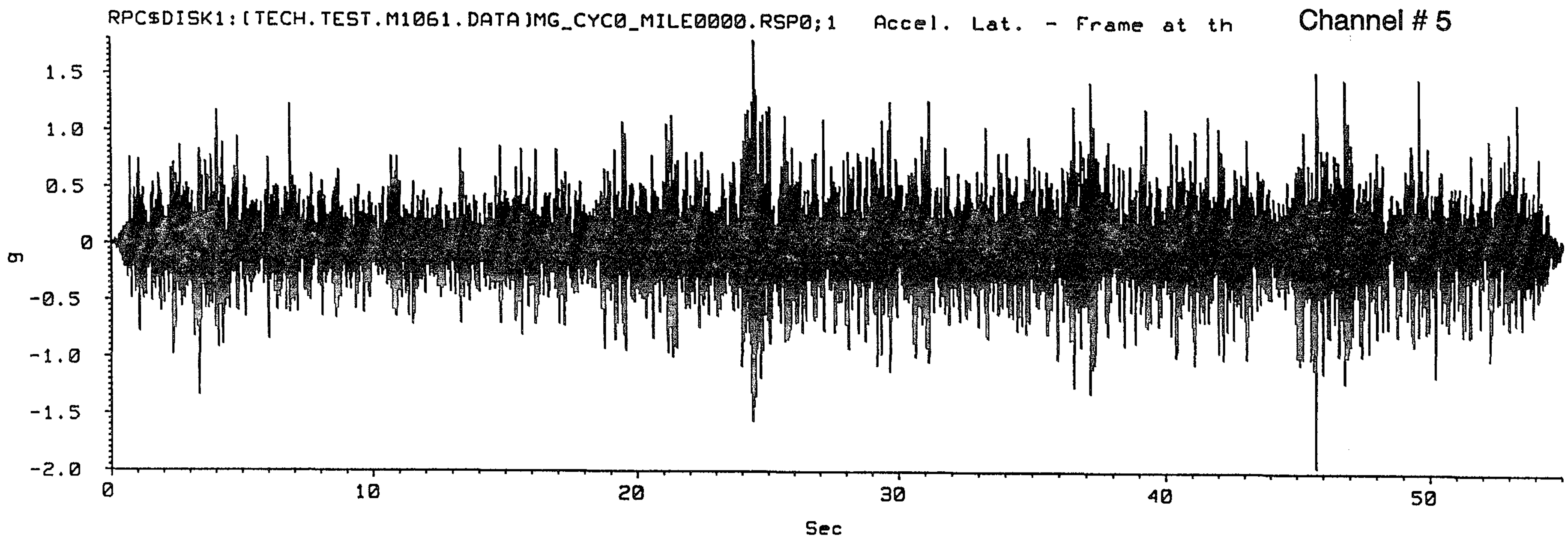
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:03:00

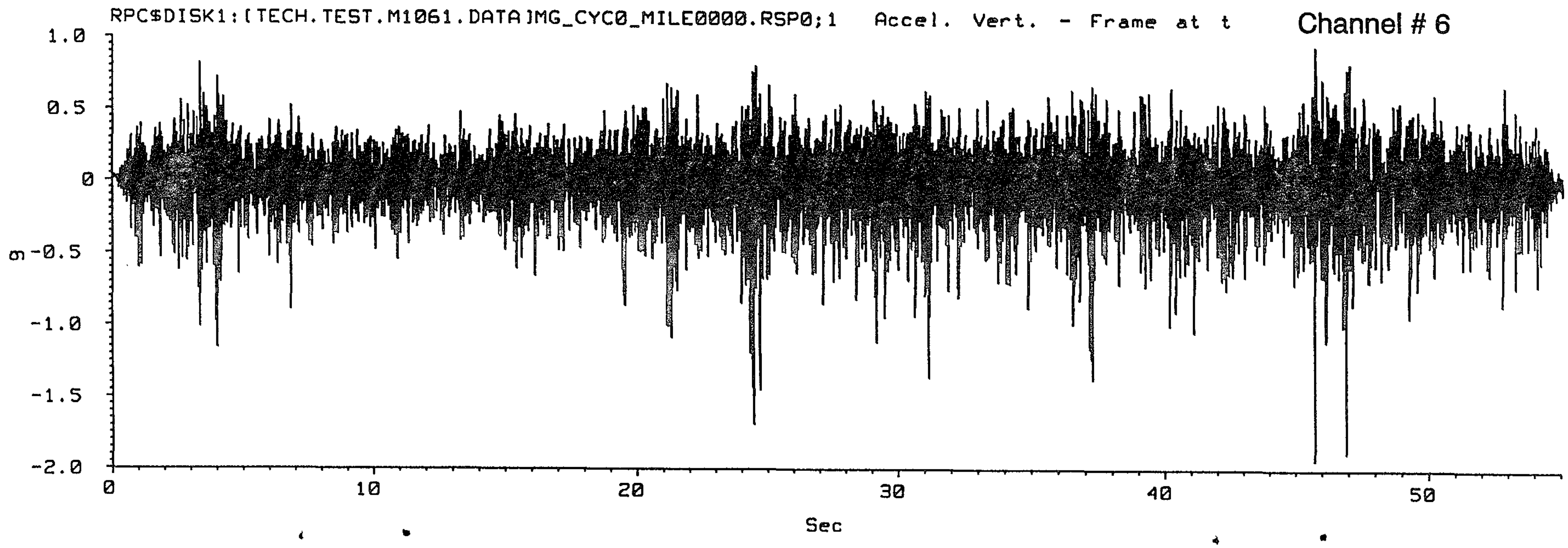
Figure D-2 LR & RR Wheel Spindle Accelerations from Munson Gravel at 25 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:04:06

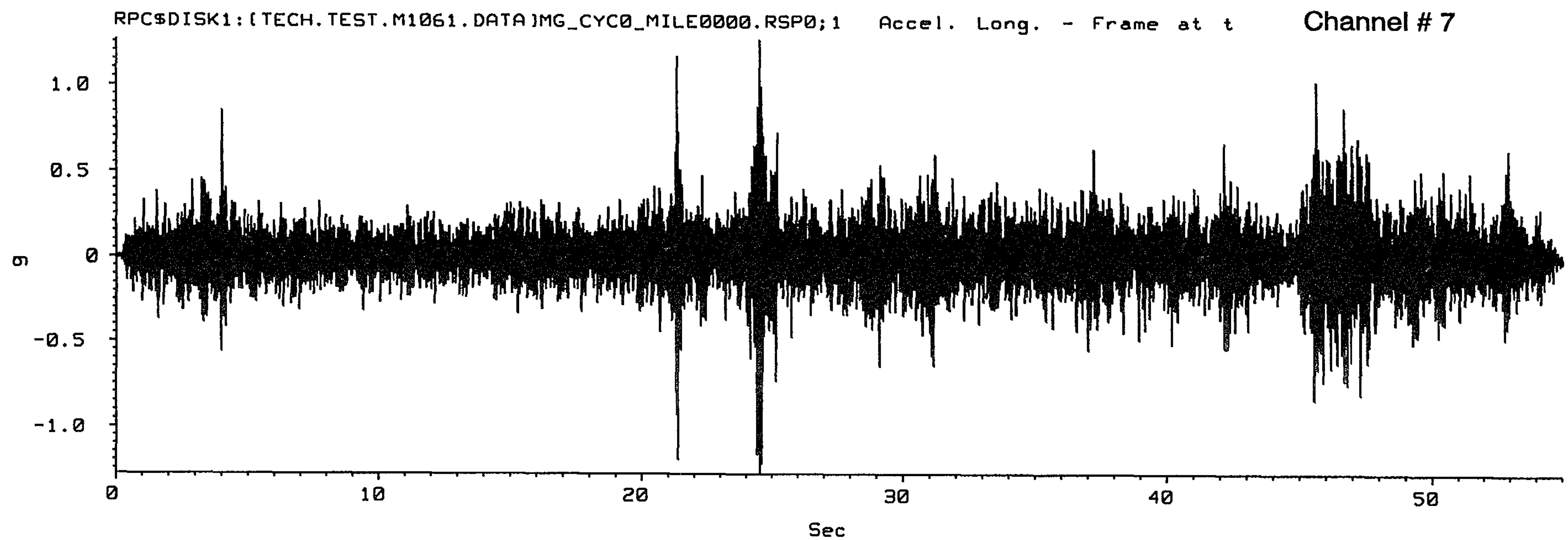
Figure D-3 Lateral & Vertical Trunnion Accelerations from Munson Gravel at 25 mph

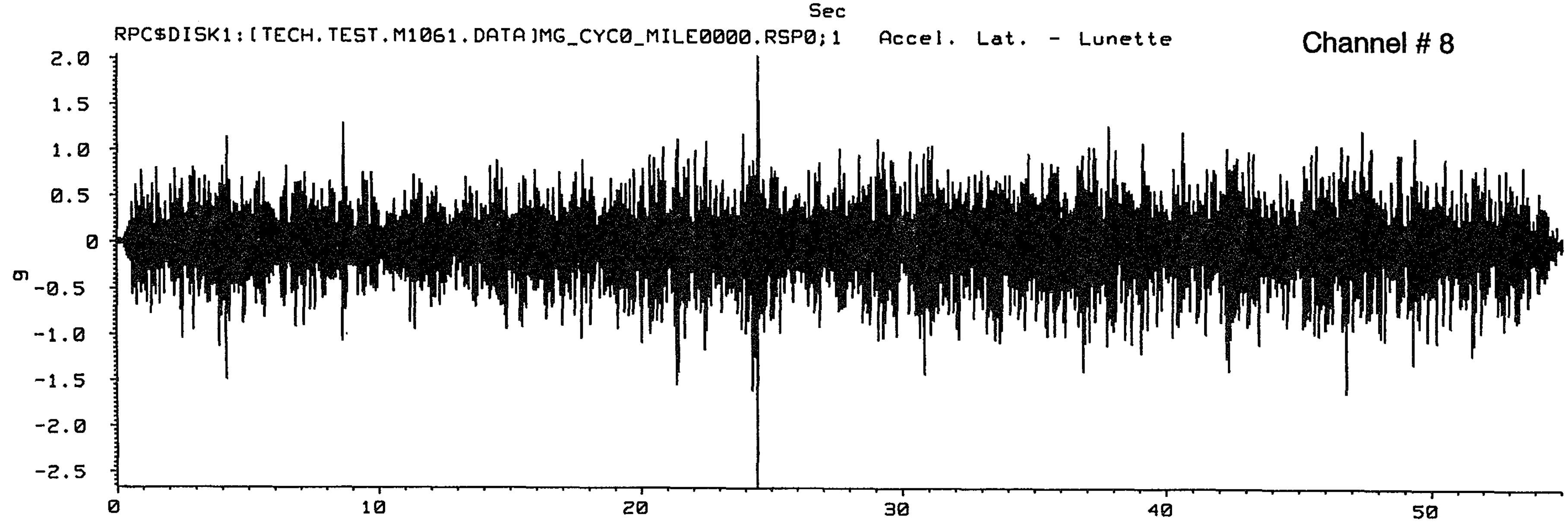




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:05:05

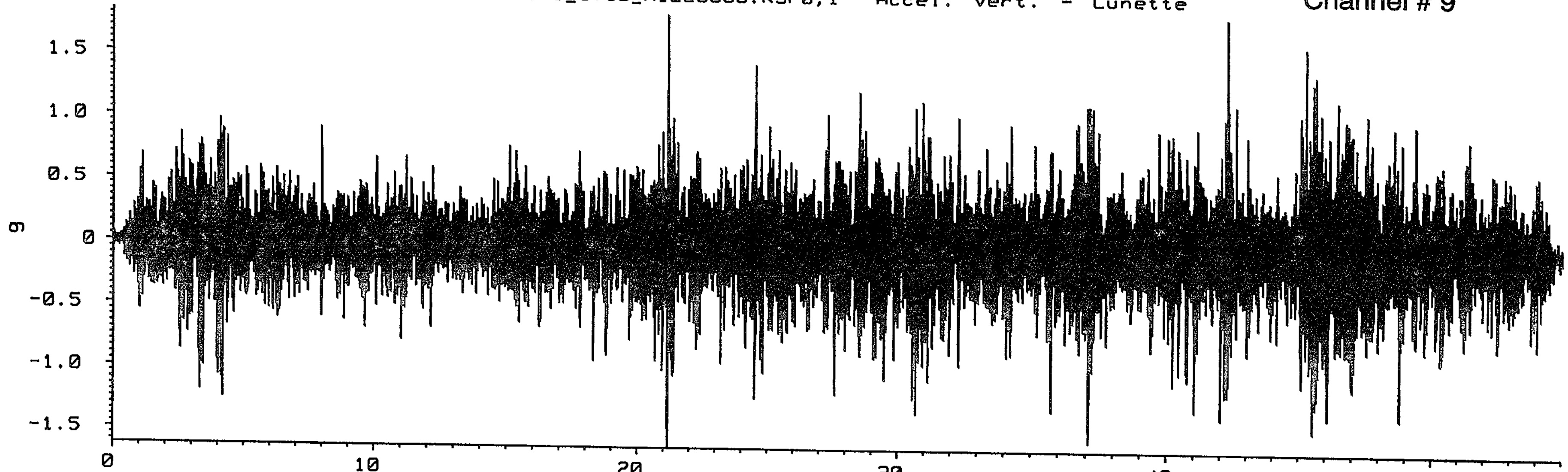
Figure D-4 Longitudinal Trunnion & Lateral Lunette Accelerations from Munson Gravel at 25 mph

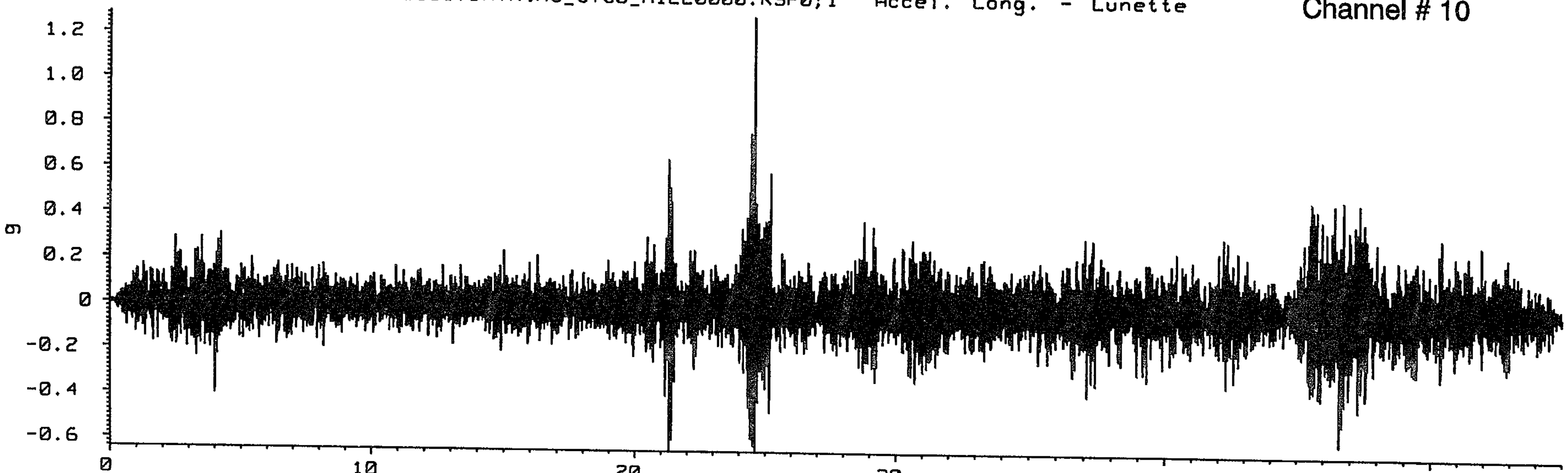




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:06:04

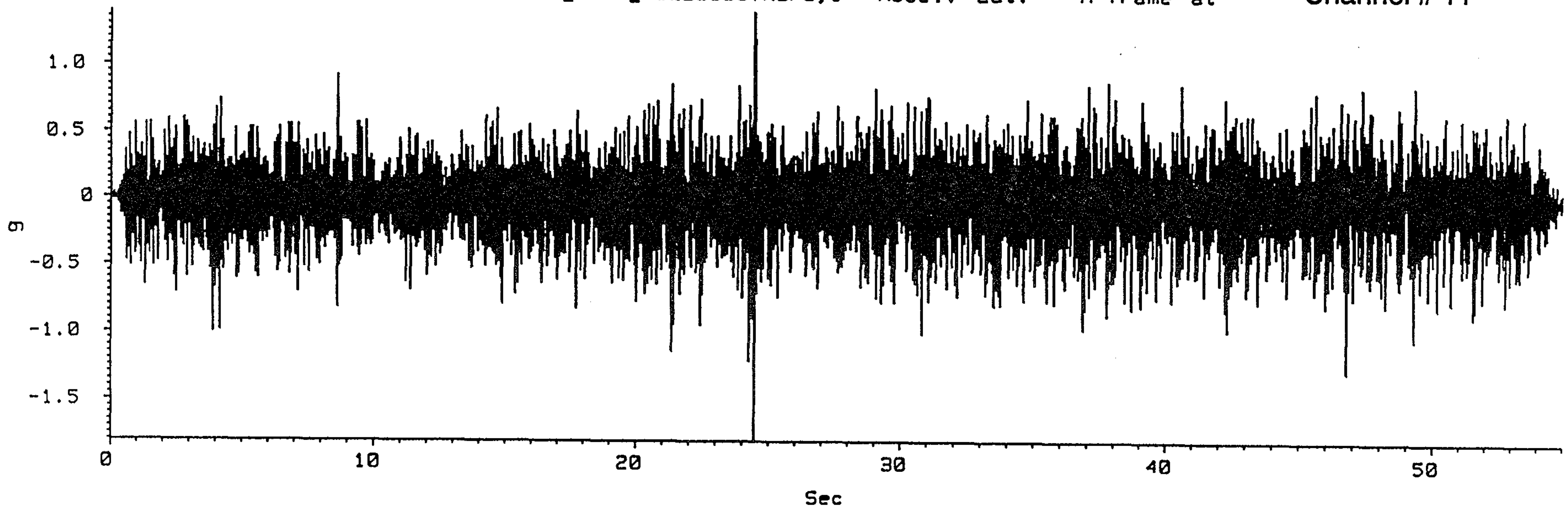
Figure D-5 Vertical & longitudinal Lunette Accelerations from Munson Gravel at 25 mph

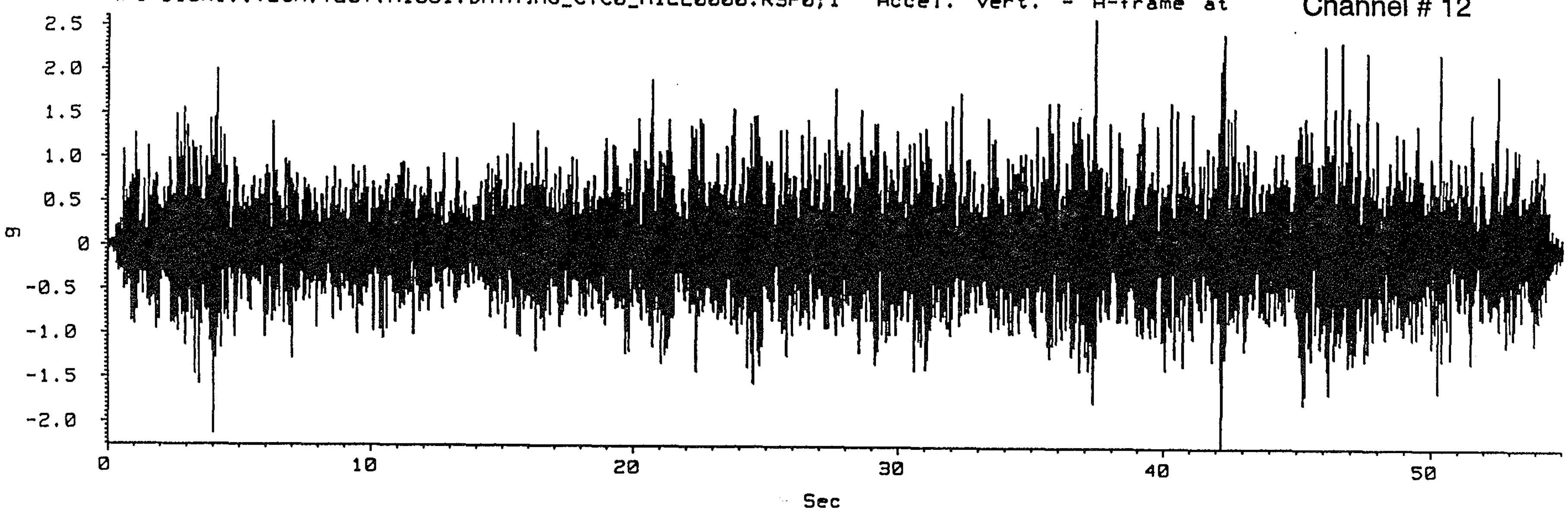




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:06:54

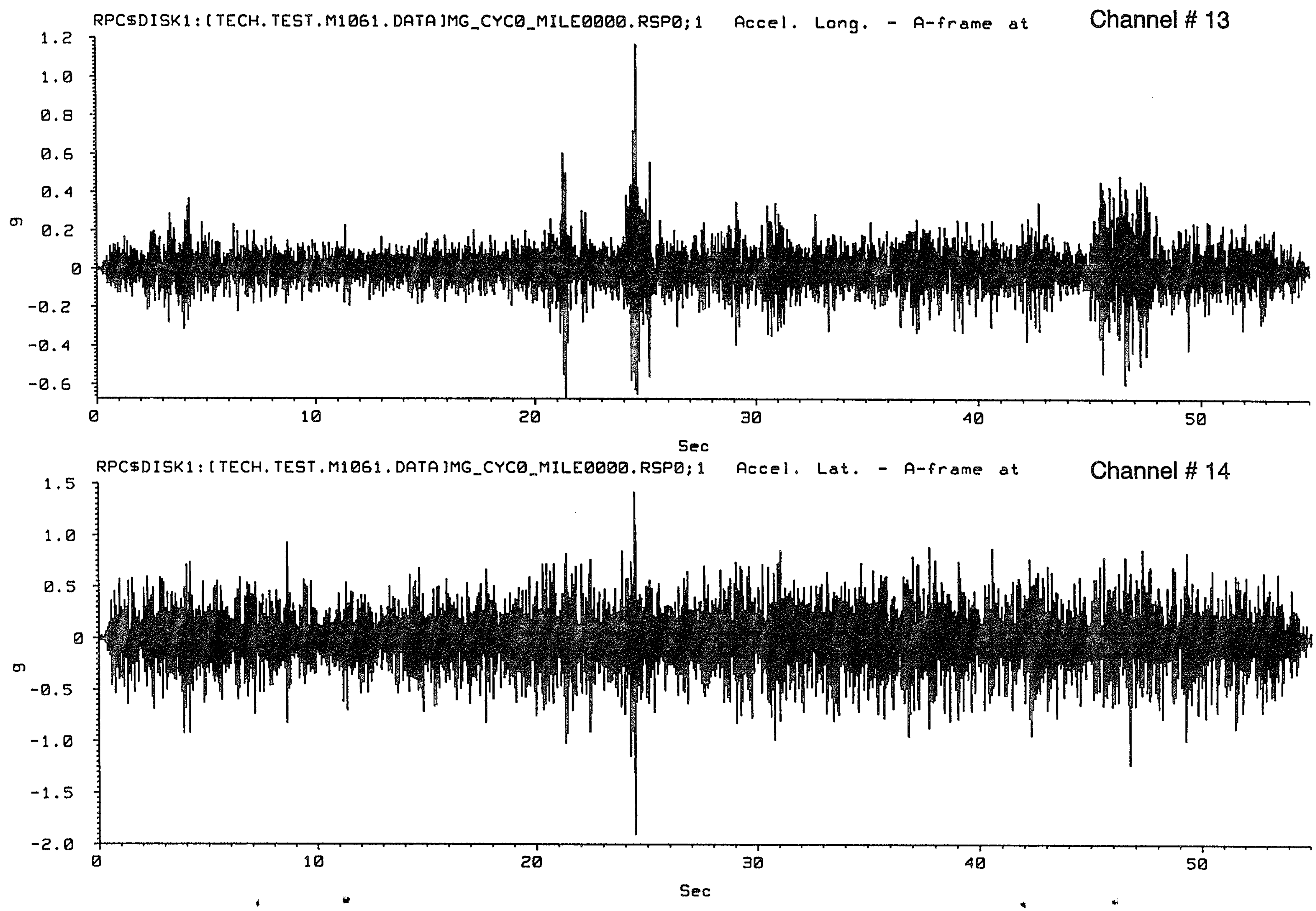
Figure D-6 Lateral & Vertical Right A-Frame Acceleration from Munson Gravel at 25 mph





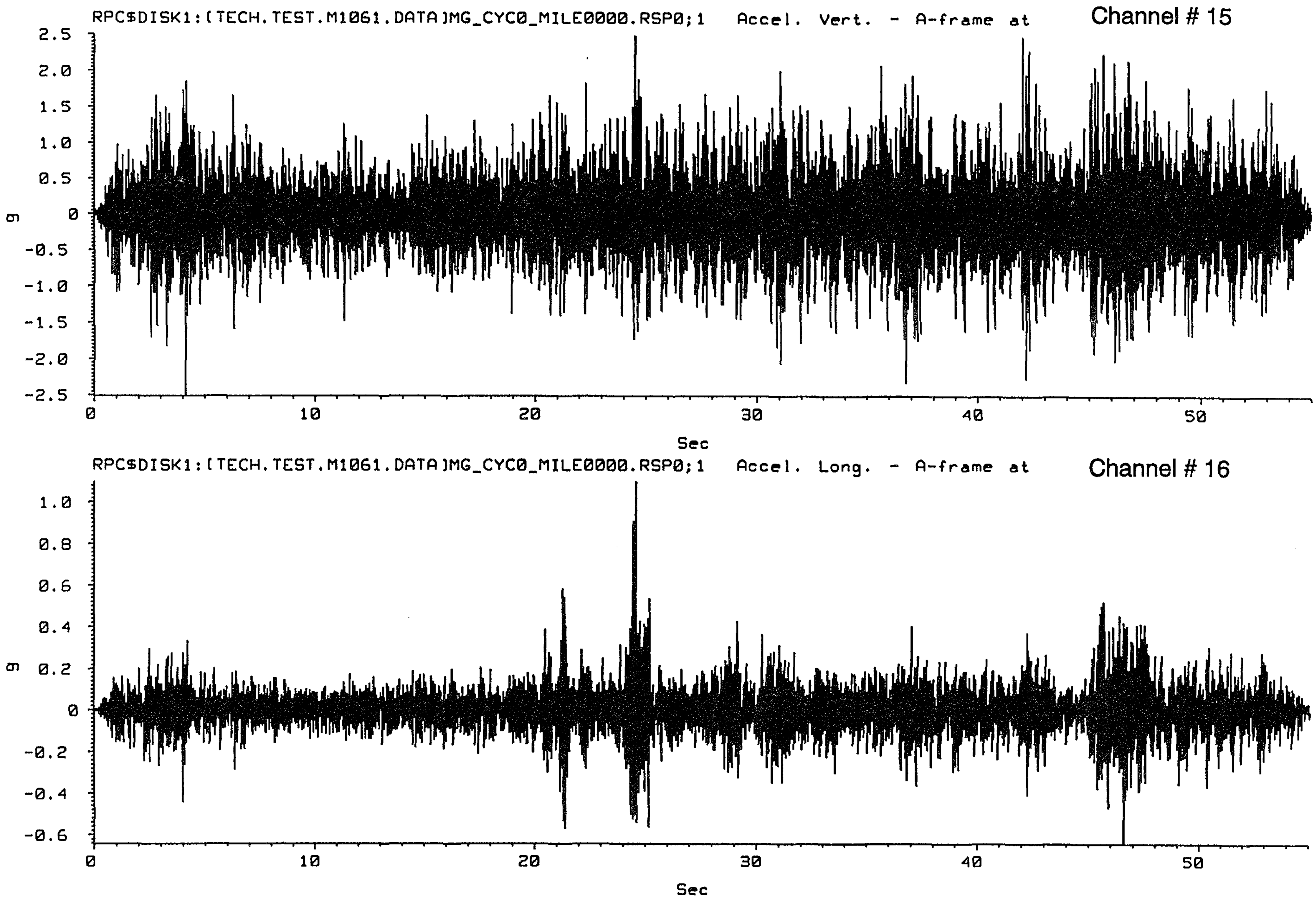
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:07:44

Figure D-7 Longitudinal R & Lateral L A-Frame Accelerations from Munson Gravel at 25 mph



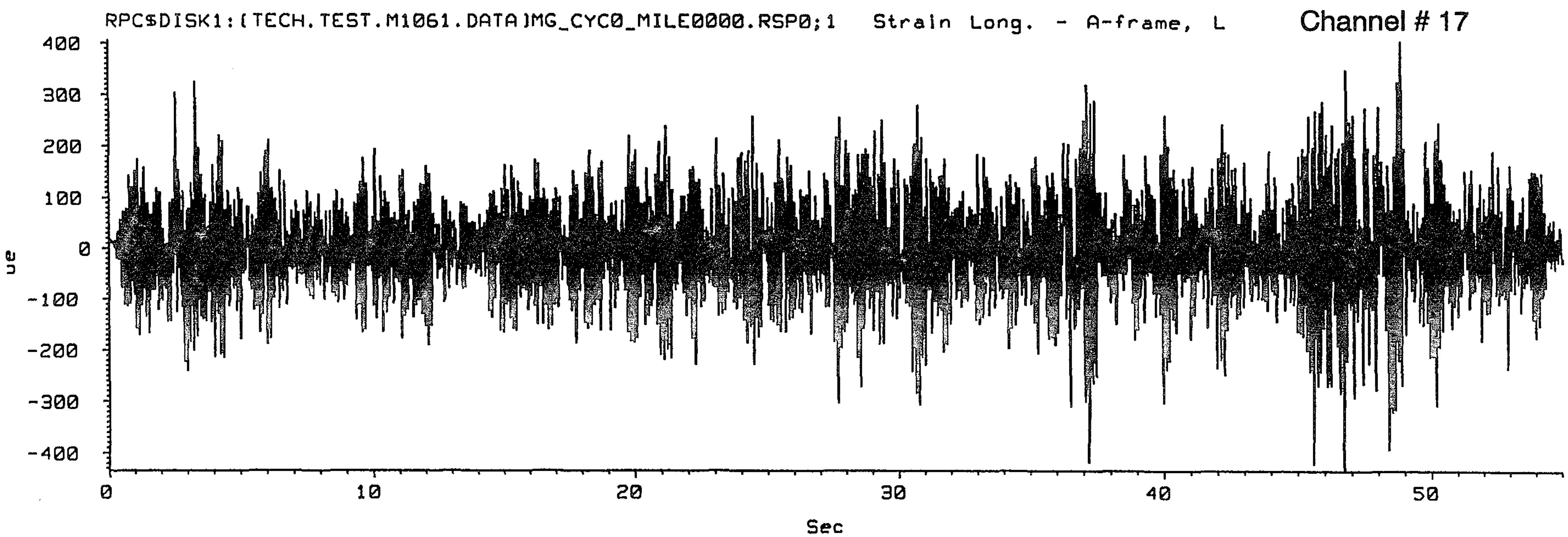
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:08:34

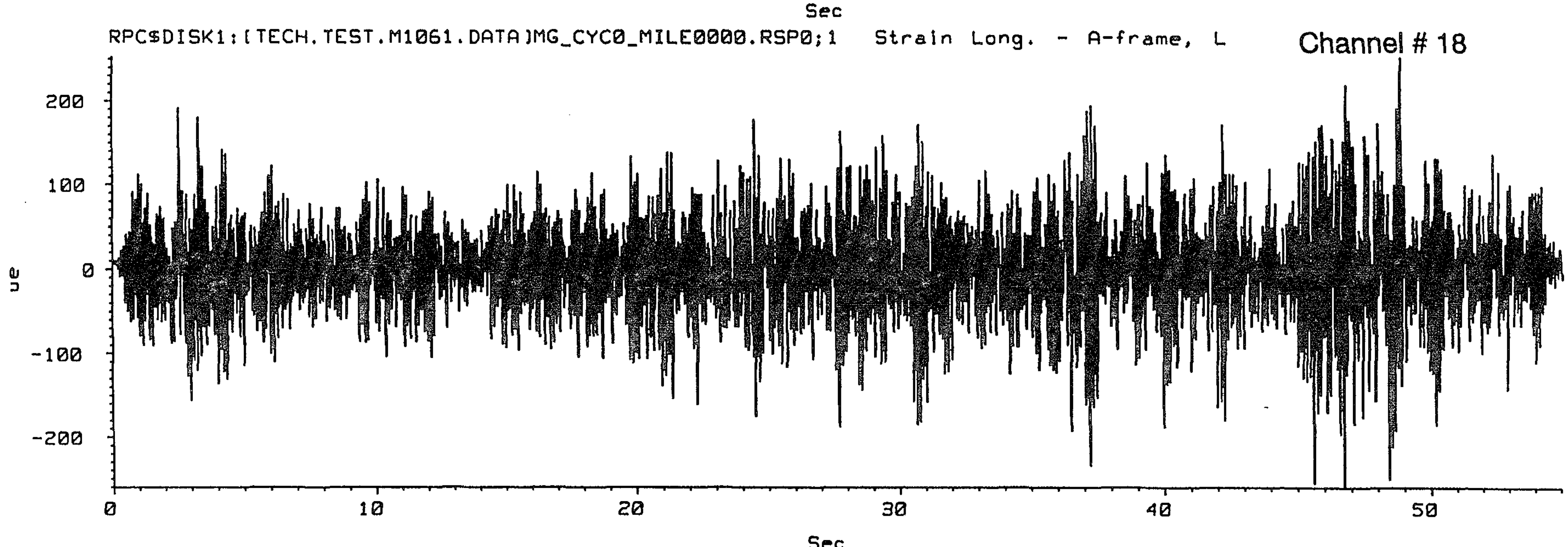
Figure D-8 Vertical & Longitudinal L A-Frame Accelerations from Munson Gravel at 25 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:09:25

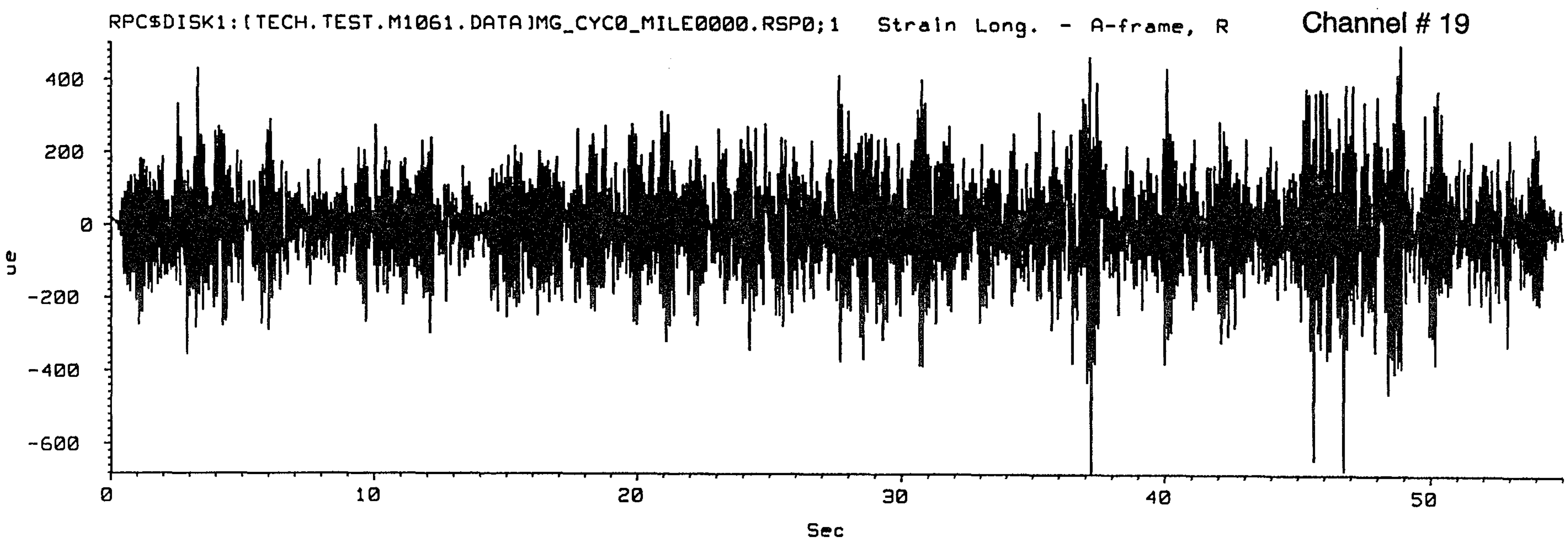
Figure D-9 Inboard & Outboard Left A-Frame Longitudinal Strain from Munson Gravel at 25 mph

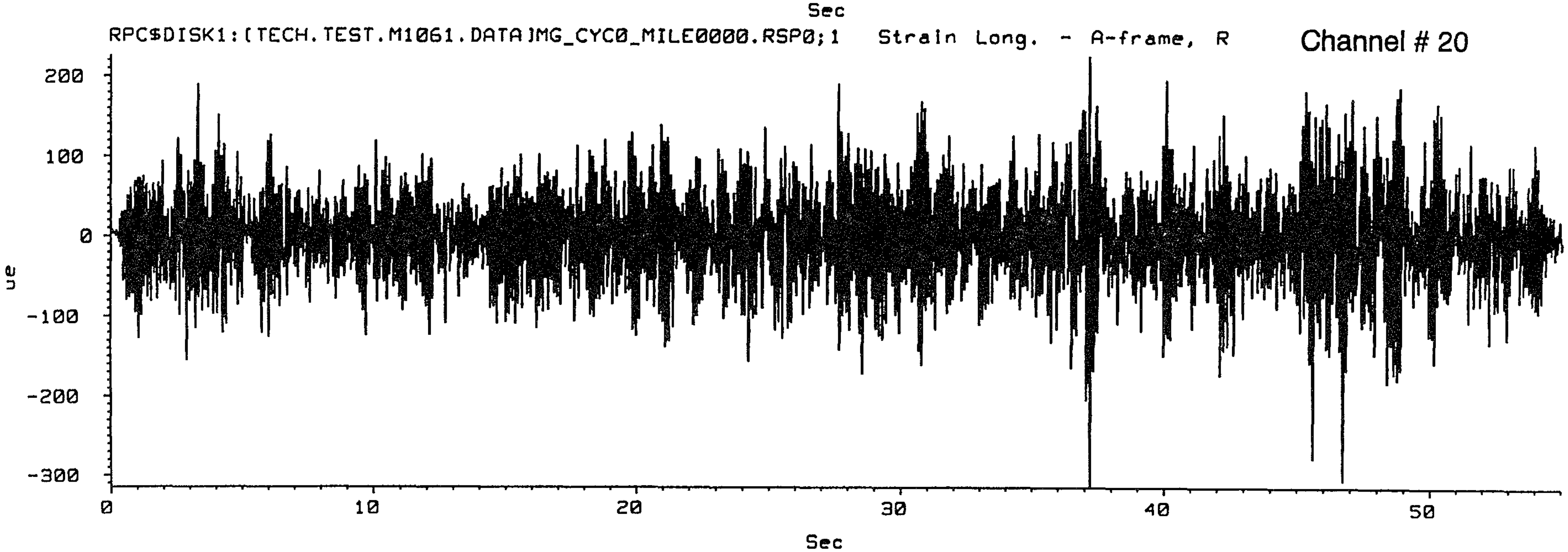




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:10:16

Figure D-10 Inboard & Outboard Right A-Frame Longitudinal Strain from Munson Gravel at 25 mph



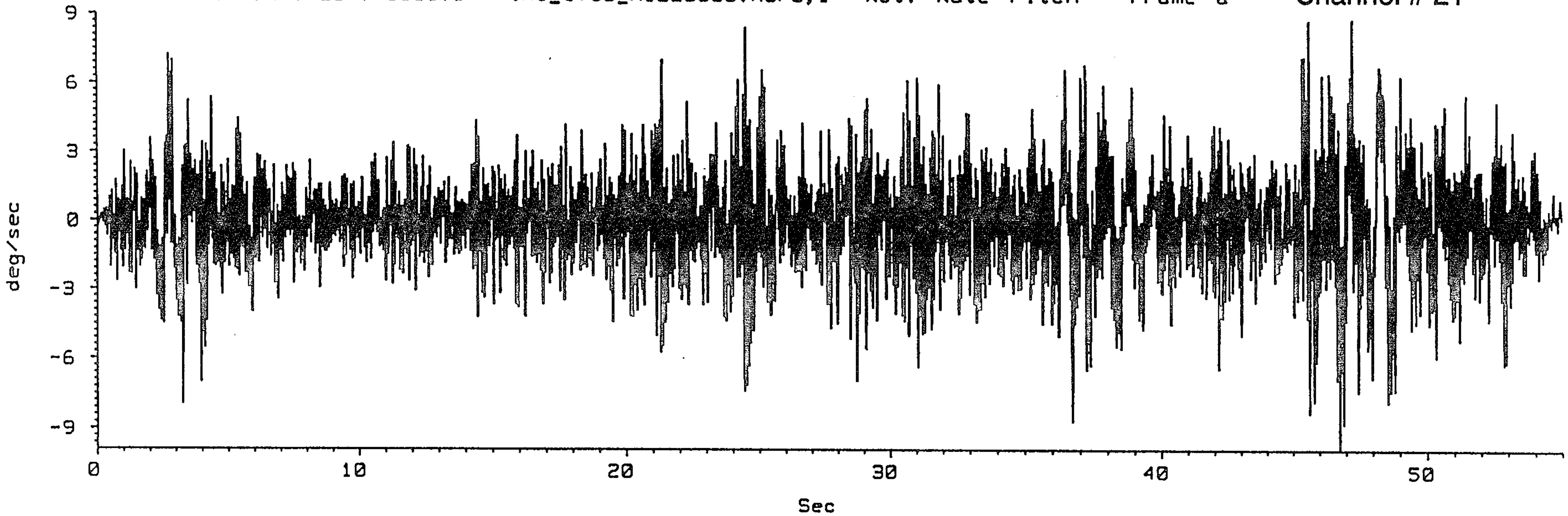


MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:11:05

Figure D-11 Pitch and Roll Rate of Trailer Frame from Munson Gravel at 25 mph

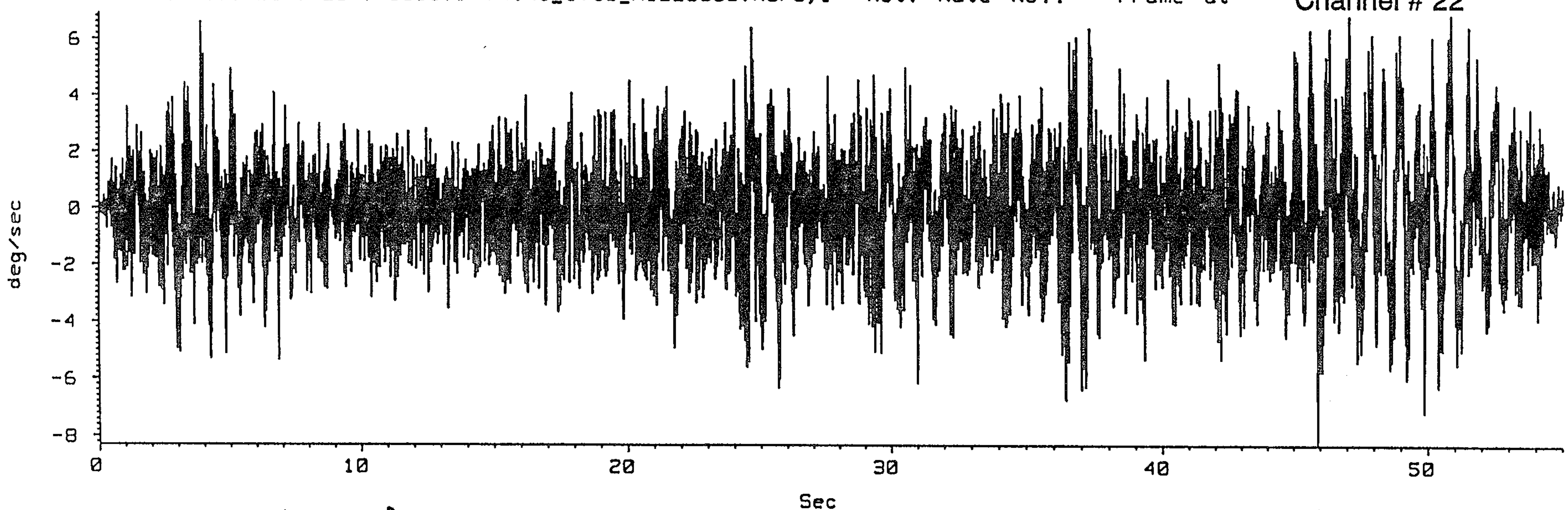
RPC$DISK1:[TECH.TEST.M1061.DATA]MG_CYC0_MILE0000.RSP0;1 Rot. Rate Pitch - Frame a

Channel # 21



RPC$DISK1:[TECH.TEST.M1061.DATA]MG_CYC0_MILE0000.RSP0;1 Rot. Rate Roll - Frame at

Channel # 22



POWER SPECTRAL DENSITY PLOTS

FROM

MUNSON GRAVEL AT 25 MPH

Figure D-12 Channels #1 - #4 from Munson Gravel at 25 mph

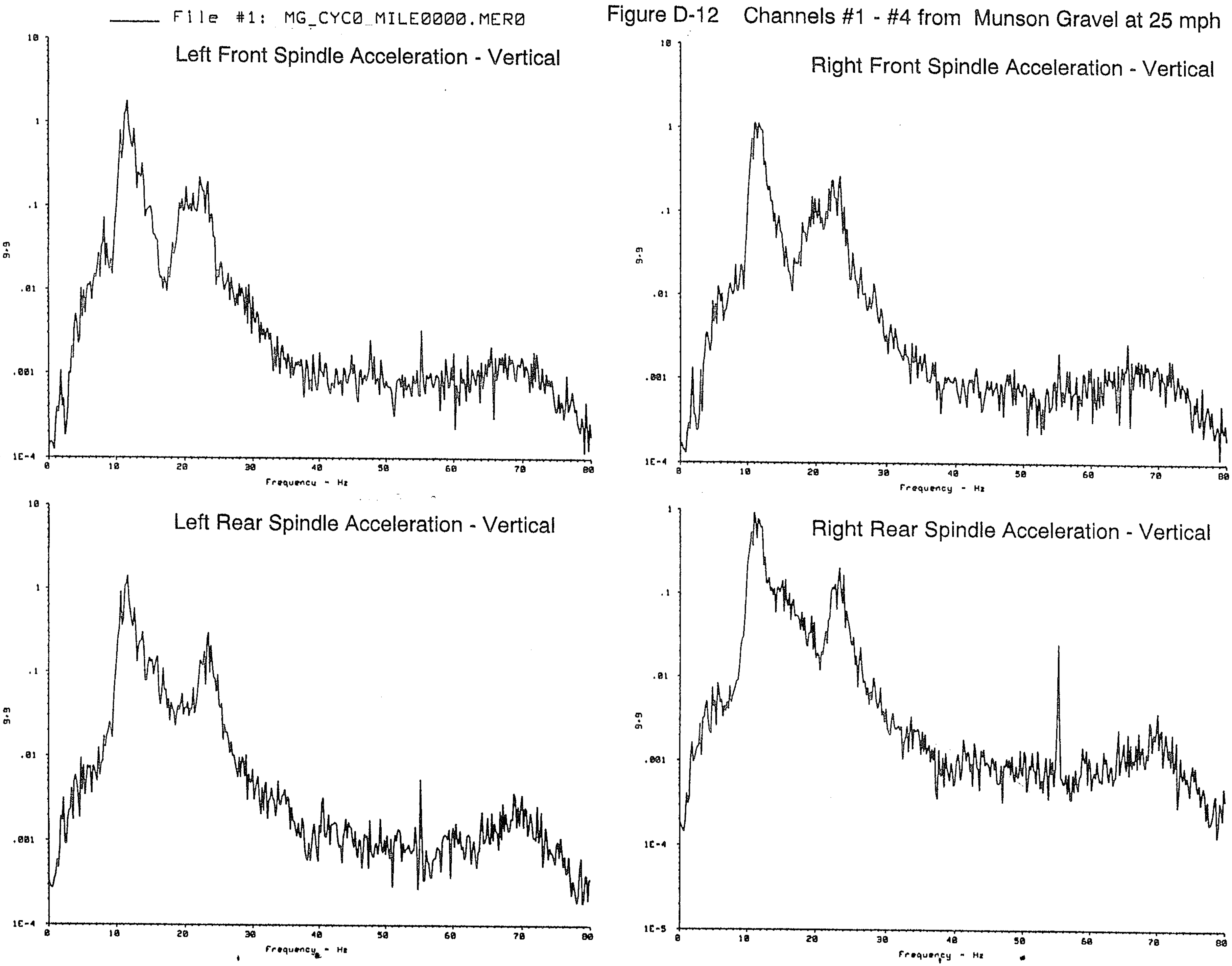


Figure D-13 Channels #5 - #8 from Munson Gravel at 25 mph

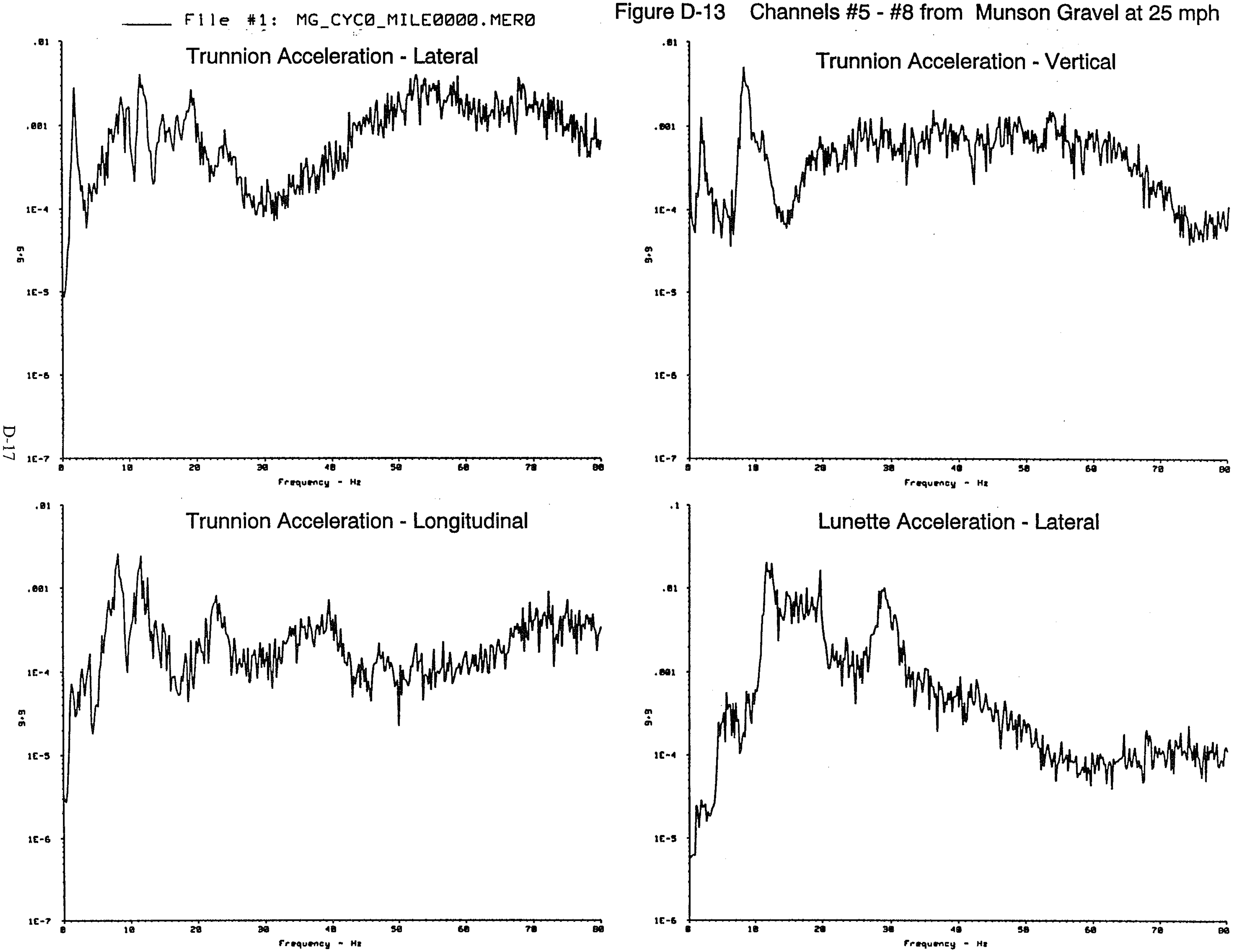
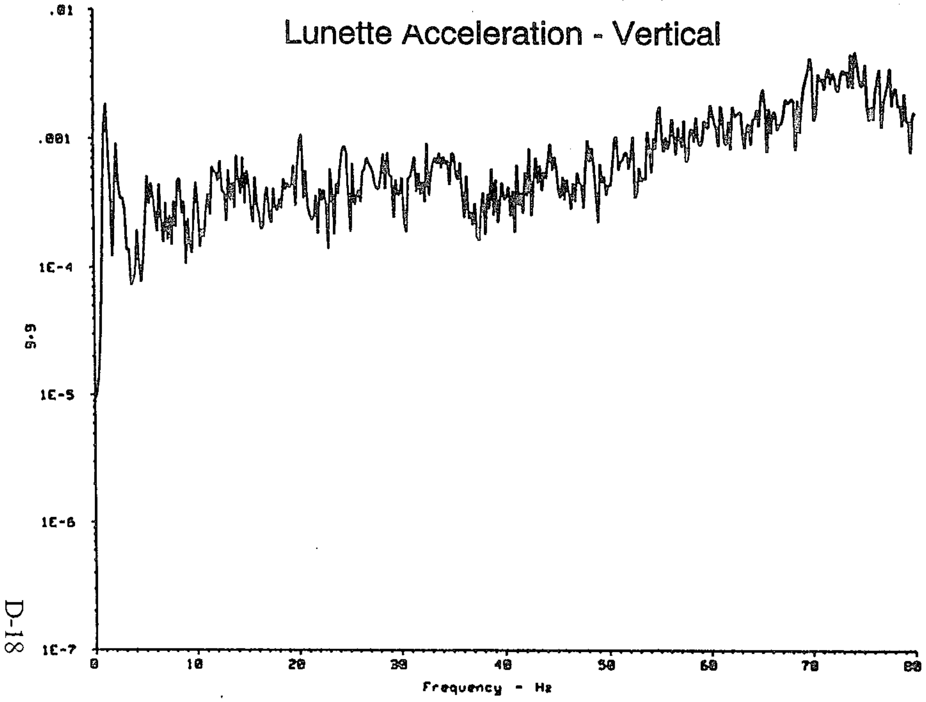
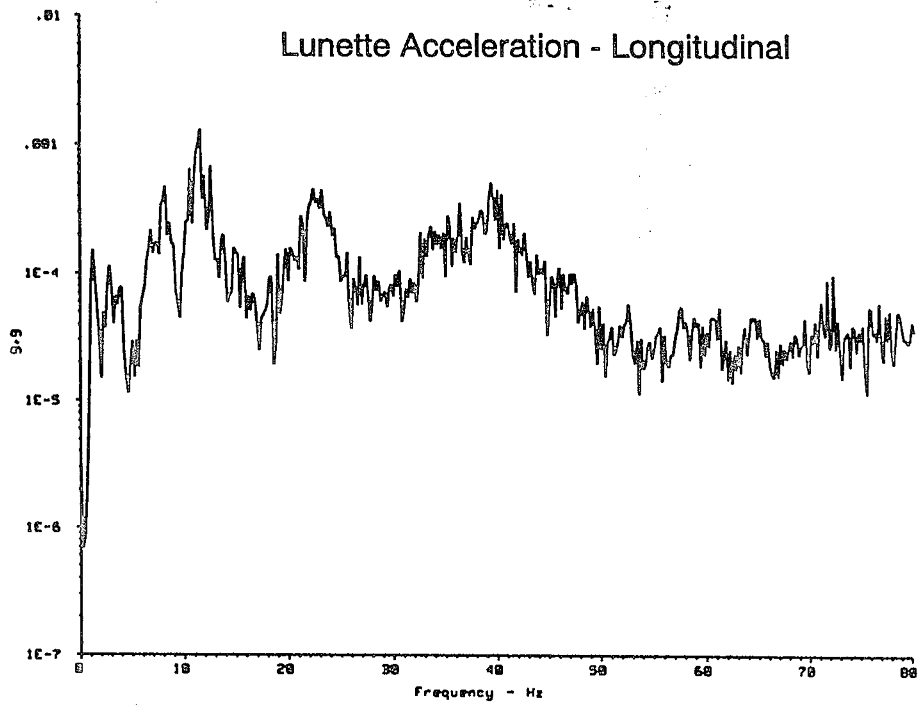
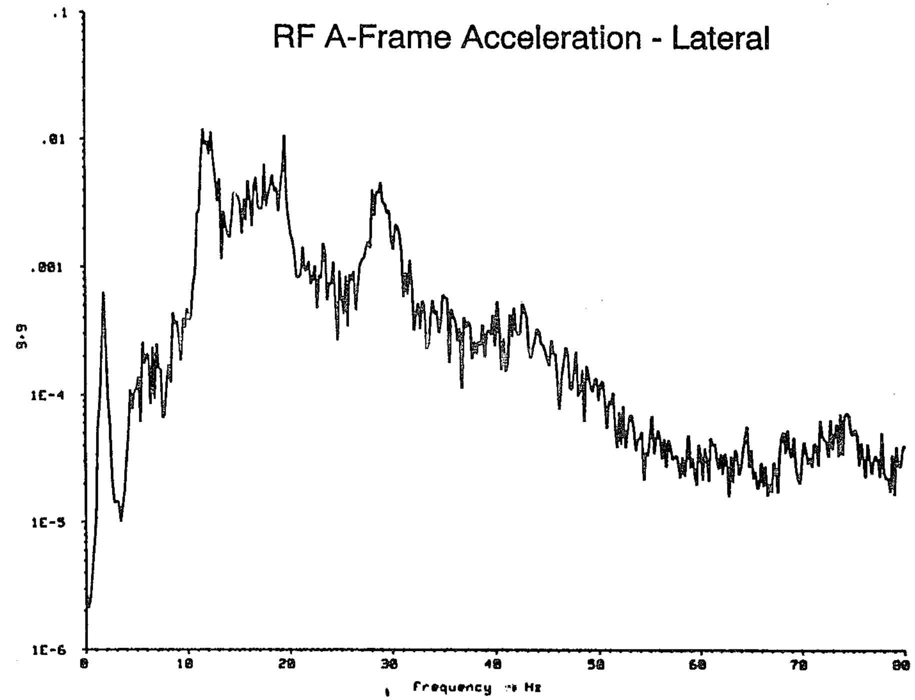


Figure D-14 Channels #9 - #12 from Munson Gravel at 25 mph

—— File #1: MG_CYC0 MILE0000.MER0







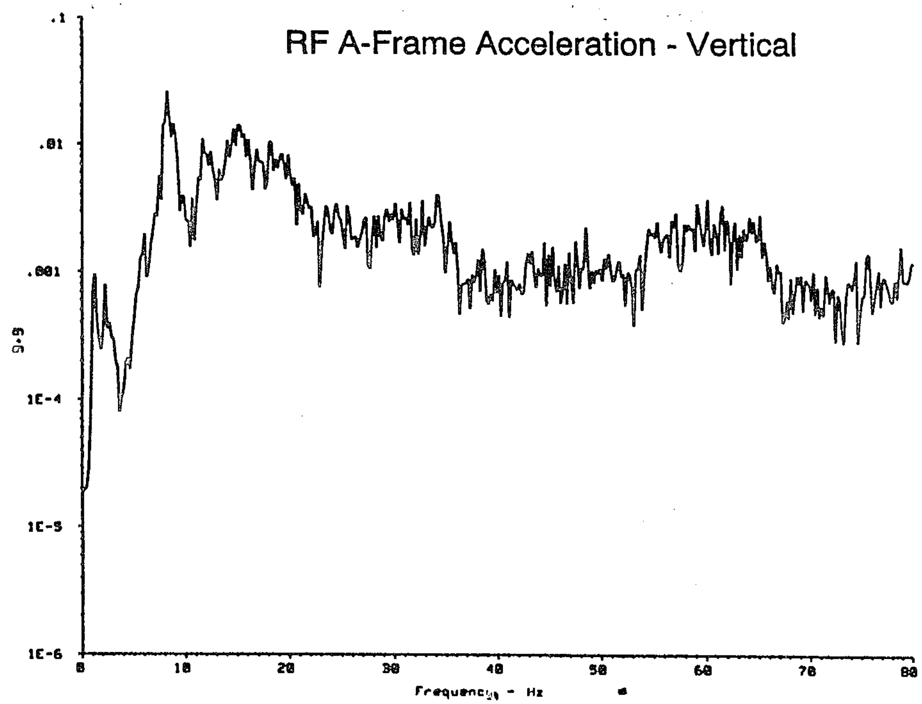


Figure D-15 Channels #13 - #16 from Munson Gravel at 25 mph

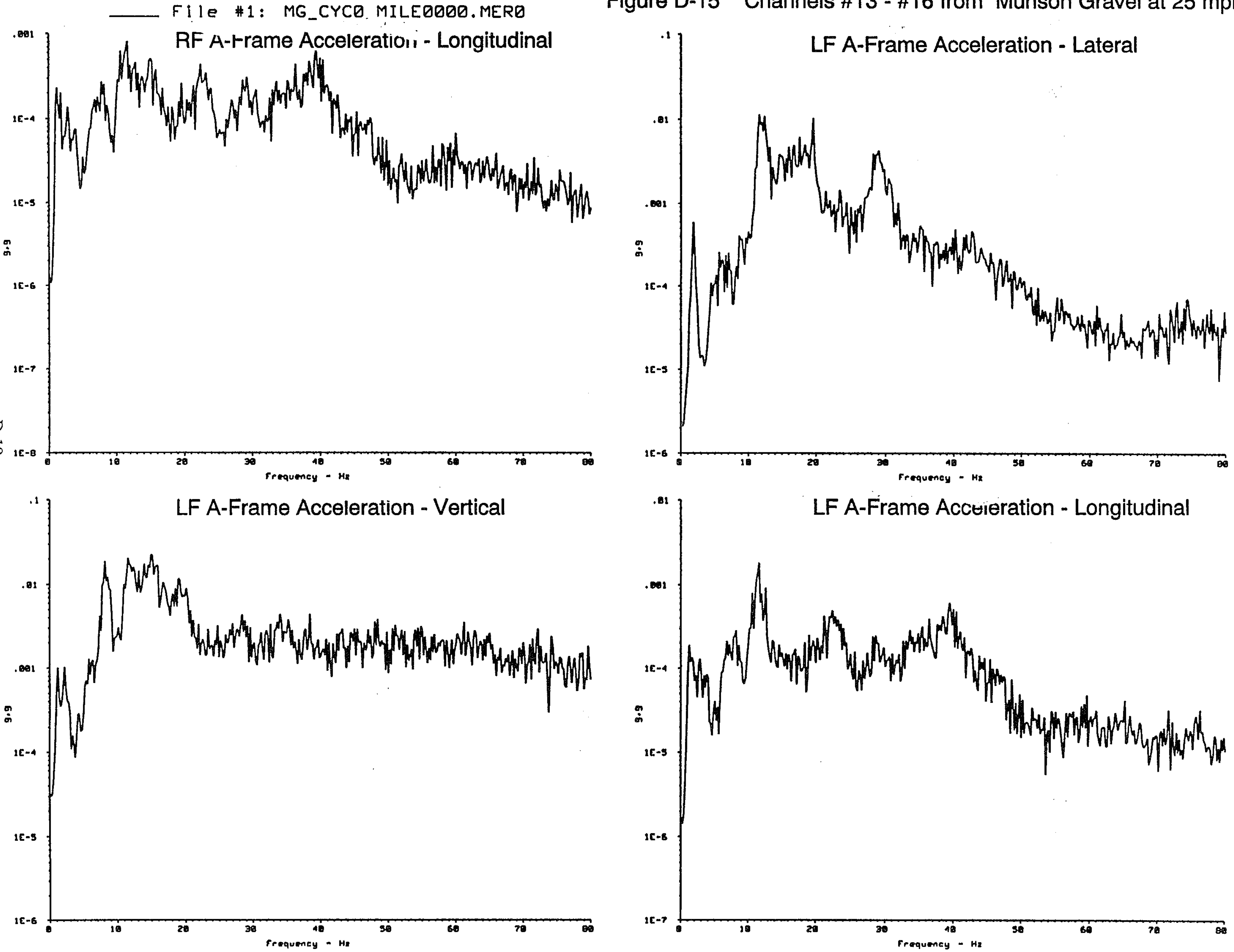


Figure D-16 Channels #17 - #20 from Munson Gravel at 25 mph

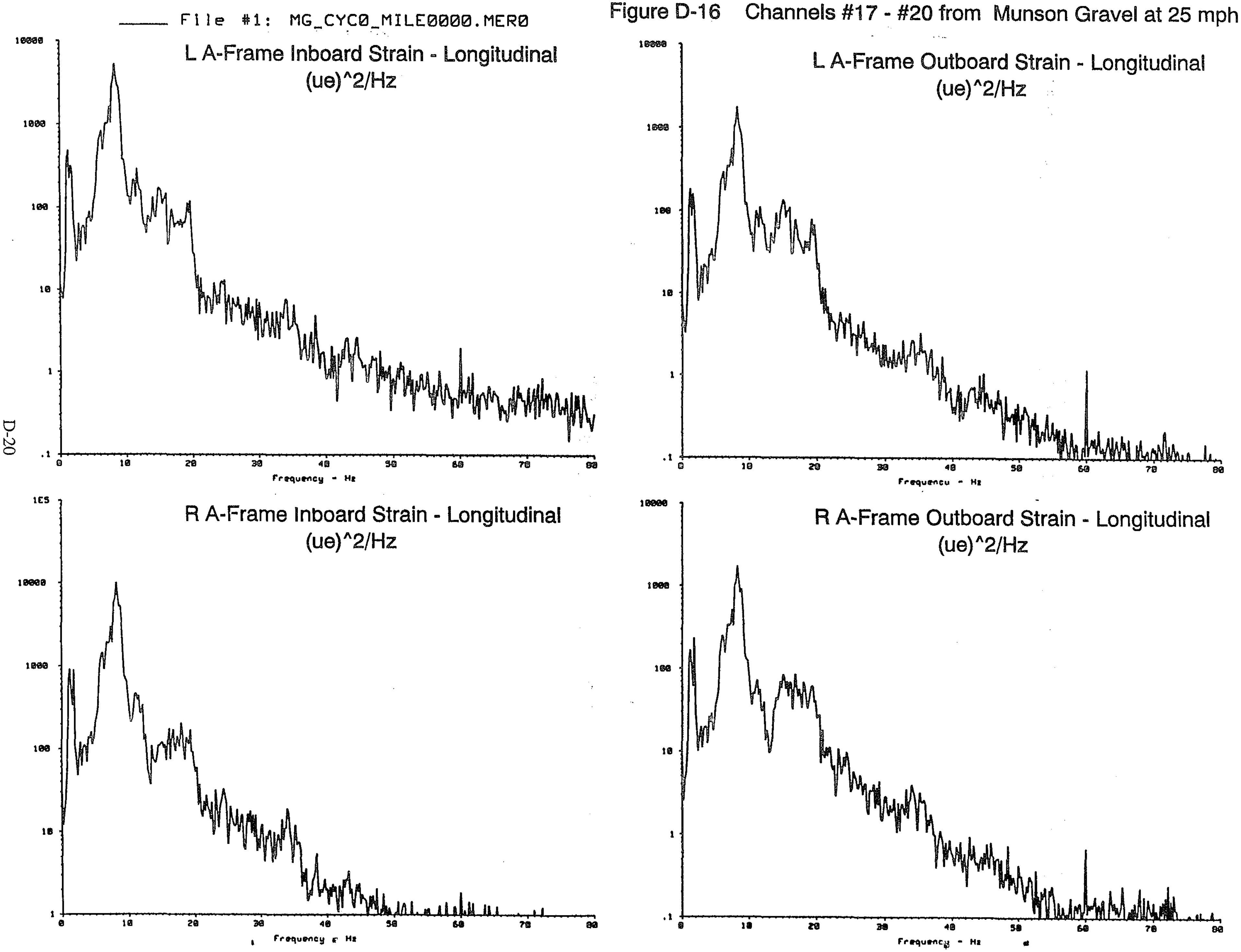
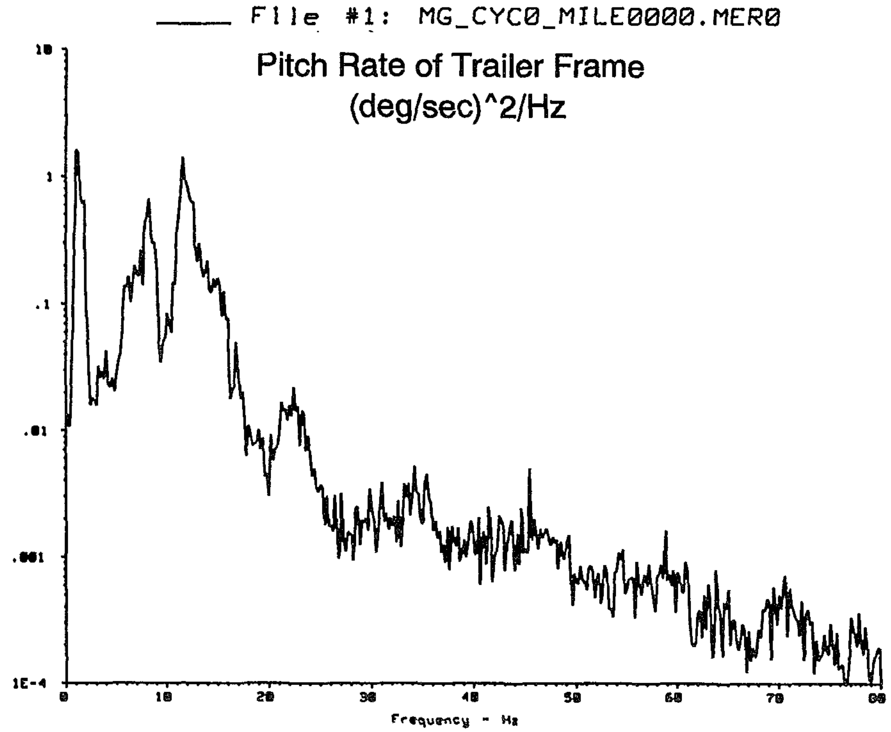
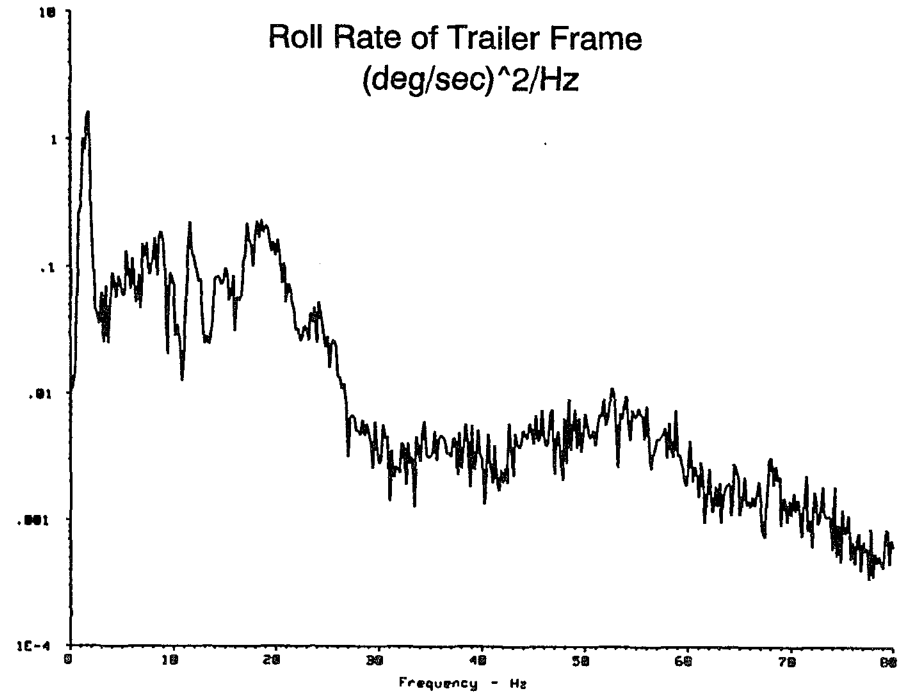


Figure D-17 Channels #21 - #22 from Munson Gravel at 25 mph





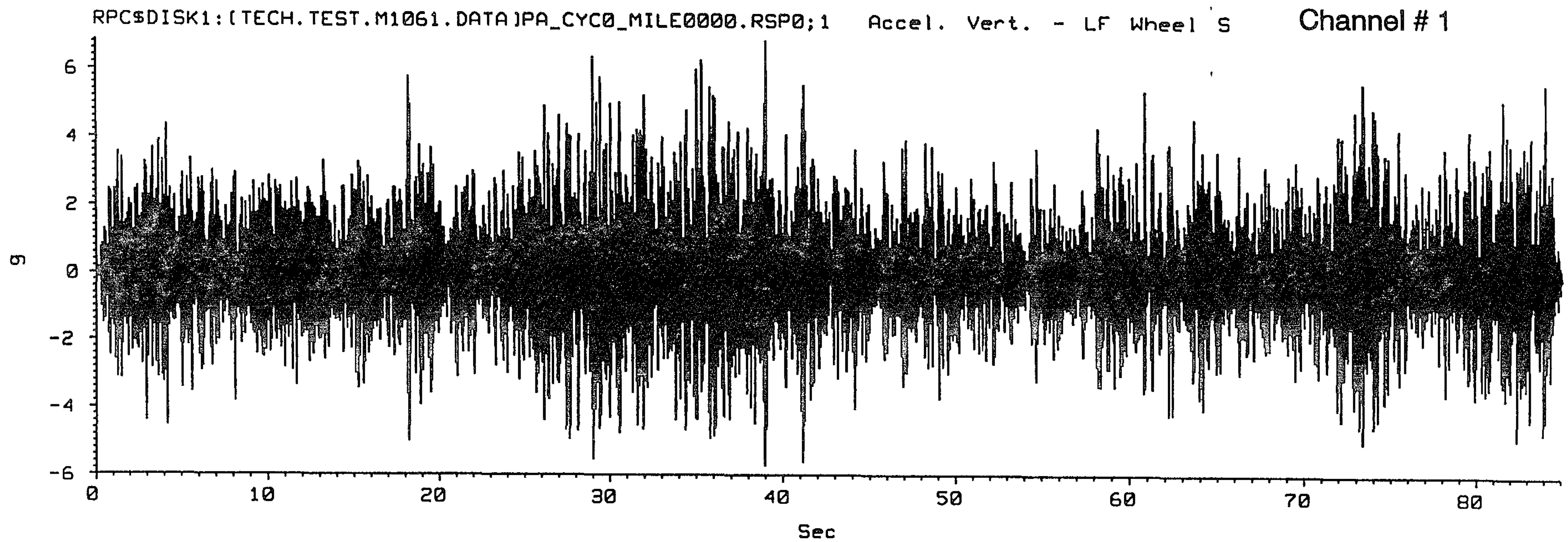
TIME HISTORY PLOTS

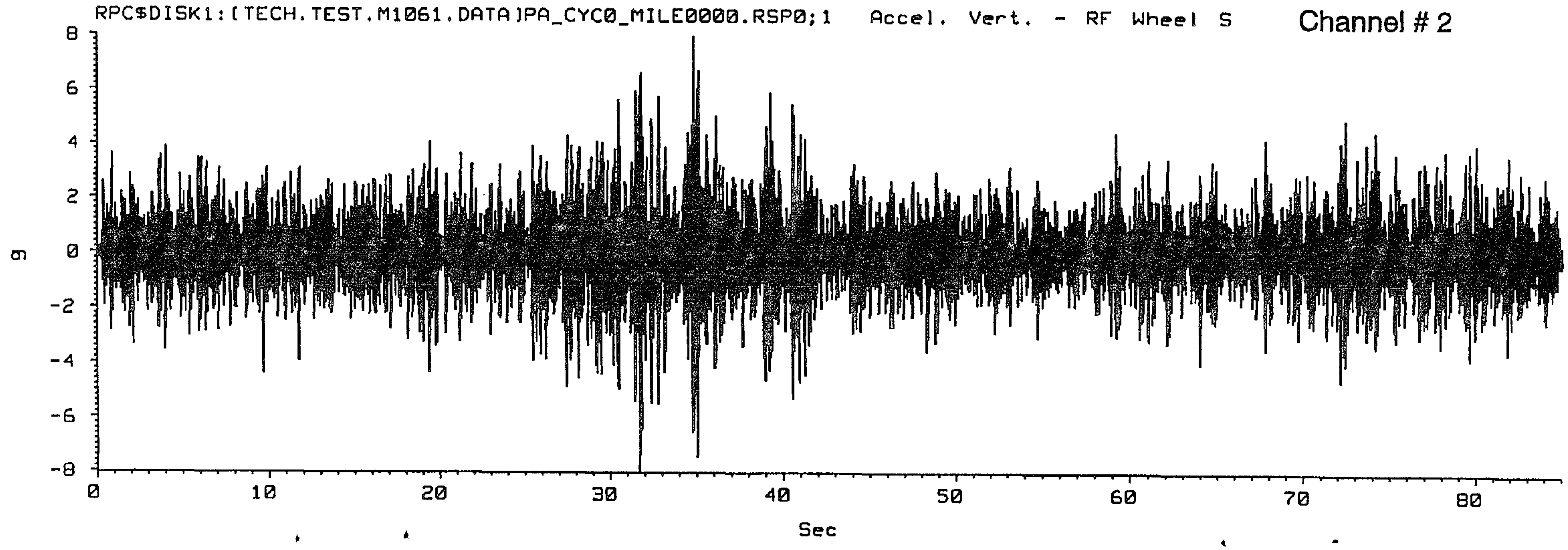
FROM

PERRYMAN A AT 16 MPH

MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:12:08

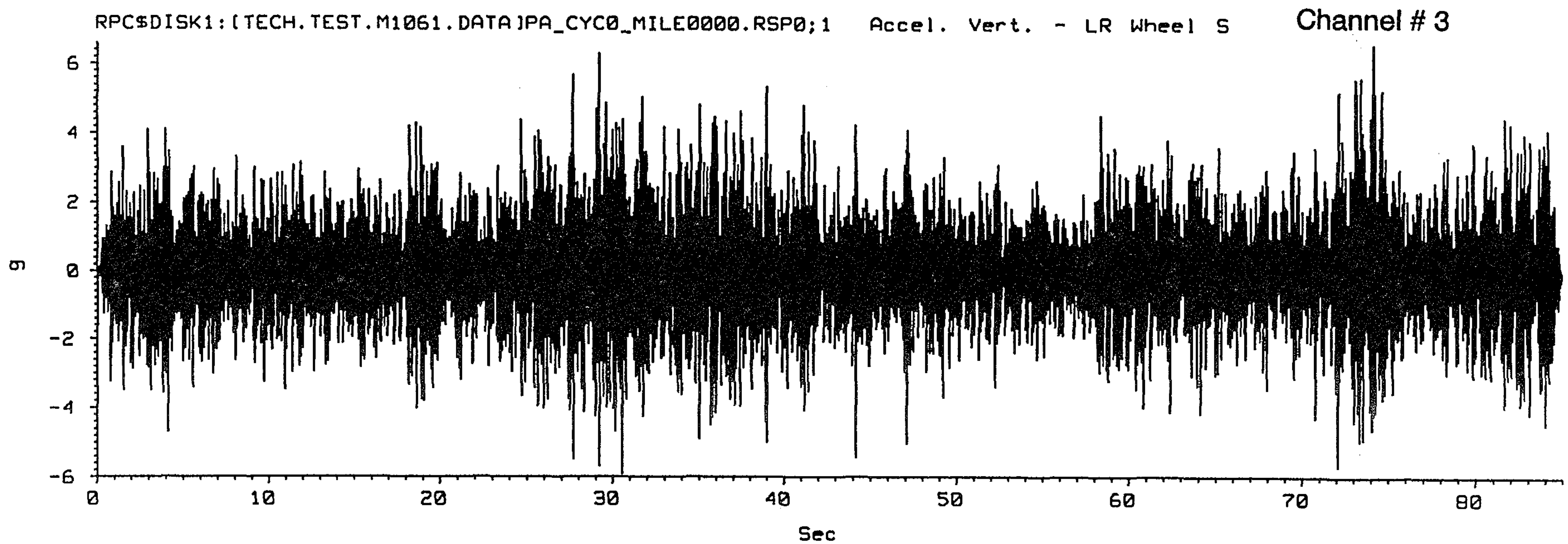
Figure D-18 LF & RF Wheel Spindle Accelerations from Perryman A at 16 mph

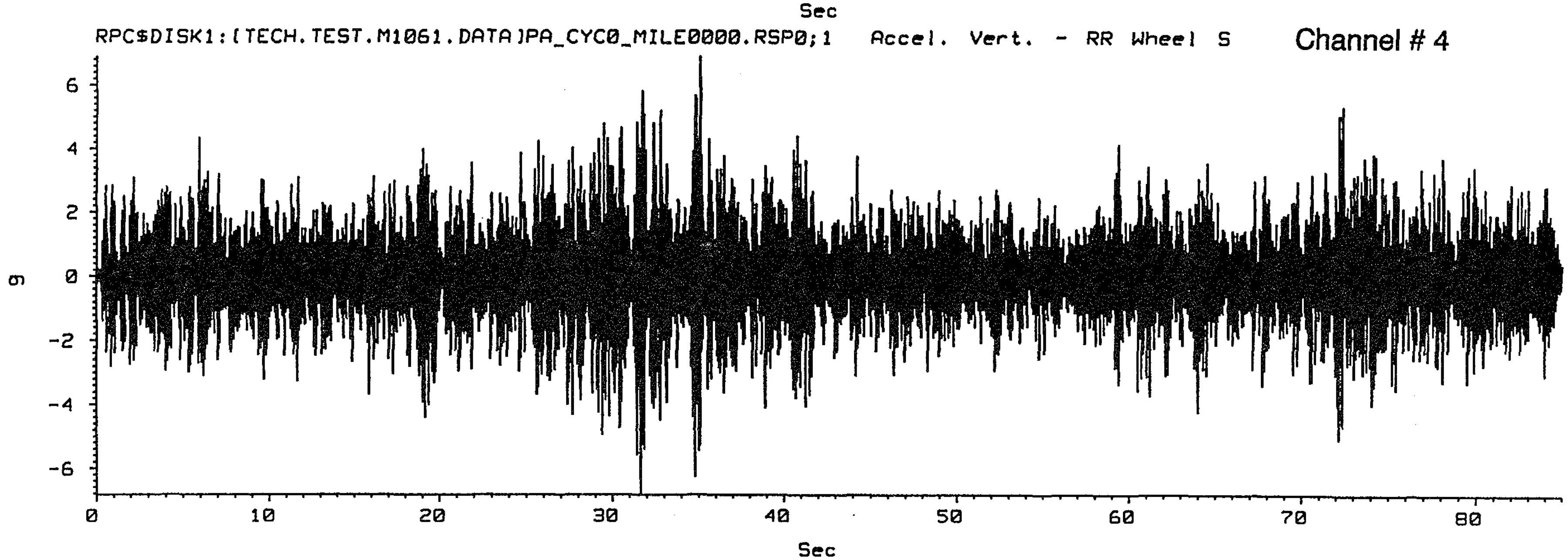




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:13:18

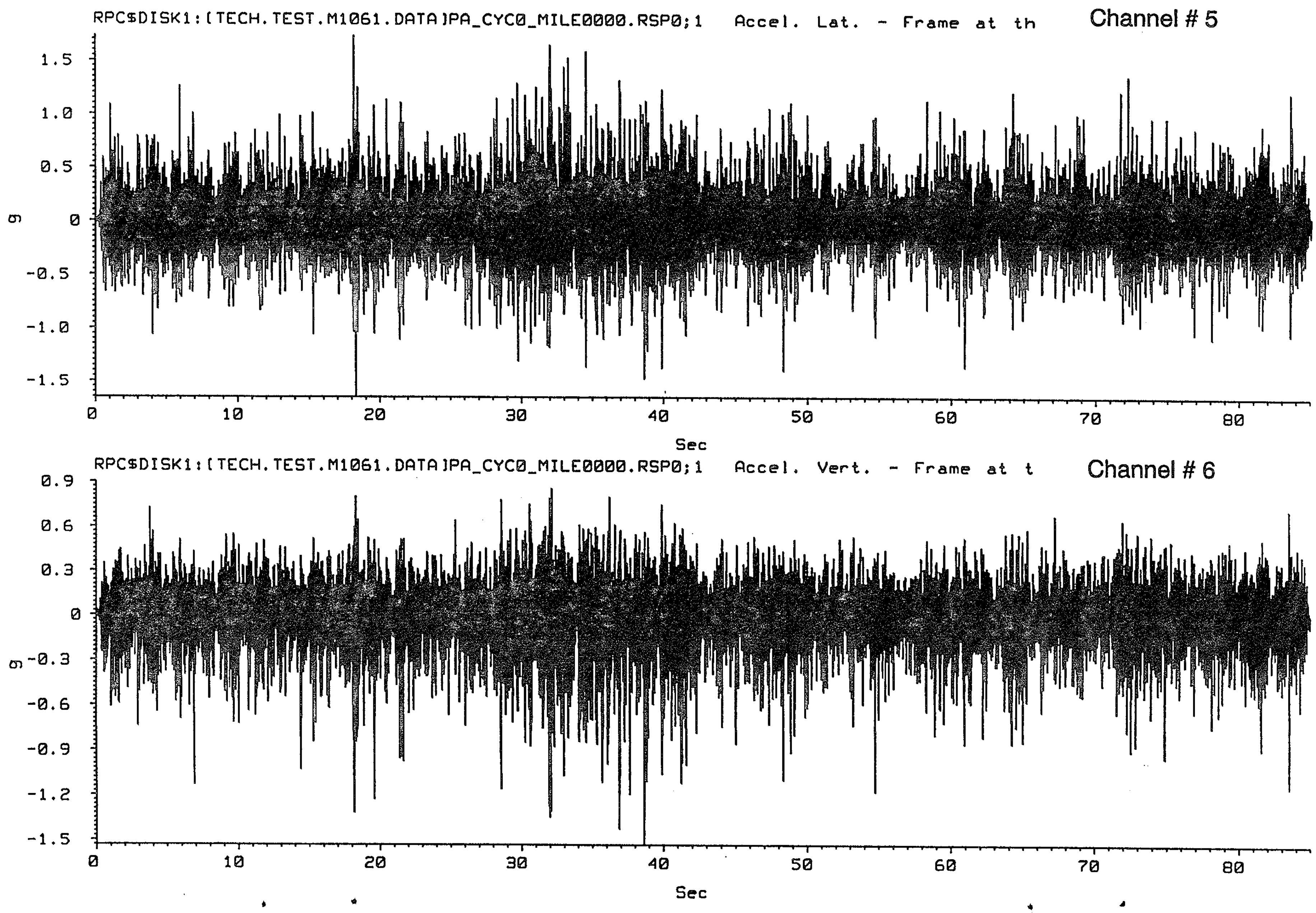
Figure D-19 LR & RR Wheel Spindle Accelerations from Perryman A at 16 mph





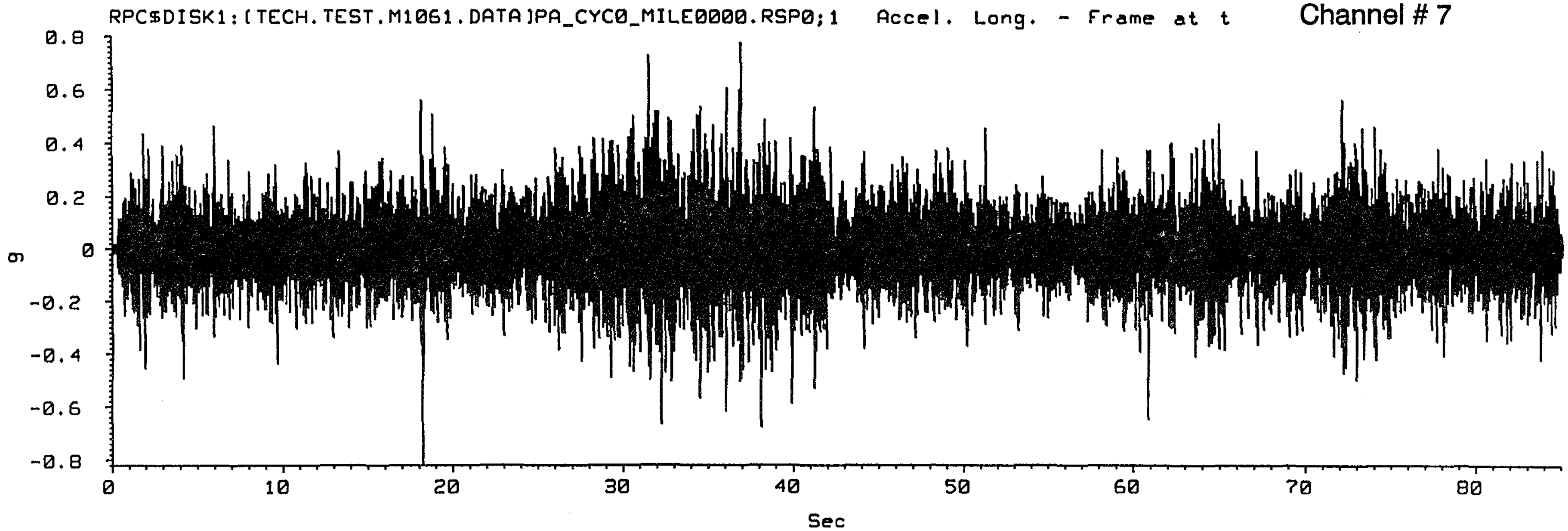
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:14:27

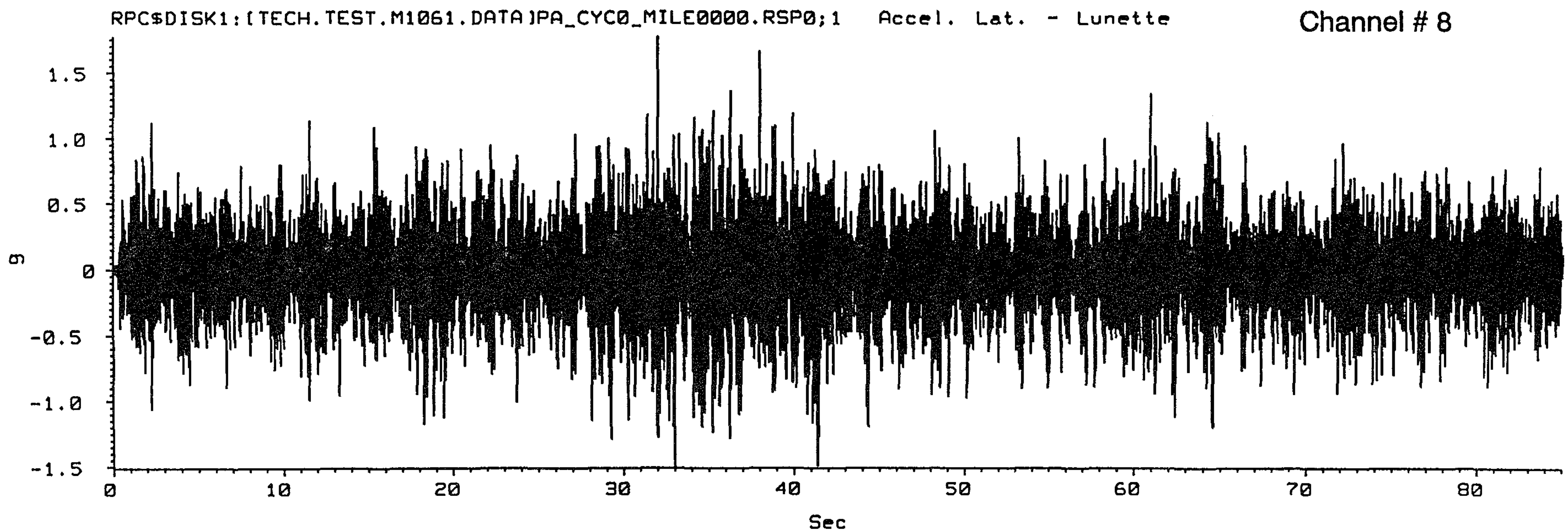
Figure D-20 Lateral & Vertical Trunnion Accelerations from Perryman A at 16 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:15:39

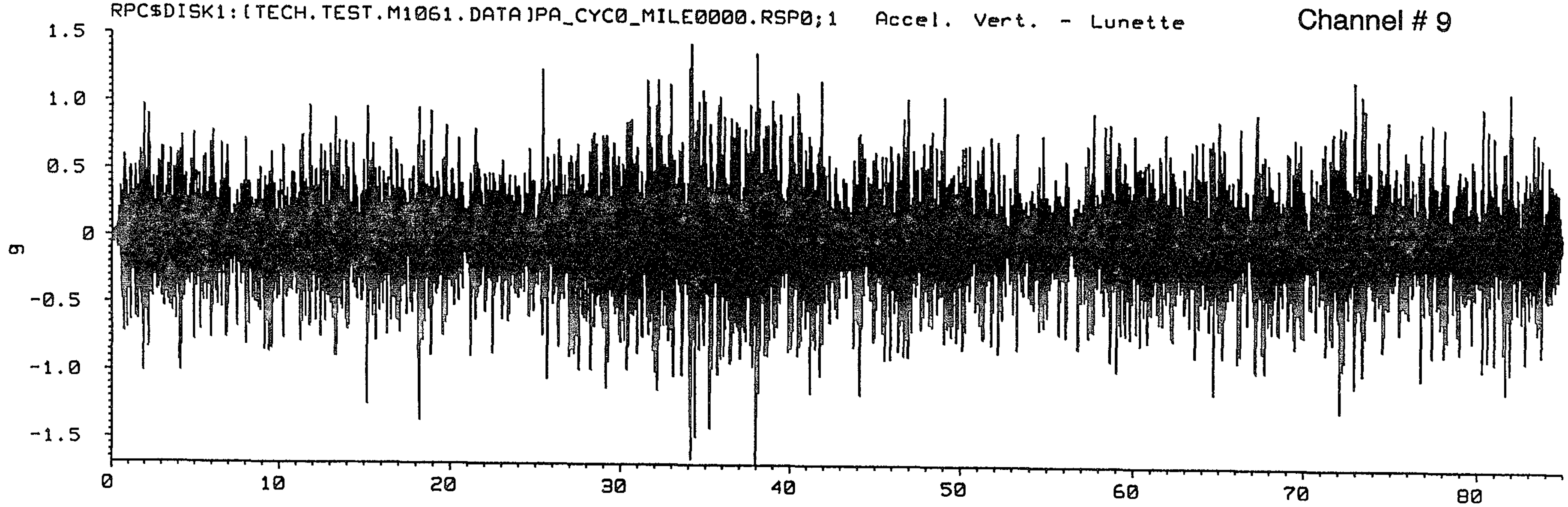
Figure D-21 Longitudinal Trunnion & Lateral Lunette Accelerations from Perryman A at 16 mph

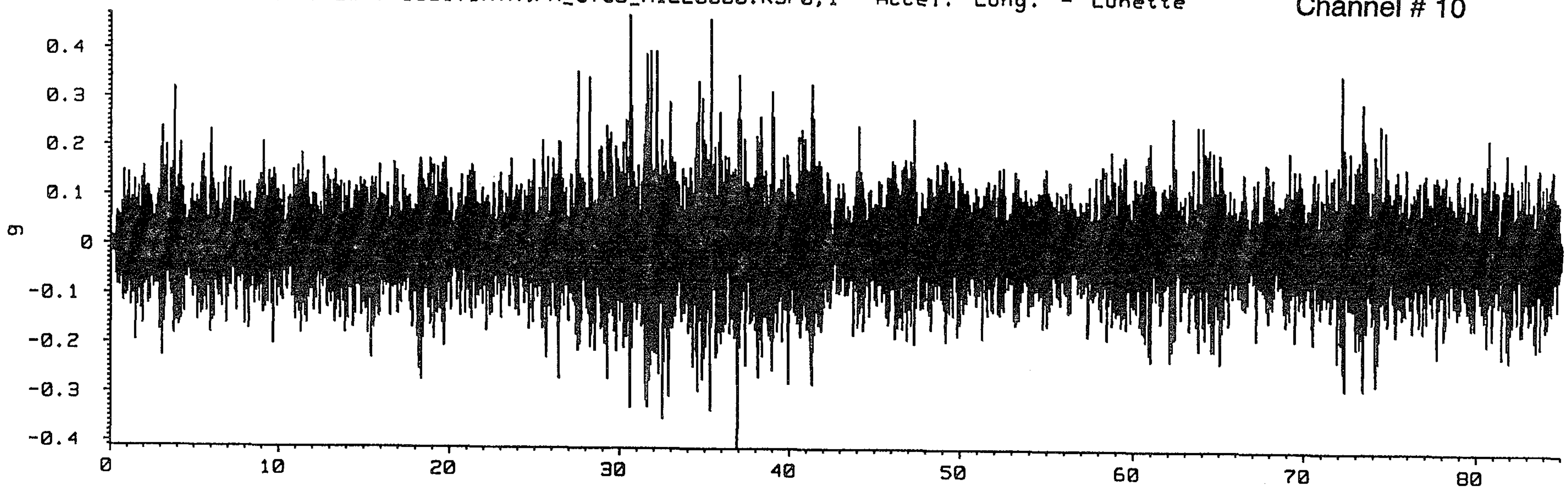




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:16:51

Figure D-22 Vertical & longitudinal Lunette Accelerations from Perryman A at 16 mph

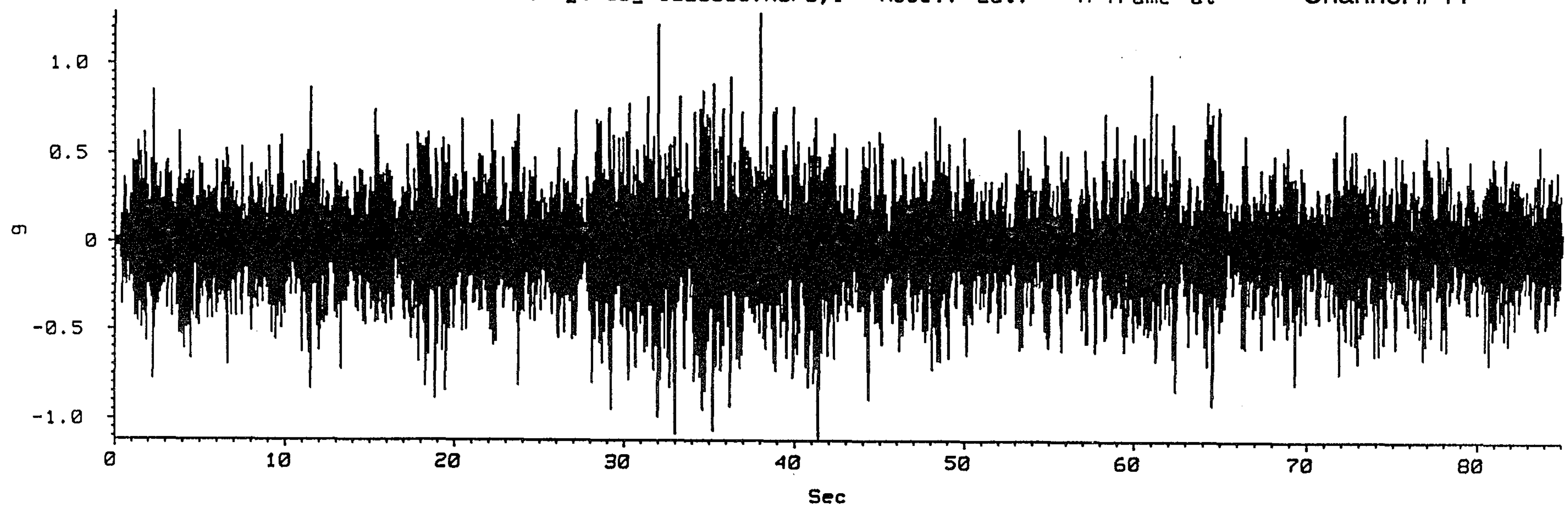




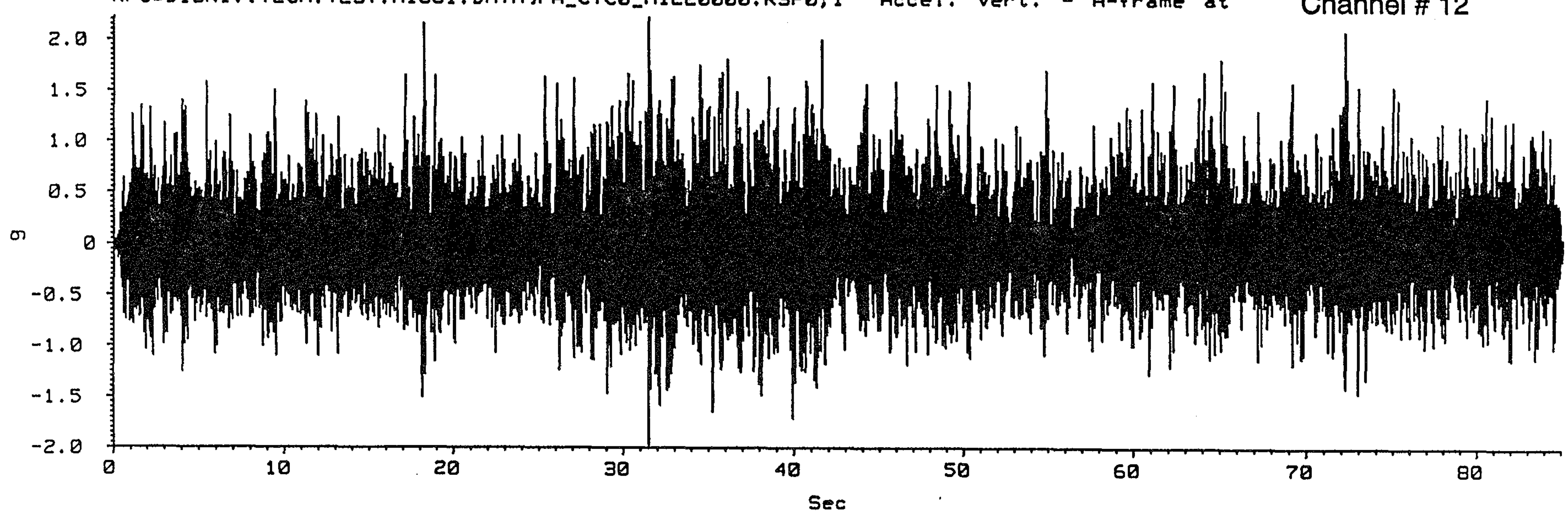
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:18:02

Figure D-23 Lateral & Vertical Right A-Frame Acceleration from Perryman A at 16 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Accel. Lat. - A-frame at Channel # 11

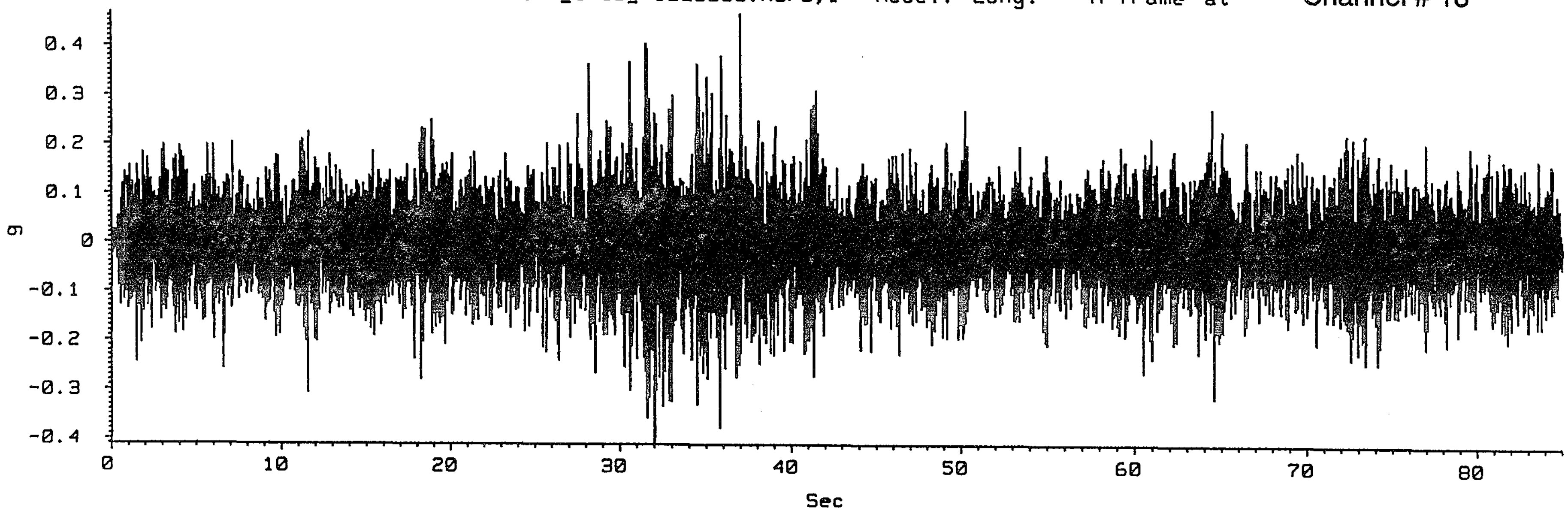


RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Accel. Vert. - A-frame at Channel # 12



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:19:14

Figure D-24 Longitudinal R & Lateral L A-Frame Accelerations from Perryman A at 16 mph



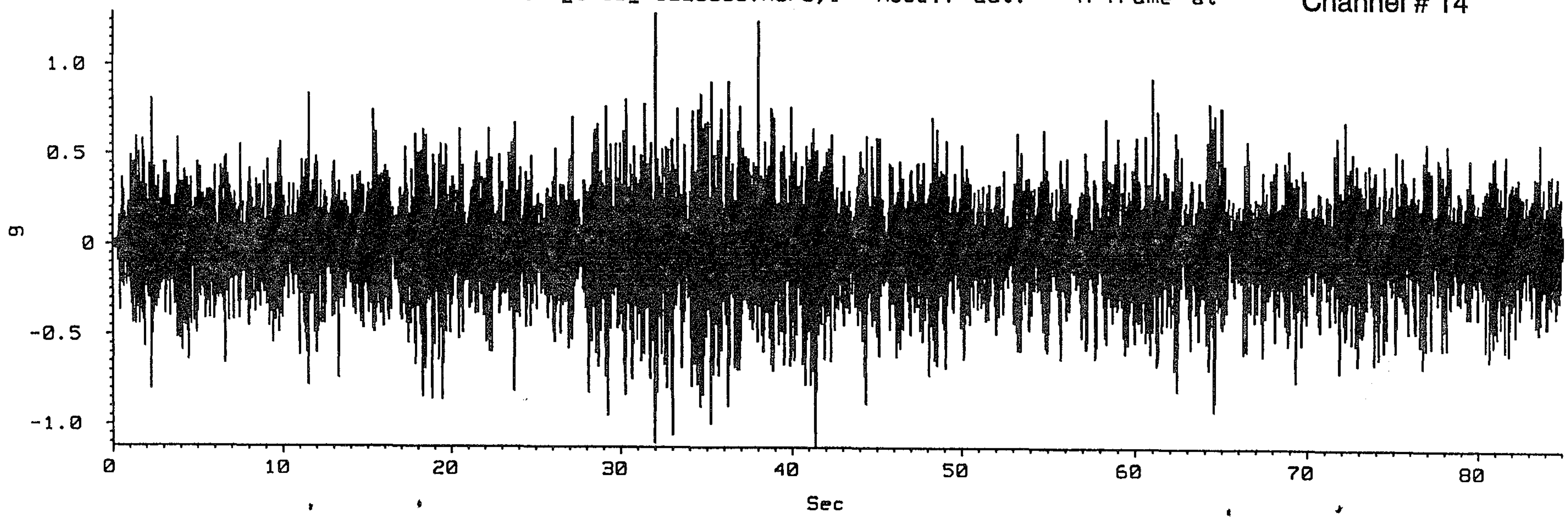
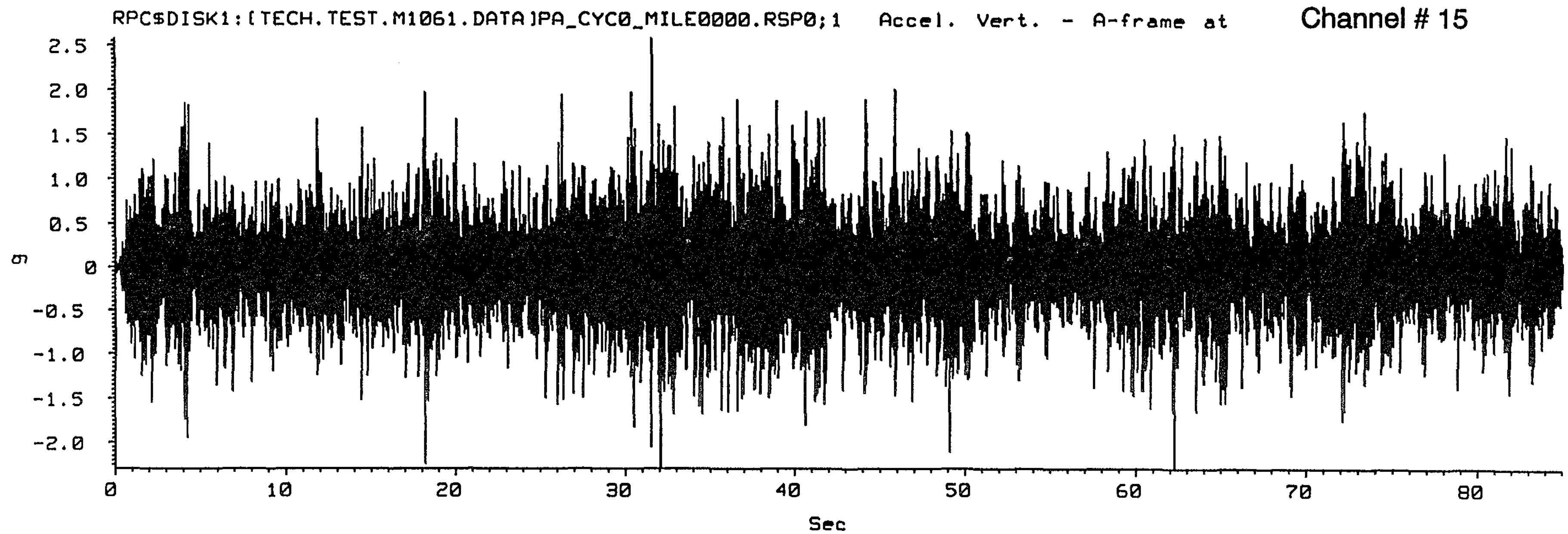
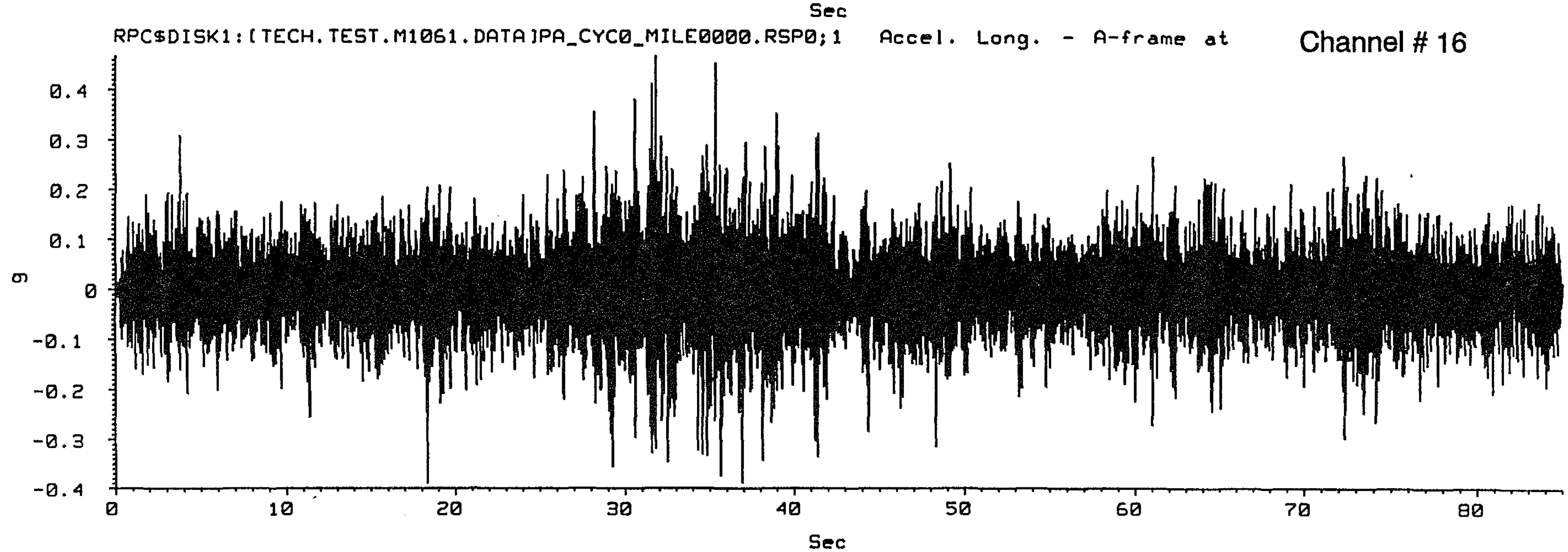


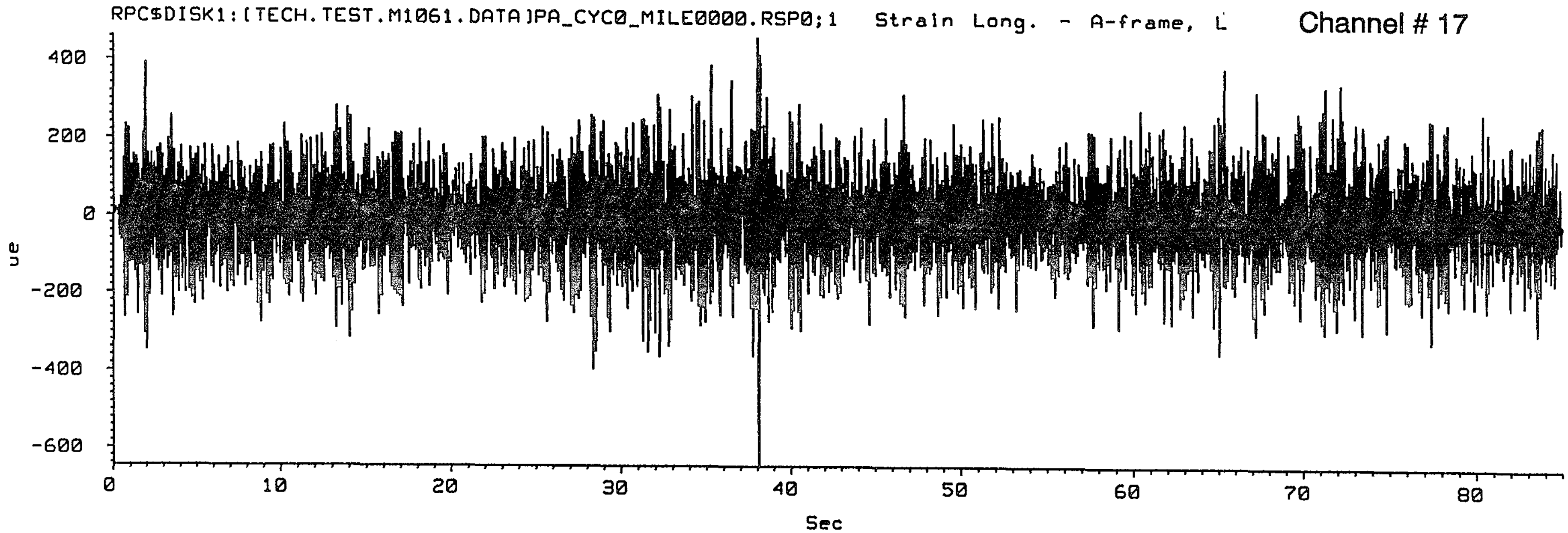
Figure D-25 Vertical & Longitudinal L A-Frame Accelerations from Perryman A at 16 mph

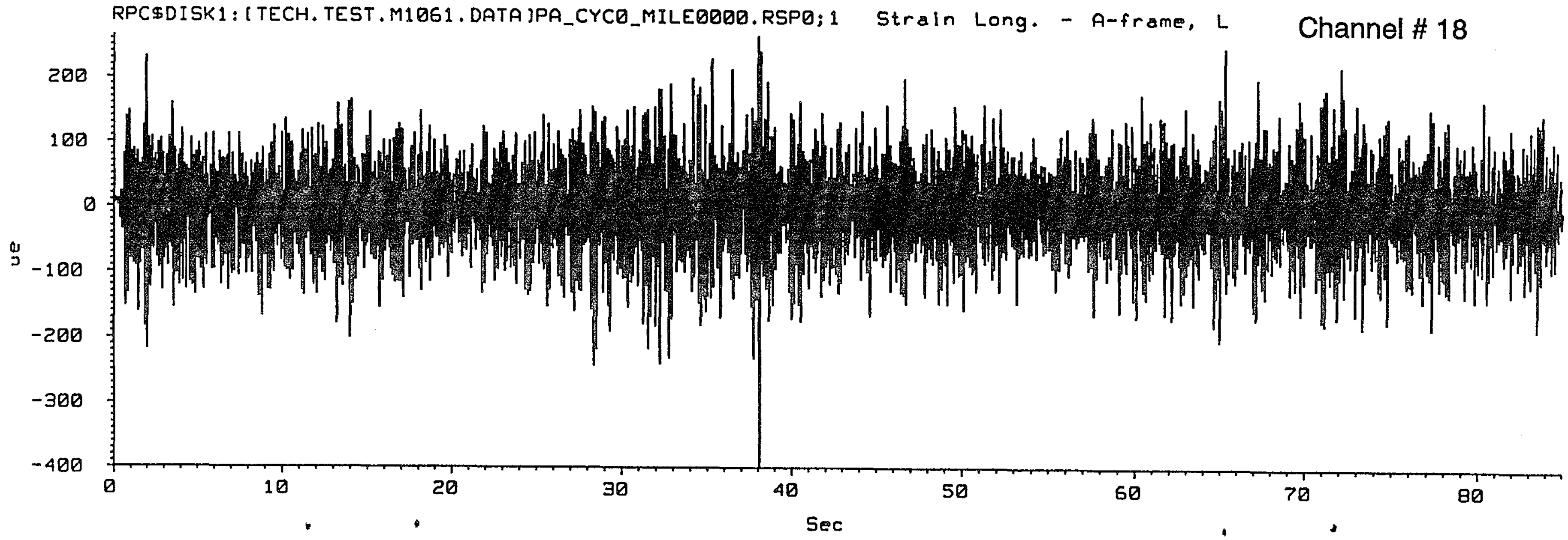




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:21:31

Figure D-26 Inboard & Outboard Left A-Frame Longitudinal Strain from Perryman A at 16 mph

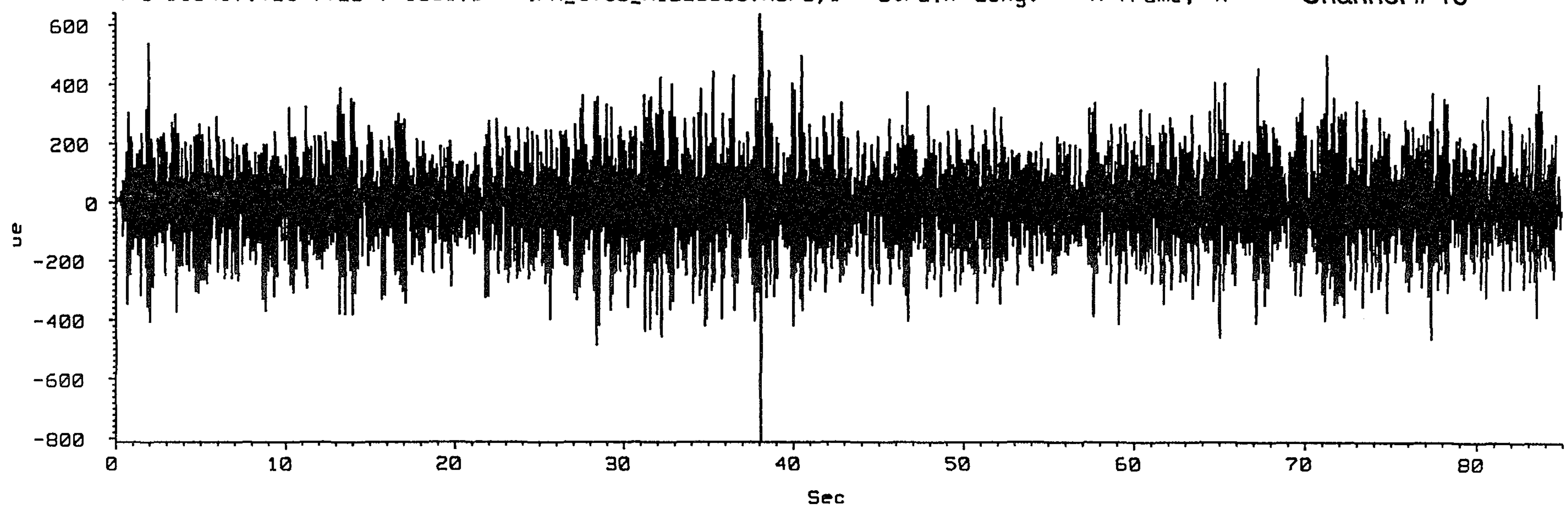




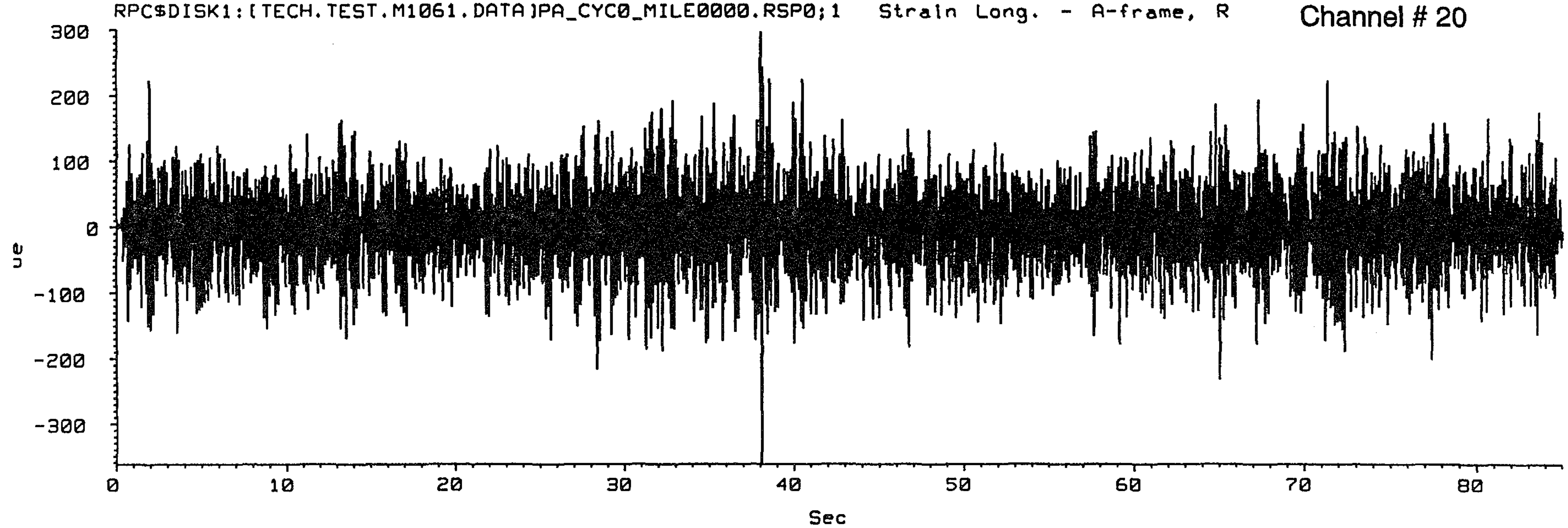
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:22:42

Figure D-27 Inboard & Outboard Right A-Frame Longitudinal Strain from Perryman A at 16 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, R Channel # 19



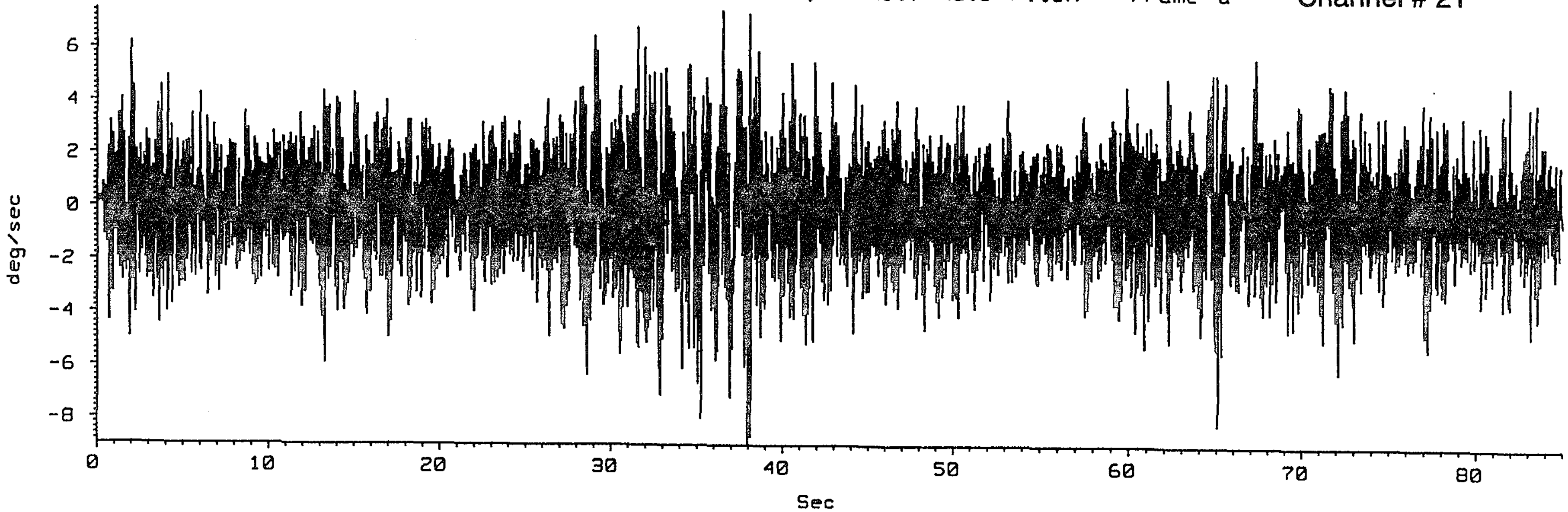
RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, R Channel # 20



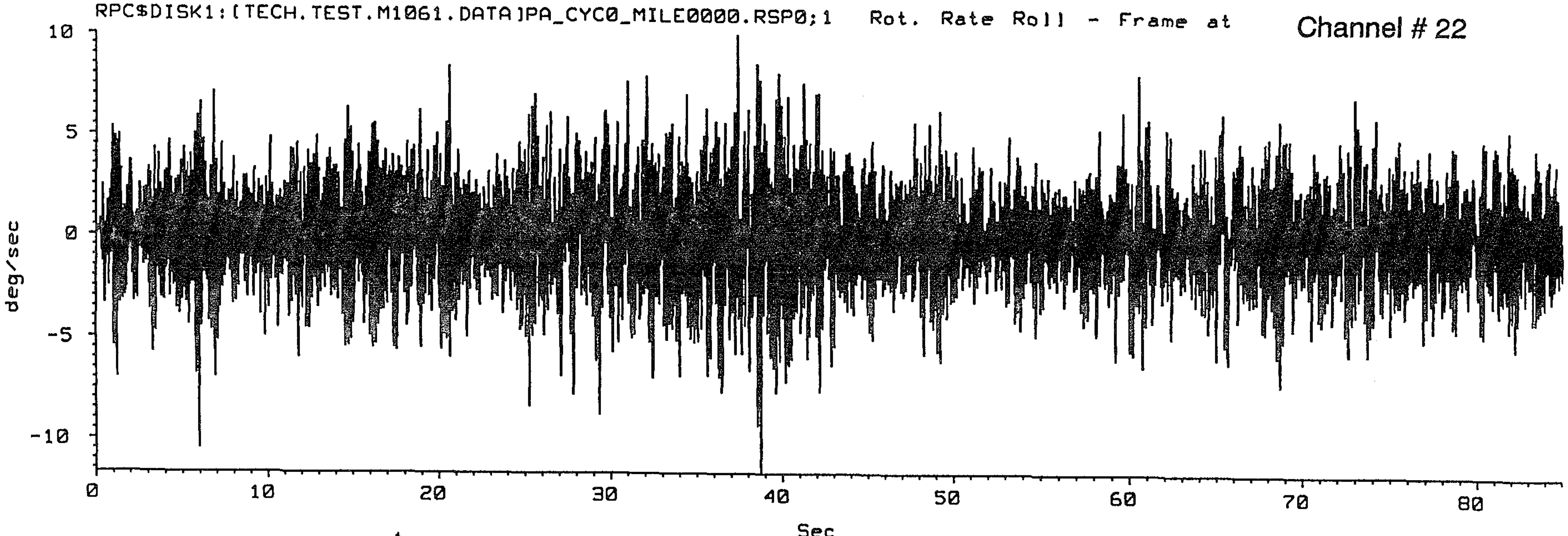
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 16:23:52

Figure D-28 Pitch and Roll Rate of Trailer Frame from Perryman A at 16 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Rot. Rate Pitch - Frame a Channel # 21



RPC$DISK1:[TECH.TEST.M1061.DATA]PA_CYC0_MILE0000.RSP0;1 Rot. Rate Roll - Frame at Channel # 22



POWER SPECTRAL DENSITY PLOTS

FROM

PERRYMAN A AT 16 MPH

Figure D-29 Channels #1 - #4 from Perryman A at 16 mph

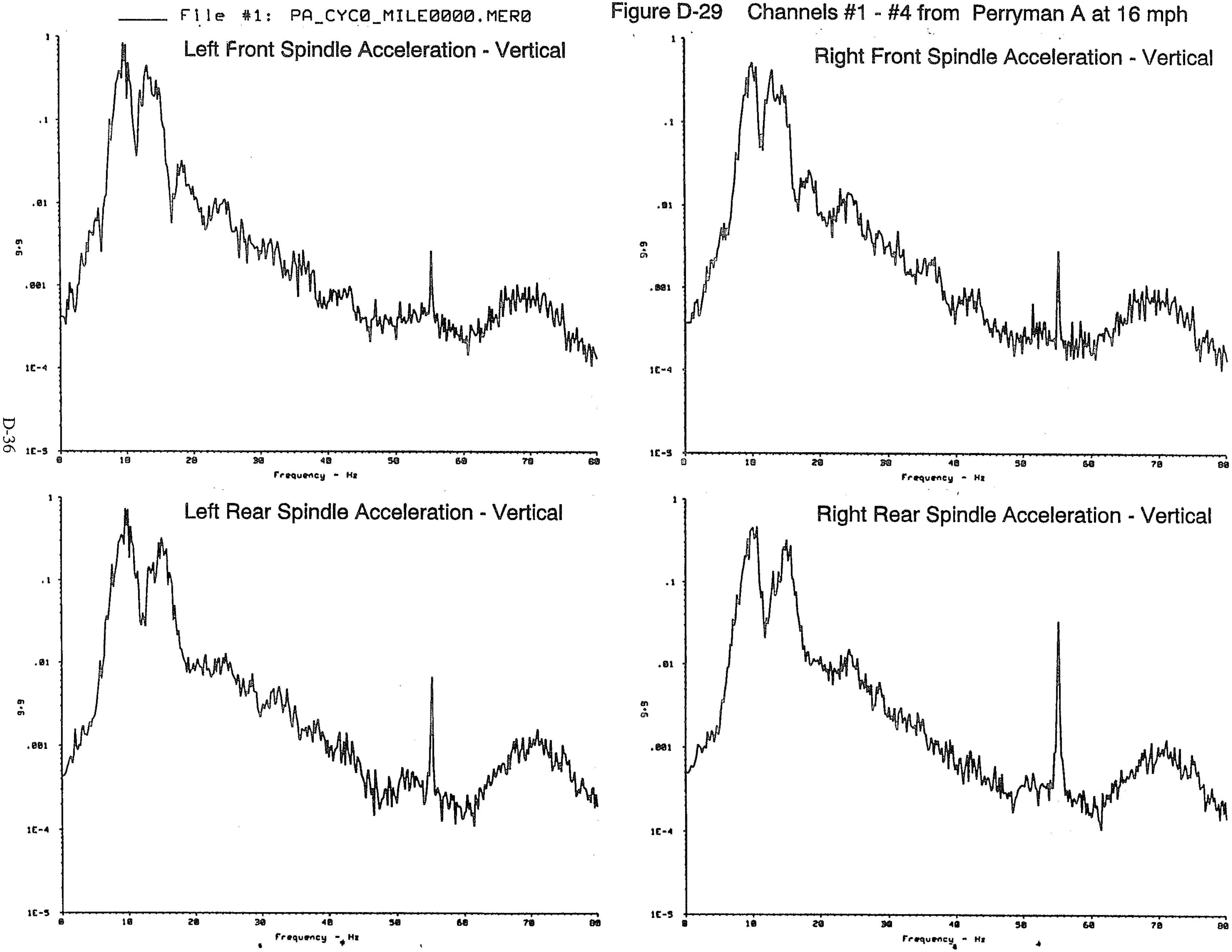


Figure D-30 Channels #5 - #8 from Perryman A at 16 mph

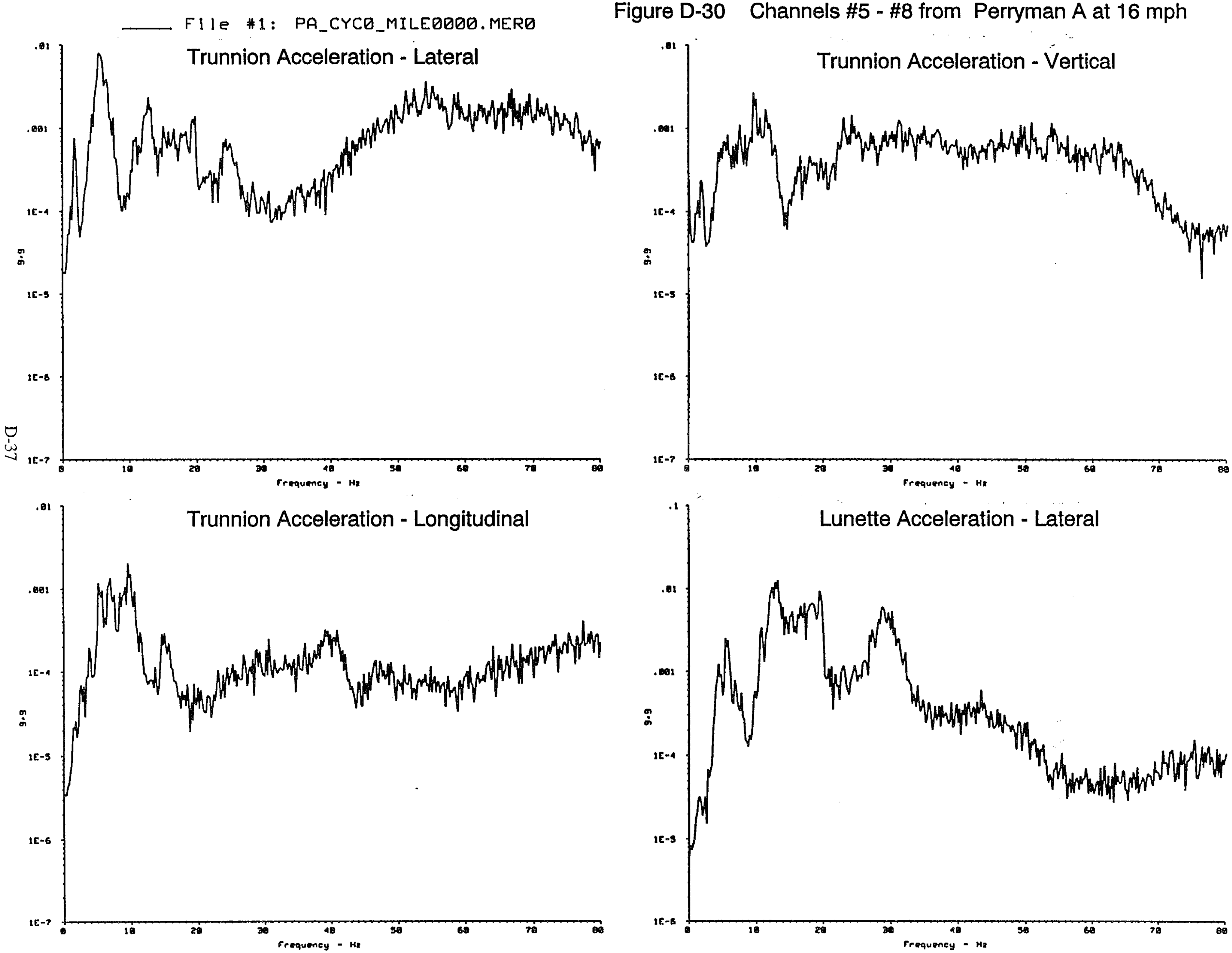


Figure D-31 Channels #9 - #12 from Perryman A at 16 mph

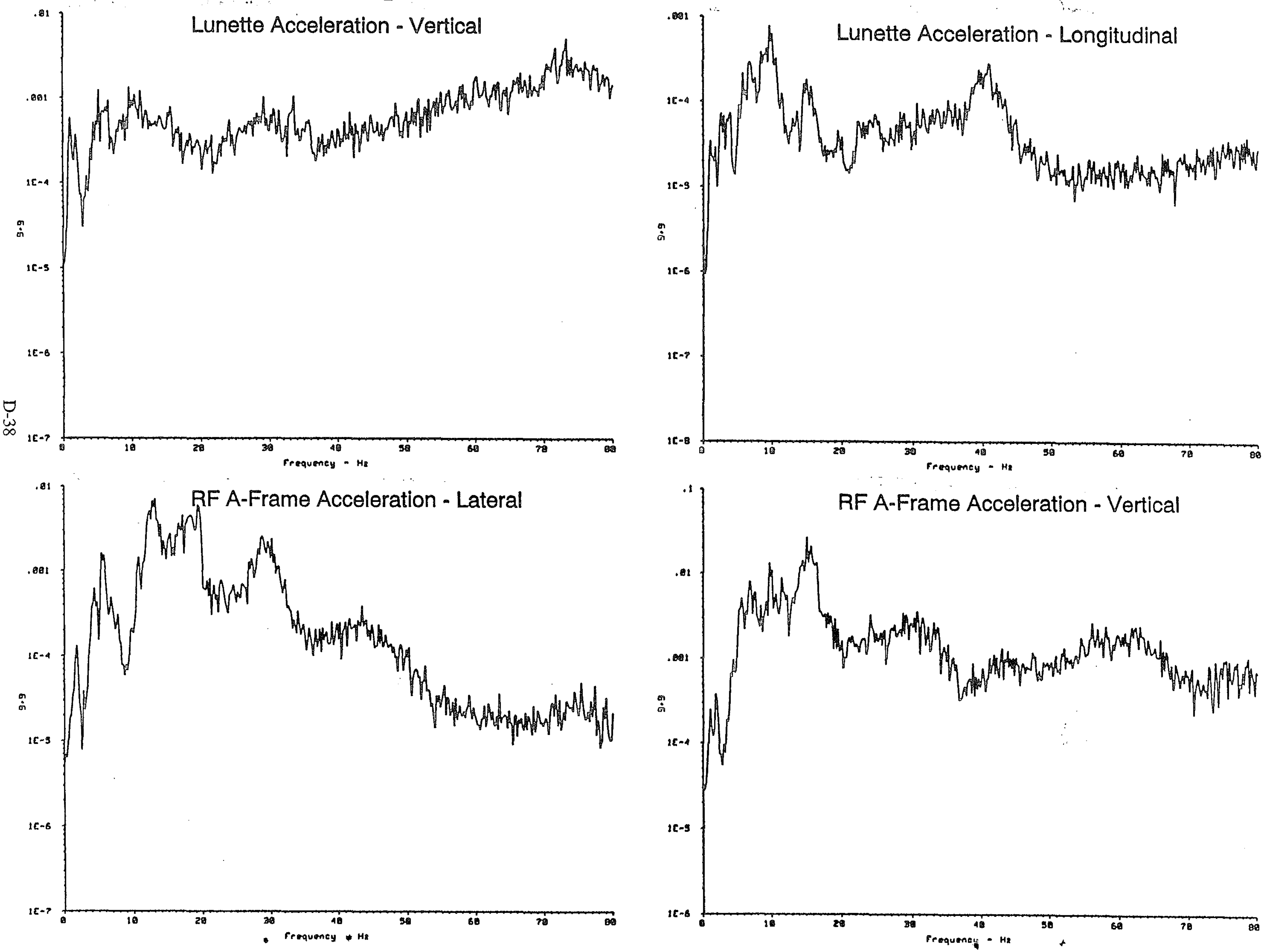


Figure D-32 Channels #13 - #16 from Perryman A at 16 mph

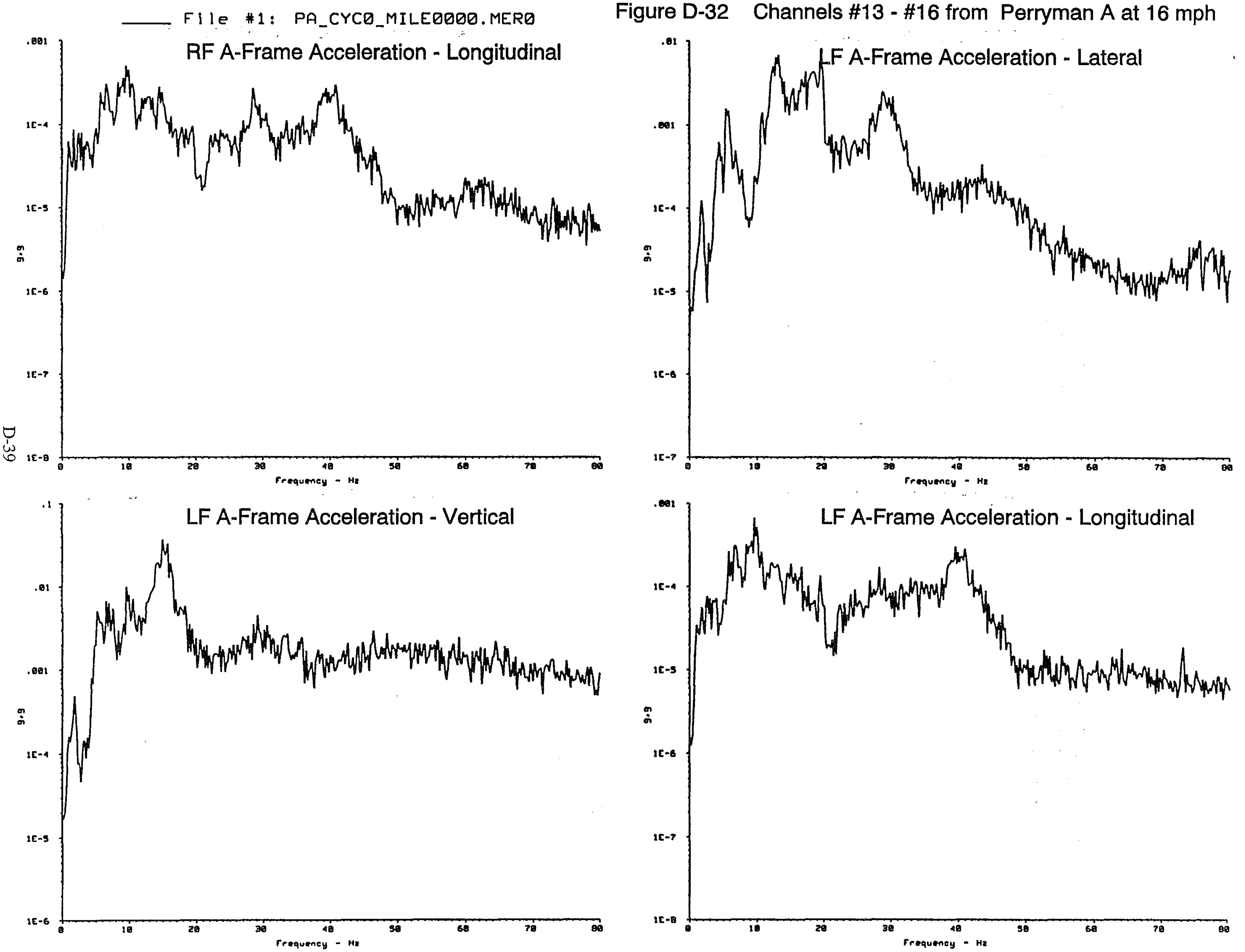


Figure D-33 Channels #17 - #20 from Perryman A at 16 mph

File #1: PA_CYC0_MILE0000.MER0

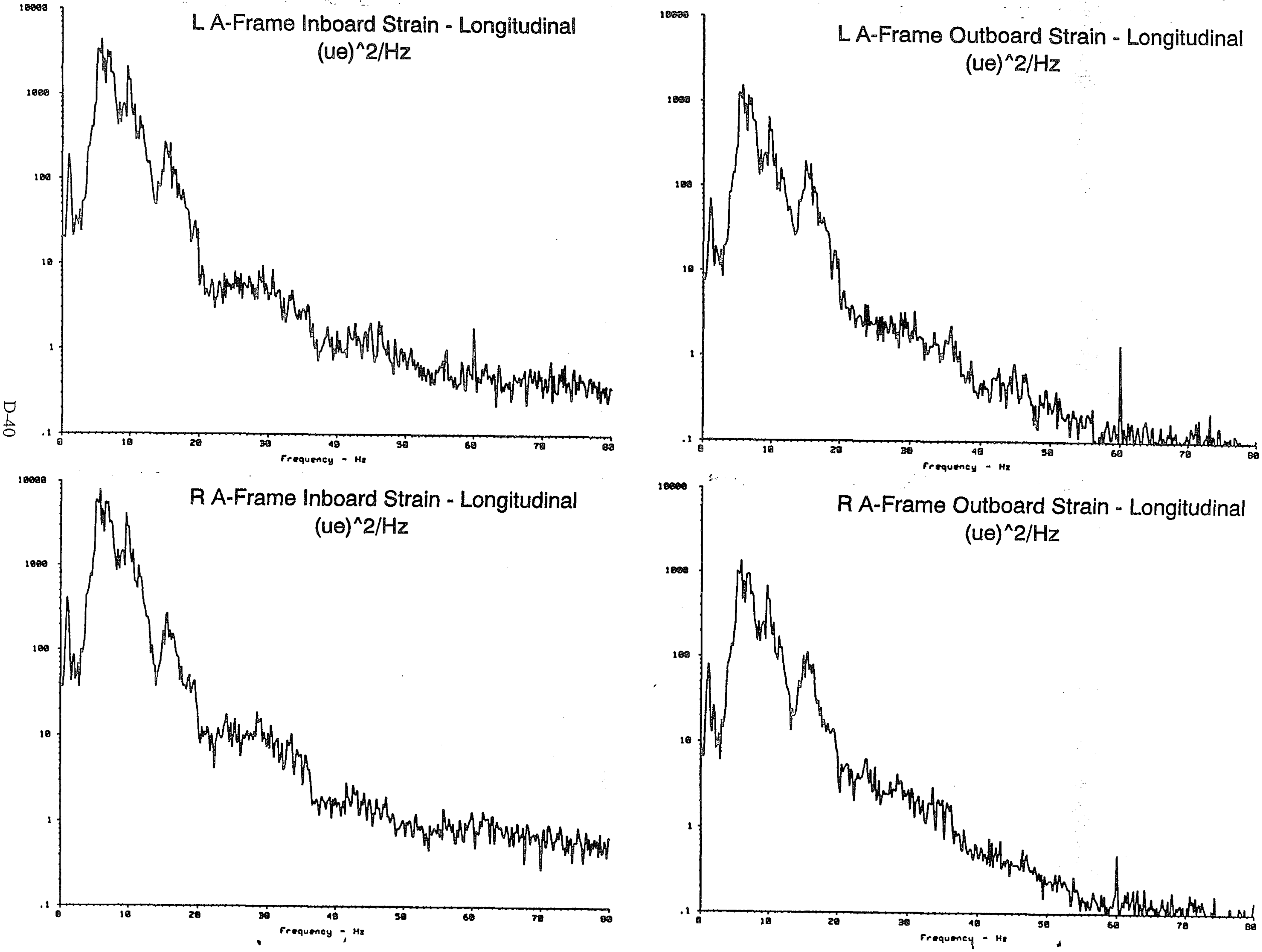
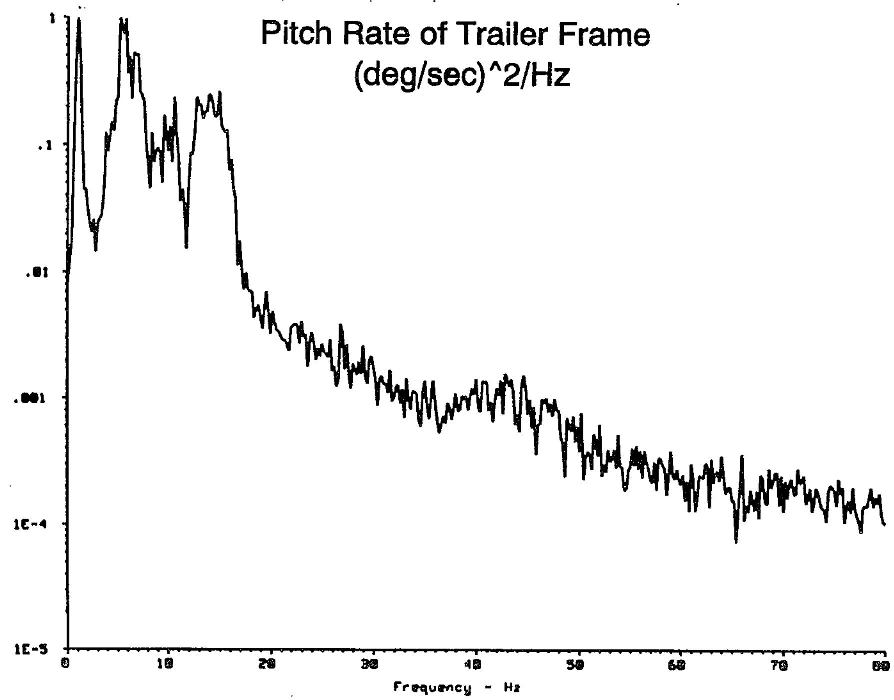
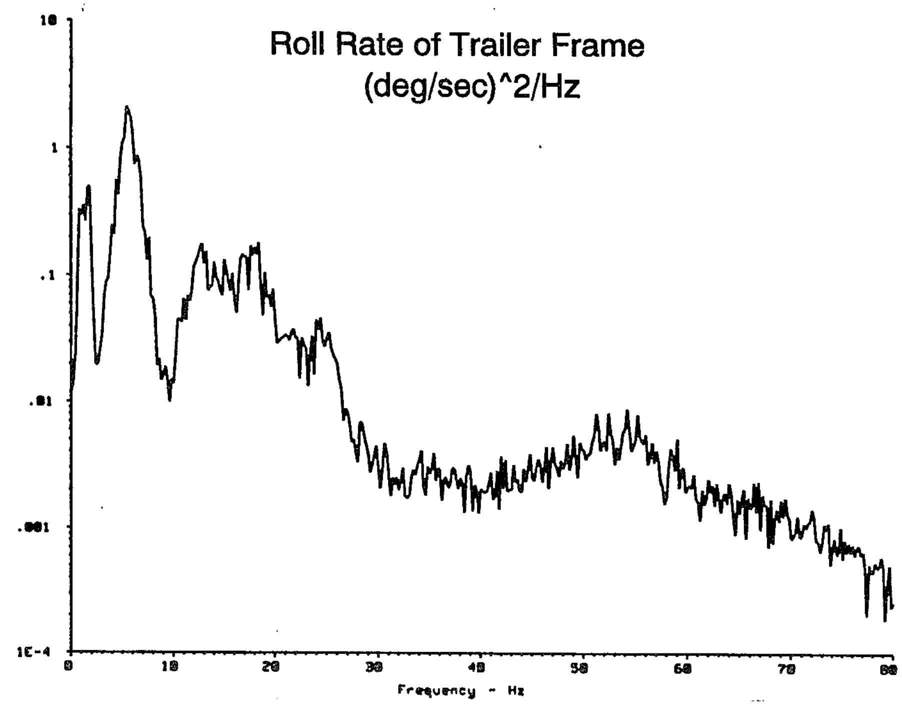


Figure D-34 Channels #21 - #22 from Perryman A at 16 mph





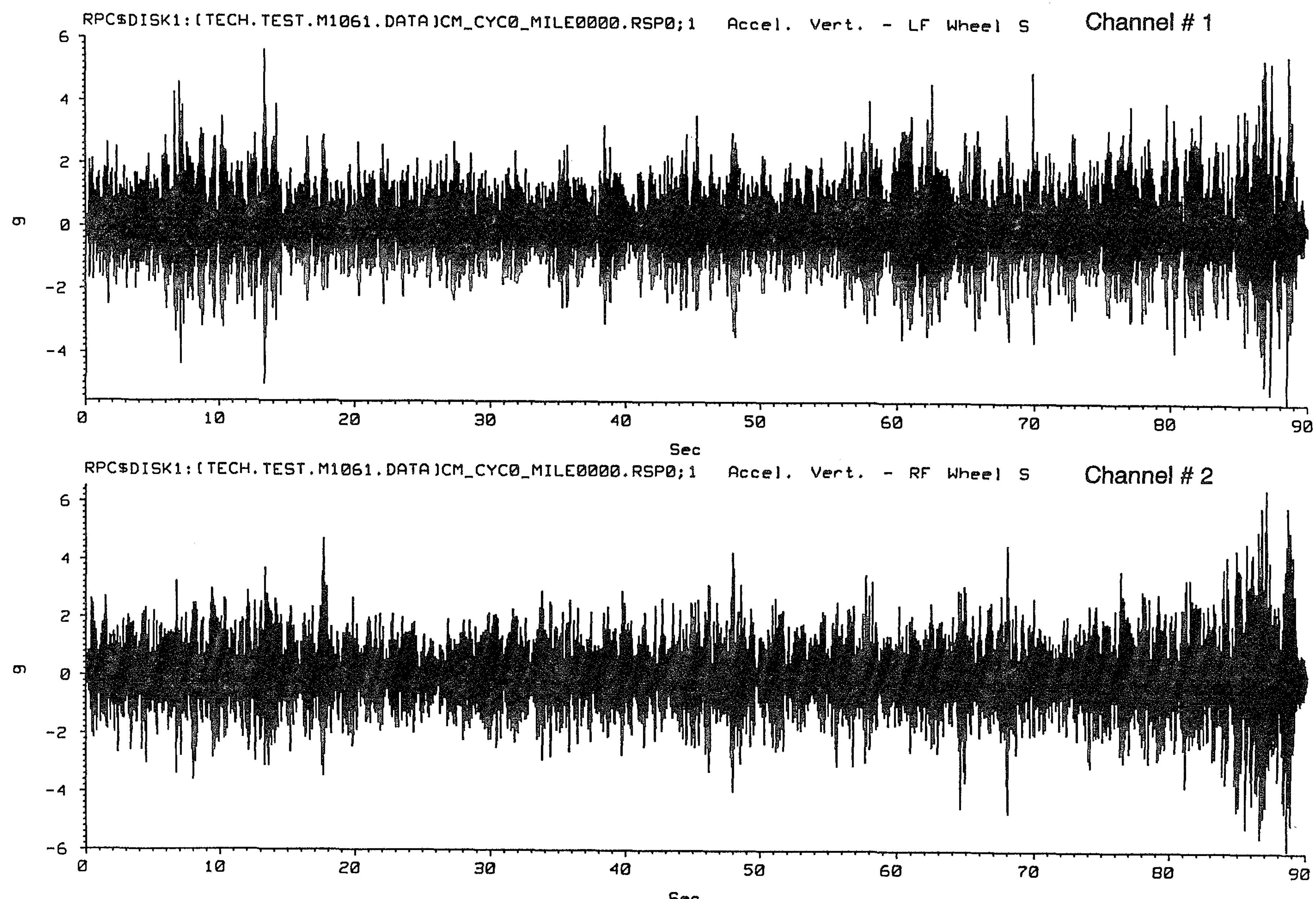
TIME HISTORY PLOTS

FROM

CHURCHVILLE B (MILD) AT 15 MPH

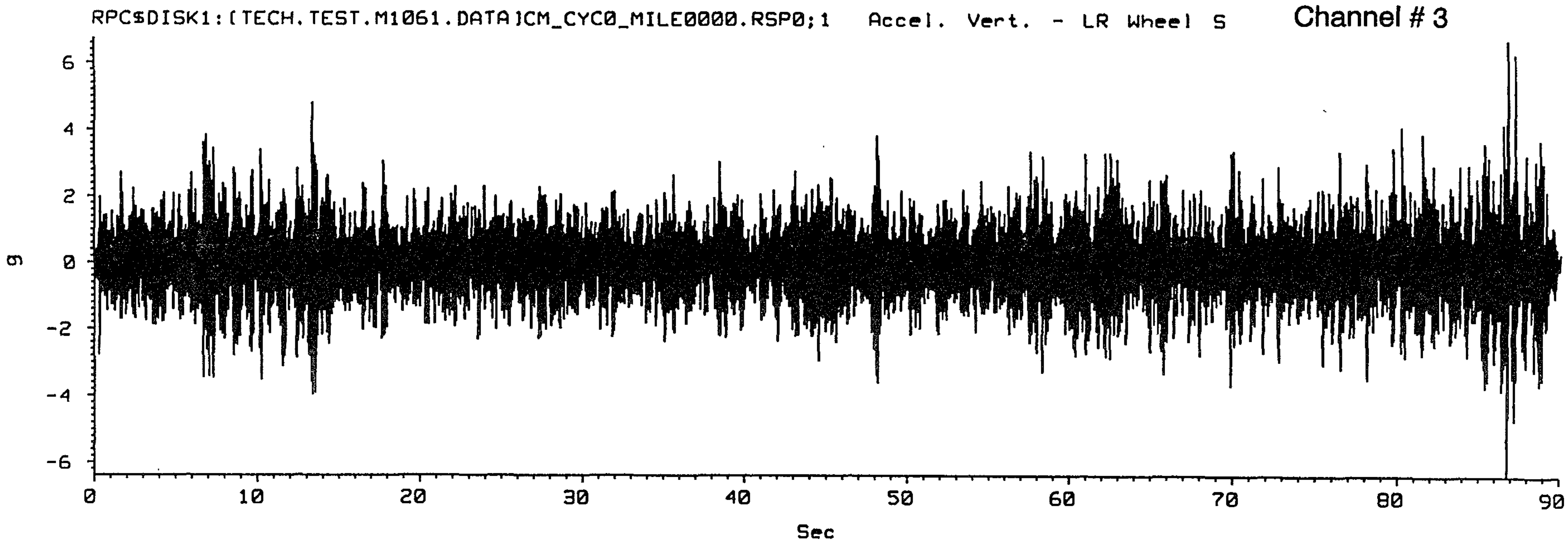
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:28:33

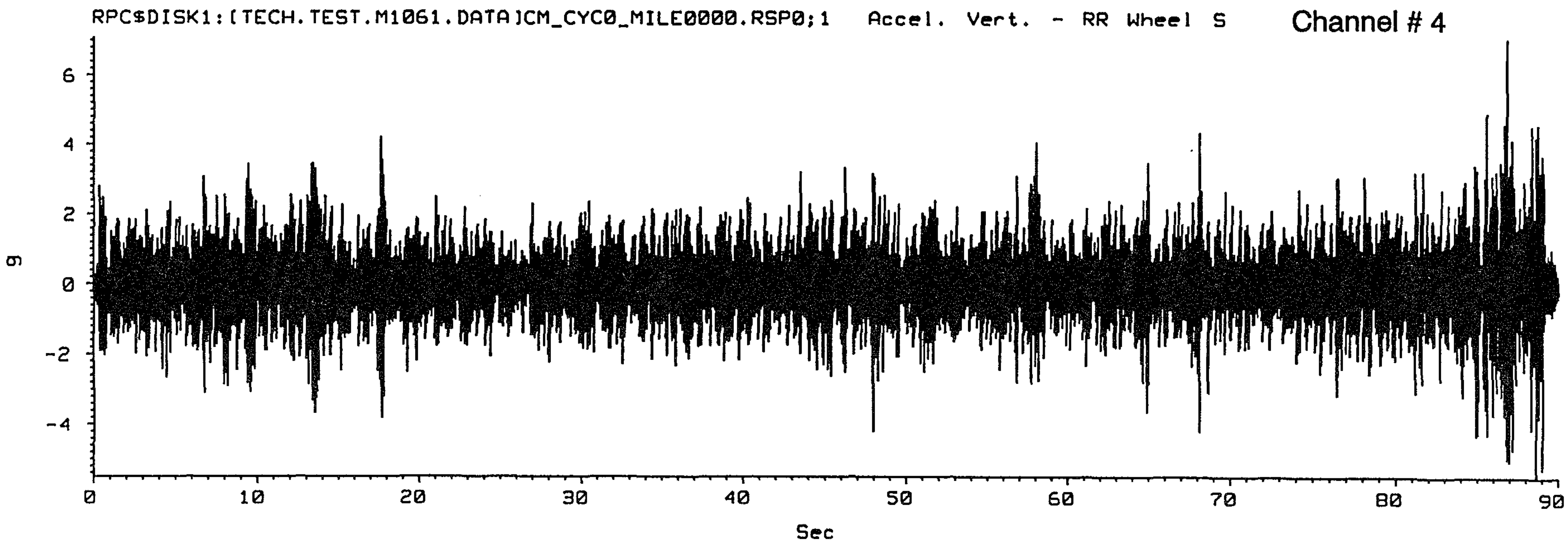
Figure D-35 LF & RF Wheel Spindle Accelerations from Churchville B (mild) at 15 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:29:45

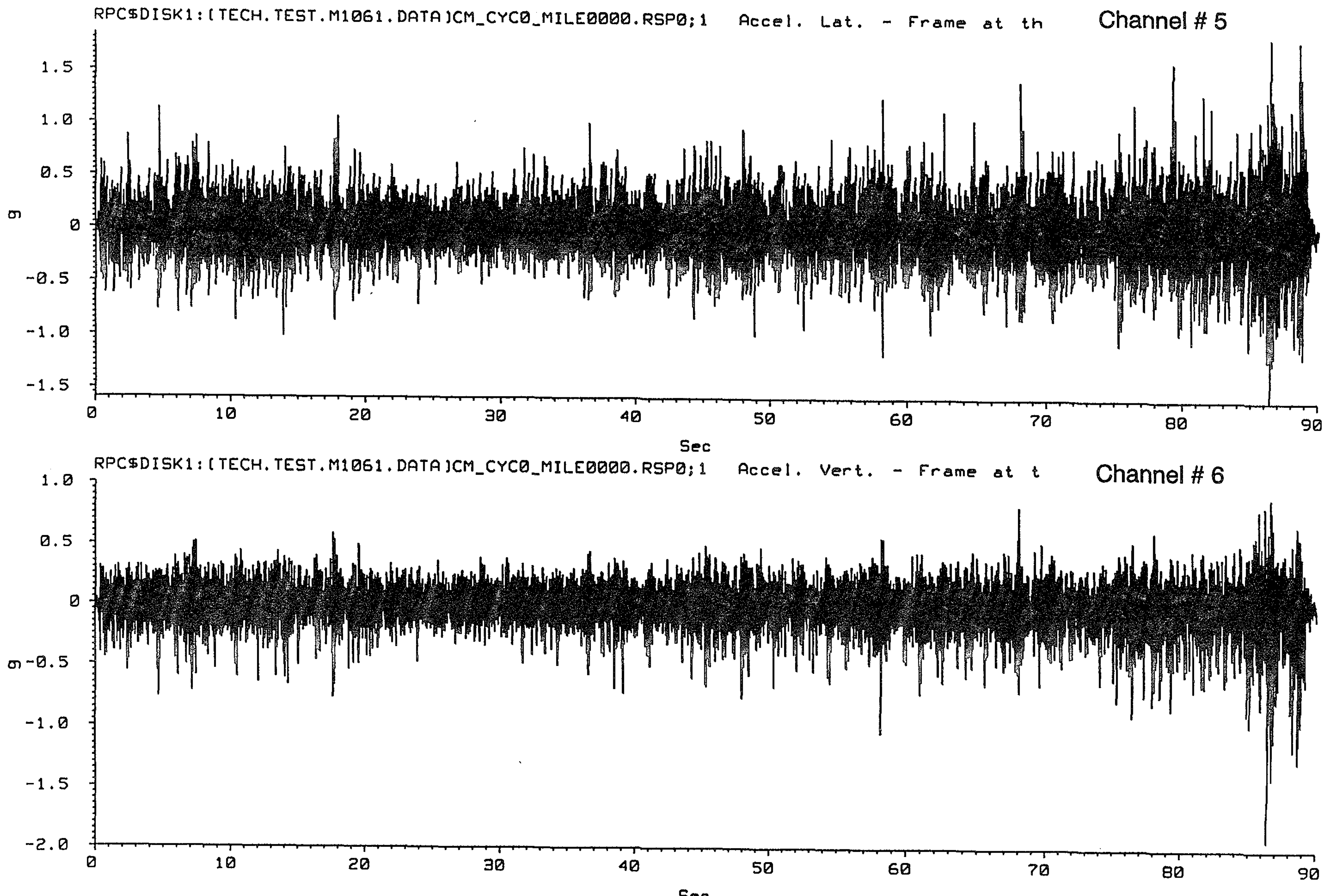
Figure D-36 LR & RR Wheel Spindle Accelerations from Churchville B (mild) at 15 mph





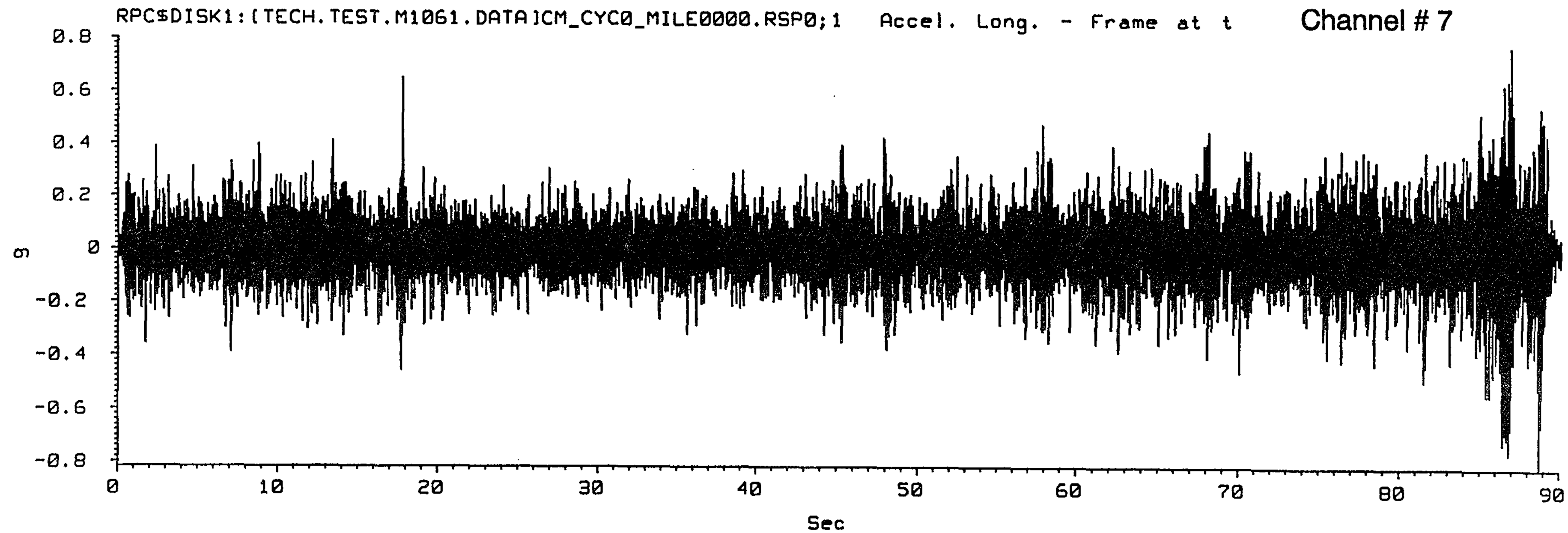
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:30:59

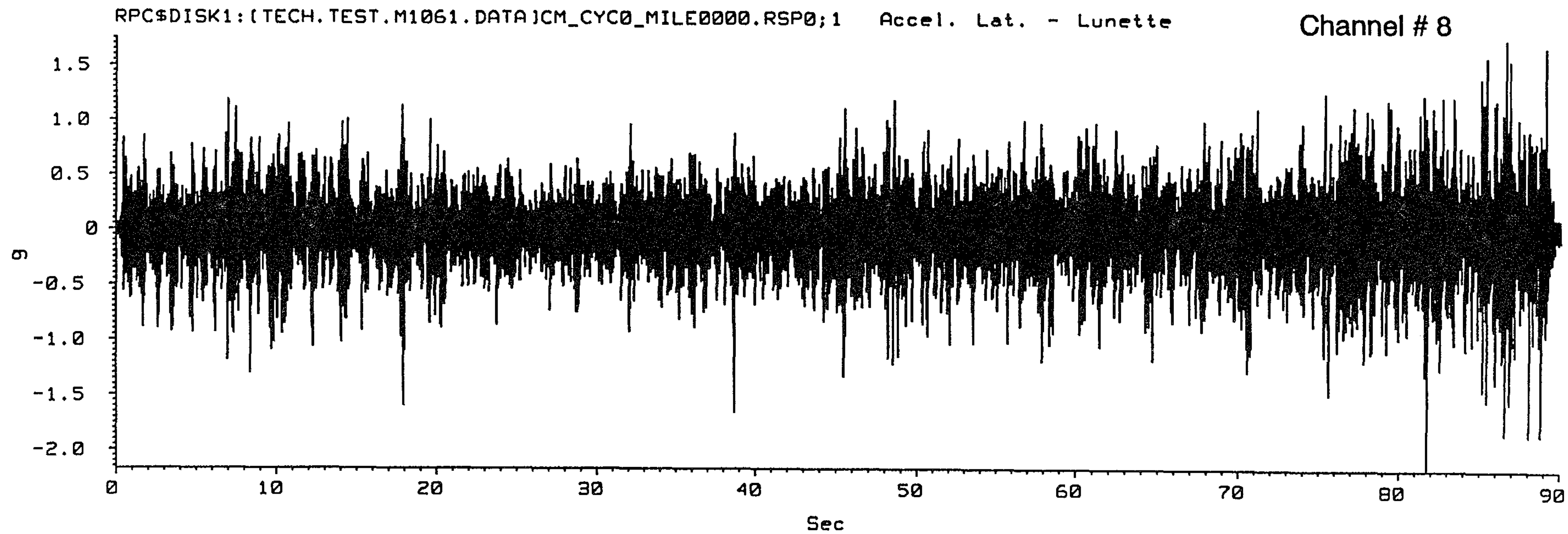
Figure D-37 Lateral & Vertical Trunnion Accelerations from Churchville B (mild) at 15 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:32:16

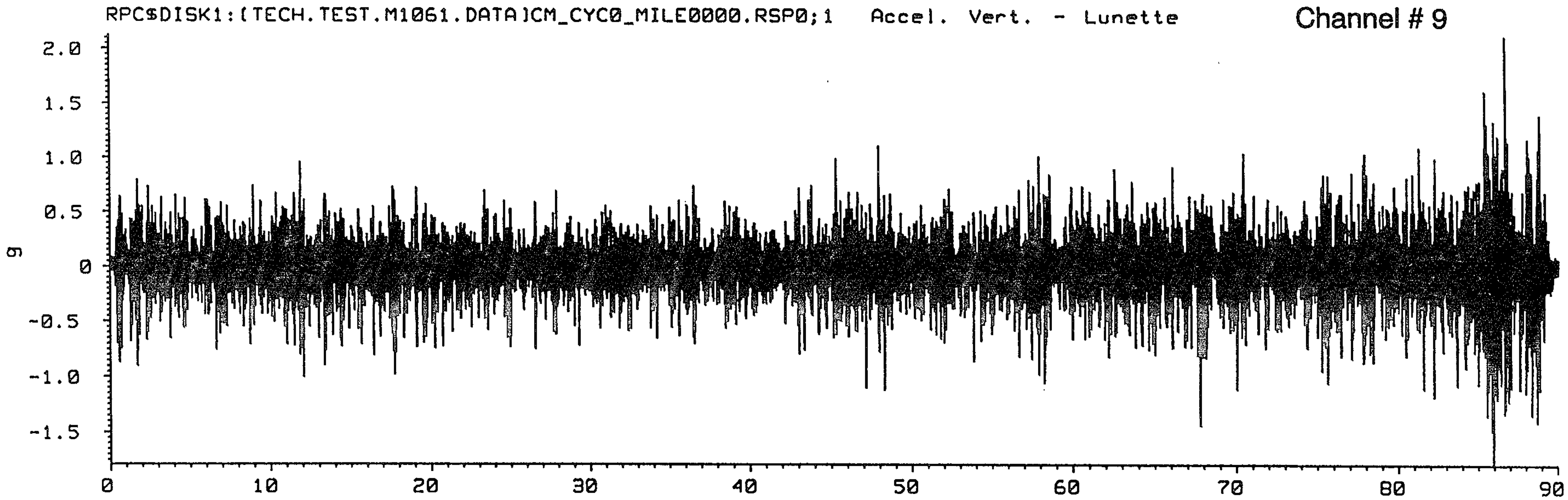
Figure D-38 Longitudinal Trunnion & Lateral Lunette Accelerations from Churchville B (mild) at 15 mph

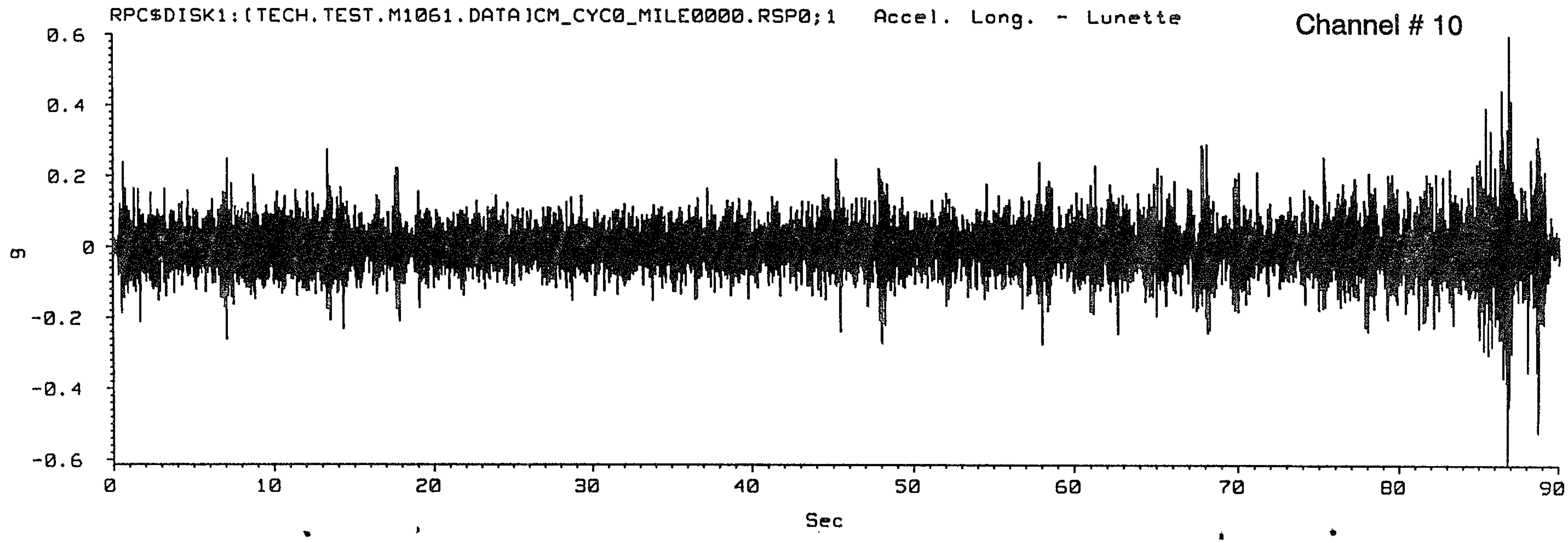




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:33:32

Figure D-39 Vertical & longitudinal Lunette Accelerations from Churchville B (mild) at 15 mph



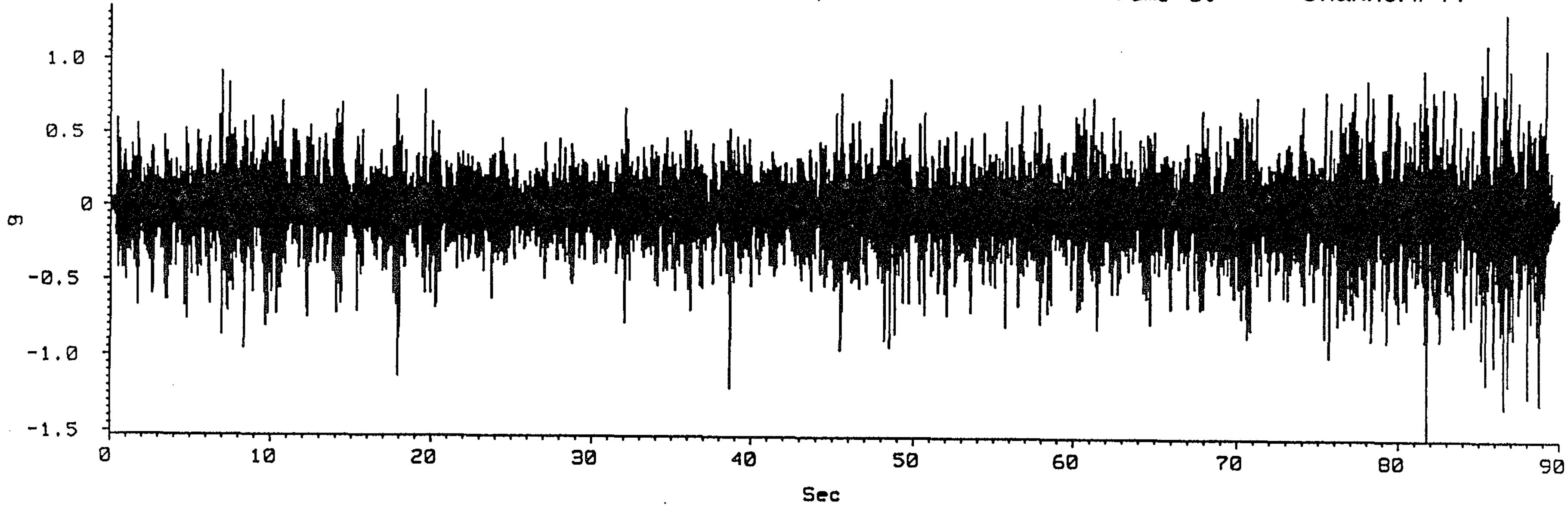


MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:34:48

Figure D-40 Lateral & Vertical Right A-Frame Acceleration from Churchville B (mild) at 15 mph

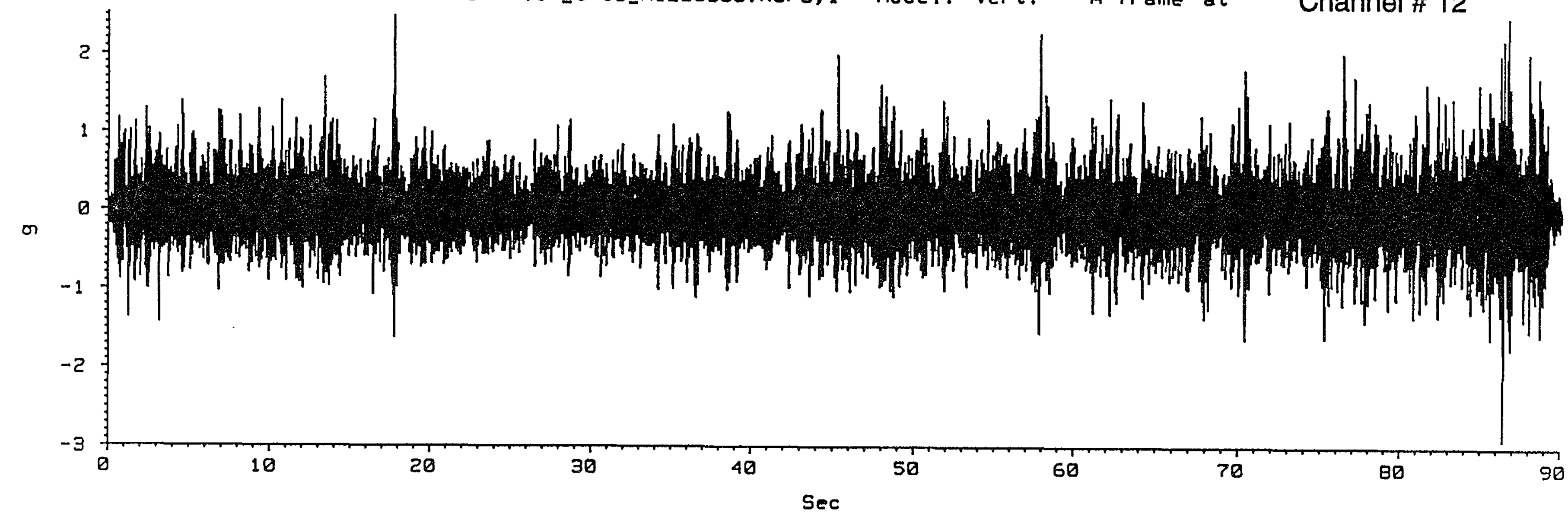
RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Accel. Lat. - A-frame at

Channel # 11



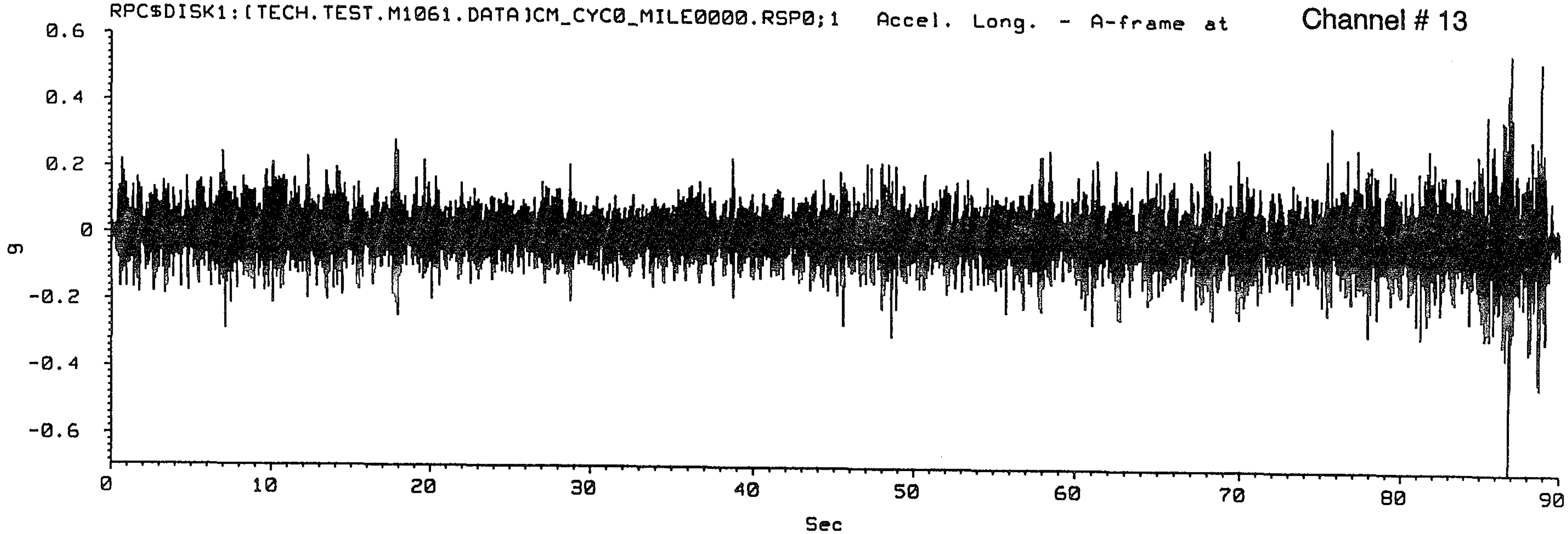
RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Accel. Vert. - A-frame at

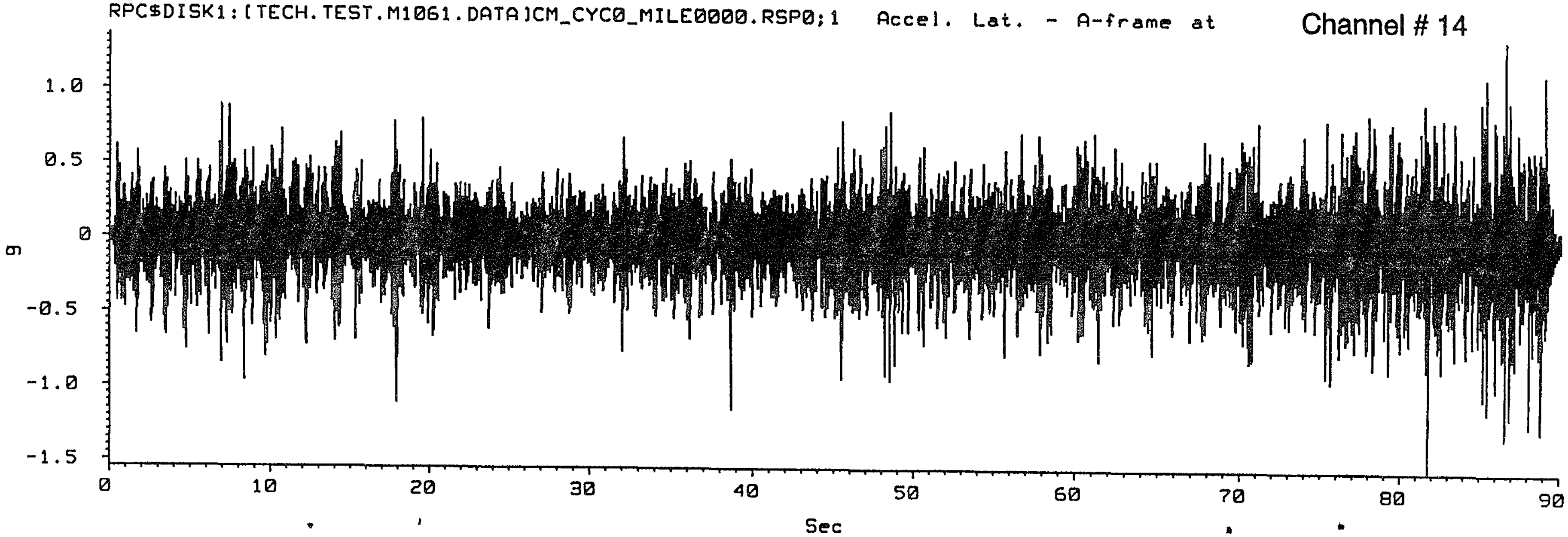
Channel # 12



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:36:05

Figure D-41 Longitudinal R & Lateral L A-Frame Accelerations from Churchville B (mild) at 15 mph

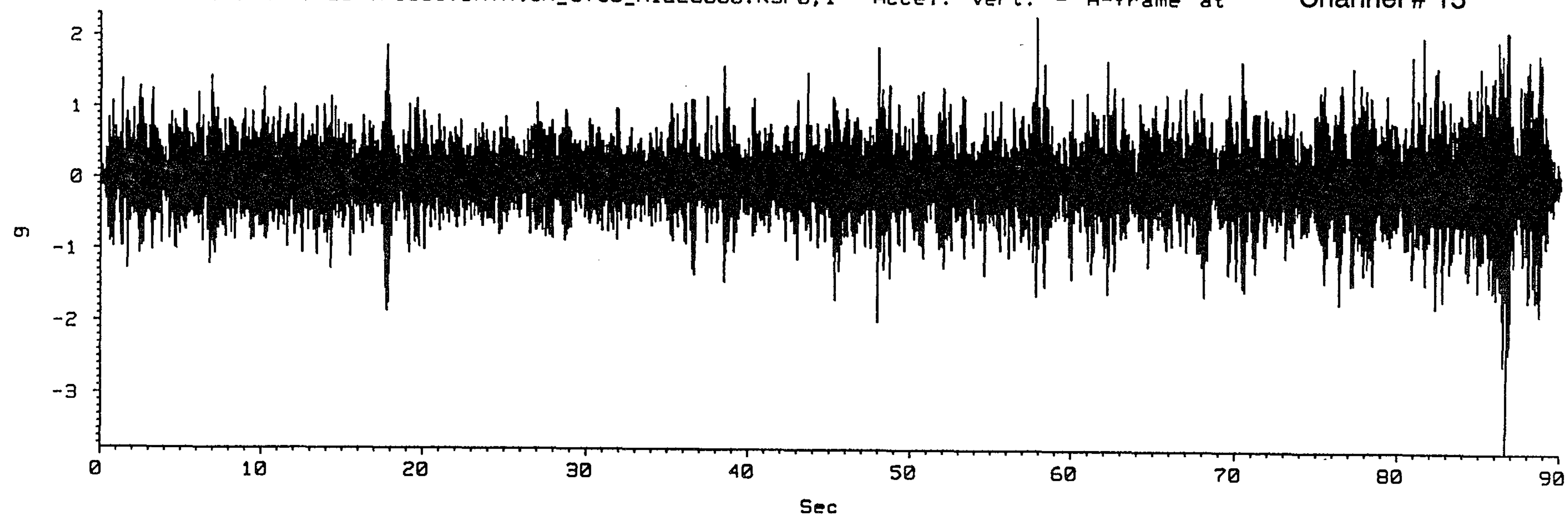




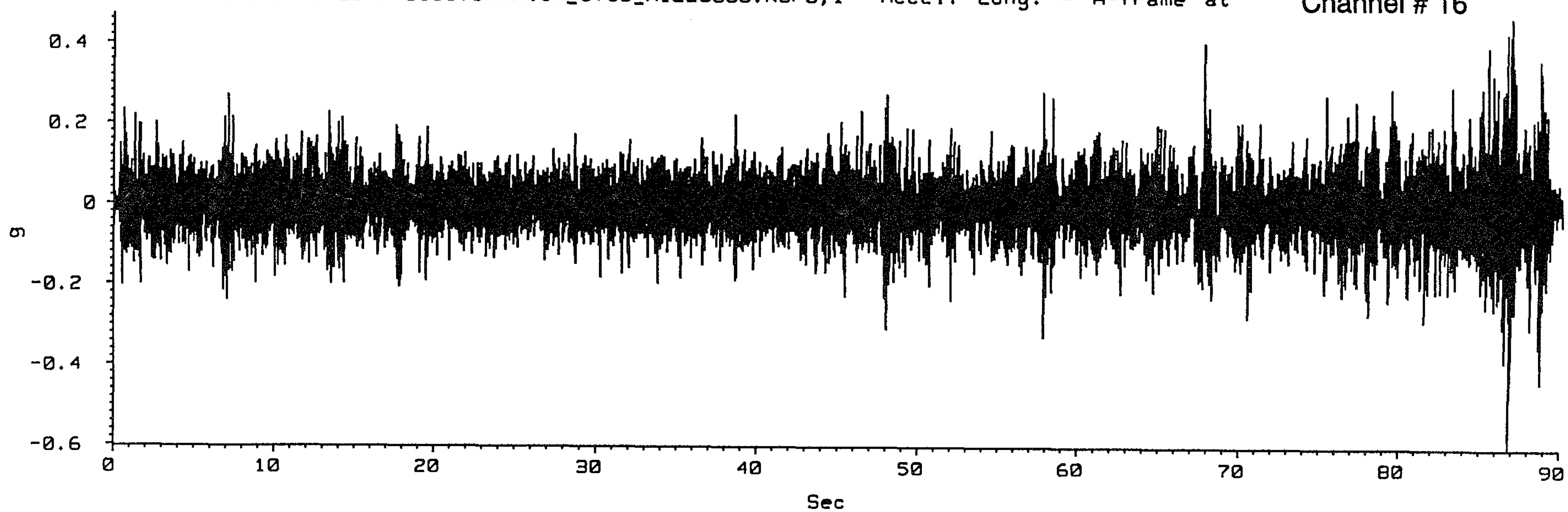
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:37:21

Figure D-42 Vertical & Longitudinal L A-Frame Accelerations from Churchville B (mild) at 15 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Accel. Vert. - A-frame at Channel # 15



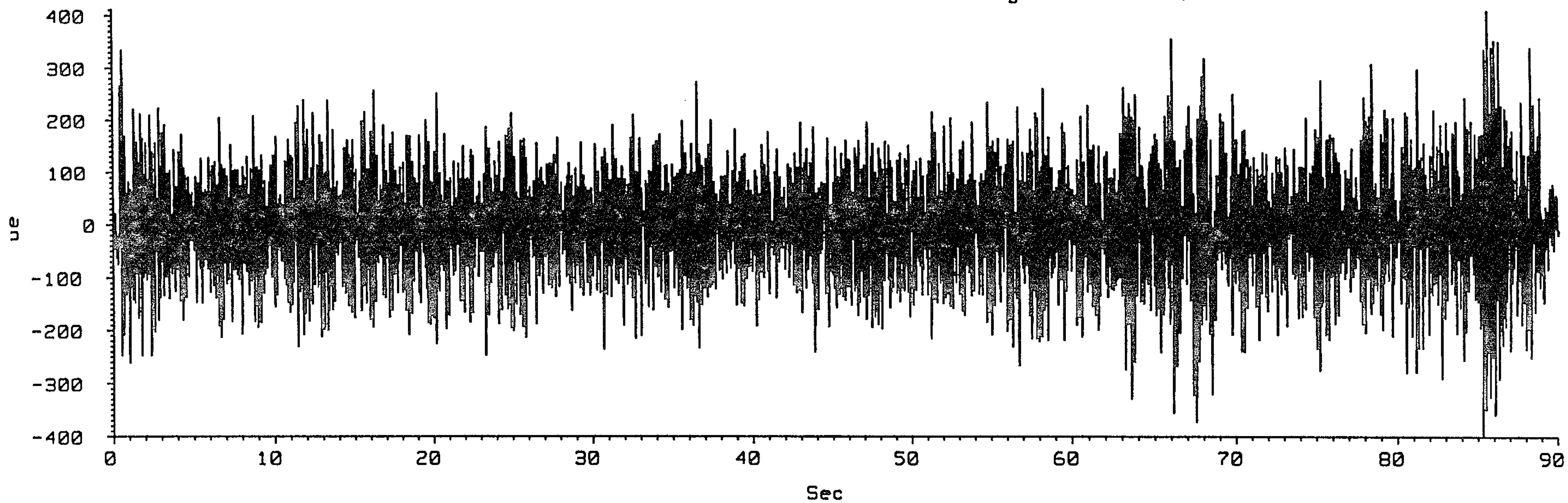
RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Accel. Long. - A-frame at Channel # 16



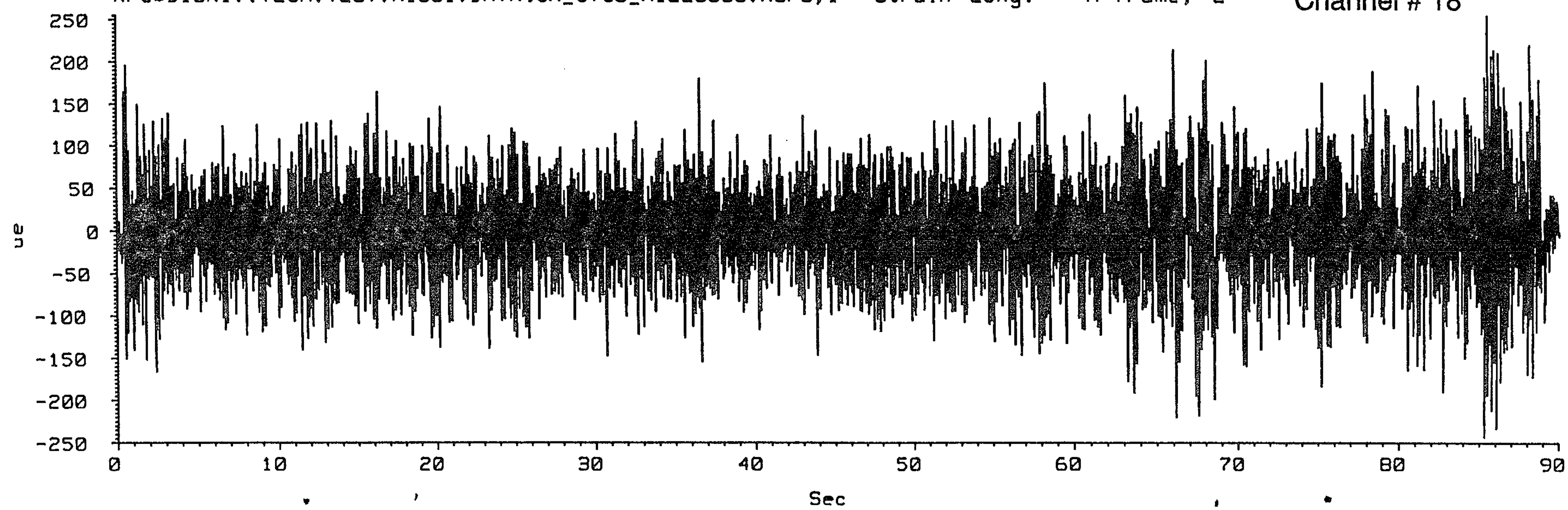
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:38:36

Figure D-43 Inboard & Outboard Left A-Frame Longitudinal Strain from Churchville B (mild) at 15 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, L Channel # 17



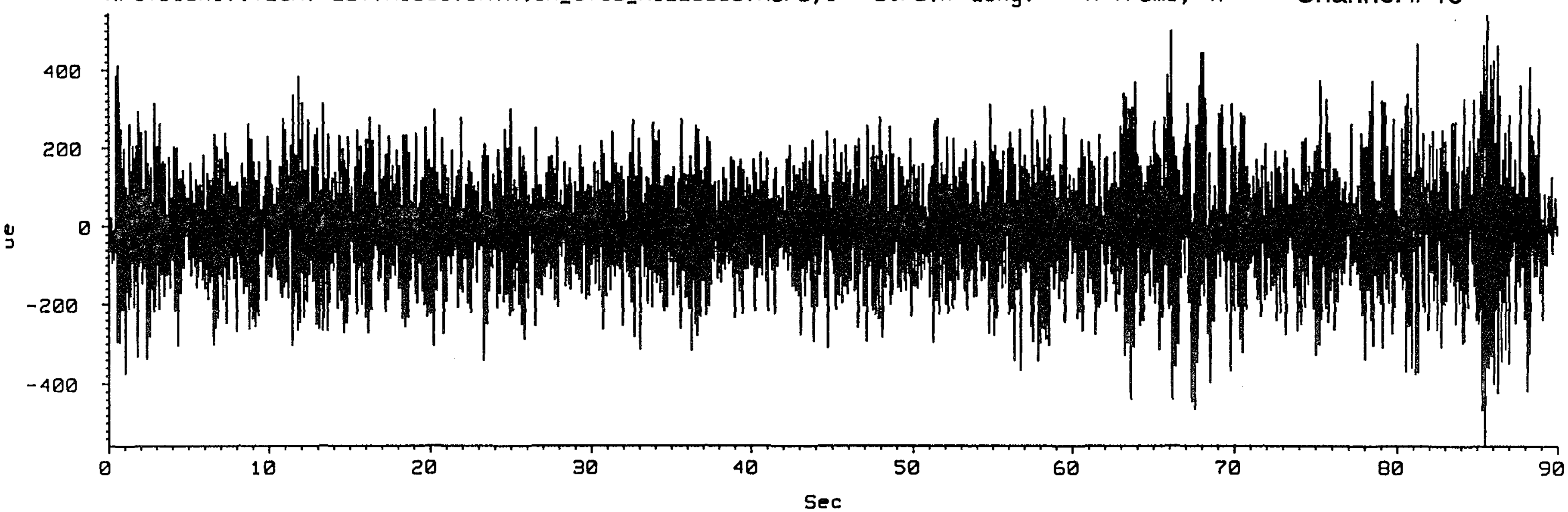
RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, L Channel # 18



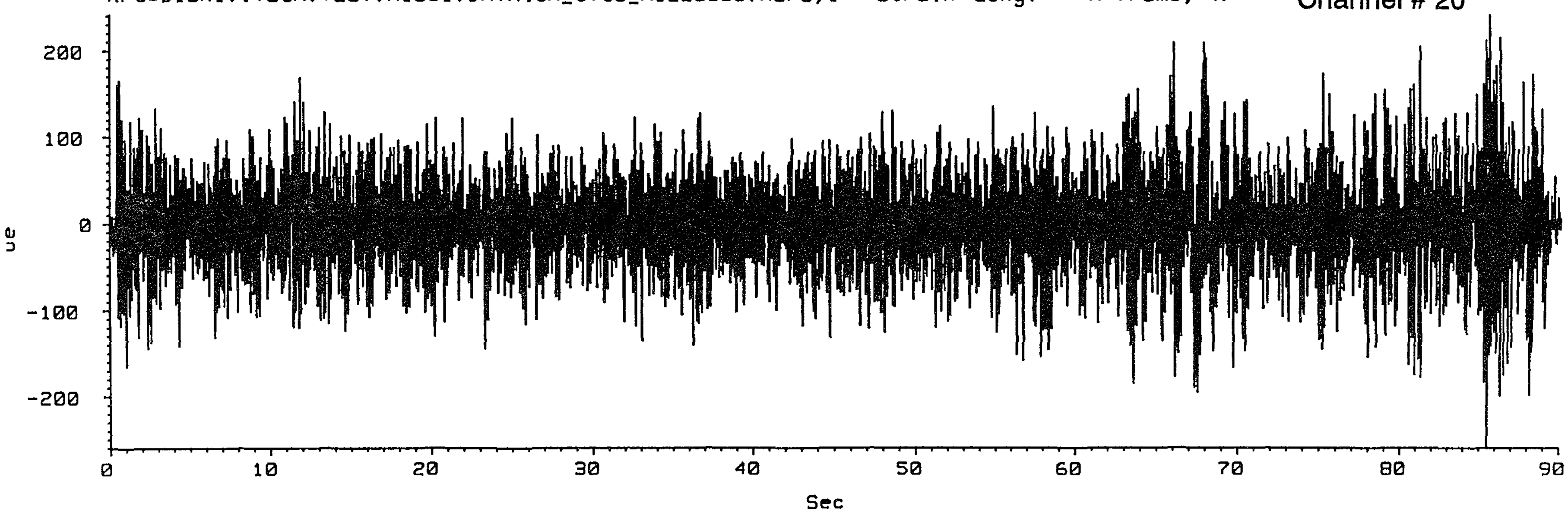
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:39:53

Figure D-44 Inboard & Outboard Right A-Frame Longitudinal Strain from Churchville B (mild) at 15 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, R Channel # 19

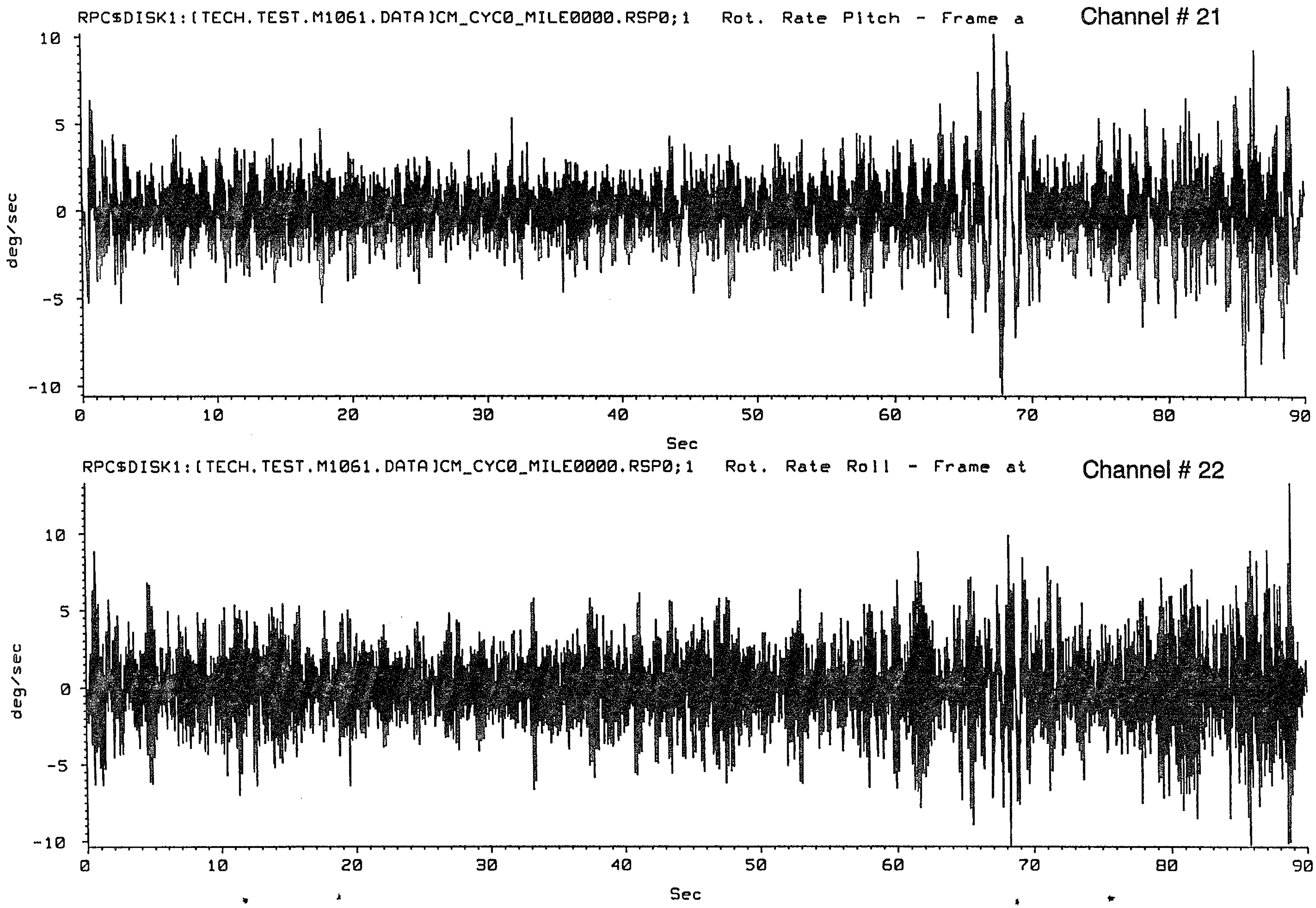


RPC$DISK1:[TECH.TEST.M1061.DATA]CM_CYC0_MILE0000.RSP0;1 Strain Long. - A-frame, R Channel # 20



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:41:09

Figure D-45 Pitch and Roll Rate of Trailer Frame from Churchville B (mild) at 15 mph



POWER SPECTRAL DENSITY PLOTS

FROM

CHURCHVILLE B (MILD) AT 15 MPH

Figure D-46 Channels #1 - #4 from Churchville B (mild) at 15 mph

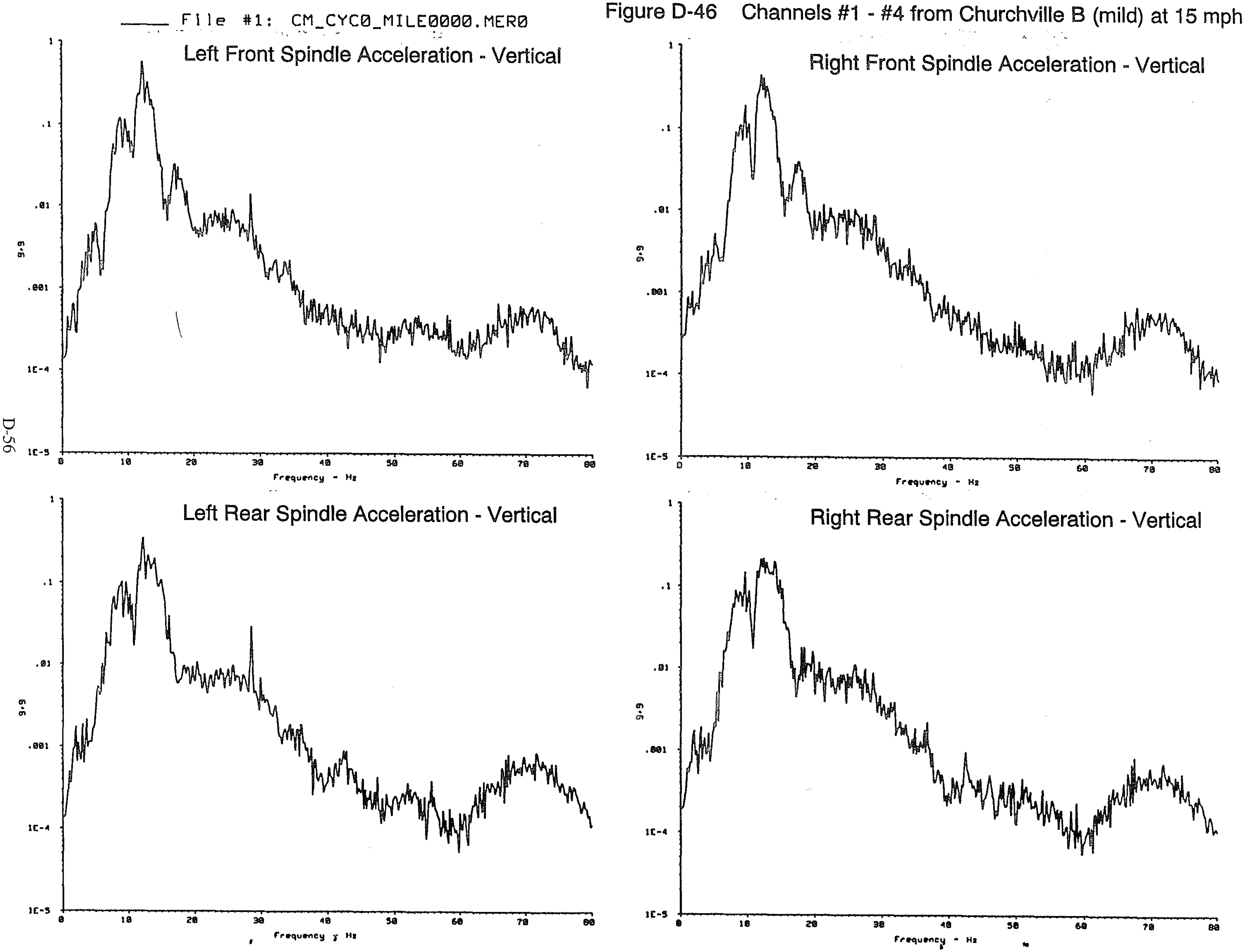


Figure D-47 Channels #5 - #8 from Churchville B (mild) at 15 mph

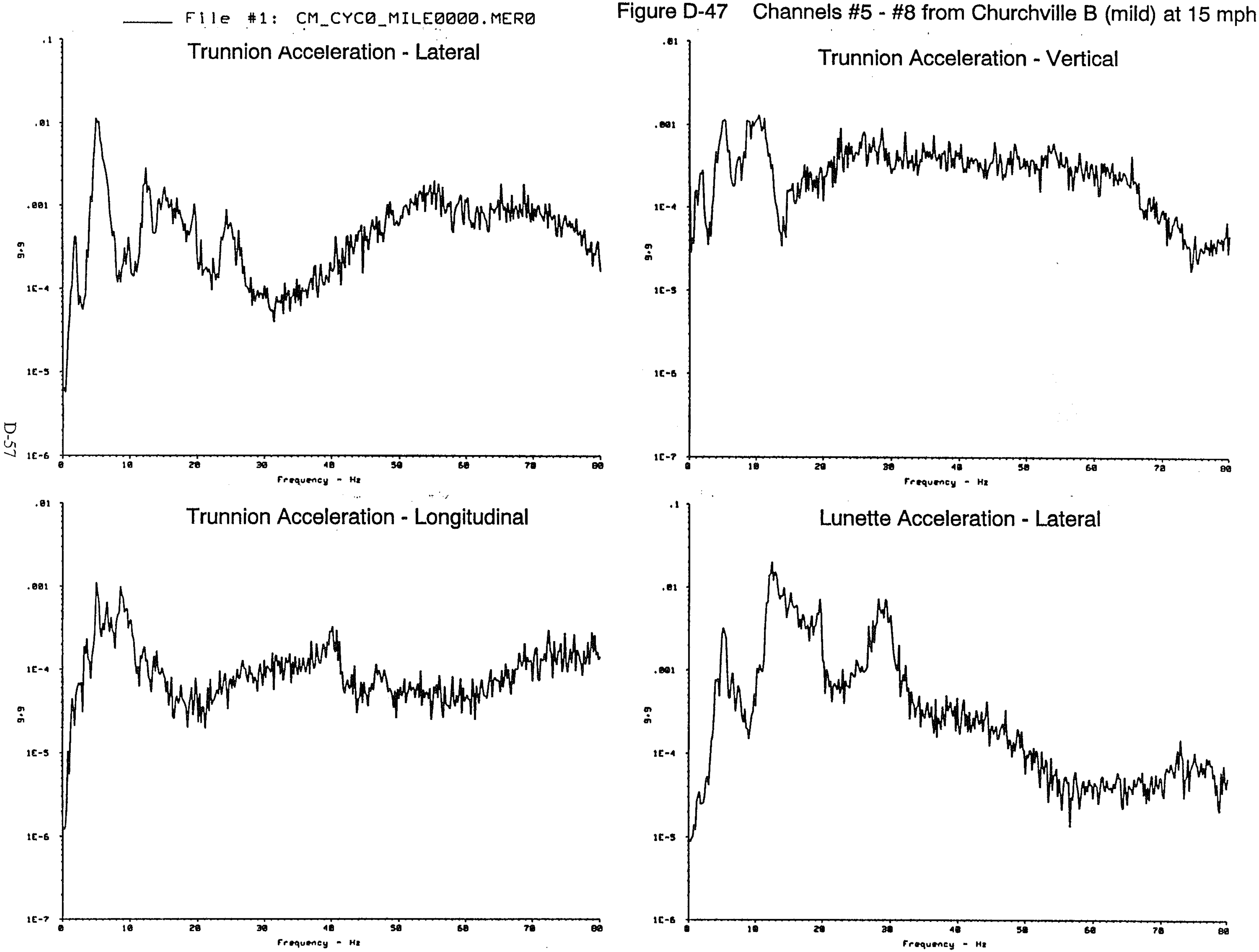


Figure D-48 Channels #9 - #12 from Churchville B (mild) at 15 mph

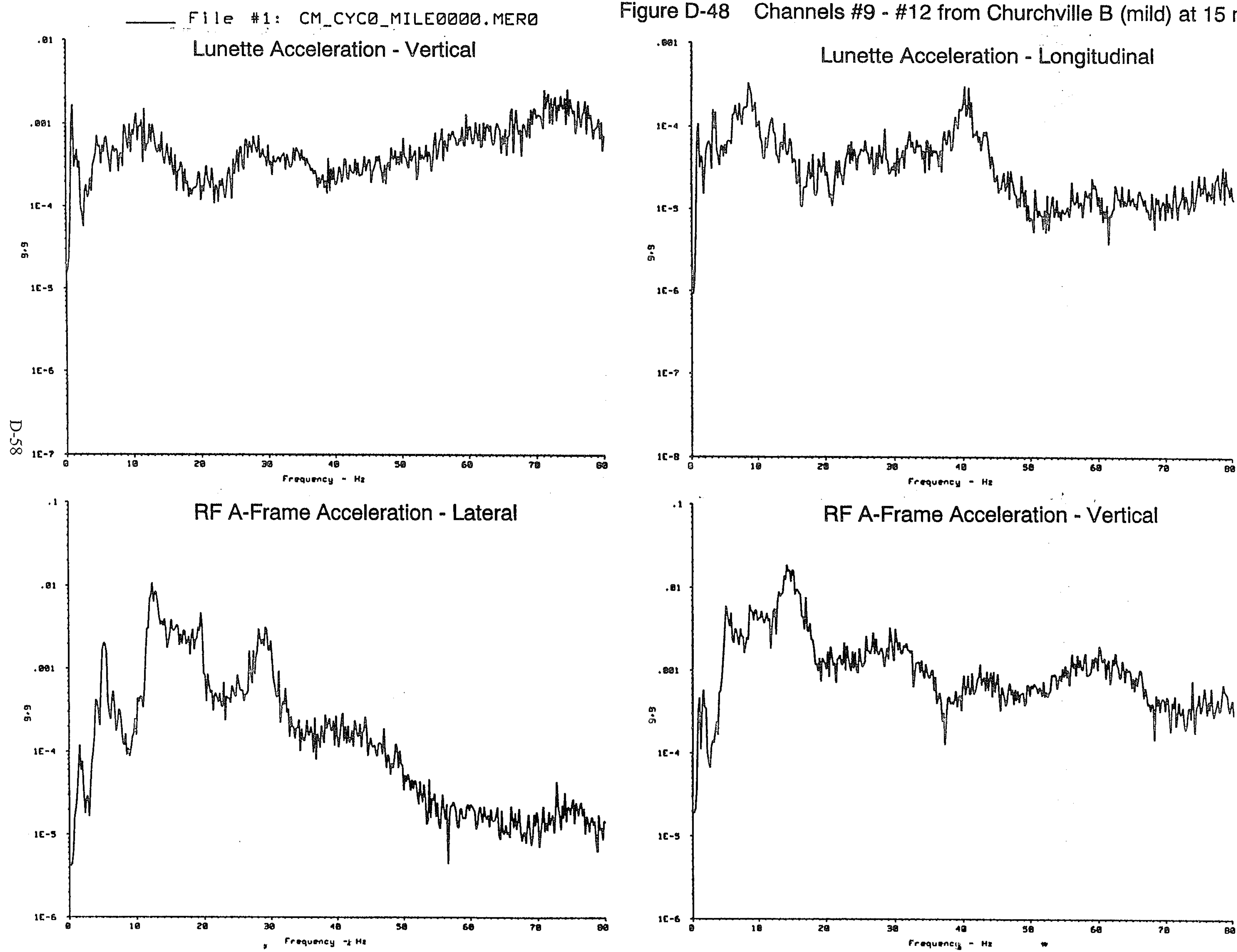
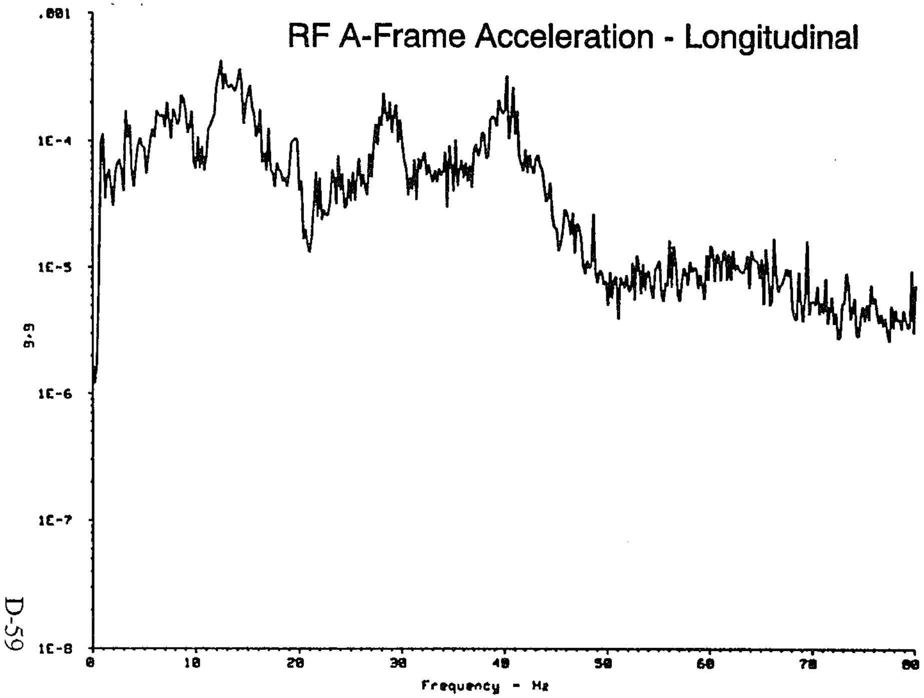
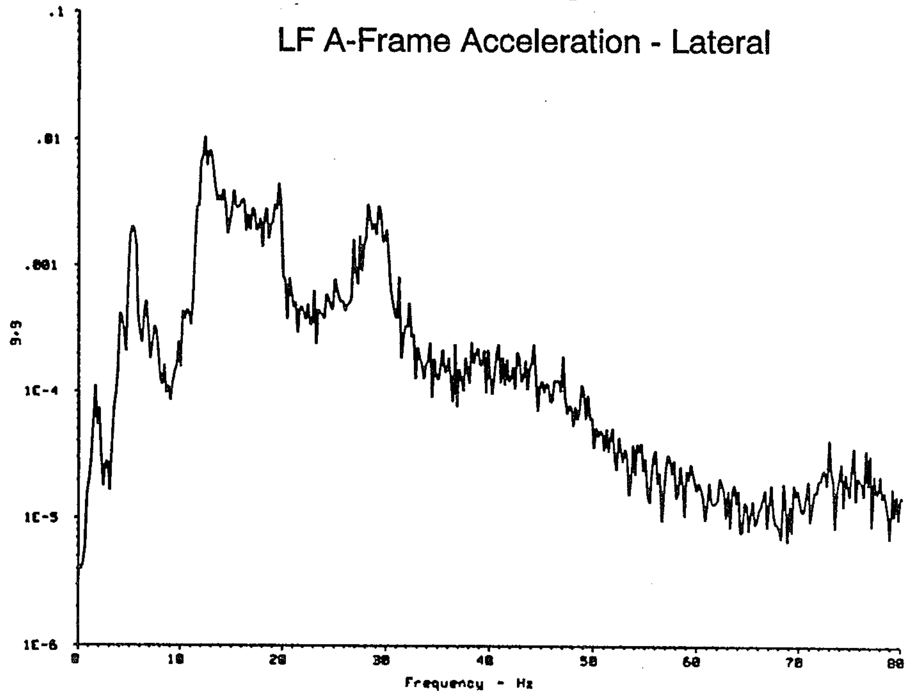
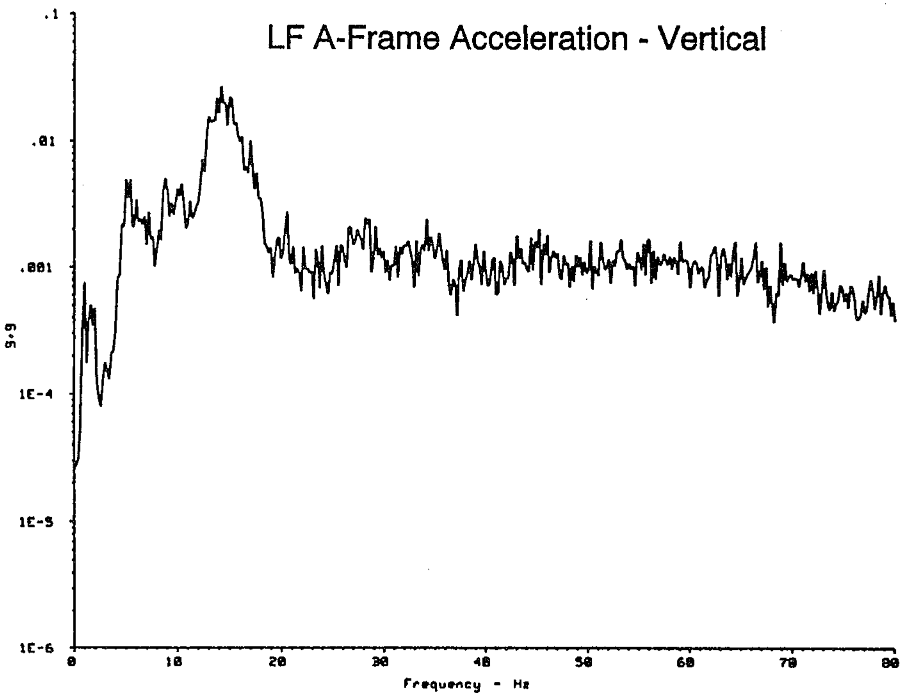


Figure D-49 Channels #13 - #16 from Churchville B (mild) at 15 mph

File #1: CM_CYC0_MILE0000.MER0







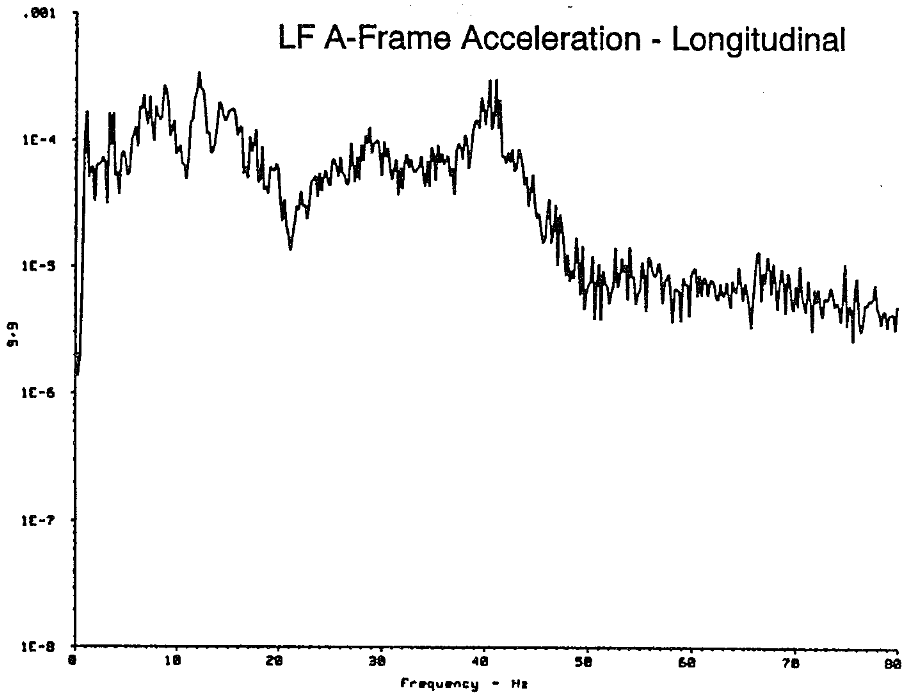


Figure D-50 Channels #17 - #20 from Churchville B (mild) at 15 mph

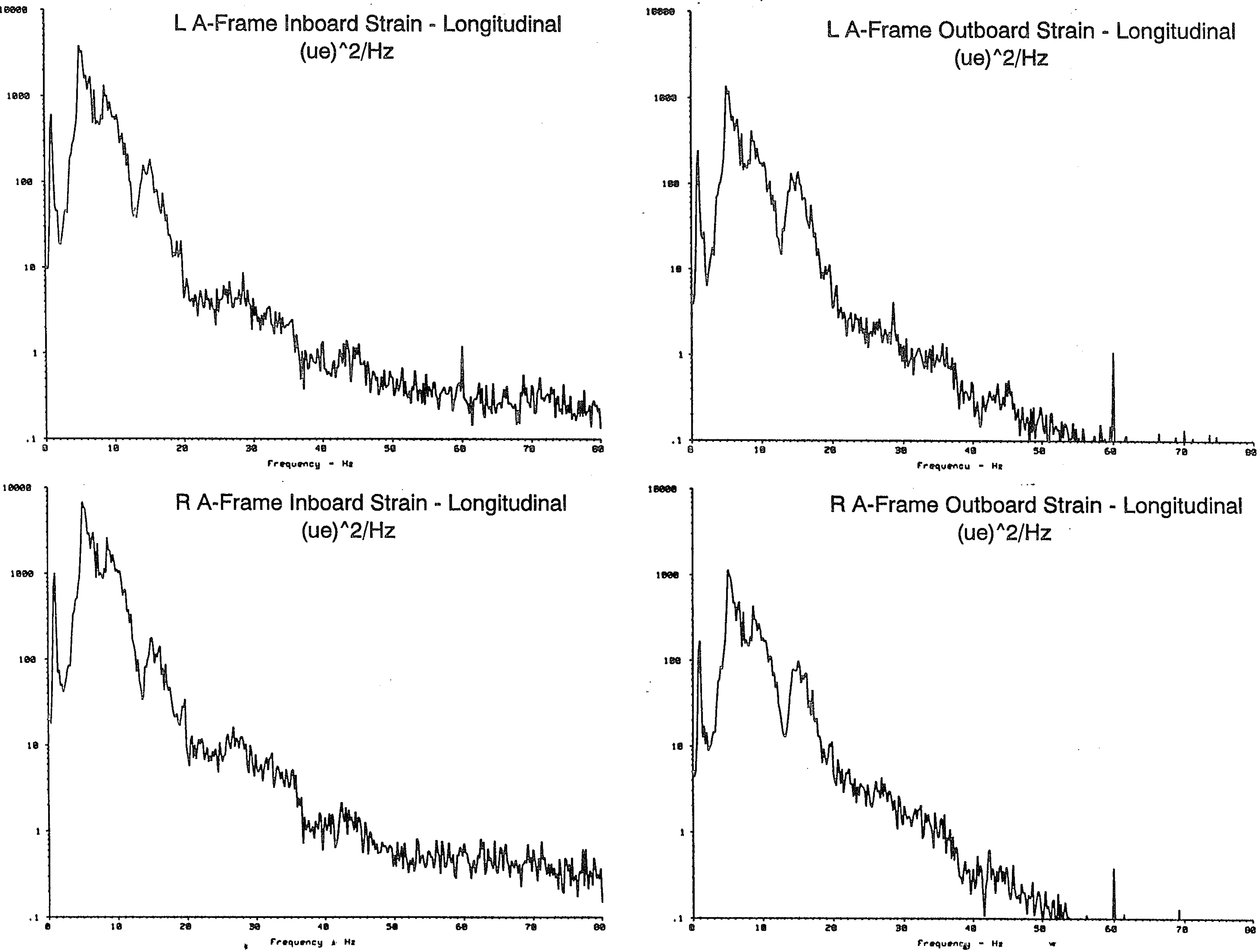
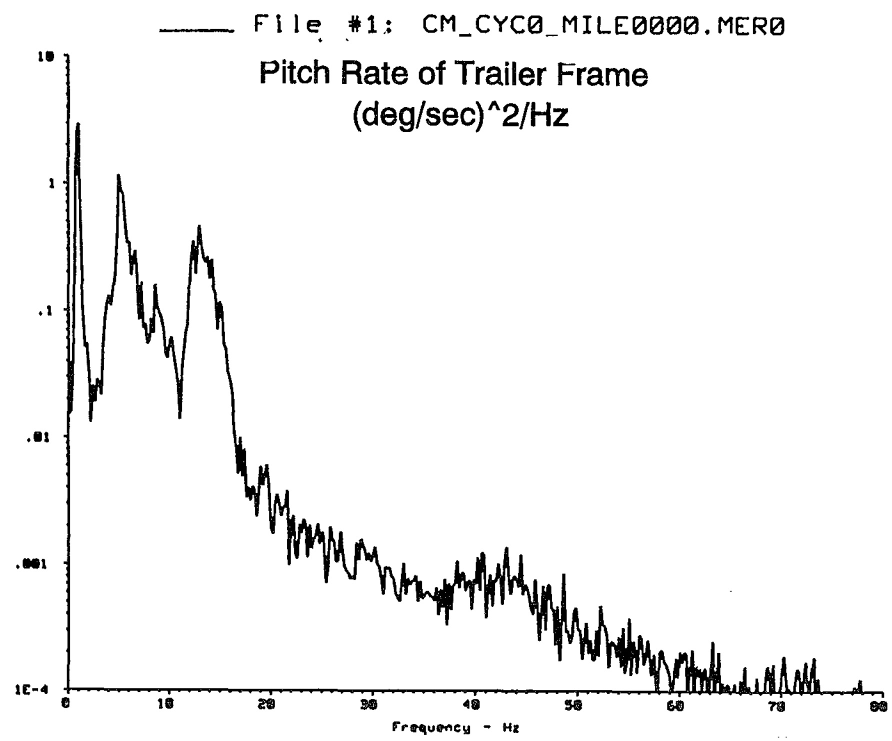
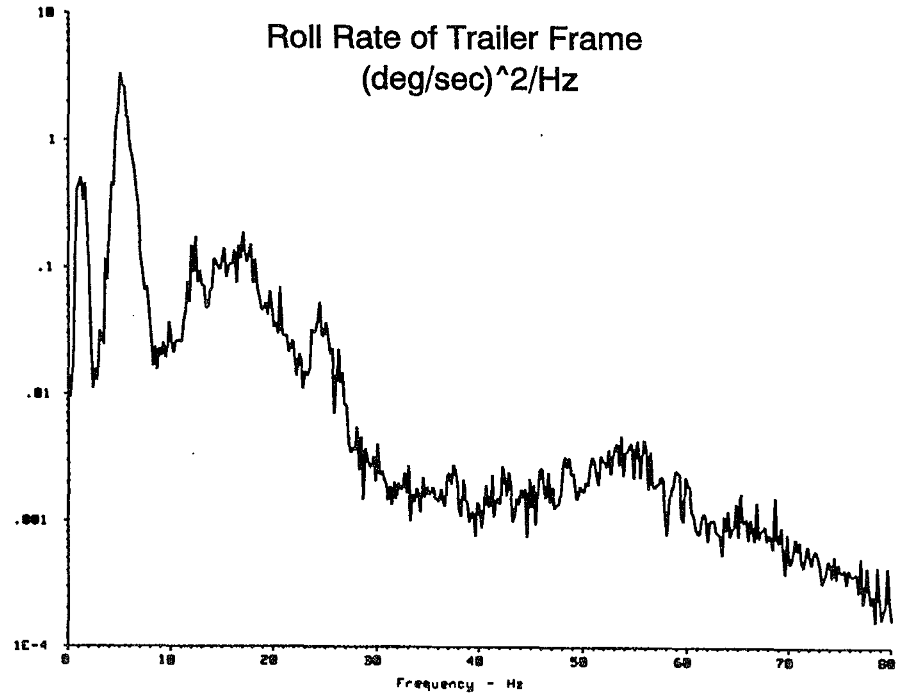


Figure D-51 Channels #21 - #22 from Churchville B (mild) at 15 mph





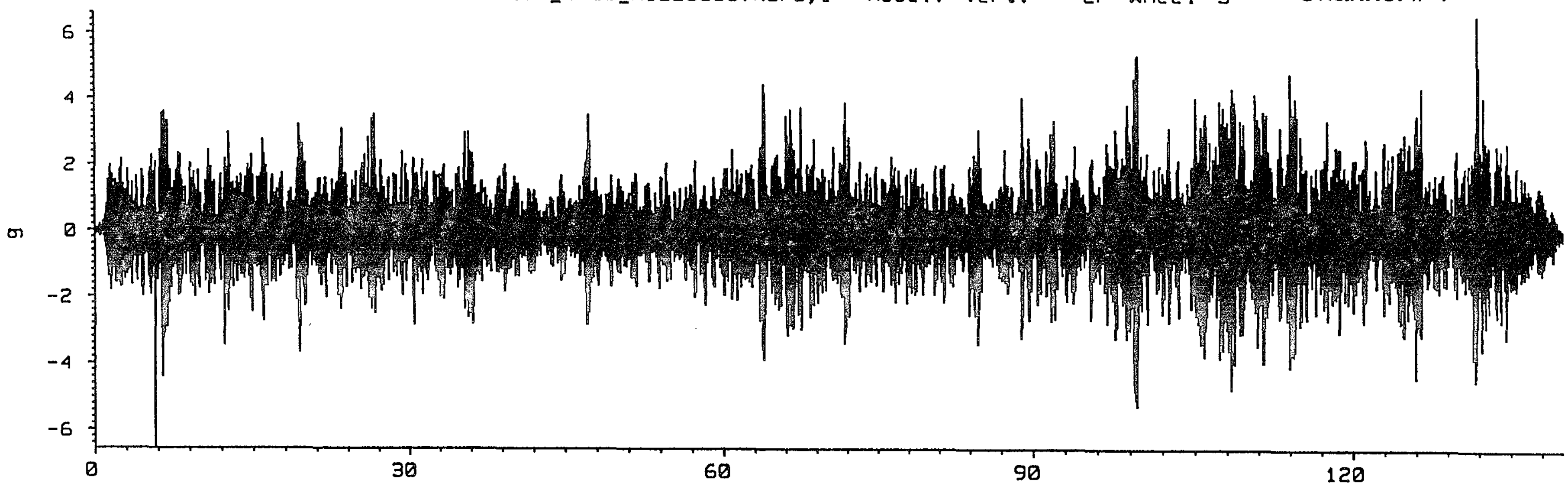
TIME HISTORY PLOTS

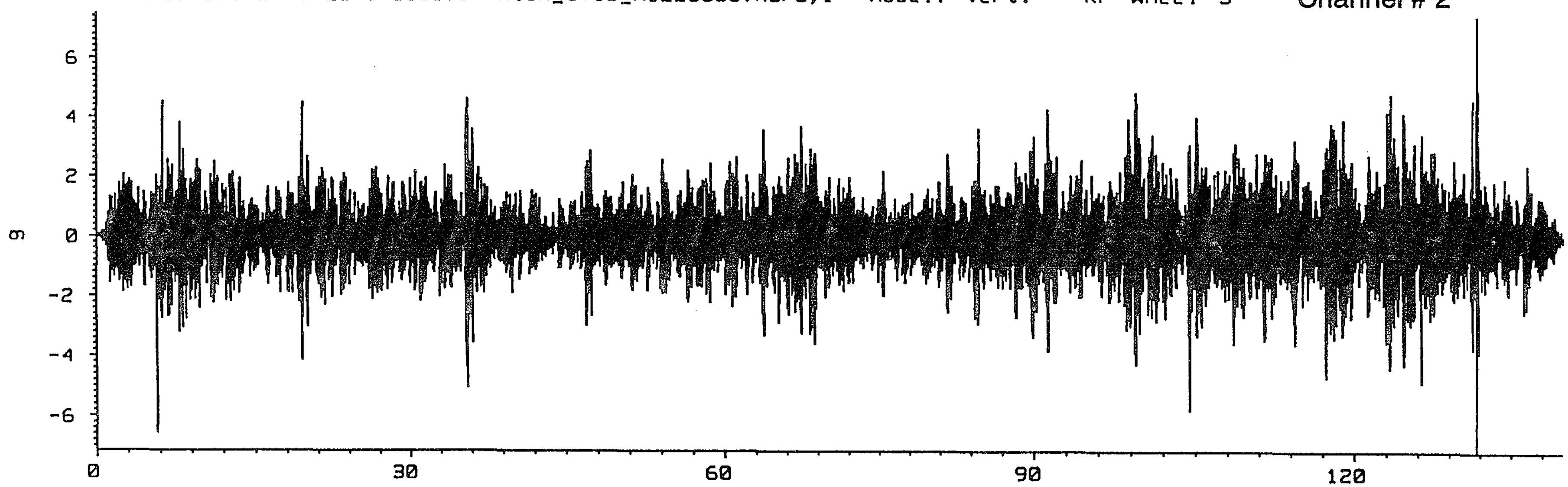
FROM

CHURCHVILLE B (ROUGH) AT 10 MPH

MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:42:46

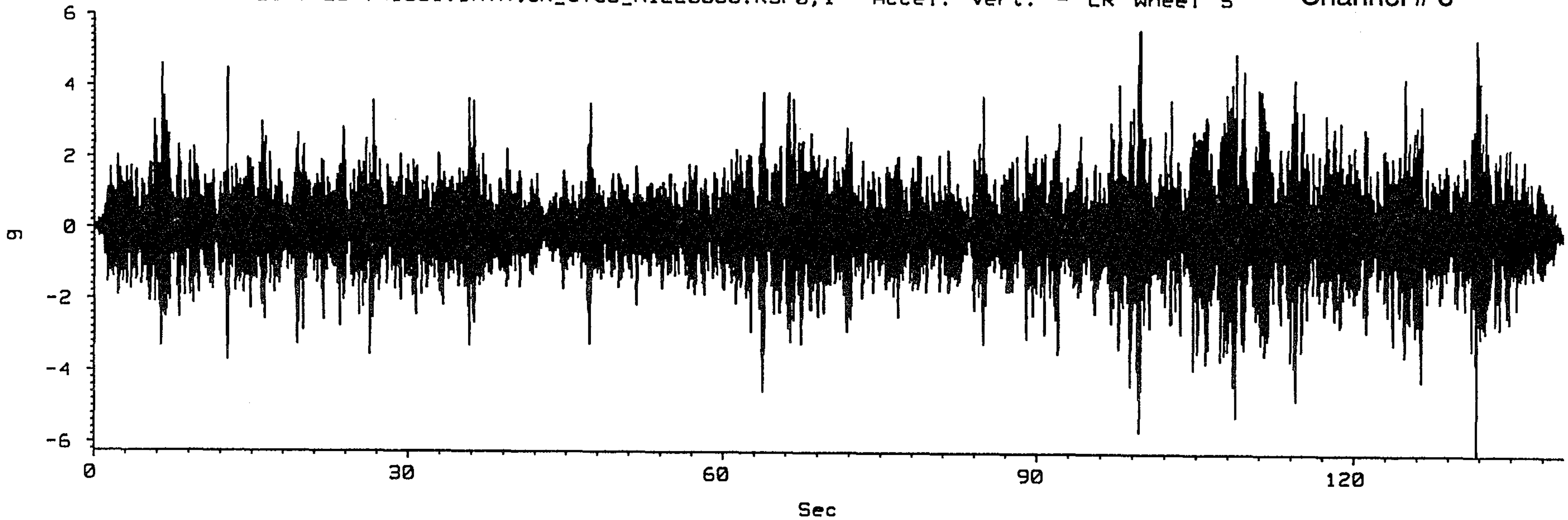
Figure D-52 LF & RF Wheel Spindle Accelerations from Churchville B (Rough) at 10 mph

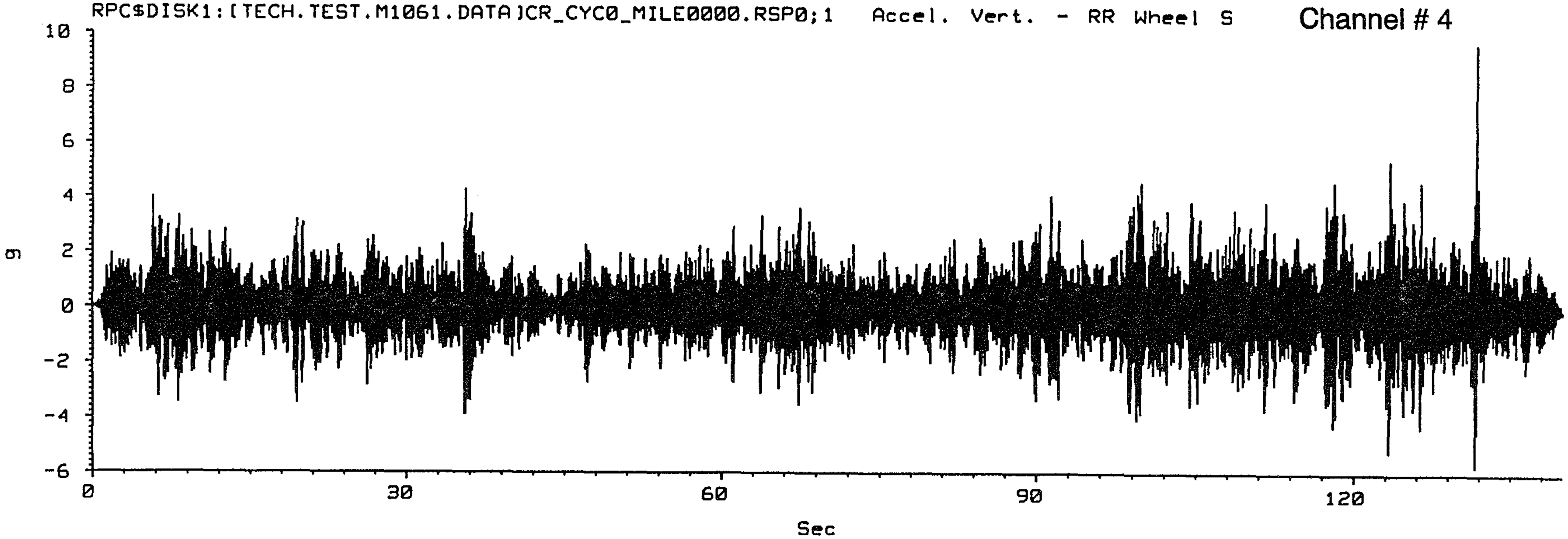




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:44:33

Figure D-53 LR & RR Wheel Spindle Accelerations from Churchville B (Rough) at 10 mph

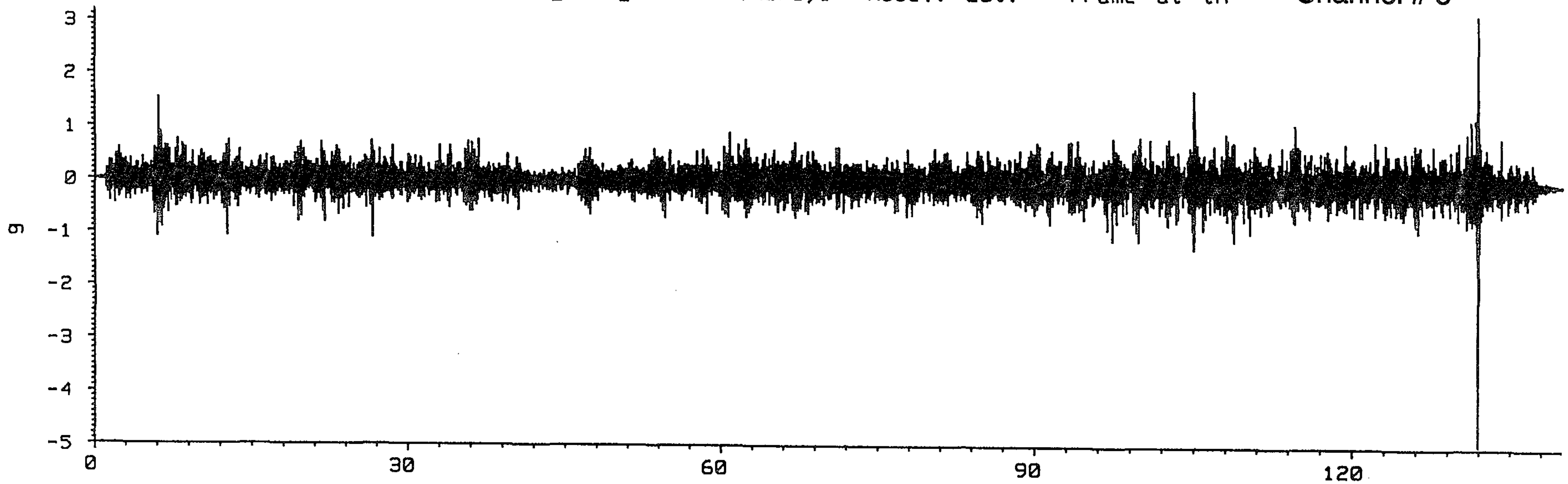




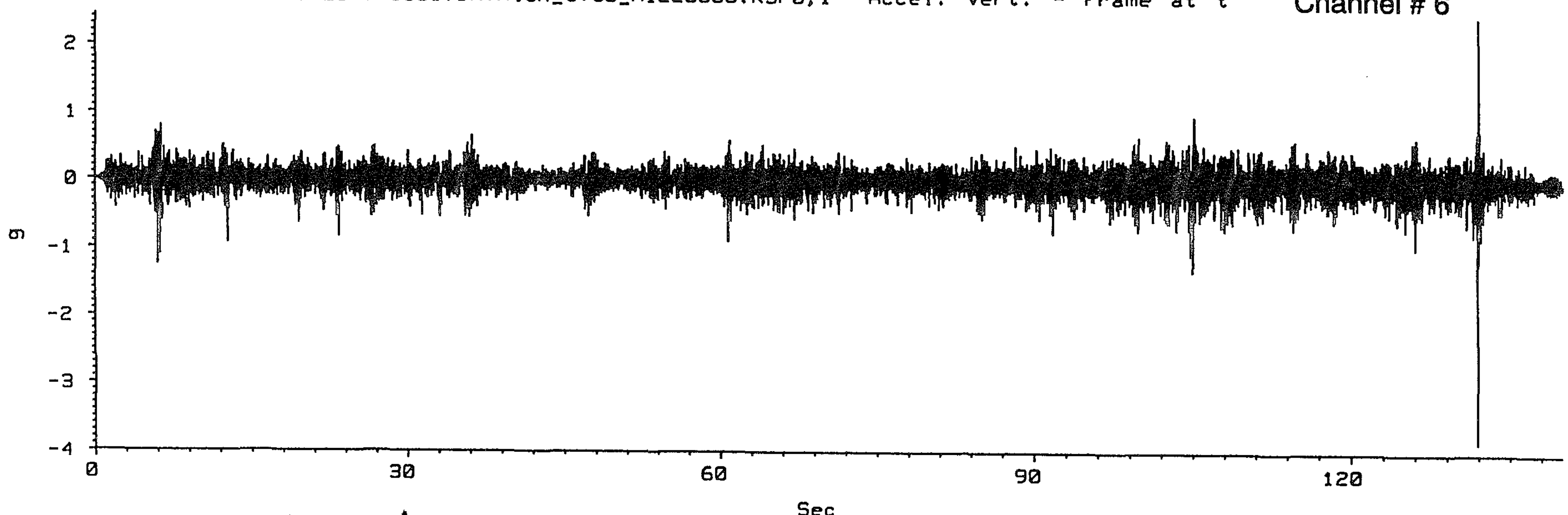
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:46:20

Figure D-54 Lateral & Vertical Trunnion Accelerations from Churchville B (Rough) at 10 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Lat. - Frame at th Channel # 5

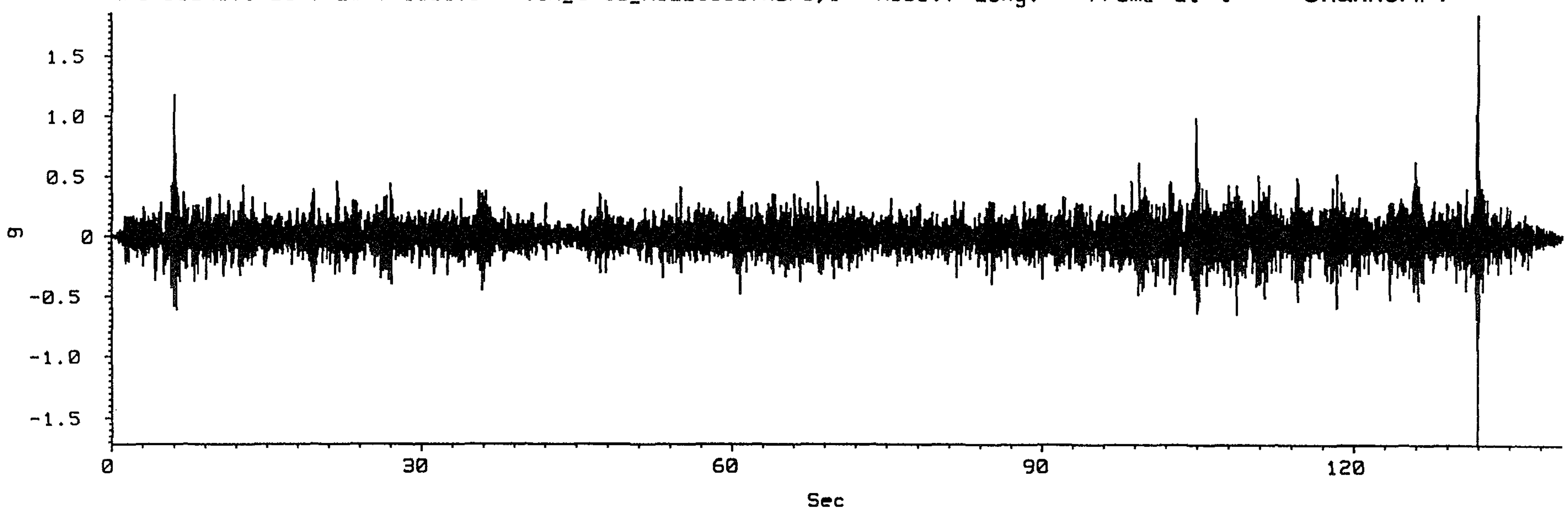


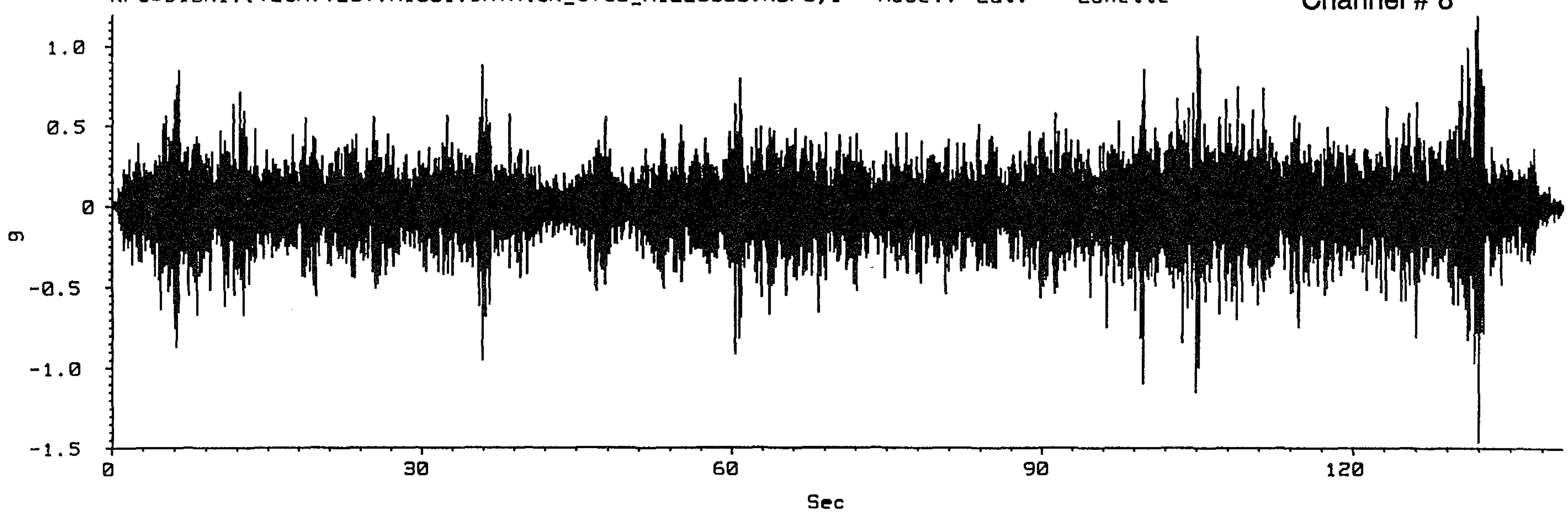
RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Vert. - Frame at t Channel # 6



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:48:08

Figure D-55 Longitudinal Trunnion & Lateral Lunette Accelerations from Churchville B (Rough) at 10 mph



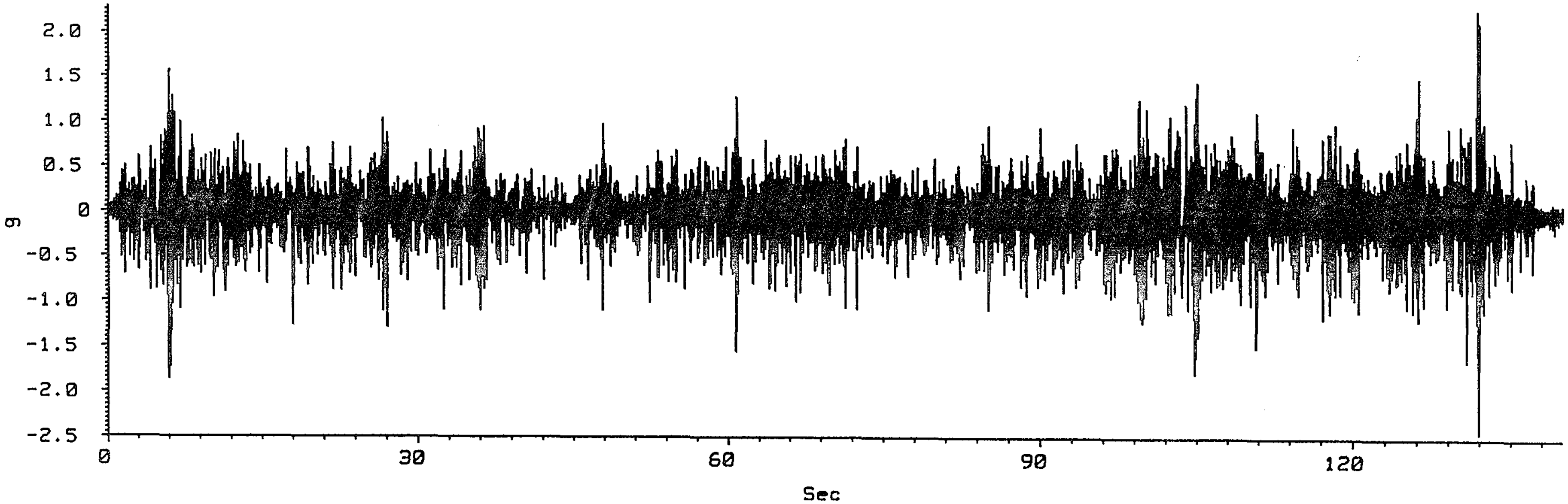


MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:49:56

Figure D-56 Vertical & longitudinal Lunette Accelerations from Churchville B (Rough) at 10 mph

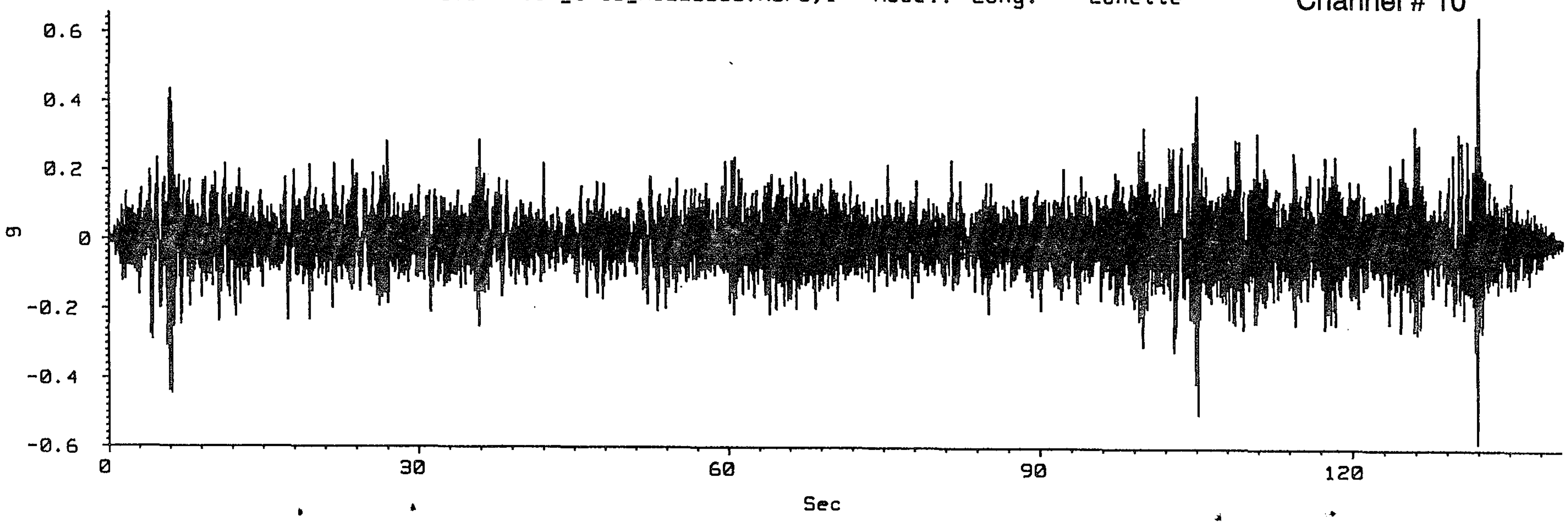
RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Vert. - Lunette

Channel # 9



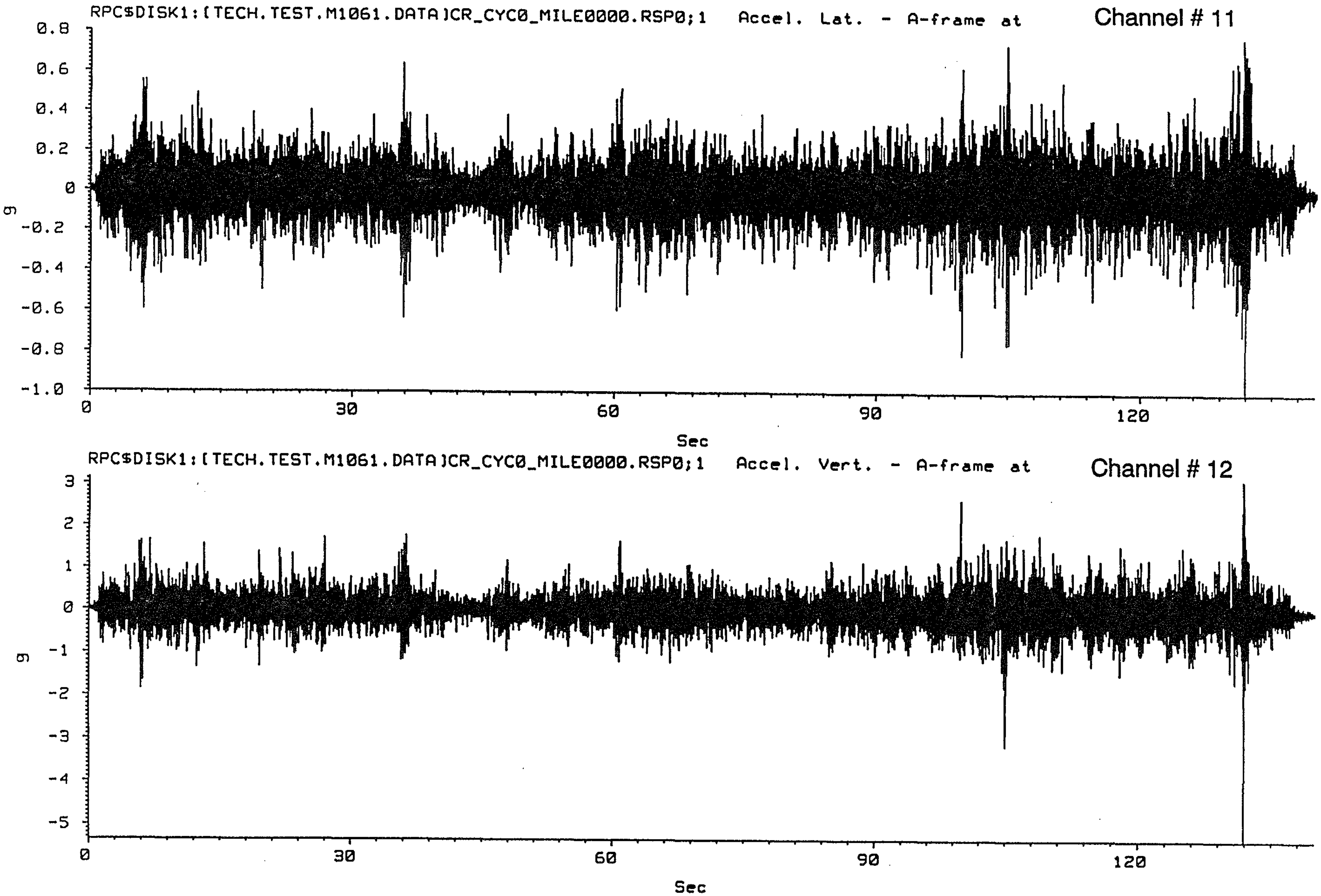
RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Long. - Lunette

Channel # 10



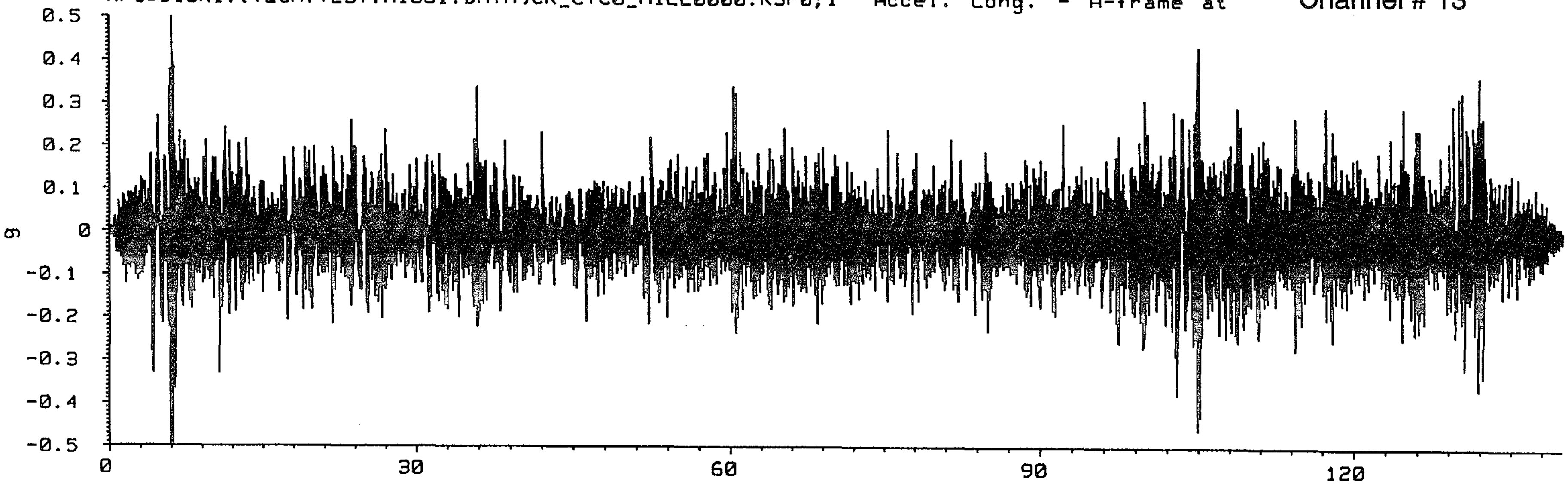
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:51:36

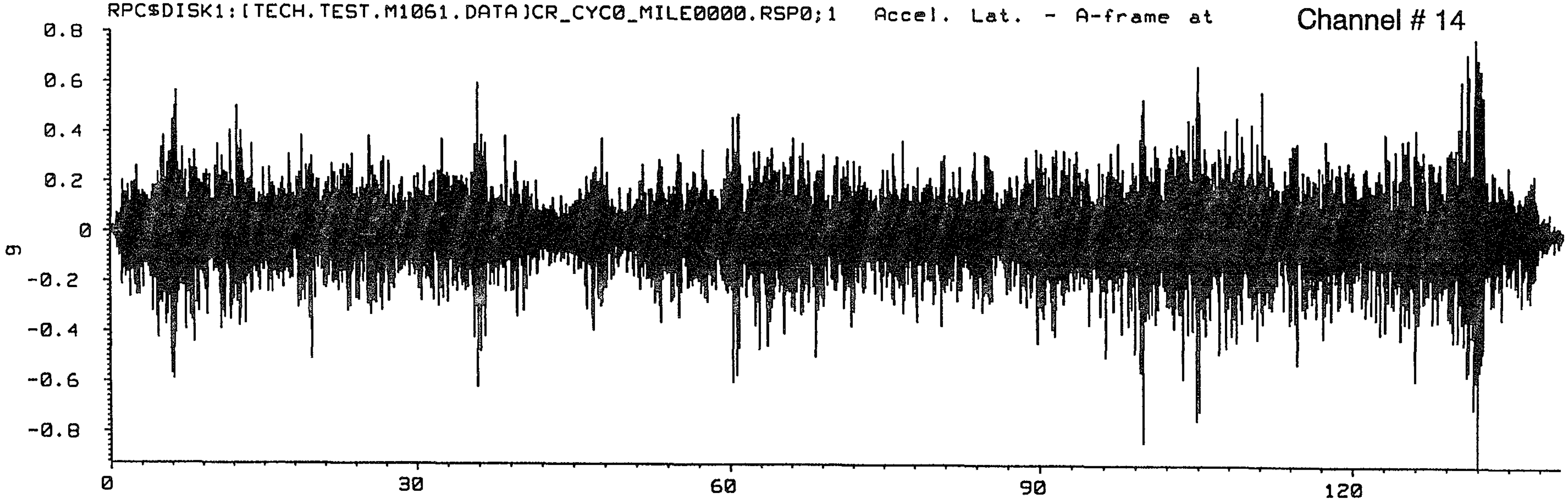
Figure D-57 Lateral & Vertical Right A-Frame Acceleration from Churchville B (Rough) at 10 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:53:12

Figure D-58 Longitudinal R & Lateral L A-Frame Accelerations from Churchville B (Rough) at 10 mph

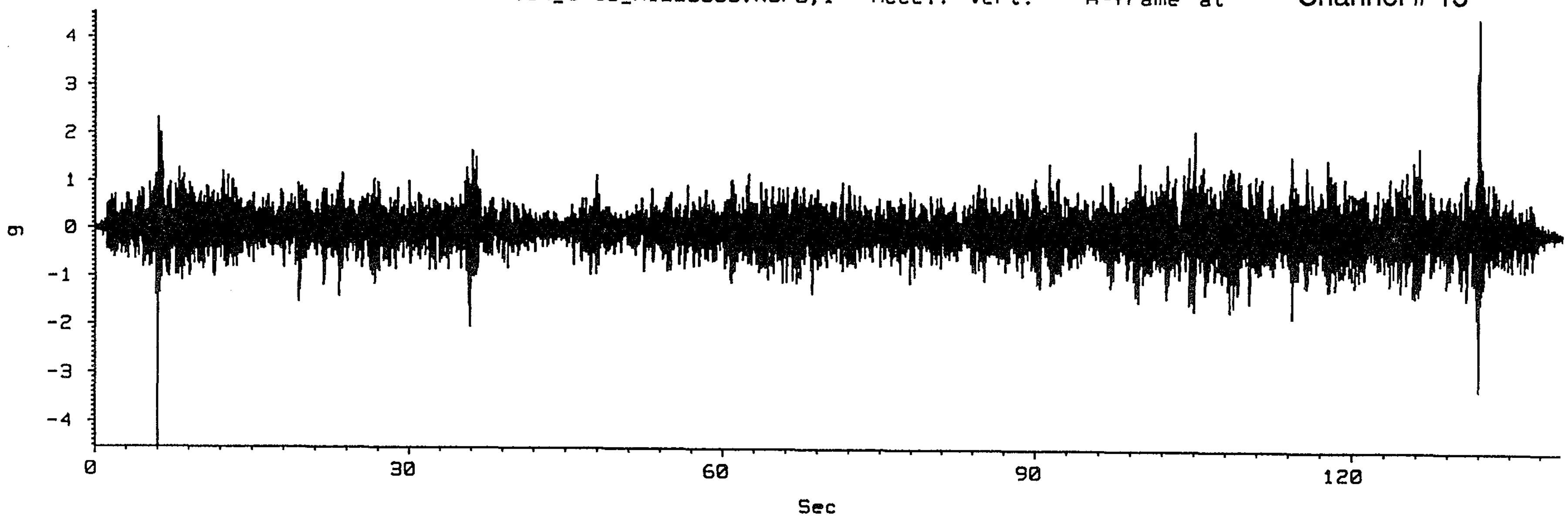




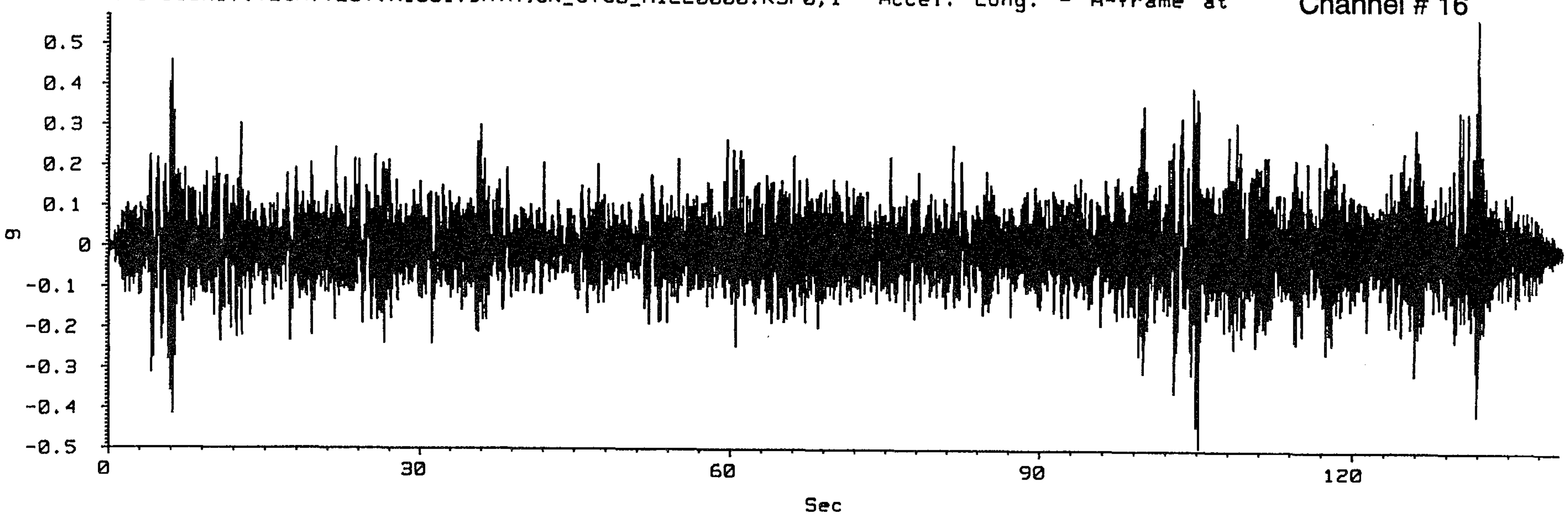
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:54:47

Figure D-59 Vertical & Longitudinal L A-Frame Accelerations from Churchville B (Rough) at 10 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Vert. - A-frame at Channel # 15

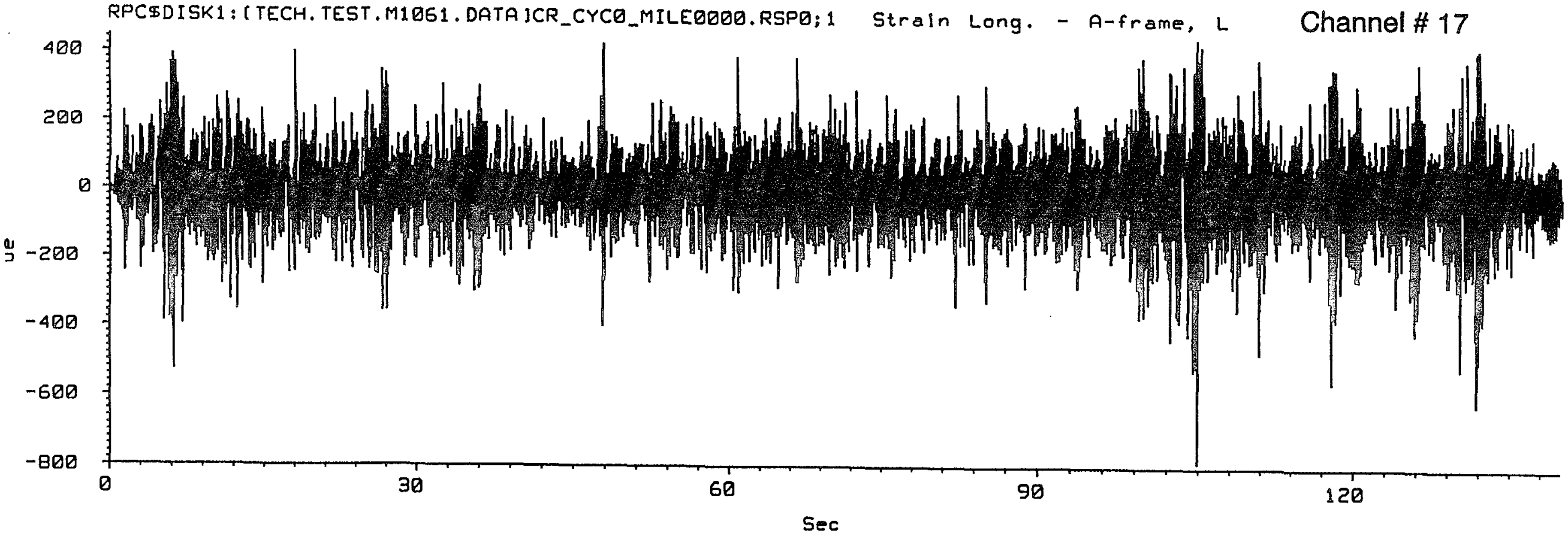


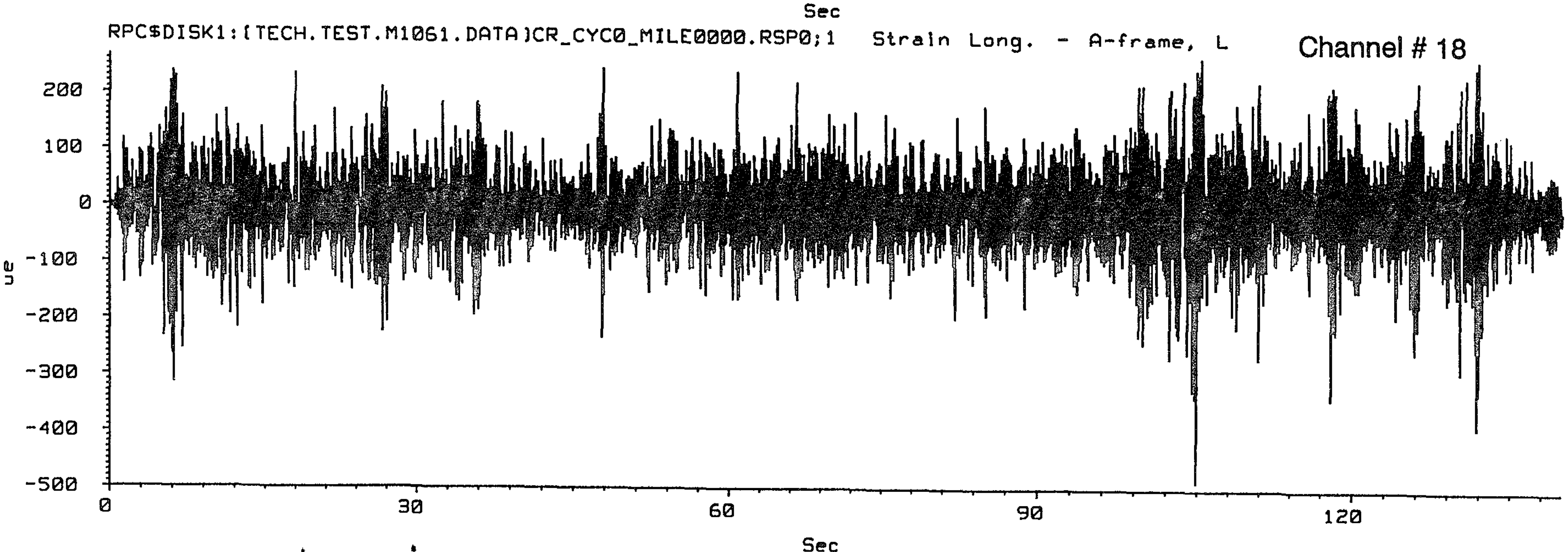
RPC$DISK1:[TECH.TEST.M1061.DATA]CR_CYC0_MILE0000.RSP0;1 Accel. Long. - A-frame at Channel # 16



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:56:21

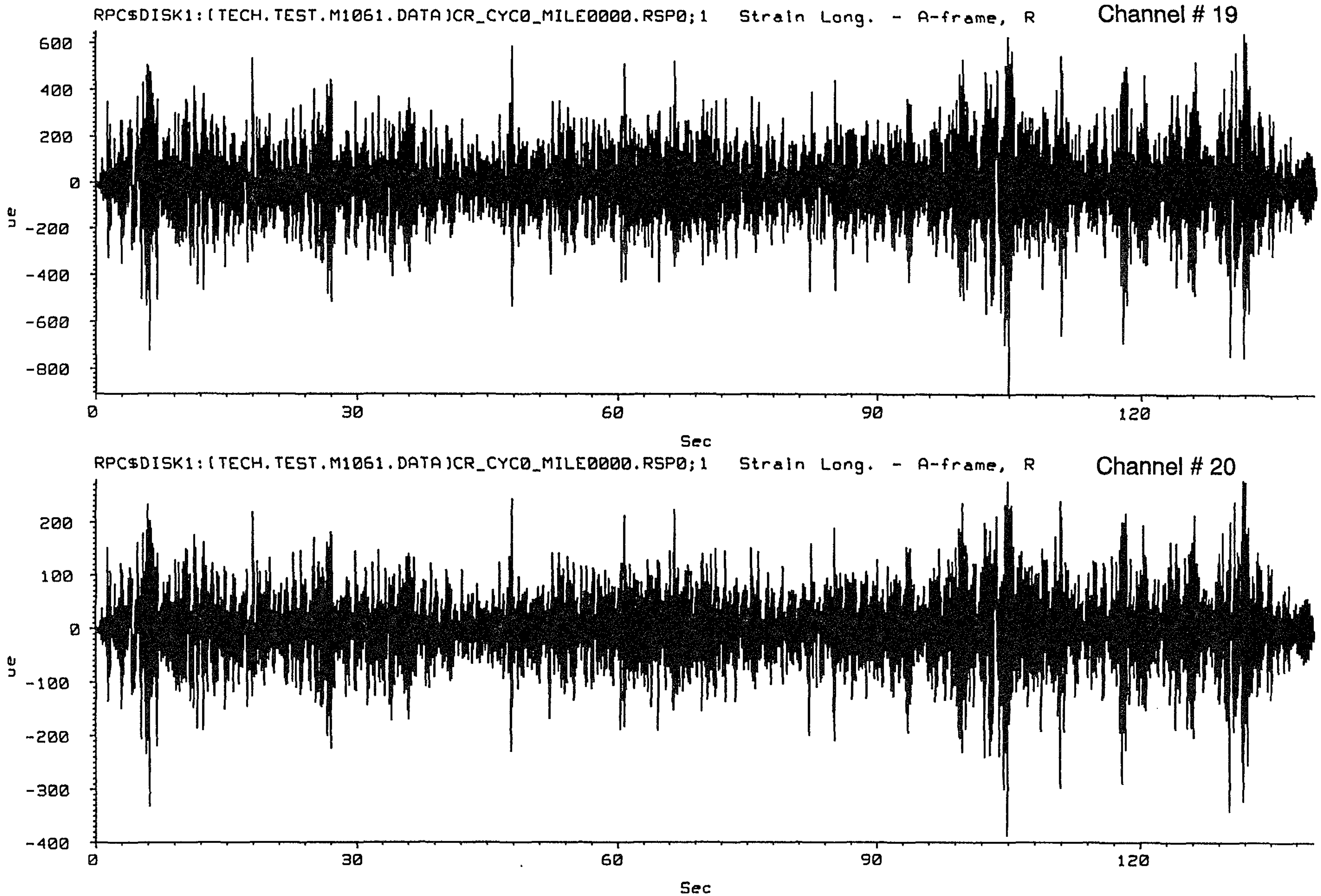
Figure D-60 Inboard & Outboard Left A-Frame Longitudinal Strain from Churchville B (Rough) at 10 mph





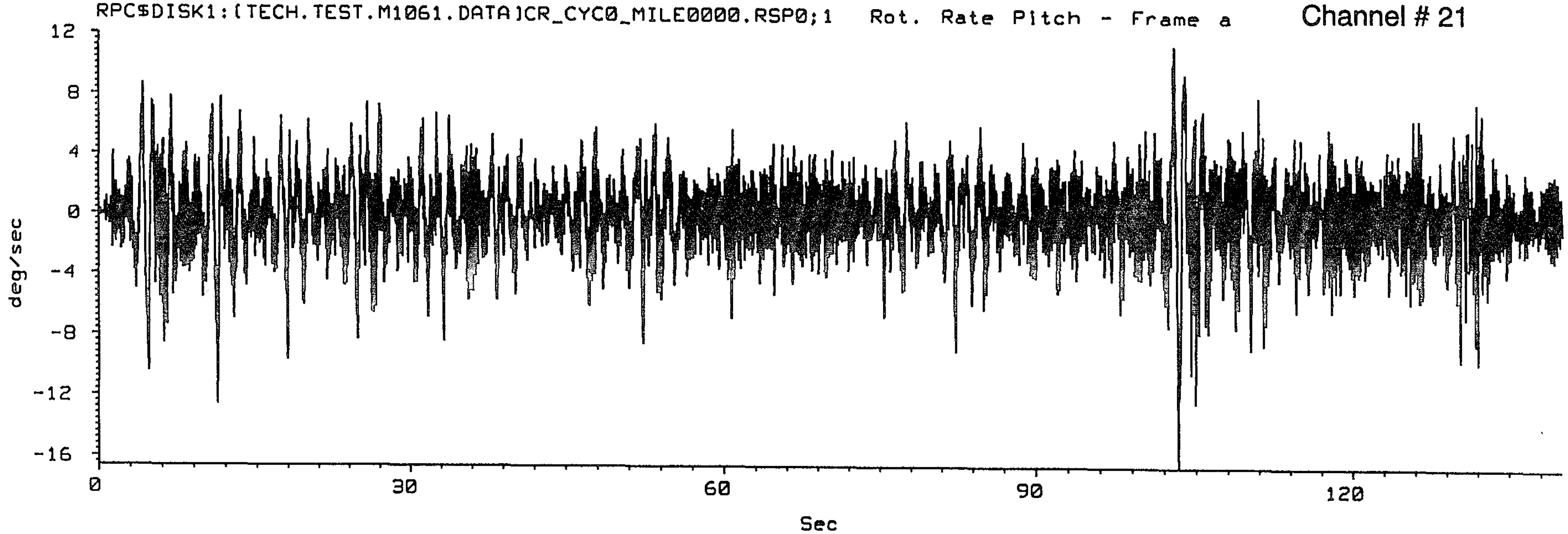
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:57:54

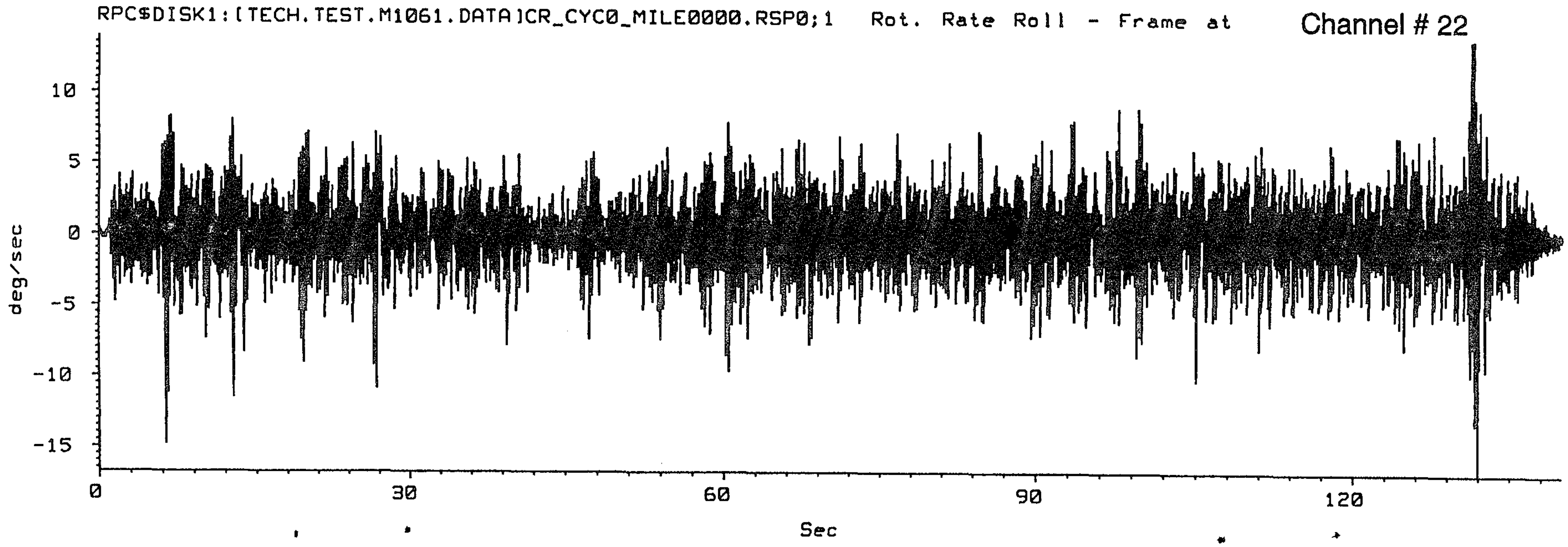
Figure D-61 Inboard & Outboard Right A-Frame Longitudinal Strain from Churchville B (Rough) at 10 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:59:29

Figure D-62 Pitch and Roll Rate of Trailer Frame from Churchville B (Rough) at 10 mph





POWER SPECTRAL DENSITY PLOTS

FROM

CHURCHVILLE B (ROUGH) AT 10 MPH

Figure D-63 Channels #1 - #4 from Churchville B (Rough) at 10 mph

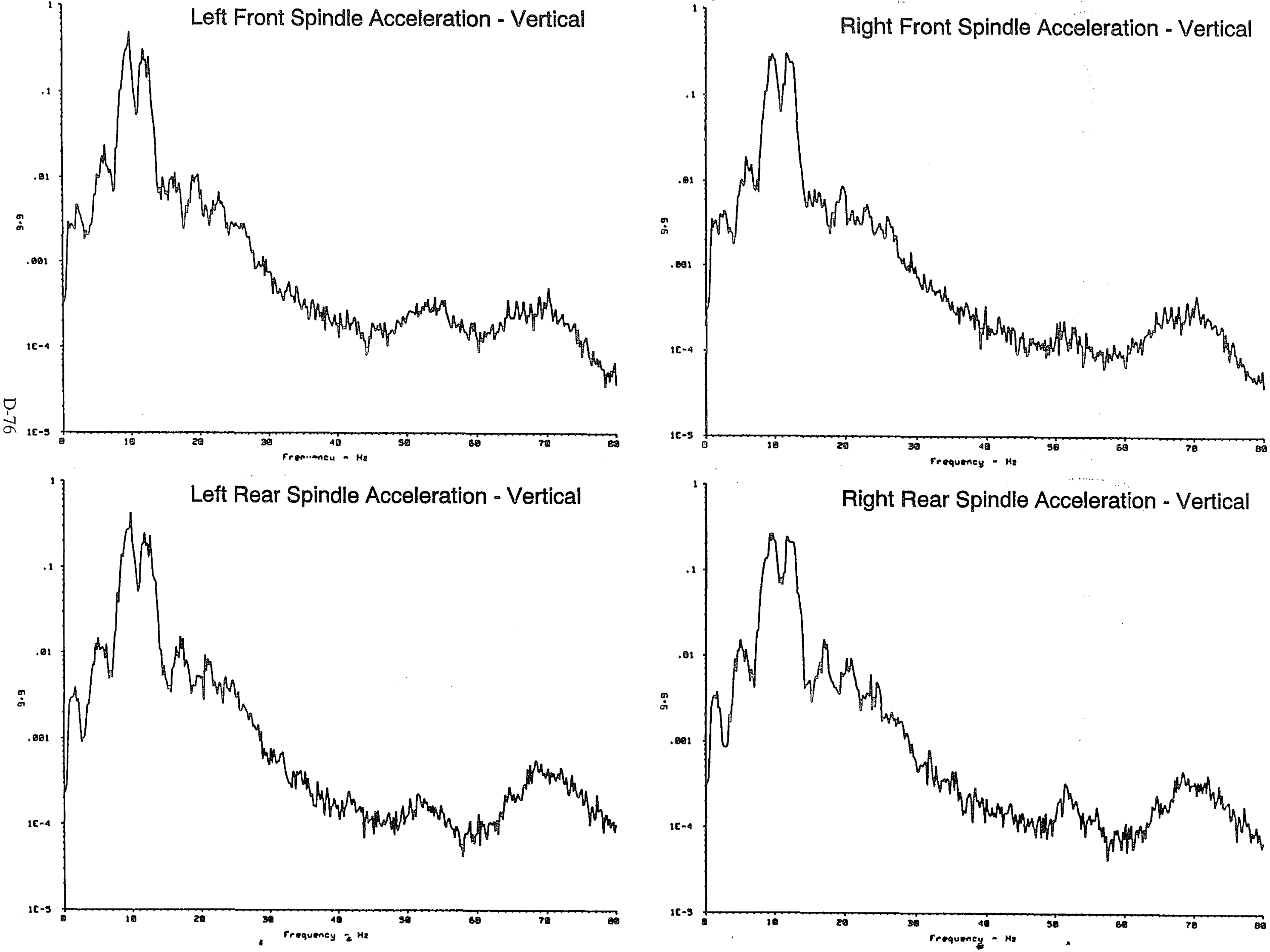


Figure D-64 Channels #5 - #8 from Churchville B (Rough) at 10 mph

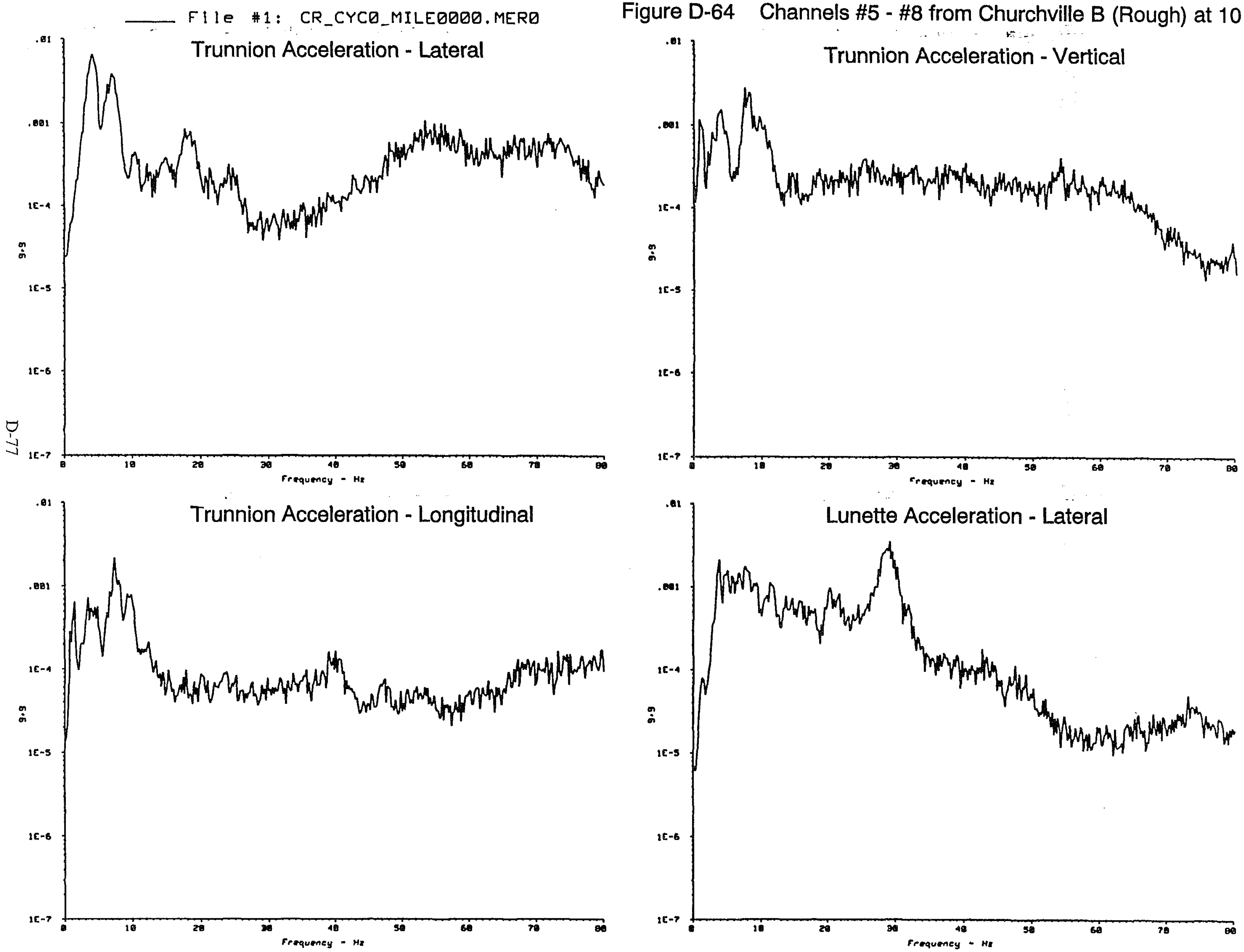


Figure D-65 Channels #9 - #12 from Churchville B (Rough) at 10 mph

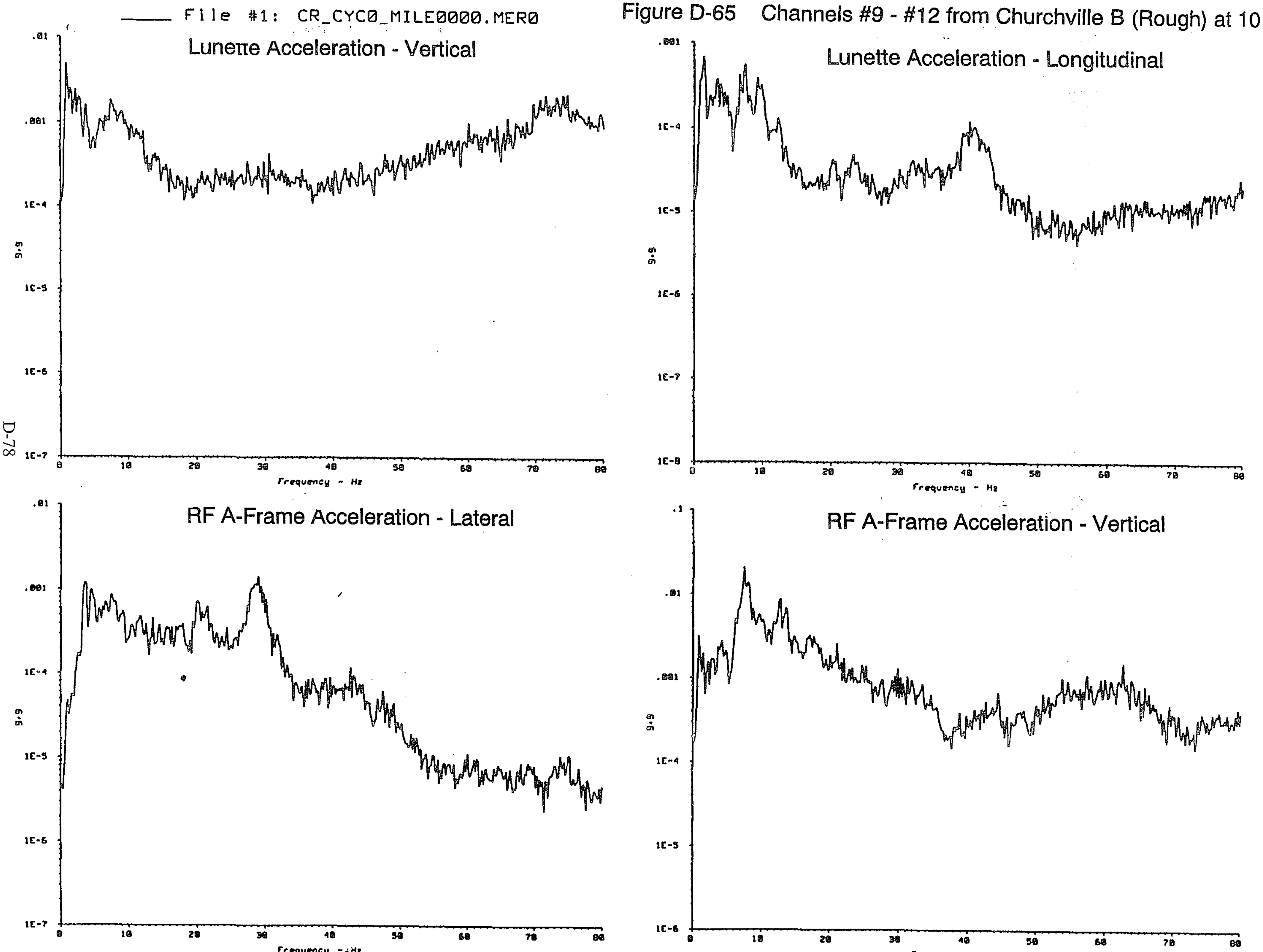


Figure D-66 Channels #13 - #16 from Churchville B (Rough) at 10 mph

File #1: CR_CYC0_MILE0000.MER0

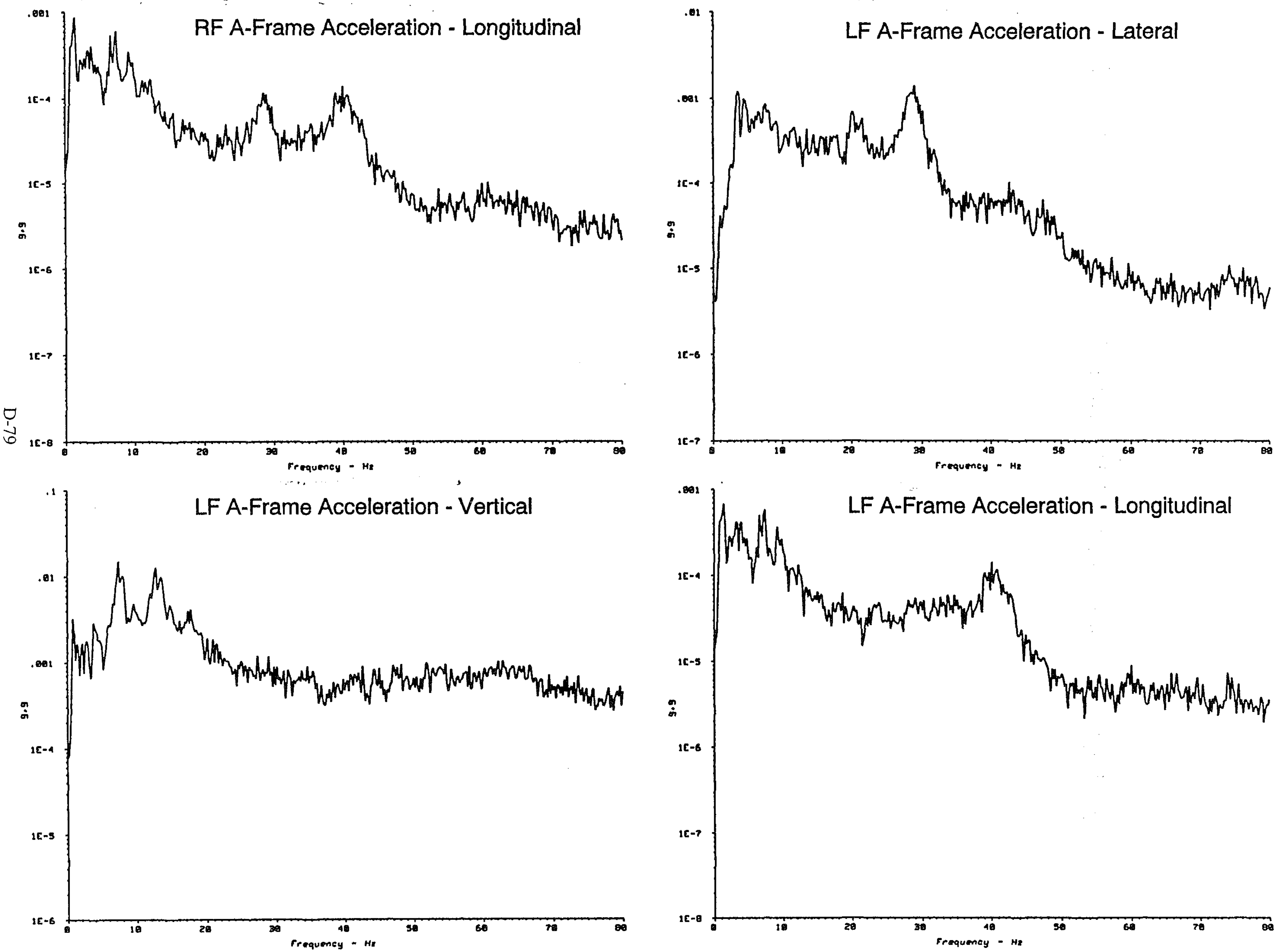


Figure D-67 Channels #17 - #20 from Churchville B (Rough) at 10 mph

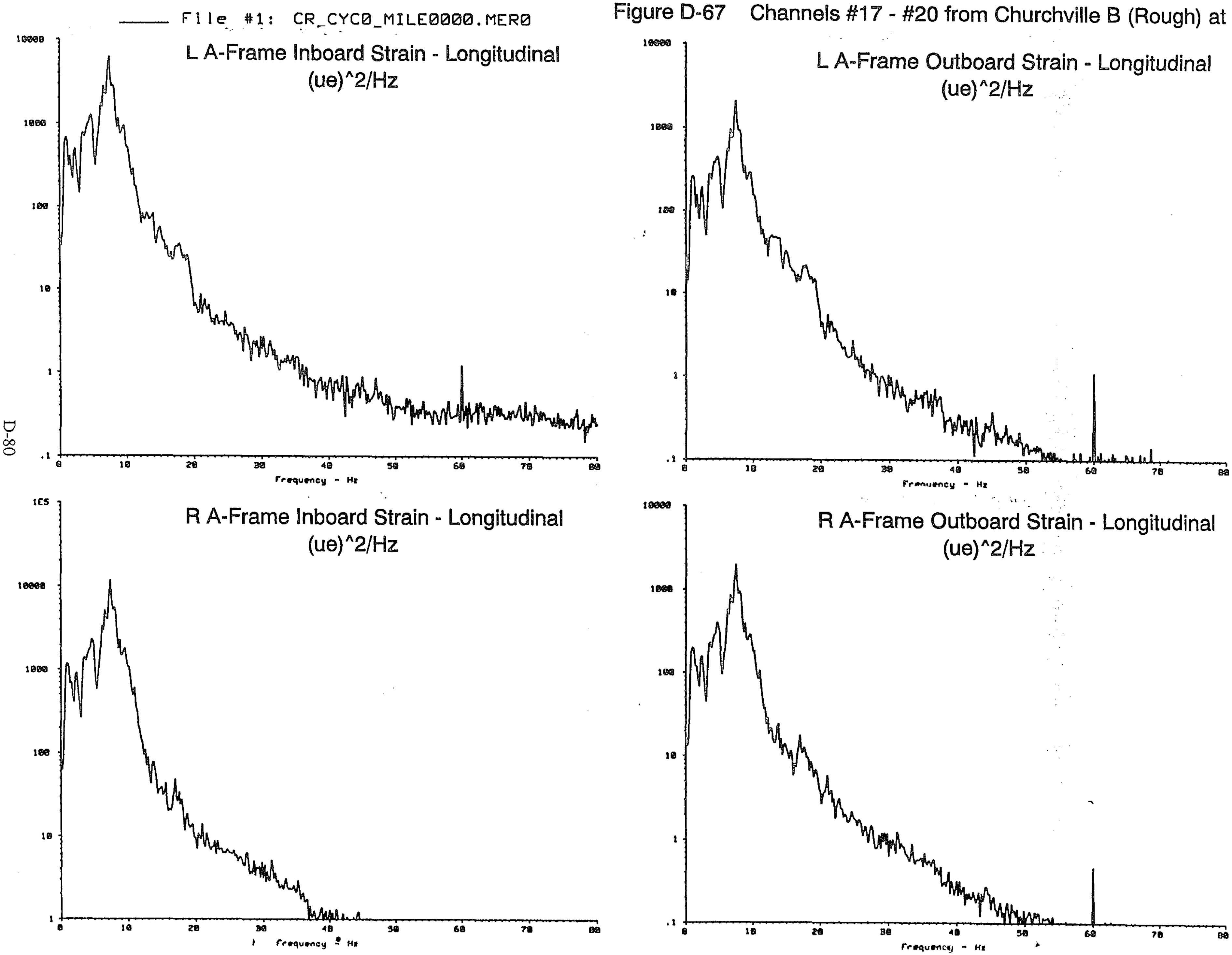
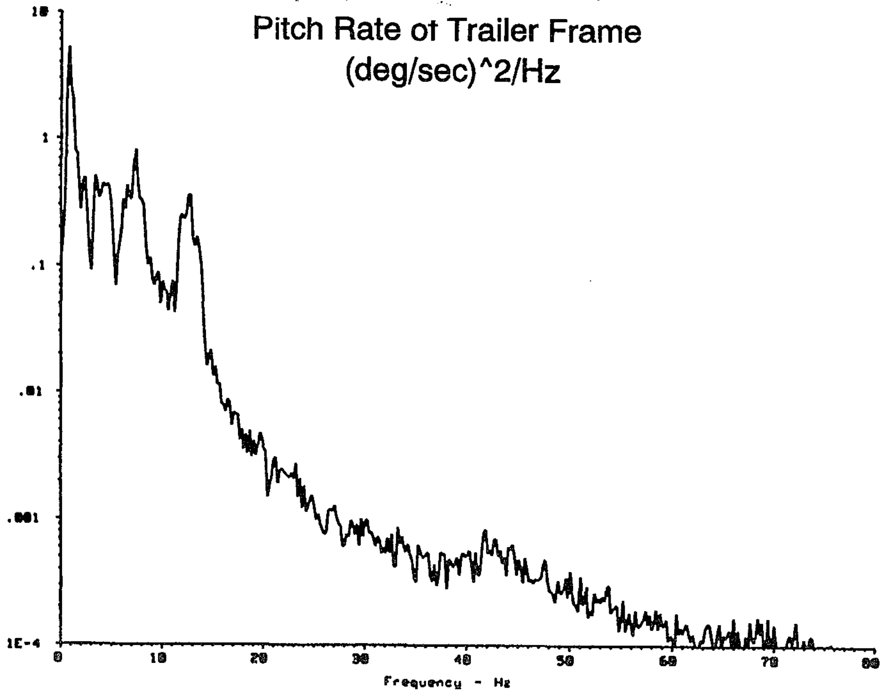
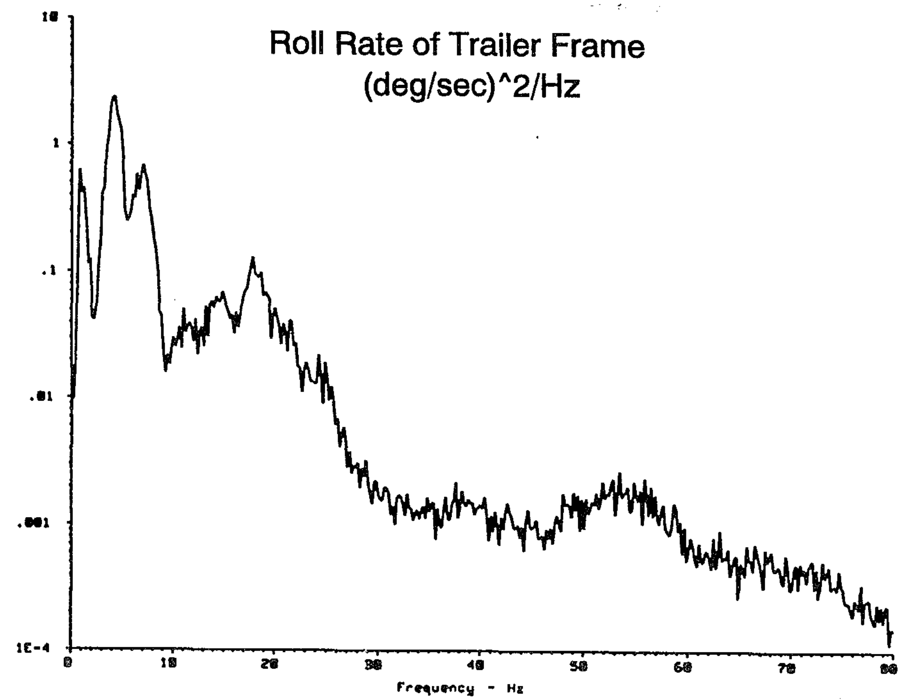


Figure D-68 Channels #21 - #22 from Churchville B (Rough) at 10 mph

——— File #1: CR_CYC0_MILE0000.MER0





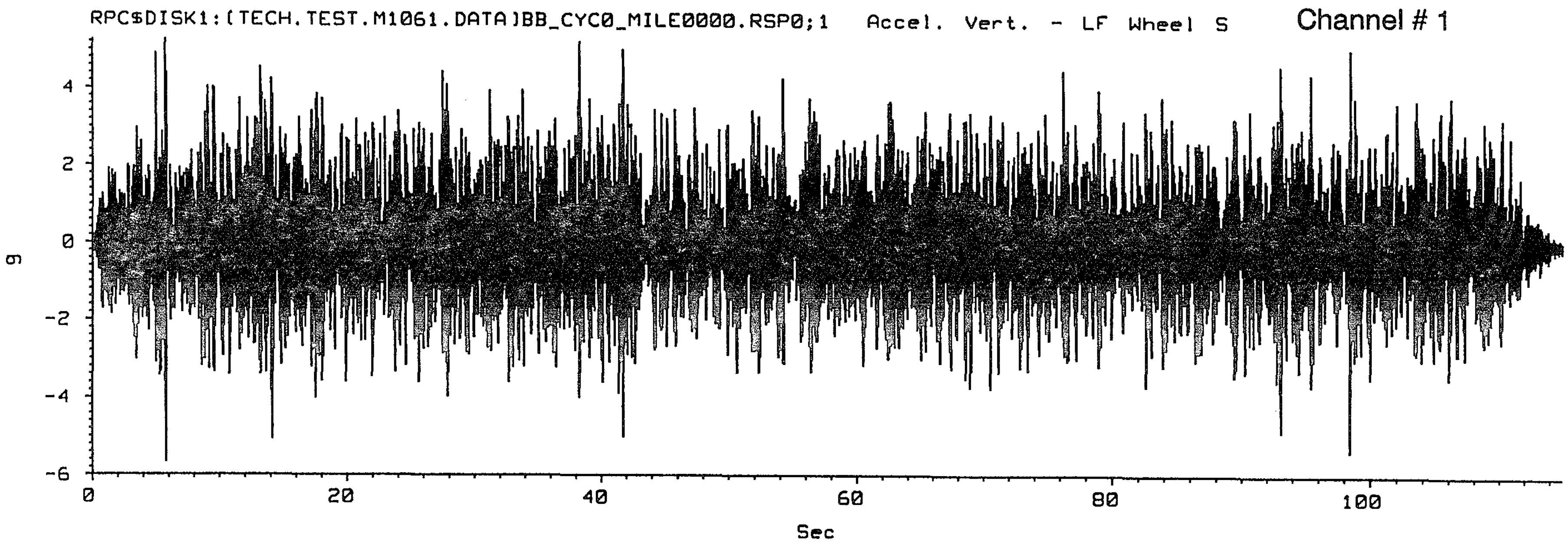
TIME HISTORY PLOTS

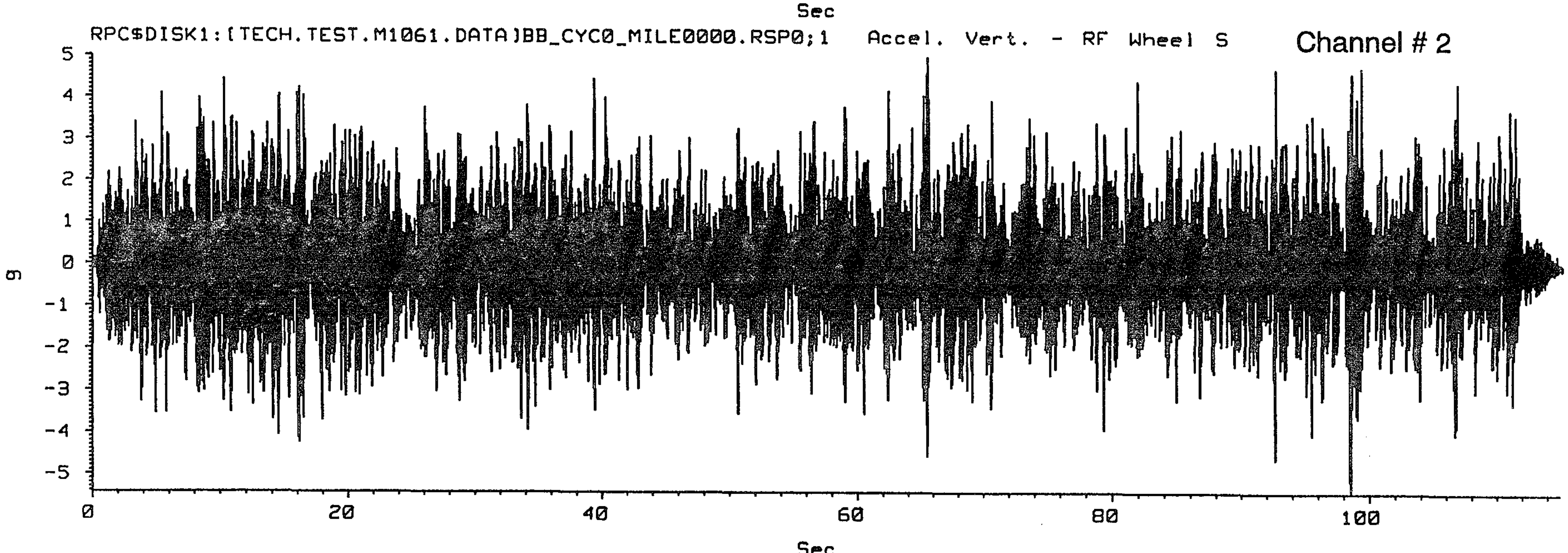
FROM

BELGIAN BLOCK AT 10 MPH

MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:11:50

Figure D-69 LF & RF Wheel Spindle Accelerations from Belgian Block at 10 mph

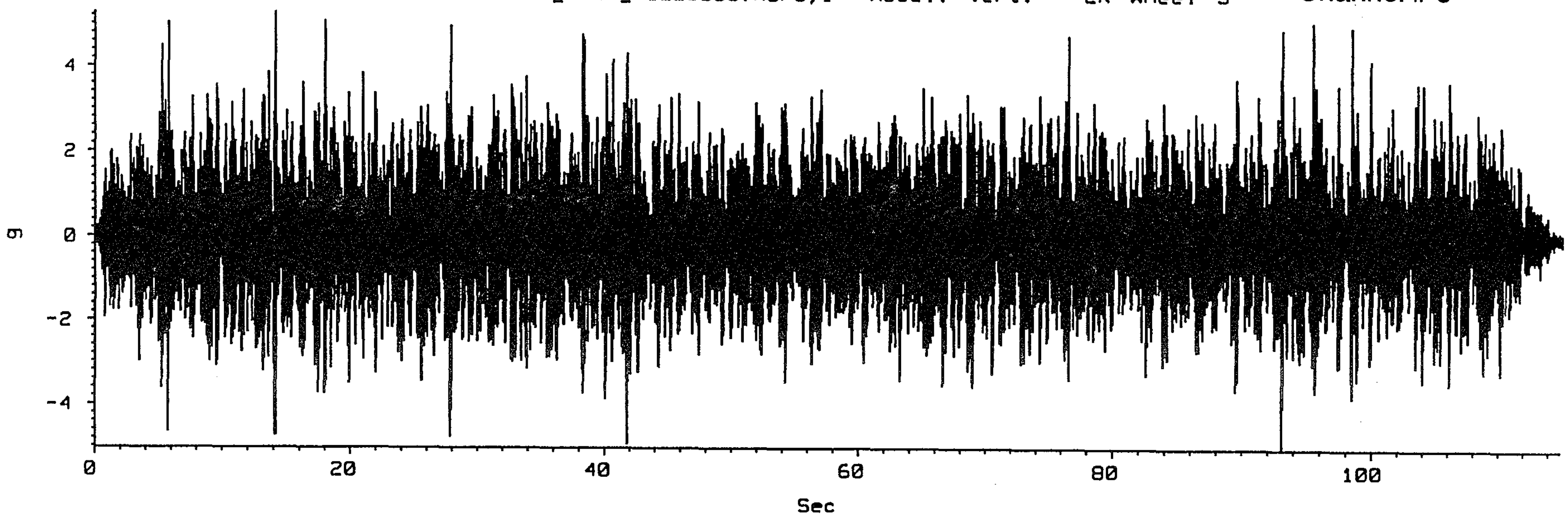




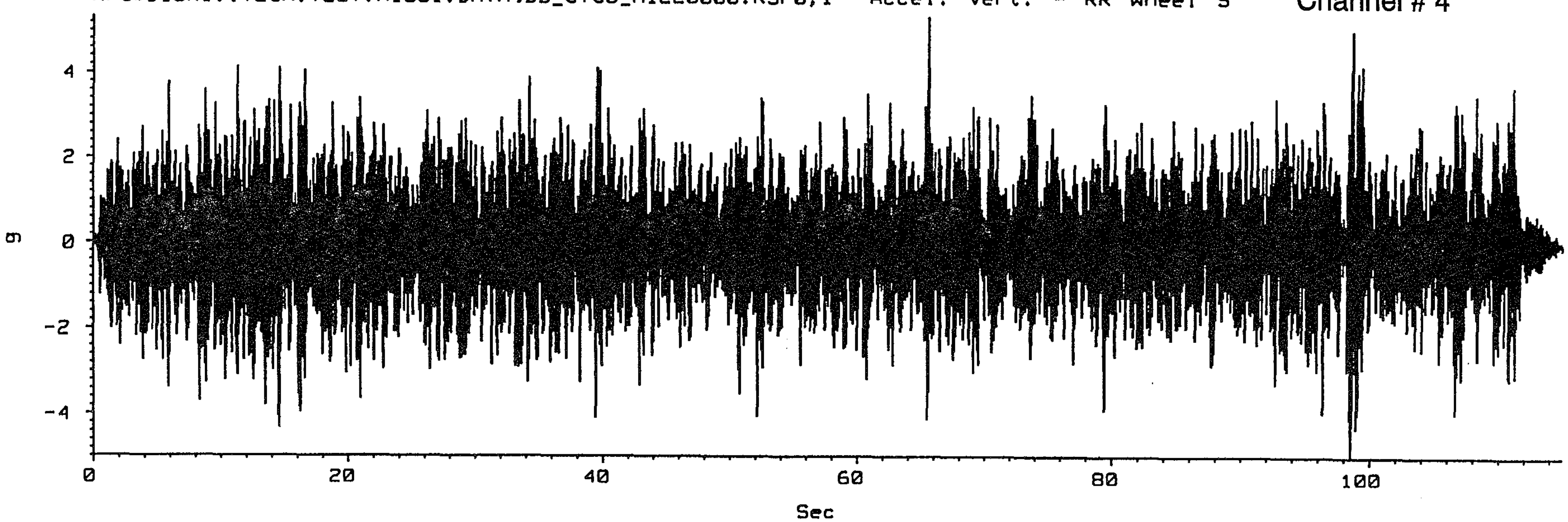
MTS - Remote Parameter Control : BTSEPARATE 5-FEB-1996 09:28:20

Figure D-70 LR & RR Wheel Spindle Accelerations from Belgian Block at 10 mph

RPC$DISK1:[TECH.TEST.M1061.DATA]BB_CYC0_MILE0000.RSP0;1 Accel. Vert. - LR Wheel S Channel # 3

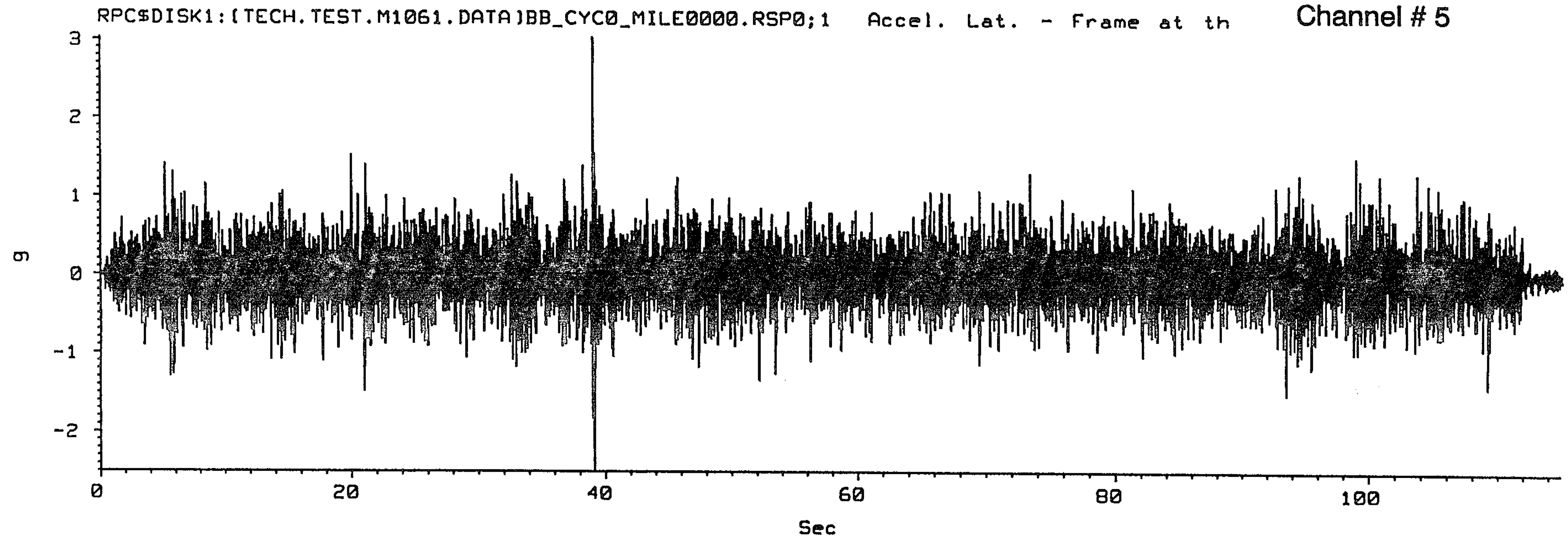


RPC$DISK1:[TECH.TEST.M1061.DATA]BB_CYC0_MILE0000.RSP0;1 Accel. Vert. - RR Wheel S Channel # 4



MTS - Remote Parameter Control : BTSEPARATE 5-FEB-1996 09:35:58

Figure D-71 Lateral & Vertical Trunnion Accelerations from Belgian Block at 10 mph



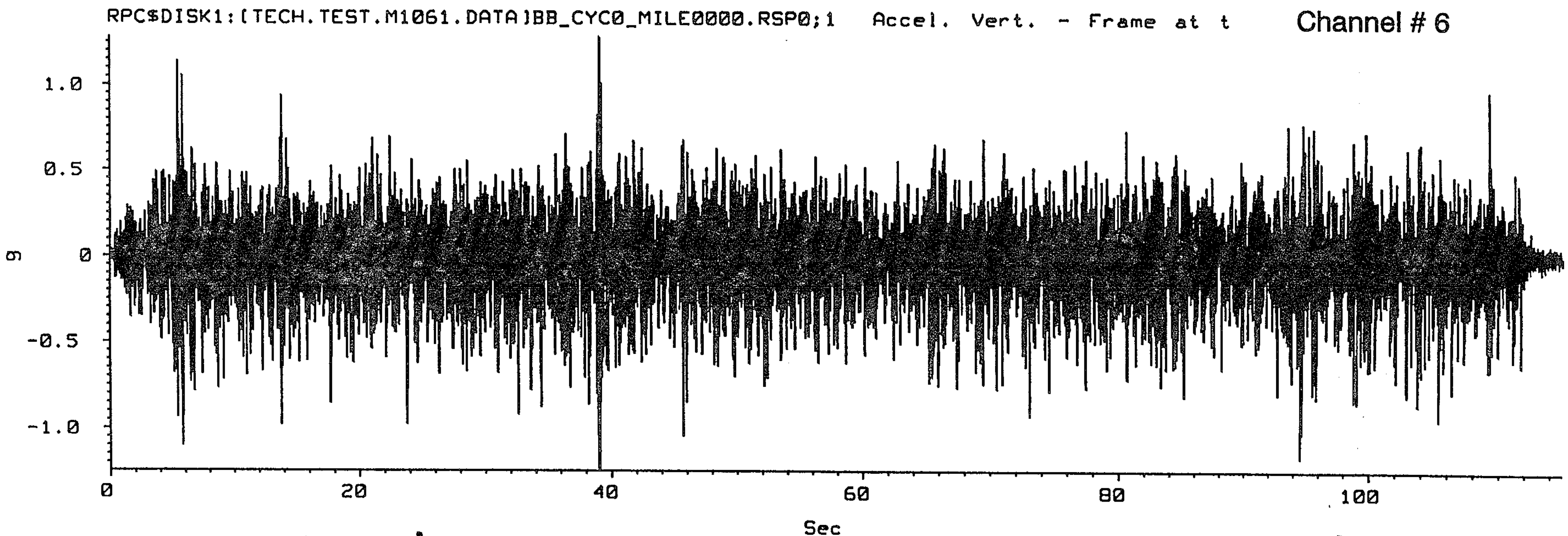
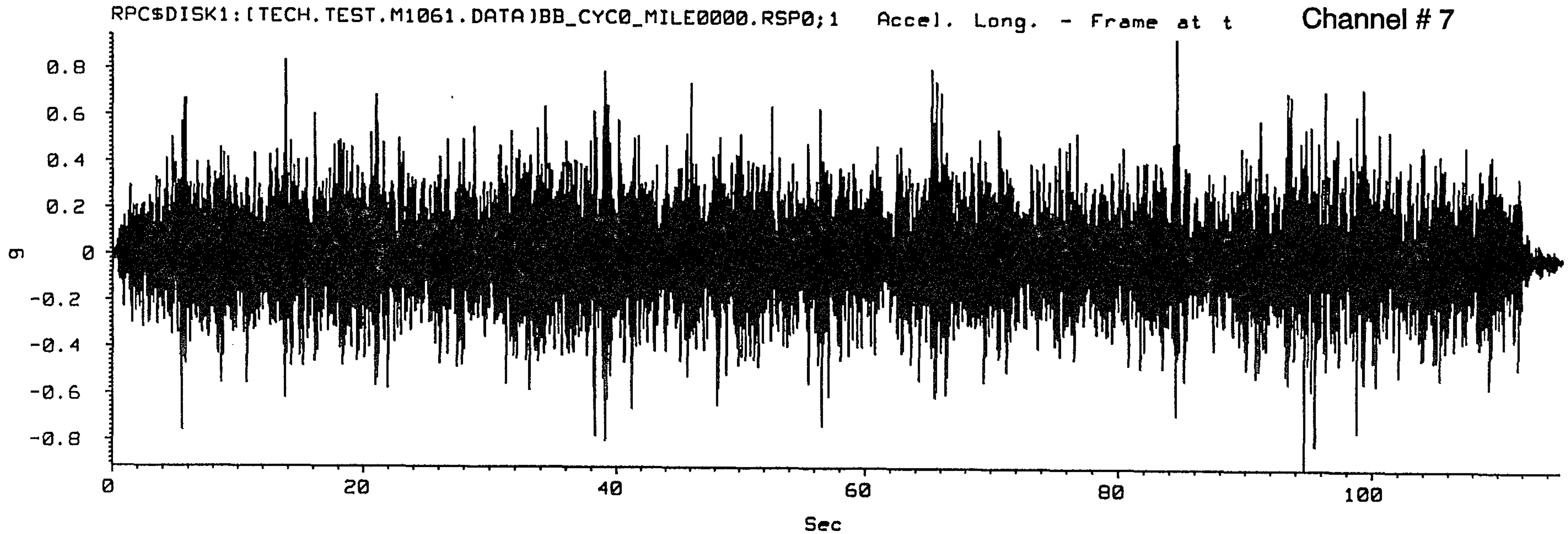
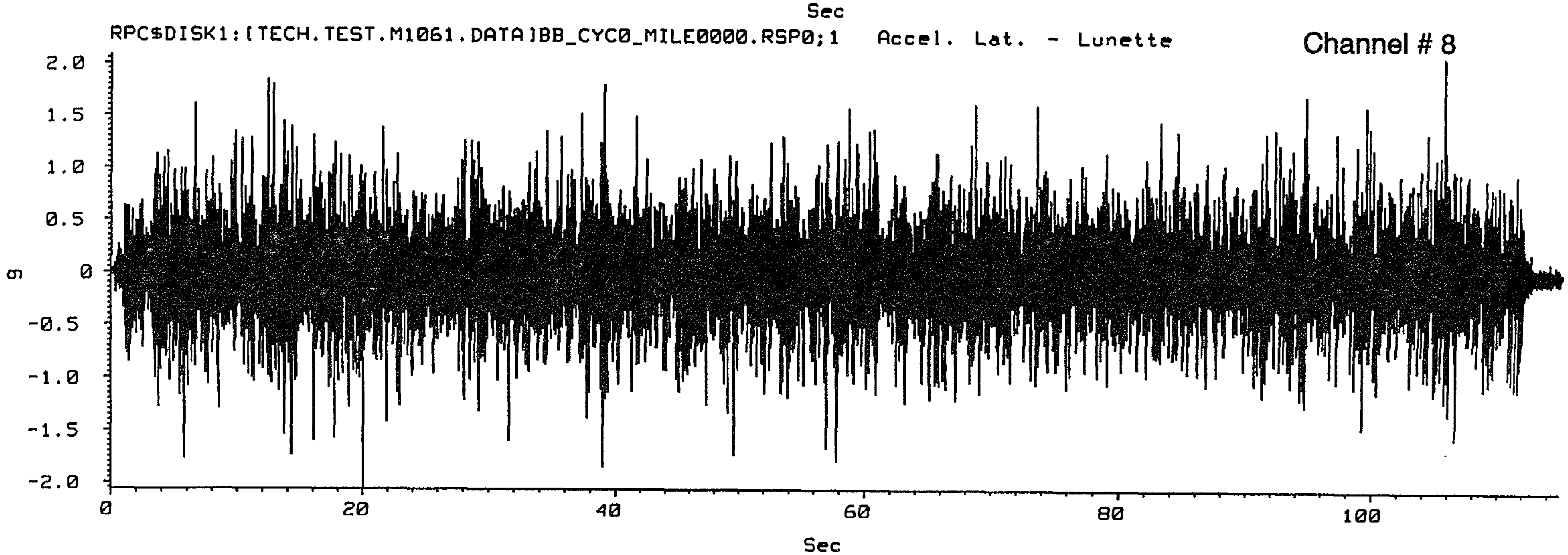


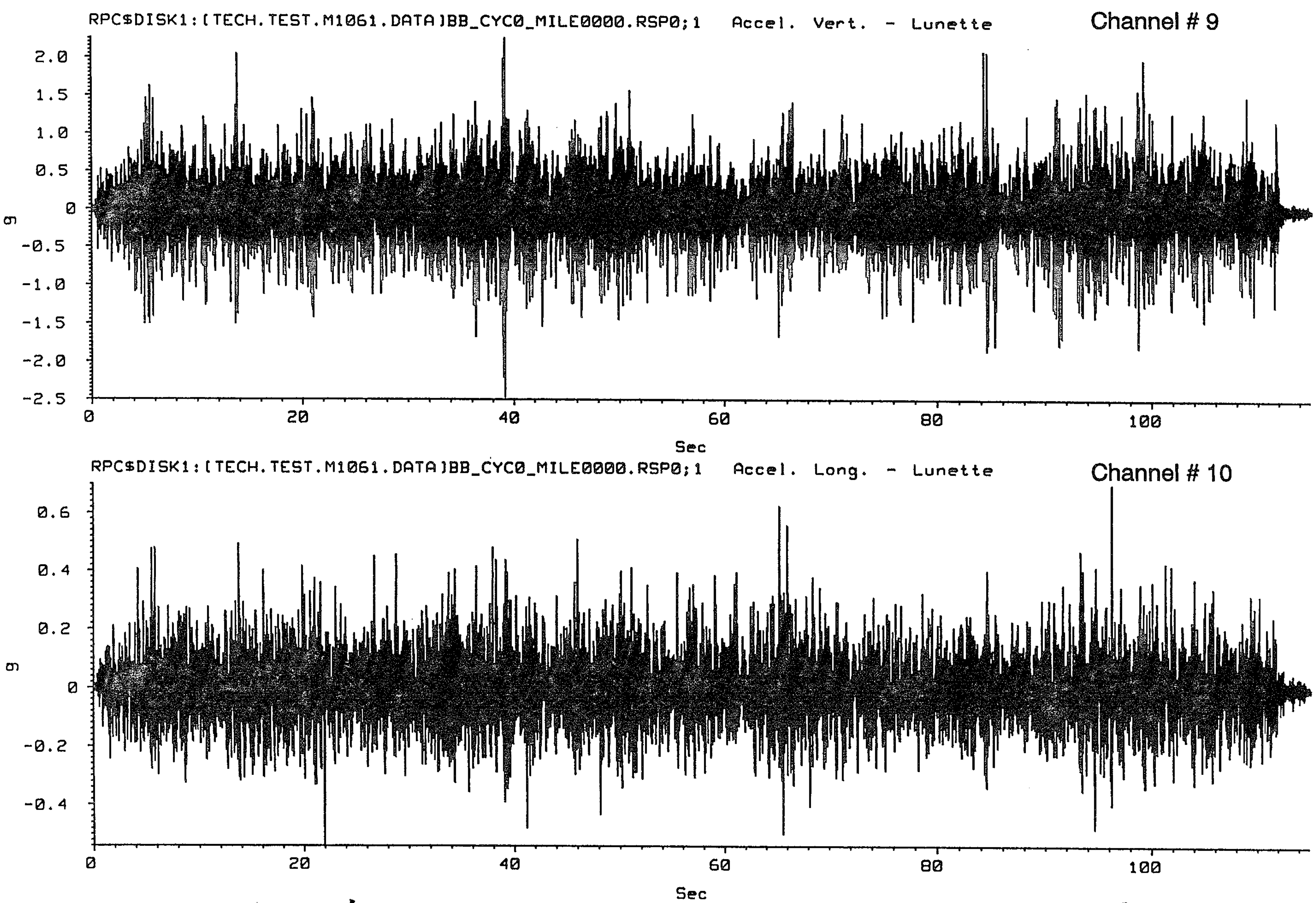
Figure D-72 Longitudinal Trunnion & Lateral Lunette Accelerations from Belgian Block at 10 mph





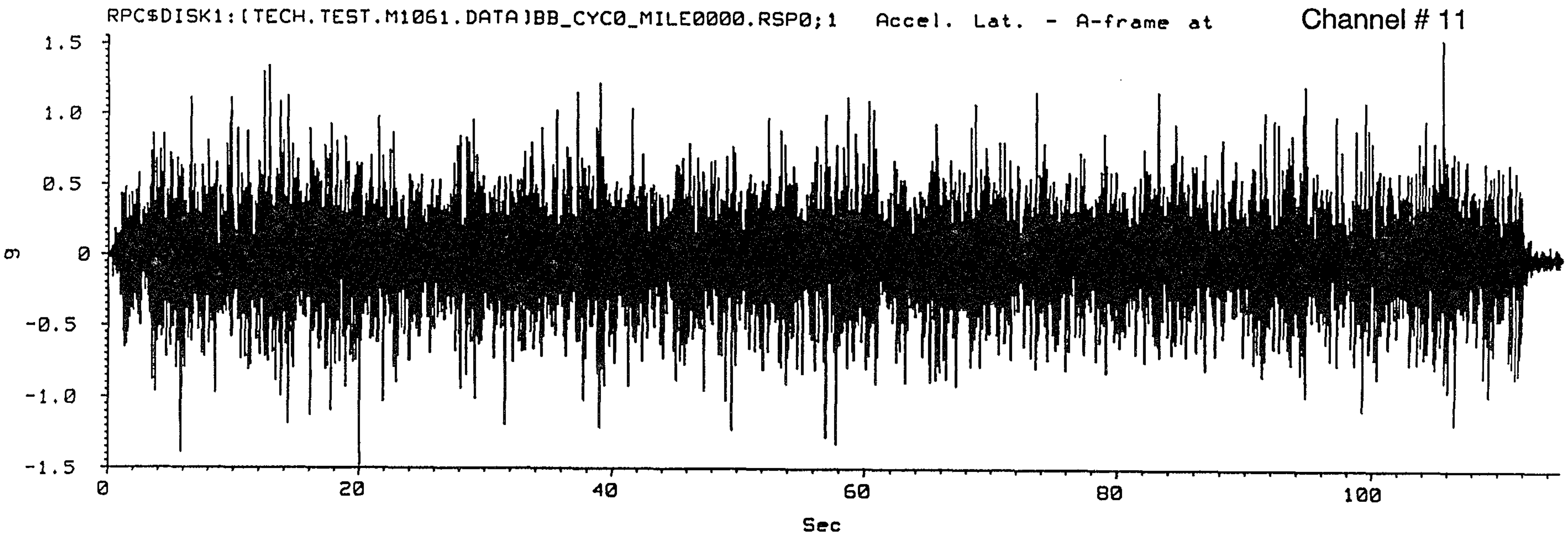
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:17:45

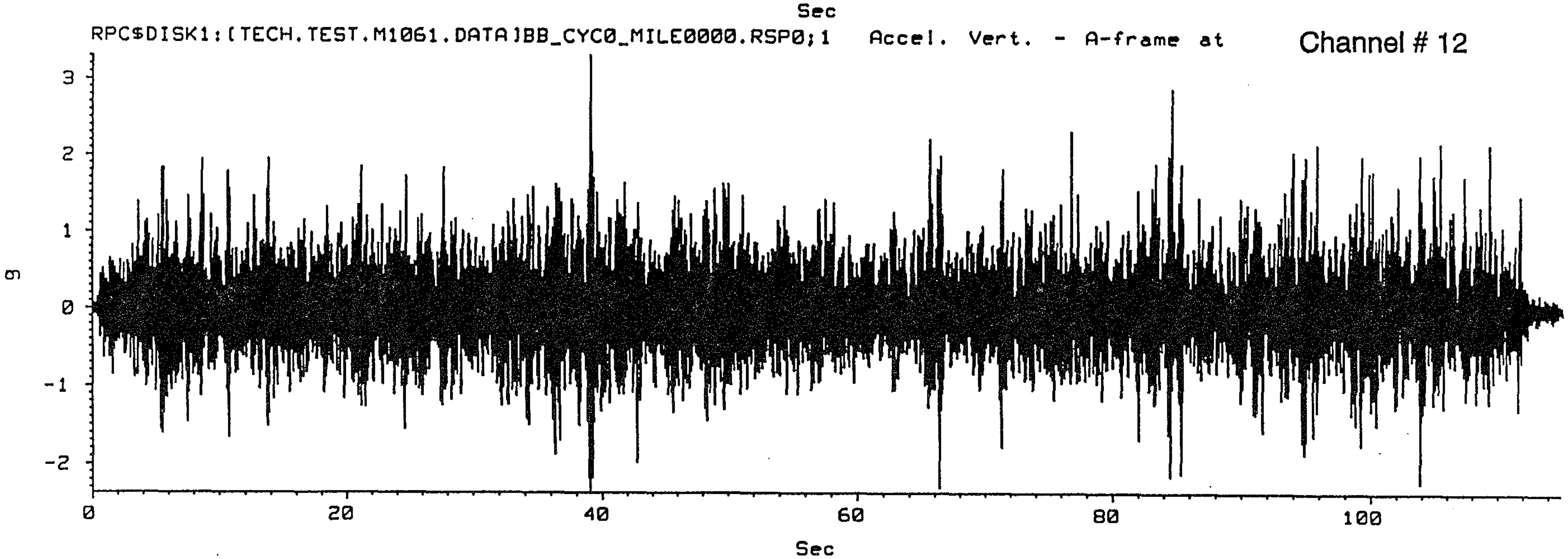
Figure D-73 Vertical & longitudinal Lunette Accelerations from Belgian Block at 10 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:19:16

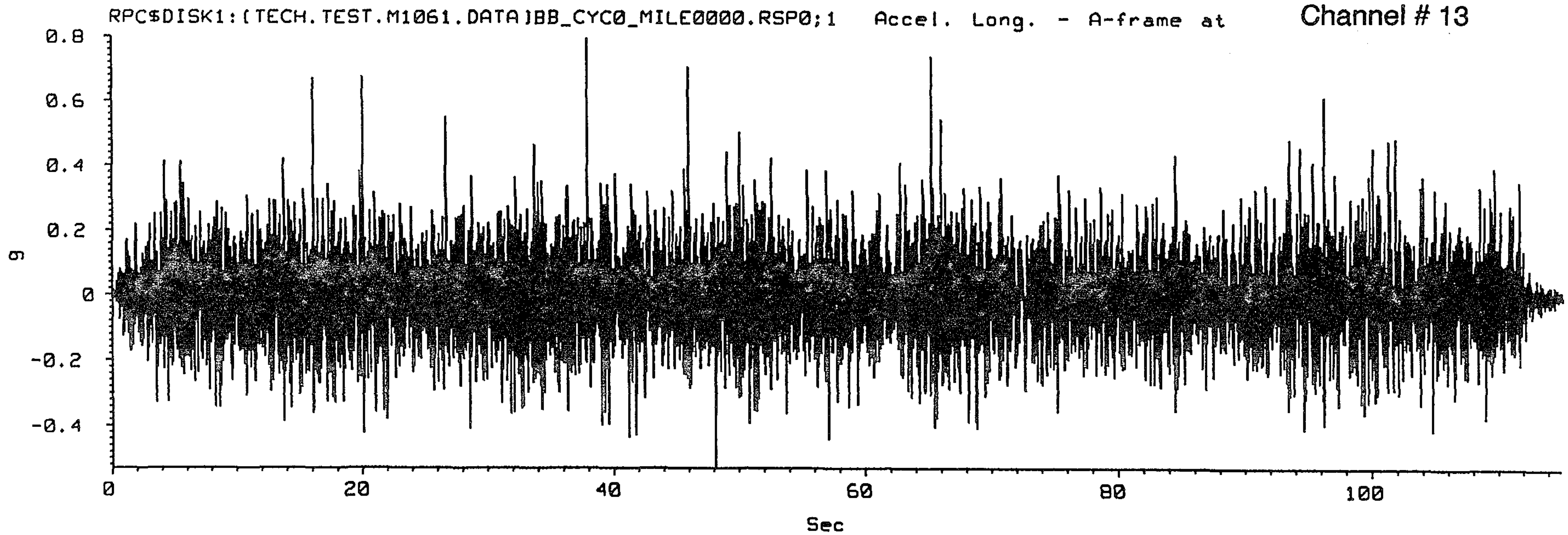
Figure D-74 Lateral & Vertical Right A-Frame Acceleration from Belgian Block at 10 mph

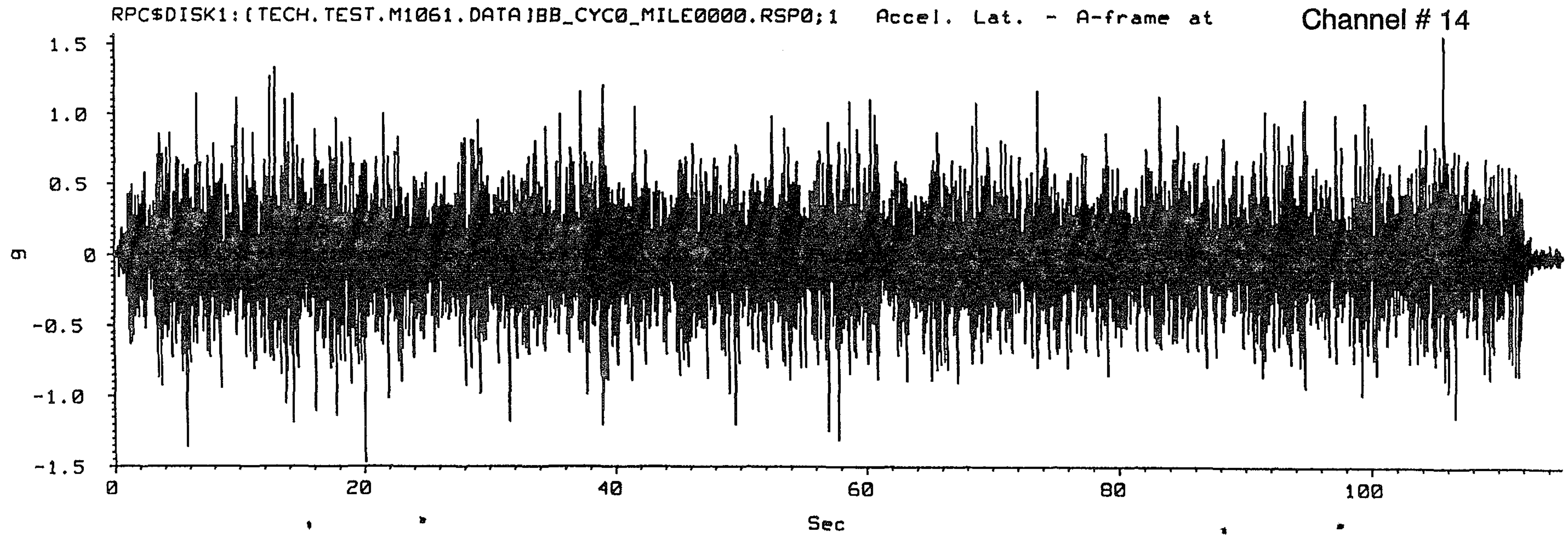




MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:20:48

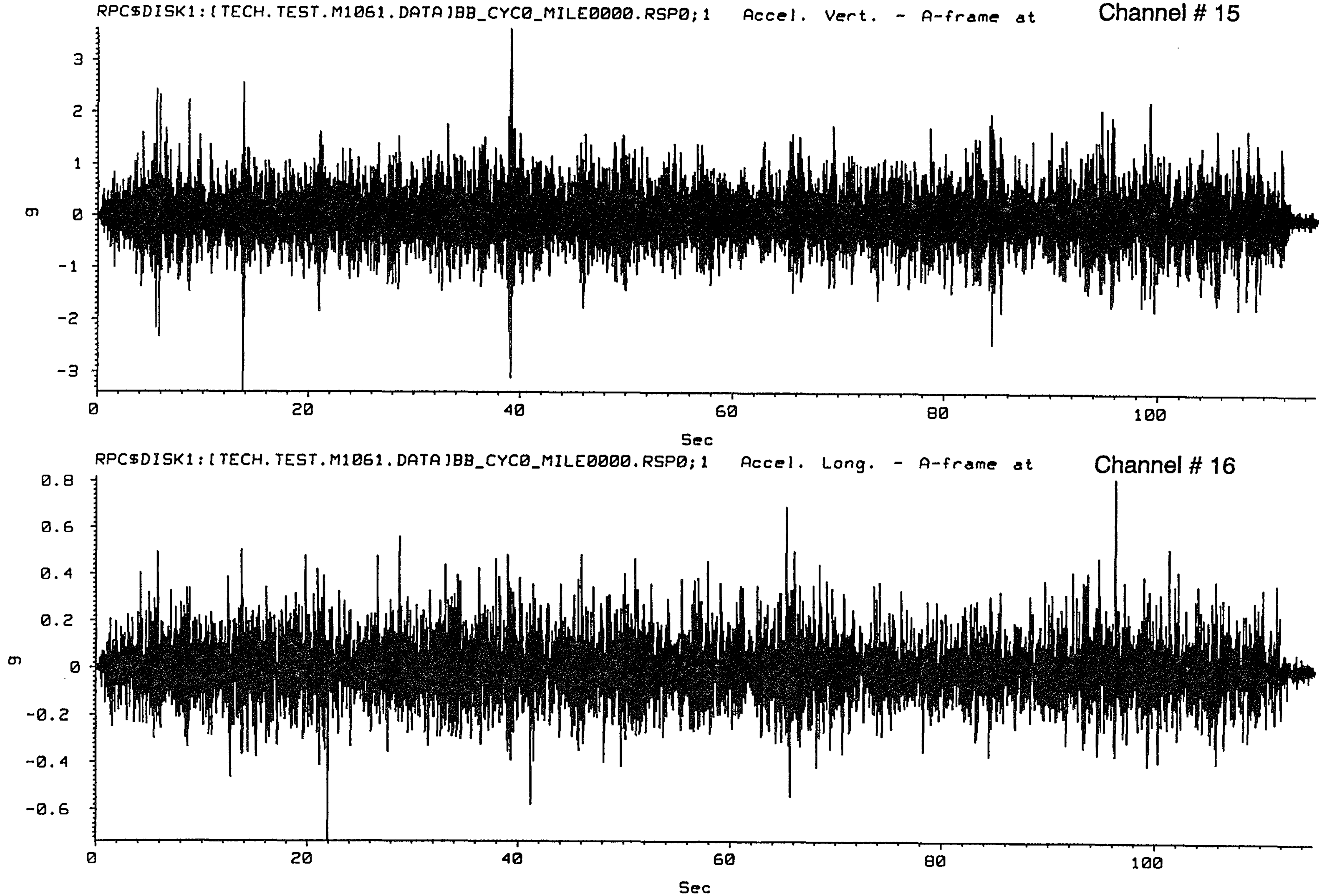
Figure D-75 Longitudinal R & Lateral L A-Frame Accelerations from Belgian Block at 10 mph





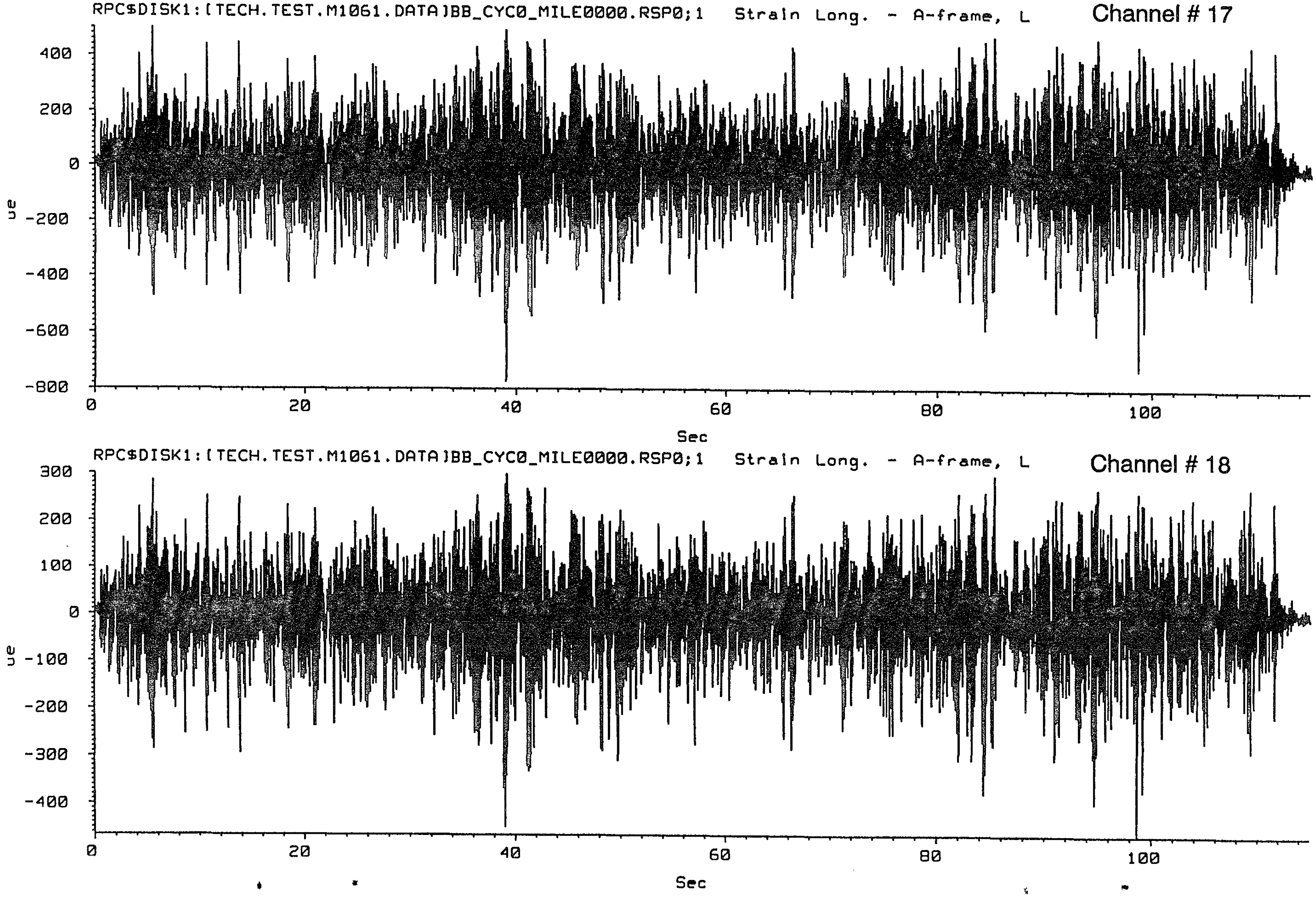
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:22:23

Figure D-76 Vertical & Longitudinal L A-Frame Accelerations from Belgian Block at 10 mph



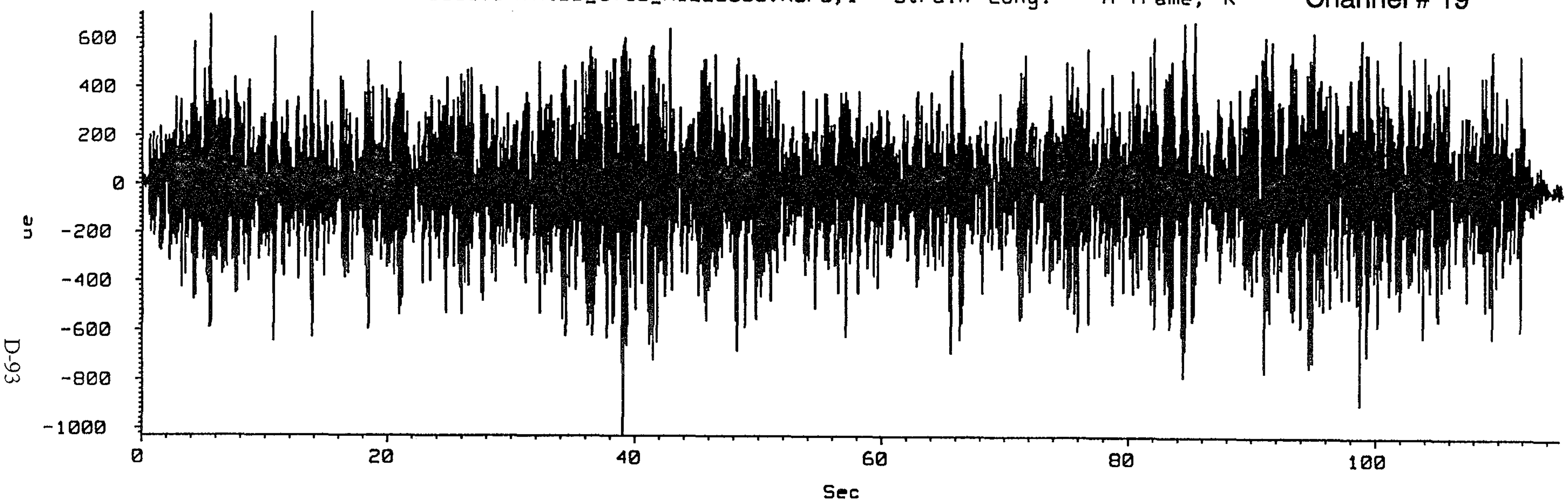
MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:23:59

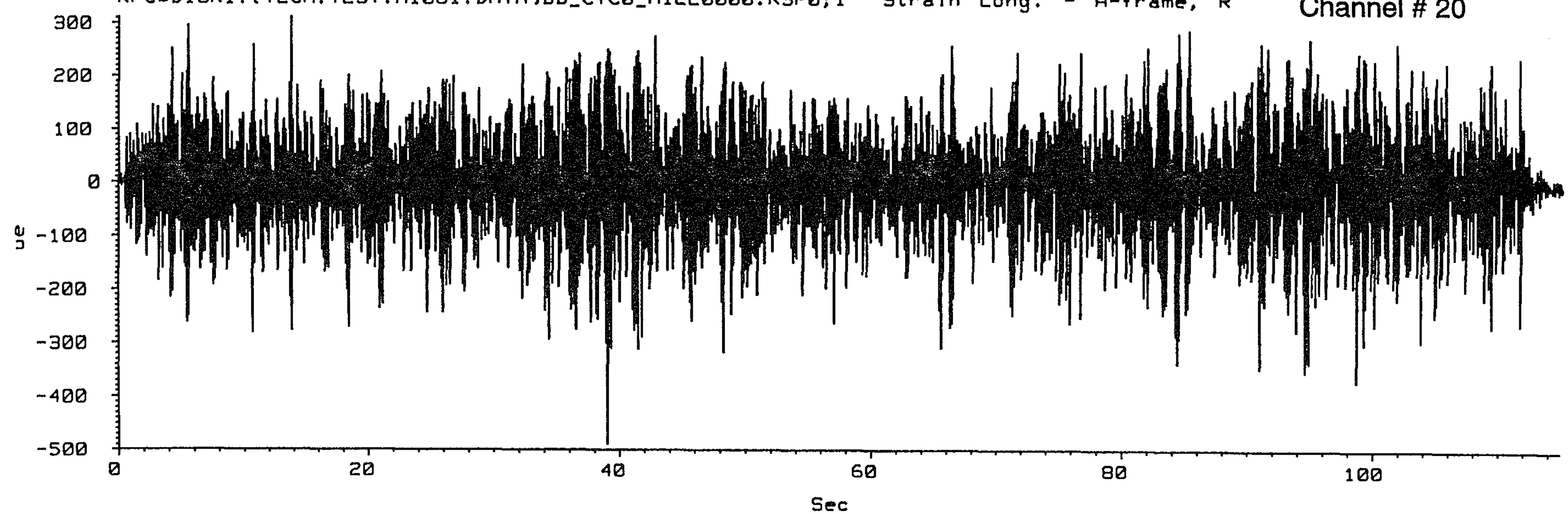
Figure D-77 Inboard & Outboard Left A-Frame Longitudinal Strain from Belgian Block at 10 mph



MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:25:32

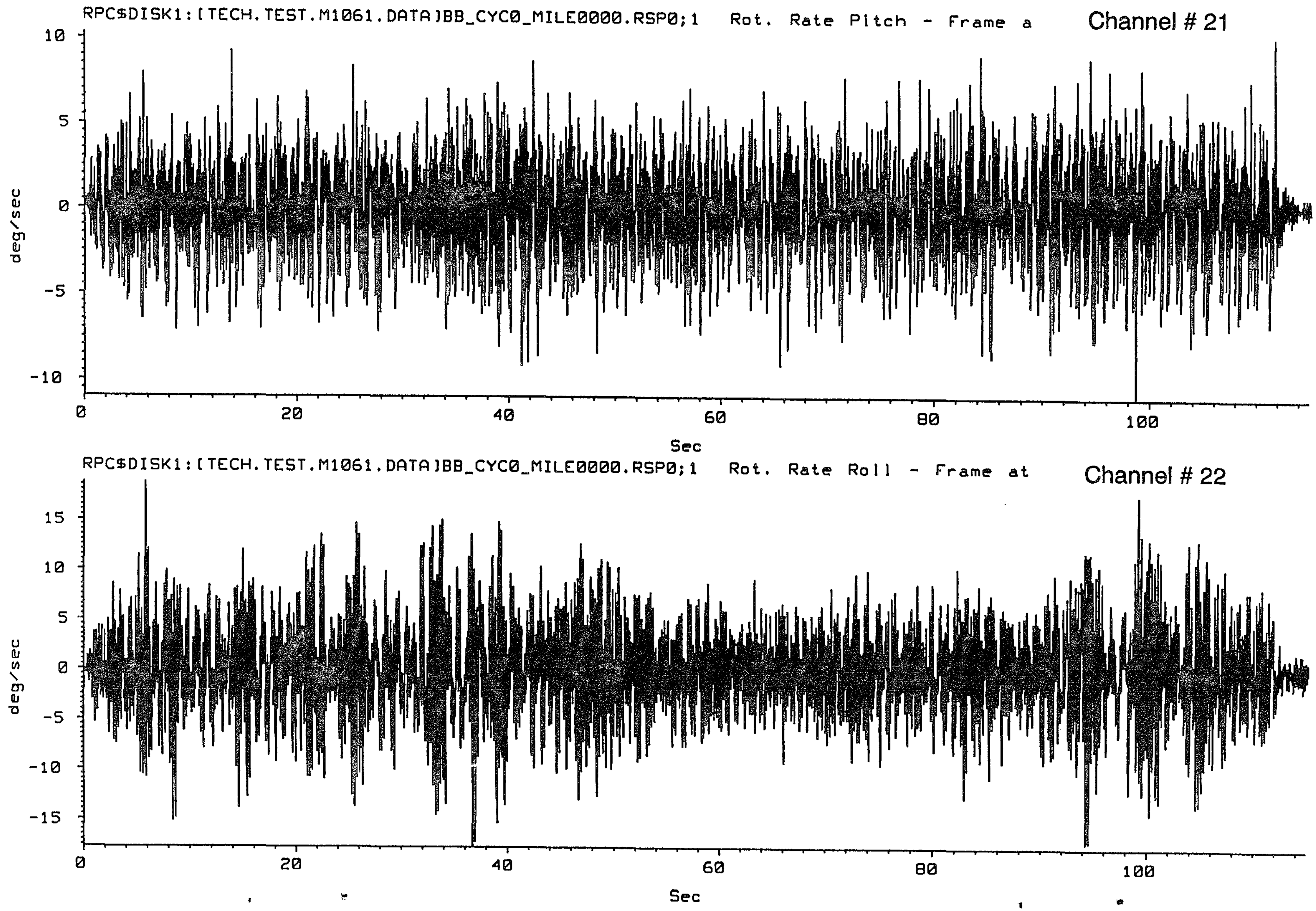
Figure D-78 Inboard & Outboard Right A-Frame Longitudinal Strain from Belgian Block at 10 mph





MTS - Remote Parameter Control : BTSEPARATE 2-FEB-1996 10:27:06

Figure D-79 Pitch and Roll Rate of Trailer Frame from Belgian Block at 10 mph

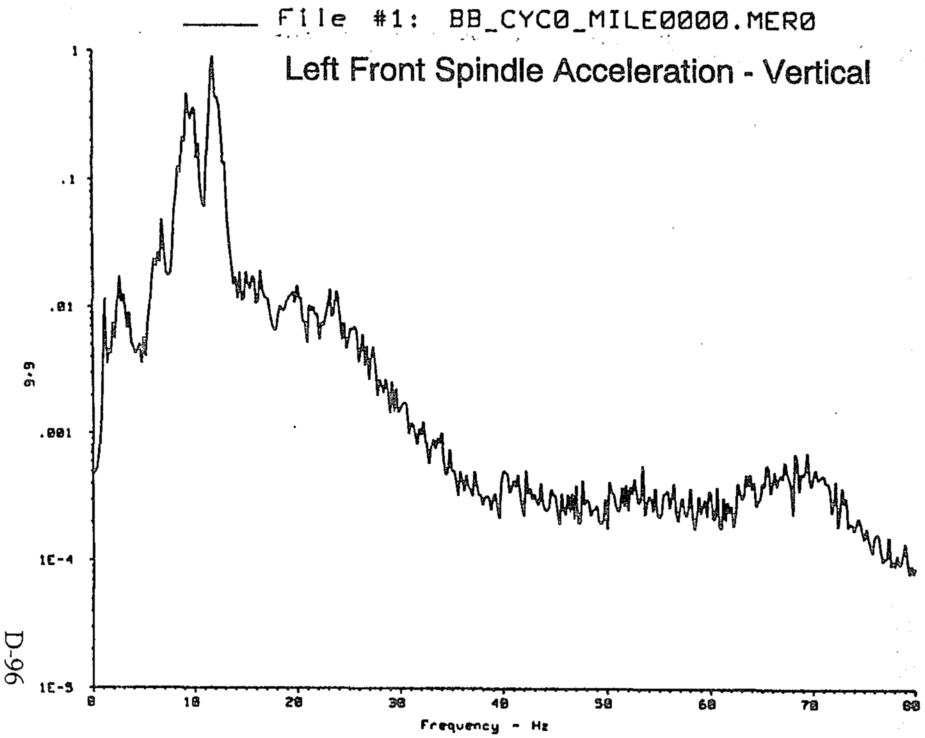


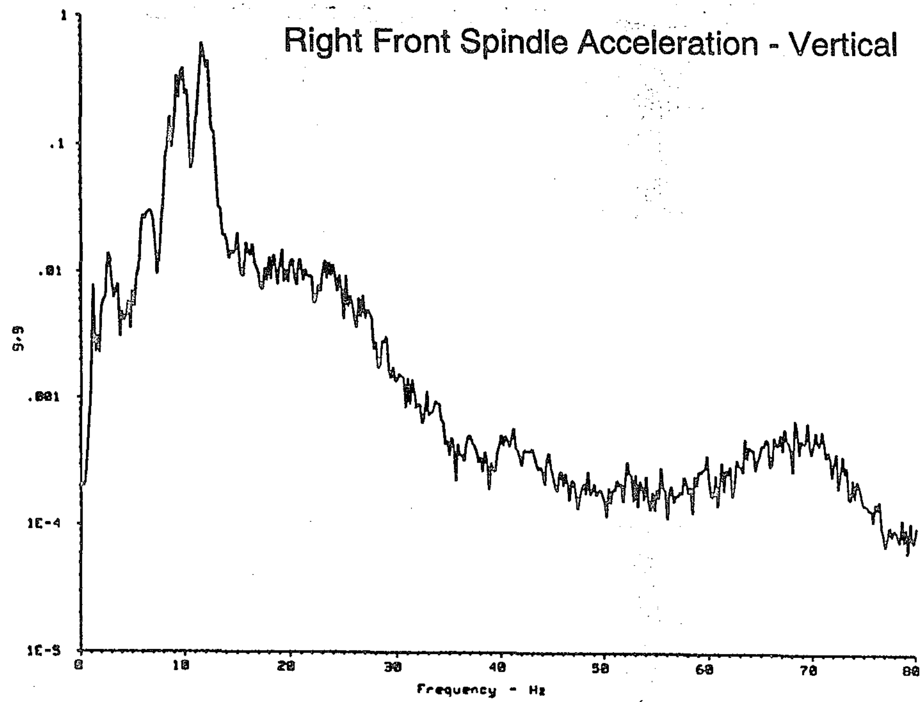
POWER SPECTRAL DENSITY PLOTS

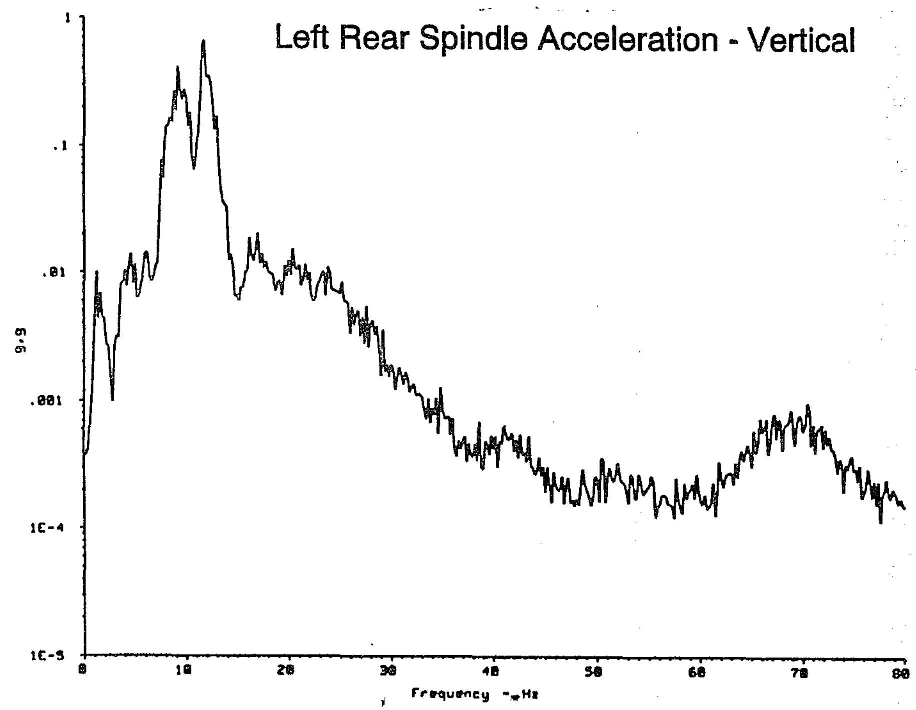
FROM

BELGIAN BLOCK AT 10 MPH

Figure D-80 Channels #1 - #4 from Belgian Block at 10 mph







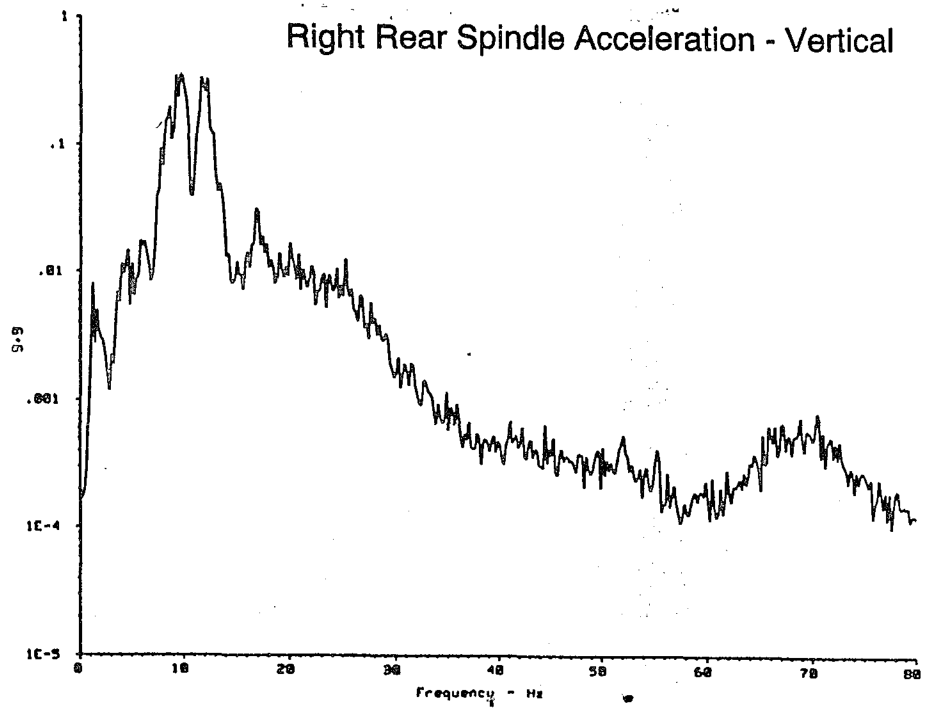


Figure D-81 Channels #5 - #8 from Belgian Block at 10 mph

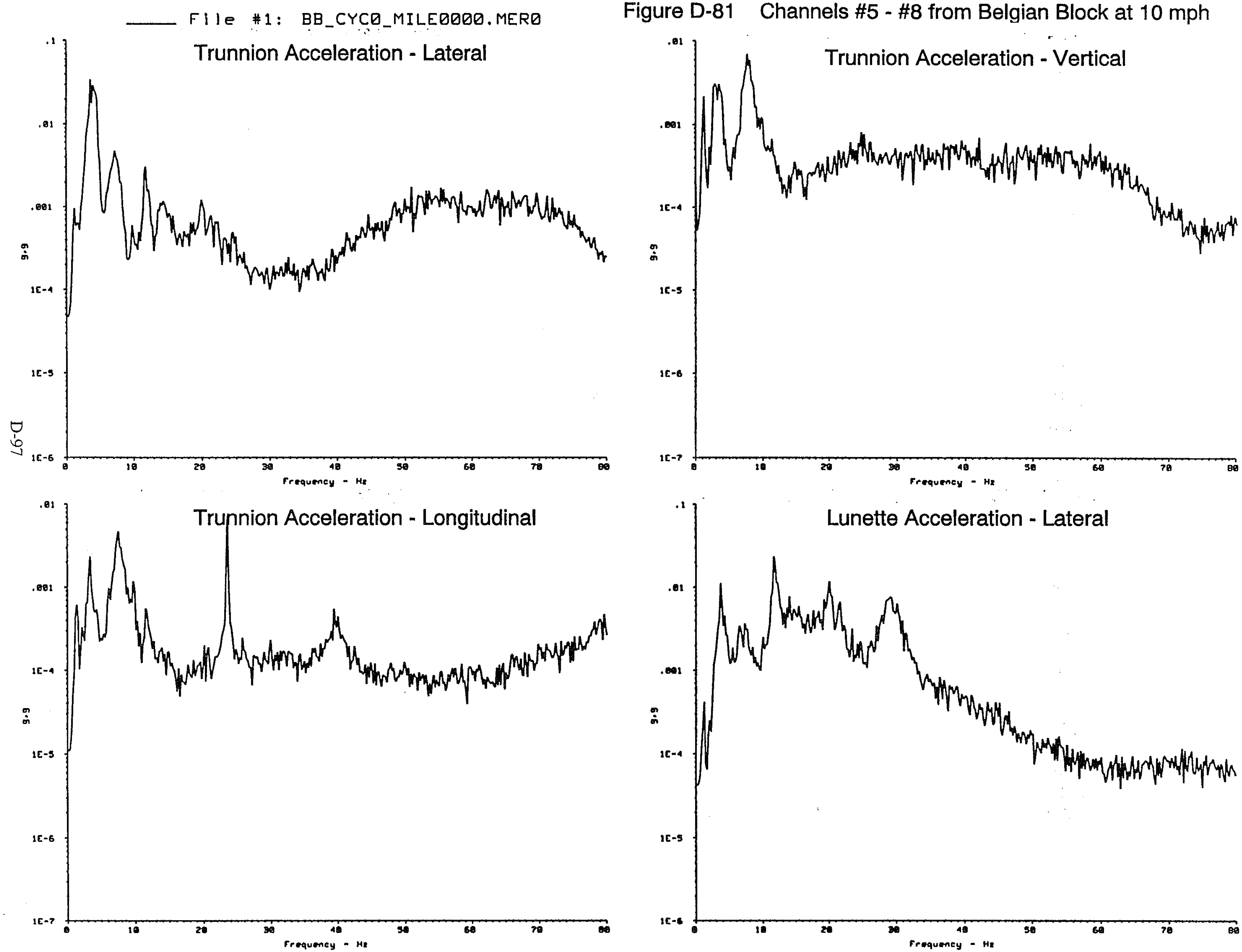


Figure D-82 Channels #9 - #12 from Belgian Block at 10 mph

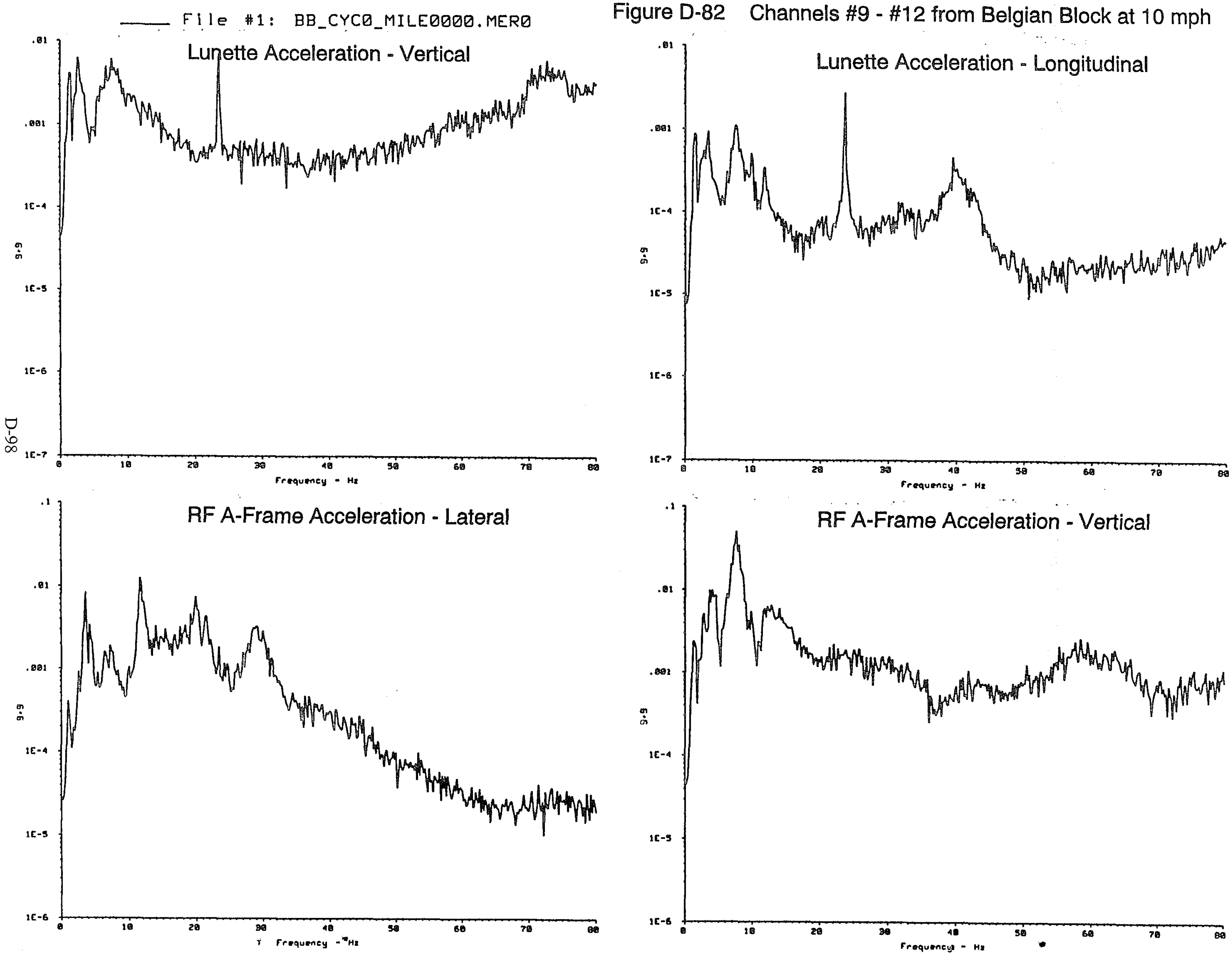


Figure D-83 Channels #13 - #16 from Belgian Block at 10 mph

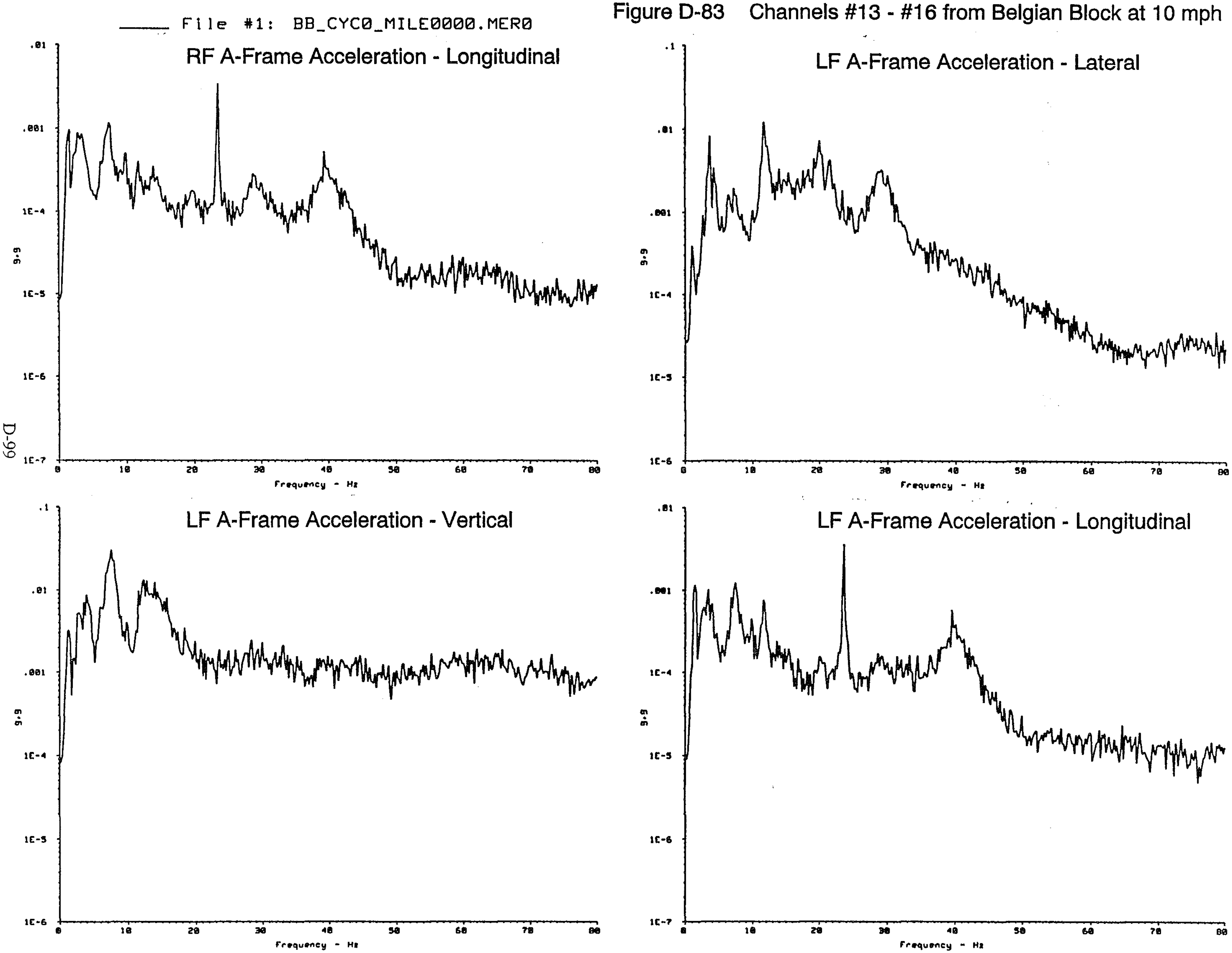


Figure D-84 Channels #17 - #20 from Belgian Block at 10 mph

File #1: BB_CYC0_MILE0000.MER0

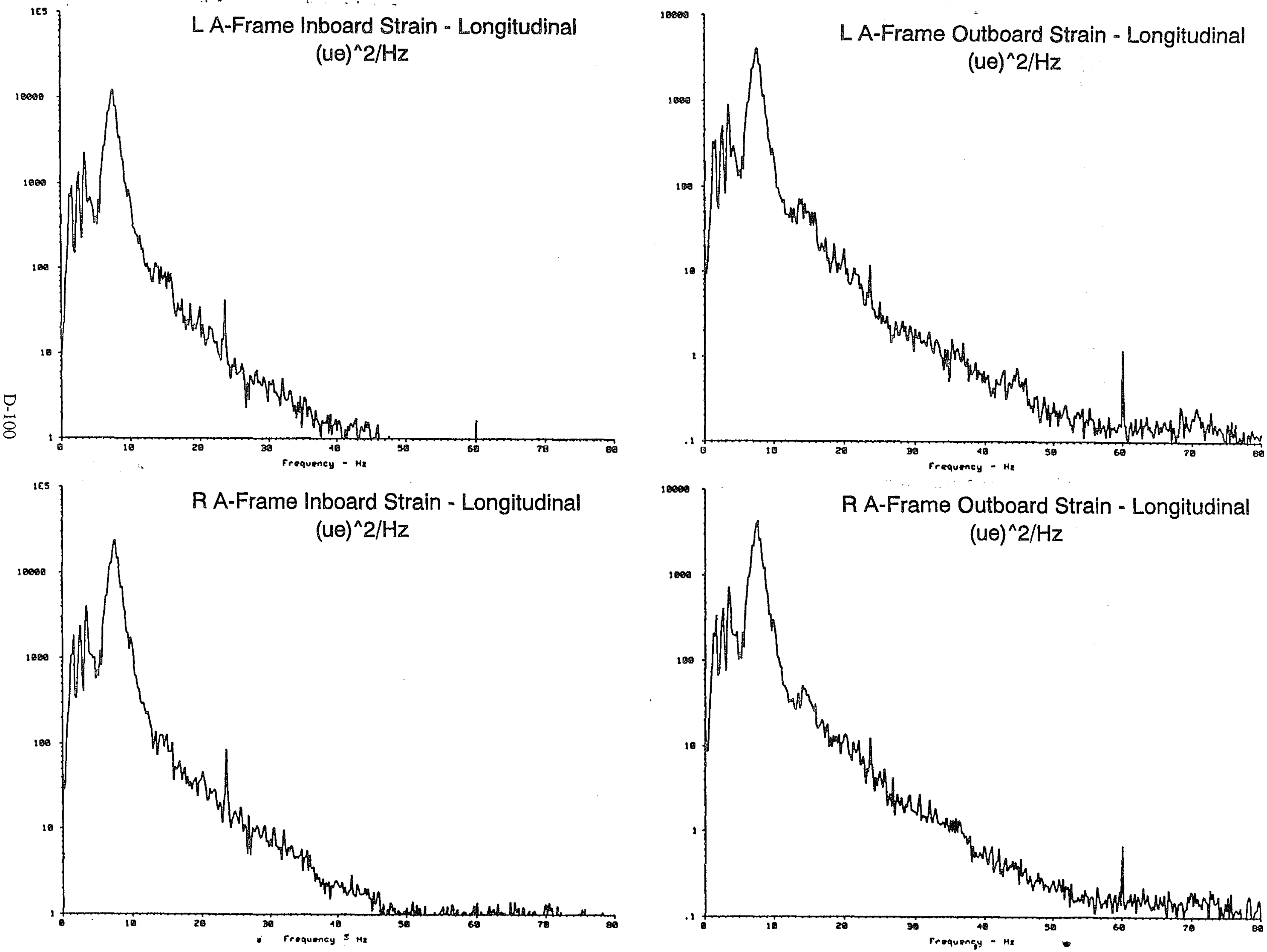
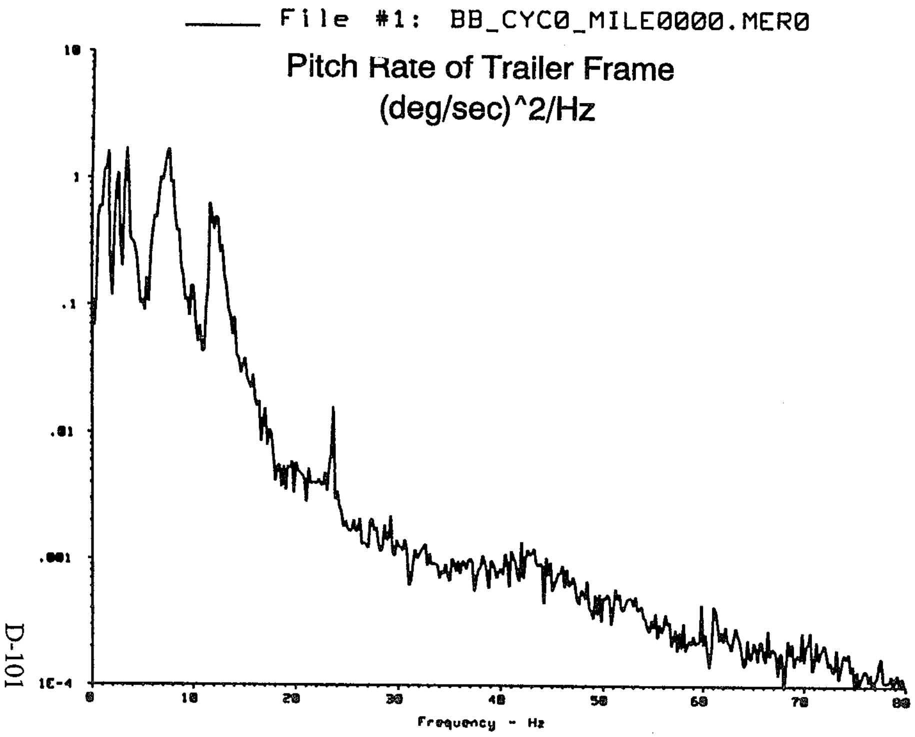
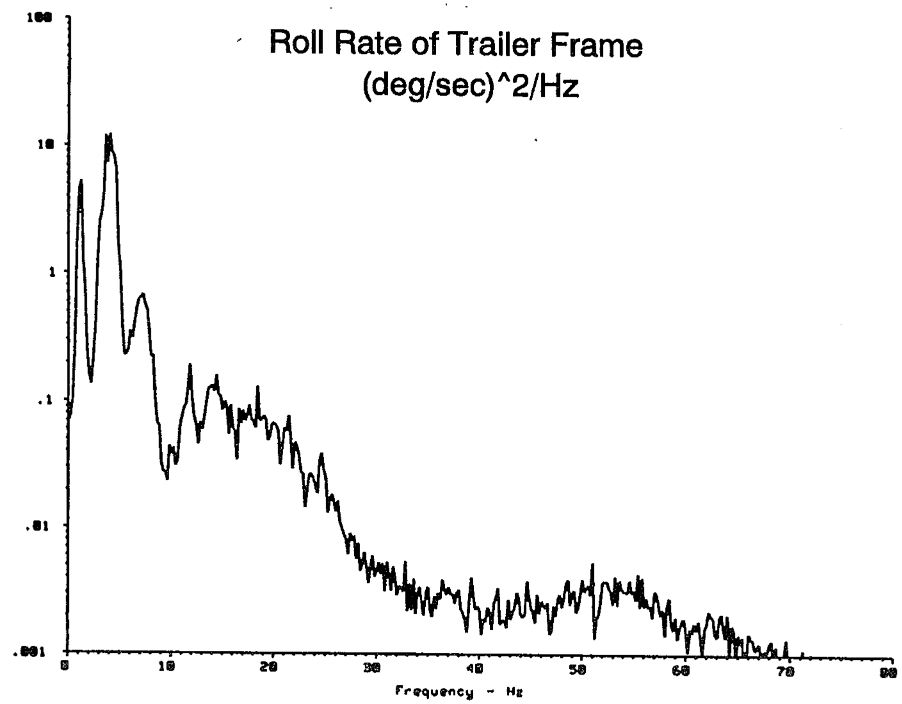


Figure D-85 Channels #21 - #22 from Belgian Block at 10 mph





APPENDIX E

TEST LOG SHEETS, INSPECTION SHEETS, AND DATA FILE LOG SHEETS

M1061A1 Trailer Durability Test Run Sheet

Cycles	Terrains			
	Munson Gravel 250 / 1,500 miles 25 mph	Perryman A 230 / 1,380 miles 16 mph	Churchville B 100 / 600 miles 13.5 mph	Belgian Block 20 / 120 miles 10 mph
Cycle 1:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				
Cycle 2:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				
Cycle 3:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				
Cycle 4:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				
Cycle 5:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				
Cycle 6:				
Start Date/Time				
Stop Date/Time				
Total Miles				
Total Hours				

M1061A1 Trailer Durability Test Inspection Sheet

Date:	Time:
Cycle:	Terrain:
Miles:	

Inspection Check List:

✔	Item to Inspect	Condition/Action	Initials
	General Condition		
	Tire Pressure (65 psi)		
	Axle Tethers		
	Suspension		
	Instrumentation Secure		
	Super-nut Tight		
	Payload Secure		
	Platens Straight		
	Payload Condition (Welds)		
	A-frame Toe Welds		
	Bump Stop Pads (4)		
	Spare Tire (Slack)		
	Wheel Chocks Secure		
	Leveling Jack Cranks Secure		

Notes/Drawings:

M1061A1 Trailer Durability Test Data File Log Sheet

File Name	Date/Time	Cycle	Miles	Comment	Cray

APPENDIX F

TRAILER CHARACTERIZATION AND MODEL VALIDATION TEST PLAN

M1061A1 Characterization Test Plan

General

This effort involves the measurement of some physical properties for the M1061A1 5-ton flat-bed trailer. This trailer will be tested in the physical simulation laboratory (PSL) using the RPC III method. This method requires response data be generated. It has been decided to derive these response data from a computer based model of the trailer. This effort has been designed to maximize the accuracy of this model. This will be achieved by the following two efforts:

1. Characterization: Measurement of mass, dimension, and spring properties of the trailer.
2. Validation: The gathering of field response data with the purpose of comparing it to model data in order to determine the accuracy of the model and further enhance it.

To characterize the trailer and validate the model please perform the following tasks:

Initial Inspection

Before disassembling or using the trailer in any way, inspect the trailer to verify that it is completely operational upon arrival.

Horizontal Center of Gravity & Weight

Measure the horizontal center of gravity (cg) of the unpayloaded trailer. This should be to the trailer without modification. Please reference all measurement to some fixed reference point on the trailer such as the center of the lunette or the pivot point for the spring and the center line of the trailer. **Do not measure the vertical location of the cg, only the two horizontal locations.**

Please provide the following information:

1. The horizontal location (wrt the reference point) of each of the four load cells used in the measurement.
2. The weight in pounds measured at each load cell.
3. The longitudinal and lateral location of the cg.

Wheel & Axle Mass

Remove one wheel and one axle from the trailer. Weigh the wheel while it is inflated at 65 psi. Weigh the axle. When complete, do not replace the wheel or axle until the next step is completed.

Please provide the following information:

1. The weight of the inflated tire and rim together in pounds.
2. The make and size of the tire.
3. The weight of the axle in pounds.

Measurement of Spring Rate

The purpose of this section is to determine a force vs. deflection curve for the leaf springs on the trailer. It is desired that at least four (4) points be attained on this curve, two of these being the 0 load case and the unloaded trailer case. The method to use for this effort will be to place different known pay loads on the bed of the trailer and measure the deflection of the springs. A load cell should be placed underneath the lunette so that this supporting force can be determined. All deflections should be measured between the spring end (where the axle mounts) and the frame for all four wheels. Before any payload is applied to the trailer two special cases will be measured:

Case 1: Zero Payload

This case will be measured by removing all four wheels and both axles from the trailer. (While doing this the trailer should be supported by the four leveling jacks.) Once the wheels and axles are removed, the springs are free from all loads. Measure the deflections at this position with the spring parallel to the frame.

Case 2: Unpayloaded Trailer

In this case the axles and wheels will be reinstalled and torque IAW the TM. The weight of the unpayloaded trailer should then rest on the lunette support and the wheels (not on the leveling jacks). Measure the four deflections at this position.

Payloaded Cases

Next begin placing payloads on the bed of the trailer in increasing weights (up to 10,000 lbs.) and measure the displacements at each wheel.

Required Data

For each payload please record the following:

1. The payload on the bed of the trailer.

2. The vertical force measured at the lunette.
3. The deflection of each axle for the payload (LF, RF, LR, RR).

Field Test

The purpose of the field test is to provide validation data to the modeler. This test will record 8 channels of acceleration data at 500 Hz using the data logger in the Astromed DASH 8 strip chart recorder. Eight runs will be done using the 6 inch fabricated bump placed at the TACOM test track. It will require that a prime mover and a driver be found. The eight channels of data should be installed on the trailer and the prime mover as specified in Table 1.

Table 1. M1061A1 Model Validation Instrumentation.

#	Accelerometer location/orientation	Range
1	Left-front Trailer Wheel Spindle, Vertical	+- 25 g
2	Right-front Trailer Wheel Spindle, Vertical	+- 25 g
3	Left-rear Trailer Wheel Spindle, Vertical	+- 25 g
4	Right-rear Trailer Wheel Spindle, Vertical	+- 25 g
5	Trailer Frame (near cg), Lateral	+- 10 g
6	Trailer Frame (near cg), Vertical	+- 10 g
7	Trailer Frame (near cg), Longitudinal	+- 10 g
8	Left-rear Prime Mover Wheel Spindle, Vertical	+- 25 g

As can be seen, channel #8 will be mounted on the spindle of the prime mover and will be used to calculate the speed of the trailer.

Before testing begins lubricate the trailer IAW the TM. The trailer should be run over the bump with one tire and two tires at each speed. All one tire strikes should be done on the left side so that the accelerometer on the spindle of the prime mover senses the bump. Table 2 describes the speeds to be run.

Table 2. M1061A1 Model Validation Runs.

Event	Speed			
Left Tire Strike	5 mph	10 mph	15 mph	25 mph
Both Tire Strikes	5 mph	10 mph	15 mph	25 mph

When these eight runs are recorded the data stored on the DASH 8 will be down loaded to a VAX computer via an IEEE-488 bus. Run sheets will be used to record the time, speed, bump, etc. for each run.

Once this field test is completed, inspect the trailer to assure that the trailer was not damaged.

APPENDIX G

TEST CHRONOLOGY

Table G-1. Chronology of the M1061A1 Durability Test.

Date / Time	Cycle / Miles	Event
3 Aug 95	0 / 0	Trailer arrives at TARDEC
10 Aug 95	0 / 0	Spare tire noticed loose (TIR #001)
16 Aug 95	0 / 0	Trailer characterization begins
16 Aug 95	0 / 0	RF leveling jack found inoperable (TIR #002)
12 Sep 95	0 / 0	Trailer characterization complete
14 Sep 95	0 / 0	Conducted the model validation field test (TIR #003)
20 Sep 95	0 / 0	Had a tarp hook failure (TIR #004)
27 Sep 95	0 / 0	Instrumentation of trailer (22 channels) complete
24 Oct 95	0 / 0	Trailer mounted on the PMBS
20 Nov 95	0 / 0	Began iterations
5 Dec 95	0 / 0	Iterations complete (51 miles accumulated)
6 Dec 95 / 0925 hrs	1 / 0	Began testing on Munson Gravel at 25 mph
6 Dec 95 / 1145 hrs	1 / 51	RF leveling jack found extended (TIR #005)
7 Dec 95 / 1125 hrs	1 / 250	Started on Perryman A at 16 mph
9 Dec 95 / 1050 hrs	1 / 374	Started on Churchville B at 13 mph
11 Dec 95 / 1340 hrs	1 / 581.6	Started on Belgian Block at 10 mph
12 Dec 95 / 0747 hrs	2 / 601.7	Completed cycle 1, Started on Munson Gravel at 25 mph
12 Dec 95 / 1615 hrs	2 / 776	Metal filings noticed under trunnion. Trunnion lubricated on both sides
13 Dec 95 / 0645 hrs	2 / 789	Trailer lubricated, leaf springs shifted
13 Dec 95 / 1032 hrs	2 / 851.7	Started on Perryman A at 16 mph
15 Dec 95 / 0943 hrs	2 / 1081	Started on Churchville B at 13 mph
15 Dec 95 / 1422 hrs	2 / 1133	Right-rear inner trunnion bracket bolt failed (TIR #006)
18 Dec 95 / 1336 hrs	2 / 1133	Bolt replaced and testing resumed
19 Dec 95 / 0930 hrs	2 / 1182	Started on Belgian Block at 10 mph
20 Dec 95 / 0751 hrs	3 / 1202	Completed cycle 2, Started on Munson Gravel at 25 mph
21 Dec 95 / 0700 hrs	3 / 1375	Lubricated trunnion, leveling jacks, simulator. Operational check on the leveling jacks
21 Dec 95 / 0700 hrs	3 / 1375	Lubrication rendered the swivel locks on the leveling jacks inoperable. (TIR #007)
21 Dec 95 / 1541 hrs	3 / 1452	Started on Perryman A at 16 mph
26 Dec 95 / 1222 hrs	3 / 1630	Smoke noticed at right side trunnion, slop found in left side trunnion bearing.
27 Dec 95 / 0715 hrs	3 / 1682	Started Churchville B at 13 mph
27 Dec 95 / 1547 hrs	3 / 1784	Started Belgian Block at 10 mph
28 Dec 95 / 0922 hrs	4 / 1805	Completed cycle 3, Started on Munson Gravel at 25 mph

Table G-1 (Continued). Chronology of the M1061A1 Durability Test.

Date / Time	Cycle / Miles	Event
29 Dec 95 / 0600 hrs	4 / 1946	Leaf springs found to be shifted. Bolts were retorqued to 160 ft-lb as specified in the TM.
29 Dec 95 / 1132 hrs	4 / 2016	Right-front inner trunnion bracket bolt failed (TIR #008)
29 Dec 95 / 1433 hrs	4 / 2055	Started on Perryman A at 16 mph
3 Jan 96 / 1338 hrs	4 / 2285	Started on Churchville B at 13 mph
4 Jan 96 / 1336 hrs	4 / 1784	Started on Belgian Block at 10 mph
5 Jan 96 / 0605 hrs	4 / 2406	Right front outer trunnion bracket bolt found to be broken during inspection (TIR #009)
5 Jan 96 / 0714 hrs	5 / 2406	Completed cycle 4, Started on Munson Gravel at 25 mph
8 Jan 96 / 1045 hrs	5 / 2656	Started on Perryman A at 16 mph
10 Jan 96 / 0600 hrs	5 / 2843	Operational check on leveling jacks completed
10 Jan 96 / 0925 hrs	5 / 2886	Started on Churchville B at 13 mph
11 Jan 96 / 0840 hrs	5 / 2988	Started on Belgian Block at 10 mph
11 Jan 96 / 0910 hrs	5 / 2993	Lubricated trunnion bearings on trailer and also lubricated the simulator
11 Jan 96 / 1228 hrs	6 / 3008	Completed cycle 5, Started on Munson Gravel at 25 mph
12 Jan 96 / 0615 hrs	6 / 3080	Lubricated trunnion bearings on trailer
12 Jan 96 / 1447 hrs	6 / 3258	Started on Perryman A at 16 mph
17 Jan 96 / 1329 hrs	6 / 3488	Started on Churchville B at 13 mph
18 Jan 96 / 1325 hrs	6 / 3589	Started on Belgian Block at 10 mph
19 Jan 96 / 0800 hrs	6 / 3610	Completed Test
24 Jan 96	Complete	Trunnion axle disassembled and inspected, wear found (TIR #010)
5 Feb 96	Complete	Trunnion axle replaced with new part

APPENDIX H

THE RPC PROCESS

The PMBS can control the motion of the lunette in two different modes, actuator rod position or strut force. So, the PMBS expects to receive a command signal equal to the amount of desired output (displacement or force) for each input axis. Ideally, the resulting output (displacement or force) as experienced by the trailer will be what was expected (or commanded). In reality, this is not the case, because the simulator control system has bandwidth limitations.

Also, responses measured on the trailer are influenced by more than one simulator command input. So, ideally, it is desirable to control all simulator inputs to produce the desired output. Then, the response channels on the trailer can be commanded to a previously recorded time history. If this time history was recorded in the field, under desired terrain and speed conditions, then the same vibrations experienced in the field will be reproduced in the laboratory. If these time histories are accurately reproduced, we know we are faithfully reproducing the desired test environment and any vibration induced damage.

This being the case, it is desirable to have a control system which will reproduce these recorded time histories (strains and/or accelerations) on the specimen at the input points (such as the wheels or lunette). The Remote Parameter Control™ (RPC III) system was designed to do just that. It will attempt to reproduce the time histories on a vehicle in the laboratory by manipulating the command input to the simulator. The process by which this is achieved is called the RPC process.

The recording of these time histories in the field, Road Load Data Acquisition (RLDA), is a necessary step in the RPC™ process. The RLDA can be bypassed, however, if another reliable method of acquiring the necessary data is used. An alternative method is to build and validate a computer based model of the vehicle system. Then record the necessary time histories by using the model to conduct computer simulations of the vehicle on the desired terrains. Although this method is not as accurate as a field test, it is used at times to save the expense of an RLDA.

The RPC™ process iteratively derives a command time history (drive) which can directly drive the simulator actuators (in position or force). This drive, when complete, will produce the desired response time history on the on the specimen. The development of this command time history is a five-step process consisting of the following steps:

1. Record field data
2. Analyze and edit data
3. System characterization
4. Estimate initial drive file
5. Iterate until desired accuracy is achieved.

Step 1. (Record field data)

The first step is to record the field response time histories on the terrains for which the drive time histories are to be developed. This requires at least one channel for each drive channel. Each vehicle sensor should be primarily sensitive to only one of the drive channels. These data recorded will define the vibration inputs to the simulator; so it is important that they be as accurate as possible.

Step 2. (Analyze and edit data)

The analysis is primarily used to determine the validity and damage content of the data. RPC™ offers a number of analysis techniques including frequency domain analysis, rain-flow counting, fatigue estimation, and statistical analysis. These tools are used to determine which portions of a time history can be considered non-damaging. Once these regions are known, they can be marked and deleted from the time history. This is done to shorten the test time by removing portions of the time histories which cause negligible damage to the specimen.

Step 3. (System characterization)

The system characterization is the step in which the system Frequency Response Function (FRF) is measured. The FRF is measured by inputting shaped noise into the control channels of the simulator while recording the vehicle response channels. The transfer function of the system is then calculated, yielding a frequency domain representation of the system. The engineer can then determine what direct effect each input has on each output measured. The FRF is calculated using the following equation:

$$FRF(f) = \frac{CSD(f)}{ASD(f)}$$

where the CSD(f) is the cross-spectral density matrix of the drive and response time histories and ASD(f) is the auto-spectral density matrix of the drive time history. Both the ASD and CSD are NxN matrices where each element of the matrix is a complex frequency spectrum. Although the system is nonlinear, the FRF is a linear model of the system.

Step 4 (Estimate initial drive file)

The next step is to calculate an initial drive estimate to the simulator. This is calculated by the following process:

1. Invert the FRF matrix (non-causal).

2. Use this to estimate the drive.

3. Scale the drive to allow for iterations.

The inverse of the FRF will be an indication of the output's effect on the input, so that given a response, it is an indication of what the drive should be to yield that response. The inverse FRF is the tool by which drive command estimates are determined from response data.

The inverse-FRF is used to transform the desired output (field data) into a drive time history (simulator input). This is the command to the simulator which would reproduce the correct dynamics as seen in the field if the system was perfectly linear. Unfortunately, no system is perfectly linear and therefore this initial drive estimate will not likely produce the correct response. Therefore, this initial drive estimate is scaled to 50 percent or less of its original value to reduce the risk of damaging the specimen.

Step 5 (Iterate until desired accuracy is achieved)

Next, the initial drive estimate is used to drive the simulator and vehicle responses are measured. The response error is then calculated by subtracting the measured responses from the desired response (field response). The response error is then transformed into a command error using the inverse-FRF in the same manner in which the initial drive estimate was calculated. This then represents the error in the initial drive estimate. The error is scaled, again to avoid overshooting, and added to the previous drive file to calculate the next drive estimate. This process is then continued until the drive estimate produces responses which are sufficiently close to the field responses. No further iterations are necessary when the accuracy attained by further iterations are too small to justify the time spent iterating.

APPENDIX I

TRUNNION BRACKET BOLT FAILURE REPORTS

FAILURE ANALYSIS

CONDUCTED BY

UTILITY TOOL AND BODY COMPANY, INC.

Spectrographic and Chemical Analysts
Metallurgists
6245 S. OAK PARK AVE. • CHICAGO, IL 60638
AREA CODE 312 - 229-0088 • FAX 229-0313

ANALYSIS REPORT FOR:

Utility Tool and Body Company, Inc.
151 East 16th Street
Post Office Box 360
Clintonville, WI 54929
Attention: Jim Schutt

PURCHASE ORDER NO. N1061-1209

DATE 1/24/96

Report/Lab Number: A4677

SUBJECT: Chemical composition, tensile testing, and hardness testing of sample received 1/24/96.

SAMPLE IDENTIFICATION/DESCRIPTION: 7/8" x 9 3/8", Gr. 5, Hex Head Capscrew

CHEMICAL ANALYSIS:

Carbon	0.41 %
Manganese	0.97
Phosphorus	0.014
Sulfur	0.006
Silicon	0.24
Nickel	0.01
Chromium	0.31
Molybdenum	0.20
Copper	0.02

TEST METHODS:

Carbon per ASTM E1019-93; Others per ASTM E415-95.

MECHANICAL PROPERTIES:

Tensile Strength: 139,800 psi
Hardness: 285 BHN

TEST METHOD: ASTM A370-92

CERTIFICATION:

Test results conform to SAE J429, Grade 5, specification limits.

CHICAGO SPECTRO SERVICE LABORATORY, INC.

BY ____________

MECHANICAL AND MATERIAL REQUIREMENTS FOR EXTERNALLY THREADED FASTENERS

Table 2 Chemical Composition Requirements[A]

Grade	Material and Treatment	Element, % C Min	C Max	Mn Min	P Max	S Max	B Min
1	Low or medium carbon steel	—	0.55	—	0.048	0.058	—
2	Low or medium carbon steel	—	0.55	—	0.048	0.058[B]	—
4	Medium carbon cold drawn steel	—	0.55	—	0.048	0.13	—
5	Medium carbon steel, quenched and tempered	0.28	0.55	—	0.048	0.058[C]	—
5.1	Low or medium carbon steel, quenched and tempered[E]	0.15	0.30	—	0.048	0.058	—
5.2	Low carbon martensite steel, fully killed, fine grain, quenched and tempered	0.15	0.25	0.74	0.048	0.058	0.0005
7	Medium carbon alloy steel, quenched and tempered[D]	0.28	0.55	—	0.040	0.045	—
8	Medium carbon alloy steel, quenched and tempered[D]	0.28	0.55	—	0.040	0.045	—
8.1	Elevated temperature drawn steel — medium carbon alloy or SAE 1541 (or 1541H steel)	0.28	0.55	—	0.048	0.058	—
8.2	Low carbon martensite steel, fully killed, fine grain, quenched and tempered[F]	0.15	0.25	0.74	0.048	0.058	0.0005

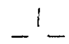
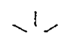
[A] All values are for product analysis (percent by weight). For cast or heat analysis, use standard permissible variations as shown in SAE J409 (January, 1942).
[B] For studs only, sulfur content may be 0.33% max.
[C] For studs only, sulfur content may be 0.13% max.
[D] Steel shall be fine grain, with hardenability that will produce a minimum hardness of Rockwell C47 at the center of a transverse section one diameter from the threaded end of the bolt, screw, or stud after oil quenching (see SAE J407 [August, 1947]). Carbon steel may be used by agreement between producer and consumer, for sizes 1/4 - 3/4 in. diameter products. SAE 1541 (or 1541H) steel, oil quenched and tempered, may be used at the option of the producer for products 7/16 in. nominal diameter and smaller.
[E] For sems only, sizes 7/16 - 5/8 in. diameter, low carbon martensite steel (as specified for Grade 5.2) may be used.
[F] Steel with hardenability that will produce a minimum hardness of Rockwell C38 at the center of a transverse section one diameter from the threaded end of the bolt or screw after quenching.

rolled, cut, or ground, at option of the manufacturer. Threads of all grades and sizes of studs may be rolled, cut, or ground, at option of the manufacturer.

3.4 Heat Treatment Practice. Grade 1 bolts and screws and Grades 1 and 2 studs need not be heat treated. When specified by purchaser, Grade 2 cold headed bolts and screws shall be stress relieved at a minimum stress relief temperature of 875°F (468°C). Grades 4 and 8.1 studs are manufactured from pretreated material and the studs, as manufactured, need no further heat treatment. Grades 5 and 5.2 bolts, screws, and studs shall be heat treated, oil or water quenched, at option of manufacturer, and tempered at a minimum tempering temperature of 800°F (427°C). Grade 5.1 bolts, screws, and sems shall be heat treated, quenched, and tempered at a minimum tem-

MECHANICAL AND MATERIAL REQUIREMENTS FOR EXTERNALLY THREADED FASTENERS

Table 1 Mechanical Requirements and Identification Marking for Bolts, Screws, Studs, Sems, and U-Bolts[I]

Grade Designation	Products	Nominal Size Dia, in.	Full Size Bolts, Screws, Studs, Sems		Machine Test Specimens of Bolts, Screws, and Studs				Surface Hardness	Core Hardness		Grade Identification Marking[J]
			Proof Load (Stress), psi	Tensile Strength (Stress) Min, psi	Yield[A] Strength (Stress) Min, psi	Tensile Strength (Stress) Min, psi	Elongation[F] Min, %	Reduction of Area Min, %	Rockwell 30N Max	Rockwell Min	Rockwell Max	
1	Bolts, Screws, Studs	¼ thru 1½	33,000[K]	60,000	36,000[B]	60,000	18	35	—	B70	B100	None
2	Bolts, Screws, Studs	¼ thru ¾[C]	55,000[K]	74,000	57,000	74,000	18	35	—	B80	B100	
		Over ¾ to 1½	33,000	60,000	36,000[B]	60,000	18	35	—	B70	B100	None
4	Studs	¼ thru 1½	65,000	115,000	100,000	115,000	10	35	—	C22	C32	None
5	Bolts, Screws, Studs	¼ thru 1	85,000	120,000	92,000	120,000	14	35	54	C25	C34	
		Over 1 to 1½	74,000	105,000	81,000	105,000	14	35	50	C19	C30	
5.1[D]	Sems,[H]	No. 6 thru 5/8	85,000	120,000	—	—	—	—	59.5[G]	C25	C40[G]	
	Bolts, Screws	No. 6 thru ½										
5.2	Bolts, Screws	¼ thru 1	85,000	120,000	92,000	120,000	14	35	56	C26	C36	
7[E]	Bolts, Screws	¼ thru 1½	105,000	133,000	115,000	133,000	12	35	54	C28	C34	
8	Bolts, Screws, Studs	¼ thru 1½	120,000	150,000	130,000	150,000	12	35	58.6	C33	C39	
8.1	Studs	¼ thru 1½	120,000	150,000	130,000	150,000	10	35	—	C32	C38	None
8.2	Bolts, Screws	¼ thru 1	120,000	150,000	130,000	150,000	10	35	58.6	C33	C39	

[A]Yield strength is stress at which a permanent set of 0.2% of gage length occurs.
[B]Yield point shall apply instead of yield strength at 0.2% offset.
[C]Grade 2 requirements for sizes ¼ through ¾ in. apply only to bolts and screws 6 in and shorter in. length, and to studs of all lengths. For bolts and screws longer than 6 in., Grade 1 requirements shall apply.
[D]Grade 5 material heat treated before assembly with a hardened washer is an acceptable substitute.
[E]Grade 7 bolts and screws are roll threaded after heat treatment.
[F]See Table 6 for gage length.
[G]Hex washer head and hex flange products without assembled washers shall have a core hardness not exceeding Rockwell C38 and a surface hardness not exceeding Rockwell 30N 57.5.
[H]Sems and similar products without washers.
[I] See footnote 2 of text.
[J] Not applicable to studs or slotted and cross recess head products.
[K]Proof load test: Requirements in these grades only apply to stress relieved products.

Grade 5.1 bolts, screws, and sems shall be cold headed.

3.3 Threading Practice. Grades 2, 5, 5.2, 8, and 8.2 bolts and screws in sizes up to ¾ in, inclusive, and lengths up to 6 in, inclusive, shall be roll threaded, except by special agreement. Grade 7 bolts and screws shall be roll threaded after heat treatment. Grade 5.1 bolts, screws, and sems shall be roll threaded. Threads of all sizes of Grade 1 bolts and screws, and Grades 2, 5, 5.2, 8, and 8.2 bolts and screws in sizes over ¾ in. and/or lengths longer than 6 in, may be

HARDNESS CONVERSION CHART

BRINELL	ROCKWELL-C	TENSILE 1000's P.S.I.
—	66	—
—	65	—
—	64	—
—	63	—
—	62	—
—	61	—
—	60	314
—	59	308
—	58	299
—	57	291
—	56	284
—	55	277
—	54	270
—	53	263
(500)	52	256
(487)	51	250
(475)	50	243
(464)	49	236
451	48	230
442	47	223
432	46	217
421	45	211
409	44	205
400	43	199
390	42	194
381	41	188
371	40	182
362	39	176
353	38	171
344	37	168
336	36	162
327	35	157
319	34	153
311	33	149
301	32	144
294	31	140
286	30	136
279	29	132
271	28	129
264	27	126
258	26	123
253	25	120
247	24	117
243	23	114
237	22	112
231	21	110
226	20	108
215	(17)	—
204	(15)	—
194	(12)	—
184	(9)	—
180	—	—
176	—	—
172	—	—
169	—	—
165	—	—

Medallion Steel Company
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Values in ( ) are beyond normal range and given for information purposes only.

FAILURE ANALYSIS

CONDUCTED BY

THE TARDEC METALURGICAL LABORATORY

AMSTA-TR-D (70-n) 25 Jan 96

MEMORANDUM FOR Development Business Group (AMSTA-TR-D), Physical Simulation Team, ATTN: Mr Mark Brudank

SUBJECT: Failure Analysis of Grade 5 Bolt (Lab 1383)

1. One 7/8 x 9.5 inch Grade 5 bolt was delivered for failure analysis to the Metallurgical Lab. It was reported that the bolt was used in the leaf spring bracket of the M1061A1 trailer, and had failed in use. It was also reported that the bolt had been torqued to the specified value of 150 - 175 ft/lbs.

2. Visual examination of the fracture showed that the failure occurred immediately beneath the head. The failure mode was fatigue (Reference Figure 1 & 2, Encl 1). Wear rings were noted on the bolt shaft. (Reference Figure 3, Encl 2).

3. Chemical analysis (Table I, Encl 3) shows that the material did not meet requirements for SAE J429 which calls for a medium (plain) Carbon Steel, quenched and tempered. The material used appears to be an alloy steel which exceeds the requirements.

4. Microstructural examination showed a core of coarse tempered martensite, typical of a quenched and tempered part, however it also displayed a decarburized layer approximately .01 inches deep.(Reference Figures 4 & 5, Encl 4)

5. Hardness readings taken in the core of the bolt were Rc 27-29, which meets the hardness requirements of SAE J429 (Rc 25-34 required). The shank of the bolt was sanded clean of paint and plating and tested for hardness. The surface hardness readings were Rc 20 /21 and below scale. (Reference Table II, Encl 3)

6. It may be concluded that the bolt failed due to decarburization. The wear points on the bracket wore through the decarburized layer causing a stress riser, and the bolt fatigued to failure.

7. The POC for this matter is Ms. M. Krueger, AMSTA-TR-D, extension 45563. Unless otherwise instructed, these parts will be disposed of within 30 days of the date of this memorandum .

4 Encls

Thomas M. Mathes
Associate Director
Development Business Group

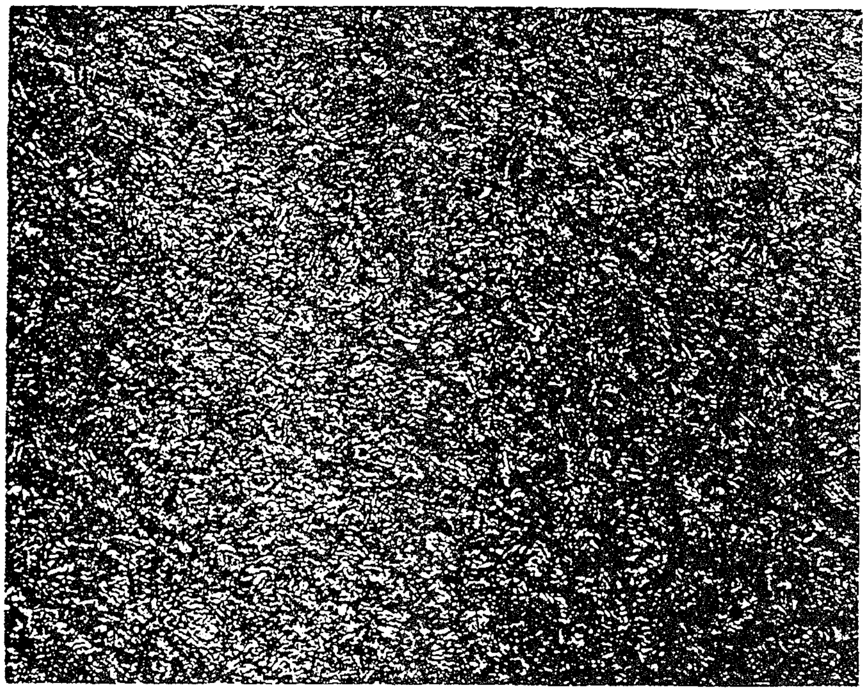

Fig 4. Micrograph showing bolt core of coarse tempered martensite. 200x, Nital etch

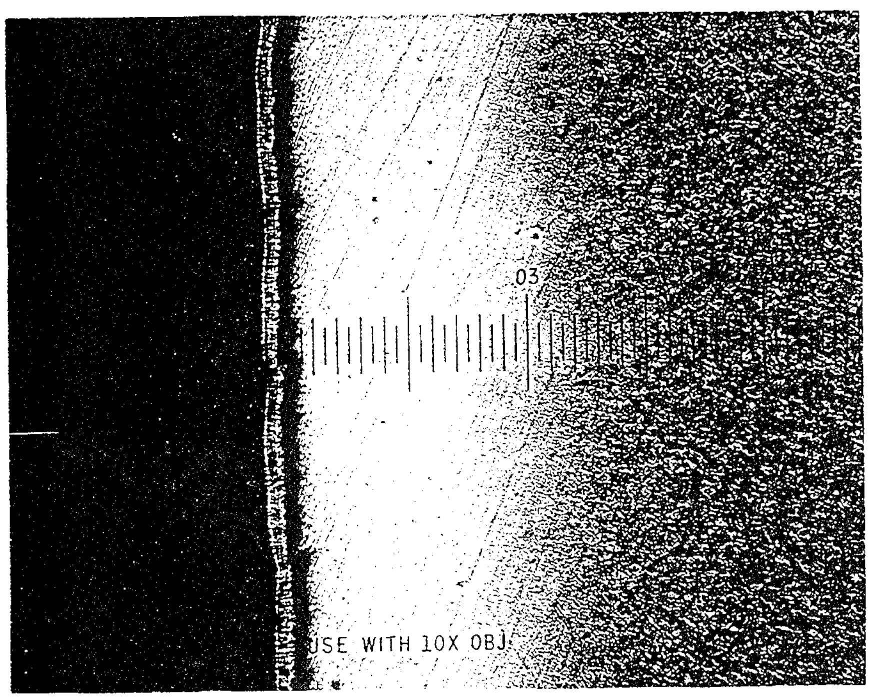

Fig 5. Micrograph showing decarburized surface layer. 100x Nital etch.

Table I

	Result	Chemical Requirements - SAE 429, Grade 5
Carbon	0.40	0.28 - 0.55
Manganese	0.98	-
Phosphorous	0.014	0.048 maximum
Sulfur	0.005	0.058 maximum
Silicon	0.22	-
Chromium	0.33	-
Nickel	0.03	-
Molybdenum	0.20	-
Copper	0.01	-
Vanadium	<0.01	-
Aluminum	0.02	-

Note: Grade 5 requires material to be medium carbon steel quenched and tempered.

Table II

Grade 5 bolt core readings		Grade 5 bolt surface readings	
Rc 28.3	Rc 28.6	Rc 20.3	Rc 20.9
28.9	29.0	below scale	21.4
28.7	27.4	below scale	20.1

Note: Grade 5 requires Rc 25 - 34

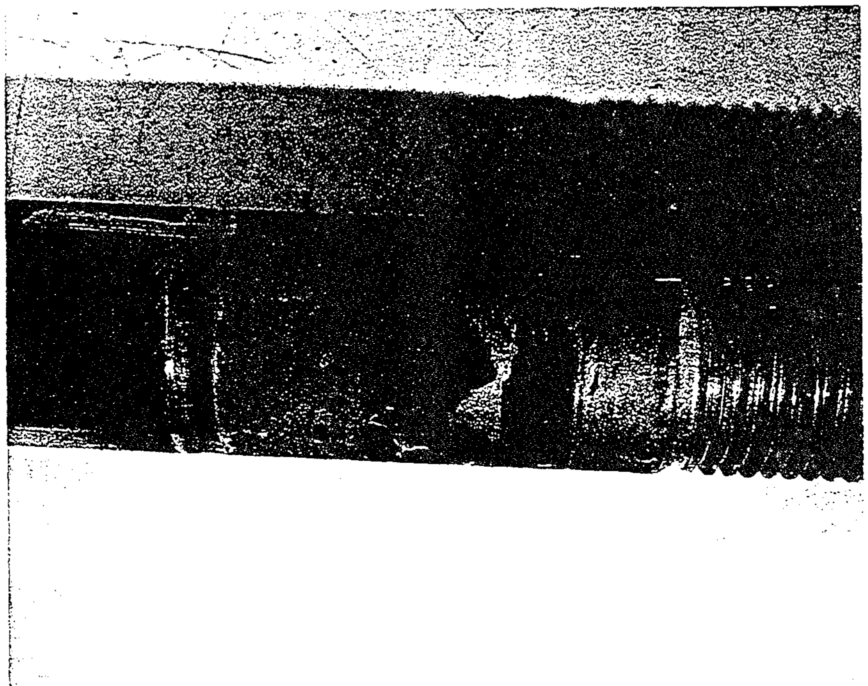

Fig. 3 Wear rings on bolt shaft. Apx 1 1/2x unetched.

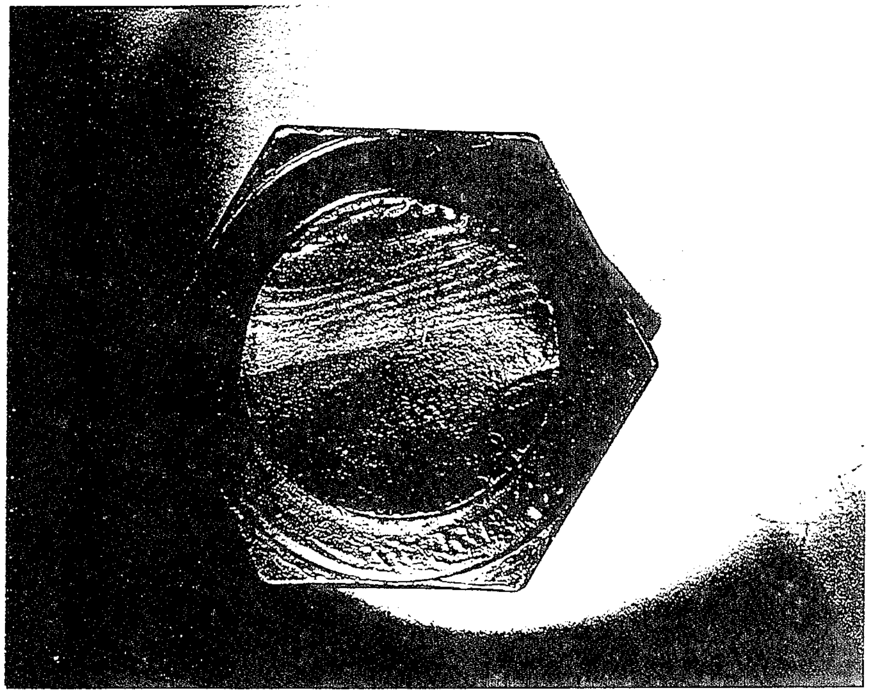

Fig. 1 Fracture face of Grade 5 bolt, showing fatigue "beach marks" . Apx 2x, unetched

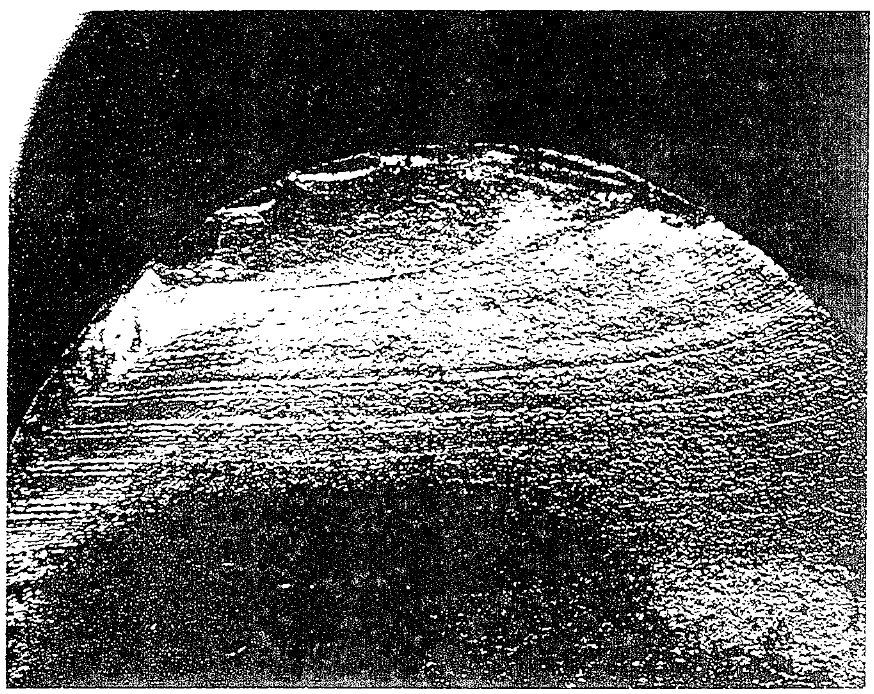

Fig. 2 Enlargement of "beach marks" and initiation site. Apx 7.5x unetched.

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