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GENERAL VEHICLE TEST PLAN (GVTP) FOR URBAN RAIL TRANSIT CARS

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SEPTEMBER 1975
FINAL REPORT

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16. Abstract

The General Vehicle Test Plan provides a system for general vehicle testing and for documenting and utilizing data and information in the testing of urban rail transit cars. Test procedures are defined for nine categories: 1) Performance; 2) Power Consumption; 3) Power System Interaction; 4) Adhesion; 5) Ride Roughness; 6) Passenger Compartment Noise; 7) Community Noise; 8) Simulated Revenue Service; 9) Structure Dynamics. The procedures can be adapted to any vehicle in the general class of urban rail vehicles. They are derived from testing on UMTA's Rail Transit Test Track in Pueblo, Colorado. In addition, these procedures can be modified for use on other urban rail tracks as required.

Specifications are included for instrumentation required to implement the tests. Data processing and analysis requirements are defined by specifying standard output formats for the parameters of interest.

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PREFACE

The Rail Technology Division of the Urban Mass Transportation Administration (UMTA) Office of Research and Development is conducting programs directed toward the improvement of urban rail transportation systems. The Transportation Systems Center (TSC) is supporting UMTA by providing systems management for the Urban Rail Supporting Technology Program (URSTP) in the design, construction and operation of UMTA test facilities, the analysis and testing of vehicles and components, and the development of key technological data. The standardized procedures presented in this report have been prepared as part of the test and evaluation task of this program.

Boeing Vertol Company has been under contract to UMTA as systems manager for the Urban Rapid Rail Vehicle and Systems Program (contract DOT-UT-10007). One phase of this vehicle and component development program was the design, development and demonstration of two State-of-the-Art Cars (SOAC) whose primary objective is to demonstrate the best current technology in rail rapid transit car design.

The accomplishments of Boeing and TSC were brought together when the SOAC's were delivered to DOT's Transportation Test Center (TTC) (formerly called High Speed Ground Test Center) in September, 1970 in Pueblo, Colorado. The design and construction of the 9.1 mile Rail Transit Test Track and the Transit Maintenance Building had been carried out as one of TSC's Tasks on the Rail Program.

In February, 1973, TSC awarded Boeing Vertol Company a contract (DOT-TSC-580) to perform engineering tests on the SOAC vehicles. The tests were based on procedures that had been defined in a TSC document published in April, 1972, "General Vehicle Test Plans for Urban Rapid Transit Cars", Ground Systems Programs Specification No. GSP-064. The contract, (DOT-TSC-580), for testing SOAC included a task for expanding and improving this document based on the experience gained on the SOAC test program. The resulting document presented here is applicable to a general category of urban rail vehicles for testing on the Rail Transit Test Track in Pueblo, Colorado.

The original publication was authored by Dr. Robert Lotz and Mr. Robert Kasameyer of TSC. The document presented here which includes much of the original publication was prepared by Messrs. Ray Oren and Pete Brown of Boeing Vertol. Mr. George Neat, Assistant Program Manager for Test and Evaluation, on the Urban Rail Supporting Technology Program at TSC provided technical direction as contract monitor for this effort.

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SUMMARY

The General Vehicle Test Plan (GVTP) provides a system for general vehicle testing (GVT) and for documenting and utilizing data and information in the testing of urban rail transit cars.

A primary objective of the GVTP is to provide technology for the various aspects and phases of rail transit vehicle testing. It is conceived and developed to be adaptable and flexible to the variations of the vehicle design and the circumstantial operating factors. The GVTP is organized and arranged to facilitate rail transit car testing operations using the Rail Transit Test Track (RTTT) and facilities at the Department of Transportation (DOT) Transportation Test Center (TTC), Pueblo, Colorado. It can also be adapted to vehicle tests carried out on operating properties.

Operating procedures and specific facts are provided for testing primary functions such as vehicle control, propulsion, braking, and vehicle dynamics; and to induce standardization of data and data acquisition. The plan divides vehicle functions into categories grouped according to common features and parameters, thereby enhancing the efficiency of test operations and the validity of test data. Each category of testing defines one or more specific tests for a practical system of testing operations.

Basic test categories are:

- Performance (Propulsion and control)
- Power Consumption
- Adhesion
- Passenger Noise
- Community Noise
- Ride Roughness
- Power System Interactions (Radio Frequency Interference)
- Simulated Revenue Service
- Structural Dynamics

Test Sets for each of the tests (by category) are contained in Appendix A. These tests are consistent with the TTC operating policies and with the DOT Transportation Systems Center (TSC) Urban Rail Supporting Technology (URST) Program procedures.

The main elements of the GTVP are:

Test Sets, which standardizes a specific test by identifying and describing the test objective, the test vehicle configuration, the test procedures and the test data requirements.

Baseline Test Plan, a catalog of tests considered to be the basic test plan for testing of a general class of urban rail vehicles.

Standard Outputs, a specification of test parameters and sensors.

Preliminary Aanlysis, a definition of the data reduction, analysis and cross-plotting of Standard Outputs.

Scheduling, some elements essential and practical, in the sequencing of transit railcar tests.

1. INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The General Vehicle Test Plan (GVTP) is part of the Urban Rail Supporting Technology (URST) Program, an Urban Mass Transportation Administration (UMTA) program of research and development directed toward the improvement of urban rail transportation.

Evaluation of system performance, for the purpose of determining relative merit is a fundamental part of research, development, and evaluation efforts. Performance, measured by tests, can provide data for:

- Deciding between competing systems
- Identifying technical areas where research and/or development is desirable
- Ascertaining system improvement achieved by R&D efforts.

Such test outputs are useful to purchasers of systems and to those planning developmental programs.

The purpose of a General Vehicle Test Plan is to present a program for measuring performance characteristics of rapid transit vehicles. It provides a framework for planning and executing tests, analyzing data, and reporting of evaluative, developmental, simulated revenue service, and baseline testing. GVTP standardized output specifications and procedures, used in conjunction with a controlled track system, operate to minimize the number of uncontrolled variables in testing and provide a method for comparison of railcars or comparison of subsystems. It also allows the effects of age and wear of the individual car to be measured quantitatively.

The General Vehicle Test Plan is intended to foster the development and the application of technology in the various aspects of transit railcar testing, and to induce standardization in the acquisition and the use of data.

One element of the objective of the GVTP is to be general enough to be adaptable to various rail vehicles. GVTP tests are applicable to the types of testing that have been conducted on the UMTA Rail Transit Test Track (RTTT) at the Department of Transportation (DOT) Transportation Test Center (TTC) including:

- o Developmental - debugging and troubleshooting tests for both vehicle and instrumentation systems
- o Evaluation - for comparing vehicle performance with design specifications
- o Simulated revenue - a series of tests to verify performance for a revenue service environment
- o Baseline - a series of tests to provide baseline vehicle performance data

Types of testing indicated above might, ideally, occur separately, however, time and cost constraints may dictate that some of the types be intermixed or be overlapped. Engineering judgement is necessary in order to determine which testing may be mixed together or overlapped. These considerations are discussed in Section 7, Scheduling.

Baseline testing ordinarily embraces a broader scope than the other types of testing. Developmental, evaluative, and simulated revenue tests are related, somewhat, to the individual vehicle or system under test whereas uses of baseline tests include uses in comparing vehicles or comparing systems, possibly in different time frames.

1.2 SCOPE

Although the GVTP is organized and arranged to facilitate general testing operations at the DOT Transportation Test Center, using the UMTA Rail Transit Test Track (RTTT) and facilities, it is organized and arranged to facilitate test operations using other track systems as appropriate. It provides a format for presenting a test plan and contains information and procedures for performing tests. In the form of a Test Set for each individual test, the GVTP contains specific details in procedures and data requirements to provide a consistency between tests and a validity in evaluative comparison of test data. Test plans and operations arranged and conducted in the concept of the GVTP provide a method for comparative evaluation between test data, between vehicles, and between systems. However, the GVTP tests are general and adaptation must be made for use with specific vehicles and track systems.

1.3 ELEMENTS OF THE GENERAL VEHICLE TEST PLAN

Essential elements of the GVTP are the Test Sets, Standard Outputs, Preliminary Analysis, and Baseline Test Plan.

The Test Set format is the basic element of the GVTP. Each Test Set is related to one testing area or category and contains a descriptive title, test objective, test description, procedure, instrumentation and equipment (sensor list), test outputs, and preliminary analysis. It specifies and controls those elements of testing which must be consistent from test to test and it provides sufficient latitude to allow adapting for specific vehicles.

Application and use of GVTP Test Sets are discussed in Section 2, Baseline Tests. Section 2 defines a baseline group of Test Sets that, when applied to a number of vehicles or systems, results in data of consistent form and qualities such that subsequent evaluation and comparison are practicable.

Test Set composition is discussed in both Section 3, The General Vehicle Test Plan, and Section 4, The Test Set. Appendix A contains test sets that may be reproduced, adapted to a particular vehicle, and used in a test plan.

Standard Output definitions and format are discussed in Section 5, Standard Outputs, and defined data elements are contained in Appendix B, Standard Outputs.

In order for test results to be in a form to enable comparisons between different tests and between different vehicles, certain preparatory analysis must be performed. This is discussed in Section 2.4, Preliminary Analysis, and specific examples are presented and defined in Appendix C.

The characteristics of a particular test vehicle and a particular test track must be considered in order to translate a test plan into Test Sets and the Test Sets into Test Runs. The development of a test schedule may be accomplished by coordinating Test Sets with a logical sequence of vehicle operations and Test Runs.

Test schedule development requires some assumptions with regard to testing operations. Some assumptions and variations of a schedule are discussed in Section 6, Scheduling.

1.4 BACKGROUND INFORMATION

Evaluative tests have been conducted by transit properties for many years, usually to determine whether a railcar or an order of cars is acceptable for delivery. Some transit properties conducted evaluative tests on cars comprised of competing subsystems such as trucks, power collection features, and automatic train control subsystems. These tests led to engineering management decisions on which manufacturers "subsystems" would be specified for the production run of revenue railcars.

The "Guideline Specification for Urban Railcars" Report No. IT-06-0027-1, produced by Boeing Vertol Company under contract to UMTA, includes a list of test areas and some outlines for evaluative tests. Also, the MITRE Corporation, under UMTA sponsorship, assessed the problems existing in the rapid transit industry and in their report identified evaluative areas, many of which correspond to evaluative testing areas identified by the transit properties and by Boeing Vertol Company. From these and similar sources evaluative testing areas were defined as follows in the original publication of this document:

- o Performance
- o Power Consumption
- o Power System Interaction and Electromagnetic Interference
- o Air Pollution (where applicable)
- o Clearance and Curve Tests
- o Car Weight and Weight Distribution
- o Ride Roughness
- o Wheel and Rail Wear
- o Passenger Compartment Noise
- o Community Noise
- o Community Ground Vibration

Table 1-1 shows the relationship between these test areas and the definition of tests in the original General Vehicle Tests Plan and in this current version. Tests have now been defined in seven of the original 12 categories. Tests may be defined in the future for some of the remaining five categories.

In a number of other test areas such as water tightness, heating and air conditioning capacity, and static structural testing, sufficient national capability already exists at railcar manufacturers and testing laboratores. In still other areas, including vandalism resistance, reliability, and maintainability, the design of repeatable, unambiguous evaluative tests appear to be less straightforward than in the test areas above, especially with regard to how such tests might be run during relatively brief testing periods.

TABLE 1-1

TEST CATEGORIES

Passenger Areas for Testing at Pueblo per GVTP	Categories for Which Tests Were Actually Defined in Original GVTP	Categories for Which Tests Are Defined in This Document
1. Performance	1. Performance	1. Performance
2. Power Consumption		2. Power Consumption
3. Power System Interaction and Electromagnetic Interference		3. Power System Interaction
4. Air Pollution		
5. Adhesion	2. Adhesion	4. Adhesion
6. Clearance and Curve Tests		
7. Car Weight and Weight Distribution		
8. Ride Roughness	3. Ride Roughness	5. Ride Roughness
9. Wheel and Rail Wear		
10. Passenger Compartment Noise	4. Passenger Compartment Noise	6. Passenger Compartment Noise
11. Community Noise	5. Community Noise	7. Community Noise
12. Community Ground Vibration	5. Community Noise	8. Simulated Revenue Service
		9. Structure Dynamics

2. BASELINE TEST PLAN

The purpose for defining a Baseline Test Plan is to present a consistent program for quantifying a rapid transit vehicles' operational characteristics. Based on the General Vehicle Test Sets presently available, the following is considered a complete Baseline Test Plan for a typical transit vehicle.

2.1 PERFORMANCE

Purpose

To determine the range of performance capability and operating characteristics of the transit vehicle and control system.

Method

a. Nominal performance will be evaluated by testing the acceleration and deceleration of the vehicle in a normal service configuration. A series of three car weights will be used to describe effect of weight on performance levels.

b. Off-Design performance will be evaluated by testing the acceleration and deceleration of the vehicle while at the low and high design point input voltages (electric driven transit cars) and by testing, individually, the various deceleration modes (friction only, dynamic only, etc.).

c. Control Response Characteristics will be evaluated by testing the vehicle response to two different levels of input command signals. Three vehicle weights will be used to define the range.

d. Vehicle protection systems efficiencies (SPIN/SLIDE) will be evaluated by performing a series of drift, adhesion and spin/slide tests.

e. The tests defined by the above will all be performed on single cars; train consists tests will be performed only as necessary.

2.2 POWER CONSUMPTION

Purpose

To determine the power consumption of the transit vehicle while operating on a reference route.

Method

Nominal power consumption will be measured on a single car and for a train operating over a simulated route with stops at specified stations.

2.3 ADHESION

Purpose

To determine the dry and wetted rail adhesion factors for use in spin/slide system detailed performance analysis.

Method

a. Axle speeds will be monitored while gradually applying friction brakes to the forward truck with no braking applied to the rear truck on level tangent track.

b. The coefficient of adhesion will be computed from the vehicle deceleration measured just as sliding is induced by the braking force.

2.4 NOISE

Purpose

To determine the levels of noise generated by the transit vehicle and experienced by passengers on board the vehicle and wayside by the community. Characteristics of the vehicle interior and noise sources will be determined.

Method

a. Community noise effects will be evaluated by measuring equipment noise levels and the effect of speed and screech loop on noise levels from a wayside station.

b. Passenger Noise levels will be determined by surveying the vehicle interior characteristics and by measuring the noise levels under various operating modes and track construction types.

c. The tests defined by the above will be performed at two different vehicle weights. The wayside tests will be performed on a signal car and on train consists.

2.5 RIDE ROUGHNESS

Purpose

To determine the vehicle ride characteristics as experienced by a typical passenger and to identify component induced vibrations.

Method

a. Car body vibration levels will be measured while operating in a series of different modes (speeds, acceleration, etc.). Three car weights will be used.

b. Vehicle natural modes and frequencies will be determined by monitoring vibrations while exciting a stationary vehicle with a shaker.

2.6 STRUCTURE DYNAMICS

Purpose

To determine the level and phasing of loads induced into the truck frame while the vehicle is in normal operation.

Method

Truck frame loads and various component deflections will be measured as the vehicle operates in various modes (speeds, acceleration, etc.). Three vehicle weights will be used.

2.7 POWER SYSTEM INTERACTIONS

Purpose

To determine the radio frequency interference (RFI) signature of the test vehicle.

Method

The RFI signature of the vehicle will be measured at a wayside station as the vehicle passes under different operating modes.

2.8 SIMULATED REVENUE SERVICE

Purpose

To determine the response of the test vehicle while operating on a sample service route at a defined level of schedule performance.

Method

The cars will be operated over a simulated route with stops at specified stations. Track environment, riding comfort and noise levels will be summarized for the entire route.

2.9 TEST PLAN TO TEST SETS

The characteristics of the particular test vehicle must be considered in order to translate the Test Plan into the Test Sets. Given a vehicle which has a blended braking capability with dynamic (no regneration) and friction brakes, an emergency braking system, a linear control signal loop, (range 0. to 1.0) design operating voltage is 600 VDC (range 450 to 700) operates in a four car train, at speeds up to 50 mph, Table 2-1 presents the Test Sets to be used, and delineates the vehicle configurations for each test.

From the table it can be seen that the acceleration performance Test Set, P-2001-TT is repeated 24 times, 12 times at 600 V and 6 each with 450 and 700 V. This leads to a total of 383 test records for the Baseline Test Plan. Many of the records can be completed on one Test Run, such as acceleration and all the braking tests. Given a large enough instrumentation capability other records can be completed simultaneously such as Ride Quality and Structures. These possibilities are discussed in Section 6, Scheduling.

TABLE 2-1

BASELINE TEST PLAN

TEST SET	TITLE	VEHICLE WEIGHTS	CONSISTS	SPD. MPH	CONTROL LEVEL	INPUT VOLT.	REMARKS	TEST REC.
P-2001-TT	Acceleration	AW0,AW2,AW3	Single&Train		1.0&.75	600(1)	(1) Do 450&700 VDC with Single	24
P-3001-TT	Deceleration-Blended Braking	AW0,AW2,AW3	Single&Train	(2)	0.0&.25	600(1)	(2) 15,25,35,50 MPH	48
P-3002-TT	Deceleration-Service Friction	AW0,AW2,AW3	Single&Train	(2)	0.0&.25	600		48
P-3003-TT	Deceleration-Dynamic	AW0,AW2,AW3	Single&Train	(2)	0.0&.25	600		48
P-3004-TT	Deceleration-Emergency	AW0,AW2,AW3	Single&Train	(2)	-	-		24
P-4001-TT	Drift Test	AW0,AW2	Single&Train			600		4
P-5001-TT	Duty Cycles-Friction Brake	AW2	Single			600	Repeat for Two Cycles	2
P-2011-TT	Spin/Slide-Acceleration	AW0	Single			600		1
P-3011-TT	Spin/Slide-Deceleration	AW0	Single			600	Repeat for Brake Modes	3
PC-5011-TT	Power Consumption	AW2	Single&Train			600		2
A-3021-TT	Adhesion	AW0	Single			600		1
CN-0001-TT	Equipment Noise Survey	AW0						1
CN-1001-TT	Speed Effect-Wayside	AW0,AW3	Single&Train	(2)		600		16
CN-1201-TT	Screech Loop-Wayside	AW0,AW3	Single			600		1
PN-1001-TT	Speed Effect-On Car	AW0,AW3	Single	(2)		600	Four Interior Locations	32
PN-1101-TT	Track Type Effect-On Car	AW0	Single	35		600		1
PN-1201-TT	Screech Loop-On Car	AW0,AW3	Single			600		2
PN-1301-TT	Interior Survey	AW0	Single	35		600		1
PN-2001-TT	Acceleration-On Car	AW0,AW3	Single			600		2
PN-3001-TT	Deceleration-On Car	AW0,AW3	Single			600	Repeat for Brake Modes	8
R-0001-XX	Dynamic Shake-Vertical	AW0,AW2,AW3	Single				Min. of 4 interior locations	12
R-0002-XX	Dynamic Shake-Lateral	AW0,AW2,AW3	Single				Min. of 4 interior locations	12
R-0003-XX	Dynamic Shake-Longitudinal	AW0,AW2,AW3	Single				Min. of 4 interior locations	12
R-3001-TT	Deceleration	AW0,AW2,AW3	Single			600	Repeat for Brake Modes	
R-0010-TT	Component Induced Vibration	AW0	Single			600		1
R-2001-TT	Acceleration	AW0,AW2,AW3	Single			600		3
R-1101-TT	Worst Speeds	AW0,AW2,AW3	Single	(2)		600		12
RS-5001-TT	Simulated Revenue Service	AW2	Single&Train			600		2
PSI-6001-TT	Radio Frequency Interference	AW0	Single&Train	(2)		600		8
S-1001-TT	Constant Speed	AW0,AW2,AW3	Single	(2)		600		12
S-2001-TT	Acceleration	AW0,AW2,AW3	Single			600		3
S-3001-TT	Deceleration	AW0,AW2,AW3	Single			600	Repeat for Brake Modes	12

AW0 = Vehicle Empty Weight
AW1 = Vehicle Empty Weight plus Normal Load
AW2 = Vehicle Empty Weight plus Full Load
AW3 = Vehicle Empty Weight plus Crush Load

3. ELEMENTS OF THE GENERAL VEHICLE TEST PLAN

The General Vehicle Test Plan (GVTP), in its entirety, includes the appendices hereto:

Appendix A	-	GVTP Test Sets
Appendix B	-	Standard Outputs
Appendix C	-	Preliminary Analyses

3.1 TEST PLAN

The progression of a test program from inception through actual test operations begins with a test plan which relates program objectives to the particular vehicle or system under consideration. The Baseline Test Plan, presented in Section 2, provides a definition of the scope for a Test Program to be used for a typical vehicle. Additional tests and or parameters can be included to meet the specific needs of any test program. Similarly, the scope can be reduced if time or budget constraint so dictate.

3.2 TEST SETS

A GVTP Test Set, Figure 3-1, consists of test identification; test objective; test description; test procedure; instrumentation (equipment and sensors); test outputs; and preliminary analysis. The contents of the Test Set are discussed in Section 4, the Test Set. The purpose of predefining a test or a series of tests in this manner is to:

- o Provide a frame work for the documentation required while testing

- o Ensure that tests are performed in a consistent manner and thereby facilitate any subsequent comparisons or analyses.

A given vehicle test plan contains, essentially, test categories for which applicable tests can be selected and modified to the specific vehicle. When completed, the selected Test Sets form a test plan in practical terms of the test operations and are readily usable, Figure 3-2, for

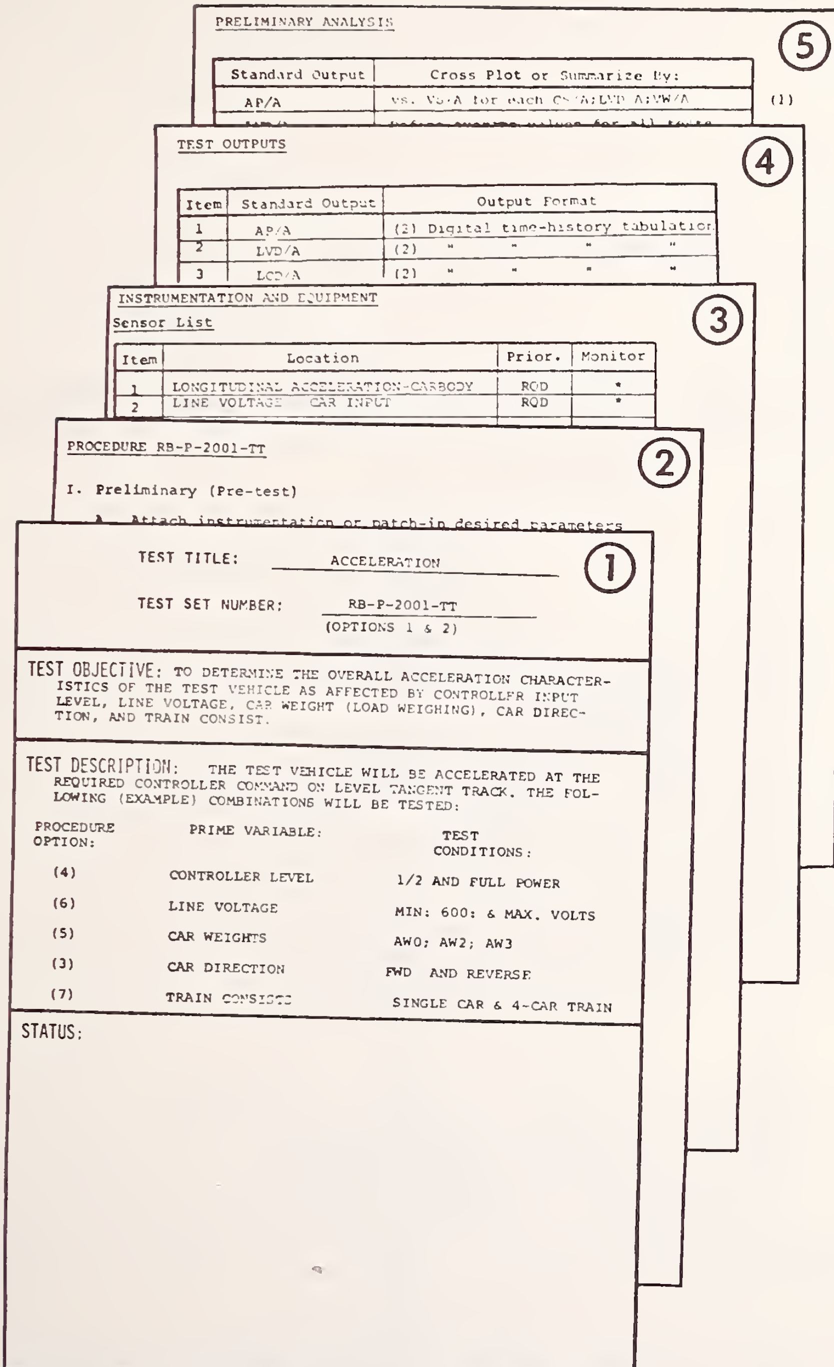

Figure 3-1 Sample of a General Vehicle Test Set

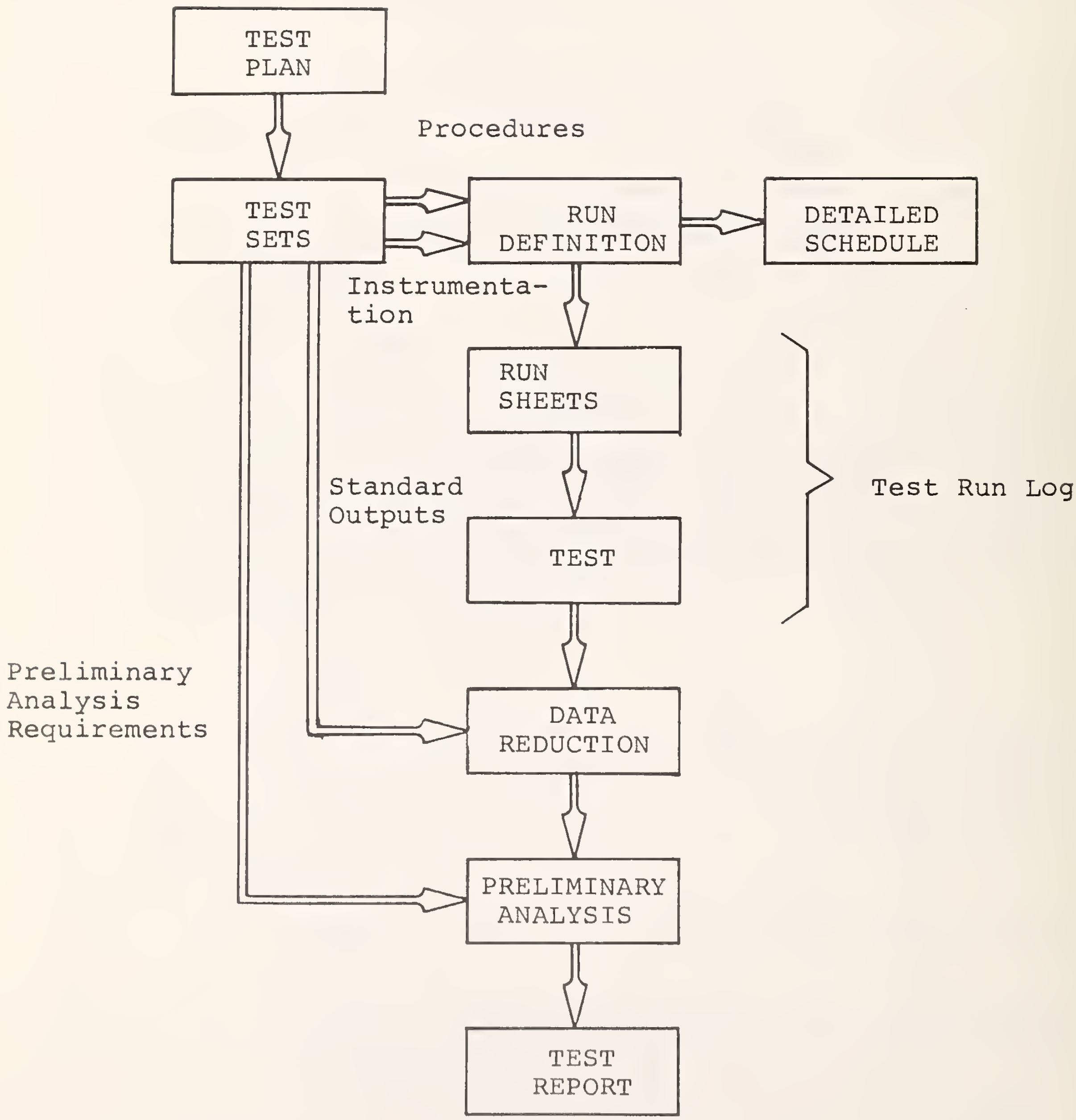

Figure 3-2 GVTP Schedule and Operation Flow

scheduling, performing, and reporting the tests.

A test run is a logical block of vehicle test operation performed without a major change of configuration. Thus, the test run may comprise portions of different tests (such as acceleration and deceleration) while the vehicle is in a particular configuration.

For each test run that is defined, Figure 3-2, test run logs are developed which detail the following:

- Test procedures - a copy of the test procedures from each of the referenced test sets, made relevant to the vehicle under test

- Instrumentation requirements - detailed by comparing the Test Set standard outputs to the instrumentation available

- Assigns task responsibilities

- Delineates support required

A test run log is a pre-run checklist of requirements and provides a record of the activities during the test.

The development of a test schedule is accomplished by planning Test Sets into test runs and the test runs into a logical sequence of vehicle operations. Test schedule development requires certain assumptions on testing operations. Some assumptions, based on experience gained during the State-Of-The-Art Car (SOAC) Engineering Test Program at the DOT Transportation Test Center, and two variations of a schedule are shown in Section 6, Scheduling.

3.3 TEST OUTPUTS

The test outputs, Figure 3-1, define the processing required of the instrumented and the manually recorded data. Where the desired output is a Standard Output, Appendix B, an appropriate abbreviation is provided in the appendix. For other outputs, the item should be specified in the manner and in corresponding format of Standard Outputs and included in the Test Sets.

Standard outputs may have various forms, one or more of which may be specified in the output format column in the test output portion of the test set. Each output has a name (such as acceleration, car body) and a concise alphanumeric (such as AC/A). The same physical quantity or combination of quantities may be measured or processed in different ways. The letter following the solidus in the alphanumeric indicates the particular version.

Standard outputs are discussed in Section 5, and are further designated and defined in Appendix B. The Standard Outputs in Appendix B represent the present measurement requirements for general vehicle testing at the TTC.

National and international standards for making measurements apply to many of the outputs in Appendix B. Conforming to these standards insures that measurements made in UMTA programs can be compared directly with measurements made elsewhere in the United States and abroad.

3.4 PRELIMINARY ANALYSIS

Preliminary Aanlysis is intended to reflect those processes which are not readily machine reproducible or those for which engineering judgement is required. Preliminary Analysis includes the extraction of additional parameters by analysis and/or extrapolation of the test outputs. The Preliminary Analysis section of the Test Set specifies the test outputs or parameters that will be cross plotted between the test runs or between vehicle configurations.

Preliminary Analysis is discussed in Appendix C, Preliminary Analyses. The Preliminary Analyses in Appendix C represent the basic form of test data that may be readily used for vehicle and system evaluative comparisons. These items require knowledge of the vehicle being tested and some engineering judgement on the development of the output.

As with the Standard Outputs, each of the Preliminary Analysis elements has a name and an alphanumeric designation. The characteristics of the element (range and accuracy) correspond to those of the Standard Output for which it is specified. In each description, the technique of developing the parameter and samples of the format are given.

3.5 SCHEDULING

Test programs and test operations almost without exception emerge in the form of a test plan and a test plan naturally relates program objectives to the particular vehicle or system to be evaluated. A test plan usually identifies the tests to be performed and the vehicle or system configuration on which it is to be performed.

Some important considerations of scheduling are discussed in Section 6, Scheduling.

4. THE TEST SET

4.1 PURPOSE OF THE TEST SET

Test Sets provide the means for translating a test plan into operationally attainable goals. The Test Set specifies and controls those elements of testing that must be consistent from test to test, and it provides for sufficient flexibility to allow adaptation for different vehicles. The purpose of predefining a test or a series of tests in this manner is to: (1) provide a framework and system for the documentation required while testing, and (2) ensure that the tests are performed in a consistent manner and thereby facilitate subsequent comparisons and analyses.

The Test Sets, collectively, form a test plan, in the practical terms of test operations, usable for scheduling the tests, performing the tests, and reporting the tests. Use of the Test Sets in the scheduling of operations is discussed in Section 6, Scheduling.

4.2 COMPOSITION OF THE TEST SET

The Test Set, Figure 3-1, is composed of: the Test Set Title Sheet (1), the Test Procedure (2), the Instrumentation and Equipment Sensor List (3), the Test Outputs (4), and the Preliminary Analysis (5). Each of these items is discussed in detail in this section.

The Test Set Title Sheet, Figure 4-1, is arranged so as to provide a one page summary of the test. It contains the test title, the test set number, the test objective, the test description, and the status. The status section is prepared and recorded as the testing progresses, thus the test set title sheet is a complete summary of the test from the time of inception through the time of the latest status record.

4.2.1 Test Title

The test title generally names the main test parameter(s) and/or the operating function of the vehicle. It is logical that the test title correspond to the parameter to be tested or measured. However, the parameter is often influenced by the operating mode of the vehicle.

TEST SET	SHEET 1 OF 7 TEST TITLE: Acceleration TEST SET NO.: P-2011-TT

TEST OBJECTIVE:

To determine the overall acceleration characteristics of the test vehicle as affected by controller input level, line voltage, car weight (load weighing), car direction and train consist.

TEST DESCRIPTION:

The test vehicle will be accelerated at the required controller command on level tangent track. The following combinations will be tested:

Prime Variable	Test Conditions
Controller Level	1/2 and Full Power
Line Voltage	Minimum, Nominal and Maximum Voltage
Car Weights	AW0; AW2; AW3
Car Direction	Forward and Reverse
Train Consists	Single Car & Four-Car Train

STATUS:

Figure 4-1 Sample of a Test Set Title Sheet

4.2.2 Test Set Number

The test set number is coded to identify:

a. The type vehicle

b. The evaluative category

c. The testing procedure category

d. The testing location

The following example illustrates the use and meaning of the various test set number codes.

EXAMPLE (See Table 4-1 TEST SET NUMBER CODES)

a. Type vehicle - Railcar Baseline

b. Evaluative category - Propulsion and Control

c. Procedure category - Acceleration

d. Testing location - UMTA Test Track

Test Set Number RB - P - 2001 - TT

4.2.3 Test Objective

The test objective relates the test plan to the test vehicle. Combined with the other contents of the Test Set Title Sheet, the test objective provides explicit definition of the test and minimizes the possibility of ambiguity and misinterpretation.

The test objective generally states what is to be determined, ascertained, or delineated by the test.

EXAMPLE: (See Figure 4-1)

TEST OBJECTIVE: To determine the overall acceleration characteristics of the test vehicle as affected by controller input level, line voltage, car weight (load weighting), car direction, and train consist.

TABLE 4-1

TEST SET NUMBER CODES

A. TYPE VEHICLE		B. EVALUATIVE CATEGORY		C. PROCEDURE CATEGORY		D. TESTING LOCATION	
R42	NYCTA R42 Car	A	Adhesion	001 to 999	Car Stationary	TT	UMTA Transit Track
R44	NYCTA R44 Car	AP	Air Pollution	1001 to 1999	Nominally Steady Speed		
RB	Rail Car Base-line	CC	Clearance and Curve Tests	2001 to 2999	Acceleration	LAB	FRA/UMTA Rail Dyna-mics Lab
SOAC	UMTA State-of-the-Art Car	CN	Community Noise	3001 to 3999	Braking		
ACT	UMTA Advanced Concept Train Model	CV	Community Ground Vibration	4001 to 4999	Coasting		
				5001 to 5999	Sample Service		
		P	Performance	6001 to 6999	Other		
		PC	Power Consumption				
		PN	Passenger Compartment Noise				
		PSI	Power System Interaction				
		R	Ride Roughness				
		S	Structure Dynamics				
		RS	Revenue Service				
		WH	Wheel and Rail Wear				

4.2.4 Test Description

The test description describes and/or specifies primary essentials of the test such as the manner or mode in which the vehicle is to be operated, the configuration of the vehicle to be tested, the characteristics of the test track and facilities, and various test conditions.

EXAMPLE: (Figure 4-1)

TEST DESCRIPTION: The test vehicle will be accelerated at the required controller command on level tangent track. The following combinations will be tested:

Procedure Option*	Prime Variable	Test Conditions
(4)	Controller Level	1/2 and Full Power
(6)	Line Voltage	Min., 600, & Max. Volts
(5)	Car Weight	AW0; AW2; & AW3
(3)	Car Direction	Forward & Reverse
(7)	Train Consists	Single & 4-Car Train

*See test procedure.

4.2.5 Status

The status shows pertinent facts and actual history of the test. The accomplishment of each item of operations associated with the test and any useful facts, not otherwise apparent in the test record, are pertinent to the status. The completed test set title sheet, with the status, becomes a one-page summary of the test and provides concise data for a test report.

4.2.6 Test Procedure

Test procedure includes preliminary or pre-test procedures as well as test run procedures as the test zone.

Preliminary or pre-test procedures provide for mandatory and essential preparation of the vehicle, the test equipment and apparatus, and the test track and facilities prior to proceeding with testing. Pre-test procedures may include equipment installation, checkout, calibration, safety checks, briefings, equipment, and similar items. The procedure may also specify pertinent testing options.

Test procedure is a step-by-step instruction to a test conductor. Ideally it is a simple unambiguous statement of the actions to be taken by test personnel during the test.

The Test Sets in Appendix A contain sample test procedures. In some instances, additions to the procedures will be required in order to make them applicable to a specific vehicle.

4.2.7 Instrumentation and Equipment

The instrumentation and equipment part of the Test Set, Figure 4-2, provides for a sensor list and a system description as pertains to the particular Test Set and the features of the instrumentation system to be used. Instrumentation and equipment placement, calibration, and operation are presented or referenced with sufficient detail that the instrumentation and equipment could be duplicated and therefore the measurements could also be duplicated.

The sensor list is a tabulation of sensors, in item number order, specifying the sensor location and priority and whether or not the parameter measured by the sensor is to be monitored. Monitored outputs are those that are required to be available for interpretation during the test, in real time. Many of these will appear as strip chart recorder readouts.

The priority is assigned on the sensor list by the requester and used by the test conductor to determine contingency operation when all test parameters or data outputs cannot be obtained. The priority abbreviations are defined as follows:

RQD - Required, the output is required in order to make reasonable use of the test. If this output cannot be provided the test will be significantly less value.

HD - Highly Desirable. The output is not essential to the test, but its includion will probably add measurably to the value of the test.

NTH - Nice to have. The output may be of use. Its inclusion might add to the value of the test.

INSTRUMENTATION TEST SET NO. P-2011-TT SHEET 5 OF 7

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	RQD	*
3	Line Current Car Input	HD	
4	Truck Armature Current Fwd Truck	RQD	*
5	Truck Armature Current Aft Truck	RQD	*
6	Truck Field Current Fwd Truck	RQD	(1)
7	Truck Field Current Aft Truck	RQD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	*
11	Car Speed Calibrated Axle RPM	RQD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	*(2)
15			
16			
17			
18			
19			
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

Figure 4-2 Sample of a Test Set Instrumentation Section

CR - Capability Required. After examining the quick look data, the test requester may select certain segments of the data for analysis or display in a certain form. The compatibility for such data processing is required. Generally "CR" is used only for complete outputs.

Test Outputs

The Test Outputs Section Figure 4-3 defines the processing required of the instrumented and manually recorded data. Where the desired output is a Standard Output, the appropriate abbreviation is given (See Appendix B). For other outputs, the element should be specified in the Standard Output form and included in the Test Set.

The Standard Outputs may have various forms, and one or more of these may be specified in the Format column of the sheet. Item number refers to the item number defined by the Instrumentation Sensor List.

Preliminary Analysis

The Preliminary Analysis section of the Test Set specifies the parameters or Standard Outputs which will be cross plotted between test runs, or by vehicle configurations. It also includes the creation of new parameters by further analysis of the Standard Outputs. It is intended to reflect those processes which are not readily machine reproducible or those for which engineering judgement is required.

STANDARD OUTPUTS TEST SET NO. P-2011-TT SHEET 6 OF 7

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	LVD/A	" " " "
3	LCD/A	" " " "
4	MACD/A (F)	" " " "
5	MACD/A (A)	" " " "
6	MFCD/A (F)	" " " "
7	MFCD/A (A)	" " " "
8	MAVD/A (F)	" " " "
9	MAVD/A (A)	" " " "
10	CS/A	" " " "
11	VS/A	" " " "
12	T/A	" " " "
13	ET/A	" " " "
14	D/B	Counter & Digital T-H tabulation
15		
16		
17		
18		
19		
20		

Figure 4-3 Sample of a Test Set Standard Output Section

5. STANDARD OUTPUTS

5.1 INTRODUCTION

The Standard Outputs specified in Appendix B represent the present measurement requirements for general vehicle testing at the TTC. A simple form is used to present the requirements for each output. The requirements may be considered performance specifications from the point of view of the user. The specifications for the outputs will be realized by proper selection of the instrumentation and data processing system. After the instrumentation and data acquisition system have been procured and checked out, a certification procedure will be implemented to document actual performance of the test instrumentation system.

5.2 STANDARD OUTPUT REQUIREMENTS

National and international standards for making measurements apply to many of the outputs specified in Appendix B. Conforming to these standards insures that UMTA measurements can be compared directly with measurements made elsewhere in the United States and abroad. The following abbreviations are used in the Standard Output requirements to indicate standards organizations:

IEC - International Electrotechnical Commission

ISO - International Organization for Standardization

ANSI - American National Standards Institute

Given on the following page is an explanation of the headings used in the specification of a Standard Output.

Output Name

Each Output has a name (such as Ride Roughness-Vertical) and a concise alphanumeric (such as RRV/A). Often the same physical quantity or combination of quantities may be measured or processed in several different ways leading to differing accuracies, frequency responses. In particular, as the instrumentation and data processing systems evolve with time some outputs will be replaced by later versions having, for example, greater accuracies. The letter following the solidus in the alphanumeric indicates the particular version under discussion.

The following is a description of the elements of a Standard Output specification:

- <u>Range, Accuracy, Frequency Response</u>

  These descriptors refer to the measured quantity in its final (correctly read) output form.

- <u>Units</u>

  Generally accepted units are used except where this clearly would be contrary to current rapid transit practice. Abbreviations in all cases conform to accepted technical writing practice.

- <u>Special Features</u>

  This heading includes selectable averaging time, reset capability and other hardware/software capabilities that are not covered under other headings.

- <u>Signal Processing</u>

  Filtration, weighting, averaging, rectifying or other processing applied to the electrical analog of a physical quantity are contained in this area.

- <u>Calibration Method, Certification Method</u>

  The calibration method is a sequence of operations with the instrumentation and possible additional test equipment designed to adjust the measurement system to provide the accuracies and scale desired for an individual test.

  The certification method is a thorough testing of the measurement system in all its modes of operation in order to certify that the system design has all the capabilities required. This certification may be viewed as a performance test for the measurement system.

o <u>Output Formats and Samples</u>

For one Standard Output there may be various formats. A number of these are delineated and samples shown within the Standard Output Specification. This gives the Test Requester the freedom to select the output format.

6. SCHEDULING

The development of a test schedule is accomplished by tying the Test Sets to a logical sequence of vehicle operations. This test schedule development requires some basic assumptions on testing operations. Some assumptions based on experience gained during the SOAC Engineering Test Program at the TTC and two variations of a schedule are shown below. These programs are based on the Baseline Test Plan developed in Section 2.

6.1 BASIC SCHEDULING ASSUMPTIONS

Table 6-1 showing Baseline Test Time by Configuration, and contains an estimate of operating time to obtain a record of information. This estimate includes moving the vehicle into position, final control point settings and obtaining the test data and some time for manual log entries. It does not include instrumentation calibration and checkout.

From the SOAC test experience two other assumptions may be used in setting a schedule. First, add two hours to the Test Operations Time for every configuration change, such as changing instrumentation lists or vehicle weights. Second, a fairly tight schedule is generated by assuming six hours of test operations per day. Based on these assumptions, two alternate test schedules are presented.

6.2 SERIAL OPERATION SCHEDULE

Given that the test operations have to occur serially, the test schedule may be developed roughly by considering each major configuration. For the single car at AW0 weight, there are six instrumentation changes, so add 12 hours to the test operation time (1590 minutes) to yield 2310 minutes or 38.5 hours. For a six hour day, this gives seven days to complete AW0, single car tests. By the same method, the Serial Operation Schedule Table, shown below, is developed.

TABLE 6-1

BASELINE TEST TIME BY CONFIGURATION

TEST SET	TIME PER RECORD MIN.	NUMBER OF RECORDS	TOTAL TIME MIN.	AW0 SIN	AW0 TRN	AW2 SIN	AW2 TRN	AW3 SIN	AW3 TRN
P-2001	20	24	480	120	40	120	40	120	40
P-3001	10	60	600	120	80	120	80	120	80
P-3002	10	48	480	80	80	80	80	80	80
P-3003	10	48	480	80	80	80	80	80	80
P-3004	10	24	240	40	40	40	40	40	40
P-4001	80	4	320	80	80	80	80	-	-
P-5001	60	2	120	-	-	120	-	-	-
P-2011	20	1	20	20	-	-	-	-	-
P-3001	20	4	80	80	-	-	-	-	-
PC-5011	60	2	120	-	-	60	60	-	-
A-3021	20	1	20	20	-	-	-	-	-
CN-0001	60	1	60	60	-	-	-	-	-
CN-1001	10	16	160	40	40	-	-	40	40
CN-1201	10	2	20	10	-	-	-	10	-
PN-1001	5	32	160	80	-	-	-	80	-
PN-1101	30	1	30	30	-	-	-	-	-
PN-1201	10	2	20	10	-	-	-	10	-
PN-1301	60	1	60	60	-	-	-	-	-
PN-2201	10	2	20	10	-	-	-	10	-
PN-3001	7.5	8	60	30	-	-	-	30	-
R-0001	10	12	120	40	-	40	-	40	-
R-0002	10	12	120	40	-	40	-	40	-
R-0003	10	12	120	40	-	40	-	40	-
R-3001	10	12	120	40	-	40	-	40	-
R-0010	30	1	30	30	-	-	-	-	-
R-2001	10	3	30	10	-	10	-	10	-
R-1101	30	12	360	120	-	120	-	120	-
PSI-6001	240	2	480	240	240	-	-	-	-
S-1001	2.5	12	30	10	-	10	-	10	-
S-2001	20	3	60	20	-	20	-	20	-
S-3001	7.5	12	90	30	-	30	-	30	-
R-5001	60	2	120	-	-	60	60	-	-
TOTAL TIME, MIN			5230	1590	680	1110	520	970	360

Configuration	Test Time Hours	Conf. Change Time	Oper. Time	Days to Complete
AW0, SIN	26.5	12	38.5	7
AW0, TRN	11.33	6	17.3	3
AW2, SIN	18.5	6	24.5	5
AW2, TRN	8.67	0	8.67	2
AW3, SIN	16.1	10	26.1	5
AW3, TRN	6.	2	8.	2
	TOTAL TIME, DAYS			24

Full Parallel Operation Schedule

Give the conditions that adequate instrumentation and personnel are available to enable complete parallel operation, consideration is given to compatible Test Sets which may be performed simultaneously. This type of schedule is more difficult to generate and extreme care must be given to the compatibility of Test Sets. The Baseline Full Parallel Schedule is developed by a detailed check of daily operations, using the 6-hour day assumption. Some variations to the Test Sets procedures must be accomplished, such as track locations for the tests (these are not detailed here). The following is a breakdown of the operations which show the completion of tests in ten days:

Baseline, Parallel Operation, Schedule

Hours	Driving Test Sets	Additional Test Set		
Day 1 Configuration: Single Car, AW0				
	P-2001(120)	PN-2001(10);	R-2001(10);	S-2001(10)
6 Hrs. 40 Min.	P-3001(80)			
	P-3002(80)	PSI-6001(240);	PN-1001(80);	CN-1001(40)
	P-3003(80)		PN-3001(30);	R-3001(40)
	P-3004(40)		S-3001(20)	

Day 2 Configuration: Single Car, AW0

5 Hrs. 10 Min.	P-4001 (80)	
	P-2001 (20)	
	P-3011 (60)	
	A-3021 (20)	
	CN-0001 (60)	R-0010 (30)
	CN-1201 (10)	PN-1201 (10)
	PN-1301 (60)	

Day 3 Configuration: Single Car, AW0

2 Hrs.	R-1101(120)	S-1001(30)

Configuration: Train, AW0

1 Hr., 20 Min.	P-4001(80)	

Day 4 Configuration: Train, AW0

5 Hrs., 20 Min.	P-2001 (40)	
	P-3001 (80)	
	P-3002 (80)	PSI-6001 (240); CN-1001(40)
	P-3003 (80)	
	P-3004 (40)	

Day 5 Configuration: Single Car, AW2

6 Hrs., 40 Min.	P-2001 (120	R-2001(10); S-2001(10)
	P-3001 (80)	
	P-3002 (80)	R-3001(40); S-300(20)
	P-3003 (80)	
	P-3004 (40)	

Day 6 Configuration: Single Car, AW2

6 Hrs., 20 Min.	P-4001 (80)	
	P-5001 (120)	
	PC-5011 (60)	
	R-1001 (120)	S-1001(30)

Day 7 Configuration: Train, AW2

5 Hrs., 20 Min.	P-2001 (40)	
	P-3001 (80)	
	P-3002 (80)	
	P-3003 (80)	
	P-3004 (40)	

Day 8 Configuration: Train, AW2

2 Hrs., 20 Min.	P-4001 (80) PC-5011 (60)	

Configuration: Single Car, AW3

2 Hrs., 10 Min.	R-1101 (120) CN-1201 (10)	S-1001(30) PN-1201(10)

Day 9 Configuration: Single Car, AW3

6 Hrs., 40 Min.	P-2001(120) P-3001(80) P-3002(80) P-3003(80 P-3004(40)	PN-2001(10); R-2001(10); S-2001(10) CN-1001(40); PN-1001(80); PN-3001(40) R-3001(40); S-3001(20)

Day 10 Configuration: Train, AW3

5 Hrs., 20 Min.	P-2001(40) P-3001(80) P-3002(80) P-3003(80) P-3004(40)	 CN-1001(40)

APPENDIX A

GENERAL VEHICLE TEST SETS

GENERAL VEHICLE TEST SETS

PERFORMANCE

P-2001-TT	ACCELERATION
P-3001-TT	DECELERATION-BLENDED BRAKING
P-3002-TT	DECELERATION-SERVICE FRICTION
P-3003-TT	DECELERATION-DYNAMIC ONLY
P-3004-TT	DECELERATION-EMERGENCY
P-4001-TT	DRIFT TEST
P-5001-TT	FRICTION BRAKE-DUTY CYCLES
P-2011-TT	SPIN/SLIDE-ACCELERATION
P-3011-TT	SPIN/SLIDE-DECELERATION

POWER CONSUMPTION

PC-5011-TT	POWER CONSUMPTION

ADHESION

A-3021-TT	ADHESION-DECELERATION

COMMUNITY NOISE

CN-001-TT	EQUIPMENT NOISE SURVEY-WAYSIDE
CN-1001-TT	EFFECT OF CAR SPEED-WAYSIDE
CN-1201-TT	SCREECH LOOP SURVEY-WAYSIDE

PASSENGER NOISE

PN-1001-TT	EFFECT OF CAR SPEED-ON CAR
PN-1101-TT	EFFECT OF TRACK SECTION-ON CAR
PN-1201-TT	SCREECH LOOP SURVEY-ON CAR
PN-1301-TT	INTERIOR NOISE SURVEY
PN-2001-TT	ACCELERATION EFFECT-ON CAR
PN-3001-TT	DECELERATION EFFECT-ON CAR

GENERAL VEHICLE TEST SETS

RIDE ROUGHNESS

R-0001-XX	DYNAMIC SHAKE TEST-VERTICAL
R-0002-XX	DYNAMIC SHAKE TEST-LATERAL
R-0003-XX	DYNAMIC SHAKE TEST-LONGITUDINAL
R-0010-TT	COMPONENT INDUCED VIBRATION
R-1101-TT	RIDE ROUGHNESS-WORST SPEEDS
R-2001-TT	RIDE ROUGHNESS-ACCELERATION
R-3001-TT	RIDE ROUGHNESS-DECELERATION

SIMULATED REVENUE SERVICE

RS-5001-TT	SIMULATED REVENUE SERVICE

POWER SYSTEM INTERACTION

PSI-6001-TT	RADIO FREQUENCY INTERFERENCE

STRUCTURE DYNAMICS

S-1001-TT	CONSTANT SPEED
S-2001-TT	ACCELERATION
S-3001-TT	DECELERATION

TEST SET

TEST TITLE: Acceleration

TEST SET NO.: P-2011-TT

TEST OBJECTIVE:

To determine the overall acceleration characteristics of the test vehicle as affected by controller input level, line voltage, car weight (load weighing), car direction and train consist.

TEST DESCRIPTION:

The test vehicle will be accelerated at the required controller command on level tangent track. The following combinations will be tested:

Prime Variable	Test Conditions
Controller Level	1/2 and Full Power
Line Voltage	Minimum, Nominal and Maximum Voltage
Car Weights	AW0; AW2; AW3
Car Direction	Forward and Reverse
Train Consists	Single Car & Four-Car Train

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at work area.

2. Add ballast to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors, etc.).

5. Make up required train consists.

6. Proceed to test zone.

7. Make inspection passes over the test zone; check out vehicle and track.

8. Record ambient conditions as required.

9. Make several full-power accelerations on test zone such that line voltage at full power can be adjusted to the desired value for testing.

OPERATION (at Test Zone)

1. Position car for testing from Station 300 to Station 340 (clockwise), forward anticlimber at Station 300. Identify test record.

2. Start recording instrumentation.

3. Move controller to desired input position as rapidly as possible (step input).

4. Start timing devices and put event mark on recorders at time of control input or "first sensed car motion" as required by specific test program.

5. Accelerate vehicle at the fixed input command for the full 4000 foot test zone.

6. If required, put event mark on recorders at each track distance marker as forward anticlimber passes point. (Required if carborne distance instrumentation is not in use.)

7. After passing Station 340, note car speed and stop recorders.

Supplement:

If car weight or input command result in less than maximum car speed at Station 340, the next test record will be an acceleration at the previous input command but from the exit speed noted in Step 7. The following procedure applies:

7-1 Position car such that the speed attained in Step 7 can be obtained at Station 300. Identify test record.

7-2 Put controller in desired input position and accelerate car to test entry speed. Maintain test entry speed as test zone is approached.

7-3 Start recording instrumentation prior to entering test zone.

7-4 Start timing devices, put event mark on recorders, and move controller to desired input command as forward anticlimber passes Station 300.

7-5 Repeat Steps 5 through 7.

8. Stop vehicle, complete test records and set-up for next test point.

NOTE:

If required, repeat Steps 1 through 8 to provide sufficient confidence in test and data accuracy.

This procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet, and detailed in the Test Plan.

(1) Controller Level (input command)

(2) Line Voltage

(3) Car Weight

(4) Car Direction

(5) Train Consist

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	RQD	*
3	Line Current Car Input	HD	
4	Truck Armature Current Fwd Truck	RQD	*
5	Truck Armature Current Aft Truck	RQD	*
6	Truck Field Current Fwd Truck	RQD	(1)
7	Truck Field Current Aft Truck	RQD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	*
11	Car Speed Calibrated Axle RPM	RQD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	* (2)
15			
16			
17			
18			
19			
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	LVD/A	" " " "
3	LCD/A	" " " "
4	MACD/A (F)	" " " "
5	MACD/A (A)	" " " "
6	MFCD/A (F)	" " " "
7	MFCD/A (A)	" " " "
8	MAVD/A (F)	" " " "
9	MAVD/A (A)	" " " "
10	CS/A	" " " "
11	VS/A	" " " "
12	T/A	" " " "
13	ET/A	" " " "
14	D/B	Counter & Digital T-H tabulation
15		
16		
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
AP/A	vs. VS/A for each CS/A;LVD/A;VW/A (1)
LVD/A	Define average values for all tests
MACD/A (F) & (A)	vs. VS/A for each CS/A;LVD/A;VW/A (2)
MFCD/A (F) & (A)	" " " " " " " (2)
CS/A	Define values for all tests
VS/A	vs. T/A for each CS/A;LVD/A;VW/A (1)
D/B	vs. " " " " " "

Notes:

(1) Plots for each type of consist and car direction if significant.

(2) Not mandatory for baseline comparisons but useful for traction system characteristics definition.

TEST SET

TEST TITLE: Deceleration-Blended Braking

TEST SET NO.: P-3001-TT

TEST OBJECTIVE:

To determine the overall deceleration characteristics of the test vehicle utilizing the blended braking system as affected by controller input level, line voltage, car weight (load weighing), car direction, and train consist. Regeneration capability will be tested at varying line "load".

TEST DESCRIPTION:

The test vehicle will be decelerated at the required controller command on level tangent track. The following (example) test combinations will be tested:

Prime Variable	Test Conditions
Controller Level	1/2 and Full Brake
Car Weights	AW0; AW2; AW3
Line Voltage	Minimum; Nominal; 600; and Maximum Volts
Train Consists	Single Car and Four-Car Train
Car Direction	Forward and Reverse
Regeneration "Load"	100% and 50% Line Receptivity

STATUS:

PRELIMINARY (pre-test

1. Attach instrumentation or patch-in desired parameters at storage or shop.

2. Add ballast to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors, etc.).

5. Make up desired train consist.

6. Proceed to test zone.

7. Make inspection passes over test zone. Check out vehicle and track.

8. Record ambient conditions as required.

9. Adjust track voltage as required for specified tests. (Track voltage will affect brake blending during regenerative brake tests.)

10. Adjust line receptivity (load) for regenerated power as required (substation load banks).

OPERATION (at Test Zone)

1. Test zone is track Station 300 to Station 340 for level tangent track tests. Brake "mark" will be at Station 300 or Station 340 depending on car direction. Car reference point will be the forward anticlimber location.

2. Accelerate car to target test speed and approach test zone (Station 300, clockwise) at constant target speed.

3. Identify test record and start recorders.

4. As anticlimber passes the brake "mark" (Station 300 clockwise or Station 340 counterclockwise) initiate blended service braking by putting master controller in the desired input position as rapidly as possible (step input).

5. Start timing devices and put event mark on recorders at time of "brake" input.

6. Decelerate car to a full stop with master controller in the required input position.

7. Put event marks on recorders as each off-car distance reference is passed by the forward anticlimber. (Required if distance data is needed and if carborne distance instrumentation is not in use.)

8. Vehicle Stops: Stop timing devices, put event mark or recorders, stop recorders.

9. Measure off-car stopping distance as required. (Measure to nearest foot from adjacent 100 ft. track station painted on rail.)

10. Reposition vehicle for next test record.

Supplement 10:

If the input command calls for low braking rate, the car may not come to a complete stop in the 4000-ft. test zone. In this case the target entry speed for the next record will be the exit speed from the 4000-ft. course during the previous record. The following procedure applies:

10-1 Steps 1 through 10 with target entry speed as defined above.

NOTE:

Repeat Steps 1 through 10 as required to provide sufficient confidence in data accuracy.

Repeat Steps 1 through 10 such that target speeds of 80, 60, 40 and 20 mph are tested (as required).

The above procedures will be repeated for the various combination of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Direction

(2) Controller Level (input command)

(3) Car Weight

(4) Line Voltage

(5) Train Consist

(6) Ratio of Brake Blending

(7) Regeneration Line Receptivity

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	RQD	*
3	Line Current Car Input	RQD	*
4	Truck Armature Current Fwd Truck	RQD	*
5	Truck Armature Current Aft Truck	RQD	*
6	Truck Field Current Fwd Truck	RQD	(1)
7	Truck Field Current Aft Truck	RQD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	*
11	Car Speed Calibrated Axle RPM	RQD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	*(2)
15	Friction Brake Control Signal	RQD	
16	Brake Cylinder Pressure	RQD	*
17	Car Power Consumption (in and out)	HD	*(3)
18	Brake Temperatures (A) and (B)	HD	*
19	Dynamic Brake Feedback Signal	RQD	
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

(3) Used to determine energy returned to the line during stops using regenerative braking.

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	LVD/A	" " " "
3	LCD/A	" " " "
4	MACD/A (F)	" " " "
5	MACD/A (A)	" " " "
6	MFCD/A (F)	" " " "
7	MFCD/A (A)	" " " "
8	MAVD/A (F)	" " " "
9	MAVD/A (A)	" " " "
10	CS/A	" " " "
11	VS/A	" " " "
12	T/A	" " " "
13	ET/A	" " " "
14	D/B	Counter and Digital T-H tabulation
15	FBCS/A	Digital time-history tabulation
16	BCP/A	" " " "
17	PCC/A	" " " "
18	BT/A & BT/B	Monitor and record peak values
19	DBFB/A	Digital time-history tabulation
20		

Standard Output	Cross Plot or Summarize
AP/A	vs. VS/A for each CS/A;LVD/A;VW/A (1)
LVD/A	Define average values for all tests
MACD/A (F) & (A)	vs. VS/A for each CS/A;LVD/A;VW/A (2)
MFCD/A (F) & (A)	" " " " " " " (2)
CS/A	Define values for all tests
VS/A	vs. T/A for each CS/A;LVD/A;VW/A (1)
D/B	vs. " " " " " " (1)
BCP/A	Define values for all tests (1)
PCC/A	Define energy returned to line as a
	function of: Initial VS/A; LVD/A; VW/A;
	"LOAD"; and CS/A

Notes:

(1) Plots for each type of consist and car direction if significant.

(2) Not mandatory for baseline comparisons but useful for traction system characteristics definition.

TEST SET

TEST TITLE: Deceleration - Service Friction

TEST SET NO.: P-3002-TT

TEST OBJECTIVE:

To determine the overall deceleration characteristics of the test vehicle utilizing the friction braking only system as affected by controller input level, car weight (load weighting), car direction, and train consist.

TEST DESCRIPTION:

The test vehicle will be decelerated at the required controller command on level tangent track. The following (example) test combinations will be tested:

Prime Variable	Test Conditions
Controller Level	1/2 and Full Brake
Car Weights	AW0; AW2; AW3
Train Consists	Single Car and Four-Car Train
Car Direction	Forward and Reverse

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.

2. Add ballast to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors, etc.).

5. Make up desired train consist.

6. Proceed to test zone.

7. Make inspection passes over test zone. Check out vehicle and track.

8. Record ambient conditions as require.

9. Adjust track voltage as required for specified tests.

10. Adjust car such that dynamic brakes can be disabled at the same time braking is initiated.

OPERATION (at Test Zone)

1. Test zone is track Station 300 to Station 340 for level tangent track tests. Brake "mark" will be at Station 300 or Station 340 depending on car direction. Car reference point will be the forward anticlimber location.

2. Accelerate car to target test speed and approach test zone (Station 300, clockwise) at constant target speed.

3. Identify test record and start recorders.

4. As anticlimber passes the brake "mark" (Station 300 clockwise or Station 340 counterclockwise) initiate service friction braking by disabling the dynamic brakes at the same time the master controller is put in the desired position.

5. Start timing devices and put event mark on recorders at time of "brake" input.

6. Decelerate car to a full stop with master controller in the required input position.

7. Put event marks on recorders as each off-car distance reference is passed by the forward anticlimber. (Required if distance data is needed and if carborne distance instrumentation is not in use.)

8. Vehicle Stops: Stop timing devices, put event mark on recorders, stop recorders.

9. Measure off-car stopping distance as required. (Measure to nearest foot from adjacent 100 ft. track station painted on rail.)

10. Reposition vehicle for next test record.

Supplement 10:

If the input command calls for low braking rate, the car may not come to a complete stop in the 4000-ft. test zone. In this case the target entry speed for the next record will be the exit speed from the 4000-ft. course during the previous record the following procedures applies:

10-1 Repeat Steps 1 through 10 with target entry speed as defined above.

NOTE:

Repeat Steps 1 through 10 as required to provide sufficient confidence in data accuracy.

Repeat Steps 1 through 10 such that target speeds of 80, 60, 40 and 20 mph are tested (as required).

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Direction

(2) Controller Level (input command)

(3) Car weight

(4) Train Consist

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	HD	*
3	Line Current Car Input	HD	
4	Car Speed Standard Reference	RQD	
5	Master Controller Signal Cab	HD	*
6	Time	RQD	
7	Event Marker	RQD	
8	Distance	RQD	(1)
9	Brake Cylinder Pressure	HD	*
10	Friction Brake Control Signal	RQD	
11	Brake Temperature (A) and (B)	HD	* (2)
12			
13			
14			
15			
16			
17			
18			
19			
20			

Notes:

(1) Distance displayed on digital counter and as analog recording.

(2) Record as required.

STANDARD OUTPUTS TEST SET NO. P-3002-TT SHEET 6 OF 7

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	LVD/A	" " " "
3	LCD/A	" " " "
4	CS/A	" " " "
5	VS/A	" " " "
6	T/A	" " " "
7	ET/A	" " " "
8	D/B	Counter and Digital T-H tabulation
9	FBCS/A	Digital time-history tabulation
10	BCP/A	" " " "
11	BT/A and BT/B	Monitored and record peak values
12		
13		
14		
15		
16		
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
AP/A	vs. VS/A for each CS/A;LVD/A:VW/A (1)
LVD/A	Define average values for all tests
CS/A	Define values for all tests
VS/A	vs. T/A for each CS/A;LVD/A:VW/A (1)
D/B	vs. " " " " " " (1)
BCP/A	Define values for all tests
FBCS/A	vs. T/A for each CS/A;LVD/A;VW/A (1)

Notes:

(1) Plots for each type of consist and car direction if significant.

TEST SET

TEST TITLE: Deceleration - Dynamic Braking

TEST SET NO.: P-3003-TT

TEST OBJECTIVE:

To determine the overall deceleration characteristics of the test vehicle utilizing the dynamic braking system as affected by controller input level, line voltage, car weight (load weighing), car direction, and train consist. Regeneration capability will be tested at varying line "LOAD".

TEST DESCRIPTION:

The test vehicle will be decelerated at the required controller command on level tangent track. The following (example) test combinations will be tested:

Controller Level	1/2 and Full Brake
Car Weights	AW0; AW2; AW3
Line Voltage	Minimum; Nominal and Maximum Volts
Train Consists	Single Car and Four-Car Train
Car Direction	Forward and Reverse
Regeneration "Load"	100% and 50% Line Receptivity

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.
2. Add ballast weights to simulate desired car weight (AW).
3. Check out and calibrate instrumentation.
4. Photograph instrumentation (location of transducers/sensors, etc.).
5. Make up desired train consist.
6. Proceed to test zone.
7. Make inspection passes over test zone. Check out vehicle and track.
8. Record ambient conditions as required.
9. Adjust track voltage as required for specified tests. (Track voltage will affect brake blending during regenerative brake tests.)
10. Adjust line receptivity (load) for regenerated power as required (substation load banks).
11. For dynamic brakes cut out service friction brakes at the friction brake control unit. Service friction brakes should be cut out in a manner such that the emergency brakes are not affected.
12. With test vehicle at a stand, check emergency brake operation prior to initiating test.

OPERATION (at Test Zone)

1. Test zone is track Station 300 to Station 340 for level tangent track tests. Brake "mark" will be at Station 300 or Station 340 depending on car direction. Car reference point will be the forward anticlimber location.

2. Accelerate car to target test speed and approach test zone (Station 300, clockwise) at constant tartet speed.

3. Identify test record and start recorders.

4. As anticlimber passes the brake "mark" (Station 300 clockwise or Station 340 counterclockwise) initiate dynamic braking by putting master controller in the desired input position as rapidly as possible (step input).

5. Start timing devices and put event mark on recorders at time of "brake" input.

6. Decelerate car to a full stop with master controller in the required input position.

7. Put event marks on recorders as each off-car distance reference is passed by the forward anticlimber. (Required if distance data is needed and if carborne distance instrumentation is not in use.)

8. Vehicle Stops: Stop timing devices, put event mark on recorders, stop recorders.

9. Measure off-car stopping distance as required. (Measure to nearest foot from adjacent 100 ft. track station painted on rail.)

10. Reposition vehicle for next test record.

Supplement 10:

If the input command calls for low braking rate, the car may not come to a complete stop in the 4000-ft. test zone. In this case, the target entry speed for the next record will be the exit speed from the 4000-ft. course during the previous record. The following procedure applies:

10-1 Steps 1 through 10 with target entry speed as defined above.

NOTE:

Repeat Steps 1 through 10 as required to provide sufficient confidence in data accuracy.

Repeat Steps 1 through 10 such that target speeds of 80, 60, 40 and 20 mph are tested (as required).

The above procedures will be repeated for the various combinations of controlled test variables listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Direction

(2) Controller Level (input command)

(3) Car Weight

(4) Line Voltages

(5) Train Consist

(6) Regeneration Line Receptivity

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	RQD	*
3	Line Current Car Input	RQD	*
4	Truck Armature Current Fwd Truck	RQD	*
5	Truck Armature Current Aft Truck	RQD	*
6	Truck Field Current Fwd Truck	RQD	(1)
7	Truck Field Current Aft Truck	RQD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	*
11	Car Speed Calibrated Axle RPM	RQD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	*(2)
15	Brake Cylinder Pressure	RQD	*
16	Car Power Consumption (in and out)	HD	(3)
17			
18			
19			
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

(3) Used to determine energy returned to the line during stops using regenerative braking.

Item	Standard Output		Output Format			
1	AP/A		Digital time-history tabulation			
2	LVD/A		"	"	"	"
3	LCD/A		"	"	"	"
4	MACD/A	(F)	"	"	"	"
5	MACD/A	(A)	"	"	"	"
6	MFCD/A	(F)	"	"	"	"
7	MFCD/A	(A)	"	"	"	"
8	MAVD/A	(F)	"	"	"	"
9	MAVD/A	(A)	"	"	"	"
10	CS/A		"	"	"	"
11	VS/A		"	"	"	"
12	T/A		"	"	"	"
13	ET/A		"	"	"	"
14	D/B		Counter and Digital T-H tabulation			
15	BCP/A		Digital time-history tabulation			
16	PCC/A		"	"	"	"
17						
18						
19						
20						

Standard Output	Cross Plot or Summarize	
AP/A	vs. VS/A for each CS/A; LVD/A; VW/A	(1)
LVD/A	Define average values for all tests	
MACD/A (F) & (A)	vs. VS/A for each CS/A; LVD/A; VW/A	(2)
MFCD/A (F) & (A)	" " " " " " "	(2)
CS/A	Define values for all tests	
VS/A	vs. T/A for each CS/A; LVD/A; VW/A	(1)
D/B	vs. " " " " " "	(1)
BCP/A	Define values for all tests	
PCC/A	Define energy returned to line as a	
	function of: Initial VS/A; LVD/A;	
	VW/A; "LOAD"; and CS/A	

TEST SET

TEST TITLE: Deceleration - Emergency Braking

TEST SET NO.: P-3004-TT

TEST OBJECTIVE:

To determine the overall deceleration characteristics of the test vehicle utilizing the emergency braking system as affected by car weight (load weighing), car direction, and train consist.

TEST DESCRIPTION:

The test vehicle will be decelerated at the required controller command on level tangent track. The following (example) test combinations will be tested:

Prime Variable	Test Conditions
Car Weights	AW0; AW2; AW3
Train Consists	Single Car and Four-Car Train
Car Direction	Forward and Reverse

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.

2. Add ballast weights to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors, etc.).

5. Make up desired train consist.

6. Proceed to test zone.

7. Make inspection passes over test zone. Check out vehicle and track.

8. Record ambient conditions as required.

9. Adjust track voltage as required for specified tests.

OPERATION (at Test Zone)

1. Test zone is track Station 300 to Station 340 for level tangent track tests. Brake "mark" will be at Station 300 or Station 340 depending on car direction. Car reference point will be the forward anticlimber location.

2. Accelerate car to target test speed and approach test zone (Station 300, clockwise) at constant target speed.

3. Identify test record and start recorders.

4. As anticlimber passes the brake "mark" (Station 300 clockwise or Station 340 counterclockwise) initiate emergency braking by pushing "Emergency Stop" button.

5. Start timing devices and put event mark on recorders at time of "brake" input.

6. Decelerate car to a full stop with master controller in the required input position.

7. Put event marks on recorders as each off-car distance reference is passed by the forward anticlimber. (Required if distance data is needed and if carborne distance instrumentation is not is use.)

8. Vehicle Stops: Stop timing devices, put event mark on recorders, stop recorders.

9. Measure off-car stopping distance as required. (Measure to nearest foot from adjacent 100 ft. track station painted on rail.)

10. Reposition vehicle for next test record.

Supplement 10:

If the input command calls for low braking rate, the car may not come to a complete stop in the 4000-ft. test zone. In this case the tar et entry speed for the next record will be the exit speed from the 4000-ft. course during the previous record. The following procedure applies:

10-1 Repeat Steps 1 through 10 with target entry speed as defined above.

NOTE:

Repeat Steps 1 through 10 as required to provide sufficient confidence in data accuracy.

Repeat Steps 1 through 10 such that target speeds of 80, 60, 40 and 20 mph are tested (as required).

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Direction

(2) Car Weight

(3) Train Consist

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	RQD	*
3	Line Current Car Input	RQD	*
4	Car Speed Standard Reference	RQD	
5	Master Controller Signal Cab	HD	*
6	Time	RQD	
7	Event Marker	RQD	
8	Distance	RQD	(1)
9	Brake Cylinder Pressure	HD	
10	Friction Brake Control Signal	RQD	
11	Brake Temperature (A) and (B)	HD	*(2)
12			
13			
14			
15			
16			
17			
18			
19			
20			

Notes:

(1) Distance displayed on digital counter and as analog recording.

(2) Record as required.

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	LVD/A	" " " "
3	LCD/A	" " " "
4	CS/A	" " " "
5	VS/A	" " " "
6	T/A	" " " "
7	ET/A	" " " "
8	D/B	Counter and Digital T-H tabulation
9	FBCS/A	Digital time-history tabulation
10	BCP/A	" " " "
11	BT/A and BT/B	Monitored and record peak values
12		
13		
14		
15		
16		
17		
18		
19		
20		

PRELIMINARY ANALYSIS TEST SET NO. P-3004-TT SHEET 7 OF 7

Standard Output	Cross Plot or Summarize	
AP/A	vs VS/A for each CS/A; LVD/A; VW/A	(1)
LVD/A	Define average values for all tests	
CS/A	Define values for all tests	
VS/A	vs. T/A for each CS/A; LVD/A; VW/A	(1)
D/B	" " " " " " "	(1)
BCP/A	Define values for all tests	
FBCS/A	vs. T/A for each CS/A; LVD/A; VW/A	(1)

Notes:

(1) Plots for each type of consist and car direction if significant.

TEST SET

TEST TITLE: Drift Test (traction resistance)

TEST SET NO.: P-4001-TT

TEST OBJECTIVE:

To determine the traction (train) resistance of the test vehicle for use in the analysis of adhesion test data, to check the coefficients used to calculate the design performance of the vehicle, and as a baseline for analysis of the vehicle tractive and braking effort values.

TEST DESCRIPTION:

During the drift tests the test consist will be allowed to coast from an initial speed on level tangent track. Both propulsion and friction brake systems will be disabled to attain a true coast. The speed-time-distance data will be the source of the final resistance values.

Prime Variable	Test Conditions
Car Weight	AW0 and AW2
Train Consist	Single Car and Four-Car Train

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.
2. Add ballast weights to simulate desired car weight (AW).
3. Check out and calibrate instrumentation.
4. Photograph instrumentation (location of transducers/sensors etc.).
5. Make up desired train consist.
6. Proceed to test zone.
7. Make inspection passes over test zone; check out vehicle and track.
8. Record ambient conditions as required.
9. Determine if ambient conditions are within the maximum allowables for the drift tests.
10. Insure that a true "coast" condition can be obtained, i.e., disabled propulsion system, no "inshot" brake pressure from service brakes.

OPERATION (at Test Zone)

1. The test zone is the 4000-ft. level tanget track from Station 300 to Station 340.

2. Approach test zone at maximum train speed in clockwise direction.

3. Start recorders, disable traction system and obtain a true coasting mode with no airbrake "Inshot". Leave master controller slightly above coast position in "Power" mode.

4. At beginning of test zone (Station 300 clockwise; Station 340 counterclockwise) put event mark on recorders for distance reference with off-car distance markers or identify "Zero" distance on carborne distance instrumentation.

5. Put event mark on recorders as each off-car distance reference is passed.

6. At end of 4000-ft. test zone stop recorders, note exit speed, engage the traction system, and position car for next test record in opposite direction.

7. Approach test zone from opposite direction at maximum car speed (Counterclockwise).

8. Repeat Steps 3 through 6 for records in each car direction.

9. Repeat Steps 2 through 7, but with a test zone entry speed equal to the exit speed of Step 6 less 5 mph. (One record in each direction).

10. Repeat Step 9 until an exit car speed less than 10 mph in each direction is obtained.

NOTE:

Repeat Steps 1 through 10 as required to provide sufficient confidence in data accuracy.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted in the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

INSTRUMENTATION TEST SET NO. P-4001-TT SHEET 4 OF 6

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	
2	Truck Armature Currents (F) & (A)	RQD	* (1)
3	Car Speed Calibrated Axle RPM	RQD	*
4	Car Speed Standard Reference	RQD	(2)
5	Master Controller Signal Cab	HD	* (3)
6	Time	RQD	
7	Event Marker	RQD	
8	Distance	RQD	
9	Brake Cylinder Pressure	HD	*
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Notes:

(1) Monitor to validate no propulsion or braking current.

(2) Required to provide accurate time-speed data.

(3) Monitor to ensure a true "coast" condition.

STANDARD OUTPUTS TEST SET NO. P-4001-TT SHEET 5 OF 6

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	VS/A	" " " "
3	VS/B	" " " "
4	T/A	" " " "
5	ET/A	" " " "
6	D/B	" " " "
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
TR/A	Plot vs. VS/B and VW/A, and Consist

TEST SET

TEST TITLE: Duty Cycle - Friction Brakes

TEST SET NO.: P-5001-TT

TEST OBJECTIVE:

To determine the thermal capacity of the vehicle's friction braking system during a sample service run. The dynamic brake system will be inoperative during the tests with the friction brake providing all of the decelerating force, as applicable.

TEST DESCRIPTION:

The test vehicle will be accelerated to a target cruise speed, cruise for a defined time, and brake to a simulated station stop. Following a defined station dwell the cycle will be repeated.

Prime Variable	Test Conditions
Cruise Speed and Time	35 mph for 45 sec. 50 mph for 55 sec.
Car Weight	AW2 (or AW)
Brake Type	Solid and Resilient Wheels
Brake Blending	Blended and Friction Only

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.
2. Add ballast weights to simulate desired car weight (AW).
3. Check out and calibrate instrumentation.
4. Photograph instrumentation (location of transducers/sensors, etc.).
5. Make up desired train consist.
6. Proceed to test zone.
7. Make inspection passes over test zone; check-out vehicle and track.
8. Record ambient conditions as required.
9. Adjust car such that the dynamic brake can be disabled on each start-stop cycle.

OPERATION (at Test Zone)

1. Position car at defined track location for testing in the defined car direction.

2. Start recorders, identify records, record track station number.

3. Accelerate car at full service rate to the target speed. Put event mark on recorders and record time-of-day as the controller is moved to full power.

4. Maintain the target cruise speed for the specified time period.

5. At end of cruise time, disable dynamic brake and apply full service friction braking.

6. Bring car to complete stop and simulate a station dwell of the desired length.

7. Record completed cycle number and off-car temperatures as required (Note: any increased station dwell during off-car measurements should be subtracted from succeeding station stops).

8. Repeat Steps 3 through 7 until the specified number of start-stop cycles have been completed. Record completed laps of the test oval, total elapsed time from the start (Step 3) and the track station at which the test was completed.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet, and detailed in the Test Plan:

(1) Cruise Speed and Times

(2) Car Weights

(3) Braking/Wheel Configuration

(4) Commanded Braking Rate

(5) Dynamic Brake Blending

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	HD	*(3)
3	Line Current Car Input	HD	(3)
4	Truck Armature Current Fwd	NTH	*(4)
5	Truck Armature Current Aft Truck	NTH	*(4)
6	Truck Field Current Fwd Truck	NTH	(1)(4)
7	Truck Field Current Aft Truck	NTH	(1)(4)
8	Car Power Consumption (in and out)	HD	(5)
9			
10	Master Controller Signal Car	RQD	*
11	Car Speed Calibrated Axle RPM	RQD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	*(2)
15	Friction Brake Control Signal	HD	
16	Brake Cylinder Pressure	HD	*
17	Brake Temperature (shoe or pad)	RQD	*(6)
18	Brake Temperature (wheel or disk)	RQD	*(6)
19	Dynamic Brake Feedback Signal	RQD	(7)
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recordings.

(3) May be used for input to power consumption equipment.

(4) May be used for developing RMS value for motor duty cycle severity using blended brakes.

(5) Will provide useful data on a sample service profile.

(6) Number and location of thermocouples to be defined.

(7) For use with brake blending tests.

STANDARD OUTPUTS TEST SET NO. P-5001-TT SHEET 5 OF 6

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation
2	RMS-MAC/A	Sum of $(MACD/A)^2 \times (\Delta t)$
3	PCC/A	Sum of total No. of stops
4	T/A	Digital time-history tabulation
5	D/B	" " " "
6	BT/B (shoe)	" " " "
7	BT/A (wheel)	" " " "
8	VS/A	" " " "
9	DBFB/A	" " " "
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
BT/A and BT/B	Plot with Stops for each Duty Cycle and
(Shoe or Wheel)	type of wheel or brake blending.
AP/A	Plot vs. VS/A for selected stops for rate
	comparisons at temperatures.
RMS-Current	Take RMS-MAC/A and divide by total cycle
	time for each cycle; blended braking.

TEST SET

TEST TITLE: Spin/Slide - Acceleration

TEST SET NO.: P-2011-TT

TEST OBJECTIVE:

To determine the efficiency of the test vehicles spin/slide protective system during acceleration for various rail conditions.

TEST DESCRIPTION:

The test will be conducted on level tangent track at the desired rail condition. The test vehicle will be accelerated at full service rate beyond base speed allowing the spin/slide system to function.

Prime Variable	Test Condition
Rail Condition	Clean-wet, dry

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.
2. Add ballast weights to simulate desired car weight (AW).
3. Check out and calibrate instrumentation.
4. Photograph instrumentation (location of transducers/sensors, etc.).
5. Install rail spray apparatus on forward truck - forward axle.
6. Fill spray reservoir with desired mix (water +).
7. Make up desired train consist.
8. Proceed to test zone.
9. Make inspection passes over test zone; check out vehicle and track.
10. Record ambient conditions as required.
11. Make several low speed passes over test zone to fully wet the rails.
12. Assure functioning of spin/slide systems.

OPERATION (at Test Zone)

1. The test zone is the 4000 ft. level tangent track from Station 300 to 340. The test vehicle will be operated in the forward direction with the spray apparatus on the leading axle.

2. Position car for testing from Station 300 to Station 340 (clockwise): Forward anticlimber at Station 300.

3. Identify test record, start recording instruments.

4. Move controller to position for full service rate as rapidly as possible, put event mark on recorders at time of control input or "first sensed car motion".

5. As car accelerates, spin/slide system should function as wheels slide. Maintain tractive effort command obtaining approximately 20 seconds of spin/slide data. Test vehicle should accelerate beyond base speed to approximately 35 mph.

6. Following data record, reduce tractive effort command below spin/slide level; stop recorders; stop spray apparatus.

NOTE:

Repeat Steps 1 through 6 for the desired rail conditions: clean-wet; oiled-wet; sanded; dry, etc.

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	HD	*
3	Line Current Car Input	HD	
4	Truck Armature Current Fwd Truck	RQD	
5	Truck Armature Current Aft Truck	RQD	
6	Truck Field Current Fwd Truck	HD	(1)
7	Truck Field Current Aft Truck	HD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	
11	Car Speed Calibration No. 1 Axle RPM	RQD	
12	Car Speed Calibration No. 2 Axle RPM	RQD	
13	Car Speed Calibration No. 3 Axle RPM	RQD	*
14	Car Speed Calibration No. 4 Axle RPM	RQD	
15	Time	RQD	*
16	Event Marker	RQD	
17	Brake Pressure	RQD	
18			
19			
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

Item	Standard Output	Output Format	
1	AP/A	Digital time-history tabulation	(1)
2	LVD/A	" " " "	(1)
3	LCD/A	" " " "	(1)
4	MACD/A (F)	" " " "	(1)
5	MACD/A (A)	" " " "	(1)
6	MFCD/A (F)	" " " "	
7	MFCD/A (A)	" " " "	
8	MAVD/A (F)	" " " "	
9	MAVD/A (A)	" " " "	
10	CS/A	" " " "	(1)
11	VS/A No. 1	" " " "	(1)
12	VS/A No. 2	" " " "	(1)
13	VS/A No. 3	" " " "	(1)
14	VS/A No. 4	" " " "	(1)
15	T/A	" " " "	
16	ET/A	" " " "	(1)
17	BCP/A	" " " "	(1)
18			
19			
20			

Note:

(1) Analog time history plot, format also required.

Standard Output	Cross Plot or Summarize
VS/A No. 1	VS T/A
VS/A No. 2	T/A
VS/A No. 3	T/A
VS/A No. 4	T/A
AP/A	VS T/A and then obtain average (1)
	acceleration
	Determine actual acceleration rate (2)
	Calculate efficiency

Notes:

(1) Plot peak acceleration.

(2) From true car speed time history (no-slides).

TEST SET

TEST TITLE: Spin/Slide - Deceleration

TEST SET NO.: P-3011-TT

TEST OBJECTIVE:

To determine the efficiency of the test vehicles spin/slide protective system during blended, dynamic and service friction only braking throughout the speed range of the test vehicle for various rail conditions.

TEST DESCRIPTION:

The test will be conducted on level tangent track at the desired rail condition. Initiate full service braking at the target speed decelerating, with sliding wheels on wetted rails, and allowing the spin/slide system to function.

Prime Variable	Test Conditions
Rail Condition	Dry, clean wet, oil and water wet
Braking Mode	Friction Only, Dynamic Only, Blended
Stopping Distance and Time	

STATUS:

PRELIMINARY (pre-test)

1. Attach intrumentation or patch-in desired parameters at storage or shop.
2. Add ballast weights to simulate desired car weight (AW).
3. Check out and calibrate instrumentation.
4. Photograph instrumentation (location of transducers/sensors etc.).
5. Install rail spray apparatus on forward truck - forward axle.
6. Fill spray reservoir with desired mix (Water +).
7. Make up desired train consist.
8. Proceed to test zone.
9. Make inspection passes over test zone; checkout vehicle and track.
10. Record ambient conditions as required.
11. Make several low speed passes over test zone to fully wet the rails.
12. Ensure that the proper combination of brake systems can be selected during the test.
13. Assure functioning of spin/slide systems.

OPERATION (at Test Zone)

1. The test zone is the 4000-ft. level tangent track from Station 300 to Station 340. Car will be operated in the forward direction with the spray apparatus on the leading axle.

2. Approach test zone in car's forward direction at a car speed of 20 mph.

3. Start recorders, identify records, set up proper brake system combination, start rail sprayers.

4. When in test zone apply full service braking by decreasing the master controller command. (Note: Increase brake rate gradually to avoid any excessive wheel slides).

5. Maintain the brake command for 10 to 20 cycles of the spin/slide system (20 to 30 seconds) as applicable to the test car speed.

6. Following these cycles reduce the command below the slide level and bring car to stop, stop recorders, stop rail sprayers.

7. Repeat Steps 2 through 6 at initial speeds of 40, 60, 80 mph, or maximum car speed such that the full range of operational speeds is tested.

The above procedure will be repeated with the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Rail Condition

(2) Braking Mode

(3) Stopping Distance and Time

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	HD.	*
3	Line Current Car Input	HD	
4	Truck Armature Current Fwd Truck	RQD	
5	Truck Armature Current Aft Truck	RQD	
6	Truck Field Current Fwd Truck	HD	(1)
7	Truck Field Current Aft Truck	HD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	
11	Car Speed Calibration No. 1 Axle RPM	RQD	
12	Car Speed Calibration No. 2 Axle RPM	RQD	
13	Car Speed Calibration No. 3 Axle RPM	RQD	*
14	Car Speed Calibration No. 4 Axle RPM	RQD	
15	Time	RQD	*
16	Event Marker	RQD	
17	Brake Pressure	RQD	
18	Friction Brake Control Signal	RQD	
19	Distance	RQD	(2)
20	Dynamic Brake Feedback Signal	RQD	(3)

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

(3) Required during blended braking only.

Item	Standard Output	Output Format
1	AP/A	Digital time-history tabulation (1)
2	LVD/A	" " " " (1)
3	LCD/A	" " " " (1)
4	MACD/A (F)	" " " " (1)
5	MACD/A (A)	" " " " (1)
6	MFCD/A (F)	" " " "
7	MFCD/A (A)	" " " "
8	MAVD/A (F)	" " " "
9	MAVD/A (A)	" " " "
10	CS/A	" " " " (1)
11	VS/A No. 1	" " " " (1)
12	VS/A No. 2	" " " " (1)
13	VS/A No. 3	" " " " (1)
14	VS/A No. 4	" " " " (1)
15	T/A	" " " "
16	ET/A	" " " " (1)
17	BCP/A	" " " " (1)
18	FBCS/A	" " " " (1)
19	D/B	Counter and Digital T-H tabulation
20	DBFB/A	Digital time-history tabulation

Note:

(1) Analog time history plot, format also required.

Standard Output	Cross Plot or Summarize
VS/A No. 1	vs. T/A
VS/A No. 2	" "
VS/A No. 3	" "
VS/A No. 4	" "
AP/A	vs. T/A and then obtain average de- (1)
	celeration
	Determine actual deceleration rate (2)
	Calculate efficiency

Notes:

(1) Plot peak deceleration.

(2) From true car speed time history (no-slide).

TEST SET

TEST TITLE: Power Consumption

TEST SET NO.: PC-5011-TT

TEST OBJECTIVE:

To determine the power consumption of the test vehicle while operating on a sample service route at a defined level of schedule performance. The tests will provide a measure of car schedule performance, power consumption (regeneration), and overall traction system efficiency.

TEST DESCRIPTION:

The car(s) will be operated over a simulated route with stops at specified stations. Normal service performance will be used. Power consumed by the traction and auxiliaries will be measured for each stop and the round-trip.

Prime Variable	Test Conditions
Car Weight	AW2
Braking Mode	Blended Only; 100% Regeneration
Regeneration Line Receptivity	100% and 50%
Line Voltage	Minimum; Nominal Maximum Volts
Train Consists	Single Car and Four-Car Train

STATUS:

PROCEDURE TEST SET NO. PC-5011-TT SHEET 2 OF 6

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.

2. Add ballast weights to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors etc.).

5. Layout simulated route: Station locations and "brake" application markers.

6. Make up desired train consist.

7. Proceed to test zone.

8. Make inspection passes over test zone; check out vehicle and track.

9. Record ambient conditions as required.

10. Energize the normal auxiliary power load of the car, including traction system auxiliary equipment. Measure line power drawn for each or all auxiliaries with car at full stop.

OPERATION (at Test Zone)

1. The test zone is the complete transit oval or designated sections with station locations specifically marked.

2. Position car at the first simulated station, identify records, "zero"counters, start recorders.

3. Accelerate car in the clockwise direction at full service rate. Start timing devices, put event mark on recorders.

4. As car attains the required cruise speed, decrease power and maintain cruise speed.

5. Apply full service (blended) braking at the "brake" marker for the next station.

6. Bring car to a complete stop within one car length of the "station"marker using motorman's controller as required.

7. Simulate station dwell of the required time.

8. At end of station dwell, accelerate the car at full service rate, put event mark on recorders, record elapsed time and watt-hours energy consumed (quick-look counter).

9. Repeat Steps 4 through 8 until a complete trip of the specified route has been made in the clockwise direction.

0. Repeat Steps 2 through 9 with car operating in the counter-clockwise direction. (Will provide for a complete round-trip.)

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weights

(2) Braking Modes

(3) Regeneration Line Receptivity

(4) Line Voltage

(5) Train Consist

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	HD	*
2	Line Voltage Car Input	RQD	*(3)
3	Line Current Car Input	RQD	(3)
4	Truck Armature Current Fwd Truck	HD	*(4)
5	Truck Armature Current Aft Truck	HD	*(4)
6	Truck Field Current Fwd Truck	HD	(1)(4)
7	Truck Field Current Aft Truck	HD	(1)(4)
8	Truck Armature Voltage Fwd Truck	NTH	
9	Truck Armature Voltage Aft Truck	NTH	
10	Master Controller Signal Cab	HD	*
11	Car Speed Calibrated Axle RPM	HD	*
12	Time	RQD	*
13	Event Marker	RQD	
14	Distance	RQD	*(2)
15	Car Power Consumption (in and out)	RQD	*(5)
16	Brake Temperature (shoe or pad)	HD	*(6)
17	Brake Temperature (wheel or disk)	HD	*(6)
18	Equipment Temperatures	HD	(7)
19			
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

(2) Distance displayed on digital counter and as analog recording.

(3) May be used for power consumption equipment.

(4) May be used for developing RMS values for motor duty cycle severity on simulated route.

(5) Available as energy input to car and returned to line on all stops and as a summary.

(6) To be recorded as a measure of duty cycle severity.

(7) Record equipment temperatures as required-thermocouples installed in equipment locations.

Item	Standard Output	Output Format
1	PCC/A	Input from line and return to line on
2		a per-stop basis and total trip.
3	T/A	Time for all station-station runs and
4		total trip.
5	D/B	Distance for all station-station runs
6		and total trip.
7	RMS-MAC/A	Sum of $(MACD/A)^2 \times (\Delta t)$
8	RMS-MFC/A	Sum of $(MFCD/A)^2 \times (\Delta t)$
9	BT/B (shoe)	Digital time-history tabulation
10	BT/A (wheel)	" " " "
11	EQT/A (VAR)	" " " "
12		
13		
14		
15		
16		
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
PCC/A	Summarize net power consumed (and per car-mile) over each of the various station spacings and the total route for each of the test conditions.
T/A	Summarize the "schedule times" and "schedule speeds" for each of the station spacings and the total route.
D/A	Use to determine the station spacings (along with specific route markers).
BT/AB (shoe,wheel)	Plot with station stops, etc.
RMS-Current(s)	Determine armature and field RMS currents by dividing RMS-MAC/A and RMS-MFC/A by the total trip times.
EQT/A	Determine maximum and average equipment temperatures during the tests.

TEST SET

TEST TITLE: Adhesion - Deceleration

TEST SET NO.: A-3021-TT

TEST OBJECTIVE:

To determine the dry and wetted rail adhesion factors for use in spin/slide system detailed performance analysis.

TEST DESCRIPTION:

Adhesion testing will be performed on the level tangent track using friction brakes only on the front truck. The aft truck friction brakes will be cutout. The complete dynamic brakes will be disabled prior to testing. The rails will be wetted utilizing a spray apparatus attached in front of the leading axle. For dry rail testing the brake pressure will have to be increased at the friction brake control unit to induce wheel slides. Sample test conditions are:

Prime Variable	Test Condition
Rail Condition	Dry; Clean-Wet
Car Weight	AW0
Track Type	Level Tangent; Curved

STATUS:

PRELIMINARY (pre-test)

1. Attach instrumentation or patch-in desired parameters at storage or shop.

2. Add ballast weights to simulate desired car weight (AW).

3. Check out and calibrate instrumentation.

4. Photograph instrumentation (location of transducers/sensors, etc.).

5. Attach rail wetting apparatus to front axle of leading truck.

6. Provide desired mixture of rail wetting fluid (Water +).

7. Cut-out service friction brakes on aft truck. (Ensure full emergency brake capability both trucks.)

8. Provide for cut-out of full dynamic brake system during test runs. (Disable at shop or provide for cut-out during car operation.)

9. Make up desired train consist.

10. Proceed to test zone.

11. Make inspection passes over test zone; check out vehicle and track.

12. Record ambient conditions as required.

13. Make several passes over test zone with sprayers activated to thoroughly wet the rails.

14. Ensure proper functioning of all brake control and slide protection systems.

OPERATION (at Test Zone)

1. Test zone is the 4000-ft. level tangent track from Station 300 to Station 340. Car will be tested in the forward direction with rail sprayers on leading axle.

2. Approach test zone in forward direction at an initial speed of 20 mph.

3. Start recorders, identify records, start rail sprayers.

4. When car is within test zone, transition to "Brake" mode, disable dynamic brake as applicable.

5. Increase "Brake" command slowly (increase BCP) until forward truck wheel "Slide" is induced. Difference in axle speeds between forward truck and non-braked aft truck will provide "Slide" indication. On board spin-slide monitors may also detect the axle speed difference.

6. When slide occurs reduce "Brake" command (and BCP) until slide is corrected and all axle speeds become equal.

7. Repeat Steps 5 and 6 for several "Slide-Roll" cycles. Monitor friction brake temperatures as applicable.

8. Following desired number of cycles, decrease "Brake" command to a non-sliding level, stop rail sprayers, stop recorders, stop car. Monitor brake temperature.

9. Allow brakes to cool to acceptable temperatures and position car for the next test run in the same, forward direction.

10. Repeat Steps 2 through 9 for initial speeds of 40, 60, 80 mph or maximum car speed.

NOTE:

Repeat Steps 2 through 10 as required to provide sufficient data accuracy.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan.

(1) Rail Condition

(2) Car Weights

(3) Track Type

Item	Sensor Location	Priority	Monitor
1	Longitudinal Acceleration-Car Body	RQD	*
2	Line Voltage Car Input	HD	*
3	Line Current Car Input	HD	
4	Truck Armature Current Fwd Truck	RQD	
5	Truck Armature Current Aft Truck	RQD	
6	Truck Field Current Fwd Truck	HD	(1)
7	Truck Field Current Aft Truck	HD	(1)
8	Truck Armature Voltage Fwd Truck	HD	
9	Truck Armature Voltage Aft Truck	HD	
10	Master Controller Signal Cab	RQD	
11	Car Speed Calibration No. 1 Axle RPM	RQD	
12	Car Speed Calibration No. 2 Axle RPM	RQD	
13	Car Speed Calibration No. 3 Axle RPM	RQD	*
14	Car Speed Calibration No. 4 Axle RPM	RQD	
15	Time	RQD	*
16	Event Marker	RQD	
17	Brake Pressure	RQD	
18	Friction Brake Control Signal	RQD	
19	Brake Temperature (A) and (B)	RQD	*
20			

Notes:

(1) Motor field currents as applicable to the car's traction system.

Item	Standard Output		Output Format				
1	AP/A		Digital	time-history	tabulation		(1)
2	LVD/A		"	"	"	"	(1)
3	LCD/A		"	"	"	"	(1)
4	MACD/A	(F)	"	"	"	"	(1)
5	MACD/A	(A)	"	"	"	"	(1)
6	MFCD/A	(F)	"	"	"	"	
7	MFCD/A	(A)	"	"	"	"	
8	MAVD/A	(F)	"	"	"	"	
9	MAVD/A	(A)	"	"	"	"	
10	CS/A		"	"	"	"	(1)
11	VS/A	No. 1	"	"	"	"	(1)
12	VS/A	No. 2	"	"	"	"	(1)
13	VS/A	No. 3	"	"	"	"	(1)
14	VS/A	No. 4	"	"	"	"	(1)
15	T/A		"	"	"	"	
16	ET/A		"	"	"	"	(1)
17	BCP/A		"	"	"	"	(1)
18	FBCS/A		"	"	"	"	(1)
19	BT/A and BT/B		Monitor and record peak values				
20							

Notes:

(1) Analog time history plot, format (1) also required.

Standard Output	Cross Plot or Summarize
VA/A No. 1	vs. T/A
VS/A No. 2	" "
VS/A No. 3	" "
VS/A No. 4	" "
AP/A	vs. T/A to obtain peak (1)
	Deceleration rates to calculate ad-
	hesion factor

Note:

(1) Traction resistance from test set number P-4001-TT utilized in calculated adhesion factor data results.

TEST SET

TEST TITLE: Equipment Noise Survey - Wayside

TEST SET NO.: CN-0001-TT

TEST OBJECTIVE:

To determine the contribution of equipment noise to total test vehicle signature.

TEST DESCRIPTION:

This test will be performed at a boarding platform area.

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Position the test vehicle at a boarding platform away from other noise sources with all equipment turned off.

2. Position one microphone at the ear level of a standing passenger on the platform.

3. Position the second microphone 50 feet from the track centerline at mid car.

4. Start the recorders prior to equipment cycle, identify the test point and the record gain level by voice.

5. Start up each item of equipment and record approximately 15 seconds of noise data for each record.

6. Maintain a written log of the equipments and record numbers.

7. Cycle the passenger doors for the last test point.

Item	Sensor Location	Priority	Monitor
1	Passenger door mid car 5 ft. from car	RQD	
2	Mid car 50 ft. from track centerline	RQD	
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Note:

(1) A portable noise recording system is used for this test.

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	SP/A	" " " " " "
3	NL/A	For each Test Point
4	NL/A	" " " "
5	S3B/A	" " " "
6	S3B/A	" " " "
7	SN/A	" " " "
8	SN/A	" " " "
9		
10		
11		
12		
13		
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Note:

(1) Provide wind velocity and direction, ambient temperature, pressure and relative humidity for each test point on the Standard Outputs.

TEST SET

TEST TITLE: Effect of Car Speed - Wayside

TEST SET NO.: CN-1001-TT

TEST OBJECTIVE:

Determine Wayside noise levels during vehicle passbys during constant speed conditions.

TEST DESCRIPTION:

This test will be performed at a wayside station 50 feet from the track for the following conditions:

Prime Variable	Test Conditions
Car Speed	Five Selected Speeds
Car Weight	AW0, AW3
Train Consist	Single Car, Multiple Unit

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheels flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Select five (5) discrete speeds within the normal operating speed range at the test vehicle.

2. Set-up the noise measurement system at Track Station 156 on the outside of the loop at a distance of 50 feet and 5 feet above the rail.

3. Start the recorder prior to the passby of the test vehicle and identify the test point, location, amplifier gain level and ambient weather conditions by voice.

4. Have the test vehicle operate up to one of the selected test speeds. Timing should be such that the vehicle is up to speed 10 seconds prior to passing microphone and should maintain speed for 10 seconds beyond the microphone.

5. Repeat Steps 3 and 4 for each of the 5 selected speeds.

NOTE:

Repeat the test point at a mid-speed three times (to ensure repeatable test data).

CAUTION

The direction of motion of the car will be the same for all passbys.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

Item	Sensor Location	Priority	Monitor
1	50 Feet From Track Centerline	RQD	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

STANDARD OUTPUTS TEST SET NO. CN-1001-TT SHEET 5 OF 6

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	NL/A	Format 1
3	NL/A	Format 2
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Note:

(1) Provide wind velocity and direction, ambient temperature, pressure and relative humidity for each test point on the Standard Outputs.

Standard Output	Cross Plot or Summarize
NL/A Format 2	Cross plot as a function of speed

TEST SET

TEST TITLE: Screech Loop Survey - Wayside

TEST SET NO.: CN-1201-TT

TEST OBJECTIVE:

Determine Wayside Noise during car operation on short radius curves.

TEST DESCRIPTION:

This test will be completed on the UMTA Test Track Screech Loop for Test Vehicle weights of AW0 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive charateristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATIONS (UMTA Sceech Loop)

1. Position the microphone of the noise recording system at the center of the screech loop 5 feet above the local ground height.

2. Start the recorder prior to car entering the loop, identify the test point, location, the recorder gain level and ambient weather conditions by voice.

3. Record noise data as the test vehicle traverses one complete loop.

The above procedures will be repeated for the various combinations of controlled test parameters as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

Item	Sensor Location	Priority	Monitor
1	75 ft. from Track ℄ at Loop Center	RQD	
2	15 ft. from Track ℄ at Wayside	RQD	
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Note:

(1) Wind velocity and direction, ambient temperature, pressure and relative humidity as well as test vehicle weight, speed and operating direction are to be voice recorded with the noise data.

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	SP/A	" " " " " "
3	NL/A	Format 1
4	NL/A	" " "
5	S3B/A	" " "
6	S3B/A	" " "
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Note:

(1) Provide wind velocity and direction, ambient temperature, pressure and relative humidity as well as vehicle weight, speed and operating direction on all Standard Outputs.

TEST SET

TEST TITLE: Effect of Speed - On Car

TEST SET NO.: PN-1001-TT

TEST OBJECTIVE:

To determine noise levels inside the test vehicle while operating at various speeds.

TEST DESCRIPTION:

This test will be performed at the following condi-conditions:

(1) Car Weights of AW0 and AW3

(2) Four Car Interior Locations

(3) Five Car Speeds

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Select the four-car interior locations (These test points should be representative of standing or seated passengers throughout the test vehicle).

2. Select 5 Test Vehicle Speeds, representative of the normal operating speed range.

3. Operate the Test Vehicle at the test speed over Track Section I. Repeat passes over Section I until data has been obtained for the 4 car locations.

4. For each test point, identify the test point and record gain level on the recorder by voice, and obtain a minimum of 15 seconds of data.

5. Repeat Steps 3 and 4 for each Car Interior location.

6. Repeat Steps 3 through 5 for each test speed.

The above procedure will be repeated for the specific vehicle weights noted on the Title Sheet and detailed in the Test Plan.

Item	Sensor Location	Priority	Monitor
1	4 car locations representative	RQD	
2	of passenger positions - depends	RQD	
3	upon vehicle design.	RQD	
4		RQD	
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	SP/A	" " " " " "
3	SP/A	" " " " " "
4	SP/A	" " " " " "
5	NL/A	Format 2
6	NL/A	" " "
7	NL/A	" " "
8	NL/A	" " "
9	S3B/A	For all test points
10	S3B/A	" " " "
11	S3B/A	" " " "
12	S3B/A	" " " "
13	SNB/A	For all test points
14	SNB/A	" " " "
15	SNB/A	" " " "
16	SNB/A	" " " "
17		
18		
19		
20		

Note:

(1) Provide wind velocity and ambient acoustical conditions for each test point on the Standard Output.

PRELIMINARY ANALYSIS TEST SET NO. PN-1001-TT SHEET 6 OF 6

Standard Output	Cross Plot or Summarize
NL/A Format	Cross plot as a function of speed, for all
	Car Interior locations

TEST SET

TEST TITLE: Effect of Track Section - On Car

TEST SET NO.: PN-1101-TT

TEST OBJECTIVE:

To determine the effect of track construction on interior noise levels.

TEST DESCRIPTION:

This test will be performed at one Test Vehicle weight (AW0) and one speed on all sections of the UMTA Test Track.

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheels flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Select a Car Interior location, representative of a typical passenger position as the test location.

2. Select a Test Vehicle speed, representative of a high normal operation as the test speed.

3. Instruct the Test Vehicle Operator to announce the entering and leaving of the various track sections.

4. Operate the Test Vehicle at the test speed continuously around the test track.

5. For each test section, identify the test point and record gain level on the recorder by voice and obtain a minimum of 15 seconds of noise data.

Item	Sensor Location	Priority	Monitor
1	A representative Car Interior Location	RQD	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	NL/A	Format 1 - All track sections
3	SNB/A	All track sections
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

TEST SET

TEST TITLE: Screech Loop Survey - On Car

TEST SET NO.: PN-1201-TT

TEST OBJECTIVE:

To determine on car noise levels during car operation on short radius curves.

TEST DESCRIPTION:

This test will be completed on the UMTA Test Track Screech Loop for Test Vehicle Weights of AW0 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.
2. Position recording microphone such that it is not shielded from the source of noise.
3. Record wind velicity and direction prior to each test point.
4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Screech Loop)

1. Position the microphone of the noise recording system at a mid-car, standing ear level location.

2. Start the recorder prior to entering the screech loop, idenfity the test point, location, recorder gain level and ambient weather conditions by choice.

3. Record noise data as the test vehicle traverses one complete loop.

4. Repeat Steps 2 and 3 operating the test vehicle in the reverse direction.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

Item	Sensor Location	Priority	Monitor
1	Mid Car standing passenger ear level	RQD	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Note:

(1) Wind velocity and direction, ambient temperature, pressure and relative humidity as well as test vehicle weight, speed and operating direction are to be voice recorded with the noise data.

OPERATION (UMTA Screech Loop)

1. Position the microphone of the noise recording system at a mid-car, standing ear level location.

2. Start the recorder prior to entering the screech loop, idenfity the test point, location, recorder gain level and ambient weather conditions by choice.

3. Record noise data as the test vehicle traverses one complete loop.

4. Repeat Steps 2 and 3 operating the test vehicle in the reverse direction.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

Item	Sensor Location	Priority	Monitor
1	Mid Car standing passenger ear level	RQD	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Note:

(1) Wind velocity and direction, ambient temperature, pressure and relative humidity as well as test vehicle weight, speed and operating direction are to be voice recorded with the noise data.

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system b recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data page.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Select a series of interior locations representative of the typical distribution of passengers in the Test Vehicle. This set of test locations might consist of 30 to 50 positions.

10. Select a test speed representative of high normal operation of the test vehicle.

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Operate the Test Vehicle through Track Section I at the selected test speed.

2. For each test location, identify the test point and record gain level on the recorder by voice and obtain a minimum of 15 seconds of noise data.

3. Repeat Steps 1 and 2 as necessary to complete all of the test locations selected.

The above procedure will be repeated for the various combinations of controlled test variables as listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weight

(2) Train Consist

Item	Sensor Location	Priority	Monitor
1	Various locations as selected	RQD	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Note:

(1) A portable noise measurement system will be used for this test.

STANDARD OUTPUTS TEST SET NO. PN-1301-TT SHEET 5 OF 5

Item	Standard Output	Output Format
1	NL/A	Format 1 - All test locations
2	S3B/A	All test locations
3	SNB/A	All test locations
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Note:

(1) Provide car speed, equipment operation information on each Standard Output.

TEST SET	TEST TITLE: Acceleration Effect - On Car TEST SET NO.: PN-2001-TT

TEST OBJECTIVE:

To determine noise levels inside the test vehicle while accelerating.

TEST DESCRIPTION:

This test will be performed at the following conditions:

(1) For selected interior test points

(2) Car weights of AW0 and AW3

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

    No rain or other precipitation

    Less than 90% Relative Humidity

    Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4 Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Select two Car Interior Locations as test points (these test points should be representative of standing or seated passengers throughout the test vehicle).

2. Position the Test Vehicle at Track Section I on the UMTA Test Track.

3. Start the recorder, identify the test point and record gain level by voice. Vehicle indicated speeds at selected points should also be voice entered on the recorder.

4. Initiate full acceleration, and record sound pressure levels until Test Vehicle reaches maximum speed.

5. Repeat Steps 2 through 4 for the second interior location.

Note:

(1) During the test, specific additional car locations may be identified, and data obtained. This should be accomplished if noise levels appear abnormal and the data can be used to identify the source.

The above procedure will be repeated for the various car weights noted on the Title Sheet and detailed in the Test Plan.

Item	Sensor Location	Priority	Monitor
1	Two car locations representative of	RQD	
2	Passenger positions	RQD	
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file.
2	SP/A	" " " " " "
3	NL/A	Format 1
4	NL/A	" " "
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
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TEST SET

TEST TITLE: Deceleration Effect - On Car

TEST SET NO.: PN-3001-TT

TEST OBJECTIVE:

To determine noise levels inside the test vehicle while decelerating.

TEST DESCRIPTION:

This test will be performed at the following conditions:

(1) For selected Interior Test Points

(2) For various braking configurations (depends upon modes available on Test Vehicle). The basic configuration will be the normal service system.

(3) Car weights of AW0 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Ensure that the test vehicle is in a true test configuration (no wheel flats, no missing acoustical barriers such as seats or windscreens).

2. Ensure that the following weather conditions prevail:

   No rain or other precipitation

   Less than 90% Relative Humidity

   Less than 10 Knots Wind Velocity

3. Identify model and serial number of the noise measurement system.

4. Ensure that the test site is relatively free of excessive sound absorptive or obstructive characteristics.

5. Install a windscreen on the noise measurement microphone.

6. Calibrate the noise measurement system by recording a known acoustic calibration signal in order to provide a reference level. Do this at the beginning and end of the test, but at least twice on each test data tape.

7. Record ambient noise, including both acoustical background and electrical noise of the measurement system.

8. Record barometric pressure, relative humidity and ambient temperature at beginning of test.

9. Record position and direction of microphone(s).

CAUTIONS

1. Caution Test Crew on maintaining integrity of the noise test data.

2. Position recording microphone such that it is not shielded from the source of noise.

3. Record wind velocity and direction prior to each test point.

4. The direction of motion of the Test Vehicle will be the same for all test points.

OPERATION (UMTA Test Track)

1. Select 2 car interior locations as test points (these test points should be representative of standing or seated passengers throughout the test vehicle).

2. Operate the Test Vehicle at maximum speed such that the full deceleration cycle will occur with Track Section I on the Transit Test Track.

3. Start the recorder, identify the test point and record gain level by voice. Vehicle indicated speeds at selected points should also be voice entered on the recorder.

4. Initiate full service deceleration and maintain until test vehicle comes to a complete stop.

5. Repeat Steps 2 through 4 for the second interior test point location.

NOTE:

(1) During the test, specific additional car locations may be identified and data obtained. This should be accomplished if noise levels appear abnormal and the data can be used to idenfity the source.

The above procedure will be repeated for the various combinations of controlled test variables listed below, noted on the Title Sheet and detailed in the Test Plan:

(1) Car Weights

(2) Braking Modes

Item	Sensor Location	Priority	Monitor
1	2 Car locations representative of	RQD	
2	Passenger positions	RQD	
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

STANDARD OUTPUTS TEST SET NO. PN-3001-TT SHEET 5 OF 5

Item	Standard Output	Output Format
1	SP/A	To be maintained for permanent file
2	SP/A	" " " " " "
3	NL/A	Format 1
4	NL/A	" " "
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

TEST SET

TEST TITLE: Dynamic Shake Test - Vertical

TEST SET NO.: R-0001-XX

TEST OBJECTIVE:

To determine the vehicle natural modes and frequencies.

TEST DESCRIPTION:

This test will include performing frequency sweeps of the vehicle by using a shaker to provide excitation forces. These sweeps will be generated for selected locations of the vehicle to determine the natural frequencies. At these natural frequencies detailed probes of the vehicle are necessary to determine the associated mode shapes.

This test will be performed at car weights of AW0, AW2 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Install the required equipment and instrumentation. Shaker should be oriented to apply a vertical excitation force.

2. Locate one sensor on the car body structure adjacent to the shaker location to determine amplitude and phase at the input source.

3. In addition to the accelerometer located adjacent to the shaker position, at least one more accelerometer is required to determine frequency response curves. It is highly recommended that a sufficient number of additional accelerometers be used during the test to be compatible with the recording device utilized so as to be able to determine more expediently, and with a minimum of error, the vehicle mode shapes.

4. Record vehicle weight.

5. Calibrate system.

6. Operate the shaker throughout the range of frequencies to be tested and ascertain that no flexible equipment mounts are bottoming and that the test vehicle is in a suitable test configuration.

OPERATION (at Test Zone)

1. The shaker will be located at the longitudinal centerline (C/L) of the car body at a car end.

2. Orient reference probe and portable probe in the vertical direction.

3. Utilize a continuous sweep oscillator to control the shaker frequency.

4. Perform frequency sweeps of the vehicle (1 Hz - 30 Hz). Simultaneously obtain accelerometer output, amplitude and phase as a function of frequency and automatically record these data with an X-Y plotter.

5. Move portable probe to another position and repeat "4" until a sufficient number of car, truck and component locations have been surveyed to determine the vehicle mode shp shapes and frequencies.

6. Repeat Steps 1 through 5 with portable probe oriented in the lateral direction.

7. Repeat Steps 1 through 5 with shaker mounted off the longitudinal centerline of the car body at the car end.

Item	Sensor Location	Priority	Monitor
1	Reference Pickup (Pos. Adj. to Shaker)	RQD	(Note 1)
2	Portable Probe	RQD	" "
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Notes:

(1) Sensor Item 1 should be located at the shaker in order to provide a reference phase.

(2) A continuous sweep oscillator will be used to control the input force frequency.

(3) The pickups should be secured to the vehicle so there is no relative motion between the structure and the pickup.

(4) Test Equipment

(1) Accelerometers

(2) Continuous Sweep Oscillator

(3) Shaker (1-30 Hz)

(4) X-Y Plotter

Item	Standard Output	Output Format
1	AFR/A	See note below.
2	AFR/A	" " "
3	APA/A	" " "
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Note:

(1) If automatic data processing is not readily available, the monitor, i.e., oscillograph tracings, may be used to develop the standard output.

PRELIMINARY ANALYSIS TEST SET NO. R-0001-XX SHEET 6 OF 6

Standard Output	Cross Plot or Summarize
VMS/A	Vehicle Mode Shapes - Vertical

TEST SET

TEST TITLE: Dynamic Shake Test - Lateral

TEST SET NO.: R-0002-XX

TEST OBJECTIVE:

To determine the vehicle lateral natural modes and frequencies.

TEST DESCRIPTION:

This test will include performing frequency sweeps of the vehicle by using a shaker to provide excitation forces. These sweeps will be generated for selected locations of the vehicle to determine the natural frequencies. At these natural frequencies detail probes of the vehicle are necessary to determine the associated mode shapes.

This test will be performed at car weights of AW0, AW2 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Install the required equipment and instrumentation. Shaker should be oriented to apply a lateral excitation force.

2. Locate one sensor on the car body structure adjacent to the shaker location to determine amplitude and phase at the initial source.

3. In addition to the accelerometer located adjacent to the shaker position, at least one more accelerometer is required to determine frequency response curves. It is highly recommended that a sufficient number of additional accelerometers be used during the test to be compatible with a minimum of error the vehicle mode shapes.

4. Record vehicle weight.

5. Calibrate system.

6. Operate the shaker throughout the range of frequencies to be tested and ascertain that no flexible equipment mounts are bottoming and that the vehicle is in a suitable test configuration.

OPERATION (at Test Zone)

1. The shaker will be located at the longitudinal centerline (C/L) of the car body at a car end.

2. Orient reference probe and portable probe in the lateral direction.

3. Utilize a continuous sweep oscillator to control the shaker frequency.

4. Perform frequency sweeps of the vehicle (1 Hz - 30 Hz). Simultaneously obtain accelerometer output, amplitude and phase as a function of frequency and automatically record these data with an X-Y plotter.

5. Move portable probe to another position and repeat Step 4 until a sufficient number of car, truck and component locations have been surveyed to determine the vehicle mode shapes and frequencies.

6. Repeat Steps 1 through 5 with portable probe oriented in the vertical direction.

Item	Sensor Location	Priority	Monitor
1	Reference Pickup (Pos. Adj. to Shaker)	RQD	(Note)
2	Portable Probe	RQD	" "
3			
4			
5			
6			
7			
8			
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20			

System Description

(1) Sensor Item should be located at the shaker in order to provide a reference phase.

(2) A continuous sweep oscillator will be used to control the input force frequency.

(3) The pickups should be secured to the vehicle so there is no relative motion between the structure and the pickup.

(4) Test Equipment

(1) Accelerometers

(2) Continuous Sweep Oscillator

(3) Shaker (1-30 Hz)

(4) X-Y Plotter

Standard Output	Cross Plot or Summarize
AFR/A	See note below.
AFR/A	" " "
APA/A	" " "

Note:

(1) If automatic data processing is not readily available, the monitor, i.e., oscillograph tracings may be used to develop the standard output.

Standard Output	Cross Plot or Summarize
VMS/A	Vehicle Mode Shapes - Lateral

TEST SET

TEST TITLE: Dynamic Shake Test - Longitudinal

TEST SET NO.: R-0003-XX

TEST OBJECTIVE:

To determine the vehicle longitudinal natural modes and frequencies.

TEST DESCRIPTION:

This test will include performing frequency sweeps of the vehicle by using a shaker to provide excitation forces. These sweeps will be generated for selected locations of the vehicle to determine the natural frequencies. At these natural frequencies detailed probes of the vehicle are necessary to determine the associated mode shapes.

This test will be performed at car weights of AW0, AW2 and AW3.

STATUS:

PRELIMINARY (pre-test)

1. Install the required equipment and instrumentation. Shaker should be oriented to apply a longitudinal excitation force.

2. Locate one sensor on the car body structure adjacent to the shaker location to determine amplitude and phase at the input source.

3. In addition to the accelerometer located adjacent to the shaker position, at least one more accelerometer is required to determine frequency response curves. It is highly recommended that a sufficient number of additional accelerometers be used during the test able to determine more expediently and with a minimum of error the vehicle mode shapes.

4. Record vehicle weight.

5. Calibrate system.

6. Operate the shaker throughout the range of frequencies to be tested and ascertain that no flexible mounts are bottoming and that the vehicle is in a suitable test configuration.

OPERATION (at Test Zone)

1. The shaker will be located at the longitudinal centerline (C/L) of the car body at a car end.

2. Orient reference probe and portable probe in the longitudinal direction.

3. Utilize a continuous sweep oscillator to control the shaker frequency.

4. Perform frequency sweeps of the vehicle (1 Hz - 30 Hz). Simultaneously obtain accelerometer output, amplitude and phase as a function of frequency and automatically record these data with an X-Y plotter.

5. Move portable probe to another position and repeat Step 4 until a sufficient number of car, truck and component locations have been surveyed to determine the vehicle mode shapes and frequencies.

Item	Sensor Location	Priority	Monitor
1	Reference Pickup (Pos. Adj. to Shaker)	RQD	(Note 1)
2	Portable Probe	RQD	" "
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
16			
15			
16			
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System Description

(1) Sensor Item 1 should be located at the shaker in order to provide a reference phase.

(2) A continuous sweep oscillator will be used to control the input force frequency.

(3) The pickups should be secured to the vehicle so there is no relative motion between the structure and the pickup.

(4) Test Equipment

(1) Accelerometers

(2) Continuous Sweep Oscillator

(3) Shaker (1-30 Hz)

(4) X-T Plotter

Item	Standard Output	Output Format
1	AFR/A	See note below.
2	AFR/A	" " "
3	APA/A	" " "
4		
5		
6		
7		
8		
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Note:

(1) If automatic data processing is not readily available, the monitor, i.e., oscillograph tracings may be used to develop the standard output.

Standard Output	Cross Plot or Summarize
VMS/A	Vehicle Mode Shapes - Longitudinal

<u>OPERATION</u> (UMTA Test Track)

1. Position Test Vehicle at Track Section 300.

2. Shut down all car equipment.

3. Start recorder and provide record number.

4. Turn on car equipment, one system at a time, and identify that item for the record.

5. Record 15 to 20 seconds of data for each car equipment before repeating 4 for all of the equipment which may be cycled.

6. Stop recorder.

Item	Sensor Location		Priority	Monitor
1	Fwd Car Floor - Centerline	- Vert.	RQD	*
2	Fwd Car Floor - Centerline	- Lat.	RQD	*
3	Fwd Car Floor - Centerline	- Long.	RQD	*
4	Mid Car Floor - Centerline	- Vert.	RQD	*
5	Mid Car Floor - Centerline	- Lat.	HD	
6	Mid Car Floor - Left Side	- Vert.	HD	
7	Lead Axle - Right Journal	- Vert.	RQD	*
8	Lead Axle - Right Journal	- Lat.	RQD	*
9	Lead Axle - Left Journal	- Vert.	HD	
10	Any Suspected Equipment	- Vert.	HD	
11	Portable Car Body Probe	NTH	NTH	*
12				
13				
14				
15				
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18				
19				
20				

*Quick-Look

System Description

1. Items 1-10 are accelerometers capable of good frequency response from suspension frequencies up to 50 Hz.

2. Strip chart records are required for the Quick-Look parameters.

3. Item 11 is a portable probe capable of being moved about the car during the test. This probe will be used to obtain data on any noticable anomalies during the test (such as excessive seat vibration).

STANDARD OUTPUTS TEST SET NO. R-0010-TT SHEET 5 OF 8

Item	Standard Output	Output Format
1	AC/A	
2	AC/A	Permanent stripout for each test
3	AC/A	point with a maximum of 5 to 10
4	AC/A	cycles per inch, and 1 inch peak to
5	AC/A	to peak.
6	AC/A	
7	AJ/A	
8	AJ/A	Same as the above
9	AJ/A	
10	AJ/A	
11	AC/A	Same as the above
12		
13		
14		
15		
16		
17		
18		
19		
20		

STANDARD OUTPUTS TEST SET NO. R-0010-TT SHEET 6 OF 8

Item	Standard Output	Output Format
1	ASD/A	
2	ASD/A	Filter bandwidths of .2 to .5 Hz
3	ASD/A	in the 0 to 10 Hz range and
4	ASD/A	1.0 Hz for frequencies above 10 Hz.
5		
6		
7	ASD/A	Same as for the above.
8	ASD/A	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Notes:

(1) Complete for each test point.

(2) Additional Power Spectral Densities (ASD/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Item	Standard Output	Output Format
1	ANB/A	
2	ANB/A	Filter bandwidths of .2 to .5 Hz
3	ANB/A	in the 0 to 10 Hz range and
4	ANB/A	1.0 Hz for frequencies above 10 Hz.
5		
6		
7	ANB/A	Same as for the above.
8	ANB/A	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Notes:

(1) Complete for each test point.

(2) Additional Spectrum Analysis (ANB/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Standard Output	Cross Plot or Summarize
ASD/A	Cross plot the prime frequencies (such
	as first car body bending mode) as a func-
	tion of speed and gross weight. Complete
	this item for each ASD/A and ANB/A re-
	quested on items 1 through 6.
RRH/A	For Item 2
RRV/A	For Item 4

Note:

(1) Additional Preliminary Analysis will be requested upon examination of the Standard Outputs.

TEST SET

TEST TITLE: Ride Roughness - Worst Speeds

TEST SET NO.: R-1101-TT

TEST OBJECTIVE:

To determine worst steady vibration levels of the test vehicle on the UMTA test track.

TEST DESCRIPTION:

The following configuration will be tested:

- o Vehicle weights of AW0, AW2, and AW3.
- o All track sections including grade crossings and switches as required to simulate revenue service.
- o Select discrete vehicle speeds simulating revenue service and include V (maximum).
- o Select other speeds as required to identify known or suspected acute vibration levels associated with car body characteristics.

STATUS:

<u>PRELIMINARY</u> (pre-test)

1. Install required equipment and instrumentation and photograph same.

2. Manually record vehicle weight and passenger weight.

3. Calibrate all instrumentation, data acquisition and processing equipment.

OPERATION (UMTA Test Oval)

1. Turn on all car auxiliary equipment and make note of equipment operation.

2. Accelerate to and maintain test point speed.

3. Prior to entering a test section, start recorders and mark tapes and data sheets with a record number.

4. Provide an event mark on tape record at beginning of test section (see attached test section locations).

5. Provide an event mark at the end on 20 seconds on data.

6. Stop Recorders.

7. Proceed to next section or speed and repeat the above.

TRACK TEST SECTION BEGINNING LOCATIONS

SECTION	BEGIN AT CW	BEGIN AT CCW
I	120	150
II	215	240
III	255	280
IV	360	385
V	450	480
VI	480	510
North Gap and Switch	520	50

Item	Sensor Location		Priority	Monitor
1	Fwd Car Floor - Centerline	-Vert.	RQD	*
2	Fwd Car Floor - Centerline	-Lat.	RQD	*
3	Fwd Car Floor - Centerline	-Long.	RQD	*
4	Mid Car Floor - Centerline	-Vert.	RQD	*
5	Mid Car Floor - Centerline	-Lat.	HD	
6	Mid Car Floor - Left Side	-Vert.	HD	
7	Lead Axle - Right Journal	-Vert.	RQD	*
8	Lead Axle - Right Journal	-Lat.	RQD	*
9	Lead Axle - Left Journal	-Vert.	HD	
10	Any Suspected Equipment	-Vert.	HD	
11	Portable Car Body Probe		HD	*
12				
13				
14				
15				
16				
17				
18				
19				
20				

*Quick-Look

System Description

1. Items 1-10 are accelerometers capable of good frequency response from suspension frequencies up to 50 Hz.

2. Strip chart records are required for the Quick-Look parameters.

3. Item 11 is a portable probe capable of being moved about the car during the test. This probe will be used to obtain data on any noticeable anomalies during the test (such as excessive seat vibration).

STANDARD OUTPUTS TEST SET NO. R-1101-TT SHEET 5 OF 8

Item	Standard Output	Output Format
1	AC/A	
2	AC/A	Permanent stripout for each test
3	AC/A	point with a maximum of 5 to 10 cycles
4	AC/A	per inch, and 1 inch peak to peak.
5	AC/A	
6	AC/A	
7	AJ/A	
8	AJ/A	Same as the above
9	AJ/A	
10	AJ/A	
11	AC/A	Same as the above
12		
13		
14		
15		
16		
17		
18		
19		
20		

Item	Standard Output	Output Format
1	ASD/A	
2	ASD/A	Filter bandwidths of .2 to .5 Hz
3	ASD/A	in the 0 to 10 Hz range and 1.0 Hz
4	ASD/A	for frequencies above 10 Hz.
5		
6		
7	ASD/A	Same as for the above.
8	ASD/A	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Notes:

(1) Complete for each test point.

(2) Additional Power Spectral Densities (ASD/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Item	Standard Output	Output Format
1	ANB/A	
2	ANB/A	Filter bandwidths of .2 to .5 Hz
3	ANB/A	in the 0 to 10 Hz range and 1.0 Hz
4	ANB/A	for frequencies above 10 Hz.
5		
6		
7	ANB/A	Same as for the above.
8	ANB/A	
9		
10		
11		
12		
13		
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18		
19		
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Notes:

(1) Complete for each test point.

(2) Additional Spectrum Analysis (ANB/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Standard Output	Cross Plot or Summarize
ASD/A	Cross plot the prime frequencies (such
ANB/A	as first car body bending mode) as a func-
	tion of speed and gross weight. Complete
	this item for each ASD/A and ANB/A requested
	on items 1 through 6.
RRH/A	For Item 2
RRV/A	For Item 4

Note:

(1) Additional Preliminary Analysis will be requested upon examination of the Standard Outputs.

TEST SET

TEST TITLE: Ride Roughness - Acceleration

TEST SET NO.: R-2001-TT

TEST OBJECTIVE:

To determine the most severe vibration levels encountered during car acceleration.

TEST DESCRIPTION:

This test is to be performed on Tract Section I the Vehicle Test weights will be:

AW, AW2, and AW3

STATUS:

PRELIMINARY (pre-test)

1. Install and checkout required equipment.

2. Photograph placement of sensors.

3. Calibrate all instrumentation, data processing and acquisition equipment.

OPERATION (UMTA Test Track)

1. Turn on all car auxiliary equipment and make note of equipment operation.
2. Proceed to start location and stop vehicles. (Location 120 CW or Location 150 CCW.)
3. Start recorders and provide record number.
4. Initiate full acceleration and maintain.
5. Provide event mark at first motion.
6. Provide event mark at selected speeds and at maximum speed.
7. Stop recorder.
8. Stop vehicle.

Item	Sensor Location	Priority	Monitor
1	Fwd Car Floor - Centerline - Vert.	RQD	*
2	Fwd Car Floor - Centerline - Lat.	RQD	*
3	Fwd Car Floor - Centerline - Long.	RQD	*
4	Mid Car Floor - Centerline - Vert.	RQD	*
5	Mid Car Floor - Centerline - Lat.	HD	
6	Mid Car Floor - Left Side - Vert.	HD	
7	Lead Axle - Right Journal - Vert.	RQD	*
8	Lead Axle - Right Journal - Lat.	RQD	*
9	Lead Axle - Left Journal - Vert.	HD	
10	Any Suspected Equipment - Vert.	HD	
11	Portable Car Body Probe	NTH	*
12			
13			
14			
15			
16			
17			
18			
19			
20			

*Quick-Look

System Description

(1) Items 1-10 are accelerometers capable of good frequency response from suspension frequencies up to 50 Hz.

(2) Strip chart records are required for the Quick-Look parameters.

(3) Item 11 is a portable probe capable of being moved about the car during the test. This probe will be used to obtain data on any noticeable anomalies during the test (such as excessive seat vibration).

STANDARD OUTPUTS TEST SET NO. R-2001-TT SHEET 5 OF 8

Item	Standard Output	Output Format
1	AC/A	
2	AC/A	Permanent stripout for each test
3	AC/A	point with a maximum of 5 to 10
4	AC/A	cycles per inch, and 1 inch peak
5	AC/A	to peak.
6	AC/A	
7	AJ/A	
8	AJ/A	Same as the above
9	AJ/A	
10	AJ/A	
11	AC/A	Same as the above
12		
13		
14		
15		
16		
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19		
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Item	Standard Output	Output Format
1	ASD/A	
2	ASD/A	Filter bandwidths of .2 to .5 Hz
3	ASD/A	in the 0 to 10 Hz range and
4	ASD/A	1.0 Hz for frequencies above 10 Hz
5		
6		
7	ASD/A	Same as for the above
8	ASD/A	
9		
10		
11		
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Notes:

(1) Complete for each test point.

(2) Additional Power Spectral Densities (ASD/A) may be be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Item	Standard Output	Output Format
1	ANB/A	
2	ANB/A	Filter bandwidths of .2 to .5 Hz
3	ANB/A	in the 0 to 10 Hz range and
4	ANB/A	1.0 Hz for frequencies above 10 Hz.
5		
6		
7	ANB/A	Same as for the above
8	ANB/A	
9		
10		
11		
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Notes:

(1) Complete for each test point.

(2) Additional Spectrum Analysis (ANB/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Standard Output	Cross Plot or Summarize
ASD/A	Cross plot the prime frequencies (such
ANB/A	as first car body bending mode) as a
	Function of speed and gross weight.
	Complete this item for each ASD/A and
	ANB/A requested on items 1 through 6.
RRH/A	For Item 2
RRV/A	For Item 4

Note:

(1) Additional Preliminary Analysis will be requested upon examination of the Standard Outputs.

TEST SET	SHEET 1 OF 8 TEST TITLE: Ride Roughness - Deceleration TEST SET NO.: R-3001-TT

TEST OBJECTIVE:

To determine the most severe vibration levels encountered during car deceleration.

TEST DESCRIPTION:

This test to be performed on Track Section I, the Test Vehicle weights will be:

AW0, AW1, and AW3

STATUS:

PRELIMINARY (pre-test)

1. Install and checkout required equipment.
2. Photograph placement of sensors.
3. Calibrate all instrumentation, data acquisition and processing equipment

OPERATION (UMTA Test Track)

1. Turn on all car auxiliary equipment and make note of equipment operation.

2. Proceed to Start Location at maximum speed (Location 120 CW or 150 CCW).

3. Start recorder and provide record number.

4. Initiate Full Service Brake, Blended or Friction, as required.

5. Provide an event mark at initiation of braking.

6. Provide an event mark at complete stop.

7. Stop recorder.

Item	Sensor Location	Priority	Monitor
1	Fwd Car Floor - Centerline - Vert.	RQD	*
2	Fwd Car Floor - Centerline - Lat.	RQD	*
3	Fwd Car Floor - Centerline - Long.	RQD	*
4	Mid Car Floor - Centerline - Vert.	RQD	*
5	Mid Car Floor - Centerline - Lat.	HD	
6	Mid Car Floor - Left Side - Vert.	HD	
7	Lead Axle - Right Journal - Vert.	RQD	*
8	Lead Axle - Right Journal - Lat.	RQD	*
9	Lead Axle - Left Journal - Vert.	HD	
10	Any Suspected Equipment - Vert.	HD	
11	Portable Car Body Probe	NTH	*
12			
13			
14			
15			
16			
17			
18			
19			
20			

*Quick-Look

System Description

(1) Items 1-10 are accelerometers capable of good frequency response from suspension frequencies up to 50 Hz.

(2) Strip chart records are required for the Quick-Look parameters.

(3) Item 11 is a portable probe capable of being moved about the car during the test. This probe will be used to obtain data on any noticeable anomalies during the test (such as excessive seat vibration).

Item	Standard Output	Output Format
1	AC/A	
2	AC/A	Permanent stripout for each test
3	AC/A	point with a maximum of 5 to 10
4	AC/A	cycles per inch, and 1 inch peak
5	AC/A	to peak.
6	AC/A	
7	AJ/A	
8	AJ/A	Same as the above
9	AJ/A	
10	AJ/A	
11	AC/A	Same as the above
12		
13		
14		
15		
16		
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18		
19		
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STANDARD OUTPUTS TEST SET NO. R-3001-TT SHEET 6 OF 8

Item	Standard Output	Output Format
1	ASD/A	
2	ASD/A	Filter bandwidths of .2 to .5 Hz
3	ASD/A	in the 0 to 10 Hz range and
4	ASD/A	1.0 Hz for frequencies above 10 Hz.
5		
6		
7	ASD/A	Same as for the above
8	ASD/A	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Notes:

(1) Complete for each test point.

(2) Additional Power Spectral Densities (ASD/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Item	Standard Output	Output Format
1	ANB/A	
2	ANB/A	Filter bandwidths of .2 to .5 Hz
3	ANB/A	in the 0 to 10 Hz range and
4	ANB/A	1.0 Hz for frequencies above 10 Hz.
5		
6		
7	ANB/A	Same as for the above
8	ANB/A	
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Notes:

(1) Complete for each test point.

(2) Additional Spectrum Analysis (ANB/A) may be requested for the HD parameters upon examination of the AC/A and AJ/A Standard Outputs.

Standard Output	Cross Plot or Summarize
ASD/A	Cross plot the prime frequencies (such
ANB/A	as first car body bending mode) as a
	function of speed and gross weight.
	Complete this item for each ASD/A and
	ANB/A requested on items 1 through 6.
RRH/A	For Item 2
RRV/A	For Item 4

Note:

(1) Additional Preliminary Analysis will be requested upon examination of the Standard Outputs.

TEST SET

TEST TITLE: Simulated Revenue Service

TEST SET NO.: RS-5001-TT

TEST OBJECTIVE:

To determine the response of the test vehicle while operating on a sample service route at a defined level of schedule performance. The test will provide a measure of track conditions, riding comfort and noise levels.

TEST DESCRIPTION:

The car(s) will be operated over a simulated route with stops at specified stations. Normal service performance will be used. Track environment, riding comfort and noise levels will be summarized for the entire route.

Prime Variable	Test Conditions
Car Weight	AW2
Braking	Normal Service Configuration
Line Voltage	Nominal
Train Consist	Single Car and Four Car Train

This test will be performed in conjunction with Power Consumption PC-5011-TT.

STATUS:

PRELIMINARY (pre-test)

1. Mount all required sensors.

2. Calibrate Instrumentation System.

3. Layout the required Simulated service route on the Rail Transit Test Track. Layout should include station markers and brake activation flags. Schedule speed limits and/or running times may be posted onboard the test vehicles.

4. Brief the test crew on test operations.

NOTE:

Only one vehicle will be instrumented for noise measurements. Caution crew to avoid other than normal conversation in that vehicle.

All personnel are to advise the Test Controller of any abnormal operations on events that occur during the test run.

OPERATION (at Test Zone)

1. The test zone is the complete transit oval or designated sections with station locations specifically marked.

2. Position car at the first simulated station, identify records, "zero" counters, start recorders.

3. Operate the test vehicle over the route in a manner to maintain the schedule.

4. Simulate the required station dwell times, with door openings, as required.

5. The Test Controller will terminate and invalidate the test if:

   (a) An extended delay or train shutdown occurs.

   (b) One or more required data channel malfunctions.

   (c) The test vehicle is not operating properly.

Item	Sensor Location	Priority	Monitor
1	Lead Axle - Right Journal - Vertical	RQD	*
2	Lead Axle - Right Journal - Lateral	RQD	*
3	Lead Axle - Left Journal - Vertical	RQD	*
4	Mid Car Centerline - Vertical	RQD	*
5	Mid Car Centerline - Lateral	RQD	*
6	Forward Car Centerline - Vertical	RQD	*
7	Forward Car Centerline - Lateral	RQD	*
8	Truck Frame, Lead Axle, Vertical	RQD	*
9	Truck Frame, Lead Axle, Lateral	RQD	*
10	Pitch, Mid Car Centerline	NTH	*
11	Roll, Mid Car Centerline	NTH	*
12	Yaw, Mid Car Centerline	NTH	*
13	Interior Sound Pressure Level	RQD	
14			
15			
16			
17			
18			
19			
20			

Item	Standard Output	Output Format
1	AJ/A	(1), (2), (3) and (4)
2	AJ/A	(1), (2), (3) and (4)
3	AJ/A	(1), (2), (3) and (4)
4	AC/A	(1), (2) and (3)
5	AC/A	(1), (2) and (3)
6	AC/A	(1), (2) and (3)
7	AC/A	(1), (2) and (3)
8	AJ/A	(1), (2), (3) and (4)
9	AJ/A	(1), (2), (3) and (4)
10	ACA/A	(1), (2), (3) and (4)
11	ACA/A	(1), (2), (3) and (4)
12	ACA/A	(1), (2), (3) and (4)
13	SP/A	(1)
14		
15		
16		
17		
18		
19		
20		

STANDARD OUTPUTS TEST SET NO. RS-5001-TT SHEET 6 OF 6

Item	Standard Output	Output Format
1	-	
2	-	
3	-	
4	RRV/A	(1) and (3)
5	RRH/A	(1) and (3)
6	RRV/A	(1) and (3)
7	RRH/A	(1) and (3)
8	-	
9	-	
10	-	
11	-	
12	-	
13	NL/A	(1) and (3)
14		
15		
16		
17		
18		
19		
20		

TEST SET

TEST TITLE: Radio Frequency Interference

TEST SET NO.: PSI-6001-TT

TEST OBJECTIVE:

To determine levels of broadband radiated electromagnetic emission from the test vehicle to the wayside.

TEST DESCRIPTION:

This test to be performed with test vehicle passing by a wayside station under each of the following conditions:

1. Acceleration above and below base speed

2. Constant speed

3. Braking

STATUS:

PRELIMINARY (pre-test)

1. Identify model and serial numbers of each components of radio frequency interference measurement system.

2. Set up radio frequency interference measurement system inside and near midpoint of test vehicle. With all test vehicle systems and third rail power deenergized, scan complete test frequency range and select four discrete test frequencies per decade, at which electric field intensity is to be measured throughout wayside test program. Measure and record electric field intensity at each test frequency.

3. Repeat frequency scan after all test vehicle systems have been energized, in order to identify any emission frequencies (noise peaks) associated with test vehicle systems. Add any such frequencies to list of test frequencies. Measure and record electric field intensity at each test frequency.

4. Set up radio frequency interference measurement system with antenna tripod located 100 feet from track centerline. With all test vehicle systems and third rail power deenergized, measure and record electric field intensity at each test frequency.

CAUTIONS

1. Test frequencies with high ambient electromagnetic noise level (such as broadcast frequency of local station) are to be avoided.

2. For tests performed with test vehicle passing by wayside test station at constant speed, absence of acceleration or braking is more important than accurate nominal test velocity.

OPERATION (UMTA Test Track)

1. Select three test vehicle speeds representative of normal operating speed range.

2. At each test frequency, measure and record electric field intensity level with test vehicle passing by wayside test station at each selected constant speed.

3. At each test frequency, measure and record electric field intensity level while test vehicle passes by wayside test station accelerating, above base speed, at maximum rate. With test vehicle accelerating, below base speed, at maximum rate, repeat measurements at some test frequencies (at least one frequency per decade).

4. At each test frequency, measure and record electric field intensity level while test vehicle passes by wayside test station decelerating at maximum rate.

Item	Sensor Location	Priority	Monitor
1	Radio Interference Field Intensity	RQD	
2	Meter and Antenna - 100 feet from		
3	track Centerline		
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

System Description

(1) Instrumentation may be a series of antennas and meters for applicable frequency ranges.

STANDARD OUTPUTS TEST SET NO. PSI-6001-TT SHEET 5 OF 5

Item	Standard Output	Output Format
1	EFI/A	Table Format
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

TEST SET

TEST TITLE: Structures - Constant Velocity

TEST SET NO.: S-1001-TT

TEST OBJECTIVE:

To determine the loads induced into the truck components during operation at constant velocity.

TEST DESCRIPTION:

The following configurations will be tested:

- o Vehicle weights of AW0, AW2, and AW3.
- o All track sections including grade crossings and switches as required to simulate revenue service.
- o Select discrete vehicle speeds simulating revenue service and include V (maximum).
- o Select other speeds as required to identify possible load or displacement trends.

STATUS:

PRELIMINARY (pre-test)

1. Install required equipment and instrumentation and photograph same.

2. Manually record vehicle weight and passenger weight.

3. Calibrate all instrumentation, data acquisition and processing equipment.

OPERATION (UMTA Test Oval)

1. Turn on all car auxiliary equipment and make note of equipment operation.
2. Accelerate to and maintain test point speed.
3. Prior to entering a test section, start recorders and mark tapes and data sheets with a record number.
4. Provide an event mark on tape record at beginning of test section (see attached test section locations).
5. Provide an event mark at the end of 20 seconds on data.
6. Stop Recorders.
7. Proceed to next section or speed and repeat the above.

TRACK TEST SECTION BEGINNING LOCATIONS

Section	Begin At CW	Begin At CCW
I	120	150
II	215	240
III	255	280
IV	360	385
V	450	480
VI	480	510
North Gap & Switch	520	50

Notes:

(1) Record at other selected locations to ensure a complete history of the test track.

(2) Events recorded shall be identical between the various test configurations selected.

Item	Sensor Location	Priority	Monitor
1	Strain Gages located at critical		
2	locations on the truck components	RQD	*
3			
4			
5			
6			
7	Instrumentation applied to		
8	accurately record relative		
9	displacement between selected		
10	components	RQD	*
11			
12			
13			
14			
15	Fwd chevron, left hand side	HD	
16	Car speed	RQD	
17			
18			
19			
20			

System Description

(1) Strain gages can be located from experimental static test observations for good results, but ideally calibrated gages should be utilized.

(2) Strip chart records are required for quick-look parameters.

(3) Item 15 is a thermocouple.

Item	Standard Output	Output Format
1	STP	Permanent stripouts for each
2	STP	test point with paper speeds of
3	STP	approximately 1/2 inch and
4	STP	2 inches per second with a
5	STP	minimum trace amplitude of
6	STP	1 1/2 inch peak to peak.
7	STP	
8	STP	
9	STP	
10	STP	
11	STP	
12	STP	
13	STP	
14	STP	
15	EQT/A	
16	VS/A	
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
STP/Items	Review traces for maximum, minimum
	and relative phasing. Develop gross
	weight, speed and other trends identify
	maximum loads applied.

Note:

(1) Additional preliminary analysis will be requested upon examination of the standard outputs.

TEST SET

TEST TITLE: Structure - Acceleration

TEST SET NO.: S-2001-TT

TEST OBJECTIVE:

To determine the loads induced into the truck components during car acceleration.

TEST DESCRIPTION:

This test is performed on Track Section I. The Test Vehicle weights will be: AW0, AW2, and AW3.

STATUS:

<u>PRELIMINARY</u> (pre-test)

1. Install and checkout required equipment.

2. Photograph placement of sensors.

3. Calibrate all instrumentation, data processing and acquisition equipment.

OPERATION (UMTA Test Track)

1. Turn on all car auxiliary equipment and make note of equipment operation.
2. Proceed to start location and stop vehicles (Location 120 CW or Location 150 CCW).
3. Start recorders and provide record number.
4. Initiate full acceleration and maintain.
5. Provide event mark at first motion.
6. Provide event marks at selected speeds and at maximum speed.
7. Stop recorder.
8. Stop vehicle.

Item	Sensor Location	Priority	Monitor
1	Strain gages located at critical		
2	locations on the truck components	RQD	*
3			
4			
5			
6			
7	Instrumentation applied to		
8	accurately record relative		
9	displacement between selected		
10	components.	RQD	*
11			
12			
13			
14			
15	Fwd chevron, left hand side	HD	
16	car speed.	RQD	
17			
18			
19			
20			

System Description

(1) Strain gages can be located from experimental static test observations for good results, but ideally calibrated gages should be utilized.

(2) Strip chart records are required for quick-look parameters.

(3) Item 15 is a thermocouple.

Item	Standard Output	Output Format
1	STP	Permanent stripouts for each
2	STP	test point with paper speeds of
3	STP	approximately 1/2 inch and
4	STP	2 inches per second with a
5	STP	minimum trace amplitude of
6	STP	1 1/2 inch peak to peak.
7	STP	
8	STP	
9	STP	
10	STP	
11	STP	
12	STP	
13	STP	
14	STP	
15	EQT/A	
16	VS/A	
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
STP Items	Review traces for maximum, minimum
	and relative phasing. Develop gross
	weight, speed and other trends identify
	maximum loads applied.

Note:

(1) Additional preliminary analysis will be requested upon examination of the standard outputs.

TEST SET	TEST TITLE: Structures - Deceleration TEST SET NO.: S-3001-TT	SHEET 1 OF 6

TEST OBJECTIVE:

To determine the loads induced into the truck components during car deceleration.

TEST DESCRIPTION:

This test is performed on Track Section I. The Test Vehicle weights will be: AW0, AW2, and AW3.

STATUS:

PRELIMINARY

1. Install and checkout required equipment.

2. Photograph placement of sensors.

3. Calibrate all instrumentation, data acquisition and processing equipment.

OPERATION (UMTA Test Track)

1. Turn on all car auxiliary equipment and make note of equipment operation.

2. Proceed to Start Location at maximum speed (Location 120 CW or 150 CCW).

3. Start recorder and provide record number.

4. Initiate Full Service Brake, Blended or Friction, as required.

5. Provide an event mark at initiation of braking.

6. Provide an event mark at complete stop.

7. Stop recorder.

Item	Sensor Location	Priority	Monitor
1	Strain Gages located at critical		
2	locations on the truck components	RQD	*
3			
4			
5			
6			
7	Instrumentation applied to		
8	accurately record relative		
9	displacement between selected		
10	components.	RQD	*
11			
12			
13			
14			
15	Fwd chevron, left hand side	HD	
16	car speed.	RQD	
17			
18			
19			
20			

System Description

(1) Strain gages can be located from experimental static test observations for good results, but ideally calibrated gages should be utilized.

(2) Strip chart records are required for quick-look parameters.

(3) Item 15 is a thermocouple.

Item	Standard Output	Output Format
1	STP	Permanent stripouts for each
2	STP	test point with paper speeds of
3	STP	approximately 1/2 inch and
4	STP	2 inches per second with a
5	STP	minimum trace amplitude of
6	STP	1 1/2 inch peak to peak.
7	STP	
8	STP	
9	STP	
10	STP	
11	STP	
12	STP	
13	STP	
14	STP	
15	EQT/A	
16	VS/A	
17		
18		
19		
20		

Standard Output	Cross Plot or Summarize
STP Items	Review traces for maximum, minimum
	and relative phasing. Develop gross
	weight, speed and other trends identify
	maximum loads applied.

Note:

(1) Additional preliminary analysis will be requested upon examination of the standard outputs.

APPENDIX B

STANDARD OUTPUTS

STANDARD OUTPUT CODES

CODE:	PARAMETER:
AC/A	ACCELERATION, CARBODY
AJ/A	ACCELERATION, JOURNAL
AP/A	LONGITUDINAL ACCELERATION
AFR/A	ACCELERATION FREQUENCY RESPONSE
ANB/A	ACCELERATION NARROW BAND ANALYSIS
AOB/A	ACCELERATION OCTAVE BAND ANALYSIS
APA/A	ACCELERATION PHASE ANGLE
API/A	ACCELERATION - PEAK INSTANTANEOUS
ASD/A	ACCELERATION POWER SPECTRAL DENSITY
AVD/A	ACCELERATION, VEHICLE SPEED, MOTOR SPEED, DISTANCE vs TIME
A3B/A	ACCELERATION 1/3 OCTAVE BAND ANALYSIS
BT/A	BRAKE TEMPERATURE (ROTATING PART)
BT/B	BRAKE TEMPERATURE (FIXED PART)
BCP/A	BRAKE CYLINDER PRESSURE
CL/A	LONGITUDINAL CREEP
CS/A	MASTER CONTROLLER SIGNAL
D/A	DISTANCE (A)
D/B	DISTANCE (B)
DBFB/A	DYNAMIC BRAKE FEEDBACK SIGNAL
ET/A	EVENT TRACE (MARKER)
ETI/A	ELECTRIC FIELD INTENSITY
EQT/A	EQUIPMENT TEMPERATURES
FBCS/A	FRICTION BRAKE CONTROL SIGNAL
J/A	JERK
LCD/A	DC LINE CURRENT
LVD/A	DC LINE VOLTAGE
MSD/A	DC MOTOR SPEED
MACD/A	DC MOTOR ARMATURE CURRENT
MAVD/A	DC MOTOR ARMATURE VOLTAGE
MFCD/A	DC MOTOR FIELD CURRENT
NL/A	NOISE LEVEL
PCC/A	POWER CONSUMED - Product of line volts x line amps x time

STANDARD OUTPUT CODES (CONT'D)

CODE:	PARAMETER:
RMS-MAC/A	DC MOTOR ARMATURE - Sum of current squared times delta time
RMS-MFC/A	DC MOTOR FIELD - Sum of current squared times delta time
RRH/A	RIDE ROUGHNESS - HORIZONTAL
RRV/A	RIDE ROUGHNESS - VERTICAL
SP/A	SOUND PRESSURE
SNB/A	SOUND - NARROW BAND ANALYSIS
SOB/A	SOUND - OCTAVE BAND ANALYSIS
SPL/A	SOUND PRESSURE LEVEL
STP	STRUCTURAL TEST PARAMETER
S3B/A	SOUND - THIRD OCTAVE BAND ANALYSIS
T/A	TIME
T/B	TIME
VS/A	VEHICLE SPEED (A)
VS/B	VEHICLE SPEED (B)
VW/A	VEHICLE WEIGHT

ACCELERATION, CAR BODY (AC/A)

RANGE:	$\pm$ 0.003 to $\pm$ 2.0 g rms
ACCURACY:	$\pm$ 0.5 dB
UNITS:	m/sec^2
FREQUENCY RESPONSE:	0.1 to 350 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	None
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None

FORMAT:

(1) Recording format is a magnetic tape signal which can be used to reproduce the original motion (using an electromechanical shaker) or processed to produce other Standard Outputs.

(2) Monitor output format will be time history trace with a maximum of 10 cycles per inch and 1 inch peak to peak. Frequency response may be 0.1 to 100 Hz.

(3) A permanent time history at a slow chart speed for the complete test record. This chart to be used to determine levels. A short burst of data, in time history, at high chart speed is required to indicate cyclical content.

ACCELERATION, CAR BODY ANGULAR (ACA/A)

RANGE:	± 1.5 Radians per second per second
ACCURACY:	1.0% (of Full Scale)
UNITS:	Radians per second per second
FREQUENCY RESPONSE:	0 to 4 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	None
CALIBRATION METHOD:	Primary: Servo rate table and tachometer Secondary: Strain

FORMAT:

(1) Data is recorded on magnetic tape.

(2) The recorded data is monitored on a time-based strip chart with a one inch peak-to-peak display chart speed is variable depending upon interest at time of monitoring.

(3) A permenant time-history strip chart of a slow chart speed for the complete test run. This chart is to be used to determine levels. A short burst of data at a high chart speed to indicate the cyclical content of the data.

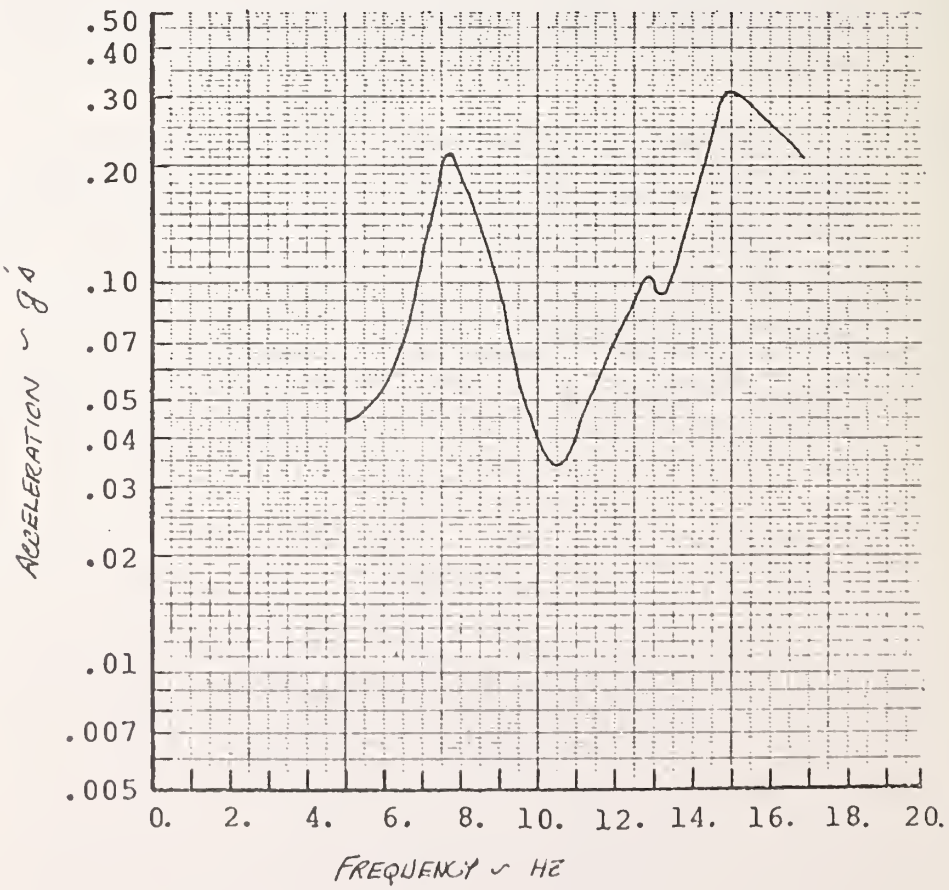
(4) Frequency Histogram

A time dependent distribution of the car body angular acceleration over the entire test record.

ACCELERATION FREQUENCY RESPONSE (AFR/A)

RANGE:	± 0.0003 to ± 2.0 g rms
ACCURACY:	± 0.5 dB
UNITS:	g
SPECIAL FEATURES:	None
CALIBRATION METHOD:	
CERTIFICATION METHOD:	
DISCUSSION:	None
FORMAT:	

Frequency Response Curve



ACCELERATION, JOURNAL (AJ/A)

RANGE:	$\pm$ 30 g rms
ACCURACY:	$\pm$ 0.5 dB
UNITS:	m/sec^2
FREQUENCY RESPONSE:	0.1 to 350 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	None
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None

FORMAT:

(1) Recording format is a magnetic tape signal which can be used to reproduce the original motion (using an electromechanical shaker) or processed to produce other Standard Outputs.

(2) Monitor Output format will be time history trace with a maximum of 10 cycles per inch and 1 inch peak to peak. Frequency response may be 0.1 to 100 Hz.

(3) A permanent time history at a show chart speed for the complete test record. This chart to be used to determine levels. A short burst of data, in time history, at high chart speed to indicate content.

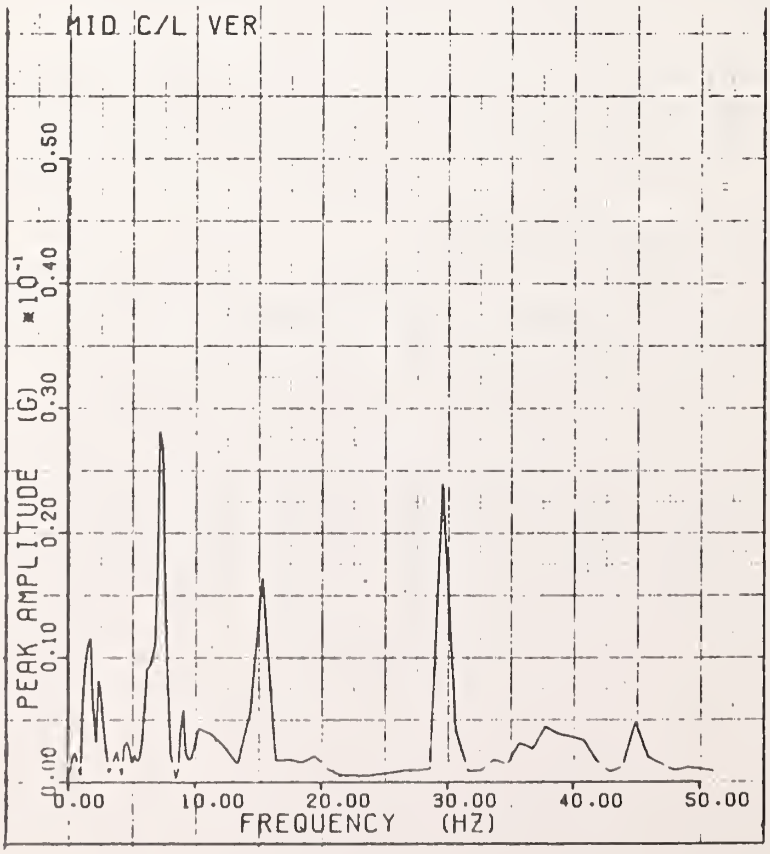
(4) Frequency Historgram

A time dependent distribution of acceleration levels for the complete test record.

ACCELERATION NARROW BAND ANALYSIS (ANB/A)

RANGE:	±0.0003 to ± 2.0 g rms
ACCURACY:	±0.5 dB
UNITS:	g
FREQUENCY RESPONSE:	Continuously tunable or discreetly tunable filters spanning the frequency response given in API/A.
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	Filters- User may select from the following: six percent (percentage bandwidth) 0.5 Hz (constant bandwidth) 5.0 Hz (constant bandwidth)
CALIBRATION METHOD:	To be determined.
CERTIFICATION METHOD:	To be determined.
DISCUSSION:	None

FORMAT:



ACCELERATION OCTAVE BAND ANALYSIS (AOB/A)

RANGE:	70 db (above electronic noise)
ACCURACY:	per IEC 225 1966
UNITS:	db re 10^{-5} m/sec^2
FREQUENCY RESPONSE:	0.1 to 350 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	IEC Standard Octave filters centered at requested frequencies, rms averaging, log conversion.
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	Similar to SOB/A

ACCELERATION PERFORMANCE (AP/A)

RANGE: ±6.5 mph/sec (~ .3g)

ACCURACY: 1.0% of full scale @ 1/2 scale
2.0% of full scale @ full scale

UNITS: mph/sec

FREQUENCY RESPONSE: 0 to 6 Hz

SPECIAL FEATURES: None

SIGNAL PROCESSING: Filter; Flat to 2 Hz

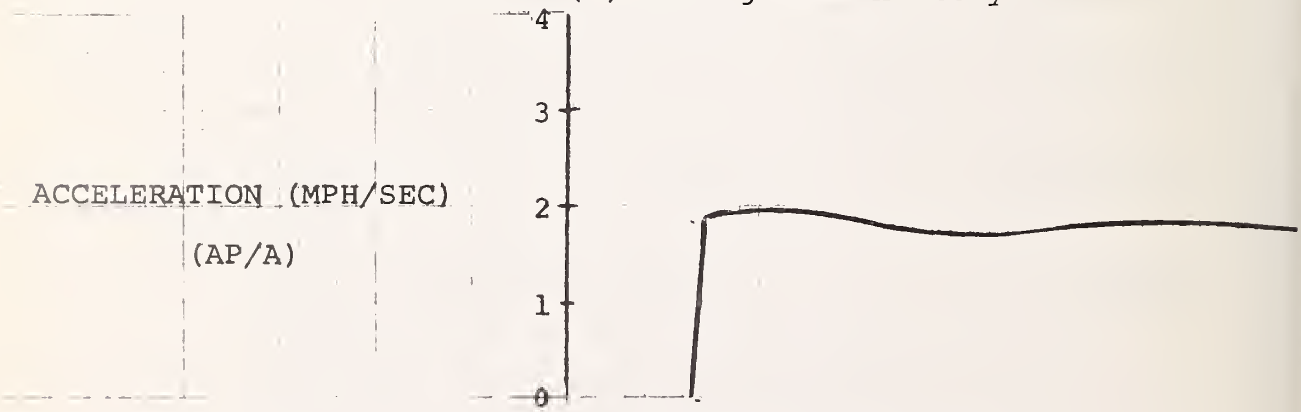
CALIBRATION METHOD: Precision Wedge

CERTIFICATION METHOD: To be determined

DISCUSSION: None

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page AP/A-2) from analog data.

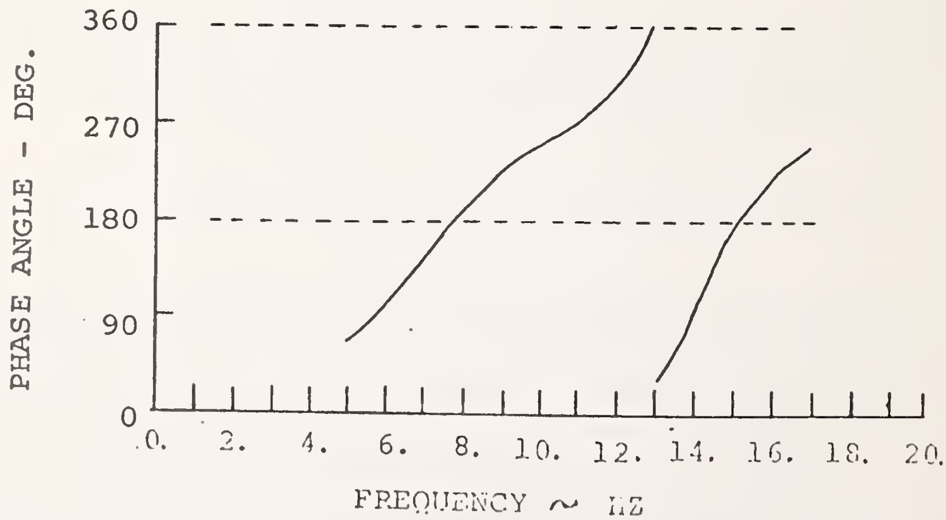
DIGITAL TIME-HISTORY TABULATION

EVENT	T/A TIME	SPEED	P-WIRE	AP/A ACCEL	LINE		MOTOR		ARMATURE		FIELD	
							NO.1	NO.2	NO.1	NO.2	NO.1	NO.2
	SEC	MPH	AMPS	MPH/SEC	VOLT	AMPS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	292.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.15	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	35.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.9
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.736	0.52	652.	568.	639.6	652.8	206.9	190.3	16.6	16.0
	56.0	48.24	-0.736	0.52	652.	560.	637.9	653.2	203.4	200.4	16.3	15.8
	58.0	48.96	-0.737	0.43	657.	510.	638.7	651.5	203.4	182.1	16.1	15.5

ACCELERATION PHASE ANGLE (APA/A)

RANGE:	0.0 to 360 degrees
ACCURACY:	± 5 %
UNITS:	Degrees
SPECIAL FEATURES:	None
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Reference for the phase angle shall be the input force.

FORMAT:



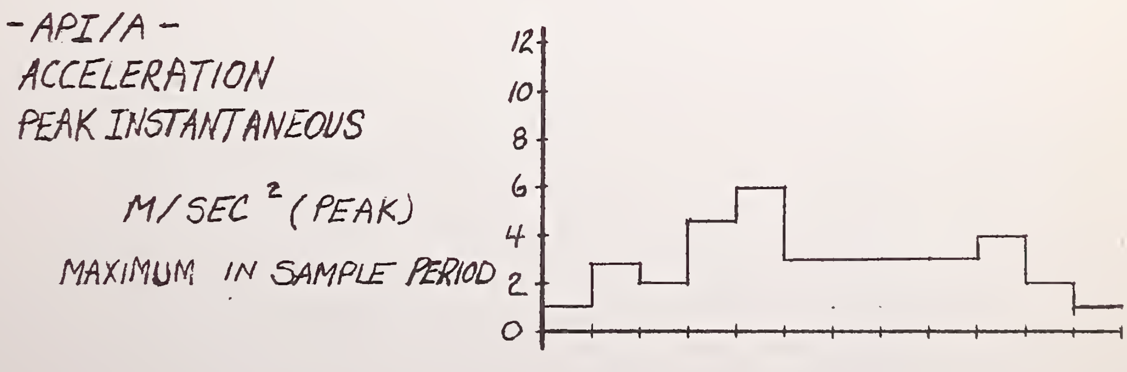
ACCELERATION - PEAK INSTANTANEOUS (API/A)

RANGE:	0.003 to 2.0 g rms
ACCURACY:	± 0.5 dB
UNITS:	m/sec^2 (peak)
FREQUENCY RESPONSE:	0.1 to 350 Hz.
SPECIAL FEATURES:	Sample interval selectable to 0.2, 1.0, 2, 5, 10, or 30 sec.
SIGNAL PROCESSING:	Peak reading, log conversion
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined

DISCUSSION:

Output quantity is the maximum absolute value of acceleration during the sample interval.

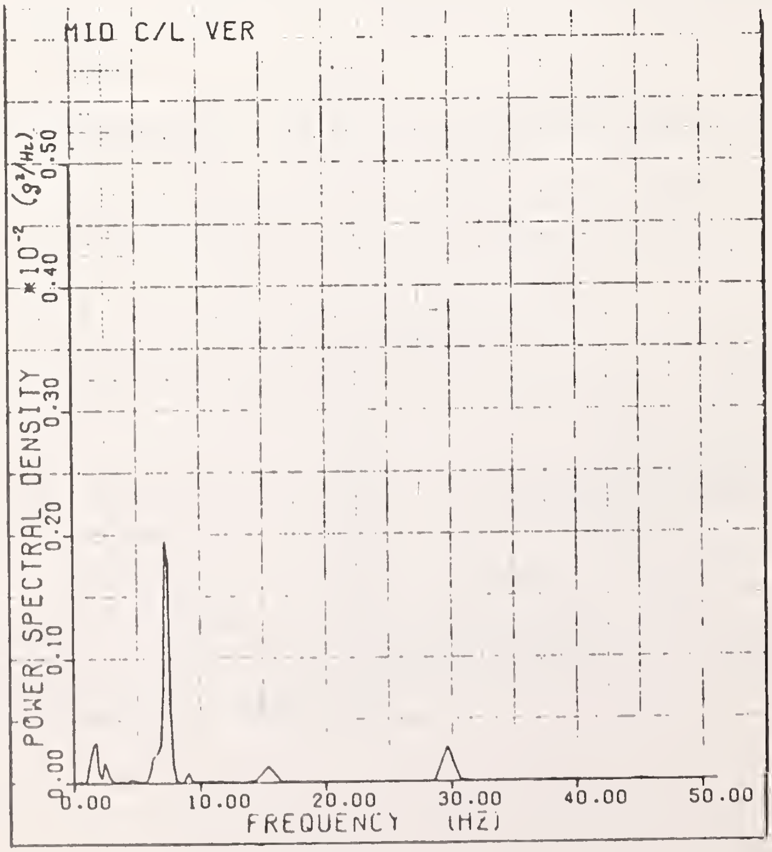
FORMAT:



ACCELERATION POWER SPECTRAL DENSITY (ASD/A)

RANGE:	±0.003 to ± 2.0 g rms
ACCURACY:	±0.5 dB
UNITS:	g^2/Hz
FREQUENCY RESPONSE:	Continuously tunable or discretely tunable filters spanning the frequency response given in API/A.
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	Filters-User may select from the following: six percent (percentage bandwidth), 0.5 Hz (constant bandwidth) 5.0 Hz (constant bandwidth).
CALIBRATION METHOD:	To be determined.
CERTIFICATION METHOD:	To be determined.
DISCUSSION:	None

FORMAT:



ACCELERATION, VEHICLE SPEED, MOTOR SPEED, DISTANCE VS TIME (AVD/A)

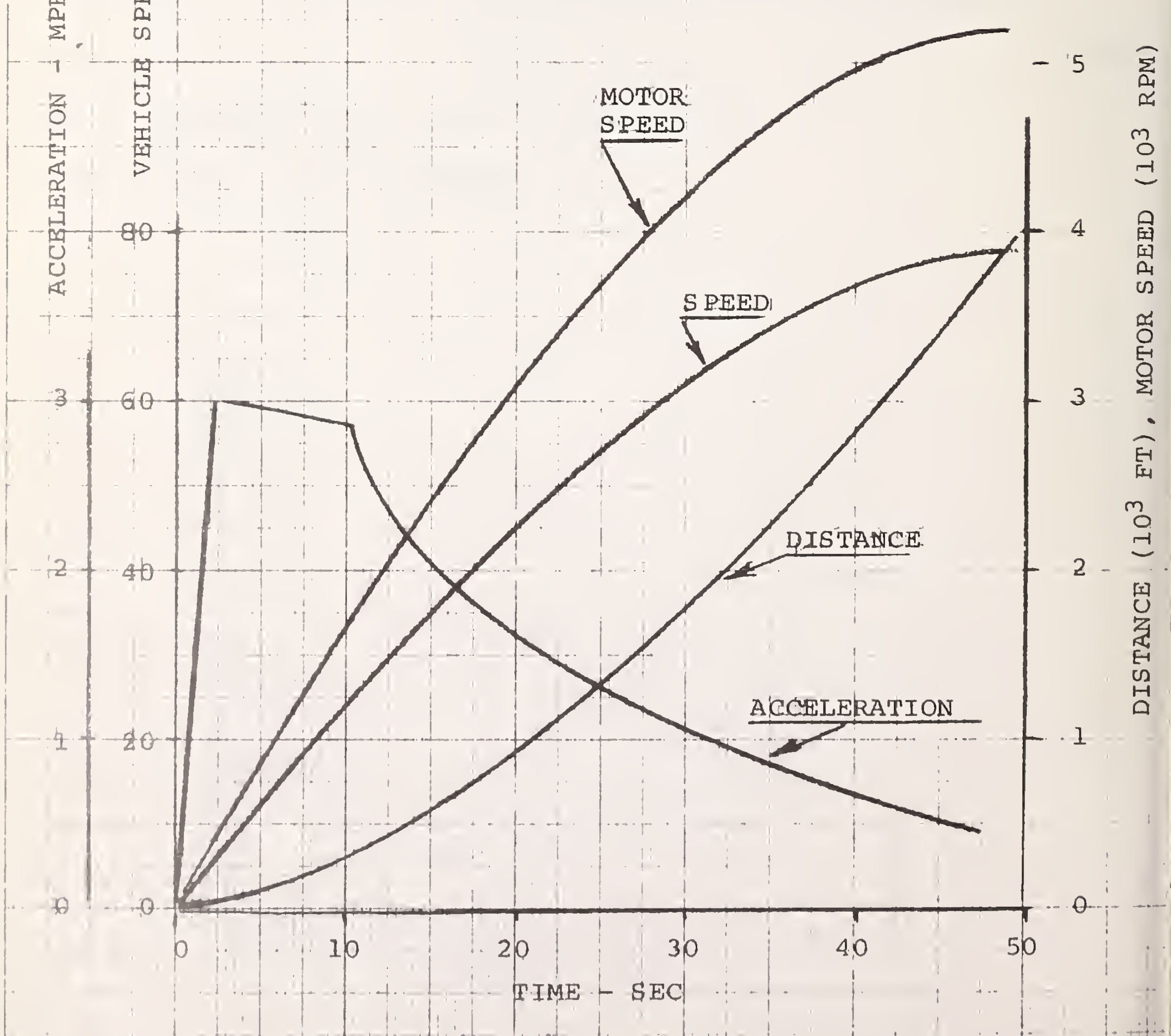
ACCELERATION SPECIFICATION	See AP/A
VEHICLE SPEED SPECIFICATION	See VS/A
MOTOR SPEED SPECIFICATION	See MS/A
DISTANCE SPECIFICATION	See D/A
TIME SPECIFICATION	See T/A

DISCUSSION

Except for the output format, specification on these physical quantities are given as shown above.

FORMAT:

1. Time History Plot (AVD/A-2)
2. Digital Time History Tabulation (AVD/A-3) from analog data.


ACCELERATION - MPH
VEHICLE SPEED - MPH
DISTANCE (10^3 FT), MOTOR SPEED (10^3 RPM)
MOTOR SPEED
SPEED
DISTANCE
ACCELERATION
TIME - SEC
0
1
2
3
0
20
40
60
80
0
1
2
3
4
5
0
10
20
30
40
50

DIGITAL TIME-HISTORY TABULATION

T/A VS/A AP/A

EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLT	LINE AMPS	MOTOR NO.1 VOLTS	MOTOR NO.2 VOLTS	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	454.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.9
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	292.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.736	0.52	652.	568.	639.6	652.8	206.9	190.3	16.6	16.0
	56.0	48.24	-0.736	0.52	652.	560.	637.9	653.2	203.4	200.4	16.3	15.8
	58.0	48.96	-0.737	0.43	657.	510.	638.7	651.5	203.4	182.1	16.1	15.5

ACCELERATION - 1/3 OCTAVE BAND ANALYSIS (A3B/A)

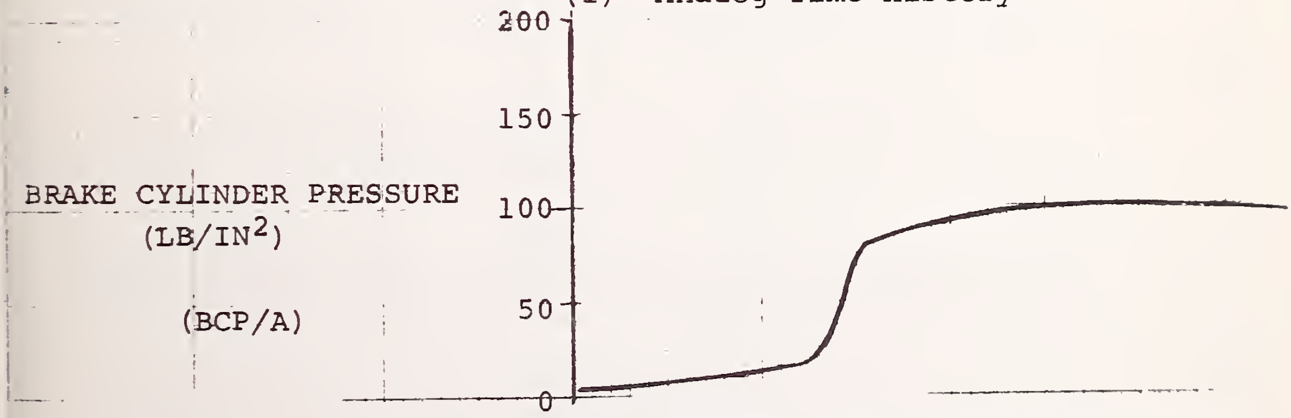
RANGE:	70 dB (above electronic noise)
ACCURACY:	per IEC 225 1966
UNITS:	dB re 10^{-5} m/sec^2
FREQUENCY RESPONSE:	0.1 to 350 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	IEC Standard 1/3 Octave Band filters centered at requested frequencies, rms averaging, log conversion.
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	Similar to S3B/A

BRAKE CYLINDER PRESSURE (BCP/A)

RANGE:	0 to 200 psi (pneumatic) 0 to 2000 psi (hydraulic)
ACCURACY:	±1.0% full scale
UNITS:	lb/in^2
FREQUENCY RESPONSE:	0 to 12 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	As required by sensor type
CALIBRATION METHOD:	Based on sensor type
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page BCP/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A BCP/A

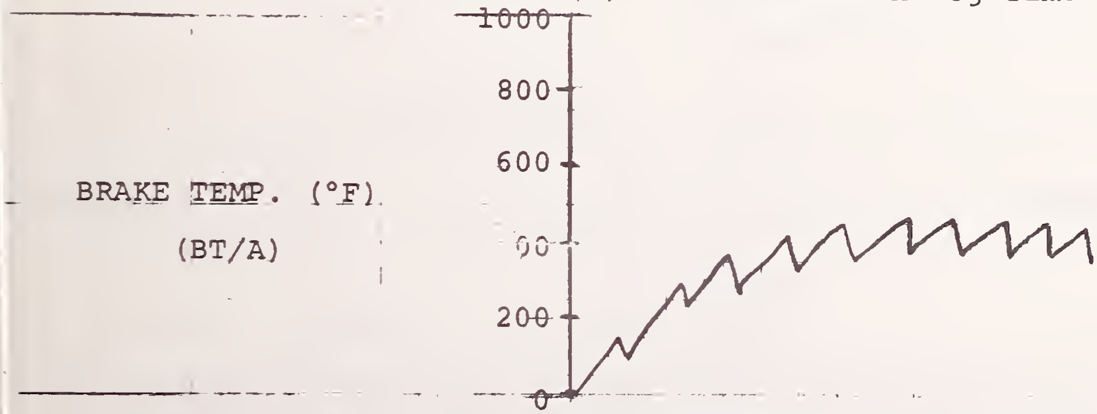
TIME	EVENT SECS	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLTS	LINE AMPS	ANALOG VALVE AMPS	BRAKE PRESSURE PSI
0.		57.22	0.839	0.18	636.	491.	0.02	-1.2
1.		57.31	0.839	0.37	637.	484.	0.02	-1.2
2.		57.36	0.837	0.11	637.	471.	0.02	-1.2
3.	+.5	57.50	0.831	0.00	644.	441.	0.01	-1.1
4.		56.76	0.081	-1.87	692.	19.	0.88	54.6
5.		54.10	0.077	-2.98	691.	28.	1.52	90.9
6.		51.18	0.078	-2.80	684.	37.	2.41	92.4
7.		48.28	0.078	-3.03	679.	47.	2.41	92.0
8.		45.34	0.078	-2.72	681.	46.	2.41	91.6
9.		42.32	0.077	-3.43	680.	44.	2.41	91.4
10.		39.29	0.078	-3.04	679.	40.	2.42	91.4
11.		36.52	0.076	-3.02	681.	43.	2.40	91.1
12.		33.49	0.078	-3.05	678.	42.	2.41	91.1
13.		30.52	0.074	-3.03	679.	43.	2.41	91.3
14.		27.54	0.077	-3.05	679.	41.	2.41	91.0
15.		24.54	0.076	-2.92	678.	42.	2.41	91.0
16.		21.37	0.074	-3.28	678.	42.	2.41	90.9
17.		18.26	0.073	-3.29	678.	44.	2.41	90.9
18.		14.90	0.074	-3.38	676.	42.	2.41	90.9
19.		11.63	0.073	-3.56	678.	44.	2.41	90.9
20.		7.98	0.074	-3.75	676.	42.	2.39	90.8
21.		4.12	0.073	-4.16	678.	44.	2.42	90.9
22.	+.5	-0.15	0.073	-4.00	676.	42.	2.42	90.2
23.		-0.42	0.073	0.20	676.	42.	2.41	91.0
24.		-0.39	0.072	-0.17	676.	42.	2.41	91.0
25.		-0.46	0.057	0.04	675.	43.	2.42	91.0
26.		-0.37	0.058	-0.07	676.	40.	2.41	90.9

BRAKE TEMPERATURE (BT/A)

RANGE:	0° to 800° F Tread 0° to 1200°F Disc
ACCURACY:	± 1.0% full scale
UNITS:	°F
FREQUENCY RESPONSE:	None
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	Precision voltage source and thermocouple data for tread or disc (rotating part)
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Continuous recording or manual positioning following test points.

FORMAT:

(1) Continuous Analog Time History



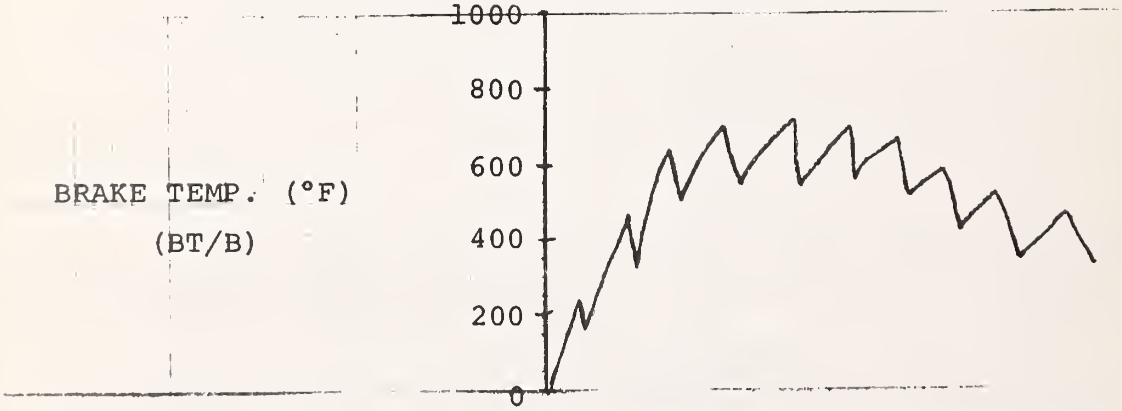
(2) Sequential recording on "Series" type recorder (many channels) similar to BT/B-2

BRAKE TEMPERATURE (BT/B)

RANGE:	0 to 1200 °F
ACCURACY:	± 1.0% full scale
UNITS:	°F
FREQUENCY RESPONSE:	None
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	Precision voltage source and thermcouple data for brake shor or disc (fixed part)
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Continuous recording

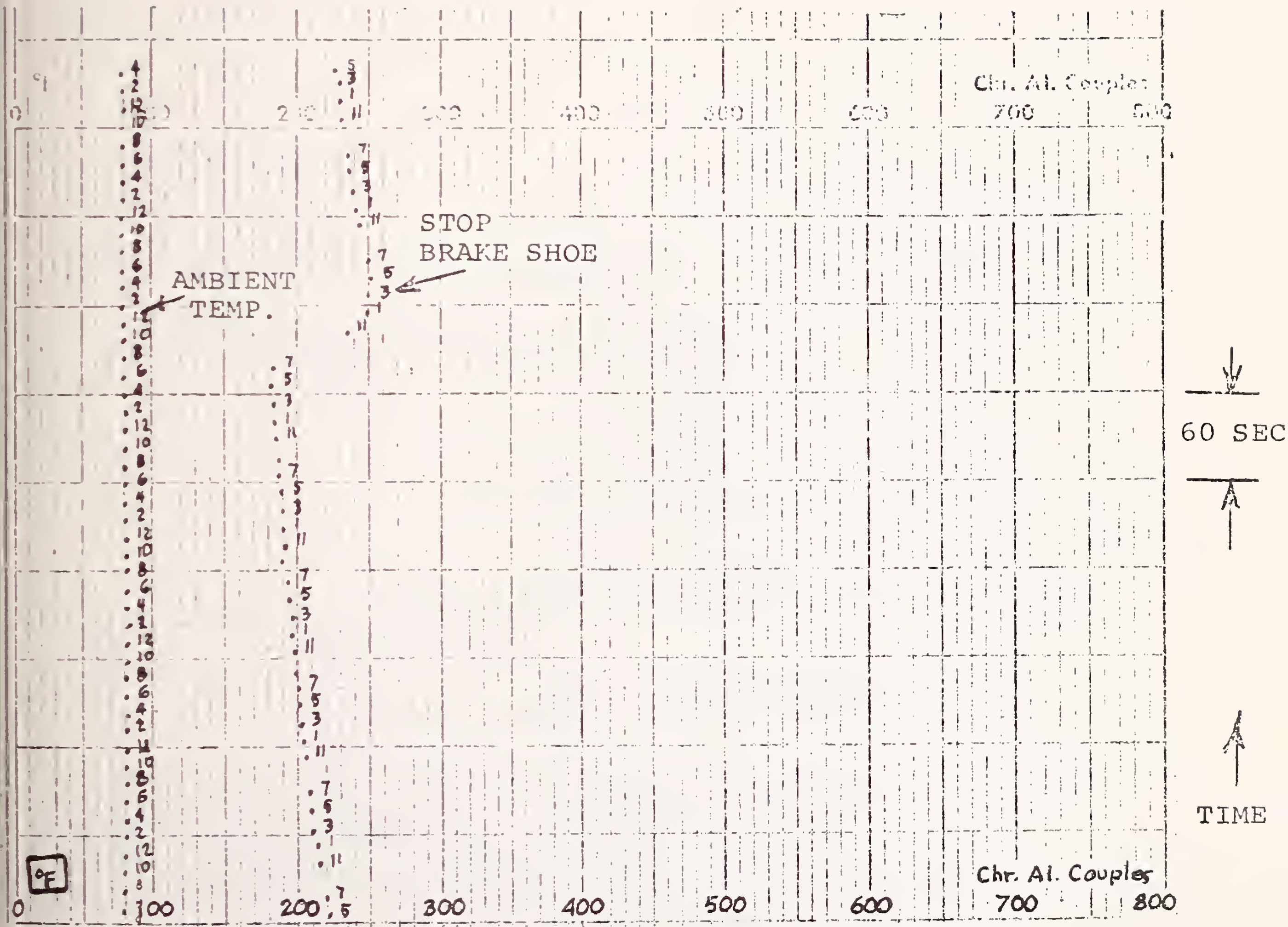
FORMAT:

(1) Continuous Analog Time History



(2) Sequential recording on "Series" type recorder (many channels) page BT/B-2

TYPICAL BRAKE SHOE DATA, (BT/B)



ODD NUMBERS: THERMOCOUPLE IN BRAKE SHOE

EVEN NUMBERS: LOOSE THERMOCOUPLE TO BE PLACED MANUALLY ON WHEEL TREAD TO RECORD BT/A FOLLOWING SELECTED STOP. THIS WAS NOT DONE FOR STOP SHOWN, THEREFORE, TEMPERATURE RECORDED IS FOR FREE AIR.

LONGITUDINAL CREEP (CL/A)

RANGE: 0 to 1.0 as applicable to type of testing

ACCURACY: .2% full scale speed

UNITS: $\frac{\Delta \text{mph}}{\text{mph}}$ (decimal)

FREQUENCY RESPONSE: 0 to 20 Hz

SPECIAL FEATURES: Display may be full or partial scale (offset from zero)

SIGNAL PROCESSING: Combine standard VS/A and VS/B raw signals

CALIBRATION METHOD: To be determined

CERTIFICATION METHOD: To be determined

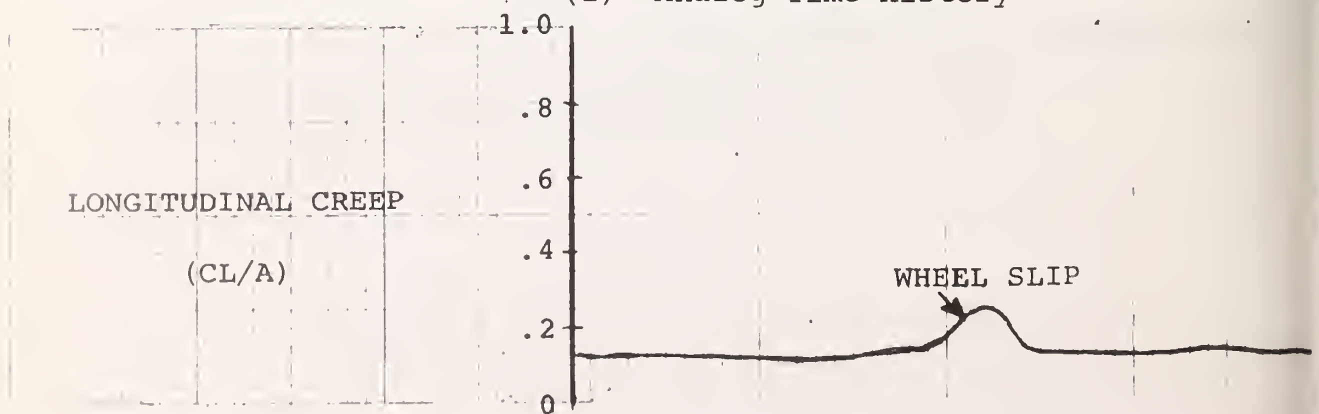
DISCUSSION:

$$\text{Longitudinal creep} = \frac{\text{Longitudinal Slip Velocity}}{\text{Actual Velocity}}\text{; or}$$

$\left|\frac{VS/A - VS/B}{VS/B}\right|$ or $C_1 = \left|\frac{\omega r - V}{V}\right|$ where V is the actual velocity, ω is the angular velocity of the wheel, r is the radius of the wheel. Longitudinal creep occurs when the rolling velocity of the wheel does not equal the velocity of the car. In terms of quantities discusse elsewhere in the Standard Outputs, ωr corresponds to VS/A and V corresponds to VS/B.

FORMAT:

(1) Analog Time History



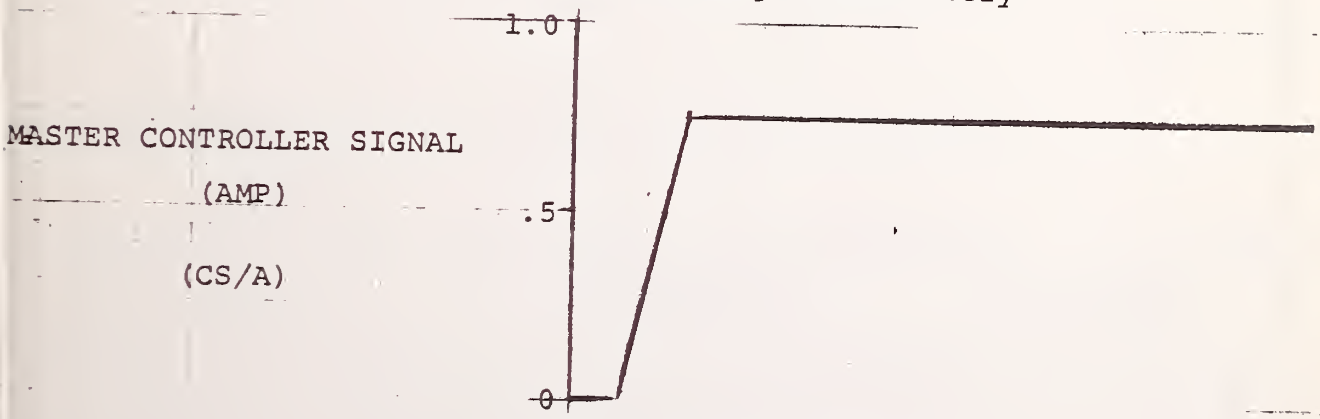
(2) Digital time history tabulation (not shown) similar to page AP/A-2

MASTER CONTROLLER SIGNAL (CS/A)

RANGE:	0 to 1.0 amp (variable)
ACCURACY:	±2.0% full scale
UNITS:	Amperes (variable)
FREQUENCY RESPONSE:	0 to 12 Hz (variable)
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	The master controller signal may consist of a low DC current, a low AC current or a low DC voltage. Range, Unit and Frequency Response are functions of these signals. Propulsion and brake signals may also be separate train lines.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page CS/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A CS/A

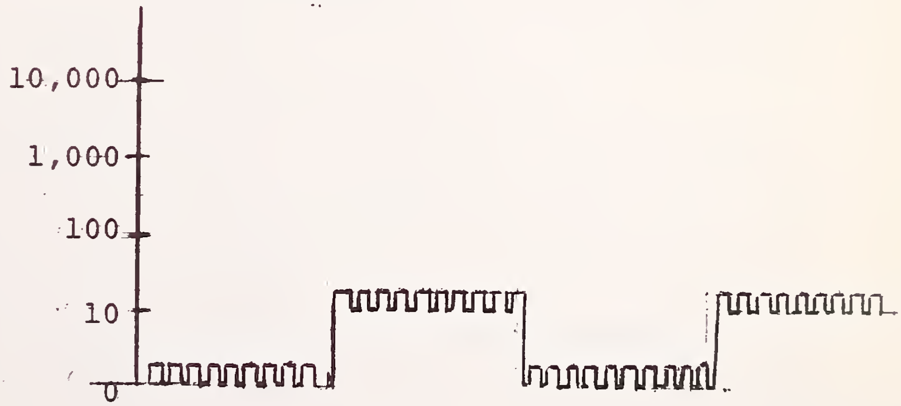
EVENT	TIME	SPEED	P-WIRE	ACCEL	LINE		MOTOR		ARMATURE		FIELD	
							NO.1	NO.2	NO.1	NO.2	NO.1	NO.2
	SEC	MPH	AMPS	MPH/SEC	VOLT	AMPS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	292.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	468.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.2
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.9
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.736	0.52	652.	568.	639.6	652.8	206.9	190.3	16.6	16.0
	56.0	48.24	-0.736	0.52	652.	560.	637.9	653.2	203.4	200.4	16.3	15.8
	58.0	48.96	-0.737	0.43	657.	510.	638.7	651.5	203.4	182.1	16.1	15.5

DISTANCE (D/A)

RANGE:	0 to 10 mile
ACCURACY:	±0.2% over 1000 ft. linear maximum error ±2 ft. in 10 mile
UNITS:	Ft.
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	Operator may reset output to any value in range during test or during data analysis
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	

DISTANCE (FT.)

(D/A)



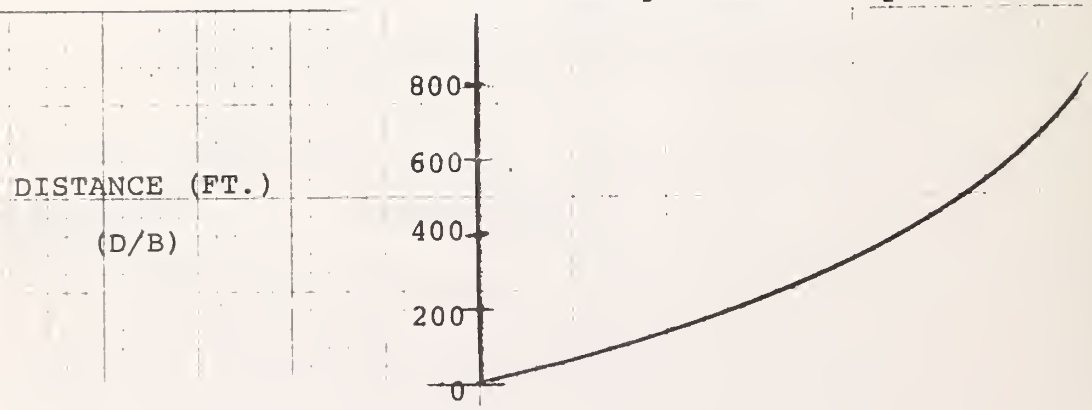
DISTANCE (D/B)

RANGE:	0 to 10 mile
ACCURACY:	±.2% over 1000 ft linear
UNITS:	Ft.
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	Output conditioned for both digital counter and analog time history output.
SIGNAL PROCESSING:	Based on VS/B and T/A combination
CALIBRATION METHOD:	See VS/B and T/A
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Based on "True" car speed from VS/B source and T/A. Provides digital pulse to counter and analog signal for time history processing.

FORMAT:

(1) Digital counter, Real Time output accumulated distance.

(2) Analog time history



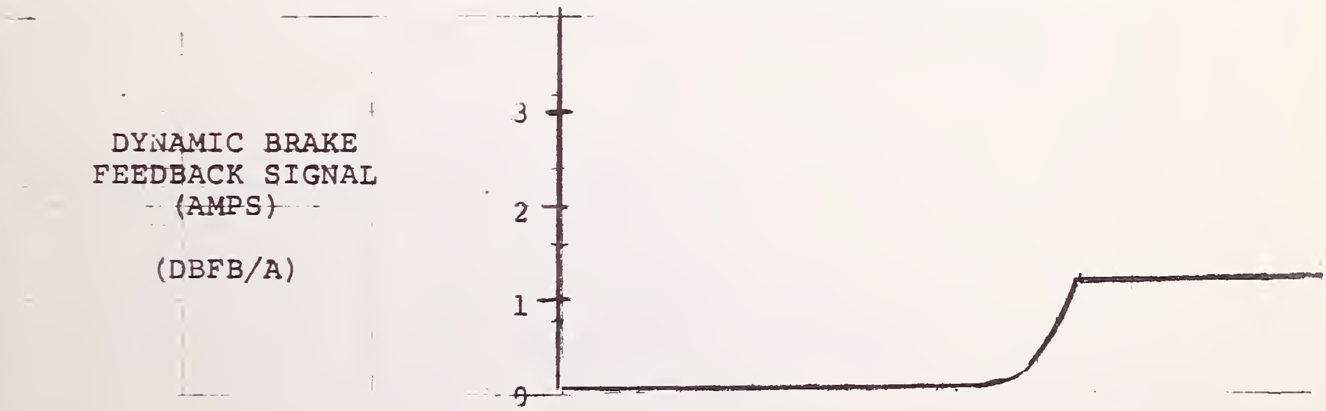
(3) Digital time history tabulation (not shown but similar to page AP/A-2)

<u>DYNAMIC BRAKE FEEDBACK SIGNAL</u> (DBFB/A)

RANGE:	0 to 5 amps variable
ACCURACY:	±2.0% full scale
UNITS:	Amperes (variable)
FREQUENCY RESPONSE:	0 to 12 Hz (variable)
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	DC current supply and current shunt (variable)
CERTIFICATION METHOD:	To be determined
DISCUSSION:	The dynamic brake feed back signal may consist of a low DC current, a low AC current or a low DC voltage. Range, Unit and Frequency Response are functions of these signals.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation from analog data. Similar to page FBCS/A-2

ELECTRIC FIELD INTENSITY (EFI/A)

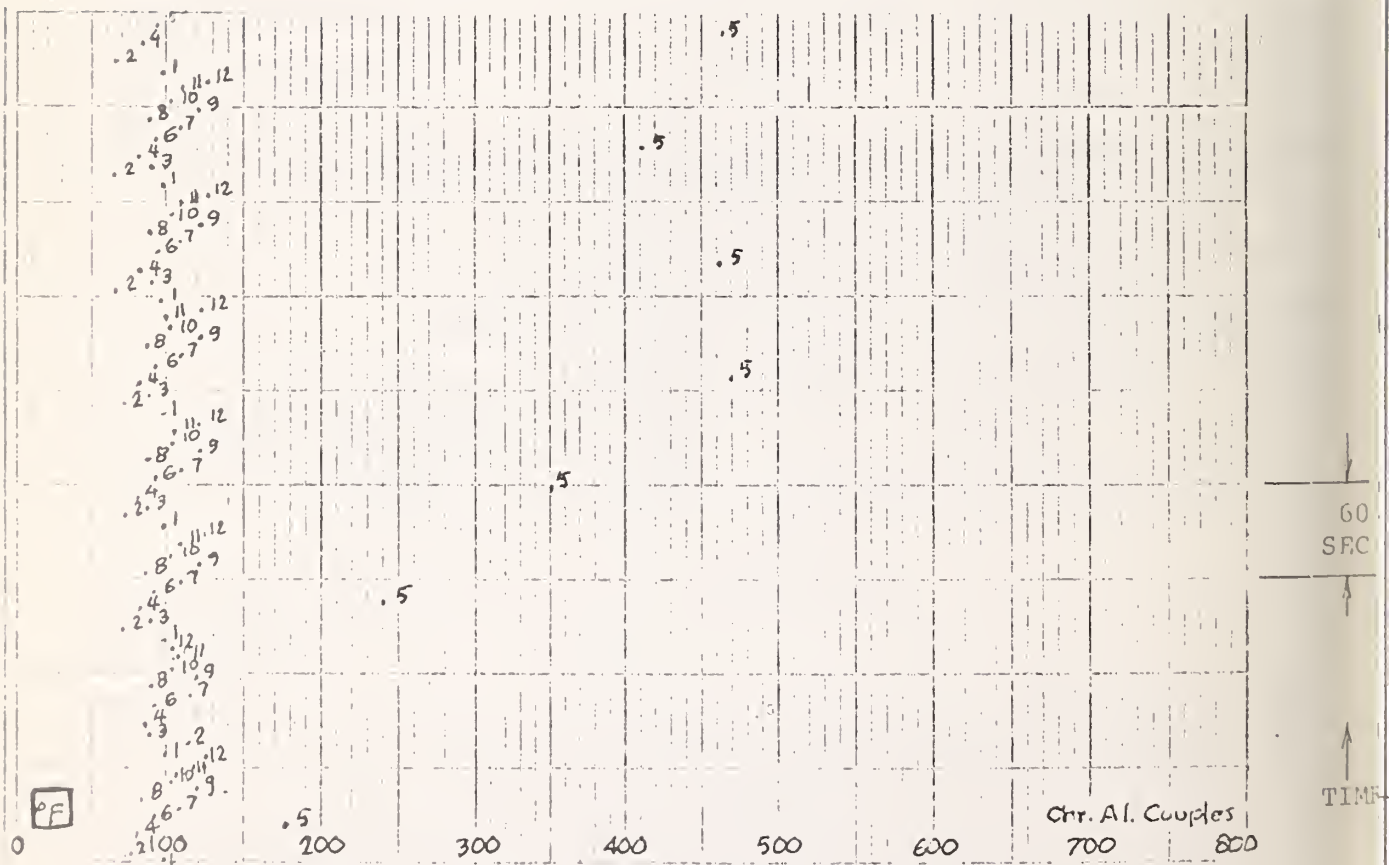
RANGE:	150 kHz to 400 MHz
ACCURACY:	± 3 dB
UNITS:	db μV/m/MHz
FREQUENCY RESPONSE:	150 kHz to 400 MHz
SPECIAL FEATURES:	Not applicable
SIGNAL PROCESSING:	The raw data are, in fact, voltage measurements at the antenna terminals, which are derived from Radio Interference Intensity meters and are in units of dB μV/MHz. Appropriate antenna factors (units of dB/m) are applied to convert the voltage measurements to electric field intensity readings (units of dB μV/m/MHz).
CALIBRATION METHOD:	Each RIFI meter measurement is checked against the output of a calibrated impulse generators.
CERTIFICATION METHOD:	To be determined.
DISCUSSION:	None.
FORMAT:	The output format is a table consisting of electric field intensity readings at all test frequencies, under each test condition. The highest value of wayside emission recorded at each frequency can be plotted on a semi-logarithmic graph to yield a spectrum signature of the test vehicle.

<u>EQUIPMENT TEMPERATURE</u> (EQT/A)

RANGE:	0 to 1000 °F
ACCURACY:	±1.0% full scale
UNITS:	°F
FREQUENCY RESPONSE:	None
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	Precision voltage source and thermocouple data.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Continuous recording
FORMAT:	(1) Sequential recording on "Series" type recorder (many channels) similar to example shown on page EQT/A-2.

SYNTHETIC TRANSIT ROUTE

EQUIPMENT TEMPERATURE (EQT/A)



EQUIPMENT IDENTIFIED BY "STAMP NUMBER" ON RECORDER.
EXAMPLE: "STAMP NUMBER" 4 IDENTIFIES PROPULSION BLOWER OUTLET AIR.

EVENT TRACES (ET/A) (EVENT PULSE ON TRACE)

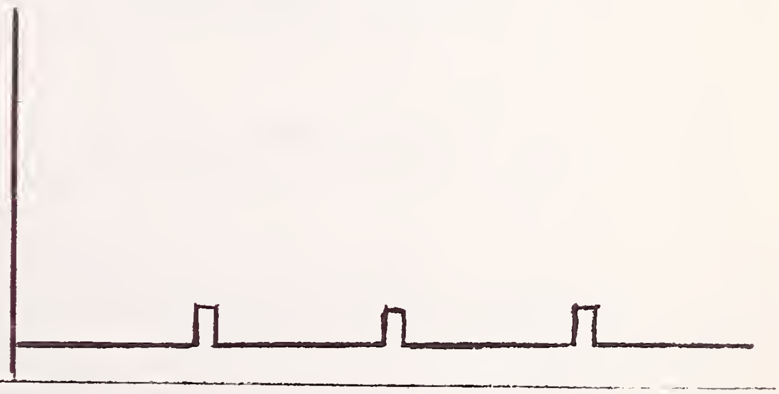
RANGE:	Not applicable
ACCURACY:	±0.01 second
UNITS:	None
FREQUENCY RESPONSE:	(High)
SPECIAL FEATURES:	None
SIGNAL PROCESSING	Not applicable
CALIBRATION METHOD	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Marks the time at which an event occurred during a test.

FORMAT:

(1) Analog Time History

EVENT TRACE

(ET/A)



(2) Specific time noted on digital time history tabulation (ET/A-2)

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A ET/A

TIME	EVENT SECS	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLTS	LINE AMPS	ANALOG VALVE AMPS	BRAKE PRESSURE PSI
0.		57.22	0.839	0.18	636.	491.	0.02	-1.2
1.		57.31	0.839	0.37	637.	484.	0.02	-1.2
2.		57.36	0.837	0.11	637.	471.	0.02	-1.2
3.	+.5	57.50	0.831	0.00	644.	441.	0.01	-1.1
4.		56.76	0.081	-1.87	692.	19.	0.88	54.6
5.		54.10	0.077	-2.98	691.	28.	1.52	90.9
6.		51.18	0.078	-2.80	684.	37.	2.41	92.4
7.		48.28	0.078	-3.03	679.	47.	2.41	92.0
8.		45.34	0.078	-2.72	681.	46.	2.41	91.6
9.		42.32	0.077	-3.43	680.	44.	2.41	91.4
10.		39.29	0.078	-3.04	679.	40.	2.42	91.4
11.		36.52	0.076	-3.02	681.	43.	2.40	91.1
12.		33.49	0.078	-3.05	678.	42.	2.41	91.1
13.		30.52	0.074	-3.03	679.	43.	2.41	91.3
14.		27.54	0.077	-3.05	679.	41.	2.41	91.0
15.		24.54	0.076	-2.92	678.	42.	2.41	91.0
16.		21.37	0.074	-3.28	678.	42.	2.41	90.9
17.		18.26	0.073	-3.29	678.	44.	2.41	90.9
18.		14.90	0.074	-3.38	676.	42.	2.41	90.8
19.		11.63	0.073	-3.56	678.	44.	2.41	90.9
20.		7.98	0.074	-3.75	676.	42.	2.39	90.8
21.		4.12	0.073	-4.16	679.	44.	2.42	90.8
22.	+.5	-0.15	0.073	-4.00	676.	42.	2.42	90.2
23.		-0.42	0.073	0.20	676.	42.	2.41	91.0
24.		-0.39	0.072	-0.17	676.	42.	2.41	91.0
25.		-0.46	0.057	0.04	675.	43.	2.42	91.0
26.		-0.37	0.058	-0.07	676.	40.	2.41	90.9

FRICTION BRAKE CONTROL SIGNAL (FBCS/A)

RANGE: 0 to 5 amps (variable)

ACCURACY: ±2.0% full scale

UNITS: Amperes (variable)

FREQUENCY RESPONSE: 0 to 12 Hz (variable)

SPECIAL FEATURES: Display may be full or partial scale (offset zero)

SIGNAL PROCESSING: Not applicable

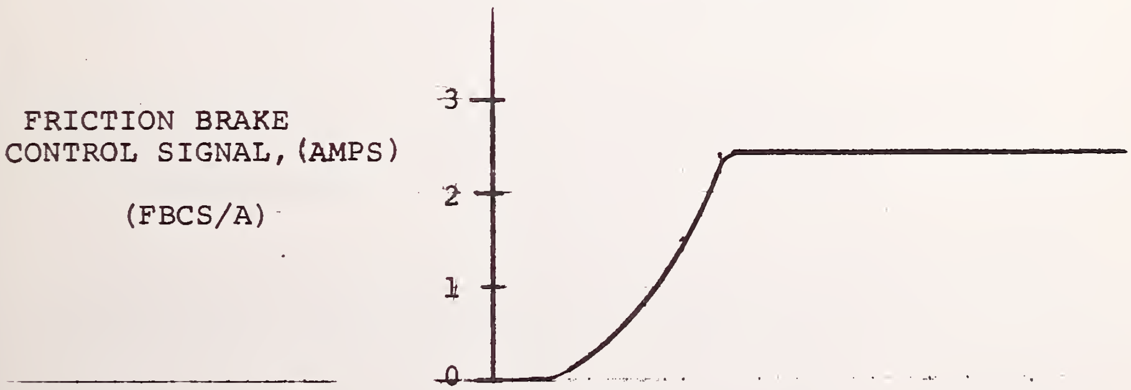
CALIBRATION METHOD: DC current supply and current shunt (variable)

CERTIFICATION METHOD: To be determined

DISCUSSION: The friction brake control signal may consist of a low DC current, a low AC current or a low DC voltage. Range, Unit and Frequency Response are functions of these signals.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page FBCS/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A FBCS/A

TIME	EVENT SECS	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLTS	LINE AMPS	ANALOG VALVE AMPS	BRAKE PRESSURE PSI
0.		57.22	0.839	0.18	636.	491.	0.02	-1.2
1.		57.31	0.839	0.37	637.	484.	0.02	-1.2
2.		57.36	0.837	0.11	637.	471.	0.02	-1.2
3.	+.5	57.50	0.831	0.00	644.	441.	0.01	-1.1
4.		56.76	0.081	-1.87	692.	19.	0.88	54.6
5.		54.10	0.077	-2.98	691.	28.	1.52	90.9
6.		51.18	0.078	-2.80	684.	37.	2.41	92.4
7.		48.28	0.078	-3.03	679.	47.	2.41	92.0
8.		45.34	0.078	-2.72	681.	46.	2.41	91.6
9.		42.32	0.077	-3.43	680.	44.	2.41	91.4
10.		39.29	0.078	-3.04	679.	40.	2.42	91.4
11.		36.52	0.076	-3.02	681.	43.	2.40	91.1
12.		33.49	0.078	-3.05	678.	42.	2.41	91.1
13.		30.52	0.074	-3.03	679.	43.	2.41	91.3
14.		27.54	0.077	-3.05	679.	41.	2.41	91.0
15.		24.54	0.076	-2.92	678.	42.	2.41	91.0
16.		21.37	0.074	-3.28	678.	42.	2.41	90.9
17.		18.26	0.073	-3.29	678.	44.	2.41	90.9
18.		14.90	0.074	-3.38	676.	42.	2.41	90.8
19.		11.63	0.073	-3.56	678.	44.	2.41	90.9
20.		7.98	0.074	-3.75	676.	42.	2.39	90.8
21.		4.12	0.073	-4.16	678.	44.	2.42	90.8
22.	+.5	-0.15	0.073	-4.00	676.	42.	2.42	90.2
23.		-0.42	0.073	0.20	676.	42.	2.41	91.0
24.		-0.39	0.072	-0.17	676.	42.	2.41	91.0
25.		-0.46	0.057	0.04	675.	43.	2.42	91.0
26.		-0.37	0.058	-0.07	676.	40.	2.41	90.9

JERK (J/A)

RANGE: -8.0 to +8.0 mph/sec^2

ACCURACY: ±1.5%, -3.5 to +3.5 mph/sec^2

±4.0% $\begin{cases} -3.5 \text{ to } -8.0 \text{ mph/sec}^2 \\ +3.5 \text{ to } +8.0 \text{ mph/sec}^2 \end{cases}$

UNITS: mph/sec^2

FREQUENCY RESPONSE: 0 to 20 Hz

SPECIAL FEATURES: Display format may be full or partial scale, offset from zero.

SIGNAL PROCESSING: Not applicable

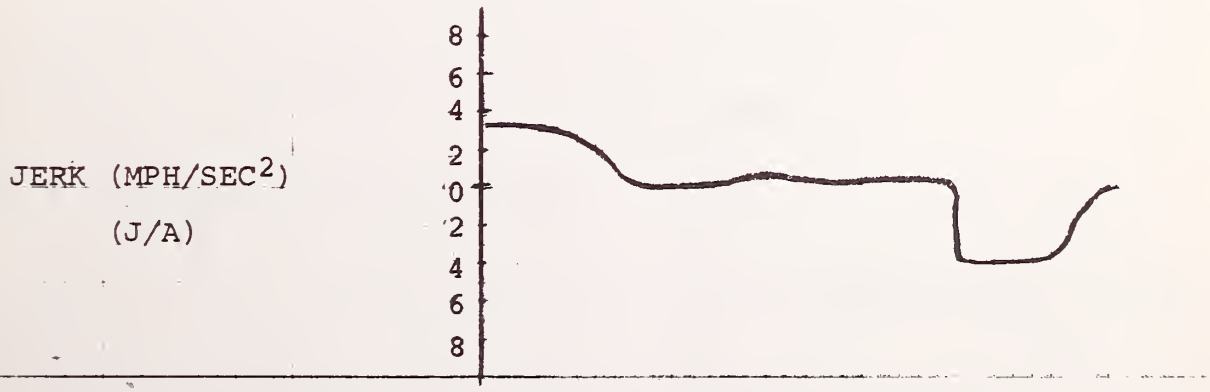
CALIBRATION METHOD: To be determined

CERTIFICATION METHOD: To be determined

DISCUSSION: None

FORMAT:

(1) Analog Time History

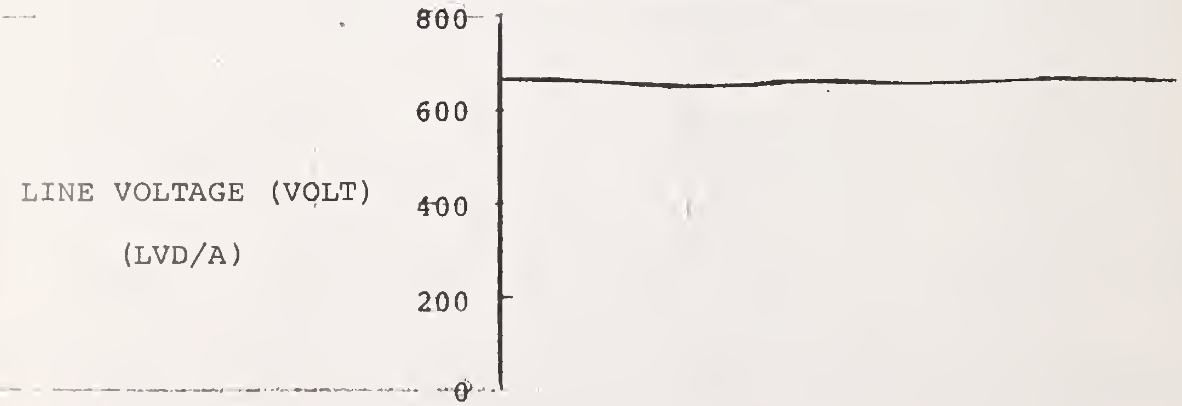


DC LINE VOLTAGE (LVD/A)

RANGE:	0 to 1000 VDC
ACCURACY:	±2.0% full scale
UNITS:	Volts
FREQUENCY RESPONSE:	0 to 400 Hz (as required)
SPECIAL FEATURES:	Display format may be full or partial scale, (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	High voltage DC power supply and a precision digital voltmeter.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	High frequency response is required if line voltage transients, due to solid state control equipment, are to be measured. Output must be filtered for steady state data.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page LVD/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A LVD/A

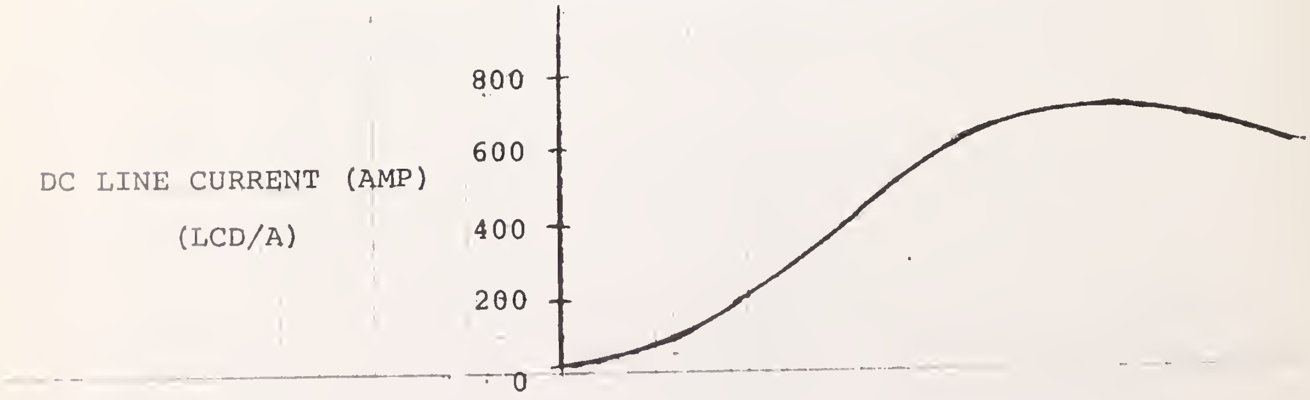
EVENT	TIME	SPEED	P-WIRE	ACCEL	LINE		MOTOR		ARMATURE		FIELD	
							NO.1	NO.2	NO.1	NO.2	NO.1	NO.2
	SEC	MPH	AMPS	MPH/SEC	VOLT	AMPS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.2
	44.0	42.22	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.9
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.39	-0.736	0.52	652.	548.	639.6	652.8	206.9	190.3	16.6	16.0
	[illegible]	[illegible]	[illegible]	0.52	652.	540.	[illegible]	652.2	203.4	200.4	16.2	15.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	203.4	1?2.1	17.1	15.5

DC LINE CURRENT (LCD/A)

RANGE:	0 to 2000 amps
ACCURACY	±2.0% full scale
UNITS:	Amperes
FREQUENCY RESPONSE:	0 to 400 Hz (as required)
SPECIAL FEATURES:	Display format may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	High level DC current supply and current shunt.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	High frequency response is required if line current transients due to solid state control equipment are to be measured. Output must be filtered for steady state data. Current can be measured with magnetoresistive sensors which sense the flux induced in lines due to current flowing in them or with standard ammeter current shunts.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page LCD/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A

LCD/A

EVENT	TIME	SPEED	P-WIRE	ACCEL	LINE		MOTOR		ARMATURE		FIELD	
							NO.1	NO.2	NO.1	NO.2	NO.1	NO.2
	SEC	MPH	AMPS	MPH/SEC	VOLT	AMPS	VOLTS	VOLTS	AMPS	AMPS	AMPS	AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.3[illegible]	-0.736	0.52	652.	[illegible]	[illegible]	652.8	206.9	190.3	16.6	16.0
	[illegible]	[illegible]	-0.736	0.52	[illegible]	[illegible]	[illegible]	[illegible]	203.4	200.4	16.3	15.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.5

DC MOTOR ARMATURE CURRENT (MACD/A)

RANGE: 0 to 1000 amps

ACCURACY: ±2.0% full scale

UNITS: Amperes

FREQUENCY RESPONSE: 0 to 400 Hz (variable)

SPECIAL FEATURES:

SIGNAL PROCESSING: Pre-condition to delete high frequency (200-400 Hz)

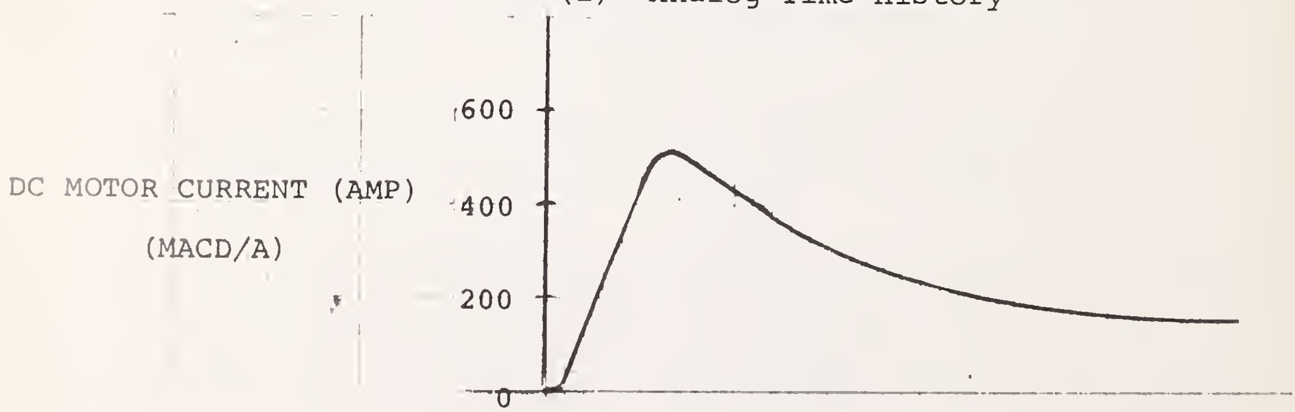
CALIBRATION METHOD: DC current supply and current shunt

CERTIFICATION METHOD: To be determined

DISCUSSION: High frequency response is required if armature current transients due to solid state control equipment are to be measured. Output must be filtered for steady state. Current can be measured with magnetoresitive sensors which sense the flux induced in lines due to current flowing in them or with standard ammeter current shunts.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page MACD/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A MACD/A

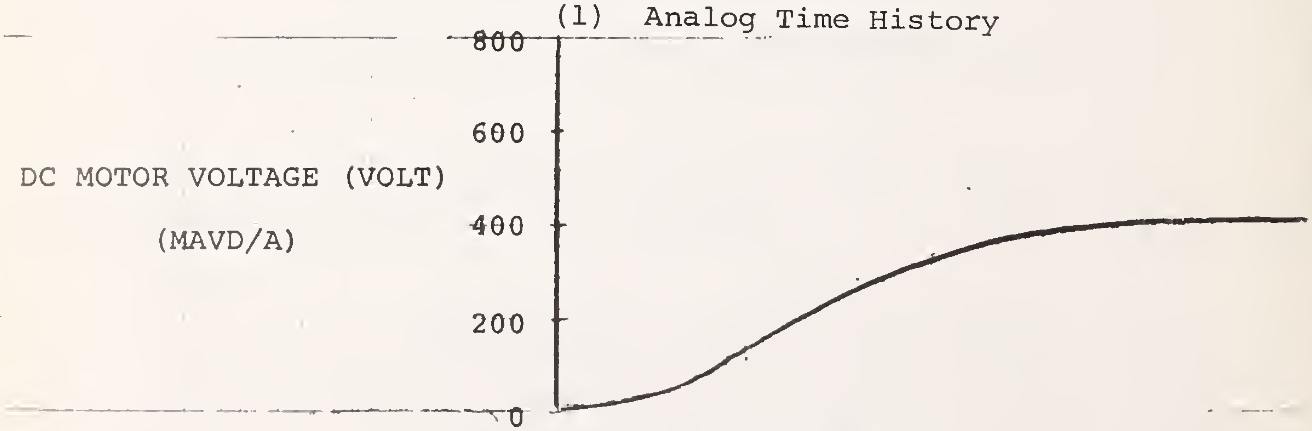
EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLT	LINE AMPS	MOTOR NO.1 VOLTS	MOTOR NO.2 VOLTS	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.0	46.47	-0.736	0.54	652.	579.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.735	0.52	652.	568.	639.6	652.8	206.9	190.3	16.6	16.0
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	203.4	200.4	16.5	15.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.1	15.5

DC MOTOR ARMATURE VOLTAGE (MAVD/A)

RANGE:	0 to 1000 VDC
ACCURACY:	±2.0% full scale
UNITS:	Volts
FREQUENCY RESPONSE:	0 to 400 Hz (as required)
SPECIAL FEATURES:	Display format may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Pre-condition to delete high frequency (200 - 400 Hz)
CALIBRATION METHOD:	High voltage DC power supply and a precision digital voltmeter.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	High frequency response is required if armature voltage transients, due to solid state control equipment, are to be measured. Output must be filtered for steady state data.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page MAVD/A-2) from analog data

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A

MAVD/A

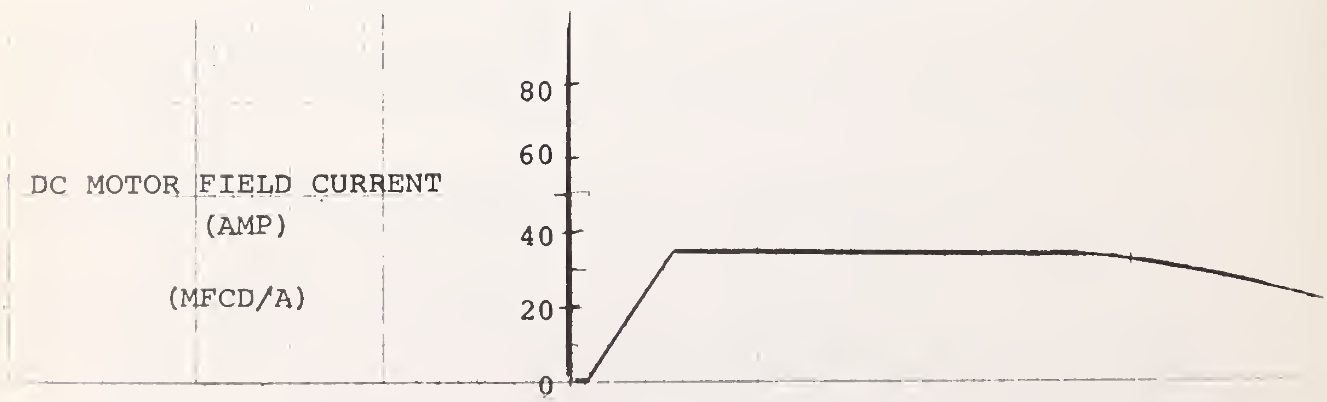
EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLT	LINE AMPS	MOTOR NO.1 VOLTS	MOTOR NO.2 VOLTS	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	455.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	126.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.[illegible]	46.47	-0.736	0.54	652.	5[illegible]9.	632.0	646.1	212.4	198.3	17.0	16.4
	[illegible]	47.3[illegible]	-0.736	0.52	[illegible]52.	56[illegible].	639.6	652.8	206.9	190.3	16.6	16.0
	[illegible]	[illegible]	[illegible]	0.52	[illegible]	[illegible]	[illegible]	653.2	203.4	[illegible]	16.3	15.8
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.1	15.5

DC MOTOR FIELD CURRENT (MFCD/A)

RANGE:	0 to 150 amps
ACCURACY:	±2.0% full scale
UNITS:	Amperes
FREQUENCY RESPONSE:	0 to 400 Hz (as required)
SPECIAL FEATURES:	Display format may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Pre-condition to delete high frequency (200 - 400 Hz)
CALIBRATION METHOD:	DC current supply and current shunt
CERTIFICATION METHOD:	To be determined
DISCUSSION:	High frequency response is required if field current transients, due to solid state control equipment, are to be measured. Output must be filtered for steady state. Current can be measured with magnetoresistive sensors which sense the flux induced in lines due to current flowing in them or with standard ammeter current shunts.

FORMAT:

(1) Analog Time History



(2) Digital time history tabulation (page MFCD/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A MFCD/A

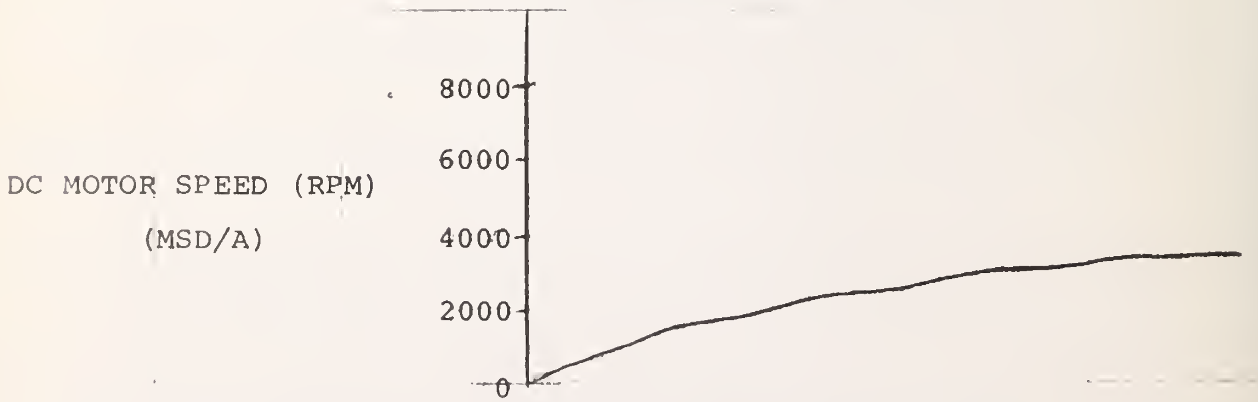
EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLT	LINE AMPS	MOTOR NO.1 VOLTS	MOTOR NO.2 VOLTS	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	36.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.737	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.736	0.52	652.	568.	[illegible]	652.8	206.9	190.3	16.6	16.0
	[illegible]	[illegible]	[illegible]	0.52	652.	540.	[illegible]	[illegible]	203.4	200.4	16.3	15.8
	[illegible]	[illegible]	[illegible]	0.43	647.	510.	[illegible]	[illegible]	203.4	[illegible]	16.1	15.5

DC MOTOR SPEED (MSD/A)

RANGE:	0 to 8000 rpm
ACCURACY:	±1.0% full scale
UNITS:	RPM
FREQUENCY RESPONSE:	0 to 12 Hz (on final output)
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	As applicable to particular installation (tachometer generator or monopole on gear teeth)
CALIBRATION METHOD:	To be determined (monopole)
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None

FORMAT:

(1) Analog Time History



NOISE LEVEL (NL/A)

RANGE:

ACCURACY:

UNITS: All the same as SOUND PRESSURE (SP/A)

FREQUENCY RESPONSE:

SPECIAL FEATURES:

SIGNAL PROCESSING: IEC "A" - weighting

CALIBRATION METHOD: To be determined

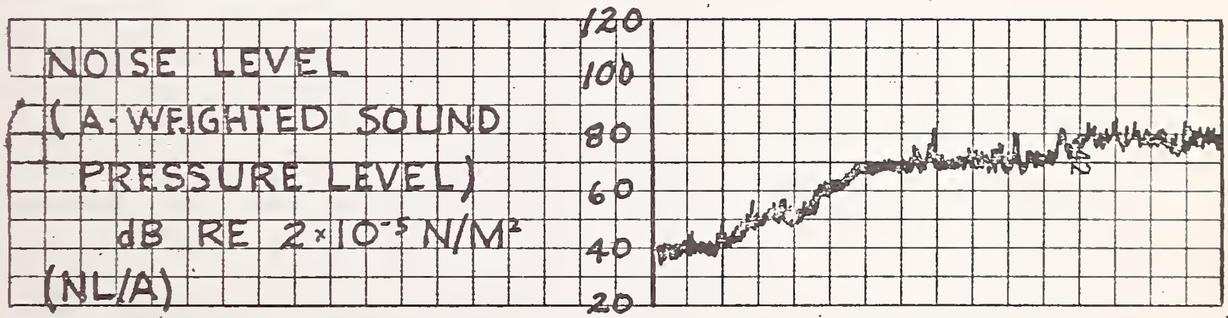
CERTIFICATION METHOD: To be determined

DISCUSSION:

For a wide variety of noise sources, A weighted sound pressure level correlates well with human annoyance.

FORMAT:

(1) Time History Plot



(2) Noise Level Number

A unique noise level number shall be determined by the greater of:

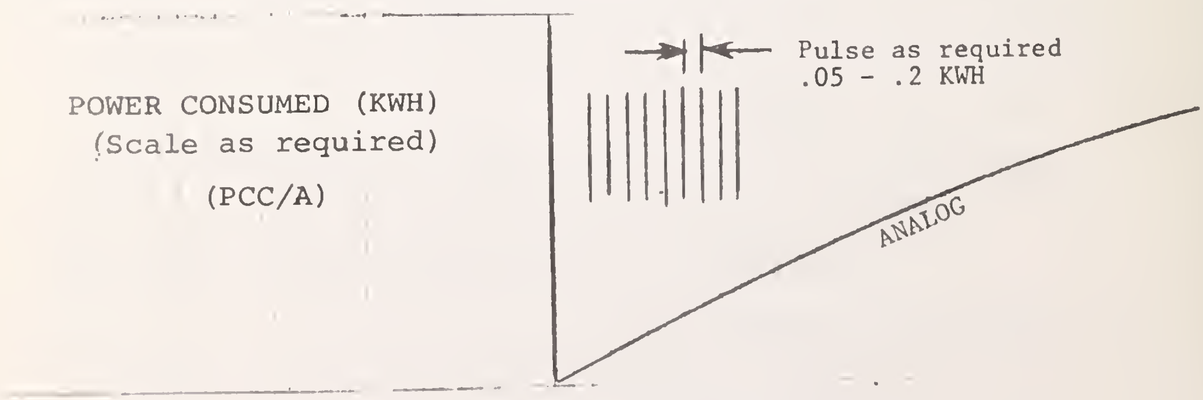
(a) The average of a 15 second record, or
(b) Peak values in a 15 second record less 3 dB.

(3) Frequency Histogram

A time dependent distribution of the Noise Level over the entire test record.

POWER CONSUMED (PCC/A)

RANGE:	As required [(0 to 1000 VDC) x (0 to 2000 amps)] [0 to 2 hours
ACCURACY:	±3% full scale
UNITS:	Kilowatt-Hour (KW-HR)
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	Display format may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	See (LVD/A), (LCD/A) + timed current and volt input
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Power consumed is the cumulative sum of the product of line current (LCD/A) X line voltage (LVD/A) X time during testing on a synthetic transit route. In the Standard Performance Output shown on page PCC/A-2 KW-HR is printed out at a selected digitizing time interval of 5 seconds from analog data.
FORMATS:	(1) Digital pulses on tape and/or to digital counter.



(2) Analog time history.

(3) Digital time history tabulation (page PCC/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

T/A

DIGITAL TIME-HISTORY TABULATION

PCC/A

TIME	EVENT	SPEED	P-WIRE	ACCEL	LINE		KW HR
SEC		MPH	AMPS	MPH/SEC	VOLT	AMPS	VOLTSxAMPxTIME
565	+4.75	-0.18	0.000	0.39	700.	66.	
570		1.50	0.978	-1.54	684.	169.	0.005
575		15.45	0.978	-2.36	599.	993.	0.518
580		28.63	0.977	-1.93	574.	1451.	1.512
585		38.65	0.977	-1.26	577.	1479.	2.682
590		46.61	0.976	-0.97	579.	1486.	3.871
595		49.78	0.609	0.14	735.	175.	4.653
600		49.81	0.587	0.39	717.	104.	4.794
605		49.78	0.004	0.55	709.	84.	4.887
610		38.07	0.001	3.28	704.	61.	4.957
615		27.09	0.398	0.30	703.	68.	5.028
620		15.94	0.001	3.27	700.	66.	5.093
625		1.14	0.001	1.82	698.	84.	5.166
630		-0.12	0.001	0.29	699.	69.	5.239
635		-0.07	0.000	0.26	699.	70.	5.308
640		-0.03	0.001	0.25	699.	69.	5.375
645	+1.25	-0.07	0.973	0.25	699.	73.	5.445

DC MOTOR ARMATURE RMS SUM (RMS-MAC/A)

RANGE:	As required (0-1000 amps) (0 - 2 hours)
ACCURACY:	±3% current^2
UNITS:	Ampere^2-seconds
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Pre-condition MACD/A to delete high frequency (200-400 Hz)
CALIBRATION METHOD:	See (MACD/A) + timed current input.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	RMS-MAC/A is the cumulative sum of $I^2 \Delta t$ where I^2 is the Real-Time DC motor armature current (MACD/A) squared.

In the Standard Performance Outputs shown on page RMS-MAC/A-2, $I^2\ \Delta t$ is printed out at a selected digitizing time interval of 2 seconds from analog data.

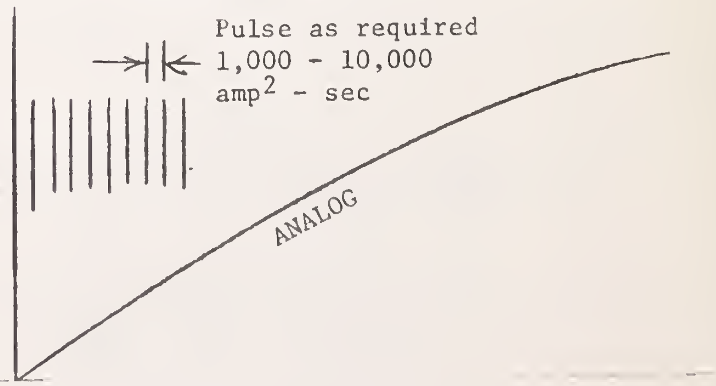
FORMAT:

(1) Digital pulses on tape and/or to digital counter.

DC MOTOR ARMATURE RMS SUM

AMP^2 - SEC (scale as reqd.)

(RMS-MAC/A)



(2) Analog time history

(3) Standard Performance Digital Output from analog data (page RMS-MAC/A-2)

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A

RMS-MAC/A

EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	$\Sigma I^2 \times \Delta t$ X10^6 amp^2-sec ARMATURE NO.1 AMPS	$\Sigma I^2 \times \Delta t$ X10^6 amp^2-sec ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS	$\Sigma I^2 \times \Delta t$ X10^3 amp^2-sec FIELD NO.1 AMPS	$\Sigma I^2 \times \Delta t$ X10^3 amp^2-sec FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	11.1	-15.9			0.8	0.8		
	2.0	-0.41	-0.007	0.04	11.7	-15.9			0.8	0.8		
	4.0	-0.39	-0.589	0.08	12.1	-15.7			0.9	1.0		
*	6.0	0.01	-0.734	0.69	513.1	456.8	0.0	0.0	17.9	16.4	0	0
	8.0	2.59	-0.735	1.46	383.2	340.6	0.4014	0.3168	36.1	35.8	1.458	1.352
	10.0	5.40	-0.736	1.46	385.1	327.7	0.6963	0.5386	36.4	35.6	4.093	3.901
	12.0	8.21	-0.736	1.42	374.8	324.2	0.9912	0.7514	36.5	35.4	6.757	6.421
	14.0	11.00	-0.737	1.40	362.9	324.0	1.2620	0.9611	36.5	35.3	9.422	8.928
	16.0	13.79	-0.736	1.36	350.7	323.4	1.5169	1.1710	36.5	35.3	12.086	11.420
	18.0	16.51	-0.737	1.32	340.9	317.4	1.7550	1.3758	36.5	35.5	14.751	13.912
	20.0	19.16	-0.737	1.31	335.8	304.4	1.9835	1.5680	36.5	35.2	17.416	16.404
	22.0	21.74	-0.738	1.31	331.8	291.0	2.2053	1.7445	36.5	35.1	20.080	18.882
	24.0	24.34	-0.738	1.28	319.9	291.8	2.4178	1.9128	36.5	35.1	22.745	21.346
	26.0	26.84	-0.738	1.31	306.9	295.9	2.6137	2.0867	36.4	35.1	25.409	23.810
	28.0	29.32	-0.739	1.23	293.9	276.9	2.7938	2.2503	36.3	35.0	28.059	26.274
*	30.0	31.46	-0.737	1.11	272.0	241.8	2.9597	2.3844	35.9	34.7	30.665	28.697
	32.0	33.41	-0.737	0.96	253.8	221.4			30.5	29.6		
	34.0	35.12	-0.736	0.85	241.0	222.7			26.9	26.0		
	36.0	36.75	-0.737	0.81	237.7	220.8			24.3	23.5		
	38.0	38.20	-0.737	0.77	236.8	220.6			22.4	21.7		
	40.0	39.66	-0.737	0.69	226.8	224.7			21.1	20.3		
	42.0	40.99	-0.737	0.70	222.0	227.0			20.0	19.3		
	44.0	42.22	-0.737	0.60	220.3	218.3			19.2	18.5		
	46.0	43.37	-0.737	0.70	213.6	214.6			18.6	17.9		
	48.0	44.47	-0.736	0.64	218.9	198.6			18.0	17.3		
	50.0	45.54	-0.737	0.52	220.5	194.0			17.4	16.9		
	52.0	46.47	-0.736	0.54	212.4	198.3			17.0	16.4		
	54.0	47.38	-0.736	0.52	206.9	190.3			16.6	16.0		
	56.0	48.24	-0.736	0.52	203.4	200.4			14.3	15.8		
	58.0	48.94	-0.737	0.43	203.4	192.1			16.1	15.5		

DC MOTOR FIELD RMS SUM (RMS-MFC/A)

RANGE: As required (0 - 150 amps)
(0-2 hours)

ACCURACY: $\pm 3\%$ current^2

UNITS: Ampere^2 - seconds

FREQUENCY RESPONSE: Not applicable

SPECIAL FEATURES: Display format may be full or partial scale (offset from zero)

SIGNAL PROCESSING: Precondition MFCD/A to delete high frequency (200 - 400 Hz)

CALIBRATION METHOD: See (MFCD/A) + timed current input

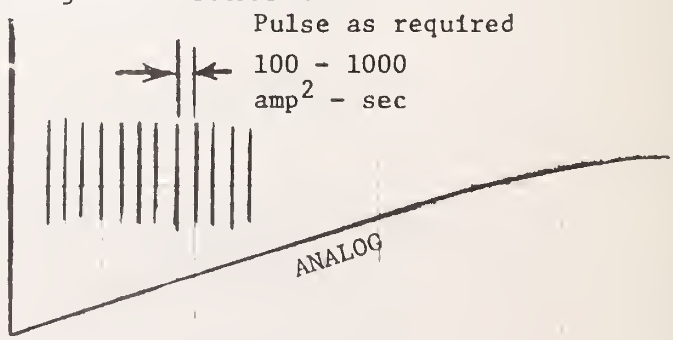
CERTIFICATION METHOD: To be determined

DISCUSSION: RMS-MFC/A is the cumulative sum of $I^2\Delta t$ where I^2 is the Real-Time DC motor field current (MFCD/A) squared.

In the Standard Performance Output shown on page RMS-MFC/A-2, $I^2\Delta t$ is printed out at a selected digitizing time interval of 2 seconds from analog data.

FORMATS: (1) Digital pulses on tape and/or to digital counter.

DC MOTOR FIELD RMS SUM
AMP^2 - SEC
(Scale as required)
(RMS-MFC/A)



(2) Analog time history.

(3) Digital time history tabulation (RMS-MFC/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

T/A

DIGITAL TIME-HISTORY TABULATION

RMS-MFC/A

EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	$\Sigma I^2 \times \Delta t$ $\times 10^6$ amp²-sec ARMATURE NO.1 AMPS	$\Sigma I^2 \times \Delta t$ $\times 10^6$ amp²-sec ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS	$\Sigma I^2 \times \Delta t$ $\times 10^3$ amp²-sec FIELD NO.1 AMPS	$\Sigma I^2 \times \Delta t$ $\times 10^3$ amp²-sec FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	11.1	-15.9			0.8	0.8		
	2.0	-0.41	-0.007	0.04	11.7	-15.9			0.8	0.8		
	4.0	-0.39	-0.589	0.08	12.1	-15.7			0.9	1.0		
*	6.0	0.01	-0.734	0.69	513.1	456.8	0.0	0.0	17.9	16.4	0	0
	8.0	2.59	-0.735	1.46	383.2	340.6	0.4014	0.3168	36.1	35.8	1.458	1.352
	10.0	5.40	-0.736	1.46	385.1	327.7	0.6963	0.5386	36.4	35.6	4.093	3.901
	12.0	8.21	-0.736	1.42	374.8	324.2	0.9912	0.7514	36.5	35.4	6.757	6.421
	14.0	11.00	-0.737	1.40	362.9	324.0	1.2620	0.9611	36.5	35.3	9.422	8.928
	16.0	13.79	-0.736	1.36	350.7	323.4	1.5169	1.1710	36.5	35.3	12.086	11.420
	18.0	16.51	-0.737	1.32	340.9	317.4	1.7550	1.3758	36.5	35.3	14.751	13.912
	20.0	19.16	-0.737	1.31	335.8	304.4	1.9835	1.5680	36.5	35.2	17.416	16.404
	22.0	21.74	-0.738	1.31	331.8	291.0	2.2053	1.7445	36.5	35.1	20.080	18.882
	24.0	24.34	-0.738	1.28	319.9	291.8	2.4178	1.9128	36.5	35.1	22.745	21.346
	26.0	26.84	-0.738	1.31	306.9	295.9	2.6137	2.0867	36.4	35.1	25.409	23.810
	28.0	29.32	-0.739	1.23	293.9	276.9	2.7938	2.2503	36.3	35.0	28.059	26.274
*	30.0	31.46	-0.737	1.11	272.0	241.8	2.9597	2.3844	35.9	34.7	30.665	28.697
	32.0	33.41	-0.737	0.96	253.8	221.4			30.5	29.6		
	34.0	35.12	-0.736	0.85	241.0	222.7			26.9	26.0		
	36.0	36.75	-0.737	0.81	237.7	220.8			24.3	23.5		
	38.0	38.20	-0.737	0.77	236.8	220.6			22.4	21.7		
	40.0	39.66	-0.737	0.69	226.8	224.7			21.1	20.3		
	42.0	40.99	-0.737	0.70	222.0	227.0			20.0	19.3		
	44.0	42.23	-0.737	0.60	220.3	218.3			19.2	18.5		
	46.0	43.37	-0.737	0.70	213.6	214.6			18.6	17.9		
	48.0	44.47	-0.736	0.64	218.9	198.6			18.0	17.3		
	50.0	45.54	-0.737	0.52	220.5	194.0			17.4	16.8		
	52.0	46.47	-0.736	0.54	212.4	198.5			17.0	16.4		
	54.0	47.39	-0.736	0.52	206.9	190.3			16.6	16.0		
	56.0	48.24	-0.736	0.52	203.4	200.4			14.3	15.6		
	58.0	48.94	-0.737	0.43	203.4	192.1			16.1	15.5		

RIDE ROUGHNESS - HORIZONTAL (RRH/A)

STANDARD OUTPUTS REQUIRED:

TIME HISTORY

AC/A ACCELERATION, CAR BODY - HORIZONTAL

DISCUSSION:

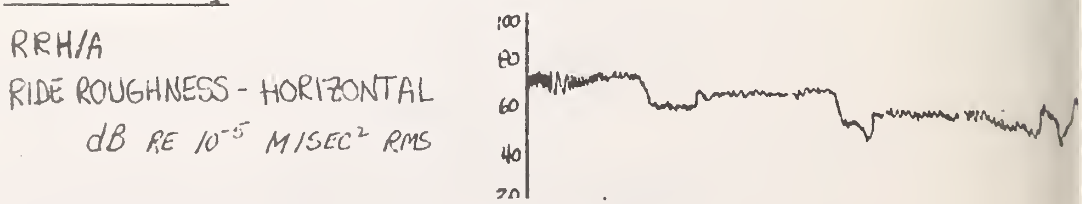
The purpose of this parameter is to provide a "figure-of-merit to indicate the roughness of the ride experience by a typical passenger on a moving transit vehicle. The basic standards set forth in Reference 10 provide a well defined, internationally accepted method for measuring human exposure to vibration in the 1 to 80 Hz range. The Ride Roughness - Horizontal "figure-of-merit" is obtained by applying the Car body Acceleration (AC/A) through a weighting network (in the same manner as Sound Pressure Level (SPL/A) is converted to Noise Level (NL/A)). This weighting network is defined by the standards found in Reference 10 and it's characteristics are shown below.

Note (1) Weighting Networks for Horizontal and Vertical Ride Roughness are not the same due to different sensitivities of human exposure in those axes.

Note (2) This "figure-of-merit" does not account for motion sickness (0.1 to 1.0 Hz) or the effects of high frequency vibrations (80 Hz).

FORMAT:

(1) Time History

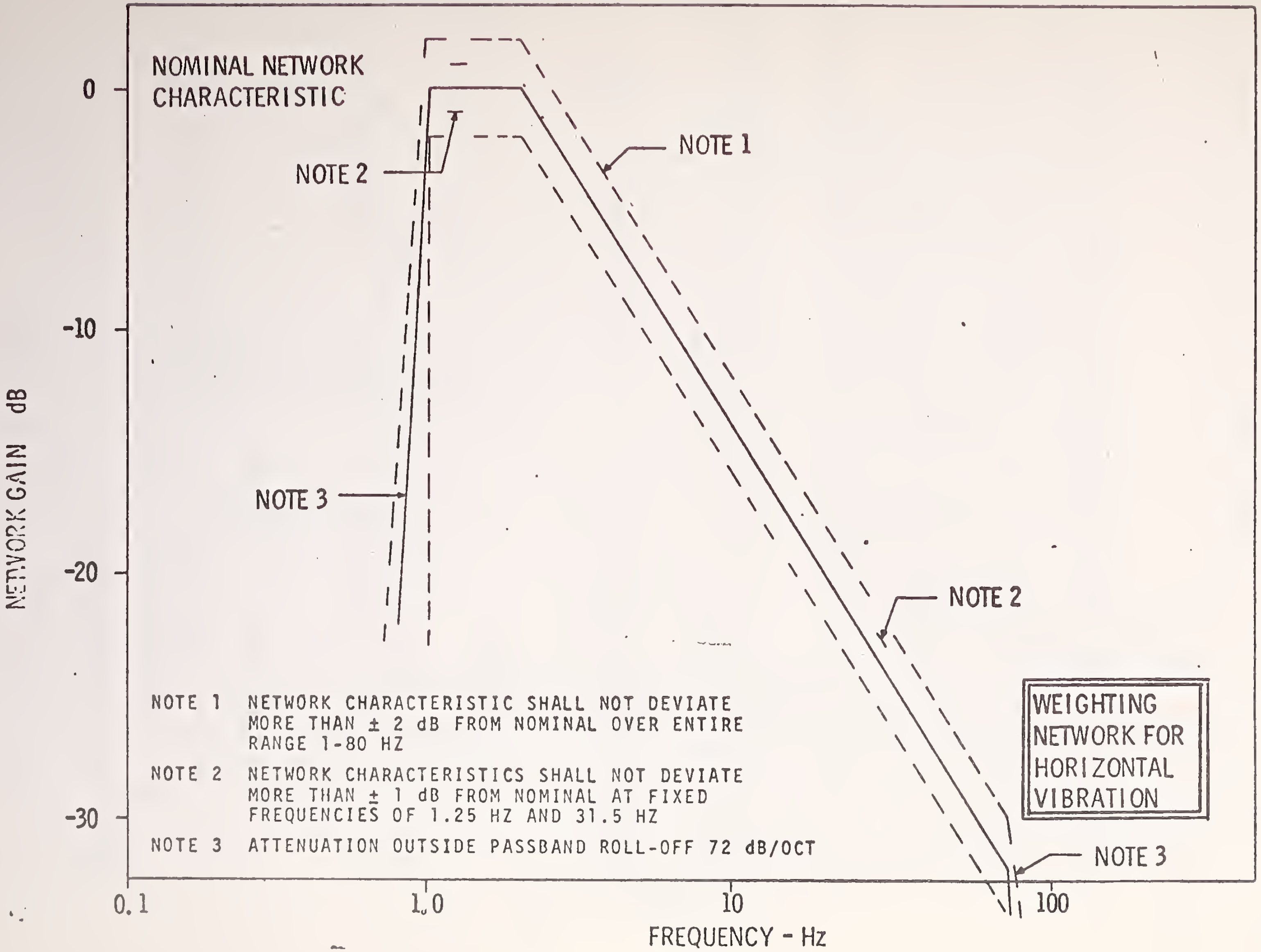


(2) Ride Roughness - Horizontal Number

A unique Ride Roughness Number is determined by obtaining the RMS average of the Time History Format for a selected time interval.

(3) Frequency Histogram

A time dependent distribution of Ride Roughness levels over the entire test record.


NOMINAL NETWORK CHARACTERISTIC
NOTE 1
NOTE 2
NOTE 3
NOTE 2
NOTE 3
WEIGHTING NETWORK FOR HORIZONTAL VIBRATION
NOTE 1 NETWORK CHARACTERISTIC SHALL NOT DEVIATE MORE THAN ± 2 dB FROM NOMINAL OVER ENTIRE RANGE 1-80 HZ
NOTE 2 NETWORK CHARACTERISTICS SHALL NOT DEVIATE MORE THAN ± 1 dB FROM NOMINAL AT FIXED FREQUENCIES OF 1.25 HZ AND 31.5 HZ
NOTE 3 ATTENUATION OUTSIDE PASSBAND ROLL-OFF 72 dB/OCT
0
-10
-20
-30
NETWORK GAIN dB
0.1
1.0
10
100
FREQUENCY - Hz

<u>RIDE ROUGHNESS - VERTICAL</u> (RRV/A)

STANDARD OUTPUTS REQUIRED:

TIME HISTORY

AC/A ACCELERATION, CAR BODY - VERTICAL

DISCUSSION:

The purpose of this parameter is to provide a "figure-of-merit" to indicate the roughness of the ride experienced by a typical passenger on a moving transit vehicle. The basic standards set forth in Reference 10 provide a well defined, internationally accepted method for measuring human exposure to vibration in the 1 to 80 Hz range. The Ride Roughness - Vertical "figure-of-merit" is obtained by applying the Car body Acceleration (AC/A) through a weighting network (in the same manner as Sound Pressure Level (SPL/A) is converted to Noise Level (NL/A)). This weighting network is defined by the standards found in Reference 10 and it's characteristics are shown below.

<u>Note (1)</u> Weighting Networks for Vertical and Horizontal Ride Roughness are not the same due to different sensitivities of human exposure in those axes.

<u>Note (2)</u> This "figure-of-merit" does not account for motion sickness (0.1 to 1.0 Hz) or the effects of high frequency vibrations (80 Hz).

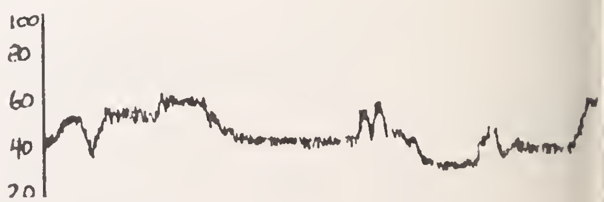
FORMAT:

(1) <u>Time History</u>

RRV/A

RIDE ROUGHNESS - VERTICAL

dB RE 10^{-6} M/SEC^2 RMS

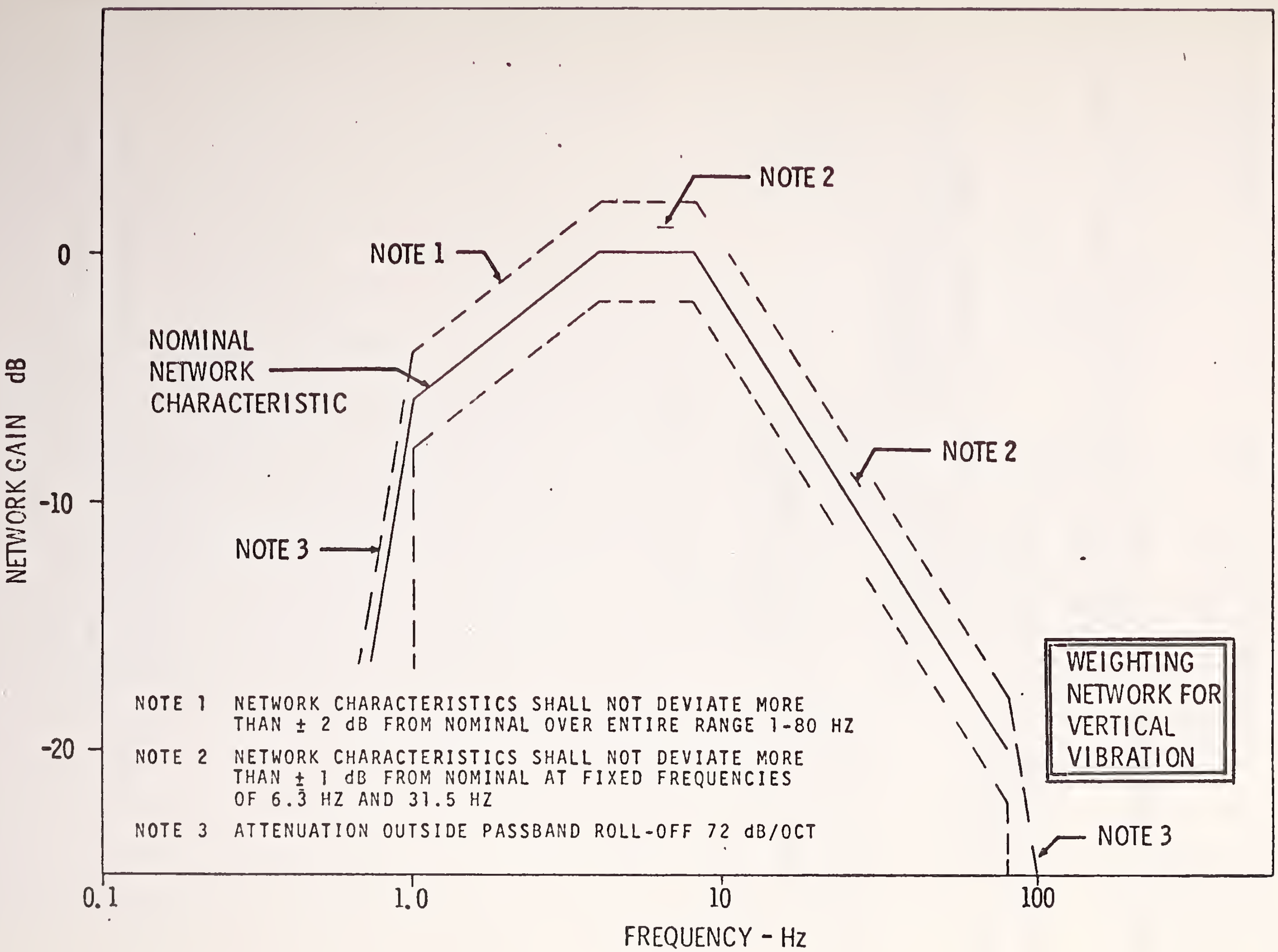


(2) <u>Ride Roughness - Vertical Number</u>

A unique Ride Roughness Number is determined by obtaining the RMS average of the time History Format for a selected time interval.

(3) <u>Frequency Histogram</u>

A time dependent distribution of Ride Rougness levels over the entire test record.


NOTE 2
NOTE 1
NOMINAL NETWORK CHARACTERISTIC
NOTE 2
NOTE 3
WEIGHTING NETWORK FOR VERTICAL VIBRATION
NOTE 3
NETWORK GAIN dB
0
-10
-20
0.1
1.0
10
100
FREQUENCY - Hz
NOTE 1 NETWORK CHARACTERISTICS SHALL NOT DEVIATE MORE THAN ± 2 dB FROM NOMINAL OVER ENTIRE RANGE 1-80 HZ
NOTE 2 NETWORK CHARACTERISTICS SHALL NOT DEVIATE MORE THAN ± 1 dB FROM NOMINAL AT FIXED FREQUENCIES OF 6.3 HZ AND 31.5 HZ
NOTE 3 ATTENUATION OUTSIDE PASSBAND ROLL-OFF 72 dB/OCT

SOUND NARROW BAND ANALYSIS (SNB/A)

RANGE: ACCURACY: UNITS:	Same as Sound Octave Band Analysis (SOB/A)
FREQUENCY RESPONSE:	Continuously tunable or discretely tunable filters spanning the frequency response given in SP/A.
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	Filters - user may select from the following: six percent (percentage bandwidth), 0.5 Hz (constant bandwidth), 5 Hz (constant bandwidth).
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	Similar to ANB/A

SOUND OCTAVE BAND ANALYSIS (SOB/A)

RANGE:	60 dB
ACCURACY:	See IEC 225 1966
UNITS:	dB re 2 x 10^{-5} N/m^2
FREQUENCY RESPONSE:	Same as for Sound Pressure (SP/A)
SPECIAL FEATURES:	Not applicable
SIGNAL PROCESSING:	IEC Standard Octave band filters, rms averaging, log conversion.
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	Similar to S3B/A, Sound Third Octave Band Analysis.

SOUND PRESSURE (SP/A)

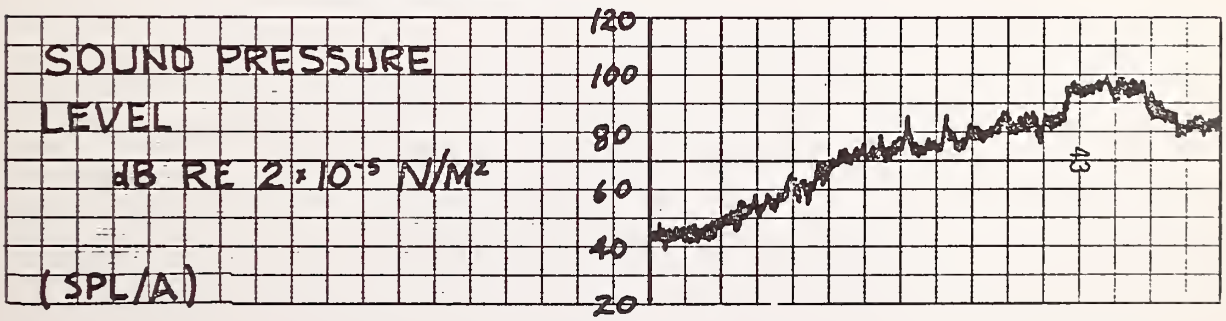
RANGE:	40 dB to 120 dB re 2×10^{-5} N/m^2
ACCURACY:	± 1.0 dB
SIGNAL-TO-NOISE RATIO:	Less than 50 dB
HARMONIC DISTORTION:	Microphone less than 1% System less than 4%
UNITS:	N/m^2
FREQUENCY RESPONSE:	50 to 10,000 Hz
SPECIAL FEATURES:	None
SIGNAL PROCESSING:	None
CALIBRATION METHOD:	The complete measurement system and recording system will be subjected to a frequency amplitude electrical calibration by the use of a swept frequency sinusoidal insert voltage, over the range of 20 Hz to 20 KHz, at known levels covering the expected measurement dynamic range.
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None
FORMAT:	Output format is a magnetic tape recorded signal which can be used to reproduce the original sound (using headphones or speaker) or processed to yield other Standard Outputs.

SOUND PRESSURE LEVEL (SPL/A)

RANGE:	40 dB to 120 dB re 2 x 10 $^{-5}$ N/m^2
ACCURACY:	$\pm$ 1 dB
UNITS:	dB re 2 x 10 $^{-5}$ N/m^2
FREQUENCY RESPONSE:	Same as for SP/A
SPECIAL FEATURES:	IEC "Fast" and "Slow" averaging times
SIGNAL PROCESSING:	rms averaging, log conversion
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISUCSSION:	None

FORMAT:

(1) Time History Plot



STRUCTURAL TESTING PARAMETER (STP/A)

DISCUSSION: Until this test category becomes more defined, Standard Outputs will have to be developed for each test vehicle. As an example, the SOAC test program used: AC Coupled Strain Gages for Truck Strains, DC Couple Strain Gages for Damper Rod Loads, and Potentiometers for displacements.

There measurement techniques are still being investigated. In addition the output formats are still being developed, and no recommended format can be presented at this time.

However, the value of this category of testing should not be overlooked. Although much is known about static loading of transit vehicle trucks, no data is available on truck frame loads during operation and each manufacturer has it's own design criterion.

SOUND - THIRD OCTAVE BAND ANALYSIS (S3B/A)

Range:

ACCURACY:

UNITS:

FREQUENCY RESPONSE:

SPECIAL FEATURES:

} Same as Sound Octave Band Analysis (SOB/A)

SIGNAL PROCESSING: IEC Standard 1/3 - Octave Band Filters, rms averaging, log conversion. The first filter will be centered at geometric mean frequency of 25 Hz and the last at 10K Hz.

CALIBRATION METHOD: To be determined

CERTIFICATION METHOD: To be determined

DISCUSSION: None

FORMAT:

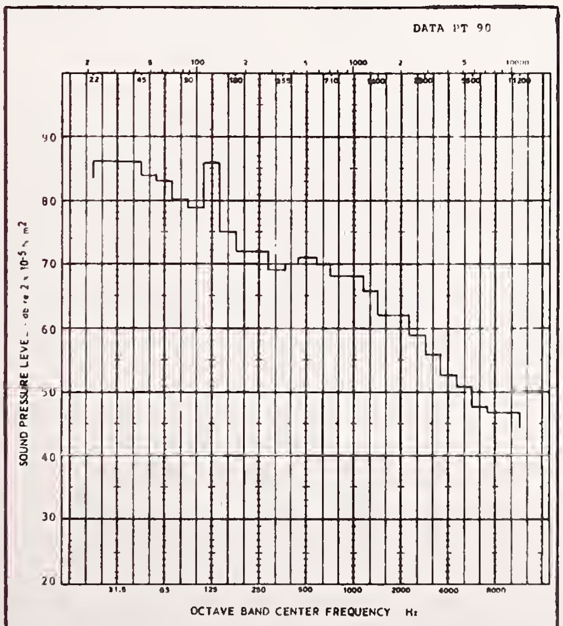
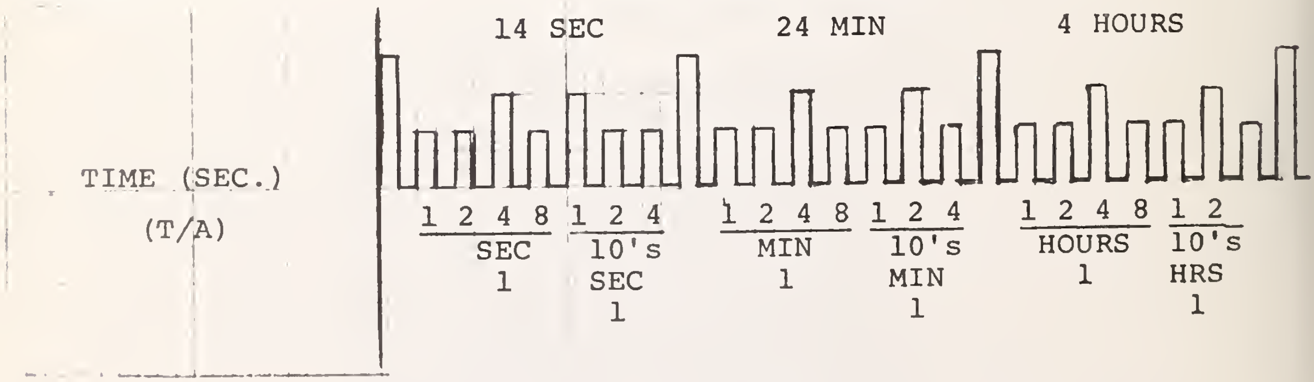


FIGURE INTERIOR NOISE, POS 55, CAR 1, V=80 mph, ALL SYSTEMS ON STEEL WHEEL, FLATS

TIME (T/A)

RANGE:	0 to 24 hrs.
ACCURACY:	0.01 sec. or 0.01%, whichever is greater.
UNITS:	Seconds, minutes, hours
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	May be reset to zero or any other value within range.
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	Digital time code provides both accurate time within a test record and a sequence code for time of day determination to provide automatic location of data records on tape.
FORMATS:	(1) Time Code (digital).



(2) Digital time history tabulation (page T/A-2).

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A

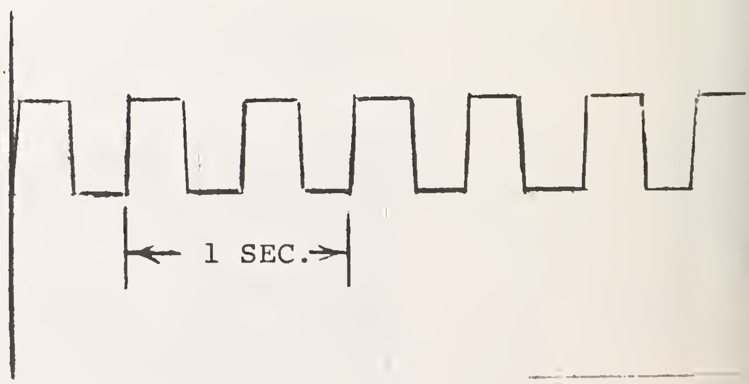
TIME	EVENT SECS	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLTS	LINE AMPS	ANALOG VALVE AMPS	BRAKE PRESSURE PSI
0.		34.08	0.073	0.52	669.	334.	0.00	-0.2
1.	+.5	33.87	0.017	0.04	710.	62.	0.00	-0.0
2.		33.32	0.018	-0.70	699.	66.	0.00	13.7
3.		31.35	0.017	-2.78	700.	59.	0.00	56.3
4.		27.90	0.017	-2.63	694.	72.	0.00	40.5
5.		24.84	0.016	-3.05	693.	63.	0.00	51.7
6.		21.35	0.016	-3.15	696.	55.	0.00	61.9
7.		18.01	0.015	-3.01	698.	60.	0.00	64.1
8.		14.44	0.017	-3.04	697.	63.	0.00	58.7
9.		11.00	0.014	-3.33	699.	61.	0.00	48.0
10.		7.10	0.015	-3.64	696.	60.	0.00	-10.6
11.		2.97	0.014	-4.27	698.	65.	0.00	47.9
12.	+.0	0.69	0.016	0.29	696.	61.	0.00	-22.3
13.		0.74	0.018	0.28	698.	65.	0.00	6.5
14.		0.72	0.002	0.39	697.	63.	0.00	24.0

TIME (T/B)

RANGE:	Continuous operation
ACCURACY:	0.01 sec. or 0.01%, whichever is greater.
UNITS:	Seconds; .1 sec.
FREQUENCY RESPONSE:	1 to 10 Hz oscillator
SPECIAL FEATURES:	Digital continuous timer on tape or paper edge track.
SIGNAL PROCESSING:	
CALIBRATION METHOD:	
CERTIFICATION METHOD:	
DISCUSSION:	Provides accurate time base within test records (same precision as T/A), however no time code (time of day) is provided.
FORMAT:	(1) Digital timer shown on analog stripout.

TIME (SEC.)

(T/B)



VEHICLE SPEED (VS/A)

RANGE:	0 to 100 mph
ACCURACY:	$\pm 3\%$ full scale; precision 3 parts in 10^4
UNITS:	MPH
FREQUENCY RESPONSE:	0 to 12 Hz
SPECIAL FEATURES:	Display format may be selected by operator to full scale or partial scale (offset zero)
SIGNAL PROCESSING:	Filter; flat
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined

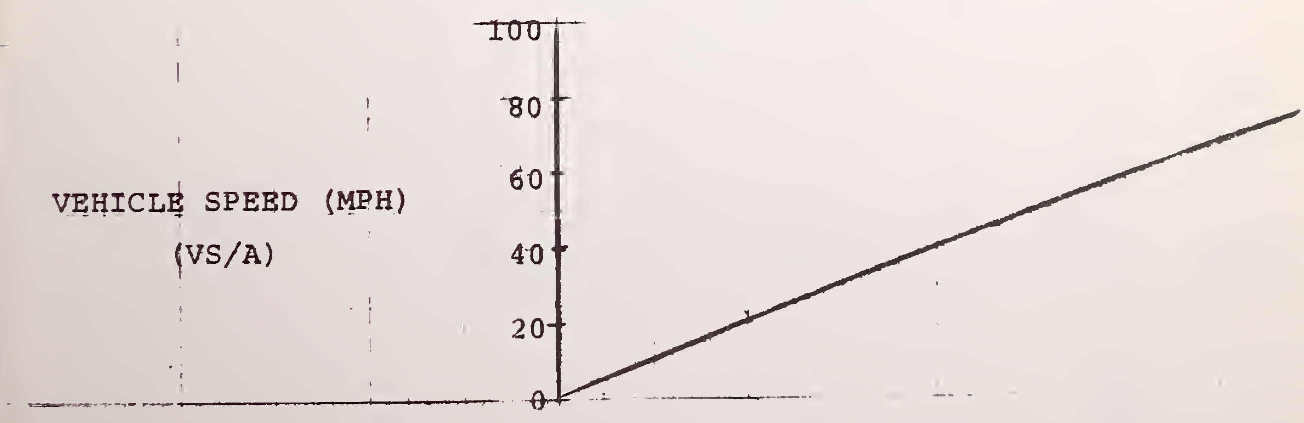
DISCUSSION:

This output is taken from the axle of the railcar. It serves two distinct purposes: First, the accuracy requirement on VS/A while not severe, is adequate in many tests. VS/A is thus used as a measure of the vehicle speed.

The error between the true railcar velocity and VS/A is due primarily to wheel slip and data processing truncation error. The slip is itself an important piece of data in adhesion and creep measurements. For adhesion measurements, two axle speeds are measured in order to determine when braking on one axle causes gross sliding at the wheel/rail interface. For creep, the axle-indicated velocity is compared with a more accurate (but equally precise) measure of velocity to determine the creep coefficient (see also CL/A). It is this last requirement that sets the precision limits on this measurement.

FORMATS:

(1) Anlog time history.



(2) Digital time history tabulation (page VS/A-2) from analog data.

STANDARD PERFORMANCE OUTPUT

DIGITAL TIME-HISTORY TABULATION

T/A VS/A

EVENT	TIME SEC	SPEED MPH	P-WIRE AMPS	ACCEL MPH/SEC	LINE VOLT	LINE AMPS	MOTOR NO.1 VOLTS	MOTOR NO.2 VOLTS	ARMATURE NO.1 AMPS	ARMATURE NO.2 AMPS	FIELD NO.1 AMPS	FIELD NO.2 AMPS
	0.0	-0.49	-0.007	0.08	683.	44.	-10.2	-3.4	11.1	-15.9	0.8	0.8
	2.0	-0.41	-0.007	0.04	683.	46.	-9.6	-3.0	11.7	-15.9	0.8	0.8
	4.0	-0.39	-0.589	0.08	682.	48.	-9.6	-2.6	12.1	-15.7	0.9	1.0
	6.0	0.01	-0.734	0.69	677.	92.	12.5	19.8	513.1	456.8	17.9	16.4
	8.0	2.59	-0.735	1.46	672.	153.	65.1	73.6	383.2	340.6	36.1	35.8
	10.0	5.40	-0.736	1.46	666.	222.	119.5	128.6	385.1	327.7	36.4	35.6
	12.0	8.21	-0.736	1.42	662.	290.	174.6	184.6	374.8	324.2	36.5	35.4
	14.0	11.00	-0.737	1.40	658.	356.	228.6	240.0	362.9	324.0	36.5	35.3
	16.0	13.79	-0.736	1.36	656.	419.	282.7	294.0	350.7	323.4	36.5	35.3
	18.0	16.51	-0.737	1.32	654.	477.	335.7	348.5	340.9	317.4	36.5	35.3
	20.0	19.16	-0.737	1.31	651.	538.	387.6	399.8	335.8	304.4	36.5	35.2
	22.0	21.74	-0.738	1.31	647.	597.	438.9	451.6	331.8	291.0	36.5	35.1
	24.0	24.34	-0.738	1.28	645.	654.	488.4	501.2	319.9	291.8	36.5	35.1
	26.0	26.84	-0.738	1.31	645.	697.	537.1	550.8	306.9	295.9	36.4	35.1
	28.0	29.32	-0.739	1.23	643.	734.	583.9	598.3	293.9	276.9	35.3	35.0
	30.0	31.46	-0.737	1.11	643.	732.	624.0	639.4	272.0	241.8	35.9	34.7
	32.0	33.41	-0.737	0.96	646.	663.	629.5	644.6	253.8	221.4	30.5	29.6
	34.0	35.12	-0.736	0.85	649.	638.	630.9	645.0	241.0	222.7	26.9	26.0
	36.0	36.75	-0.737	0.81	649.	629.	631.8	645.9	237.7	220.8	24.3	23.5
	38.0	38.20	-0.737	0.77	647.	630.	631.6	646.3	236.8	220.6	22.4	21.7
	40.0	39.66	-0.737	0.69	648.	616.	632.2	646.3	226.8	224.7	21.1	20.3
	42.0	40.99	-0.737	0.70	646.	593.	628.8	643.1	222.0	227.0	20.0	19.3
	44.0	42.23	-0.737	0.60	650.	594.	630.9	644.0	220.3	218.3	19.2	18.5
	46.0	43.37	-0.727	0.70	652.	584.	635.6	649.0	213.6	214.6	18.6	17.9
	48.0	44.47	-0.736	0.64	650.	597.	638.5	652.4	218.9	198.6	18.0	17.3
	50.0	45.54	-0.737	0.52	651.	589.	637.2	652.2	220.5	194.0	17.4	16.8
	52.0	46.47	-0.736	0.54	652.	539.	632.0	646.1	212.4	198.3	17.0	16.4
	54.0	47.38	-0.736	0.52	652.	568.	639.6	652.8	206.9	190.3	16.6	16.0
	56.0	48.24	-0.736	0.52	652.	560.	637.9	653.2	203.4	200.4	16.3	15.8
	58.0	48.96	-0.737	0.43	657.	510.	638.7	651.5	203.4	182.1	16.1	15.5

VEHICLE SPEED (VS/B)

RANGE:	0 to 100 mph
ACCURACY:	0.03%
UNITS:	MPH
FREQUENCY RESPONSE:	0 to 12 Hz
SPECIAL FEATURES:	Display may be full or partial scale (offset from zero)
SIGNAL PROCESSING:	Filter; flat
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined

DISCUSSION:

This output is taken from speed measuring equipment, that is separate from basic equipment such as a modified automotive fifth wheel installation. The true vehicle speed will be measured independent of any car wheel slip or speedometer calibration methods.

The installation of the speed reference equipment shall be designed to preclude any dynamic instabilities between the rail and speed measuring device. The precision limits of the speed reference (VS/B) shall be consistent with VS/A in order to determine the creep coefficients (CL/A).

In addition, this precision speed reference (VS/B) may be used as the basis for analog distance data (D/B).

FORMATS:

(1) Analog time history, similar to VS/A (page VS/A-1).

(2) Digital time history tabulation, similar to VS/A (page VS/A-2).

VEHICLE WEIGHT (VW/A)

RANGE:	0 to 150,000 lbs.
ACCURACY:	±0.01%
UNITS:	Lb.
FREQUENCY RESPONSE:	Not applicable
SPECIAL FEATURES:	Measurements may be made on either side separately and on each truck separately.
SIGNAL PROCESSING:	Not applicable
CALIBRATION METHOD:	To be determined
CERTIFICATION METHOD:	To be determined
DISCUSSION:	None.

FORMAT:

RIGHT SIDE WEIGHT ____________	No. 1 TRUCK ____________
LEFT SIDE WEIGHT ____________	No. 2 TRUCK ____________
	No. 3 TRUCK ____________
TOTAL VEHICLE WEIGHT ____________________	

APPENDIX C

PRELIMINARY ANALYSES

PRELIMINARY ANALYSIS CODES

CA/A	Coefficient of adhesion (also CAS/A) plotted vs car speed or longitudinal creep.
PCCM/A	Power consumption per car mile
RMS-Current	RMS current values for armature or field (Based on total trip or route times)
TR/A	Traction (Train) Resistance Force
AMS/A	Vehicle Mode Shapes

Cross Plots Which Provide a Summary of Baseline Tests

Traction Resistance Summary

Acceleration Summary

1. Control Characteristics
2. Load Weight Compensation
3. Off Nominal Track Voltage

Deceleration Summary

1. Control Characteristics
2. Load Weight Compensation
3. Off Nominal Track Voltage

Friction Brake Duty Cycle Summary

Spin/Slide Summary

Ride Quality and Gross Weight Summary

Interior Noise and Speed Summary

COEFFICIENT OF ADHESION (CA/A)

STANDARD OUTPUTS REQUIRED:

TIME HISTORY

AP/A	Longitudinal deceleration
VS/A	Vehicle speed

DISCUSSION:

For deceleration tests the maximum coefficient of Adhesion is:

$$A = \frac{2F_f}{W};$$

Where $F_f = F - TR$, The friction force

$$F = \left[\frac{W}{g} + \frac{ew}{g}\right] a,$$ The total retarding force

W is the test vehicle weight, ew is the equivalent weight of rotating parts, g is the acceleration due to gravity, a is the longitudinal deceleration, and TR is the train resistance. The calculation Format for Adhesion is presented on page CA/A-2 with a sample calculation utilizing test data obtained during the SOAC Engineering Tests.

The Format for presenting adhesion is vs. train speed as shown on page CA/A-3 for SOAC test data.

A blank sheet for the calculation of the coefficient of adhesion is included as page CA/A-4.

ADHESION CALCULATION
SAMPLE CALCULATION SOAC

CAR WEIGHT: 90,000 LB.
WETTED RAILS

RUN NO. 100

RECORD NO.	TIME SEC	DECEL. a MPHS	TRAIN SPEED V MPH	RETARDING FORCE (= 4454.2) (1) LB	TRAIN RESISTANCE TR (2) LB	FRICTION FORCE F_f (F-TR) LB	COEFFICIENT OF ADHESION A $= \frac{2F_f}{W}$
300	14.25	.96	51	4276	943	3333	.074
255	19.5	1.01	28	4499	520	3979	.0884

NOTES:

(1) $F = \left[\frac{W}{g} + \frac{ew}{g}\right] a$

$= \frac{90,000 + 7774}{32.2} \times 1.467\ a$

$= 4454.4\ a$

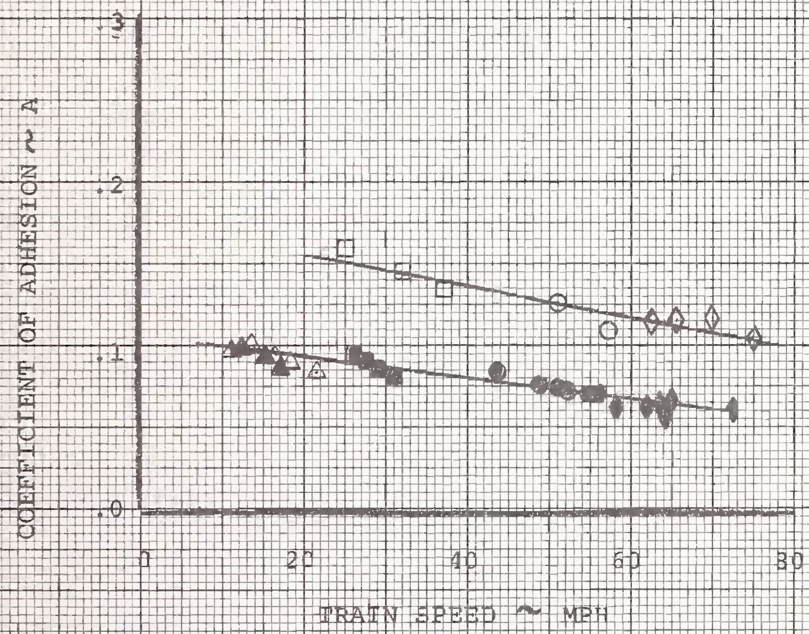
(2) Drift Test Data For Train Speed V

CA/A-3

ADHESION
HIGH DENSITY SOAC

CAR WEIGHT 90,000 LB
WETTED RAILS

TEST RUN	RECORD	ENTRY SPEED	SYMBOL
100	245	20 MPH	▲
	255	40 MPH	■
	300	60 MPH	●
	305	80 MPH	◆
151	1653	20 MPH	△
	1626	40 MPH	□
	1631	60 MPH	○
	1648	80 MPH	◇



NOTE: TWO LEVELS OF ADHESION DUE TO DIFFERENCES IN MIXING THE WETTING AGENT

COEFFICIENT OF ADHESION CALCULATION

CAR WEIGHT:

RUN NO.

RECORD NO.	TIME SEC	DECEL. a MPHS	TRAIN SPEED V MPH	RETARDING FORCE (1) LB	TRAIN RESISTANCE TR (2) LB	FRICTION FORCE F_f (F−TR) LB	COEFFICIENT OF ADHESION A $= \frac{2F_f}{W}$

NOTES: (1) $F = \left[\frac{W}{g} + \frac{ew}{g}\right] a$

(2) Drift Test Data for Train Speed V

EQUIPMENT TEMPERATURE (EQT/A)

STANDARD OUTPUT REQUIRED

EQUIPMENT TEMPERATURE °F

DISCUSSION:

The data reduction of the equipment temperature consists of determining the peak temperature for each parameter and adjusting to the test vehicle design goal on a one-to-one basis.

FORMAT: (1) Tabulation of peak equipment temperature

SUMMARY OF UNDERCAR
EQUIPMENT TEMPERATURES
SYNTHETIC TRANSIT ROUTE

CAR WEIGHT ________________LB

TEMPERATURES ADJUSTED TO_________°F AMBIENT(1)

PARAMETER	PEAK TEMPERATURES		
	NO.	RUN_____	RUN_____
INSTRUMENTATION BOX NO. 1	4	__ ° F	__ ° F
INSTRUMENTATION BOX NO. 2	1	___° F	___° F
INSTRUMENTATION BOX NO. 3	5	__ ° F	__ ° F
INSTRUMENTATION BOX NO. 4	6	__ ° F	__ °F

NOTE: (1) _____°F is Test Vehicle Design Goal

POWER CONSUMPTION PER CAR MILE (PCCM/A)

STANDARD OUTPUTS REQUIRED

PCC/A	Power consumed on a per stop basis and total time.
D/B	Distance for all station-to-station runs and total trip.
VS/A	Vehicle speed
DISCUSSION:	Power consumption per car mile is obtained from the test vehicle's energy consumption during a Synthetic Transit Route (defined series of station stops at various maximum speeds). The overall round trip energy consumption divided by the round trip distance provides the KW-HR per car mile (PCCM/A). The calculation format for PCCM/A is shown on page PCCM/A-2 with an illustrated example of a Synthetic Transit Route. The round trip distance, from Station A to O (outbound) and for O to A (inbound) is 18.5 miles with a round trip energy consumption of 229.9 KW-HR providing a PCCM/A of 12.43 KW-HR. The schedule for the example shown is 27.8 MPH for simulated 20 seconds station stops. The total energy consumed includes auxiliary power (34 KW for example shown).

SUMMARY OF SOAC ENERGY CONSUMPTION ON ACT-1
SYNTHETIC TRANSIT ROUTE

TEST RUN 153

STATION (Two Directions)	MAX. SPEED (mph)	DISTANCE (Miles)	(TWO-WAY) ENERGY - KW-HR TOTAL	PER CAR-MILE
A to B	60.	.75	9.35	12.47
B to C	70.	1.00	11.55	11.55
C to D	50.	.50	6.25	12.50
D to E	60.	.75	9.15	12.20
E to F	50.	.50	6.25	12.50
F to G	40.	.25	4.00	16.00
G to H	40.	.25	4.00	16.00
H to I	50.	.50	6.20	12.40
I to J	80.	1.50	16.20	10.80
J to K	80.	1.25	14.70	11.76
K to L	40.	.25	4.10	16.40
L to M	50.	.50	6.55	13.10
M to N	40.	.25	4.40	17.60
N to O	70.	1.00	12.25	12.25
	TOTAL	X(2) 18.5 MILE	X(2) 229.9	12.43

SCHEDULE SPEED: 27.8 MPH

RMS ARMATURE CURRENT VALUE	RMS-A/A
STANDARD OUTPUT REQUIRED	
RMS-MAC/A	Cumulative sum of DC motor armature current squared times Δt
T/A	Elapsed time
DISCUSSION	The RMS armature current values for the test vehicle can be obtained from sample service runs for duty cycle and energy consumption testing.

The RMS value is calculated by obtaining the square root of the results of RMS-MAC/A divided by T/A, where T/A is the total elapsed time to complete the service run. The data for the example shown below is from the Standard Performance Output for RMS-MAC/A (page RMS-MAC/A-2)

$$\text{RMS-A/A} = \sqrt{\frac{I^2 \Delta t}{\text{T/A elapsed}}}$$

where T/A = 24 seconds, time for the run noted by an asterisk for time of start and end event.

$I^2 \Delta t = 2.9597 \times 10^6$ amp^2-sec at the end of 24 sec for truck No. 1 armature current.

$$\text{RMS-A/A (truck No. 1)} = \sqrt{\frac{2.9597 \times 10^6}{24}} = 351 \text{ amp}$$

RMS FIELD CURRENT VALUE — RMS-F/A

STANDARD OUTPUT REQUIRED

RMS-MFC/A — Cumulative sum of DC motor field current squared times Δt

T/A — Elapsed time

DISCUSSION

The RMS field current values for the test vehicle can be obtained from sample service runs for duty cycle and energy consumption testing.

The RMS value is calculated by obtaining the square root of the results of RMS-MFC/A divided by T/A, where T/A is the total elapsed time to complete the service run. The data for the example shown below is from the Standard Performance Output for RMS-MFC/A (page RMS-MFC/A-2)

$$\text{RMS-F/A} = \sqrt{\frac{I^2 \ \Delta t}{\text{T/A elapsed}}}$$

where T/A = 24 seconds, time for the run noted by an asterisk for time of start and end event.

$I^2 \ \Delta t = 30.665 \times 10^3$ amp^2-sec at the end of 24 sec for truck No. 1 field current.

$$\text{RMS-F/A} = \sqrt{\frac{30.665 \times 10^3}{24}} = 35.7 \text{ amp}$$

(truck No. 1)

TRAIN RESISTANCE (TR/A)

STANDARD OUTPUTS REQUIRED:

TIME HISTORY

VS/A	Vehicle Speed

DISCUSSION:

Train resistance, TR = $\left[\frac{W}{g} + \frac{ew}{g}\right]$ a, where W is the the test vehicle weight, ew is the equivalent weight of rotating parts, g is the acceleration due to gravity and a is the longitudinal deceleration.

The calculation Format for train resistance is shown on page TR/A-2 and the sample calculation is based on deceleration rates obtained from train speed time histories recorded during BART LAB CAR C-2 Drift Tests (page TR/A-3).

The Format for presenting train resistance is shown on page TR/A-4. Train resistance is shown as a function of train speed as LB/CAR and MPH/SEC. The test data and fairing are presented for the BART C-2 car. There is a negligible amount of scatter of test data from the fairing since the deceleration rates utilized in the calculation of train resistance were mean values of the X and Y direction and with no profile difference between the CAB and Rear End. If, however there is a difference in the test vehicle between the cab and rear end, the use of a bidirectional mean deceleration rate would not be appropriate. A conservative approach would be to calculate the train resistance for each direction and present a fairing through the test data that is weighted by the more severe end of the train relative to a higher drag profile.

Blank sheets for the calculation of train resistance and equivalent weight of rotary inertia are included as pages TR/A-5 and TR/A-6.

TRAIN RESISTANCE CALCULATION
SAMPLE CALCULATION BART LAB. CAR C-2

CAR WEIGHT: 79,800 LB

RUN NO. ______

RECORD NO.	DIREC-TION	SPEED RANGE		$\bar{V}$	ΔV	ELAPSED TIME	DECEL. @ $\bar{V}$	BIDIREC-TIONAL MEAN	TRAIN RESISTANCE
		$V_{Initial}$ MPH	V_{Final} MPH	(Avg. V_i, V_f) MPH	$V_i - V_f$ MPH	$t_{v_f} - t_{v_i}$ SEC	a = v/ t MPHPS	a' MPHPS	= 3958 x a' (1) LB/Car
2R,4,6	x	75	71	73	4	9.9	0.404		
1R,3,5	y	75	71	73	4	7.	0.572	0.488	1932
2R,4,6	x	71	67	69	4	10.7	0.374		
1R,3,5	y	71	67	69	4	7.7	0.520	0.447	1770

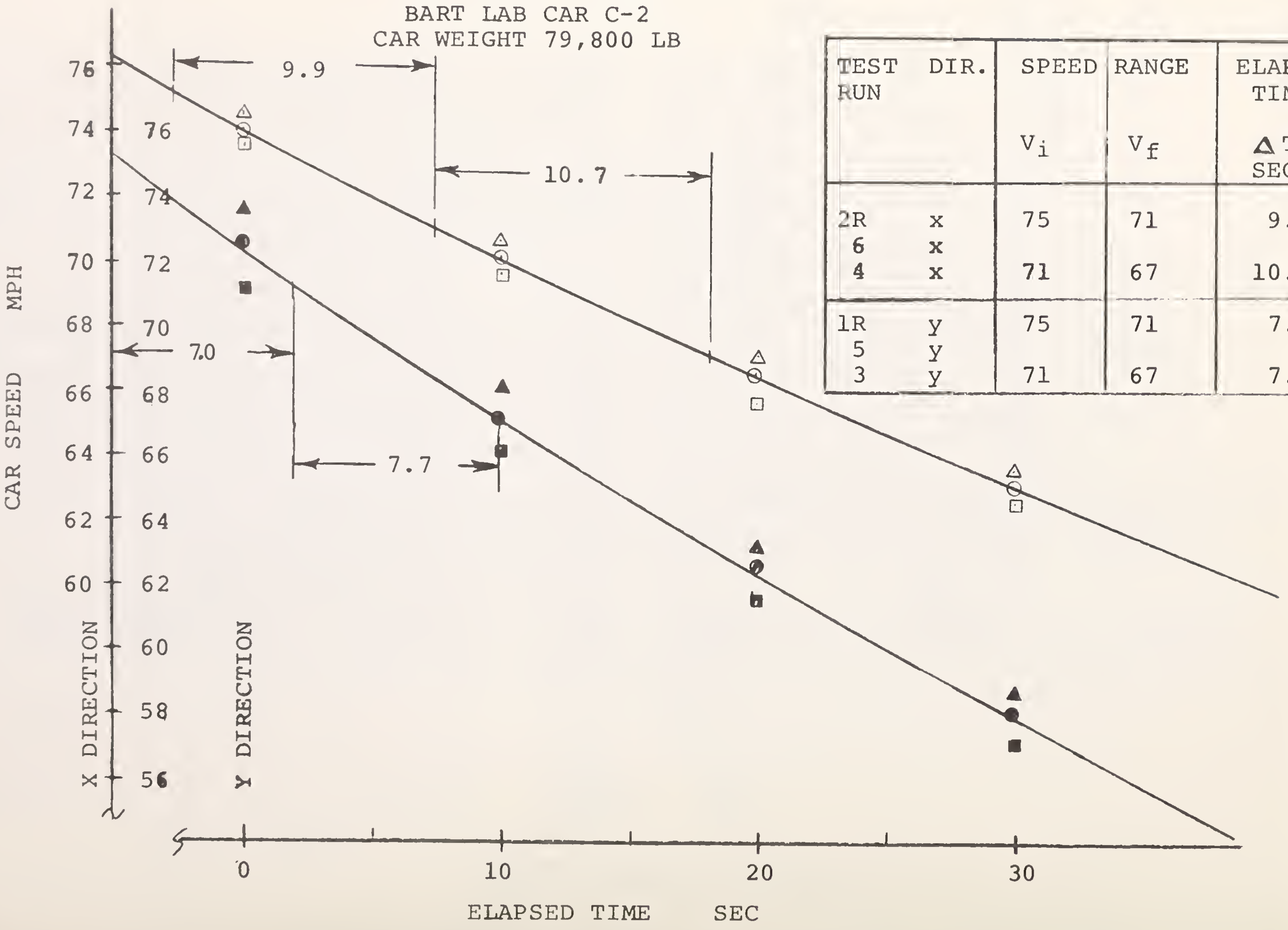
NOTE: (1) $TR = \left[\frac{W}{g} + \frac{ew}{g}\right] a'$

$$= \left[\frac{79{,}800 + 7084}{32.2}\right] a' \times 1.467$$

$$= 3958.2 \times a'$$

TR/A-2

DRIFT TEST DATA
CAR SPEED VS TIME
BART LAB CAR C-2
CAR WEIGHT 79,800 LB



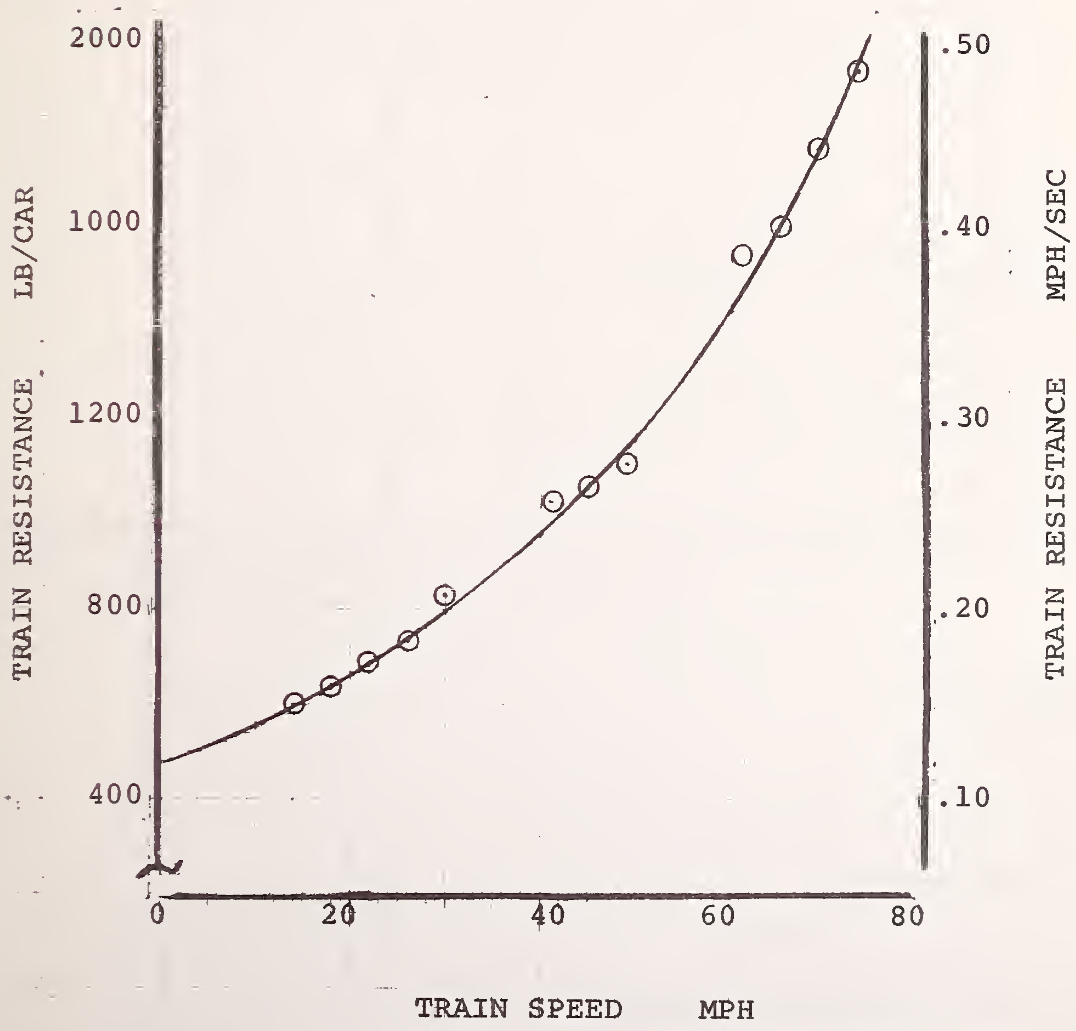
TEST RUN	DIR.	SPEED V_i	RANGE V_f	ELAPSED TIME ΔT SEC
2R	x	75	71	9.9
6	x			
4	x	71	67	10.7
1R	y	75	71	7.0
5	y			
3	y	71	67	7.7

TR/A-3

TRAIN RESISTANCE
DRIFT TEST
BART LAB CAR C-2

CAR WEIGHT 79,800 LB

NOTE: TRAIN RESISTANCE CALCULATIONS BASED ON BIDIRECTIONAL MEAN DECELERATION.



CALCULATION OF EQUIVALENT WEIGHT OF ROTARY INERTIA

ROTATING PART	MOVEMENT OF INTERIA, I LB-FT-SEC^2	GEAR RATIO	RIF	NO OF ROTATING PARTS PER CAR	TOTAL RIF (NO. OF PARTS X RIF)
WHEELS					
DISC BRAKE					
BULL GEAR					
AXLE					
INTERMEDIATE GEAR AND SHAFT					
PINION GEAR					
COUPLINGS					
TRACTION MOTORS					
		RIF TOTAL ⟶			

$$RIF = \frac{4(GR)^2 I a}{D^2}$$

Where:

GR = Gear Ratio

I = Moment of Interia

a = Car Acceleration (fps^2)

D = Wheel Diameter (ft.)

RIF = Equivalent Weight of Rotating Parts

TRAIN RESISTANCE CALCULATION

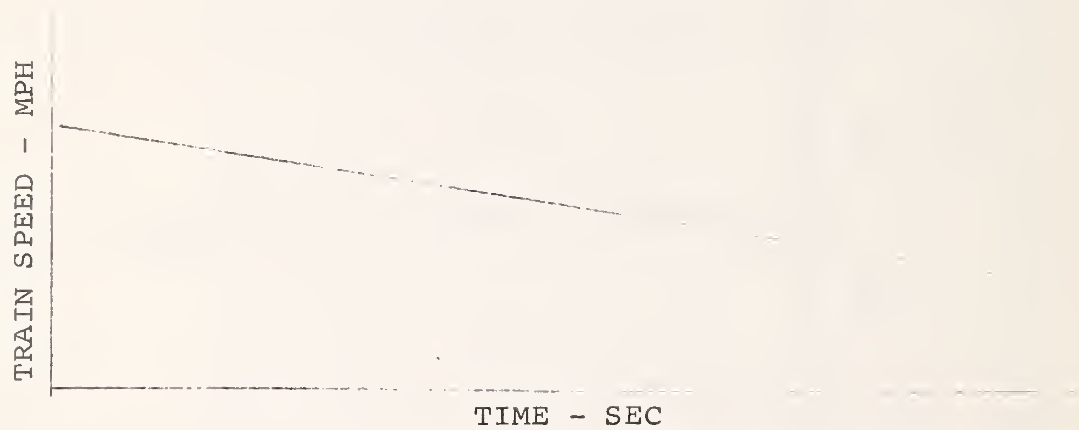
CAR WEIGHT:

RUN NO.________

RECORD NO.	DIRECTION	SPEED RANGE		$\overline{V}$	ΔV	ELAPSED TIME	DECEL. @ $\overline{V}$	BIDIRECTIONAL MEAN	TRAIN RESISTANCE
		$V_{Initial}$ MPH	V_{Final} MPH	(Avg. V_i,V_f) MPH	V_i-V_f MPH	$t_{v_f}-t_{v_i}$ SEC	$a = v/\ t$ MPHPS	a' MPHPS	LB/CAR

TRACTION RESISTANCE SUMMARY

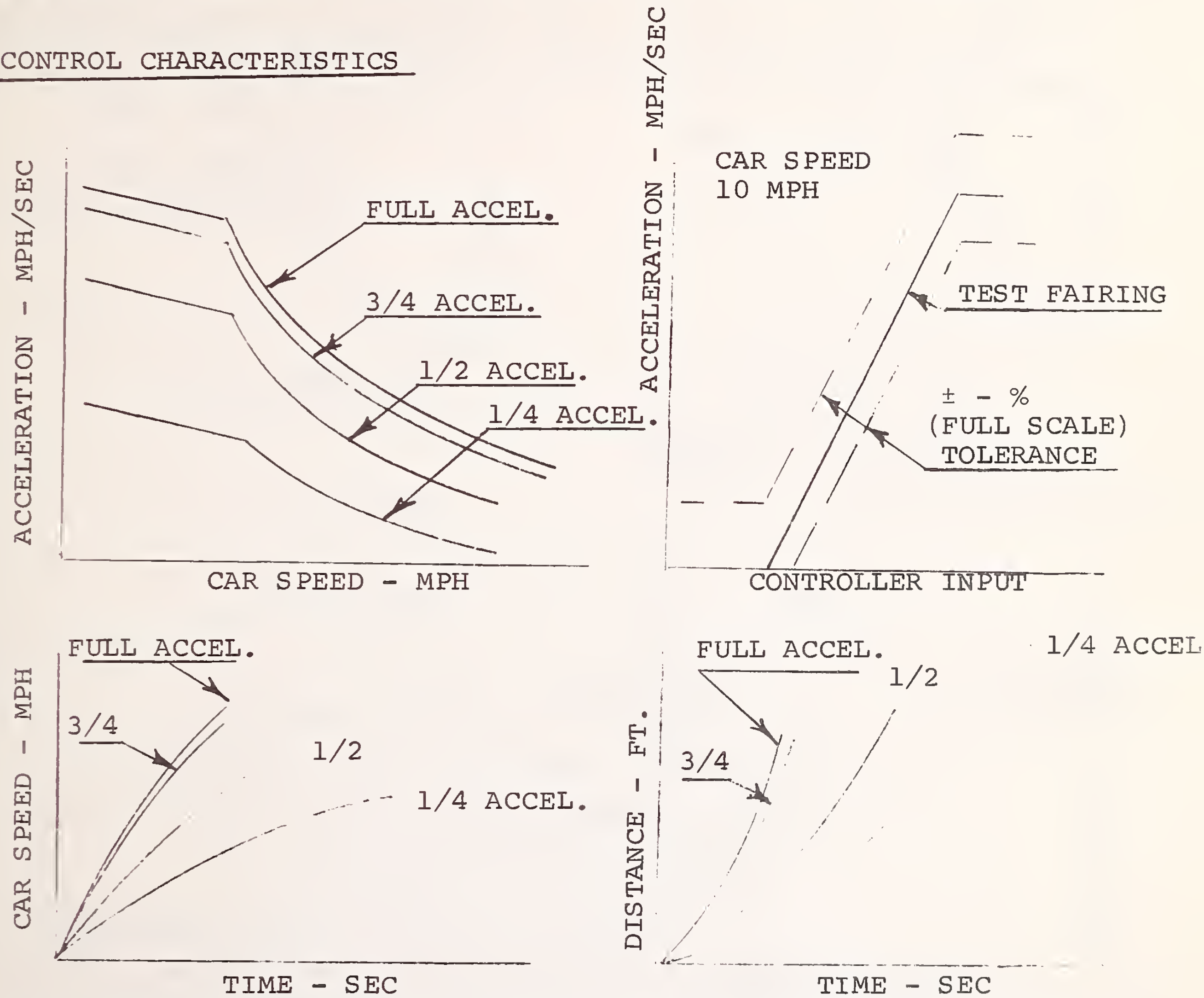
The examples of the cross plots required to obtain baseline comparison formats for the preliminary analysis of Traction Resistance are shown below. Cross plots are required for Forward and Reverse direction data, for train consist, and for car weight. Actual test data plotted in the formats shown below are presented on pages TR/A-3 and TR/A-4 of this Section (Preliminary Analysis)



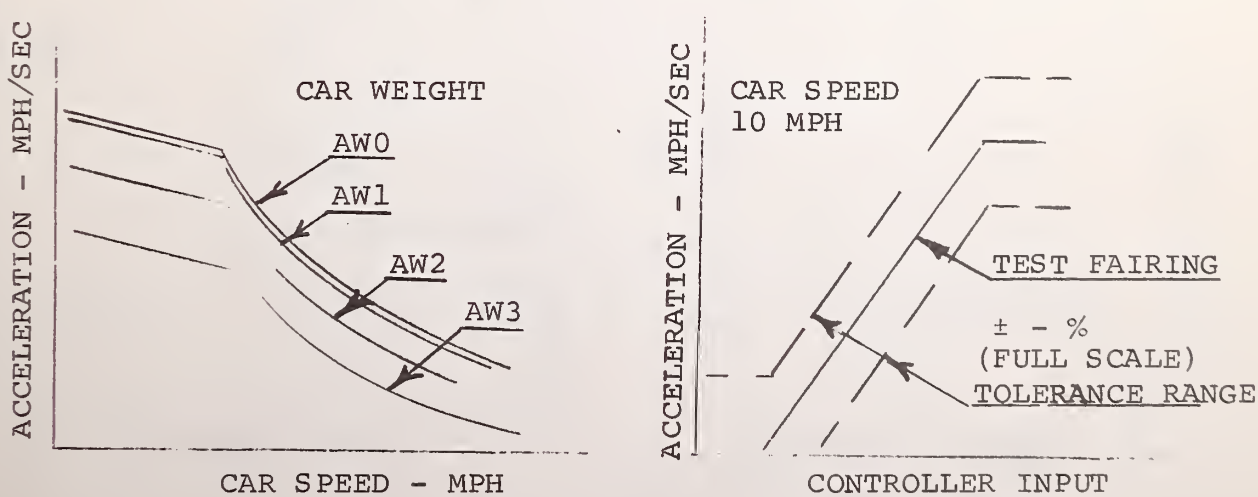
ACCELERATION SUMMARY

The examples of the various cross plots required to obtain baseline comparison formats for the preliminary analysis of acceleration are shown below.

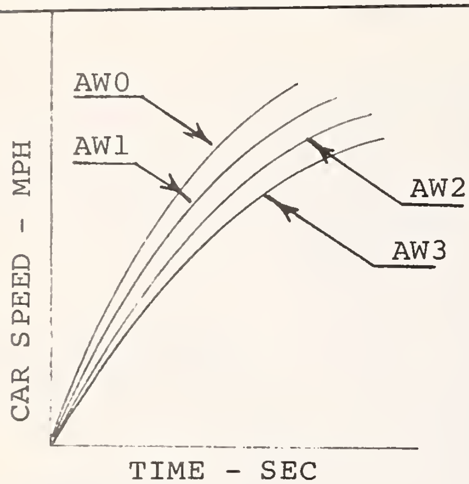
1. CONTROL CHARACTERISTICS

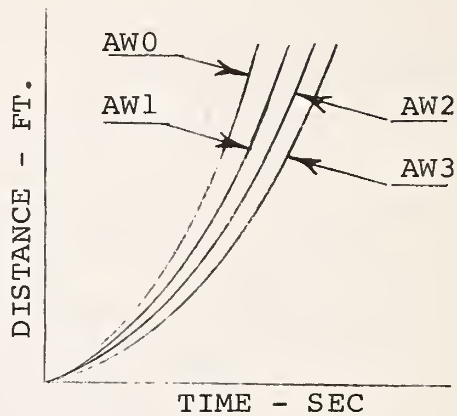


2. LOAD WEIGHT COMPENSATION: Shown for full acceleration. Repeat for 3/4, 1/2 accel. for test data to cross plot controller input.

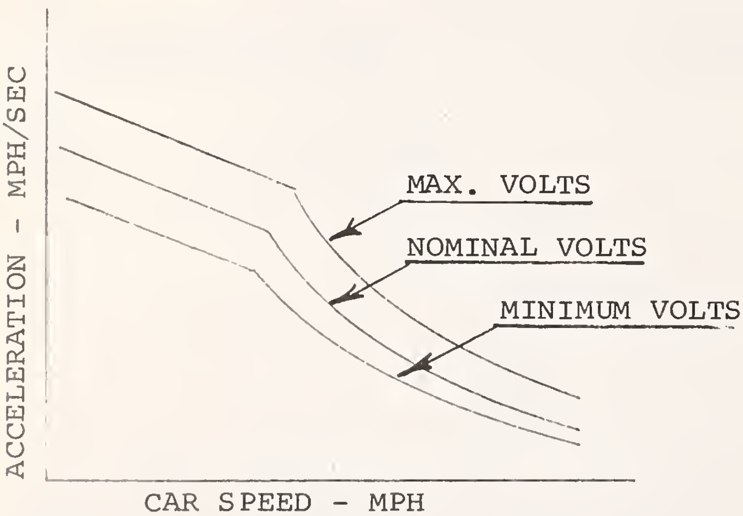


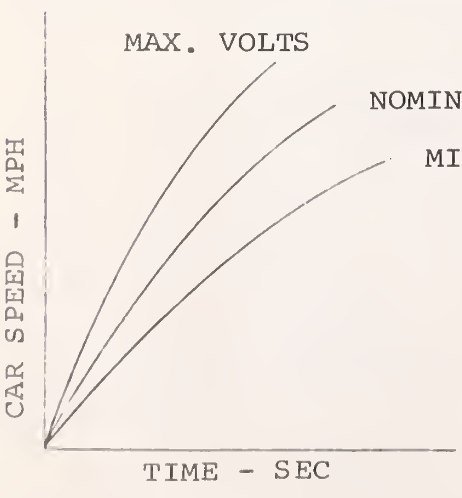
2. LOAD WEIGHT COMPENSATION (cont.)

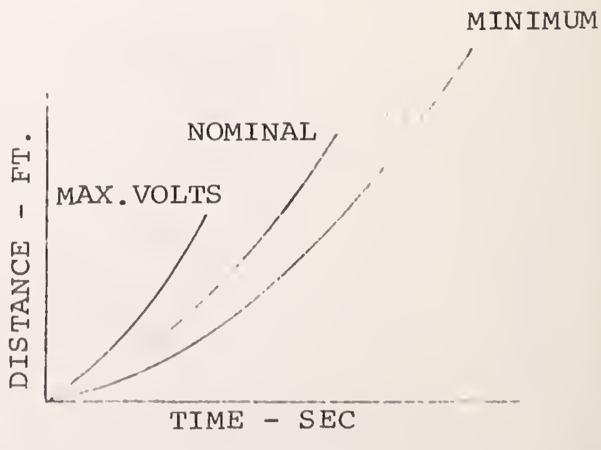




3. OFF NOMINAL TRACK VOLTAGE



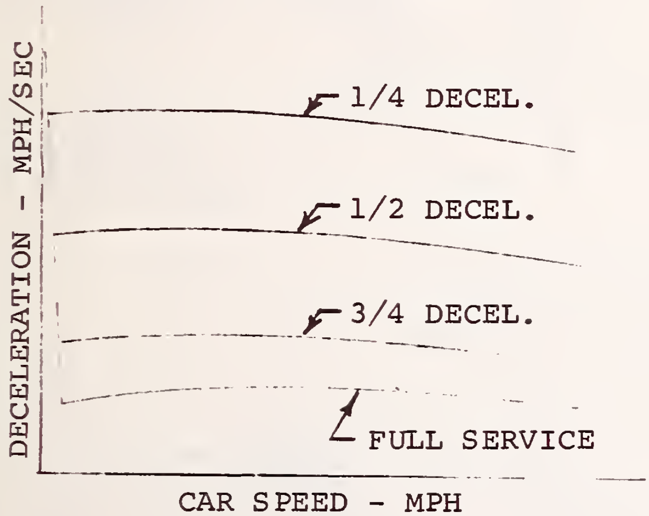


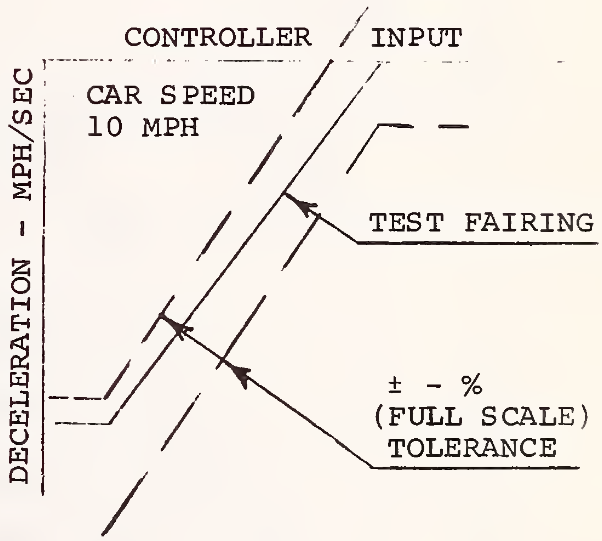


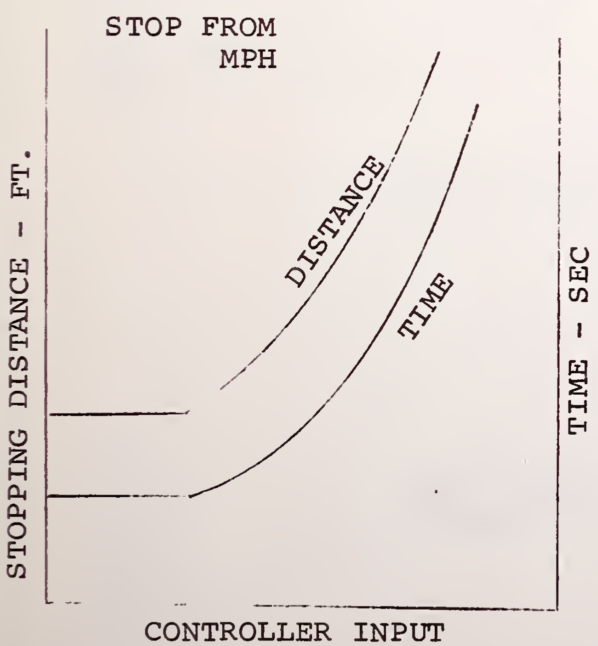
DECELERATION SUMMARY

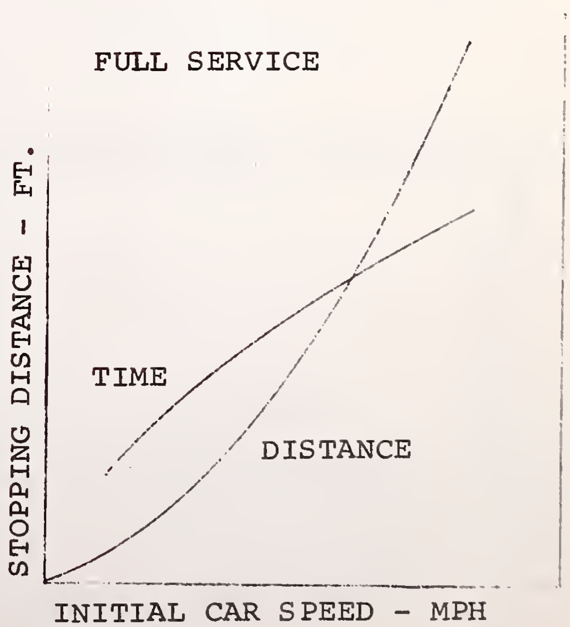
The examples of the various cross plots required to obtain baseline comparison formats for the preliminary analysis of deceleration are shown below for BLENDED BRAKING. Similar formats are required for SERVICE FRICTION, DYNAMIC, and EMERGENCY BRAKING, where applicable.

1. CONTROL CHARACTERISTICS

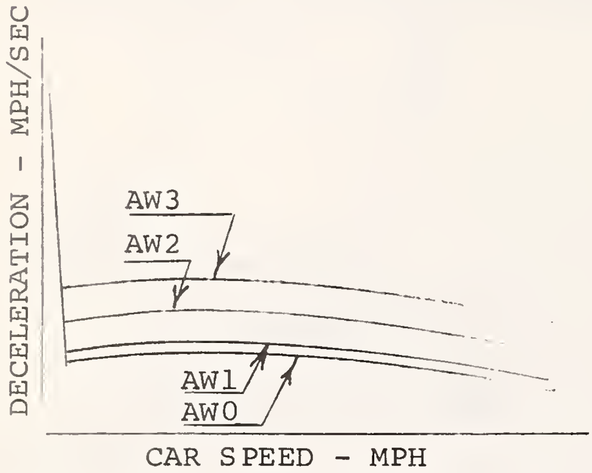


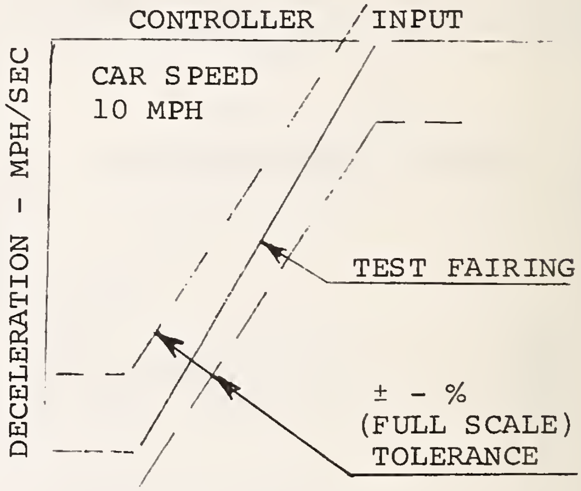


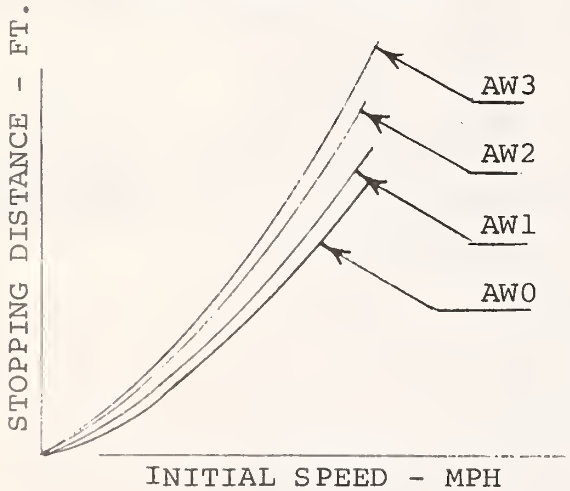


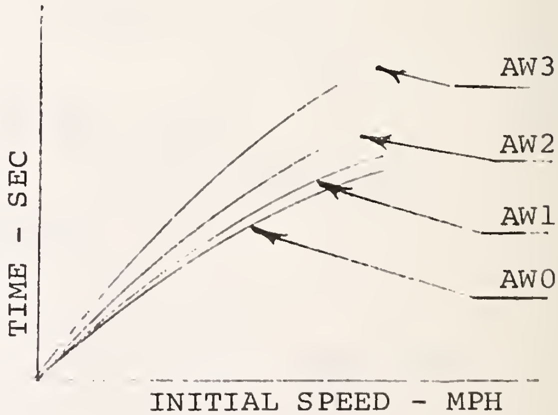


2. LOAD WEIGHT COMPENSATION shown for full service deceleration. Repeat for 3/4, 1/2 decel. for test data to cross plot for controller linearity (controller input)

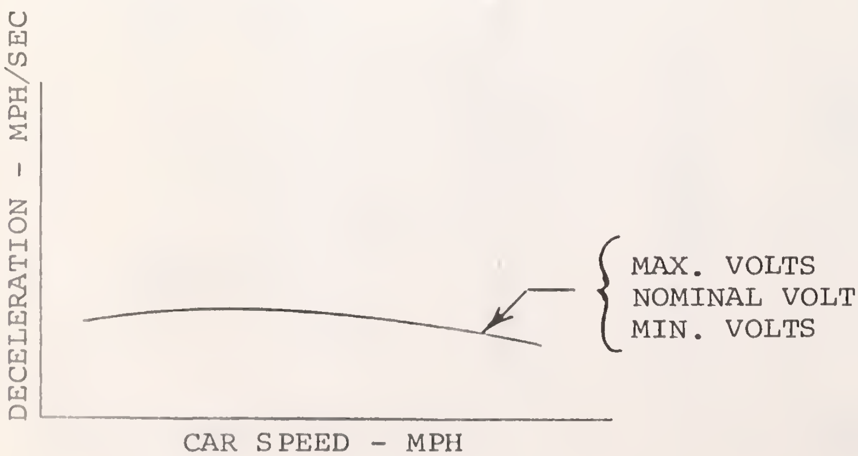






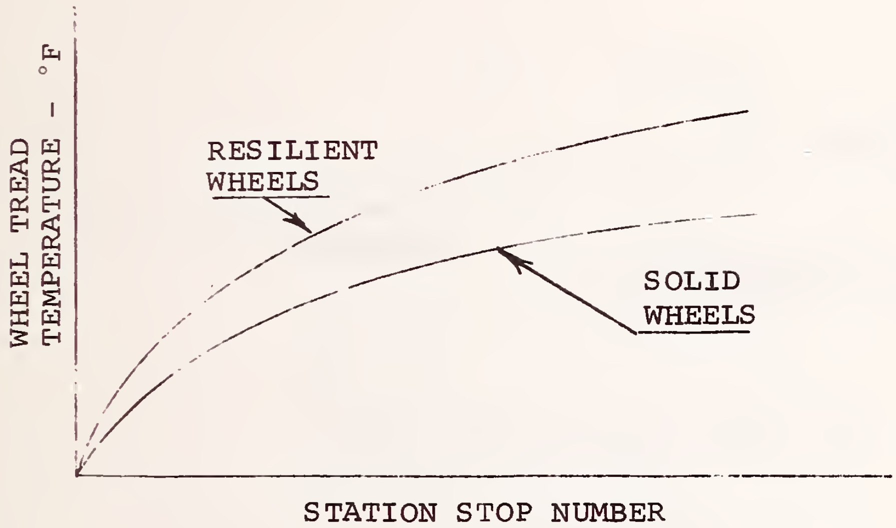


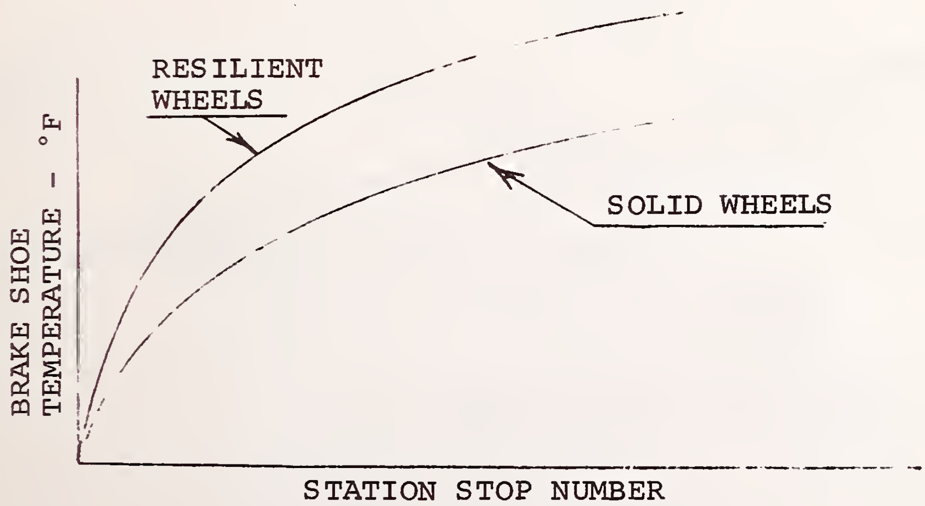
3. OFF NOMINAL TRACK VOLTAGE

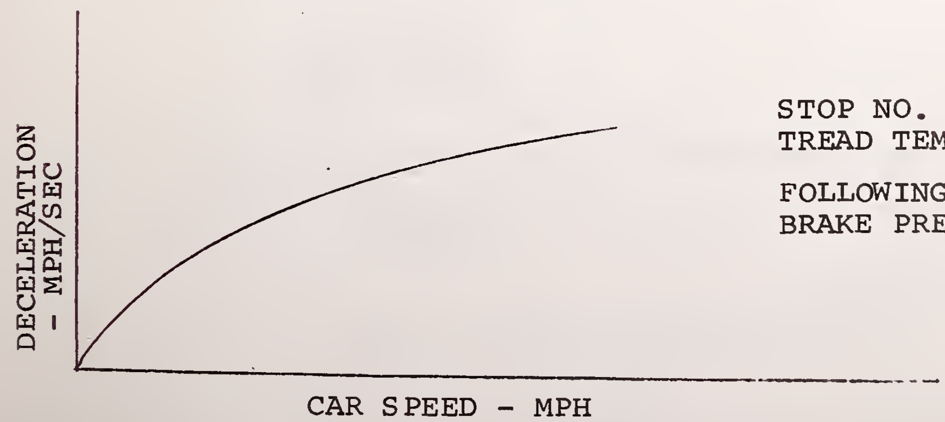


FRICTION BRAKE DUTY CYCLES SUMMARY

The cross plots required to obtain baseline comparison formats for the preliminary analysis of the thermal capacity of the test vehicle's brake system are shown below.





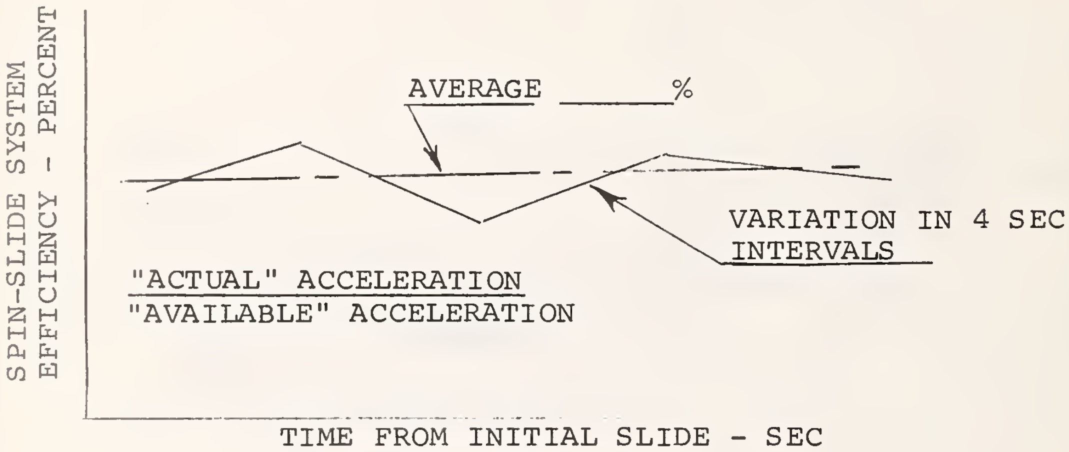


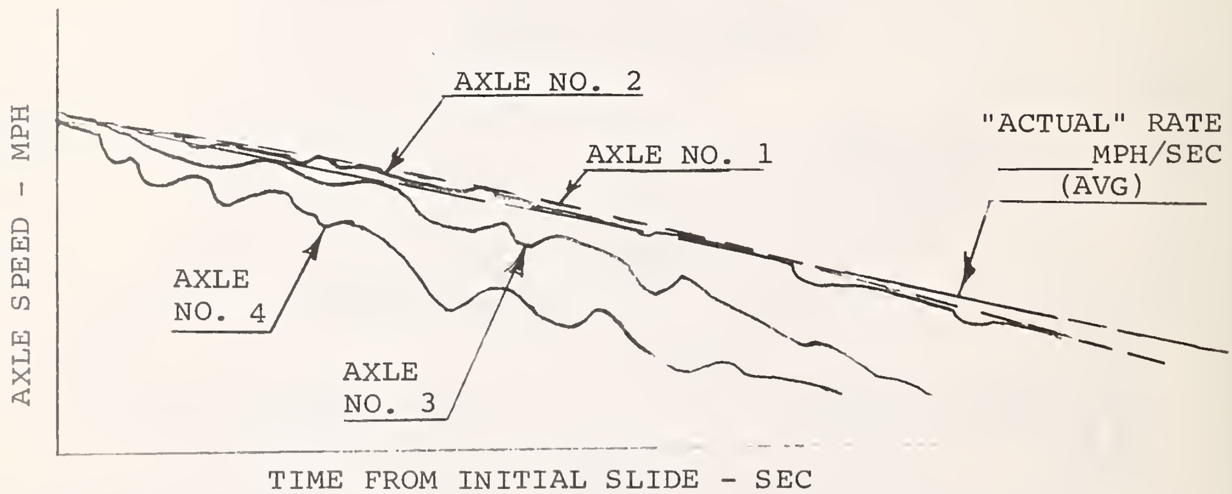
STOP NO.
TREAD TEMP.

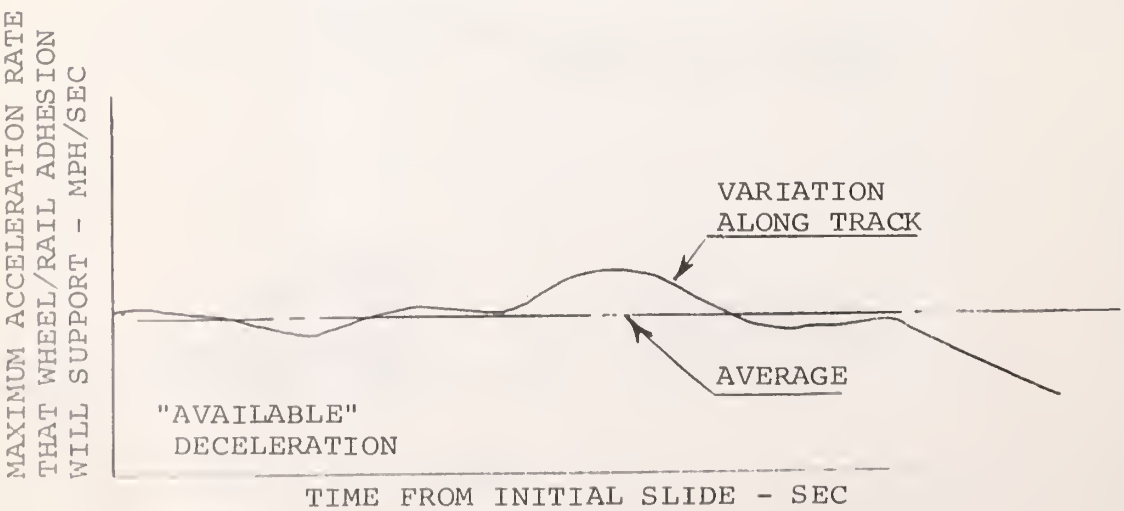
FOLLOWING STOP ______ °F
BRAKE PRESSURE ______ PSI

SPIN-SLIDE SUMMARY

The various cross plots presented below are required to obtain baseline comparison formats for the preliminary analysis of the test vehicle's efficiency of the spin-slide protective system. The cross plots shown below can be utilized for determining the efficiency during acceleration and deceleration with blended braking, service friction and dynamic only braking.





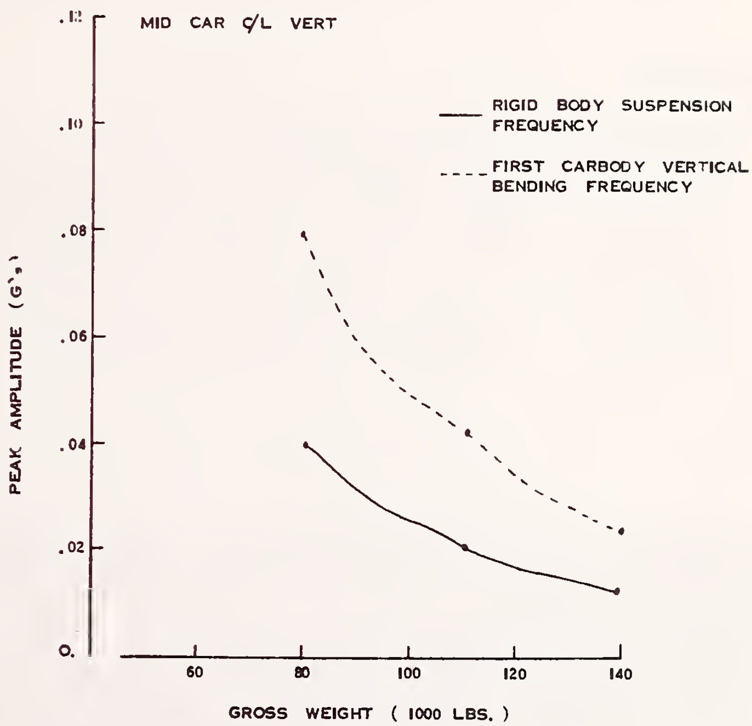


RIDE QUALITY AND GROSS WEIGHT SUMMARY

RIDE QUALITY DATA

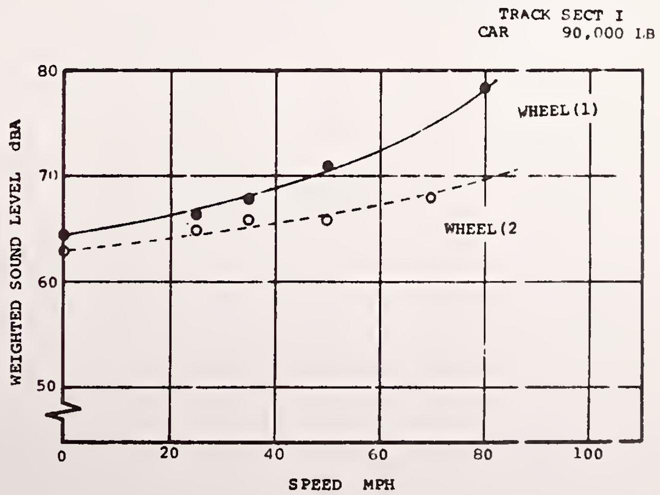
BASELINE COMPARISON PLOT

EFFECT OF GROSS WEIGHT



INTERIOR NOISE AND SPEED SUMMARY

EFFECT OF SPEED ON INTERIOR NOISE
FOR TWO WHEEL CONFIGURATIONS



CAR BODY ACCELERATION MODE SHAPES (CAMS/A)

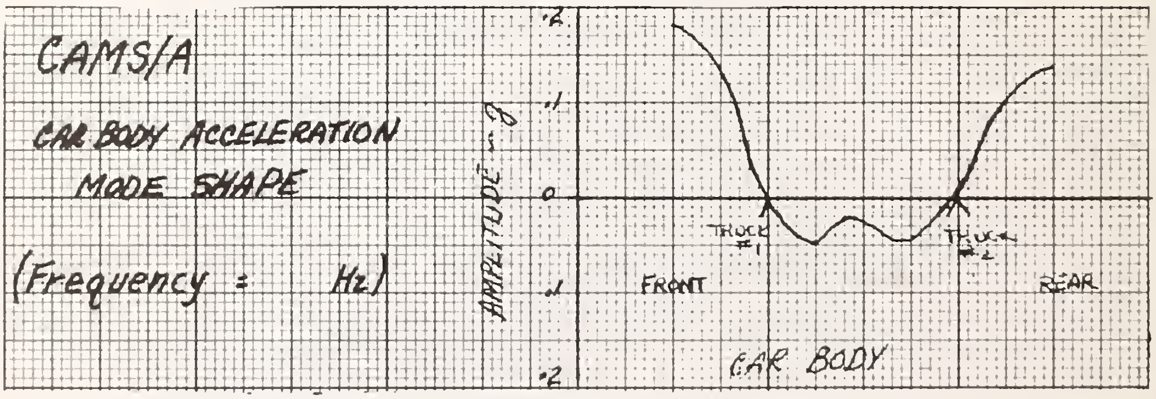
Standard Outputs Required:

AFR/A	ACCELERATION FREQUENCY RESPONSE
APA/A	ACCELERATION PHASE ANGLE

DISCUSSION:

Examination of the AFR/A outputs for a series of car body locations identifies the dominant resonant frequencies. These may be summarized by plotting the amplitude of the AFR/A as a function of car body location, taking into consideration the phase angle.

FORMAT:



APPENDIX D
REPORT OF INVENTIONS

After a diligent review of the work performed under this contract, it was determined that no new innovation, discovery, improvement or invention was made.

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UMTA- 75-16

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