Report No. UMTA-IT-06-0026-74-12

SOAC

STATE-OF-THE-ART CAR DEVELOPMENT PROGRAM FINAL TEST REPORT

VOLUME 5: POST-REPAIR TESTING

Boeing Vertol Company
(A division of The Boeing Company)
Surface Transportation Systems Branch
Philadelphia, Pa. 19142

DECEMBER 1974
FINAL REPORT

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Prepared for

URBAN MASS TRANSPORTATION ADMINISTRATION
Office of Research and Development
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16. Abstract

This document presents the test results for the Post Repair testing of the State-of-the-Art Car. The SOAC has been developed under UMTA's Urban Rapid Rail Vehicle and Systems Program to enhance the attractiveness of rapid rail transportation to the urban traveller with transit vehicles that are comfortable, reliable, safe and economical.

The purpose of these tests was to show compliance with the SOAC Detail Specification IT-06-0026-73-2 following repairs to the No. 2 Car which had been damaged in an accident on August 11, 1973 at the DOT High Speed Ground Test Center, Pueblo, Colorado and to complete the Simulated Demonstration Testing which had been interrupted by the accident.

This document, Volume V plus the following additional volumes comprise Boeing Vertol Report D174-10024, State-of-the-Art Car Final Test Report as specified in Section 17.1.4.2 of the SOAC Detail Specification.

Volume I - Component Testing
Volume II - Subsystem Functional Testing
Volume III - Acceptance Testing
Volume IV - Simulated Demonstration Test

These reports, as well as the SOAC Detail Specification, are available from the National Technical Information Service (NTIS), Springfield, Va. 22151.

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MODEL SOAC CONTRACT DOT-UT-10007

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PREPARED BY	G. Christiansen	DATE 12-19-74
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REVISIONS			
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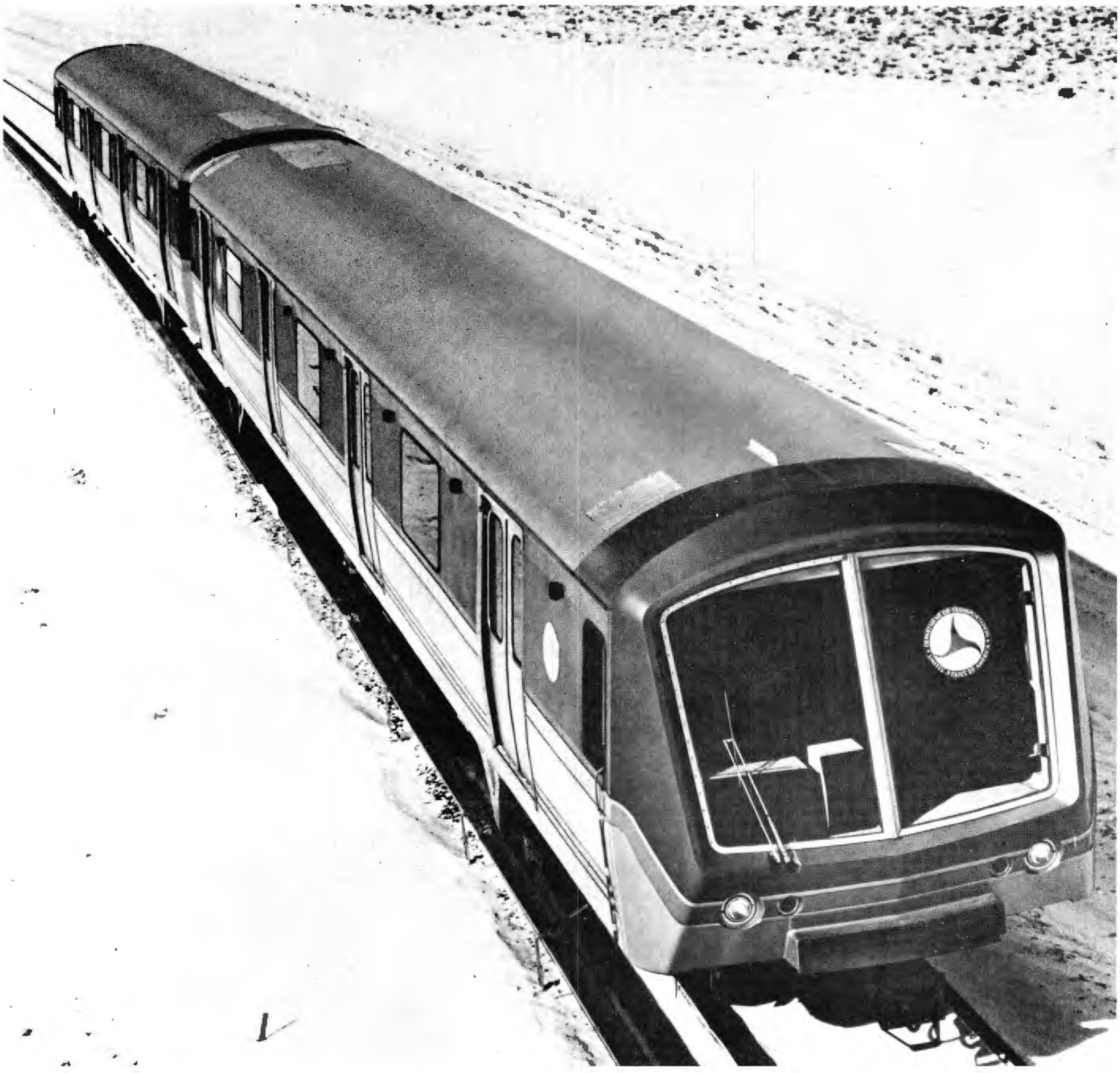
CONTENTS

ILLUSTRATIONS

TABLES



State-of-the-Art Cars

SOAC POST-REPAIR TESTING

1.0 INTRODUCTION

The U.S. Department of Transportation (DOT), Urban Mass Transportation Administration (UMTA), under contract DOT-UT-10007 has engaged the Boeing Vertol Company to act as Systems Manager of the Urban Rapid Rail Vehicle and Systems Program. This is an integrated program directed toward improving high speed, frequent stop urban rail systems. The overall objective is to enhance attractiveness of rail transportation to the urban traveller by providing service that is as comfortable, reliable, safe and economical as possible.

The objective of the State-of-the-Art Car (SOAC) is to demonstrate the best state-of-the-art in rapid rail car design with two new improved cars using existing proven technology. Primary goals for the cars are passenger convenience and operating efficiency.

Testing of the SOAC cars at the UMTA Rail Transit Test Track at the Department of Transportation High Speed Ground Test Center (HSGTC) Pueblo, Colorado started in September 1972 and was interrupted by a collision of the SOAC cars with a standing gondola car on August 11,1973. The accomplishments to that date included completion of the Acceptance Tests, Engineering Tests and 1312 miles of the 3000 miles of two car operation scheduled under the Simulated Demonstration Test Program.

This report presents the results of Post-Repair Testing of the SOAC Cars during the period January 30th to April 10, 1974 at HSGTC. The objectives were:

(a) Show compliance with the original acceptance criteria

(b) Establish test data continuity with the original HSGTC tests

(c) Complete Simulated Demonstration Testing

The tests were conducted in accordance with Reference (1)[1] and included the following:

- Subsystem Functional Tests
- Acceptance Tests

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1. Reference 1. State-of-the-Art Car Test Program, Appendix I, "Test Plan and Procedures for Post-Repair Testing", Document No. D174-10007-1, Boeing Vertol Company, Philadelphia, Pa., January 1974.

- Simulated Demonstration Tests
- Engineering Tests

2.0 CONFIGURATION

Acceptance tests were conducted on the two cars individually and as a two-car train. Both cars were ballasted to normal load (AW1)[2] of 105,000 lb, representing light car plus 100 passengers at 150 lb each. The Engineering Tests were conducted at 90,000 lb, 105,000 lb and 130,000 lb car weights. All Simulated Demonstration testing was as a two-car train with each car ballasted to 105,000 lb.

3.0 INSTRUMENTATION

3.1 SUBSYSTEM FUNCTIONAL TESTS

The test and checkout equipment used for the subsystem functional tests were as follows:

ITEM	MAKE
Oscilloscope (1)	Tektronix
SOAC System Simulator (1)	Garrett/AiResearch
SOAC System Monitor (2)	Garrett/AiResearch

The SOAC System Monitors were installed in the cab of each car and remained in the cabs for the acceptance and engineering tests. The monitor panel contains features to perform several functions:

- Annunciator lights for indication of propulsion and braking events and modes.
- Fault indicator lights
- Calibrated meters for indication of the following:

Armature currents	Car speed
Field currents	Calculated tractive effort
Capacitor bank voltage	Thyristor firing command
Motor voltage	Tractive effort command

  Plus additional internal system functions.
- Terminals for connecting the above parameters with a recording oscillograph (when required).

2. AW1 - Normal Load Car Weight

3.2 ACCEPTANCE TESTING

Testing was conducted without any onboard data recording equipment; instead, a handheld stopwatch was used to obtain car speeds, accelerations and decelerations from trackside markers placed at 100 ft. intervals along the right-of-way. The data also served to calibrate the motorman's console-mounted speedometer and the accuracy of the Automatic Speed Maintaining System (ASMA).

3.3 ENGINEERING TESTING

The test data recording equipment included two (2) magnetic tape recorders and two (2) direct reading oscillographs. They were used to selectively record any 28 test parameters including: vertical, lateral and longitudinal accelerations, relative motions, structural strains, electrical voltages, electrical currents, and car wheel speeds. A separate temperature recorder was used for recording temperatures. Additional details may be obtained from Reference 2.[3]

3.4 SIMULATED DEMONSTRATION TESTING

The SOAC propulsion and braking system performance was monitored through the use of the SOAC Monitor Panels installed in the cab of each car (see description in Section 3.1).

4.0 TEST PROCEDURES

4.1 SUBSYSTEM FUNCTIONAL TESTS

Tests were performed on those items specified in Table 4-1, along with additional functional tests of the Propulsion and Braking Systems, in accordance with Ref. (1)[4] Section 3. The latter tests were performed on each of the two cars, separately, sitting in a static position using the SOAC Propulsion Simulator (Figure 4-1) to simulate the system electrical loads, and the SOAC Monitor Panel (Figure 4-2) to check proper functioning and sequence of propulsion control events by observing the event lights on the Annunciator Panel.

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3. Reference 2. Urban Rail Rapid Transit SOAC Engineering Tests at Dept of Transportation HSGTC, Document No. D174-10026-6, Volume VI, Boeing Vertol Company, Philadelphia, Pa., May 1974.
4. See footnote 1 on p 1.

TABLE 4-1

SUBSYSTEM TESTS ACCOMPLISHED ON CAR NO. 2

TEST	TEST DATA SHEET NO.[5]
Coupler Function and Gathering Range (No. 1 end only)	A-2
Electric Couplers	A-3
Camber	A-4
Air Comfort	A-5
End Door	A-6
Side Door	A-7
Windshield	A-8
Lighting, Head and Tail Lights	A-9
Cab Lights	A-10
Console Lights	A-11
Emergency Lights	A-12
Main Lights	A-13
Wiring, High Pot	A-14
Main Power Application	A-15
Trainlines	A-16,-17
Windshield Wiper	A-18
Horn	A-19
Public Address	A-20
Radio	A-21
Side Sign	A-22
Main Propulsion Control & Motor Rotation	A-23
Main/Emergency Brake	A-24,-25
Handbrake	A-26
Snow Brake	A-27
Propulsion Auxiliaries	A-28
Car Weight	A-29
Air Compressor	A-30
Hostling Panel	A-31
Visual	A-32

5. These sheets are contained in Appendix A of this report.

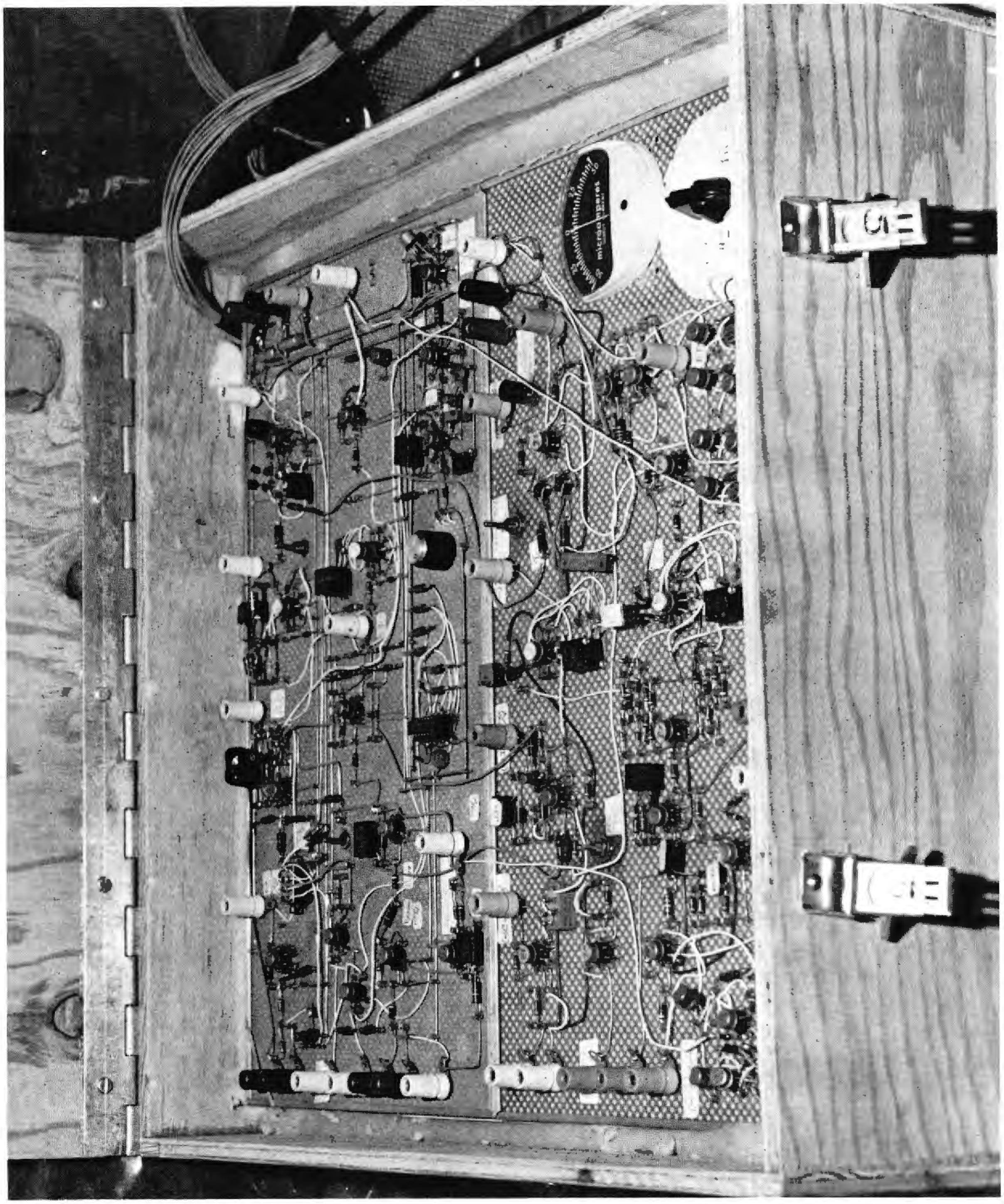

Figure 4–1. SOAC System Simulator

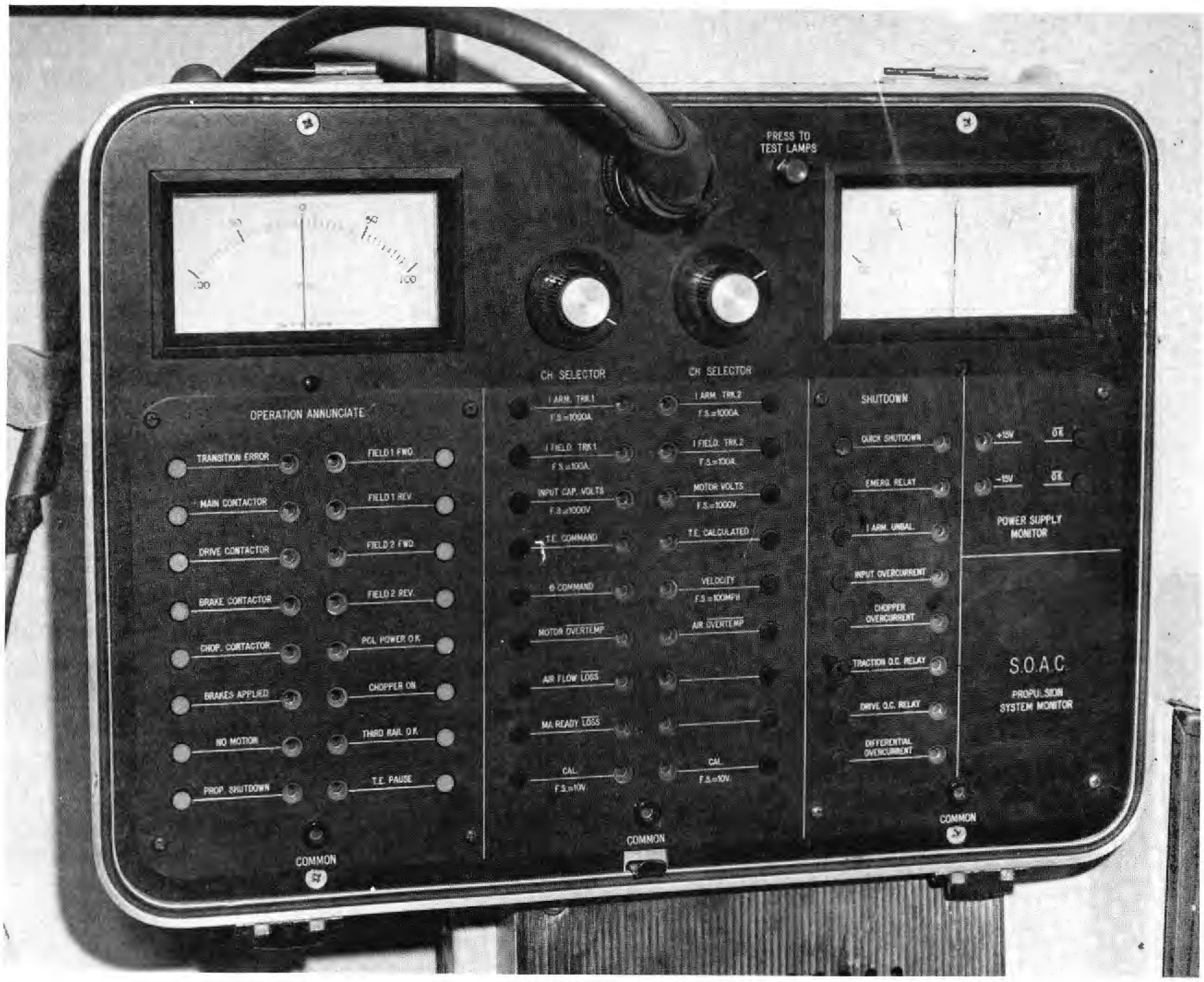

Figure 4–2. SOAC Monitor Panel

4.2 ACCEPTANCE TESTS

This phase of the test program included the following:

- Speedometer Calibration
- Acceleration
- Deceleration
- Automatic Speed Maintaining System
- Ride Quality

4.2.1 Speedometer Calibration

The true car speeds were obtained from the measured times required for the car to travel a measured course using handheld stopwatches. The desired test car speeds were set by pushing one of the ASMS Push Button controls on the control console. The car speed over the test track was monitored and recorded for the Speedometer and the SOAC Monitor Panel Speed Indicator.

4.2.2 Acceleration Tests

Tests were conducted in forward and reverse on each car individually with car weights of 105,000 lb. The test car or train was accelerated on the level tangent track at full power (P-signal = 1.0 amp). Stopwatches were used to measure the time to reach 700 ft. and the time to reach 60 mph from a standing start, and the time to accelerate from 5 to 25 mph. Maximum speed was recorded at the end of the course. Additional monitored data included line voltage, armature and field currents from the SOAC monitor panel. Testing with the two-car train was prevented by failure of one of the two auxiliary generators which allowed track line voltage to drop below the minimum required 600 volts.

4.2.3 Deceleration Tests

Tests were conducted in forward and reverse on both cars and the two-car train with car weights of 105,000 lb. The test car or train was decelerated at full service rate for blended and friction only braking, and with emergency braking on the level tangent track. Stops were made from 40 and 80 mph. Stopwatches were used to measure time required to stop for each braking mode and initial test speed, and the time to decelerate from 60 to 30 mph.

4.2.4 Automatic Speed Maintaining System

Tests were conducted in forward and reverse on both cars and the two car train with car weights of 105,000 lb. The ASMS was cycled through all push button speed settings with the Controller in the full power setting (P-signal - 1.0 amp) from 3 to 80 and back to 3 mph. The test data included the indicated speeds from the speedometer and SOAC Monitor Panel, and the Armature Current and Field Current for each ASMS speed setting.

4.2.5 Ride Quality Tests

The measurement of the car body vibrations related to Ride Quality by Reference 3[6] was accomplished under the Engineering Test Program.

4.3 SIMULATED DEMONSTRATION

This portion of the SOAC Test Program included scheduled inspection/maintenance procedures and daily two-car train operation over the test track following a composite route profile of the routes in the five cities where SOAC would be demonstrated: New York, Boston, Cleveland, Chicago and Philadelphia. The route consisted of "station" stops averaging approximately 1/2 mile apart (ranging from 1/4 mile to 1-1/4 miles) where the train stopped, opened the doors, 20 second dwell, closed the doors, and travelled to the next station at the average speeds shown in Figure 4-3. This sequence (in general) was repeated for two circuits of the oval transit track, then two laps were run at 80 mph. The cars were operated at 105,000 lb car weight (AW1).

4.4 CAB SIGNALLING

Cab signalling equipment supplied by Massachusetts Bay Transportation Authority (MBTA) and AiResearch Manufacturing Company under separate contract was installed and functionally checked out during normal maintenance during the Simulated Demonstration testing. A tape recording of the signals supplied through the MBTA running rails was played to a receiver coil mounted ahead of the forward truck and automatic train control response was evaluated. The SOAC Propulsion Control System automatically responded to the signals by accelerating, decelerating and maintaining speed of the train as called for by the signals.

6. Reference 3. Detail Specification for State-of-the-Art Car, Document No. IT-06-0026-73-2, Urban Mass Transportation Administration, May 1973.

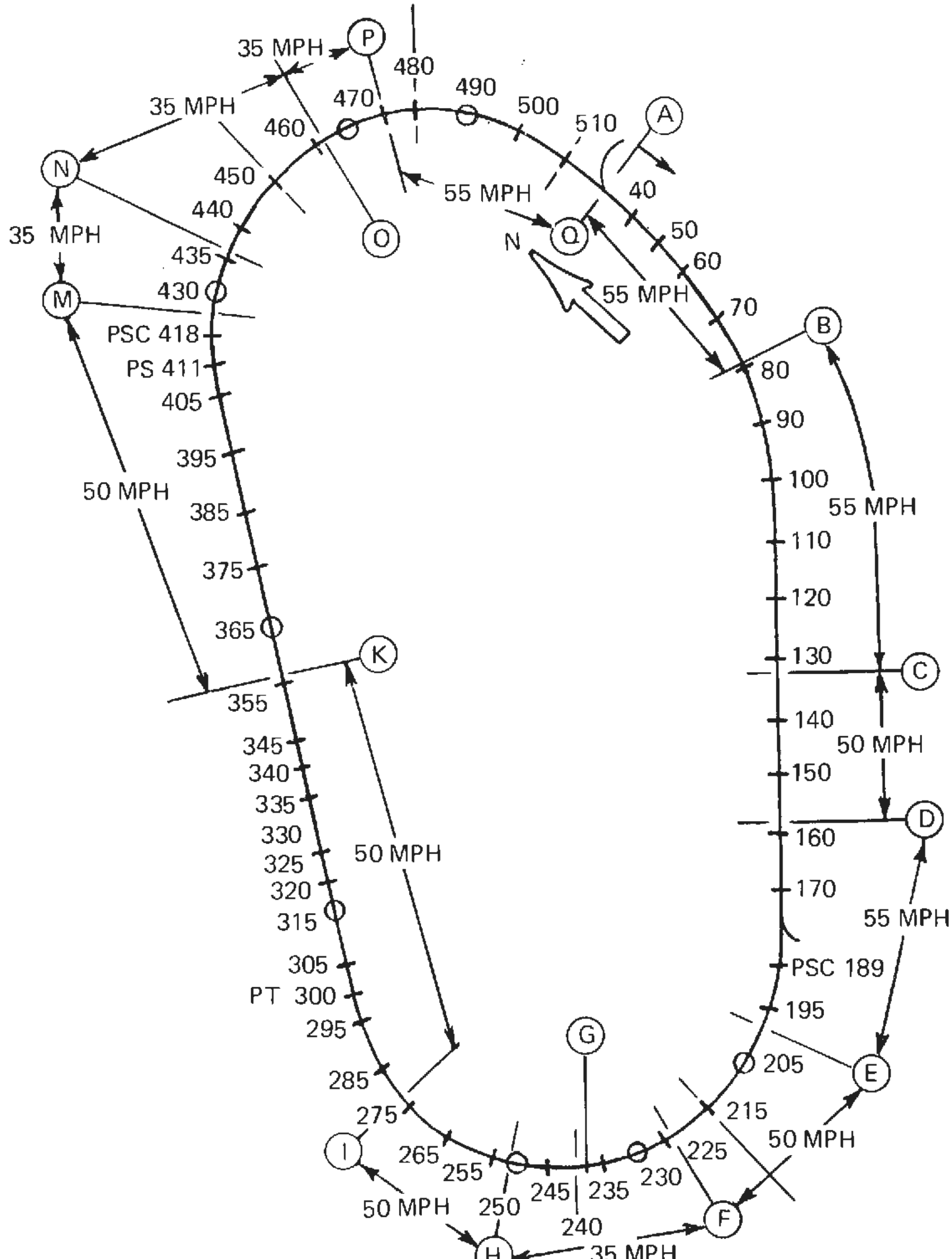

Figure 4-3. 1974 Simulated Demonstration Route at HSGTC

4.5 ENGINEERING TESTS

An abbreviated Engineering Test Program was conducted in accordance with Reference (1)[7] as follows:

Acceleration

Deceleration-Blended Braking

Power Consumption/Undercar Equipment Temperatures

Ride Quality

Structures

Interior Noise

Wayside Noise

The number of recorded test data points was greatly reduced from the total obtained during the original test program.

5.0 TEST RESULTS

5.1 SUBSYSTEM FUNCTIONAL TESTS

The test results for the items specified in Table 4-1 were recorded on the applicable test data sheets along with approved signatures. These are presented in Appendix A.

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7. See footnote 1 on p 1.

5.2 ACCEPTANCE TESTS

5.2.1 Speedometer Calibration

The maximum deviation between the speedometer indicated speed and the calculated speed was 1.5 mph at 80 mph, see Figures 5-1 and 5-2.

5.2.2 Acceleration Tests

Acceleration from a standing start to 700 ft. ranged from 18.8 to 19.5 seconds with average acceleration from 5 to 25 mph of 2.78 and 2.74 mphps, respectively. Both cars were tested individually and both met or exceeded the specification and/or previous test data, see Table 5-1.

TABLE 5-1

SUMMARY OF SOAC ACCELERATION TEST DATA

TEST PARAMETER	SOAC SPEC.	CAR NO. 1	CAR NO. 2
Avg. Acceleration (mphps)*	2.74 **	2.74	2.78
Time to travel 0 to 700 ft. from stand'g. start (secs.)	20	19.5	18.8
Time 0 to 60 mph (secs.)	34 **	33.8	31.2
Maximum Speed (mph)	80	80	79

*From 5 to 25 mph

**Previous Data (not a spec. item)

5.2.3 Deceleration Tests

Table 5-2 summarizes the deceleration rates and stopping distances together with the specification requirements or previous acceptance test data. The data for extended service braking, service friction braking and emergency friction braking modes are plotted in Figures 5-3, 5-4 and 5-5 respectively.

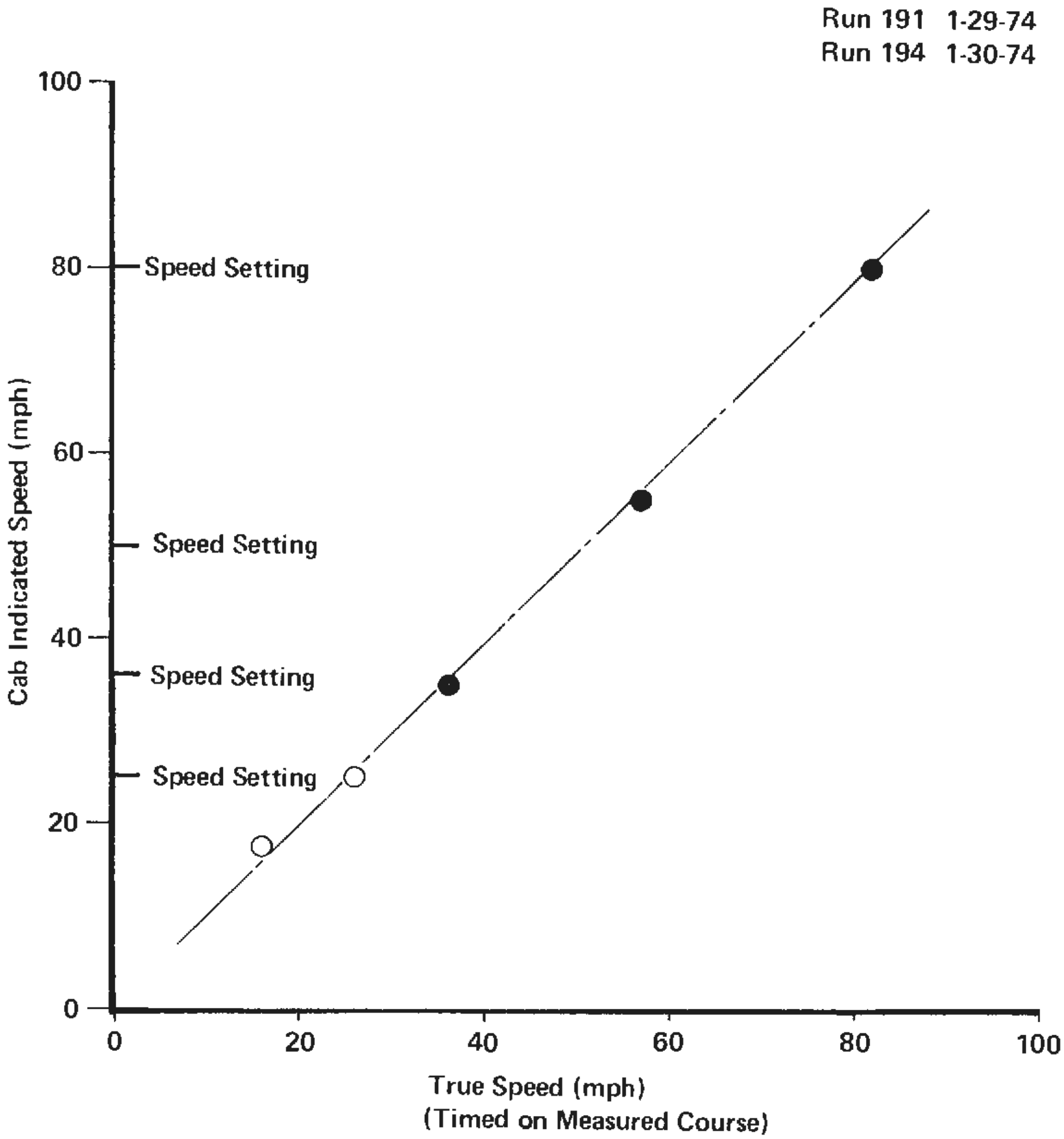

Figure 5–1. SOAC Speedometer Calibration – Low Density Car No. 1

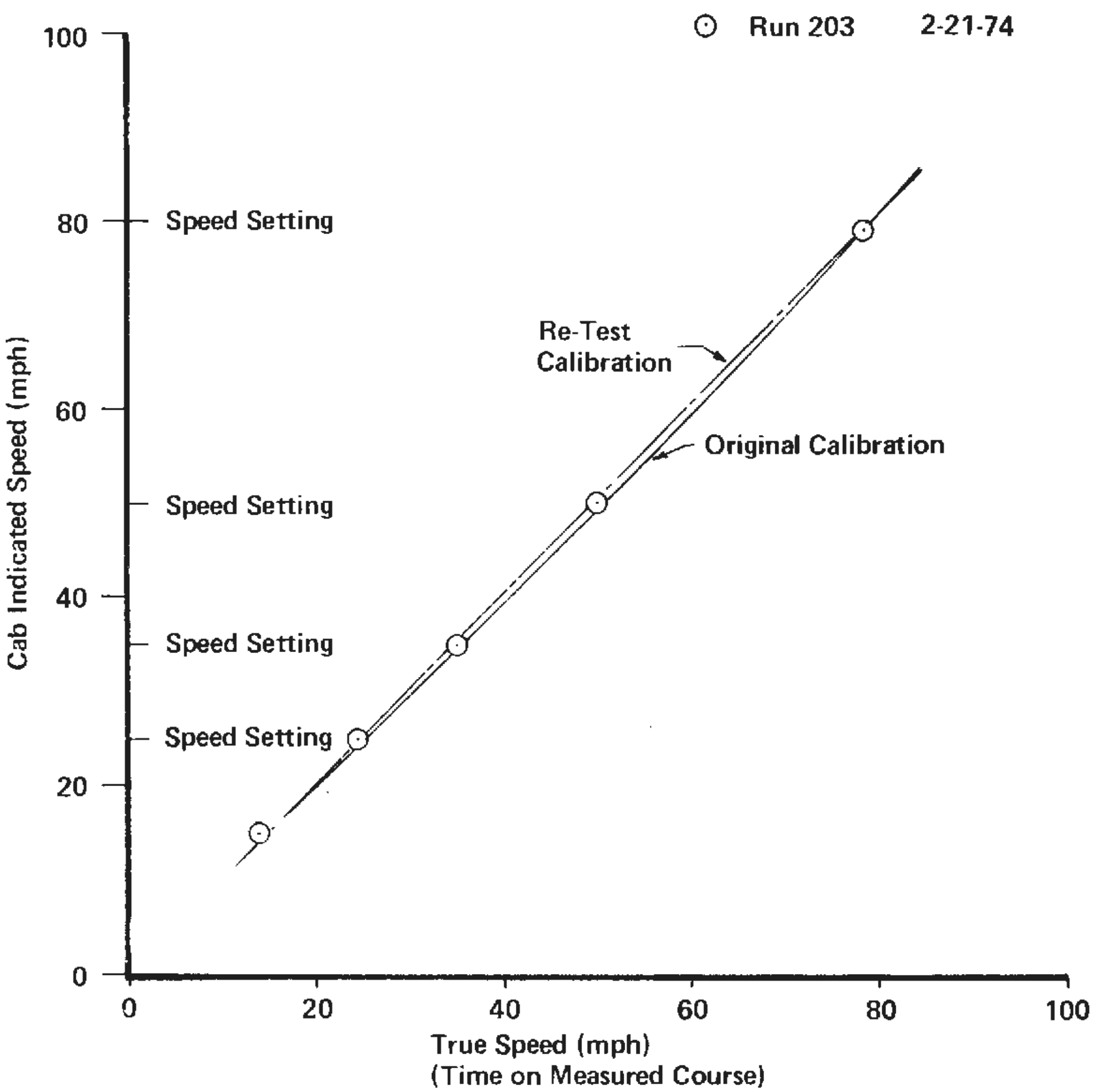

Figure 5–2. SOAC Speedometer Calibration – High Density Car No. 2

TABLE 5-2

SUMMARY OF SOAC DECELERATION TEST DATA

BRAKING MODE	SOAC SPEC.	PREVIOUS DATA	CAR NO. 1	CAR NO. 2	2 CAR TRAIN
Deceleration Rates*					
Blended Service (mphps)	**	3.1	3.3	3.4	3.5
Service Friction (mphps)	**	2.7	2.9	3.3	2.8
Emergency (mphps)	**	3.2	-	3.0	3.3
STOPPING DISTANCE FROM 40 MPH					
Blended Service (feet)	450	430-445	455	423	408
Service Friction (feet)	450	420-440	457	440	408
Emergency (feet)	425	335-365	365	372	349
STOPPING DISTANCE FROM 80 MPH					
Blended Service (feet)	2250	1650-1660	1700	1550	1539
Service Friction (feet)	2250	1925-2000	1967	1650	1653
Emergency (feet)	2200	1600-1635	1680	1560	1503

*Average from 60 to 30 mph (Car Weight 105,000 lb)

**Not a Spec. Item

5.2.4 Automatic Speed Maintaining System

ASMS functioned satisfactorily on both cars. All speeds were maintained within one (1) mph of the button setting.

5.2.5 Ride Quality Tests

A comparison of the original and the re-test vibration levels, together with the SOAC design goals for vertical and lateral vibrations at mid-car and aft car center line locations respectively are presented

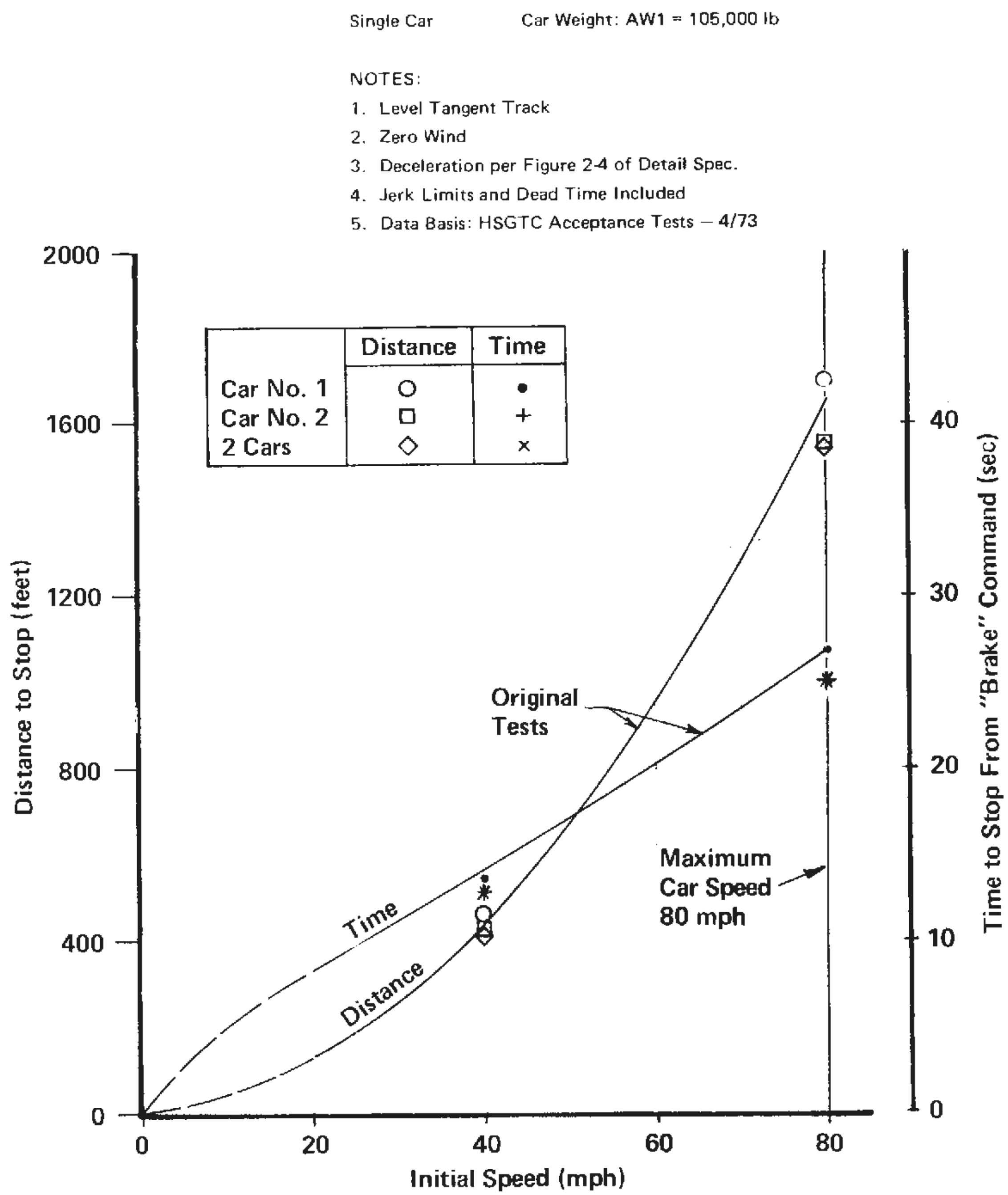

Figure 5–3. Comparison of Time and Distance to Stop Blended Service Braking with Original Tests.

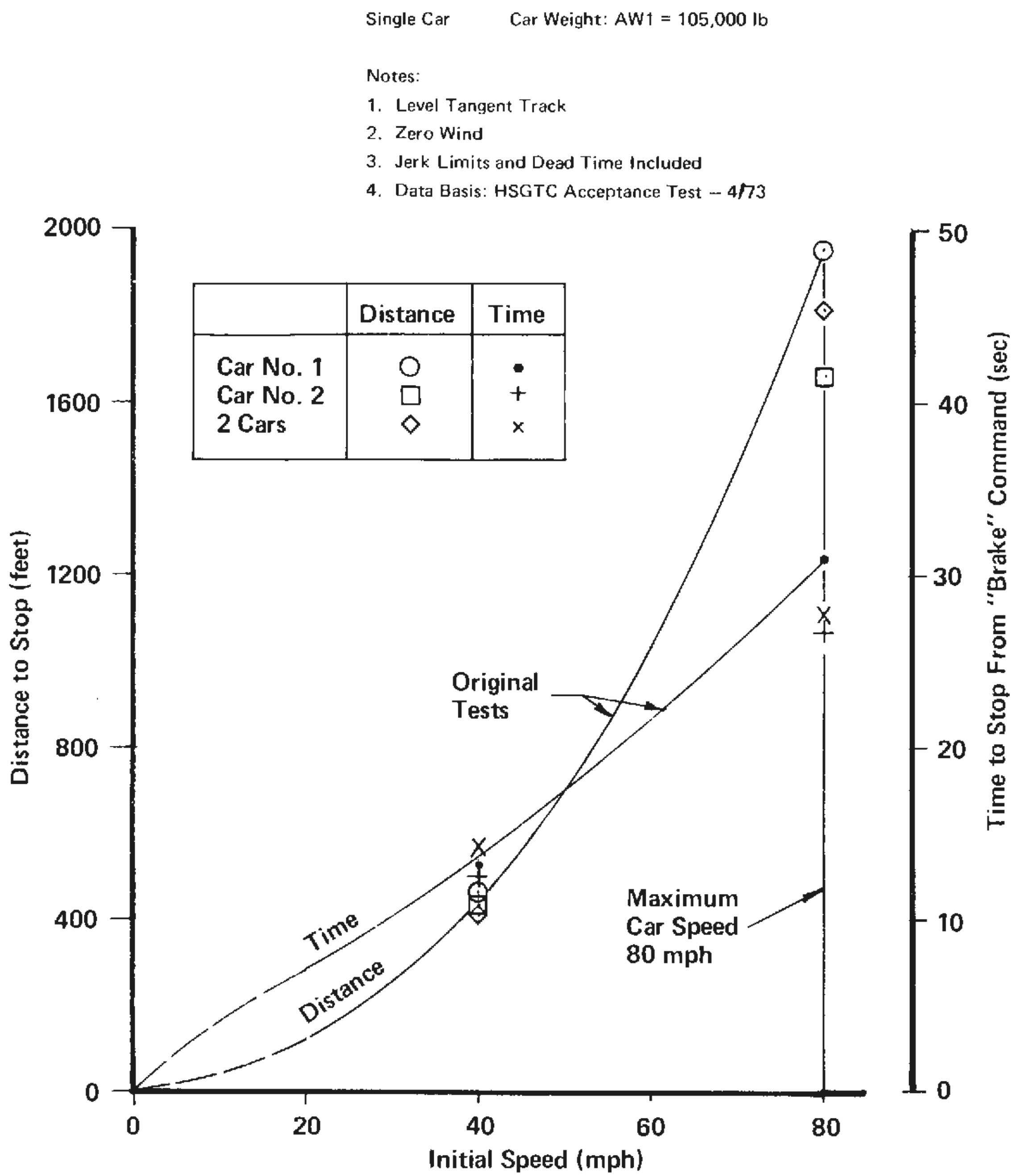

Figure 5–4. Comparison of Time and Distance to Stop Service Friction Braking with Original Tests

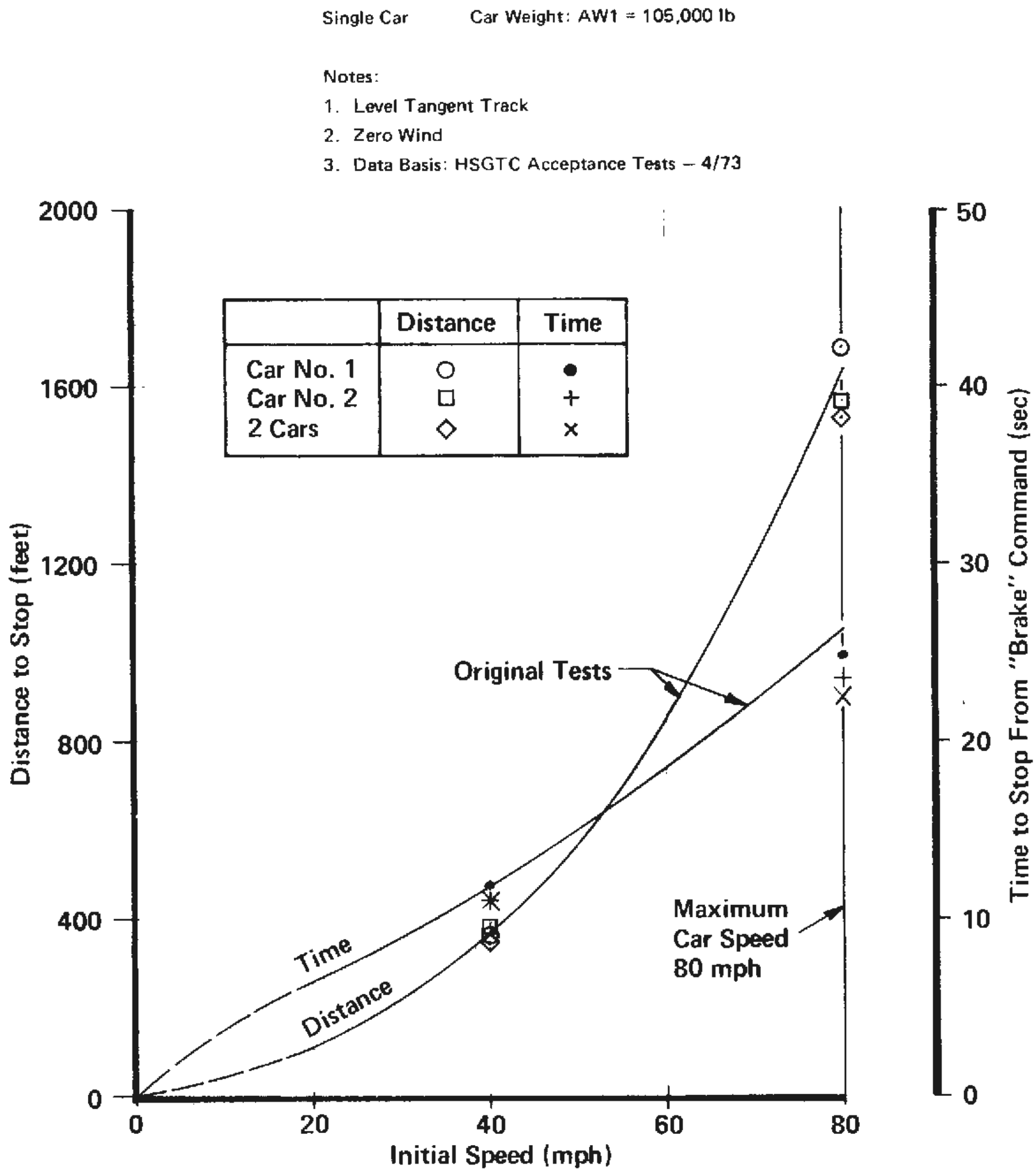

Figure 5–5. Comparison of Time and Distance to Stop Emergency Friction Braking with Original Tests

in Figure 5-6. All vibration levels are below the SOAC design goals with the exception of the vertical acceleration at 15 Hz. This exception at 15 Hz was measured at a corrected true car speed of 94 mph instead of 80 mph as originally programmed. This 15 Hz bending mode is sharply dependent upon speed and a very small difference in speed between the original tests and the retests could account for the differences.

5.3 SIMULATED DEMONSTRATION

The first part of the Simulated Demonstration program was conducted from February 27th to March 13, 1974 with 1555 miles of two-car train operation accumulated in eight (8) days of testing. The second part of the program was conducted from March 29th to April 10, 1974 with 1456 miles of two-car train operation accumulated in five (5) days of testing. See Table 5-3 and Figure 5-7.

The only significant discrepancies were encountered during the first part of the program. They were:

(1) Broken motor brushes due to high commutator bars. Corrected by grinding the commutator.

(2) One slip-slide circuit card failure.

(3) One B (+) short to ground in the airflow circuit.

(4) One (intermittent) short in the P-wire cable.

It was further noted that there was no gearbox oil leakage through the labyrinth seals. This indicates that the leakage problem noted during the original test program was solved by installation of the drains as originally shown on the gearbox drawings.

5.4 CAB SIGNALLING

An operational checkout of the MBTA cab signalling equipment was conducted April 5, 1974. Both cars were checked individually using a tape recorder input to the signal receivers. The SOAC propulsion control system automatically responded to the signals by accelerating, decelerating and maintaining speed of the train as called for by the signals.

A signal noise problem was encountered when in the vicinity of the diesel electric locomotive providing track power. The electrical noise generated caused intermittent brake applications. Since this type of 600 v power source will not be encountered on the transit properties where cab signalling will be used, this was not a cause for concern.

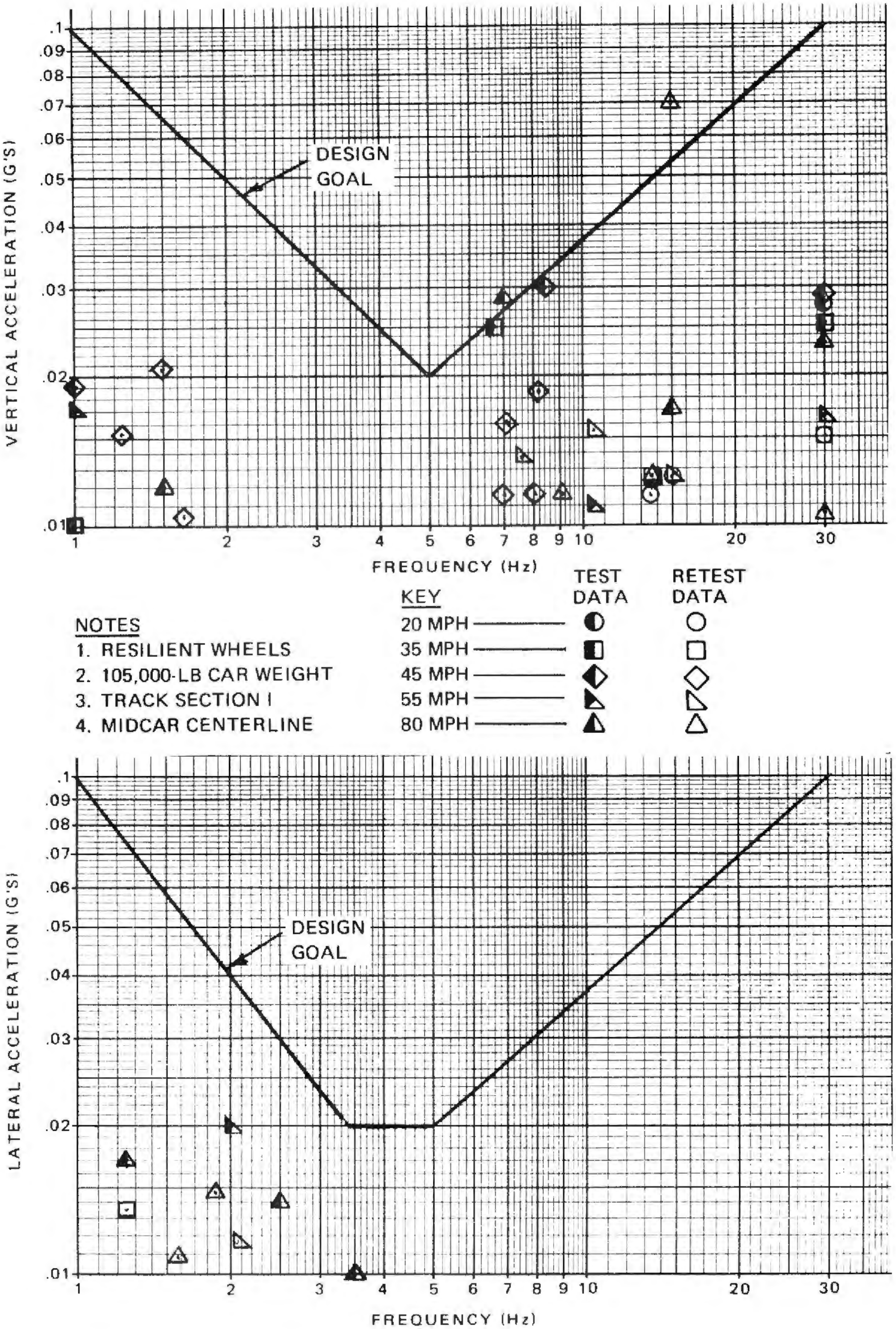

Figure 5–6. Comparison of High-Density Car Ride Quality and Goals

TABLE 5-3

TEST RUN LOG-SOAC SIMULATED DEMONSTRATION 1974

RUN NO.	DATE	MILES RUN
PART (1)		
208	Feb. 27	82
209	Feb. 27	182
210	Feb. 28	118
211	Feb. 28	164
212	March 5	172
213	March 6	82
214	March 8	82
215	March 8	182
216	March 11	118
217	March 12	118
218	March 12	219
219	March 13	36
	SUB-TOTAL	1555
PART (2)		
233	March 29	155
234	April 1	364
238	April 8	364
239	April 9	400
240	April 10	173
	SUB-TOTAL	1456
	TOTAL	3011 MILES

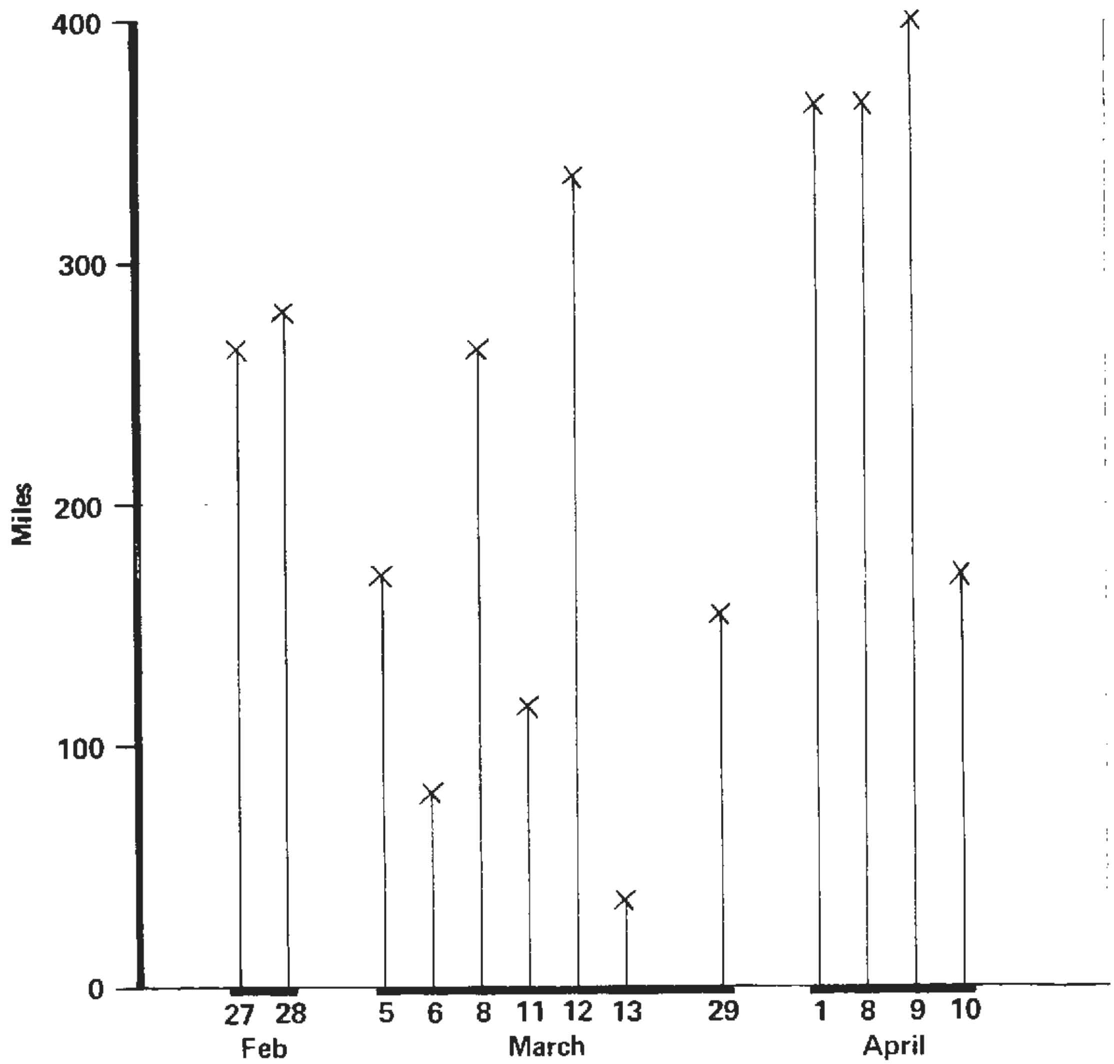

Figure 5–7. Daily Mileage Accumulation During Simulated Demonstration 1974

5.5 ENGINEERING TESTS

The Engineering Tests were conducted under Contract DOT-TSC-580 to show continuity with the original engineering test data. Results of these tests are reported in "State-of-the-Art Car (SOAC) Post-Repair Engineering Tests at Department of Transportation High Speed Ground Test Center", Report No. UMTA-MA-06-0025-75-7. The following paragraphs present brief descriptions of the test results:

5.5.1 Acceleration Tests

The test results for the post-repair tests are sufficiently close to those obtained from the original tests to conclude that there was no appreciable change due to the repairs.

5.5.2 Deceleration Tests

The deceleration rates for all the post-repair tests exceeded those measured during the original tests. Even though they exceeded the SOAC specification rates, it was not considered necessary to make any system changes prior to starting demonstration testing.

5.5.3 Power Consumption and Undercar Equipment Temperature Tests

The test data showed that the current and rms values for the motor armature and field at the 90,000 lb car weight were slightly less than for the 105,000 lb car weight. A comparison between the post-repair tests and the original tests shows the former to be approximately 12% less than the latter.

5.5.4 Ride Quality Tests

See Paragraph 5.2.5.

5.5.5 Interior Noise Tests

The post-repair measured sound levels, without the air conditioning duct silencer installation, fall within the total envelope of data measured on both SOAC cars; therefore, the interior noise baseline data base obtained during the original test program is still valid. Additionally, it is concluded that the air conditioning air duct silencer installation did have a beneficial effect in providing more uniform sound levels throughout the car.

5.5.6 Wayside Noise Tests

The comparison of post-repair and original test results for the No. 2 SOAC at 90,000 lb car weight with resilient wheels shows substantial agreement after normalizing to a standard condition.

5.5.7 Structure Tests

A comparison of post-repair test results with those from the original tests shows the following:

- The relationships of load levels and phasing are similar to the original test data. No significant differences were noted.
- One of the truck frame strain gages showed strain levels at 80 mph slightly higher than the original data but well below the design criteria for truck loads.

6.0 CONCLUSIONS

6.1 SUBSYSTEM FUNCTIONAL TESTS

All subsystems met specification requirements as shown by the signed data sheets.

6.2 ACCEPTANCE TESTS

- The Speedometer Calibration, Acceleration, and Automatic Speed Maintaining System test results showed that the SOAC cars met or exceeded the SOAC specification requirements.
- The Deceleration tests showed the measured deceleration rates to be somewhat higher than those from the original tests; however, the increases were not considered significant. Stopping distances were within the SOAC specification requirements.
- The Ride Quality test results showed peak acceleration to be in good agreement with previous test data except for the 15 Hz point which was taken at a speed of 94 mph instead of the programmed 80 mph speed. SOAC Ride Quality Performance is considered satisfactory.

6.3 SIMULATED DEMONSTRATION TESTING

The SOAC Performance during the Simulated Demonstration Operations totaling more than 3000 miles of two-car train operation was satisfactory with only four discrepancies of a random nature.

6.4 ENGINEERING TESTS

The test data obtained from the Engineering Tests shows satisfactory continuity between the data obtained during the original tests and the post-repair tests.

6.5 SOAC POST-REPAIR TEST PROGRAM

In conclusion, the overall results for the post-repair testing were as follows:

(a) Compliance with the original SOAC acceptance criteria was demonstrated.

(b) Test data continuity between the original and the post-repair tests was established.

(c) The 3000 mile two-car operation goal for the Simulated Demonstration testing was satisfactorily reached.

REFERENCES

1. State-of-the-Art Car Test Program

   Appendix I (Test Plan and Procedures for Post-Repair Testing),Document D174-10007-1, Boeing Vertol Company, Philadelphia, Pa., January 24, 1974.

2. Urban Rail Rapid Transit SOAC Engineering Tests at Dept. of Transportation HSGTC, Document No. D174-10026-6 (Volume VI), Boeing Vertol Company, Philadelphia, Pa., May 1974.

3. Detail Specification for State-of-the-Art Car, Document No. IT-06-0026-73-2, Urban Mass Transportation Administration, May 1973.

4. State-of-the-Art Car Test Program, Document No. D174-10007-1 Boeing Vertol Company, Philadelphia, Pa., April 28, 1972.

APPENDIX A

ACCEPTANCE TESTS

SUBSYSTEM FUNCTIONAL TEST DATA SHEETS [8]

8. Test data sheet forms are reproduced from Reference 4, State of the Art Car Test Program, Document No. D174-10007-1, Boeing Vertol Company, Philadelphia, Pa., April 1972.

GATHERING RANGE AND COUPLE/UNCOUPLE

Test Results

Test Date: 3-11-74 Car # 2

Conclusions:

Couplers have sufficient gathering range. YES

Test Data:

1. Couple cars with couplers displaced to "A" side of Center

#2 End OK

2. Couple cars with couplers displaced to "B" Side of Center

#2 End OK

3. Couple cars with #2 car rotated 5°.

OK

Tested By: J. McKoon Date: 3-11-74

Approved By (Engr.) Date: 3/11/74

Approved By (Q. A.) Date:

c. ELECTRIC COUPLERS

Test Results

Test Date: 2/25/74 Car # 2

Conclusion:

1. #1 End Hook Operates YES
2. #2 End Hook and Contact Pins Operate YES

Test Data:

1. Time between operation of uncouple button and operation of the hook FOUR Seconds.

Tested By: [signature] Date 2/25/74

Approved By(Engr.) [signature] Date 2/25/74

Approved By(Q.A.) ______ Date ______

CAMBER (Contd.)
Test Results

Test Date: 10-11-73 Car # 2

Test Conclusion:

1. Car has positive camber YES

Side	A	B	C	$\frac{A+B}{2}$	$C - \frac{(A+B)}{2}$	Camber
B	23.420	23.410	23.655	23.415	.240	.240

Tested By: DUKART/GRIFFIN Date: 10-11-73

Approved By(Engr.) F. Boma Date: 12-10-73

Approved By(Q.A.) ____ Date: ____

g. AIR COMFORT

Test Results

Test Date: 2/25/74 Car # 2

Conclusion:

1. "A" End unit responds to thermostat YES

"B" End unit responds to thermostat YES

Test Data:

Condition (O-Open, C-Closed)

1. Fresh Air	Overhead Thermo.				Duct Therm.	Result
35°	70°	72°	74°	75°	76°	
C	0	0	0	0	0	Full Overhead and Floor Heat ON.
C	0	0	0	0	C	9 KW Overhead Heat ON Floor Heat ON.
C	0	0	0	0	C	Floor Heat ON. 9 KW Overhead Heat ON.
*	C	C	C	0	*	All Heat OFF
*	C	C	O	0	*	9 KW Overhead Heat ON Modulated Cooling
*	C	C	C	0	*	Modulated Cooling, No Hear
*	C	C	0	0	*	Full Cooling, Floor Heat ON.

2. Layover Therm Closed.

Tested by: [signature] Date 2/25/74

Approved by (Engr.) [signature] Date 2/25/74

Approved by (Q.A.) ____________ Date ____________

i. END DOOR

Test Results

Test Date: 3-17-77 Car # 2

Conclusion:

1. End Door Lock Electrically Yes
2. End Door Lock Mechanically Yes
3. End Door Unlock Electrically or Mechanically Yes
4. End Door Unlock Electrically from Outside Yes
5. End Door Latches without assistance Yes

Test Data:

1. Opening Force 24 Lbs.
2. Closing Force 8 Lbs.

Tested By [illegible] Date: 3-17-77

Approved By (Engr.) [illegible] Date: 3-22-77

Approved By (Q.A.) ______ Date: ______

j. SIDE DOOR

Test Results

Test Date: 2/25/74 Car # 2

Conclusions:

1. "A" Side Doors respond to "A" Side Conductor's Panel. YES
2. "B" Side Doors respond to "B" Side Conductor's Panel. YES
3. Side Doors respond to trainline signals. YES
4. Trainlines respond to "A" and "B" Side Conductor's Panel. YES

Test Data:

1. Door Open Time. 1.6 Seconds.
2. Door Close Time. 2.0 Seconds.

Tested By: D. A. McCoy Date

Approved by (Engr.) W. Webb Date 2/25/74

Approved by (Q.A.) Date

Test Result - SOAC - Windshield

Test Date: 3 16 74 Car # 2

Conclusions: Windshield can be opened as an emergency exit. YES

Test Data:

	Top	Bottom	
1. Latch unlock force	26	31	lbs.
2. Windshield open force	220		lbs.
3. Open Angle	70+0		o

Tested By: [illegible] Date: 3-17-74

Approved by (Eng.) [illegible] Date: 3-22-74

Approved by (Q.A.) ____________ Date: ____________

a. HEAD AND TAIL LIGHTS

Test Results

Test Date: 2-12-74 Car # 2

Conclusions:

1. Headlights function YES
2. Headlights aimed YES
3. Back-up lights aimed YES
4. Back-up lights function YES
5. Taillights #1 End Function YES
6. Taillights #2 End Function YES

Tested By: [illegible signature] Date:

Approved By (Engr.) [illegible signature] Date: 2-12-74

Approved By (Q.A.) Date:

b. CAB LIGHTS

Test Results

Test Date: 2-12-74 Car # 2

Conclusions:

1. Cab light function independently from car lights. YES

2. Cab light level is satisfactory. YES

Tested By: [illegible] Date: 2/12/74

Approved by (Engr.) [illegible] Date: 2/12/74

Approved by (Q.A.) ______ Date: ______

c. CONSOLE LIGHTS

Test Results

Test Date: 9-12-77 Car # 2

Conclusions:

1. All lamps function. yes

Tested By: ______________ Date: ______________

Approved by (Engr.) ______________ Date: ______________

Approved by (Q.A.) ______________ Date: ______________

d. EMERGENCY LIGHTS

Test Result

Test Date: 2-12-74 Car # 2

Conclusions:

1. Emergency Lights operate satisfactorily Yes

Test Data:

1. Time from 600 V removal to emergency light operation 23 Seconds.
2. Emergency Light battery drain 2.68 Amps.

Tested By: [signature] Date: 2-12-74

Approved By (Engr.) [signature] Date: 2/12/74

Approved By (Q.A.) ______ Date: ______

600 VDC Removal simulated by removing 1 & 2 Inputs to inverter

[signature]

e. MAIN LIGHTING

Test Results

Test Date: 2/22/74 Car # 2

Conclusions:

1. Overhead LIghts operate satisfactorily YES.
2. Inverter Output Voltage 550 VAC

   500 Hz
3. Inverter Input Voltage 36 VDC

Tested By: D McEvoy Date: 2/22/74

Approved By (Engr.) [illegible] Date: 2/22/74

Approved By (Q.A.) ____________ Date: ________

a. HIGH POTENTIAL (Contd.)

Test Results

Test Date: 10/19/73 Car # 3

Conclusions:

1. No. Breakdown in 32 VDC circuits 0
2. No. Breakdown in 600 VDC circuits 0
3. No. Breakdown in 230 VAC circuits 0

Test Data:

1. Minimum insulation resistance N/A
2. Hipot Voltage 32 VDC circuits 1 KV
3. Hipot Voltage 600 VDC circuits 1.5 KV
4. Hipot Voltage 230 VAC circuits 1.5 KV

Tested By: [illegible] Date: 10/19/73

Approved By (Engr.) [illegible] Date: 10/19/73

Approved By (Q.A.) ____________ Date: ________

MAIN POWER APPLICATION

Test Results

Test Date: 2/25/75 Car # 2

Conclusions:

Motor Alternator Voltage is satisfactory: YES.

Test Data:

1.	Input Voltage	600	VDC
2.	No Load Condition		
a.	Input Current	17	AMPS DC
b.	Phase A Voltage	220	VAC
c.	Phase B Voltage	220	VAC
d.	Phase C Voltage	220	VAC
e.	Output Frequency	60 +	Hz
f.	Rectifier Output Voltage	37	VDC
3.	Loaded Condition		
a.	Input Current	91	AMPS DC
b.	Phase A Voltage	220	VAC
c.	Phase B Voltage	220	VAC
d.	Phase C Voltage	220	VAC
e.	Output Frequency	60+	Hz
f.	Rectifier Output Voltage	35.5	VDC

Tested By: [signature] Date: 2/25/74

Approved By (Engr.): [signature] Date: 2/25/74

Approved By (Q.A.): ____________ Date: ________

c. TRAINLINES

Test Results

Test Date 7/24   Car # 2

Conclusions:

1. There is continuity between #1 end junction box and #2 end junction box. Yes

2. There is continuity below #2 end junction box and #2 end coupler. Yes

Test Data:

Line	Continuity Checked
Door Open "A"	✓
Door Closed "A"	✓
Door Open "B"	✓
Door Closed "B"	✓
Traction Interlock.	✓
EMV1	✓
EMV2	
Propulsion Trip Indicator	✓
Snow Brake ON	✓
Snow Brake Indicator	✓
Friction Brake Indicator	✓
Handbrake Indicator	✓
Brake B+	✓
Slip/Slide Indicator	✓
CSR Control	✓
Crawl Mode	✓
Reset	✓

c. TRAINLINES (Contd.)

Test Results:

Forward

Reverse

"P" Signal

"P" Signal Return

SP2

SP1

Motorman Signal Light

Zone Light

Tested By: [illegible] Date [illegible]

Approved By: (Engr) [illegible] Date 2/5/74

Approved By: (Q.A) ______________ Date ______________

a. WINDSHIELD WIPER

Test Results

Test Date: 2/22/74 Car # 2

Conclusions:

1. Windshield Wiper Functions YES.
2. Windshield Washer Functions YES

Test Data:

1. Wiping Frequency W.P.S. 2 Max.
2. Air Pressure P.S.I. 90

Tested By: [signature] Date: 2/22/74

Approved By(Engr.) [signature] Date: 2/22/74

Approved By(Q.A) ______ Date: ______

b. HORN

Test Results

Test Date: 2/26/74 Car # 2

Conclusions:

1. Horn functions properly Yes.

Test Data:

1. Horn Pressure PSI 150 Max.

Tested By: [illegible] Date: 2/26/74

Approved By(Engr.) [illegible] Date: 2/28/74

Approved By(Q.A.)________ Date:________

c. PUBLIC ADDRESS

Test Results

Test Date: 2-12-74 Car # 2

Conclusion:

1. All speakers balanced YES
2. Chime circuit functions YES
3. Motormans handset functions YES

Tested by: D.P. McCoy Date: 2/12/74

Approved by (Engr.) ______ Date: ______

Approved by (Q.A.) ______ Date: ______

d. RADIO

Test Results

Test Date: [illegible] Car # 2

Conclusion:

1. Car #1 receives from and transmits to Car #2 Yes
2. Car #2 receives from and transmits to Car #1 Yes

Tested by: [illegible] Date: [illegible]

Approved by(Engr.) [illegible] Date: [illegible]

Approved by (Q.A.) ______ Date: ______

f. SIDE SIGN

Side Sign Operation:

1. Place the following circuit breakers on the LVCBP to the position indicated:

10A	On
10B	On

2. Insert console key into sign key switch and observe that the curtain moves forward and reverse in response to key position.

3. Check operation of both side signs using key.

4. Place the following circuit breakers on the LVCBP to the position indicated:

10A	Off
10B	Off

Test Results

Test Date: 3-17-74   Car Number: 2

Conclusions:

Side sign operation is satisfactory:

Tested by: [illegible]   Date: [illegible]

Approved by (Engr.): [illegible]   Date: [illegible]

Approved by (QA): ____________   Date: ____________

MAIN PROPULSION CONTROL & MOTOR ROTATION

TEST RESULTS

TEST DATE: 2/1/74 CAR # 2

CONCLUSION:

1. Propulsion System Operation Correct YES
2. Motor Rotation Correct YES

TEST DATA:

1. Direction of Car Movement when Master Controller Key is in Forward Position and Control Handle is in Power Position Forward
2. Direction of Car Movement when Master Controller Key is in Reverse Position and Control Handle is in Power Position Reverse

TESTED BY: G. Davis DATE: 2/1/74

APPROVED BY (ENGR.): [illegible] DATE: 2/1/74

APPROVED BY (Q.A.): ____________ DATE: ____________

a. MAIN BRAKE/EMERGENCY/BRAKE

Test Results

Test Date: 3-17-74 Car # 2

Conclusion:

1. There are no leaks (piping) in pneumatic system YES
2. Main reservoir pressure adequate YES

Test Data:

1. Time for compressor to build main reservoir pressure (0 to modulate) 4 MIN 55.6 Seconds
2. Compressor Modulation 133.0 psi Cut-in
   150.0 psi Cutout
3. Leak Test - Air .5 psi/Min.
4. Brake cylinder pressure: #1 End Full Service 67 psi
   #1 End Release Time 2 Seconds
   #1 End Apply Time 1.7 Seconds
   #2 End Full Service 66 psi
   #2 End Release Time 2.1 Seconds
   #2 End Apply Time 1.8 Seconds
   #1 End Load sensor full load brake cylinder pressure 67 psi
   #2 End load sensor full load brake cylinder pressure 66 psi

   [illegible] CAR.
5. Trip Cock Functions: Car goes into Emergency ✓ yes __ no
   Trip cock automatically resets ✓ yes __ no

a. MAIN BRAKE (Contd.)

Test Results (Contd.)

6. Emergency valve function: Car goes into Emergency ✓ yes

___ no.

7. Deadman functions: Car goes into Full Service brake when handle released ✓ yes ___ no.

8. Emergency brake cylinder pressure.

#1 End 75 psi

#2 End 75 psi

Time to recharge 40 Seconds

Tested By: J. McK[illegible] Date: 3-12-74

Approved By (Engr.) [illegible] Date: 3-12-74

Approved By (Q.A.) ____________ Date: ____________

b. HANDBRAKE

Test Results

Test Date: [illegible] Car # [illegible]

Conclusion:

1. Handbrake functions properly [illegible]

Test Data:

1. Number of pumps for full service application [illegible]

2. Number of pumps for full release [illegible]

Tested By: [illegible] Date: [illegible]

Approved By(Engr.) [illegible] Date: [illegible]

Approved By(Q.A.)__________ Date:__________

d. SNOW BRAKING

Test Results

Test Date: 3/12/74 Car # 2

Conclusions:

1. Snow brake operated independently from "P" signal Yes

Test Data:

1. Cylinder Pressure:

A End 8 PSI.

B End 8 PSI.

Tested By: W. Cobb Date: 3-12-74

Approved By (Engr.) ______ Date: 3/12/74

Approved By (Q.A.) ______ Date: ______

9. PROPULSION AUXILIARIES

Test Results

Test Date: 2-7-84 Car # 2

Conclusion:

1. There is sufficient cooling air to the motor alternator Yes
2. There is sufficient cooling air to the traction motors Yes

Test Data:

1. Motor Alternator starts properly Yes
2. Motor Alternator load sheds properly Yes
3. Motor Alternator cooling air pressure Not measured psi N/A
4. Traction Motor cooling air pressure

#1 6.4 psi
#2 6.3-6.4 psi
#3 6.3-6.4 psi
#4 6.3-6.4 psi.

Tested By: [illegible] Date: 2/7/84

Approved By(Engr.) [illegible] Date: 2/2/84

Approved By(Q.A.) Date:

10. CAR WEIGHT

Test Results

Test Date:______________________________ Car #___________________

Test Data:

Weight #1 End____________________________lbs.

Weight #2 End____________________________lbs.

Total Weight ______________________________lbs.

12. AIR COMPRESSOR

Test Results

Test Date: 3/16/74 Car # 2

Conclusion:

1. Air compressor has sufficient capacity YES

Test Data:

1. Time for compressor to recharge system after four (4) successful brake applications 1 min 34 sec Seconds.

2. Main Reservoir air pressure after one (1) brake cylinder hose has been disconnected and brakes applied once 140 psi.

Tested By: [illegible] Date: 3/12/74

Approved By(Engr.) [illegible] Date: 3/12/74

Approved By(Q.A.) Date:

HOSTLING PANEL

Test Results

Test Date: ______________________ Car # ______________

Item	YES	NO
Item 4. "Forward" Position:		
4-a) Car moved forward when "Go" button was pressed.		
-b) Car braked when "Go" button was released.		
-c) Car continued to move forward without braking.		
-d) Car braked when "Coast" button was released.		
Item 5. "Reverse" Position:		
5-a) Car moved backward when "Go" button was pressed.		
-b) Car braked when "Go" button was released.		
-c) Car continued to move backward without braking.		
-d) Car braked when "Coast" button was released.		
Item 6. Car uncoupled and coupled satisfactorily using hostler.		

Tested By: ______________________ Date: ______________

Approved By (Engr.) ______________________ Date: ______________

Approved By (Q.A.) ______________________ Date: ______________

14. VISUAL

Test Results

Test Date: 4-12-74 Car # 2

Conclusion:

1. Car is complete and satisfactory for shipment.

YES

Tested By: [signature] Date:

Approved By (Engr.) [signature] Date: 4-12-74

Approved By (Q.A.) Date: