Report No. UMTA-IT-06-0026-75-2

SOAC

STATE-OF-THE-ART CAR DEVELOPMENT PROGRAM

VOLUME 2: REPAIR, RE-TEST AND OPERATIONAL EVALUATION

BOEING VERTOL COMPANY
(A Division of The Boeing Company)
Surface Transportation Systems
Philadelphia, Pa. 19142

SEPTEMBER 1975

FINAL REPORT

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Prepared for

URBAN MASS TRANSPORTATION ADMINISTRATION
Office of Research and Development
Washington, D.C. 20590

Technical Report Documentation Page

1. Report No.	UMTA-IT-06-0026-75-2
2. Government Accession No.	
3. Recipient's Catalog No.	
4. Title and Subtitle	SOAC STATE-OF-THE-ART CAR DEVELOPMENT PROGRAM, Vol 2. Repair, Re-Test and Operational Evaluation
5. Report Date	September 1975
6. Performing Organization Code	
7. Author(s)	W. H. Dunton
8. Performing Organization Report No.	D174-10031-2
9. Performing Organization Name and Address	Boeing Vertol Company (A Division of The Boeing Company) Surface Transportation Systems Branch Philadelphia, Pa. 19142
10. Work Unit No. (TRAIS)	IT-06-0026
11. Contract or Grant No.	DOT-UT-10007
12. Sponsoring Agency Name and Address	Department of Transportation Urban Mass Transportation Administration Office of Research and Development Washington, D.C. 20590
13. Type of Report and Period Covered	Final Report (August 1973 to May 1975)
14. Sponsoring Agency Code	
15. Supplementary Notes	

16. Abstract

As systems manager for the Urban Mass Transportation Administration's Urban Rapid Rail Vehicle and Systems Program, the Boeing Vertol Company supervised the design, fabrication and test of two new State-of-the-Art Cars (SOAC) whose objective was to demonstrate the best available (1971-72) rail rapid transit vehicle technology. Passenger convenience and operating efficiency were primary goals for the cars which were designed to be operated on at least one line of the rapid transit systems in New York, Boston, Cleveland, Chicago and Philadelphia. Built by the St. Louis Car Division of General Steel Industries, the SOAC features a DC-DC chopper in the propulsion system, separately excited DC traction motors, all-steel construction (with molded fiberglass ends), and vandal-resistant and fire-retardant materials in the interior. Volume 1 of this report, covered the development program through engineering testing; including data on design and performance, propulsion and braking, subsystems, test program, mockup and demonstration programs, and economic analysis. This volume, Volume 2, of a two-volume report covers the repair of the damage sustained by the No. 2 car in an accident at the Transportation Test Center (TTC) in August 1973, the post-repair testing at the TTC, and the operational evaluation of the SOAC in revenue service in New York, Boston, Cleveland, Chicago and Philadelphia.

17. Key Words	18. Distribution Statement
SOAC Report State-of-the Art Car UMTA URRV Program Modern Rapid Transit	Availability is unlimited. Document may be released to the National Technical Information Service, Springfield, Virginia 22151, for sale to the public.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED			

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1. INTRODUCTION

In June 1971, the Boeing Vertol Company was awarded a contract (DOT-UT-10007) for systems management of the Urban Rapid Rail Vehicle and Systems Program (URRVS), whose overall objective is to enhance the attractiveness of urban rail transportation. Sponsored by the U.S. Department of Transportation's Urban Mass Transportation Administration (UMTA), the program builds upon and accelerates the technical evolution of rail rapid transit so that new urban rail systems and system extensions can benefit from improved operating economics and enhanced passenger appeal.

1.1 URBAN RAPID RAIL VEHICLE AND SYSTEMS PROGRAM

Boeing is performing eight tasks under the Urban Rapid Rail Vehicle and Systems Program:

1. Provide program management in implementing UMTA efforts toward improving high-speed, frequent-stop urban rail systems.

2. Monitor the testing of the BART prototype cars for input to the program. (Complete)

3. Using BART as a baseline, and using current (1971-1972) technology in car building, direct the design and construction of two new State-of-the-Art Cars (SOAC), representative of the best available technology; demonstrate these cars to the transit authorities and the riding public in five major cities. (Complete)

4. Conduct an industry-wide design competition and award contracts to produce a two-car Advanced Concept Train (ACT-1), representative of the next generation of rail transit cars; demonstrate these cars to the transit authorities and the riding public in five major cities.

5. Conduct an industry-wide design competition and award contracts for alternative advanced subsystems under the Advanced Subsystem Development Program (ASDP).

6. Plan for an operational demonstration of an advanced train that incorporates the major advances of SOAC, ACT-1 and ASDP, which is to be called ACT-3.

7. Perform an economic analysis of the SOAC and ACT cars leading to estimates of life cycle costs in production quantities.

8. Perform a human factors evaluation of the SOAC, and ACT cars.

1.2 STATE-OF-THE-ART CAR (SOAC) PROGRAM

The objective of the SOAC task was to demonstrate the current state-of-the-art in rail rapid transit vehicle technology. This objective was fulfilled by the development, test, and demonstration of two rail rapid transit cars embodying the best available (1971-72) technology. Passenger convenience and operating efficiency were primary goals for the cars which were designed to be capable of operation on at least one line of the rapid transit systems in New York, Boston, Cleveland, Chicago and Philadelphia.

The two SOAC cars were designed, fabricated, functionally tested and delivered to the U.S. Transportation Test Center (TTC) in Pueblo, Colorado, 11-1/2 months after contract go-ahead by the St. Louis Car Division of General Steel Industries. The cars were shipped to the Rail Transit Test Track at the TTC in August, 1972 and on October 12, SOAC was unveiled and demonstrated to the public, including Secretary of Transportation John Volpe, and other officials.

During 1973, the SOAC vehicles underwent an extended period of engineering testing. A delay in operational testing and evaluation was caused by a switching accident in August, 1973 necessitating major repairs to one of the two cars. The results of the SOAC development program through August 1973, and the economic analysis are reported in Volume I of this report, entitled "State-Of-The-Art Car Development Program, Volume 1: Design, Fabrication and Test".

SOAC repairs were completed in December, 1973. The cars were returned to the TTC and systems testing was repeated on the repaired cars between January and April, 1974.

The operational test and evaluation phase of the SOAC program started when the cars arrived in New York City on April 18, 1974. This final phase of the SOAC program ended with the completion of the Philadelphia demonstration on April 30, 1975.

This report, Volume 2 of a two volume report, presents the results of the repair, post-repair testing and operational evaluation of the SOAC in five cities. Major milestones in this program are shown in Figure 1-1.

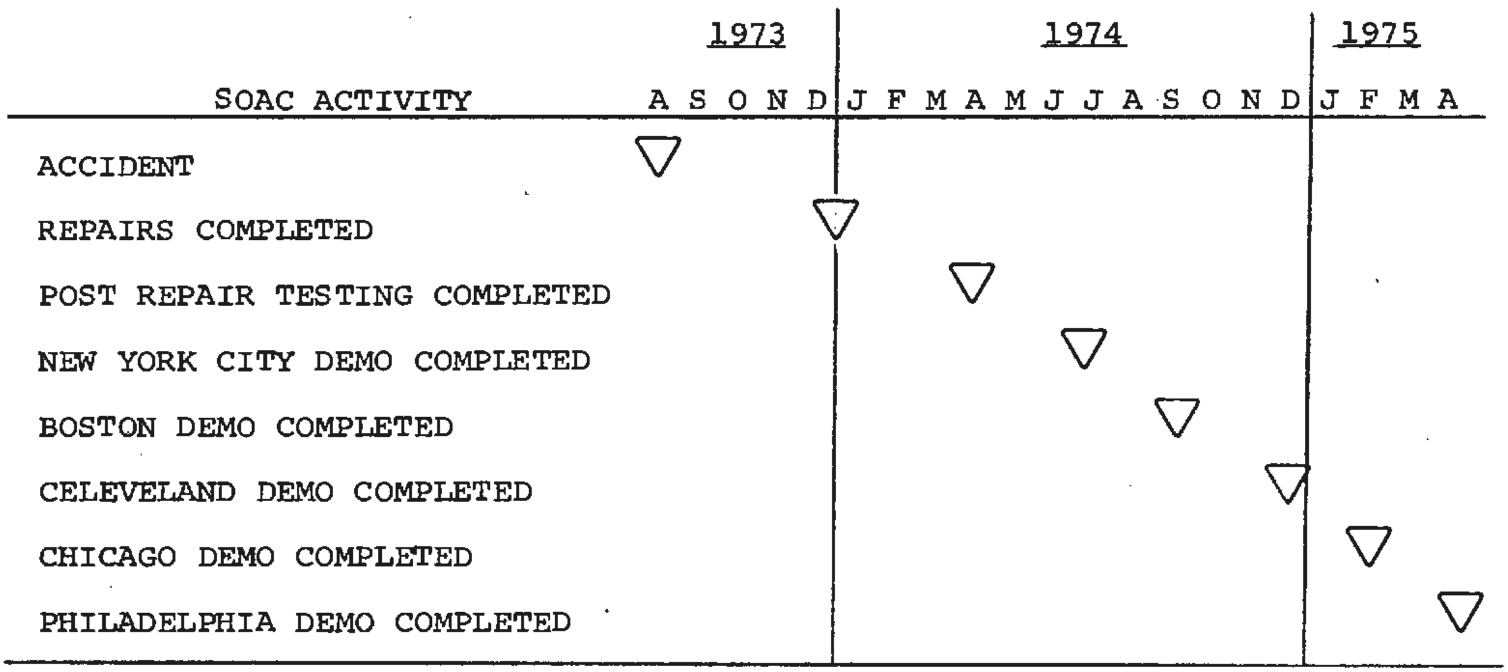


FIGURE 1-1 MAJOR SOAC MILESTONES

1.3 EXECUTIVE SUMMARY

1.3.1 SOAC successfully achieved its overall objective of demonstrating the best available technology to transit authorities and the riding public in five major cities. In so doing, the cars demonstrated that they met their design objective of being adaptable to the specific operating requirements of five different transit properties.

1.3.2 The SOACs were well received by the riding public; particularly the smooth ride, low noise level, air conditioning, interior appointments and high light level.

1.3.3 The motormen assigned to SOAC were enthusiastic about the car and found the smooth response, fine control and automatic speed maintaining system particularly desirable.

1.3.4 The DC-DC chopper used for propulsion control provided smooth acceleration as designed and proved to have excellent reliability.

1.3.5 The back-to-back pantograph installation on SOAC resulted in excessive arcing of the contact strips on the aft pantograph. For a two-car train, pantographs would be better located at the No. 1 end of each car.

1.3.6 Additional handholds should be provided for standees, particularly in areas where bench (longitudinal) seating is used.

1.3.7 A significant portion of the riding public would prefer more windows in SOAC so that wayside station signs could be read more easily. This is particularly important in crowded conditions.

1.3.8 Although most riders believed that the SOAC stylized interiors would not stand up to vandalism, virtually no vandalism was experienced in 20,000 miles of operational evaluation. Even though one guard was provided in each car, it is evident that there was a tendency for the riding public to appreciate and care for the improved environment.

1.3.9 End signs showing destination are of great assistance to riders waiting on the platform. Portable signs were inserted behind the windshield on SOAC to provide this information.

1.3.10 Maintenance requirements were encountered in the cities that were not encountered at the TTC and could be traced to large differences in the quality of the track and road bed. Motor power cable failures, lateral shock absorber mount failures, and various pipe failures can be attributed to the more severe environment. Design changes were made and others should be incorporated in future design applications.

1.3.11 Four resilient wheel elastomer bond failures were experienced on SOAC, which uses tread brakes. Batch process controls during wheel assembly were considered to be a factor in all four failures. In addition, two of the four failures were the direct result of parking brake malfunctions and one failure occurred during on-the-car wheel cutting.

1.3.12 SOAC experience with on-the-car wheel truing of resilient wheels was unsatisfactory. Out-of-round conditions resulted in all cases using two different machines of the same type.

1.3.13 Problems were encountered with movement of the aluminum centered resilient wheels on the steel axles, making it necessary to install axle end caps. All instances occurred in Cleveland. Compatability of SOAC to the existing track geometry may have been a contributing factor. The cause of this problem was not satisfactorily determined. BART experienced some of the same type of problem.

1.3.14 SOAC traction motor blowers are the principal contributors to a 70 dbA exterior sound level at zero speed. This is particularly noticeable when the cars are standing in a station. As noted in Volume 1, page 145, the traction motor blowers are the major source of wayside noise under 35 mph. The traction motor blowers, however, are considered to be an essential advancement presented by SOAC; the wayside noise appears noticeable but not objectionable.

1.3.15 The passenger reaction survey results indicate that a) the SOACs offered effective improvements in most features rated as important by the public, b) more handholds should be provided for standees, and c) carpeting is not particularly desired on rapid transit cars.

1.3.16 The SOAC passenger survey shows that the SOAC rider tends to rate improvements, such as ride quality, noise levels, internal light intensity and others, higher as a result of having directly perceived them than does the general public which has not perceived them.

2. ACCIDENT AND REPAIR

2.1 SOAC ACCIDENT

On August 11, 1973, the State-of-the-Art Cars were being tested on the Rail Transit Test Track at the U.S. Transportation Test Center (TTC), Pueblo, Colorado. The tests simulated conditions that would be encountered during normal transit operations and included starting and stopping at 16 simulated stations spaced around the 9.1 mile oval track (Figure 3-5). At 2:30 P.M., as the SOAC's approached Station A, they were inadvertently diverted through an open switch onto a siding where they collided with a gondola - transition car coupled to an unmanned diesel-electric locomotive. The SOAC motorman, an employee of Kentron-Hawaii Ltd., was fatally injured in the crash. Four other people on the train, all in the rear car, were uninjured.

The National Transportation Safety Board investigated the accident and presented their findings in Document NTSB-RAR-74-2, "Collision of State-of-the-Art Transit Cars with a Standing Car, High Speed Ground Test Center, Pueblo, Colorado, August 11, 1973".

The accident conditions and the damage to the SOAC structure were investigated in detail by Boeing Vertol and officially reported to the NTSB in an internal document "Accident Report, State-of-the-Art Car, High Speed Ground Test Center" in September, 1973.

A crashworthiness analysis of the SOAC was conducted for UMTA* after the accident. The conclusion from the study were the SOAC "as built" meets the crashworthiness standards implicit in the current practice of specifying buff strength. However it was noted that the car might be improved by the addition of underframe to roof vertical posts that would develop the strength of the draft sill and roof in the event of an override. The small degree of damage incurred by SOAC supports these conclusions.

2.2 ACCIDENT REPAIR

Following the collision, the SOAC cars were transported to the Boeing-Vertol manufacturing facility near Philadelphia, Pennsylvania, for inspection and repair as required to return

*E. Widmayer, A.E. Tanner, and R. Klump - "Crashworthiness Analysis of the UMTA State-of-the-Art Cars - Report DOT-TSC-791-3 June 1975.

the cars to their original condition. Car No. 2 departed Pueblo aboard a flat car on August 31, 1973 and arrived at Boeing Vertol on September 10. Car No. 1 departed Pueblo on its own wheels on September 24, and arrived at Boeing Vertol on October 6. The following work items were accomplished between September 10 and December 22, 1973:

Car No. 1 and No. 2

- Straighten and weld build-up anti-climber and tread plate at No. 2 end.
- True up the wheel tread surfaces of wheel sets.
- Disassemble, inspect and refurbish traction motors and gearboxes.

Car No. 2

- Remove and replace the following: draft sill structure, including coupler mounting; horizontal shear panels of underbody; side sill channels from approximately Car Station 130 forward; car sides; bonnet, door and windows forward of the structural bulkhead near Car Station 212.
- Straighten and grind out/weld repair questionable weld areas as revealed by magnetic particle inspection on body bolster.
- Inspect truck frames for cracks and structural distortion (none).
- Replace undercar wiring and plumbing.
- Remove and repair air conditioning evaporator unit.
- Replace No. 1 coupler and associated equipment.
- Inspect and straighten undercar equipment mounts and magnetic particle inspect and weld repair equipment support structure.
- Replace bolster anchor bolts and spacers at both trucks.

Both SOACs, the two transition cars, and the support car departed Boeing Vertol on December 22, 1974 for Pueblo. The two SOACs were shipped de-trucked aboard flat cars.

3. POST-REPAIR TESTING

After repairs, the SOAC's were returned to the TTC on January 14, 1974. Testing was conducted during the period January 30th through April 10, 1974 with the following specified objectives:

1. To show compliance with the original acceptance criteria.

2. To substantiate that SOAC performance after car repairs agreed with previous engineering test results.

3. To complete the simulated demonstration testing which was in progress at the time of the accident.

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

- Subsystem Functional Tests
- Acceptance Tests
- Simulated Demonstration Tests
- Engineering Tests

Results of these tests are reported in Reference (2)[2].

3.1 SUBSYSTEM FUNCTIONAL TESTS

The cars were shipped detrucked on flat cars from Philadelphia to the TTC at Pueblo, Colorado. Travel time was eighteen days. The cars were unloaded, retrucked and functionally tested prior to conducting subsystem functional tests.

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.

2. Reference 2. "State-of-the-Art Car Final Test Report, Volume 5 Post-Repair Testing", Report No. UMTA-IT-06-0026-74-12.

TABLE 3-1

SUBSYSTEM TESTS ACCOMPLISHED ON CAR NO. 2

TEST
Coupler Function and Gathering Range (No. 1 end only)
Electric Couplers
Camber
Air Comfort
End Door
Side Door
Windshield
Lighting, Head and Tail Lights
Cab Lights
Console Lights
Emergency Lights
Main Lights
Wiring, High Pot
Main Power Application
Trainlines
Windshield Wiper
Horn
Public Address
Radio
Side Sign
Main Propulsion Control & Motor Rotation
Main/Emergency Brake
Handbrake
Snow Brake
Propulsion Auxiliaries
Car Weight
Air Compressor
Hostling Panel
Visual

Tests were performed on those items specified in Table 3-1, along with additional functional tests of the Propulsion and Braking Systems, in accordance with Reference (1)[1] 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 3-1) to simulate the system electrical loads, and the SOAC Monitor Panel (Figure 3-2) to check proper functioning and sequence of propulsion control events by observing the event lights on the Annunciator Panel.

3.2 ACCEPTANCE TESTS

Preliminary testing was accomplished to set brake and propulsion system rates to their proper values and to check-out the train prior to acceptance testing. These tests included functional checks of all systems under typical transit operating conditions and trial runs for the acceptance tests.

Limited acceptance tests were conducted to verify that the individual cars and the two-car train met their original acceptance criteria. Acceptance tests included speedometer calibration, acceleration, deceleration, and automatic speed maintaining.

3.2.1 Speedometer Calibration

The test was conducted on both cars at steady speeds of 15, 25, 35, 50 and 80 mph over the 4000-foot section of level tangent track between track stations 298 and 338, using 1000, 2000 or 4000 feet as required.

Both cars were checked in forward and reverse at five speeds (Figure 3-3). Maximum deviation between indicated speed, and true speed was 1.5 mph at 80 mph.

3.2.2 Acceleration

Tests were conducted in forward and reverse on both cars. The test car was accelerated on level tangent track at full power (P = 1.0 amp). Stopwatches were used to time 0 to 700 feet, 5 to 25 mph and 0 to 60 mph.

Both cars were checked individually. Acceleration from a standing start to 700 feet ranged from 18.8 (Car No. 2) to 19.5 seconds (Car No. 1) with average accelerations from 5 to 25 mph of 2.78 and 2.74 mphps respectively.

Both cars met or bettered the specification and/or previous data (see Table 3-2). Testing of the two-car train configuration was not possible because of failure of one of the two auxiliary generators used to supplement the temporary locomotive track power source. The locomotive plus one auxiliary generator could not maintain the required 600 volts dc minimum line voltage during full acceleration of the two-car train.

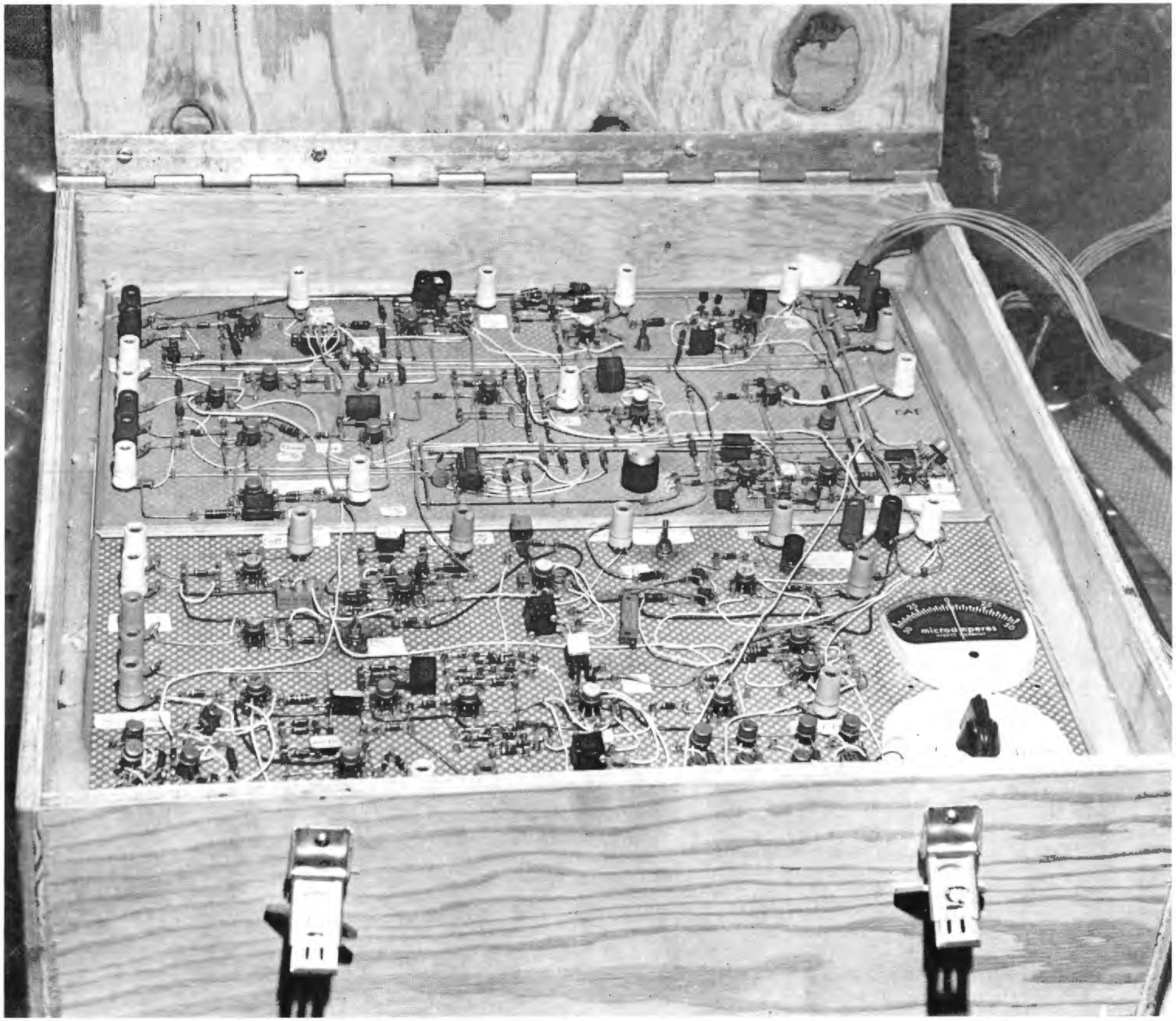


Figure 3-1. SOAC System Simulator

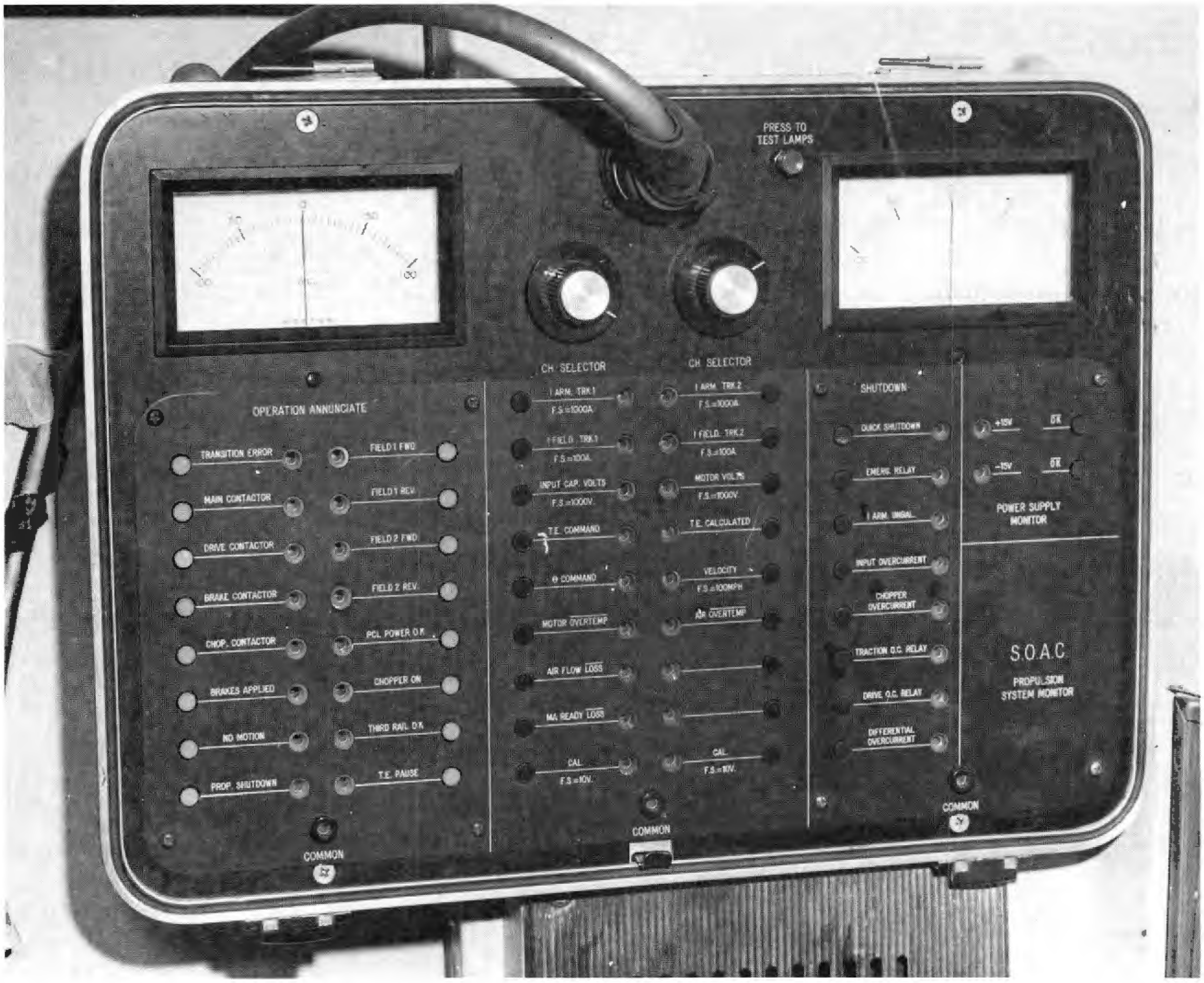


Figure 3-2. SOAC Monitor Panel

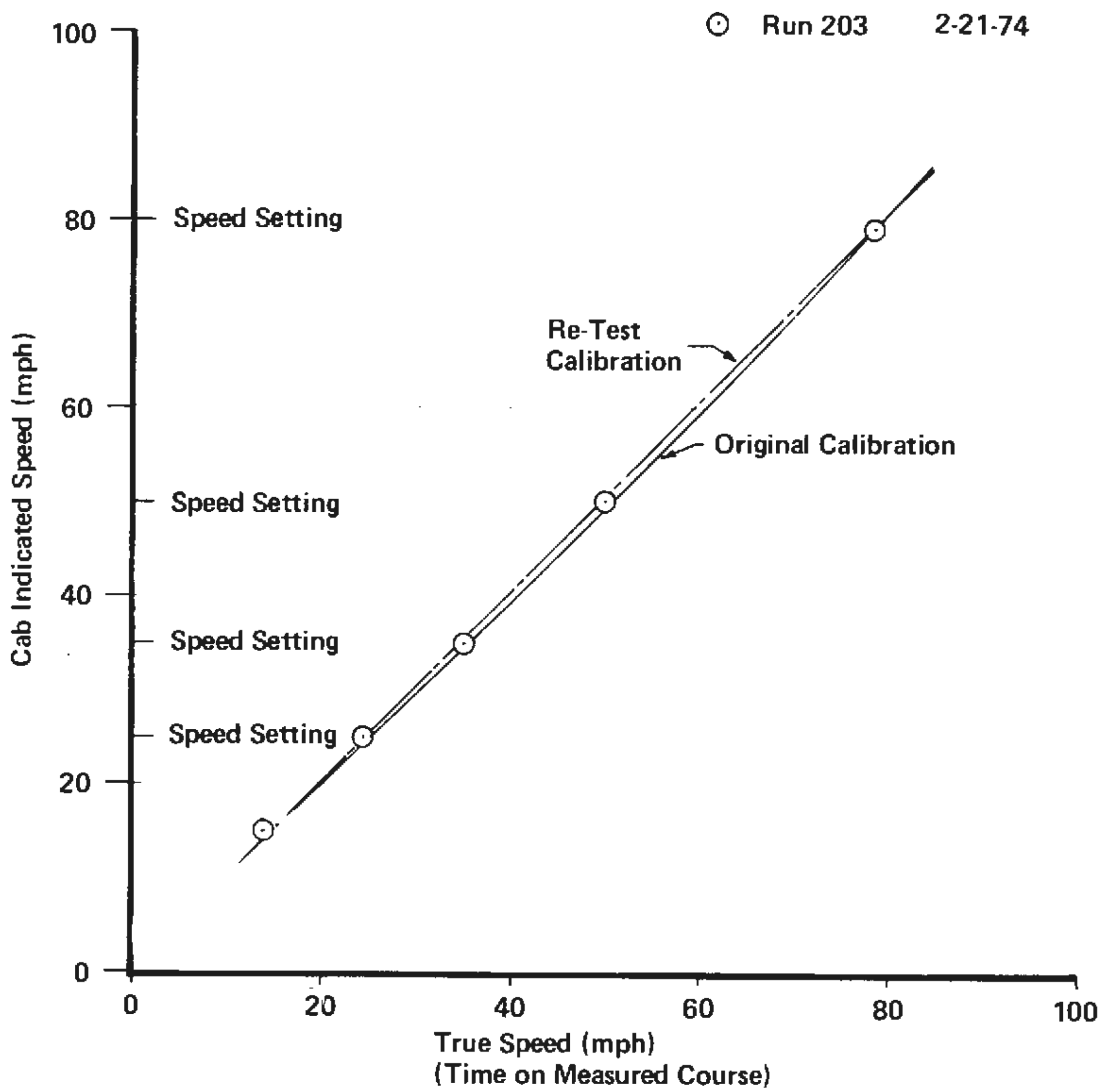


Figure 3-3. SOAC Speedometer Calibration - High Density Car No. 2

3.2.3 Deceleration

Braking tests were conducted in forward and reverse on both cars and the two-car train. The car or train was decelerated at full service rate for blended and friction-only braking, and with emergency braking on level tangent track. Stops were made from 40 and 80 mph.

Table 3-3 summarizes deceleration rates and stopping distances and compares these data to the specification and previous acceptance data.

3.2.4 Automatic Speed Maintaining System (ASMS)

Tests were conducted in forward and reverse on both cars and the two-car train. The ASMS was cycled through all speed settings (3, 15, 25, 35, 50, 70 and 80 mph) with the controller in the full power setting. The ASMS functioned properly on both cars. All speeds were within one mph of the ASMS button setting.

3.3 SIMULATED DEMONSTRATION

A goal of 3000 miles of simulated transit operation as a two-car train was established for the SOAC post-repair test program. This requirement was in addition to the 1312 miles of two-car train operation obtained prior to the accident.

The 3000 mile simulated demonstration was split into two 1500 mile phases, the first phase to be accomplished before the engineering re-test and the second phase at the end of the Pueblo test program. The test program was arranged in this manner to give the engineering tests the benefit of 1500 miles of prior shakedown.

Train configuration for most of the testing was a two-car train running 8 hours a day, 5 days a week. The simulated transit route (see Figure 3-4) is a composite of routes in the five cities and consists of 14 stations at an average distance of approximately 1/2-mile (ranging from 1/4-mile to 1-1/4-miles) with various run speeds between stations. In order to simulate actual operation on the transit properties, the SOAC was operated on simulated trips consisting of:

1. Two laps of the oval stopping at each station for door opening and closing. Doors on one side were opened at one stop, and the other side at the next stop. The prescribed run speeds between stations were achieved with the SOAC speed limiting system, using maximum acceleration and full-service brake rates.

TABLE 3-2. SOAC ACCELERATION AND SPEED

Test Mode	SOAC Spec	Car No. 1	Car No. 2
Average initial acceleration (mphps)*	2.74**	2.74	2.78
Time to travel 700 feet from standing start, 600 VDC (sec)	20	19.5	18.8
Time to reach 60 mph from a standing start (sec)	34**	33.8	31.2
Maximum speed (mph)	80	80	79

*From 5 to 25 mph
**Previous data, not a specification item

TABLE 3-3. SOAC BRAKING TESTS

Braking Mode (105,000 lbs or as noted)	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)	**	2.8	2.7	2.9	2.9
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	1957	1650	1653
Emergency (feet)	2200	1600-1635	1680	1560	1503

*Average from 60 to 30 mph
**Not a specification item

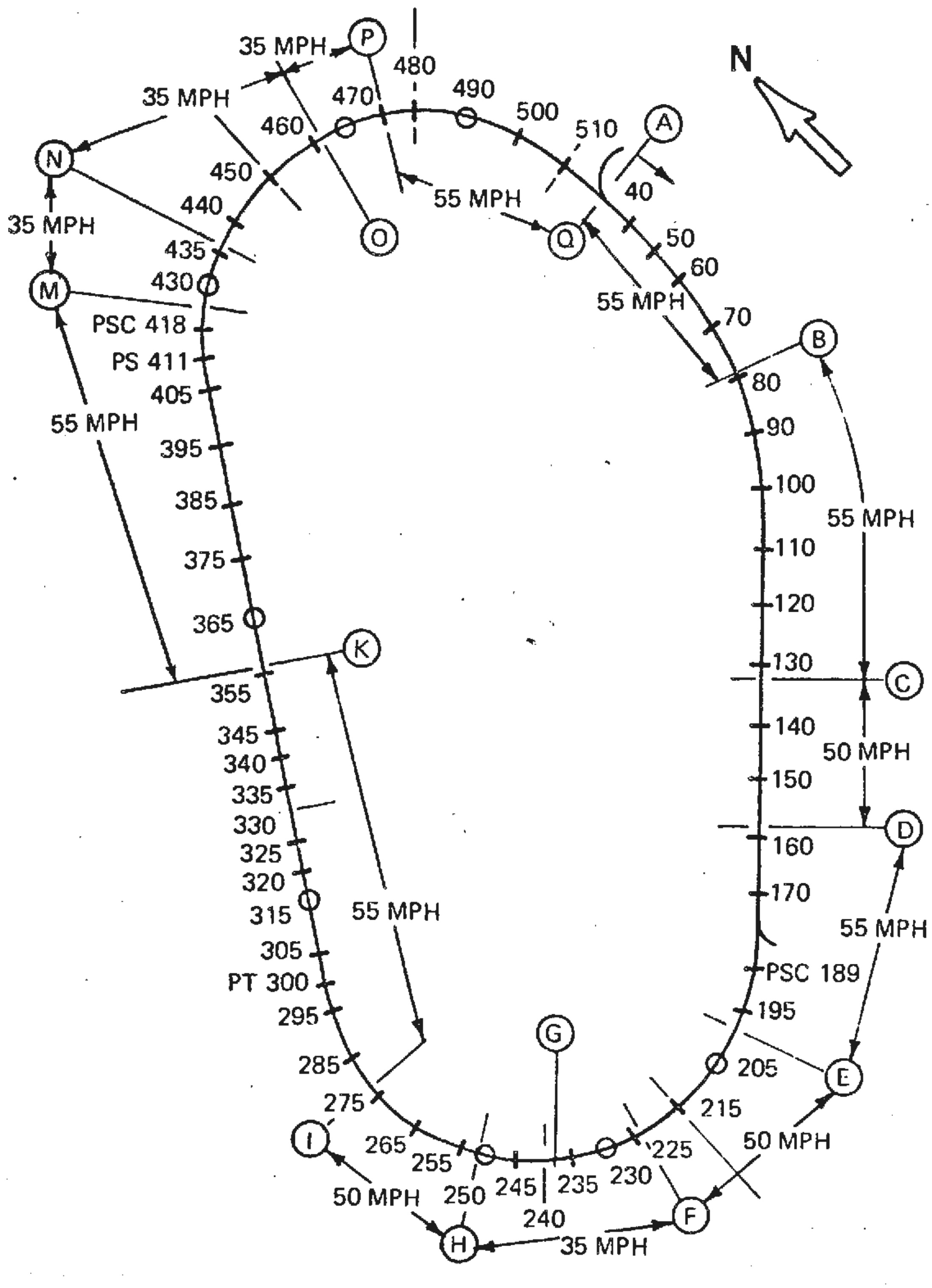


Figure 3-4. Simulated Demonstration Route at TTC

2. Two non-stop laps of the oval at 80 mph.

3. After a 5-minute layover, the same run profile as described in 1 and 2 above was made in the opposite direction.

The first phase of the simulated demonstration was conducted during the period between February 27 and March 13, 1974. Fifteen hundred and fifty-five (1555) miles were accumulated in eight days of testing (Figure 3-5). The only significant discrepancy encountered during this simulated revenue service testing was one case of high commutator bars causing broken brushes. This was corrected by grinding the commutator. Other discrepancies included replacement of one slip-slide circuit card, one B+ short to ground in the airflow sensor circuit, and one intermittent short in the P-wire cable. There was no measurable gearbox oil leakage.

The second phase of the simulated demonstration was conducted during the period March 29 to April 10, 1974. Fourteen hundred and fifty six (1456) miles were accumulated on the two-car train in five days of testing (see Figure 3-5 and Table 3-4). No discrepancies were encountered.

3.4 ENGINEERING TESTS

The Engineering Tests were conducted (under separate Contract DOT-TSC-580) to show continuity with the original engineering test data. An abbreviated test series was utilized to verify that the data previously obtained was valid for use as a baseline for comparison with the data to be obtained on the five city properties. Results of these tests are reported in Reference (3)[3]. The following paragraphs present brief descriptions of the test results:

3.4.1 Acceleration Tests

The SOAC car was accelerated to reach a maximum speed of 80 mph. The car was tested to provide data under various conditions of P-signal, car weight, and train consist. 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.

3.4.2 Deceleration Tests

The SOAC car was decelerated from specified entry speeds. Data was recorded for controller level, car weight, and train consist. The deceleration rates for all the post-repair tests

3. Reference 3. "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.

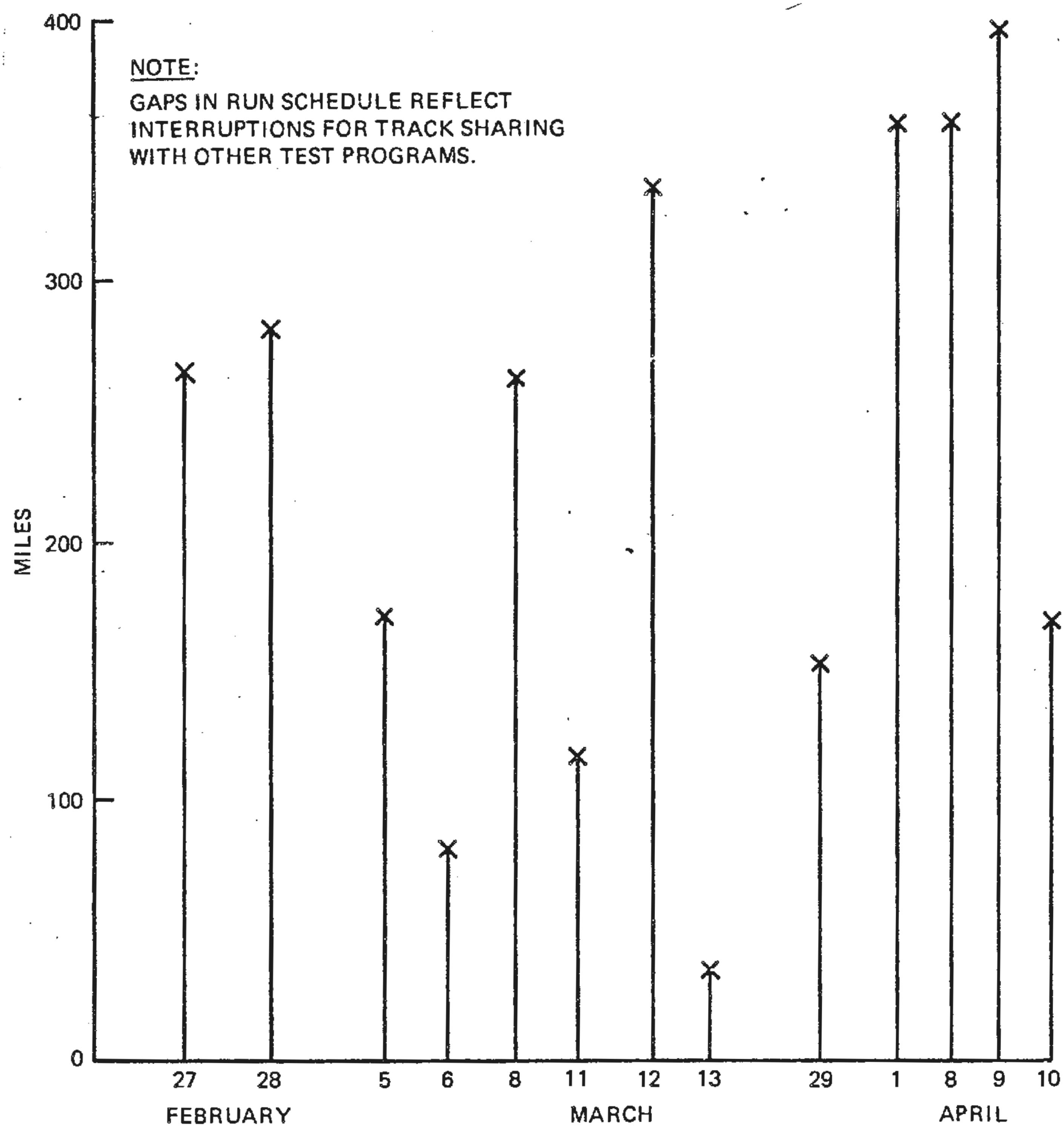


Figure 3-5. *Daily Mileage Accumulation During Simulated Demonstration (February 27 to April 10, 1974)*

TABLE 3-4

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

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.

3.4.3 Power Consumption

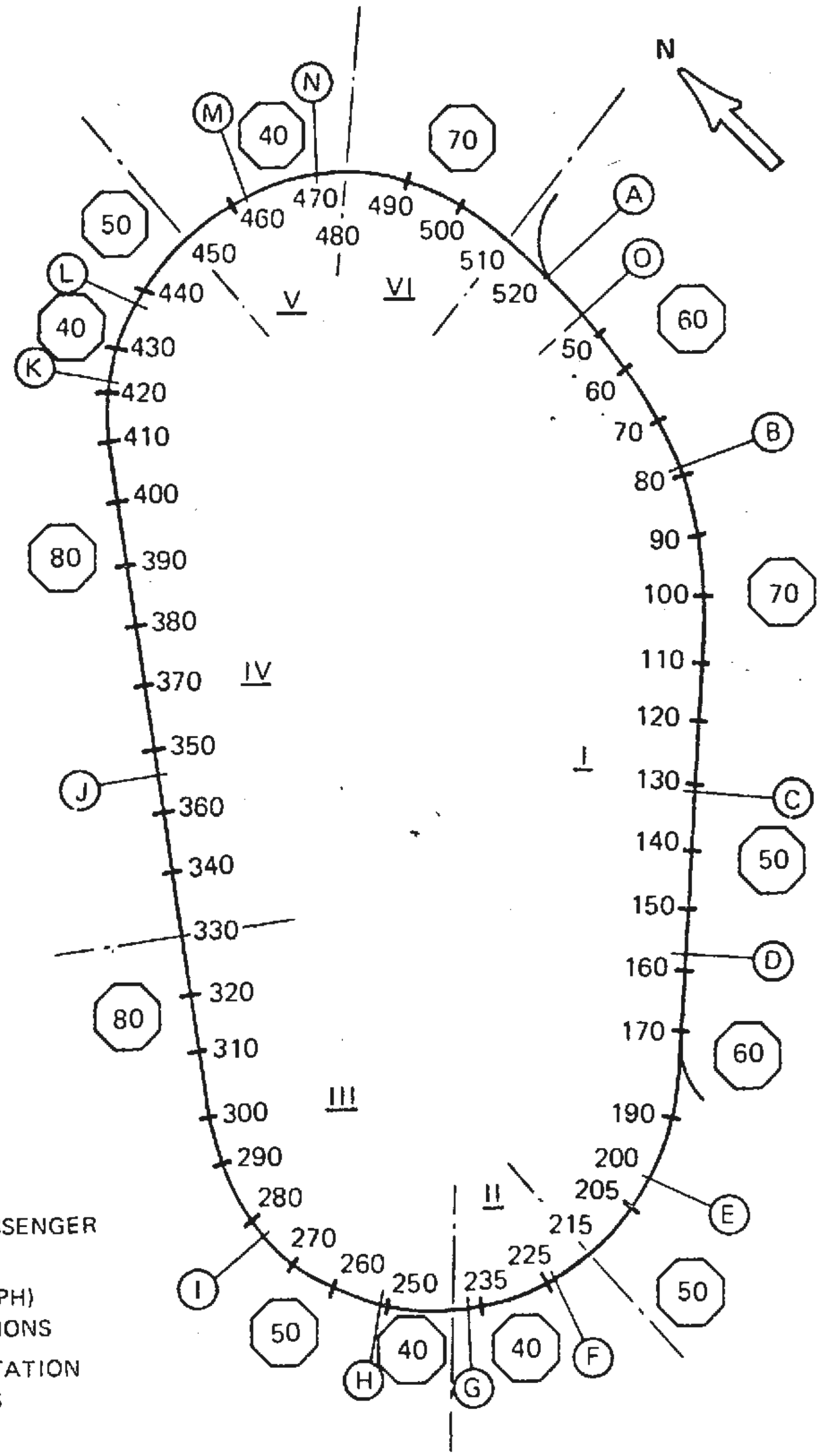
Power Consumption was measured over a prescribed synthetic route, as shown in Figure 3-6. The test data showed that the current and rms values for the motor armature and field at the 90,000 lb car weight (Table 3-5) were slightly less than for the 105,000 lb car weight (Table 3-6). A comparison between the post-repair tests and the original tests shows the former to be approximately 12% less than the latter.

3.4.4 Ride Quality Tests

The SOAC was operated at a single speed over all track sections and at five speeds over Track Section 1 to compare the response of the post-repair SOAC with previous test results. A sample acceleration and deceleration was accomplished. 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 in Figure 3-7. 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 re-tests could account for the differences.

3.4.5 Interior Noise Tests

A test of the interior noise levels was made at various speeds over Track Section I (see Figure 3-6) for the post-repair SOAC. A weight-effect comparison was accomplished and the effect of an air conditioning air duct silencer was also evaluated. The post-repair measured sound levels, without the duct silencer installation ran 2-4 db higher than the original test data, including the car at rest (see Figure 3-8). The sound levels at the forward end of the car (Location 49, Figure 3-9) showed the greatest increase, indicating that the air conditioning blower noise was greater after the repair than before. The installation of an air conditioning duct silencer as shown in (Figure 3-10) brought the interior sound levels down to where they were prior to the repair (Figure 3-11).



NOTE

DISTANCE FROM
A TO O IS
9.25 MILES

KEY

○ SIMULATED PASSENGER STATIONS

⯃ SPEED LIMIT (MPH) BETWEEN STATIONS

50 TO 520: TRACK STATION NUMBERS

TRACK SECTIONS

I	119-LB WELDED RAIL, WOOD TIES
II	100-LB WELDED RAIL, WOOD TIES
III	100-LB JOINTED RAIL, WOOD TIES
IV	119-LB WELDED RAIL, CONCRETE TIES
V	119-LB WELDED RAIL, CONCRETE TIES (23 IN. ON CENTER)
VI	119-LB WELDED RAIL, CONCRETE TIES (23 IN. ON CENTER)

Figure 3-6. Synthetic Transit Route

TABLE 3-5. SUMMARY OF SOAC ENERGY CONSUMPTION AND RMS VALUES FOR ARMATURE AND FIELD CURRENTS ON SYNTHETIC TRANSIT ROUTE (90,000-POUND CAR

STATIONS (TWO DIRECTIONS)	MAXIMUM SPEED (MPH)	DISTANCE (MILES)	ENERGY (KW-HR)* TOTAL	ENERGY (KW-HR)* PER CAR MILE	TIME BETWEEN STATIONS (SEC.)	I^2 ARMATURE-SEC. $\times 10^6$	I^2 FIELD-SEC. $\times 10^3$
A-B	60	0.75	6.4	8.55	74.5	16.82	49.22
B-C	70	1.00	8.8	8.8	89.0	22.78	55.79
C-D	50	0.50	5.4	10.8	119.0	12.5	61.87
D-E	60	0.75	6.6	8.8	80.5	16.9	52.3
E-F	50	0.50	4.58	9.17	69.0	12.96	46.6
F-G	40	0.25	3.25	12.98	56.0	9.67	41.9
G-H	40	0.25	3.43	13.72	54.5	9.32	34.94
H-I	50	0.50	4.4	8.8	65.5	12.75	46.82
I-K	80	1.50	12.38	8.25	105.0	29.59	58.5
K-M	80	1.25	11.17	8.94	97.5	28.75	55.23
M-N	40	0.25	3.63	14.5	58.5	9.1	33.55
N-O	50	0.50	4.68	9.36	65.0	13.88	48.05
O-P	40	0.25	3.2	12.83	56.0	9.44	43.78
P-X	70	1.00	8.99	8.99	99.5	23.93	53.3
Total x	(2)	18.5	173.8	9.39	2179	456.78×10^6	1363.7×10^3

	ARMATURE	FIELD
RMS VALUE ~ AMP $\left(\frac{\Sigma I^2 \Delta t}{\Delta t}\right)$	457.8	25.0

SCHEDULE SPEED: 27.5 MPH

*INCLUDES AUXILIARY POWER

TABLE 3-6. SUMMARY OF SOAC ENERGY CONSUMPTION AND RMS VALUES FOR ARMATURE AND FIELD CURRENTS ON SYNTHETIC TRANSIT ROUTE (105,000-POUND CAR

STATIONS (TWO DIRECTIONS)	MAXIMUM SPEED (MPH)	DISTANCE (MILES)	ENERGY (KW-HR)* TOTAL	ENERGY (KW-HR)* PER CAR MILE	TIME BETWEEN STATIONS (SEC.)	I^2 ARMATURE-SEC. $\times 10^6$	I^2 FIELD-SEC. $\times 10^3$
A-B	60	0.75	7.8	10.4	86.0	20.2	52.62
B-C	70	1.00	10.75	10.75	102.5	26.15	59.25
C-D	50	0.50	5.0	10.0	79.0	14.5	48.12
D-E	60	0.75	7.8	10.4	93.0	19.9	53.63
E-F	50	0.50	5.4	10.8	86.0	14.25	50.25
F-G	40	0.25	3.5	14.0	67.0	10.9	42.0
G-H	40	0.25	3.55	14.2	64.5	9.1	37.25
H-I	50	0.50	5.15	10.3	79.0	14.5	50.0
I-K	80	1.50	14.6	9.73	130.5	39.15	60.8
K-M	80	1.25	13.75	11.0	115.0	33.3	61.13
M-N	40	0.25	3.9	15.6	64.5	12.2	45.63
N-O	50	0.50	5.5	11.0	79.5	16.1	51.88
O-P	40	0.25	3.65	14.6	67.0	10.8	43.38
P-X	70	1.00	10.95	10.95	107.0	28.85	56.88
Total x	(2)	18.5	202.6	10.95	2440	539.8×10^6	1425.64 x 10

RMS VALUE ~ AMP $\left(\frac{\Sigma I^2 \Delta t}{\Delta t}\right)$	ARMATURE	FIELD
	470.3	24.17

SCHEDULE SPEED: 27.3 MPH

*INCLUDES AUXILIARY POWER

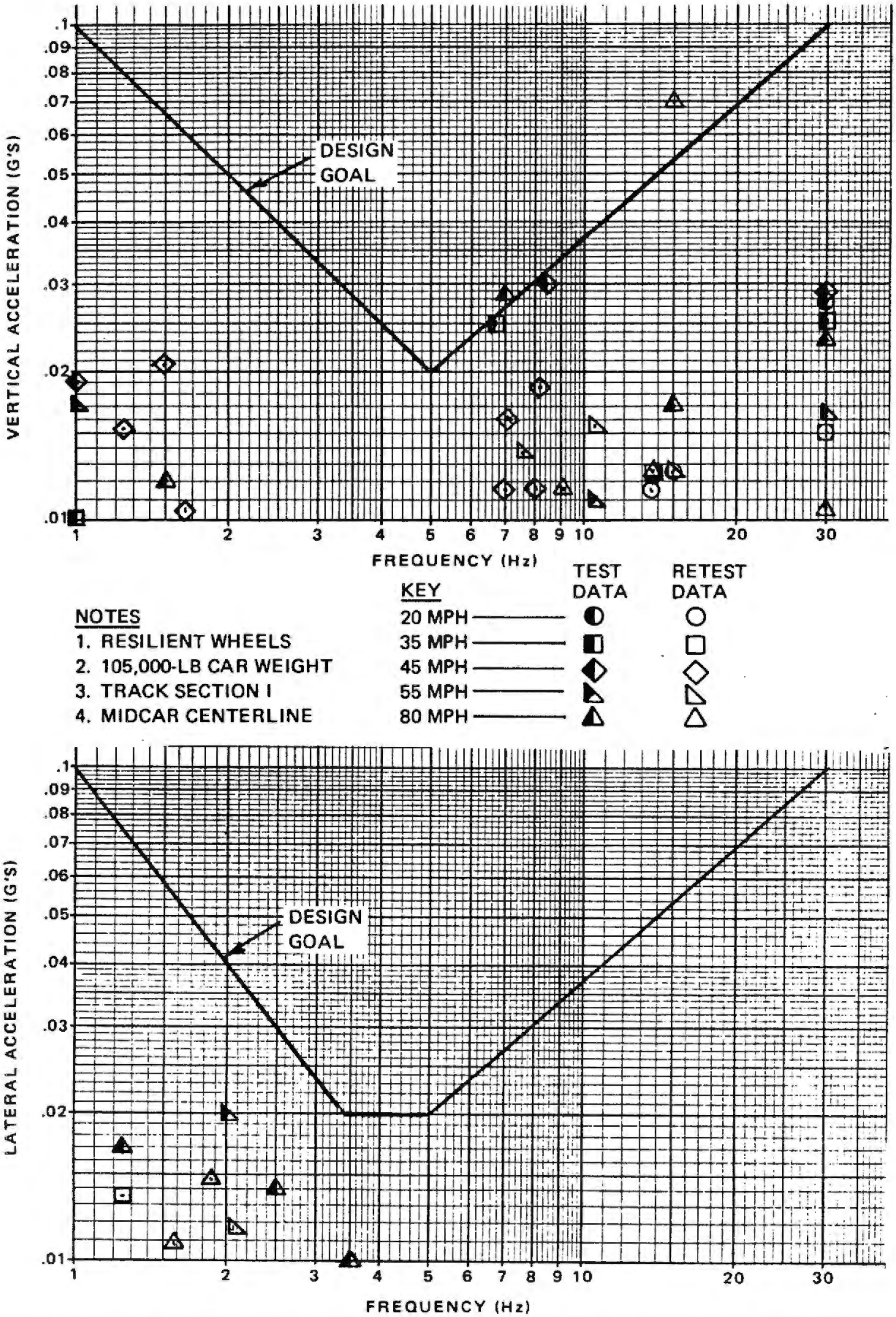


Figure 3-7. Comparison of High-Density Car Ride Quality and Goals

NOTES
1. 90,000 LB CAR WEIGHT
2. TRACK SECTION 1
3. RETURN AIR SILENCERS NOT INSTALLED
4. UNTRUED RESILIENT WHEELS

KEY
TEST
RETEST

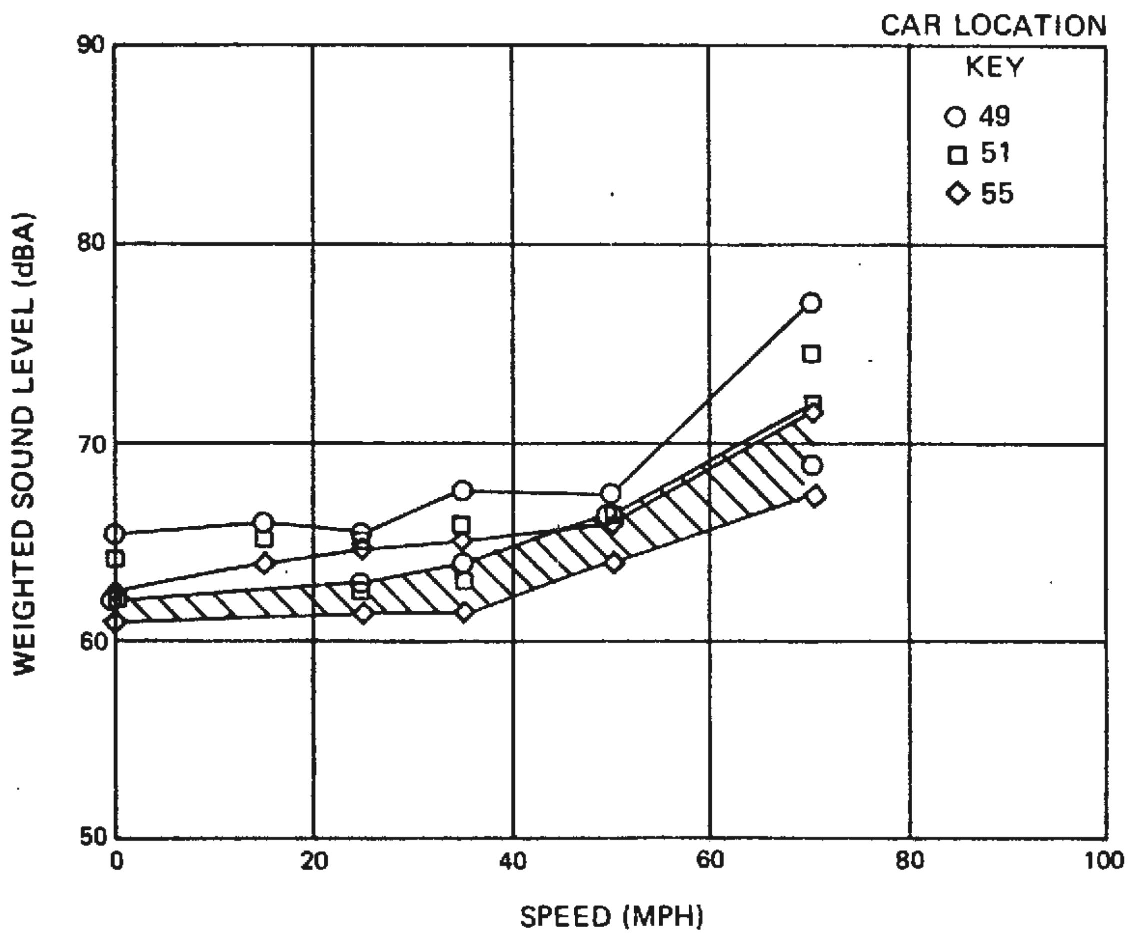
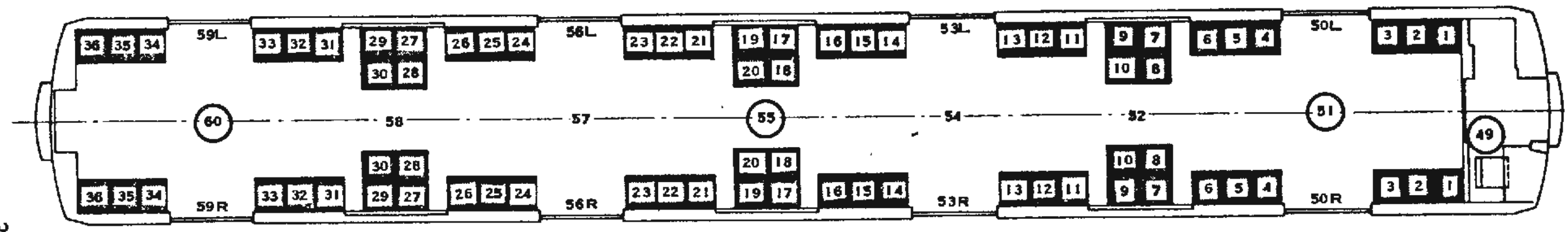


Figure 3-8. *Comparison of Interior Noise Levels of SOAC No. 2 Car Before and After Repair*



NOTES
1. NO. 2 CAR (HIGH-DENSITY) SEATING PLAN
2. ◯ RETEST MICROPHONE LOCATION

Figure 3-9. *Interior Noise Measurement Positions*

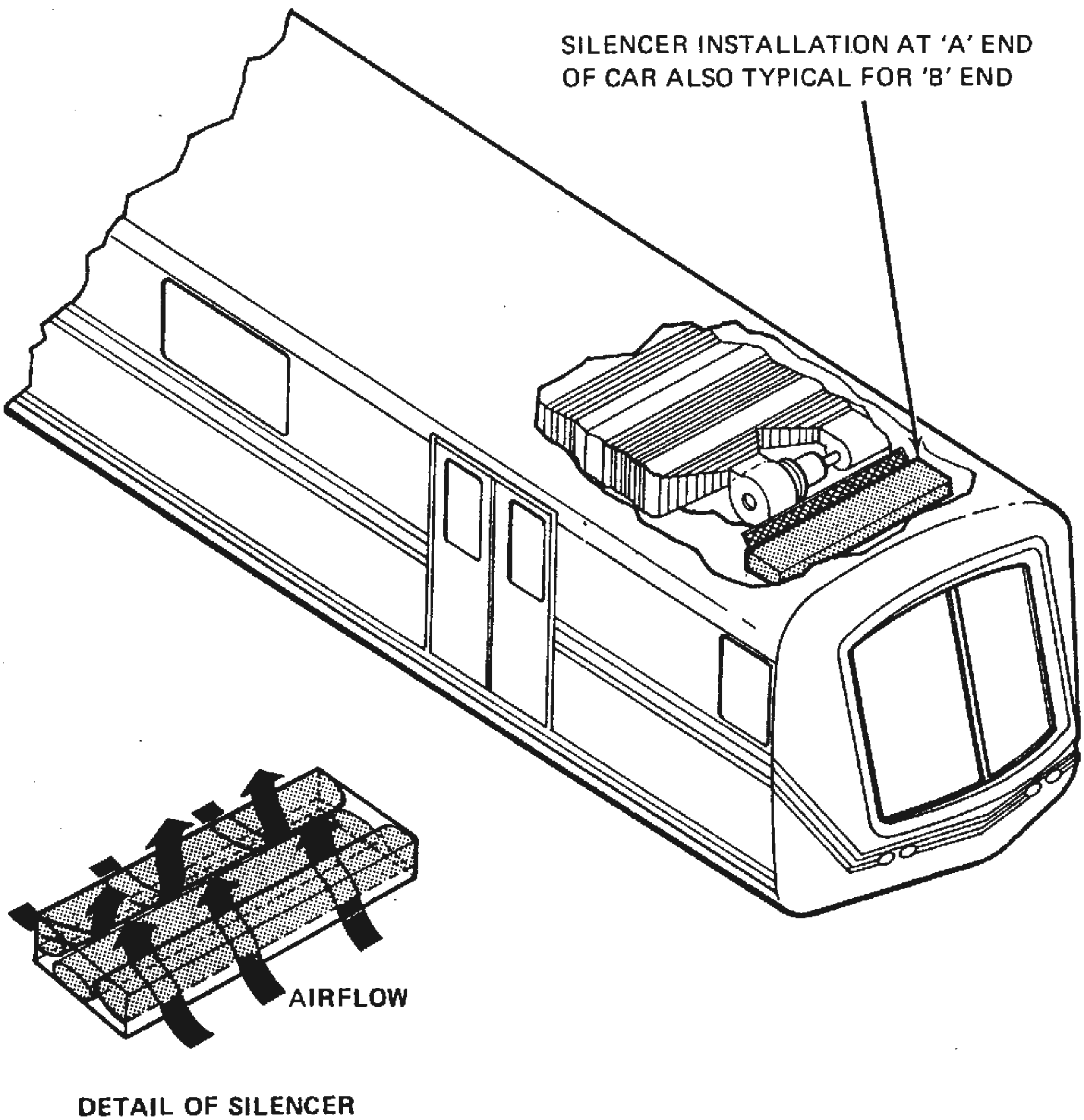


Figure 3-10. *Location of Silencer in Return Air System*

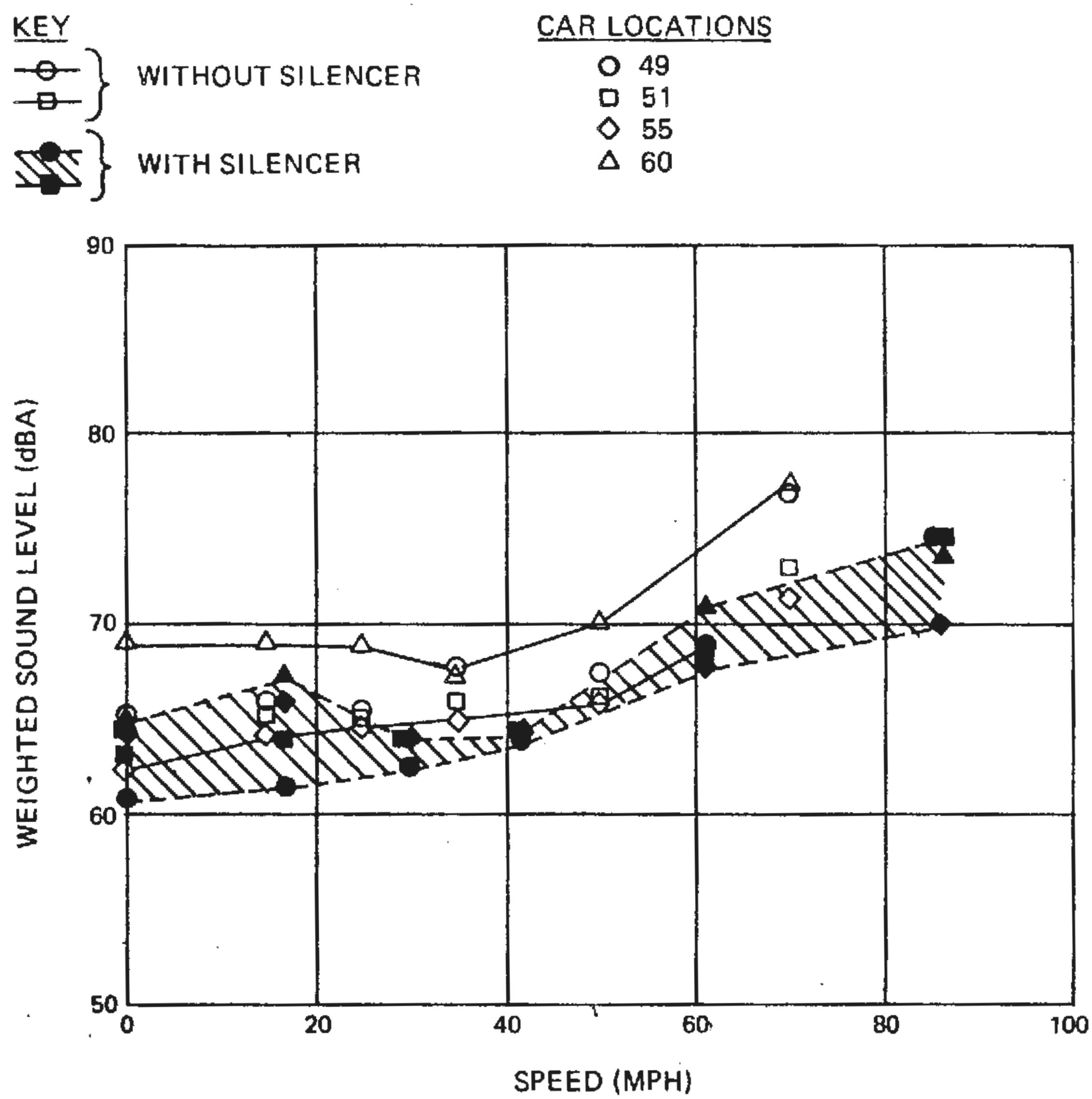


Figure 3-11. *Comparison of Interior Noise Levels Before and After Silencer Installation*

3.4.6 Wayside Noise Tests

A test of the wayside noise level was made at various speeds over Track Section I. Weight and train consist comparisons were also accomplished. The comparison of post-repair and original test results for the No. 2 SOAC at 90,000 lb car weight with resilient wheels is shown in Figure 3-12. The data shows good agreement from zero to 50 mph with slightly higher levels from 50 to 70 mph for the post-repair data. This is attributed to some small wheel flats which were audible during the tests.

3.4.7 Structure Tests

The SOAC was operated at a single speed over all track sections and at five speeds over Track Section 1 to compare the response of the post-repair SOAC with previous test results. A sample acceleration and deceleration was accomplished. 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.

3.5 CAB SIGNALLING INSTALLATION AND CHECKOUT

Cab signalling equipment supplied by the Massachusetts Bay Transportation Authority (MBTA) and AiResearch Manufacturing Company under separate contract was installed and functionally checked out during normal maintenance shifts. An operational checkout was performed during the second phase of the simulated demonstration testing of the two-car train.

A tape recording of the signals supplied through the MBTA running rails was played to the receiver coils mounted ahead of the forward truck. SOAC automatically accelerated, decelerated and maintained speed as called for by the signals. Car speeds were within one mph of the speed signals in all cases.

3.6 MAINTENANCE

The requirements for unscheduled maintenance during the post-repair testing of the SOACs at the TTC were generally of a random nature, typical of the shakedown phase for a prototype vehicle.

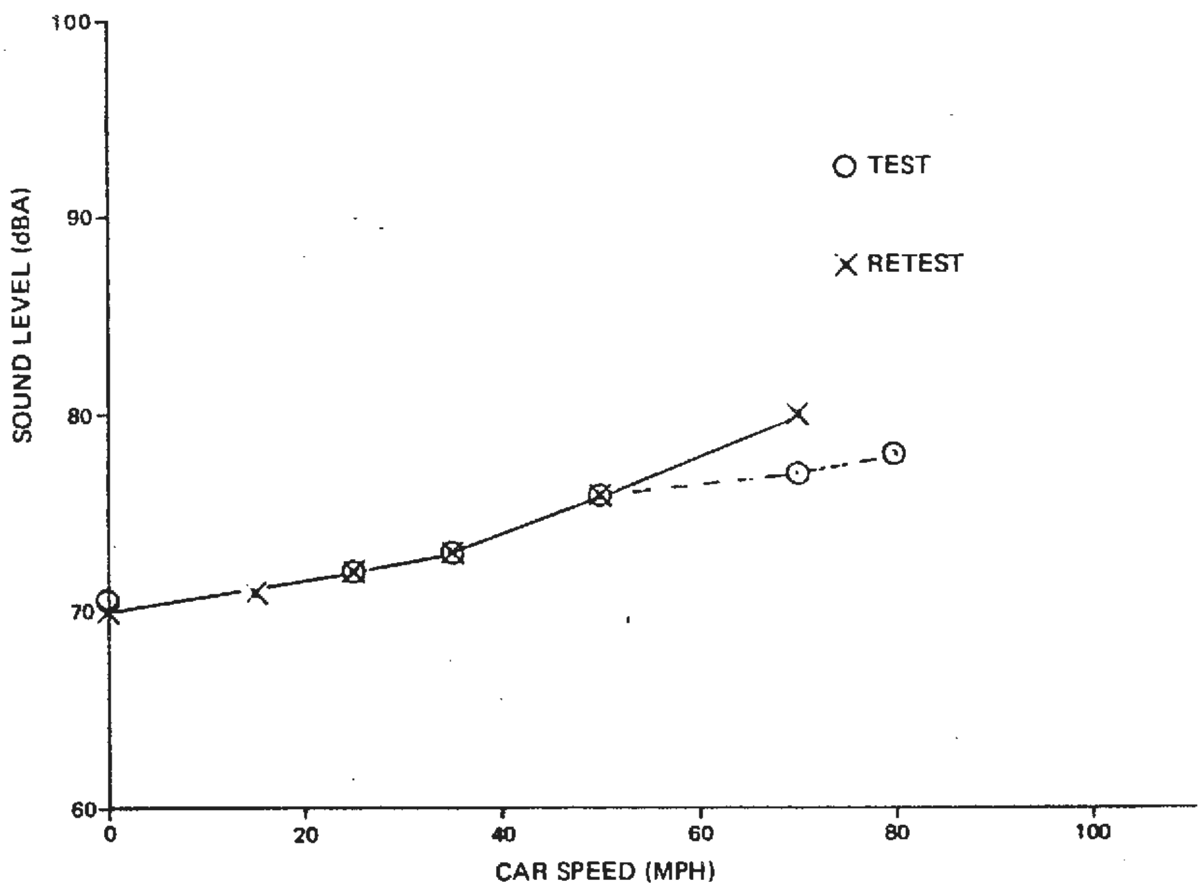


Figure 3-12. Comparison of Wayside Noise Levels Measured 50 Feet From Track Before and After Repair

One car was inadvertently operated at a speed of 94 mph when a mis-calibrated speed sensor logic card was installed. The card was 17 percent off calibration and the overspeed protection circuit was inoperative. The speed error was detected by the speed fault system in the trailing cab when the car was operated as a two-car train on the next run. All subsequent speed card changes during single car operation were checked with a single-point speed-time-distance check. The only maintenance requirements that can be considered as recurring were high commutator bars on the traction motors and parking brake malfunctions.

Traction Motor Commutators

Several traction motor commutators had to be ground after the first period of extended high speed operation. This occurred after the first 500 miles of simulated demonstration testing which was equally divided between 0-55 mph station-stop operation and steady-state running at 80 mph. The commutator grinding operation had to be repeated on three traction motors after Car No. 2 was tested to 94 mph (which is beyond the specification requirements). One traction motor commutator, which was not ground after 250 miles of 80 mph operation, had to be ground after completing 1500 miles of 80 mph operation. Commutator grinding statistics are shown in Table 3-7.

Parking Brake Malfunctions

Failure of the parking brake to fully release was a continuing problem throughout the post-repair test program. Two modifications were made at Pueblo in an effort to solve the problem, but neither was successful.

The hang-ups were caused by a cocking of the hydraulic piston when fully extended, and both modifications were attempts to alleviate this condition. The first change was to reduce the "brake applied" pressure from 1500 psi to 800 psi. Although the 800 psi pressure was adequate to meet the parked braking requirements, it did not solve the piston cocking problem. The second modification was to increase the size of the rollers in the actuator linkage. This was done immediately prior to the departure for New York City and there was no chance to evaluate its effect at Pueblo. The results in New York would show that it did not solve the problem. The solution to the problem, however, was determined before leaving New York and is described in that section of this document.

The following is a list of significant maintenance actions accomplished during the post-repair test program at the TTC, Pueblo, Colorado.

TABLE 3-7. TRACTION MOTOR COMMUTATOR GRINDING HISTORY

CAR/MOTOR NO.	MOTOR S/N	COMMUTATOR GROUND	MILES OF 80 MPH OPERATION AT TIME OF GRINDING
1-1	52-D6	Yes	250
1-2	52-D3	Yes	1500
1-3	52-D1	Yes	250
1-4	52D15	No	-
2-1	52-D5	Yes	750*
2-2	52-D2	Yes	250, 750*
2-3	52-D7	Yes	250
2-4	52-D4	Yes	250, 750*

* THESE MOTORS GROUND AFTER 94 MPH OVERSPEED CONDITION.

DATE	MAINTENANCE ACTION
1-21-74	Car No. 1 - Brake air compressor motor burned out. Compressor seized. Installed spare compressor and motor.
2-07-74	Car No. 1 - M/A repeatedly oversped and tripped out after approximately 30 minutes on line. Replaced speed card in Phase Delay Rectifier (PDR).
2-14-74	Car No. 1 - Door chimes inoperative. Cleaned and adjusted contacts on chime and door relays.
2-19-74	Car No. 1 - No. 2 Axle, parking brake hang-up. Released by repetitive cycling from RELEASE to NEUTRAL. Removed No. 2 parking brake cyclinder.
	Car No. 2 - No. 2 coupler, unable to advance or retrieve pins. Repaired loose wire in Electro-Pneumatic (EP) box.
	Car No. 2 - Repetitive propulsion trips caused brake air compressor motor failure. Installed air compressor from Car No. 1. Capped main reservoir (compressor side) on Car No. 1.
2-21-74	Car No. 2 - 60 Hz ripple in armature current. Replaced J35 card in Propulsion Power Control Unit (PPCU). Card had not been modified.
2-26-74	Car No. 1 - Windshield wiper switch failed. Replaced.
3-01-74	Car No. 1 - Routine inspection disclosed extensive traction motor brush wear and broken brushes on motors No. 1 and 3. Measured one commutator bar .003" high on each motor. Ground and polished commutator. Installed new brushes.
	Car No. 2 - Same as Car No. 1 for motors No. 2, 3 and 4. Measured four high bars (.002" - .0045"). Ground wheels on axles No. 3 and 4 with abrasive grinding shoes to remove flats.
3-04-74	Car No. 1 - Installed spare brake air compressor with AC interlock to prevent starting up under load. This car has been running in train without an air compressor.
	Car No. 2 - Car would not go into drive mode after T/M field breaker tripped under acceleration. Found PCL breaker 37v output shorted to ground at airflow sensor connector and main contactor auxiliary contacts stuck open (secondary failure). Replaced connector and cleaned and reset contactor auxiliary contacts.

DATE	MAINTENANCE ACTION
3-07-74	Car No. 2 - Magnetic charging valve leaking. Disassembled, cleaned and reinstalled.
3-08-74	Car No. 1 - Unable to go into Emergency Brake with master controller handle. Reset No. 3 cam switch.
3-11-74	Car No. 1 - Intermittent short in P-wire circuit. Replaced flex cable from controller handle to deadman switch.
3-12-74	Car No. 2 - Replaced 90 amp T/M Field breaker with 100 amp breaker. Drawing error.
3-14-74	Car No. 1 - Ground wheels with abrasive grinding shoes to remove flats, all 4 axles.
3-16-74	Car No. 1 - Found loose bolts on No. 1 gearbox housing cover. Retorqued all gearbox cover bolts, both cars.
3-19-74	Car No. 2 - Replaced J49 speed sensor card to correct zero speed problem. Installed AC interlock to brake air compressor to prevent starting up under load.
3-20-74	Car No. 2 - Open thermal switch in traction motor No. 3 (S/N 52-D7). Switch cannot be replaced without removing motor. Installed jumper to by-pass switch. Replaced J49 speed card - calibration error and overspeed protection inoperative.
3-24-74	Car No. 2 - Inspection after 94 mph run disclosed broken brushes on traction motors No. 1, 2 and 4. Ground and polished commutators. Installed new brushes.
4-05-74	Car No. 2 - Brake air compressor failed to start. Cleaned and reset governor contacts and replaced time delay relay in AC interlock.
4-06-74	Car No. 2 - No. 2 air conditioner inoperative. Repaired shorted wires and replaced a relay in the control module.
4-11-74	Car No. 1 - Reinstalled No. 2 parking brake cylinder (see 2-19-74 entry). Modified all parking brake cylinders by installing larger rollers on the actuator arm, both cars. Ground commutator on traction motor No. 2 to remove high bar.

DATE	MAINTENANCE ACTION
4-11-74	Prepared both cars for rail shipment to New York: • Removed all traction motor brushes • Locked-out all side doors • Installed brake cylinder 20 psi relief valves • Set brake system for locomotive haul • Removed third rail collector assemblies • Installed windshield protective covers

4. OPERATIONAL TEST AND EVALUATION

4.1 SUMMARY

The SOACs travelled just under 20,000 miles and carried an estimated 312,000 passengers during the five-city operational evaluation. Operating statistics for the five cities are presented in Table 4-1. The cars were transported between cities by railroad, travelling on their own wheels between two modified gondola transition cars. A summary of miles hauled by locomotive is presented in Table 4-2.

Passenger loads ran from moderate-to-heavy in New York, Boston and Philadelphia, to light in Cleveland and Chicago. In general, the riding public was very enthusiastic about the SOACs, even to the point of applause from people waiting on the platform as the train pulled into the station. The passengers were impressed with the quietness and smoothness of the ride on SOAC. Without exception, the motormen assigned to SOAC from the various transit properties considered the cars a pleasure to operate. The automatic speed control and smoothness of acceleration were noted as particularly impressive.

The most frequent criticisms were "Not enough handholds" (for standees) and "Not enough windows". When the cars were heavily loaded, it was apparent that some form of overhead handhold was required, particularly at the ends of the car (low ceiling area) and between each pair of A and B side doors. Many comments were generated by comparisons drawn between SOAC and the equipment in use on a particular transit property. For example, the riders in Cleveland and on Boston's South Shore Line are accustomed to more window area. The Clevelanders were also critical of the seats in the high density car as being too narrow and too short from front to back. These comments are understandable considering that the CTS Airporter cars have comfortable, upholstered seats of ample proportions, similar to the seats in the low density SOAC.

The passengers were pleased with the interior appointments, although many felt that they would not stand up to vandalism. It is interesting to note that in the 20,000 miles travelled in the five city operational evaluation the only vandalism encountered

TABLE 4-1. REVENUE SERVICE SUMMARY

	NYCTA	MBTA	CTS	CTA	SEPTA	TOTAL
Revenue Service Days	30	22	15	13	24	104
Round Trips Scheduled	123	178	96.50	149	127	673.5
Round Trips Made	86	176.25	84.75	149	121	617
Car Availability (%)	70	99	88	100	95	91.6
Est. Passenger Count	100,000	125,000	20,000	7,500	60,000	312,500
Miles in Service	5,680	4,730	4,217	1,968	3,000	19,595

TABLE 4-2. TOWED MILES BETWEEN CITIES

Pueblo To New York	-	2,000
New York To Boston	-	278
Boston To Cleveland	-	818
Cleveland To Chicago	-	415
Chicago To Philadelphia	-	968
	T O T A L	4,479

was one small cut in a seat. Even though one guard was provided in each car, it is evident that there was a tendency for the riding public to appreciate and care for the improved environment.

4.2 OPERATIONAL PLANNING

Operational planning for the five-city test and evaluation was conducted while the SOAC was at the Transportation Test Center (TTC). Discussions were held with the various transit properties concerning clearance checks, operating requirements, maintenance facilities, logistics and personnel training. This information was assembled in a formal Operational Demonstration Plan which was prepared for each transit property.

4.2.1 Clearance Investigations

Platform, tunnel and bridge clearances were a prime concern for all the cities except New York. The demonstration lines were selected in each city based upon their compatibility with the 75 ft SOAC. The four lines selected in New York were already handling the 75 ft R-44 cars which are the same width as SOAC. Maximum length of cars operating on the lines selected for demonstration in the other cities ranged from 70 ft for Boston and Cleveland down to 48 ft in Chicago.

Boston

The MBTA South Shore cars (Silverbirds) are 3 inches wider than SOAC in maximum width, but slightly narrower at floor level. This made platform clearances the prime concern in Boston. A clearance car test was conducted on the Cambridge Dorchester (Red) Line in December 1972 using the MBTA clearance car. This test indicated that there would be no changes required for SOAC.

Cleveland

The Cleveland Airporter cars are approximately 9 inches wider than SOAC. An analysis was made of the clearance car run conducted by CTS when they purchased the Airporters, and it was determined that only minor relocations of signals and wayside equipment would be required for SOAC clearance.

Chicago

A major clearance problem was presented on the CTA because SOAC is approximately 6" wider (11 inches at floor level) than the CTA cars. Extensive modifications were required to the Skokie Swift facilities to permit operation of SOAC. The changes required included modifications to the platforms at the Dempster and Howard stations, track repositioning, the revision of and additions to existing signal controls and some third rail modifications. These changes are discussed in detail in Section 4.7.2.2.

Philadelphia

The three types of cars used on the Broad Street Subway are all wider than SOAC, although only 67.5 ft in length. The MBTA clearance car was shipped to SEPTA and a clearance car test was conducted on the Broad Street Subway in August 1973. This test indicated that there would be no changes required for SOAC. The SEPTA clearance test report is included as Appendix I.

4.2.2 Platform Height Variations

SOAC was designed with provisions for floor height adjustment to accommodate variations in platform height at the demonstration sites. A comparison of platform and car floor heights at the five transit properties is presented in Table 4-3. SOAC floor height is adjustable from 3 feet 5 1/2 inches to 3 feet 10 1/2 inches with intermediate positions of 3 feet 7 1/2 inches and 3 feet 8 1/2 inches.

TABLE 4-3 TRANSIT PROPERTY PLATFORM AND CAR FLOOR HEIGHTS

Transit Property	Platform Height	Car Floor Height
New York (NYCTA)	3 Feet 6 3/8 Inches	3 Feet 9 1/2 Inches
Boston (MBTA)	3 Feet 11 1/2 Inches	4 Feet 1 Inch
Cleveland (CTS)	3 Feet 3 Inches	3 Feet 6 Inches
Chicago (CTA)	3 Feet 6 Inches	3 Feet 9 1/2 Inches
Philadelphia (SEPTA)	3 Feet 10 Inches	4 Feet 1 Inch

4.2.3 Operation Demonstration Plans

A formal Demonstration Plan Document was prepared for each participating property. This document covered all facets of the planned operation, including familiarization, briefings, testing, revenue service and maintenance. The SOAC Demonstration Plan for the Southeastern Pennsylvania Transportation Authority (SEPTA) is included as Appendix II.

4.3 MOCKUP DISPLAY PROGRAM

In order to demonstrate the SOAC exterior and interior design to a larger segment of the public than would see the cars during operational testing in the cities, a full-scale mockup of the SOAC vehicle was designed and built by Sundberg Ferrar.

The two-section mockup was designed to be transportable over regular highways with each section separately built onto a complete flatbed trailer. The mockup is air conditioned and equipped with heating, lighting and public address systems. Commercial 60 Hz electric power must be provided at each display site.

The first public display of the SOAC mockup was at the U.S. International Transportation Exposition (TRANSPO 72) at Dulles International Airport, Washington, D.C. in May, 1972. After TRANSPO the mockup was displayed in Washington, D.C.; Pueblo, Colorado; and Rochester, Buffalo and Syracuse, New York. More than 400,000 people visited the mockup during this phase of the program.

The SOAC mockup accompanied the SOACs to four of the five demonstration cities (all except New York). Display sites were picked by the individual transit properties and display dates were arranged to suit their requirements. The mockup opening usually preceeded the SOAC inaugural ceremonies by several weeks, ranging from two weeks in Chicago and Philadelphia to seven weeks in Cleveland.

The mockup was staffed by Boeing Vertol and local transit authority personnel who provided technical data describing the SOAC project to the public. Questionnaire-type opinion surveys were conducted in each city.

At the completion of the tour in Philadelphia, more than 680,000 people had visited the SOAC mockup. Table 4-4 summarizes the mockup display activities during the operational test and evaluation phase of the SOAC program.

4.4 NEW YORK CITY

4.4.1 Shipment

The two SOACs, the two gondola transition cars and the support car, (a modified REA express refrigerator car) were assembled into a five-car consist on the Rail Dynamics Laboratory spur track at the Transportation Test Center on April 11, 1974. The cars were taken to the Pueblo Army Depot by D.O.T.

TABLE 4-4. MOCKUP DISPLAY ACTIVITIES

DATES	DISPLAY SITE	DAYS	ATTENDANCE
	BOSTON, MASS.		
July 8-13, 1974	Government Center	6	27,231
July 17-26, 1974	Braintree Mall	10	39,920
Aug. 1-17, 1974	Danvers Liberty Tree Mall	17	38,879
	CLEVELAND, OHIO		
Aug. 30-Sept. 11, 1974	Public Square	12	17,541
Sept. 16-22, 1974	Parmatown Mall	7	6,551
Sept. 27 - Oct. 4, 1974	Severance Shopping Center	8	7,287
	CHICAGO, ILL.		
Jan. 8 - Feb. 8, 1975	Federal Plaza	32	74,312
	PHILADELPHIA, PA.		
Feb. 24 - March 15, 1975	Penn Center	20	44,263
March 26 - April 5, 1975	Upper Darby	10	25,740
		TOTAL	281,724

Figure 4-1 New York

locomotive at 8:00 AM on April 12, where they were picked up by the Santa Fe Railroad at 11:00 PM the same day. The cars were transferred to the Penn Central at Streator, Illinois, on April 15, and arrived at the South Brooklyn, New York rail yard on April 18, 1974. The cars were taken to the NYCTA Coney Island yard by a TA locomotive, uncoupled, and the two SOACs were coupled to an R-44 train and towed to the 207th Street Yard. The cars were inspected by Boeing Vertol and NYCTA representatives at 207th Street and found undamaged except for one cracked side window glass which required replacement.

Support Car Location

The support car and the two transition cars were stored at the Coney Island Yard. Although SOAC operated out of Coney Island on two of the four lines run in New York, all the heavy maintenance work was done at 207th Street, 25 miles away. This made the acquisition of spare parts from the support car extremely inconvenient, since the round trip travel time was approximately three hours. A van was rented to alleviate this problem by providing mobile storage for tools and some spare parts.

Security

All necessary security services were provided by the NYCTA transit police. These services included guards for the SOACs when stored outside, and onboard security during revenue service (one man per car). The support car was covered under the normal security protection for the Coney Island Yard.

4.4.2 Car Preparation and Modifications

The cars were prepared for their first operation on a transit property between April 22, and April 25, 1974. The work required to bring the cars to operational status consisted primarily of removing and installing items installed or removed for cross-country locomotive hauling. These tasks (which would be repeated at each transit property) included removal of the windshield protective covers, removing brake relief valves, resetting all brake system valves for transit operation, installation of third rail collector assemblies and traction motor brushes, and removal of the instrumentation console and equipment transported in car No. 2.

Since the cars were tested at Pueblo in the NYCTA configuration, no configuration changes or modifications were required for NYCTA except installation of a redesigned cab door.

Cab Door Modification

The original cab door design for SOAC incorporated a right side hinge and opened into the cab. This arrangement was selected to allow emergency egress through the cab and out the left side windshield which is hinged on the car centerline. Cab doors were not installed during the Pueblo test program, but after the accident it became apparent that an inward opening cab door would make it difficult for the motorman to make emergency egress from the cab in the case of an impending collision. The cab door was redesigned to provide a two-way swing capability and the modified doors were installed prior to the start of revenue service operations.

Communications

The SOAC train-to-wayside communications system uses the same two-way FM radio as the NYCTA R-44. NYCTA provided a radio which was installed in the SOAC radio rack (the SOAC radio had been re-set to the TTC test frequencies).

4.4.3 Briefings and Training

NYCTA gave safety and operational procedures briefings to the SOAC team on April 24. The orientation and training presentation (Reference Section 4.2) was given to NYCTA management personnel on April 29, and to NYCTA operations and maintenance personnel on April 30.

Four experienced motormen were assigned to SOAC. Operator training was accomplished during the test and clearance runs. Each line provided an instructor to ride in the cab and supervise the motorman while operating on that particular line.

4.4.4 Route Description

Three IND lines and one BMT line (Figure 4-2) were selected for the NYCTA demonstration service as follows:

SYSTEM	DESIGNATION	NAME
IND	"A"	8th Avenue Express to Lefferts Boulevard
IND	"D"	Avenue of Americas (6th Avenue) Express
IND	"E"	8th Avenue Express
BMT	"N"	Broadway Express

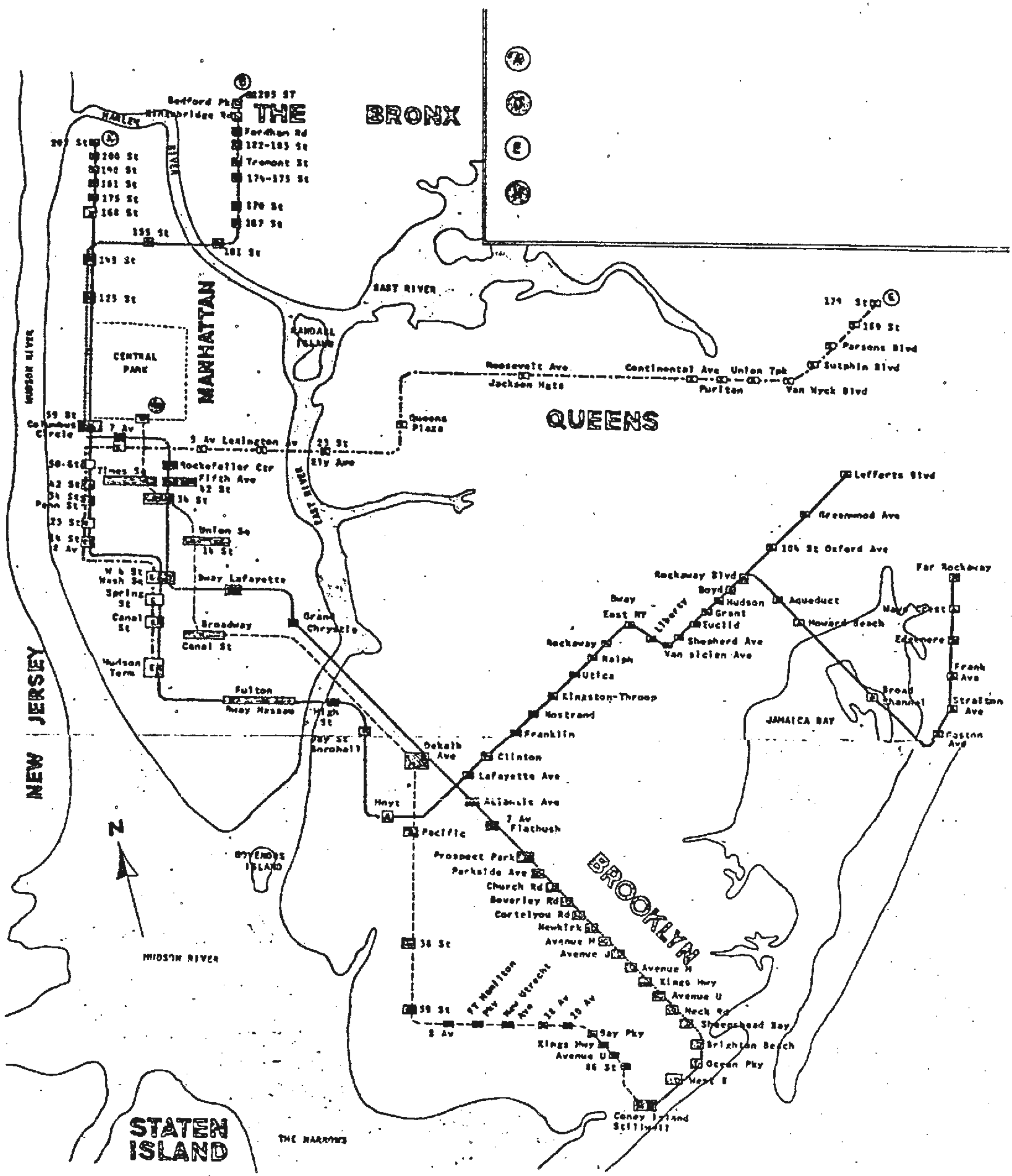


Figure 4-2. NYCTA Demonstration Routes

The "A" line runs underground in express service from 207th street down through lower Manhattan, crosses the East River by tunnel and remains underground past Grant Avenue. The line is open-cut from midway between Grant Avenue and Hudson Street until the terminal point of Lefferts Boulevard. This route is 23.6 miles long and has a scheduled run time of 76 minutes each direction. The "A" line also branches at Euclid Avenue and after Grant Avenue crosses Jamaica Bay at surface level and terminates at Far Rockaway. The length of this route from 207th Street to Far Rockaway is 32.3 miles and has a scheduled run time of 96 minutes in each direction.

The "D" line is the 6th Avenue Express and operates underground from 205th Street in the Bronx down 8th Avenue to 53rd Street, crosses to 6th Avenue south to Washington Square and crosses the East River via the Manhattan Bridge. It is underground until Prospect Park, open-cut to Newkirk, and elevated to Stillwell Avenue. This route is 25.8 miles in length and has a scheduled service run of 79 minutes.

The portion of the "E" line selected for the SOAC demonstration originates at 179th Street in Queens and runs underground into Manhattan to 8th Avenue where it turns south, terminating at the Chambers Street Hudson Terminal. The route is 16.2 miles with a scheduled run time of 44 minutes.

The "N" line starts from 57th and 7th Avenue in Manhattan, crosses the Manhattan Bridge, becomes elevated after DeKalb Avenue and terminates at Stillwell Avenue. This route is 15.4 miles with a schedule run time of 49 minutes.

Wayside signals with track trips are used on all of the NYCTA demonstration lines.

4.4.5 Testing

The cars were checked out on the propulsion simulator and moved out into the yard under their own power on April 25. While heading for the test track on the 26th, two third rail shoe strikes occurred in rail gaps for switch turnouts.

This situation can occur on properties that utilize low third rail height in relation to running rail height (NYCTA, SEPTA) if there happens to be a soft or low spot adjacent to or under the switch. If the car dips while passing through the switch and one third rail shoe strikes the running rail branching from the switch while another shoe is drawing current from the third rail, there is a direct 600V short to ground. Several SOAC propulsion system components were damaged and extensive trouble shooting was required before the cars could complete their acceptance tests and clearance runs. The test instrumentation console was installed on May 14, 1974, after the inaugural ceremonies, and engineering tests were completed on May 16.

4.4.6 VIP Ceremonies

The SOAC inaugural ceremonies were held in the new station at 57th Street and 6th Avenue on May 13, 1974. The inaugural run travelled south on the D line to West 4th Street, then south on the A line to Hudson Terminal, and back to 57th Street over the same route.

Approximately 350 city and transit officials, members of the press and T.V. and other guests took part in SOACs first passenger-carrying run on a metropolitan transit property.

Diode Installation

Revenue service commenced on the D line on May 17. Another third rail shoe strike occurred on the next day in the middle of a crossover. At this point it was decided that diodes would have to be installed in the 600V power collection system to block the flow of 600 volts to ground through a third rail collector shoe. This system was designed, installed and checked out by June 12.

4.4.7 Revenue Service

Summary

Revenue service was conducted on NYCTA from June 14, to July 19, 1974. During this period, operations were conducted on the A, D, and E lines of the IND and the N line of the BMT. These routes took the SOACs over the length and breadth of Manhattan, Brooklyn, Queens, into the Bronx and encompassed subway, elevated and grade level operations.

Revenue Service Days	- 30
Round Trips Scheduled	- 123
Round Trips Made	- 86
Availability	- 70%
Total Passengers (Est.)	- 100,000
Total Miles	- 5,680

Method of Operation

Revenue service commenced on the D line on June 14, 1974, with service from Stillwell Avenue (Coney Island) to 205th Street in the Bronx. Hours of operation for the New York demonstration were roughly 10:00 AM to 4:00 PM and 7:00 PM to 9:00 PM weekdays and Sundays. Trip schedules are presented in Appendix III.

Service was conducted on the N line (Stillwell Avenue to 57th Street) from June 21 through the 28th. Service on the A line commenced on June 30, and ended on July 5, with the SOACs operating out of 207th Street. Some runs went to

Lefferts Boulevard, and others to Far Rockaway. Service was conducted on the E line from July 7, through the 14th, with the SOACs operating from 179th Street in Jamaica to Hudson Terminal. The SOACs returned to Coney Island on July 15, and completed the New York City operational evaluation with four additional days of revenue service on the D line from July 16 through the 19th.

Passenger Reaction

SOAC passenger loads on the NYCTA were generally heavy. SOAC team members handed out literature, answered the many questions and made announcements over the PA system to provide the riders with information on SOAC and the overall program. Any technical questions were referred to SOAC team members onboard the train.

The riding public was very enthusiastic about the SOACs in New York. The interior appointments, improved ride quality and reduced noise level were readily apparent to the riders. Because of the lack of air conditioning in a large percentage of the NYCTA cars, windows are often opened to provide ventillation. This creates extremely high noise levels in those cars. Most of the riders found SOAC a welcome relief but some complained that SOAC was too quiet. They had learned to associate lack of noise with lack of forward motion, which usually meant a delay in reaching their destination. Most of the riders felt that the interior appointments, particularly in the low density car, would not stand up in service on the NYCTA where vandalism is a serious problem. Many riders felt that the number of handholds provided for standees was inadequate, particularly at the ends of the car, and some riders did not like the tinted glass in the underground environment. A large number of rail fans rode the cars in New York and there were many questions and much interest in the program.

The four motormen assigned to SOAC in New York were very enthusiastic about the cars. They made a serious request to be assigned to the program for the duration of the five-city demonstration. They found the smooth response, fine control and the automatic speed maintaining system particularly desirable.

Availability

One hundred twenty three (123) roundtrips were scheduled during the five week operational evaluation in New York City. Mechanical and electrical problems caused 37 trips to be cancelled. Availability was 70%.

4.4.8 Maintenance

Various problems and failures were encountered in New York during SOACs first exposure to a true operating environment. The most serious problem encountered was the third rail shoe strikes discussed in Sections 4.4.5 and 4.4.6.

600V Diode Installation

The 600V diodes installed to block outward current flow at each collector shoe were installed in pairs in the traction motor/chopper cooling air ducts adjacent to each truck. A 1-5/8" wooden spacer was required around the 18 x 20" duct cut out to provide clearance between the top of the diode assembly and the top of the duct for the installation at the No. 2 end. Except for one faulty diode (quality control problem) on the initial installation, no further problems were experienced with the diode modification.

Parking Brake Malfunctions

Two wheel/axle sets were changed because of wheel overheating as a result of a parking brake hang-up. In each case, the acoustaflex elastomer surface was blistered. These wheels were subsequently disassembled and inspected and found to have retained a satisfactory bond between the elastomer and the aluminum hub and steel rim. Parking brake hang-ups had been a continuing problem throughout the SOAC test program at the Transportation Test Center. Several minor modifications had been accomplished but the problem persisted. After the experience in New York, the problem was finally and correctly diagnosed as a cocking of the hydraulic piston (in the parking brake actuator) caused by deflection of the axle chevron springs under the combined load of full service air brake pressure plus the hydraulic brake pressure. Prior to revenue service operations in Boston, a modification was incorporated to vent the air brake cylinder when hydraulic pressure was applied. This modification only affected the No. 1 truck, A side brake cylinders since these wheels are the only ones which have the parking brake actuators. After this modification, no further parking hand-ups were experienced throughout the five-city operational demonstration.

Traction Motor Cable Failures

Three traction motor cable failures were experienced in New York. This problem had not been previously experienced during the SOAC test program at the TTC and was to continue through the demonstration in Cleveland. This problem was generated by the g forces acting on the cables and relative motion between the traction motor (resiliently mounted) and the truck. These variables are both directly related to the quality of the track and road bed, two conditions for which the TTC was not representative. Various means for securing the cables were tried in New York without success.

The following is a list of significant maintenance actions accomplished in New York.

DATE	MAINTENANCE ACTION
4-24-74	Car No. 1 - Replaced two diodes (shorted out) in M/A exciter field.
4-26-74	Replaced blown 3rd rail collector fuse, No. 1 truck, A side, both cars.
4-26-74	Car No. 1 - Replaced 11 main fuses and 11 trip fuses in capacitor bank. Replaced blown battery charger fuse. Car No. 2 - Replaced A-1 chopper drawer - blown thyristors. Repaired ± 15 VDC power supply. Replaced damaged arc chute on K-5 contactor.
4-28-74	Replaced K-5 contactors and rewired in series, both cars.
4-30-74	Increased cap. bank fuse size to 70 amp, both cars. Car No. 1 - Repaired PCL power supply in PPCU. Replaced A-1 and A-2 chopper drawers (A-1 shorted).
5-01-74	Car No. 1 - Replaced damaged wiring in PCU. Replaced K-2 main contactors.
5-02-74	Car No. 1 - Repaired PCL power supply.
5-03-74	Car No. 2 - Repaired snow brake relay circuit in PPCU.
5-06-74	Car No. 2 - Wheel No. 2A acoustaflex elastomer surface blistered from overheat resulting from parking brake hang-up. Replaced wheel/axle set.
5-10-74	Added steel plates to beef-up 3rd rail collectors after minor cracks developed both cars.
5-12-74	Car No. 1 - Wheel No. 1A acoustaflex elastomer surface blistered from parking brake hang-up. Replaced the wheel and reinstalled the wheel/axle set.
5-17-74	Car No. 2 - Repaired air conditioning relay.

DATE	MAINTENANCE ACTION
5-18-74	Car No. 1 - Replaced both 3rd rail collector fuses (rail strike).
	Car No. 2 - Replaced all cap bank fuses.
5-30-74	Installed diodes for all four 3rd rail collectors, both cars.
6-07-74	Car No. 1 - Replaced 2 chopper thyristors (blown) and a K-5 drive contactor from rail strike with a faulty diode.
6-11-74	Car No. 1 - No. 2 end A side lateral shock absorber car body attachment fitting failed. Made welded repair.
6-14-74	Car No. 2 - No. 2 air conditioner fan blade assembly came off and was retained. Repaired and reinstalled. Replaced blown fuse in lighting inverter.
6-17-74	Car No. 1 - No. 2 end A side lateral shock absorber car body attachment fitting failed. Made welded repair. Installed gussets on all four lateral shock absorber fittings, both cars.
6-19-74	Lost one 3rd rail shoe. Replaced.
6-20-74	Car No. 1 - No. 3 traction motor field cable support failed, cable abraded on gearbox coupling and shorted with resultant PDR failure. Replaced the cable and repaired the PDR.
6-24-74	Car No. 1 - Master controller deadman return spring failed causing secondary failures of a diode in the MC console and a load compensation card. Replaced all failed components.
6-26-74	Car No. 2 - Replaced 551 P-wire pre-regulator card.
6-29-74	Car No. 2 - Open field winding in M/A. Installed spare M/A.
7-03-74	Car No. 2 - Diode failed in P-wire circuit. Replaced.
7-07-74	Car No. 2 - No. 2 T/M armature cable failed at the Williams grip. Replaced cable.

DATE	MAINTENANCE ACTION
7-07-74	Car No. 1 - No. 1 T/M armature cable 80% failed at the Williams grip. Trimmed cable end and replaced the Williams grip connector. Cable fatigue evidently caused by truck-mounted clamp located too close to T/M. Removed all T/M cables from the clamps and secured with tie wraps.
7-10-74	Car No. 1 - No. 3 axle flanged coupling retaining nut lock tabs failed and nut backed off the bull gear allowing splined connection to separate. Replaced the wheel/axle/gearbox set.
7-12-74	Car No. 1 - No. 3 traction motor field cable support failed, cable shorted with resulting PDR failure. Replaced the cable and repaired the PDR.
7-13-74	Car No. 2 - Glass in No. 15 door leaf cracked by passenger. Replaced.
7-14-74	Car No. 2 - Repaired frayed armature cable on No. 4 traction motor.
7-16-74	Car No. 2 - No. 1 truck brakes failed to release. Cleaned analog valve unit.

4.5 BOSTON

4.5.1 Shipment

The SOAC five-car consist was picked up at the Parkville Interchange by a Penn Central locomotive at 10:00 AM on July 23, 1974 and taken to Oak Point via the Bay Ridge Branch. The SOACs left Oak Point at 11:00 PM and arrived at the Penn Central First Street rail yard in South Boston at 6:00 AM on July 25, 1974. The cars were inspected upon arrival by Boeing Vertol and MBTA representatives and found undamaged.

The move onto the MBTA property was accomplished during the night of the 25th. The SOAC consist minus the boxcar was taken via Penn Central single track to Butler Street where the Penn Central track runs alongside the Matapan High Speed (Trolley) Line. Trolley service was stopped at 9:00 PM and both tracks were torn up and lined together.

After uncoupling the transition cars, the SOACs were towed onto the trolley tracks by a diesel Unimog. By 12:30 AM the trolley tracks were restored and the SOACs were towed over the trolley line to a switch into the Codman Street yard at the end of the Ashmont Line. At 1:30 AM a four-car Bluebird Train coupled up to SOAC No. 1 and towed the cars to the Cabot Transportation Center. Two crew platforms had to be cut back before the SOACs could be moved inside the still-to-be-completed facility. The support car and the two transition cars were moved to the Penn Central Southampton Street yard for storage.

Support Car Location

Track space was rented from the Penn Central for storage of the support car and the two transition cars at their Southampton Street rail yard. The close proximity of this yard to the Cabot Transportation Center (also known as the South Bay Maintenance Center) made for relatively easy access to the support car for tools and spare parts.

Security

Since the Southampton Street rail yard was open and unprotected, security services were procured from the Burns International Detective Agency. Twenty-four hour guard protection was provided and the quality of service was adjudged excellent.

The SOACs were stored inside at all times at Cabot and security was provided by MBTA. MBTA transit police were also provided for onboard security during revenue service.

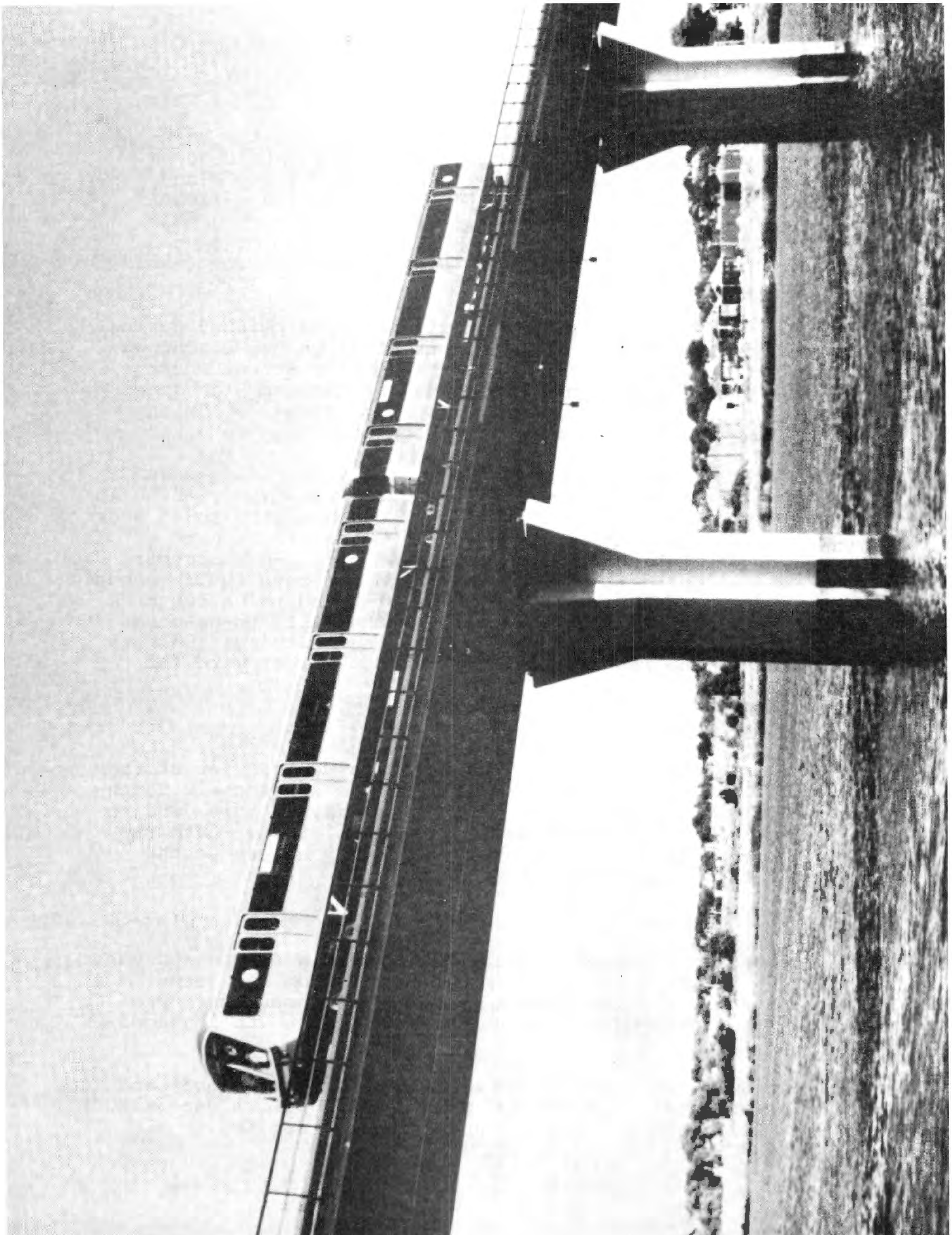


Figure 4-3 Boston

4.5.2 Car Preparation and Modification

The cars were prepared for operation between July 29 and August 2, 1974. All the routine tasks were accomplished as noted for the NYCTA demonstration. The 600V diode assemblies installed in New York were left in the traction motor cooling air ducts but were electrically disconnected. All gearboxes were inspected for loose retaining nuts (see Maintenance Section 4.5.8) and improved retaining nut locks installed. Additional work was accomplished after August 2nd between test runs. All padded seat inserts in both cars were replaced with neoprene inserts for improved fire resistance.

Cab Signalling

The principal modification required for running on the Cambridge-Dorchester (Red) Line in Boston was installation of cab signalling equipment. The equipment was supplied and packaged by the MBTA under contract and was functionally checked out at the Transportation Test Center during the pre-demo test program. Reinstallation at Boston consisted of attaching a signal receiver coil beam assembly to the front of the No. 1 truck of each car and mounting the signal decoder relay in the ATO cabinet of each cab along with the appropriate electrical connections.

The MBTA utilizes a General Railway Signal Company (GRS) system which employs two carrier frequencies and four code rates as shown in Table 4-5. The SOAC ATO console provides an ATO/MANUAL selector button and a lighted display of the signals received from the track circuits. A brake warning signal is displayed with a flashing red light. The SOAC propulsion control system responds to the signals by accelerating, decelerating or maintaining the speed of the train as called for by the signals. The system responds to a loss of signal by applying full service brake.

Communications

No radio installation was required. Train-to-wayside communications were accomplished with a hand-held radio in each cab as requested by MBTA. There were no problems with this approach.

4.5.3 Briefings and Training

MBTA gave a safety and operational procedures briefing to the SOAC team on July 31. The SOAC orientation and training presentation was given to MBTA operations and maintenance personnel on August 1st. A SOAC briefing was given to MBTA management personnel on August 2nd.

TABLE 4-5. MBTA Cab Signalling Frequencies and Code Rates

CODE	SPEED COMMAND	
	CARRIER FREQUENCY	
	4550 Hz (F1)	5525 Hz (F2)
Steady energy	Stop and stay command	Stop and stay command
No energy	Stop and stay command	Stop and stay command
120 codes per minute	10 mph speed command	Yard command*
180 codes per minute	25 mph speed command	Cut out cab signal command**
270 codes per minute	40 mph speed command	65 mph speed command
410 codes per minute	50 mph speed command	70 mph speed command

Note: * This command, once received, permits 10 mph manual operation in yards with no code being received.

** This command cuts out cab signals and permits operation at 50 mph under wayside signal and mechanical train stop control.

Five MBTA motor instructors were assigned as SOAC motormen for the Boston demonstration. Operator training was accomplished during the clearance, test and ATO check-out runs. These men were extremely competent and contributed a great deal to the success of the SOAC operational demonstration in Boston.

4.5.4 Route Description

The Cambridge-Dorchester Line (Figure 4-4) was selected for the SOAC operational demonstration in Boston. The MBTA has four rail rapid transit lines color coded and known as the Red, Blue, Orange and Green Lines. The Cambridge-Dorchester Red Line incorporates the South Shore service and is the only one of the four capable of handling 70 to 75 ft. cars. The line runs from Harvard Station in Cambridge to Andrew Station in South Boston and from there, the line branches to provide service to Ashmont or service to Quincy Center. The SOAC schedule was set up to alternate two days of Quincy service and two days of Ashmont service. On Sundays and holidays, SOAC ran Ashmont service in the morning and Quincy service in the afternoon.

The Harvard-Ashmont route is 9 miles long with 14 stations, while the Harvard-Quincy route is 11.8 miles long with 12 stations. Running time is 22 minutes to Ashmont and 23 minutes to Quincy. MBTA uses Automatic Car Identification (ACI) panels to automatically set the route for Ashmont and Quincy trains leaving Andrew southbound. This function was handled verbally via radio for SOAC.

Wayside signals with track trips are used on all portions of the Red Line except the South Shore Line where cab signalling is employed. The maximum allowable speed with wayside signals is 50 mph. The cab signals call for speeds of 10, 40, 50, 65 and 70 mph on the South Shore Line, but the MBTA cars are limited to 50 mph by edict of the Massachusetts Department of Public Utilities. This is accomplished by feeding the decoder relay outputs for 50, 65 and 70 into the 50 mph propulsion control circuit. SOAC was not restricted to 50 mph for test runs or the VIP runs. Revenue service on the SOAC was initially restricted to 50 mph and then the restriction was lifted to permit 70 mph passenger service for the first time on the MBTA.

4.5.5 Testing

Both cars were powered and all systems functionally checked on August 2nd. The cars were then coupled and operated in forward and reverse inside the barn.

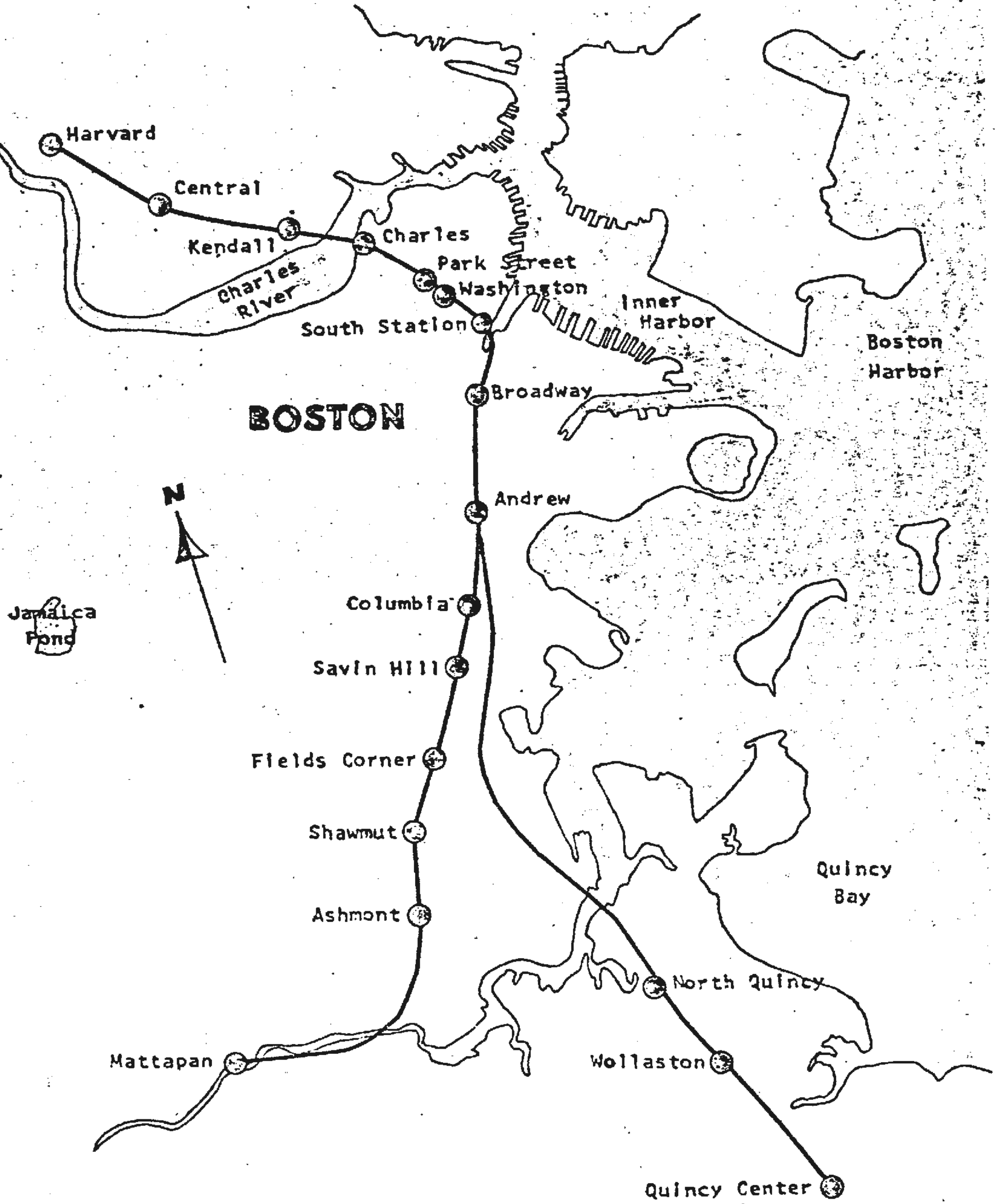


Figure 4-4. MBTA Cambridge - Dorchester (Red) Line

The initial no-load clearance run on the Red Line was made between 3:50 AM and 5:00 AM on August 3rd. Clearances of 1 to 2 inches were observed on several platforms and contact was made with a signal platform going into the No. 1 pocket at Harvard Station. Contact occurred on SOAC No. 1 at the No. 2 door scuff plate, B side with no discernible damage. A tripcock airline failure on SOAC No. 2 caused an emergency brake application which resulted in 2-inch wheel flats on axles 1 and 2 of SOAC No. 1

Car No. 2 was ballasted with 30,000 lbs. of sand bags on August 3 and 120,000 lb. clearance runs were conducted between 1:00 AM and 4:00 AM on August 4, 7 and 8. No additional clearance problems were encountered.

The test instrumentation recording console was installed and a data run was made on August 9. Excessive lateral sway was noted and the effects of wheel flats were noticeable in ride quality and noise levels. All wheels were cut approximately .200" on August 13 using the MBTA Stanray Wheel Truing Machine and the lateral shock absorbers settings were increased from 50% to 75%. Another data run was made on August 13 between 10:00 PM and 2:00 AM. Ride quality was much improved with a slightly harder ride and much less lateral sway. An improvement was also noted in the car-to-platform clearances when entering and leaving stations. An undesirable vibration was noted in both cars at 70 mph on the Quincy Line, particularly in the cab of Car No. 1. This was later determined to have been caused by an out-of-round condition generated by improper wheel truing. A new wheel flat was picked up on No. 3 axle of Car No. 1 during this run and additional small flats were sustained on all wheels when the operator used the emergency brake to stop the train from 3 mph upon returning to the barn.

Bolt, Beranek & Newman, under contract to the DOT Transportation Systems Center (TSC) to evaluate wheel squeal, installed two accelerometers and an axle-mounted FM transmitter on August 14 and wheel squeal data was taken that night at the Quincy Center crossover and on the curve entering South Station. Wayside noise data was also taken at a location between Andrew and North Quincy, but wheel flats were audible. Wheel grinding was accomplished in the yard at Cabot with abrasive brake shoes on August 15th.

Test runs were conducted on the 15th and 16th for final checkout of Automatic Train Operation (ATO) using the cab signalling equipment. The only problem encountered on the MBTA South Shore Line (Andrew to Quincy) was associated with loss of signal or weak signals, which would initiate a brake warning light and brake command. A five-second delay was added to the brake warning light circuit to eliminate brake applications when crossing track circuit bonds. This modification plus a general upgrading of signal strengths by MBTA eliminated the problem at all but one particular location. The SOAC ATO checkout proved beneficial to the MBTA by pinpointing some of their signal equipment which was not up to specification and had been intermittently affecting their own operations. This was facilitated by the SOAC cab signalling-to-propulsion system interface design which made it possible to isolate signal problems from propulsion system response problems.

4.5.6 VIP Ceremonies

The cars were cleaned inside and out on August 16th and 17th in preparation for the VIP ceremonies. An open house at Cabot Center was held on the 18th for MBTA personnel and their families, followed by a demonstration run to Quincy Center and back. After this run, the train was taken to the Elliot Yard overnight to be in a good location for the VIP run the following day.

The SOAC inaugural ceremonies were held at Park Street Station on August 19th. The inaugural run carried the VIP contingent to Quincy Center, the terminus of the South Shore Line and back to Park Street. The SOACs returned to Elliot Yard for the night prior to starting revenue service.

Approximately 300 invited guests were present for the SOAC inaugural in Boston, including Governor Sargent and UMTA Administrator Herringer. Speeds up to 70 mph were demonstrated during the inaugural with the approval of the Massachusetts Department of Public Utilities. Three TV news teams, as well as teams from all Boston newspapers, covered the event.

4.5.7 Revenue Service

Summary

Revenue service on the MBTA was conducted during the period of August 20th to September 13, 1974. During this period, approval to operate the SOACs at 70 mph on the South Shore Line under ATO was granted by the Massachusetts Department of Public Utilities. Of 14 full or partial days involving South Shore service, 7 were operated at the 70 mph limit.

Revenue Service Days	-	22	
Miles Per Day	-	167/212	(dependent upon route)
Round Trips Scheduled	-	178	
Round Trips Made	-	176.25	

Availability	-	99%
Total Passengers (Est.)	-	125,000
Total Miles	-	4,730

Method of Operation

Revenue service commenced on August 20 with service to Quincy. Hours of operation for the MBTA demonstration were 9:30 AM to 3:00 PM and 6:00 PM to 9:00 PM weekdays and 9:10 AM to 12:40 PM and 1:48 PM to 8:10 PM Sundays and holidays. The SOACs operated six days a week with Saturdays off. Day and trip schedules are presented in Appendix III.

SOAC team day-shift personnel powered the train each morning at 8:15 AM in the barn at Cabot Center with 600V "bugs" clipped on the third rail shoes. At 8:30 AM the train moved out onto the pocket track connecting Cabot Center to the main line. Since Cabot was not yet operational the yard and pocket track had to be powered each morning and evening for SOAC movements.

At approximately 9:00 AM SOAC would be admitted to the main line near the Ashmont-Quincy junction and proceed southbound to Ashmont or Quincy (according to the schedule for the day) picking up passengers enroute. The first scheduled run each day departed Ashmont at 9:33 AM or Quincy at 9:37 AM.

At 3:00 PM each weekday the SOACs were taken out of service and laid up at Quincy or Ashmont (Codman Yard) over the rush-hour period. At 5:30 PM the SOAC team second shift personnel powered the train and departed Ashmont at 6:04 PM or Quincy at 5:54 PM for the evening runs. On the last trip of the evening, departing Harvard at 8:35 PM (Quincy service) or 8:45 PM (Ashmont service), all passengers were unloaded at Park Street and the SOACs returned to Cabot Center. Daily maintenance items were accomplished by the SOAC team second shift personnel between 9:00 PM and 12:00 PM each evening.

Sunday and holiday operation ran straight through from 9:10 AM to 8:10 PM with a one-hour layover at Harvard at noon. The morning service was Ashmont and the afternoon and evening service was Quincy.

Passenger Reaction

SOAC passenger loads on the MBTA ran moderate to heavy. Any questions of a technical nature were referred to SOAC team members onboard the train. The SOACs were very well received by the MBTA riding public with much interest and many questions and comments. On two occasions, the train was applauded by people waiting on the platform at Park Street when the train pulled into the station. Announcements were made over the PA system onboard the train generally four times on each roundtrip to provide the riders with information on SOAC and the purpose of the program. These announcements were made by the SOAC team leader for that particular shift.

The most frequent criticisms were "Not enough handholds" and "Not enough windows". Many people missed the overhead straps and handrails. The most frequent questions were "When are we going to get them?", "Will the fares go up?", and "How much does it cost?" Many passengers felt that the low density car was too plush for a subway car. Although less comfortable, the high density car handled high passenger volumes better than the low density car by providing easier ingress and egress. This was a design feature of this interior arrangement.

The MBTA motor-instructors were equally as enthusiastic about SOAC as their New York counterparts. They liked the ease of control, smoothness of acceleration and deceleration and above all, the automatic speed maintaining system and automatic train operation (ATO). With respect to the cab layout, they felt the cab was somewhat cramped and they did not like having the 600 V relay panel behind the motorman.

Special Trips

Two Sunday operations were conducted for the Jimmy Fund, a well known charitable organization in Boston dedicated to research on diseases afflicting children. The first Jimmy Fund Day was August 25th with four roundtrips from Quincy to Harvard. The second Jimmy Fund operation was conducted on September 14th for two rail fan groups. One group attended in the morning and one in the afternoon. Each group was given a trip from Quincy to Harvard to Ashmont to Harvard to Quincy with two photo stops.

Availability

Three mechanical failures were experienced (See Section 4.5.8 Maintenance) which resulted in cancellation of 1.75 trips. A total of 178 trips was scheduled. Availability was 99%.

4.5.8 Maintenance

During the move onto the MBTA property on July 25th, a clanking noise was noted in the No. 1 gearbox of Car No. 2. Inspection revealed that the internal retaining nut lock had failed and the nut had backed off. This had occurred on a gearbox just before leaving New York so all gearboxes were inspected and redesigned nut locks were installed. This was completed on August 2nd.

Wheel flats were experienced as a result of inadvertent and/or unnecessary emergency brake applications. After cutting the wheels on a Stanray Wheel Truing Machine, an undesirable vibration was evident near 40 and 70 mph, particularly in the cab of Car No. 1. Wheel concentricity measurements were subsequently taken and the wheels on axles No. 1 and 4 of Car No. 1 were found to be out-of-round by approximately .025 - .035". On September 14th after the completion of the revenue service demonstration, the wheels on axles 1 and 4 were recut and concentricity again measured. The out-of-round condition was reduced to .007 - .013". A test run on September 16 showed the vibration to be reduced 50% (qualitatively).

The following is a list of significant maintenance actions accomplished in Boston.

DATE	MAINTENANCE ACTION
8-02-74	Completed axle/gearbox coupling inspection and installed modified retaining nut locks, both cars.
8-03-74	Car No. 2 - Truck No. 2, trip-cock airline failed. Repaired.
8-06-74	Three third rail shoes and one current collector broken on a piece of yard third rail with no ramp. Replaced shoes and collector assembly.
	Car No. 1 - Repaired windshield defroster.
8-09-74	Car No. 2 - Truck No. 1, EP valve leaking. Replaced.
8-12-74	Car No. 2 - Completed seat pad changeout.
8-13-74	Completed beef-up of horizontal shock absorber mounting posts, both cars. Completed wheel cutting, both cars.
8-14-74	Completed handbrake mods to release air pressure when hydraulic pressure is applied, both cars.

DATE	MAINTENANCE ACTION
8-15-74	Car No. 1 - Completed seat pad changeout. Noted slip-slide indications without slip or slide. Ground all wheels with abrasive brake shoes, both cars.
8-28-74	Car No. 2 - Motor No. 2, broken field cable and resultant PDR failure. Replaced cable and repaired PDR.
8-30-74	Car No. 1 - Motor No. 4, broken field cable and resultant PDR failure. Replaced cable and repaired PDR.
9-01-74	Car No. 2 - Truck No. 1, field reversing relay failure. Rebuilt relay.
9-14-74	Car No. 1 - Re-cut wheels on axle No. 1 and 4.

4.6 CLEVELAND

4.6.1 Shipment

The SOAC five-car consist left the First Street Rail Yard in South Boston at 9:00 AM, September 20, 1974 on the Penn Central and arrived at the Collinwood Yard in Cleveland the night of the 21st. The cars were moved to the Cloggvile interchange at 8:00 AM, September 22, 1974 for pickup by the Norfolk and Western (N&W), arriving at the N&W 55th Street Rail Yard at noon. The cars were moved to the Shaker Heights 49th Street siding at 8:00 AM on September 23, 1974, where a Cleveland Transit System (CTS) airporter hooked up to SOAC No. 1 using the SOAC/CTS towbar. The airporter pulled the SOAC's onto the rapid transit line and then pushed them to Cleveland Union Terminal (westbound). At the Terminal, the Airporter moved around behind SOAC No. 2, the towbar was hooked up, and the SOAC's were pushed eastbound to the Windermere Yard. Upon arrival at Windermere, the cars were inspected for damage by Boeing Vertol and CTS representatives. A few small dents were noted as a result of stones thrown by vandals as the train left South Boston.

Support Car Location

Track space was rented from the N&W for storage of the support car and the two transition cars at their Mayfield team track. This location is adjacent to the rapid transit station at 120th and Euclid and only two stops away from the Windermere Yard.

Security

Security services were arranged to provide twenty-four hour guard protection for the support car and also protection for the SOAC's outside at Windermere. SOAC coverage was basically 4:00 PM to 8:00 AM on weekdays and twenty-four hours on weekends and holidays.

CTS could not provide transit police for onboard security during revenue service, having a total of only three people in that category. In order to obtain armed and experienced security personnel onboard the train, arrangements were made with the Cleveland police department to hire off-duty, uniformed police. The police department handled the administrative tasks associated with the SOAC duty roster.

Figure 4-5 Cleveland

4.6.2 Car Preparation and Modification

The SOAC's were prepared for operation between September 30, 1974 and October 5, 1974. All the routine tasks were accomplished as noted for the NYCTA demonstration, except that the third-rail current collector assemblies were not installed.

Several configuration changes were necessary for operation on the Cleveland Transit System. These included a floor height adjustment, trip cock relocation, cab signalling changes and installation of pantographs, door sill extensions, fare boxes and radios.

Floor Height Adjustment

SOAC was designed with provisions for floor height adjustment to accommodate variations in platform height at the demonstration sites. A comparison of platform and car floor heights at the five transit properties is presented in Table 4-3.

Operation in Cleveland required that the SOAC floor height be decreased from 3' 10 1/2" (maximum) to 3' 5 1/2" (minimum). This entailed jacking both cars and removing both height adjusting spacers, the 2" spacers between the airbag and the body bolster and the 3" spacers between the truck and the truck bolster. Since the CTS jacking equipment was not compatible with the SOAC, a pair of high-capacity hydrualic jacks with pump and manifold was rented locally and each car was jacked one end at a time. Removal of the 2" spacers between the airbag and the body bolster also makes it necessary to reposition all vertical and lateral shock absorbers and the bolster anchor rods. These items are provided with two mounting locations.

The 600V diode assembly installation required for operation in New York was not compatible with the minimum floor height position required for Cleveland. Because of a clearance problem with the No. 2 truck it was necessary to remove the No. 2 end diode assembly from the propulsion system cooling duct and install a cover plate. The No. 1 end diode assembly was left installed and disconnected, as configured for Boston.

Pantograph Installation

Power for the CTS system is supplied from an overhead catenary and represented the first requirement for SOAC to operate with pantographs. The pantographs had been installed and functionally checked for operation at

Pueblo during the pre-demonstration test program but had never operated against an overhead wire to power the cars. The pantographs were installed in the Windermere Shop using the CTS pantograph hoist and loft facilities. After installation, the pantographs were functionally checked for proper operation, lubricated and checked for spring tension. Initial spring tension settings were 18-19 lbs. which was the same as the CTS settings.

Trip Cock Relocation

A trip cock modification was required to relocate the trip cocks for proper alignment with the CTS track trips. A mounting plate was installed to allow the trip cock to be moved 7 inches outboard. The piping was modified to suit.

Door Sill Extensions

Since the SOAC is approximately 9 inches narrower than the CTS airporters, door sill extensions were designed and fabricated for SOAC to prevent people from accidentally stumbling when crossing between the car and the platform during the Cleveland demonstration.

The mounting holes and riv-nuts were installed below the thresholds before the cars left Boston. The sill extensions, measuring 4 5/8" per side, were installed before the first clearance run and gave the SOAC's a width over the thresholds of 10' 5" as compared to 10' 4 1/2" for the airporters.

Fare Boxes

The CTS uses onboard fare collection between the hours of 10:00 AM and 2:00 PM. They provided two fare boxes, one for each car which they mounted by clamping to the forward windscreen stanchion of the No. 1, "A" side door. This arrangement allowed the fare collector to sit on the "A" side bench seat between the No. 1 "A" side door and the cab.

Cab Signalling

The MBTA cab signalling equipment required some minor modifications for use on the CTS. Both properties utilize GRS equipment, frequencies and code rates, with the primary differences being that CTS only uses one carrier frequency and substitutes a 75 cycle code rate for the 120 cycle code rate as shown in Table 4-6. CTS signalling personnel made the necessary changes.

TABLE 4-6 CTS CAB SIGNALLING FREQUENCIES AND CODE RATES

CARRIER FREQUENCY 4550 Hz

CODE	SPEED COMMAND
Steady energy	Stop and proceed command *
No energy	Stop and proceed command *
75 code	15 mph speed command
180 code	35 mph speed command
270 code	65 mph speed command
410 code	Cut out cab signal command **

NOTES: * This command permits operation at a maximum of 15 mph, following a stop.

** This command cuts out cab signals and permits operation under wayside signal and mechanical trip stop control.

Communications

CTS provided two bus radios and accomplished the installation. The 12 volt power source was obtained by a tap off the SOAC 37 volt battery power supply. The transceiver and hand set were mounted on the forward bulkhead of each cab; the transceiver below the parking brake and the hand set below the left hand edge of the motorman's console. The antenna was mounted in the roof at the No. 1 end of each car.

4.6.3 Briefings and Training

A SOAC briefing was given to CTS management at 1404 E. 9th Street on October 2, 1974. The orientation and training presentation was given to operations and maintenance personnel at Hayden Garage on October 3, 1974.

Three inspector - instructors were trained as SOAC operators during the clearance, test and ATO checkout runs. One of the these men was assigned to SOAC full time and was in the cab whenever SOAC was on the line. Regular motormen were utilized during revenue service, receiving on-the-job training from the supervising instructor. Approximately ten motormen were utilized, with five doing the bulk of the driving.

4.6.4 Route Description

The CTS has one rail rapid transit line (Figure 4-6) which runs basically south west to north east from Cleveland Hopkins Airport to Windermere in East Cleveland. The line is 19 miles long with 18 stations. Cleveland Union Terminal is the downtown terminus with 8 stations on the East Side and 9 stations on the West Side. The entire line is at grade level with power supplied from overhead catenary. Running time is 36 minutes, 15 minutes on the East Side and 21 minutes on the West Side.

Wayside signals with track trips are used on all portions of the line except the western end from West Park to the airport where cab signalling is employed. The cab signals call for speeds of 15, 35 and 65 mph in cab signalling territory, but CTS has a 58 mph speed limit on the line because of track condition and all CTS cars have speed governors set to 58 mph. The SOAC speed maintaining system was set up to provide 55 mph in response to the 65 mph cab signal command.

4.6.5 Testing

SOAC No. 2 was powered and operated in the yard with the pantograph for the first time on October 3, 1974. On October 4th, after functional checkout of Car No. 1, both cars were coupled and operated in forward and reverse in the yard with no problems.

The initial no-load clearance run over the line was made between 12:40 AM and 5:30 AM on October 6, 1974. With the door sill extensions installed, some station platforms were quite tight; many 1" clearances were noted and two platforms had only 3/4" clearance. The lateral clearance problem was alleviated by vertical clearances running mostly from 1 to 3" above the station platforms. All turnouts and spurs and most crossovers were checked in case SOAC had to be taken off the line because of a breakdown. A clearance of 1/2" was noted between No. 2 and 3 door sills and an iron railing when leaving the West Park spur eastbound.

Additional check runs at light weight were made on the 7th and 8th. A recheck of the platform clearance at East 120th and Euclid showed zero lateral clearance and 3/4" vertical clearance above the platform. CTS agreed to cut this platform back.

At this point CTS expressed concern about mismatch between the SOAC door sills and the platforms at many of the stations. Vertical clearances ranged from zero to 5 inches

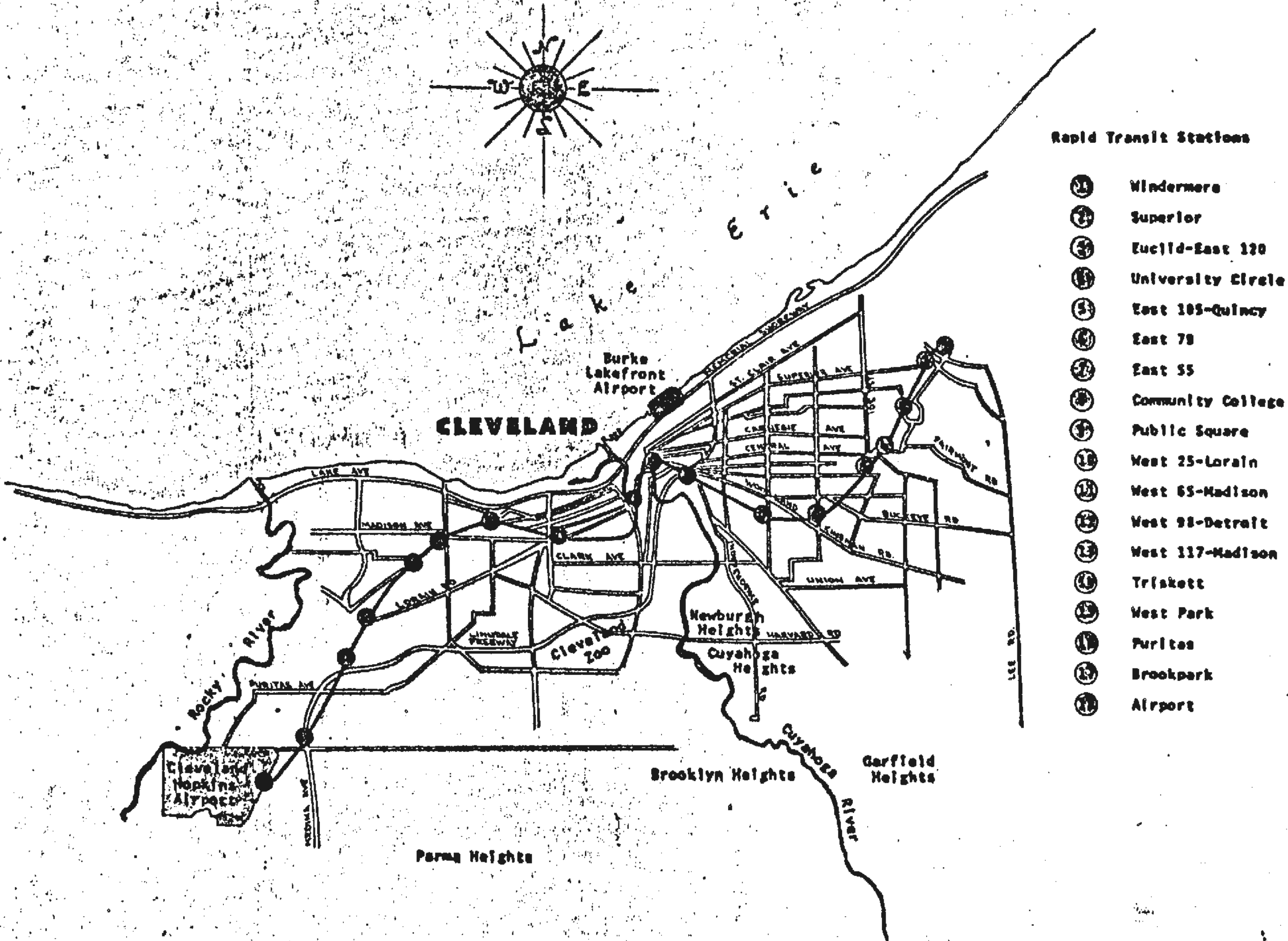


Figure 4-6. CTS Airport - Windermere Line

above the platforms and lateral clearances ranged from zero to 3 inches. It was agreed that toe plates extending 3 to 4 inches below the outer lip of the door sills would prevent passengers' feet from slipping beneath the door sills when boarding the train. Since this fix was not compatible with the lateral clearance problem at mid-car (due to the overhang of the 75 ft. SOAC's), it was agreed that the SOAC's would be operated with the No. 2 and 3 doors locked out on both sides of the car and the door sills removed from these doors. This was consistent with the CTS operation since their cars have only two doors per side and onboard fare collection between 10:00 AM and 2:00 PM requires the use of one door only. Wooden 2 x 4's were attached to the outer edge of the door sills for toe plates and were painted silver to match the door sills. This installation proved quite satisfactory and there were no problems in revenue service.

The propulsion aspects of pantograph operation were satisfactory on the initial test runs, but excessive arcing and pitting of the rub strips was noted under maximum current draw. Pantograph spring tension was increased from 19 to 21 lbs. A check run on October 9, 1974 showed the arcing to be less pronounced at the higher spring tension, and it was noted that the arcing was always on the trailing pantograph, regardless of train direction of travel. The placement of the SOAC pantographs back-to-back on the No. 2 ends of the cars is evidently a factor in the amount of arcing generated. No further adjustments were made to the pantographs during the Cleveland demonstration.

Car No. 2 was ballasted with 30,000 lbs. of sand bags on October 10, 1974 and the 120,000 lb. clearance run was conducted between 1:00 AM and 4:00 AM on October 11, 1974. Marker plates were installed to replace the door sills removed from the No. 2 and 3 doors on both cars. Car floor height at 120,000 lbs. proved to be approximately 3/4 inch lower than at light car weight. The marker plates indicated 1/8 inch lateral clearance level with the platform at 120th and Euclid, even after the platform had been cut back. If the SOAC's were to be operated with door sills at all doors, this platform would have to be cut back a minimum of 1 inch over a span of 15 ft. With door sills at the front and rear doors only, clearances were satisfactory over the entire line at the 120,000 lbs. weight. Clearances generally ran 1 to 3 inches with a minimum of 3/4 inch.

The instrumentation console was installed in Car No. 2 on October 16, 1974 and two data runs were made between 10:00 PM and 4:00 AM that night. One set of data was taken with the 50% lateral shock absorber settings used in New York and the data was repeated with the 75% settings used in Boston and Cleveland. Wayside and interior noise levels were measured.

Test runs were conducted on October 17th and 18th, 1974 for operator training and ATO checkout. The only problem encountered with the cab signalling (ATO) was the same loss of signal problem encountered in Boston. The five-second delay between loss of signal and brake application which solved the Boston problem was not adequate for the CTS operation. Four thousand microfarods of capacitance and 560 ohms of resistance were added to the F-carrier relay circuit to hold the relay in while crossing the track circuit bonds. This modification was checked out on October 20, 1974 during the day run for the VIP inaugural run and found to be satisfactory.

4.6.6 VIP Ceremonies

The cars were cleaned inside and out on October 18th and 19th, 1974 in preparation for the VIP ceremonies. A round-trip dry run was conducted on October 20, 1974. Inspection of the cars following this run disclosed that SOAC No. 2 wheel No. 2A had suffered an unbonding of the resilient material in the threads between the hub and the rim (See Maintenance, Section 4.6.8).

The SOAC inaugural ceremonies were held in Public Square across from Cleveland Union Terminal (CUT) on October 21, 1974 as scheduled. SOAC No. 2 was uncoupled and SOAC No. 1 was run in reverse from Windermere to CUT where approximately 100 invited guests boarded the car for the inaugural run to University Circle. A full service brake application from 50 mph and a maximum acceleration from a standing start were demonstrated. The VIP contingent disembarked at University Circle where they were picked up by a 2-car Airporter for the return trip to CUT.

4.6.7 Revenue Service

Summary

Revenue service on the CTS was conducted from October 25th through November 1st, 1974 and November 22nd through December 10th, 1974. After 6 days of operation in passenger service, the SOAC's were taken out of service for three weeks for a wheel/axle problem which required a wheel retention modification (See Maintenance, Section 4.6.8). Two full weeks of revenue service were accomplished after their return to service on November 22, 1974. Availability was calculated for the three weeks of revenue service.

Revenue Service Days	-	15
Miles Per Day	-	272
Round Trips Scheduled	-	96.5
Round Trips Made	-	84.75
Availability	-	88%
Total Passengers (Est.)	-	20,000
Total Miles	-	4,217

Method of Operation

The hours of operation for the SOAC operational evaluation on the CTS were 8:30 AM to 6:30 PM, five days a week. There was no operation on Saturdays, Sundays or over the four day Thanksgiving Holiday. Six round trips from Windermere to the airport plus one round trip to Public Square were scheduled each day. Day and trip schedules are presented in Appendix III.

SOAC team first shift personnel powered the train each morning at 8:10 AM. At 8:20 AM the train moved out through the switch at the west end of the yard westbound on the eastbound track. The operator then changed ends and moved back into the Windermere station. The normal flow of traffic from the yard onto the line is around a loop at the east end of the yard into the station heading west. The radius of the loop is 131.5 ft. which was too tight for the SOAC's, particularly at the minimum floor height.

At 10:00 AM each morning, two fare collectors boarded the train to collect fares in the fare box until 2:00 PM. During these hours, the rear doors were locked out leaving only the front doors in each car for passenger boarding and egress. The exceptions to this were Windermere, Cleveland Union Terminal and the airport, where fares are collected in the station all day long. When entering these stations, the applicable rear doors were unlocked for passenger convenience. After leaving these stations the rear doors were again locked out. As stated earlier, the No. 2 and No. 3 doors were not used during revenue service in Cleveland (See Section 4.6.5). CTS uses flashing white lights at each station to tell the operator when he is required to collect fares on the train.

At 2:30 PM each day the SOAC team second shift personnel took over for the remainder of the day's running and the daily maintenance. The shift change was accomplished each day at Windermere station prior to the 2:36 PM departure.

It was found that the SOAC's were losing time at each station because of the 4-second time delay between the door warning chime and the door closure. The door time delay relay was adjusted to cut the time delay to 2-seconds, which proved beneficial for the CTS operation.

Passenger Reaction

SOAC passenger loads on the CTS were generally light except for the late afternoon runs. As in the other cities, a hostess was employed to hand out literature and answer general questions. The SOAC's were well received by the riding public, but with somewhat less interest than was displayed in New York and Boston. Passengers using the "Rapid" to get to or from the airport generally displayed the most interest in the project. Announcements were made over the P.A. system by the SOAC team leader to provide the riders with information on SOAC and the purpose of the program.

As in the other cities, the riding public was impressed with the quietness and smoothness of the ride on SOAC. CTS management personnel commented that SOAC was the "best riding car" they had seen.

The low density car however, was the star of the show in Cleveland. This is understandable in an operation where the entire route is at grade level with longer distances between stations, similar to many commuter rail lines. The two tables were used occasionally for crossword puzzles and at least one Clevelander addressed his Christmas cards while inbound from the airport. Most of the passengers travelling to the city from the airport were noticeably impressed by the interior appointments of the low density car.

The most frequent criticisms again were "Not enough handholds" and "Not enough windows", only this time the emphasis was on the windows. The Clevelanders were also critical of the seats in the high density car. They commented that the seats were too narrow and too short from front to back. These comments are understandable when viewed in light of the fact that all CTS cars have padded, upholstered seats of ample proportions.

Special Trips

One special trip was conducted on Saturday, November 2, 1974 for the Detroit Engineering Society and railfans from the Midwest Chapter of this National Railway Historical Society. Inspection of the cars just prior to this trip disclosed that wheel No. 3A of Car No. 1 had moved outboard on the axle and was out of gauge tolerance. Car No. 1 was uncoupled and Car No. 2 was used for the trip from Windermere to the airport and back. Car No. 1 was used for a walk-through at Windermere after the trip.

Availability

No trips were missed during the first six days of revenue service prior to the layup for the wheel retention modification. During the two weeks of revenue service after the layup, two mechanical failures, one electrical failure and one electrical problem (See Maintenance, Section 4.6.8) caused SOAC to miss 11 3/4 scheduled trips. A total of 96.5 trips was scheduled during this period. Availability was 88%.

4.6.8 Maintenance

Wheels

The major maintenance problems in Cleveland were associated primarily with wheels and axles. The first problem was encountered on October 21, 1974 when Acoustaflex wheel S/N 02V607 was found with torn elastomer on both sides and all electrical bonding wires torn loose. Inspection disclosed that the steel rim and tire had rotated approximately 60° on the aluminum hub and had moved approximately 0.10" laterally as it unthreaded. The wheel was sectioned at the vendor's plant and showed very little bond between the elastomer and the aluminum threads on the hub. A good bond was evident between the elastomer and the steel threads of the rim. The vendor advised that machine controlled degreasing and priming had been introduced since the original SOAC wheel fabrication and that all new wheels should have an adequate bond between the elastomer and the steel and aluminum threads. The wheel/axle set was replaced with a spare set incorporating 2 new wheels fabricated under the new process controls. A twice daily wheel inspection was instigated on SOAC as a result of this failure.

On November 2, 1974, wheel S/N 02V1116 (No. 3A on Car No. 1) was found to have moved approximately 5/8" outboard on the axle. Measurements taken between the journal bearing shoulder and the inside hub face showed 8 other wheels had moved outboard from .008" to .151" (see maintenance action entry for November 2, 1974). Wheel S/N 02V1116 was pressed off axle S/N 2C200, the wheel bore and axle diameter measured, the mating surfaces cleaned up and the wheel repressed on the axle. The recorded press tonnage was only 26 tons, well below the minimum specified 50 tons, so the wheel axle set was returned to the vendor for reassembly with two new wheels.

Wheel S/N 02V610 (No. 2A on Car No. 1) which had moved .151" was pressed back against the journal bearing with a recorded tonnage of 60 tons. All other wheels were left in position. Axle end caps were designed, fabricated and installed to preclude any wheel-axle separations. The axles were drilled and tapped with 3 holes for 5/8" bolts using an axle center pilot, base plate and a magnetic drill base. Shims were used to position the end caps so that a gap of .030"- .060" existed between the cap and the wheel to act as an indicator of any additional wheel movement. After 2000 additional miles, wheel No. 2B (S/N 04T3177) on Car No. 2 had moved .030" outboard to rest against the cap. This wheel had been tight against the journal bearing when the end cap was installed.

On November 23, 1974 wheel No. 1A (S/N 04T3168) on Car No. 1 was found to have torn elastomer on the inside but not on the outside. Visual inspection disclosed that the steel tire had rotated approximately 1.5 inches on the steel rim. There was no failure of the elastomer bond between the rim and the hub; the torn elastomer was caused by the filler on the inside face adhering to the retaining ring which is attached to the tire. All resilient action takes place between the rim and the hub.

The tire on wheel S/N 04T3168 rotated another 0.6" during the next 120 miles and then remained in this position for another 424 miles. The vendor then drilled and pinned the tire to the rim to prevent any further rotation. Six equally spaced 1/4" steel dowel pins were inserted parallel to the axle and bisecting the parting line between the two mating surfaces.

The movement of the aluminum wheel hubs on the steel axles in Cleveland is believed to have been caused in part by an extremely tight guard rail condition on an S-curve approximately 1/4 mile west of the West 98th Street Station. SOAC exhibited a pronounced wheel chatter when negotiating this curve at any speed in excess of 10 mph. External observation disclosed that the outboard wheel flanges were climbing the rail and that the car was being restrained by contact between the guard rail and the back side of the inboard wheel flanges. The guard rail at this location is 1 1/2 to 1 5/8 inches from the running rail and is well worn with a highly polished contact surface. The CTS Airporter Cars, which have a shorter wheel base and a shorter distance between truck centers, were able to negotiate this curve at speeds of approximately 25 mph.

Traction Motor Cables

Traction motor cable problems resulted in the repair or replacement of 9 field or armature cables. In 8 of the 9 cases, the problem was embrittled and broken strands at the crimped connection to the Williams connector lug, apparently caused by mechanical fatigue. One field cable failed in service with a resultant failure of the phase delay rectifier (PDR) in the motor field power supply. Non-availability of spare thyristors for the PDR caused SOAC to miss all 6 1/2 trips the following day. This same failure occurred twice in New York and Boston with resultant PDR failures. The problem was recognized as cable fatigue caused by relative motion between the shock mounted traction motor and the truck mounted cables. A clamp was designed to provide support for all four cables on each motor approximately 6 to 8 inches back from the connector block. Parts for this modification were not available prior to the SOAC departure from Cleveland.

Shock Absorber Mounts

Three lateral shock absorber car body attachment fittings failed on Car No. 2 during the fifth trip on December 4, 1974. Gussets had been previously installed on the tubular mount after all four fittings failed on Car No. 1 in New York. Diagonal steel braces were designed and fabricated for installation in Chicago. Welded repairs were accomplished in Cleveland, to serve until the modification could be accomplished.

Gearbox

A persistent false spin-slide and speed fault indication problem was solved in Cleveland when investigation disclosed that 60% of one gear tooth had broken off the pinion drive gear in the No. 1 gearbox of Car No. 1. Since the spin-slide detector counts teeth on the pinion gear, false signals were generated. The gearbox was replaced with a spare unit. Inspection of input pinion gears on all installed gearboxes showed no other failures.

DATE	MAINTENANCE ACTION
10-19-74	Car No. 2 - Replaced blown fuse in battery charger.
10-21-74	Car No. 2, wheel No. 2A, acoustaflex elastomer unbonded and the rim rotated approximately 60° on the hub. Replaced wheel axle set.
10-26-74	55 mph speed maintaining button in Car No. 2 gives full service brake. Repaired short circuit.
10-28-74	Car No. 2, truck No. 1 derailed on a facing point switch. Jacked the car back on the tracks.
10-29-74	Reduced side door time delay from 4 to 2 seconds.
11-02-74	Car No. 1 Truck No. 2 airbrakes would not release. Changed analog components and adjusted new EP valve. Car No. 1, motor No. 4 armature cable overheated at Williams connector. Brittle and broken strands. Cut off Williams Connector lug and 6" of cable. Installed new Williams lug.
11-02-74	Car No. 1, wheel No. 3A has moved 5/8" outboard on the axle. Gauge measures 54 1/16". Removed and repressed the wheel. Press tonnage of 26 tons unacceptable. Replaced the wheel/axle assembly. Other wheels show movement as follows:

CAR NO. 1		CAR NO. 2	
Wheel No. 1A	.011	Wheel No. 1B	.025
1B	.016	3A	.060
2A	.151	3B	.012
4A	.008		
4B	.070		

11-02-74	Car No. 2, Motor No. 3 field cable has broken strands at Williams lug. Cut back cable and replaced Williams lug.
11-03-74	Car No. 1 end door lock relay diode failed. Replaced diode.

DATE	MAINTENANCE ACTION
11-07-74	Car No. 1, axle No. 1, gearbox S/N 52-D9 has broken tooth on drive pinion. Replaced wheel/ axle/gearbox assembly. Replacement gearbox S/N 52-D1.
11-07-74	Car No. 1, motor No. 1 armature cable male and female Williams connectors welded together. Replaced motor S/N 52-D6 Williams grip. Replaced both motor armature cables.
11-11-74	Car No. 1, wheel No. 2A repressed. Press tonnage 60 tons.
11-13-74	Car No. 1, No. 2 end draft gear rubber washers replaced.
11-18-74	Installed end caps on all axles both cars. Axles drilled and tapped for 3 each 5/8" socket head bolts. Bolt heads lockwired.
11-23-74	Car No. 1, wheel No. 1A steel tire rotated 2.1 inches on the steel rim. Drilled and pinned tire to rim with 6 equally spaced 1/4" steel dowel pins parallel to axle centerline and bisecting the mating surface.
12-04-74	Car No. 2, No. 1 end A and B side and No. 2 end A side shock absorber car body attachment points failed. Made welded repair.
12-05-74	Car No. 2, motor No. 2 field cable failed at the Williams lug with resultant PDR failure. Replaced the cable and repaired the PDR. Inspected all motor field and armature cables and replaced the following additional cables: Car No. 1, motor No. 1 field cable, upper Car No. 1, motor No. 2 field cable, lower Car No. 2, motor No. 1 field cable, lower Car No. 2, motor No. 2 armature cable, upper, cut back cable 3" and replaced Williams lug.

DATE	MAINTENANCE ACTION
12-06-74	Car No. 1 horn valve malfunctioning. Removed, cleaned, adjusted main spring and reinstalled.
12-07-74	Car No. 2 M/A shutting down during start cycle. Repositioned time delay relay drum.
12-09-74	Car No. 1 air compressor motor windings failed. Replaced the motor.
12-09-74	Car No. 2 air brakes came on while running, both trucks. Removed J-45 P-signal transducer card, cleaned contacts and reinstalled.
12-09-74	Car No. 2 main contactors opened repeatedly while running in blowing snow. Found ice in cooling air ducts and a mixture of water and steel dust on chopper circuit card connector pins. Cleaned and dried circuit cards. Air filter had been removed for system evaluation.

4.7 CHICAGO

4.7.1 Shipment

The SOAC five-car consist left Cleveland on the Norfolk and Western on the evening of December 16, 1974 and arrived at the Calumet Yard in Chicago at 11:00 PM on December 16, 1974. The cars were handed over to the Chicago and Northwestern at the 40th Street Yard on December 19, 1974 and arrived at the Chicago Transit Authority (CTA) Skokie Shops at noon that day. A CTA diesel-powered crane was used to push the two SOACs and the support car into the yard. The cars were inspected by Boeing Vertol representatives and found undamaged.

Support Car Location

The support car was brought into the Skokie Yard and stored adjacent to the shop. Because of tight clearances between the support car trucks and the third rail in the yard, third rail power for the yard was shut down during the move. Having the support car stored with the SOACs made spare parts and tools readily accessible.

Security

A security service was employed to provide protection for the support car from 4:00 PM to 8:00 AM in the Skokie Yard (24 hours on Saturday and Sunday) and also for security onboard the SOACs during revenue service. The SOACs were stored inside the shop at Skokie and did not require security protection.

4.7.2 Preparation and Modifications

4.7.2.1 Car Preparation

The cars were prepared for operation between January 2, 1975 and January 9, 1975. All the routine tasks were accomplished as noted for the NYCTA demonstration. The door sill extensions were removed, the floor height re-adjusted to the 3' 10 1/2" maximum setting and the trip cocks reset for proper alignment with CTA track trips before leaving Cleveland. The pantographs were left on the cars for use on the Skokie Swift Line (part catenary and part third rail). The cars were detrucked at Skokie and those wheels which were noted to have moved prior to the axle end cap installation in Cleveland were pressed back against the journal bearings (see Maintenance Section 4.7.8).

Door Cut-Out Switches

Key operated door cut-out switches were installed for the forward doors in each car so that these doors could be cut-out at the Dempster Street station where car length exceeded platform length. A switch was mounted above each No.1 ("B" side) and No. 16 ("A" side) swing panel. The "B" side switch controls the No. 1 and two door leafs and the "A" side switch controls the No. 15 and 16 leafs. The key switch eliminated the requirement to unlock the swing panel and individually cut-out each door leaf.

Air Compressor Sump Heaters

Two cold weather modifications were made prior to the January and February operation in Chicago. One of these was the installation of a 110V/220V immersion heater in each air compressor oil sump to preclude compressor motor failures when attempting to start the compressor after cold soaking at very low temperatures. The immersion heaters were installed in the sump drain openings.

Air System Dryers

Another cold weather modification was the installation of a Bendix AD-2 air dryer in the air brake system of each car. This was done to preclude freeze-ups caused by moisture in the system. Additional benefits are derived from this installation in terms of reduced corrosion of the various air brake system components. The installation includes a desiccant dryer purge valve, purge tank, 12 volt heater, step down heater resistor and a purge control valve. In addition, the relief valve was moved from the after cooler to the purge tank and the compressor automatic drain valve was replaced with a pneumatically controlled drain valve.

Motor Cable Brackets

Traction motor armature and field cable failures encountered in New York, Boston and Cleveland resulted in the design of a clamp to provide support for all four cables on each motor connector block (see Section 4.3.8, Cleveland Maintenance). These clamps were installed prior to operation in Chicago.

Shock Absorber Mount Braces

Diagonal steel braces were installed to stiffen the lateral shock absorber car body attachment fittings. These parts were designed and fabricated during the Cleveland operation.

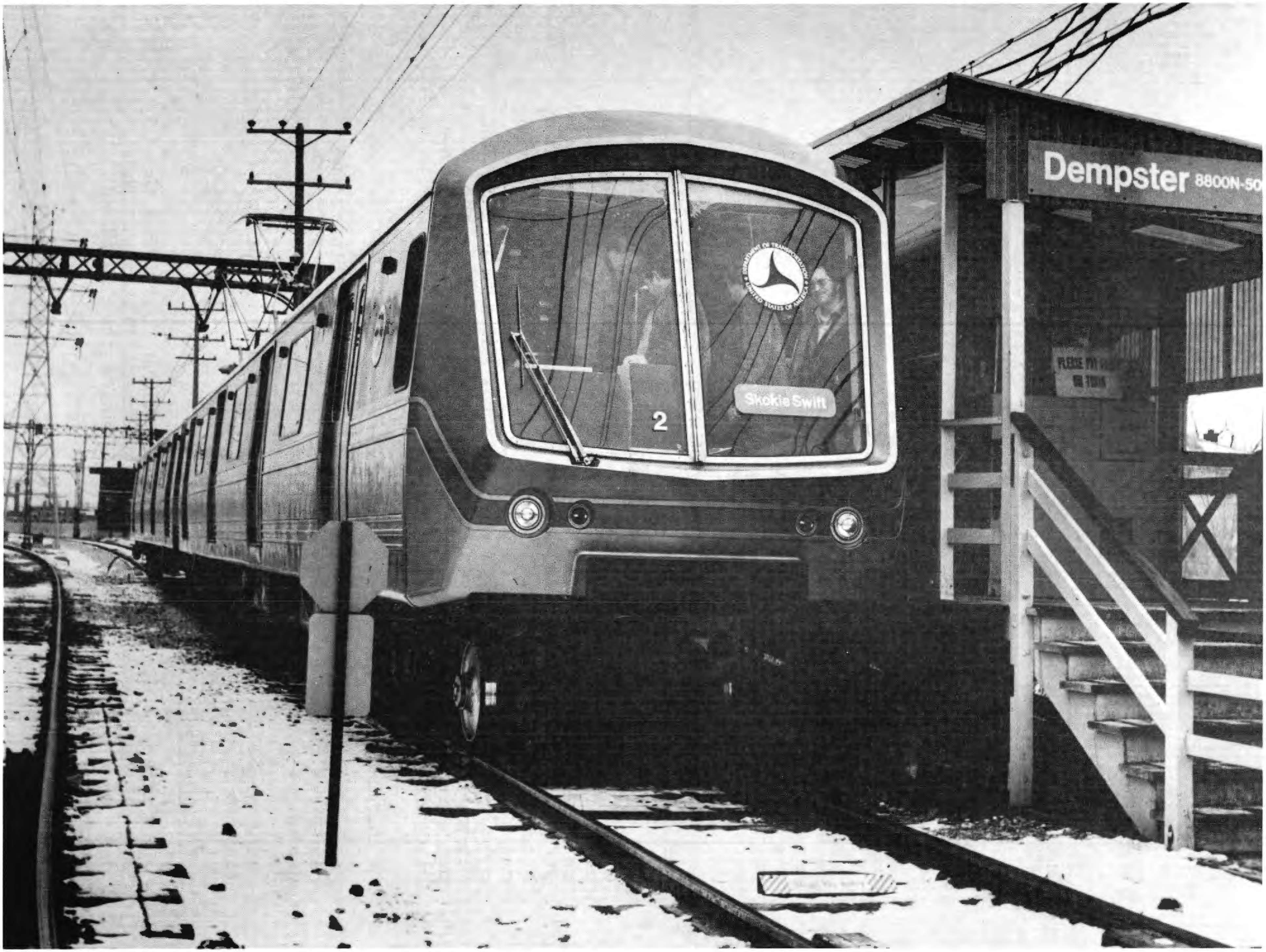


Figure 4-7 Chicago

Communications

CTA provided two trainphones and made the installation. The trainphone set was attached to the forward bulkhead of each cab below the parking brake and adjacent to the console. The trainphone works by receiving and transmitting a signal via the 600 volt third rail and/or catenary. The coupling of the trainphone to the third rail is by a capacitive hi-pass filter. For SOAC 600 volts for the trainphone were obtained from the overhead heater circuit. Reception and transmission quality was as good as on CTA cars.

4.7.2.2. CTA Property Modifications

Extensive modifications were required to the Skokie Swift facilities to permit the operation of the SOACs. The changes were required because the SOAC is approximately 50% longer than the CTA cars and is one foot wider at the floor level (the SOACs maximum width is 6" wider than the CTA's maximum width).

The changes required were modifications to the platform edges at the Dempster and Howard stations, track movement, revising and adding new signal control, and modifying some third rails.

Platform Modifications

Platforms at the Dempster and Howard stations required that movable platform edge extensions be installed. These edge extensions had a hinged edge that was lowered to allow clearance for the wider SOAC to move into and through the platform. When a CTA train was to use the platform the edge was raised so that the gap between platform and car was kept constant. The platform edge extensions were provided by Boeing Vertol (Ref. Drawing No. SK-332-10022) and installed by CTA. The edge extensions at the Dempster station were electrically actuated and controlled by a platform attendant. The electrical actuation was required at Dempster because the position of the flaps had to be changed every time a train approached the Dempster station during the hours of SOACs operation.

The edge extensions at the Howard station were manually operated. These extensions were dropped during the hours of SOACs operation and then raised after the last SOAC trip of the day.

The SOAC operation at Howard involved pulling into the northern end of the platform and reverse running out of the platform. The SOAC did not pull through the platform as the CTA trains do. The platform was cut back to accommodate the edge extensions for a distance of approximately 170 feet from the northern end. Edge extensions were installed from the south end of the cut-out continuously for approximately 145 feet.

The CTA trains did not use the portion of the Howard platform with the extensions during SOAC operating hours. The Howard platform is sufficiently long for the shorter non-rush hour CTA trains to use only the unmodified part of the Howard platform.

At both Howard and Dempster, edge extension position was indicated to the approaching train by an illuminated sign indicating "flaps up" or "flaps down". No movement into the station was allowed during flap position changes as controlled by block signals and track trips. At the end of the demonstration the edge extensions were left in place. The electrical actuators were removed from those at Dempster and solid links installed. Additional structural supports were installed at both Howard and Dempster. These supports secured adjacent corners of extensions to one another and to the lower platform structure.

An additional modification was required for the northbound Dempster platform. The track north of the northbound platform turns sharply to the left (away from the platform) to enter the tail track. The sharp turn caused the rear end of the SOAC cars to move outward from the track centerline approximately 10" and have approximately an 8" maximum interference. To eliminate this interference the existing wood platform was cut back for a length of 27 feet tapering to a maximum cut-back of 10" at the north end. This cut-back portion was blocked off by a hand rail and an additional 27 feet of new platform was constructed on the south end.

Signal Modifications

The Skokie Swift route, at the time of the SOAC demonstration, was controlled by wayside block signals with track trips. Additional signal control was required for the SOAC operation because of the reverse move from the Howard No. 1 track to the Ridge Avenue cross-over, the cross-over move and the platform edge extension operation. Control of the additional signals was by a combination of automatic and manual control.

The signal control allowing access to the Dempster station was automatic for track occupancy and manual for edge extension position changes. The signals and flaps were controlled by a platform attendant in a supervisors booth. The signal control allowing access to the Howard station was manually controlled from the Howard Tower and manual from the platform for edge extension position changes and for final entry into the platform.

Signal control at the Ridge Avenue cross-over was automatic for track occupancy. Traffic control through the cross-over, for other than normal Skokie Swift operations, was controlled by a supervisor located in a supervisor's booth at the cross-over. Switches were manually thrown.

Five train stops (track trips) were added and nine signals were either added or modified for the SOAC operation. Two new presence detectors were also required, one each at Dempster and Howard.

<u>Track Movement and Third Rail Modification</u>

The track crossing the Dodge Avenue bridge had to be moved away from the center of the bridge so that SOAC would clear island platform on the bridge (this platform is no longer used). The Dodge Avenue bridge is located near a high speed curve and the 6 inch movement affected the spiral entry to this curve, requiring the adjustment of the track alignment over a distance of approximately a half a mile.

Third rail modifications were required at the Ridge Avenue cross-over and at the rail gap at the junction of the Skokie Swift tracks with the Evanston Service tracks just north of the Howard platform.

At Ridge, power rails had to be added across the cross-over. From the cross-over toward Howard on the normal southbound track the run-off ramps had their incline adjusted so they would be satisfactory as run-on ramps for the reverse move that SOAC would make.

The rail gap between the Skokie Swift and Evanston Service tracks was lengthened so that the SOAC cars could not bridge this gap and cross feed power between these rail sections.

4.7.3 Briefings and Training

CTA gave a shop safety briefing to the SOAC team on January 2, 1975. The SOAC orientation and training presentation was given to CTA maintenance personnel at the Skokie Shops on the morning of January 7, 1975, and to transportation personnel at the Merchandise Mart on the afternoon of the same day. A presentation of SOAC features and program objectives was made to CTA management personnel by the Boeing Vertol Program Engineer on January 15, 1975.

Two instructor-supervisors were trained in the operation of the SOAC during the clearance and engineering test runs. One of these two instructor-supervisors was always onboard the train supervising the normally scheduled motorman. Approximately 12 different motormen were involved in the operating of the SOACs. Some of these were trained on a Sunday training run and the others were broken-in during regular service.

4.7.4 Route Description

The Skokie Swift route was selected for the SOAC operational demonstration in Chicago because it is the only CTA route that could be modified at a reasonable expense to accommodate the 75 ft. SOAC cars. All other CTA routes have turns tighter than can be negotiated by a 75 ft. car (the CTA cars are 48.5 ft. long). A further problem with route selection in Chicago was that the CTA cars are approximately 11 inches narrower at the floor level than the SOAC and thus the CTA station platforms have approximately a 3 inch interference with the side of the SOAC. The Skokie route was the only CTA route where modifications to the station platforms were practical.

The Skokie Swift route (Figure 4-8) runs from the Dempster Avenue station in the village of Skokie to the Howard Street station on the CTA's Evanston Line. The only stations on the line are the Dempster and Howard stations. The line is approximately 4.9 miles long. There are 7 grade crossing with automatic gates. Approximately 40% of the line, from Dempster toward Howard, uses a catenary for power distribution; the rest of the line uses a third rail. The changeover from catenary to third rail and vice versa was done by allowing the raised pantograph to run onto or off of the catenary.

The SOAC run from Dempster to Howard was the same as the normal Skokie service except that the SOAC pulled into Track No. 1 at Howard Street rather than the normal Skokie spot on Track No. 2. The run from Howard to Dempster was made by

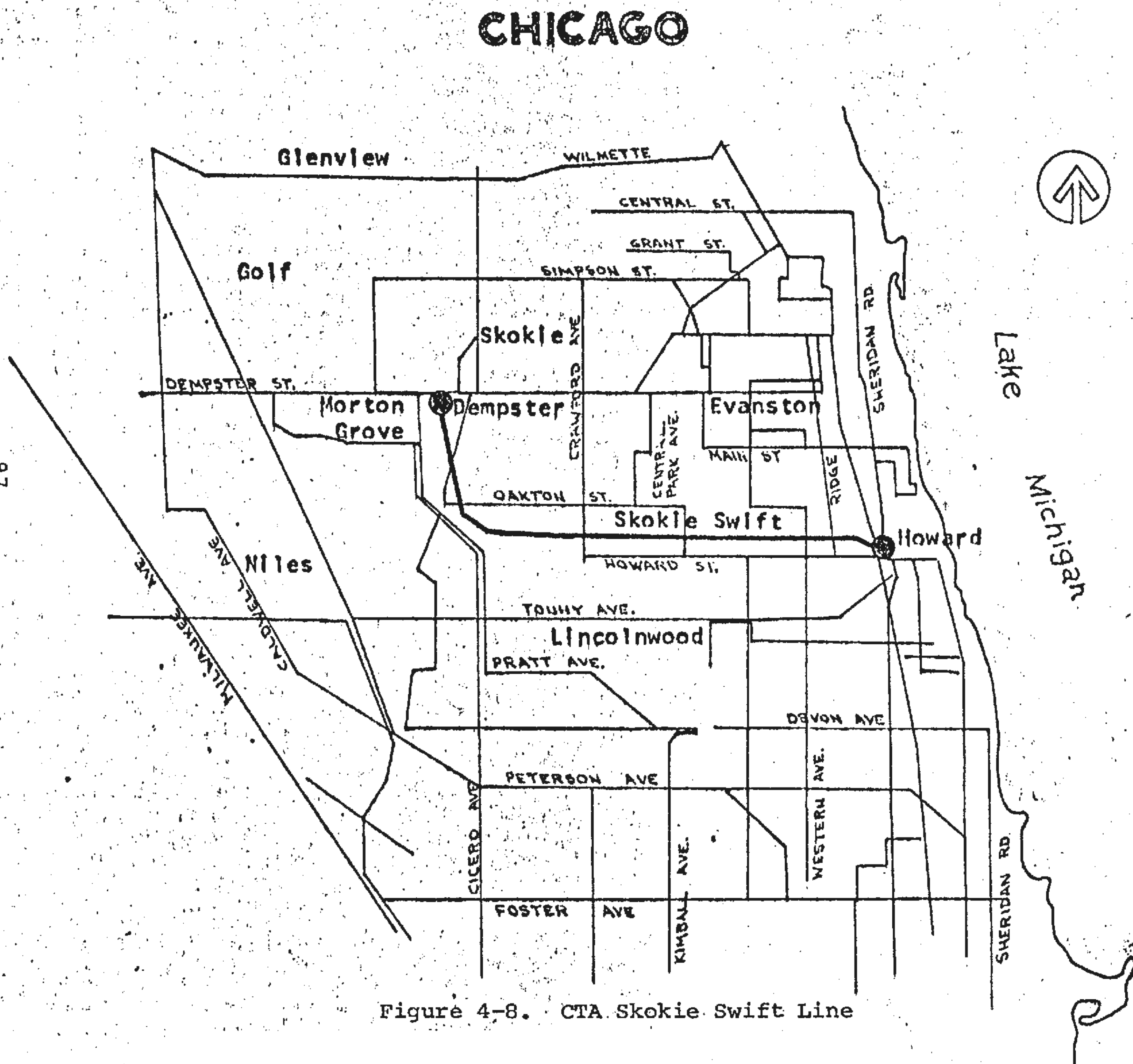


Figure 4-8. CTA Skokie Swift Line

running against the normal direction of movement from the Track No. 1 Howard platform to the Ridge Avenue cross-over where the SOAC was crossed over to the normal northbound track. Signal modifications were made to protect for this reverse move (these modifications are described in Paragraph 4.7.2.2, CTA Property Modifications).

Signalling on the Skokie Swift route is by wayside signals.

4.7.5 Testing

SOAC No. 2 was powered and operated in the yard for the first time on January 8, 1975. Car No. 1 was checked out and the two car train operated in the yard on January 9, 1975.

The first no load clearance run on the Skokie Swift was made during the day on Sunday, January 12, 1975. The bracket which supports the pantograph manual crank fitting on Car No. 2 contacted the station canopy at Dempster Avenue, and this bracket was removed from both cars. No other clearance problems were encountered. Pantograph operation was slow in the 5°F weather, more so up than down.

Based upon results obtained in New York, Boston and Cleveland, the requirement for a 120,000 lb. ballasted clearance run was deleted.

The instrumentation console was installed in Car No. 2 on January 14, 1975 and the engineering test data runs were made between 11:00 PM and 4:00 AM that night.

A full day of operator training was conducted on Sunday, January 19, 1975.

4.7.6 VIP Ceremonies

The cars were cleaned on January 20, 1975 and January 21, 1975 in preparation for the VIP ceremonies. A dry run was conducted on the January 22, 1975 with no problems. The SOAC inaugural ceremonies were held in the Skokie Shops on Thursday, January 23, 1975. The inaugural run was conducted with approximately 300 invited guests from the Skokie Shops to Dempster Avenue to Howard Street where the VIP contingent debarked. A full service brake application from 70 mph was demonstrated.

4.7.7 Revenue Service

Summary

Revenue Service was conducted on the CTA Skokie Swift from January 24, 1975 to February 8, 1975. Operation on this line required changeover from pantograph to third rail "on the fly" (See Section 4.7.4). Speeds of 70 mph were reached between McCormick Blvd. and Asbury Street southbound after leaving the last of seven grade crossings.

Revenue Service Days	-	13
Miles Per Day	-	133
Round Trips Scheduled	-	149
Round Trips Made	-	149
Availability	-	100%
Total Passengers (Est.)	-	7,500
Total Miles	-	1,968

Method of Operation

Revenue service commenced on January 24, 1975. Hours of operation were 9:28 AM to 3:05 PM, six days a week with Sundays off. Trip schedules are presented in Appendix III. The SOAC train took the place of a regularly scheduled Skokie Swift train.

The SOAC day shift personnel powered the train at 8:30 AM each morning by "stinging" the No. 2 car, (the car closest to the shop door) from the third rail (outside the Skokie Shop building). Stinging was done from the third rail as the shop's 600 DC breakers were not able to handle the M/A start-up current. Immediately after starting up the No. 2 car the train was moved outside onto the third rail. At 8:50 AM the train was moved from immediately outside of the shop to the south end of the Skokie yard where the CTA instructor and yard man were picked up for the start of the day's operations. The move out of the shop and through the yard was made by a SOAC crew member.

At approximately 9:10 AM the SOAC would receive clearance to move onto the mainline, following the train that was to be replaced. At Dempster station the regular Skokie train would unload passengers and move to the extreme end of the tail track. SOAC would, on signal clearance, move into the Dempster station and pass "over top" of the Skokie train in the tail track and pick up passengers at the Dempster inbound platform. The first scheduled departure for SOAC was 9:28 AM from Dempster.

The SOAC second shift picked up the train at 1:00 PM each day, finished the day's running and accomplished daily maintenance. The last revenue departure of each day was at 2:58 PM from Dempster. The run to Howard was completed and the motorman was relieved by a yard man. The SOAC's were then returned to the Skokie yard. The CTA crew left the SOAC's in the Skokie yard and the cars were moved into the Skokie shop by the SOAC team.

Upon entering the Skokie shop on February 6, 1975 at the end of the day's running, SOAC slid into a CTA car that was undergoing repair. The slide was caused by slippery rails in the shop. SOAC was undamaged, but minor damage was sustained by the coupler/draft gear and windshield of the CTA car and by the shop doors. Four CTA maintenance men received minor injuries when they were knocked off their feet. SOAC continued revenue service the following day as scheduled.

Passenger Reaction

SOAC passenger loads at CTA were very light as is normal during the mid-day hours on the Skokie Swift route. A hostess was employed from a local agency to hand out literature and answer general questions. Technical questions were referred to the SOAC team members onboard the train. The SOAC's were well received by the public and on the two Saturdays that the train operated, many people made special trips to ride the train.

The most frequent question asked by passengers was "Why aren't these running downtown?" and the most frequent criticism was "Not enough windows".

Visits to the SOAC's were made by several special groups. These included transportation and engineering students from local universities who made noise measurements, representatives from the National Safety Council and technical staff members from the Illinois Department of Environmental Control who made noise and vibration level measurements onboard.

Special Trip

One Sunday run was made for a rail-fan group. The SOAC trip was one part of an all day CTA rail-fan excursion that traveled around the entire CTA system on various pieces of CTA rolling stock including some restored 4000 series cars. SOAC carried the rail-fans from the Skokie yard to Dempster to Howard and returned to the Skokie yard. Enroute, a full service stop was demonstrated from 70 mph. Approximately 100 persons were carried on this trip.

Availability

No SOAC revenue trips were cancelled for mechanical or electrical failures during revenue service on the Skokie Swift. Availability was 100%. One day's operation was cancelled by CTA because of snow.

4.7.8 Maintenance

There were very few maintenance problems in Chicago and those encountered were minor in nature. Prior to operating in Chicago, all wheels which had gaps between the inside face and journal bearing (noted when the axle end caps were installed in Cleveland) were pressed back against the bearings. Shims were removed between the end caps and the axles to give a preload between the end caps and the wheels.

The following is a list of significant maintenance actions accomplished in Chicago.

DATE	MAINTENANCE ACTION
1-07-75	Repressed the following wheels against the journal bearings. Removed shims between axle end caps and axles to preload the wheels when tightening the end cap bolts. Changed all end cap bolts from socket head to hex head. Car No. 1 - Wheel No. 4B - 100 tons Car No. 2 - Wheel No. 1B - 80 tons 2B - 70 tons 3A - 80 tons 3B - 85 tons
1-07-75	Vacuumed chopper cabinets and checked all chopper circuit cards, both cars.
1-08-75	Installed new brushes in all traction motors, both cars.
1-09-75	Replaced fresh air filters, both cars.
1-09-75	Car No. 1 - Replaced pantograph control switch (broken spring).

DATE	MAINTENANCE ACTION
1-10-75	Installed air compressor sump immersion heaters and changed oil and filter, both cars.
1-10-75	Car No. 1 - Removed No. 2 traction motor cooling fan S/N 72-02 for apparent bearing failure. Installed S/N 52-103.
1-10-75	Car No. 2 - Repaired handbrake light (loose wire terminal).
1-14-75	Car No. 2 - Replaced windshield wiper arm and blade.
1-18-75	Adjusted pantograph linkage, both cars.
1-25-75	Car No. 1 - Replaced EP and emergency load-weigh valves, No. 1 analog unit.
1-27-75	Car No. 1 - Replaced brake shoes 1A, 1B, 2A, 2B, 4A.
	Car No. 2 - Replaced brake shoes 1A, 1B, 2A, 2B, 4A, 4B.
1-28-75	Car No. 2 - Replaced current swapping diode in PCU (shorted).
1-30-75	Car No. 2 - Replaced circuit breaker for main lighting inverter.
	Replaced carbon strips on the pantograph (grooved and chipped).
2-09-75	Car No. 1 - Electrical coupler pins would not advance or retrieve. Lubricated the pins.

4.8 PHILADELPHIA

4.8.1 Shipment

The SOAC five-car consist was picked up at Skokie by the Chicago and Northwestern Railroad at noon on February 12, 1975 and taken to the 59th Street Yard where it was transferred to the Penn Central for the trip to Philadelphia. It was originally planned to transfer the cars to the Reading Railroad at Harrisburg for delivery to the SEPTA Fern Rock Shops in Philadelphia, while the cars were enroute it was decided to true the wheels at the Penn Central 30th Street Yard before delivery to Fern Rock. The cars continued on Penn Central to 30th Street where they arrived on February 17th. The cars were inspected by Boeing Vertol representatives and found undamaged, except for a 6" crack in the fiberglass bonnet at the No. 2 end of Car No. 1. After wheel truing, the cars were taken to North Philadelphia where they were picked up by the Reading and delivered to SEPTA at the Fern Rock Shops on February 20, 1975.

Support Car Location

The support car was brought into the yard at Fern Rock and stored along the northern side of the shop. As in Chicago, having the support car close to the SOACs provided ready access to spare parts and tools.

Security

A security service was employed to provide security for the SOACs and the support car at Fern Rock from 4:00 PM to 8:00 AM weekdays (24 hours on weekends) and also for security onboard the SOACs during revenue service.

4.8.2 Car Preparation and Modification

The cars were prepared for operation between February 20th and February 26, 1975. All the routine tasks were accomplished as noted for the NYCTA demonstration. The pantographs were removed before leaving Chicago.

Door Sill Extensions

The door sill extensions fabricated for Cleveland were modified for use on SEPTA. The 4 5/8" extensions were cut back to 2 3/8".

Figure 4-9 Philadelphia

Idententra Coil Brackets

Operations on the Broad Street Subway required the use of a removable Identra coil on the front end of the train to provide automatic signal alignment for the intended route. Mounting brackets for these coils were installed on the external A side front corner of each cab 9' 6" above the top of rail and approximately 55" from the centerline of the car. The coil provides a preset frequency response in passing through the magnetic field of various wayside pick-up points.

Communications

SEPTA provided two trainphones and made the installation. The equipment was essentially the same as provided by CTA and the installation was identical (see Section 4.7.2.1). Transmission quality was very good.

4.8.3 Briefings and Training

SEPTA gave the SOAC team a shop briefing on February 24, 1975. This was followed by the SOAC orientation and training presentation to SEPTA operations and maintenance personnel. A SOAC program presentation was given to SEPTA management personnel on February 25, 1975.

The SOAC was operated by regular SEPTA motormen under the supervision of a SEPTA supervisor or instructor. Initial training of motormen was accomplished by operating a single car on a cleared yard track that was approximately 900 ft. long. Additional training was given during the clearance runs, a special training run on Sunday, March 2, 1975 and during the VIP rehearsal run on Monday, March 3, 1975. A total of six motormen plus four yardmen were trained. Two SEPTA supervisors and one instructor were also trained in the operation of the SOACs.

4.8.4 Route Description

The SEPTA Broad Street Subway (Figure 4-10) was selected for the SOAC operational demonstration in Philadelphia. This line runs beneath Broad Street from Fern Rock on the north to Pattison Avenue on the south, a distance of slightly less than 10 miles. There are 22 stations on the line which is powered by third rail. Running time from Fern Rock to Pattison is 34 minutes. Wayside signals and track trips are employed, along with a 45 mph speed limit.

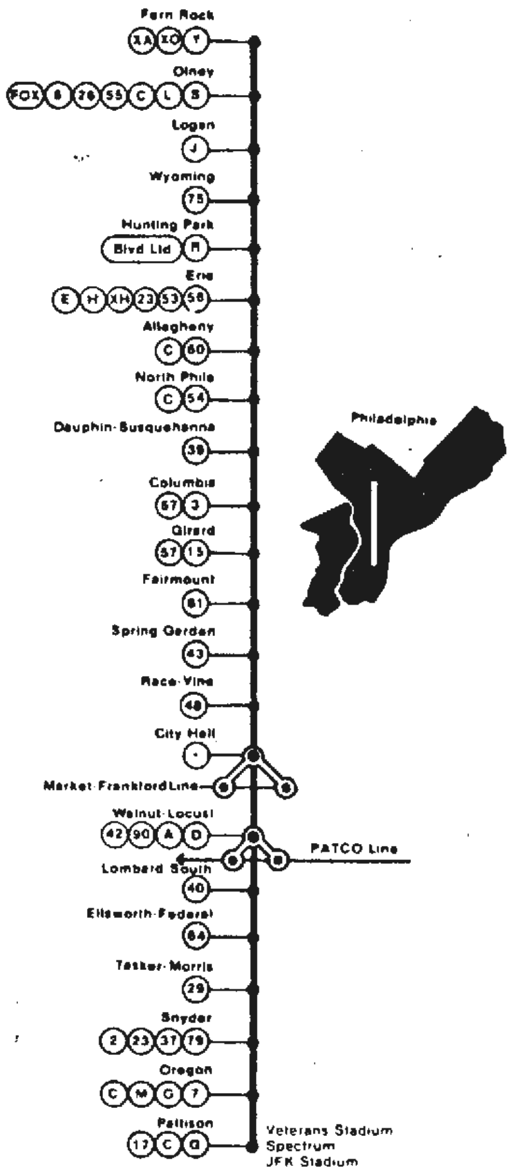


Figure 4-10. SEPTA Broad Street Subway

4.8.5 Testing

Both cars were powered, functionally checked, coupled and operated in the yard on February 22, 1975. Operator training was conducted in the yard on February 24, 1975.

The initial clearance run over the line was conducted from 12:00 PM to 5:00 PM on February 27, 1975 and included all express tracks, northbound local tracks from Erie to Fern Rock and the Ridge Avenue branch to the PATCO interchange. It was determined that SOAC could not enter the Fern Rock yard from the north side of the Fern Rock station because of interference between third rail power pot connections and SOAC undercar equipment boxes. The 168 ft. curve just south of Fern Rock on the northbound local track was negotiable at low speed.

On February 28, 1975 the SOACs were taken onto the PATCO property for a clearance run to verify that it would be feasible to run revenue service on the Lindenwold line after completion of the SEPTA demonstration. SOAC entered PATCO at the Vine Street interchange with the SEPTA Ridge Avenue Line, went to the west end of the line at 16th and Locust, then eastbound across the Ben Franklin Bridge to Ferry Avenue and then back across the river to the Ridge Avenue interchange. The only clearance problem encountered was at the eastern end of the Franklin Square platform westbound where the door sill marker plate contacted the platform. PATCO agreed to cut this platform back to provide a reasonable clearance. The Broad Street local track northbound was checked on the return run to Fern Rock and there were no clearance problems.

Clearance runs and operator training were completed on March 1, 1975. Engineering tests were deferred until revenue service running was completed to allow these tests to be accomplished on both SEPTA and PATCO without having to remove and reinstall the instrumentation recording systems.

The test instrumentation console was installed in Car No. 2 on April 22, 1975. Additional instrumentation was installed on the No. 1 and No. 2 trucks to obtain data on a gearbox resonance reported by Garrett AiResearch from test stand results. The following additional accelerometers were installed:

No. 1 gearbox vertical
No. 1 traction motor vertical
No. 1 motor mount (truck frame) vertical
No. 4 gearbox vertical

Engineering test data runs were made on April 23, 1975. SEPTA authorized speeds in excess of 45 mph for the purpose of evaluating gearbox accelerations. Car No. 2 was unacceptably rough throughout the car at speeds between 70 and 75 mph. Examination of the oscillograph traces showed that the high vibration levels were coming from the No. 1 truck with a beat frequency evident. A check of wheel tape measurements showed the wheels on No. 1 axle to be slightly over 1" smaller in diameter than the wheels on No. 2 axle, and calculation of the beat frequency that could be expected from this difference was in close agreement with the beat noted on the oscillograph records.

The No. 2 and No. 3 wheel/axle assemblies were switched on April 25, 1975 and the following additional accelerometers were installed:

No. 4 traction motor vertical
No. 4 motor mount (truck frame) vertical
No. 4 journal box vertical

Another test run was conducted on April 28, 1975. Car No. 2 was still rough, but the beat frequency was no longer evident. The data showed that the vibration was still coming from No. 1 truck, and since the No. 2 axle had been changed the problem appeared to be associated with No. 1 axle. Inspection of the No. 1 gearbox showed that the flanged coupling retaining nut lock tabs had broken off and the nut had backed partially off the bull gear allowing the splined connection to rock. This was the first failure of the redesigned nut lock and it substantiated a report from Garrett that a rocking resonance in the axle-to-gearbox coupling had been noted in test stand data corresponding to the 60 to 70 mph speed range.

The No. 1 wheel/axle/gearbox assembly was replaced and another test run made on April 30, 1975. The car was smooth at all speeds up to 84 mph. The cars were taken to PATCO on the evening of May 1, 1975 and engineering test data runs were conducted on the Lindenwold line in the early morning hours of May 2, 1975. The test instrumentation was removed from Car No. 2 at the Lindenwold Shops on May 5, 1975.

4.8.6 <u>VIP Ceremonies</u>

A dry run over the VIP route was conducted on March 3, 1975. The cars were cleaned on March 3 and 4 in preparation for the VIP Ceremonies which were held at the Pattison Avenue station on March 5, 1975. The inaugural run went from Pattison to Erie and back to Walnut - Locust where the VIP contingent of approximately 200 debarked.

4.8.7 Revenue Service

Summary

Revenue service was conducted on the Broad Street Subway from March 6, 1975 to March 13, 1975 and from March 27, 1975 to April 15, 1975. Revenue service was interrupted by a transit workers (TWU) strike at SEPTA during which time the SOACs were taken to the PATCO Lindenwold Shops for storage.

Revenue Service Days	-	23
Round Trips Scheduled	-	127
Round Trips Made	-	121
Availability	-	95%
Total Passengers (Est.)	-	60,000
Total Miles	-	3,000

Method of Operation

The SOACs were operated out of the Fern Rock Shop as an extra train on the Broad Street Subway, where the hours of operation were, 9:40 AM to 2:15 PM and 6:33 PM to 9:14 PM weekdays and 9:39 AM to 4:29 PM on Saturdays. Each weekday the SOACs were laid up at Fern Rock from 2:15 PM to 6:33 PM to miss the evening rush hours. Trip schedules are presented in Appendix III.

Passenger Reaction

Passenger loads ran moderate-to-heavy on SEPTA. As in the other cities, a hostess was employed to hand out literature and answer general questions. The SEPTA riders were very pleased with the SOACs, primarily because they represented such a dramatic improvement over the regular equipment in use on the Broad Street Subway. These cars are very old, the newest having been built in 1938. Very few criticisms were received.

Special Trips

On April 5 and 6, 1975, 16 roundtrips were conducted from Pattison Avenue to Erie for Boeing Vertol employees and their families. Approximately 1800 passengers were carried and the cars were very well received.

One Sunday double run was conducted on April 13th for the Philadelphia Chapter of the National Railway Historical Society. Approximately 60 rail fans participated in this trip which included the Ridge Avenue Line.

Availability

One electrical and three mechanical failures (see Maintenance, Section 4.8.8) resulted in the cancellation of six trips. A total of 127 trips was scheduled during this period. Availability was 95%.

4.8.8 Maintenance

Wheels were trued on a Stanray machine at the Penn Central 30th Street Shops before going to SEPTA. No problems were noted during the initial test running and during revenue service on SEPTA where speeds were less than 50 mph. While travelling to Lindenwold on the PATCO line during a transit worker strike at SEPTA, vibration was noted in both cars near 70 mph. Wheel concentricity measurements showed the wheels which had been cut on the Stanray machine to be out-of-round from .022" to .060". These wheels were re-cut on the SEPTA wheel lathe at Fern Rock after completion of revenue service and before the engineering tests. All wheel concentricities were within .007" TIR after the re-cutting.

Vibration was still evident on Car No. 2 during the engineering test runs at speeds between 70 and 75 mph (see Section 4.8.5 Testing). The source of this vibration was determined to be a rocking resonance in the splined coupling of the No. 1 gearbox caused by failure of the retaining nut lock with a resultant loosening of the splined connection. The wheel/axle/gearbox assembly was removed and replaced.

The following is a list of significant maintenance actions accomplished in Philadelphia.

DATE	MAINTENANCE ACTION
2-19-75	Car No. 1 - Re-cut wheels on axles No. 1, 2 and 4 using Penn Central Stanray machine to get proper flange contour and remove flats.
	Car No. 2 - Same for axles No. 1, 3 and 4.
2-23-75	Car No. 2 - Wheel No. 4B rim rotated approximately 3/8" on the hub showing a 2 1/2 x 1/16" tear in the elastomer on the outside wheel face. Replaced wheel axle set.

DATE	MAINTENANCE ACTION
2-25-75	Car No. 2 - Replaced tumbler in master controller key switch.
	Cleaned and lubricated electrical coupler pins, both cars.
2-26-75	Car No. 2 - No. 1 traction motor cooling fan intake cover plate and screen damaged in contact with 600V third rail pot connector. Shortened cover plates by removing 2" from vertical dimension, both cars.
3-04-75	Car No. 1 - Replaced blown fuse in knife switch box.
	Car No. 2 - Replaced blown main light switch fuse.
3-07-75	Car No. 1 - Repaired cracked aftercooler in brake air compressor.
3-08-75	Car No. 1 - Speedometer inoperative from 0 to 10 mph. Replaced P/N 172 x 0430 unit.
3-12-75	Car No. 1 - Replaced cracked aftercooler in brake air compressor. Installed aftercooler from spare compressor.
3-21-75	Car No. 1 - Cracked aftercooler (recent replacement). Removed air compressor and modified aftercooler using an 18" length of flexible hose. Reinstalled air compressor.
3-23-75	Car No. 2 - Cracked aftercooler in brake air compressor. Same corrective action as Car No. 1 above.
3-24-75	Car No. 2 - Axle No. 2 flanged coupling retaining nut loose. Possible bearing failure. Replaced wheel/axle/gearbox set.
3-27-75	Car No. 2 - No. 2 traction motor cooling fan bearing failed. Motor burned out. Repaired motor and installed new bearings.
3-29-75	Car No. 2 - Three chopper thyristors failed. Replaced A-1 and A-2 chopper drawers.

DATE	MAINTENANCE ACTION
3-31-75	Car No. 1 - Replaced leaking air compressor hose.
4-02-75	Replaced bearings in No. 1 traction motor cooling fan, both cars. Preventative.
4-03-75	Car No. 2 - Replaced leaking air compressor hose.
4-14-75	Car No. 1 - Repaired trip cock air pipe failure, No. 1 truck.
4-18-75	Car No. 1 - Re-cut wheels on axles No. 1, 2 and 4 using SEPTA wheel lathe to correct out-of-round condition.
	Car No. 2 - same for all four axles.
4-21-75	Car No. 1 - Repaired leak in copper tubing on brake air compressor.
4-25-75	Car No. 2 - De-trucked and interchanged axles No. 2 and 3. Found cracked spacer on inner race of Axle No. 2 A side. To be replaced at next wheel change prior to PATCO operation.
4-29-75	Car No. 2 - Axle No. 1 flanged coupling retaining nut lock tabs broken and nut loose. Replaced wheel/axle/gearbox set.

5. SOAC PUBLIC REACTION SURVEY

As part of the SOAC demonstration in the five cities a public reaction survey was conducted. The purpose of this survey was to measure the reaction to the SOAC cars and the various features incorporated in these cars.

The survey utilized two different questionnaires and sampled two separate groups of people. One group was composed of people who were randomly selected onboard the SOAC cars. These people were asked the question "How would you rate (How fresh the air in the car is) for the new car you recently rode on"? The phrase in parenthesis named the different features incorporated in the SOACs. This questionnaire is referred to as the Rider Questionnaire.

In order to compare the results of the SOAC riders against the expectations or desires of the public a second questionnaire was administered to randomly selected people living in the areas served by the transit lines on which the SOAC was demonstrated. These people were asked the question "How important is (the freshness of the air in the cars)"? The phrase in parenthesis names the various aspects that were to be rated. This questionnaire is referred to as the General Questionnaire.

Both surveys were conducted by telephone. People were contacted on the SOAC cars and asked to participate in a telephone survey. They were then contacted by telephone within the next few days to complete the questionnaire. The General Questionnaire was completed by calling people at random in the service area and asking them to participate in the survey.

Responses were obtained from 1200 people for each questionnaire, a total of 2400 interviews were thus conducted. Two hundred responses were obtained to each questionnaire in the cities of Boston, Cleveland, Chicago and Philadelphia. Four hundred responses to each questionnaire were obtained in New York (approximately 100 on each of the four lines that SOAC ran).

A slightly different scoring was used on the Rider Questionnaire than on the General Questionnaire. The scoring for the General Questionnaire was from 0 to 100, with 100 being very important and 0 being unimportant. The scoring for the Rider Questionnaire used a scale from +100 to -100, with +100 being very favorable and -100 being most unfavorable.

The following is a summary of the results of this survey. A complete reporting of the survey and survey results is contained in "Volume 4, Public Reaction Survey." of the SOAC Development Program Final Report.

5.1 SUMMARY GENERAL QUESTIONNAIRE RESULTS

Figures 5.1-1, 2, 3 give summarized results of the General Questionnaire for the combined five cities sample. Figure 5.1-1 gives some of the General Questionnaire populations characteristics plus a few reference statistics for the U.S. population.

Figure 5.1-2 lists the results of the General Questionnaire in rank order, highest first. The average score for each feature is also given and in the intensity column is listed the percent of the people that gave the item the maximum possible score (100).

As a note of caution, differences in average ratings of less than 2 between items should not be considered as statistically significant.

The first three items on the list, "The cars being safely built so not to contribute to accidents", "Freedom from criminals and vandals" and "The cars not breaking down and causing delays" are of essentially equal importance and significantly more important than the lower listed items. The number four item "Having a handhold if you have to stand" while being less important than the first three items is significantly higher than the rest. These first four items also have very high intensity ratings with more than two thirds of all the respondents giving a maximum score to these items. The importance of the cost of the fare ended up with approximately a middle rating. The lowest item was "Having carpeted floors."

Figure 5.1-3 presents the same information as in Figure 5.1-2 but in a graphical form that visually indicates how much difference exists between various items. Comparisons

GENERAL QUESTIONNAIRE

SAMPLE POPULATION CHARACTERISTICS

OCCUPATION

PROFESSIONAL	WHITE COLLAR	BLUE COLLAR	STUDENT	UNEMP./RETIRED	HOUSEWIFE
16.0%	26.0%	18.6%	6.4%	9.4%	23.6%

INCOME

USA AVERAGE	$5K	$5K-10K	10K-15K	15K-20K	20K-25K	≥25K
$12,000	13.2%	23.5%	24.8%	17.6%	10.3%	10.6%

% Own Auto's - 73.3% (U.S.A. Population 80.0)

% Licensed Drivers - 70.4

% Commuting On Rapid Transit - 32.4

Average Length Of Commute - 25.4 Min.

Average No. Rides/Mo. On R.T. - 8.1

FIGURE 5.1-1

GENERAL QUESTIONNAIRE

FIVE (5) TOTAL

		AVG. RATING	INTENSITY
1.	Safely Built	96.8	81.3
2.	Freedom From Criminals & Vandals	96.6	84.3
3.	Not Breaking Down & Causing Delays	95.7	74.7
4.	Having a Handhold	93.0	69.8
5.	Interior Cleanliness	90.5	59.0
6.	Doors-Easy Entry/Exit	90.0	53.9
7.	Temp.-Air Quality	89.6	55.4
8.	Smooth Ride	86.9	43.2
9.	No Smoking	86.8	66.7
10.	Having a Seat	86.0	50.8
11.	Route Map	85.3	49.5
12.	Cost of Fare	85.2	52.3
13.	Bright Lights	83.9	45.3
14.	Announced Stops	83.0	47.5
15.	Low Noise	82.3	39.2
16.	Wide Aisles	79.8	32.8
17.	Seeing Out	66.5	22.4
18.	Bright Colors	56.1	14.1
19.	Tinted Windows	53.0	15.4
20.	Carpeting	24.7	4.0

Figure 5.1-2

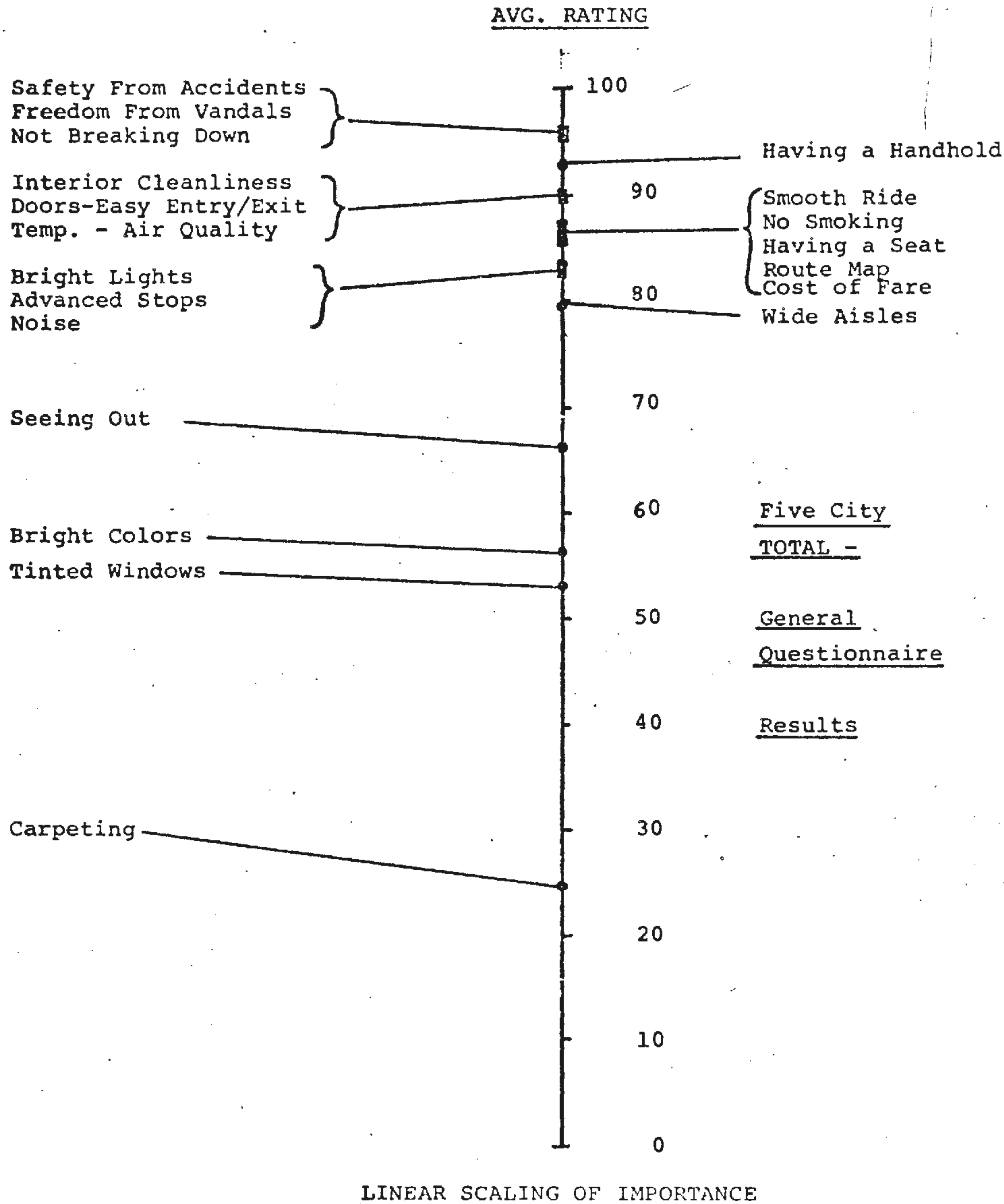

AVG. RATING
Safety From Accidents
Freedom From Vandals
Not Breaking Down
Interior Cleanliness
Doors-Easy Entry/Exit
Temp. - Air Quality
Bright Lights
Advanced Stops
Noise
Seeing Out
Bright Colors
Tinted Windows
Carpeting
Having a Handhold
Smooth Ride
No Smoking
Having a Seat
Route Map
Cost of Fare
Wide Aisles
100
90
80
70
60
50
40
30
20
10
0
Five City
TOTAL -
General
Questionnaire
Results
LINEAR SCALING OF IMPORTANCE

Figure 5.1-3

of the relative importance between highly ranked items can be made by inverting the scale and using 100 percent as the reference point, e.g. "Having a handhold" is twice as important as "Having a seat" and three times as important as "Wide aisles".

5.2 SUMMARY RIDER QUESTIONNAIRE RESULTS

Figures 5.2-1, 2 give summarized results of the Rider Questionnaire for the combined five cities sample. Figure 5.2-1 gives the Rider Questionnaire population statistics comparable to the General Questionnaire statistics presented in Figure 5.1-1.

Figure 5.2-2 presents the results of the Rider Questionnaire and compares these results with the results from the analogous questions from the General Questionnaire.

The listing of questions in Figure 5.2-2 is by their ranking from the General Questionnaire, the most important question listed at the top. This chart shows whether the SOAC (Rider Questionnaire result) exceeded or fell short of the populations expectations (General Questionnaire result). The Rider Questionnaire average rating is indicated by the circle and the General Questionnaire average rating is indicated by the triangle.

While reviewing Figure 5.2-2 it is important to remember that the question asked on the General Questionnaire was "How important to you is...?" while the question asked on the Rider Questionnaire was "How would you rate...?" The one deviation from the standard question on the Rider Questionnaire was the question concerning the cost of fare. That question was "Would you be willing to pay 5¢ more to ride a car like SOAC?"

Generally the SOAC was close to or exceeded the expectations of the public. The two exceptions are the questions regarding fare and having a handhold if one must stand. The difference between responses on the fare questions is readily understood from the difference in the questions asked on the two surveys; the SOAC rider was asked if he would be willing to pay a premium to ride SOAC - he is not. The difference on the handhold question is understandable when the relatively fewer number of handholds on SOAC is compared with the number on most other rapid transit cars.

RIDER QUESTIONNAIRE

SAMPLE POPULATION CHARACTERISTICS

Occupation

Professional	White Collar	Blue Collar	Student	Unemployed/Retired	Housewife
15.7%	24.3	18.1	20.6	8.5	12.9

Income

USA Average	< $5K	$5K-10K	10K-15K	15K-20K	20K-25K	> 25K
$12,000	13%	27%	24%	18%	9%	9%

% Own Autos - 71% (USA Population 80%)

% Licensed Drivers - 62%

% Commuting on Rapid Transit - 78%

Average Length of Commute - 34 Min.

Average Number Rides/mo. on Rapid Transit - 21

Figure 5.2-1

FIVE CITY TOTAL

IMPORTANCE OF FEATURES VS SOAC PERFORMANCE

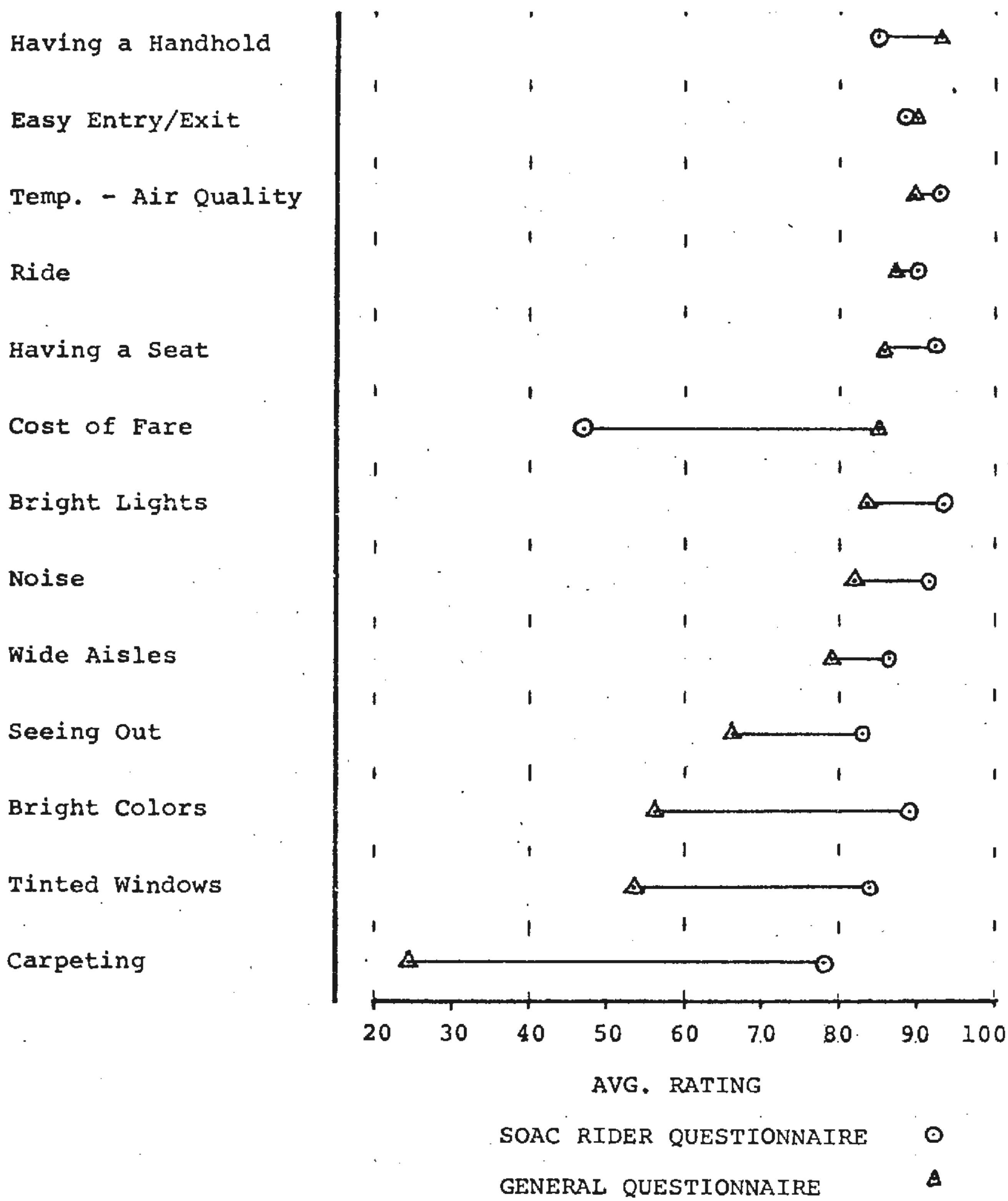


Figure 5.2-2

5.3 INDIVIDUAL CITY RESULTS

Figures 5.3-1 through 5 present the General Questionnaire results from the cities of New York, Boston, Cleveland, Chicago and Philadelphia. These figures are similar to 5.1-3.

Figures 5.3-6 through 10 present the Rider Questionnaire results from the five cities. These figures are similar to 5.2-2.

GENERAL QUESTIONNAIRE RESULTS - NEW YORK

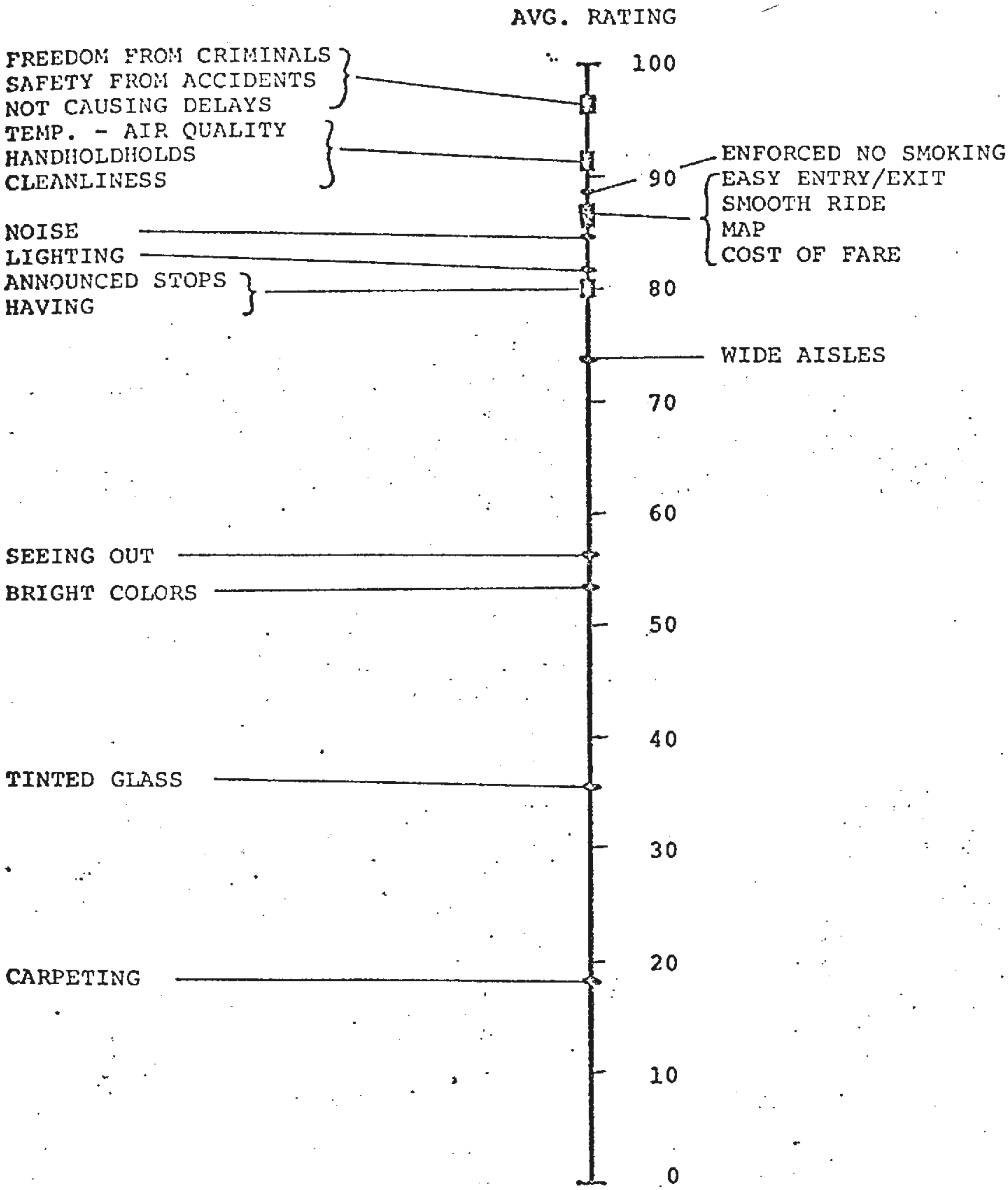


Figure 5.3-1

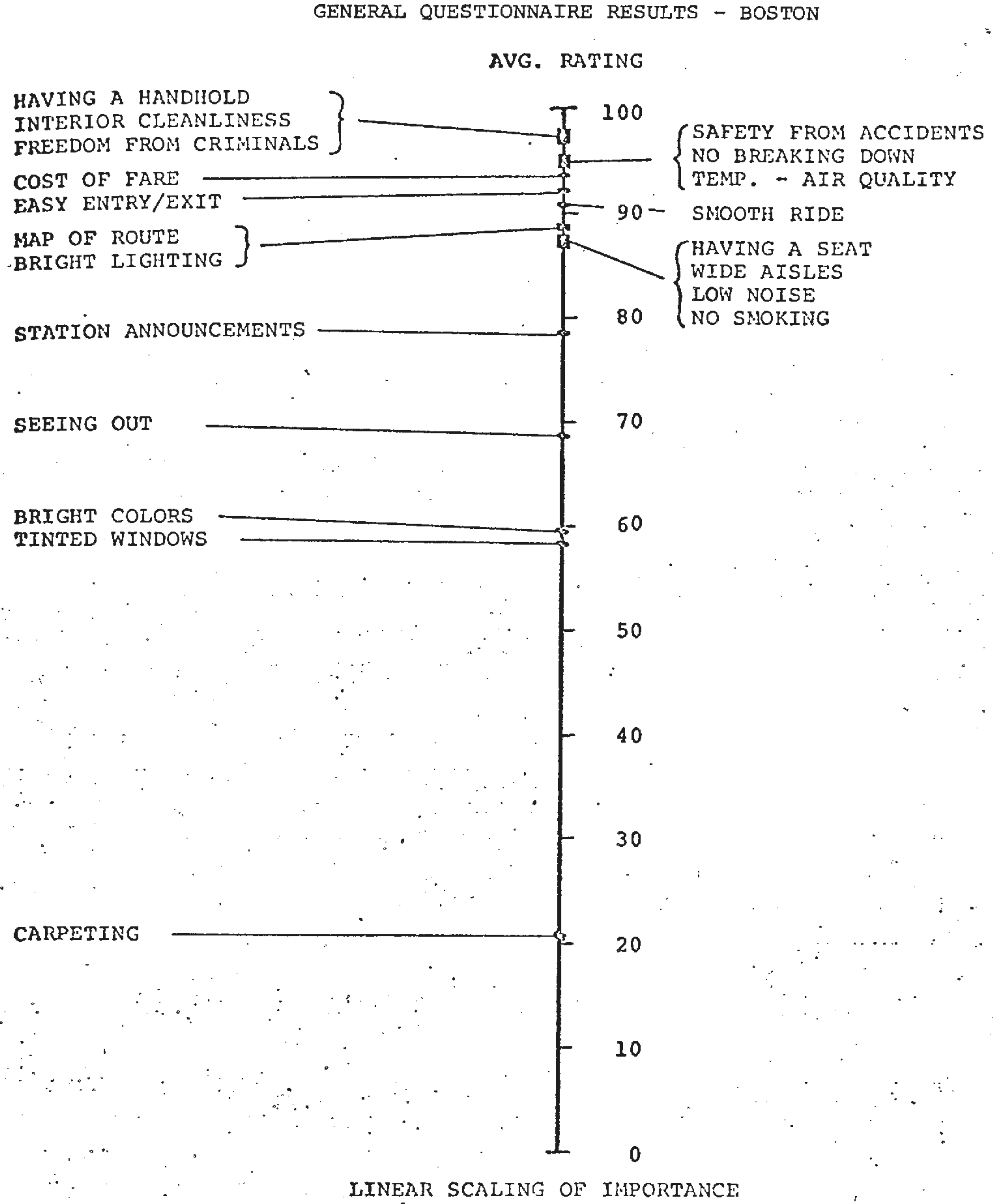
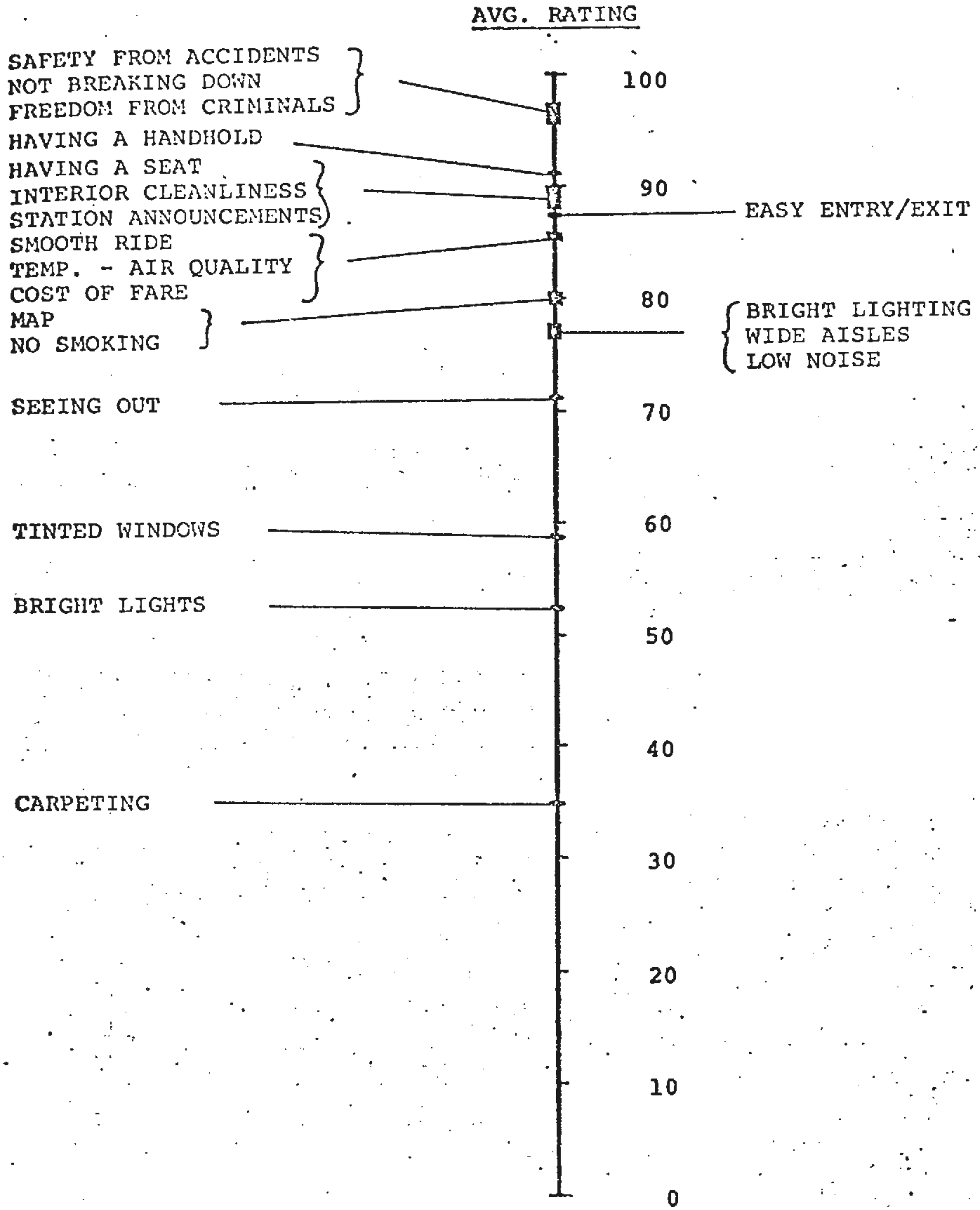
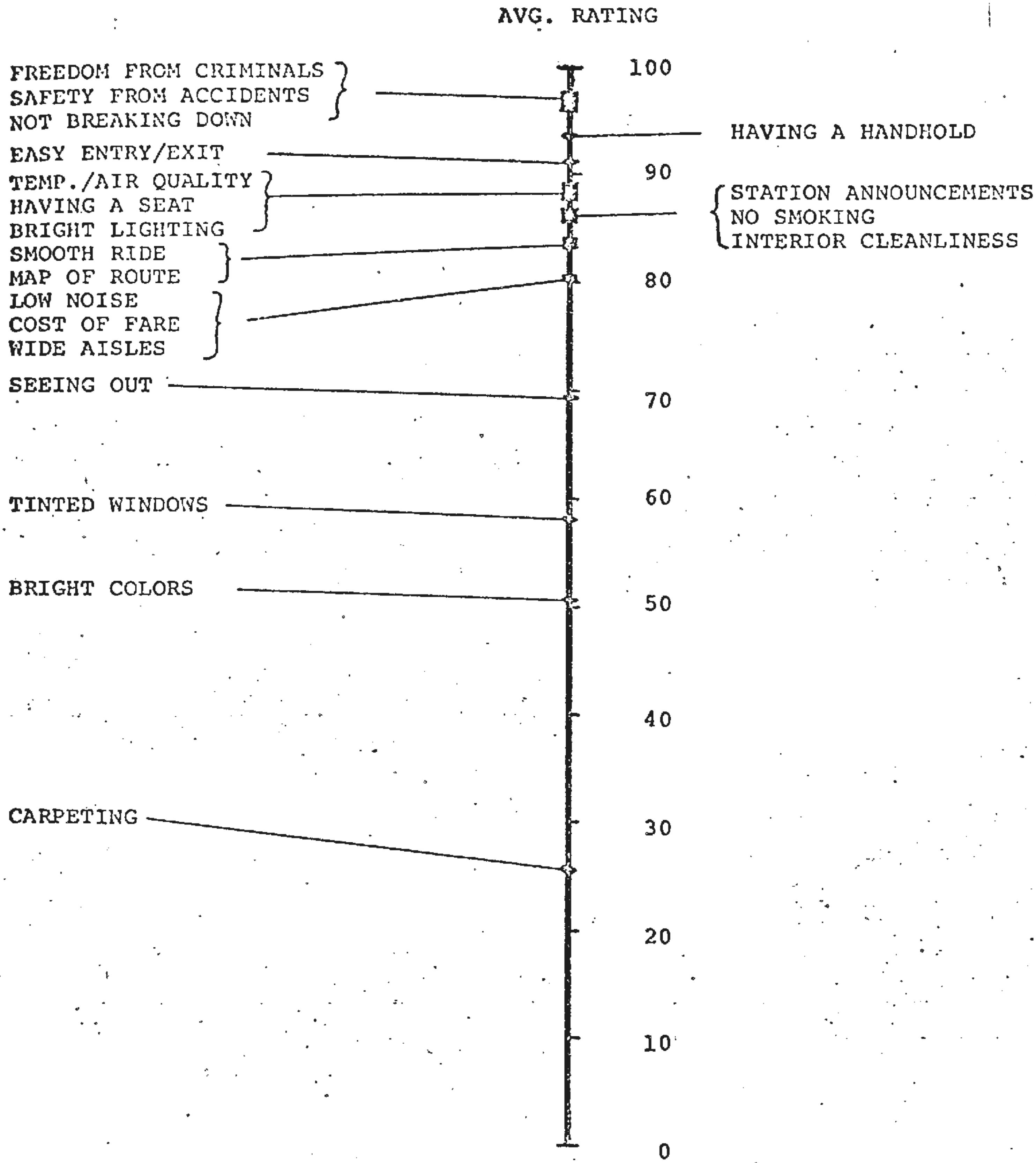

GENERAL QUESTIONNAIRE RESULTS - BOSTON
AVG. RATING
HAVING A HANDHOLD
INTERIOR CLEANLINESS
FREEDOM FROM CRIMINALS
COST OF FARE
EASY ENTRY/EXIT
MAP OF ROUTE
BRIGHT LIGHTING
STATION ANNOUNCEMENTS
SEEING OUT
BRIGHT COLORS
TINTED WINDOWS
CARPETING
SAFETY FROM ACCIDENTS
NO BREAKING DOWN
TEMP. - AIR QUALITY
SMOOTH RIDE
HAVING A SEAT
WIDE AISLES
LOW NOISE
NO SMOKING
100
90
80
70
60
50
40
30
20
10
0
LINEAR SCALING OF IMPORTANCE

Figure 5.3-2



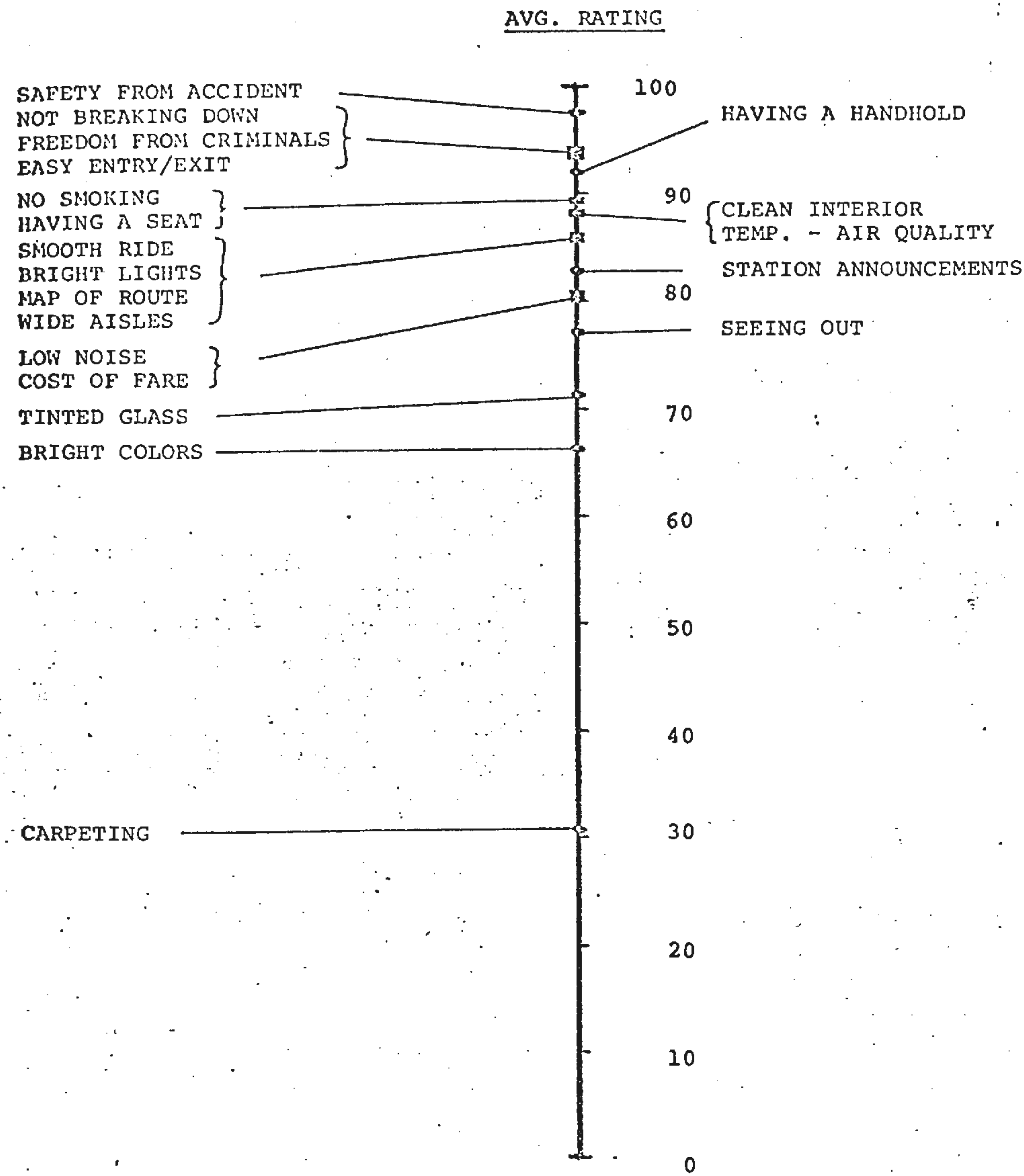
LINEAR SCALING OF IMPORTANCE

Figure 5.3-3



LINEAR SCALING OF IMPORTANCE
Figure 5.3-4

GENERAL QUESTIONNAIRE RESULTS - PHILADELPHIA



LINEAR SCALING OF IMPORTANCE

Figure 5.3-5

NEW YORK

IMPORTANCE OF FEATURE VS SOAC PERFORMANCE

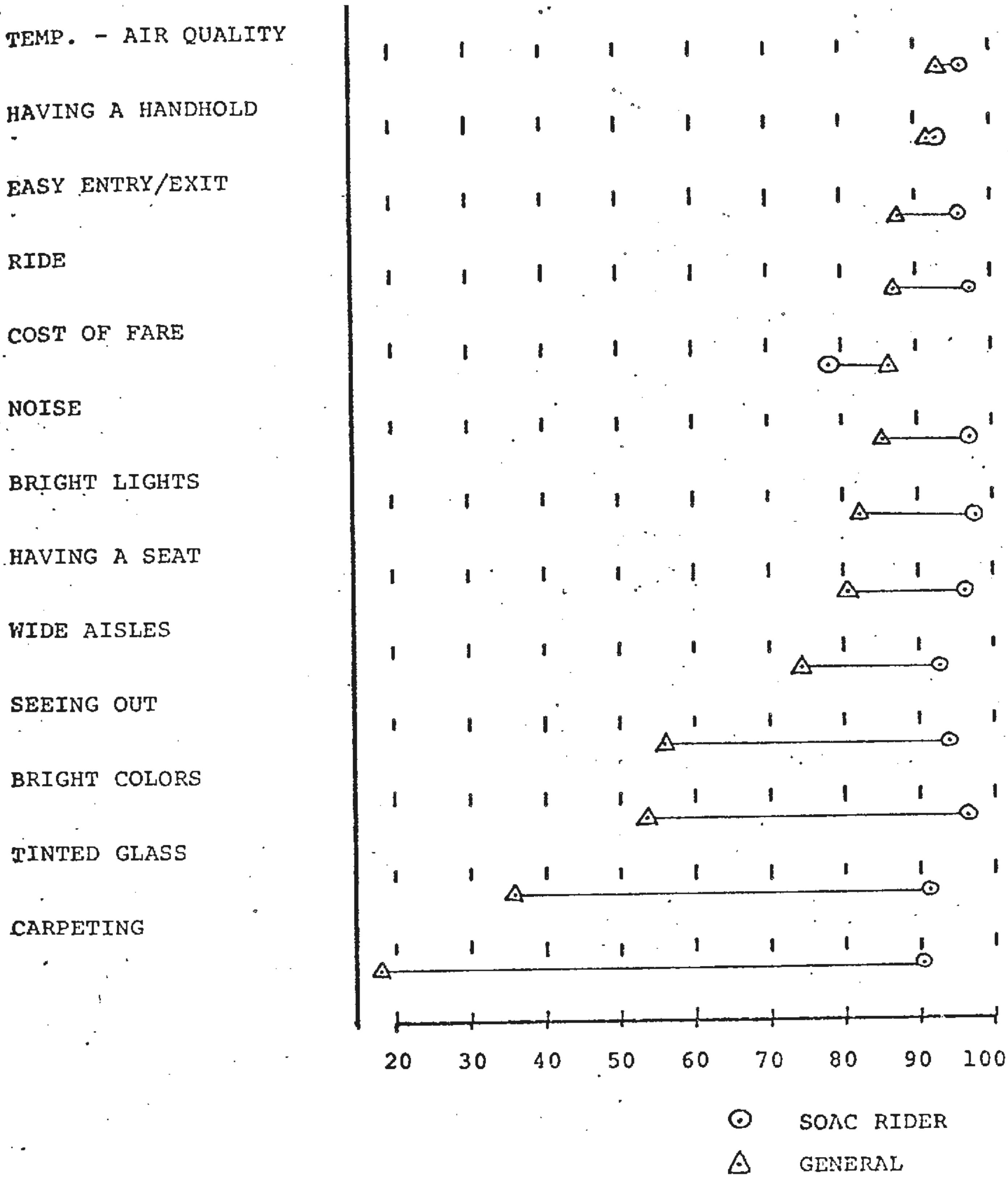


Figure 5.3-6

BOSTON

IMPORTANCE OF FEATURE VS SOAC PERFORMANCE

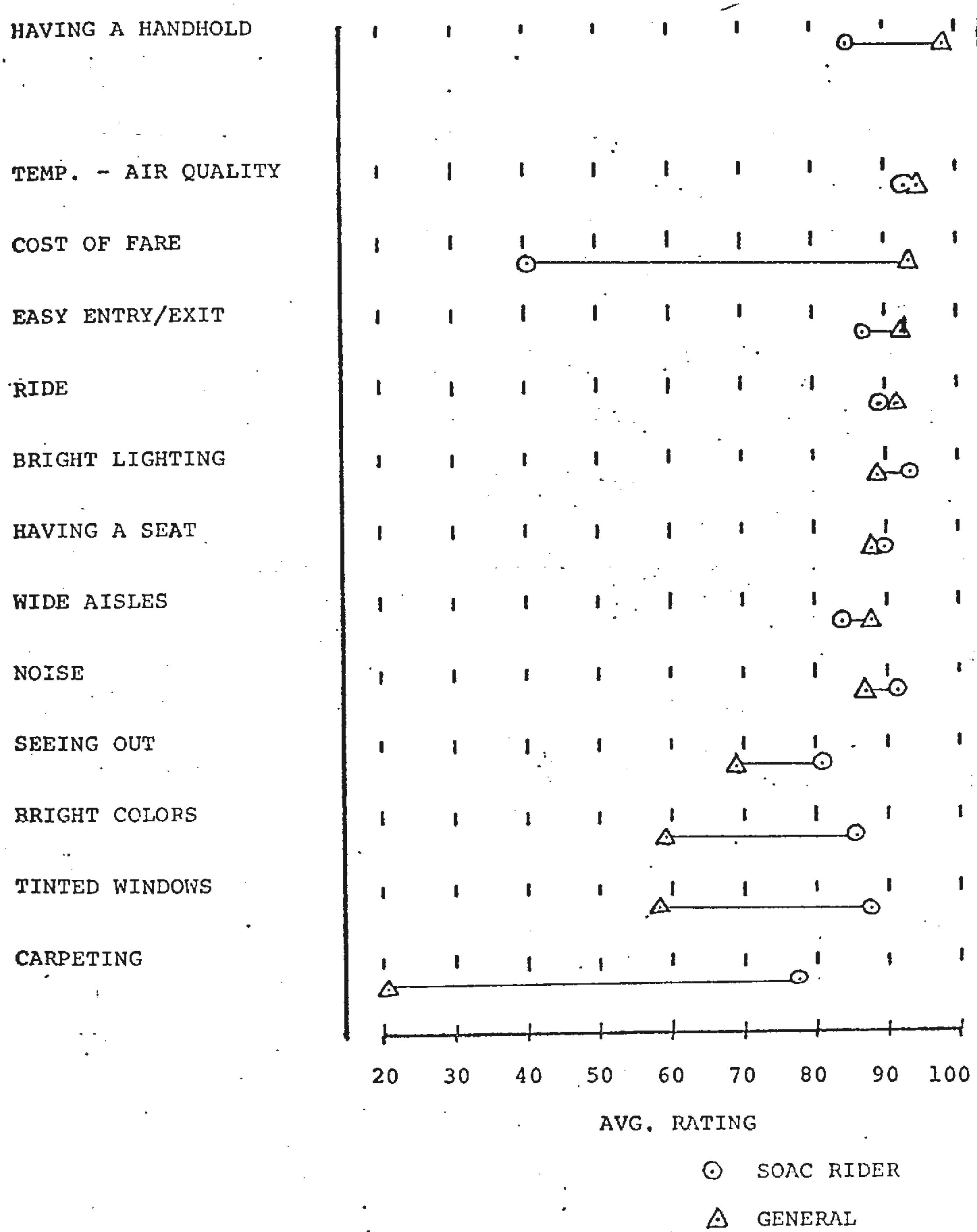


Figure 5.3-7

CLEVELAND

IMPORTANCE OF FEATURE VS SOAC PERFORMANCE

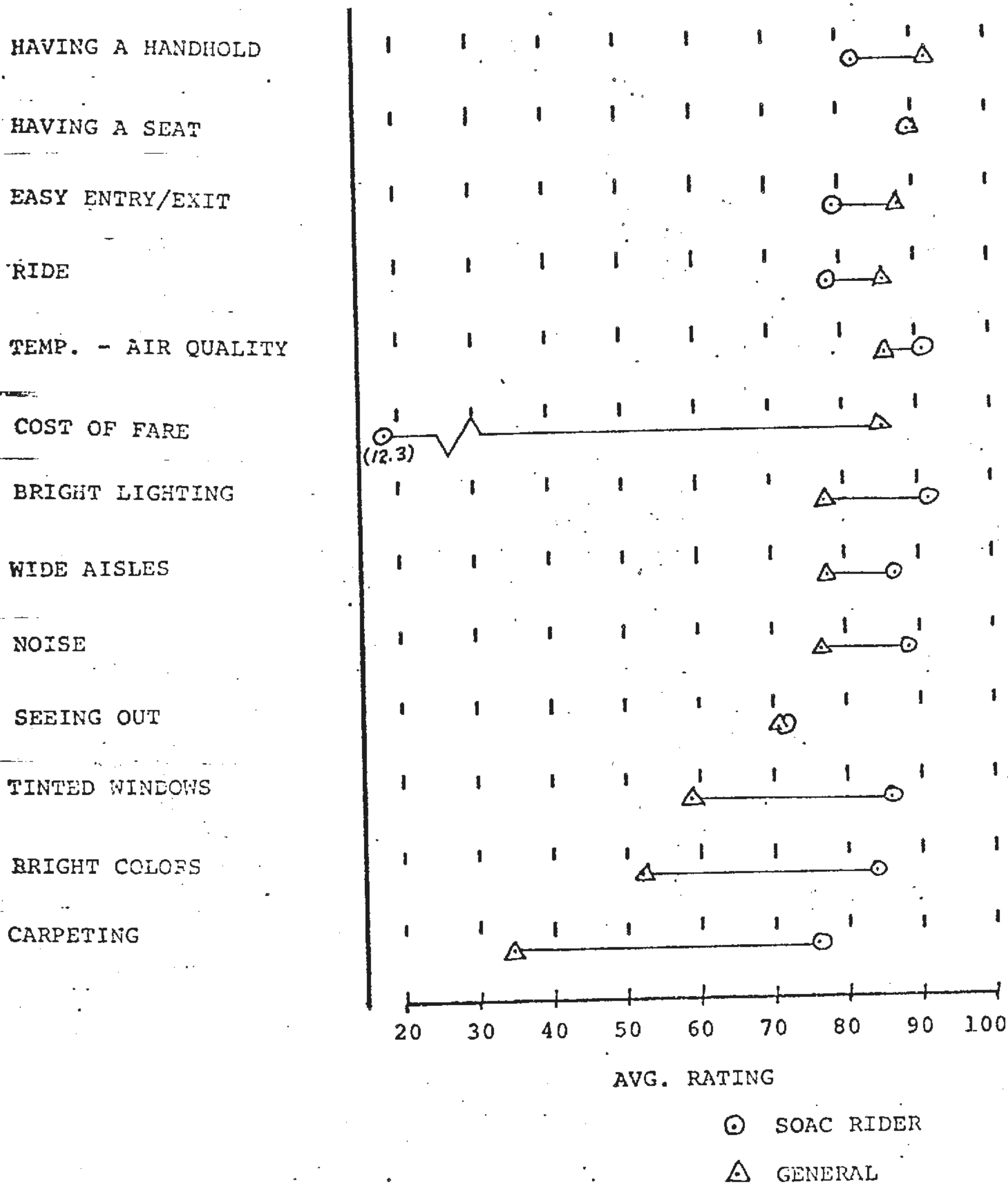


Figure 5.3-8

CHICAGO

IMPORTANCE OF FEATURE VS SOAC PERFORMANCE

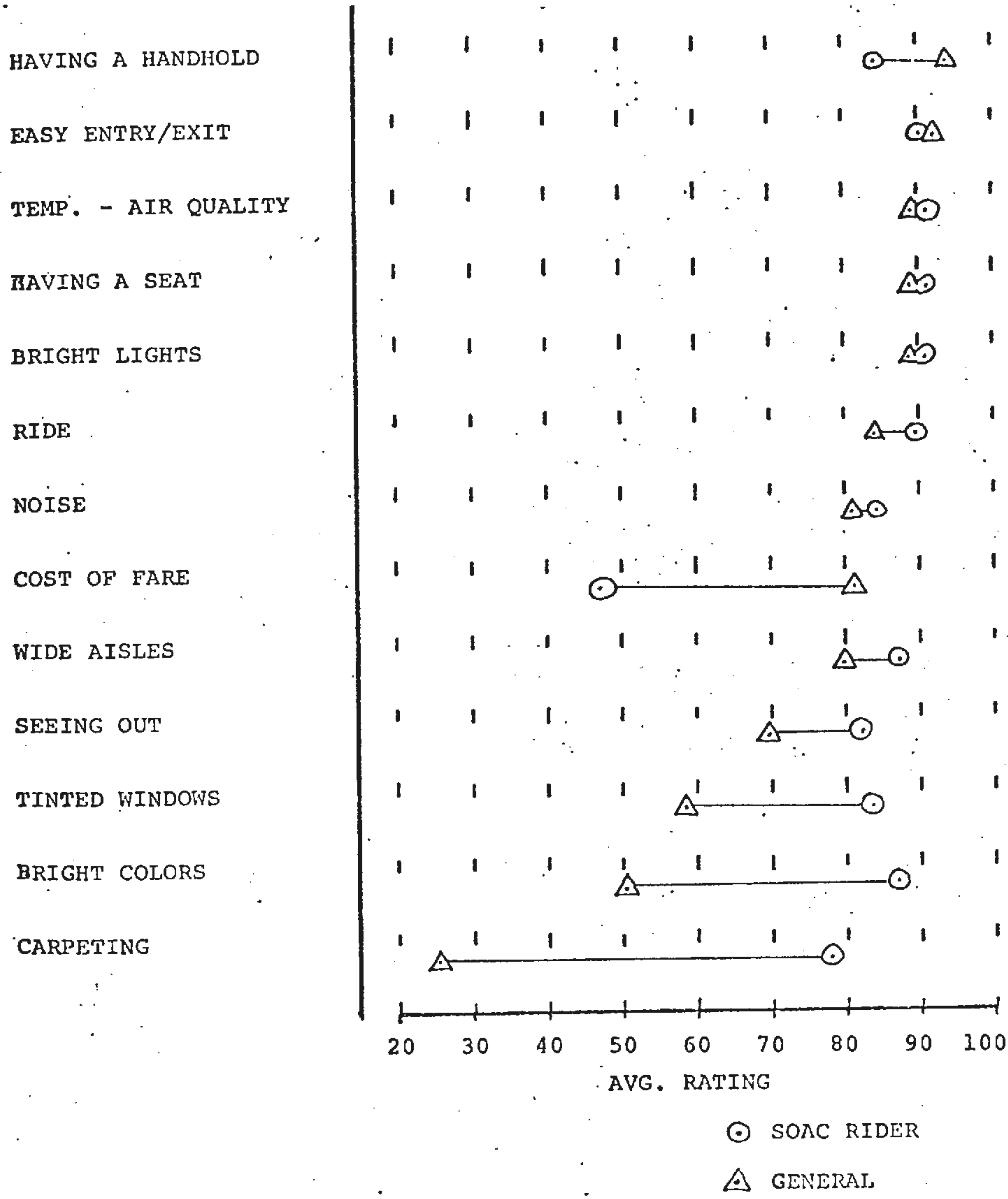


Figure 5.3-9

PHILADELPHIA

IMPORTANCE OF FEATURE VS SOAC PERFORMANCE

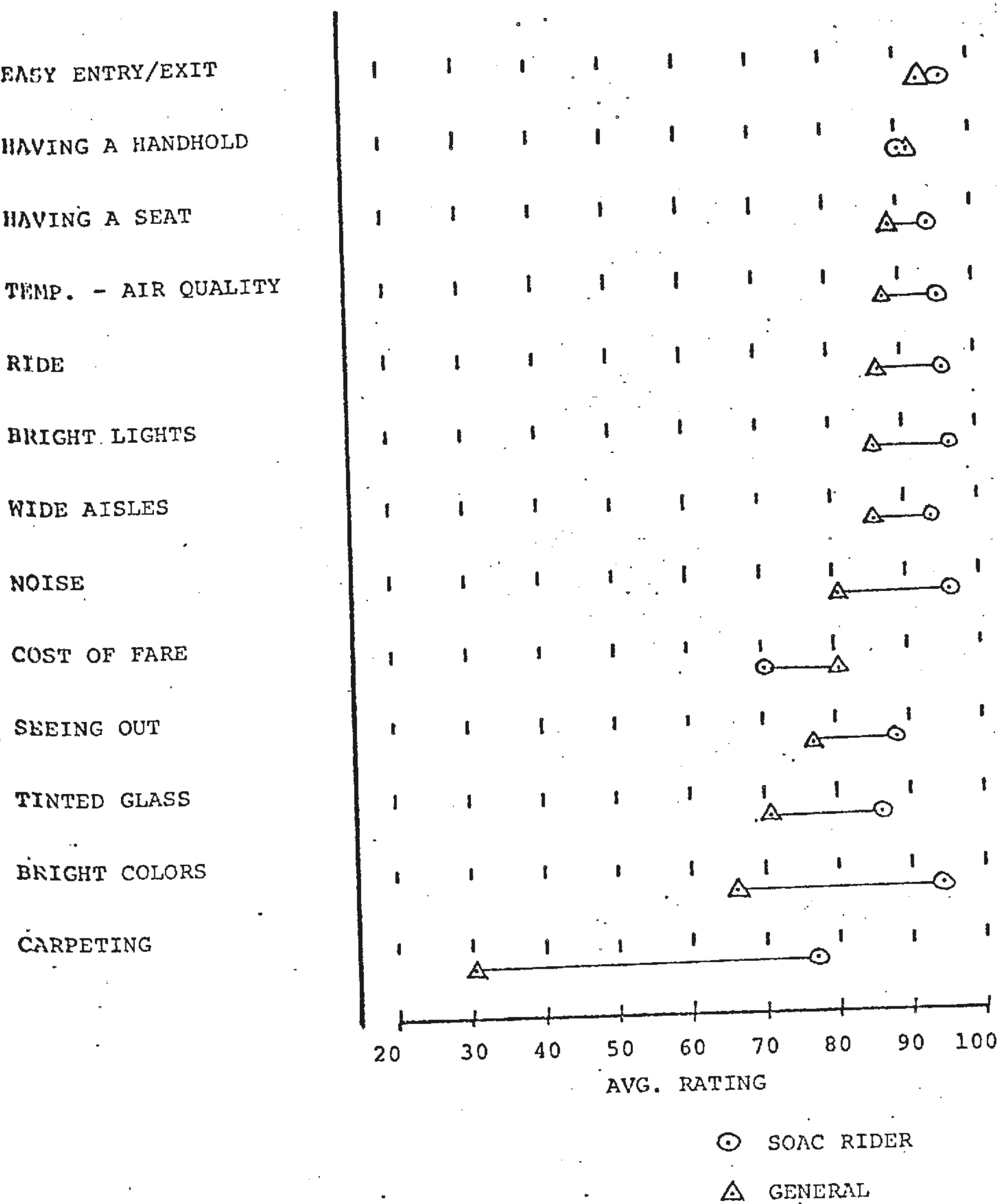


Figure 5.3-10

6. CONCLUSIONS

6.1 SOAC successfully achieved its overall objective of demonstrating the best available technology to transit authorities and the riding public in five major cities. In so doing, the cars demonstrated that they met their design objective of being adaptable to the specific operating requirements of five different transit properties.

6.2 The SOACs were well received by the riding public; particularly the smooth ride, low noise level, air conditioning, interior appointments and high light level.

6.3 The motormen assigned to SOAC were enthusiastic about the car and found the smooth response, fine control and automatic speed maintaining system particularly desirable.

6.4 The DC-DC chopper used for propulsion control provided smooth acceleration as designed and proved to have excellent reliability.

6.5 The back-to-back pantograph installation on SOAC resulted in excessive arcing of the contact strips on the aft pantograph. For a two-car train, pantographs would be better located at the No. 1 end of each car.

6.6 Additional handholds should be provided for standees, particularly in areas where bench (longitudinal) seating is used.

6.7 A significant portion of the riding public would prefer more windows in SOAC so that wayside station signs could be read more easily. This is particularly important in crowded conditions.

6.8 Although most riders believed that the SOAC stylized interiors would not stand up to vandalism, virtually no vandalsim was experienced in 20,000 miles of operational evaluation. Even though one guard was provided in each car, it is evident that there was a tendency for the riding public to appreciate and care for the improved environment.

6.9 End signs showing destination are of great assistance to riders waiting on the platform. Portable signs were inserted behind the windshield on SOAC to provide this information.

6.10 Maintenance requirements were encountered in the cities that were not encountered at the TTC and could be traced to large differences in the quality of the track and road bed. Motor power cable failures, lateral shock absorber mount failures, and various pipe failures can be attributed to the more severe environment. Design changes were made and others should be incorporated in future design applications.

6.11 Four resilient wheel elastomer bond failures were experienced on SOAC, which uses tread brakes. Batch process controls during wheel assembly were considered to be a factor in all four failures. In addition, two of the four failures were the direct result of parking brake malfunctions and one failure occurred during on-the-car wheel cutting.

6.12 SOAC experience with on-the-car wheel truing of resilient wheels was unsatisfactory. Out-of-round conditions resulted in all cases using two different machines of the same type.

6.13 Problems were encountered with movement of the aluminum centered resilient wheels on the steel axles, making it necessary to install axle end caps. All instances occurred in Cleveland. Compatability of SOAC to the existing track geometry may have been a contributing factor. The cause of this problem was not satisfactorily determined. BART experienced some of the same type of problem.

6.14 SOAC traction motor blowers are the principal contributors to a 70 dbA exterior sound level at zero speed. This is particularly noticeable when the cars are standing in a station. As noted in Volume 1, page 145, the traction motor blowers are the major source of wayside noise under 35 mph. The traction motor blowers, however, are considered to be an essential advancement presented by SOAC; the wayside noise appears noticeable but not objectionable.

6.15 The passenger reaction survey results indicate that a) the SOACs offered effective improvements in most features rated as important by the public, b) more handholds should be provided for standees, and c) carpeting is not particularly desired on rapid transit cars.

6.16 The SOAC passenger survey shows that the SOAC rider tends to rate improvements, such as ride quality, noise levels, internal light intensity and others, higher as a result of having directly perceived them than does the general public which has not perceived them.

REFERENCES

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, Pennsylvania, January 1974.

2. "State-of-the-Art Car Final Test Report, Volume 5 - Post-Repair Testing", Report No. UMTA-IT-06-0026-74-12.

3. "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.

APPENDIX I

SEPTA

ROLLING STOCK AND SHOPS DEPARTMENT

(1) INFORMATION RXXXXST/RELEASE

(2) I.R. NO.	SUBJECT	AREA	SEQUENCE NO.	REV. LTR.
	R	O.D.	0004	

FROM	TO (4)
Amit. K. Bhattacharyya Transportation Systems Engineer	Joseph O. Wagner Manager - R.S. & S. Depart. P-2

DATE SENT (5)	DATE INFO. REQUIRED (6)	CHARGE NO. (7)	REFERENCE I.R. NO. (8)
6/12/74			

SUBJECT (9)

SOAC CLEARANCE CAR RUN

INFORMATION XXXXXXXX/RELEASED (Include Diagrams Where Applicable) (10)

Report on Broad Street Subway Line "The State of the Art Car" (SOAC) Clearance Run.

Atte: Enclosure

DISTRIBUTION (11)	APPROVALS & DATE (12)	PAGE NO. (13)	(14) RETENTION REQUIREMENTS	
G.W. Thomas R. Lanni T.C. Slugocki J.R. Nielsen P.M. Caldwell N. Marcus	WRITTEN BY: A.K. Bhattacharyya REVIEWED BY: A.R. Wunsch APPROVED: J.O. Wagner	36 OF 36	COPIES FOR: ☐ 1 Month ☐ 3 Months ☐ 6 Months ☐ Months ☐	MASTERS FOR: ☐ 2 Months ☐ 6 Months ☐ 12 Months ☐ Months ☒ Do Not Destroy

FORM

SOUTHEASTERN PENNSYLVANIA

TRANSPORTATION AUTHORITY

SOAC CLEARANCE CAR RUN

SOAC CLEARANCE CAR RUN

DATE: 8/10/73

ATTENDED BY:

BOEING:

Mr. F. M. Caldwell Boeing

Mr. A. K. Griffin Boeing

Mr. Matthew Lacko Boeing

Mr. Troy Bomar Boeing

Mr. G. A. Hix Boeing

Mr. Ray A. Oren Boeing

Mr. Don Stabalito Boeing

CITY OF PHILADELPHIA:

Mr. Stan Carroll	Department of Public Property
Mr. S. Robert Rubin	Department of Transit Operations
Mr. Carl C. Hartmann	Department of Transit Operations

SEPTA:

Mr. Joseph O. Wagner

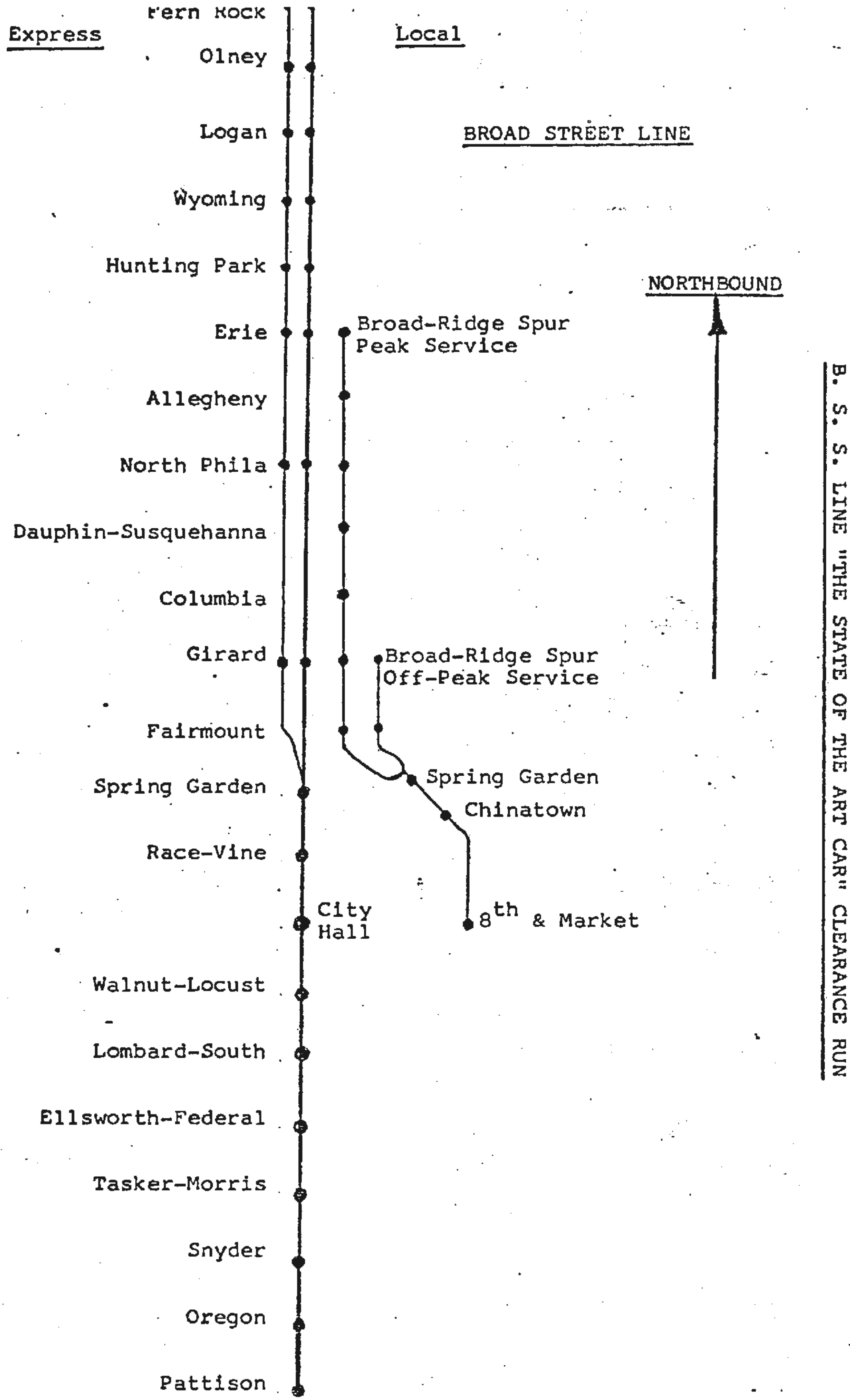
Mr. A. K. Bhattacharyya

Mr. Norman Marcus

Mr. Andrew W. Maginnis

Mr. William J. McDevitt

Mr. David Caddick


B. S. S. LINE "THE STATE OF THE ART CAR" CLEARANCE RUN
BROAD STREET LINE
NORTHBOUND
Express
Local
Fern Rock
Olney
Logan
Wyoming
Hunting Park
Erie
Allegheny
North Phila
Dauphin-Susquehanna
Columbia
Girard
Fairmount
Spring Garden
Race-Vine
City Hall
Walnut-Locust
Lombard-South
Ellsworth-Federal
Tasker-Morris
Snyder
Oregon
Pattison
Broad-Ridge Spur
Peak Service
Broad-Ridge Spur
Off-Peak Service
Spring Garden
Chinatown
8th & Market

B. S. S. LINE SOAC CLEARANCE CAR RUN

This clearance report is based on Plant Maintenance & Construction Department Drawing Nos. 6-J-5200,6-J-5193 and 2-W-15520.

Six (6) clearance templates conforming to the shape of the state of the Art Car were made up of 3/4" plywood. Attached to this plywood were metal feelers which included maximum roll of 6 -3/4", plus a 6" clearance line; also 2 front end clearance templates conforming to the slope of the car neglecting roll or clearance were made up of ¼" plywood. These car outline templates were attached to the skeleton clearance car.

The arrangement of these templates and the numbering of the metal feelers are shown on attached plans.

The clearance car was pushed by a 2 car #81 Brill unit very slowly through the subway in the early morning hours during the period August 10, 1973 through August 13, 1973. Under the heading "Remarks," the figures represent the amount metal fingers were encroaching on obstruction.

SOAC CLEARANCE CAR RUN

B. S. S. LINE

Broad Street Subway Northbound, express & local, Southbound local, including all crossovers.

SOAC CLEARANCE CAR RUN

DATE: 8/10/73 - a.m.
R.B./B

South from Fern Rock - Mid Car

Feeler Number	Remarks	Striking Obstructions
29--31,34,35	1-2"	L-14
27-28	3"	Olney Platform
27-28	8½"	Mid Olney Platform
35-36	3-4"	Markers 4,5,6,7,8
29-31	1"	Switch Box 150' North of Logan
34-35	1"	Lights or Brackets
40-41	3½"	At Logan
27-	2"	South Box at Logan
29-30	1-2"	Signal Box out of Logan
29--31	1-2"	Signal Box 200' North of Wyoming (1B-473)
40-41	5"	At Wyoming
29--31	1-2"	Signal Box Leaving Wyoming
34	1"	At Roosevelt Express Overpass
27--29	2-3"	Signal Box before Huntington Park
40-41	3"	At Huntington Park
27--31	3-4"	Signal Box after Huntington Park

Feeler Number	Remarks	Striking Obstructions
31-32	1-3"	Concrete Abutments
29-34	1-3"	Water Pipe Before L-24 Signal
27-28	9"	At Erie
28-32	2-3"	Signal Box South of Erie (3 Signal Boxes)
35	1-2"	Flourescent Light Fixtures
29-30	2-3"	Signal Box North of Alleghany
40-41	5"	At Alleghany
30-31	1"	Signal Box South of Alleghany
29-31	1-2"	Signal Box South of Alleghany
28--32	3-4"	Signal Box 2B-294
28	4"	Cable North of North Philadelphia
27-28	7"	At North Philadelphia
29--32	2-4"	Safety Gate at South end of North Philadelphia
35	3"	Light Fixtures
31	1-2"	Signal Box 2B-261
34		Ticks Light Fixtures
29--31	1-2"	Signal Box 2B-241 & Next Signal Box
34	1-2"	Light Fixtures
30-31	2"	Signal Box LB-230
40-41	5"	At Susquehanna
29--31	1-2"	Signal Box 2B-233 & Next Signal Box
30	1"	Signal Box 2B-202 & Next Signal Box
29--32	2-3"	Signal Box 2B-183 & 1B-173

Feeler Number	Remarks	Striking Obstructions
40-41	6"	At Columbia
28--32	2-3"	Signal Box 2B-164 & 2B-152
34--36	4"	Sign Brackets
29-32	2"	Signal Box
34-35	1-2"	Light Fixtures
27-28	9"	At Girard
29--31	2"	Signal Box North of Fairmount (3 Boxes)
		Fairmount
29--31	2-3"	Signal Boxes out of Fairmount
27-28	8"	At Spring Garden
27-28	8"	At Race
28-32	3-4"	Safety Gate North of City Hall
41--45	4"	At City Hall
27-28	8"	At City Hall
41-45		Hit Boxes in City Hall
46	1-2"	Hit Wall in City Hall
31-32	1-2"	Signal Boxes
27-31	1-2"	Signal Boxes North of Walnut
40-41	3"	At Walnut
44-46	2-3"	Signal Box L-16 & Next
27--31	2-3"	Signal Box 15B-30
29-30	3-4"	Electrical Junction Box near Exit
27-28	7"	At Lombard
49-50		Signs in Lombard

Feeler Number	Remarks	Striking Obstructions
29-30	4-5"	Safety Gate South Lombard
29-30	3"	Signal Box
43--47	3"	35B-77
27--32	3"	35B-77
30--32		Safety Gate At Elsworth
27-28	9"	At Elsworth
44--46	1-2"	Signal 35B-120
35	2-3"	Light Fixtures
27--32	1-2"	Signal Boxes
44	1"	35B-144
43--45	1-2"	35B-153
27-28	9"	At Tasker
42--45	4-5"	35B-170
35	1-2"	Light Fixtures
29--32 & 34	1-2"	Hits Steel Girders North of Snyder
27-28	8"	Snyder
33	1-2"	Pipe on Wall
32--35	1-3"	On Wall
32-35	4-5"	On conduit
29-33	9"	Safety Gate at Oregon
27-28	8-9"	At Oregon
29--31	10"	Safety Gate South Oregon
31--33	1"	On Wall
31--33	3-4"	On conduit

Feeler Number	Remarks	Striking Obstructions
30--35	1-3"	On Wall
36 & 35	6"	On Signal Box
40--48	3-4"	Signal R20
40-41	6"	At Pattison
40-46	9-10"	Station Operator at Pattison

SOAC CLEARANCE CAR RUN

DATE: 8/10/73
R.B./S
South from Fern Rock

North Bound/South Bound

Station to Station	Feeler Number	Striking Obstructions	Remarks
Fern Rock	10,11,11		2"
	8,10,9	Car Marker Sign	2"
South end of Administration building	47,48		2"
Through Curves	27,34	Car Marker Lights	3"
Over Third Rail (Very close)	1,2		4"
Olney Street (5600 N)	28,27	Platform	8½"
Olney Street (5600 N)	53,56	Outline of car to platform	8,8½"
Olney (South Road) R.H.S.	40,41	No. 2 Track	4"
	36,35	Car Marks	3"
	9	Car Marks	3"
	9,35	Car Marks	3"
North Logan	29,30,34	Pillar Lights	2"
Logan	40,41,15,16,66 67	Platform	5"
After Logan (4900 Block)	29,30	Pillars	2"

Station to Station	Feeler Number	Striking Obstructions	Remarks
After Logan	22	Signal	½"
Wyoming Platform	14,15	Platform	5"
Wyoming Platform	40,41,66,67	Platform	5"
After Platform	29,30,31	Leaving Pillar	3"
Huntington Park Platform	40,41	Platform	5"
Huntington Park Platform	66,67	Platform	5"
Huntington Park Platform	14,15	Platform	5"
Huntington Park Platform	1,2	Signal Box	1"
Huntington Park Platform	4,5,6	Signal Box	3"
After Huntington Park Platform	34,32,29	Pillars	3"
	6,7,8,9,10	Signal L-24	3"
	22,48	4-Mark	2"
Erie Platform	1,2,28,27	Platform	5"
Erie Platform	27,28	Platform	9"
After Erie	4,5,30,29	Signal	4"
Alleghany Platform	14,15,41,48	Platform	5"
Alleghany Platform	4,5	Signal	2"
North Philadelphia (South End)	27,28		9"
After N. Philadelphia	4,5	Platform (South end N. Philadelphia)	7-8"
After N. Philadelphia	29,28		2"

Station to Station	Feeler Number	Striking Obstructions	Remarks
Susquehanna Daulphin	14,15	Platform	5"
Susquehanna Daulphin	40,41,68		5"
Susquehanna Daulphin	10	conduit pipe	2"
Susquehanna Daulphin	31,29	Pillars	3"
Columbia Platform	14,15,40,41,67,68	Platform	6"
After Platform	30,29	Signal Box	3"
After Platform	8,9,28,27	Car Mark	8"
Girad Platform	1,2	Platform	5"
After Girad Platform	1,2,3	Signal Box	3"
Fairmount Platform	14,15,47,48	Platform	5"
Spring Garden	28,27,1,2		9"
City Hall	27,28,1,2,	Block Mark	2"
City Hall	22	Block Mark	2"
City Hall	23,22	Marker	8"
Walnut -Locust	40,41		5-6"
City Hall		On Wall	1"
South Penn. Sq. (Crossover S. of S. Penn)	7,8,9	Column	2"
South Walnut-Locust	22,21	Signal , Crossover No. 2 Track	2"
	29,30,31	Lights Conduit	3"
South St. Platform	1,2,23,22	Platform	5"
	20,19,18	3SB-60	3"
	43,42,44,46	Signal	3"
	6,7,8,4	Signal Box	3"

Station to Station	Feeler Number	Striking Obstructions	Remarks
	43,44,45,46,19 20,18,21	Signal 3SB-77	4"
	22,23	Signal	2"
Elsworth Federal Platform	1,2	Platform	5"
Platform	32,31,30	Hard Rail	5"
	21,22	Operating Sign	3"
After Platform	21,45,46	Signal 3SB-120	3"
	3,4,5	Signal Box	3"
	6,7,8,9	Conduit	3"
	19,18,17	Signal 3SB-144	3"
	22	Operating Sign	3"
	19,18,17	Signal 3SB-153	3-4"
Tasker Morris	1,2,28,27		5"
	22,23	B-Sign	3"
After Sign	17,18,19,20	Signal 3SB-17	5"
	22	Lights	2"
Snyder	22,21, 19,18	R2 T	4"
	9	Car Marker	4"
	9	Column	2"
Snyder	21,22	R-4	3"
Snyder Platform	1,2,28,27	Platform	5"
Snyder & Oregon	6,7,33,32	Conduit	
	1,2,3,4,5	Touching Wall	4"
	32,36,30	Air Line	4"
Oregon Station	1,2,28,27	Platform	3"

Station to Station	Feeler Number	Striking Obstructions	Remarks
Oregon Platform & Passing over	1,2,3,4,5,28,29		6"
	33,32,7,6	Air Pipe	4"
	3,10,32,31	Touching Wall	
	9,10	Car Mark	5"
	22,21,19,18,17 60--50	R20T	
Pattison Platform	19,18,17,16,43 44,42	Platform	8"

SOAC CLEARANCE CAR RUN

DATE: 8/13/73
R.B./B

North from Pattison

Feeler Number	Remarks	Striking Obstructions
60,67,41-40	3"	Pattison
43-50,68-72	3"	Safety Gate North Pattison
53-55,27-31	3"	South Bound 4SB-330
	okay	4SB-310
	okay	4SB-290
27,28,29	6-7"	Oregon (Safety Gate Office)
29-31,53-57	3-4"	Safety Gate North Oregon
	okay	4SB-243
34-35,57	1"	Electrical Junction Box
	okay	4SB-213
27-28,53 & 54	6"	At Snyder
	okay	L-10
	okay	4SB-192
29-55	1"	Junction Box
33,34,35,57-59	3"	Exit Sign
	okay	4SB-170
27-28-53-54	6-7"	At Tasker
	okay	4SB-153

Feeler Number	Remarks	Striking Obstructions
31,57	1"	Exit Sign
	okay	4SB-123
	okay	4SB-120
27-28,53,54	7-8"	Federal
	okay	4SB-112
55	1"	Electrical Junction Box
	okay	4SB-91
29-30,35	1"	Junction Box
31-34,57-58	1-2"	Exit Sign
	okay	4SB-72
	okay	4SB-60
27-28,53-54	6-7"	At Lombard
	okay	R-10
48	½"	Identra Stand
27-28	1-2"	Signal Box 4SB-5453
35,36,61-62	2-3"	Side Signs
	okay	R-26
27--37	2"	R-22
66-67-61-62		coming into platform
41	2"	Walnut
61-62-36-37	1-2"	On signs
40-41,66-67	3-4"	On Walnut
48,69	½"	R-38
57-31	½"	Conduit

Feeler Number	Remarks	Striking Obstructions
66-67-40-41	6-7"	Platform (City Hall)
33-31-54-62		Wall (City Hall)
46-50	3"	Signal Leaving (City Hall)
	okay	3B-10
	okay	3B-19
42-44,68-70	2"	Sign
48-50	½"	okay
40-41,66-67	6"	Platform (Race)
57	½"	Conduit
74	okay	3B-43
74	okay	3B-45
66-67,40	3"	Spring Garden
31-58	1-2"	Conduit, in station (Spring Garden)
44-47-50,66--74	2-3"	Signal
27-34,54-60	1-2"	Girad
69-70,73-74,48-50	1-2"	Signs
47-69-71	2"	Fairmount 3B-67
62-63	1"	Fairmount
61-63-56-57	Minor ½"	Unknown atFairmount
58	½"	3B-83
71--74,48-45-46		3B-91
62,63,64,66-67-40-41	3"	Platform (Girad)
61-62,35-36	1"	Car Marker
57,31	1"	Conduit

Feeler Number	Remarks	Striking Obstructions
43-49,69--74	1"	R-56
27-31,53-57	3"	Electrical Junction Box
66-74-43-49	2-3"	R-58
66-69-74	½"	Girad
28-37,54-62	2"	Pipe
59-60,69	1"	Car Marker
48-50,94-75	2"	Sign
67-68-41	1"	Box
43-50,68-72,70-71	1-2"	R-64
69-70	1"	Columbia
48-43,46,69-77	1-2"	3B-171
68-69	1"	Junction Box
43-49-69--72	2"	3B-19
68-69	2"	Electrical Box
44--46,48,49,69--72		3B-210
31-57-58	1"	On Conduit continuing to Susquehanna
43-48,69-72	1-2"	3B-224
68-69	1"	Control Box
69-72,48-43--46	1-2"	3B-236
69-72,48-43--46	1-2"	3B-250
48-44,69-71	1"	3B-261
	okay	3B-265
48-74	1"	Car Marker
	okay	3B-272

Feeler Number	Remarks	Striking Obstructions
66-67-40-41	4-6"	North Philadelphia
44-69--71	1"	3B-282
57	1"	End of Girad - pipe
69-72,43-46	1-2"	3B-294
57-31	1"	On Conduit
57-31	1"	On Conduit
69-72	1"	3B-313
43--45,69--72	2"	Alleghany 3B-331
68,69	2"	Electrical Junction Box
43--45,69--72	3"	3B-343
43-46-69-72	1-2"	3B-354
44-46-69-72	1"	3B-360
	okay	3B-363
66-67-40-41	2"	Platform (Erie)
32-34		Valve 2nd of Girad L-34
29-32,56-58	8"	Safety Gate, Walnut
	okay	R-42
	okay	4SB-9
34-35		Light on curve
69-71		Signal
27-28,53-54	6-8"	Platform (City Hall)
75-48-49	2"	Car Markers
44-48		On Curve 4B-4
	okay	4B-10

Feeler Number	Remarks	Striking Obstructions
	okay	4B-19
	okay	4B-20
27-28-53-54	6"	Platform (Vine)
	okay	4B-26
	okay	4B-43
	okay	4B-45
53,54,27-28	6"	Spring Garden
56-58 & 29--31	1"	4B-67
40-41,66-67	1-2"	R-16; 4B-65
	okay	4B-83
31-35-57--59	3"	Sign
	okay	4B-91
53-54,27-28	8"	Girad
58--60	1"	Box
	okay	4B-133
29-34,52-59	2-3"	Start Of Girad
33-34,57-58	2"	Pipes or Sign in Girad
55-57,29-31	1"	Signal Box 4B-161
40-41,66-67	3"	Columbia
56-59	1-2"	Box
56-57-29-30	1"	Signal Box 4B-182
55-58-29-31	1-2"	Signal Box
56-57	1"	4B-210
	okay	4B-220

Feeler Number	Remarks	Striking Obstructions
66-67-40-41	4"	Susquehanna
55-58	1"	Mark
55-58-29-31	1"	Box, Signal On (3)
	okay	4B-242
	oaky	4B-264
	okay	4B-272
27-28,54-56	8"	North Philadelphia
	okay	4B-212
55-57-29-30	½"	Station - Girad
56-57-31	½"	Signal Box
33-35-58-60	3"	Exit Sign
55-56-58		Signal Box 3B-313
66-67-40-41	2-3"	Alleghany
55-57	½"	Girad
56-58	1"	Box 3B-331
	okay	4B-333
55-58	1"	Box 3D-341
30-34,55-58	2"	Identra on Track 3
	okay	4B-463
53-54,27-28	6-7"	Erie
	okay	L-42
70-71		Identra Box
	okay	L-40
	okay	4B-395

Feeler Number	Remarks	Striking Obstructions
56-57-29-30	1"	4B-413
	okay	4B-423
66-62,40-41	3-4"	Huntington Park
55-29	1"	4B-432
	okay	4B-452
	okay	4B-462
66-67-40-41	2-3"	Wyoming
	okay	4B-473
29-30,55--57	1"	4B-192
55	1"	4B-193
66-67-40-41	2"	Logan
55-29	1"	4B-508
	okay	4B-513
34-35	2"	Exit Sign
55	1"	On Signal Box
61-62-36-35		Car Markers
55-57-30,31	2"	L-68
27-28,53-54	4-5"	Olney L-56
	okay	L-32
56-60	1-2"	Wall
	okay	L-24
69-70-44	½"	

SOAC CLEARANCE CAR RUN

DATE: 8/13/73
R.B./S
North from Pattison

Station to Station	Feeler Number	Striking Obstructions	Remarks
Pattison	5,14	Platform	6"
	14,15,16,17,19,20	Signal (#3 Track) Leaving Signal	4"
	2	Signal R-6	3"
Oregan Platform	2	Away from one end	8"
	2,3,4,5	End of Platform railing steps	6"
Between Oregan & Snyder	3,2	Train Phone Box (Relay Box)	3"
Snyder Platform	1,2	Platform	3"
Leaving Snyder	3,4,5	Cable & Conduit	3"
	3,6,7,8	Exit Sign	4"
	3,4	Signal Box	3"
	3,4	Signal Box	3"
Tasker Morris	1,2	Platform	2"
	3	Signal Box	2"
	5	Exit Sign	1"
Elsworth - Federal Platform	1,2	Platform	4"

Station to Station	Feeler Number	Striking Obstructions	Remarks
Leaving Elsworth	3,4	Signal Box	3"
	3,4,5	Exit Sign	2"
Lombard-South Platform	1,2	Platform	5"
	1,2,3,4	Telephone Signal Box	3"
Train Line	9	Car Mark	3"
	9	Car Mark	3-4"

EXPRESS

Crossover #3 (Walnut St.)
#4 Track to #3 Track

Station to Station	Feeler Number	Striking Obstructions	Remarks
Walnut-Locust Platform	14,15	Platform	4"
	8,9	Car Markers	3"
Walnut-Locust Platform (Express)	4,5,6	Platform	3"
	5	Platform	5"
	18,17,16	Signal R-38	2"
#3 Track Express	1	Low Signal	2"
	5	Air Line	1"

Station to Station	Feeler Number	Striking Obstructions	Remarks
City Hall Platform	14,15	Platform	4"
	3,4,5,6	Wall	2"
	7,8,9,10	Wall	2"
	5	Air Line	1"
	16,17,18	Caution Sign	2"
	22,23	Operating Sign	2"
Race-Vine Platform	14,15	Platform	4"
	5	Air Line	2"
Leaving Race-Vine Platform	5	Air Line	1"
	17,18	Signal Box	4"
Spring Garden Plat-form	14,15	Platform	4"
	16-23	Signal R-12	4"
	5	Air Line	1"
	2-10	Signal & Box, Low Signal	3"
	22,23	Car Mark	2"
	22,21	Car Mark	3"
	22,23	Car Mark	3"
	22,23	Car Mark	2"
Fairmount	17-20	3B67, R-28	3"
	10-11	Car Marker	2"
	10	Car Marker	1"
	16-22	3B-90, R-60	4"
Girad Platform	14,15	Platform	4"

Station to Station	Feeler Number	Striking Obstructions	Remarks
	10,11	Car Markers	3"
	5	Air Line	1"
Leaving Girad	17-23	Signal R-56	2"
	5	Air Line	2"
	2,3,4,5,9	Signal	3"
	22	Telephone Box	2"
	15-23	R-58 (Signal)	2"
	14-17	Air Line	3"
	23,22	Operating Signs	3"
	1-10	Signal Conduit	2"
	2-10	Signal Box	3"
	22,23	Operating Sign	2"
	23	Operating Sign	2"
	23	Operating Sign	2"
	14,15	Electrical Box	3"
	23	Operating Sign	2"
	22,23	Operating Sign	2"
	18-21	Stop Sign	2"
	22,23	Operating Sign	2"
	16-23	R-64	2"
	5	Air Line	3"
	16-18	Sign	2"
	22	Car Mark	2"
	17	Signal Box	2"

Station to Station	Feeler Number	Striking Obstructions	Remarks
	22,23	Car sign	2"
	23	Car Sign	1"
Columbia	18-22	3B-171	3"
	16-17	Electrical Box	2"
	16-17	Signal Box	2"
	16-21	3B-191	2"
	15-16	Train Phone Box	2"
	20-22	3B-210	3"
	16-17	Signal Box	2"
	16-22	3B-224	3"
	16-17	Signal Relay Box	2"
	17-22	3B-236	2"
	17	Signal Box	2"
	17-22	3B-250	2"
		Air Line	2"
	5	3B-261	2"
	17-22	3B-265	3"
	17-22	3B-272	3"
N. Philadelphia	14-15	Platform	4"
	17-22	3B-282	3"
	17-22	3B-294	3"
	5	Air Line	2"
	16,17	Signal Box	2"
Alleghany	17-22	3B-313	3"

Station to Station	Feeler Number	Striking Obstructions	Remarks
Leaving Alleghany	17-22	3B-331	3"
	22	Electrical Box	1"
	16	Signal Box	2"
	16-17	Telephone Box	2"
	17-22	3B-343	3"
	16-17	Signal Box (Relay)	2"
	16-17	Relay Box	2"
	17-22	3B-354	3"
	17-22	3B-360	3"
	17-22	3B-363	3"
Erie Platform	14-15	Platform	5"
	5	Air Line	2"
Leaving Erie	16,17,18	L-34,T Crossover	3"
	3-10	Signal	3"

LOCAL

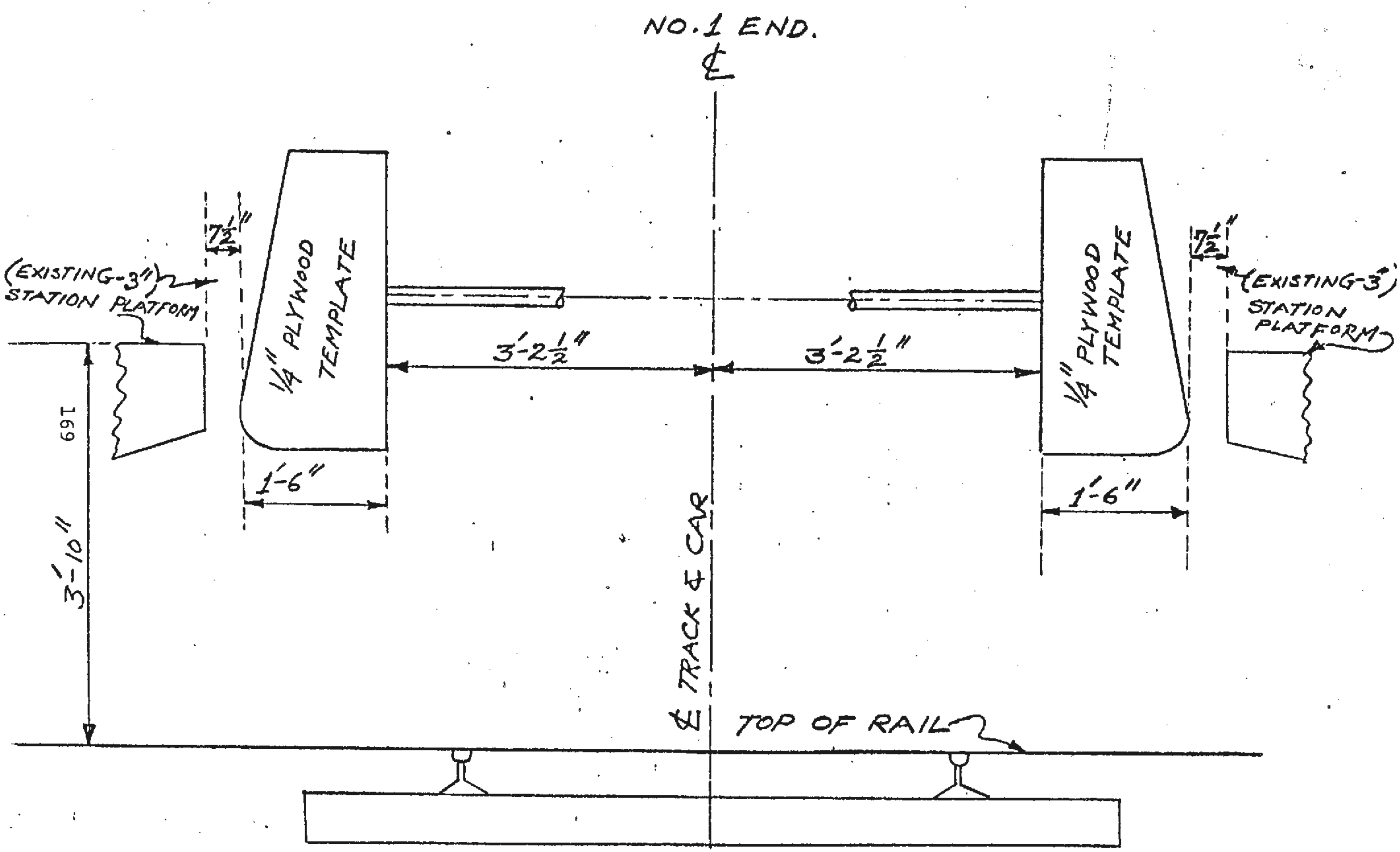
From Walnut - Locust

Lombard-South

Station to Station	Feeler Number	Striking Obstructions	Remarks
	14-15	Platform	5"

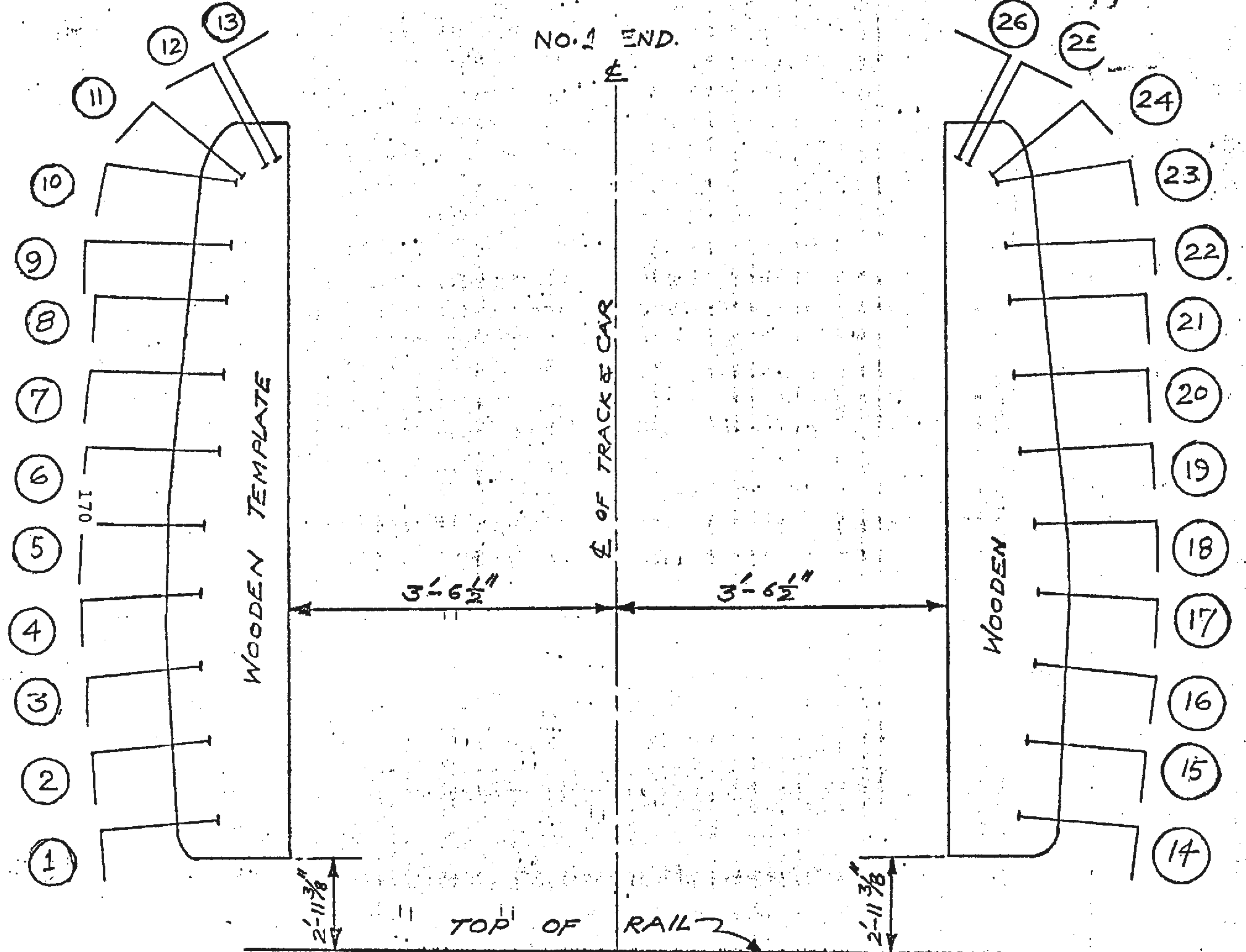
Station to Station	Feeler Number	Striking Obstructions	Remarks
	9	Train Marker	4"
	4,5	Signal	3"
Walnut-Locust	1,2	Platform	6"
	17-23	4SB-5	3"
City Hall Platform	1,2	Platform	6"
	22-23	Track Sign	3"
	22-23	Car Sign	2"
Race-Vine	1,2	Platform	6"
Spring Garden	1,2	Platform Crossover	6"
Fairmount	14,15	Platform Crossover	6"
	6,7,8,9	Exit Sign	6"
Girad Platform	1,2	Platform Crossover	6"
	3,4	Signal Box Crossover	6"
	3,4	Signal Box	6"
Columbia	14,15	Platform	6"
Susquehanna	14,15	Plafform Signal Box	4"
N. Philadelphia	1,2	Platform	4"
	2,3,4,5	Signal Box	4"
Alleghany	14,15		6"
	2-5	Signal Box	6"
	2-5	Signal Box	6"
Erie Platform	1,2	Platform	8"
	3,4	Signal Box	6"
Huntington Park	14,15	Platform	6"

Station to Station	Feeler Number	Striking Obstructions	Remarks
Leaving Huntington	3,4	Signal Box	2"
	22	Special Signal	3"
Wyoming Platform	14,15	Platform	6"
		Signal Box	3"
Logan Platform	14,15	Platform	8"
Leaving Logan	3,4	Signal Box	3"
	9	Exit Sign	4"
	9	Car Mark	3"
	8,9	Car Mark	3"
	4,5,6	Signal Box Crossover	4"
Olney Platform	1,2	Platform	6"
	4,5,6	R-56	4"
	22-24	Lights	4"
	18	Air Line	2"
	10-11	Car Mark	2"



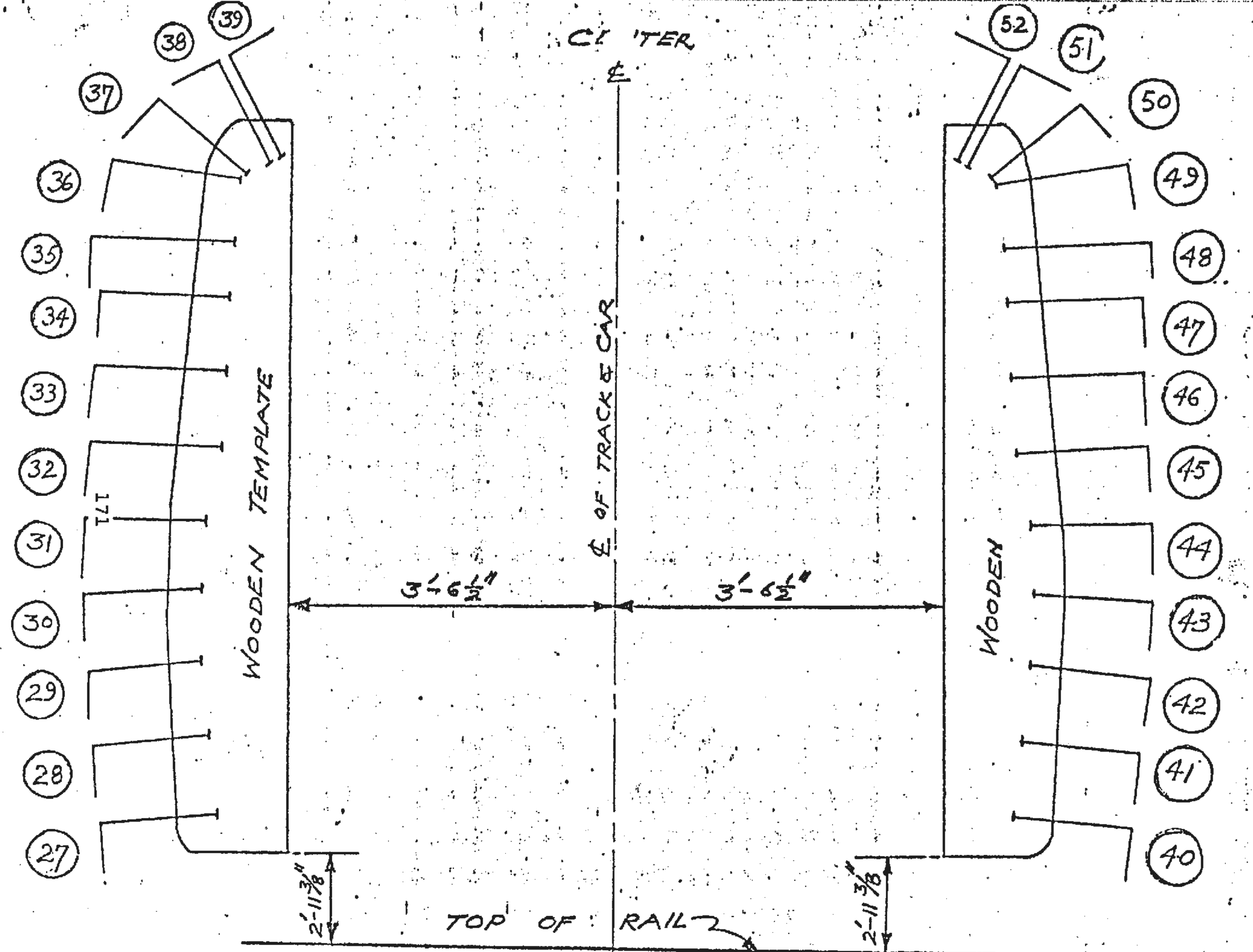
FRONT END TEMPLATES

PLAN # BSSC/10-8-73

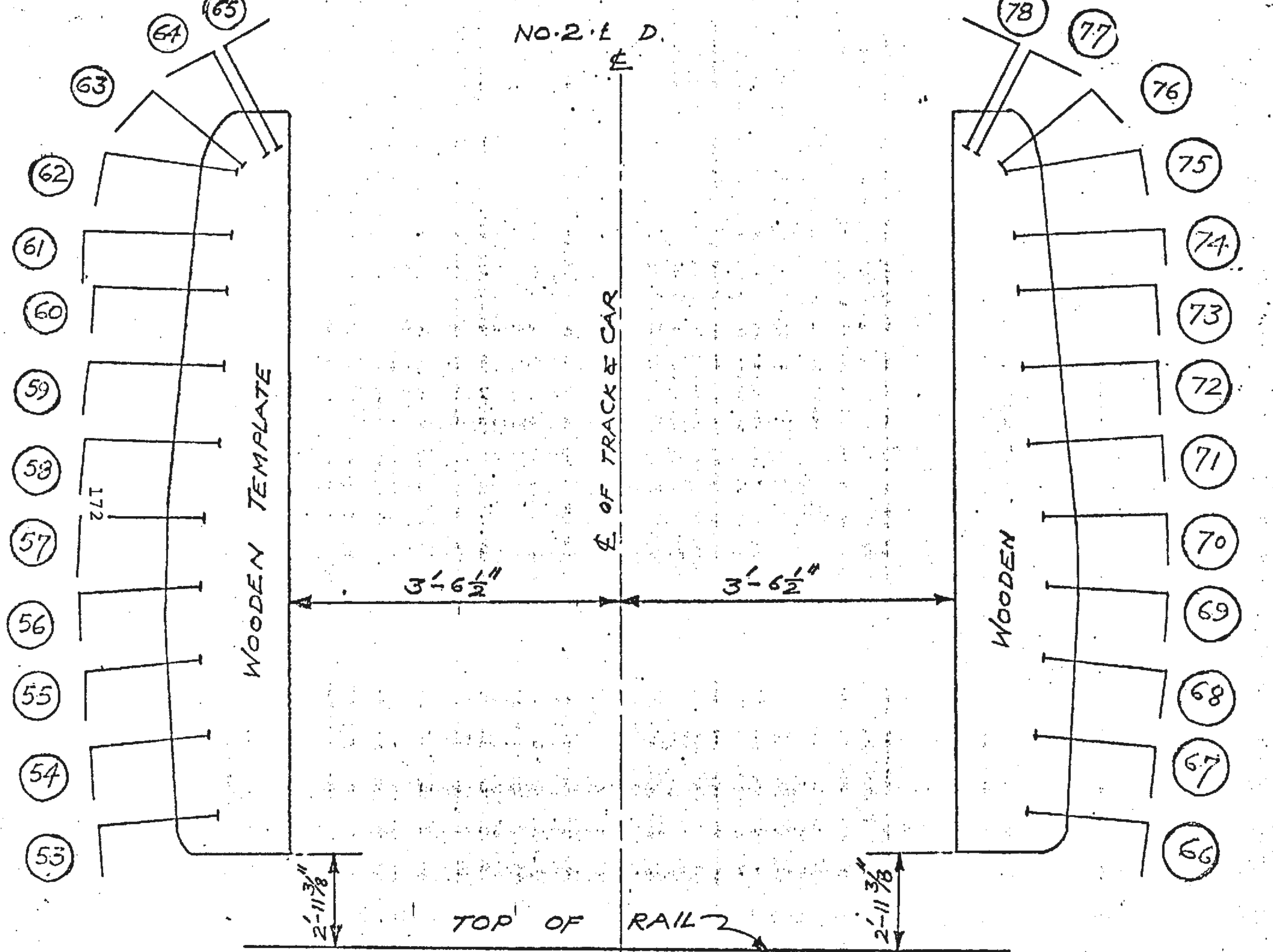


#2 END TEMPLATES & FEELERS

PLAN# BSSC/11-8-73

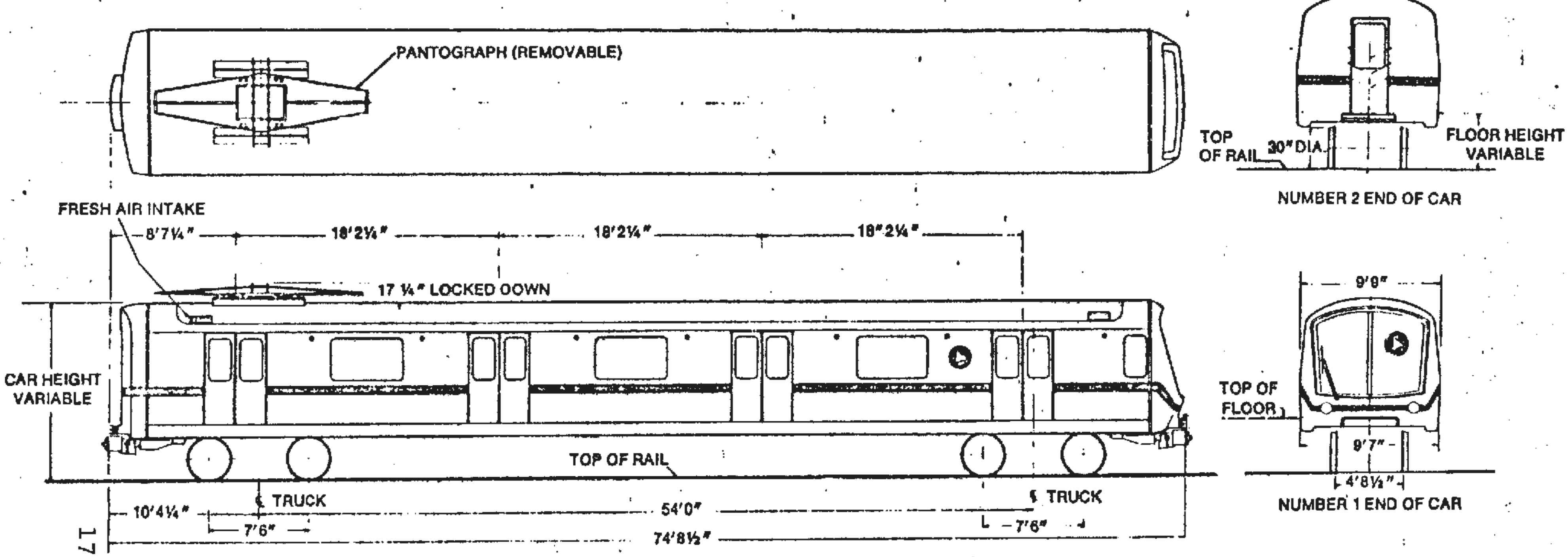


CENTER TEMPLATES & FEELERS PLAN # BSSC/12-8-73

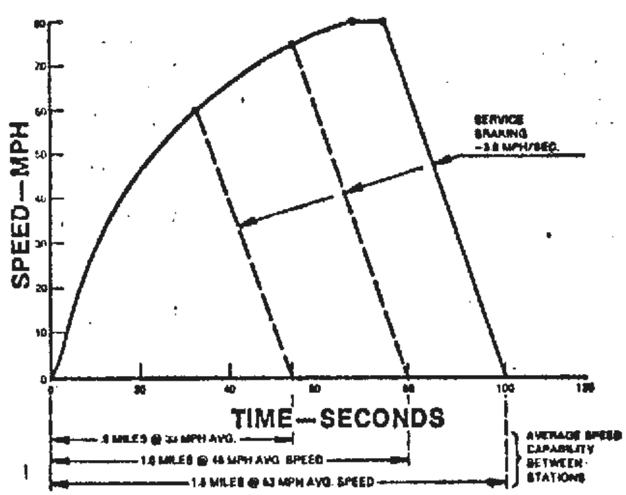


#1 END TEMPLATES & FEELERS

PLAN # BSSC/13-8-73



PERFORMANCE AND DESIGN CHARACTERISTICS:	
Length	75 Feet
Width	9.75 Feet
Minimum Track Curve Radius	145 Feet
Passenger Capacity (No. 1 car)	
Seated	64
Nominal	100
Maximum	220
Speed	80 MPH
Acceleration, Initial	3.0 MPH/SEC.
Jerk Rate	2.5 MPH/SEC.[2]
Power	600 V.D.C. Nominal
Noise Level, interior	75 dBA @ 45 MPH

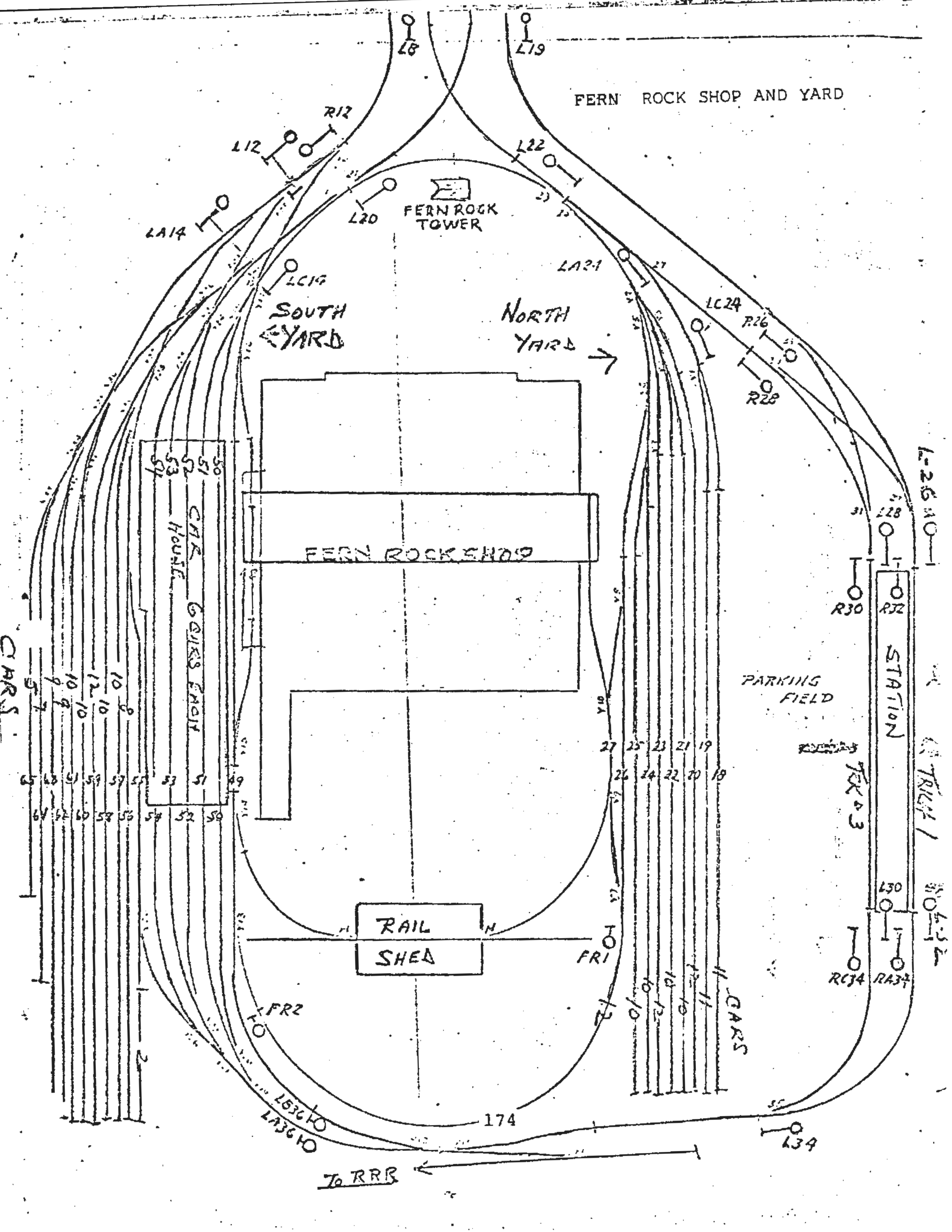


PERFORMANCE CAPABILITY

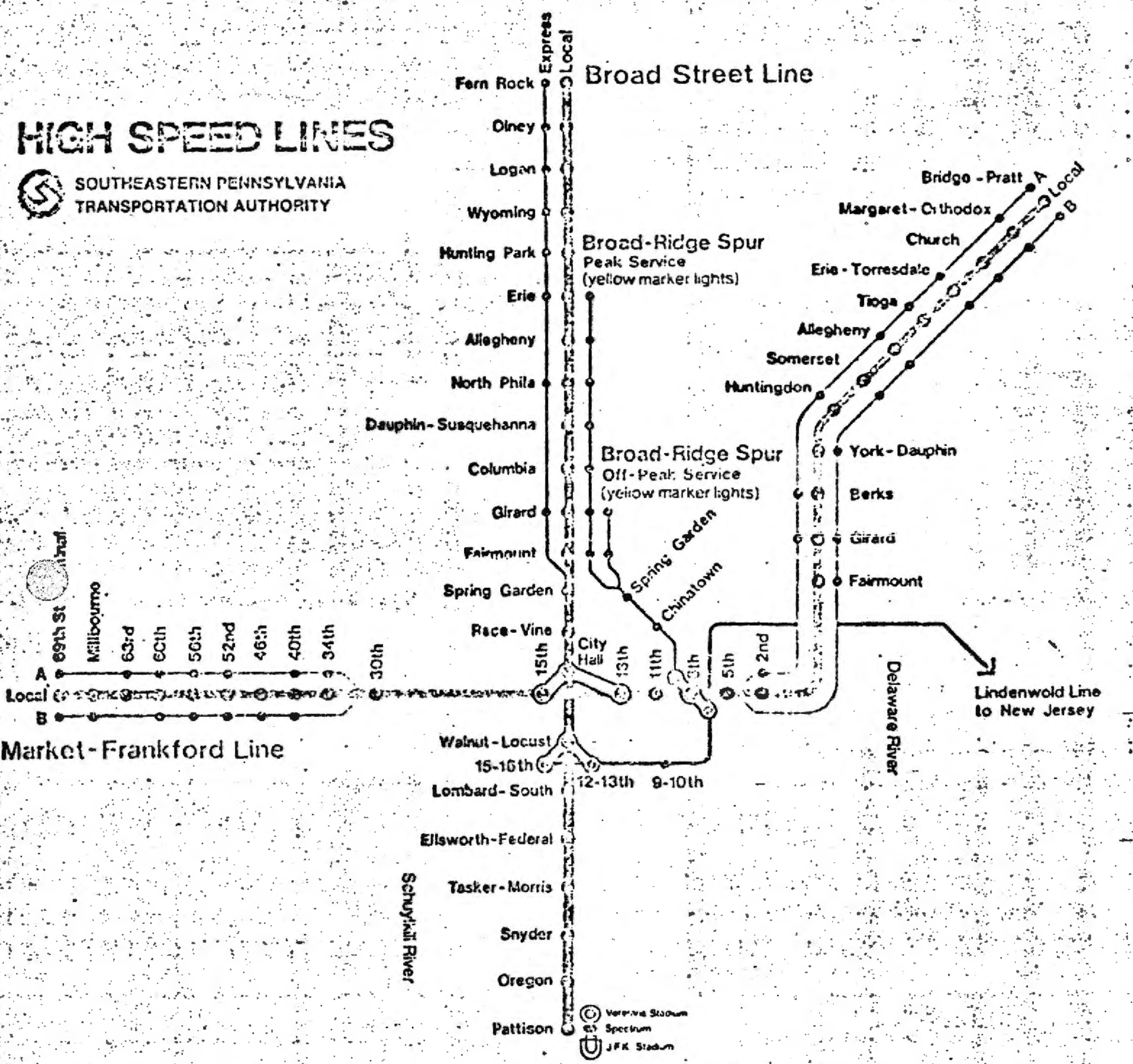
BASIC CAR PLUS 100 PASSENGERS

SCHEDULE SPEED CAPABILITY
(20 SECOND STATION STOP)

STATION SPACING	SCHEDULE SPEED
.5 MILE	24 MPH
1.0 MILE	36 MPH
1.5 MILE	44 MPH



FERN ROCK SHOP AND YARD
L8
L19
R12
L12
L22
LA14
L20
FERN ROCK
TOWER
LA21
LC19
LC24
SOUTH
YARD
NORTH
YARD
R26
R28
CAR
HOUSE
FERN ROCK SHOP
L26
L28
R30
R32
STATION
PARKING
FIELD
TRACK 3
TRACK 1
L30
RAIL
SHED
FR1
FR2
RC34
RA34
CARS
LS36
LA36
174
L34
TO RRR



Route Map of Subway-Elevated Lines

APPENDIX II

BOEING VERTOL COMPANY
A DIVISION OF THE BOEING COMPANY
P.O. BOX 16858
PHILADELPHIA, PENNSYLVANIA 19142

CODE IDENT. NO. 77272

NUMBER ______________________

TITLE STATE OF THE ART CAR
DEMONSTRATION PLAN FOR THE
SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

ORIGINAL RELEASE DATE ____________. FOR THE RELEASE DATE OF SUBSEQUENT REVISIONS, SEE THE REVISION SHEET. FOR LIMITATIONS IMPOSED ON THE DISTRIBUTION AND USE OF INFORMATION CONTAINED IN THIS DOCUMENT, SEE THE LIMITATIONS SHEET.

MODEL SOAC CONTRACT DOT-UT-10007

ISSUE NO. ____________ ISSUED TO: ______________________

PREPARED BY	R. Line	DATE	3-10-75
APPROVED BY	R. Wesson	DATE	3-11-75
APPROVED BY	D. Hervey	DATE	3-12-75
APPROVED BY		DATE	

FORM 46280 (5/73)

STATE OF THE ART CAR

DEMONSTRATION PLAN FOR THE

SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

STATE-OF-THE-ART CARS DEMONSTRATION PLAN FOR THE SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

Table of Contents

I. INTRODUCTION

The U. S. Department of Transportation, 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 (URRV&S) Program. This program is an integrated development program directed toward improving high speed, frequent-stop urban rail systems. The overall objective is to enhance the attractiveness of rail transportation to the urban traveler by providing service that is as comfortable, reliable, safe and economical as possible.

Boeing Vertol's tasks under the URRV Program are:

1. Monitor the BART Program
2. Using current technology in car building, have designed and built two new State-of-the-Art Cars (SOAC). Upon completion of the test phase at the High Speed Ground Test Center (HSGTC), demonstrate the cars to the transit authorities and the riding public in New York, Boston, Cleveland, Chicago and Philadelphia.
   The objective of the SOAC is to demonstrate the best state-of-the-art in rail rapid transit car design, with two new improved cars using existing proven technology. Primary goals for the cars are passenger convenience and operating efficiency.
3. Conduct an industry-wide design competition and award a contract to produce an Advanced Concept Train (two-car train), ACT-1. Demonstrate these cars in the same five cities as the SOAC.

4. Concurrent with ACT-1, conduct industry-wide design competition and award contracts for the Advanced Subsystems Development Program (ASDP). Incorporate some of these systems in the SOAC and demonstrate again in the five cities.
5. Perform planning for an operational demonstration of the ACT train.
6. Perform an economic analysis of BART and SOAC.
7. Perform a human factors evaluation of BART and SOAC.

II. DEMONSTRATION PLAN

The SOAC demonstration will be conducted from May 1974 through April 1, 1975 in New York, Boston, Cleveland, Chicago and Philadelphia. The plan is centered around a revenue service oriented demonstration and includes participation by public officials, industry associates and the public in general. The Boeing Vertol project engineer for the SOAC operational demonstration in Philadelphia is Richard H. Line (215/522-3318). Mr. Line is responsible for the SOAC operational demonstration at Philadelphia and all interfaces with SEPTA.

The cars will be shipped to Philadelphia on their own wheels with a transition car on each end and will be accompanied by a rider employed by Boeing Vertol. The transition cars will have a standard AAR coupler on one end and SOAC coupler O.B. type 70 on the other end. In addition, a box-express (B-X) car for handling spare parts and equipment will be a part of the consist. Thus, the delivery will consist of a five-car train, necessitating handling equipment with an AAR coupler.

The SOAC will be routed to the Reading RR siding at the SEPTA Fern Rock Shop and turned over to SEPTA by the Reading Railroad. Boeing Vertol and SEPTA will inspect the cars for road damage. The box car will be stored in the Fern Rock Yard and Boeing will arrange for security.

It is planned that the SOAC will be operated by SEPTA personnel and maintained by SEPTA personnel with assistance and technical direction from Boeing Vertol personnel. All Boeing Vertol and Garrett SOAC team members shall be authorized to operate the SOAC's in the yard and on the Broad Street Subway with a SEPTA line supervisor in the cab. Details of SEPTA support required are contained in Sections VI and VII. The demonstration at SEPTA will start in February 1975 and will be completed within six weeks, according to the schedule shown in Figure I.

As indicated on the schedule, engineering tests will be conducted at the end of the demonstration at SEPTA (see Section V for details).

OPERATING SCHEDULE

The SOAC's will operate six days a week on the Broad Street Subway between the hours of 9:30 a.m. to 2:15 p.m. and 6:30 p.m. to 9:15 p.m. The run schedule is given in Appendix A.

LEGEND

BOEING VERTOL COMPANY

SCHEDULING DATA SHEET

PROGRAM SOAC DEMO. AT SEPTA

CONTRACT

AUTHORIZATION

ISSUED BY

CODE NO.

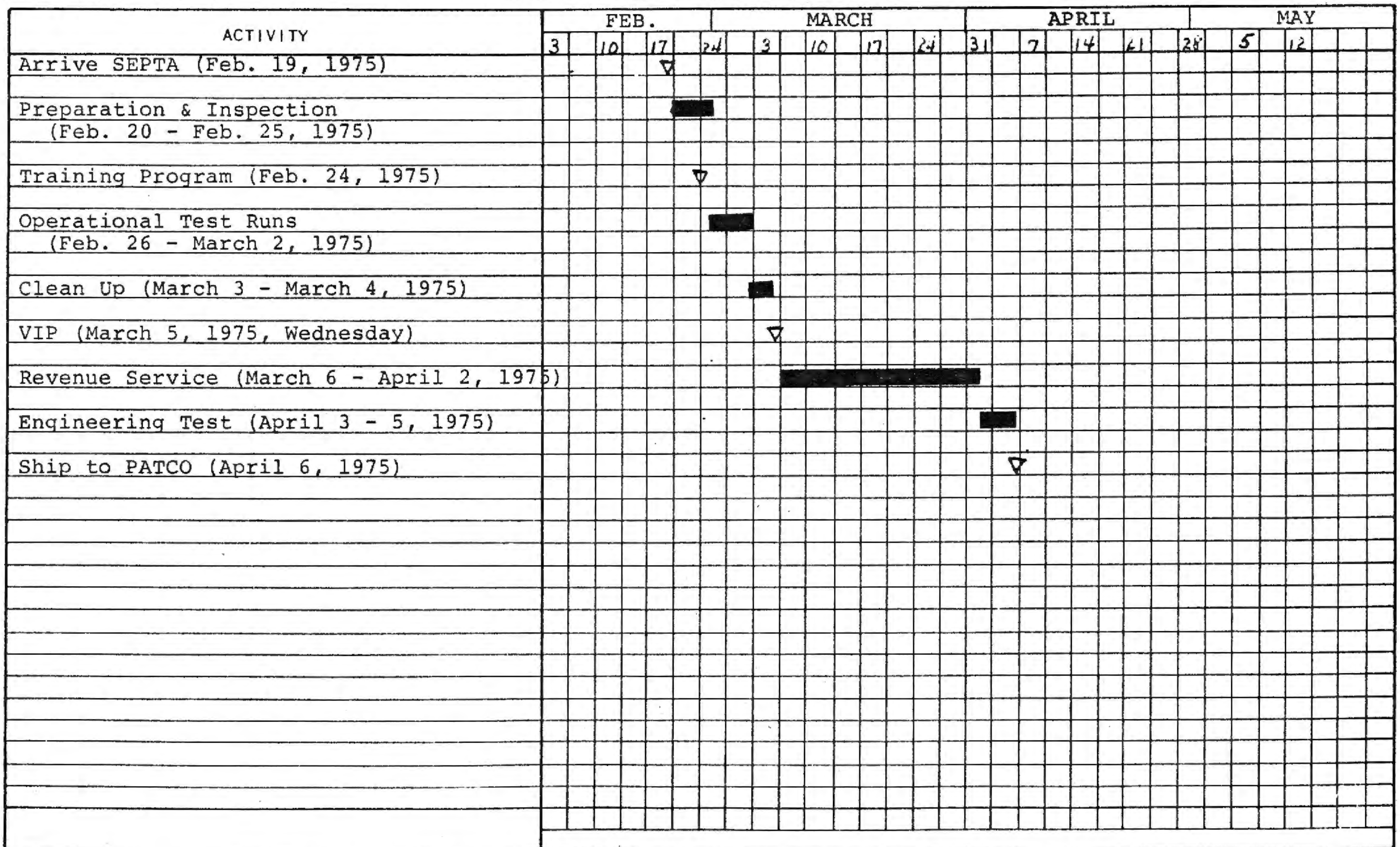
DATE ISSUED

DATE REVISED

PREPARED BY

APPROVED

APPROVED



FORM 22280 (3/73)

FIGURE 1

III. SOAC FAMILIARIZATION

Semi-Technical Presentation

A two hour classroom presentation will be given by Boeing Vertol to familiarize interested SEPTA personnel with the features of the SOAC. Emphasis will be placed on those areas where the SOAC equipment varies from the equipment presently being used by SEPTA. Attendance of this semi-technical 35 MM slide presentation will be determined by SEPTA and is limited only by the size of classroom facilities available. At the conclusion of the presentation, a document containing SOAC information will be given to each attendee. The outline of the presentation is as follows:

Program Outline and Objectives
Urban Rapid Rail Program Organization
Background of State-of-the-Art Car
SOAC Features
Performance and Design Characteristics
Car Configurations
Electrical Propulsion
Tractive Effort Control
Propulsion Power Control Unit
Chopper
Dynamic Brake
Motor Alternator
Auxiliary Power Control Unit (APCU)
Friction Brake System
Emergency Brake Control

Truck Assembly and Suspension System

Coupler

Operator's Cab

Hostler

ACT-1 (Advanced Concept Train)

Technical Presentation

On the following day a more technical presentation will be given to those SEPTA personnel requiring a more in-depth understanding of the SOAC. Boeing Vertol and Garrett technical personnel will be available to answer questions concerning SOAC peculiar hardware. The outline for this presentation is as follows:

PROPULSION SYSTEM

Master Controller
"P" Generator Panel
Propulsion Power Control Unit (PPCU)
Propulsion Control Unit (PCU)
Input Reactor
DC Chopper
Smoothing Reactor
Traction Motors
Traction Cooling Fans
Gear Box and Coupling

BRAKE SYSTEM

Dynamic Braking
Friction Braking
Handbrake (Parking)

AUXILIARY POWER SYSTEM

Auxiliary Power Control Unit (APCU)
Motor Alternator (M/A)

IV. SAFETY BRIEFING

In order to assure that the Boeing Vertol SOAC team is familiar with SEPTA Safety Rules and Regulations, safety briefings will be given by qualified SEPTA personnel. These briefings will be given in one day to the entire Boeing Vertol SOAC team before any work is performed at SEPTA.

Industrial Safety

The following topics are suggested as an outline for an Industrial Safety briefing:

- Preventing the Accident
- Special Instructions
- General Instructions for Car Maintenance Employees
  - Entering on Tracks
- Flagging and Hand Signals
- No Clearance Signs
- General Rules
- Personal Protection
- Fire Prevention
- Gas Cutting and Welding
- Care and Storage of Compressed Gas Cylinders
- Handling Air Brake Equipment
- Car and Truck Repairs
- Handling Electrical Equipment
- Operating Hoisting Machines
- Operating Machinery
- Operating Shop Trucks

Handling Material

Working on or Adjacent to Track Roadbed

Working on Ladders, Scaffolds, Pit Boards and in Pits

Six-Hundred (600) Volt Power Removal

Operational Safety

SEPTA will provide instruction in the following specific areas and any other instruction deemed necessary for safe operation of the Boeing Vertol SOAC team while at SEPTA.

Public Relations

Fire and Fire Prevention

Car Opeation in a Yard

Proper use of Whistle, Buzzers, Color, Telephone Public Address, Radio and special lights in emergencies and in communications

Automatic, fixed, interlocking, automatic block and miscellaneous signals

Signal aspects and indications

Flagging rules and safety procedures

Automatic Key-By

V. TEST OPERATIONS

Background

The Rail Programs Branch of the Urban Mass Transportation Administration (UMTA) Office of Research and Development is conducting programs directed towards the improvement of urban rail transportation systems. The Urban Rail Supporting Technology Program (URSTP) of the DOT/Transportation Systems Center (TSC) is providing Systems Management for the Rail Programs Branch in design, construction and operation of UMTA test facilities, in analysis and testing of vehicles and components and in the development of key technological data. Four tasks outlined for the URSTP are facility development, test and evaluation, technology development and application engineering.

In August of 1972, the UMTA Rail Transit Test Track at the High Speed Ground Test Center (HSGTC) in Pueblo, Colorado became available for rail rapid transit vehicle testing. This facility permits the use of known track and grade conditions for tests while freeing the test operations from interfering with revenue service. A methodology for controlling test variables by standardizing procedures and data requirements was developed in Fiscal Year 1972 and is contained in a TSC document identified as GSP-064. This methodology was successfully checked by a series of tests using R-42 transit cars, on loan from the New York City Transit Authority, on the initial section of the test track in March 1972. This testing and reporting system promotes the development of an industry wide data base to facilitate vehicle and component comparisons.

In February 1973, TSC awarded Boeing Vertol a contract to perform engineering tests on the SOAC vehicles at the HSGTC and at each of the five demonstration properties. The objective of this program is to provide a set of engineering data on the SOAC and to further develop the methodology for providing vehicle comparisons as defined in GSP-064.

The engineering tests on the SOAC were conducted by using the methodology of GSP-064, which facilitates the comparison of SOAC to other vehicles. These tests also demonstrated the use of the UMTA Rail Transit Test Track as a test facility, which permits a large scale test plan to be completed in a relatively short time. The Property Test phase of the SOAC Engineering Test Program will relate test results on the HSGTC Test Track to vehicle performance on each of the five operational demonstration properties.

Objectives

The primary objectives of this test program are:

1. Provide engineering data for the Advanced Concept Train (ACT-1), and Advanced Subsystems Development Program (ASDP) programs.
2. Provide UMTA with an engineering baseline to judge future program progress.
3. Relate HSGTC track characteristics to those of the five demonstration properties.
4. Provide an instrumentation package that can be used on the ACT-1 program and other railcar test programs.

Tests

The Engineering Testing to be performed at SEPTA is in conjunction with the third program objective stated above, i.e., relating the SEPTA track characteristics to conditions at the DOT HSGTC. This relationship can best be described in terms of statistical summaries of the variation in levels of a few select parameters. This program does not attempt to relate the test sites on the basis of a comparison of parameter variation under discrete controlled test conditions which is far more complex and extensive than intended for the SOAC Engineering Test Program.

The tests will be conducted under conditions that will be experienced by any vehicle operating on the Broad Street Subway. The test plan is, therefore, to measure a few select parameters while the SOAC is operated as closely as possible to a scheduled revenue service run. The variation of these parameters will be statistically summarized. Axle journal accelerations, car speed and longitudinal acceleration will be used as the parameters that describe the property track and operation. Car body acceleration, truck frame strain levels, noise levels and energy consumption will be used as an indication of the vehicle response to existing conditions.

Test Procedure

SOAC operations during the engineering test program will be the joint responsibility of the Boeing Vertol Operations Team Leadman and the SEPTA New Car R.S.&S. Engineering Representative.

(The SEPTA representative has the ultimate responsibility for safe movements within the SEPTA property.) These individuals will coordinate train movements with the Engineering Test Program Project Engineer.

After set-up of the instrumentation, SOAC will be run on sections of the SEPTA line to verify that SOAC acceleration and deceleration rates are acceptable to SEPTA.

SOAC will make the first trip over the line at a reduced speed to insure that the determination of SOAC/SEPTA system clearance. which has been made is satisfactory. (The clearance run shall include a run down Ridge Avenue to the PATCO interchange.) During this clearance run, radio communications will be checked. After the clearance run, additional round trips may be made over the line as required to provide motorman checkout. The test parameters will not be recorded until a near schedule service run can be reasonably assured. These runs will be made at times designated by SEPTA, but usually between the hours of 12:30 a.m. and 5:00 a.m. The following procedure will be followed by Boeing Vertol test personnel:

1. One hour prior to scheduled test run, begin Instrumentation Checkout (two hours prior if this is a test run only).

2. During Clearance and Motorman Checkout Runs, test personnel shall:

   Calibrate all data channels (performance, ride quality and structural).

Check out equipment temperature recording system.

Provide written notice to instrumentation engineer on special instructions (quick-look parameters, special event markers, etc.).

Acoustics test engineer to obtain all required wayside measurements.

3. During the Test Run:

The Boeing Vertol Operations Team Leadman will complete a log sheet with a complete log of all relevant events occurring during the run.

Equipment temperature will be monitored.

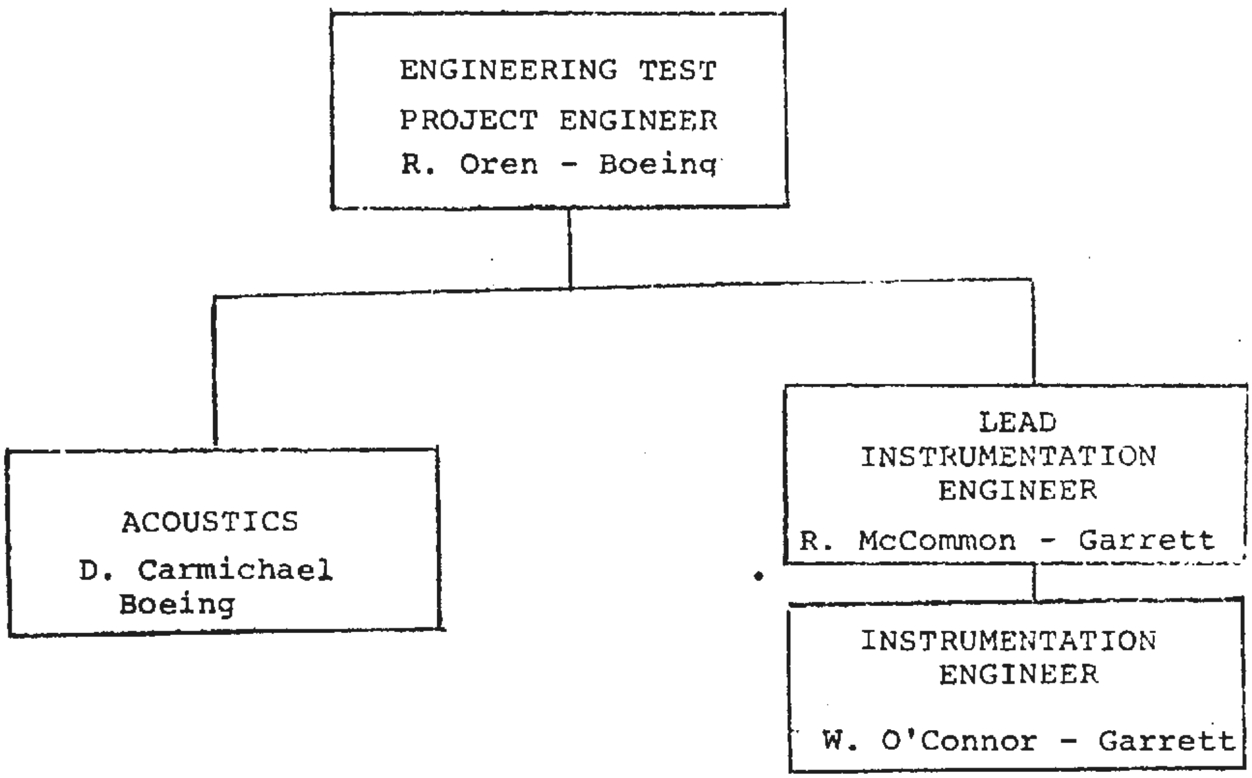
Quick-look parameters will be monitored, with special incidents recorded with system tape footage for correlation during future data analysis.

4. Post Run:

The instrumentation system will be given a post-run checkout and shut-down. To assure adequate record and data identification, everyone will provide a copy of their data logs and correlate them with the instrumentation data log prior to leaving the vehicle.

Organization

The organization for the Engineering Test Program is given in Figure 2.



SOAC SEPTA ENGINEERING TESTS ORGANIZATION STRUCTURE

FIGURE 2

VI. REVENUE SERVICE

Opening Day Ceremonies

At the conclusion of the crew training program, the car will be cleaned and prepared by SEPTA or an outside contractor for opening day ceremonies. The opening day ceremonies will include static display of the cars and an inaugural run, which will be coordinated jointly by SEPTA, UMTA and Boeing Vertol.

SOAC Revenue Service Operation

After the opening day ceremonies are completed, the SOAC will go into revenue service and run as scheduled by the timetables in Appendix A.

During revenue service, the SOAC will be operated by SEPTA personnel and will be governed by SEPTA operations procedures as modified for the special SOAC operation. SOAC will operate in revenue service according to the schedule in Appendix A.

A security guard, supplied by Boeing Vertol, will provide security on board the cars during revenue operation. In the event of any emergency, the Emergency Standard Operating Procedure contained in Appendix B will be followed. In any situation requiring evacuation of passengers, the left-hand side ("B" side) of the SOAC front windshield can be opened to provide an emergency exit. The windshield is opened by releasing the two catches on the left of the windshield and then pushing out. The left windshield will lay back on the right windshield. During the SOAC Familiarization at SEPTA, emergency egress through the windshield will be demonstrated. A ladder will be carried on board the SOAC in the event it is necessary to evacuate passengers to the roadbed.

As indicated in the timetables, the SOAC will usually run from approximately 9:30 a.m. to 2:15 p.m. and 6:30 p.m. to 8:00 p.m. To accomplish this scheduled operation, the Boeing Vertol SOAC team will work in two shifts. The first shift will start at 8:00 a.m. and prepare the SOAC for running. This team will work through the 2:15 p.m. revenue service operation and will return to Fern Rock, completing their shift at approximately 4:00 p.m.

The second shift, a Boeing Vertol operations and maintenance team, will start at 2:00 p.m., coordinate maintenance and operations with the first shift, finish the days operations and complete their shift at 9:00 p.m. Maintenance will normally be performed between 2:30 p.m. and 5:30 p.m. A shift turnover log will be maintained by Boeing Vertol for both first and second shifts to account for all actions taken on the SOAC.

BOEING VERTOL SOAC TEAM

The crew and their functions are as follows:

Project Engineer - R. Line, Boeing Vertol: Overall project responsibility and focal point for all coordination with SEPTA. Alternate - W. Dunton.

Operations Team Leader - W. Cobb, Boeing Vertol: Responsible for assisting CTA during SOAC revenue operations. He will be responsible for coordinating train movements with SEPTA to the agreed schedule. He will be under the direction of the project engineer and be responsible for turnover log. Fulfills duties of project engineer in his absence. Alternate - B. Woodcock.

Maintenance Team Leader - G. Tuson, Boeing Vertol: Responsible for SOAC maintenance under direction of project engineer. Also functions as second shift operations team leader during revenue service.

Garrett Leadman - W. Byrne: Responsible for Garrett Corp. support personnel and equipment under direction of the Boeing Vertol project engineer. Coordinates all Garrett maintenance activities with Boeing Vertol maintenance team leaders.

Garrett Driver and Propulsion System Maintenance - G. Davis: Responsible for system maintenance and for interfacing with SEPTA motorman during operation of SOAC. He will be under the direction of Operations Maintenance Team Leader and Garrett Leadman.

Garrett System Maintenance - A. McIzzie and N. Karatsonyi: Responsible for system maintenance under the direction of Maintenance Team Leader and Garrett Leadman.

SEPTA PERSONNEL

SEPTA project manager is F. Mylnarsky. All SEPTA interface will be through him or through specific SEPTA personnel designated by him. In addition to the Boeing Vertol/Garrett SOAC team, SEPTA personnel will be on board the train any time the SOAC is operating over the SEPTA system. These personnel and their functions are as follows:

Line Supervisor - As designated by Superintendent of Transportation: Will have prime responsibility for operation of SOAC within the SEPTA system during the test and operational demonstration program.

Car Repairman: Will coordinate with Boeing Vertol and Garrett team leaders and will perform or cause to be performed any corrective actions required to move the train in the event of a SOAC breakdown. (Emergency procedures for corrective action are contained in Appendix B.)

The Boeing Vertol SOAC Demonstration Organization is shown in Figure 3.

SOAC REVENUE SERVICE DEMONSTRATION TEAM

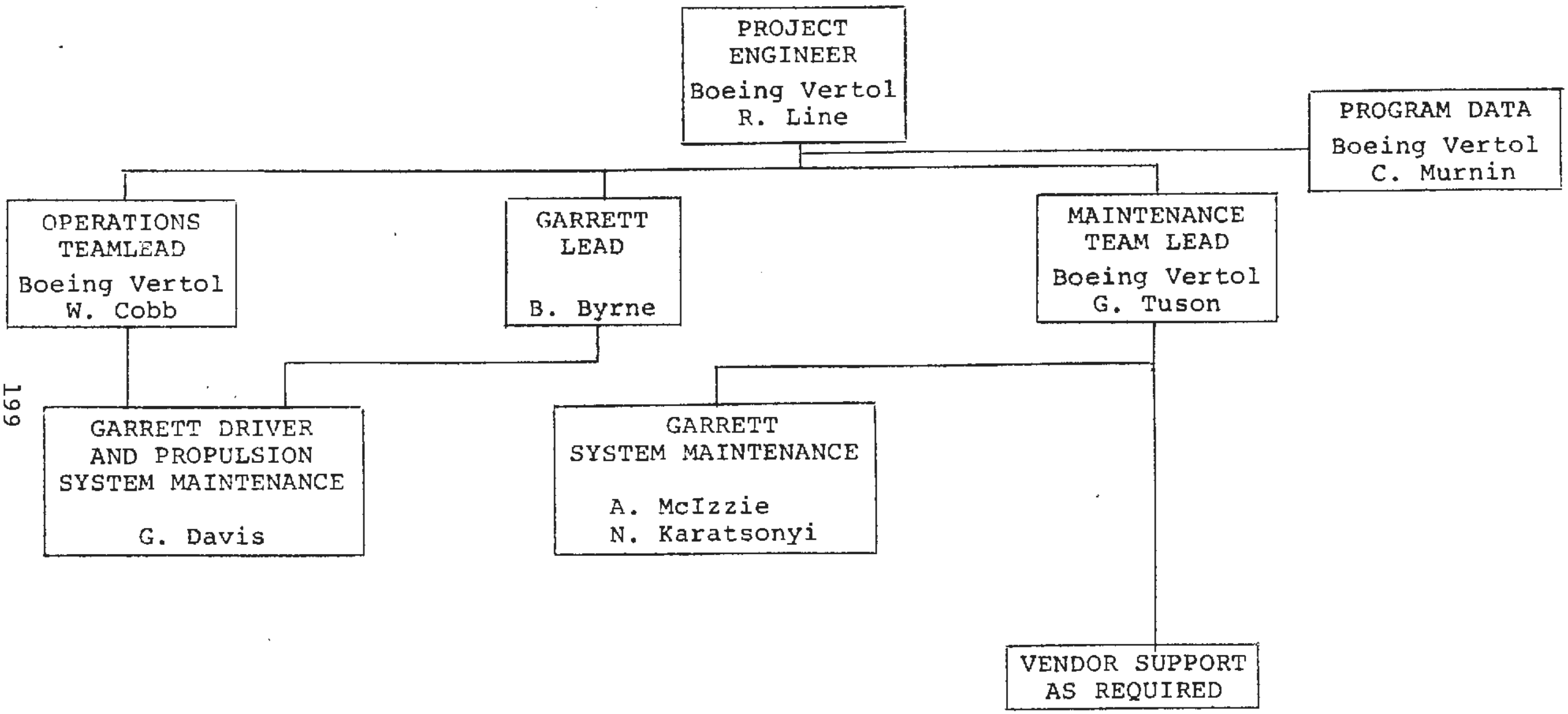


FIGURE 3

VII. MAINTENANCE

Included in this section are the SOAC Set-Up Procedures and Maintenance Plan. The Set-Up Procedures will be accomplished by the Boeing Vertol SOAC Maintenance Team upon arrival at the SEPTA Fern Rock Shop. Weekly and monthly maintenance checks will also be accomplished at this time. Three months, six months and yearly maintenance checks were accomplished prior to leaving the HSGTC in Pueblo, Colorado. As indicated, all maintenance will be performed at the direction and under the supervision of Boeing Vertol with manpower furnished as required by SEPTA. Inspection of critical systems (e.g., brakes, wheels, etc.) will be accomplished by SEPTA in the same manner as inspection of all other SEPTA equipment.

1. SOAC SET-UP AFTER TRANSIT TO SEPTA

After the SOAC cars arrive at the Fern Rock Shop, the following tasks will be accomplished by the SOAC maintenance crew supported by SEPTA personnel.

- Enter car through rear door and Set Hydraulic Handbrake.

- Remove protective cover from windshield.

- Check oil level in gear boxes. Add oil as necessary to bring level to five quarts (4 gear boxes).

- Remove insulation from battery cable and reconnect to battery. (Note: Check battery voltage, of voltage is below 30 V.D.C., recharge the batteries to 37 V.D.C. using portable charger.)

- Install brushes in traction motors (48 sets).

- Remove lockwire on two-way valve from brake pipe/ emergency to analog unit "A". Reset valve closing line. Lockwire handle in position.

- Remove lockwire on two-way valve from brake pipe/ emergency pipe to triple valve. Reset valve closing line. Lockwire handle in position.

- Remove lockwire on three-way valve from analog unit "B" to brake supply reservoir. Reset valve closing line. Lockwire handle in position.

- Remove lockwire on three-way valves from analog units "A" and "B" to wheel cylinders. Reset valves to open supply to wheel cylinders.

- Remove lockwire on angle cocks front and rear of car. Reset angle cocks, closing supply to couplers.

  (Note: Cars are now set-up for single car operation If cars are to be coupled in two car train, angle cocks on rear of car must be reset to open position.)

- Remove wire holding trip cocks in up position, allowing them to return to normal down position. Remove trip cock sealing plates. Relocate trip cocks to be compatible with SEPTA track trips.

- Remove shipping washers from Ross valve front and rear of car.

- Remove pressure relief valves from eight (8) each wheel cylinders and reinstall pipe plugs.

- Install third rail pick up assemblies.

- Install SEPTA train phone.

- Install Identra Coil Mount

The car is now ready for normal check out procedures prior to running on the property.

2. MAINTENANCE PLAN

DAILY

Operator (Typical, designates skill required to perform maintenance)
De-energized (Typical, designates car condition)
Air Compressor (Typical, designates system)
Check Oil Level, (Typical, designates action)

Operator
Energized
Radio/Communications
Check Operation

Operator
Energized
Wheel Brake Unit
Check for Correct Operation during Functional Test

WEEKLY

Operator
Energized
Brakes
Check the gap between brake shoe and wheel, 5/16 in. gap should be maintained. Check brake shoe for lining thickness. 1/2 in. minimum.

Mechanical
De-energized
Main Reservoir
Drain Reservoir of Water

MONTHLY

Mechanical
De-energized
Wheels
Inspect wheels for cracks, flat spots, spalls, wear high flange, thin flange, false flange, grooves, heat marks, elastomer condition, built-up tread, etc.

Air Diffusers
Inspect for loose, missing, broken parts, and hardware. Check adjustable vanes for freedom of movement.

Coupler
Lubricate coupler mechanism. Check filter for water, drain, inspect air lines for tightness, inspect electrical connections for security. Inspect electrical contacts.

MONTHLY (CONTINUED)

Mechanical
De-energized
Parking Brake
Check fluid level.

Air Compressor
Check oil level, check for oil leaks, check mounting for security, drain intercooler.

Gear Unit
Check oil level. Inspect for oil leakage.

Trucks
Inspect leveling valves for secure mounting and loose missing hardware.

Trucks
Inspect air bags for wear, chaffing, cuts or deflation.

Trucks
Inspect side bearing wear surfaces for wear or damage.

Inspect shock absorbers for secure mounting, loose, missing hardware and oil leaks.

Inspect bölster anchor rods for loose fittings and cracked, worn or aged rubber pads.

Air Conditioning
Clear or change air filters, grilles and screens.

Check compressor and compressor motor mounting bolts for tightness.

Check evaporator blower motor and condenser fan motor for secure mounting and free rotation.

Check evaporator blowers and condenser for tightness on their shafts and for free rotation.

Clean surface of condenser coil.

Mechanical
Energized
Carbody - Interior
Inspect interior for damage, loose missing parts. Inspect seats, carpet, walls, windows, doors for graffiti, damage, excessive soiling.

Mechanical
Energized
Door Operator
Inspect emergency handle for free operation. Check lock pawl operation. Check actuation of door lock

switch, inspect limit switches LS1, LS2, LS3, LS4, LS5, for adjustment and operating. Check operation of each door operator. Check operation of individual master key switch.

Check the following for proper operation signal, push buttons, screw, key switches, signal lights.

Air Conditioning

Operate the air conditioning units and check the oil and refrigerant levels. Inspect for oil leakage.

Electrical (CTA & CTS Only)

De-energized

Pantograph

Inspect carbon slide shoes for wear and condition, check condition of shunts.

3rd Rail Shoe

Inspect for wear contact shoe shunt assembly, check contact pressure.

Propulsion Control

Check, clean air filters. Check connectors as required, check for open/loose connections, broken components. Check operation of power contactors in auxiliary power unit by hand.

Motor-Alternator

Clean dirt from commutator covers and surrounding area. Remove covers and wipe dirt from brush holders and commutator banding. Inspect commutator for roughness, high, low, or flat spots, inspect motor alternator mountings for loose missing hardware.

Traction Motors

Inspect brush length, clean dirt from commutator covers and surrounding area, remove covers and wipe dirt from brush holders and commutator banding.

Inspect commutator for roughness, high or low spots, or flat spots. Inspect motor mountings for looseness, inspect motor leads for damage, deterioration.

Battery

Inspect battery fluid level. Clean battery as necessary.

Electrical

De-energized

Air Conditioning

Inspect control panel, clean surfaces of the terminal connections of any dirt fillings, etc.

Energized

Carbody - Interior

Inspect interior lights for operation. Check annunciator.

Carbody - Exterior
Inspect exterior lights for operation.

Propulsion Control
Check operation muffin fans.

Air Conditioning
Check operation of units.

3 MONTHS

Mechanical
De-energized
Brakes
Lubricate side lever suspension bolt, main lever fulcrum pin, and brake head, grease.

Electrical
De-energized
Temperature and Lighting Control
Inspect thermostat assembly for loose connections, clean dust from assemblies. Check panel components for security.

6 MONTHS

Mechanical
De-energized
Ventilation
Clean dust from ducts, heater elements, high voltage switches.

Pantograph
Lubricate all joints. Check contact pressure against wire. Check oil level in drive unit. Check length of drive rods.

Coupler
Lubricate coupler pneumatic system. Inspect internal wiring.

Gear Unit Coupling
Check alignment.

YEARLY

Mechanical
De-Energized
Door Operators
Inspect all mechanical connections, check all mounted

components for secure mounting, clean operator assemblies.

Electrical

De-energized

Door Operators

Inspect all electrical connections. Check motor field diode. Inspect all electrical panels for loose connections. Check for worn frayed wiring. Check diodes, clean, inspect 600 V panels. Check resistance to ground.

3. SOAC SET-UP FOR TRANSIT TO PATCO

At the completion of the SEPTA demonstration it is planned that the SOAC cars will be transferred to the PATCO line via the Ridge Avenue interchange. The cars will be driven to the interchange by SEPTA and turned over to PATCO.

The SOAC support car (box car) will be transferred to PATCO by railroad.

APPENDIX A

OPERATING SCHEDULE

APPENDIX A - OPERATIONS TIMETABLES

SOAC SCHEDULED OPERATION (LOCAL) WK #1 - #4306

BLOCK TYPE	YARD	LEAVE FERN-ROCK	ARRIVE CITY-HALL	ARRIVE PATTISON	LEAVE PATTISON	ARRIVE CITY-HALL	ARRIVE FERN-ROCK
SOAC	Y	9:40 AM	10:03^{3} AM	10:14^{3} AM	10:25^{2} AM	10:36^{2}AM	10:59 AM 17^{2}Mins LAYOVER
SOAC		11:17^{2}AM	11:41 AM	11:52 AM	12:03 PM	12:14 PM	12:36^{2}PM 18^{2} Mins LAYOVER
SOAC		12:55 PM	1:18^{2} PM	1:29^{2} PM	1:40 PM	1:51^{2} PM	2:14 PM YARD
SOAC	Y	6:33^{2} PM	6:56^{2} PM	7:07^{2} PM	7:11 PM	7:21^{2} PM	7:44 PM 19^{2} Mins LAYOVER
SOAC		8:03^{2} PM	8:26^{2} PM	8:37^{2} PM	8:41 PM	8:51^{2} PM	9:14 PM YARD

NOTE: Express service to events Weekday and Sat - Sun.
Motorman and Conductor (Crew) 9:00 AM to 3:00 PM
Motorman and Conductor (Crew) 6:00 PM to 10:00 PM

SOAC SCHEDULED OPERATION SATURDAY #4 - 4307

BLOCK TYPE	YARD	LEAVE FERN-ROCK	ARRIVE CITY-HALL	ARRIVE PATTISON	LEAVE PATTISON	ARRIVE CITY-HALL	ARRIVE FERN-ROCK
SOAC	Y	9:39 AM	10:02[1] AM	10:13[2] AM	10:32[2] AM	10:43 AM	11:06 AM 18 Min LAYOVER
SOAC		11:24 AM	11:47[1] AM	11:58[2] AM	12:17[2] PM	12:28 PM	12:51 PM 25[2] Min LAYOVER
SOAC		1:16[2] PM	1:39[2] PM	1:50[2] PM	2:10 PM	2:20[2] PM	2:44 PM 17[2] Min LAYOVER
SOAC		3:01[2] PM	3:24[2] PM	3:35[2] PM	3:55 PM	4:05[2] PM	4:29 PM YARD

NOTE: Motorman and Conductor (Crew) 9:15 AM to 5:15 PM

APPENDIX B

SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

Emergency Procedure SE1

Persons in Subway-Elevated Track Areas

TO ALL EMPLOYES:

I. Immediate Safety Precaution

All employes becoming aware of a person in the track area will immediately provide for the person's safety as follows:

First STOP TRAINS by running down the platform or footwalk waving a red flag provided, or any object, or the arms.

Time is essential - to avoid delay, employe can usually stop a train fastest by doing it himself, avoiding communications delays and misunderstandings.

Second CUT POWER after trains are stopped by calling Train Dispatcher and requesting power to be shut off in the usual manner.

Third Assist person out of the danger area.

II. Standard Rule No. 124 remains in effect except insofar as the above paragraph I establishes priority for action.

Rule 124: Trespassing on Tracks

(a) Unauthorized persons are not permitted on footwalks or tracks.

All persons found on footwalks or track areas, including local and express tracks and in yard areas, not recognized as authorized employés must be requested to leave property immediately. Occurrence must be reported to Train Dispatcher, giving name, and employer of trespassers, if obtainable.

(b) When unauthorized persons are walking on footwalks or tracks, trainmen shall make every effort possible to protect them from injury, and must stop the train, pick up persons and carry them to the next station. Confused persons and those under influence of intoxicants and unable to take care of themselves, shall be kept on the train until they can be turned over to a stationman, porter, supervisor, or other responsibile person.

(c) A red flag for emergency use is located near the center of all station platforms which may be placed at the edge of platform by passengers, stationmen, cashiers or other persons to flag trains when unauthorized persons are in the track, or in other emergencies.

After train has been flagged, employe shall notify Train Dispatcher. Cashier shall request passengers or any available person to wave flag across track from edge of platform to stop train. If no other person is available, cashier shall leave booth and flag train as described above. Motorman shall stop train immediately when such as signal id displayed and shall telephone Train Dispatcher for instructions.

Employes shall familiarize themselves with the location of emergency flag hung near the center of all station platforms.

(d) Employes must submit written reports of all such incidents to the Superintendent.

H. AIKENS

General Superintendent-Transportation

SAFETY IN STARTING

(a) Motorman must not start train after making station stop without receiving the proper light, buzzer, hand, or lantern signal.

(b) When a train has been stopped for any reason whatsoever, excepting a normal station or signal stop, the motorman will not start train until he is assured that all persons and material are clear of train and he has called for and received a proceed buzzer signal from his conductor in accordance with the following procedure:

(1) Motorman will signal the conductor requesting starting signal by giving one (1) short whistle blast.

(2) Conductor will signal the motorman to proceed by giving two (2) buzzer signals.

When a train is delayed by brake or control trouble the conductor must remain in his cab prepared to give assistance to Motorman, should such assistance be required.

(c) Immediately before closing doors, conductor must call out "Watch the Doors".

Should it become necessary to re-open doors after both sections have been closed, and before train has started, conductor must open conductor's emergency valve before re-opening doors. Trainmen operating doors must make certain that everything is clear by looking along the outside of train as it starts, and should it be unsafe to proceed, train must be stopped immediately by use of conductor's emergency valve.

(d) If a conductor's red pilot light remains lighted after toggle switches are set for doors to close, conductor must exit thru center door by using key, leave center door open and take key with him, go to car where pilot light is still burning and before giving motorman signal to proceed, must make certain that all doors are closed sufficiently for safe operation. If the door cannot be closed to a safe position, conductor must place a responsible person in position to guard the door opening before proceeding.

(e) In the event of a train line air obstruction, a member of crew of train must operate on either side of point of obstruction.

REGULATION OF SPEED

(a) Passenger trains must stop at all stations except as otherwise directed by timetable, train order or a responsible employe. Trains which do not stop at stations must reduce speed when passing station platforms.

(b) Motormen shall operate trains at normal speed between station stops except when it is necessary to reduce speed in accordance with operating signs, block signal indications, flag, lantern, banner or hand signals, or under following conditions:

When view of the track is obscured by fog, snow, smoke, etc., motorman must reduce speed of train so that he can stop with a service brake application within range of his vision.

When operating without block signal protection; whenever motorman is in doubt as to safety of normal speed operation; or when directed by a responsible employe, motorman must reduce speed of train.

(c) When trains are behind schedule time, reasonable efforts consistent with safe operation shall be made to re-establish schedule.

STATION STOPS

(a) Motormen must stop front of train at proper station stop marker in accordance with length of train. Motormen must assure themselves at all times as to the number of cars in the train, in order that proper station stops may be made.

(b) Should train stop short, or overrun station, and motorman is not certain that all doors are on the platform, he must use foot switch to prevent conductor from opening doors until train is moved to proper position on platform. If reverse movement is necessary, motorman must give three long blasts of whistle before backing train and conductor must repeat this signal.

(c) In the event of train stopping short or overrunning the station, conductor must make certain that it is absolutely safe to open doors.

SAFE OPERATION

(a) Conductors must see that all doors are closed before trains depart from terminals or yards.

(b) DOOR DRUM SWITCHES MUST NOT BE CHANGED WHILE DOORS ARE OPEN, NOR WHILE TRAIN IS IN MOTION ON THE LINE.

(c) Motorman must not start train while cars are being cut off or added on until the proper signal has been given by the yardman, and the buzzer signal received from the conductor.

(d) When changing ends, motorman must make a pneumatic service brake application before leaving cab and shall release brakes at the end from which train will be operated.

(e) When operating from a new cab for the first time, or when any change in train makeup has been made, motorman must immediately test motorman's foot switch in accordance with instructions.

(f) Motormen must not permit trains to drift with the reverse lever in center or removed from the controller.

(g) Motormen must not stop train by reversing motors except in cases of emergency.

(h) When flood water covers the top of running rail, motormen must bring trains to a stop before entering flooded track area and Train Dispatcher for instructions unless otherwise ordered by a responsible employe.

COIL AND MARKER SETTINGS

SOAC trains must be equipped with a coil - on the forward end of train only - set according to TYPE shown on trip sheets. MARKERS and destination signs must correspond to type shown.

NB or SB TYPE (set coil)	" SET " MARKERS	TYPE OF SERVICE	DESTINATIONS
A	White	Broad Local	Fern-Rock - Pattison
B	Green	Broad Exp.	Fern-Rock - Pattison (skip Allegheny, Dauphin Columbia, Fairm't)

EMERGENCY TELEPHONE DIRECTORY

Telephone Numbers to be Called to Report Emergency, Including Fire and Smoke

CALLS TO DISPATCHER	S E P T A AUTOMATIC	BELL SYSTEM OUTSIDE	EXTENSION
Emergency Train Dispatcher	2781	DA 9-1333	266
Emergency Surface Dispatcher	2721	DA 9-9400	266
Emergency Power Dispatcher	2621	DA 9-9626	266
CALLS TO FIRE DEPARTMENT			
Direct to Fire Radio	2500	LO 3-6700	-
CALLS TO POLICE DEPARTMENT			
Direct to Police Radio	2701	911	-
Transit Police Unit (Concourse Area)	2738	-	-

GENERAL CALLS

For general call to Authority Offices and separtments from outside, Bell Phone - DA 9-4000

APPENDIX C

SEPTA RESPONSIBILITY

TECHNICAL AND SEMI-TECHNICAL PRESENTATION

The SOAC Technical and Semi-technical presentation will be held at the SEPTA Board Room, 200 W. Wyoming Avenue. Attendance of this presentation will be determined by Mr. A. R. Wunsch.

SAFETY BRIEFING

Safety briefing will be given by Mr. E. Rudisill (Transportation Dept.), Mr. C. Griffin (Facilities Dept.) and Mr. W. Griffin (B. S.&S. Dept.) to the Boeing Vertol SOAC Team.

These briefings will cover safety rules and regulations for the entire B.S.S. System, including operational safety instructions.

MAINTENANCE

All maintenance will be performed at the direction and and under the supervision of Boeing Vertol, with manpower furnished, as required, by Mr. J. Wiesinger - Shop Superintendent (Fern Rock).

Inspection of critical systems (e.g., brakes, wheels, etc.), will be accomplished by Shop Superintendent (Fern Rock) in the same manner as inspection of all other B.S.S. equipment.

APPENDIX III

REVENUE SERVICE SCHEDULES

New York City Transit Authority

Massachusetts Bay Transportation Authority

Cleveland Transit System

Chicago Transit Authority

Southeastern Pennsylvania Transportation Authority

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NEW YORK CITY TRANSIT AUTHORITY

A LINE - S.O.A.C. DAILY - SAT. - SUN.

207TH ST.		125ST	59-ST	42-8	W.4ST	JAY	EUCLID AVE.		FAR R	LEFFERTS BL		FAR R	EUCLID AVE.		JAY	W.4ST	42-8	59-ST	125ST	207ST
ARRVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	ARRVE	LEAVE	ARRVE	ARRVE	LEAVE	LEAVE	ARRVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	ARRVE
-------DAILY S.O.A.C. TRAIN-------																				
P	951	1005	1012	1014	1020	1030		1050		1059	1127			1136	1157	1205	1212	1214	1221	1235
1235	111	125	137	134	140	150		210		219	245			254	315	324	330	332	339	353L
-------SATURDAY S.O.A.C. TRAIN-------																				
P	955	1009	1016	1018	1024	1033		1054	1124			1139		1209	1230	1239	1245	1247	1254	108
103	145	159	205	200	214	223		214		253	310			319	340	349	355	357	404	410L
-------SUNDAY S.O.A.C. TRAIN-------																				
P	951	1005	1012	1014	1020	1029		1050		1059	1136			1145	1206	1215	1221	1223	1230	1244
1244	139	153	200	202	208	217		230	300			327		357	418	427	433	435	442	456L

NEW YORK CITY TRANSIT AUTHORITY
S O A C
E LINE DAILY - SAT. - SUN.

179TH ST.		CONTL	QU.PL	42-8	W.4ST	HUDSON	TURN	W.4ST	42-8	QU.PL	CONTL	179ST
ARRVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	ARRVE	LEAVE	LEAVE	LEAVE	LEAVE	LEAVE	ARRVE
						-DAILY-						
P	944	956	1008	1019	1025	1030	1037	1042	1048	1059	1111	1123
1123	1134	1146	1158	1209	1215	1220	1227	1232	1238	1249	101	113
113	154	206	218	229	235	240	247	252	258	309	321	333
						-SAT.-						
P	947	959	1011	1022		1003	1040		1051	1102	1114	1126
1126	1137	1149	1201	1212		1223	1230		1241	1252	104	116
116	157	209	221	232		243	250		301	312	324	336
						-SUN.-						
P	944	956	1008	1019		1030	1040		1051	1102	1114	1126
1126	1144	1156	1208	1219		1230	1240		1251	102	114	126
126	200	220	232	243		254	304		315	326	330	350

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NEW YORK CITY TRANSIT AUTHORITY

"D" LINE

SOAC TEST-TRAIN FOR DAILY, SAT, & SUN

STILLWELL ARRVE	STILLWELL LEAVE	DOC ARRVE	DOC LEAVE	KHWY LEAVE	PPK LEAVE	DKLB LEAVE	W4 LEAVE	59ST LEAVE	125ST LEAVE	BDFD LEAVE	205TH STREET ARRVE	205TH STREET LEAVE	BDFD LEAVE	125ST LEAVE	59ST LEAVE	W4 LEAVE	DKLB LEAVE	PPK LEAVE	KHWY LEAVE	DOC ARRVE	STILLWELL ARRVE	STILLWELL LEAVE
									-------------- DAILY --------------													
			P 947	952	1001	1006	1020	1030	1037	1057	1059	1128	1130	1150	1157	1107	1219	1226	1235	1238		
		1238	137	142	151	158	210	220	227	247	249	309	311	331	338	348	400	407	416	421 L		
									-------------- SATURDAY --------------													
P	948		953	959	1011	1018	1030	1040	1047	1107	1109	1133	1135	1155	1202	1212	1224	1231	1243	1249	1254	
1254	148		153	159	211	218	230	240	247	307	309	323	325	345	352	402	414	421	433	439	444 L	
									-------------- SUNDAY --------------													
P	948		953	959	1011	1018	1030	1040	1047	1107	1109	1126	1128	1148	1155	1205	1217	1224	1236	1242	1247	
1247	148		153	159	211	218	230	240	247	307	309	326	328	348	355	405	417	424	436	442	447 L	

NEW YORK CITY TRANSIT AUTHORITY
"N" SEA BEACH LINE
(SOAC TEST TRAIN)

	57TH ST.		STILLWELL		57TH ST.		STILLWELL		57TH STREET		STILL	
LEAVE	ARRIVE	LEAVE	ARRIVE	LEAVE	ARRVE	LEAVE	ARRVE	LEAVE	ARRVE	LEAVE	ARRVE	
DAILY												
921	1008	1024	1111	1131	1218	1234	(121	201)	248	304	351	
SATURDAY												
917	1003	1014	1101	1127	1213	1224	(111	157)	243	254	341	
SUNDAY												
918	1006	1022	1110	1130	1218	1234	(122	206)	254	310	358	

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

STATE OF THE ART CAR - DEMONSTRATION DATES AND LINES

Dates	Lines	Day of Week
Aug. 20 & 21	Quincy-Harvard	Tues.-Wed.
" 22 & 23	Ashmont-Harvard	Thu-Fri.
" 25	South Shore only-"Jimmy Fund"	Sunday
" 26 & 27	Quincy-Harvard	Mon.-Tue.
" 28 & 29	Ashmont -Harvard	Wed.-Thu.
" 30	Quincy-Harvard	Fri.
Sept. 1 & 2	Sunday Schedule	Sun.-Mon.
" 3	Quincy-Harvard	Tue.
" 4 & 5	Ashmont-Harvard	Wed.-Thu.
" 6	Quincy-Harvard	Friday
" 8	Sunday Schedule	Sunday
" 9 & 10	Ashmont-Harvard	Mon.-Tue.
" 11 & 12	Quincy-Harvard	Wed.-Thu.
" 13	Ashmont-Harvard	Friday
" 14	Rail Club ?	Saturday

Number of Days on Each Line (Mon.-Thu.-Fri.)

Quincy-Harvard	Ashmont-Harvard
9	9

Note: Sundays divided between both lines

Total: Revenue operating days proposed

21 full days
1 special - Jimmy Fund
22 Total

R. M. Caddigan
Supt., Rail Lines

RMC:mkc
8-22-74

SPECIAL NOTICE

TO

ALL PERSONNEL OF THE RAPID TRANSIT DIVISION
AND ASSOCIATED SURFACE LINES DIVISIONS

RE: THE STATE OF THE ART CAR - REVENUE DEMONSTRATIONS ON THE RED LINE EFFECTIVE TUESDAY, AUGUST 20, 1974

The following is the proposed schedule concerned with the operation of the State of the Art Car on the Red Line. The schedules, as posted, will be adhered to unless unforeseen circumstances arise. Station personnel should be kept informed of any changes so that the general public will not be inconvenienced.

The State of the Art Cars will alternate, every two days, Monday through Friday, between Harvard and Quincy and Harvard and Ashmont. The first two days will be on the Harvard and Quincy line.

Routes 933 and 934 - 933 Harvard to Quincy, 934 Quincy to Harvard.

933 - Leave Harvard		10:08AM	11:12AM	12:16PM	1:20PM	2:24PM	Lay up Quincy
934 - Leave Quincy	9:37A	10:41AM	11:45AM	12:49PM	1:53PM		
933 - Leave Harvard		6:24PM	7:28PM	8:35PM	Deadhead to Cabot Center		
934 - Leave Quincy	5:54P	6:54PM	8:03PM				

Routes 931 and 932 - 931 Harvard to Ashmont, 932 Ashmont to Harvard

931 - Leave Harvard		10:04AM	11:08AM	12:12PM	1:16PM	2:20PM	Lay up at Codman
932 - Leave Ashmont	9:33AM	10:37AM	11:41AM	12:45PM	1:49PM		
931 - Leave Harvard		6:36PM	7:40PM	8:45PM	Deadhead to Cabot Ctr		
932 - Leave Ashmont	6:04PM	7:06PM	8:10PM				

RE: STATE OF THE ART CAR - REVENUE DEMONSTRATIONS ON THE RED LINE EFFECTIVE TUESDAY, AUGUST 20, 1974

SUNDAY'S SCHEDULES

Leave Harvard		9:40AM	10:40AM	11:40AM		
Leave Ashmont	9:10AM	10:10AM	11:10AM	12:10PM	Off at Harvard Store head of track #8	
Leave Harvard	1:48PM	2:48PM	3:48PM	4:48PM	5:48PM 6:48PM / 7:53PM Deadhead to Cabot	
Leave Quincy	2:18PM	3:18PM	4:18PM	5:18PM	6:18PM	7:18PM

Note: Sunday schedules subject to change for special functions.

Note: Train Starters and Yardmasters. Whenever the SOAC train comes off the road either for relief or to Cabot Center a two-or four-car relay must be available to fill in the schedule with the scheduled crews. During the scheduled operating periods the scheduled crews will be on board the SOAC and will pick up their scheduled runs when it comes off.

All moves into or out of Cabot Center must be coordinated with Central Control.

All speed restrictions must be adhered to at all times and movements over all bridges must be coordinated with Central Control

R. M. Caddigan
R. M. Caddigan
Supt., Rail Lines

RMC:mkc

August 21, 1974

CLEVELAND TRANSIT SYSTEM

DEMONSTRATION DATES

Oct. 25	Revenue Service
26 & 27	Weekend - Not Scheduled
28	Revenue Service
29	Revenue Service
30	Revenue Service
31	Revenue Service
Nov. 1	Revenue Service
2	Rail Fan Trip
3 - 21	Out-of-Service, Axle Modification
22	Revenue Service
23 & 24	Weekend - Not Scheduled
25	Revenue Service
26	Revenue Service
27	Revenue Service
Oct. 28 - Dec. 1	Not Scheduled - Thanksgiving Holidays
Dec. 2	Not Scheduled - Snowstorm
3	Revenue Service
4	Revenue Service
5	Revenue Service
6	Not Scheduled - Awaiting Parts
7 & 8	Weekend - Not Scheduled
9	Revenue Service
10	Revenue Service

CLEVELAND TRANSIT SYSTEM

SOAC SCHEDULE

RAPID TRANSIT - WESTBOUND

BLOCK NO.	LV WIND.	LV C.U.T.	WEST PK.	ARR. BROOKPARK	ARR. AIRPORT
5	829	845	859	905	908
5	1009	1024	1037	1042	1045
5	1139	1154	1207	1212	1215
5	109	124	137	142	145
5	236	252	306	312	315
55X	411	427	441	447	450
55X	544	600			

RAPID TRANSIT - EASTBOUND

BLOCK NO.	LV AIRPORT	LV BROOKPARK	LV WEST PK.	ARR. C.U.T.	ARR. WIND.
5	920	923	928	941	957
5	1052	1055	1100	1113	1128
M5	1222	1225	1230	1243	1258
5M	152	155	200	213	228
5M	322	325	331	345	401
55X	459	502	508	522	538
55X				609	625

RUN	EQUIPMENT	HOWARD LEAVE	DEMPSTER ARRIVE	DEMPSTER LEAVE	EQUIPMENT	HOWARD ARRIVE	HOWARD LEAVE
529	CTA	9:10 A	9:17½A	Howard St. Extra Switchman D. H. to Skokie Shop P.U. Soac Leave Skokie with aid of Skokie Switchman and bring SOAC to Dempster. From there L.U. CTA Car at Howard Street THEN:			
30N526	CTA	9:25AM	9:32½A	9:28AM 9:43AM	SOAC CTA	9:35AM 9:50AM	9:40AM 9:55AM
529	SOAC	9:40AM	9:47½A	9:58AM	SOAC	10:05½AM	10:10AM
526	CTA	9:55AM	10:02½A	10:13AM	CTA	10:20½AM	10:25AM
29N527	SOAC	10:10AM	10:17½A	10:28AM	SOAC	10:35½AM	10:40AM
526	CTA	10:25AM	10:32½A	10:43AM	CTA	10:50½AM	10:55AM
527	SOAC	10:40AM	10:47½A	10:58AM	SOAC	11:05½AM	11:10AM
526	CTA	10:55AM	11:02½A	11:13AM	CTA	11:20½AM	11:25AM
527	SOAC	11:10AM	11:17½A	11:28AM	SOAC	11:35½AM	11:40AM
526	CTA	11:25AM	11:32½A	11:43AM	CTA	11:50½AM	11:55AM
527	SOAC	11:40AM	11:47½A	11:58AM	SOAC	12:05½PM	12:10PM
526	CTA	11:55AM	12:02½PM	12:13PM	CTA	12:20½PM	12:25PM
527	SOAC	12:10PM	12:17½P	12:28PM	SOAC	12:35½PM	12:40PM
526	CTA	12:25PM	12:32½P	12:43PM	CTA	12:50½PM	12:55PM
527	SOAC	12:40PM	12:47½P	12:58PM	SOAC	1:05½PM	1:10PM
26N534	CTA	12:55PM	1:02½P	1:13PM	CTA	1:20½PM	1:25PM
[illegible]N535	SOAC	1:10PM	1:17½P	1:28PM	SOAC	1:35½PM	1:40PM
534	CTA	1:25PM	1:32½P	1:43PM	CTA	1:50½PM	1:55PM
535	SOAC	1:40PM	1:47½P	1:58PM	SOAC	2:05½PM	2:10PM

CHICAGO TRANSIT

AUTHORITY

RUN	EQUIPMENT	HOWARD LEAVE	DEMPSTER ARRIVE	DEMPSTER LEAVE	EQUIPMENT	HOWARD ARRIVE	HOWARD LEAVE
534	CTA	1:55PM	2:02½PM	2:13PM	CTA	2:20½PM	2:25PM
535	SOAC	2:10PM	2:17½PM	2:28PM	SOAC	2:35½PM	2:40PM
534	CTA	2:25PM	2:32½PM	2:43PM	CTA	2:50½PM	2:55PM
535	SOAC	2:40PM	2:47½PM	2:58PM	SOAC	3:05½PM	3:10PM

Extra Switchman will relieve Crew and D.H. with SOAC train to Skokie Shops.

Howard St. Yard Foreman will see that a CTA Car or Articulated unit is P.O. by Switchman for Run 535 the 3:10PM interval to Dempster Skokie.

STATE-OF-THE-ART CAR

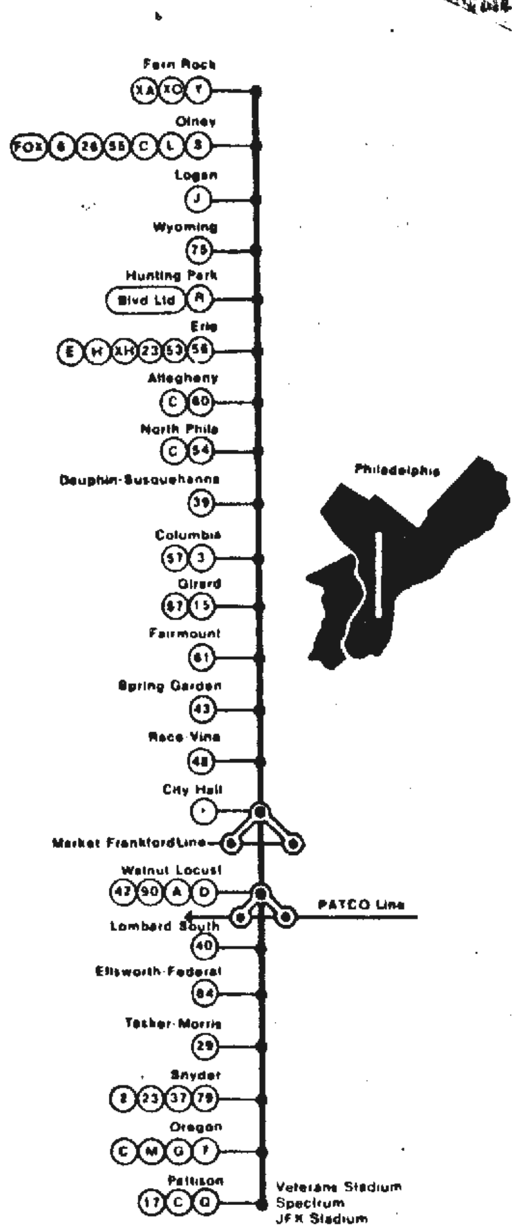
SOUTHBOUND

Leave Fern Rock	Olney Ave.	Erie Ave.	Girard Ave.	City Hall	Pattison Ave.
MONDAY thru FRIDAY					
AM	AM	AM	AM	AM	AM
9.40	9.43	9.50	9.58	10.03	10.14
11.17	11.21	11.28	11.36	11.41	11.52
PM	PM	PM	PM	PM	PM
12.55	12.58	1.05	1.13	1.18	1.29
6.33	6.37	6.44	6.51	6.56	7.07
8.03	8.07	8.14	8.21	8.26	8.37
SATURDAY					
AM	AM	AM	AM	AM	AM
9.39	9.42	9.49	9.57	10.02	10.13
11.24	11.27	11.34	11.42	11.47	11.58
PM	PM	PM	PM	PM	PM
1.16	1.20	1.27	1.34	1.39	1.50
3.01	3.05	3.12	3.19	3.24	3.35

NORTHBOUND

Leave Pattison Ave.	City Hall	Girard Ave.	Erie Ave.	Olney Ave.	Fern Rock
MONDAY thru FRIDAY					
AM	AM	AM	AM	AM	AM
10.25	10.36	10.41	10.48	10.55	10.59
PM	PM	PM	PM	PM	PM
12.03	12.14	12.19	12.26	12.33	12.36
1.40	1.51	1.56	2.04	2.10	2.14
7.11	7.21	7.26	7.33	7.40	7.44
8.41	8.51	8.56	9.03	9.10	9.14
SATURDAY					
AM	AM	AM	AM	AM	AM
10.32	10.43	10.48	10.55	11.02	11.06
PM	PM	PM	PM	PM	PM
12.17	12.28	12.33	12.40	12.47	12.51
2.10	2.20	2.25	2.32	2.40	2.44
3.55	4.05	4.10	4.17	4.25	4.29

Additional weekday SOAC trips will be scheduled to sports events at the Spectrum.



SOAC

STATE-OF-THE-ART CAR

Call

DA 9-4800

for complete SEPTA information

APPENDIX IV

TRANSPORTATION STUDY - RIDER QUESTIONNAIRE

Chilton Research Services
Philadelphia, Pennsylvania

Int. #________ (1-3)

CRS Job #8353
OMB # 04-573023
Date June, 1974

TRANSPORTATION STUDY - RIDER QUESTIONNAIRE

INTRODUCTION: Good____________, my name is________________________calling for Chilton Research Services in Philadelphia, Pennsylvania. We are doing a marketing research survey for the U. S. Department of Transportation and would like to ask you a few short questions regarding the subject of transportation.

Time Int. Began________A.M.________P.M.

Time Int. Ended________A.M.________P.M.

1. A few days ago, you were kind enough to give our representative your name while on board the new car running the ___(LINE)___. About how many times would you say you rode in the new car since it has been on that line?

		4-
ASK Q. 2	Once	1
SKIP TO Q. 3	Twice	2
	Three times	3
	Four times	4
	Five or more times (SPECIFY)________	5
TERMINATE IF SURE YOU HAVE LISTED RESPONDENT	None. No knowledge of new car	6

2. Did you sit during your trip; stand during your trip, or both sit and stand?

		5-
SKIP TO Q. 4	Sat	1
	Stood	2
	Both	3

3. Since you have ridden the car more than once, I would like to know if you sat or stood during the trip. Did you sit during all your trips, stand during all your trips, or both sit and stand during your trip?

	6-
Sat	1
Stood	2
Both	3

4. I'm going to read a list of items having to do with various aspects of the new car you were in while riding the (READ LINE). I would like you to tell me how favorable or unfavorable you feel about each item. If you still have the card our representative gave you the other day while on the car, it would help to have it in front of you while we discuss these points. (ENCOURAGE RESPONDENT TO OBTAIN CARD IF IT IS STILL AVAILABLE.

Here's how the ratings work. If you have a favorable impression of the item, you will pick a number from +100 for extremely favorable to +1 for just slightly favorable. If you have an unfavorable impression of the item, you will pick a -100 for extremely unfavorable to a -1 for just slightly unfavorable.

Now, with +100 being the most favorable rating and -100 being the most unfavorable rating, how would you rate (READ ITEM WITH CHECKMARK TO LEFT) for the new car you recently rode on? (RATE EVERY ITEM)

	ITEMS		RATING
1.	(IN OCTOBER THROUGH MARCH) The temperature of the car during cold weather	(7-9)	
2.	(IN JUNE THROUGH SEPTEMBER) The temperature of the car during hot weather	(10-12)	
3.	How fresh the air in the car is	(13-15)	
4.	How safely built the equipment or car is so as not to contribute to accidents	(16-18)	
5.	Having to ride in seats facing backwards	(19-21)	
6.	Having to ride in seats facing forward	(22-24)	
7.	Having to ride in seats facing sideways	(25-27)	
8.	Having a pole to hold on to while standing	(28-30)	
9.	Having to stand without anything to hold on to	(31-33)	
	REMEMBER +100 to +1 ARE THE FAVORABLE RATINGS AND -100 to -1 ARE THE UNFAVORABLE RATINGS. NOW, HOW WOULD YOU RATE:		
10.	The arrangement and size of the doors for getting in and getting out of the car	(34-36)	
11.	How the windows are placed for seeing out while standing	(37-39)	
12.	How the windows are placed for seeing out while sitting	(40-42)	
13.	The fact that the glass in the windows was tinted	(43-45)	
14.	The brightness of the lights in the cars for reading	(46-48)	
15.	The fact that there is carpeting on the floor	(49-51)	
16.	The use of bright colors inside of the car	(52-54)	
17.	The level of noise from the train when one is riding inside the car	(55-57)	
18.	The ride of the car in regard to start and stop jerks	(58-60)	

REMEMBER +100 to +1 ARE THE FAVORABLE RATINGS AND
-100 to -1 ARE THE UNFAVORABLE RATINGS. NOW, HOW WOULD YOU RATE:

ITEMS	RATING
19. The ride of the car in regard to side-to-side motion (61-63)	
20. Having to pay an extra 5 cents to ride this type of car (64-66)	

(CHECK BACK TO Q. 1. IF RESPONDENT RODE THE CAR MORE THAN ONCE, READ THE FOLLOWING STATEMENT BEFORE RATING ITEMS 21 to 27. IF RODE ONLY ONCE, GO DIRECTLY TO ITEM 21). 80-1

END CARD 1

Since you have ridden this train more than once, we would like you to evaluate these next 7 statements for only the car you were in when we obtained your name and address. According to our records, that would be the (DESCRIBE CAR).

21. How close the people have to sit together (4-6)	
22. The width of the aisle (7-9)	
23. The leg-room when one is sitting in the car (10-12)	
24. The materials the seats are made of (13-15)	
25. The padding of the seats (16-18)	
26. The overall comfort of the seats (19-21)	
27. Having a hand-hold on the back of the seat to hold on to while standing (22-24)	

REMEMBER +100 to + 1 ARE THE FAVORABLE RATINGS AND -100 to -1 ARE THE UNFAVORABLE RATINGS. HOW WOULD YOU RATE:

Now, I'd like to ask just a couple short questions about the new car you rode in.

5. Under normal use, do you think these cars will show dirt more, less, or about the same as the cars that run regularly? (CIRCLE APPROPRIATE CODE)

	25-
More	1
Less	2
About the same	3
Don't know	4

6. Would you say the tinting of the windows is too dark, too light, or just about right?

	26-
Too dark	1
Too light	2
About right	3
Don't know	4

7. Do you think that the fare you are now paying for public transportation covers the entire cost of the ride?

27-

Yes	1
No	2
Don't Know	3

8. Do you feel that the federal government should help to pay for purchases of new equipment?

28-

Yes	1
No	2
Don't Know	3

9. Do you feel that the government should give money to transportation companies so as to keep fares down?

29-

Yes	1
No	2
Don't Know	3

10. If you had your choice, which of the following would you pick: (READ)

30-

A car with less seats but ample entry and exit	1
OR	
A car with more seats but restricted entry and exit	2

D.K V

11. Suppose you were a designer and you were going to design the elevated or subway car of the future. We want to know how much importance you will attach to certain parts of the car you will design. Now, to do this, I'm going to read you a list of items and you tell me how important each item is by using any number from zero to 100. If the item is extremely important, you pick a number at or near 100. If the items is of very little or no importance, you pick a number at or near zero. And you can pick any number between 100 or 0. Remember, for each item I am going to read, tell me how important it is to you when designing this new car. Now, with 100 being very important and 0 being not at all important, how important is: (READ FIRST STATEMENT)?

ITEMS		RATING
1. The cleanliness of the inside of the cars	(31-33)	
2. The cars having the right temperature during hot weather	(34-36)	
3. The overall comfort of the seats	(37-39)	
4. If you have to stand, having something to hold on to	(40-42)	
5. Being able to see out the windows while sitting	(43-45)	
6. A low level of noise from the train when one is riding inside the car.	(46-48)	

Now, I have just a few questions for classification purposes

A. Do you or your family have an automobile?

49-

	Yes	1
SKIP TO Q. C	No	2

B. (IF "YES") How many automobiles do you or your family have?

50- ____________

C. Are you, yourself, a licensed driver?

51-

Yes	1
No	2

D. To which of the following is your major commuting? (READ LIST)

52-

Work	1
Shopping	2
School	3
Some other (SPECIFY)	4

E. How do you usually commute to (READ ABOVE ANSWER)? (IF MORE THAN ONE, CIRCLE CODES FOR AS MANY AS APPLY)

53-

Car	1
Bus	2
Trolley/Street Car	3
Rapid Transit (Subway or Elevated)	4
Commuter Train	5
Walk	6
Taxi	7
Other (SPECIFY)	8

F. About how long does this trip usually take, going one way only?

____________ Minutes

(54-56)

G. How frequently during the average month do you use the following types of transportation? (READ LIST AND RECORD)

	Times per month	Never
City Buses (57-58)		00
Commuter trains (59-60)		00
Subway or elevated (61-62)		00
Trolley cars (63-64)		00

H. What is your occupation? 65-

______________________________ 66-

I. Into which of the following groups does your age fall? (READ LIST)

	Under 20	1
	20 to 29	2
	30 to 39	3
	40 to 49	4
	50 to 64	5
	65 or older	6
DO NOT READ	Not determined	7

J. Finally, into which of the following categories did your family's total income for 1972 fall before taxes? (READ LIST)

67-

	Under $5,000	1
	$5,000 but less than $10,000	2
	$10,000 but less than $15,000	3
	$15,000 but less than $20,000	4
	$20,000 but less than $25,000	5
	$25,000 or over	6
DO NOT READ	Not determined	7

K. Record sex: 68-

Male	1
Female	2

INTERVIEWER RECORD FOLLOWING INFORMATION FROM CARD:

L. Time of trip:

	69-
6 A.M. to 9 A.M.	1
9:01 A.M. to 4 P.M.	2
4:01 P.M. to 6 P.M.	3
After 6 P.M.	4

M. Crowd conditions of car:

	70-
Less than 1/2 seats occupied	1
More than 1/2 seats occupied but no one standing	2
Just a few standing	3
Many people standing	4

N. Length of trip:

	71-
Less than 5 minutes	1
5 to 15 minutes	2
Over 15 minutes	3

O. Car respondent was in:

	72-
Car with tables	1
Car without tables	2

P. City in which interview was conducted:

	73-
Boston	1
Chicago	2
Cleveland	3
New York	4
Philadelphia	5

Respondent's Name ______________________________

Telephone # ______________________________ 80-2

END CARD 2

Interviewer's Name ______________________ Date ______________

APPENDIX V

TRANSPORTATION STUDY-GENERAL SURVEY QUESTIONNAIRE

Chilton Research Services
Philadelphia, Pennsylvania

Int. #________ (1-3)

Job #8353
OMB# 04-S73023
Date June, 1974

TRANSPORTATION STUDY - GENERAL SURVEY QUESTIONNAIRE

INTRODUCTION: Good ____________, my name is ______________________ calling from Chilton Research Services in Philadelphia, Pennsylvania. We are doing a marketing research survey for the U.S. Department of Transportation and would like to ask you a few short questions regarding the subject of transportation.

Time Int. Began ________ A.M. ________ P.M.

Time Int. Ended ________ A.M. ________ P.M.

1. Have you ever had the occasion to ride on the (READ LINES)?

4-

	Yes	1
GO TO Q. 3 UNTIL QUOTA FILLED	No	2

2. About how often within the past six months have you ridden the (READ LINES)?

________________________ 5-

3. Suppose you were a designer and you were going to design the elevated or subway car of the future. We want to know how much importance you will attach to certain parts of the car you will design. Now, to do this, I'm going to read you a list of items and you will tell me how important each item is by using any number from zero to 100. If the item is extremely important, you pick a number at or near 100. If the item is of very little or no importance, you pick a number at or near zero. And you can pick any number between 100 or 0. Remember, for each item I am going to read, tell me how important it is to you when designing this new car. Now, with 100 being very important and 0 being not at all important, how important is (READ ITEM WITH CHECK MARK TO THE LEFT)? (RATE EACH ITEM).

ITEMS		RATING
1. The cleanliness of the inside of the cars	(6-8)	
2. The durability of the seat material	(9-11)	
3. Having padding on the seats	(12-14)	
4. The cars having the right temperature during cold weather	(15-17)	
5. The cars having the right temperature during hot weather	(18-20)	
6. The freshness of the air in the cars	(21-23)	
7. Feeling that the cars are built so as to be safe and not contribute to accidents	(24-26)	
8. Not having to worry about criminals or vandals	(27-29)	
9. The amount of space a person has in the seats	(30-32)	
10. How close the people sit together	(33-35)	
11. The seats facing toward the front of the car	(36-38)	

REMEMBER 100 IS THE MOST IMPORTANT RATING YOU CAN GIVE AND 0 IS THE LEAST IMPORTANT RATING. NOW, WHEN DESIGNING YOUR NEW CAR, HOW IMPORTANT IS:	
ITEMS	RATING
12. The seats facing towards the rear of the car (39-41)	
13. The seats facing sideways (42-44)	
14. The overall comfort of the seats (45-47)	
15. The importance of having a seat (48-50)	
16. If you have to stand, having a pole to hold on to (51-53)	
17. If you have to stand, having a handhold on the back of the seats to hold on to (54-56)	
18. If you have to stand, having something to hold on to (57-59)	
19. The car having wide aisles (60-62)	
20. The doors being arranged and of such a size so that it is easy to get in and get out of the cars (63-65)	
21. Being able to see out the windows while standing (66-68)	
22. Being able to see out the windows while sitting (69-71)	
23. The windows having tinted glass (72-74)	
24. The lighting in the cars being bright enough to read by (75-77)	
REMEMBER 100 IS THE MOST IMPORTANT RATING YOU CAN GIVE AND 0 IS THE LEAST IMPORTANT RATING. NOW, WHEN DESIGNING YOU NEW CAR, HOW IMPORTANT IS:	80-3 END CARD 3
25. Putting carpeting on the floors of the cars (4-6)	
26. The interior or inside of the cars having bright colors (7-9)	
27. A low level of noise when the train enters a station (10-12)	
28. A low level of noise from the train when one is riding inside the car (13-15)	
29. The ride being smooth in regard to stop and start jerks (16-18)	
30. The ride being smooth in regard to side to side motion (19-21)	
31. The importance of cars not breaking down and causing delays (22-24)	
32. The cost of the fare (25-27)	
33. Having a map in the car showing each stop (28-30)	
34. Having the stops announced over a loud speaker (31-33)	
35. Having an enforced "No Smoking" regulation (34-36)	
REMEMBER 100 IS THE MOST IMPORTANT RATING YOU CAN GIVE AND 0 IS THE LEAST IMPORTANT RATING. NOW, WHEN DESIGNING YOUR NEW CAR, HOW IMPORTANT IS:	

4. Do you think that the fare you are now paying for public transportation covers the entire cost of the ride?

37-

Yes	1
No	2
Don't Know	3

5. Do you feel that the federal government should help pay for purchases of new equipment?

38-

Yes	1
No	2
Don't Know	3

6. Do you feel that the government should give money to transportation companies so as to keep fares down?

39-

Yes	1
No	2
Don't Know	3

7. If you had your choice, which of the following would you pick: (READ)

40-

A car with less seats, but ample entry and exit	1
OR	
A car with more seats, but restricted entry and exit	2

Sp 41 to 48

Now, I have just a few questions for classification purposes

A. Do you or your family have an automobile?

		49-
	Yes	1
SKIP TO Q. C	No	2

B. (IF "YES") How many automobiles do you or your family have?

50-____________

C. Are you, yourself, a licensed driver?

	51-
Yes	1
No	2

D. To which of the following is your major commuting? (READ LIST)

	52-
Work	1
Shopping	2
School	3
Some other: (SPECIFY)	4

E. How do you usually commute to (READ ABOVE ANSWER)? (IF MORE THAN ONE, CIRCLE CODES FOR AS MANY AS APPLY)

	53-
Car	1
Bus	2
Trolley/Street Car	3
Rapid Transit (Subway or Elevated)	4
Commuter Train	5
Walk	6
Taxi	7
Other (SPECIFY)	8

F. About how long does this trip usually take, going one way only?

____________ Minutes
(54-46)

G. How frequently during the average month do you use the following types of transportation? (READ LIST AND RECORD)

	Times per month	Never
City Buses (57-58)		00
Commuter trains (59-60)		00
Subway or elevated (61-62)		00
Trolley cars (63-64)		00

H. What is your occupation? 65-

____

66-

I. Into which of the following groups does your age fall? (READ LIST)

	Under 20	1
	20 to 29	2
	30 to 39	3
	40 to 49	4
	50 to 64	5
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DO NOT READ	Not determined	7

J. Finally, into which of the following categories did your family's total income for 1972 fall before taxes? (READ LIST)

67-

	Under $5,000	1
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	$10,000 but less than $15,000	3
	$15,000 but less than $20,000	4
	$20,000 but less than $25,000	5
	$25,000 or over	6
DO NOT READ	Not determined	7

K. Record sex:

68-

Male	1
Female	2

City . . . 69-
80-4
END CARD 4

Respondent's Name ______________________________

Telephone # ______________________

Interviewer's Name ________________________ Date __________