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URBAN RAIL SUPPORTING TECHNOLOGY PROGRAM FISCAL YEAR 1975 YEAR END SUMMARY

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1. INTRODUCTION

Mass transportation is recognized, in energy conscious urban plans, as a means of conserving transportation energy while providing adequate transportation systems. The urgency of transportation needs is a primary factor in the plans of national municipalities and, in the active greater municipality urban transportation plans of the Nation, rail rapid-transit systems are being expanded; new rail systems are being planned and constructed; and parts of existing rail systems are being improved.

The Capital Assistance Program of the Urban Mass Transportation Administration was established to make available major funding for expansion and improvement of transit systems and for construction of new transit systems; accordingly, the UMTA Office of Research and Development is conducting research, development, and test and evaluation programs directed toward cost effective methods for overall improvement of urban rail mass transportation systems. These programs contribute to the effective use of UMTA Capital Assistance Program funds and other funds from grants under Federal sponsorship.

A Project Plan Agreement (PPA UM504) sponsored by the UMTA Office of R&D, Rail Technology Division, defines the role of the DOT Transportation Systems Center as Systems Manager for the fiscal year 1975 Urban Rail Supporting Technology Program to provide the necessary technical support for urban rail-transit development.

THE URBAN RAIL SUPPORTING TECHNOLOGY PROGRAM

The primary goal of the URST Program, summarized herein for fiscal year 1975, is directed toward the improvement and development of rail system technology.

As Systems Manager for the Urban Rail Supporting Technology Program, The Transportation Systems Center is charged with:

a. Development of a comprehensive program of test and evaluation of vehicles, structures, and related components.

b. Design, construction, and operation of facilities and equipment to support test and evaluation activity.

c. Conduct of selected programs of R&D for industry-wide application, and

d. Provision of technical requirements, analyses, specifications, and plans necessary for UMTA evaluation and program development.

Management of URST activity is coordinated by the program organization consisting of six subprograms or tasks. The scope of the Program is summarized in these six tasks as follows:

Program Management provides overall program plans and engineering direction; establishes resource requirements and test and demonstration schedules; identifies industry interfaces; assesses accomplishments; recommends implementation; and reports results.

Technical Support and Application Engineering provides direct assistance to operating properties to develop and establish overall operations and maintenance procedures; to develop and establish facilities and equipment requirements; and to identify significant transit industry problems. Further, this task develops R&D projects for UMTA review and approval; supports other UMTA system managers as directed and evaluates new proposals.

Facilities Development provides technical support to the design, the construction, and the operation of the facilities and equipment needed to conduct a comprehensive program of test and evaluation of urban rail cars and car systems; track structures and structural components; power systems; and signal systems for train operation and control.

Test and Evaluation provides plans and conducts system testing and operational evaluations; establishes test objectives, constraints, criteria, and procedures; provides all necessary measurements instrumentation and data acquisition and processing equipment; and prepares final reports and recommendations.

Technology Development provides research and development and evaluative testing directed toward the introduction of improved technology in urban rail system applications. Major technology efforts include:

Tunneling Technology
Noise Assessment and Abatement Technology
Safety Technology (Crashworthiness)

Transportation Test Center (TTC) Field Support. The former High Speed Ground Test Center (HSGTC), Pueblo, Colorado, was officially redesignated the DOT Transportation Test Center (TTC). Engineers are in residence at the TTC to assist the rail transit community in defining support requirements, schedule requirements, and operational requirements and procedures. The rail transit test facilities include the UMTA Rail Transit Test Track, maintenance and measurement equipment, data acquisition equipment and software, and other support facilities such as machine and carpentry shops.

2. SUMMARY

2.1 PROGRAM MANAGEMENT

The UMTA Urban Rail Supporting Technology Program initiated new activities in all tasks during fiscal year 1975.

Activities were initiated in:

1. "General Vehicle Tests on Standard Light Rail Vehicle(s) (SLRV)", contract DOT-TSC-1062, Boeing Vertol Company.
2. "Assessment of Disruptive Effects Associated with Urban Transit Tunnel Construction", contract DOT-TSC-1018, Abt Associates, Incorporated.
3. "In-Service-Performance and Costs-of-Methods for Control of Urban Rail-System-Noise", contract DOT-TSC-1053, De Leuw Cather and Company.
4. "Subway Station Design and Construction", contract DOT-TSC-1027, De Leuw Cather and Company, Washington, D.C.
5. "Transfer of Funds to FHWA for construction of Permanent Track-Power-Facilities at TTC", TSC RA-7523 to FHWA, FHWA contract to Gardner Zemke Company.
6. "Subway System Maintenance", contract DOT-TSC-1070, Bechtel, Incorporated, San Francisco, California.
7. "Installation and Removal of Cab Signalling System", contract DOT-TSC-1032, San Francisco Municipal Railroad.
8. "Workshops and Conference on Urban Transit Tunneling", contract DOT-TSC-987, Ken Guscott Associates.
9. "Increase of Carbody Crashworthiness in the Headon Collision", contract DOT-TSC-1052, Illinois Institute of Technology Research Institute.

10. "Construction monitoring of Tunnels for Urban Rapid Transit Systems, Part B - Manual", modification to contract DOT-TSC-661, Parsons, Brinckerhoff, Quade, and Douglas, Incorporated.

11. "Muck Utilization in the Urban Rapid Transit Tunneling Process", modification to contract DOT-TSC-836, Haley and Aldrich, Incorporated.

12. "The Transportation of Tunnel Muck by Pipelines", procurement request 612-0310.

13. "Economic Factors in Tunnel Construction", procurement request 612-306.

14. "Data Acquisition System", modification to contract DOT-TSC-1004, QEI, Incorporated.

15. "Support of System Integration and Test Program", modification of contract DOT-TSC-561, Sperry Univac.

16. "Transfer of funds" to FRA for construction of catenary for the RTTT, TSC-RA-7526, TTC construction task.

Activities are continuing in:

1. Advanced Concept Train (ACT) Technical Support for UMTA.

2. Crashworthiness of Urban Rail Transit Vehicles.

3. System Costs of Rail Rapid-Transit Systems (Study).

4. Track Electrification Equipment of Two Permanent Power Substations to Energize the UMTA RTTT at the DOT TTC.

5. Track Electrification Catenary for Standard Light Rail Vehicle (SLRV) Testing on the UMTA RTTT.

6. Technology News Dissemination by an Urban Rail Technology Newsletter.

7. Data Acquisition Systems for Track Geometry Measurements.

8. Track Geometry Measurement in Urban Rail Transit Systems.

9. Data Acquisition Systems for Testing and Evaluating Rail Car Performance.

10. Test and Evaluation of Urban Rail Transit Cars and Equipment.

11. Facilities and Equipment for Testing on the UMTA Rail Transit Test Track at the DOT Transportation Test Center.

12. Noise Assessment and Abatement in Urban Rail Transit Systems.

13. Tunneling Technology for Urban Rail Transit Systems.

Fiscal year 1975 URST activities are tabulated in the appendices:

Appendix A - Projects
Appendix B - Contracts and Grants
Appendix C - Documents

Program management for the URST Program during fiscal year 1975 included liaison and support for UMTA approved tests on the UMTA Rail Transit Test Track and Facilities at the TTC. Tests conducted on the UMTA RTTT included the New York City Transit Authority (NYCTA) type R-42 car equipped with the TSC designed Track Geometry Measurement System, Figure 2-1; the Energy Storage Car(s) (ESC), a modified NYCTA type R-32 car, equipped with energy storage fly-wheels, Figure 2-2; and the Gas-Turbine/Electric (G-T/E) cars(s), Figure 2-3.

Other tests or urban rail transit vehicles in fiscal year 1975 included Revenue Service Demonstration of the State-of-the-Art Car(s) in Boston, Figure 2-4, in Cleveland, Figure 2-5, in Chicago, and in Philadelphia.

Related program activities involving the UMTA RTTT and TTC Facilities included the RTTT Permanent Power System, the RTTT Catenary erection for Standard Light Rail (SLRV) use, the UMTA Wheel Truing Machine and Track Scale installation at TTC, installation of the Rail Spur to the Storage and Maintenance Building, and the installation of the Tail Track from the Transit Maintenance Building into the leg of the adjacent Wye Track.

Figure 2-1 NYCTA R-42 Car at TTC, Equipped with TSC Designed Track Geometry Measurement System

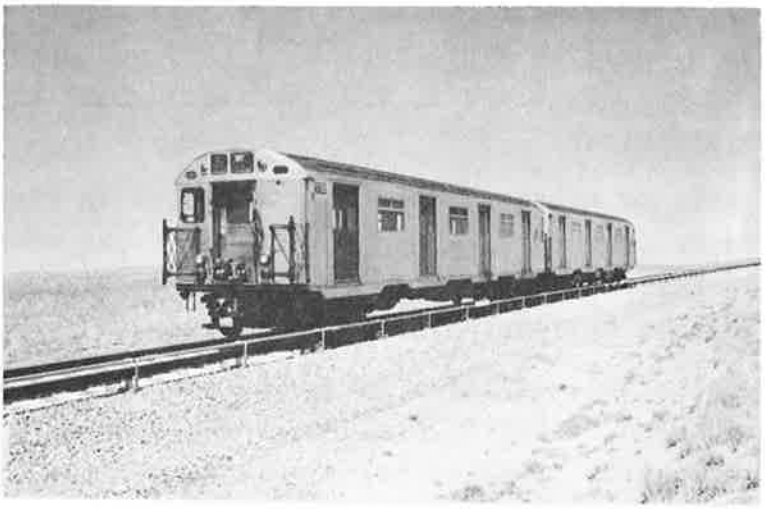

Figure 2-2 Energy Storage Cars (ESC), Modified NYCTA R-32 Cars, at TTC, Equipped with Energy Storage Flywheels

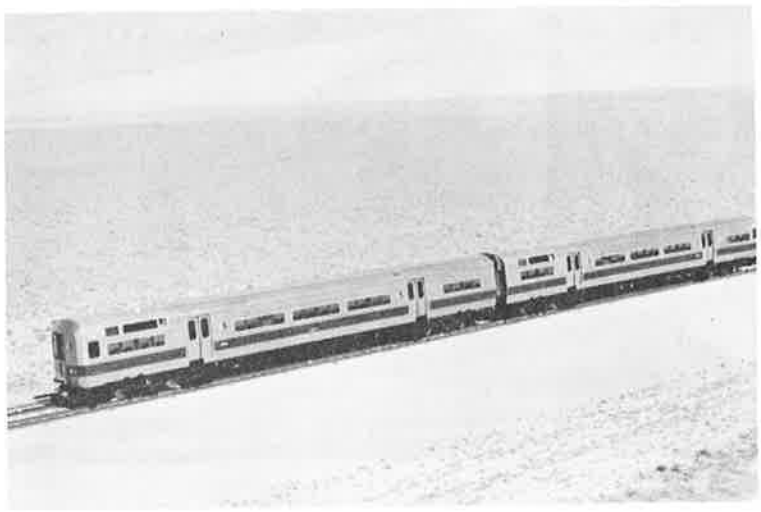

Figure 2-3 Gas-Turbine/Electric Car(s) at TTC

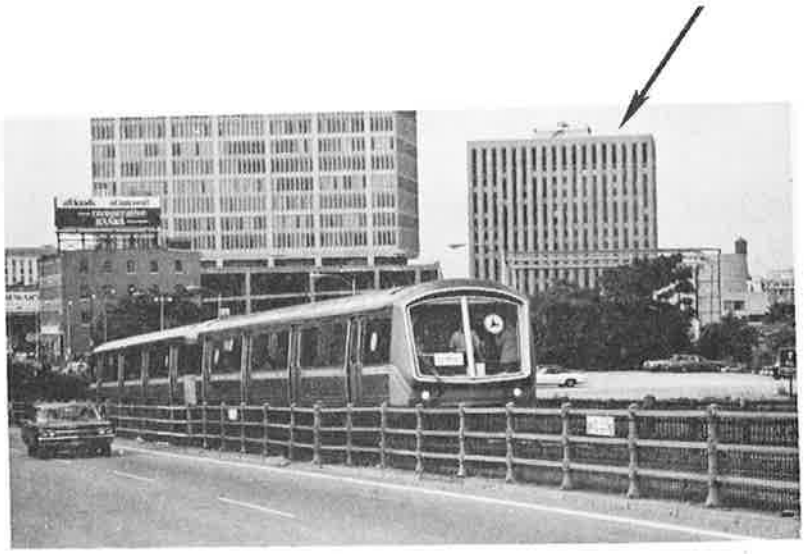

Figure 2-4 State-of-the-Art Cars (SOAC) on MBTA Red Line, TSC, Kendall Square, Cambridge, Mass., in Right Center Background

Figure 2-5 State-of-the-Art Cars in Cleveland

The former High Speed Ground Test Center (HSGTC), Pueblo, Colorado, was officially redesignated the DOT Transportation Test Center (TTC). The DOT TTC assumed responsibility for test control and safety on the UMTA RTTT under a TTC order and an associated TTC reorganization. As a result of the reorganization and the assumption of responsibility, operational procedures for the RTTT are issued from the TTC.

Urban Rail Technology Newsletter

Urban Rail Technology Newsletter Number 2, "State-of-the-Art Car Testing", was approved and published in January 1975 and Newsletter Number 3, "Document List of Urban Rail Supporting Technology", was approved and published in May 1975. Newsletter Number 4, "Solar-Energy-Powered Emergency Lighting System" was in preparation at the close of the fiscal year.

2.2 TECHNICAL SUPPORT AND APPLICATIONS ENGINEERING

Technical Support and Applications Engineering in fiscal year 1975 included:

2.2.1 Urban Rail Vehicle Crashworthiness

Assessment of Crashworthiness of Existing Urban Rail Vehicles, Contract DOT-TSC-681, Calspan Corporation - An assessment of crashworthiness of five existing urban rail vehicles has been completed by Calspan Corporation. The vehicles chosen for assessment are believed to be generically representative of the existing transit industry fleet. The report of the assessment will be transmitted to NTIS for public availability (available approximately December 1975).

Crashworthiness Analysis of the UMTA State-of-the-Art Cars, Contract DOT-TSC-791, Boeing Vertol Company - Based on actual crash data (SOAC accident at Pueblo, Colorado - August 1973) and a train occupant model developed by Calspan Corporation (contract DOT-TSC-681), Boeing Vertol performed a detailed analysis of the structural integrity of the UMTA State-of-the-Art Cars. A final report has been prepared and will be transmitted to NTIS for public availability (available approximately December 1975).

Increased Rail Transit Vehicle Crashworthiness, Contract DOT-TSC-1052, Illinois Institute of Technology Research Institute Using the Calspan and Boeing Vertol work as baseline data, a new effort was initiated in June 1975 for purposes of developing engineering methods and data pertaining to rail systems which will assure increased rail transit vehicle crashworthiness and passenger injury minimization.

I.I.T.R.I. (Illinois Institute of Technology Research Institute), teamed with Pullman-Standard, won the award of the 13-month contract for this effort on June 30, 1975.

2.2.2 Rail Transit System Costs

The primary objective of this effort was to develop up-to-date estimates of the various cost elements encountered in constructing, operating, and maintaining urban rail transportation systems. The study was completed under contract DOT-TSC-808 to T.K. Dyer, Incorporated. The report on the study is expected to be available through NTIS about November 1975.

2.2.3 Advanced Concept Train (ACT)

The Transportation Systems Center URST Staff provided technical support to UMTA and the ACT Systems Manager (Boeing Vertol) in technical and management assessments at all major critical design reviews (CDR) and program design reviews (PDR).

The ACT vehicle is depicted in Figure 2-6. Figure 2-7 shows progress of the carbody fabrication. Delivery of the vehicles to the Transportation Test Center at Pueblo, Colorado for commencement of acceptance testing is scheduled for July 1976. After acceptance testing, the vehicles will be demonstrated in revenue service in New York, Boston, Philadelphia, Cleveland, and Chicago.

2.3 FACILITIES DEVELOPMENT

Facilities Development in fiscal year 1975 included:

2.3.1 Permanent Power System for the RTTT

The permanent power system for the RTTT was scheduled for completion in March 1976. Because of delays in the selection of vendors for supplying equipment under the Wismer and Becker contract, DOT-TSC-847, completion of the substation will be delayed six to nine months.

A transfer of funds, TSC RA-7523, was made to the Federal Highway Administration (FHWA) for the construction of the Permanent Track-Power Facilities for the UMTA RTTT. Transfer of the funds was completed in April 1975.

Figure 2-6 Advanced Concept Train (ACT)
(Artists Depiction)

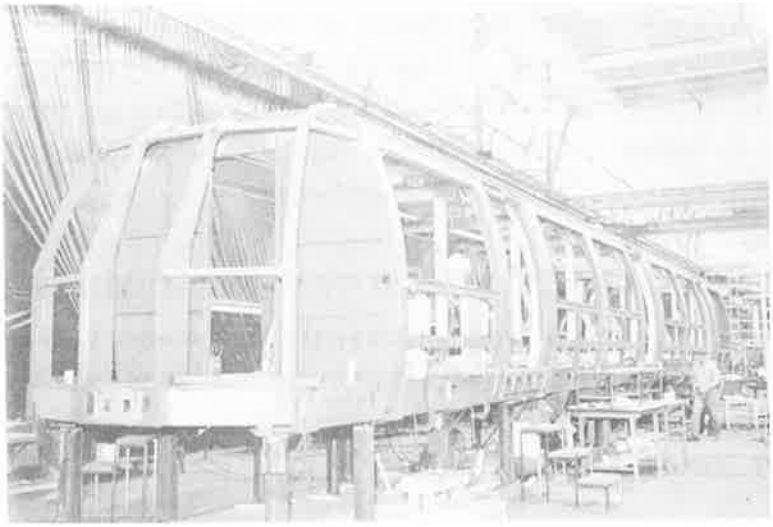

Figure 2-7 ACT Carbody Fabrication

The 115-kv Distribution Line for source power to the permanent track-power facilities is under construction. A contract between the FHWA and Gardner Zemke Company, Denver Colorado, was executed in December 1974.

2.3.2 Overhead Power System for SLRV Testing

A two-mile overhead power distribution line at TTC for SLRV testing at TTC will be completed and checked out in the first quarter of fiscal year 1976. Funds under URST UM504 were transferred to TTC for construction of the overhead under reimbursable agreement DOT-RA-7526 executed in April 1975.

2.3.3 Wheel Truing Machine

The Wheel Truing Machine contract DOT-TSC-876 was awarded to Hegenscheidt Corporation of America in June 1974, for "Underfloor Wheel Reconditioning Equipment". The contract is scheduled for completion in December 1975. The wheel-truing-machine-foundation procurement is in process.

2.3.4 Train Dynamics Track and Tight Turn Loop for UMTA RTTT

These features were set aside in fiscal year 1974 due to excessive cost proposals. A review and modification of requirements, to enhance competition and reduce costs, is pending. Funding limitations preclude construction in fiscal 1976. Earth work for both installations is completed.

2.3.5 Tail Track into the UMTA Transit Maintenance Building

Design of the track work necessary to connect the tail track at the rear of the UMTA Transit Maintenance Building into the adjacent leg of the wye has been completed. A procurement package for the tail track is in process.

2.4 TEST AND EVALUATION

Projects of Test and Evaluation in fiscal year 1975 included:

2.4.1 Test Plans and Requirements

The "Master Test Document", GSP 010, was revised for publication. This document serves as a reference for all test activity on the URST Program.

The "General Vehicle Test Plan" (GVTP), TSC GSP-064 revised under contract DOT-TSC-580, was reviewed and submitted for approval for publication. The GVTP was first published by TSC as GSP-064, with limited distribution, in fiscal year 1972. A draft version, which contains the basic material to be published, has been used as the basis for vehicle testing during fiscal year 1975.

2.4.2 Test Program Implementation

Testing on the UMTA RTTT - Test activity on the UMTA Rail Transit Test Track at the DOT TTC this year included the NYCTA R-42 cars, the Energy Storage Cars (ESC), and the Gas-Turbine/Electric (G-T/E) commuter car, Figures 2-1, 2-2, and 2-3. In addition, FRA related programs using the RTTT included tests for American Steel Foundries, Canadian National Railway, and AMTRAK.

State-of-the-Art Car (SOAC) - The results of the "SOAC Engineering Test at HSGTC" were published in a six volume report under contract DOT-TSC-580. This report contains test data presented in the form prescribed in the General Vehicle Test Plan. "Post-Repair Engineering Tests", results of tests made subsequent to repair after the accident, is a separate report designated Volume VII of the "SOAC Engineering Test at HSGTC" under the same contract. The report will be published after the start of calendar year 1976.

SOAC Revenue Service Demonstrations and Engineering Tests - SOAC engineering test were conducted in Boston, Cleveland, Chicago, and Philadelphia during fiscal year 1975, to complete the scheduled demonstration and test tour of five cities. The demonstration tour included New York City where the demonstration and test were conducted in fiscal year 1974.

The SOAC s arrived in Philadelphia in February for tests and revenue service demonstrations; and the testing, on both the Southeastern Pennsylvania Transportation Authority (SEPTA) system and the Port Authority Transportation Corporation (PATCO) system, was completed in April. The test results from the five cities will be published in a test report during the early part of fiscal year 1976.

Revenue Service Vehicle Tests - An amendment to the SOAC Engineering Test Contract, DOT-TSC-580, was initiated in fiscal year 1975 to conduct tests on revenue service vehicles in the home track system. Tests will be made on a representative vehicle on each of the operating systems included in the SOAC demonstration and test tour. Test procedures, equipment, and data format used for SOAC tests will be used for the service vehicle tests to facilitate comparison of the SOAC with the operating system service vehicles. Plans are to include New York City, Boston, Cleveland, Chicago, and Philadelphia in the program as before. The contract modification was in process at the close of fiscal 1975 and testing will begin in early 1976.

Energy Storage Car(s) (ESC) Tests on the RTTT - Engineering Testing of the ESC's on the RTTT at TTC was completed on 27 January 1975. The ESC testing at TTC was conducted by Garrett AiResearch Manufacturing Company under contract DOT-TSC-838. A draft test report from AiResearch was received in June 1975. The testing at TTC concluded the ESC test requirements under the TSC contract.

Standard Light Rail Vehicle (SLRV) - Three SLRV's, manufactured for Boston MBTA, Figure 2-8, and San Francisco Municipal Railway by Boeing Vertol Company, will be sent to TTC, Pueblo, for checkout and acceptance testing. Delivery of the first two cars is scheduled for the fall of 1975. Preparation of facilities for the SLRV at TTC, including construction of a two-mile overhead wire for power to the car, is discussed under Facilities Development and TTC Field Support.

Figure 2-8 Standard Light Rail Vehicle (SLRV) in Boston

R-42 Equipment Tests - The NYCTA R-42 cars, Figure 2-1, were used to checkout the TSC designed Track Geometry Measurement System and the General Vehicle Test system equipment at TTC.

2.5 TECHNOLOGY DEVELOPMENT

Projects of Technology Development in fiscal year 1975 included Noise Abatement and Tunneling:

2.5.1 Noise Abatement

Development of technology for evaluation and control of acoustic noise continued in fiscal year 1975 with the objective of defining and recommending noise abatement measures for urban rail system operators and planners. Research, developmental and evaluative testing was continued and additional effort was initiated in fiscal year 1975 with the objective of introducing improved technology in urban rail system applications.

Noise-assessment and abatement-options surveys of the New York, Chicago, Cleveland, Philadelphia, San Francisco, and Port Authority Trans-Hudson (PATH) rapid transit systems were monitored and given technical direction during fiscal year 1975. A Boston Survey was conducted during fiscal year 1974 and New York and Chicago surveys were in progress under UMTA University Research and Training grants, directed by TSC during fiscal years 1974 and 1975.

Activities were initiated in fiscal year 1975 to conduct in-service test and evaluation of commercially available noise abatement equipment. These tests and evaluations are planned to be conducted on the Southeastern Pennsylvania Transportation Authority (SEPTA) system Market-Frankford line in fiscal year 1976.

2.5.2 Tunneling

Development of tunneling technology was actively progressing in five previously contracted programs during fiscal year 1975 and new activities were initiated in five additional procurements.

The programs included: Requirements Study Investigating Instrumentation Development for Rapid Transit Tunneling, Contract DOT-TSC-654, Parsons, Brinckerhoff, Quade, and Douglas - This contract implements an investigation into the techniques, instrumentation, and the needs of geotechnic subsurface explorations for rapid transit tunneling. The contract was in the final report stage at the close of fiscal year 1975 and the report is expected to be published during the first quarter of fiscal year 1976.

Specifications and Design for Monitoring Instruments for Rapid Transit Tunneling, Contract DOT-TSC-661, Parsons, Brinckerhoff, Quade, and Douglas - This contract provides for a report on the purpose, techniques, and the instrumentation required for the monitoring of construction, measurement of ground movements, and the displacement and structure deformations associated with rapid transit tunneling. The final report UMTA-MA-0025-74-13, was published in the fourth quarter of fiscal year 1975. This contract was modified in fiscal year 1975 to add the preparation of a manual

for transportation system planners and designers. The added manual is scheduled to be published in the first quarter of fiscal year 1976.

System Analysis, Modeling, and Optimization of Rapid Transit Tunneling Process, Contract DOT-TSC-601, Bechtel, Incorporated - This contract provided for an in-depth look at the techniques of cut and cover tunneling, free air tunneling, and compressed air tunneling with development of models as planning tools for evaluation of alternatives. The final report was in the publication process at the close of the fiscal year.

Environmental Impact and Safety Guidelines for Improved Rapid Transit Tunneling, Contract DOT-TSC-802, A.A. Mathews, Incorporated - This effort is an investigation into, the analysis of, and the development of guidelines for rapid transit tunneling to minimize the adverse environmental impacts and improve the poor safety record of urban rapid transit tunneling. Drafts of an interim report documenting the work of phase A and of preliminary guidelines were reviewed, the Contractor has been making necessary corrections, and work on this program was actively in progress at the close of the fiscal year. Phase B work, including feedback from the tunneling industry to be obtained through workshops, will result in publication of final guidelines in fiscal year 1976.

Muck Utilization in Urban Rapid Transit Tunneling Process, Contract DOT-TSC-836, Haley and Aldrich, Incorporated - This is a study into the current and potential uses of muck from the tunneling process which provides for the development of muck utilization schemes that are not only environmentally acceptable, but are also desirable and potentially profitable. The contract was modified to include additional work involving the development of a muck utilization program for an actual case study site.

Assessment of Disruptive Effects Associated with Urban Transportation Tunnel Construction, Contract DOT-TSC-1018, Abt Associates - This contract, awarded on 6 May 1975, provides for a study of the dollar-value of the economic and social disruptive effects of rapid transit tunneling in the urban environment. It will provide data to assist in determining the economically justifiable effort that may be expended to minimize disruptions.

Subway Station Design and Construction, Contract DOT-TSC-1027, De Leuw, Cather, and Company - This procurement will study the construction techniques available throughout the world today with the objective to develop more economical, innovative, and suitable techniques for construction of subway stations under the various physical constraints encountered in the process. The contract was awarded on 3 June 1975.

Guidelines for Existing Subway Maintenance, Contract DOT-TSC-1078, Bechtel, Incorporated, San Francisco, California - This contract provides for an in-depth look at the often neglected field of subway system maintenance. An attempt is to be made to determine the methods for detection of deterioration, the methods for evaluating or measuring the degree of deterioration, and methods for repairing and improving the quality of existing tunnel systems. Also, an attempt is to be made to determine methods to detect old design errors. The contract was awarded on 30 June 1975.

Workshops and Conference on Urban Transit Tunneling, Contract DOT-TSC-987, Ken Guscott Associates - This procurement will provide the means and the support by which desired workshops and conferences may be presented on various tunneling subjects such as tunnel liners, subsurface explorations, contracting practices, slurry wall techniques, materials handling, etc. With this support, presentations can be made to interested groups of contractors, designers, owners, etc., throughout the country on relatively short notice. The contract was awarded June 9, 1975.

Economic Factors in Tunnel Construction, TSC Procurement Request 612-306 - This procurement will identify and quantify those factors which have greatest impact on tunnel construction cost. It is intended that this contract will supply the data base and methodologies needed by rapid transit designers and engineers to sensitize their cost estimates. Evaluation of proposals is concluded and the award of the contract is anticipated early in the first quarter of fiscal year 1976.

2.6 TRANSPORTATION TEST CENTER FIELD SUPPORT

Field support at the TTC during fiscal year 1975 included test operations on the UMTA Rail Transit Test Track and monitoring of the rail transit facilities.

Vehicle testing on the RTTT included the Energy Storage Car(s) (ESC), the Gas-Turbine/Electric (GTE) car(s), and the Track Geometry Measurement System (TGMS) equipped NYCTA R-42 car(s), figures 2-2, 2-3, and 2-1. Additionally the American Steel Foundries (ASF) completed a series of proprietary tests on 3 types of trucks; the Canadian Government Transportation Development Authority (TDA) completed proprietary tests on the Canadian Light-Rapid-Comfortable (LRC), Figure 2-9, locomotive and coach; and a qualification test program was carried out on a six-car Amtrak train.

Figure 2-9 Canadian Light-Rapid-Comfortable (LRC) Train on Rail Transit Test Track

3. TECHNICAL DISCUSSION

3.1 GENERAL

This section contains a brief description of the overall objectives and accomplishments of each task of the fiscal year 1975 Urban Rail Supporting Technology Program. Technical and schedule information are included as appropriate to the individual task or project also, related technical information and documents, as applicable, are noted and identified for reference.

3.2 TECHNICAL SUPPORT AND APPLICATIONS ENGINEERING

3.2.1 Urban Rail Vehicle Crashworthiness

Assessment of Crashworthiness of Existing Urban Rail Vehicles, Contract DOT-TSC-681, Calspan Corporation - Crashworthiness of five existing urban rail cars and the feasibility of crashworthiness improvements were investigated by Calspan. Both structural configurations and impact attenuation devices were studies. The efforts included:

1. Development of analytical model to predict passenger threat environment during collision;
2. Establishment of criteria for predicting passenger injury due to train collision;
3. Application of the established injury criteria and analytical models to predict passenger injuries of five existing rail cars due to collision;
4. Preliminary study of impact absorption devices for transit rail cars;
5. Design study of structural configuration for impact energy management;
6. Review of engineering standards for crashworthiness of urban rail cars.

The findings are currently being further studied and evaluated in the contractual work by the Illinois Institute of Technology Research Institute under contract DOT-TSC-1052.

A summary of the conclusions of the Calspan work are:

a. By employing a relatively simple one dimensional dynamic train collision model, it is possible to estimate theoretical car penetration and second collision injury environment in cars where effective force versus deflection characteristics and interior characteristics are known. For transit cars with seated and standing passengers, employment of the model indicates that large increases in effective transit car strength can reduce penetration (first collision) fatalities very significantly without significantly increasing second collision injury severity. This conclusion will be confirmed and refined by a more detailed analysis of colliding cars and by analysis of and experiments on existing and improved interior equipment during fiscal year 1976.

b. Specifications for existing transit cars are widely divergent in amount of coverage (structural characteristics dealt with) and strength levels required. In those specifications where longitudinal strength and weight are specified, strength requirements are given in terms of yield strength or "zero permanent deformation" strength. The resulting yield strength to weight ratios fall in a range from 3 to 7. These specifications permit cars to be built with sustained crush strength levels which permit high car penetration in frontal and front-to-rear collisions.

c. By the more efficient configuration of structural materials now used in transit cars, it is possible in many cases to obtain significantly increased car strength with no increase in car weight or cost. Assuming that added strength is obtained by increasing the amount of structural material (i.e., providing more structural material in

existing inefficient designs) collision model results and cost analyses indicate that the cost of providing added strength in all new transit cars is generally significantly less than 200,000 dollars per life saved, for unit costs of one dollar to five dollars per pound of added structure. This is based on only one frontal collision (at 40 mph) occurring once in the nation (during rush hours) every 20 years.

d. Severe override can occur in frontal collisions of similar or identical cars. This has the effect of causing large reductions in effective strength/weight ratio. Existing transit car anti-climbers are believed to be effective at low speeds, but their effectiveness at higher speeds is questionable. Further analysis supplemented by experiment will be required to obtain an adequate understanding of override between similar transit cars and the design characteristics which affect it.

Crashworthiness Analysis of the State-of-the-Art Cars Contract DOT-TSC-791, Boeing Vertol Company - On April 19, 1974, the Transportation Systems Center contracted with Boeing Vertol Company to Perform an engineering evaluation of the State-of-the-Art Cars (SOAC). As mentioned in discussion of crashworthiness of existing vehicles, Calspan has developed comparative methods of studying the crash environment and correlating passenger injury to these conditions. The Boeing Vertol assessment of the SOAC complements the Calspan effort.

The engineering assessment of the crashworthiness of the SOAC became of special interest when the cars were involved in an accident while undergoing testing at the High Speed Ground Test Center at Pueblo, Colorado on August 11, 1973. The accident conditions and the damage to the SOAC structure was investigated in detail by Boeing Vertol. The results of the Boeing investigation were made available to the National Transportation Safety Board for their investigation[1] of the accident. The accident

1. National Transportation Safety Board, Washington, D.C., "Collision of State-of-the-Art Transit Cars with a Standing Car, High Speed Ground Test Center, Pueblo, Colorado", NTSB-RAR-74-2, August 11, 1973, NTIS PB-233-254, $4.25.

data afforded a unique opportunity for a detailed analysis of the crashworthiness of the SOAC and for the validation of the crashworthiness methodology.

The SOAC accident involved a rear-end collision in which a two-car SOAC train traveling at approximately 35 mph (at impact) hit a standing train composed of a gondola, (SOAC transition car) and a 40 ton locomotive. The SOAC impacted the gondola, causing structural damage to both the SOAC and the gondola. The gondola detrucked, separated from the locomotive, and overrode the SOAC. The SOAC and gondola car body derailed, at which time the gondola car body separated from the SOAC which it had penetrated. The damage to the SOAC train was confined to the forward-bolster-to-car-end area of the lead SOAC, except for the failure of intercar coupler shear pins and "dented" anti-climbers. The damage to the gondola was in the anticlimber modifications required for transi tion service and in the coupler and draft gear.

The SOAC was built as a part of the Urban Rapid Rail Vehicle and Systems Program, and is the result of 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. The objective of SOAC is to demonstrate the best state-of-the-art in rapid rail car design on two improved cars built using existing technology.

The general conclusions to be drawn from the crashworthiness analysis of the SOAC are:

1. The SOAC "as built" meets the crashworthiness standards implied in the current practice of specifying buff strength.
2. The penetration of occupant areas by overriding must be reduced or if possible eliminated.

3. The reduction of first collision casualties may be achieved by increasing the buff strength requirement and by provision of adequate penetration resistance in the superstructure.

4. The reduction of second collision casualties may be treated independently of the first collision (to the first order), and may be achieved by providing a "soft" car interior.

A detailed report including force deflection characteristics of the vehicle will be available through NTIS about December 1975.

Increased Rail Transit Vehicle Crashworthiness, Contract DOT-TSC-1052, Illinois Institute of Technology Research Institute - The Transportation Systems Center has awarded to IITRI, teamed with Pullman Standard Division, a contract to study crashworthiness on head-on collision of rail transit vehicles. The program consists of the following:

1. Analytical Modeling - Analytical modeling of leading cars of consists in two dimensions (longitudinal and vertical) under impact conditions will be formulated and evaluated. Considerations will be given to mass distributions, non-linear force-deformation relations, shapes and configurations of impact surfaces, and forces generated by impact. Special emphasis will be on the establishment of critical parameters pertinent to overrides. The modeling will be extended to consists of cars.

2. Assessment of Impact Controlling Devices - The impact model formulated will be used to assess impact devices such as anticlimber; couplers and various draft gears currently in service; and new energy attenuation devices as well. Emphasis will be given to the identification of critical parameters which govern crush with subsequent override.

3. Experimental Test Plan for New Devices - A detailed experimental test plan for the evaluation of new impact controlling devices will be developed. The plan also describes in detail all equipment, fixtures, instrumentation, and testing procedures.

4. Prediction of Passenger Injury - Analytical methods for predicting passenger injury due to secondary collision will be formulated. The method will be capable of determining the severity of passenger injury.

5. Rail Car Design Guidelines - As a result of the study some guidelines for evaluation of rail car designs will be developed in parametric form so that individual parameters may be assessed. The major parameters include:

a. Number of cars in the consist

b. Operations speed range

c. Dimensions and weights of each car

d. Placement and size of doors and windows

e. Placement and weight of major equipment

f. Interior configuration of passenger compartment

g. Location of the centers of gravity of the car body

h. Force-deformation relationships of major structural members.

3.2.2 Rail Transit System Cost Contract DOT-TSC-808, T.K. Dyer, Incorporated

A study recently completed by T.K. Dyer, Inc. was concerned with the development of up-to-date estimates of the various cost elements encountered in constructing, operating, and maintaining urban rail transportation systems.

The purpose of this study was to develop cost information that is useful to transportation planners, policy makers, and others involved in the preliminary evaluation and selection of transportation alternatives.

Rail transit systems in several North American cities representing a cross-section of the industry were selected as a basis for developing recent cost experience data. In that there is limited use of modern light rail systems in the United States,

several cities in Europe were studied to include their experience in light rail construction and operation.

The following United States and Canadian cities were selected as the data base:

Boston, Massachusetts
Chicago, Illinois
Cleveland, Ohio
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Toronto, Ontario
Washington, D.C.

In addition, the following European cities were used to gather additional light rail information:

Berne, Switzerland
Cologne, W. Germany
Gothenburg, Sweden
Hamburg, W. Germany
Munich, W. Germany
Zurich, Switzerland

Data were collected on all types of pertinent construction including subway, elevated, and at-grade route construction; stations, signals and communications; power, utilities; and main and yard tracks. Actual contract bid documents, including unit prices and plans, were obtained for selected projects.

Property acquisition costs and conditions and terms imposed were obtained and analyzed.

Engineering and administration costs for construction projects were obtained as a percentage of overall construction project costs.

Operating costs, including maintenance expenses, were obtained in the format available on each property.

Considerable additional data that would serve to influence cost projections, such as passenger traffic statistics, equipment ownership and miles operated, railroad commuter agreement provisions, annual reports, and other system statistics were obtained and reviewed.

The cost estimates projected in the report are in 1974 dollars. Capital costs were converted to July 1, 1974 dollars by applying the Engineering News Record (ENR) Construction Cost Indices prior to 1969 and the Washington Metropolitan Transit Authority's after 1969.

The Association of American Railroads' indices of material prices and wage rates were utilized to project 1974 operating costs.

Table 3-1 from the study is a summary of capital costs for a double track system. Criteria for determining where a site specific application falls between a high and low value for a given cost element is contained in the final report of the study.

3.3 FACILITIES DEVELOPMENT

The urban rail transit facilities at the Transportation Test Center (TTC), Pueblo, Colorado, are comprised of:

a. The UMTA Rail Transit Test Track (RTTT),
b. The power system(s) for energizing transit vehicles,
c. The repair and maintenance facilities and equipment, and
d. The Rail Dynamics Laboratory (joint FRA and UMTA usage).

3.3.1 UMTA Rail Transit Test Track

The 9.12-mile Rail Transit Test Track was completed in September 1972. The track is designed for continuous 80-mile-per-hour operation and it exceeds the standards for both the Federal Railroad Administration Class 6 track and the Institute for Rapid Transit Class 4 track.

TABLE 3-1 CAPITAL COST SUMMARY FOR DOUBLE TRACK SYSTEMS (Costs in Millions of 1974 Dollars)

		Suburban						City						Core					
		At Grade		Elevated		Depressed[1]		At Grade		Elevated		Depressed[1]		At Grade		Elevated		Depressed[1]	
	Unit	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]	Low[2]	High[2]
Light Rail																			
Route Constr.[4]	Mile	.72	2.43	2.82	8.34	4.21	12.27	.50	.65	14.55	17.15	29.13	33.73	NA[3]	NA	14.55	17.15	29.13	33.73
Guideway[5]	Mile	.75	.75	.83	.83	.83	.83	1.00	1.00	.91	.91	.91	.91	NA	NA	1.00	1.00	1.00	1.00
Signal	Mile	.21	.41	.21	.41	.21	.41	.21	.41	.21	.41	.21	.41	NA	NA	.21	.41	.21	.41
Power	Mile	1.10	1.30	1.10	1.30	1.10	1.30	1.10	1.30	1.10	1.30	1.10	1.30	NA	NA	1.10	1.30	1.10	1.30
Land	Mile	.13	.40	.13	.40	.13	.40	1.32	3.96	1.32	3.96	1.32	3.96	NA	NA	2.64	7.92	2.64	7.92
Total Per Mile		2.91	5.29	5.09	11.28	6.48	15.21	4.13	7.32	18.09	23.73	32.67	40.31	NA	NA	19.50	27.78	34.08	44.36
Stations	Each	.02	2.77	.19	3.52	.21	3.56	.02	.06	.21	.70	.44	1.00	NA	NA	1.32	4.56	1.78	7.56
Yards	Each	4.02	16.03	NA	NA	NA	NA	4.02	16.03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Shops	Each	8.04	29.39	NA	NA	NA	NA	8.04	29.39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vehicles	Each	.32	.32	.32	.32	.32	.32	.32	.32	.32	.32	.32	.32	NA	NA	.32	.32	.32	.32
Land	Acre	.01	.03	.01	.03	.01	.03	.11	.33	.11	.33	.11	.33	NA	NA	.22	.66	.22	.66
Signal																			
Grade Crossings	Each	.05	.05	NA	NA	NA	NA	.05	.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Onboard Equipm't	Each	0	.02	0	.02	0	.02	0	.02	0	.02	0	.02	NA	NA	0	.02	0	.02
Yard Control	Each	0	1.20	NA	NA	NA	NA	0	1.20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rapid Rail																			
Route Constr.[4]	Mile	1.15	3.78	2.82	8.34	4.21	12.27	NA	NA	14.55	17.15	29.13	33.73	NA	NA	14.55	17.15	29.13	33.73
Guideway[5]	Mile	.75	.75	.83	.83	.83	.83	NA	NA	.91	.91	.91	.91	NA	NA	1.00	1.00	1.00	1.00
Signal	Mile	.69	2.65	.69	2.65	.69	2.65	NA	NA	.69	2.65	.69	2.65	NA	NA	.69	2.65	.69	2.65
Power	Mile	.70	.85	.70	.85	.70	.85	NA	NA	.70	.85	.70	.85	NA	NA	.70	.85	.70	.85
Land	Mile	.13	.40	.13	.40	.13	.40	NA	NA	1.32	3.96	1.32	3.96	NA	NA	2.64	7.92	2.64	7.92
Total Per Mile		3.42	8.43	5.17	13.07	6.56	17.00	NA	NA	18.17	25.52	32.75	42.10	NA	NA	19.58	29.57	34.16	46.15
Stations	Each	.35	4.15	.70	5.16	.87	5.53	NA	NA	.95	2.85	1.35	4.21	NA	NA	1.39	4.65	2.25	8.01
Yards	Each	3.41	12.97	NA	NA	NA	NA	3.41	12.97	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Shops	Each	7.71	27.73	NA	NA	NA	NA	7.71	27.73	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vehicles	Each	.35	.35	.35	.35	.35	.35	NA	NA	.35	.35	.35	.35	NA	NA	.35	.35	.35	.35
Land	Acre	.01	.03	.01	.03	.01	.03	NA	NA	.11	.33	.11	.33	NA	NA	.22	.66	.22	.66
Signal																			
Onboard Equipm't	Each	.02	.02	.02	.02	.02	.02	NA	NA	.02	.02	.02	.02	NA	NA	.02	.02	.02	.02
Yard Control	Each	1.20	10.50	NA	NA	NA	NA	1.20	10.50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Commuter Rail																			
Route, Upgrade[4]	Mile	.33	3.10	NA	NA	NA	NA	.33	3.10	NA	NA	NA	NA	.33	3.10	NA	NA	NA	NA
Guideway, Upgrade[5]	Mile	.58	.67	NA	NA	NA	NA	.64	.73	NA	NA	NA	NA	.70	.81	NA	NA	NA	NA
Signal	Mile	.08	.27	NA	NA	NA	NA	.08	.27	NA	NA	NA	NA	.08	.27	NA	NA	NA	NA
Power	Mile	.23	.35	NA	NA	NA	NA	.23	.35	NA	NA	NA	NA	.23	.35	NA	NA	NA	NA
Land	Mile	.13	.40	NA	NA	NA	NA	1.32	3.96	NA	NA	NA	NA	2.64	7.92	NA	NA	NA	NA
Total Per Mile		1.40	4.09	NA	NA	NA	NA	2.65	7.71	NA	NA	NA	NA	4.03	11.75	NA	NA	NA	NA
Stations, Upgrade	Each	.12	.62	NA	NA	NA	NA	.10	.48	NA	NA	NA	NA	.17	.85	NA	NA	NA	NA
Yards, Upgrade	Each	.30	2.59	NA	NA	NA	NA	.30	2.59	NA	NA	NA	NA	30	2.59	NA	NA	NA	NA
Shops, Upgrade	Each	.89	4.36	NA	NA	NA	NA	.89	4.36	NA	NA	NA	NA	89	4.36	NA	NA	NA	NA
Vehicles																			
Coach	Each	.25	.25	NA	NA	NA	NA	.25	.25	NA	NA	NA	NA	.25	.25	NA	NA	NA	NA
Diesel, Locom.	Each	.40	.40	NA	NA	NA	NA	.40	.40	NA	NA	NA	NA	.40	.40	NA	NA	NA	NA
Electric, Locom.	Each	.75	.75	NA	NA	NA	NA	.75	.75	NA	NA	NA	NA	.75	.75	NA	NA	NA	NA
Diesel, Self Propel.	Each	.65	.65	NA	NA	NA	NA	.65	.65	NA	NA	NA	NA	.65	.65	NA	NA	NA	NA
Electric, Self Propel.	Each	.70	.70	NA	NA	NA	NA	.70	.70	NA	NA	NA	NA	.70	.70	NA	NA	NA	NA
Land	Acre	.01	.03	NA	NA	NA	NA	.11	.33	NA	NA	NA	NA	.22	.66	NA	NA	NA	NA
Signal																			
Grade Crossings	Each	.05	.05	NA	NA	NA	NA	.05	.05	NA	NA	NA	NA	.05	.05	NA	NA	NA	NA

[1] Depressed costs are for open, retained cut in the suburbs and cut and cover in the city and core.

[2] Low and High describe the range of cost. Backup sheets provide for scaling costs to particular requirements.

[3] NA = not applicable.

[4] Includes grading, drainage, structures, and sub-ballast.

[5] Includes ballast, ties, rails, and fastenings.

The primary purpose of the RTTT is to serve as a reference track for the test and evaluation of urban rail transit vehicles including light rail, rapid-transit, and commuter rail cars. A secondary purpose is the development, test, and evaluation of state-of-the-art and advanced track structures.

Features of the Rail Transit Test Track are described in the "Urban Rail Supporting Technology Program Fiscal Year 1973 Year End Summary", report number UMTA-MA-06-0025-74-9 (NTIS PB 238602/AS) and "Urban Rail Supporting Technology Program Fiscal Year 1974 Year End Summary", report number UMTA-MA-06-0025-75-9, NTIS number not yet assigned.

Proposed additions to the RTTT, Figure 3-1, include a train dynamics track and a tight turn (screech) loop for noise evaluation. Preparations are in process for an overhead (trolley wire) system to be erected for testing the Standard Light Rail Vehicle (SLRV) produced by Boeing Vertol Company for the Boston MBTA and the San Francisco MUNI.

Train Dynamics Track and Tight Turn Loop for the UMTA RTTT - The proposed additions to the RTTT were described in the 1974 report number UMTA-MA-06-0025-75-9. An invitation for bids was issued in April 1974, a single bid was received and set aside as excessive, and no award was made. A decision was made to defer this track construction and to reallocate the funds to use in the completion of the RTTT permanent power system. When additional funds become available, the specifications and schedule for the track construction will be critically reviewed and modified to enhance competition and decrease costs.

3.3.2 Power Systems for Energizing Transit Vehicles

The permanent power system for the RTTT was scheduled for completion in March 1976. Because of delays in the selection of vendors to supply equipment under the Wismer and Becker contract, DOT-TSC-847, completion of the power system substations will be delayed four to seven months.

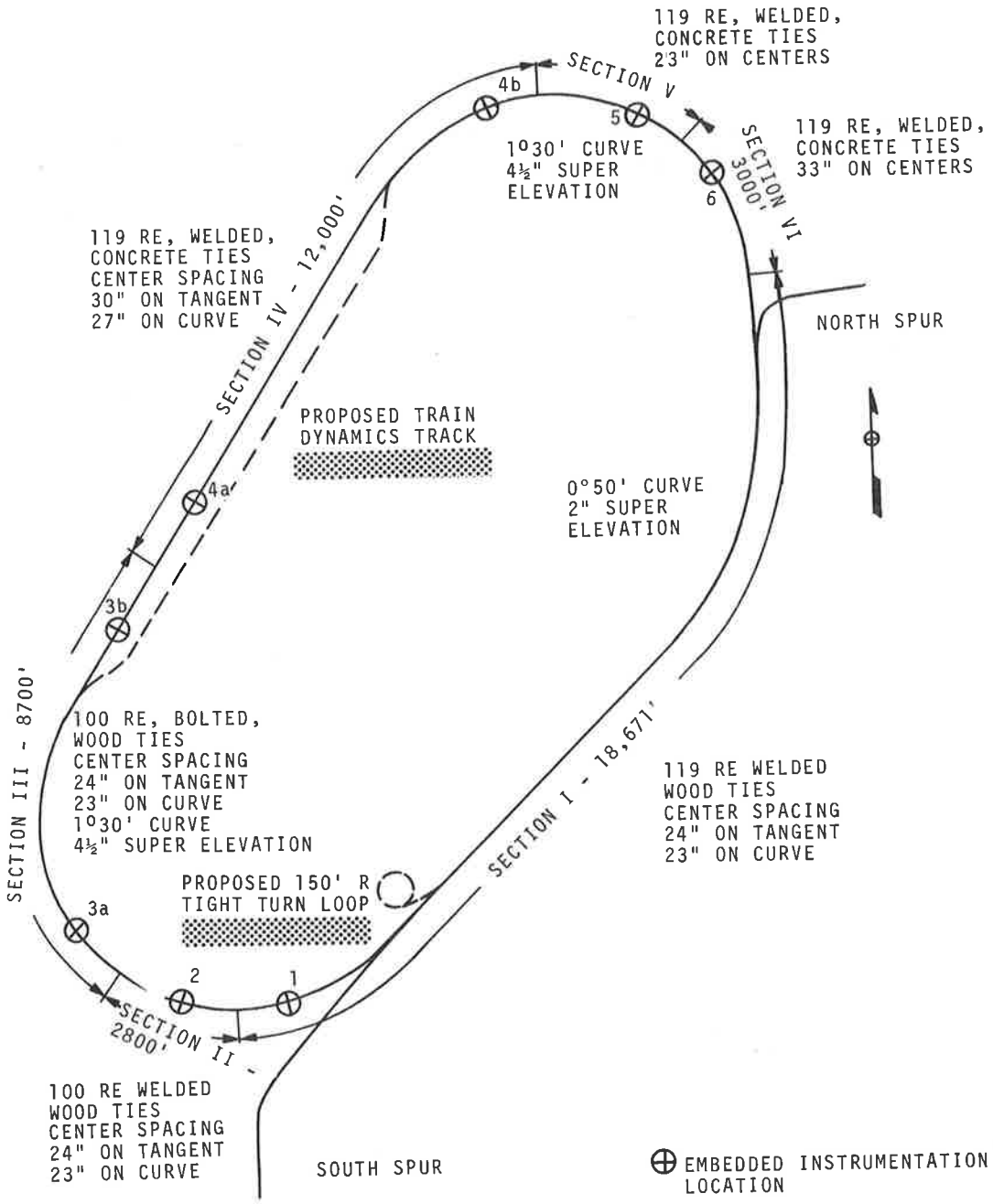

Figure 3-1 UMTA Rail Transit Test Track Additions

Rectifier Substations, Contract DOT-TSC-847, Wismer and Becker - The substation contractual effort was well underway at the close of the fiscal year however, many issues under discussion required resolution and every attempt is being made to effect satisfactory solutions.

Construction of Permanent Track-Power Facilities - TSC transferred funds in April 1975, under reimbursable agreement TSC RA 7523, to the Federal Highway Administration, Region 8, Denver, Colorado, for the construction of the permanent track-power facilities for the substations.

The 115 kv Distribution Line - Construction of the line, for source power to the permanent track-power facilities, began in fiscal year 1975 under a contract between the Federal Highway Administration and Gardner Zemke Company, Denver, Colorado, awarded in December 1974.

Catenary System - In addition to the third rail electrification, plans call for construction of an overhead system for the RTTT. The original plans for a compound catenary system were suspended indefinitely, because architectual engineering bids received were unacceptable. Therefore, construction of a two-mile overhead was initiated to provide for test and evaluation of light rail vehicles for the San Francisco MUNI and the Boston MBTA. These vehicles are equipped with a pantograph power collector. Funds for construction of the two-mile overhead were transferred to the FRA under reimbursable agreement RA-7526 in April 1975. Construction, using government furnished equipment, is scheduled to begin on July 1, 1975.

Track Interface for Cab Signalling - The two-mile section of track which will be used for SLRV tests will be equipped to interface with the San Francisco Municipal Railway signalling system. The track interface work at TTC will be done by Wismer and Becker under their contract with SFMR. This TTC work will be funded on a shared basis between SFMR and TSC. Funds were transferred to SFMR under TSC procurement request 612-0287 to cover the TSC share of $39K.

3.3.3 Maintenance and Repair Service Facilities and Equipment

Track Scale (Vehicle Weighing), Contract DOT-TSC-829, Murphy Scale and Equipment Company - Installation of the Track Scale adjacent to the Transit Maintenance Building, Figure 3-2, was started in the first quarter. Track installation of the scale, Figure 3-3, was completed in October and the North leg of the Wye was opened in November 1974.

Tail Track Connection from Transit Maintenance Building to the Adjacent Leg of the Wye Track - Funds were transferred to the FRA (RA-7549, $50K) 25 June 1975 for use by TTC to provide construction of the track connection.

Black Top Storage Area at the Transit Maintenance Building - Black-top storage area at the west side of the Transit Maintenance Building was completed in the second quarter of fiscal year 1975.

Wheel Truing Machine, Contract DOT-TSC-876, Hegenscheidt Corporation of America - The underfloor Wheel Truing Machine contract was awarded at the close of fiscal year 1974 and has been progressing normally with an expected date of completion in Dec. 1975. Preparation of a procurement request was in process for the wheel truing machine foundation at the close of fiscal year 1975.

Air Compressor (Large Unit), Contract DOT-TSC-806, Lincoln Controls Company - The air compressor was delivered in the first quarter of fiscal year 1975.

Portable Railroad Car Jacks, Contract DOT-TSC-825, Whiting Corporation - Four 35-ton car jacks arrived at TTC in April of 1975, providing a total of eight 35 ton jacks.

3.3.4 Track Structures Analysis and Design Criteria Contract DOT-TSC-563, Battelle Columbus Laboratories

The Final Report of the original contract was delivered in fiscal year 1974 and an extension of the contract was awarded for Battelle Columbus Laboratories to define embedded instrumentation for the measurement of forces and deflections at rail joints and fasteners. The final report for the extension, "Data Analysis

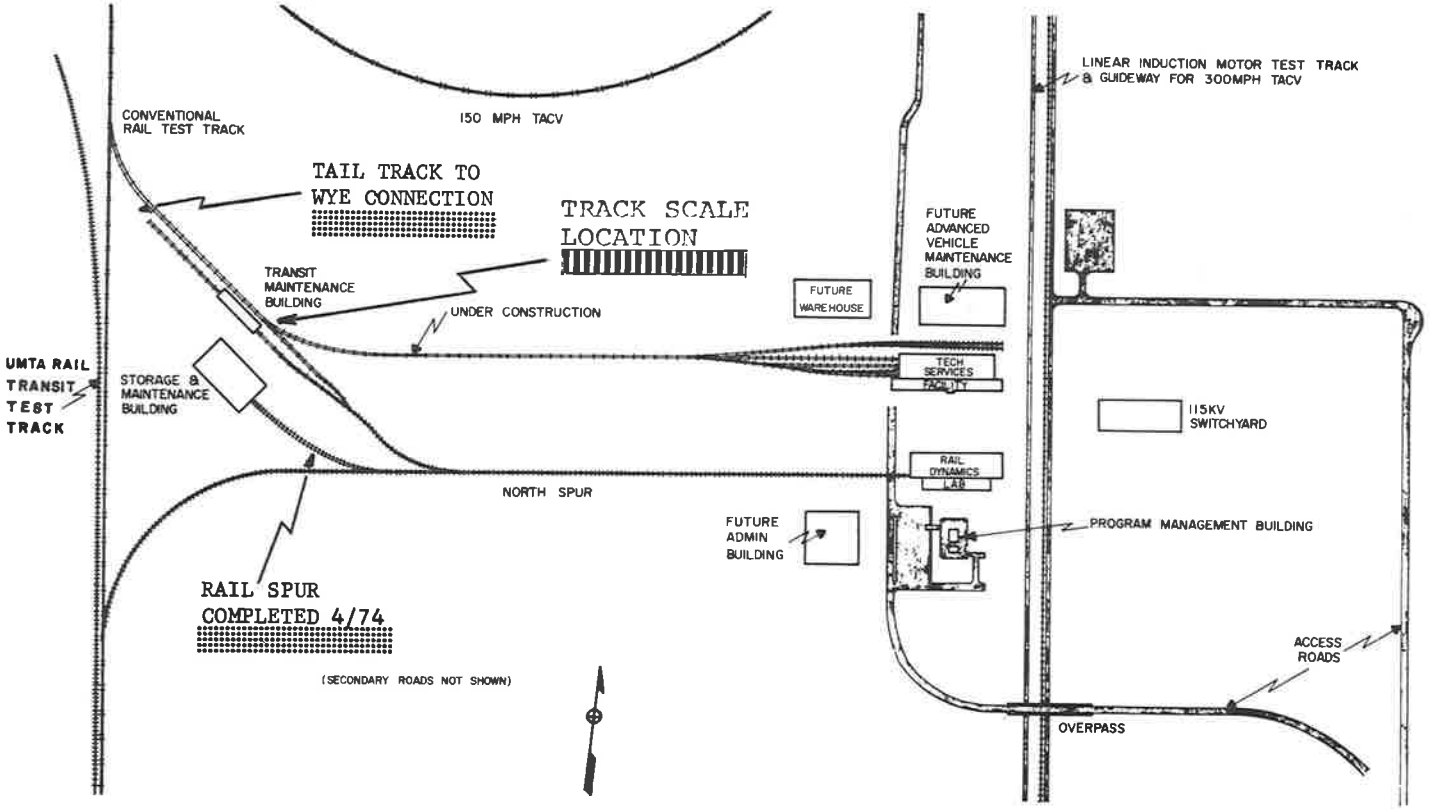

Figure 3-2 Rail Spur and Tail Track Connection

Figure 3-3 Track Scale Installed in North Leg of Wye Track Just North of the Transit Maintenance Building

and Instrumentation Requirements for Evaluating Rail Joints and Rail Fasteners in Urban Track", was published in February 1975.

3.4 TEST AND EVALUATION

3.4.1 Test Plans and Requirements

Master Test Document (GSP-010) - The "Master Test Document", GSP-010, was first published in October 1971 as the "Rail Technology Test Plan". The objective of this document has been to serve as a focal point for the test activity associated with the Urban Rail Supporting Technology Program. It includes cross-referencing for documentation of test plans, facilities, equipment, and test results. It has served as a working document for test program planning and coordination, but has not been re-issued since the original release. The document has been updated and will be published in early fiscal year 1976 to facilitate wider circulation.

The document contents is summarized as follows:

1. Introduction
2. Test Program Development

3. Rail Transit Test Facilities
4. Test Equipment
5. Test Operations and Support
6. Test Projects
7. Catalog of Tests Completed.

The tests completed to date are summarized by test series in Table 3-2. A test series is defined as a group of tests carried out for a specific vehicle at a specific site on a relatively continuous schedule. A given test project can include several test series to accomplish the project objectives.

The General Vehicle Test Plan (GSP-064) Revision, Contract DOT-TSC-580, Boeing Vertol Company - The GVTP test procedures and data specifications for evaluative testing of urban rail vehicles was expanded to include thirty-two tests in nine categories that form the basis for a quantitative comparison of urban rail vehicle characteristics, Table 3-3. The document revision, by Boeing Vertol Company, was reviewed and recommended changes were prepared. The revised plan has been submitted for approval for publication. The revised GVTP will be published during the first quarter of fiscal year 1976.

A draft version of the revised test plan, which contains the basic material to be published, was used as the basis for vehicle testing in the past year. Tests using the GVTP were completed on the Energy Storage Cars at the Transportation Test Center; preparations for testing the Standard Light Rail Vehicle in early fiscal year 1976 have been based on the GVTP; and the State-of-the-Art Car Engineering Tests, the results of which were recently published, were based on an earlier version of the GVTP. The experience gained on the SOAC test program has been incorporated into the forthcoming publication of the GVTP.

TABLE 3-2 TEST SUMMARY

Test Series	Complete	Vehicle	Location	Project	Contractor	Report No.*
1	5/71	R-42	NYCTA	Equipment Development	TSC	2
2	8/71		TTC			3
3	11/71					4
4	3/72					5
5	6/72					6
6	12/72	PCC	MBTA	Green Line Study		7
7	10/73	Air-Porter	CTS	AC Propulsion		8
8	6/73	SOAC	TTC	SOAC Program	Boeing Vertol Co.	9
9	4/74					N/A
10			NYCTA			N/A
11			MBTA			N/A
12			CTS			N/A
13			CTA			N/A
14	4/75		SEPTA			N/A
15	5/75		PATCO			N/A
16	1/75	ESC	TTC	ESC Program	Garrett AiResearch	N/A
17	3/75	R-42	TTC	TGMS C/C	TSC	N/A
18	5/75	R-42	TTC	Gvt Eqp C/O	TSC	N/A
19	6/75	R-42	TTC	TGMS C/A	TSC	N/A

Legend:

AIRPORTER - CTA Airporter Car
CTA - Chicago Transit Authority
CTS - Cleveland Transit System
ESC - Energy Storage Car
GVT - General Vehicle Test
MBTA - Massachusetts Bay Transportation Authority
NYCTA - New York City Transit Authority
PATCO - Port Authority Transit Corporation
PCC - Presidential Conference Car
SEPTA - Southeastern Pennsylvania Transportation Authority
SOAC - State-of-the-Art Car
TGMS - Track Geometry Measurement System
TSC - Transportation Systems Center
TTC - Transportation Test Center

* See footnote references. N/A - Not yet assigned.

2. U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Research and Development, Washington, D.C. "Preliminary Vibration Measurement on the Mark I Diagnostic Vehicle, Report No. DOT-TSC-UMTA-72-2", October 1971.

3. U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Research and Development, Washington, D.C. "Noise Level Measurements on the UMTA Mark I Diagnostic Car (R-42 Model), Report No. DOT-TSC-UMTA-72-3", October 1971.

4. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts, "Track Geometry System Development Tests, Report No. PM-P-4", October 1973.

TABLE 3-3 GENERAL VEHICLE TEST SETS

PERFORMANCE	
P-2001-TT	ACCELERATION
P-3001-TT	DECELERATION-BLENDED BRAKING
P-3002-TT	DECELERATION-SERVICE FRICTION
P-3003-TT	DECELERATION-DYNAMIC ONLY
P-3004-TT	DECELERATION-EMERGENCY
P-4001-TT	DRIFT TEST
P-5001-TT	FRICTION BRAKE-DUTY CYCLES
P-2011-TT	SPIN/SLIDE-ACCELERATION
P-3011-TT	SPIN/SLIDE-DECELERATION
POWER CONSUMPTION	
PC-5011-TT	POWER CONSUMPTION
ADHESION	
A-3021-TT	ADHESION-DECELERATION
COMMUNITY NOISE	
CN-001-TT	EQUIPMENT NOISE SURVEY-WAYSIDE
CN-1001-TT	EFFECT OF CAR SPEED-WAYSIDE
CN-1201-TT	SCREECH LOOP SURVEY-WAYSIDE
PASSENGER NOISE	
PN-1001-TT	EFFECT OF CAR SPEED-ON CAR
PN-1001-TT	EFFECT OF TRACK SECTION-ON CAR
PASSENGER NOISE (Continued)	
PN-1201-TT	SCREECH LOOP SURVEY-ON CAR
PN-1301-TT	INTERIOR NOISE SURVEY
PN-2001-TT	ACCELERATION EFFECT-ON CAR
PN-3001-TT	DECELERATION EFFECT-ON CAR
RIDE ROUGHNESS	
R-0001-XX	DYNAMIC SHAKE TEST-VERTICAL
R-0002-XX	DYNAMIC SHAKE TEST-LATERAL
R-0003-XX	DYNAMIC SHAKE TEST-LONGITUDINAL
R-0010-TT	COMPONENT INDUCED VIBRATION
R-1101-TT	RIDE ROUGHNESS-WORST SPEEDS
R-2001-TT	RIDE ROUGHNESS-ACCELERATION
R-3001-TT	RIDE ROUGHNESS-DECELERATION
SIMULATED REVENUE SERVICE	
RS-5001-TT	SIMULATED REVENUE SERVICE
POWER SYSTEM INTERACTION	
PSI-6001-TT	RADIO FREQUENCY INTERFERENCE
STRUCTURE DYNAMICS	
S-1001-TT	CONSTANT SPEED
S-2001-TT	ACCELERATION
S-3001-TT	DECELERATION

The Guideline Specification for Urban Rail Cars[10] - The Guideline Specification was developed by the Urban Mass Transportation Administration to be used as a basis for vehicle specifications by the operating rail transit systems. Section 17 of this document

5. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts, "Checkout of General Vehicle Test Procedures, March 1972, Report No. PM-P-3", August 1973.

6. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts, "Urban Rail Technology Instrumentation Tests, June 1972, Report No. PM-P-2", September 1973.

7. U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Research, Development, and Demonstrations, Washington, D.C., "MBTA Green Line Tests, Riverside Line, December 1972, Report No. DOT-TSC-UMTA-74-1", September 1973.

8. U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts, "Ride Roughness Tests, Cleveland Transit System, September 1973, Report No. PM-P-5", November 1973.

9. U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Research and Development, Washington, D.C., "State-of-the-Art Car Engineering Tests at Department of Transportation High Speed Ground Test Center Final Test Report", Report No. UMTA-MA-06-0025-75-1, 2, 3, 4, 5, and 6 (6 volumes), May 1975.

10. U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Research, Development, and Demonstrations, Washington, D.C., "Guideline Specification for Urban Rail Cars", Report No. IT-06-0027-1, March 1973.

defines the testing required to verify compliance with the vehicle specifications. Many of the required tests correspond to tests in the General Vehicle Test Plan and a revision to Section 17 of the guideline specification was prepared to reflect and be more consistent with the GVTP. The approach for implementation of the Section 17 revision will be reviewed by the Sponsor early in fiscal year 1976.

Study Techniques for Evaluating the Dynamic Characteristics of Rail Vehicles, Contract DOT-TSC-652, General Electric Company - A draft of the final report was delivered by the Contractor. The study provides engineering data for application to the design evaluation capability in the dynamic performance of urban rail vehicles. Since funding has been exhausted, the draft form of the report has been used for program planning at TSC.

3.4.2 Test Program Implementation

State-of-the-Art Car (SOAC) - The results of the "SOAC Engineering Tests at HSGTC" were published as a six volume report numbered UMTA-MA-06-0025-75-1 thru -6 under contract DOT-TSC-580, with Boeing Vertol Company. The report contains test data from the first SOAC tests prior to the accidental damage to the SOAC in August 1973. The data is presented in the form prescribed in the General Vehicle Test Plan. After repair of the damaged SOAC vehicle, additional tests were made and data were collected to determine if any significant changes in the vehicle characteristics had resulted from the damage. These tests were limited to sample data points, the results of which were reported in a separate one-volume report designated Volume VII to be published after the original six volume report. The draft of the post-repair test report has been reviewed and will be submitted for approval for publication in early fiscal year 1976.

The SOAC arrived in Philadelphia for revenue service tests and demonstrations in February and opening ceremonies on the Southeastern Pennsylvania Transportation Authority (SEPTA) system were held 5 March 1975. Testing on both SEPTA and Port Authority Transit Corporation (PATCO) systems was accomplished while the SOAC was in the Philadelphia area. The SOAC remained in Philadelphia for a scheduled 9 months (approximately) of revenue operation on the PATCO system.

SOAC revenue service tests and demonstrations were also conducted in Boston, Figure 3-4, Cleveland Figure 2-5, and Chicago during fiscal year 1975 to complete a tour of five cities including New York City where the demonstration and test were conducted in fiscal year 1974.

The results from the SOAC five cities tour will be presented in a report to be published during the early part of fiscal year 1976.

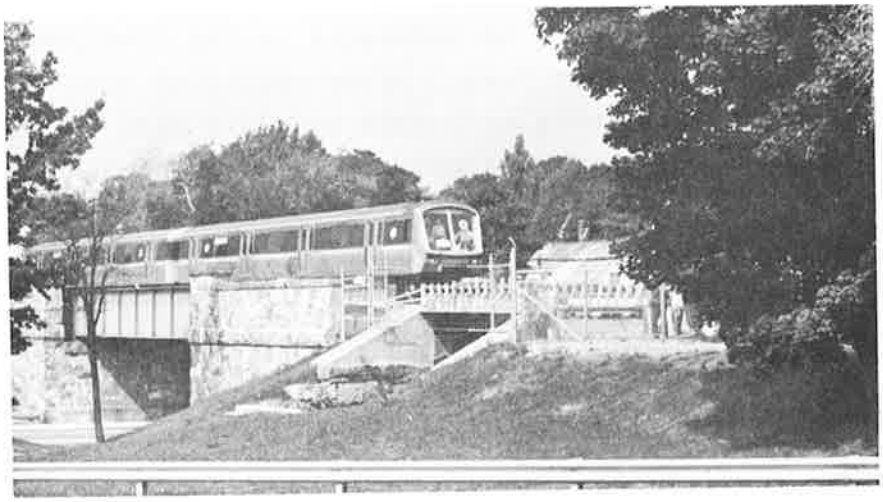

Figure 3-4 State-of-the-Art Cars in Boston, on Suburban MBTA Red Line

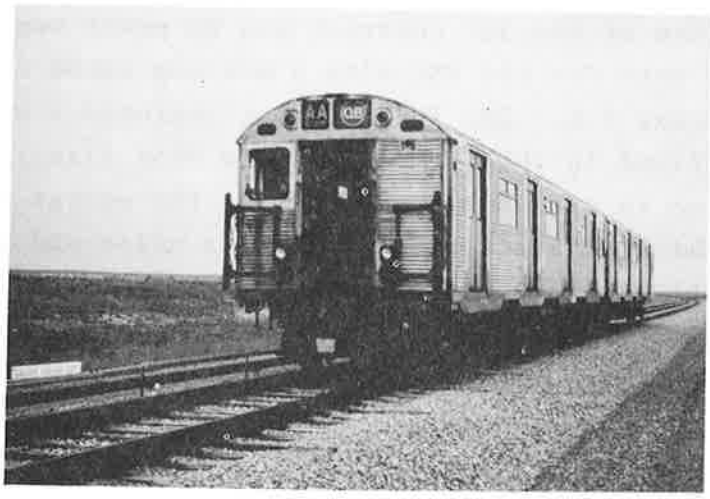

Figure 3-5 Energy Storage Cars (ESC) at the Transportation Test Center

Vehicle Tests in Revenue Service - An amendment to the SOAC Engineering Test Contract, DOT-TSC-530, is being negotiated with Boeing Vertol Company to conduct tests on revenue vehicles. Tests are to be carried out on a representative vehicle on each of the operating systems that were included in the SOAC demonstration and test tour. The test procedures, equipment, and data format used for the SOAC demonstration and test tour are to be used for the revenue vehicle tests to facilitate comparison of the SOAC with the existing revenue rolling stock.

Energy Storage Car(s) (ESC) Testing, Contract DOT-TSC-838, Garrett AiResearch Manufacturing Company - Testing of the ESC at the Transportation Test Center, Figure 3-5, was completed 27 January 1975. A draft test report submitted by AiResearch is being reviewed and publication is scheduled for early fiscal year 1976. The testing at the TTC concluded the test requirements under the TSC contract. The cars were shipped from TTC to New York City 21 February 1975.

The major emphasis on the ESC test program prior to the implementation of the TSC contract was on power consumption. Power consumption data for the ESC with a maximum speed of 45 mph is shown in Figure 3-6. The TSC contract included a wider range of tests as defined in the General Vehicle Test Plan. These tests were intended to evaluate the effect of the energy storage system on other vehicle characteristics such as noise and ride roughness. Figure 3-7 illustrates the effect of the ESC car equipment on interior noise.

Gas-Turbine/Electric Car(s) - The G-T/E commuter cars, intended for service on systems having some electrified and some non-electrified track, were developed under an UMTA Research and Development grant to the New York Metropolitan Transportation Authority. One set of four cars with gas-turbine-driven generators was developed by Garrett AiResearch under contract to the MTA. The four cars were built by Pullman under subcontract to AiResearch. The G-T/E cars were not subjected to testing in accordance with the General Vehicle Test Plan.

The G-T/E cars, Figure 3-8, were checked out on the UMTA Rail Transit Test Track prior to delivery to New York. The checkout on the RTTT aggregated more than 35 test operation days for the G-T/E cars.

NYCTA R-42 Car(s) - The R-42 cars, on loan from the New York City Transit Authority, were used for checkout and acceptance of test equipment and systems including the Track Geometry Measurement Sensor System, the General Vehicle Test System, and trainline functions of the ESC (R-32) during fiscal year 1975. Additional information is included in the TGMS and GVT equipment technical discussion.

Standard Light Rail Vehicle (SLRV) - Boeing Vertol Company is under contract to the Boston MBTA and the San Francisco MUNI to build Standard Light Rail Vehicle (SLRV) cars for those systems. The contract has been modified to test three vehicles on the RTTT and to conduct preliminary tests on the first car in Boston. The first car, Figure 2-8, was shipped to Boston in June 1975 and

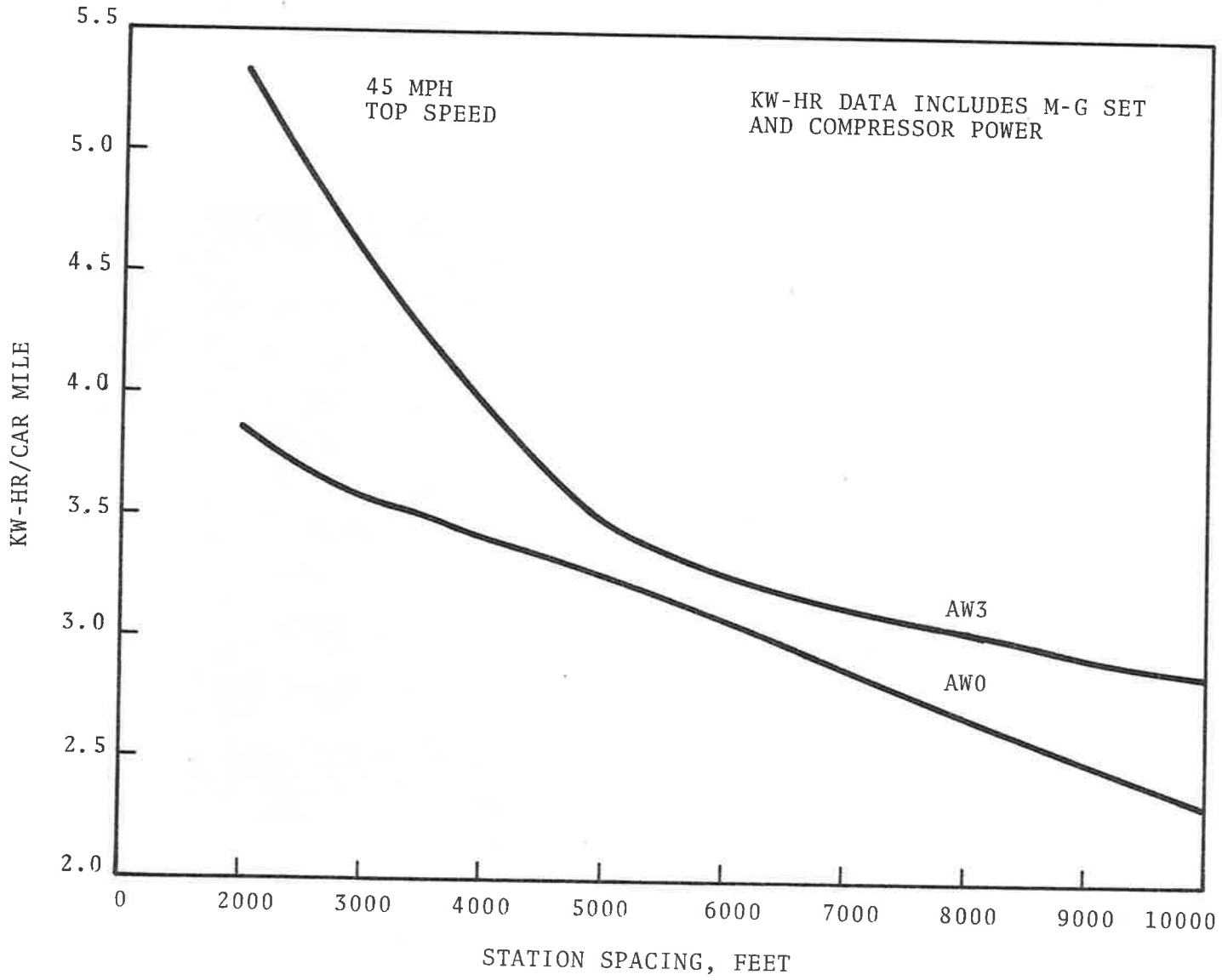

Figure 3-6 Energy Storage Cars Power Consumption Test Data

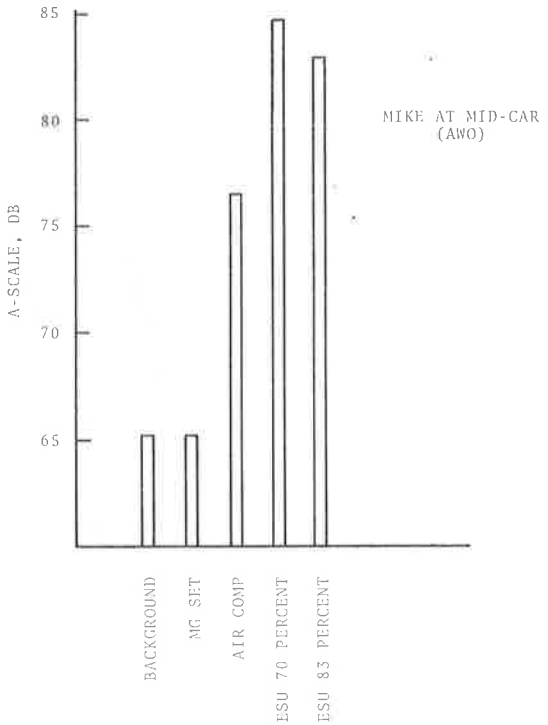

Figure 3-7 Energy Storage Cars Interior Noise Summary, Equipment Noise Survey

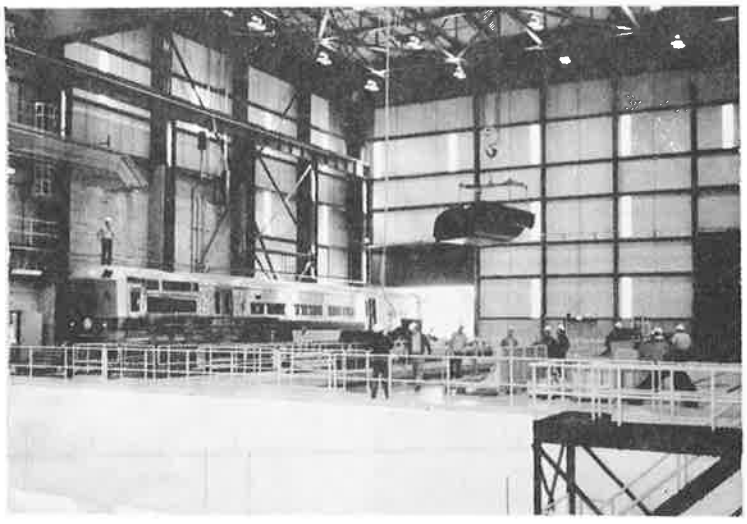

Figure 3-8 Gas-Turbine/Electric Cars in the Service Area of the Rail Dynamics Laboratory at the Transportation Test Center

started undergoing tests. A San Francisco car is scheduled to be shipped to the TTC in early September 1975, with two other cars, one MUNI and one MBTA, to be shipped later in the year.

Test planning and preparation for the SLRV tests, including facilities and equipment support, was carried out during fiscal year 1975 and a test plan was prepared by TTC, based on the test request submitted by Boeing Vertol Company.

One requirement for the SLRV tests is the exercising of the pantograph power collector for which a two-mile overhead wire was constructed on the RTTT. Cab signalling tests will be conducted by Wismer Becker Company to checkout the MUNI system and to evaluate interference with the SLRV chopper system. Facilities preparation is described in the preceding Facilities Development technical discussion.

In addition to checkout and acceptance using some of the tests from the General Vehicle Test Plan, a sole source contract, DOT-TSC-1062, was awarded to Boeing Vertol Company to conduct complete general vehicle testing on the SLRV during the first half of fiscal year 1976.

Washington Metropolitan Area Transit Authority (WMATA) Car(s) - The Rohr Corporation began delivery of WMATA cars to Washington during fiscal year 1975. A preliminary meeting was held to discuss plans for testing two of the cars on the UMTA Rail Transit Test Track. A firm date will be established after the WMATA system opens for limited service. It is expected that WMATA cars will be tested at the Transportation Test Center using the RTTT after the SLRV program is completed and before the Advanced Concept Train test program is started.

3.4.3 Instrumentation and Data Collection and Processing

The development of test equipment, data collection systems, and data processing software has emphasized three major categories; track geometry measurement, general vehicle testing (procedures

from the GVTP), and ways and structures testing. Common requirements for these categories have been considered to assure efficient development of a test capability in these areas.

Three digital data acquisition systems (DAS) were delivered by Sperry Univac in Fiscal Year 1974 for applications to urban rail testing. Two systems for use on board rail vehicles for track geometry measurement and general vehicle testing are identical. A third system has slightly reduced capability so that it will fit on a mobile test van for wayside collection of data from the instrumentation embedded in the RTTT.

Two power conditioning systems for use on board the rail car to supply the DAS from the 600 VDC system were received from AVTEL Corporation. Data collection and processing software is being developed by TSC personnel with contractor support. System integration and checkout is in process and the status is summarized in the following paragraphs.

Track Geometry Measurement System (TGMS) - The TGMS consists of a sensor system supplied by MB Associates, the digital data acquisition system supplied by Sperry Univac, and the Avtel power supply. The system, which can be mounted on any urban rail vehicle, has been mounted on the R-42 Vehicle, Figure 3-9, at the Transportation Test Center for checkout and evaluation. Software for the data collection is operational and data processing software is in the final stage of integration and checkout.

The system has been checked out on a two phase program at TTC in March and June. The tests were completed on the second phase on June 27, 1975. A 3/4-inch perturbation in profile and a 3/4-inch perturbation in alignment were introduced into the track for calibration purposes. The TGMS also measured the track before the perturbations were added and after they were removed. Several runs were made over the perturbed section to evaluate the system repeatability.

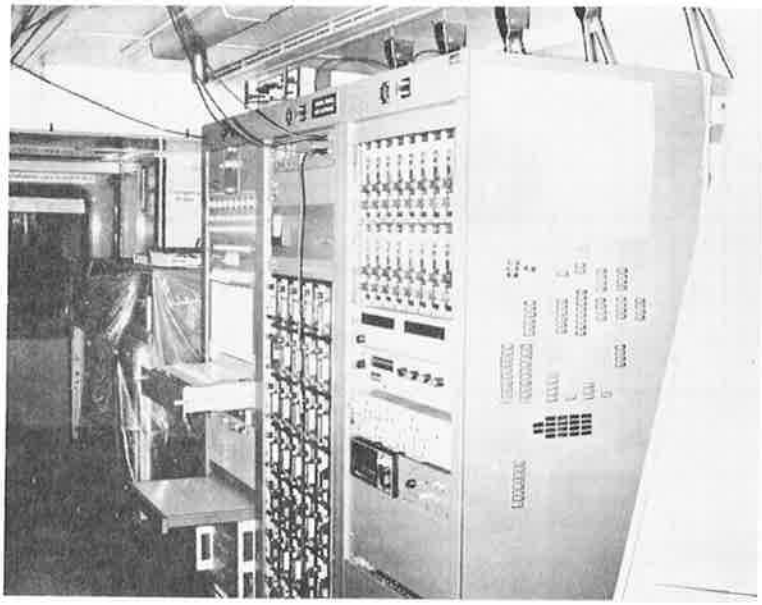

Figure 3-9 Data Acquisition System (DAS) Units Mounted in the R-42 Vehicle

Since the real time processing software has not been fully integrated, the initial evaluation is based on raw data. The repeatability appears to be very good. The data will be used for system evaluation after the processing is completed. The power supply and the DAS worked well for the test program. Some reliability problems were encountered with the MBA gauge cameras. Some rework of this hardware will be required to improve system reliability. A sample of gauge data collected in March on two different runs over the same section of track is shown in Figure 3-10.

A procurement package for track geometry system evaluation has been prepared. The contract will include tests at TTC and on an operating property with a major objective being development of a plan for utilizing the TGMS for track maintenance inspection.

General Vehicle Test Equipment - Tests were carried out on the General Vehicle Test sensors and signal conditioning equipment using the R-42 vehicle at TTC during May 1975. The tests were primarily intended to evaluate the test equipment error sources. Data were collected on analog tape for this purpose. General

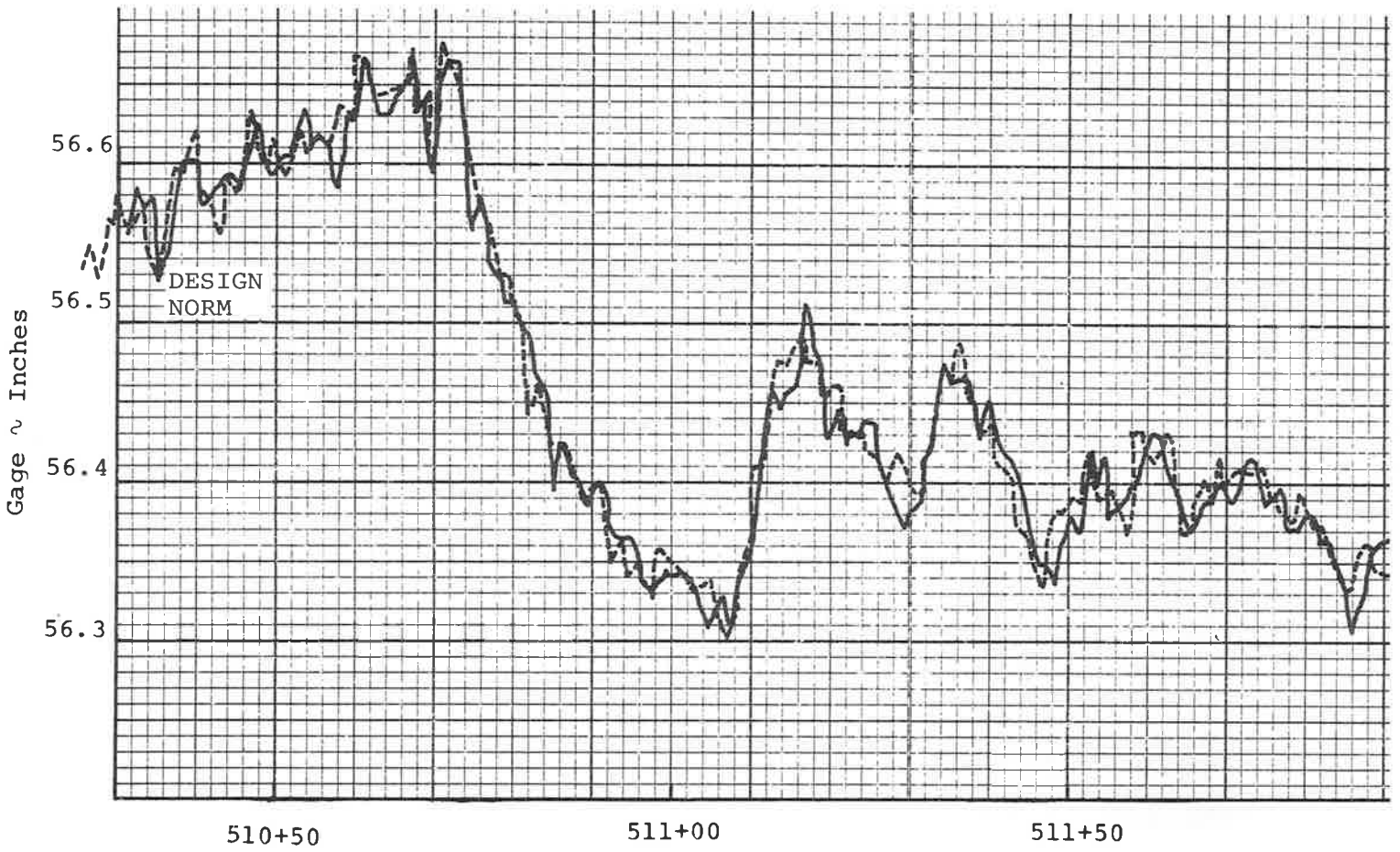

Figure 3-10 Sample of Track Geometry Measurement Gage Data

Vehicle Tests on the R-42 using this equipment along with the digital data collection system are scheduled for fiscal year 1976.

General vehicle test software for data collection will be adapted from the track geometry software. Software for processing general vehicle test data will be developed under a contract with QEI, Incorporated of Bedford, Massachusetts. A contract, DOT-TSC-1004, was awarded to QEI on a competitive procurement on April 2, 1975.

A user's manual for the GVT System equipment is being prepared and will be released in fiscal year 1976.

Ways and Structures Testing - The mobile van for use in collecting ways and structures test data on the RTTT was delivered with an excessive weight relative to axle capacity limit. Based on recommendations by Customer Service of the Dodge Division of Chrysler Corporation, modification of the undercarriage will be made to handle the weight and some of the equipment inside the van will be shifted for proper weight distribution. The van modifications are scheduled to be completed so that the van can be operational at TTC after completion of the SLRV test program.

3.5 TECHNOLOGY DEVELOPMENT

Technology development in fiscal year 1975 was directed toward improved technology in urban rail system applications of noise abatement and tunneling. New projects were initiated and several existing projects continued in both noise abatement technology and tunneling technology.

New noise abatement technology projects were initiated for noise assessments in the Cleveland, Philadelphia, and San Francisco rail transit systems; and for "In-Service Performance and Costs of Methods for Control of Urban Rail System Noise".

A noise measurement comparison experiment was conducted to determine the variations in measurements among different assessment teams. The results strengthened the basis for inter-system comparisons.

A contract award was made for testing, by an independent organization, of a new internally damped all metal wheel. The wheels are being provided by the International Copper Research Institute.

Five new programs in tunneling technology were initiated in fiscal 1975. Contracts were awarded for a study and report on "Subway Station Design and Construction" and for "Tunneling Conferences and Workshop" support. Procurement actions were in process at the close of the fiscal year for programs on "Disruptive Effects of Tunnel Construction"; "Subway System Maintenance"; and "Economic Factors in Tunnel Construction". The existing program on "Muck Utilization" was modified and extended.

3.5.1 Noise Abatement

The broad goals of this activity are to:

a. Quantify the overall size of the rail rapid transit noise problem and its distribution among U.S. systems.

b. Develop data, in a form appropriate to those who use it, on what noise levels can be achieved realistically with available technology and at what cost. Users include transit system planners and operators; state and local governmental agencies; citizen groups; Federal capital grants programs; other federal agencies; and independent contractors and consultants.

c. Develop or stimulate development of noise control methods and hardware in key technical areas where significant cost savings or significantly improved noise reduction can be achieved.

d. Establish and maintain channels of communication necessary (1) to keep program efforts technically current and (2) to encourage the adoption of program developed technology where it is applicable. Both continuing and newly initiated Urban rail noise abatement program

activities support these goals with specific objectives and tasks. These are summarized in the following.

Noise Assessments - Coordinated noise assessments are in progress on U.S. urban rail rapid transit systems (except the MBTA where it is completed). For each system, noise maps and suitable statistical measures of noise are being developed. In addition, minimized cost noise abatement options are being defined.

Noise Assessment of Chicago Rail Rapid Transit System, Grant DOT/UMTA US-DOT-IL-007, University of Illinois - A draft interim report on the noise assessment of the CTA is due in the beginning of fiscal year 1976. The final report is expected in the second quarter of fiscal year 1976.

Noise Assessment of New York City Rapid Transit System, Grant DOT/UMTA US-DOT-NY-11-0010, Polytechnic Institute of New York - A partial draft of the Noise Assessment portion of this work has been reviewed and is currently being modified and extended. A revised draft is expected in the first quarter of fiscal year 1976. The final report on the Noise Assessment and Abatement Requirements is expected for review at the beginning of the second quarter of FY76.

Noise Assessments of Cleveland Transit System (CTS), S.F. Bay Area Rapid Transit (BART) System, Southeastern Pennsylvania Transportation Authority (SEPTA) System, and Port Authority Transit Corporation (PATCO) System (Lindenwold, N.J. to Phila.), Contract DOT-TSC-850, Boeing Vertol Company and Wilson Ihrig and Associates. A draft interim report on the noise assessment portion of this work is due at the beginning of fiscal year 1976. The report on noise abatement strategies is anticipated at the beginning of the second quarter of FY76 and a final report is due in the middle of the second quarter.

Noise Measurement Comparison Experiment - An experiment was conducted in Boston, under TSC direction, to determine the scatter, if any, in measurements from four assessment teams plus a TSC noise measurement group. Six wayside and seven in-station events were recorded simultaneously by all groups. Reported noise levels

for a given event were typically within 2 dBA of each other, although a small systematic deviation (1-2 dBA) from the general trend was revealed for one group. The overall results were good for this kind of measurement and they strengthened the basis for inter-system comparisons.

Computer Program for Noise Abatement Cost Minimization - TSC developed and distributed for use by the assessment teams a computer program for optimizing noise control. Computer program inputs include costs and performance of individual treatments, desired noise goals, and the present distribution of noise over the system (further specified as to noise source and path type). The program out-puts to the user, the choice of noise control treatments (or combination of treatments) and treatment location which achieves the goal at minimum cost.

In-Service Performance and Costs of Methods for Control of Urban Rail System Noise, Contract DOT-TSC-1053, De Leuw Cather and Company (DCCO) Prime, Wilson Ihrig and Associates, Subcontractor - The objective of this activity is to develop definitive engineering data on costs and long term in-service performance of four types of commercially available noise control treatments. Currently, such data is inadequate to determine benefits versus costs for possible wider use. The specific treatments to be conducted under this contract include resilient wheels, damped wheels, wheel truing and rail grinding. The testing will be performed on the Southeastern Pennsylvania Transportation Authority (SEPTA) system, and data will be put in a form applicable to U.S. systems generally.

New Technology - These items address mainly goal (c) preceding:

Wheel/Rail Noise and Vibration Control, Contract DOT-TSC-644, Bolt, Beranek, and Newman, Inc. - The objective of this program, now essentially completed, was to develop the basic quantitative understanding of wheel-rail noise generation as a basis for improved wheel-rail noise control. The final report of this program was in the process of being published at the close of the fiscal year.

Incramute Wheel Testing, Contract DOT-TSC-644, Bolt, Beranek, and Newman - This contract was extended to permit investigative testing of a new design of wheel in which a special metal alloy is used to provide high damping. These "Incramute" wheels will be tested on a DOT vehicle and track at Pullman Standard. The International Copper Research Institute is providing the wheels at no cost to the government. Delivery of the wheels is expected in the first quarter of fiscal year 1976. The effect of the high internal damping properties of Incramute on wheel/rail noise will be investigated. This will complete activities under Contract DOT-TSC-644.

Track and Elevated Structures, Contract DOT-TSC-643, Cambridge Collaborative, Inc. - This program, now nearing completion, has as its objective the development of a quantitative basis for improved design of elevated structure and floating slab noise control technology for urban rail transit applications.

Two volumes of a three volume final report have been reviewed. The reports, entitled "Noise Prediction Models for Elevated Rail Transit Structures" and "Vibration Prediction Model for Floating Slab Rail Transit Track", will be published during the first quarter of fiscal year 1976. A third volume summarizing the practical engineering and experimental results for elevated structure noise is anticipated during the first quarter of fiscal year 1976.

3.5.2 Tunneling

Requirements Study Investigating Instrumentation Development for Rapid Transit Tunneling, Contract DOT-TSC-654, Parsons, Brinckerhoff, Quade, and Douglas - A final report detailing improved subsurface exploration technology and methodology was completed detailing a proposed systematic approach for site investigation including requirements, specifications, and preliminary designs for development of all system components. It is anticipated that the final report will be published during the first quarter of fiscal 1976.

Specifications and Design for Monitoring Instruments for Rapid Transit Tunneling, Contract DOT-TSC-661, Parsons, Brinckerhoff, Quade, and Douglas - A final report was printed and distributed during the last quarter of fiscal 1975. The report (in two volumes) outlines the benefits and potential advantages of construction monitoring of soft ground rapid transit tunnels. A modification to the original contract was written to procure a manual-based on the above final report - to assist planners and designers in planning a monitoring system. Anticipated completion date of the manual is during the first quarter of fiscal 1976.

System Analysis, Modeling, and Optimization of Rapid Transit Tunneling Process, Contract DOT-TSC-601, Bechtel, Inc. - The final report was completed and is in the process of publication. The study developed a systems analysis model of tunnel and cut and cover costs and using a data base developed from five case histories explored the sensitivities of various factors in tunnel construction.

Environmental Impact and Safety Guidelines for Improved Rapid transit Tunneling, Contract DOT-TSC-802, AA. Mathews, Inc. - A draft copy of the interim report documenting all work on Phase A of this contract will be available at the end of fiscal year 1975. The Phase A work consisted of the investigations, compilation of data, an analysis of data and the proposal of a series of guidelines to promote safety and to minimize environmental impact on urban transportation tunneling projects. In Phase B the contractor will present the proposals to industry for their comments before drafting the final safety and environmental guidelines.

Muck Utilization in the Urban Rapid Transit Tunneling Process, Contract DOT-TSC-836, Haley and Aldrich, Inc. - A draft interim report was completed, the contents of which will be used as the basis for developing an actual muck utilization program for a selected case study site in the extension of the contract. The study showed that, with proper planning, the utilization of excavated materials (muck) from tunnels can produce both economic

and environmental benefits. Guidelines developed under this contract will aid transit planners in integrating muck utilization planning into the overall planning effort necessary for the development of urban transit systems involving underground construction.

Assessment of Disruptive Effects Associated with Urban Transportation Tunnel Construction, Contract DOT-TSC-1018, Abt Associates, Incorporated - This study will identify the disruptive effects of tunnel construction, identify and assess the existing means of measuring these effects and will present a preliminary approach to assessing the impacts in order to ultimately provide guidelines for transit planners to aid them in predicting, before construction begins, the degree of disruption caused by tunnel construction. The contract was awarded on 7 May 1975.

Subway Station Design and Construction, Contract DOT-TSC-1027, De Leuw Cather and Company - In this contract the various methods of subway station construction being utilized world-wide will be reviewed to assess the relative values of the alternate techniques of subway station construction and establish the set of conditions under which each method becomes cost effective. The construction techniques will be evaluated by a select panel and new and innovative techniques of construction will also be reviewed and reported. The contract was awarded on 3 June 1975.

Guidelines for Existing Subway Maintenance, Contract DOT-TSC-1078, Bechtel, Incorporated, San Francisco, California - This contract provides for an in-depth look at the often neglected field of subway system maintenance. An attempt is to be made to determine the methods for detection of deterioration, the methods for evaluating or measuring the degree of deterioration, and methods for repairing and improving the quality of existing tunnel systems. Also, an attempt is to be made to determine methods to detect old design errors. The contract was awarded on 30 June 1975.

Workshops and Conference on Urban Transit Tunneling, Contract DOT-TSC-987, Ken Guscott Associates - The contract will provide the support necessary to the TSC in presenting four or more workshops in the next year at various locations throughout the country.

This contract will assist in providing facilities, moderators, experts, and administrative support on topics such as, Subsurface Exploration, Construction Monitoring, Slurry Wall Techniques, and Optimization of Cut and Cover Tunneling. Actual agendas and locations will be arranged through cooperation with transit authorities. The contract was awarded on 9 June 1975.

Reimbursable Agreement RA-74-39, National Science Foundation (NSF) - Procurement Request TMP-0232 provided funds for this reimbursible agreement by which the National Science Foundation, using these funds and funds from other government agencies and the tunneling industry, prepared a study on tunneling contracting practices. A report "Better Contracting for Underground Construction," was distributed in mid-year, fiscal year 1975.

Reimbursable Agreement RA-74-44, National Science Foundation (NSF) Procurement Request TMP-0236 provided funds which, together with funds from other government agencies, supported the operations of the U.S. National Committee of Tunneling Technology (under the National Academy of Sciences - NAS).

Economic Factors in Tunnel Construction - A procurement request was initiated to create a construction cost data base for bored, soft ground tunnels. Methodology will be proposed for using this base in cost estimating and systems analysis of tunnel construction alternatives.

3.6 TRANSPORTATION TEST CENTER FIELD SUPPORT

The Transportation Systems Center URST Program provided technical and planning support at the DOT Transportation Test Center, Pueblo, Colorado, to all of the urban transit vehicle test projects conducted there on the UMTA programs. Such support is available for non-UMTA testing programs on an arranged basis.

Test capability and experience on the UMTA Rail Transit Test Track has been acquired, at both the system and subsystem levels, in the testing of the NYCTA R-42 cars, the UMTA SOAC, the NYCTA R-32 modified by installation of energy storage flywheel

(Garrett AiResearch), and the Gas-Turbine/Electric (G-T/E) cars (Garrett AiResearch and Pullman). Activities are well in progress to further expand this experience to include the Standard Light Rail Vehicle (SLRV) (Boeing Vertol) and the Washington Metropolitan Area Transit Authority (WMATA) cars (Rohr).

UMTA Rapid Transit Test Track Operations

Operations on the UMTA RTTT in fiscal year 1975 included: the NYCTA R-42 cars, figure 2-1; the Energy Storage Cars (ESC's), Figure 2-2; the Gas-Turbine/Electric cars (GTE), Figure 2-3; the Canadian Light-Rapid-Comfortable (LRC) train, Figure 2-9; testing of trucks by American Steel Foundries; and a test program on an Amtrak train.

APPENDIX A

URST PROJECTS IN FISCAL YEAR 1975

TECHNICAL SUPPORT AND APPLICATIONS ENGINEERING

1. Advanced Concept Train (ACT) - Program review and technical support given to the ACT program by TSC personnel throughout fiscal year 1975.

2. Transit System Costs - Rail Rapid System Cost Study. A comprehensive study of urban rail transit system costs by Thomas K. Dyer, Inc., under Contract No. DOT-TSC-808. TSC Monitor: Frederick J. Rutyna.

3. Vehicle Crashworthiness - Engineering Program Assessment of the Crashworthiness of Existing Urban Rail Vehicles. Program development work was performed by Calspan, Inc., providing methodology and assessment criteria, under Contract No. DOT-TSC-791. TSC Monitor: A.R. Raab.

4. SOAC Crashworthiness Study - Crashworthiness evaluation and test study of the State-of-the-Art Car by engineering assessment performed by Boeing Vertol, under Contract No. DOT-TSC-791. TSC Monitor: Frederick J. Rutyna.

5. Increase of Car Body Crashworthiness in the Head-on Collision - Contract No. DOT-TSC-1052 TSC Monitor: A.R. Raab.

6. Track Geometry Sensor Systems - Two sensor systems engineered by MB Associates, to TSC specifications, under Contract No. DOT-TSC-616. TSC Monitor: Frederick J. Rutyna.

FACILITIES DEVELOPMENT

7. Development of Design Tools and Criteria for Urban Rail Structures - A study of design elements for urban rail structures by Battelle Columbus Laboratories, under Contrack No. DOT-TSC-563. Two-volume final report issued in April 1974. TSC Monitor: Leonard Kurzweil.

8. Tight Turn Loop and Train Dynamics Track for the Rail Transit Test Track (RTTT) at the Transportation Test Center (TTC). Drawings and specifications prepared by TSC personnel, earthwork completed. TSC Monitor: R.W. Ebacher.

9. Electrical Equipment, Drawings and Specifications for UMTA Substations Providing Power to RTTT - Specification No. DOT/LBP-71421 developed by Laramore, Douglas & Popham, Consultants, under Contract No. DOT-FR-30033; Wismer & Becker, Inc., under Contract No. DOT-TSC-847 for rectifier substation equipment. TSC Monitor: L.F. Zorio.

10. Catenary Power System - Planning and design work prior to the selection of a contractor for the construction of the Rail Transit Test Track catenary structure. All materials GFM. TSC Monitor: L.F. Zorio.

11. Development of RTTT Laboratory and Maintenance Facilities. Prepared specifications and initiated procurement for:

    a. Underfloor Wheel Truing Machine, DOT-TSC-876
    b. Track Scale, DOT-TSC-829
    c. Railroad Car Jacks, DOT-TSC-825
    d. Air Compressor (large unit), DOT-TSC-806

    TSC Monitor: R.W. Ebacher.

12. Transfer of Funds to FHWA for Construction of Permanent Track Power Facilities at TTC - Procurement Request No. 612 285. TSC Monitor: R.W. Ebacher.

13. Transfer of Funds to FRA for 2.1-mile Catenary Construction on RTTT at TTC - Reimbursable Agreement RA 7526. TSC Monitor: L.F. Zorio.

14. Installation and Removal of Cab Signalling System, Contract DOT-TSC-1032, San Francisco Municipal Railroad, TSC Monitor: L.F. Zorio.

TEST AND EVALUATION

15. Standard Light Rail Vehicle (SLRV), General Vehicle Tests at TTC- Contract DOT-TSC-1062, Boeing Vertol Co. TSC Monitor: George W. Neat.

16. Engineering Tests on Rail Transit Vehicles of Six Major Transit Properties on the Home Track System - Contract DOT-TSC-580 modification, Boeing Vertol Company. TSC Monitor: George W. Neat.

17. Energy Storage Car (ESC) Engineering Tests at TTC - TSC generated test plans and procedures. Tests were conducted by AiResearch Manufacturing Co., under Contract No. DOT-TSC-838. TSC Monitor: George W. Neat.

18. State-of-the-Art Car (SOAC) Tests at TTC - TSC GSP 064 test plans and procedures.

    a. Engineering testing performed by Boeing Vertol, under Contract No. DOT-TSC-580. Test Report (UMTA-MA-06-0025-75-1) published.

    b. SOAC post-repair engineering tests - special test work performed by Boeing Vertol, under Contract No. DOT-TSC-580, to verify data taken prior to accident.

    c. SOAC engineering test runs on NYCTA revenue line (4 separate lines), constituting the first phase in the five-property test plan schedule for the SOAC.

    TSC Monitor: George W. Neat.

19. General Vehicle Test Plan for Urban Rapid Transit Cars (GSP 064 - Rev. 1) - Revision of tests and procedures, based on evaluation data acquired during the SOAC engineering tests. TSC Monitor: George W. Neat.

20. Power Conditioning Systems - Engineered by the Avtel Corporation, Contract No. DOT-TSC-671, for use in conjunction with Data Acquisition System (DAS) equipment. TSC Monitor: John Nickles.

TEST AND EVALUATION (Continued)

21. Study of Techniques for the Evaluation of Dynamic Characteristics of Rail Vehicles - Study and evaluation work by General Electric under Contract No. DOT-TSC-652. TSC Monitor: Herbert Weinstock.

22. Gas Turbine/Electric Car Tests at TTC - TSC provided Technical support at the TTC for testing the UMTA-sponsored Gas Turbine/Electric Cars built by the Garrett Corporation for the New York Metropolitan Transportation Authority. TSC TTC Rep: R. Brush.

23. R-42 Transit Car Test Participation - The New York City Transit Authority R-42 cars were used to check out test equipment and test procedures at TTC and for trainline tests with the Energy Storage Cars. TSC TTC Rep: R. Brush.

24. Digital Data Acquisition - Three Data Acquisition Systems (DAS) were developed for TSC by Sperry Univac under Contract No. DOT-TSC-561. TSC Monitor: Paul Poirier.

25. Software Development for Post-Test Processing on the DAS Computer - Contract No. DOT-TSC-1004 to QEI, Inc. TSC Monitor: R.H. Robichaud.

26. Support of System Integration and Test Program - Procurement Request No. 621 92. (Modification of Contract DOT-TSC-561 to Sperry Univac.) TSC Monitor: Paul Poirier.

27. Software development for the DAS application in the Track Geometry Measurement System, General Vehicle Tests, and Wayside Data Acquisition and Processing. R.H. Robichaud.

28. Integrated accelerometer data processing test and evaluation, to provide true rail profile data. R.H. Robichaud.

NOISE ABATEMENT

29. The Procurement of Engineering Data on Wheel/Rail Noise and Vibration Control Technology - Project work was performed by Bolt, Beranek & Newman, under Contract No. DOT-TSC-644. TSC Monitor: Robert Lotz.

30. Development of an Acoustic Rating Scale for Assessing Annoyance Caused by Wheel/Rail Noise in Urban Mass Transit - The work was performed by Bolt, Beranek & Newman, under Contract No. DOT-TSC-644. TSC Monitor: Robert Lotz.

31. Noise Assessment and Abatement in Rapid Transit Systems - Complete analysis of wheel/rail noise data by Bolt, Beranek & Newman, under Contract No. DOT-TSC-644. TSC Monitor: Robert Lotz.

32. A State-of-the-Art Assessment of the Prediction and Control of Rail Transit Noise and Vibration - Project work performed by Cambridge Collaborative, under Contract No. DOT-TSC-643. TSC Monitor: Leonard Kurzweil.

33. Noise and Vibration Assessment of the Chicago Rail Rapid Transit System - A study performed by the University of Illinois, under UMTA Research Grant No. US-DOT-IL-0007. TSC Monitor: Frederick J. Rutyna.

34. Data Management System for Rail Rapid Transit Noise Measurements - Development study work performed by the University of Illinois, under UMTA Research Grant No. US-DOT-IL-0007. TSC Monitor: Frederick J. Rutyna.

35. Noise and Vibration Assessment of New York City Rapid Transit System - A study performed by the Polytechnic Institute of New York, under UMTA Research Grant No. US-DOT-NY-11-0010. TSC Monitor: Frederick J. Rutyna.

36. In-Service Performance and Costs of Methods for Control of Urban Rail System Noise, Contract DOT-TSC-1052, De Leuw Cather and Company. TSC Monitor: Robert Lotz.

TUNNELING

37. System Analysis, Modeling and Optimization of Rapid Transit Tunneling Process - Development study by Bechtel, Inc., under Contract No. DOT-TSC-601. TSC Monitor: George Kovatch.

TUNNELING

38. Requirement Study Investigating Instrumentation Development for Rapid Transit Tunneling - Investigation by Parsons, Brinckerhoff, Quade & Douglas, under Contract No. DOT-TSC-661. TSC Monitor: Andrew Sluz

39. Specifications and Design for Monitoring Instruments for Rapid Transit Soft Ground Tunneling - Design work by Parsons, Brinckerhoff, Quade & Douglas, under Contract No. DOT-TSC-661. TSC Monitor: Andrew Sluz

40. Two Studies on Tunneling Technology - Initiated by the FRA; Reimbursable Agreements RA-7439 and RA-7444 to the National Science Foundation. TSC Monitor: Santo Gozzo.

41. Environmental Impact and Safety Guidelines for Improved Rapid Transit Tunneling - A study by A.A. Mathews, Inc., under Contract No. DOT-TSC-802. TSC Monitor: Santo Gozzo.

42. Muck Utilization in Urban Rapid Transit Tunneling Process - A study by Haley and Aldrich, Inc., under Contract No. DOT-TSC-836. TSC Monitor: Gerald R. Saulnier.

43. Assessment of Disruptive Effects Associated with Urban Transportation Tunnel Construction, Contract DOT-TSC-1018, Abt Associates. TSC Monitor: Gerald. R. Saulnier

44. Engineering Data and Service on Subway System Maintenance, Contract DOT-TSC-1070. TSC Monitor: Gerald R. Saulnier.

45. Subway Station Design and Construction, Contract DOT-TSC-1027, De Leuw, Cather and Company. TSC Monitor: Santo Gozzo.

46. Workshops and Conference on Urban Transit Tunneling, Contract DOT-TSC-987, Ken Guscott Associates. TSC Monitor: Glenn S. Larson

47. Economic Factors in Tunnel Construction - Procurement Request No. 612 306. TSC Monitor: Andrew Sluz.

APPENDIX B

CONTRACTS AND GRANTS

Contracts and grants concerning the URST Program activities during fiscal year 1975 are listed in numerical order, under separate headings. The contract listing shows all active contracts, including those initiated or awarded (*) and those closed out (**) during the fiscal year. These contracts and grants, and the activities they implement, constitute efforts initiated, planned, and managed under the URST Program. Contract funding was provided from URST Project Plan Agreement (PPA) resources. Grants listed are DOT grants specifically related to URST Program activities. The grant funding was provided from the Office of the Secretary (OST) or the Urban Mass Transportation Administration (UMTA).

CONTRACTS ACTIVE IN FISCAL YEAR 1975

(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-561 UM304	Sperry Univac	Data Acquisition System for Rapid Rail Vehicle	P. Poirier
DOT-TSC-563 UM304	Battelle Columbus Laboratories	Development of Design Tools and Criteria for Urban Rail Structures	L. Kurzweil
DOT-TSC-580 UM404	Boeing Vertol	Engineering Tests of the State-of-the-Art Car	G. Neat
DOT-TSC-601 UM304	Bechtel, Inc.	System Analysis, Modeling and Optimization of Rapid Transit Tunneling Process	G. Kovatch
DOT-TSC-616 UM304	MB Associates	Track Geometry Sensor System	F. Rutyna
DOT-TSC-643 UM304	Cambridge Collaborative	Engineering Data on Track and Elevated Structure Noise and Vibration Control	L. Kurzweil
DOT-TSC-644 UM304	Bolt, Beranek & Newman	Engineering Data on Wheel/Rail Noise and Vibration Control Technology	R. Lotz
DOT-TSC-652 UM304	General Electric	Study and Evaluation of Dynamic Characteristics of Rail Vehicles	H. Weinstock
DOT-TSC-654 UM304 **	Parsons, Brinckerhoff, Quade & Douglas	Requirement Study Investigating Instrumentation Development for Rapid Transit Tunneling	A. Sluz

** Contract closed out in fiscal year 1975

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)

(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-661 UM404**	Parson, Brinckerhoff, Quade & Douglas	Specifications and Design for Monitoring Instruments for Rapid Transit Tunneling	A. Sluz
DOT-TSC-671 UM304	Avtel Corporation	Power Conditioning Systems	R. Wilmarth
DOT-TSC-681 UM304	Calspan Corp.	Assessment of the Crashworthiness of Urban Rail Vehicles	A. Raab
DOT-TSC-775 UM404	Am. Mobile Pwr.	Power Source	J. Paolini
DOT-TSC-791 UM404	Boeing Vertol	Engineering Assessment of SOAC Crashworthiness	F. Rutyna
DOT-TSC-802 UM404	A.A. Mathews, Inc.	Environmental Impact and Safety Guidelines for Improved Rapid Transit Tunneling	S. Gozzo
DOT-TSC-806 UM404 **	Lincoln Controls Co.	Air Compressor	E. McCarthy
DOT-TSC-808 UM404	Thomas K. Dyer	Rail Rapid Transit System Cost Study	F. Rutyna
DOT-TSC-825 UM404	Whiting Corp.	Portable Jacks	J. Paolini
DOT-TSC-829 UM304	Murphy Scale and Equipment Co.	Railway Track Scale	R. Ebacher

**Contract closed out in fiscal year 1975.

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)

(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-831 UM404 **	American Aerospace Controls	Sensors	L. Babb
DOT-TSC-836 UM404	Haley & Aldrich	Muck Utilization in Urban Rapid Transit Tunneling Process	G. Saulnier
DOT-TSC-838 UM404	AiResearch Mfg. Co.	Tests on Energy Storage Cars	G. Neat
DOT-TSC-847 UM404	Wismer & Becker	Rectifier Substation Equipment	L. Zorio
DOT-TSC-850 UM404 *	Boeing Vertol Co.	Urban Rail Noise and Vibration Abatement Study	E. Apgar
DOT-TSC-876 UM404	Hegenscheidt Corp. of America	Underfloor Wheel Truing Equipment	R. Ebacher
DOT-TSC-882 UM404	Endevco	Mode Cards	P. Silvia
DOT-TSC-893 UM404	Sundstrand Data Control Inc.	Accelerometer and Accessories	L. Babb
DOT-TSC-895 UM404	ACCO Tool and Mfg. Company	Fabrication of Brackets, Clamps, and Weldments	J. Paolini
DOT-TSC-898 UM404	Anaconda Wire and Cable Co.	Cable	J. Paolini

* Contract initiated or awarded in fiscal year 1975

** Contract closed out in fiscal year 1975

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)
(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-919 UM404	American Mobile Power Corp.	Lease of 150-200 KVA AC Alternator and 2 Power Sources	J. Paolini
DOT-TSC-925 UM404 *	Barkley and Dexter Labs	Railroad Gage and Cross-Level Measurement Tool	L. Babb
DOT-TSC-930 UM404	H.K. Porter Co. Inc.	Line Material	J. Paolini
DOT-TSC-931 UM404	Electrack Inc.	Line Material	J. Paolini
DOT-TSC-933 UM504	Celesco Industries Inc.	Displacement Transducers	L. Babb
DOT-TSC-934 UM404	MDS BuCode	9-Track 800BPI Tape Transport	P. Poirier
DOT-TSC-940 UM404 *	Stearns Associates Inc.	Custom Designed Mode Card	P. Silvia
DOT-TSC-952 UM504 *	Comdel, Inc.	Voltage Divider	L. Babb
DOT-TSC-957 UM404*	Datum, Inc.	Dual Cassette Tape Transport	P. Poirier
DOT-TSC-958 UM504*	Tri-Con Associates, Inc.	Fabrication of Isolation Amplifiers	L. Babb
DOT-TSC-971 UM504 *	CAL/TEB Electronics Co.	Fabrication of Event Communications Chassis Assy.	L. Babb

*Contract initiated or awarded in fiscal year 1975.

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)

(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-987 UM504 *	Ken Guscott Associates, Inc.	Workshop and Conf. on Urban Transit Tunneling	G. Larson
TSC-1004 UM504 *	QEI, Inc.	Software for Post-Test Processing on DAS Computer	R. Robichaud
DOT-TSC-1018	Abt Associates Inc.	Assessment of Disruptive Effects Associated with Urban Transportation Tunnel Construction	G. Saulnier
DOT-TSC-1027 UM504 *	De Leuw Cather and Company	Subway Station Design and Construction	S. Gozzo
DOT-TSC-1032 UM504 *	San Francisco Municipal Railroad	Furnish, Install, and Remove Cab Signalling System	L. F. Zorio
DOT-TSC-1052 UM504 *	IIT Research Institute Chicago	Increased Rail Transit Vehicle Crashworthiness in Head on Collision	A. Raab
DOT-TSC-1053 UM504 *	De Leuw Cather & Company	Dev of Eng Data In Serv Perf for Control of Urban Rail Noise	R. Lotz
DOT-TSC-1062 UM504 *	Boeing Vertol	General Vehicle Tests on SLRV at TTC	G. Neat
DOT-TSC-1070 UM504 *	Bechtel, Inc. San Francisco, Ca.	Subway System Maintenance	G. Saulnier

* Contract initiated or awarded in fiscal year 1975

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)
(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
DOT-TSC-1078 UM504 *	Bechtel, Inc. San Francisco	Guidelines for Existing Subway Maintenance	G. Saulnier
TS-7147 UM304 **	Ithaco, Inc.	Electronic Filter Modules	J. Nickles
RA-7429 UM404	Federal Highway Administration	Transfer of UMTA Funds Construction of Track at HSGTC	R. Ebacher
RA-7439 UM404 **	National Science Foundation	Study of Tunneling Technology	S. Gozzo
RA-7442 UM404	Federal Railroad Administration	Operations and Maintenance Support for URT at TTC	G. Neat
RA-7444 UM404 **	National Science Foundation	Study of Tunneling Technology	S. Gozzo
RA-7522 UM504	Federal Railroad Administration	Operations and Maintenance Support for URT at TTC	P. Silvia
RA-7526 UM504 *	Federal Railroad Administration	Transfer of Funds to FRA for Catenary Construction at TTC	L. Zorio
TS-8511 UM404	ENDEVCO	Multiple Channel Signal Conditioning System	L. Babb

* Contract initiated or awarded in fiscal year 1975.
** Contract closed out in fiscal year 1975.

CONTRACTS ACTIVE IN FISCAL YEAR 1975 (Continued)
(Including Reimbursable Agreement, RA, and Delivery Order, TS)

Number	Contractor	Purpose	TSC Monitor
TS-8779 UM404 *	Gould, Inc.	Rack-Mountable, 8-Channel Oscillograph	P. Poirier
TS-8901 UM404	Gould, Inc.	Rack-Mountable, 8-Channel Oscilloscope	P. Poirier
TS-8907 UM404	Ithaco, Inc.	Electronic Filter Modules	L. Babb
TS-8908 UM404	Ithaco, Inc.	Electronic Filter Modules	L. Babb
TS-9059 UM504*	Tri-Con Associates	Signal Cables	L. Babb

* Contract initiated or awarded in fiscal year 1975.
** Contract closed out in fiscal year 1975.

GRANTS

Number	Grantee	Purpose
US-DOT-IL-0007 DOT/UMTA	University of Illinois	Data Management System for Rail Rapid Transit Noise Measurements
US-DOT-IL-0007 DOT/UMTA	University of Illinois	Noise Assessment of the Chicago Rail Rapid Transit System
US-DOT-NY-11-0010 DOT/UMTA	Polytechnic Institute of New York	Noise Assessment of New York City Rapid Transit System

APPENDIX C

URBAN RAIL SUPPORTING TECHNOLOGY DOCUMENTS

URST documents consist of reports, papers, memoranda, and GSP documents.

The listings contain documents related to the Urban Rail Supporting Technology Program, including:

Interim Reports and Final Reports
Papers
Newsletters
Preliminary Memoranda (PM) Documents
Ground Systems Programs (GSP) Documents

Documents bearing a DOT or UMTA number may, if appropriate, be available through the National Technical Information Service (NTIS) Springfield, Virginia 22161. Other documents are, generally, internal to the Department of Transportation and, generally, are not available except by special arrangement with TSC or UMTA. The listing includes documents that are in preparation and documents that are forthcoming, some of which will be available through the NTIS when they are published.

Interim Reports and Final Reports are arranged primarily by UMTA numbers. A document having more than one number assigned to it is listed with all numbers and an asterisk (8) is placed beside the number that appears on the cover of the document. The NTIS number, if assigned, is listed preceding the name of the TSC contract monitor or author, as the case may be. Reports in preparation and reports forthcoming are listed by contract number if applicable.

Reports in preparation reflect current research, planning, and evaluation work, the reports of which are expected within the year, depending on the progress made by the related program or project.

Reports forthcoming are documents expected to be generated under contract provisions or as a result of DOT grants for study and research purposes. The issue of forthcoming reports will be in accordance with the related contract or grant schedule.

Reports produced by a contractor are identified by the letters CR and the contractor name appears after the title.

The date listed is the date of publication and the type of document, if not stated, is indicated by the following abbreviations:

FR Final Report
IR Interim Report
PM Preliminary Memorandum
TM Technical Memorandum
TR Technical Report

Papers are arranged in groups according to the location of the initial presentation.

Newsletters are listed in order of the date of publication.

Preliminary Memoranda (PM) Documents are designated as internal working documents. They are listed according to the assigned PM number, and the author, title, and date are listed in the same manner as described for reports.

Ground Systems Programs (GSP) Documents are listed in GSP number sequence with the title and date of issue. The GSP documents generally pertain to equipment specifications and requirements, or to operating procedures or plans for the implementation of test and evaluation, or to related information developed under the Urban Rail Supporting Technology Program within the DOT Transportation Systems Center, Ground Systems Programs Division.

Interim Reports and Final Reports

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
UMTA-MA-06-0025-74-7* NTIS PB-238 127 Leonard Kurzweil, CR	A Bibliography on the Design and Performance of Rail Track Structures, by Prause, Pestel and Melvin of Battelle-Columbus Laboratories Contract DOT-TSC-563	9/74	FR
UMTA-MA-06-0025-74-8* NTIS PB-238 113 Dr. L.G. Kurzweil Dr. R. Lotz Dr. E.G. Apgar	Noise Assessment and Abatement in Rapid Transit Systems Report on the MBTA Pilot Study	9/74	FR
UMTA-MA-06-0025-74-9* NTIS PB-238 602 Ronald J. Madigan	Urban Rail Supporting Technology Program Fiscal Year 1973 Year End Summary (UM-304)	1/74 10/74	PM FR
UMTA-MA-0025-74-11 George Kovatch, CR	System Analysis of Rapid Transit Underground Construction Vol II Bechtel, Inc. San Francisco DOT-TSC-601	12/74	FR
UMTA-MA-06-0025-74-12* R. Madigan	Five Year Program-Urban Mass Transportation Administration Tunneling Research and Development Elements of Department of Transportation Tunneling Program for Fiscal Years 1975 to 1979	11/74	Plan
UMTA-MA-06-0025-74-13* Santo J. Gozzo, CR	Construction Monitoring of Soft Ground Rapid Transit Tunneling/ Parsons, Brinckerhoff, Quade and Douglas, Contract DOT-TSC-661	4/75	TR

*This number appears on the cover of the document.

Interim Reports and Final Reports (Cont'd)

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
UMTA-MA-06-0025-75-1 thru 6, 6 Volumes George Neat, CR Contract DOT-TSC-580	SOAC, State-of-the-Art Car, Engineering Test at Department of Transportation High Speed Ground Test Center, Final Test Report. Boeing Vertol Co.	1/75	FR
UMTA-MA-06-0025-75-1*	Volume I, Program Description and Test Summary		
UMTA-MA-06-0025-75-2*	Volume II, Performance Tests		
UMTA-MA-06-0025-75-3*	Volume III, Ride Quality Tests		
UMTA-MA-06-0025-75-4*	Volume IV, Noise Tests		
UMTA-MA-06-0025-75-5*	Volume V, Structural, Voltage, and Radio Frequency Interference Tests		
UMTA-MA-06-0025-75-6*	Volume VI, SOAC Instrumentation System		
UMTA-MA-06-0025-75-8* L. Kurzweil, CR	Data Analysis and Instrumentation Requirements for Evaluating Rail Joints and Rail Fasteners in Urban Track Contract DOT-TSC-563	2/75	FR
UMTA-MA-06-0025-75-9* Ronald J. Madigan	Urban Rail Supporting Technology Program Fiscal Year 1974 Year End Summary	3/75	FR

*This number appears on the cover of the document.

Interim Reports and Final Reports (Cont'd)

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
UMTA-MA-06-0025-75-10* and -11*, 2 volumes Robert Lotz, CR	Wheel/Rail Noise and Vibration Bolt, Beranek, and Newman, Inc. Contract DOT-TSC-644	5/75	FR
DOT-TSC-OST-74-4* R.J. Pawlak Dr. A.M. Colella Dr. N. Knable R.H. Robichaud Dr. E. Donald Sussman	**Safety and Automatic Train Control for Rail Rapid Transit Systems	7/74	FR
DOT-TSC-561 Paul Poirier, CR	Data Acquisition System for Rapid Rail Vehicle; Sperry Univac	1974	Manual
DOT-TSC-580 George Neat, CR	State-of-the-Art-Car (SOAC) Post-Repair Engineering Tests at Department of Transportation High Speed Ground Test Center/Boeing Vertol	In Preparation	FR
DOT-TSC-580 George Neat, CR	General Vehicle Test Plan for Urban Rail Transit Cars (TSC GSP-064 - Revised)/Boeing Vertol	In Preparation	FR
DOT-TSC-643 Leonard Kurzweil, CR	Noise Prediction Models for Elevated Rail Transit Structures, Cambridge Collaborative, Inc.	In Preparation	FR

* This number appears on the cover of the document.
** Funded from the Office of the Secretary.

Interim Reports and Final Reports (Cont'd)

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
DOT-TSC-654 Santo J. Gozzo, CR	Subsurface Obstacle Detection Report/Parsons, Brinckerhoff, Quade and Douglas	In Preparation	TR
DOT-TSC-661 Andrew Sluz, CR	Monitoring Underground Construction for Rapid Transit Facilities - A Guide for Urban Planners and Managers	Forthcoming	Manual
DOT-TSC-681 Dr. A. Raab, CR	Engineering Program for Assessment of Crashworthiness of Existing Urban Rail Vehicles, by Calspan Corp.	In Preparation	FR
DOT-TSC-791 F. Rutyna, CR	SOAC Crashworthiness Report/Boeing Vertol	In Preparation	FR
DOT-TSC-802 Santo J. Gozzo, CR	Safety and Environmental Impact in the Urban Rapid Transit Tunneling Process/A.A. Mathews, Inc.	Forthcoming	FR
DOT-TSC-808 F. Rutyna, CR	Rail Rapid Transit System Cost Study, T.K. Dyer, Inc.	In Preparation	FR
DOT-TSC-836 Gerald Saulnier, CR	Muck Utilization in the Urban Rapid Transit Tunneling Process/Haley and Aldrich, Inc.	Forthcoming	FR
DOT-TSC-838 George Neat, CR	Engineering Tests on Energy Storage Cars	In Preparation	FR
DOT-TSC-850 E.G. Apgar, CR	Urban Rail Noise and Vibration Study; Boeing Vertol Co.	In Preparation	FR
DOT-TSC-925 Lowell Babb, CR	Railroad Gage and Crosslevel Measurement Tool; Barkley and Dexter Labs.	4/75	Manual

Interim Reports and Final Reports (Cont'd)

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
DOT-TSC-971 Paul Poirier, CR	Dual Cassette Tape Transport; Datum, Inc.	In Preparation	Manual
DOT-TSC-1018 Gerald Saulnier, CR	Assessment of Disruptive Effects Associated with Urban Transportation Tunnel Construction. Abt Associates, Incorporated	Forthcoming	
DOT-TSC-1027 Santo Gozzo, CR	Subway Station Design and Construction De Leuw Cather and Company	Forthcoming	
DOT-TSC-1062 George Neat, CR	General Vehicle Tests on SLRV at the Department of Transportation Transportation Test Center Boeing Vertol Company	Forthcoming	
DOT-TSC-1070 Gerald Saulnier, CR	Subway System Maintenance Bechtel, Incorporated	Forthcoming	
DOT-TSC-1053 Robert Lotz, CR	In-Service Performance and Costs of Methods for Control of Urban Rail System Noise, De Leuw Cather and Co.	Forthcoming	
US-DOT-IL-0007 (DOT Grant)	Noise and Vibration Assessment of the Chicago Rail Rapid Transit System University of Illinois (Grantee)	Forthcoming	
US-DOT-IL-0007 (DOT Grant)	Data Management System for Rail Rapid Transit Noise Measurements University of Illinois (Grantee)	Forthcoming	

Interim Reports and Final Reports (Cont'd)

Report No.(s) TSC Monitor or Author	Title/Contractor (if any)	Date	Type
US-DOT-NY-11-0010 (DOT Grant) Robert Lotz	Noise and Vibration Assessment of New York City Rapid Transit System Polytechnic Institute of New York	Forthcoming	

Papers

Title of Paper	Prepared by	For
Track Measurement Algorithms for Urban Rail Transit Systems	Dr. P. Mengert & G. Neat	Eighth Asilomar Conference 1974 Monterey

Newsletters

Number 2, 75-1	State-of-the-Art Testing	1/75
Number 3, 75-2	Urban Rail Supporting Technology Document List	5/75