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# THE UMTA RAIL MODERNIZATION PROGRAM

## EVALUATION OF THE IMPACTS OF SECTION 3 CAPITAL GRANTS FOR RAIL REHABILITATION AND MODERNIZATION, 1965-1977

prepared for the

### U. S. Department of Transportation Urban Mass Transportation Administration

Policy, Budget and Program Development  
Office of Program Evaluation  
Washington, D.C. 20590



1900 03 03 01 01 0338  
BENNETT/PEAT, MARMICK, MITCHELL & CO.  
US DOT/UMTA  
UMTA RAIL MODERNIZATION PRGM/EVALUATION OF THE  
IMPACTS OF SECTION 3/CAPITAL GRANTS FOR RAIL  
REHAB & MODERNIZATION/1965-1977  
05/01/79

PB80  
178775





1. Report No. UMTA-UPP-79-8		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle The UMTA Rail Modernization Program Evaluation of the Impacts of Section 3 Capital Grants for Rail Rehabilitation and Modernization				5. Report Date May, 1979	
				6. Performing Organization Code	
7. Author(s) John Bennett				8. Performing Organization Report No. UMTA-UPP-79-8	
9. Performing Organization Name and Address Peat, Marwick, Mitchell & Company 1990 K Street, N.W. Washington, D.C. 20006				10. Work Unit No. (TRIS)	
				11. Contract or Grant No. UMTA-IT-06-0118	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Urban Mass Transportation Administration 400 Seventh Street, S.W. Washington, D. C. 20590				13. Type of Report and Period Covered Final Report	
				14. Sponsoring Agency Code	
15. Supplementary Notes Project Monitor: Jack Bennett Contributing Team Members: Bryan Green, Diane Schwager, Steve Etkin					
16. Abstract This report is an evaluation of the Urban Mass Transportation Administration grants for the modernization of existing rail systems. From the beginning of the Section 3 Capital Grant Program through May 31, 1977, Section 3 grant approvals amounted to approximately \$6.2 billion. Of this total, \$1.7 billion, or 28 percent was approved for the rehabilitation, replacement and upgrading of existing rail systems.  The report contains an inventory of rail modernization projects by type, mode (rapid rail, light rail, and commuter rail), and city. Impacts of these funds are analyzed by examining several specific projects in detail.  In addition to the examination of project impacts, the process used by two transit operators (NYCTA and PATH) to secure rail modernization funds and to select and implement projects is discussed.					
17. Key Words Urban Transportation Rail Transit Rail Modernization Evaluation			18. Distribution Statement Available to the Public through the National Technical Information Service, Springfield, Virginia 22161.		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price

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## I. EXECUTIVE SUMMARY

The Urban Mass Transportation Act of 1964 was enacted by Congress to provide federal financial assistance for the development of comprehensive and coordinated urban mass transit systems. As one of various UMTA programs providing financial assistance to urban areas, the Capital Grants and Loan Program was established under Section 3 of the UMT Act. From the beginning of this program through May 31, 1977, Section 3 grant approvals amounted to approximately \$6.2 billion. Of this total, nearly \$1.7 billion, or 28 percent, was approved for the modernization of existing rail systems, including the replacement and upgrading of facilities and equipment.<sup>1</sup>

### A. PURPOSE OF THIS STUDY

Projects funded through the rail modernization program are often justified on the basis of their anticipated impacts on the safety, reliability, cost, and/or patronage of existing rail systems. These projects, however, are rarely examined to determine their effect on rail systems following their implementation. In this study, an initial examination of these impacts was conducted. As part of this examination, this study also involved the preparation of an inventory of rail modernization projects by type, by mode, and by city, as well as an evaluation of the process undertaken by local transit operators to secure rail modernization funds and to select and implement rail modernization projects.

The inventory of rail modernization projects was prepared during Phase I of this study and is described in an earlier complementary report.<sup>2</sup> The remaining analyses were conducted during Phase II and serve as the primary focus of this report.

### B. STUDY APPROACH

The evaluation of Rail Modernization Program impacts was conducted by examining a variety of specific projects funded through this program. This

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<sup>1</sup>Major extensions to existing facilities and new rail transit systems are also funded by Section 3 grants. They are not considered part of the rail modernization program, however.

<sup>2</sup>"The UMTA Rail Modernization Program, The Distribution of Capital Grant Funds for Rail Rehabilitation and Modernization," prepared for the U.S. Department of Transportation by Peat, Marwick, Mitchell & Co., July 1978.

evaluation approach permitted a more detailed review of the range and extent of impacts resulting from rail modernization efforts. The projects selected for examination represent a mix of modernization activities which reflect the pattern of investment undertaken for the program as a whole. This pattern suggested that projects examined in detail should reflect the fact that (1) nearly 70 percent of all funds have been approved for use in New York and Chicago, (2) funds approved for rolling stock rehabilitation and replacement have accounted for over 50 percent of the total, and (3) a significant level of funds has been approved for each of the three rail modes--light, rapid, and commuter. These factors served as the primary basis for selection of projects for in-depth examination. Other factors which influenced the final selection, however, included the extent of project completion and the availability of data to measure resulting project impacts.<sup>1</sup> The following projects were selected for detailed examination:

- . IL-15 (Chicago, Illinois) - Replace/modernize Burlington Northern commuter rail rolling stock;
- . IT-01 (New York, New York) - Power system improvements for the Port Authority Trans-Hudson Corporation;
- . MA-10, MA-13, MA-15, MA-22 (Boston, Massachusetts) - Rolling stock, way and structure, and station improvements on the Riverside Branch of the Green Line light rail system;
- . PA-10 (Philadelphia, Pennsylvania) - Replacement of SEPTA ex-Penn-Central Division commuter rail rolling stock; and
- . NY-07, PA-23, PA-33 (New York, New York; Philadelphia, Pennsylvania) - Station modernization improvements.

Reports on the evaluation of each of these projects are presented as separate appendices to this report.

In addition to the examination of project impacts, an evaluation was conducted of the process undertaken by local transit operators to secure rail modernization funds and to select and implement projects. This evaluation reviewed the process for a recipient of UMTA Section 3 grant funds (New York City Transit Authority) compared with the process for a transit authority whose rail modernization program is currently financed independent

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<sup>1</sup>Since no routine mechanism is in place to consider the impacts of rail modernization investments on a continuing basis, data for this purpose are sparse or nonexistent.

of UMTA capital grants (Port Authority Trans-Hudson Corporation). The results of this evaluation are also provided in an appendix to this report.

Findings, conclusions, and recommendations resulting from the evaluation of project impacts, the investigation of the process for identifying, funding, and implementing these projects, and the Phase I study of the overall investment program are summarized below. They are discussed in more detail in subsequent sections.

### C. FINDINGS AND CONCLUSIONS

Federal objectives with regard to mass transit are apparent in UMTA's authorizing legislation in which the Congress concluded that:

the welfare and vitality of urban areas, the satisfactory movement of people and goods within such areas, and the effectiveness of housing, urban renewal, highway and other federally aided programs are being jeopardized by the deterioration or inadequate provision of urban transportation facilities and services...<sup>1</sup>

This statement reflects a general concern for urban areas, the role of transit in affecting these areas, and the condition of transit systems.

The Capital Grants and Loan Program was established under Section 3 of the UMT Act of 1964 as one of various UMTA programs initiated to avoid deterioration and inadequate provision of urban transportation facilities and services. The Rail Modernization Program specifically addresses the capital replacement needs within the urban rail transit sector. The goals and objectives of the rail modernization program, as described by former UMTA Administrator Robert E. Patricelli, are to maintain the already substantial rail transit patronage on existing systems, to ensure safe operation, and to protect the physical integrity of the urban rail network.<sup>2</sup> It is within the context of this perspective that the evaluation of this program was conducted. The principal findings and conclusions from this evaluation are as follows:

1. Widespread system deterioration was common in the rail transit sector prior to 1965.

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<sup>1</sup>Department of Transportation, Urban Mass Transportation Act of 1964 and Related Laws, February 5, 1976, Washington, D.C., p. 1.

<sup>2</sup>"Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives," Ninety-Fifth Congress, Second Session, Department of Transportation and Related Agencies for 1977, p. 656.

2. Since 1965, UMTA has provided \$1.7 billion in Section 3 funding to replace or modernize the physical plant and equipment of urban rail systems. Only a limited number (about 45 percent) of the projects funded by this program have been completed.
3. Because capital replacement needs exceed available grant funds, these funds are used for the most critical needs.
4. UMTA investment in rail modernization has encouraged the continued provision of safe and reliable service by addressing the more critical operational needs.
5. Transit operators typically justify rail modernization investments on the basis of safety, reliability, cost savings, and patronage impacts.
6. UMTA may expect the future demand--relative to other modernization projects--for the replacement and rehabilitation of rolling stock to decrease in the absence of increased capacity pressures.
7. Maintenance of way improvements represent continuing capital replacement needs and generally impact the safety and reliability of rail transit operations.
8. As safety and reliability needs are satisfied (through rolling stock and maintenance of way investments), station modernization may be expected to assume a larger proportion of the total rail modernization program; this is consistent with UMTA's goals of making rail stations accessible to the handicapped, enhancing the role of transit in urban revitalization, and increasing transit patronage.
9. The principal impacts of the rail modernization funding have been to:
  - . increase the rate of replacement of antiquated rail transit assets;
  - . advance the technology of rail systems;
  - . contribute to an increase in patronage or reduce the rate of decline in patronage;
  - . contribute to both increases and decreases in operating and maintenance costs on a project-specific basis;

- . contribute to decreases in energy consumption on a project-specific basis; and
  - . contribute to increases in both the level and quality of service provided by transit operators .
10. Rail modernization investments characteristically yield lower incremental patronage impacts than investments in new starts , although the patronage that would be lost if the existing systems were permitted to deteriorate has not been estimated.
  11. The Rail Modernization Program is estimated to have generated between 328,000 and 610,000 person-years of employment over the period 1965-1977.

In addition to the findings noted above , the following findings and conclusions relate more specifically to the management of this program:

1. A complete program , including measurable goals and objectives and a long-term financing plan , is not currently in existence .
2. A consistent evaluation process for rail modernization grant applications does not currently exist .
3. Local transit authorities appear to have a rational process for determining their rail modernization priorities based on a specific --if non-quantifiable-- set of goals and objectives .
4. A process for routinely monitoring rail modernization grant impacts does not currently exist .

Each of these findings and conclusions is discussed more fully in this report .

#### D. RECOMMENDATIONS

Based on the findings and conclusions resulting from the Rail Modernization Program evaluation , the following recommendations are described in this report:

1. The funding of the Rail Modernization Program should continue , although a long-term program including the development of measurable goals and objectives and a long-range financing plan should be established .

2. The progress of the rail modernization investment program should not be evaluated exclusively on the basis of a single factor such as patronage increases per investment dollar.

Recommendations for short-term actions necessary for the improved management of the program are as follows:

1. Establish a concrete and measurable set of goals and objectives and develop performance measures for determining the extent to which goals and objectives have been achieved.
2. Determine the current status of each rail system in terms of performance measures and the condition of physical plant and equipment.

Long-term recommendations for the continuing improved management of the program include the following:

1. Perform an analysis to determine the appropriate actions and financial support required to achieve different levels of rail system performance.
2. Develop alternative financial and performance plans for use in definition of an overall program for rail modernization, including long-term financing and performance levels.
3. Present alternative program budgets to Congress.
4. Establish a capital grant review process which is related to performance criteria and associated goals and objectives.
5. Establish an ongoing procedure for measuring rail system performance as it is impacted by the Rail Modernization Program.
6. Report overall program performance and the results of individual projects to Congress and to the transit community.



## II. INTRODUCTION

The evaluation of the Rail Modernization Program presented in this report is based on a review of 88 grants to eight metropolitan areas approved during the period 1965-1977.<sup>1</sup> These grants were approved for the improvement of light, rapid, and commuter rail transit systems.

### A. PURPOSE OF THE STUDY

The Rail Modernization Program has resulted in federal investment in a diverse set of projects including transit rolling stock purchases, way and structure improvements, and station modernization. These projects are typically justified on the basis of safety, reliability, cost, and/or patronage impacts. This study is intended to provide an initial examination of these impacts and aims specifically to account for the distribution of rail modernization expenditures and to examine the impacts resulting from these expenditures. Based on these efforts, the study evaluates the progress of the rail modernization program in achieving its objectives.

### B. STUDY APPROACH

This study was conducted in two phases. Phase I included preparation of a catalogue of projects by type, mode, and city. A range of impacts was postulated for each project type. Following the determination of data available to measure impacts of completed projects, a series of grants was selected for more detailed case study evaluation in Phase II.

The major findings of Phase I are published under separate cover. These findings include an inventory of all rail modernization grants by type, mode, and city, and a discussion of the national impacts of the program.<sup>2</sup>

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<sup>1</sup>Grants totalling nearly \$1.7 billion were approved for the modernization of existing rail systems in New York, Chicago, Boston, Philadelphia, San Francisco, Pittsburgh, Cleveland, and Detroit. This total represents 28 percent of all UMTA Section 3 grant approvals from the beginning of the program through May 31, 1977.

<sup>2</sup>"The UMTA Rail Modernization Program, the Distribution of Capital Grant Funds for Rail Rehabilitation and Modernization," prepared for the U.S. Department of Transportation by Peat, Marwick, Mitchell & Co., July 1978.

Phase II included two types of case studies: grant impact and grant process. Six grant impact case studies were conducted to illustrate the impacts of specific rail modernization projects. Two grant process case studies examined how localities plan for rail modernization projects, from project identification and grant application through project implementation. Together, the results of these case study analyses were used to examine the overall Rail Modernization Program and assess its progress toward achieving program goals and objectives.

### C. ORGANIZATION OF REPORT

This report contains five sections. Following this section, the goals and objectives of the program are described, the transportation and non-transportation impacts on both a local and national level are illustrated, and the program's progress in achieving its objectives is evaluated. Sections are devoted to these topics as follows:

Section III - UMTA Program Goals and Objectives;

Section IV - Impacts of the Rail Modernization Program; and

Section V - Evaluation of the Rail Modernization Program.

The case study analyses which form the basis for many of the conclusions and recommendations contained in this report are provided as separate appendices. Each of the following case studies is presented:

Appendix A - Impacts Resulting from the Modernization of Existing Equipment and the Purchase of New Equipment for the Burlington Northern;

Appendix B - Impacts Resulting from the Modernization of Power Conversion Equipment by the Port Authority Trans-Hudson Corporation (PATH);

Appendix C - Impacts of UMTA Funded Improvements on the Riverside Branch of the Green Line;

Appendix D - Impacts Resulting from the Purchase of New Commuter Rail Cars by the Southeastern Pennsylvania Transportation Authority (SEPTA);

Appendix E - Station Modernization Projects Funded by the UMTA Section 3 Rail Modernization Program; and

Appendix F - Urban Rail Rehabilitation and Modernization Funding Process Case Studies.

### III. UMTA PROGRAM GOALS AND OBJECTIVES

The Urban Mass Transportation Act of 1964 was enacted to provide federal financial assistance for the development of comprehensive and coordinated mass transit systems in metropolitan and other urban areas. The goals and objectives stated in this authorizing legislation for federal financial assistance serve as the primary criteria for evaluating the progress of the Rail Modernization Program. Additional sources of data include internal reports and memoranda of UMTA as well as specific policy statements by the different Secretaries of Transportation and by Congress during appropriation hearings. Each of these sources provides a more concrete statement of UMTA goals and objectives than the authorizing legislation. However, no single source defines UMTA goals and objectives in such a way that criteria and standards can be established for measuring their attainment.

#### A. FEDERAL ROLE IN TRANSIT

Aggregate statistics for the United States transit sector, shown in Exhibit III-1, illustrate the decline that has characterized this sector since 1945. Over this period, the decrease in transit patronage is generally associated with the dispersion of population, leading to less concentrated travel patterns and lower load factors. Besides the growth in automobile travel associated with this population dispersion, the shift from transit to automobile use is partly due to an increased affection for the automobile itself. The decline in transit patronage is often attributed to the following chain of events: lower patronage led to lower levels of service and then to loss of economies of scale and operating leverage, decreasing profits, deferral of maintenance, and deterioration and cutbacks of service resulting in further patronage drops. In an effort to reverse this cycle, UMTA was created initially to provide federal financial assistance in the replacement and renewal of physical plant and equipment and subsequently to provide financing of operating costs as well.

Federal objectives with regard to mass transit are apparent in UMTA's authorizing legislation where the Congress determined that "the welfare and vitality of urban areas, the satisfactory movement of people and goods within such areas, and the effectiveness of housing, urban renewal, highway and other federally aided programs are being jeopardized by the deterioration or inadequate provision of urban transportation facilities and services..."<sup>1</sup> This statement reflects a general concern for urban areas, the perceived role of transit in these areas, and the condition of the transit sector.

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<sup>1</sup>Department of Transportation, Urban Mass Transportation Act of 1964 and Related Laws, February 5, 1976, Washington, D.C., p. 1.

**EXHIBIT III-1**

**U.S. TRANSIT SECTOR  
AGGREGATE POSTWAR STATISTICS**

	1945	1950	1955	1960	1965	1970	1975
Passengers (X 10 <sup>6</sup> )	19,000	13,845	9,184	7,521	6,798	6,032	5,643
Vehicle Miles (X 10 <sup>6</sup> )	N/A	3,007	2,448	2,143	2,008	1,883	1,989
Revenue (X 10 <sup>9</sup> \$)	1.4	1.5	1.4	1.3	1.4	1.707	2.002
Expenses (X 10 <sup>9</sup> \$)	1.2	1.4	1.4	1.3	1.5	1.892	3.535
Average Fare (\$)	N/A	.10	.15	.18	.20	.28	.33
Average Fare (constant 1972 dollars)	N/A	.18	.24	.26	.27	.31	.28
Load Factor (Passengers/VMT)	N/A	4.6	3.75	3.51	3.39	3.15	2.84

SOURCE: Derived from Annual Reports of the American Public Transit Association, Washington, D.C.

Although the emphasis on UMTA program goals and objectives has varied over the years, their scope has not. Recurrent themes set forth by Congress during appropriation hearings and by different Secretaries of Transportation in policy statements include:

- . promoting the mobility of the public, including transit-dependent groups such as the elderly and handicapped, the economically disadvantaged, and commuters;<sup>1</sup>
- . reducing urban transportation energy consumption;<sup>2</sup>
- . promoting the economic development of urban areas;<sup>3</sup> and
- . reducing air and noise pollution.<sup>4</sup>

The first goal noted above reflects "a deliberate policy decision by local, state, and federal governments that this (mass transit) is an essential public service."<sup>5</sup> The latter three goals are external benefits that the UMTA program was intended to produce through a revival of the mass transit sector.

Various objectives are associated with the overall goal of promoting the mobility of the public; these include:

- . increasing transit trip speed by giving preferential treatment to transit;<sup>6</sup>
- . increasing transit convenience by decreasing wait time and transfers and by increasing coverage;<sup>7</sup>

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<sup>1</sup>UMT Act, Sections 5(m) and 16.

<sup>2</sup>1968 UMTA Goals and Objectives and 1973 Presidential Goals and Objectives.

<sup>3</sup>UMT Act, Sections 2(b)(2), 4(a), and 5(b).

<sup>4</sup>UMTA External Operating Manual, Chapter II.

<sup>5</sup>Richard S. Page, Administrator, Urban Mass Transportation Administration, "Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives," Ninety-Fifth Congress, Second Session, Department of Transportation and Related Agencies, April 5, 1978.

<sup>6</sup>UMTA External Operating Manual.

<sup>7</sup>Ibid.

- . improving transit reliability;<sup>1</sup>
- . improving transit safety and security by reducing transit accidents and transit-related crimes;<sup>2</sup>
- . increasing transit comfort by improving its attractiveness and cleanliness and by providing passenger amenities;<sup>3</sup> and
- . meeting urban transportation needs at minimum cost by reducing transit operating costs.<sup>4</sup>

Although these objectives are generally discussed in the context of the UMTA program as a whole, they are also relevant to the Rail Modernization Program.

## B. RAIL MODERNIZATION PROGRAM GOALS AND OBJECTIVES

The Capital Grants and Loan Program was established under Section 3 of the UMT Act of 1964 as one of several UMTA programs initiated to reverse the cycle of declining transit patronage, continuing deferral of maintenance and capital replacement, and accelerating deterioration, cutbacks, and abandonments of service leading to further patronage declines. As part of this program, the Rail Modernization Program was intended to specifically address the long-term system deterioration that had occurred within the transit sector.

The proposed use of capital facilities grants for system improvements in areas with existing rapid transit systems, as described in appropriation hearings, places the problem of system deterioration in perspective:<sup>5</sup>

... replacement value of the rapid transit and commuter rail systems in New York, Chicago, Philadelphia, Boston,

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<sup>1</sup>UMTA External Operating Manual and 1968 Goals and Objectives.

<sup>2</sup>UMT Act, Sections 5(h) and 107.

<sup>3</sup>UMTA External Operating Manual and 1968 Goals and Objectives.

<sup>4</sup>UMT Act, Section 6.

<sup>5</sup>"Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives," Ninety-Fourth Congress, Second Session, Department of Transportation and Related Agencies, 1977, p. 775.



San Francisco, and Cleveland runs into the tens of billions of dollars... the majority of these systems are old, some dating from the early 20th Century. The financial condition of the systems has made necessary the use of the limited local funds to keep the services operating, with little or no attention having been paid to physical improvements... many of the structures being used in rail service are in a state of advanced deterioration because of age and poor maintenance.

Appropriations for the modernization of existing rail systems are intended to "protect and enhance this valuable national resource, and to assure the efficient functioning and orderly growth of these areas, consistent with air quality, energy conservation, urban development and revitalization, and land use policies."<sup>1</sup> More specifically, the goals and objectives of the program, as described by former UMTA Administrator Robert E. Patricelli, are to maintain the already substantial rail transit patronage on existing systems and to insure safe operation and protect the physical integrity of the urban rail network.<sup>2</sup>

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<sup>1</sup>"Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives," Ninety-Fifth Congress, Second Session, Department of Transportation and Related Agencies, 1979, p. 365.

<sup>2</sup>"Hearings Before a Subcommittee of the Committee on Appropriations, House of Representatives," Ninety-Fifth Congress, Second Session, Department of Transportation and Related Agencies, 1977, p. 656.



## IV. IMPACTS OF THE RAIL MODERNIZATION PROGRAM

This section describes the transportation and non-transportation impacts of the program on both a local (system or subsystem) and national level.

### A. LOCAL IMPACTS

During this study, selected case studies were conducted to investigate the impacts of specific rail modernization projects. The approach taken in selecting these case studies and their specific findings are summarized below. Each case study is described in detail in the appendices to this report.

#### A.1 Case Study Approach

The evaluation of Rail Modernization Program impacts was conducted by examining a variety of specific projects funded through this program. This approach permitted a more detailed review of the range and extent of impacts resulting from rail modernization efforts. One of the principal difficulties confronted in the evaluation of this program is the variety of objectives addressed by the individual projects. The impacts of specific projects can be quite different, depending on the objectives for which the projects were initiated. Transit operators generally justify modernization projects for one or more of the following reasons: safety, reliability, economics (cost), and marketability (patronage). Based on these project justifications, a range of potential impacts (primary and secondary)<sup>1</sup> can be postulated for each of the various types of projects funded through the Rail Modernization Program (Exhibit IV-1). A primary consideration in selecting case studies was the examination of the full range of potential project impacts.

The projects selected for examination therefore represent a mix of modernization activities that reflect the pattern of investment undertaken for the program as a whole. This pattern suggested that projects examined in detail should reflect the fact that: (1) nearly 70 percent of all rail modernization funds have been approved for use in New York and Chicago; (2) funds approved for rolling stock rehabilitation and replacement have accounted for over 50 percent of the total; and (3) a significant level of funds has been approved for each of the three rail modes--light, rapid, and commuter.

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<sup>1</sup>A primary impact is a direct outcome of the project; it is brought about by implementation of the project. A secondary impact is an indirect outcome of a project; it is generated by a combination of events that include implementation of the project.

**EXHIBIT IV-1  
INITIAL SURVEY OF RAIL MODERNIZATION GRANT IMPACTS**

**TRANSPORTATION**

GRANTS	COSTS		LEVEL OF SERVICE			QUALITY OF SERVICE				PATRONAGE	REVENUE
	OPERATIONS	MAINTENANCE	SPEED	FREQUENCY	RELIABILITY	SAFETY	VISUAL	AUDIO	COMFORT		
<b>Rolling Stock:</b>											
Modernization	P	P	S	S	P	P	P	P	P	P	P
Rehabilitation	P	P	S	S	P	P	P	P	P	P	P
Replacement	P	P	S	S	P	P	P	P	P	P	P
<b>Rights-of-Way:</b>											
Track	P	P	P	P	P	P		P	P	S	
Electrification	P	P	P	P	P	P				S	
Signals	P	P	P	P	P	P				S	
Structures	P	S	P	P	P	P				S	
<b>Stations, Terminals:</b>											
Modernization		S					P	P	P	S	S
Replacement		S(-)					P	P	P	S	S
Expansion		S(-)					P		P	P	P
<b>Yards and Buildings:</b>											
Modernization		P		S	S					S	
Replacement		P		S	S					S	
<b>Operational Improvements:</b>											
Maintenance Equipment		S	S	S	S						S
Fare Collection		S									S
Communications		S			S						S
Surveillance	S										
Information	S(-)									S	S
Safety			S	S	S		P				

IV. 2

P = primary impact  
S = secondary impact  
S(-) = secondary unfavorable impact

**Note:**  
P = direct outcome of a project; the impact is brought about by the implementation of the project.  
S = indirect outcome of a project; it is generated by a chain of events that includes the implementation of the project.

These factors served as the primary basis for selection of projects for in-depth examination. Other factors that influenced the final selection included the extent of project completion and the availability of data to measure resulting project impacts.

Because the UMTA program is relatively new,<sup>1</sup> only a limited number (about 45 percent) of rail modernization projects are actually "in place." Many of these projects have not been completed for a sufficient length of time to determine the resultant impacts. Moreover, rail systems have not established an internal information system for documenting impacts. There is no routine mechanism to consider the impacts of rail modernization investments on a continuing basis, and data for this purpose are therefore sparse or non-existent. The selection of case studies was thus limited to completed projects with data available for measuring specific impacts.

Based on these considerations, grant impact case studies were selected to provide for an examination of representative project impacts. Exhibit IV-2 lists the grants selected as case studies and the principal impacts investigated. Each case study is referenced for identification throughout the discussion of local impacts. The review of observed project impacts indicates generally favorable impacts on operating costs, patronage, level of service, and quality of service, and varying impacts on transit maintenance costs. Each of these impact areas is discussed below.

## A.2 Transit Operations: Summary of Case Study Impacts

Grant impact studies provided an opportunity to observe both the financial and operating impacts of rail modernization projects on transit systems.<sup>2</sup>

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<sup>1</sup>The majority of UMTA rail modernization funding was not provided until after 1970, with the enactment of the Urban Mass Transportation Assistance Act of 1970. Average yearly grant approvals during the periods 1965-1969 and 1970-1976 were \$49 million and \$201 million, respectively.

<sup>2</sup>The measurement of project impacts was complicated somewhat by external events and the subsequent difficulty in establishing a causal relation between projects and impacts. For example, patronage impacts may be attributable to increases (decreases) in population, central business district employment, or fuel prices, as well as the rail modernization project under investigation. In only a few cases was it possible to assign a direct causal relation between the modernization project and the impacts postulated. In all cases, care was taken to identify major external factors that could have influenced the project impacts being measured.

**EXHIBIT IV-2  
GRANT IMPACT CASE STUDIES**

<b>Case Study</b>	<b>Grant</b>	<b>Grant Projects Reviewed</b>	<b>Primary Impacts Examined</b>
A	IL-15 Chicago, IL	Purchase/modernization of 94 existing Burlington Northern commuter cars and purchase of 25 new commuter cars.	Level of Service/Patronage
B	IT-01 New York, NY	Power system improvements on PATH	Costs/Energy Conservation
C	MA-10 Boston, MA MA-13 MA-15 MA-22	Rolling stock, way and structure and station improvements on the Riverside Branch of the Green Line.	Costs/Level and Quality of Service/Patronage
D	PA-10 Philadelphia, PA	Purchase of 130 commuter cars for SEPTA-Penn Central Division service.	Costs/Quality of Service/Patronage
E	NY-07 New York, NY PA-23 Philadelphia, PA PA-33	Station Modernization	Quality of Service



Fiscal impacts focused on changes in costs (operating and maintenance), while the observed operating impacts encompassed patronage, level of service (frequency, capacity, reliability), and quality of service (passenger comfort and convenience, safety, etc.).

### Operating Costs

Three case studies investigated the impact of rail modernization projects on operating costs. These case studies included the purchase of 130 new commuter rail cars for service on the ex-Penn Central Division in Philadelphia (D), the purchase of light rail vehicles (LRVs) for operation on the Riverside Branch of the Green Line in Boston (C), and the modernization of the Port Authority Trans-Hudson (PATH) power system (B).

The overall impact of these projects on operating costs appears to be favorable and is primarily attributable to an increased capacity of facilities and equipment. For example, commuter cars purchased for ex-Penn Central service (D) resulted in an 11 percent reduction in car-miles (1974 vs. 1977) with no change in the service area or frequency of service. Similarly, the purchase of light rail vehicles (LRVs) for Green Line service (C) has also increased seating capacity per vehicle. This case study documents the reduction in operating personnel (through operation of fewer trains) required to provide the same level of hourly seating capacity. In this case, an 18 percent reduction in equipment requirements would have resulted in 1976 labor savings of \$263,000 if service levels were unchanged.<sup>1</sup> In either case, transit management was able to maintain service capacity while reducing costs or to expand service frequency while maintaining existing costs levels.

Reduced personnel requirements and subsequent reductions in operating costs have resulted from improvements to the PATH power system (B). This case study has shown that with the installation of modern silicon rectifiers, automated substations were introduced and substation operators were no longer needed to open and close switches. This project resulted in a net reduction of four operating employee positions.

A significant portion of operating costs consists of traction energy (power) costs. The modernization of PATH substations for traction power (B), has

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<sup>1</sup>In actuality, no vehicle transportation cost savings occurred, because additional service was added concurrent with the introduction of the LRVs. Any possible savings were expended to provide additional service beyond what was provided in 1976.

resulted in substantial savings in power costs (\$6.2 million over the period 1966-1976). These cost savings resulted from the higher efficiency of silicon rectifiers as compared with the older rating efficiency of rotary converters and from the ability to operate on 60-cycle power purchased from a low-cost supplier. Another rail modernization project, involving the purchase of rolling stock for the Boston Green Line (C), resulted in decreased energy consumption on a per capacity-mile basis (seating plus standing).<sup>1</sup>

The impacts on operating costs discussed above are the results of a limited sample of projects, both within a single functional improvement category and across the various categories. Because the impact findings are not necessarily representative, they should not be aggregated across the entire Rail Modernization Program. The impacts of these individual projects, however, serve to indicate the types and magnitude of impacts that may be expected from the program.

### Maintenance Costs

Investigation of the impacts of rail modernization projects on maintenance costs has centered on three projects: the purchase of 130 new commuter rail cars in Philadelphia (D), the purchase of LRVs in Boston (C), and the modernization of the PATH power system.

The impacts on maintenance costs have varied. For example, maintenance costs per vehicle-mile for new rolling stock ranged from 50 percent lower than the vehicles replaced (D) to 26 percent higher than the vehicles replaced (C). The data for comparing vehicle maintenance costs per car-mile for old and new vehicles were limited by the following factors:

- . New vehicles must typically go through a "debugging period" when maintenance problems frequently arise (increases current costs).
- . Certain parts of the new equipment may fall under an extended warranty (decreases current costs).
- . The current stage of the "maintenance cycle" of old and new vehicles may be such that older vehicles are undergoing a complete overhaul or, conversely, receiving a minimal level of maintenance because of plans to scrap the equipment.

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<sup>1</sup>Based on data provided by the MBTA Power Department staff. The staff indicated that although these consumption ratings are approximate, they are within 5 percent of actual.

These factors suggest that the comparison of vehicle maintenance costs on a per mile basis must be interpreted very carefully.

The installation of modern silicon rectifiers to replace rotary converters in power substations has had a favorable impact on PATH maintenance costs. The preventive maintenance required for silicon rectifiers is substantially less than that required for rotary converters. Consequently, the position of substation attendant was eliminated, and a net reduction of approximately 11 maintenance employee positions was possible.

The variance in maintenance cost impacts of rolling stock purchases at- tests to the limitations of aggregating specific project impacts and assigning them to the entire Rail Modernization Program. The fact that the projects were of a similar nature does not prevent them from having different impacts.

### Patronage

Investigation of rail modernization project impacts on patronage has focused on purchases of new rolling stock (A,C,D). In each case, there was a correlation between rolling stock purchases and increases in patronage, in part because the addition of new rolling stock has enabled management to provide an improved level and quality of service (these impacts are discussed in greater detail below). Specific case study findings regarding rail modernization project impacts on patronage are as follows:

- . The purchase of 25 new bi-level cars for Burlington Northern commuter service (A) was followed by a 30 percent increase in aggregate annual patronage from 1972 to 1975, and by a 25.4 percent increase in peak period patronage.
- . Annual patronage and peak period patronage on ex-Penn Central Division lines (D) increased 19.7 percent and 45.0 percent, respectively, with the introduction of 130 new cars.
- . The 1977 Riverside Line patronage (C) increased between 11 percent and 16 percent, reflecting the start of LRV service in 1977 and increasing trends in total system patronage.

In the first two cases noted above, patronage increases were also influenced by favorable increases in the population of the commuter area served and in the CBD (Central Business District) employment.

Despite the apparent correlation between rolling stock purchases and increases in patronage, one cannot infer that the introduction of new rolling stock will by itself result in patronage increases. The case studies discussed

above represent situations in which system patronage was growing as a whole<sup>1</sup> or other events, such as increases in the market area population or in CBD employment (A,D) occurred, thereby contributing to the demand for the service. Additionally, the need for rolling stock may be dictated by the obsolescence of existing equipment (even in the absence of demand pressures). In these cases, patronage increases may not be evident because the equipment purchases were necessary to better serve the existing patronage and prevent or reduce the decline in patronage.

Patronage impacts of rail modernization projects have a direct impact on passenger revenues. For example, the purchase of new LRVs and the modernization of stations along the Riverside branch of the Green Line (C) were followed by increased passenger revenues. The increase, which approximated 11 percent during 1977 and 16 percent during the first half of 1978, was due to the enhanced station facilities as well as the improved headways and added capacity.

### Level of Service

The impact of rail modernization projects on the level of service was investigated in three case studies. These case studies included the purchase of 25 new commuter rail cars and the modernization of 94 existing cars and locomotives for Burlington Northern service (A), the purchase of new LRVs (C), and the purchase of 130 new commuter rail cars for service on the ex-Penn Central Division in Philadelphia (D).

Investigation of level of service impacts of rail modernization projects reveals favorable impacts in the areas of frequency, capacity, and reliability. The purchase of 25 commuter cars for BN service (A) increased seating capacity by 19.9 percent and allowed for the addition of 2 rush-hour trains, thereby increasing the daily rush-hour trains from 38 to 40. Additionally, the reliability of rush-hour trains exhibited a modest improvement since the 25 new cars were placed into service and the existing fleet of 94 cars and 21 locomotives were modernized (yearly average on-time performance of rush-hour trains increased from 90.8 percent in 1971-1973, to 93.2 percent in 1974-1976).

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<sup>1</sup>It is noted that patronage on the Riverside branch of the Green Line actually increased more than systemwide patronage.

The acquisition of light rail vehicles permitted MBTA to substantially increase the level of service (C). Headways were reduced from 10 minutes to about 8 minutes during the morning, afternoon, and evening peak periods. Headways were also reduced by 2 minutes during the evening and 5 minutes during the late night service. Seating capacity increased by 21.1 percent during the evening peak periods (standing capacity per hour more than doubled during each of the time intervals). Lastly, the UMTA-funded improvements had little effect on the reliability of the Green Line operation (reliability declined marginally).

The purchase of 130 new commuter cars in Philadelphia (D) has contributed to an increase in total seating capacity of 21 percent, 1973-1977, and to the reliability of service (on-time performance increased from 81.2 percent in 1973, to 95.5 percent in 1977).

In summation, rail modernization projects involving the purchase of new rolling stock have been followed by a general improvement in the frequency of service (A,C), the capacity of service (A,C,D), and the reliability of service (A,D). However, the varying degree of these project impacts limits the evaluation of the overall program impact. Moreover, the impacts resulting from new rolling stock purchases did not occur independently of other modernization projects (i.e., track improvement projects also contribute to the reliability of service, signal modernization projects affect the frequency of service, etc.).

### Quality of Service

Evaluation of quality of service impacts includes passenger comfort and convenience, improved passenger flows, passenger safety, and aesthetic improvements. Some of these indicators are difficult to quantify because of their subjective nature; the presentation of rail modernization impacts on the quality of service is therefore based more on identification of features of new equipment or modernized stations which would tend to enhance their attractiveness to transit patrons.

The purchase of new commuter cars in Philadelphia (D) is cited by SEPTA personnel as contributing to the overall attractiveness of the commuter system, thereby enhancing the ability of SEPTA to attract new riders. Some of the modern features of the new cars include air conditioning, improved heating and lighting, automatic doors, public address system, improved seats and non-slip floors.

Various modernization projects on the Riverside branch of the Green Line (C) have had an adverse impact on passenger safety (as measured by the number of derailments). The introduction of LRVs is correlated with an increase

in the number of derailments. In 1977, 36 percent (16) of LRV derailments were caused by equipment while only 13 percent (2) of PCC derailments were caused by equipment. The track renewal program has had no observable effect in reducing the number of derailments in the 2 years following completion of the program. However, MBTA officials noted that no derailments have occurred on those sections of track which have been refurbished.

The modernization of the rapid rail passenger station in Philadelphia (E) has significantly impacted the quality of service received by passengers. Passenger safety has improved due to the installation of smoke detectors and emergency lighting for use during blackouts.<sup>1</sup> Passenger comfort and convenience have been enhanced with improved ventilation circulating fresh air throughout the station, acoustical ceilings and panels along platform edges, and improved graphics and signs. Finally, the station modernization project has improved passenger flows with the two-car length extension of the platform, the addition of ramps for elderly and handicapped passengers, and improved platform accessibility.

The modernization of the 49th Street station in New York City (E) resulted in impacts similar to those described above for the modernization of the rapid rail passenger station in Philadelphia. The quality of service provided has increased, as reflected by increased crime control efforts through improved lighting, installation of a communication system between control areas and between change booths, and a new station design eliminating columns and placing the station booth so the attendant has a full view of the platform area. Passenger comfort and convenience have been enhanced with the installation of acoustical ceilings, panels along the platform edge, and track barriers, all of which have contributed to a 20 decibel reduction in noise levels. Furthermore, improved graphics and signs, new toilet facilities and concessions, and a new architectural design (including a glazed brick finish for walls and concrete finish for the floors) have also improved passenger comfort and convenience. Finally, maintenance costs are minimized due to the use of the glazed brick finish which requires little or no maintenance. This finish has deterred vandalism in the form of unsightly graffiti.

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<sup>1</sup>Other modernization projects affecting passenger safety in this station include the installation of a TV monitoring system with a direct line to transit police and the installation of a public address system enabling authorities to "call out" to vandals.

### A.3 Non-Transportation Impacts: Summary of Case Study Findings

The case study analyses investigated non-transportation related impacts in the areas of energy conservation, employment, and environmental control. The installation of silicon rectifiers to replace rotary converters in the PATH power system (B) resulted in substantial energy savings. Because silicon rectifiers are more efficient than rotary converters in converting alternating current to direct current (98 percent versus 85 percent all-day efficiency) for traction power, silicon rectifiers require approximately 13 percent fewer kilowatts of input to generate the same level of output as rotary converters. Another rail modernization project, involving the purchase of new rolling stock for the Riverside branch of the Green Line (C), resulted in decreased energy consumption per capacity-mile (20 percent decrease).

As noted below in the discussion of national aggregate impacts, the person-years of employment generated over the life of the Rail Modernization Program (direct, indirect, and multiplier effects) ranges from 328,000 to 610,000.

Impacts of rail modernization projects on environmental control were discussed in the previous section. Modernization of passenger stations in Philadelphia and New York provided for a reduction in noise levels resulting from operation of passenger trains.

## B. NATIONAL IMPACTS

Local impacts observed through case study investigation show that the program has resulted in generally favorable impacts on transit operations. These observations, however, do not permit an aggregate assessment of the effect of the program on all rail modernization cities. To overcome this shortcoming of the case study analysis, data on various operating trends including revenue passenger trips and passenger vehicle-miles operated for these cities are used below to examine the aggregate effect of the Rail Modernization Program.

### B.1 Considerations in the Evaluation of National Aggregate Data

The analysis of aggregate impacts of the program must take into account the widespread system deterioration in the transit sector before the beginning of the program. Examples of the long-term deterioration that characterized rail systems include the poor condition of the Frankford Elevated in Philadelphia, which has necessitated slow orders (trains operating at a reduced speed), increasing running time, and, hence, greater operating expense. Similarly, the deterioration of the Rock Island commuter lines in Chicago was reflected by track conditions which required that a 10-mile-an-hour slow order be

imposed on much of the system. At one time, Rock Island service was ordered stopped (by the ICC) to prevent derailments which were becoming more probable as track conditions deteriorated.

This historical deterioration of plant and equipment suggests that the money expended under the rail modernization program to a large extent represents "catching up" on essential investment deferred due to a prior lack of funds. Consequently, the Rail Modernization Program has focused on the rehabilitation of existing systems in order to prevent continuing deterioration; and at a national aggregate level, the impacts of this program would be expected to show, first, a deceleration of the decline in the industry and, second, a contribution to the reversal of declining trends.

The extent that these impacts would be observed, however, depends on, among other things, the level of rail modernization funding in relation to total rail modernization needs. The degree to which these impacts can be attributed to the program is also related to the nature and extent of other factors affecting measures of the national aggregate performance for the transit sector (e.g., energy shortages, center city revitalization, expansion of the work force, population growth, changes in population, and activity density patterns).

No agreed upon estimate of rail modernization needs has been prepared. It is therefore a matter of speculation whether the funding for the program falls short of actual needs. In the case of New York, however, a rough estimate of modernization needs suggests that this may, in fact, be the case. The New York MTA provides an estimate of \$25 billion for the replacement value of its capital assets.<sup>1</sup> One way to estimate annual modernization needs would be to determine the composition of MTA's system assets by age and useful life category and use this information to estimate an average annual replacement life cycle for the system's assets.

To provide a rough estimate, if it is assumed that the weighted average useful life for a rail system is approximately 60 years (including subway tunnels), this estimate implies a "need" for capital replacement at an average annual rate of 1.6 percent.

This average annual rate of need is, of course, an abstraction; in some years actual need would exceed this value and in others fall short of it. It provides only a rough approximation for New York MTA since it does not reflect any historical deferrals of capital replacement which would tend to

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<sup>1</sup>John Kaiser, Executive Officer for Construction Administration, the Metropolitan Transportation Authority, New York City, New York.



increase present needs. It does, however, provide a basis for estimating modernization needs for comparison with modernization program funding levels.<sup>1</sup> This comparison is provided below:

Average Annual Rate of Capital Replacement	NY MTA Capital Asset Replacement Value (\$ Billions)	Estimated Annual MTA Rail Modernization Program Needs (\$ Millions)	Average Annual Rail Modernization Grants to MTA 1965 to 1977 (\$ Millions)
1.6%	25 15 10	400 240 160	25

As shown in this chart, even assuming a replacement value far smaller than that suggested by MTA, estimated annual program needs are far greater than historical funding under the Rail Modernization Program. This suggests that in the absence of extensive local funding, many of the system needs in New York have not been satisfied by the UMTA program and the aggregate impact of the program on systemwide patronage and level of service may be incidental.

Because the New York system dominates U.S. transit statistics, it can further be suggested that the aggregate impacts of the program on a national scale would likewise be incidental.

## B.2 Observed Impacts on Transit Operations

Rail modernization grant approvals totalling \$1.7 billion for the years 1965-1976 (the last full year in which grant approvals were analyzed) are summarized in Exhibit IV-3. These expenditures are shown for each of the three rail modes: light, rapid, and commuter. A total of 88 Section 3 grants to 8 cities were devoted to rail modernization activities. The eight cities and the total amount received by each are also shown in Exhibit IV-3. Rail modernization grant approvals increased 484 percent in current dollars from 1965 to 1976. However, the increase in grant approvals was not a gradual one. Average yearly grant approvals from 1965 to 1969 and from 1970 to

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<sup>1</sup>This simple example illustrates the need to estimate the long-range capital improvement programs for each of the major transit agencies and to determine the extent to which current rail modernization funding levels will finance these costs. Attention can then be focused on the objectives of the Rail Modernization Program and its role in the financing of modernization improvements, with more considered thought being given to the possible alternatives in terms of objectives and funding levels and the potential impacts on the nation's cities.

EXHIBIT IV-3

UMTA SECTION 3 RAIL MODERNIZATION GRANT APPROVALS  
BY MODE AND BY YEAR 1965-1977  
(000s)

YEAR	LIGHT RAIL	RAPID RAIL	COMMUTER RAIL	TOTAL RAIL	
				(CURRENT YEAR \$)	(1977 CONSTANT \$) <sup>1</sup>
1965	\$ 0	\$ 42,375	\$ 4,826	\$ 47,201	89,776
1966	0	0	6,661	6,661	12,262
1967	0	289	98,615	98,904	176,741
1968	0	62,163	26,957	89,120	152,484
1969	0	2,764	1,780	4,544	7,402
1970	16,608	1,867	113,752	132,227	204,555
1971	53,867	94,104	14,040	162,011	238,318
1972	76,000	200,369	125,645	402,014	568,045
1973	18,108	77,778	27,607	123,493	164,740
1974	6,960	124,701	128,297	259,958	316,368
1975	3,671	28,145	69,879	101,695	113,695
1976	8,290	171,398	48,727	228,415	241,435
1977 <sup>2</sup>	30,366	11,583	42,747	84,696	84,696
<b>TOTAL</b>	<b>\$213,870</b>	<b>\$817,536</b>	<b>\$709,533</b>	<b>\$1,740,939</b>	<b>\$2,370,517</b>

<sup>1</sup> GNP Implicit Price Deflator Used.

<sup>2</sup> January 1, 1977 through May 31, 1977.

UMTA SECTION 3 RAIL MODERNIZATION GRANT  
APPROVALS BY CITY, 1965-May 31, 1977  
(000s)

City	Amount	Percent of Total
New York (Tri-State Region)	\$ 832,261	47.8
Chicago	376,462	21.6
Boston	220,262	12.7
Philadelphia	167,235	9.6
San Francisco	75,462	4.3
Cleveland	48,460	2.8
Pittsburgh	19,191	1.1
Detroit	1,606	0.1
<b>Total</b>	<b>\$1,740,939</b>	<b>100.0</b>

1976 were \$49 million and \$201 million, respectively. From 1965 to 1976, they averaged \$138 million.<sup>1</sup>

Exhibit IV-4 shows trends in combined light and rapid rail patronage and vehicle-miles operated over the period 1953-1977.<sup>2</sup> During this time, patronage has declined 50.9 percent, while the level of service provided, as measured by vehicle-miles operated, has declined only 14.2 percent. Exhibit IV-4 also shows UMTA light and rapid rail modernization grants for 1965-1976. These grants total approximately \$990 million, averaging \$82 million per year.

The Rail Modernization Program has contributed to a decrease in the rate of decline of rapid and light rail patronage in rail modernization cities since 1965. This decrease is reflected by aggregate data for Chicago (rapid rail), Philadelphia (rapid rail), and Cleveland (light rail). During the period 1953-1965, rapid and light rail patronage in these cities decreased 29.8 percent or an average of 2.2 percent per year. In contrast, patronage in these cities since 1965 has declined only 25.4 percent, or an average of 1.9 percent per year. However, despite these positive impacts associated with the program, it appears that total rail patronage, when data for New York are included, decreased at an accelerated annual average rate during the period 1965-1977.

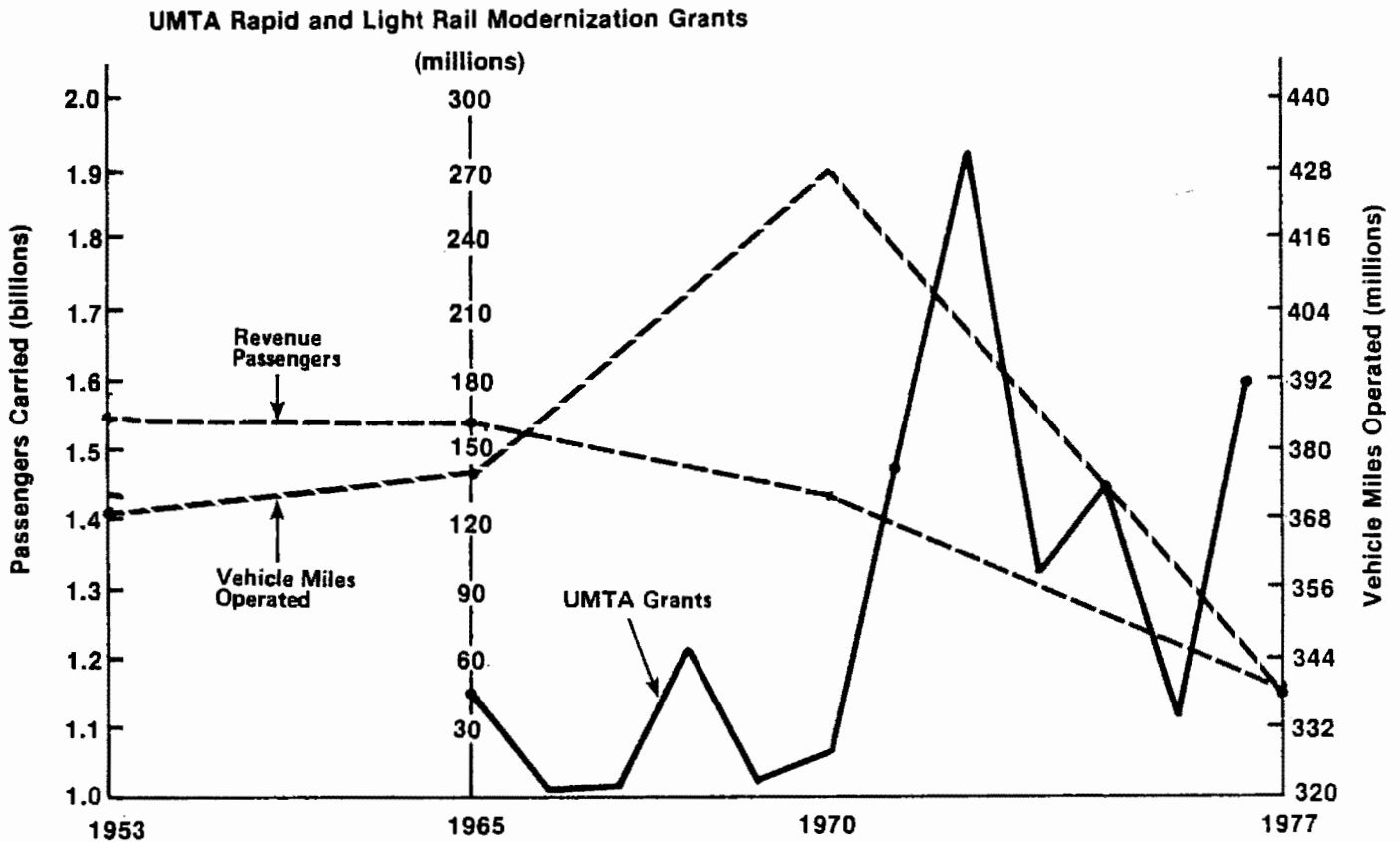
Patronage in New York accounted for nearly 90 percent of total rapid and light rail patronage in 1953, 1965, and 1977. During the period 1953-1965, patronage in New York declined 10.5 percent or an average of 0.8 percent per year. Patronage since 1965 has declined 35.0 percent or an average of 2.5 percent per year. Because of the relative significance and level of patronage declines in New York, total rapid and light rail patronage, as reflected in Exhibit IV-4, has declined at an average annual rate of 2.5 percent since 1965, as compared with an average annual rate of 1.0 percent for the period 1953-1965. The rate of decline in rail patronage since the program began in 1965, particularly in relation to the increased level of funding shown in Exhibit IV-4, can be misinterpreted if the factors previously discussed are not fully considered. The widespread system deterioration which preceded the program, the level of rail modernization funding in relation to total rail

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<sup>1</sup>It should be noted that the level of grant approvals in a given year (obligations) does not normally coincide with the actual disbursement of funds (outlays) during the same year.

<sup>2</sup>Data on revenue passengers and on vehicle-miles operated includes the following systems: New York rapid rail (NYCTA), Chicago rapid rail, Philadelphia rapid rail, and Cleveland light rail. In 1977, these four systems accounted for over 85 percent of total rapid and light rail modernization patronage.

**EXHIBIT IV-4  
TRENDS IN RAPID AND LIGHT RAIL MODERNIZATION PATRONAGE  
AND VEHICLE MILES OPERATED, 1953-1977<sup>1</sup>**



Source: APTA Annual Reports filed by New York (NYCTA), Chicago, Philadelphia (rapid rail), and Cleveland (light rail)

modernization needs, and the occurrence of external events<sup>1</sup> that also affect rail patronage tend to reduce the impact of the program (as reflected by aggregate data), in reducing the rate of patronage decline in rail modernization cities, including New York. In addition, the following two factors should be considered in the interpretation of these data:

- . The patronage impacts of completed modernization projects are not instantaneous. Consequently, the full patronage impacts of the presently completed rail modernization projects may not have occurred.
- . The amount of light and rapid rail modernization grants shown in Exhibit IV-4 is somewhat misleading in that these monies reflect grant approvals and not the expenditure of grant funds (i.e., obligations do not equal outlays). Therefore, the actual amount of monies expended for improvements to date is less than that shown in Exhibit IV-4.

It is important to note that the decrease in the rate of decline in patronage in rail modernization cities other than New York has not only continued, but has resulted in positive patronage increases in these cities and in New York itself. Recent patronage increases for these cities are as follows:

- . Patronage on the NYCTA and on the CTA has increased by 4.7 and 6.7 percent, respectively, during the first 9 months of 1978, as compared with the same period during 1977.
- . Despite a 14.7 percent decrease in patronage from 1976 to 1977, SEPTA rapid rail patronage during the first 9 months of 1978 has increased 27.9 percent over the same period during 1977.
- . PATH and GCRTA (rapid rail) patronage has increased 1.9 percent and 2.6 percent, respectively, during the first 9 months of 1978, as compared with the same period during 1977.

These systems accounted for over 90 percent of rapid and light rail system patronage in 1977. Exhibit IV-5 summarizes changes in annual patronage for each of these systems from 1976 to 1978.

The level of service provided by rapid and light rail modernization systems, as measured by vehicle-miles operated, has decreased by approximately 15 percent or at an average annual rate of 1.2 percent from 1965 to 1977.

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<sup>1</sup>For example, general population and employment growth and distribution.

**EXHIBIT IV-5**

**CHANGES IN ANNUAL PATRONAGE IN SELECTED  
RAPID RAIL SYSTEMS<sup>1</sup>**

<b>City</b>	<b>Percent Increase (decrease)</b>		
	<b>1976</b>	<b>1977</b>	<b>1978<sup>2</sup></b>
<b>New York:</b>			
NYCTA	- 4.1	- 1.2	+ 4.7
PATH	+ 6.1	- 0.8	+ 1.9
<b>Chicago:</b>			
CTA	- 2.2	- 1.0	+ 6.7
<b>Philadelphia:</b>			
SEPTA (rapid rail)	+ 4.5	- 14.7	+ 27.9
<b>Cleveland:</b>			
GCRTA (rapid rail)	+ 7.1	- 9.5	+ 2.6

<sup>1</sup> Source: APTA Monthly Transit Traffic Reports.

<sup>2</sup> Compares first 9 months of 1978 with first 9 months of 1977.

This average annual decrease in the level of service provided since the program began in 1965 roughly compares with an average annual increase of less than 0.1 percent from 1953 to 1965. Data on vehicle-miles operated include four systems: NYCTA (rapid rail), CTA (rapid rail), SEPTA (rapid rail), and GCRTA (light rail). In 1977, vehicle-miles operated by these four systems accounted for 83.7 percent of total rapid and light rail vehicle-miles operated.

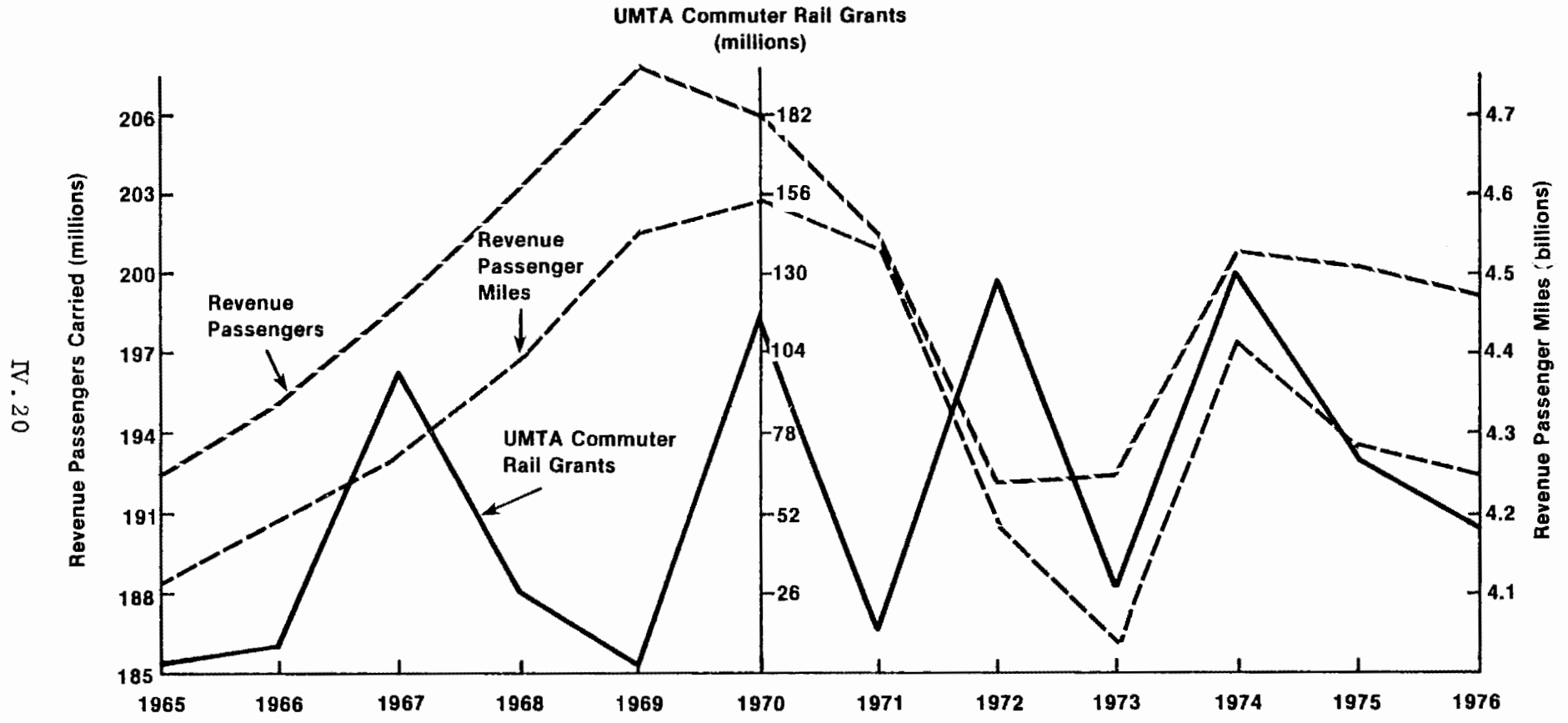
Commuter rail operating trends, revenue passengers, and revenue passenger-miles are illustrated for the years 1965-1976 in Exhibit IV-6. Operating data for commuter railroad operations are compiled by the Association of American Railroads (AAR) based on quarterly reports on "commutation" operations received from Class I railroads in the United States. These data include statistics on "commutation" operations that have not received rail modernization funds as well. This exhibit also indicates the trend in UMTA commuter rail modernization grants during the same period. Patronage of commuter rail operations increased 1 percent from 1965 to 1976, although the trend in commuter rail patronage indicates a varied performance during this period. For example, after increasing 8 percent from 1965 to 1969, revenue patronage decreased 10.7 percent between 1969 and 1973, and subsequently increased 4 percent from 1973 to 1976. The trend in revenue passenger-miles parallels the trend in revenue passengers carried, although the actual increase in revenue passenger miles from 1965 to 1976 approximated 8 percent. Yearly commuter rail grant approvals between 1965 and 1969 average \$27.8 million. This figure contrasts with the yearly average of \$75.4 million between 1970 and 1976.

Commuter rail grant approvals per revenue passenger have fluctuated widely since 1965. Although approvals per revenue passenger increased 733 percent (\$.03 to \$.25) during this period, the yearly average was approximately \$.28, with 1972 representing the peak year for grants per revenue passenger (\$.66) and 1969 representing the low year (\$.01) for grants per revenue passenger. This wide fluctuation in commuter rail grant approvals per revenue passenger indicates that a meaningful correlation between commuter rail grants and patronage cannot be reasonably determined on an aggregate basis.

## B.2 Non-Transportation Impacts

One frequently cited justification for federal participation in rail modernization projects is job creation. The expenditure of federal funds for rail modernization projects creates a demand for goods and services, and ultimately provides employment opportunities. Although the lack of primary research investigating the employment impacts of federally funded projects precludes

**EXHIBIT IV-6  
COMMUTER RAIL OPERATING TRENDS**



Source: Association of American Railroads Statistics of Railroads of Class I, Washington, D.C. December 1977.



any definitive assessment of the number of jobs created by the program, a review of the limited research on related employment impacts was conducted to provide rough estimates of these impacts for the UMTA Rail Modernization Program.

Based on this limited research, the person-years of employment generated over the life of the Rail Modernization Program (February 1965 to May 1977) are estimated to range between 164,000 and 244,000 direct and indirect jobs. These employment estimates do not account for jobs created as a result of re-spending wages and profits throughout the economy (multiplier effect). These secondary employment impacts can be substantial. For example, a typical region's multiplier ranges from 2.0 to 2.5 (i.e., \$100 million in local wages will generate a total of \$200 to \$250 million in local income). The actual number of person-years of employment generated by the program could therefore range from 328,000 to 610,000.



## V. EVALUATION OF THE RAIL MODERNIZATION PROGRAM

This section summarizes the conclusions resulting from this study and sets forth recommendations for improvements to the UMTA Rail Modernization Program. The program evaluation is based on a review of 88 grants to 8 cities, approved during the period 1965-1977. The program is evaluated through the identification of program impacts and their magnitude on existing rail operations, and the program's progress in producing impacts consistent with its goals and objectives. The conclusions reached in each of these areas form the basis for the identification and recommendation of opportunities for improved investment and management of limited UMTA resources.

### A. RAIL MODERNIZATION PROGRAM IMPACTS

#### A.1 Findings and Conclusions

As discussed in the previous section, the investigation and identification of specific project impacts has resulted in a number of conclusions relevant to the entire program. While these conclusions are based primarily on the independent measurement of project impacts, discussions with UMTA representatives and transit officials have added perspective to the interpretation of measured impacts and the significance of these impacts in relation to the program. The principal findings and conclusions resulting from the evaluation of the program are as follows:

1. Widespread system deterioration was common in the rail transit sector prior to 1965. The deterioration of rail systems prior to 1965 is partly attributable to the neglect of replacement of capital assets on a timely basis. (Deferral of maintenance represents another significant cause of system deterioration.) Previously cited examples of neglected capital replacement include the Frankford Elevated in Philadelphia and the Chicago Rock Island system. Case study findings further document this conclusion; examples include operation by the Burlington Northern, as recently as 1973, of single-level passenger cars built between 1916 and 1929, and SEPTA's similar operation, in 1973, of commuter cars, comprising nearly 80 percent of the ex-Penn Central Division fleet manufactured before 1920.
2. Since 1965, UMTA has provided \$1.7 billion in Section 3 funding to replace or modernize physical plant and equipment. During Phase I of this evaluation, all Section 3 grants approved for the modernization and rehabilitation of existing rail systems were identified

and subsequently catalogued by mode, city, and type of improvement. These 88 grants totalled \$1.7 billion. The purchase of new rolling stock accounted for \$1.2 billion (49.6 percent) of all rail modernization costs. Ways & Structures improvements totalled \$660 million (26.9 percent) and were in the following major areas: power (\$270 million), track (\$172 million), and signals (\$135 million). Station modernization costs over the period 1965-1977 were approximately \$151 million (6.1 percent). Only a limited number (about 45 percent) of the projects funded by this program have been completed.

3. Because capital replacement needs exceed available grant funds, these funds are used for the most critical needs. As previously discussed in the context of national aggregate impacts, estimated annual program needs for the New York MTA are far greater than historical funding under the Rail Modernization Program. Consequently, 96 percent of UMTA funds available to the MTA have been invested in rolling stock and maintenance of way improvements, while less than 2 percent of these funds have provided for strictly aesthetic/quality of service improvements represented by station modernization projects.
4. UMTA investment in rail modernization has encouraged the continued provision of safe and reliable service by addressing the more critical operational needs. The case studies documented the contribution of UMTA funds to an enhanced level and quality of service.
5. Transit operators typically justify rail modernization investments on the basis of safety, reliability, cost savings, and patronage impacts. Because of the widespread system deterioration, critical modernization needs typically exhaust program funds. These needs include primarily the provision of safe and reliable service with a secondary emphasis on cost savings and patronage.
6. UMTA may expect the future demand--relative to other modernization projects--for the replacement and rehabilitation of rolling stock to decrease in the absence of increased capacity pressures. Because a majority of rail modernization funds has been expended for rolling stock improvements (\$1.3 billion or 53.8 percent), vehicle reliability has improved through a decrease in the average age and an increase in the number of rehabilitated vehicles (as exhibited by the Burlington Northern and Philadelphia commuter cars case studies). As the performance of rolling stock fleets is brought increasingly in line with operator requirements, UMTA may expect a decrease in the demand for new rolling stock except to satisfy additional capacity needs.
7. Maintenance of way improvements represent continuing capital replacement needs and generally impact the safety and reliability of

rail transit operations. The deterioration of track and structures on the Frankford elevated in Philadelphia and the Rock Island commuter lines in Chicago resulted in trains operating at a reduced speed. As maintenance of way improvements are implemented, trains operate with increased safety at higher speeds, thereby contributing to the reliability of operations.

8. As safety and reliability needs are satisfied (through rolling stock and maintenance of way investments), station modernization may be expected to assume a larger proportion of the total rail modernization program; this is consistent with UMTA's goals of making rail stations accessible to the handicapped, enhancing the role of transit in urban revitalization, and increasing transit patronage. From the beginning of the program, approximately \$275 million or 11.2 percent of all rail modernization funds have been provided for station modernization projects. As critical operational and safety needs are satisfied, UMTA may expect to expend an increasing level of funds to modernize stations and terminals.
9. The principal impacts of the rail modernization funding have been as follows:
  - . To increase the rate of replacement of antiquated rail transit assets. This impact is inferred from the first two conclusions above. Because transit operations have not generated sufficient revenues to replace capital assets on a timely basis, the mere existence of federal assistance for rail modernization and rehabilitation has provided for the replacement of these assets which might otherwise have been neglected. The Burlington Northern case study demonstrated a specific instance in which a need for new equipment for replacement and expansion purposes could not have been met without UMTA funding.
  - . To advance the technology of rail systems. Rail modernization funding has resulted in the replacement of antiquated capital assets with assets that feature more technologically advanced designs. Examples include: the new commuter cars in Philadelphia with air conditioning, improved heating and lighting systems, automatic doors, and public address systems; the efficient power conversion equipment installed by PATH; and the cameras installed in the Philadelphia 8th Street Station to deter crime and vandalism.
  - . To contribute to an increase in patronage or reduce the rate of decline in patronage. The presentation of patronage impacts of rail modernization projects in Section IV revealed that the

purchase of new rolling stock was associated with increases in total patronage. The investigation of aggregate impacts provided further evidence that the Rail Modernization Program, in association with other factors, has resulted in a decreased rate of decline of rapid and light rail patronage for 1965-1977, with increases in patronage for the first 3 quarters of 1978.

- . To contribute to both increases and decreases in operating and maintenance costs and to decreases in operating energy consumption. Cost reductions are derived primarily from an increased capacity or efficiency of facilities and equipment. Examples include higher capacity cars for Chicago (BN), Philadelphia, and Boston and the installation of efficient power conversion equipment by PATH. Increases in operating and maintenance costs are attributable to more sophisticated technology, as with the new LRVs in Boston, and to an increased level and quality of service. The net effect of these impacts is not known.
  - . To contribute to increases in both the level and quality of service provided by transit operators. Positive impacts were demonstrated by investigation of rolling stock purchases and by station modernization projects. Although the exact contribution of the program to increases in the level and quality of service available cannot be ascertained, future positive increases in both areas can be reasonably expected to result from the program.
10. Rail modernization program investments characteristically yield lower incremental patronage impacts than investments in new starts. This evaluation did not focus on the examination of new rail transit systems, but new starts are expected to result in greater patronage impacts because previously untapped travel markets are served. In contrast, rail modernization investments normally improve the service to existing travel markets. Because rail modernization investments are intended to maintain existing patronage, comparison of these investments with investments in new transit systems on a per-passenger basis should include the number of passengers that would have been lost if the investment had not occurred.
11. The Rail Modernization Program is estimated to have generated between 328,000 and 610,000 person-years of employment over the period 1965-1977. Under Phase I of the evaluation, a review of the

limited research on employment impacts was conducted to provide rough estimates of these impacts for the program. Based on this review, it appears that a reasonable estimate of the total person-years of employment (direct, indirect, and multiplier effects) generated by the program would range from 328,000 to 610,000.

The findings and conclusions noted above summarize the positive impacts towards the realization of national goals and objectives associated with the program. These goals and objectives, as identified in Section III, include:

- . maintaining the level and quality of transit service;
- . maintaining the already substantial patronage in existing rail modernization cities;
- . promoting the mobility of the public, including transit-dependent groups, with the provision of more efficient transportation services;
- . reducing urban transportation energy consumption;
- . promoting the economic development of urban areas; and
- . reducing air and noise pollution.

Exhibit V-1 summarizes the findings of each of the case studies as they relate to individual goal areas. Although the observed project impacts do not completely reflect the total results of the program, they are illustrative of the types of impacts that have occurred with the program. It is expected that the future purchases of rolling stock will result in similar positive patronage impacts and in an improved level of service. Additionally, station modernization projects positively impact the quality of service received by transit patrons. Because the program's primary goals and objectives are, first, to restore the physical plant and thereby maintain service levels and, second, to maintain rail patronage, the demonstrated impacts of the program in these areas are discussed in greater detail below.

The impact of the program in enabling localities to invest in capital facilities and equipment and thereby provide an increased level and quality of service is exemplified by the use of UMTA funds for the purchase of 25 new commuter cars for Burlington Northern (BN) service. Case study documentation of this project indicated that the 25 new commuter cars purchased under grant IL-15 have enabled the BN commuter services to grow with the demand

EXHIBIT V-1

RAIL MODERNIZATION PROJECT IMPACTS ON PROGRAM GOALS

GOALS	CASE STUDY				
	BN COMMUTER CARS	PHILA. COMMUTER CARS	GREEN LINE IMP'MENTS	PATH POWER SYSTEM	STATION MODER- NIZATION
(1) Level of Service: <ul style="list-style-type: none"> <li>• Increase Transit Trip Speed</li> <li>• Increase Transit Convenience <ul style="list-style-type: none"> <li>- Increase Frequency</li> <li>- Increase Coverage (Capacity)</li> </ul> </li> <li>• Improve Transit Reliability</li> </ul>	P P P	P	P P		
(2) Quality of Service: <ul style="list-style-type: none"> <li>• Improve Safety <ul style="list-style-type: none"> <li>- Reduce Transit Accidents</li> <li>- Reduce Transit Crimes</li> </ul> </li> <li>• Improve Transit Comfort and Convenience</li> </ul>		P	N P		P P
(3) Maintain Patronage in Rail Modernization Cities	P	P	P		
(4) Promote the Mobility of the Public Including Transit Dependent Groups					
(5) Reduce Transit Operating and Maintenance Costs		P	P/N <sup>1</sup>	P	
(6) Reduce Urban Transportation Energy Consumption				P	
(7) Promote Economic Development of Urban Areas					
(8) Reduce Air and Noise Pollution					P

KEY:

- P Positive Impact on Goal Attainment
- N Negative Impact on Goal Attainment

<sup>1</sup>The operation of LRV's in Boston has resulted in the positive impact of reduced operating (energy) costs and in the negative impact of increased maintenance costs.



for these services, as exhibited by patronage trends (both annual and peak period), and that this growth in the level of service provided would not have occurred in the absence of UMTA funding. Similarly, the purchase of new light rail vehicles for operation on the Green Line in Boston and the acquisition of 130 new commuter cars for ex-Penn Central Division service in Philadelphia have been shown to contribute to improvements in the level of service provided.

Case study investigation of individual rail modernization projects has shown favorable impacts on the maintenance of patronage in existing rail cities.<sup>1</sup> The purchase of 25 new bi-level cars for the Burlington Northern commuter service in Chicago was followed by a 30-percent increase in aggregate annual patronage from 1972 to 1975. Annual and peak period patronage on ex-Penn Central Division lines in Philadelphia increased 19.7 percent and 45.0 percent, respectively, with the introduction of 130 new cars. Lastly, the 1977 patronage on the Riverside Branch of the Green Line in Boston increased between 11 and 16 percent following the initiation of LRV service and implementation of other rail modernization improvements in 1977.

The analysis of aggregate rail modernization rapid and light rail patronage, presented in Section IV, indicates a decreased average annual rate of decline in patronage in selected rail modernization cities, from 2.2 (1953-1965) to 1.9 (1965-1977) percent per year.<sup>2</sup> Although the average annual rate of decline in patronage in New York during this same period approximates 2.5 percent, recent patronage data indicates that New York patronage declined only 1.2 percent in 1977 and actually increased 4.7 percent during the first 9 months of 1978. This increase in patronage is characteristic of rail systems in other cities as well, including Chicago (+6.7 percent), Philadelphia rapid rail (+27.9 percent), and Cleveland light rail (+2.6 percent). As previously noted, these systems accounted for nearly 90 percent of total (rapid, light, commuter) rail patronage in 1977.

The progress of the Rail Modernization Program in fostering positive impacts on the attainment of level and quality of service goals and of maintenance of existing rail patronage can be illustrated further by examining what

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<sup>1</sup>In each case study investigated that involved the purchase of rolling stock, there was a correlation between rolling stock purchases and increases in patronage, primarily because the addition of new rolling stock has enabled management to provide an improved level and quality of service. However, external factors such as CBD employment and population increases were also recognized as contributing to patronage increases.

<sup>2</sup>Based on data for Chicago, Philadelphia (rapid rail), and Cleveland (light rail).

might have occurred in the absence of UMTA funding. The principal source of data for assessing these effects is found in the few alternatives analyses which have been conducted for rail modernization projects.<sup>1</sup> These alternatives analyses forecast the anticipated impacts of a proposed transportation change rather than measure the observed impacts of an actual change. However, because little research has been conducted to document deteriorating levels of service and patronage in a system that has foregone modernization, alternatives analyses must be consulted to examine the implications of not modernizing.

One alternative analysis which examined hypothetical level of service changes in the absence of UMTA funding was conducted by Edward Totten in 1973.<sup>2</sup> The purpose of this study was to provide information necessary for a decision concerning investment in SEPTA's light rail rolling stock. Of the five alternatives examined, two included the purchase of new rolling stock, another two considered various rehabilitation/modernization scenarios, and the fifth examined the "null" approach (i.e., present equipment and trends in operation continue).

The chief findings in the Totten study point to anticipated improvements in the level and quality of service provided if either new rolling stock is purchased or existing rolling stock is rehabilitated. In the absence of UMTA funding and subsequent rolling stock improvements, headways (frequency) were expected to range from 8 to 20 seconds higher, capacity was expected to be considerably lower, and reliability of equipment was also expected to be lower (1,130 miles per breakdown for existing equipment and 6,400 miles per breakdown for new equipment). In addition, the deterioration in the level of service provided was expected to continue without rolling stock improvements.

Two alternatives analyses suggest the need for the program in contributing towards maintenance of patronage goals and objectives. They investigate and compare projected patronage impacts of various rail modernization investment opportunities, including the "null" case.<sup>3</sup> The first investment

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<sup>1</sup>Alternatives analyses are not required by UMTA for rail modernization projects but are normally conducted by localities to justify the investment of scarce local resources as part of the local share of project costs.

<sup>2</sup>"Investment Analysis of Equipment Alternatives for SEPTA's Subway-Surface Lines."

<sup>3</sup>Totten, Edward. "Investment Analysis of Equipment Alternatives for SEPTA's Subway-Surface Line." September 1973.

analysis of rolling stock purchases in Philadelphia investigated the potential patronage impacts of five basic alternatives, three of which included: continued operation of the existing fleet, rehabilitation/modernization of the existing fleet, or acquisition of a new fleet. Patronage impacts were projected over the 7-year period 1975-1982, and were anticipated as follows:

#### PROJECTED PATRONAGE IMPACTS 1975-1982

"Do Nothing"	Patronage declines by 22.5 percent by 1982.
Modernize Fleet	Zero patronage growth by 1982.
Acquire New Fleet	Patronage increases by 15-61 percent by 1982.

These projections were based on past experience with new equipment purchases and on patronage trends. The decline in patronage projected under the "null" approach was attributed to reduced geographical coverage resulting from vehicle attrition and to the increasing unattractiveness of the system.

The second patronage and revenue study, conducted for PATrain,<sup>1</sup> assessed the implications of continuing existing services as opposed to modernizing these services. The planned improvements under the modernization alternative included station parking improvements, station modernization, and the operation of upgraded equipment. Two methods of estimating patronage were used, including an extrapolation of historical data (patronage records) and an estimation by use of a planning model developed by the Allegheny County Department of Planning and Development. Use of these models provided the following ranges of anticipated patronage impacts over the period 1978-1982: the continuation of existing services ("no action") was expected to result in patronage changes ranging from a 1.5 percent decrease to a 0.4 percent increase, while projected patronage changes from modernization of the existing services ranged between increases of 1.0 and 13.1 percent. The PATrain and SEPTA Equipment Analysis studies indicate the types of negative impacts in level of service and in patronage that might occur without UMTA funding.

#### A.2 Recommendations

The following recommendations are based on the findings and conclusions presented in this section:

1. The funding of the Rail Modernization Program should continue although a more complete long-term program including the development of measurable goals and objectives and a long-range financing

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<sup>1</sup>Baker, Michael J., Inc. "Port Authority of Allegheny County, Patronage and Revenue Study." 1977.

plan should be established. Because of the widespread system deterioration in the transit sector, a genuine need exists for investing in capital assets in order to protect the physical plant and equipment, maintain service levels, and keep up the substantial patronage in these cities. The inability of the transit sector to internally generate sufficient revenues for capital replacement has been accepted for many years. Also, the provision of rail modernization funding for capital replacement has resulted in positive impacts on the maintenance of service levels and patronage. These benefits are considered to be in the public interest; funding for the program should therefore continue although a more complete long-term program should be developed.

2. The progress of the rail modernization investments program should not be evaluated on the basis of a single factor such as patronage increases per investment dollar. Throughout the discussion of aggregate impacts of the program, a number of factors were presented in the interpretation of patronage data; these included the time lag associated with impacts from modernization investments and the intent of these investments to better serve existing markets and not necessarily to expand or tap new travel markets. Thus, patronage data alone may not accurately reflect the positive impacts of the program at a given time. A number of other significant and desirable impacts, some quantifiable, are associated with the program. These include level and quality of service; mobility of the public, including transit dependent groups (elderly and handicapped, economically disadvantaged, etc.); reductions in air and noise pollution; and urban transportation energy consumption. For a proper assessment of the program as an effective investment, each of these factors must be considered.

## B. RAIL MODERNIZATION PROGRAM MANAGEMENT

### B.1 Findings and Conclusions

Phase II of the program evaluation included an examination of the process undertaken by urban transit systems to finance rail rehabilitation and modernization. Specifically, the process undergone by a recipient of Section 3 grants from UMTA was compared with that for a transit authority whose rail modernization program is currently financed independent of UMTA capital grants. The findings from this case study and efforts to document the transportation and non-transportation impacts of the program have resulted in the following conclusions on the management of the Rail Modernization Program:

1. A complete program including goals, objectives, and financing plans does not currently exist. Section III of this evaluation identifies a

number of UMTA and program goals. Nonetheless, goals and objectives are not explicitly defined to establish criteria and standards for measuring their attainment, and there is no formal definition of the federal role in the modernization of rail systems. Since 1965, UMTA has provided \$1.7 billion in Section 3 funding to replace or modernize rail physical plant and equipment. There is no agreed upon estimate of the extent of the national need for rail capital replacement and modernization, so it is not clear to what extent the program has managed or has failed to satisfy these needs.

2. A consistent evaluation process for rail modernization grant applications does not currently exist. In the absence of specific program goals, objectives, and financing plans, no established criteria for examining requests for UMTA funding of rail modernization projects are utilized. Rather, the federal role in rail modernization has been primarily to distribute funds essential for capital replacement.
3. Local transit authorities appear to have a rational process for determining their rail modernization priorities based on a specific--if non-quantifiable--set of goals and objectives. The use of criteria by properties to identify modernization projects was evident in the grant process case studies. These criteria, however, were not routinely used to quantify the associated costs and benefits of a project.
4. A process for routinely monitoring rail modernization grant impacts does not currently exist. The purpose of this evaluation is to provide an initial examination of these impacts because rail modernization projects are rarely subjected to any post-grant analysis that formally evaluates their effect. This lack of evaluation is characteristic at both the federal and local levels.

These findings and conclusions are discussed in greater detail below.

One of the more frequently discussed issues during annual UMTA appropriation hearings concerns the provision of federal assistance for mass transit and is equally applicable to the Rail Modernization Program. This concern, as voiced by Congressman John J. McFall, Chairman of the Subcommittee on the Department of Transportation and Related Agencies Appropriations, during recent hearings for 1979, involves the absence of any "specific, attainable and generally accepted goals for the large amount of Federal assistance provided for mass transportation." This statement may apply to the program goals identified in Exhibit V-1. Neither the UMTA authorizing legislation nor policy statements issued by the different Secretaries of Transportation delineate specifically measurable transportation or non-transportation goals against which

to assess performance. The reasons behind the lack of specific programs goals are twofold: they relate to the issue of the federal role in rail modernization and to the limitations associated with establishing concrete goals for program evaluation.

It is a matter of continuing debate whether UMTA should establish formal goals at the federal level and then direct available funds to attain these goals or whether it should provide localities with the necessary funds to attain local goals and objectives. The latter approach more closely represents a revenue sharing concept where it is presumed that the local authorities are in the best position to determine the appropriate use of program funds. The current Rail Modernization Program reflects a combination of these approaches, as exemplified by grant applications from New York; these are of two types: the first provides for a range of projects essential to an "ongoing" orderly replacement of capital assets, and the second normally involves a specific unique project such as making a station accessible or providing for significant environmental improvements. In its application process, New York distinguishes between rail modernization projects because the latter type of application normally requires a longer period of review before approval, and it is undesirable to delay the necessary "ongoing" projects because of any individual project. Although all projects are approved by UMTA, the fact that some projects receive more scrutiny than others reflects a presumption by UMTA that local authorities are in a position to determine appropriate needs for certain types of projects.

Another difficulty associated with establishing concrete goals for program evaluation concerns the measurability of goal achievement. While a reduction in air pollution associated with transit may be a real benefit of and an appropriate goal for the program, it is difficult to determine the program's effect in this area. Secondly, it is problematical whether "those goals (program), if they are measurable, can in fact be achieved by a Federal agency ... patronage may well depend on local circumstances and local conditions and may not be susceptible to measures or actions (by UMTA) staff in Washington."<sup>1</sup> Lastly, the level of rail modernization funding in relation to existing needs is such that current funds are expended to meet critical needs. However, as a surplus of funds are available for discretionary use, it may become increasingly appropriate and essential to establish formal goals and objectives to be met with these funds.

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<sup>1</sup>Richard S. Page, Administrator, UMTA, "Hearings Before a Subcommittee on the Committee on Appropriations, House of Representatives, Department of Transportation and Related Agencies for 1979." p. 209.

Because the federal role in rail modernization has been primarily to distribute funds essential for capital replacement, UMTA has no consistent process for technical evaluation of grant applications. However, the grant process case study findings indicate that transit authorities have a well-structured process for the internal identification, approval, and implementation of rail modernization projects. Both NYCTA and PATH, for example, use criteria to identify, justify, and rank projects for implementation. In order of decreasing importance, NYCTA criteria are safety, reliability, and energy savings, and PATH criteria are structural integrity and personal safety, financial benefits, and aesthetics. To the extent that local goals are consistent with UMTA goals, it may not be necessary for UMTA to review the appropriateness of grant applications except as a control on the local evaluative process.

No process for monitoring rail modernization grant impacts currently exists. This holds true at the local level, where it was determined that the criteria to identify, justify, and rank projects are not utilized to:

- . measure and report on the base operating or performance conditions before implementation of a rail modernization improvement;
- . measure and identify the amount of improvement in operating or performance conditions expected to result from project implementation; or
- . evaluate rail modernization projects after they are implemented to determine whether projects are achieving the desired results.

Rather, NYCTA and PATH use criteria descriptively or qualitatively with respect to rail modernization projects.

## B.2 Recommendations

Based on the findings and conclusions presented above, it is recommended that UMTA take the following short-term actions for the improved management of the rail modernization program:

1. Establish a concrete and measurable set of goals and objectives and develop performance measures for determining the extent to which goals and objectives have been achieved. Because the program currently lacks well-defined goals, a measurable set of goals and objectives should be established with corresponding measures to determine their attainment. If the goal becomes one of simply providing funds



to meet local objectives, a process for determining success in meeting these objectives should also be established. Despite the previously recognized difficulties associated with establishing concrete federal goals, they provide a basis for monitoring and measuring the program's effectiveness.

2. Determine the current status of each rail system in terms of performance measures and condition of physical plant and equipment. In order to determine the needs of rail systems in relation to desired levels of service and to evaluate the impact of the program in meeting these needs, an inventory of present service levels and system condition is required as a basis for comparison. This inventory may be conducted by UMTA with input from transit operators and metropolitan planning organizations or by transit operators under UMTA guidance.

In addition to those noted above, the following recommendations represent less immediate actions required of UMTA for the continuing improved management of the program:

1. Perform an analysis to determine the appropriate actions and financial support required to achieve different levels of rail system performance. This process will result in a number of potential level-of-service "targets" and the necessary local and UMTA actions required to achieve them. Again, local involvement by transit operators and metropolitan planning organizations should be encouraged.
2. Develop alternative financial and performance plans for use in definition of an overall program for rail modernization, including long-term financing and target levels of performance. Implementation of this recommendation will be based on output developed from the previous recommendation and represents a synthesizing of estimates developed for each city into appropriate estimates and "targets" for the program.
3. Present alternative program budgets to Congress. Based on the identification of alternative performance levels and associated budgets, alternative program budgets should be presented before Congress so that an appropriate level of funding may be established.
4. Establish a capital grant review process which is related to performance criteria and associated goals and objectives. The development of a consistent evaluation process for reviewing grant applications will enable UMTA to determine the extent of anticipated impacts of specific projects on program goals and objectives.



5. Establish an ongoing procedure for measuring rail system performance as it is impacted by the Rail Modernization Program. The monitoring of a project impacts to assess whether expected levels of performance were attained will serve as a control in future planning efforts and identify those projects that result in desirable benefits.
  
6. Report overall program performance and the results of individual projects to Congress and to the community-at-large. Dissemination of program results to Congress is desirable to highlight the significance of the program. Dissemination of project impacts to the community-at-large will help in identifying reasonable alternatives to address transportation and non-transportation problems.



**APPENDIX A**

**Impacts Resulting from the Modernization of Existing  
Equipment and the Purchase of New Equipment for  
the Burlington Northern**

IMPACTS RESULTING FROM THE PURCHASE  
OF NEW AND MODERNIZATION OF EXISTING  
BURLINGTON NORTHERN EQUIPMENT

I. SUMMARY AND INTRODUCTION

II. BURLINGTON NORTHERN COMMUTER RAIL SERVICE

III. OPERATING AND FINANCIAL ENVIRONMENT PRIOR TO IL-15

. Patronage Trends and Related Factors

. Annual Patronage, 1965-1972

. Peak Period Demand

. Trip Length

. Service Capabilities

. Seating Capacity

. Frequency and Reliability

. Equipment Utilization

. Service Profitability and Funding of Equipment Purchases

. Operating Losses

. Ineligibility of BN for Federal Funds

. Alternatives Available to BN

. Implications of Non-funding of Equipment

IV. ESTABLISHMENT OF WSMTD AND APPROVAL OF IL-15

V. IMPACTS OF IL-15

. Level of Service

. Growth in Level of Service vs. Growth in Demand

## I. SUMMARY AND INTRODUCTION

On May 16, 1972, UMTA awarded a capital improvement grant to the West Suburban Mass Transit District (WSMTD), Chicago, Illinois. This grant, IL-15, provided for the purchase and modernization of 65 existing Burlington Northern (BN) commuter cars and 21 locomotives, the purchase of new bi-level commuter cars and spare parts, the modernization of 29 donated BN commuter cars, and the installation of electrical standby facilities.<sup>1</sup> Total project costs under IL-15 were \$41.7 million, with the federal and local shares comprising \$27.8 million (66-2/3 percent) and \$13.9 million (33-1/3 percent), respectively. This appendix focuses on the use of UMTA funds in the purchase of the new commuter cars for the BN service, as well as the purchase and modernization of the existing commuter car fleet.

The primary objective in evaluating these rolling stock purchases is to document the impact of UMTA funds on Burlington Northern commuter rail service. In this regard, discussions with Mr. Theodore G. Schuster (Assistant Vice President, BN Urban Services), Mr. Forrester DuSell (Manager, BN Urban Services), and Mr. Lewis E. Bulkeley (Counsel and Project Director, WSMTD), as well as a review of operating and financial data routinely compiled by the Burlington Northern, resulted in two principal findings:

- . IL-15 was instrumental in improving the quality and quantity of service provided by Burlington Northern.
- . IL-15 enabled the Burlington Northern commuter services to grow with the demand for these services.

This appendix is organized into five sections and is designed to provide a historical perspective on the pre-grant BN commuter service, describe the operating and financial characteristics of the BN commuter service which illustrate the need for additional commuter cars and for external sources of funding for these cars at the time IL-15 was approved, indicate the actions taken to fulfill these needs, and demonstrate the impact of IL-15 on the BN commuter service.

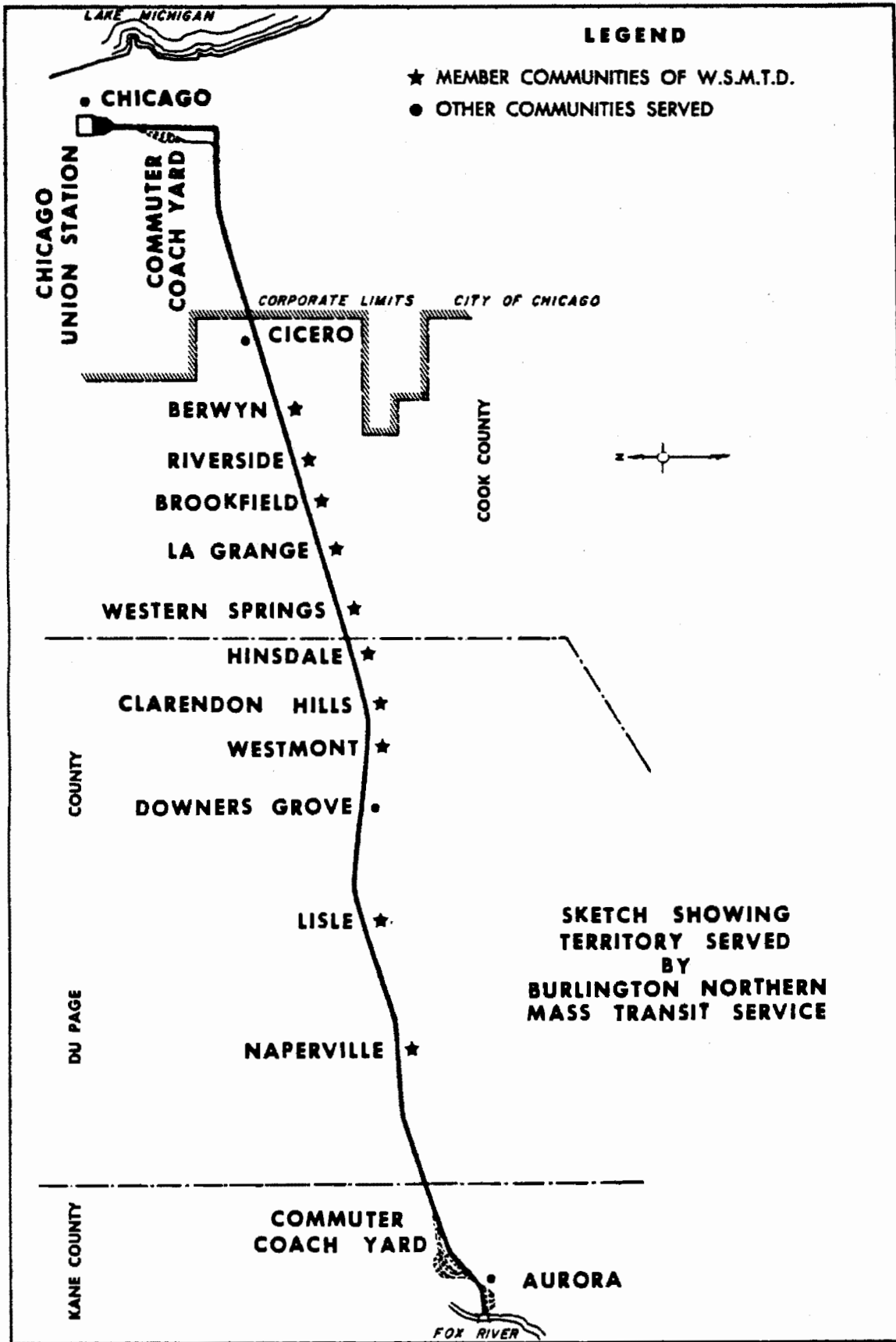
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<sup>1</sup>The modernization of commuter cars included the electrical air-conditioning, heating and lighting systems, and the modernization of diesel locomotives included a complete rebuilding of the locomotives.

## II. BURLINGTON NORTHERN COMMUTER RAIL SERVICE

The Aurora Branch Railroad was incorporated in 1849 and initiated passenger service from Aurora to Chicago with partial use of the Galena and Chicago Union (now C&NW Railway) tracks. The Aurora Branch Railroad soon became the Aurora and Chicago Railroad and, by 1855, the Chicago, Burlington & Quincy. When the Galena and Chicago Union terminated Burlington trackage rights, the Burlington constructed a 38-mile direct line from Aurora to Chicago over which the first passenger train was operated on May 29, 1864. There are currently 26 stations along the route, three of which are located within the Chicago City limits (see Exhibit A-1). The remaining 23 stations are situated in suburban Cook, DuPage, and Kane Counties. At present, all units of the BN commuter car fleet of 141 cars are utilized, either in revenue service or as spares, while providing 68 weekday trains (21 inbound during the morning peak period and 19 outbound during the evening peak period). More than 12 million passengers are transported annually (approximately 46,000 riders each weekday).

EXHIBIT A-1



SOURCE: Burlington Northern Railroad

### III. OPERATING AND FINANCIAL ENVIRONMENT PRIOR TO IL-15

#### PATRONAGE TRENDS AND RELATED FACTORS

##### Annual Patronage 1965-1972

From 1965-1972, annual patronage on the BN increased nearly 18 percent, from 8.8 million to 10.3 million. The average annual increase in patronage during this 7-year period was 2.5 percent or roughly 200,000 per year. Although this increase in patronage may not appear significant when viewed alone, its importance grows when examined in the context of BN fare policies. During the period 1965-1972, the BN increased commuter fares on three occasions: a 10-percent increase on March 29, 1968, a 5-percent increase on May 10, 1970, and a 6-percent increase on August 9, 1971. The continued increases in BN patronage despite increased fares, indicate the growing demand for commuter rail service provided by the Burlington Northern.

The increases in patronage noted above are partially attributable to increases in the population of the various townships and communities served by the BN. Although the population in those communities and townships served by the BN in Cook County (Cicero, Berwyn, Riverside, Brookfield, LaGrange, and Western Springs) experienced a population decline of nearly 1 percent from 1960 to 1970, the communities and townships in DuPage County (Hinsdale, Clarendon Hills, Westmont, Downers Grove, Lisle, and Naperville) experienced population increases of approximately 54 percent. In addition, the population of Aurora township in Kane County grew by 16.9 percent between 1960 and 1970. As a whole, population in the service area has increase nearly 21 percent from 1960 to 1970.

Another factor impacting BN patronage was the rise in the level of employment within the Chicago Central Business District (CBD). CBD employment for Chicago from 1965-1972, as shown below,<sup>1</sup> increased nearly 9 percent between 1965 and 1972.

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<sup>1</sup>Source: Chicago Area Labor Market.



## CBD Employment<sup>1</sup>

### Jobs Covered by Unemployment Compensation Act

Year	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>
Employment (thousands)	197	202	210	216	223	224	214	215 <sup>2</sup>

Although CBD employment declined 4.5 percent in 1971, BN patronage increased 2.7 percent. In 1972, when there was practically no change in CBD employment, BN patronage increased 3.8 percent.

### Peak Period Demand

Another measure of demand for BN commuter service is the number of inbound peak period riders. This is particularly relevant as it determines the number of cars required to provide service. The table below indicates morning inbound peak period patronage from 1970 through 1972:

### BN Average Patronage During Inbound Peak Periods<sup>3</sup>

<u>Year</u>	<u>1st QTR.</u>	<u>2nd QTR.</u>	<u>3rd QTR.</u>	<u>4th QTR.</u>	<u>AVERAGE</u>
1970	14,098	14,230	13,730	14,661	14,179
1971	15,286	14,756	14,471	15,028	14,959
1972	15,765	15,564	14,964	16,131	15,606

These data indicate an increase in morning inbound peak period patronage of approximately 10 percent from 1970 to 1972 (based upon yearly averages). However, depending upon which quarterly periods are chosen for comparison, increases in peak period patronage ranged from 10-17 percent. These figures point to a significant increase in morning inbound peak period patronage from 1970 to 1972.

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<sup>1</sup>CBD Boundaries: North - River and Wacker Drive, West - Wells Street;  
South - Van Buren Street.

<sup>2</sup>Coverage of Unemployment Act changed in 1972; figure might be slightly high.

<sup>3</sup>Source: Carl R. Englund and Son.

## Trip Length

The growth in a.m. peak patronage prior to 1972 was not uniform throughout the BN service area. Because of the high population increases in DuPage (54 percent) and Kane (17 percent) Counties since 1960, the greatest increases have occurred at those stations located more than 15 miles from the city, thereby increasing the average trip length. For example, peak period patronage in DuPage County grew 16.0 percent during the period 1970-1972.<sup>1</sup> The peak period patronage at those stations farthest from Chicago, such as Naperville, Lisle, Belmont, and Downer's Grove, increased 6.9, 66.1, 18.1, and 14.5 percent, respectively.

## SERVICE CAPABILITIES

The service measures discussed in this case study are capacity, frequency, and reliability. Prior to the receipt of the 25 new bi-levels purchased under IL-15, the BN commuter car fleet consisted of 94 stainless steel bi-level cars built between 1950 and 1965 and 17 single-level combination passenger and power generating cars built between 1916 and 1929. The 17 "combination" cars were extensively rebuilt in 1950 to provide a power source for the train lighting systems of the newer bi-level cars. In addition, seven single level "main line" or intercity type cars were used in suburban service. The average fleet age of the 94 bi-level cars was 18.1 years in 1972.

### Seating Capacity

The seating capacity of the old BN commuter car fleet (1972), not allowing for spares, was approximately 14,830 seats (94 bi-levels at 145 seats each; 17 "combination" cars at 50 seats each; and seven "mainline" cars at 50 seats each). In addition, recycled equipment<sup>2</sup> during the morning inbound peak period accounted for 2,355 seats, thereby increasing the seating capacity of a.m. peak period inbound trains to 17,185 seats. Because the BN commuter fleet was operating at 100 percent of capacity prior to the receipt of the 25 new bi-levels, the seating capacity of 17,185 seats represented the maximum number of seats that could be provided. These figures do not allow for deducting seats in a minimum of cars (two) held for programmed maintenance which would reduce the effective seating capacity to 16,895.

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<sup>1</sup>Based on sale of weekly/monthly tickets allocated to stations percentagewise from results of actual conductor counts. Source: Burlington Northern Railroad.

<sup>2</sup>This term refers to BN's practice of scheduling early trains for second runs during the morning and evening rush hours.

## Frequency and Reliability

Until November 1972, the BN commuter car fleet was utilized to operate 62 scheduled weekday trains, 38 of which were rush-hour trains (20 inbound during the morning peak period and 18 outbound during the evening peak period). The on-time performance of BN rush-hour trains (i.e., percentage of trains arriving at the terminal within 3 minutes of schedule) during the period 1970-1973 ranged from 71.7 to 98.0 percent. All delays, regardless of circumstances, are included in these computations. The average on-time performance for the years 1970, 1971, 1972, and 1973 was 92, 91, 93, and 88 percent, respectively.

## Equipment Utilization

In an effort to meet the 10-percent increase in morning peak period demand since 1970, the BN scheduled an additional train in November 1972 for both morning and evening peak period service, raising the commuter car utilization rate to 100 percent. Operating at maximum capacity, the BN was able to serve the increased patronage. However, the anticipated growth in patronage beyond 1973 could not be accommodated given the current equipment limitations.

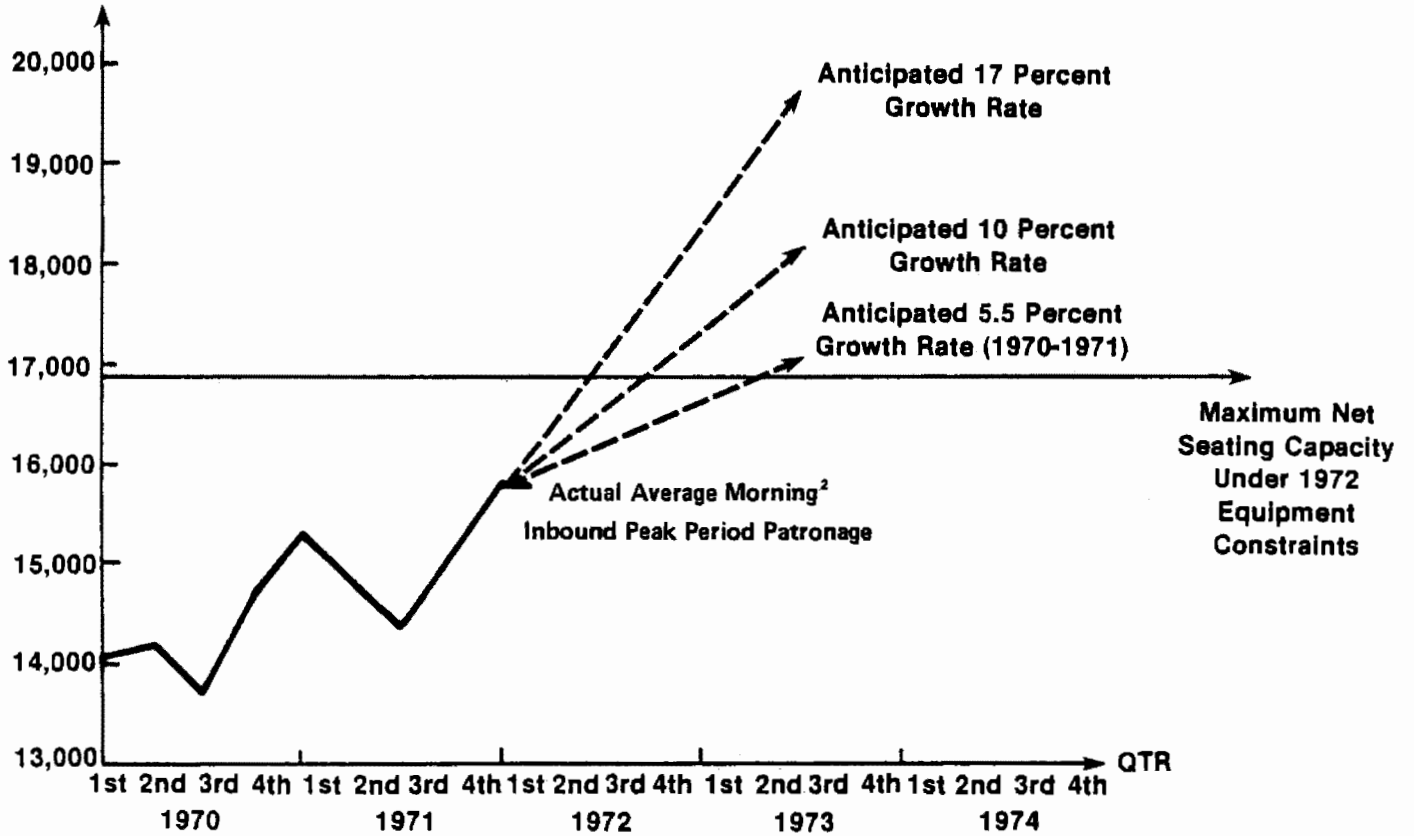
The 100-percent equipment utilization presented additional problems as well. During peak periods, cars could not be taken out of service for major maintenance work. Consequently, the BN was precluded from instituting a normal preventive maintenance program and was required to repair car components during daytime yarding when and if failures occurred. With the average fleet age exceeding 18 years, the probability of commuter car breakdowns while in operation was increasing. In summary, the high equipment utilization created problems, such as:

- . handling future demand; and
- . reducing reliability because of the inability to institute effective preventive maintenance programs.

Exhibit A-2 illustrates the problem of handling future demand by charting the maximum net seating capacity under 1972 equipment constraints against anticipated growth rates (in morning peak period patronage) of 17 percent, 10 percent, and 5.5 percent. This exhibit suggests that the number of anticipated passengers would outnumber available seats between the 2nd quarter 1972 and the 2nd quarter 1973. However, this does not imply that the BN was not experiencing equipment shortages during 1972.

When the total number of available seats on a.m. peak period trains approximates the number of passengers, some trains have vacant seats while

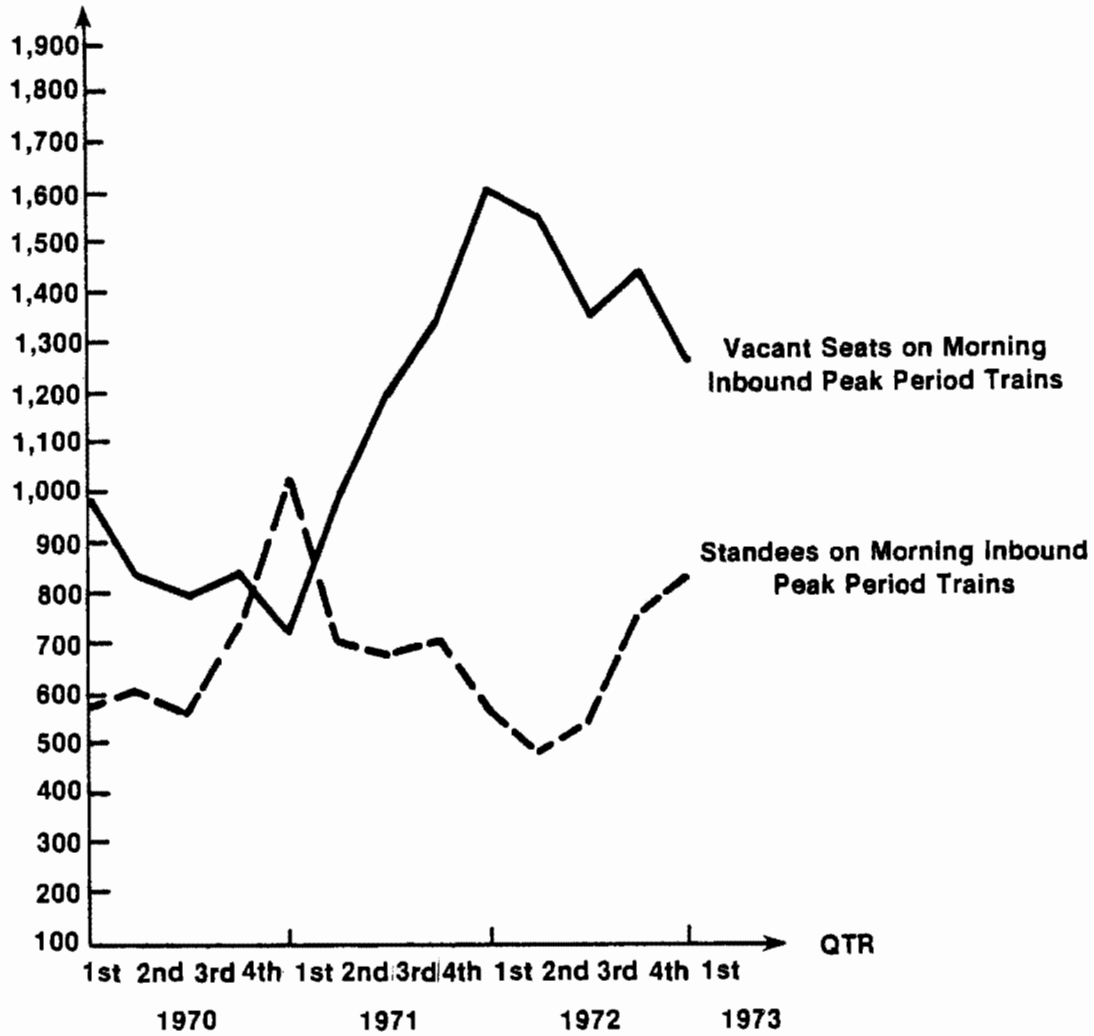
**EXHIBIT A-2  
PATRONAGE TRENDS  
AND  
MAXIMUM NET SEATING CAPACITY UNDER 1972 EQUIPMENT CONSTRAINTS**



<sup>1</sup> Source: BN Commuter Fleet Data

<sup>2</sup> Source: Carl R. Englund & Son, "Burlington Northern Ridership Forecast Study," Supplement 3, June 7, 1976.

**EXHIBIT A-3  
MORNING INBOUND PEAK PERIOD STANDEES AND VACANT SEATS**



Source: Burlington Northern conductor counts.

other trains have an excessive number of standees. Exhibit A-3 indicates the relationship between total standees and total vacant seats on BN morning inbound peak period trains during the period 1970-1973 (1st quarter). BN representatives account for this by noting that the earliest inbound train (arriving Union Station at 6:20 a.m.) and the latest inbound peak period train (arriving at 9:15 a.m.) normally have a high number of vacant seats. However, those trains arriving during the interim period, particularly around 7:30 a.m. and around 8:00 a.m., have crush loads with many standees. BN's objective for rush hour trains is to minimize standees on any particular train. As such, the size of the trains (arriving near 7:30 a.m. and near 8:00 a.m.) during the morning peak period dictates the size of trains arriving before and after these "peak" trains. This results from the fact that in order for recycled trains to arrive at the points in which they are needed, there is no available time for changing the consist of these trains. As the distance which a train must travel to reach a recycle point increases, the ability of management to match passengers with available seats diminishes and, consequently, both the number of vacant seats and the number of standees increase.

The steady growth in BN patronage during the period 1965-1972 taxed the existing fleet of commuter cars to the limit. Anticipated increases in patronage presented BN management with the task of meeting these patronage increases without a concomitant decline in the level of service provided. As such, the need for additional commuter cars became increasingly apparent.

## SERVICE PROFITABILITY AND FUNDING OF EQUIPMENT PURCHASES

### Operating Losses

Strong patronage increases from 1968 to 1971, coupled with three fare increases, during the same period contributed to an overall increase in passenger revenues of 17.2 percent. However, despite these increased passenger revenues, operating costs were increasing at the rate of 7 to 8 percent a year; BN commuter operations during the years 1968-1971 sustained net operating losses, excluding interest on equipment obligations, of \$760,090, \$1,713,320, \$567,870, and \$1,920,936.<sup>1</sup> As such, revenues from commuter operations were not available to finance the purchase of new commuter cars.

### Ineligibility of BN for Federal Funds

Although capital assistance grants were available from UMTA, the BN was not eligible by law to receive UMTA funds directly, since grants were limited

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<sup>1</sup>Source: Burlington Northern Suburban Operations Financial Statements.

to public agencies. In the absence of an interested public agency to serve as a channel for UMTA funds, the expansion of the BN commuter fleet with the aid of these funds was not possible.

#### Alternatives Available to BN

As previously noted, operating losses were continuous and, from the company's standpoint, of a magnitude to justify an attempt for abandonment. However, because abandonment of service would meet public and regulatory opposition, BN management was confronted with one or more of the following alternatives: (1) the continued diversion of other assets to commuter operations, (2) the selective discontinuance of off-peak and weekend service as a partial abandonment, (3) a selective reduction of commuter-related expenditures in areas not affecting public safety, or (4) deterioration of service due to overcrowding.

BN officials have indicated that, as a matter of company policy, the continued diversion of further company assets into commuter operations would no longer be tolerated. As such, one can assume that every effort would have been made to reduce costs (operating, maintenance, and capital) associated with the commuter operations, particularly since the three fare increases during the period 1965-1973 did not result in a net profit. These efforts may have included opting for Alternative 2, which would reduce operating costs by curtailing service. Alternative 3 would result in both reduced maintenance costs (by deferring maintenance) and reduced capital costs (by eliminating further investment in rolling stock, etc.).

#### Implications of Non-Funding

Disregarding any efforts by the BN to reduce operating and maintenance costs, it appears that private investment in the commuter service was not going to occur. Because of the unprofitability of commuter operations and the apparent inability to win rate increases that would match operating costs, BN management would not have invested in the expansion of these operations. The purchase of 25 new commuter cars would not have occurred, and, consequently, the expansion of service as measured by seating capacity (through higher capacity cars and improved equipment recycling capabilities) and by frequency (one additional recycled train) would not have occurred either.

The question of patronage increases in the absence of funds for expansion is somewhat more difficult to address. However, given the seating capacity limitations of the pre-IL-15 commuter fleet (Exhibit A-2), it does not appear that future patronage gains would have been so significant. As demand levels increased the number of standees would have increased, reducing overall service levels and diverting travelers to alternative modes.

#### IV. ESTABLISHMENT OF WSMTD AND APPROVAL OF IL-15

To address the capacity and financial dilemma and to continue high quality service to BN commuters, the West Suburban Mass Transit District (WSMTD) was formed as a channel for UMTA funds. Under Illinois state law, the local mass transit district act provides for the creation of local Mass Transit Districts by one or more municipalities for public ownership and/or operation of mass transit facilities.

The West Suburban Mass Transit District (WSMTD) is an Illinois municipal corporation organized in August 1970. Membership of the District consists of 10 Illinois cities and villages located on the BN commuter line ranging from Berwyn on the east to Naperville on the west. As a public agency, the WSMTD was able to qualify itself for a grant under Section 3(a) of the UMTA Act. However, since the Illinois local mass transit district act does not grant districts the authority to levy taxes without prior approval of a majority of the voters of the district, the WSMTD was incapable of providing the local share (33-1/3 percent) of the costs of this project as required by the UMTA Act.

As previously noted, the total project costs of IL-15 were approximately \$42 million. Of this amount, UMTA contributed \$27.8 million (two-thirds share), and the WSMTD generated the remaining one-third local share on the basis of a \$6.9 million grant from the State of Illinois and \$7.3 million from the WSMTD. In order to generate its part of the local share, the WSMTD entered into two agreements with the BN.

The first was a basic agreement (1) to accept ownership by donation of 29 double-deck BN cars appraised at \$6 million, (2) to purchase the remaining 65 cars and 21 locomotives at an appraised price of \$12.2 million, (3) to purchase 25 new cars, (4) to replace the heating, cooling, and lighting systems in the acquired cars, and (5) to rebuild the 21 locomotives.

The second agreement was a 15-year lease-back of the BN fleet which WSMTD had just acquired, plus a lease of the 25 new cars it intended to buy. The \$12.2 million in proceeds from the sale of the 65 cars and 21 locomotives were returned by the BN to the WSMTD as advance rental for the 15-year lease back period. The WSMTD then agreed to use those sale proceeds (advance rental) to pay its portion of the local share for this project and to use the remaining proceeds for such future capital improvements as the District and BN may agree to fund.

The purpose of the 29-car donation was to "trigger" a section of the Illinois State Transportation Bond Act which would allow the state to match donated equipment with an equivalent amount of cash for local share purposes. This



permitted WSMTD to match the two-thirds UMTA fleet acquisition grant with a one-third state grant (no WSMTD participation for that part of the project). Additionally, the sale proceeds for the fleet acquisition (returned to WSMTD as advance rental) were used to fund the one-third local share for the balance of the project, which included fleet rehabilitation, new car acquisitions, and locomotive rebuilding.

The net results of the transactions described above are as follows: the WSMTD became the owner of 119 commuter cars (94 old and 25 new) and 21 diesel locomotives and the owner of \$4.5 million in cash for future mass transit capital improvements; the BN lost ownership of its fleet of 94 cars and 21 locomotives, donated all sale proceeds to the WSMTD, and currently pays a nominal monthly rent for the operation of the modernized/expanded fleet; IDOT provided a grant of approximately \$7 million in 1972; and, UMTA provided a grant of approximately \$28 million, also in 1972.

The primary advantage to the BN of the sale/leaseback agreement noted above is the relief from capital costs through public ownership of the commuter equipment. Typically, BN would expect to pay a rate of 8-9 percent on equipment trusts issued to finance new equipment. Since the WSMTD purchased the 25 new commuter cars, the BN did not have to negotiate for any equipment trusts and pay the resulting capital costs and financing charges. Other advantages to the BN of the sale/leaseback agreement include a reduction in costs by eliminating fleet depreciation and the establishment of a fund for future improvements along the commuter line. The creation of this capital reserve account has allowed the BN and the WSMTD to undertake various improvements without competing for scarce Section 3 funds under the UMT Act of 1964, as amended. This, in turn, has enabled the railroad and the District to complete visible improvements (such as station work and grade crossing improvements) that have enhanced the image of the BN commuter service.

## V. IMPACTS OF IL-15

### LEVEL OF SERVICE

The primary impact of IL-15 derives from the purchase of 25 new bi-level commuter cars. With the purchase of these cars the older "combination" cars and single-level "main line" cars have been retired and approximately 2,400 seats added to the commuter fleet. Exhibits A-4, A-5, and A-6 provide an external view of a "combination" car, a "main line" car, and a bi-level car which was purchased under IL-15, respectively. Additionally, 20 of these 25 new cars have "cab-control" which allowed for "push-pull" operation resulting in lower operating costs (through reduced switching charges) and shorter recycling times. As such, the BN was able to recycle an additional early morning train train, thereby raising morning inbound peak period capacity to approximately 20,600 seats.

The frequency of service during the morning inbound peak period was increased with the addition of the recycled train set. Overall increases in frequency of service resulting from the addition of the 25 new cars includes the addition of 2 rush-hour trains from 38 to 40. The communities on the westernmost end of the line, Aurora, Naperville, and Lisle, have directly benefitted from this recycled train set with the addition of scheduled non-stop train to Chicago.

The reliability of rush-hour trains (arriving Chicago 6:20-9:15 a.m.) has exhibited a modest improvement since the 25 new cars were placed into service and the existing fleet of 94 cars and 21 locomotives were modernized. On-time performance is measured by the percentage of trains arriving at the destination terminal within 3 minutes of schedule during rush hours and 5 minutes in non-rush hours. The table below illustrates the trend in the average on-time performance of rush-hour trains during the years 1971-1973 and during the years 1974-1976 after the modernization program was completed:

#### Average On-Time Performance of BN Rush-Hour Trains<sup>1</sup>

Year	1971	1972	1973	1974	1975	1976
On-Time Performance (Percent)	91.2	93.0	88.2	90.8	94.9	93.9

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<sup>1</sup>Source: Burlington Northern Railroad

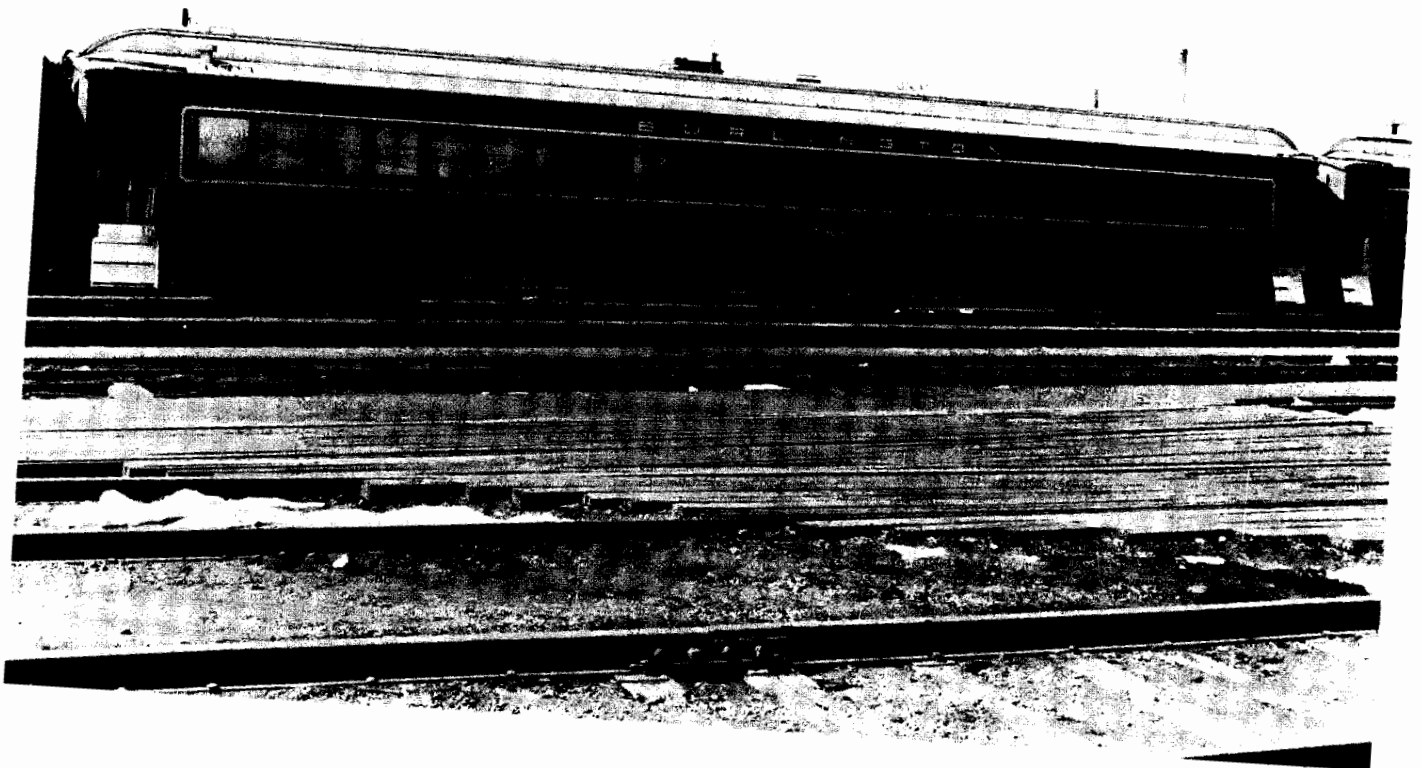
**EXHIBIT A-4**

**SINGLE-LEVEL "COMBINATION" POWER COMMUTER CAR**



**EXHIBIT A-5**

**SINGLE-LEVEL FORMER INTERCITY MAIN LINE  
PASSENGER CAR USED IN COMMUTER SERVICE**



**EXHIBIT A-6**

**DOUBLE-DECK COMMUTER CAR PURCHASED UNDER IL-15**



In summary, the addition of 25 new and 94 modernized cars has increased capacity, frequency, and reliability of the BN commuter service.

### GROWTH IN LEVEL OF SERVICE VS. GROWTH IN DEMAND

Annual patronage from 1972 to 1975 increased over 30 percent. These increases occurred despite an 8-10 percent fare increase in 1973. A good portion of post-1974 patronage increases are due to the opening of the Sears Tower, located only two blocks from Union Station, in the fall of 1973 and to the fuel crisis of 1974. The new Sears Tower accommodates approximately 16,000 employees, and a group of these employees were transferred to the downtown location from a previous location in Chicago not served by BN. BN officials have estimated that the sudden increase in ticket sales at Berwyn (from 760 in September 1973 to 890 in October 1973) was attributable to the transfer of certain of these employees who lived in Berwyn and formerly drove to the old Chicago location. The energy crisis of 1974 helped increase BN patronage even further. Patronage studies for the BN have indicated that nearly 2,000 additional trips per year resulted from the energy crisis.<sup>1</sup> The strength of patronage increases on the BN in 1973 and 1974 are highlighted by the fact that patronage gains from 1974-1975 approximated 1.7 percent.

The increases in annual patronage discussed above are reflected by increases in a.m. peak patronage. From the 1st quarter of 1972 through the 4th quarter of 1975 the increase in average a.m. peak patronage was 25.4 percent. Exhibit A-7 shows this increase in patronage in relation to the seating capacity of the BN fleet. This exhibit graphically illustrates the significance of the 25 new cars purchased under IL-15, enabling the BN to maintain a comfortable level of service.

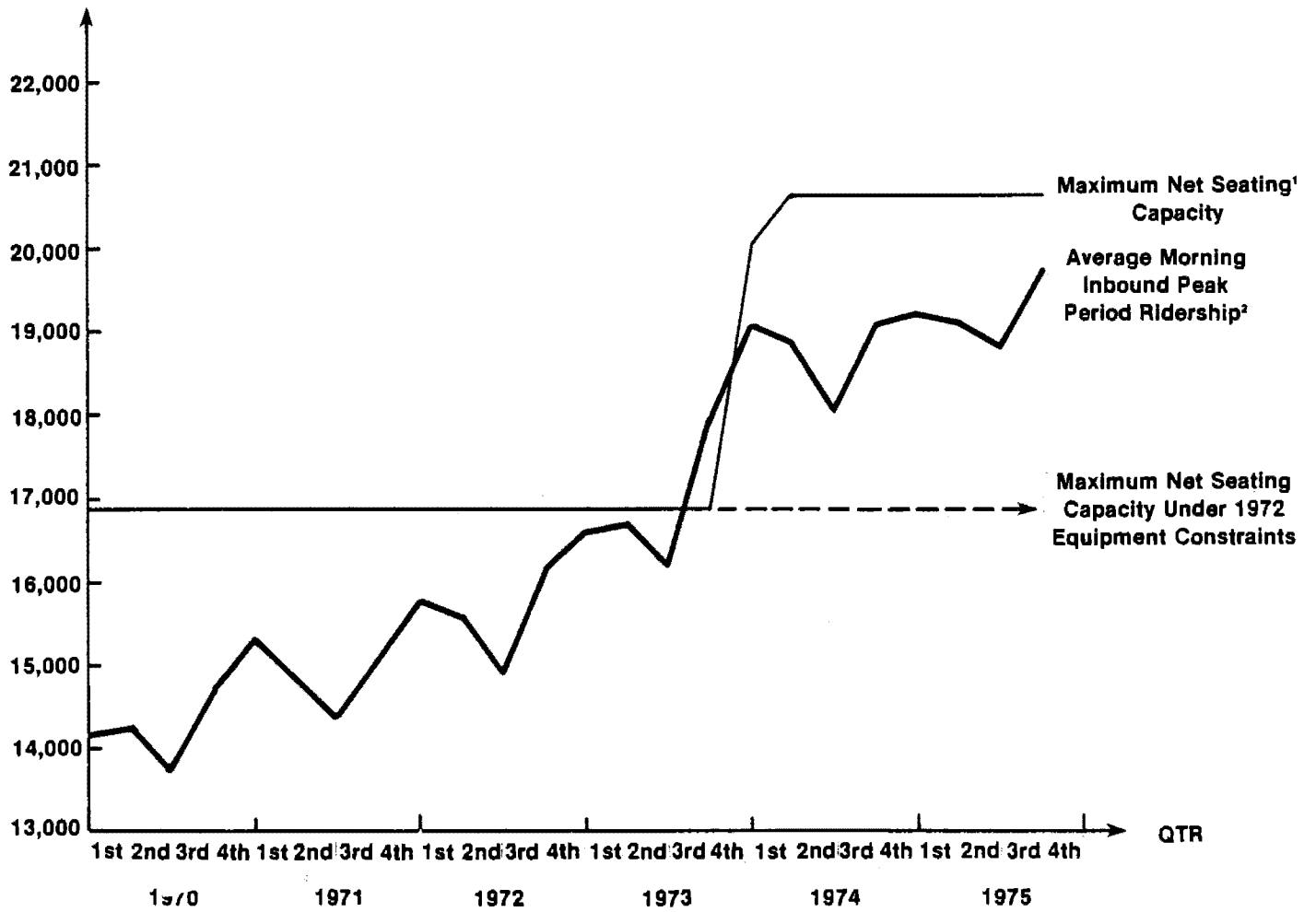
The growth in morning peak period patronage was not uniform throughout the BN service area. The majority of this growth has occurred at those stations located more than 15 miles from the city. For example, first quarter patronage gains from 1973 to 1976 have been as follows: Westmont, 33 percent; Downers Grove, 31 percent; Lisle, 38 percent; and Naperville, 117 percent.<sup>2</sup> BN officials have indicated that without the addition of 25 new cars under IL-15, it would not have been possible to add an additional non-stop train serving Aurora, Naperville, and Lisle, thereby meeting the increased demand for service from these communities. It is noted that meeting this

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<sup>1</sup>Carl R. Englund, Jr., "Burlington Northern Ridership Forecast Study," Supplement 3, June 7, 1976.

<sup>2</sup>Ibid.

**EXHIBIT A-7  
PATRONAGE TRENDS AND MAXIMUM NET SEATING CAPACITY 1970-1975**



<sup>1</sup> Source: BN Commuter Fleet Data

<sup>2</sup> Source: Carl R. Englund & Son, "Burlington Northern Ridership Forecast Study," Supplement 3, June 7, 1976.

demand during the peak hours taxed the post-IL-15 fleet to the limit because all spare cars were pressed into service thus distorting the normal opportunities for preventive maintenance.

In summary, it is clear that the 25 new commuter cars under IL-15 have enabled the Burlington Northern commuter services to grow with the demand for these services as exhibited by patronage trends (both annual and peak period) and that this growth would not have occurred in the absence of the WSMTD and of UMTA funding.



## APPENDIX B

Impacts Resulting From the Modernization of Power Conversion Equipment by the Port Authority Trans-Hudson Corporation (PATH)

IMPACTS RESULTING FROM THE MODERNIZATION  
OF POWER CONVERSION EQUIPMENT BY THE PORT  
AUTHORITY TRANS-HUDSON CORPORATION (PATH)

I. INTRODUCTION

II. PATH RAPID RAIL SERVICE

III. PATH POWER SYSTEM PRIOR TO MODERNIZATION

- . Overview
- . Energy Costs
- . Operating and Maintenance Manpower Requirements

IV. MODERNIZATION OF THE FORMER H&M SUBSTATIONS

- . Power Studies
- . Installation of Silicon Rectifiers

V. IMPACTS OF PATH SUBSTATION MODERNIZATION

- . Reduced Power Costs
- . Reduced Operating and Maintenance Costs
- . Summary

## I. INTRODUCTION

The Port Authority Trans-Hudson Corporation (PATH), a subsidiary of The Port Authority of New York and New Jersey, provides rapid rail service between Newark, New Jersey, and two terminals in downtown and midtown Manhattan. Since 1962 when PATH was created to acquire, operate, and modernize the bankrupt Hudson & Manhattan Railroad interstate rapid transit system, PATH has invested \$23.4 million in the modernization of the electric traction power system. Significant aspects of this modernization program include the replacement of antiquated rotary converter and mercury arc substations with modern silicon rectifier substations,<sup>1</sup> the installation of two additional silicon rectifier substations, the replacement of power transmission lines, and the construction of an advanced computerized supervisory control center for traction power distribution. This appendix focuses on the modernization of rotary substations in the former Hudson & Manhattan Railroad (H&M) power system. UMTA participated in this modernization program under Grant IT-1. This grant, approved July 2, 1965, provided \$616,000 in federal funds for the construction of a silicon rectifier substation at Exchange Place (total project costs equalled \$1,232,000).<sup>2</sup>

The primary objective in evaluating the modernization of PATH substations is to identify and measure the impacts arising from modernization projects of this type including reductions in power costs and in operating and maintenance costs. Evaluation of the modernization of former H&M substations by PATH indicates substantial savings in power costs totalling \$6.2 million through improved efficiency and through a switch to a low-cost supplier, and in maintenance and operating costs through reduced manpower requirements (a net reduction of 15 employee positions resulted).

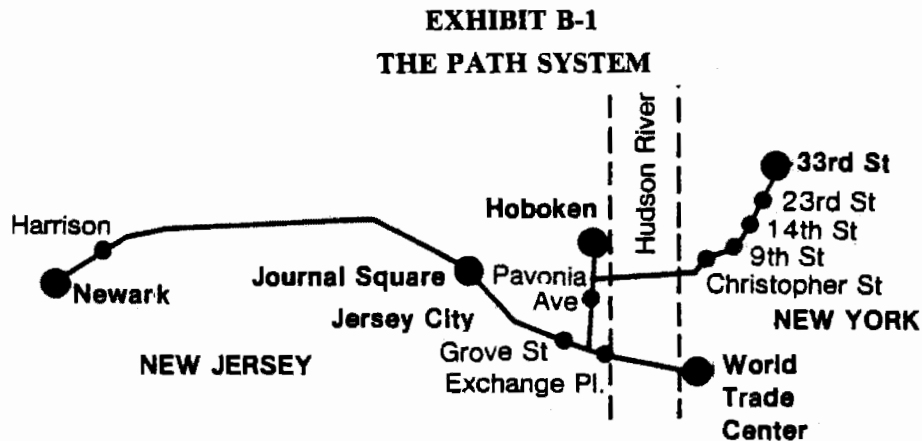
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<sup>1</sup>The principal function of substations is to convert commercially produced electric power from high-voltage alternating current (AC) to low-voltage direct current (DC) for transmission along the third rail, for passenger car traction power.

<sup>2</sup>Between February 1965 and May 1977, \$270 million or 11.0 percent of the total project costs (federal and local shares) of UMTA Section 3 rail modernization projects provided for the improvement of power systems nationally.

## II. PATH RAPID RAIL SERVICE

In an effort to preserve the rapid rail service between New Jersey and New York, the Port Authority of New York and New Jersey acquired the rail properties of the bankrupt H&M on September 1, 1962. These properties comprised the areas located east of the Journal Square Station in Jersey City, New Jersey (see Exhibit B-1). Operations between the Journal Square Station and Newark, New Jersey, were conducted jointly with the Pennsylvania Railroad (PRR), using PRR tracks and other facilities. In 1962, the rail service comprised 14.2 route miles with seven stations in New Jersey and six in New York. In addition, the system included two pairs of tunnels beneath the Hudson River. The two north tunnels formed the midtown line, handling service between Hoboken, New Jersey, and 33rd Street in New York and between Jersey City, New Jersey, and midtown Manhattan. The two south tunnels formed the downtown line, connecting Hoboken, Jersey City, and Newark with the Hudson Terminal (now the World Trade Center) in lower Manhattan. The line was completely electrified.



Source: PATH Brochure on Journal Square Transportation Center

Although the route structure and number of stations served remain essentially unchanged from the old H&M-PRR system,<sup>1</sup> the PATH system of today represents a significantly more advanced system over its predecessor. The new World Trade Center has replaced the original Hudson Terminal in lower Manhattan, the Journal Square Station has undergone a comprehensive modernization, and former joint PATH-PRR operations between Jersey City and Newark, New Jersey, have been terminated, with PATH assuming complete operation of these facilities through a long-term lease arrangement. A total of 297 active vehicles transported over 40 million passengers in 1977. Morning peak period patronage approximates 49,000, while total weekday patronage exceeds 147,000. PATH schedules 1,100 daily trains to meet this passenger volume (276 rush-hour trains and 824 non-rush-hour trains).

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<sup>1</sup>1978 route-miles total 13.9.

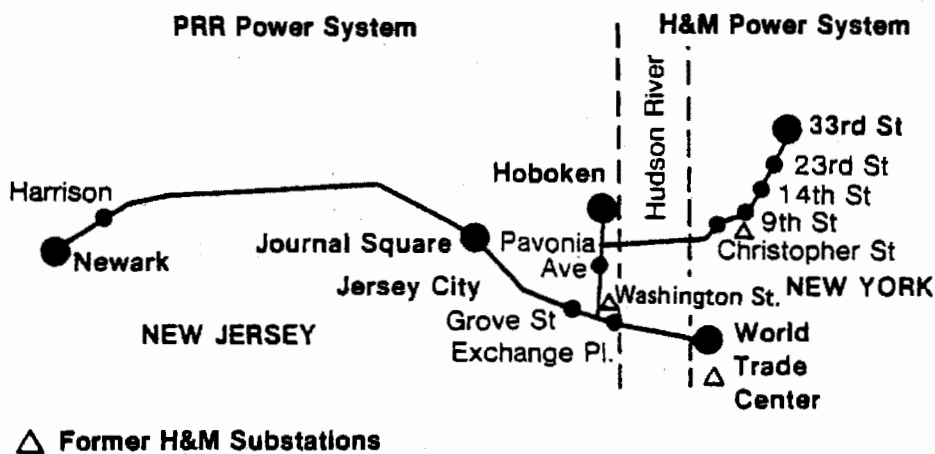
### III. PATH POWER SYSTEM PRIOR TO MODERNIZATION

#### OVERVIEW

At the time of the PATH's purchase of the H&M rail facilities, PATH was responsible for providing power in the areas east of the Journal Square Station (see map). Although operations between Newark and Jersey City were initially conducted jointly by PATH and PRR, the PRR had assumed responsibility for providing power to the third rail in areas west of the Journal Square Station. In order to supply the required power to the third rail east of Journal Square, PATH utilized 14 rotary converters of varying kilowatt output which were located in three substations: Christopher Street and Hudson Terminal (World Trade Center) in New York and Washington Street in Jersey City, New Jersey (see Exhibit B-2). Twentyfive cycle power was received directly from a New York utility company at the two New York substations and converted to 650-volt direct current by the rotary converters for transmission along the third rail. The Washington Street substation in New Jersey received 25-cycle power through transmission cables from the Christopher Street substation in New York. This power system presented PATH management with particular problems, including the associated cost of energy and the operating and maintenance manpower requirements.

#### EXHIBIT B-2

##### FORMER H&M SUBSTATIONS



#### ENERGY COSTS

During its first full year of operation in 1963, PATH incurred energy costs for traction power of approximately \$845,000. Although the majority of these costs were a function of the level of service provided by PATH, a significant portion of these costs were attributable to the type and source of power received at rotary converter substations and to the efficiency with which this power was converted from AC to DC by the rotaries. Two separate utility companies were located in territories served by PATH substations: one in New York and one in New Jersey. However, because PATH's rotaries were designed to re-

ceive 25-cycle power, they were limited to receiving this power from the utility company in New York. This was a result of a nationwide trend in which 25-cycle power was being "phased out" while industries operated increasingly on (and utilities generated only) 60-cycle power. As such, the supply of 25-cycle power was growing both scarce and costly relative to 60-cycle power. In addition to the type of power consumed by the rotary converters, evaluation of electric power charges for 60-cycle power between the New York utility company and the New Jersey company indicated a substantial saving if power were to be purchased in New Jersey.

As previously noted, the primary function of a substation is to convert commercially produced electric power from high-voltage AC to low-voltage DC for traction power. Rotary converters and silicon rectifiers convert power from AC to DC, while transformers reduce the voltage. Throughout this process, normal losses of energy occur in proportion to the efficiency of the conductor of electricity. The efficiency of rotary converters in converting electric power from AC to DC approaches 95 percent, while silicon rectifiers typically perform at an efficiency rate of 98 percent. Although the efficiency of rotary converters approximates the efficiency of silicon rectifiers, the rotary converter efficiency rating of 95 percent applies only when they are operating at peak capacity. However, since the peak operating period lasts only 2-4 hours per day, the actual efficiency of rotaries (all-day efficiency) is closer to 85 percent. Silicon rectifiers operate at 98 percent efficiency regardless of whether or not they operate at peak capacity.<sup>1</sup> These efficiency ratings apply to the converters themselves and not to auxiliary equipment throughout the remainder of the substation. Consequently, rotary converters require that more electricity be purchased in order to achieve the same total output as a silicon rectifier. The cost of the energy lost in the conversion process can be significant.

#### OPERATING AND MAINTENANCE MANPOWER REQUIREMENTS

The former H&M rotary converters were installed in the early 1900s and reflected 50 years of use. PATH officials noted that the rotaries had never undergone a complete overhaul and had proven to be very rugged and reliable.<sup>2</sup> However, they required constant, ongoing preventive maintenance. This necessitated shutting down the rotaries in each substation at regular intervals in order to check wires and bearings, perform brush-gear maintenance, renew oil circuit breakers, grind down commutators, and generally clean and polish the rotaries.

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<sup>1</sup>Efficiency ratings for silicon rectifiers represent minimum standards established by electrical manufacturers. Rotary converter efficiency ratings are based on discussions with national manufacturers of power conversion equipment and on actual experience of various transit properties.

<sup>2</sup>Despite an acceptable level of reliability, PATH's ability to obtain replacement parts and components as necessary was becoming more difficult; original equipment manufacturers no longer provided replacement parts which often had to be custom made at excessive cost.

To perform these duties, each substation was manned by an operator and an attendant. The operator's primary responsibility was to maintain the power flow to the third rail (by the opening and closing of switches) and to ensure that the rotaries and auxiliary equipment remained in working order. The substation attendant was responsible for lubricating and cleaning whichever rotary was "off-line." Since these duties were performed on an "around-the-clock" basis, three shifts of substation operators and attendants were required. Neither the operator nor the attendant performed heavy maintenance work on the rotaries. A substation electrician handled the actual (heavy) maintenance problems in conjunction with other normal duties. The total number of substation operators, attendants, and electricians employed by PATH to operate and maintain the rotary converters was approximately 28.

## IV. MODERNIZATION OF THE FORMER H&M SUBSTATIONS

### POWER STUDIES

The preceding section has served to demonstrate some of the difficulties and costs associated with the continued operation of the three former H&M substations. Because this power system was deemed inadequate to meet the power requirements of the PATH system, various power studies were conducted to identify and assess alternative replacement power systems.<sup>1</sup> In 1962, the Rail Planning Division of PATH initiated a study which examined two such alternative systems: the rehabilitation of existing rotary converter substations and the replacement of existing rotary converter substations with modern silicon rectifier substations. The conclusions and recommendations arising from this study indicated that the installation of modern silicon rectifier substations would most adequately meet the long-term power needs of PATH. With the decision to install silicon rectifiers, additional power studies were conducted to determine the optimal design and location of the silicon rectifier substations.<sup>2</sup>

### INSTALLATION OF SILICON RECTIFIERS

Each of the three former H&M rotary converter substations, Christopher Street and Hudson Terminal (World Trade Center) in New York and Washington Street in Jersey City, New Jersey, was replaced by a modern silicon rectifier substation which was constructed adjacent to the existing facility. In addition, a new substation was built in a part of the Exchange Place (New Jersey) passenger station which had previously contained elevator equipment. The construction of this substation benefited from \$616,000 in UMTA funds under IT-1, and it assumed some of the power load for the third rail in areas that were formerly handled by the Washington Street substation. This redistribution of the power supply aided in accommodating the increased train activity between Newark and Hudson Terminal (World Trade Center) as part of

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<sup>1</sup>One power study undertaken by outside consultants in 1950 recommended the complete replacement of the H&M power conversion equipment. However, these recommendations were not implemented at that time.

<sup>2</sup>Various factors impact the decision concerning the optimal supply and distribution of power generated by substations, including the size and frequency of trains operating throughout the system, the number of stops, track grade characteristics, and car characteristics (size, weight, acceleration, lighting, air conditioning).



the Aldene Plan.<sup>1</sup> The Washington Street substation was the first of the four substations to come "on-line" in the third quarter of 1966. The Exchange Place substation was completed in the third quarter of 1969, while Christopher Street and World Trade Center were completed during the fourth quarter of 1969 and the third quarter of 1971, respectively. As each silicon rectifier substation was placed into service, power was supplied by a utility company in New Jersey. All power is received at the Washington Street substation and subsequently transmitted through 27KV distribution cables to the Exchange Place substation and to the New York substations.

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<sup>1</sup>Under this plan, passenger trains of the Central Railroad of New Jersey (CNJ) were rerouted to operate over Lehigh Valley trackage into Penn Station, Newark, where passengers would transfer to PATH for the ride into lower Manhattan or to the PRR for trips to midtown Manhattan. Under development for many years, the Aldene Plan was implemented in April 1967. Since 1967, the morning peak period traffic (eastbound) from Newark has more than doubled from 3,000 to 6,500, and peak period train capacities to handle this traffic have increased commensurately.

## V. IMPACTS OF PATH SUBSTATION MODERNIZATION

### REDUCED POWER COSTS

The primary impact of the modernization of former H&M substations is the reduction of power costs incurred to provide service east of Journal Square. Since the installation of the first silicon rectifier substation on PATH in 1966, savings in power costs incurred by PATH have totalled \$6.2 million, an average of \$559,000 per year.<sup>1</sup> These cost savings result from the higher efficiency of silicon rectifiers in converting alternating current to direct current (demand charge) and from the ability of silicon rectifiers to operate on 60-cycle power which may be purchased from a low-cost producer (energy charge).

As previously noted, silicon rectifiers are highly efficient in converting alternating current to direct current and typically operate at an efficiency rate of 98 percent. In contrast, the all-day efficiency of rotary converters approximates 85 percent. This implies that in order for rotary converters to achieve the same total output as silicon rectifiers, rotaries require 15 percent more kilowatts of input. Exhibit B-3 indicates the monthly average maximum kilowatt demand (input) during the years 1966-1976. These figures are shown for the actual consumption of the silicon rectifiers and for the hypothetical consumption of the rotary converters (assuming that they are required to produce the same level of output as the silicon rectifiers). The reduction in KW demand arising from the more efficient silicon rectifiers is apparent. Exhibit B-4 indicates the total savings in power costs from this reduced KW demand since 1966. These savings approximate \$2.2 million and average \$203,000 per year. They are assignable to both a reduced demand for KW and to the fact that the cost per KW of 60-cycle power consumed is significantly lower than the cost per KW of 25-cycle power previously consumed from a high-cost supplier.

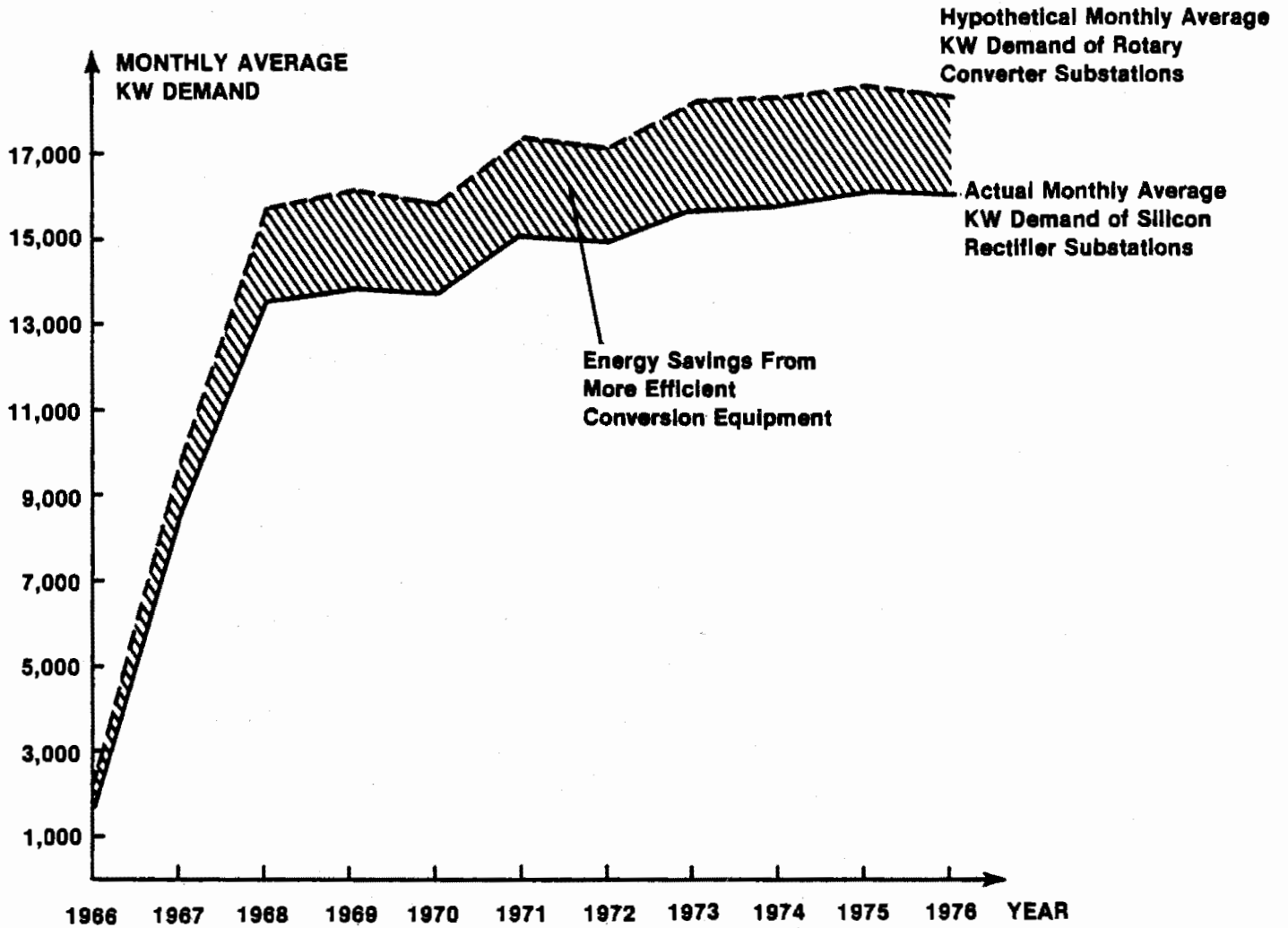
The total energy bill (KW demand and KWH energy charge), 1966-1976, paid by PATH for power received at the silicon rectifier substations is shown in Exhibit B-5. This exhibit contrasts the actual power costs incurred with

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<sup>1</sup>Utility company power bills are comprised of two components: a demand charge and an energy charge. The demand charge is a cost based on a customer's peak short-time usage of power in kilowatts (KW) within a given period, normally on a monthly basis, and is calculated by taking the average of the four greatest 15-minute periods of kilowatt demand during the billing month and assigning the applicable rates to this average. The energy charge is a cost based on the customer's total consumption of energy in kilowatt hours (KWH).

**EXHIBIT B-3**

**MONTHLY AVERAGE MAXIMUM KILOWATT DEMAND**



**EXHIBIT B-4  
KW DEMAND POWER COST SAVINGS**

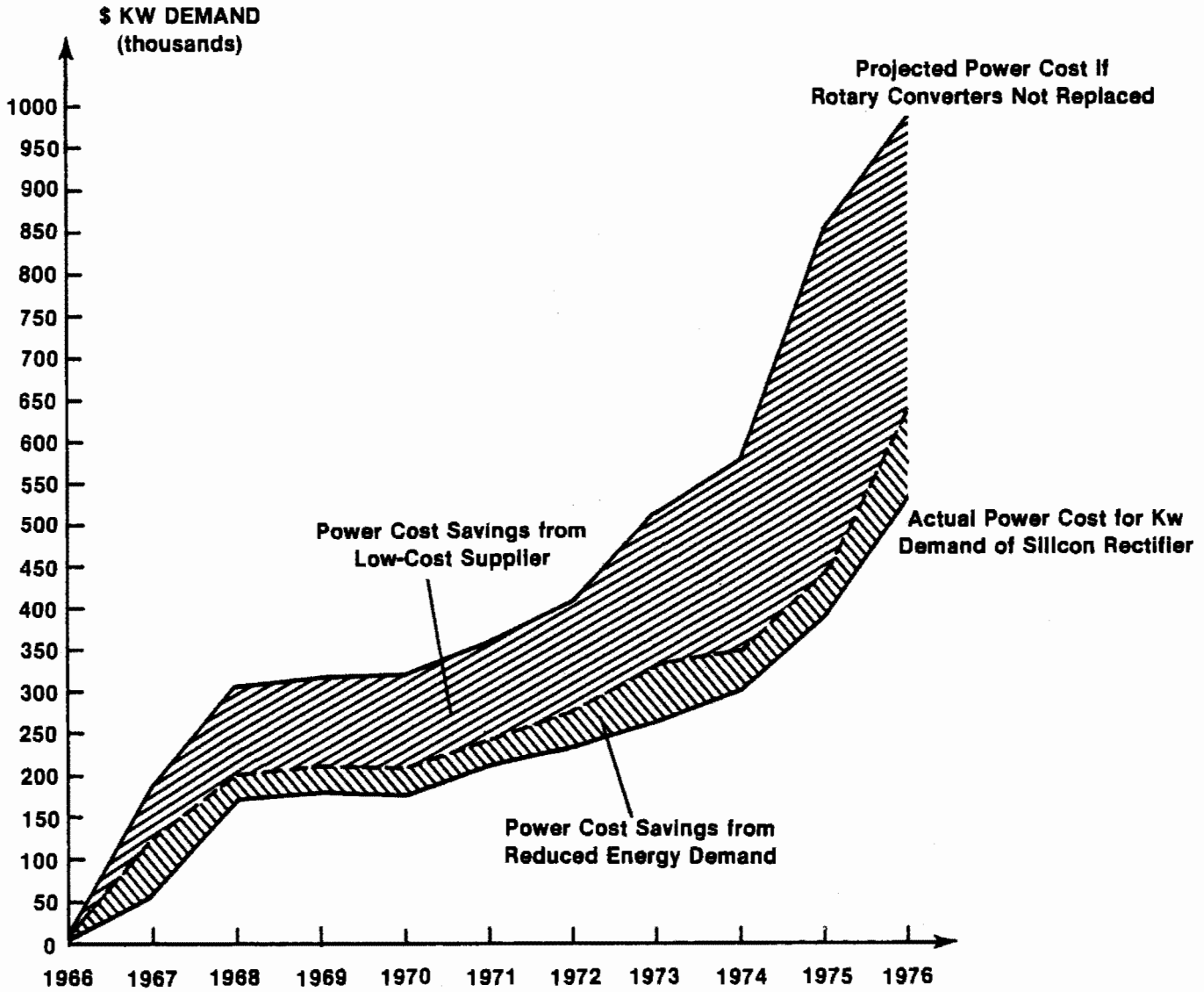
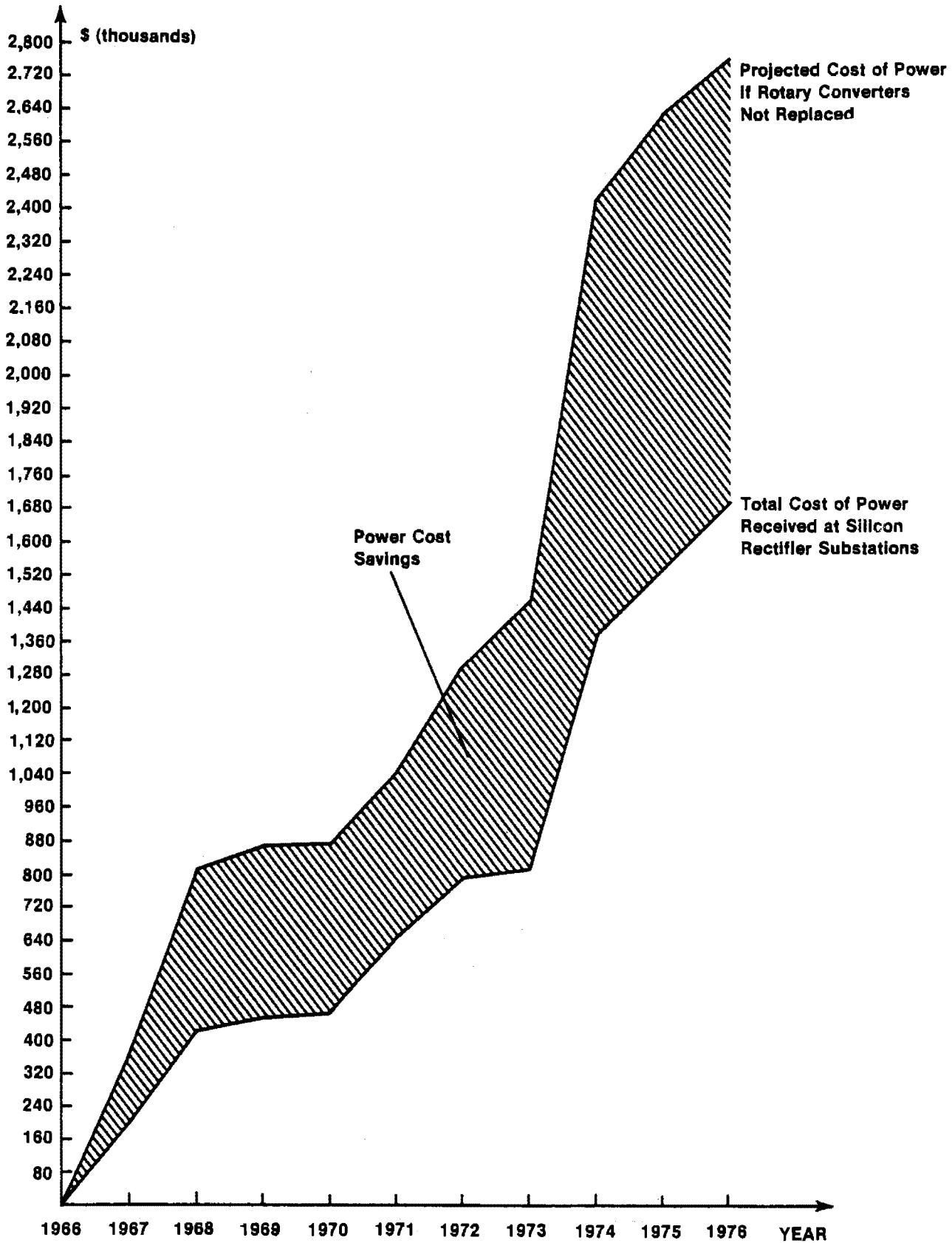


EXHIBIT B-5

TOTAL POWER COSTS FOR POWER RECEIVED AT SILICON RECTIFIER SUBSTATIONS



the power costs that would have been incurred if PATH had continued the operation of the rotary converters to generate the same level of output. As previously noted, savings in power costs, 1966-1976, totalled \$6.2 million while averaging \$559,000 per year.

### REDUCED OPERATING AND MAINTENANCE COSTS

Principal savings in operating and maintenance costs arising from the installation of silicon rectifier substations are attributable to the reduced manpower requirements for these facilities. The total number of substation operators, attendants, and electricians employed by PATH to operate and maintain the rotary converters was 28. With the construction of silicon rectifiers, the potential for automated substations was introduced, and the need for substation operators to open and close switches was subsequently eliminated. Additionally, the preventive maintenance required for the silicon rectifiers is substantially less than that required for the old rotary converters. As such, the position of substation attendant was eliminated as each silicon rectifier substation was placed into service. With the opening of the central power supervisory control center in the Journal Square Transportation Center during the fourth quarter of 1974, substantial reductions in manpower occurred, made possible by the silicon rectifier substations. Exhibit B-6 illustrates the net reduction in staffing (annual person-year savings) resulting from the change from the old rotary converter power system to the new silicon rectifier power system with supervisory control.<sup>1</sup> The net reduction of 15 person-years of employment resulted in a substantial savings in operating and maintenance labor costs. Although company policy precludes the disclosure of wage earnings of any particular labor class, PATH officials estimate that labor cost savings realized in 1977, including wages and benefits, approximated \$500,000.

### SUMMARY

The evaluation of the modernization of PATH substations cost of Journal Square indicates substantial savings in power costs totalling \$6.2 million through improved efficiency and through a switch to a low-cost supplier and in maintenance and operating costs through reduced manpower requirements (a net reduction of 15 employee positions resulted). PATH has continued to invest in the modernization of substations, independent of UMTA capital grants,

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<sup>1</sup>As a matter of policy, PATH does not lay off employees from work because of technological innovation. The net reduction in person-years of employment was accomplished through promotion and natural attrition.

**EXHIBIT B-6  
ECONOMIC REDUCTION IN STAFFING ANNUAL PERSON-YEAR SAVINGS <sup>1</sup>**

<b>Staffing Requirements</b>	<b>Prior to Silicon Rectifiers and Supervisory Control</b>	<b>With Silicon Rectifiers and Supervisory Control</b>
Power Directors	0	5
Power Directors (In Training)	0	2
Chief Substation Operators	3	0
Substation Operator I (Attendants)	13	2
Substation Operator II	10	2
Electrical Technician	0	2
Electricians	2	0
<b>Total</b>	<b>28</b>	<b>13</b>

<sup>1</sup> Source: PATH

with the implementation of the Aldene Plan in 1967.<sup>1</sup> The two substations west of Journal Square, formerly mercury arc substations, were replaced with silicon rectifier substations, and, in addition, a new substation, using silicon rectifier conversion equipment, was constructed west of Journal Square.

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<sup>1</sup>Under the Aldene Plan, former joint PATH-PRR operations between Jersey City and Newark, New Jersey, were terminated, with PATH assuming complete operation of these facilities through a long-term lease arrangement.



## **APPENDIX C**

### **Impacts of UMTA-Funded Improvements on the Riverside Branch of the Green Line**

# IMPACTS OF UMTA-FUNDED IMPROVEMENTS ON THE RIVERSIDE BRANCH OF THE GREEN LINE

## I. INTRODUCTION

- . Patronage
- . Level of Service
- . System Reliability
- . Safety
- . Energy Consumption
- . Vehicle Maintenance Costs
- . Vehicle Transportation Costs
- . Passenger Revenue

## II. BACKGROUND

- . Light Rail
- . Rapid Rail
- . Commuter Rail
- . Green Line Improvements

## III. PROJECT DESCRIPTIONS

- . New Light Rail Vehicles
- . Station Improvements
- . Way and Structure Renewals
- . New Maintenance Facility

## IV. ANALYSIS OF RAIL MODERNIZATION IMPACTS

- . Operational Impacts
- . Traction Energy Impacts
- . Financial Impacts

## I. INTRODUCTION

As the principal financial contributor to urban rail rehabilitation and modernization, the Federal Government is concerned that the funds spent produce the maximum benefits possible. The purpose of this appendix is to examine the impacts, both positive and negative, of federal funds awarded to improve the Green Line Light Rail Service provided by the Massachusetts Bay Transportation Authority (MBTA). The discussion of these impacts is organized into three sections in addition to this Introduction:

- Section II provides background information, including a description of the MBTA system, area population, and employment statistics, as well as the reasons for selecting the Green Line as a case study;
- Section III describes the Green Line Rail Modernization projects; and
- Section IV describes the impacts of the Green Line Rail Modernization projects.

This case study focused on the improvements made to the Riverside Branch and the subway segment of the Green Line. The improvements funded by UMTA Section 3 grants include: the purchase of 175 new light rail vehicles (LRVs), way and structure improvements, station improvements, and the construction of a new facility designed for LRV maintenance. The impacts described below reflect the collective effect of these rail modernization projects.

### PATRONAGE

According to Riverside passenger counts, patronage increased by 16 percent during 1977. An analysis of Riverside Line revenues shows an 11 percent increase during 1977. Based on review of supporting data and information, it is concluded that the actual 1977 Riverside patronage increase lies in the range of 11 to 16 percent. Total system patronage increased 5 percent from 1976 to 1978. The Riverside Line increase in patronage reflects both the start of LRV service in December 1976 and an increasing trend in total system patronage.

## LEVEL OF SERVICE

The acquisition of the new light rail vehicles permitted MBTA to substantially increase the level of service. Headways were reduced from 10 minutes to about 8 minutes during the morning peak periods, the afternoon, and the evening peak periods. Headways were also reduced by 2 minutes during the evening and 5 minutes during late night service. Seating capacity per hour increased by:

- . 13 percent during the morning peak;
- . 13 percent during the late morning;
- . 80 percent during the afternoon;
- . 20 percent during the evening peak;
- . 28 percent during the evening; and
- . 106 percent during the late night service.

Standing capacity per hour more than doubled during each of the time intervals.

## SYSTEM RELIABILITY

An analysis of the number of trains breaking down and equipment availability indicates that the UMTA-funded improvements had little effect on improving the reliability of Green Line operations.

According to MBTA, the reliability and maintainability of the LRVs have had a worsening effect on system reliability. This can be attributed to the poor overall design of the vehicles, which is the result of the three following factors:

- . No prototype vehicle was developed and thoroughly tested before a production line was set up.
- . The vehicle has relied too heavily on "high technology" and not enough upon conventional, proven technology (e.g., door mechanisms, vehicle trucks, and suspension).
- . The vehicle was designed by a Committee (the Boston-San Francisco Committee or the BSF Committee) with resulting compromises in design.

## SAFETY

The change in the number of annual derailments is used to illustrate the safety impacts of rail modernization projects. The track renewal program completed in 1974 had a minimal effect on the number of derailments because derailments primarily occur on track not refurbished under this program. The number of annual derailments, however, increased from 23 during 1976 to 61 during 1977. Only PCC vehicles were in service during 1976; both PCC vehicles and LRVs were used during 1977.

## ENERGY CONSUMPTION

MBTA Power Department staff estimate that PCCs consume 5.0 kwh per vehicle-mile, while LRVs consume 7.5 kwh per vehicle-mile. As a result, LRVs require:

- . 50 percent more energy per vehicle-mile;
- . 21 percent more energy per seat-mile; and
- . 20 percent less energy on a total capacity (seating plus standing) per mile basis.

## VEHICLE MAINTENANCE COSTS

Under anticipated steady-state normal operations, LRVs are expected to cost \$0.055 to maintain per seat-mile, while PCCs and rebuilt PCCs cost \$0.055 and \$0.042, respectively, to maintain. Under current operations, however, LRV maintenance costs per seat-mile are higher than both PCCs and rebuilt PCCs. The higher LRV maintenance costs are the result of many factors including the following:

- . poor reliability performance;
- . more vehicle parts (than PCCs) to be maintained;
- . more stringent inspection and warranty requirements;
- . higher mechanic salaries;
- . more complex equipment; and
- . the effect of inefficient equipment designs on maintenance procedures.

## VEHICLE TRANSPORTATION COSTS

LRVs reduced labor costs due to increased vehicle capacity per motorman. The analysis shows that, if LRVs were used to provide the same level of service in 1978 as the PCCs did in 1976, the labor savings would be \$263,000 annually. Though labor productivity increased, no vehicle transportation cost saving occurred because additional service was added concurrent with the introduction of the LRVs. Any possible savings were thus spent in providing additional service.

## PASSENGER REVENUE

The analysis of Riverside passenger revenues indicates that revenues increased by 11 percent during 1977 and 16 percent during the first half of 1978.

## II. BACKGROUND

The MBTA serves a highly transit-dependent urban region of eastern Massachusetts. Exhibit C-1 provides estimates of population and employment for the Greater Boston Region, the Central Boston area, and the Riverside Corridor. According to the exhibit, the region's population will increase by about 4 percent from 1975 to 1980; the Central Boston area will remain about the same; and the Riverside Corridor population will increase slightly over 1 percent. Employment changes for these three areas show increases from 9 percent to 11 percent. As a result of the increase in employment, there will be an increase in the number of work-trips and in the demand for public transportation.

### EXHIBIT C-1

#### POPULATION AND EMPLOYMENT TRENDS

Area	Population			Employment	
	1970	1975	1980	1975	1980
Regional Total <sup>a</sup>	3,769,410	3,813,825	3,955,597	1,595,303	1,735,870
Percent Change	-	1.2%	3.7%	-	8.8%
Central Boston <sup>b</sup>	190,630	188,447	188,567	368,640	410,800
Percent Change	-	-1.1%	0.1%	-	11.4%
Riverside Corridor	409,251	406,047	410,767	447,945	492,900
Percent Change	-	-0.8%	1.2%	-	10.0%

<sup>a</sup> Includes the 157 cities and towns in the Greater Boston Area.

<sup>b</sup> Includes the following subsections of Boston: Back Bay; Beacon Hill; Financial and Retail District; Government Center; North End; Park Square; Prudential; South End; Waterfront; Allston-Brighton; Charlestown; and Fenway-Parker Hill.

<sup>c</sup> Includes Downtown Boston; Brookline; Needham; Newton; Wellesley; and Weston.

Source: Central Transportation Planning Staff; Population and Employment Forecasts

The official MBTA District comprises 79 cities and towns including approximately 2.8 million persons. The reliance on the MBTA system extends beyond the official District boundaries. Average weekday patronage on the entire system exceeds 500,000 trips. Patronage on the MBTA system has been increasing since 1975. MBTA staff believe that the arrest and turnaround of historically declining patronage is principally due to the implementation of capital improvements assisted by UMTA.

The MBTA provides bus service; light, rapid, and commuter rail service; and trackless trolley service. The inner-area system consists of three rapid transit lines; a light rail system in which four branches serve a core area central subway; and approximately 1,100 MBTA buses that provide service along 190 bus routes. The commuter rail service is extensive and provides service throughout eastern Massachusetts. The three forms of rail service (light, rapid, and commuter rail) are further described below.

## LIGHT RAIL

Light rail operations of the MBTA are conducted on the Green Line. The northernmost station of the Green Line is Lechmere. Proceeding south from Lechmere to North Station, the Green Line route is a viaduct and elevated structure. From North Station, the Green Line operates underground to Copley Station. At Copley, the subway operation divides into two routes. One route continues underground to Kenmore Square, where it begins at-grade operations. It eventually branches into three lines ending at Boston College, Cleveland Circle, and Riverside. The second route continues underground from Copley to Symphony Hall Station, where it begins at-grade operations to Arborway. Light rail operations also include the southern tip of the Red Line between Ashmont and Mattapan. The light rail system encompasses:

- . approximately 100 surface stops;
- . 10 subway stations;
- . 3 elevated stations;
- . 14 at-grade stations;
- . 132 active PCCs; and
- . 91 active LRVs.

## RAPID RAIL

The rapid rail system in Boston consists of three lines: the Blue Line (Wonderland-Bowdoin); the Orange Line (Oak Grove-Forest Hills); and the Red Line (Harvard-Quincy Center and Harvard-Ashmont). The Red Line branches out to Ashmont and Quincy Center south of Andrew Station. This rapid rail system embraces a total of 29.8 route-miles, 48 stations, and 289 active cars. Total annual passengers exceed 95 million.

## COMMUTER RAIL

With UMTA loans and grants, the MBTA has acquired the following rights of way and equipment from the former bankrupt owners and operators of the Boston region's commuter rail system:

- . 440 route-miles of railroad rights of way;
- . 25 locomotives, 103 coaches, and 92 rail diesel cars;
- . about 90 station properties; and
- . various maintenance facilities.



In addition, UMTA funds have provided for investment in track, signals, and structures to allow service to be continued on all lines. New or rebuilt equipment on order with current funds includes:

- . 13 new locomotives;
- . 60 new coaches; and
- . 17 rebuilt locomotives.

Six routes radiate out of North Station (totaling 118 miles) and five routes radiate out of South Station (totaling 139 miles).

### GREEN LINE IMPROVEMENTS

The Green Line is a light rail system composed of four surface branches leading into a central core area subway system. The three branches which provide street level service, designated by their terminal stations, are: the Boston College Branch, the Cleveland Circle Branch, and the Arborway Branch. The fourth, known as the Riverside Branch, is entirely grade-separated and is a high-speed line. Exhibit C-2 shows a map of the Boston area and depicts the four Green Line branches and the Green Line subway segment. The Riverside Branch has 13 station stops. Trains originating at the Riverside Station terminate at the last Boston Green Line subway station, North Station (a 12.4 mile trip). Trains originating on the Beacon Street and Commonwealth Avenue lines terminate at Lechmere. Trains from the Arborway Line terminate at Park Street.

The Riverside Branch of the Green Line is the focus of this case study, since a number of UMTA-funded improvements have been concentrated on this branch. This Section 3 program, therefore, reflects a different approach to rail modernization than that practiced in most other urban areas (i.e., distributing funds to various projects throughout the system).

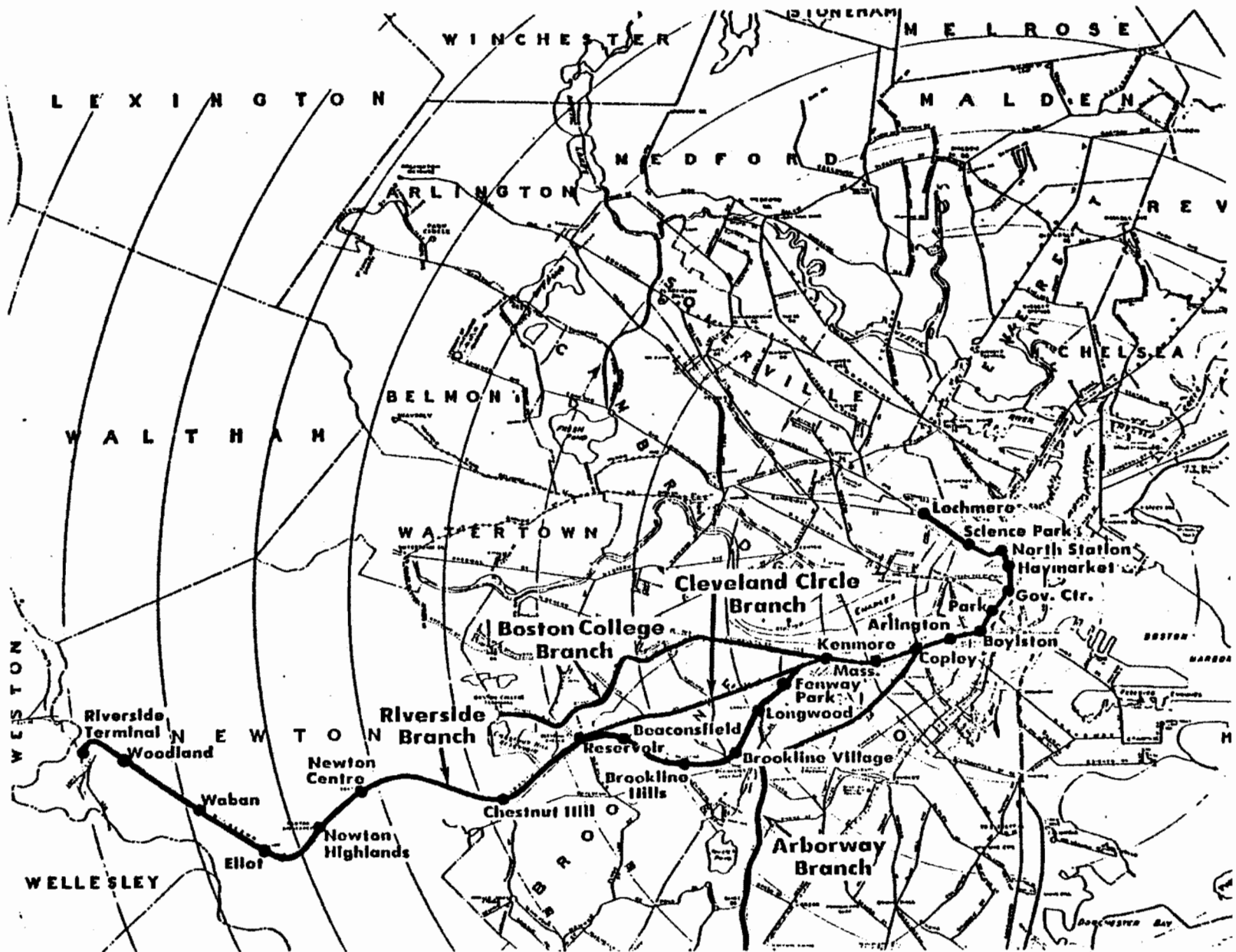
Since the Riverside Branch feeds into the central subway line, improvements to the central subway will influence the impact of Riverside modernization projects. Therefore, improvements to the central subway are included in the focus of this case study to the extent that they affect the impacts of the Riverside rail modernization projects. Throughout the remaining portion of this appendix, Green Line improvements refer to those made on the Riverside and subway lines.

Improvements to the Green Line since 1970 were made possible by four UMTA grants:

- . MA-22;
- . MA-15;

EXHIBIT C-2  
GREEN LINE SYSTEM

C10



. MA-13; and

. MA-10.

Grant MA-22 provided for the purchase of 175 new light rail vehicles (LRVs) for use in Green Line operations. Grant MA-15 primarily funded improvements to the Riverside and subway lines necessary to enhance and support LRV operations such as electrification and track refurbishing. It also provided funds for a new facility to maintain the LRVs and to improve the Riverside and subway stations. Grants MA-13 and MA-10 were directed to a variety of station improvements.

### III. PROJECT DESCRIPTIONS

The Riverside line was selected as the primary focus of this case study because of the combination of rail modernization projects directed towards improving local transit service. The four projects conducted along the Riverside Line that are the subject of this study include:

- . the acquisition of 175 new light rail vehicles;
- . station improvements;
- . way and structure renewals; and
- . the construction of a new maintenance facility.

These four projects are integrated and are supportive of each other. The acquisition of the LRVs is supported by the track improvements and power distribution system in the way and structure renewals and by the construction of a new maintenance facility designed for LRV maintenance. The station improvements, along with the LRV acquisitions, combine to enhance the service provided along this portion of the Green Line.

#### NEW LIGHT RAIL VEHICLES

The purpose of acquiring the new LRVs is to replace portions of the aging and deteriorating PCC fleet at the MBTA. Exhibit C-3 compares the basic characteristics of LRVs and PCC vehicles. As shown, the PCC vehicles are being replaced by equipment that exceeds the PCCs in every physical dimension or capacity.

The MBTA started the acquisition process in 1972 with the development of LRV specifications. Development of the specifications occurred under a joint effort of the MBTA, the San Francisco Municipal Railway (MUNI), other interested transit authorities, and UMTA. In October 1972, UMTA awarded MBTA a \$32,800,000 grant for two-thirds of the total project value (\$49,200,000) to purchase 150 LRVs. In June 1974, UMTA awarded MBTA an amendatory grant of \$7,628,488 for four-fifths of the project value (\$9,535,610) to purchase an additional 25 LRVs.

The history of MBTA's LRV operations has been one of deteriorating service and increasing demands on support resources. To a large extent, the start of LRV service problems began with late deliveries. Exhibit C-4 compares the first revision to the original delivery schedule with the actual acceptance of LRVs by MBTA. As shown, the acceptance schedule lags behind

**EXHIBIT C-3**

**COMPARISON OF LRV AND PCC CARS**

<b>Characteristics</b>	<b>MBTA LRVs</b>	<b>MBTA PCCs</b>
Length	71 Feet	48 Feet
Width	8 Feet 8 Inches	8 Feet 4 Inches
Articulated	Yes	No
Double End Operation	Yes	No
Seating Capacity <sup>a</sup>	52	42
Standing Capacity <sup>a</sup>	167	73
Doors	3 Double Doors Per Side	2 Double Doors on Right Side 1 Double Door on Left Side
Maximum Train Operation	4 Cars	3 Cars
Maximum Speed	55 MPH	38 MPH
Weight	67,000 Pounds	Approx. 36,000 Pounds
Air Conditioned	Yes	No

<sup>a</sup> The rated capacity of an LRV is 219 people; 52 people sitting and 167 people standing. The maximum practical capacity according to MBTA which constitutes a crush load is between 190 and 195. The MBTA uses 180 passengers with 52 sitting and 128 standing as the LRV capacity for scheduling purposes. MBTA's standard capacity figures for PCCs are 42 sitting and 54 standing. The capacity analyses in this report reflect MBTA's standards for scheduling.

Sources: (1) UMTA Memorandum, October 1972  
(2) Lea Transit Compendium

**EXHIBIT C-4**

**COMPARISON OF DELIVERY AND ACCEPTANCE SCHEDULES**

<b>Month</b>	<b>Revised Delivery Schedule (Cumulative)<sup>a</sup></b>	<b>MBTA Actual Acceptance (Cumulative)</b>
1975 November	2	0
December	2	0
1976 January	3	0
February	8	0
March	20	0
April	33	0
May	47	0
June	67	0
July	87	0
August	107	0
September	127	0
October	147	0
November	167	0
December	175	4
1977 January	-	10
February	-	11
March	-	20
April	-	23
May	-	30
June	-	32
July	-	32
August	-	33
September	-	38
October	-	48
November	-	52
December	-	65
1978 January	-	73
February	-	87
March	-	101
April	-	109
May	-	121
June	-	134

<sup>a</sup> As shown in Table II-2, the first test car was actually delivered on March 3, 1976. The first production LRVs were delivered on September 9, 1976. The origin delivery schedule was revised on June 5, 1975.

Sources: (1) Status Report on Light Rail Vehicles, BSF-515-D, February 5, 1976.

(2) LRV Operations Report, July 19, 1978.

the proposed delivery schedule by more than a year. As a result, MBTA has had to rely on the PCC fleet much longer than planned. After a severe snow-storm on December 30, 1976, MBTA pressed four cars into service because of a resulting equipment shortage. The late deliveries were only the start of MBTA's LRV problems. Problems surfaced in every subsystem of the LRV during initial revenue service. Examples of problems encountered include the following:

- . propulsion system failures;
- . failure of materials in the articulation section;
- . unreliable door operations;
- . air conditioning failures;
- . cracking of sealed and painted sheet metal joints; and
- . brake system failures, including non-release of friction brakes and/or erroneous indications on control panels.

By June 1977, 6 months of operating experience had been gained with the new LRV. It had become clear that, unless serious problems with the vehicle were corrected prior to acceptance, reliability would not be realized without significant increases in costs. By July 1977, a modification program (Mod III) was agreed upon by MBTA and the manufacturers of the LRV, Boeing-Vertol. It consisted of 74 items intended to improve the reliability of each subsystem in the vehicle. If the modification program proves successful, shipment of all 175 MBTA LRVs is scheduled for November 1978. However, the current delivery schedule beyond June 1978 may be changed as a result of current negotiations between the MBTA and Boeing-Vertol.

### STATION IMPROVEMENTS

The MBTA has conducted a station improvement program that has improved every Riverside Branch Station, as well as most of the subway stations which merge the Riverside Branch with the remainder of the MBTA system. The station improvements fall into two categories, major renovation and minimal modernization. The two most recent major Green Line renovations have been to the Park Street and Auditorium Stations. These two renovation projects are funded under grant MA-13, which was approved in May 1972. These renovations are designed to improve the circulation and increase the capacity of these stations. The type of renovations provided at these stations include:

- . availability of a/c power sources;

- . a/c and d/c lighting;
- . floor and wall tiles;
- . fare collection equipment;
- . new escalators and elevators;
- . acoustical paneling;
- . stair treads and hand rails;
- . concession stands;
- . information booths;
- . fencing;
- . signs; and
- . an underground passenger connection (Park Street Station).

The Auditorium Station renovation is 99 percent completed, while the Park Street Station is about 85 percent completed. Minimal modernization consists of improvements to stations designed to enhance their attractiveness. These station improvements were performed under grants MA-10 and MA-15. Exhibit C-5 summarizes these improvements by station. As shown in this exhibit, every Riverside Branch Station has undergone some improvement. Exhibit C-6 shows the approximate start and completion dates for the station modernization work under these grants. Exhibits C-7, C-8, C-9, and C-10 show examples of some Riverside Line improvements. Exhibit C-7 shows the Longwood Station undergoing improvements; Exhibit C-8 shows the completed improvements. Exhibit C-9 shows the Urban Station undergoing improvement; Exhibit C-10 shows the completed improvements.

### WAY AND STRUCTURE RENEWALS

A number of improvements were made to the ways and structures along the Riverside Branch in order to accommodate the LRVs. These modifications include structural changes within the central subway at North Station and along the Lechmere viaduct to ensure adequate clearance of LRVs in the subways and on structures. Other modifications include changes in the power distribution system for proper pantograph operation and the installation of two new substations to service the higher power requirements of the LRV.



EXHIBIT C-5

SUMMARY OF GREEN LINE SUBWAY AND HIGHLAND BRANCH  
STATION MODERNIZATION IMPROVEMENTS

Stations	Improvements																					
	Platform Lengthening	Parking Lot Paving	Curbing	Landscaping	Fencing	Retaining Wall	Pedestrian Track Crossing	Station Signage	New or Renovated Shelters	New Benches	Lighting	Street Signage	Guardrails	Stairway Repair or Construction	Slope Treatment	Public Address System	Radiant Heat	Wall Treatment of Panels	Windbreaks	Newstand	New Fare Collection Equipment	
<b>Subway</b>																						
Lechmere					▲		▲		▲						○	▲	▲	▲				
Science Park					▲		▲		▲						○	○	▲	▲	▲			
North Station																○						▲
Haymarket																						
Government Center																						
Park Street																○					▲	
Boylston																○						
Arlington																○						
Copley																						
Auditorium																○						
Kenmore																○						
<b>Riverside Branch</b>																						
Fenway Park				●	●		●	●		●			●									
Longwood			●	●	●		●	●		●			●									
Brookline Village				●	●		●	●		●			●									
Brookline Hills	○		●		●		●	●		●			●									
Besconfield	○		●	●	●		●	●		●			●									
Reservoir	○																					
Chestnut Hill	○				●		●	○		●			●									
Newton Centre	○				●		●	○		●			●									
Newton Highlands	○				●		●	○		●			●									
Eliot	○		●		●		●	○		●			●									
Waban	○	●	●		●	●	●	○		●			●									
Woodland	○				●		●	○		●			●			●						
Riverside	○							○														

- Note:
- ▲ Indicates work was funded under grant MA-03-0010.
  - Indicates work was funded under grant MA-03-0015; contract GL-103.
  - Indicates work was funded under grant MA-03-0015; contract GL-107.
  - ⊙ Indicates work was funded under grant MA-03-0015; contract GL-100.

Sources: (1) Status Report on Green Line Improvements (Phase I) and Light Rail Vehicles, July 1, 1975.  
(2) MBTA grant applications.

**EXHIBIT C-6**

**GRANT SUMMARY DATES AND EXPENDITURES**

<b>Grants</b>	<b>Start Date</b>	<b>Contract Award Price</b>	<b>Date Completed</b>	<b>Final Cost</b>
MA-03-0015				
Contract GL-100 <sup>a</sup>	Sept. 1973	N.A.	Jul. 1975 <sup>b</sup>	N.A.
Contract GL-103	Oct. 1974	\$ 111,550	Dec. 1975	\$ 120,000
Contract GL-107	Jun. 1976	\$1,306,163	Feb. 1977	\$1,989,841
MA-03-0010	May 1971	N.A.	June 1977 <sup>c</sup>	N.A.

**Note:**

N.A. means that the station improvement portion of contract or grant price was not available.

<sup>a</sup> Contract GL-100 includes Riverside Line modernization work other than station improvements. The station improvement portion of the contract price was not available.

<sup>b</sup> Date completed is an estimate for the station improvements.

<sup>c</sup> Date completed is an estimate for the station improvements. Approximately 90% of the entire grant was completed at this time.

Sources: (1) Status Report on Green Line Improvements (Phase I) and Light Rail Vehicles, July 1, 1975.

(2) MBTA Quarterly Progress Reports for grant MA-03-0015.

EXHIBIT C-7

LONGWOOD STATION UNDERGOING IMPROVEMENTS



**EXHIBIT C-8**

**LONGWOOD STATION AFTER IMPROVEMENTS**



**EXHIBIT C-9**

**URBAN STATION UNDERGOING IMPROVEMENTS**



EXHIBIT C-10

URBAN STATION AFTER IMPROVEMENTS



New supplementary power feeders to the overhead catenary and overhead wire support poles are being installed.

The track work caused substantial interruption to service during the construction period. In order to reduce the amount of inconvenience due to service interruption, MBTA provided substitute service when possible. Rather than shutting down the entire line during the track renewal program, the work was done in three sections. Exhibit C-11 describes the three sections, substitute service, and project dates during the track renewal program.

The way and structure projects discussed above are summarized in Exhibit C-12. As of July 1, 1978, less than 1 percent of the total project contract work remained to be completed.

### NEW MAINTENANCE FACILITY

The remaining major Riverside Branch modernization project is the construction of the new maintenance facility at the Riverside Terminal. The new maintenance facility was designed and built for maintenance of the 175 vehicle LRV fleet. The construction of the maintenance facility was 99 percent complete in January 1977. The facility cost \$105,000 to design and \$9,811,510 to construct.

**EXHIBIT C-11**

**RIVERSIDE BRANCH TRACK RENEWAL PROGRAM**

<b>Section Number</b>	<b>Portion of Riverside Branch</b>	<b>Type of Substitute Service</b>	<b>Construction Dates</b>
1	Riverside Terminals to the Newton Highlands Station	Parallel Bus Service	Sept. 1973 to Jan. 1974
2	Newton Highlands Station to the Reservoir Station	Single Track Service	Jan. 1974 to Sept. 1974
3	Reservoir Station to the Fenway Station	Parallel Streetcar Service (Beacon St.)	Sept. 1974 to Dec. 1974

Source: Discussions with MBTA Construction Department Staff

**EXHIBIT C-12**

**WAY AND STRUCTURE PROJECT EXPENDITURES**

<b>Project</b>	<b>Estimated or Actual Final Cost</b>
Electrification	\$ 7,770,000
Engineering and Design <sup>a</sup>	2,809,000
Construction of Facilities <sup>a</sup>	1,389,000
Track Work	12,575,000
Force Account Work	9,817,000
Overhead	2,126,000
<b>Total</b>	<b>\$36,486,000</b>

<sup>a</sup> Excludes Riverside Maintenance Facility

Source: MBTA Quarterly Progress Report for the period ending June 30, 1978. Grant MA-03-0015.



#### IV. ANALYSIS OF RAIL MODERNIZATION IMPACTS

The four projects described in the previous section have impacted the MBTA in numerous ways. The purpose of this section is to identify and analyze these impacts. Exhibit C-13 illustrates the correspondence between the four project areas and their associated impacts.

The exhibit distinguishes between primary and secondary impacts. A primary impact is the direct outcome of a project; the impact is brought about by the implementation of the project. A secondary impact is the indirect outcome of a project; it is generated by a chain of events that includes the implementation of the project. The "P" and "N" symbols designate primary impacts and illustrate whether the impacts are positive or negative, respectively. The "S" symbols designate secondary impacts.

The purpose of choosing the Green Line improvements is to investigate the impacts of a collective and reinforcing program of modernization projects. The exhibit illustrates the collective effects of four categories of rail modernization projects. The impact areas listed across the top of the exhibit are often affected by more than one of the projects. Rather than attempt to analyze the individual impacts of specific projects, the collective effects of the rail modernization program are analyzed below.

#### OPERATIONAL IMPACTS

There are four operational impacts considered in the analysis:

- service level, defined by headways, seating capacity per hour, and standing capacity per hour;
- patronage, defined in terms of daily and annual totals;
- system reliability, defined by vehicles in revenue service, available vehicles, trains unloaded at terminal stations, and trains unloaded while in service; and
- safety, defined by the number of vehicle accidents and derailments.

One particular difficulty in analyzing the rail modernization impacts is lack of data. Projects funded with UMTA Section 3 grants do not require the measurement of impacts during and following implementation. The effect of this is two-fold. In some instances, the lack of the data limits the strength of the conclusions which can be reached concerning impacts. In other cases,

**EXHIBIT C-13**

**ACCOUNTING OF IMPACTS BY RAIL MODERNIZATION PROJECT**

	Rail Modernization Project			
	LRV Acquisitions	Station Improvements	Way and Structure Renewal	New Maintenance Facility
<b>Operational Impacts</b>				
Service Level	P	-	S	S
Patronage	P	P	S	S
System Reliability	N	-	-	S
Safety	N	-	-	-
Traction Energy	N	-	S	S
<b>Financial Impacts</b>				
Vehicle Maintenance Costs	-	-	S	P
Vehicle Transportation Cost	P	-	S	S
Passenger Revenue	P	-	S	S

**Note:**

P signifies a direct positive impact

N signifies a direct negative impact

S signifies a secondary impact

- signifies negligible or no impact

the types of impact analyses which can be performed are constrained by the lack of data or by restrictions on data availability. For example, although it is possible to collect and review the daily dispatcher records for service delays during the last 3 years, these records have not been maintained for such a purpose and the level of detail is inconsistent with the attempt to measure the aggregate impacts of rail modernization projects.

### Service Level Impacts

As summarized in Exhibit C-13, only one project (LRV acquisitions) resulted in a direct effect on service level. Exhibit C-14 compares the service levels for six periods during the day. The two fall seasons are selected for specific reasons. Fall 1976 is the last seasonal period of all-PCC operation; Fall 1978 is the first comparable season of all-LRV operation. The selection of these periods permits a comparative analysis of PCC operating service levels with LRV service levels under similar seasonal demands. It is important to note that Fall 1976 service represented the maximum amount of service available from the existing PCC fleet for the Riverside Line without a reduction of service along the other streetcar routes. Although data for Fall 1977 would be helpful to show interim service level improvements, the vehicles in service at this point were a mixture of PCCs and LRVs (41 percent and 59 percent, respectively). It is therefore not possible to determine the changes in service levels attributable to the new LRVs because of the mixed composition of vehicles.

Exhibit C-14 shows two types of service improvements: improved headways and increased vehicle seating and standing capacity. The "headways" portion of the exhibit shows that MBTA improved headways for all periods except for mid-day (9:01 a.m. to 2:00 p.m.). Though the mid-day headways remained the same, MBTA increased the seating and standing capacities during this interval, as well as for all five of the other periods. The exhibit also shows that the afternoon period (2:01 p.m. to 4:00 p.m.) and afternoon peak period (4:01 p.m. to 6:00 p.m.) have the same Fall 1978 headways and capacities. The reason for providing a peak level of service in the afternoon is to better accommodate the public school students and college students traveling during the fall season.

The next section of this chapter illustrates the effect these improvements in service had on patronage.

### Patronage Impacts

As shown in Exhibit C-13, two rail modernization projects have contributed directly to increasing patronage on the Riverside Line--LRV acquisitions and

**EXHIBIT C-14**

**SERVICE LEVEL CHANGES IN RIVERSIDE LINE OPERATIONS**

<b>Headway Times (minutes)</b>	<b>PCC Operations Fall 1976</b>	<b>LRV Operations Fall 1978</b>
AM-Peak	10	8
Mid-Day	10	10
Afternoon	10	7/8
PM-Peak	10	7/8
Evening	12	10
Late	15	10
<b>Trains and Cars</b>		
AM-Peak	11 3-car trains	15 2-car trains
Mid-Day	11 2-car trains	10 2-car trains
Afternoon	11 2-car trains	16 2-car trains
PM-Peak	11 3-car trains	16 2-car trains
Evening	9 1-car trains	10 1-car trains
Late	6 1-car trains	10 1-car trains
<b>Capacity Per Hour (seats)<sup>a</sup></b>		
AM-Peak (2 hours)	1,386	1,560
Mid-Day (5 hours)	924	1,040
Afternoon (2 hours)	924	1,664
PM-Peak (2 hours)	1,386	1,664
Evening (2 hours)	378	520
Late (3 hours)	252	520
<b>Capacity Per Hour (standing)<sup>b</sup></b>		
AM-Peak (2 hours)	1,782	3,840
Mid-Day (5 hours)	1,188	2,560
Afternoon (2 hours)	1,188	4,096
PM-Peak (2 hours)	1,782	4,096
Evening (2 hours)	486	1,280
Late (3 hours)	324	1,280

**Note:**

- AM-Peak is from 7:00 a.m. to 9:00 a.m.
- Mid-Day is from 9:01 a.m. to 2:00 p.m.
- Afternoon is from 2:01 p.m. to 4:00 p.m.
- PM-Peak is from 4:01 p.m. to 6:00 p.m.
- Transition Period is from 6:01 p.m. to 8:00 p.m.
- Evening is from 8:01 p.m. to 10:00 p.m.
- Owl is from 10:01 p.m. to approximately 1:00 a.m.

The transition period is not included in the table because there are no specific equipment schedules or headways for this period. The transition period allows for the phase-out of unnecessary PM-Peak equipment.

<sup>a</sup> PCC cars have 42 seats and LRV cars have 52 seats

<sup>b</sup> PCC cars have practical standing room for 54 passengers and LRV cars have practical standing room for 128 passengers according to MBTA.

station improvements. As described in the rail modernization project descriptions, the station improvements have generally been performed on a small scale.<sup>1</sup> The station improvements (improved parking conditions, landscaping, additional shelters and benches, and improved lighting) have made the Riverside Line a more pleasant transit service, offering passengers greater security. It is reasonable to assume that these improvements have had a favorable impact on transit riders, and thus on patronage. However, the level of data collection cannot support a definitive statement regarding actual increases in patronage due to station improvements.

Patronage increases attributable to the rail modernization projects are primarily the outcome of the LRV acquisitions and the associated improvements to the level of service.

The amount of data necessary to satisfactorily analyze patronage changes is quite large. Unless this type of analysis is specifically planned for, the data collected for normal schedule planning may not be entirely adequate to draw conclusive results. However, the Riverside Line patronage data collected by MBTA are analyzed in Exhibit C-15, which shows estimates of daily patronage on the Riverside Line from Spring 1965 to Summer 1978. This exhibit also shows estimates of annual MBTA system patronage (unlinked trips) between 1962 and 1978.<sup>2</sup> The purpose of showing both the annual system patronage and the daily Riverside Line patronage in the same exhibit is to compare these trends before and after LRV introduction.

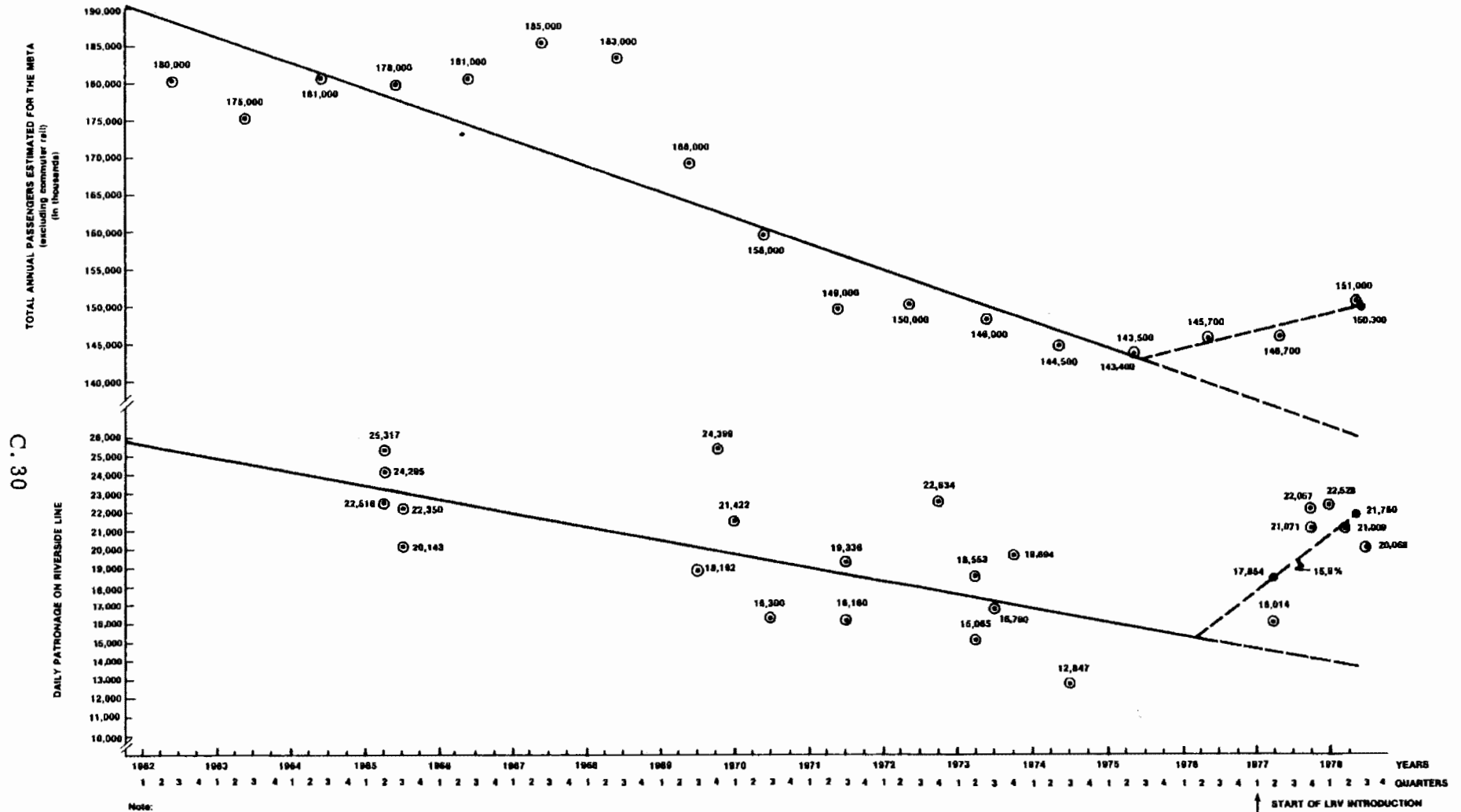
As shown in the exhibit, both sets of patronage data were fitted with piecewise linear trend lines developed from time trend regression analyses. An implicit assumption is employed in fitting these lines. The assumption is that the mid-1970s marked the end of the decreasing patronage trend for both the annual total system and the daily Riverside Branch. According to estimates of total annual passengers, there were approximately 289 million trips

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<sup>1</sup>Two Green Line subway stations, Park Street and Auditorium, are undergoing substantial improvements. Once completed, the circulation and capacity of these two stations will be increased.

<sup>2</sup>MBTA estimates total system patronage on an annual basis by dividing annual passenger revenues by a calculated average fare. MBTA estimates daily weekday line patronage by estimating train occupancy at the line's peak-load station. The trends of annual system patronage and daily weekday line patronage can be directly compared even though they have different time frames. It is possible to convert daily weekday line patronage to annual line patronage by multiplying by 300. MBTA staff indicate that annual patronage is approximately equal to the total patronage of 300 weekdays.

## EXHIBIT C-15 PATRONAGE TRENDS



Note:  
 \* Annual patronage is estimated by divided total passenger revenue by calculated average fare per passenger.  
 \* Daily patronage on the Riverside Branch was estimated using "spider counts." MBTA's spider count procedures require a MBTA staff person to make estimated visual counts of vehicle occupancy at the peak load point. The peak load point for estimating Riverside Branch patronage is the Fenway Station. The Fenway Station is the first Riverside Branch station on outbound service of the Green Line. It is the last station on inbound service.

The daily patronage spider counts were made at various times of the year for the years shown. In an attempt to control for seasonal fluctuations in patronage, the daily patronage counts were categorized into one of the following four quarters:

Quarter	Months	Season
1	January, February	Winter
2	March, April, May	Spring
3	June, July, August	Summer
4	September, October, November, December	Fall/Winter

SOURCE: 1. Department of the Treasurer-Custodian  
 2. Scheduling Department: Form 5447

made in 1951. After that, annual patronage decreased until 1964. During the period 1964 to 1967, annual patronage levels temporarily increased but the downward trend continued until 1975. From 1975 until the present, annual patronage has been increasing. The decline in patronage after 1967 was the consequence of reduced service levels because of deteriorating equipment and the deferral of the purchase of replacement equipment. The increase in patronage starting in 1975 can be correlated with the capital intensive renewal and modernization of the Green Line. It is not possible, however, to suggest that the modernization program "caused" these patronage impacts.

### System Patronage

The low point of system patronage, 143.4 million trips per year, occurred in 1975. The high point of the upward trend, 150.3 million trips per year, occurred in 1978. This shows approximately a 5 percent increase in patronage over 3 years. Part of this increase may be attributable to population and business growth trends in the MBTA service area; part may be attributable to improved service levels in early 1977.

### Riverside Line Patronage

The Riverside Line patronage appears to follow the same trend as annual system patronage: decreasing through the 1960s to the mid-1970s and increasing from then on. However, the Riverside Line patronage data do not show a clear point for a reversal of the decreasing patronage trend such as the annual system patronage data. In order to estimate the percentage increase in patronage, a linear trend line was estimated by regressing the six data points after January 1977. The resulting trend is shown as the lower dashed line in Exhibit C-15. The trend shows a 16 percent increase in Riverside Line patronage per year. Because there are no data available from 1975 to 1977, however, it is not possible to estimate the actual patronage trend prior to the introduction of LRVs. Although it is not unreasonable to show a patronage increase in the second half of 1976, given a known increase in total system patronage, a 16 percent increase during this period may be considered too high.

Finally, it is not reasonable to attribute the 16 percent annual patronage increase in 1977 and 1978 solely to the introduction of LRV service. As evidenced by the total system's patronage growth trend, there were factors increasing patronage prior to LRV introduction. These same factors most likely caused increases in Riverside Line patronage. However, it is difficult to separate the impact of these factors on patronage from the increased service and attractiveness of the LRVs and other modernization improvements.

The results of the passenger count analysis (Exhibit C-15) indicate a patronage increase of approximately 16 percent per year. However based upon an analysis of increased passenger revenues, patronage increased only about 11 percent.<sup>1</sup> It is reasonable to conclude that the actual patronage increase lies in the 11 to 16 percent per annum range. This increase reflects both the impact of LRV introduction and other factors contributing to patronage growth in the MBTA service area.

<sup>1</sup>According to an MBTA official statement, the LRVs caused a 19 percent increase in patronage during 1977. This estimate is based upon changes in Riverside Line passenger revenue figures. The tabulation below illustrates the revenue figures used to support MBTA's statement.

<u>Rating Station</u>	<u>Periods</u>		<u>Increase (Decrease)</u>	<u>Percent Change</u>
	<u>January 1, 1977, to December 31, 1977</u>	<u>January 3, 1976, to December 31, 1976</u>		
Reservoir	\$2,673,114	\$2,789,062	(\$115,948)	4.2%
Riverside	\$1,627,007	\$1,359,094	\$267,913	19.7%

The 19 percent estimate in the annual report is based on the 19.7 percent shown in the tabulation. However, the 19.7 percent reported in this exhibit is misleading for the following reason. The LRV uses a Keene vacuum fare box system which differs from the PCC Keene vault fare box system. In order to retrieve passenger revenues from the LRV fare boxes, special vacuuming equipment was installed at the Reservoir and Riverside rating stations. Until recently, there were intermittent operating problems with the Reservoir vacuuming equipment. As a result, LRVs operating on the Commonwealth Line had their fare boxes vacuumed at the Riverside Station. A discussion with MBTA's revenue auditing staff indicated that it is not possible to determine how much revenue counted at the Riverside Station was generated on the Commonwealth Line. The staff indicated that a reasonable correction would be to subtract the decrease in Reservoir revenues from the increase in Riverside revenues shown in the above tabulation. The next tabulation shows the effect of this adjustment indicating a 11.2 percent increase in Riverside passenger revenues.

<u>Rating Station</u>	<u>Periods</u>		<u>Increase (Decrease)</u>	<u>Percent Change</u>
	<u>January 1, 1977, to December 31, 1977</u>	<u>January 3, 1976, to December 31, 1976</u>		
Reservoir	\$2,789,062	\$2,789,062	-0-	0%
Riverside	\$1,511,059	\$1,359,094	\$151,965	11.2%



## System Reliability Impacts

As shown in Exhibit C-13, two rail modernization projects have impacted on system reliability. The LRV acquisitions have had a negative impact in their short history of operations.

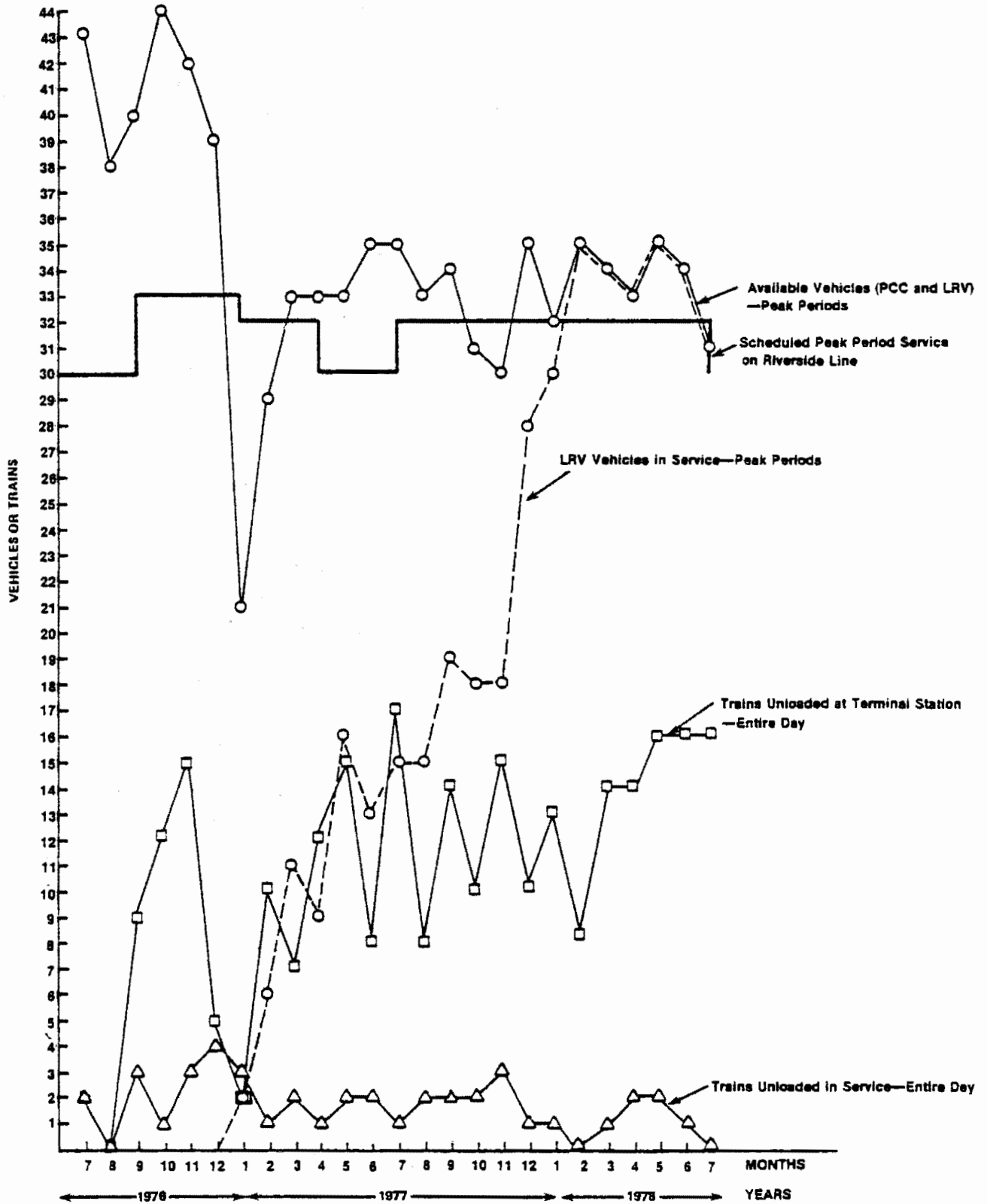
One measure of system reliability compares actual train service to scheduled train service. This measure illustrates the impacts upon the public and ultimately forms the public's opinion about the service. One particular drawback to this approach, however, is that it does not analyze the efficiency of equipment usage. The public may perceive a highly reliable service only because the operation is keeping an inordinate amount of extra equipment on hand to cover all service breakdowns. A second approach to measuring system reliability is to analyze the number of equipment breakdowns in relation to the number of vehicles in the revenue fleet. The MBTA does not routinely summarize data comparing actual and scheduled train service. However, the MBTA does record and summarize equipment failures and fleet size on a daily basis. Therefore, an analysis using this second approach was performed.

Exhibit C-16 shows the history of Riverside Line equipment utilization and service breakdowns. The exhibit is intended to show three specific sets of trends with regard to system reliability. The first set of trends (appearing in the upper region of the graph) shows the number of vehicles required for peak period service as compared to the number of vehicles available for such service. A second set of trends (appearing in the lower region of the graph) shows the number of trains taken out of revenue service over the entire day. When trains are taken out of revenue service, they are returned to the terminal station if they can proceed safely. Otherwise, they are unloaded at a mid-portion of the line. The third trend shows the phasing of LRVs into revenue service. This trend shows that the Riverside service was provided by PCC vehicles until 1977. Service during 1977 was provided by PCCs and LRVs. Starting early in 1978, only LRVs were in service. The LRV introduction trend is included to show how the LRVs affected the revenue service equipment availability and service breakdown trends.

### Vehicle Availability

Exhibit C-16 shows that the fewest number of vehicles available for revenue service occurred in January 1977. This was primarily due to a severe snowstorm that put many of the PCC vehicles out of commission. There was a steady improvement in vehicle availability until August 1977. This improvement corresponds with the introduction of LRVs into revenue service. During October and November 1977, vehicle availability was below requirements. During this same period, the rate at which LRVs were being introduced into

**EXHIBIT C-16**  
**HISTORY OF RIVERSIDE LINE**  
**EQUIPMENT UTILIZATION AND SERVICE BREAKDOWNS**



Source: MBTA Department of Operations Planning

revenue service was reduced. Since November 1977, vehicle availability has fluctuated between meeting requirements and exceeding requirements.

According to these trends, it appears that the LRVs' effect on improving the availability of vehicles for revenue service was principally to overcome the severe equipment shortage in early 1977 and to provide replacement equipment for the aging PCC fleet. In addition, a higher level of service was provided starting in mid-1977 with the LRV-dominated fleet. MBTA was able to maintain approximately the same availability rate during this period, but at higher service levels because of the LRV-dominated fleet.

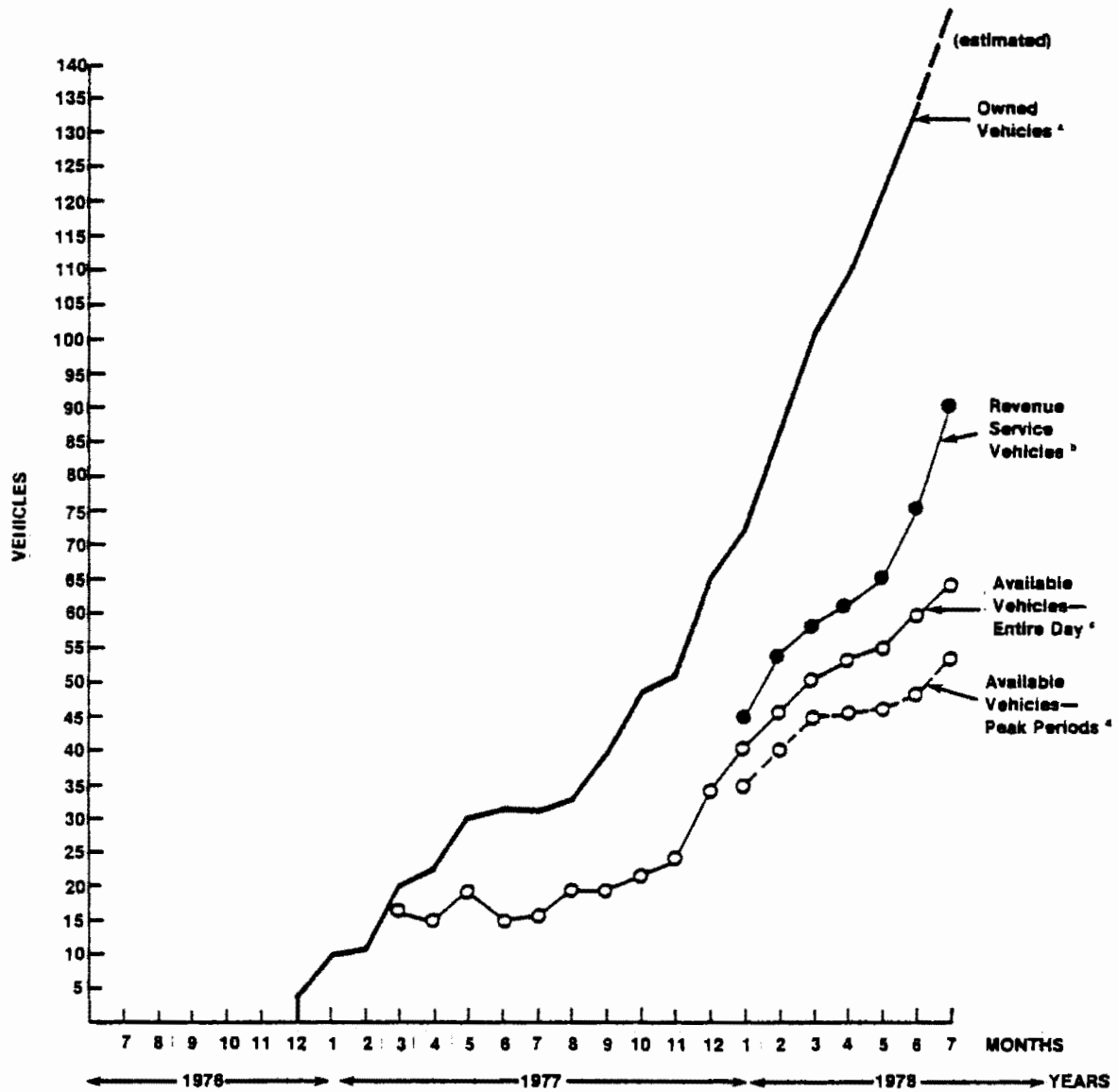
Before discussing the service breakdown trends, it is important to add another dimension to LRV introduction--LRV availability and utilization. Exhibits C-17 and C-18 illustrate the availability and usage of the LRV equipment from the time when cars were first accepted on December 31, 1976. Exhibit C-17 shows the monthly acceptances of LRVs and the number that were available for daily service. In January 1978, MBTA added two new data reporting categories--revenue service vehicles and vehicles available for peak period service. Revenue service vehicles are distinguished from vehicles available for service because they include vehicles awaiting maintenance, parts, or inspection. Exhibit C-17 illustrates some important aspects of the LRV acquisition. The gap between the available vehicles (entire day and peak) and the vehicles owned appears to be widening as more and vehicles are accepted. In comparison, the gap between the revenue service vehicles and the vehicles owned appears to be more constant. The revenue service vehicles line follows a trend somewhat closer to the vehicles accepted line. Exhibit C-18 presents this comparison on a percentage basis. According this exhibit, the number of vehicles available for daily service is down to about 50 percent of the vehicles owned by MBTA. The number of vehicles in revenue service has fluctuated between 52 percent and 62 percent of the vehicles owned by MBTA. Both Exhibits C-17 and C-18 indicate that there is a widening gap between revenue service vehicles and available vehicles. The reason for this widening gap is that an increasing number of vehicles are awaiting maintenance, parts, and inspection. The "parts" situation is so critical that equipment in temporary storage<sup>1</sup> is being cannibalized to keep other equipment running.

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<sup>1</sup>On November 6, 1978, there were 42 LRVs in temporary storage. Of the 42, 15 vehicles have been cannibalized due to a lack of parts and other spare parts ordered by MBTA.

EXHIBIT C-17

LRV EQUIPMENT IN REVENUE SERVICE AND AVAILABLE FOR SERVICE



<sup>a</sup> Owned vehicles are vehicles located on the property that have been accepted by MBTA.

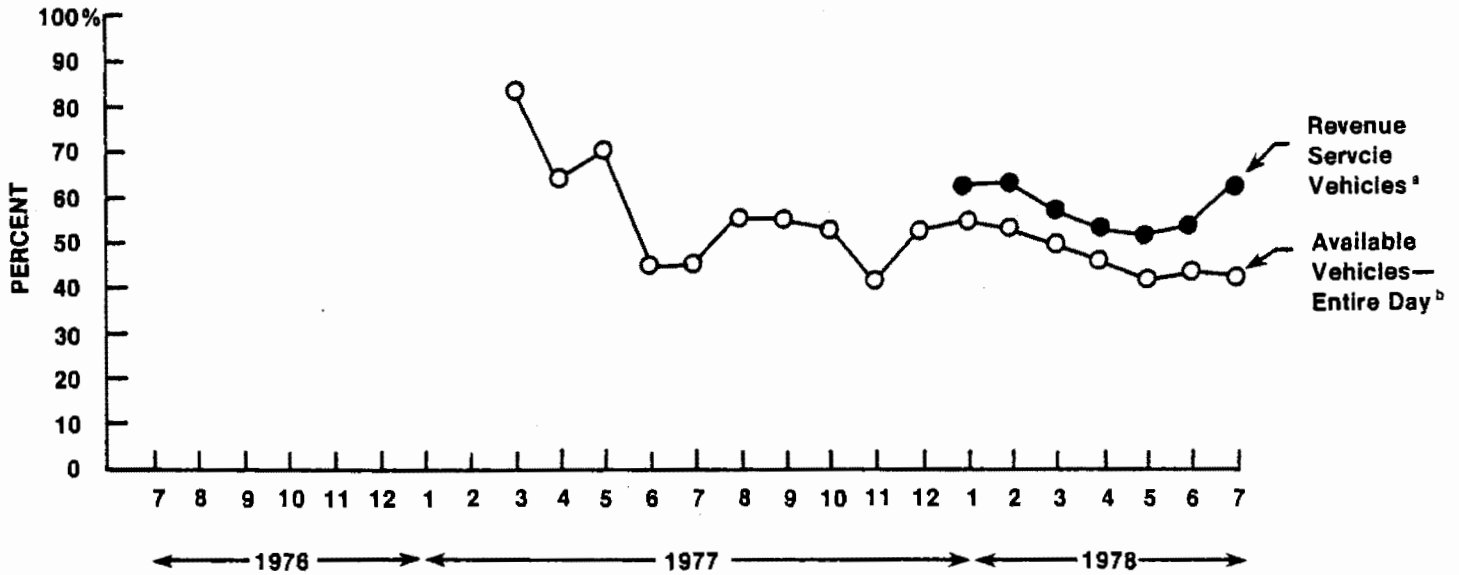
<sup>b</sup> Revenue service vehicles are the owned vehicles less those that are in temporary storage or are awaiting modification. Data on this category were available starting January 1977.

<sup>c</sup> Available vehicles-entire day are the revenue service vehicles less those awaiting maintenance, parts or inspection.

<sup>d</sup> Available vehicles-peak periods are the revenue service vehicles less those awaiting maintenance, parts or inspection; and are available for peak period revenue service.

Source: Department of Operations Planning; LRV Daily Status Reports

**EXHIBIT C-18  
OWNED LRV'S IN REVENUE SERVICE AND AVAILABLE**



\* The percent of owned LRV's in revenue service is calculated with the following formula:

$$\text{Percent Owned LRV's in Revenue Service} = \frac{\left( \text{Number of Revenue Service Vehicles} \right) \times \left( \text{18 Hours of Revenue Service Per Vehicle} \right) - \left( \text{Total Revenue Service Hours Lost} \right)}{\left( \text{Number of Vehicles Owned} \right) \times \left( \text{18 Hours of Revenue Service Per Vehicle} \right)}$$

° The percent of own LRV's that are available is calculated with the following formula:

$$\text{Percent of Owned LRV's That Are Available} = \frac{\left( \text{Number of Available Vehicles} \right) \times \left( \text{18 Hours of Revenue Service Per Vehicle} \right) - \left( \text{Total Revenue Service Hours Lost} \right)}{\left( \text{Number of Vehicles Owned} \right) \times \left( \text{18 Hours of Revenue Service Per Vehicle} \right)}$$

Source: Department of Operations Planning; LRV Daily Status Reports

It is the consensus of the MBTA staff that the poor reliability and maintainability of the LRVs can be attributed to the poor overall design of the vehicles which is the product of three factors:

- . No prototype vehicle was developed and thoroughly tested before a production line was set up.
- . The design has relied heavily on "high technology" and not enough upon conventional, proven technology such as door mechanisms, vehicle trucks, and suspension.
- . The vehicle was designed by a committee (the Boston-San Francisco Committee or the BSF Committee) with resulting compromises in design.

The poor availability of LRVs (50 percent as shown in Exhibit C-18) has not had an adverse impact on Riverside service levels. Even though only 50 percent of the LRVs are in service, the actual number available exceeded the requirements for Riverside service in December 1977 before the Riverside Line initiated full LRV service.

#### Service Breakdowns

Exhibit C-16 shows the average daily number of trains unloaded at the terminal stations and those unloaded at points along the Riverside Line. According to the exhibit, the number of trains unloaded at the terminals has fluctuated more than the number of trains unloaded while in service. From the passengers' perspective, breakdowns that require a vehicle transfer (such as in-service breakdown) are much more visible. For MBTA, these occurrences are much less frequent than breakdowns which result in vehicles being unloaded at the terminal stations. The all-LRV service in 1978 appears to have slightly reduced the number of trains being unloaded while in service. It is difficult to discern any impact of the LRVs on terminal unloadings in 1977, given the large fluctuations in these occurrences.

#### Safety Impacts

According to Exhibit C-13, LRV acquisitions had an impact on the safety of Riverside Branch operations. As shown in this exhibit, the impact was negative.

The track refurbishing program, part of the Way and Structure Renewal project, started in Fall 1973 and was completed by the end of 1974. The safety impacts related to the LRV acquisitions started with the beginning of LRV service introduction in 1977.

The number of annual derailments is used to measure the impacts of the two projects on safety. Exhibit C-19 shows the number of derailments for the years 1970 through 1977. For the years 1970 through 1975, only the total number of derailments was available. For 1976 and 1977, the distribution of derailment causes are shown. The 1977 figures show the distribution of causes for PCC derailments and for LRV derailments. According to the exhibit, there was a substantial increase in the number of derailments between 1973 and 1974. From 1974 to 1976, the number of derailments remained fairly constant. In 1977, the number of derailments more than doubled. A large majority of the derailments shown between 1970 and 1976 occurred on areas of track that were not refurbished as part of the Way and Structure Renewal project. These areas included turnouts, crossovers, and sections of storage yards. The Riverside mainline track was rebuilt under the Way and Structure program, and no LRV or PCC has derailed on this track according to MBTA. The introduction of the LRVs in 1977 correlates with an increase in the number of derailments. The increase in derailments can be traced primarily to the LRV trucks, interacting both with new turnouts (i.e., at Riverside Yard) and old track and turnouts (i.e., in the Central Subway). The combination of a truck which is "stiffer" than a PCC truck and the side-bearing suspension system have apparently been causal in this regard. An LRV truck generates more lateral force than a PCC truck when going through the tight radius turns encountered at turnouts and crossovers. This has not only caused derailments and spreading of older track but is also grinding rails and wheels faster than with PCC trucks.

### TRACTION ENERGY IMPACTS

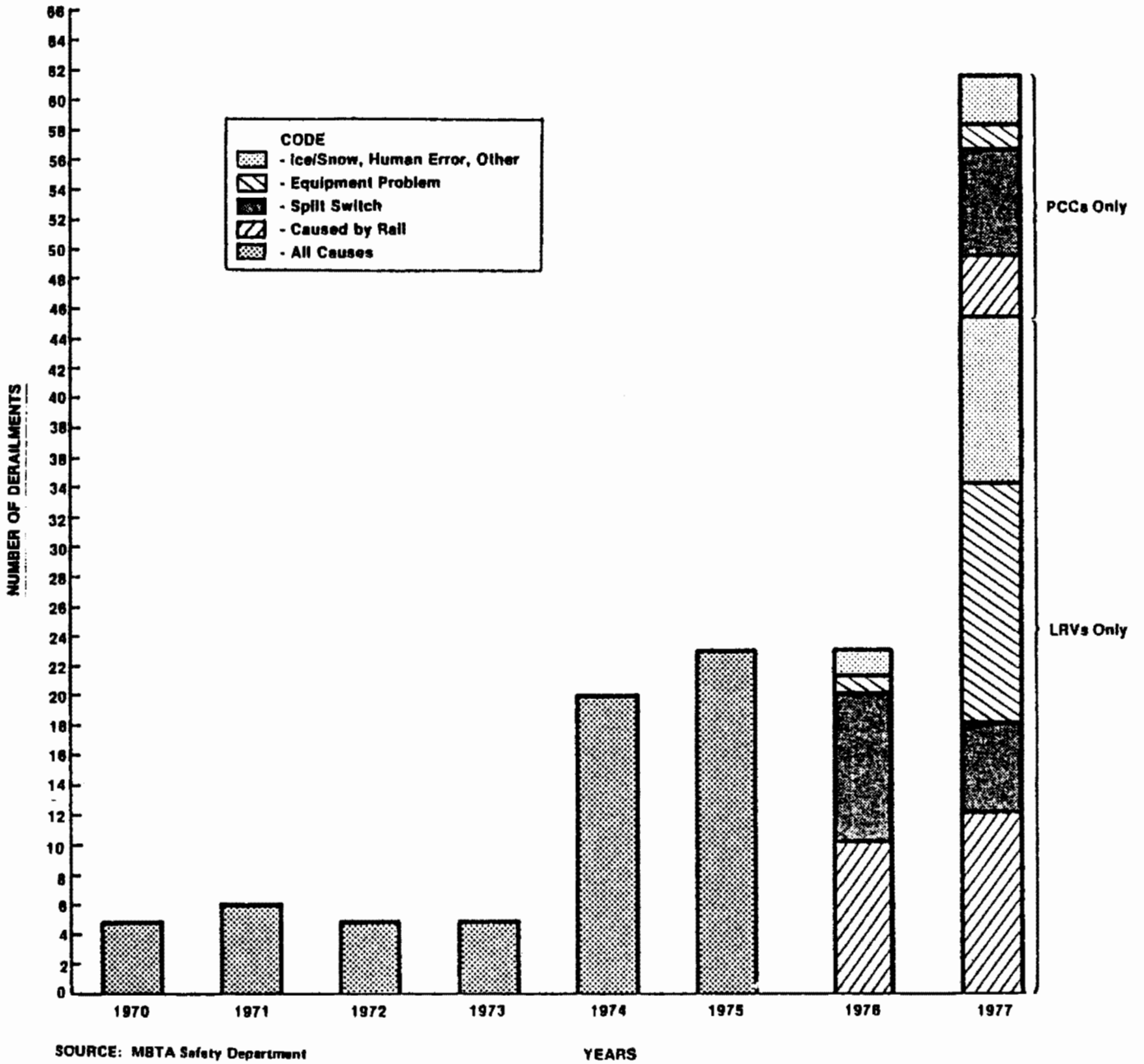
As shown in Exhibit C-13, the LRV acquisitions have impacted on traction energy requirements. The impact is positive since the LRVs have decreased energy consumption per capacity-mile. The measurement of energy requirements on a capacity-per-mile basis reflects the energy efficiency of LRVs per unit of service supplied and is considered superior to measures of energy efficiency per unit of service consumed (i.e., energy consumption per vehicle-mile and per passenger-mile). According to MBTA Power Department staff, LRVs require 20 percent less energy per total capacity-mile (seating plus standing) than PCCs. The staff indicated that, although these consumption ratings are approximate, they are within 5 percent of the actual ratings.

### FINANCIAL IMPACTS

There are three financial impacts considered in the analysis: vehicle maintenance costs, vehicle transportation costs, and passenger revenues. It is particularly difficult to measure the vehicle maintenance cost impact of the

EXHIBIT C-19

HISTORY OF RIVERSIDE LINE DERAILMENTS





LRVs and the new maintenance facility. Most of the LRV maintenance and repair is presently being conducted under a warranty program. Therefore, MBTA is not experiencing full maintenance costs. Furthermore, a certain amount of the LRV acquisition deployment cost appears in the maintenance operating cost. These deployment costs primarily consist of training maintenance personnel to service the LRVs and in purchasing special maintenance equipment. The deployment costs are not part of normal routine maintenance costs and must therefore be factored out in any direct comparisons.

### Vehicle Maintenance Costs

Exhibit C-13 shows that the LRV acquisitions have a negligible impact and the new maintenance facility has a positive impact on vehicle maintenance costs.

Exhibit C-20 illustrates the impact of LRV maintenance on vehicle maintenance costs. It compares the total cost of maintaining LRVs as compared to rebuilt PCCs and regular PCCs under anticipated, steady-state conditions.<sup>1</sup> The exhibit also compared unit maintenance costs for the three types of vehicles. In terms of costs per vehicle, LRVs cost about 2-1/3 times as much as rebuilt PCCs and almost twice as much as regular PCCs to maintain. Maintenance costs per vehicle-mile show a similar trend, although LRV costs are 1-1/2 times as high as those for rebuilt PCCs and 3/4 as high as those of regular PCCs. In comparing maintenance costs per seat-mile, LRV costs are about 1/3 higher than rebuilt PCCs but the same as regular PCCs. The lesser differences on the seat-mile basis are primarily due to the increased seating capacity of the LRVs. LRV acquisitions are considered to have a negligible impact because vehicle maintenance costs on a seat-mile basis are unchanged. It is important to note, however, that, under current operations, initial LRV maintenance costs per seat-mile are higher than PCC maintenance costs per seat-mile.

### Vehicle Transportation Costs

According to Exhibit C-13, only LRV acquisitions had a direct impact on vehicle transportation costs. The impact is positive because it decreased vehicle transportation costs, largely due to the reduction of operating personnel. Exhibit C-21 shows the decrease in vehicle requirements. The analysis is based on providing the same level of service with the LRVs that was scheduled for the PCCs in Fall 1976. The results show an 18 percent decrease in Fall

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<sup>1</sup>In order to make the comparison valid, start-up, warranty-reimbursed, and deployment expenses are excluded from the LRV maintenance cost, but anticipated normal heavy maintenance expenses are included.

EXHIBIT C-20

RELATIVE VEHICLE MAINTENANCE COSTS (1978 Dollars)

Items	Type of Equipment		
	LRV <sup>a</sup>	Rebuilt PCC <sup>b</sup>	PCC <sup>c</sup>
Labor	\$ 5,243,000	\$ 5,054,000	\$ 6,519,700
Materials	2,282,000	2,491,000	3,212,000
Fringe benefits <sup>d</sup>	2,622,000	2,527,000	3,260,000
<b>Total</b>	<b>\$10,147,000</b>	<b>\$10,072,000</b>	<b>\$12,991,000</b>
Estimated scheduled vehicles	71	168	168
Maintenance cost per scheduled vehicle	\$ 142,915	\$ 59,952	77,327
Estimated vehicle-miles	3,533,000	5,671,000	5,671,000
Maintenance cost per vehicle-mile	\$2.87	\$1.78	\$2.29
Estimated Seat Miles	183,716,000	238,182,000	238,182,000
Maintenance cost per seat-mile	\$0.055	\$0.042	\$0.055

<sup>a</sup> LRV estimates are based on 1979 budget figures and on Amendatory Application to Green Line Vehicles Project No. MA-03-022. The dollar figures in these documents are expressed in terms of 1978 dollars. The estimated LRV service levels (scheduled vehicles, vehicle-miles and seat-miles) are based upon planned 1979 levels. In order to make the comparisons valid, start-up, warranty reimbursed and deployment expenses are excluded from the LRV maintenance costs but anticipated normal heavy maintenance expenses are included.

<sup>b</sup> Rebuilt PCC vehicle maintenance costs are based upon a study conducted by MBTA on the value of rebuilding PCC's. The figures are based on the 1976 fleet operational levels and 1976 dollars. The 1976 labor and fringe benefits and material costs were inflated using different factors. Labor and fringe benefit expenses were inflated at 6% per annum and an addition 3% to reflect non-accrued labor adjustment wages expenses in the 1976 costs. Material costs were inflated at the rate of 13.3% per annum which is MBTA's experience.

<sup>c</sup> PCC vehicle maintenance costs are based on 1976 PCC fleet operational levels and 1976 dollars. The inflation factors described in Footnote b. were applied.

<sup>d</sup> Fringe benefit expenses were calculated based on 50.07% of labor expenses.

- Sources: (1) 1979 Proposed Budget (Unapproved)  
 (2) Scheduling Department  
 (3) Amendatory Application to Green Line Vehicles  
 DOT Project No. MA-03-0022, November 17, 1977  
 (4) Correspondence with MBTA; November 6, 1978

**EXHIBIT C-21  
VEHICLE TRANSPORTATION COSTS**

<b>Time Period</b>	<b>1976 Fall Scheduled PCCs</b>	<b>Comparable Service with Scheduled LRVs*</b>
AM-Peak	33	27
Mid-Day	22	18
Afternoon	22	18
PM-Peak	33	27
Evening	9	7
Late	6	5

**Reduction in Peak Periods Requirements: 18.2%**  
**Reduction in All Day Requirements: 18.4%**

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\*Comparable service is based on hourly seating capacity.  
**SOURCE: MBTA Scheduling Department**

1976 vehicle requirements for both the peak period requirements and the all-day requirements. Results of a separate analysis show that the total annual labor expense per scheduled peak vehicle in 1976 was \$44,202. Using the Fall 1976 vehicle requirements as a basis for estimating annual requirements, the annual Riverside PCC operations labor expenses were \$1,459,000. An 18-percent reduction in equipment requirements resulted in an approximate 1976 annual labor savings of \$263,000.

In actuality, no vehicle transportation cost savings occurred, however, because additional service was added concurrently with the introduction of the LRVs. Any possible savings were expended to provide additional service beyond that which was provided in Fall 1976.

### Passenger Revenue

The last impact shown in Exhibit C-13 is passenger revenue. Both the LRV acquisition and the station improvement projects had the positive impact of increasing passenger revenues. The increase is due to the enhanced attractiveness of the station facilities and ride, as well as the improved headways and added capacity. Exhibit C-22 shows the increases in patronage for the Riverside and Reservoir Lines, as well as for the entire MBTA system. It was necessary to combine the Riverside and Reservoir revenues because of the fare collection equipment problems at the Reservoir rating station. As a result of these problems, Reservoir Line revenues had to be counted at the Riverside rating station. MBTA does not keep financial revenue records by line. The figures provided earlier were from a separate MBTA analysis that shows the relative magnitudes of the revenues counted at each rating station. Riverside rating station revenues are in a ratio of 1 to 1.85 to Reservoir rating station revenues. The revenue analysis in the patronage impacts section concluded that Riverside Line revenues increased by 11 percent in 1977, even though the combined Riverside and Reservoir revenues increased by about 4 percent. With the type of data shown for 1978, it is difficult to conclude what effects the LRVs had on passenger revenue in 1978.

**EXHIBIT C-22**  
**PASSENGER REVENUE**  
(thousands of dollars)

Financial Period	Riverside and Reservoir Lines		Total MBTA System	
	Passenger Revenue <sup>1</sup>	Percent Increase (Decrease) Over Prior Year's Period	Passenger Revenue	Percent Increase (Decrease) Over Prior Year's Period
1977 1	\$ 272.8	(13.6%)	\$ 4,142.5	0.9%
2	341.2	5.6	4,232.3	1.0
3	417.3	0.0	5,263.5	(1.5)
4	364.4	6.7	4,214.3	0.9
5	316.1	3.8	4,176.7	0.8
6	375.0	3.3	4,870.2	(0.3)
7	331.4	7.0	3,780.7	(5.5)
8	307.7	8.6	3,855.4	2.1
9	442.5	5.1	5,123.8	1.3
10	370.8	5.5	4,327.4	3.1
11	357.0	4.4	4,185.2	3.7
12	<u>421.9</u>	<u>6.8</u>	<u>5,300.7</u>	<u>4.8</u>
Subtotal	\$4,300.1	3.7%	\$53,472.7	0.9%
1978 1	\$ 283.4	4.6%	\$ 3,741.3	9.2%
2	344.3	0.9	4,064.8	4.0
3	496.3	18.9	5,658.0	7.5
4	395.5	14.2	4,481.9	6.4
5	364.5	15.3	4,315.6	3.3
6	<u>441.4</u>	<u>17.7</u>	<u>5,177.0</u>	<u>6.3</u>
Subtotal	\$2,325.4	12.5%	\$27,438.6	2.1

<sup>1</sup>In 1978, a substantial amount of LRV service was provided on the lines using the Reservoir rating station. If it is assumed that the first year's revenue increases on these lines are similar to the first year revenue increases on the Riverside Line, the 1978 LRV impacts on Riverside revenues can be estimated. Exhibit C-22 shows a combined revenue increase of 12.5 percent (or \$290,700). Using a 1 to 1.84 ratio of Riverside to Reservoir revenues and assuming an 11 percent increase in Reservoir revenues in the first half of 1978, the increase in Riverside revenues is calculated to be about 16 percent in the first half of 1978.

Source: Department of Revenue Accounting



## APPENDIX D

### Impacts Resulting from the Purchase of New Commuter Rail Cars by the Southeastern Pennsylvania Transportation Authority (SEPTA)

IMPACTS RESULTING FROM THE PURCHASE  
OF NEW COMMUTER RAIL CARS BY THE  
SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY  
(SEPTA)

- I. INTRODUCTION
  
- II. DESCRIPTION OF COMMUTER RAIL SERVICE IN THE SEPTA AREA
  - . SEPTA's Purchase of Service Agreement
  - . Operations on the Penn Central Division
  
- III. COMMUTER RAIL PATRONAGE TRENDS
  - . SEPTA Area Commuter Rail Patronage
  - . Other Factors Influencing SEPTA Area Commuter Rail Patronage
  - . Summary of Findings
  
- IV. COMMUTER RAIL OPERATIONAL AND LEVEL-OF-SERVICE TRENDS
  - . Car Fleet Composition
  - . Fleet Seating Capacity
  - . Car Availability and Reliability
  - . Car Operating and Maintenance Costs
  - . Marketing Improvements
  
- V. SUMMARY OF FINDINGS AND CONCLUSIONS



## I. INTRODUCTION

On March 3, 1970, UMTA awarded a capital grant to the Southeastern Pennsylvania Transportation Authority (SEPTA). This grant, PA-10, provided for the purchase of 144 multiple unit commuter cars, 14 for service on the Reading Railroad and 130 for service on the Penn Central Railroad. The first cars arrived and were placed into service in May 1974, and all cars had arrived by the end of 1976. The actual cost under PA-10 was \$58.9 million, with a federal share of \$39.3 million and a local share of \$19.6 million.

This appendix focuses on the purchase of the 130 cars for operation on Penn Central Railroad lines. The cost for these cars was \$52.9 million, with the federal and local shares representing \$35.3 million and \$17.6 million, respectively.

The objective in evaluating these rolling stock purchases is to document the impact of UMTA funds on SEPTA commuter rail services. Based on discussions with SEPTA representatives, as well as a review of operating and financial data compiled by SEPTA, the five principal impacts resulting from the new commuter cars are:

- . a contribution to patronage growth resulting from increased vehicle comfort and convenience. Patronage growth during this period, however, was also significantly affected by the positive impacts of residential and employment locational changes and the negative impacts of fare increases.
- . increased car availability and reliability of service.
- . reduced vehicle maintenance costs.
- . reduced fleet size and associated operating costs.
- . reduced operating costs due to smaller train consists.

The remainder of this appendix is devoted to a presentation of background information and an analysis of specific data in support of these findings.

## II. DESCRIPTION OF COMMUTER RAIL SERVICE IN THE SEPTA AREA

SEPTA is an agency of the Commonwealth of Pennsylvania created under the Metropolitan Transportation Authorities Act of 1963 in recognition of a need to preserve, unify, and expand the region's public transportation system. The City of Philadelphia and the Counties of Bucks, Chester, Delaware, and Montgomery comprise the SEPTA service region (see Exhibit D-1).

The Authority cannot levy taxes, but it does have broad powers to borrow funds through the issuance of revenue bonds and other forms of indebtedness. It also is empowered to receive grants from federal, state, and local governments.

### SEPTA'S PURCHASE OF SERVICE AGREEMENT

Since 1958, SEPTA has maintained purchase of service agreements with the Pennsylvania (later Penn-Central) and the Reading Railroads to provide commuter rail service. Since 1976, however, the Penn-Central's (P-C) and the Reading's rail properties and operations have been part of the system of the Consolidated Rail Corporation (ConRail). The purchase of service arrangement has continued with the operation of the lines by ConRail.

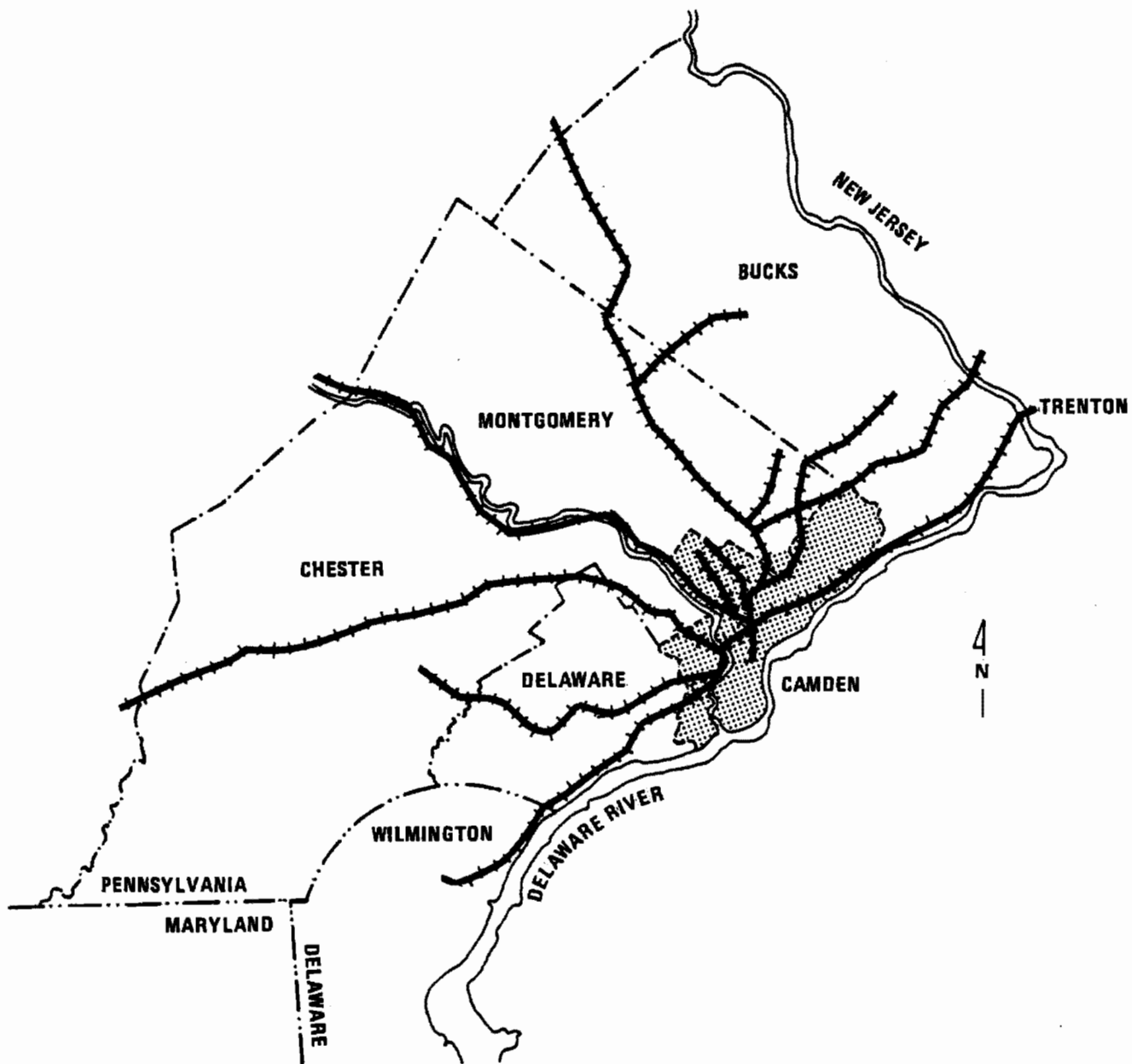
The general terms of the agreement between SEPTA and ConRail provide for the latter to operate "contract trains" according to a specific timetable. Fare schedules are prescribed for stations within the contract area. In addition, obligations are required of the railroad with respect to the following:<sup>1</sup>

- . train consist;
- . on-time performance;
- . equipment availability and utilization;
- . car cleanliness;
- . station maintenance and cleanliness;

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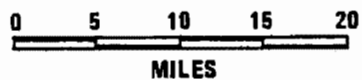
<sup>1</sup>SEPACT II Final Report: A Study of the 1975 Commuter Railroad System in the Southeastern Pennsylvania Metropolitan Region, prepared by SEPTA, 1971, p. 19.

EXHIBIT D-1



THE SEPTA AREA

- +++++ COMMUTER RAIL LINES
- ▨ PHILADELPHIA



Source: SEPACT II Final Report: A Study of the 1975 Commuter Railroad System in the SEPTA Region.

- . parking facility maintenance;
- . agreements with transit operators relating to feeder services and coordinated fares;
- . management of commuter operations; and
- . advertising and public relations.

Today, SEPTA reimburses ConRail for a major portion of the cost incurred, (per the RSPO standards), as a result of operation of contract service within the SEPTA area.

In fiscal year 1975, the total avoidable cost of operating SEPTA commuter lines was \$50.3 million. Commuter rail revenues in 1975 were \$22.4 million, leaving a net avoidable loss of \$27.9 million. Public financial support to offset the loss consisted of \$22.6 million by the state and jurisdictions within the SEPTA area. The other \$5.3 million was absorbed by the railroads. For the year ending March 31, 1978, SEPTA estimates operating cost at \$77 million--an increase of over 50 percent in 3 years. The net loss projected for this period is \$44.8 million, to be funded by \$21.3 million in UMTA Section 17 funds,<sup>1</sup> and \$23.5 million from the state and the jurisdictions within the SEPTA area. Of the local share, the state contributes up to two-thirds, and the city and counties provide the remaining one-third.<sup>2</sup>

#### OPERATIONS ON THE PENN-CENTRAL DIVISION

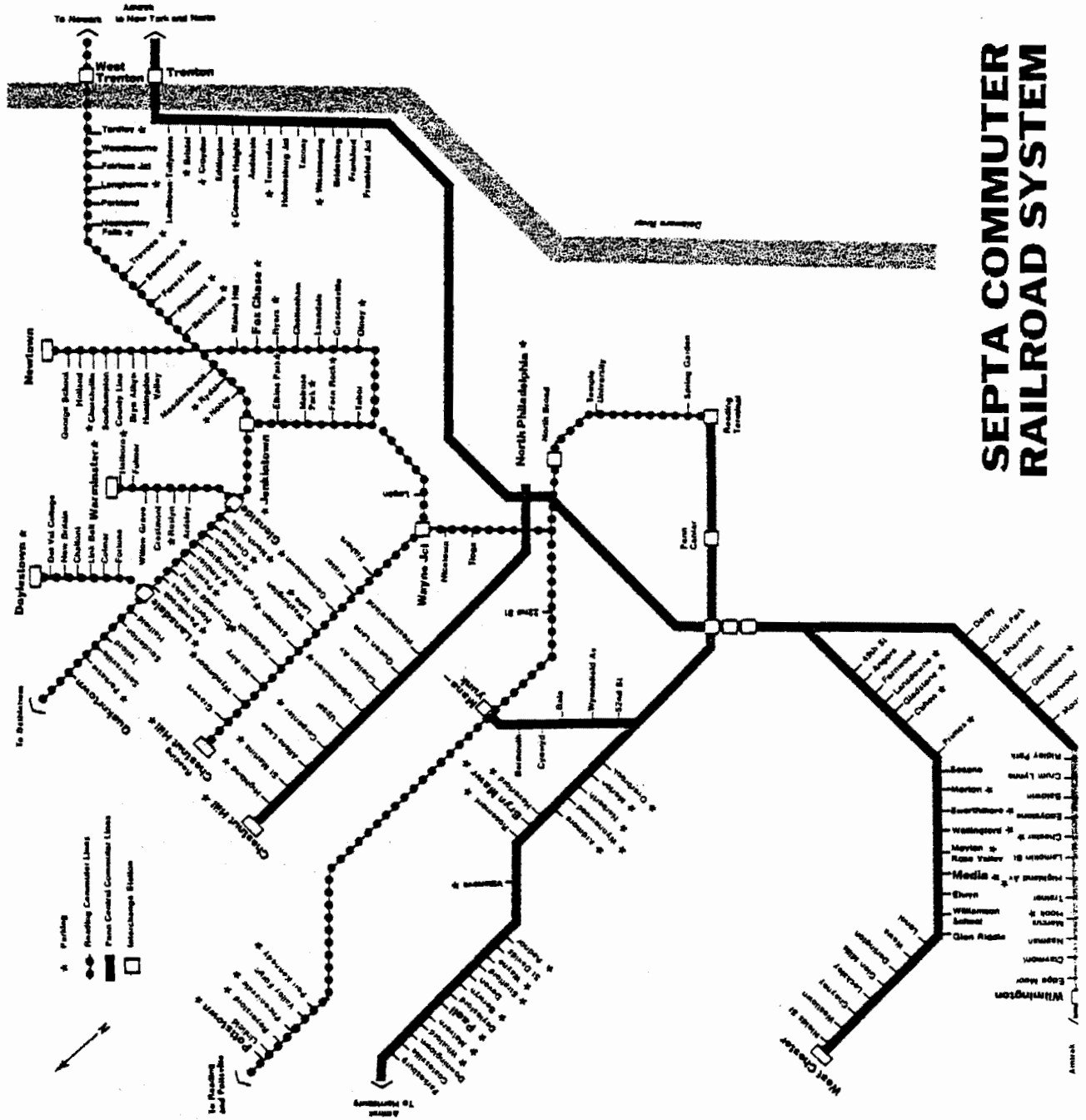
ConRail operates six lines under a purchase-of-service contract on former P-C lines (see Exhibit D-2). These lines serve all of the counties of the SEPTA area over a network of 142.8 route miles (excluding overlapping services) serving 97 stations. In 1977, 420 trains were operated on weekdays, carrying approximately 75,800 passengers daily. A listing of these lines, their route miles, and the average number of weekday trains is provided below. The terminus for all P-C Division trains is the Suburban Station (Penn Center).

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<sup>1</sup>UMTA Section 17 funds provide financial assistance for the purpose of reimbursing ConRail for costs of rail passenger service operations.

<sup>2</sup>SEPTA Accounting Department, Commuter Rail Division.

EXHIBIT D-2



<u>SURBURBAN STATION TO</u>	<u>ROUTE MILES</u>	<u>AVERAGE WEEKDAY<sup>1</sup> TRAINS</u>
Chestnut Hill	6.6	75
Manayunk	5.2	36
Media - West Chester	25.3	83
Paoli - Parksburg	43.1	131
Trenton	23.7	41
Wilmington - Newark	<u>38.9</u>	<u>54</u>
TOTAL	142.8	420

#### OPERATIONS ON THE READING DIVISION

ConRail also operates seven lines on the former Reading Railroad. While operations over these lines are not discussed in detail in this report, they are an important component of commuter rail service in the SEPTA region. These lines serve all counties in the SEPTA region except Delaware over a network of approximately 140 route miles and 101 stations (see Exhibit D-2). In 1977, 367 trains were operated over these lines, on an average weekday, carrying approximately 54,825 riders daily.

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<sup>1</sup>November 1977.

### III. COMMUTER RAIL PATRONAGE TRENDS

#### SEPTA AREA COMMUTER RAIL PATRONAGE

As shown in Exhibit D-3, SEPTA area commuter rail patronage has been gradually increasing since 1960, with a record number of passengers riding SEPTA commuter trains in 1977. In this record year, total patronage on the Reading and P-C Division lines was 33,592,152--a 41.9 percent increase over the 1960 figure and a 10.2 percent increase over the Bicentennial year patronage. From 1970 to 1973 when the Penn Central bankruptcy occurred, patronage showed moderate declines.

SEPTA representatives attribute the 1977 patronage increase in part to a 44-day SEPTA City Transit Division strike.<sup>1</sup> After this strike ended, however, SEPTA reported that many former transit riders who had been introduced to the commuter rail service continued to remain on it.<sup>2</sup>

#### Patronage on P-C Division Lines

Patronage on Penn-Central Division lines has shown relatively the same growth pattern as that of the local SEPTA commuter rail system. As illustrated in Exhibit D-4, patronage on P-C Division lines from 1960 to 1977 increased 48.7 percent.

From 1960 to 1970, annual patronage increased by 35.8 percent. Although patronage declined by 8.5 percent between 1971 and 1973, this trend was reversed after 1973, with patronage showing moderate increases in 1974, 1975, and 1976. Patronage in 1977 was 19,832,337, representing a 10-percent increase over the 1976 figure and 59 percent of SEPTA's total commuter rail patronage.

#### Peak Period Patronage

Peak period patronage as a proportion of average weekday patronage is an important measure of demand for SEPTA commuter rail service and the resulting commuter rail vehicle requirements. For SEPTA's commuter rail service, the peak period consists of weekday trains arriving between 6:00 to 9:30 a.m. and 4:00 to 6:00 p.m. The a.m. peak period is the highest patronage period.

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<sup>1</sup>"Critique of Rail Commuter Ridership," Southeastern Pennsylvania Area, 1977, p. 1.

<sup>2</sup>Ibid.

EXHIBIT D-3

COMMUTER RAIL PATRONAGE TRENDS

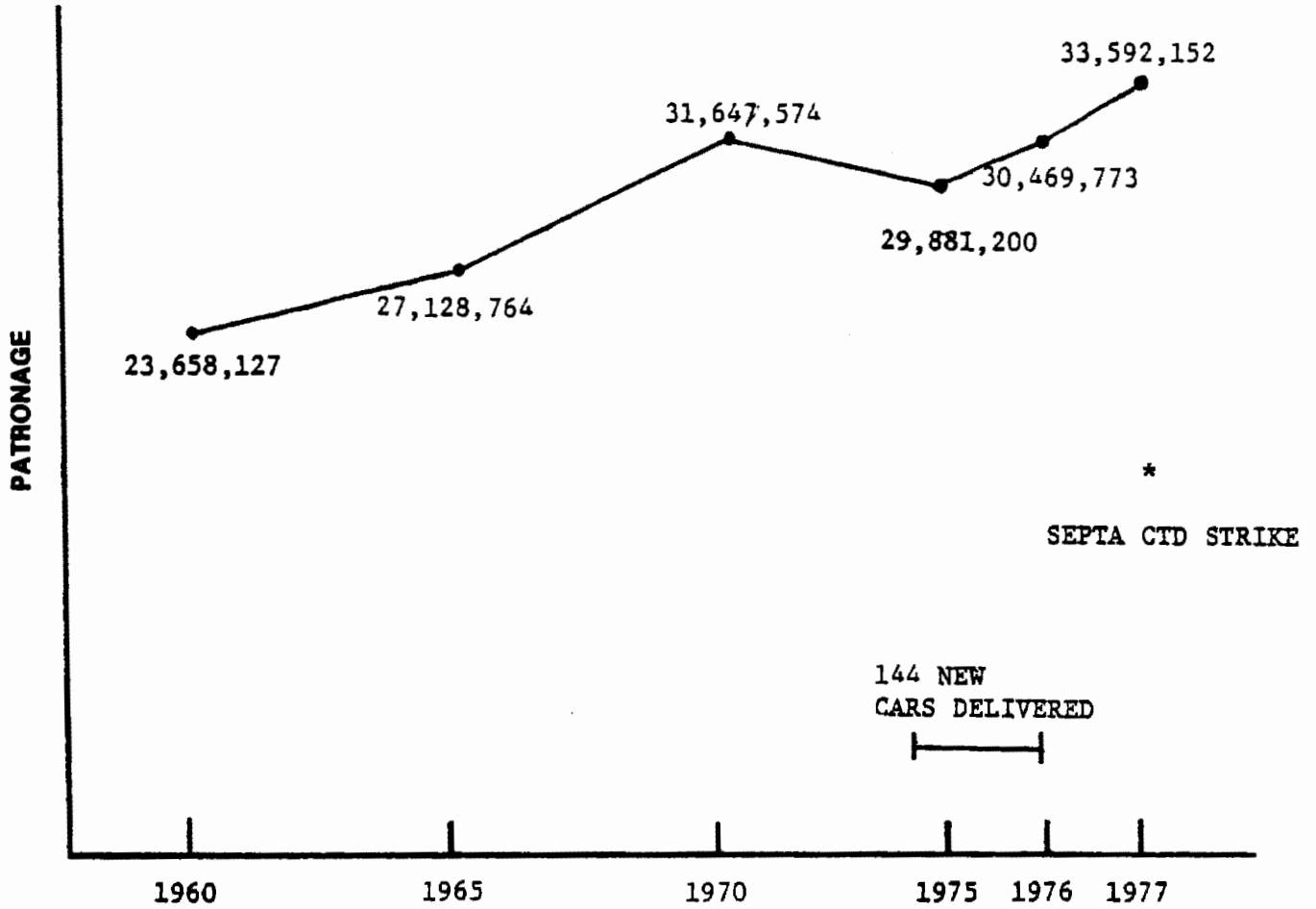




EXHIBIT D-4

ANNUAL PATRONAGE  
PENN CENTRAL DIVISION LINES  
(Thousands)

LINE	YEAR										1977 % of Total
	1960	1965	1970 <sup>1/</sup>	1971 <sup>2/</sup>	1972	1973	1974	1975	1976	1977 <sup>3/</sup>	
Chesnut Hill	1,879	2,556	2,918	3,036	2,929	2,765	2,868	2,931	2,961	3,322	16.8%
Maynayunk	-	409	440	455	424	377	360	363	365	463	2.3
Media-West Chester	3,364	3,512	3,848	3,794	3,631	3,537	3,625	3,744	3,788	4,356	22.0
Paoli	5,189	5,341	5,993	5,898	5,720	5,320	5,526	5,520	5,745	6,061	30.5
Trenton	491	1,571	2,121	2,142	2,036	1,955	2,065	2,304	2,392	2,789	14.1
Wilmington	2,414	2,313	2,797	2,744	2,722	2,621	2,731	2,708	2,780	2,841	14.3
TOTAL	13,337	15,702	18,117	18,069	17,462	16,575	17,175	17,570	18,031	19,832	100.0%
PERCENT CHANGE		1960-65	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1960-77	
		+17.7%	-0.3%	-3.4%	-5.1%	+3.6%	+2.3%	+2.6%	+10.0%	+48.7%	

D.11

SOURCE: CRITIQUE OF RAIL COMMUTER RIDERSHIP,  
Southeastern Pennsylvania Area, 1977

<sup>1/</sup> Penn Central Railroad Strike - December 10, 1970

<sup>2/</sup> Philadelphia City Transit Strike - April 12 to April 27, 1971  
Signalmen's Strike - Penn Central May 17-18, 1971

<sup>3/</sup> SEPTA Transit Strike - March 25, 1977 to May 7, 1977

Exhibit D-5 indicates that peak period patronage increased from 21,000 in 1973 to 30,500 in 1977, representing a 45 percent increase. The a.m. peak period patronage represented 31 percent of average daily patronage in 1973 and by 1977 it had increased to 40 percent.

## OTHER FACTORS INFLUENCING SEPTA AREA COMMUTER RAIL PATRONAGE

### Trends in Regional Population

One factor which has influenced commuter rail patronage has been the dramatic change in population distribution in the SEPTA area in the past 15 years. The population of the five-county SEPTA area for 1960, 1965, 1970, and 1975, along with the patterns of population distribution in the area, are shown in Exhibit D-6. During the 15-year period from 1960 to 1975, the study area grew in population by only 5.8 percent.

The City of Philadelphia, representing at least 50 percent of the population of the entire SEPTA area in every year except 1975, experienced a 9.1 percent decrease in population between 1960 and 1975. From 1970 to 1975 alone, Philadelphia lost approximately 134,000 inhabitants or nearly 7 percent of its population.

By contrast, the three suburban counties of Bucks, Chester, and Montgomery achieved a rapid growth rate, with an increase in population of 49.2, 38.9, and 22.9 percent, respectively, during the same period. Delaware County, the most densely populated of the suburban counties, did not grow as rapidly, achieving a 7.1 percent increase in population during the same period.

### Trends In CBD Employment

Another factor influencing patronage is the change in Central Business District (CBD) employment. Decentralization of Philadelphia's CBD employment has not matched the decentralization of its residential population. By contrast, as shown in Exhibit D-7, employment in Philadelphia's CBD has been increasing over the past two decades, achieving a 37 percent increase from 1960 to 1978.

For the City of Philadelphia as a whole, there has been a steady decline in total employment due to the exodus of many businesses from Philadelphia to the surrounding suburban counties. With respect to employment distribution, however, CBD employment is the important component in an evaluation of commuter rail ridership, since the majority of commuter rail trips are work trips to or from the CBD.

**EXHIBIT D-5**

**A.M. PEAK HOUR PATRONAGE VERSUS AVERAGE DAILY PATRONAGE**

	PATRONAGE				
	1973	1974	1975	1976	1977
AVERAGE DAILY PATRONAGE	67,000	71,600	68,000	74,250	75,800
A.M. PEAK PERIOD PATRONAGE	21,000	24,500	22,700	29,700	30,500
A.M. PEAK AS PERCENT OF AVERAGE DAILY PATRONAGE	31%	34%	33%	40%	40%

SOURCE: SEPTA Ridership Statistics Reports

**EXHIBIT D-6**

**SEPTA AREA POPULATION  
(Thousands)**

YEAR	POPULATION IN YEAR			
	1960	1965	1970	1975
Bucks	309	343	417	461
Chester	211	244	278	293
Delaware	553	587	603	592
Montgomery	516	581	624	634
City of Philadelphia	1,998	2,052	1,950	1,816
(Philadelphia County) TOTAL	3,587	3,807	3,872	3,796
PERCENT CHANGE	PERCENT POPULATION CHANGE IN PERIOD			
	1960-65	1965-70	1970-75	1960-75
Bucks	11.0%	21.5%	10.6%	49.2%
Chester	15.6	13.9	5.4	38.9
Delaware	6.1	2.7	-1.8	7.1
Montgomery	12.5	7.4	1.6	22.9
City of Philadelphia	2.7	-5.0	-6.9	-9.1
TOTAL	6.1%	1.7%	-2.0%	5.8%

SOURCE: Population Estimates for the Delaware Valley Region, Delaware Valley Regional Planning Commission, No. 16, July 1977.

SEPACT II FINAL REPORT: A Study of the 1975 Commuter Railroad System in the Southeastern Pennsylvania Metropolitan Region, 1971.

**EXHIBIT D-7**

**PHILADELPHIA  
CBD EMPLOYMENT  
(Thousands)**

<b>YEAR</b>	1960	1970	1975	1978
<b>EMPLOYMENT</b>	288	325	378	395

**SOURCE:** Philadelphia Commerce Department

**EXHIBIT D-8**

**SEPTA FARE INCREASES**

<b>DATE</b>	<b>AVERAGE INCREASE</b>
September 1, 1970	20%
March 1, 1971	10%
January 5, 1972	12.5%
April 1, 1977	20%
May 1, 1978	11.5%

**Source:** SEPTA, Rail Operations Division

The average passenger revenue for a trip on the P-C Division was 73¢ in 1973, compared to 84¢ in 1977.

The major types of employment increases in Philadelphia have been in the office, retail and trade, and services (finance, insurance, and real estate) categories.<sup>1</sup>

### Fares

Another important factor in analyzing commuter rail patronage trends is fare increases. From 1970 to 1978, SEPTA enacted five fare increases, with the two most recent fare increases occurring within a 13-month period (Exhibit D-8).

### SUMMARY OF FINDINGS

The information presented in this section has shown that in recent years, the SEPTA service area has experienced a shift in residential population to the suburbs, along with an increase in CBD employment. Since commuter rail serves trips from suburban locations to the center city, the potential number of commuter rail patrons increased with these changes, and these changes were probably influential in the patronage growth trends which have been experienced by SEPTA, despite fare increases.

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<sup>1</sup>Philadelphia Commerce Department

## IV. COMMUTER RAIL OPERATIONAL AND LEVEL-OF-SERVICE TRENDS

### CAR FLEET COMPOSITION

SEPTA representatives attribute some of the success in patronage increases experienced in recent years to the acquisition of new equipment. The commuter car fleet composition trends on the P-C Division, focusing on the 130 commuter cars acquired through PA-10, are discussed below. The impact of this acquisition program on fleet composition (age) is one of the important factors suggested as having contributed to patronage increases.

#### Car Fleet Prior to PA-10

Exhibit D-9 shows the car fleet trends on the P-C Division from 1973 to 1977. In 1973, 73 percent of the commuter cars were old P-C Red Cars manufactured prior to 1920. These cars were inferior in comfort and convenience standards to those purchased under PA-10

The total number of cars in the fleet in 1973 was 262, which is higher than at present. The old cars seated only 72 passengers, and this required the operation of longer trains than those now operating over the same lines. With such a large percentage of antiquated equipment in operation in 1973, the average of all cars in service on the P-C Division was 46.4 years.

#### Car Fleet After PA-10

In 1974, the first 30 of the new 127 passenger multiple unit electric Silverliner IV commuter cars arrived and were placed into service. As SEPTA personnel report (and as described below), the many improved features of these cars made the ride much more comfortable and convenient for SEPTA patrons. Additionally, the new equipment provided greater mechanical reliability, reduced failures, and ensured greater reliability of service.

With the acquisition of 30 new Silverliner IVs in 1974, the average age of the commuter fleet was reduced to 42.5 years. The total number of cars in the fleet increased to 284.

In 1975 and 1976, 76 and 24 new cars arrived, respectively, reducing the average car age to 17 years and 8.5 years, respectively. By 1976, all 130 of the new cars had arrived, and 240 old cars had been scrapped.

In 1977, one additional old Red Car was scrapped, and the total fleet size on the P-C Division dropped to 225 vehicles. Approximately 85 percent of

EXHIBIT D-9

PENN CENTRAL DIVISION CAR FLEET TRENDS

CAR TYPE	NUMBER OF CARS IN FLEET					SPECIAL FEATURES
	1973	1974	1975	1976	1977	
Red Car	200	200	90	34	33	none
Pioneer	5	5	5	5	5	air conditioned
Silverliner	57	57	57	57	57	air conditioned/radio/
Silverliner IV (New cars)	0	30	106	130	130	air conditioned/radio/PA. Sys.
TOTAL CARS	262	292	258	226	225	
Average Car Age (Years)	46.4	42.5	17.0	8.5	9.5	



the vehicles were modern equipment, and nearly 60 percent were less than 3 years old. The average car age was 9.5 years.

Thus, as a result of PA-10, average car age on the P-C Division has been reduced by nearly 37 years and the fleet size has been reduced 14 percent.

### FLEET SEATING CAPACITY

Fleet seating capacity provides a measure of a system's ability to handle patronage during peak time periods. For SEPTA commuter trains, the highest single patronage period is between 6:00 and 9:30 a.m. (40 percent of average daily patronage). As illustrated in Exhibit D-10, on an aggregate basis, maximum fleet seating capacity has increased by 4,485 seats or nearly 21 percent from 1973 to 1977,<sup>1</sup> while a.m. peak hour patronage has increased by 9,500 patrons or 44 percent. Although PA-10 has resulted in a 21 percent increase in fleet seating capacity, the decrease in level of service during the a.m. peak period due to vehicle capacity constraints largely reflects the impact of significant patronage increases since 1973.

### CAR AVAILABILITY AND RELIABILITY

Another impact of PA-10 has been to improve car availability on the P-C Division lines. Availability of equipment is one of the major determinants of seating capacity and the ability to transport riders at peak periods. The Red Cars which are still operating on the P-C Division only operate during the morning and evening peak periods, so a comparison between the availability of the Red Cars versus the new Silverliner IVs would be invalid.

However, since April 1976, SEPTA compiled statistics on the availability of new Silverliner IVs versus the 57 older Silverliners in the fleet. These vehicles operate throughout the day and, on an average, are about 13 years of age. In Exhibit D-11, the availability of this equipment is computed based on the number of cars that were in the shop and thus were not available to provide commuter rail service (including those in the shop for normal repair).

As shown in this exhibit, the differences in the percentage of equipment available for the Silverliner IVs versus the older Silverliners increased in

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<sup>1</sup>Fleet seating capacity increased by 4,485 due to the retiring of 167 old cars seating 72 passengers and the acquisition of 130 new cars seating 127 passengers.

**EXHIBIT D-10**

**FLEET SEATING CAPACITY  
AND A.M. PEAK HOUR PATRONAGE**

YEAR	1973	1974	1975	1975	1977
Maximum Fleet Seating Capacity	21,895	25,705	27,600	26,450	26,380
A.M. Peak Period <sup>1/</sup> Patronage	21,000	24,500	22,700	29,700	30,500

1/ Fleet seating capacity increased by 4,485 due to retiring 167 old car seating 72 passengers and the acquisition of 130 cars seating 127 passengers.

2/ SOURCES: SEPTA Patronage Reports

**EXHIBIT D-11**

**AVAILABLE EQUIPMENT**

	1976	1977	1978 <sup>1/</sup>
CAR TYPE	PERCENT OF EQUIPMENT AVAILABLE		
Old Silverliners	81.0%	80.9%	71.7%
Silverliner IV's	86.6%	88.0%	87.3%

1/ January through May only.

Source: SEPTA Equipment Availability/Shopped Summaries, 1976-1977,  
and 1978

each of the 3 years, representing a 5.6, 7.9, and 15.6 percent difference, respectively, for 1976, 1977, and 1978. During the first 5 months of 1978, severe traction motor failures on the older Silverliners resulted in a high percentage of out-of-service vehicles.

Car reliability refers to adherence to schedules (on-time performance) and the resulting confidence on the part of commuters that trains will arrive and depart from stations at or near the times published in timetables. SEPTA's agreement with ConRail stipulates that trains should arrive within 5 minutes of the times listed in timetables to be considered on-time. At one time, SEPTA imposed monetary penalties for failure to meet scheduled times and provided bonuses when a high percentage of trains were operated on-time. At present, such monetary penalties and bonuses are not part of the contract.

As shown in Exhibit D-12, on-time performance has improved substantially since the receipt of the first Silverliner IVs in 1974. The average on-time performance for all lines in 1973 was 81.2 percent, as compared to 95.5 percent in 1977.

SEPTA personnel attribute increases in the on-time performance to the operation of the new cars, which provided greater mechanical reliability and tended to reduce failures. There were few improvements to the track and roadbed which would have contributed to improvements in on-time performance during this period.

#### CAR OPERATING AND MAINTENANCE COSTS

Based on a comparison of the maintenance costs of old Red Cars versus the new Silverliner IVs over a 3-year period, the new cars have had a much lower total maintenance cost per mile than the old cars which they replaced.<sup>1</sup>

Exhibit D-13 shows the maintenance of equipment expenses on the Penn-Central Division for the first quarters of 1973, 1974, 1975, and 1976. The maintenance costs for the new cars were approximately 50 to 60 percent of those of the Red Cars.

The maintenance cost data presented in Exhibit D-13 have been compiled by SEPTA on a quarterly basis to April 1976. Beginning on April 1, 1976,

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<sup>1</sup> SEPTA representatives reported that this was partly attributed to the fact that the new cars are still under warranty for most major repairs.

ConRail instituted a new accounting system whereby joint and common costs of system operations are allocated to commuter rail operations, thus making new cost data (after April 1, 1976) incomparable with past cost data.

While ConRail does not provide SEPTA with information on operating costs per mile for specific car types, there are two factors which support the argument that commuter rail operating costs have also been reduced with the new car purchase under PA-10. The first factor is the reduction in car miles which has resulted due to the shorter train consists. The new cars, which seat 127 passengers as compared with the old cars which seat 72 passengers, require fewer cars per train. Car miles therefore have been reduced from 7.2 million miles in fiscal year 1974 to 6.4 million miles in fiscal year 1977 (a reduction of 11 percent) with no change in the service area or level of service.

The other factor which would tend to reduce operating costs is the reduced car weight of the new cars. The new cars weigh 22,500 pounds less than the old cars (Exhibit D-14). Car weight influences both operating cost and power consumption. Benefits due to decreased power consumption have been partially offset, however, due to the increase in electric power consumed by the new cars which are air conditioned.

### MARKETING IMPROVEMENTS

One of the most significant impacts resulting from the purchase of the new cars has been improved comfort and convenience for riders. Although SEPTA has not conducted a survey to assess this impact, the new cars are equipped with many modern features such as:

- . air conditioning;
- . improved heating system;
- . improved lighting;
- . smoother rides (new cars have an improved truck design);
- . improved doors (automatic doors on new cars versus manual doors on the old cars);
- . public announcement system;
- . improved seats (reflecting high quality comfort and appearance standards); and
- . non-slip floors (compared to worn tile floors in old cars).

EXHIBIT D-12

ON-TIME PERFORMANCE FOR THE PENN CENTRAL DIVISION<sup>1</sup>

Year	1973 <sup>2/</sup>	1974	1975	1976	1977
Average On-Time Performance	81.2%	88.3%	89.2%	95.0%	95.5%
<sup>1/</sup> On-time performance before exceptions (allowances are made for acts of God, and other unavoidable situations). <sup>2/</sup> July to December 1973 only.					

SOURCE: Performance By Line, Percentage on Time Before Exception Reports, Penn Central Division, 1973-1978.

EXHIBIT D-13

MAINTENANCE OF EQUIPMENT  
COST PER MILE

CAR TYPE	TIME PERIOD			
	1st Quarter 1973	1st Quarter 1974	1st Quarter 1975	1st Quarter 1976
Old Red Car	\$ .96	\$1.12	\$1.45	\$2.15
Silverliner IV	--	--	\$ .74	\$1.39

SOURCE: Penn Central, SEPTA-Related Maintenance of Equipment Expenses, Reports

EXHIBIT D-14

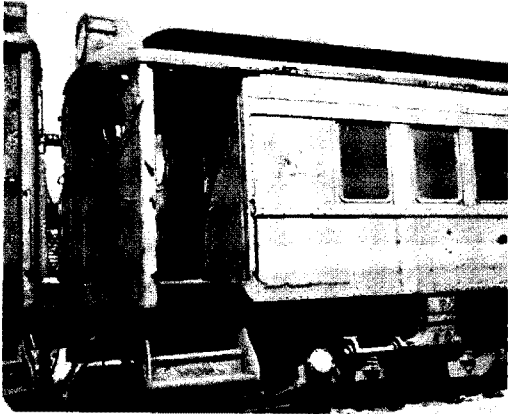
CAR WEIGHT AND FEATURES OF CARS

	Red Cars	New Silverliner IV's
Weight/Car	150,000 lbs.	127,500 lbs.
Seats/Car	72	127
Features	None	Air Conditioning Public Announcement System Radio

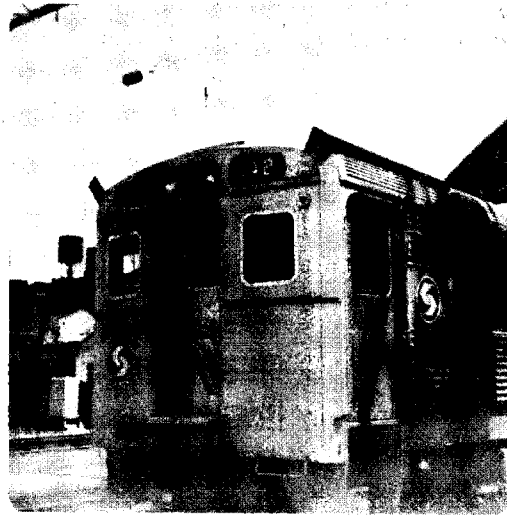
Source: SEPTA Rail Operations, Mechanical Department

Exhibit D-15 is included to provide a better understanding of the aesthetic differences between the old cars and those purchased under PA-10. The improved comfort and convenience of the new cars contributes to the attractiveness of the system, thus enhancing SEPTA's ability to attract new riders.

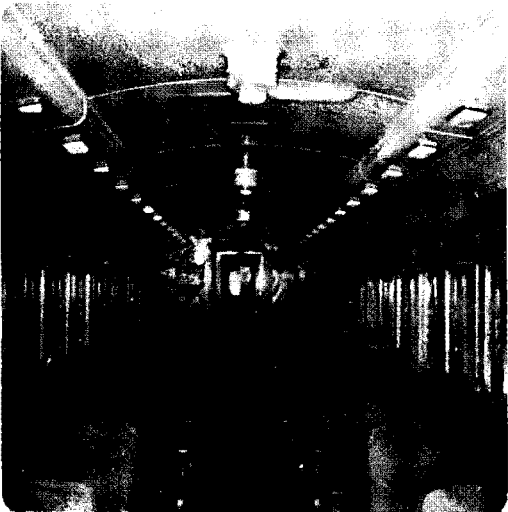
**EXHIBIT D-15  
PHOTOGRAPHS OF OLD AND NEW CARS**



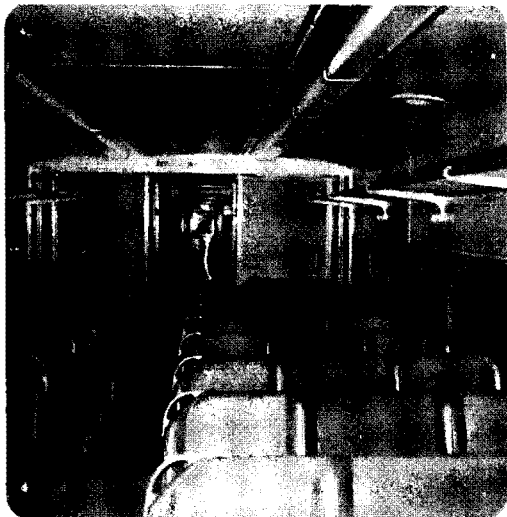
**EXTERIOR OF OLD RED CAR**



**EXTERIOR OF NEW SILVERLINER IV**



**INTERIOR OF OLD RED CAR  
(note the overhead fan and the lighting)**



**INTERIOR OF NEW SILVERLINER IV  
(equiped with air conditioning and  
florescent lighting)**



**MANUAL DOOR OF AN OLD RED CAR**



**AUTOMATIC DOORS OF THE NEW  
SILVERLINER IV**

## V. SUMMARY OF FINDINGS AND CONCLUSIONS

Based on the analysis of the data and information available to document the impacts of rail modernization projects in Philadelphia, the commuter rail car purchase under PA-10 has contributed to:

- patronage growth resulting from increased passenger comfort and convenience. At the same time, the positive impacts of residential and employment locational changes, and the negative impacts of fare increases have also significantly impacted commuter rail patronage (patronage increased 18.5 percent since 1974).
- increased car availability and reliability of service. The percent of equipment available for new Silverliners is 87.3 percent, as compared to 71.7 percent for older Silverliners. On-time performance has increased from 81.2 percent in 1973 to 95.5 percent in 1977.
- reduced maintenance cost. The maintenance costs for the new cars are approximately 50 to 60 percent of those for the old cars.
- reduced fleet size and associated operating costs. Fleet size has been reduced 33 percent. However, fleet seating capacity has increased nearly 21 percent from 1973 to 1977.
- reduced operating costs due to smaller train consists and lighter weight vehicles.



APPENDIX E

Station Modernization Projects  
Funded by the  
UMTA Section 3 Rail Modernization Program

STATION MODERNIZATION PROJECTS  
FUNDED BY THE  
UMTA SECTION 3 RAIL MODERNIZATION PROGRAM

I. INTRODUCTION

II. STATION DESCRIPTIONS

- . Philadelphia's 8th and Market Street Station
- . New York's 49th Street Station

III. PROJECT DESCRIPTIONS

- . Philadelphia's Station Modernization Projects (PA-23 and PA-33)
- . New York's Station Modernization Project (NY-07)

IV. STATION MODERNIZATION PROJECT IMPACTS

- . 8th and Market Street Station Modernization Impacts
- . 49th Street Station Modernization Impacts

## I. INTRODUCTION

UMTA has funded the modernization of many rapid rail stations through its Section 3 capital grant program. The purpose of this appendix is to examine the impacts which have resulted from these projects by providing examples of two stations that have been modernized under the program. The two stations are the Southeastern Pennsylvania Transportation Authority's (SEPTA) 8th and Market Street Station and the New York City Transit Authority's (NYCTA) 49th Street Station. These projects are presented as examples of stations which have been modernized under the Section 3 Rail Modernization Program. They are, however, not necessarily representative of all station modernization projects which have resulted from the program.

The remainder of this appendix is devoted to a description of these projects and the identification of the impacts which have resulted from the expenditure of federal funds for them.

## II. STATION DESCRIPTIONS

Two stations were selected for this case study in order to illustrate the diverse impacts which may occur following a station modernization effort, as well as identify the common impacts which are typical of these projects. Both stations are representative of downtown, heavily used stations in areas of urban revitalization. Other revitalization efforts in the area of these stations were naturally complementary to the overall impact of the modernization effort.

### PHILADELPHIA'S 8TH AND MARKET STREET STATION

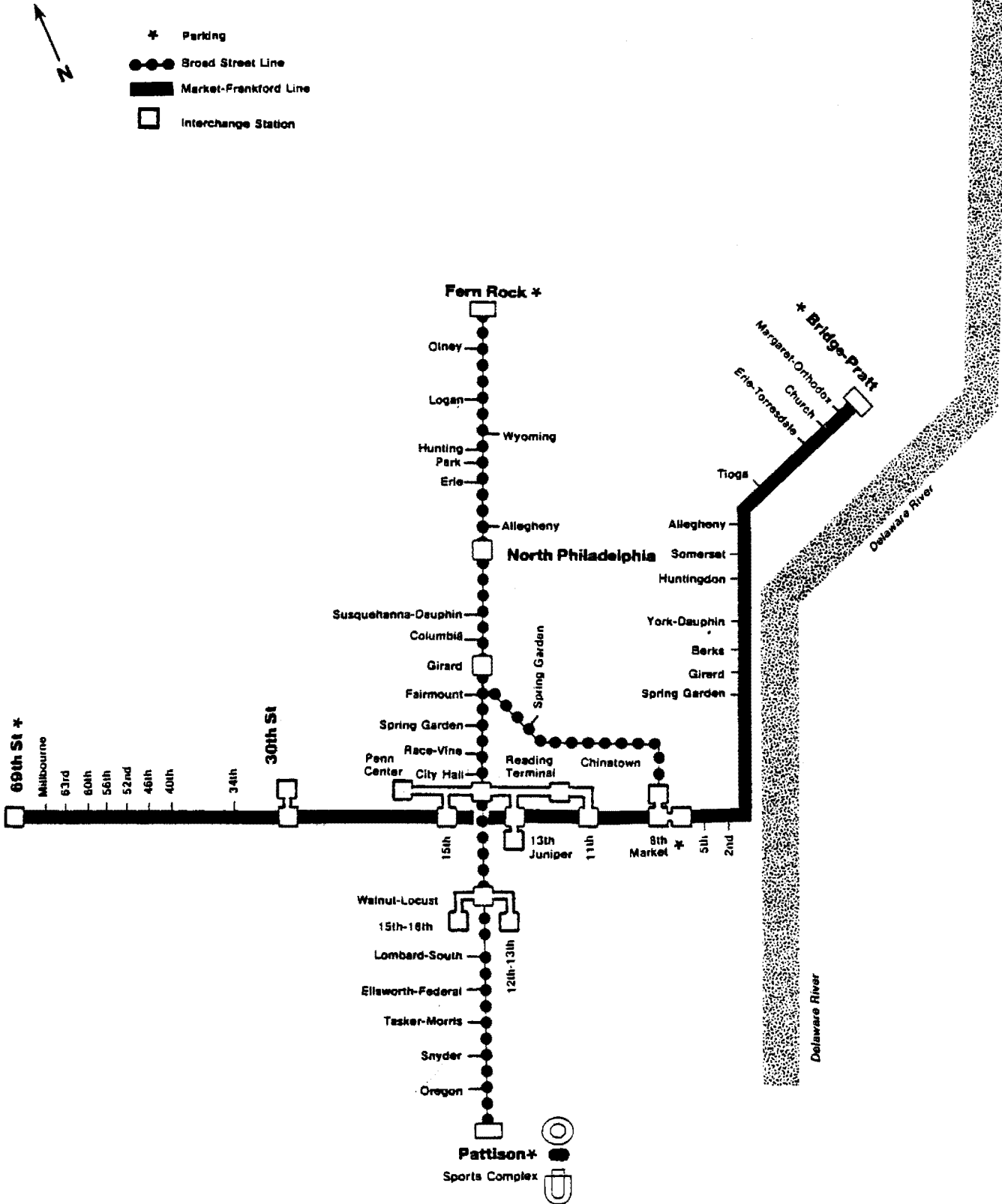
As shown in Exhibit E-1, the rapid rail system in Philadelphia consists of the two lines which intersect in the CBD. The Broad Street line runs across from the sports stadium in South Philadelphia through the CBD at City Hall to the Fern Rock Station in North Philadelphia. The Market-Frankford line (containing the 8th and Market Street Station) is essentially an east-west line that operates on an elevated railway at each end and on a subsurface line through the CBD.

The 8th Street Station is a double-track station below street level, which has been in service since 1907. Prior to PA-23, most improvements made to this station were limited to painting. According to SEPTA personnel, the age, design, and deteriorated condition of this station led to a number of problems including:

- . severe water leakages, which damaged wall and ceiling surfaces and permitted water puddles to develop on the station floor;
- . a poor line-of-sight in the station, including many dark corners that fostered crime and vandalism;
- . dirty and unattractive surroundings;
- . inaccessible areas for handicapped patrons; and
- . uncomfortable heat and humidity, since there was no provision for ventilation at the station except for air entering from the passenger stairway.

SEPTA's interest in the 8th Street Station increased with the proposed development of the Gallery at Market East, a contemporary shopping center which opened in August 1977. The Gallery development included 125 shops

# EXHIBIT E-1 SEPTA RAPID RAIL SYSTEM



SOURCE: Bicentennial Transportation Guide to Greater Philadelphia, SEPTA.

and restaurants, many public areas, and additional leasable space. The notion that the mall should be directly served by rapid rail transit was suggested by the developers when the mall was in the design stage. Since the 8th Street Station was adjacent to the site of the new mall, the developers encouraged the station expansion project in order to enhance the mall's functional appeal.

To include the station in the design of the new mall, the westbound platform of the station had to be lengthened by two car lengths to better serve anticipated patrons. The westbound platform opens directly into the lower level of the Gallery.

The 8th Street Station is in use 24 hours a day. On a typical weekday in the spring of 1978, 14,240 passengers used this station. This is roughly equal to the patronage at the station prior to the station modernization project and the opening of the Gallery at Market East. During the fall of 1977 when the Gallery first opened, the patronage at the station on an average weekday was approximately 14,900.<sup>1</sup>

#### NEW YORK'S 49TH STREET STATION

The NYCTA rapid transit system represents one of the largest systems in the world. This system is comprised of three divisions--Interborough Rapid Transit (IRT), Brooklyn-Manhattan Transit Corporation (BMT), and Independent System (IND). The 49th Street Station lies directly below the street level on the BMT line at 49th Street and 7th Avenue in downtown Manhattan.

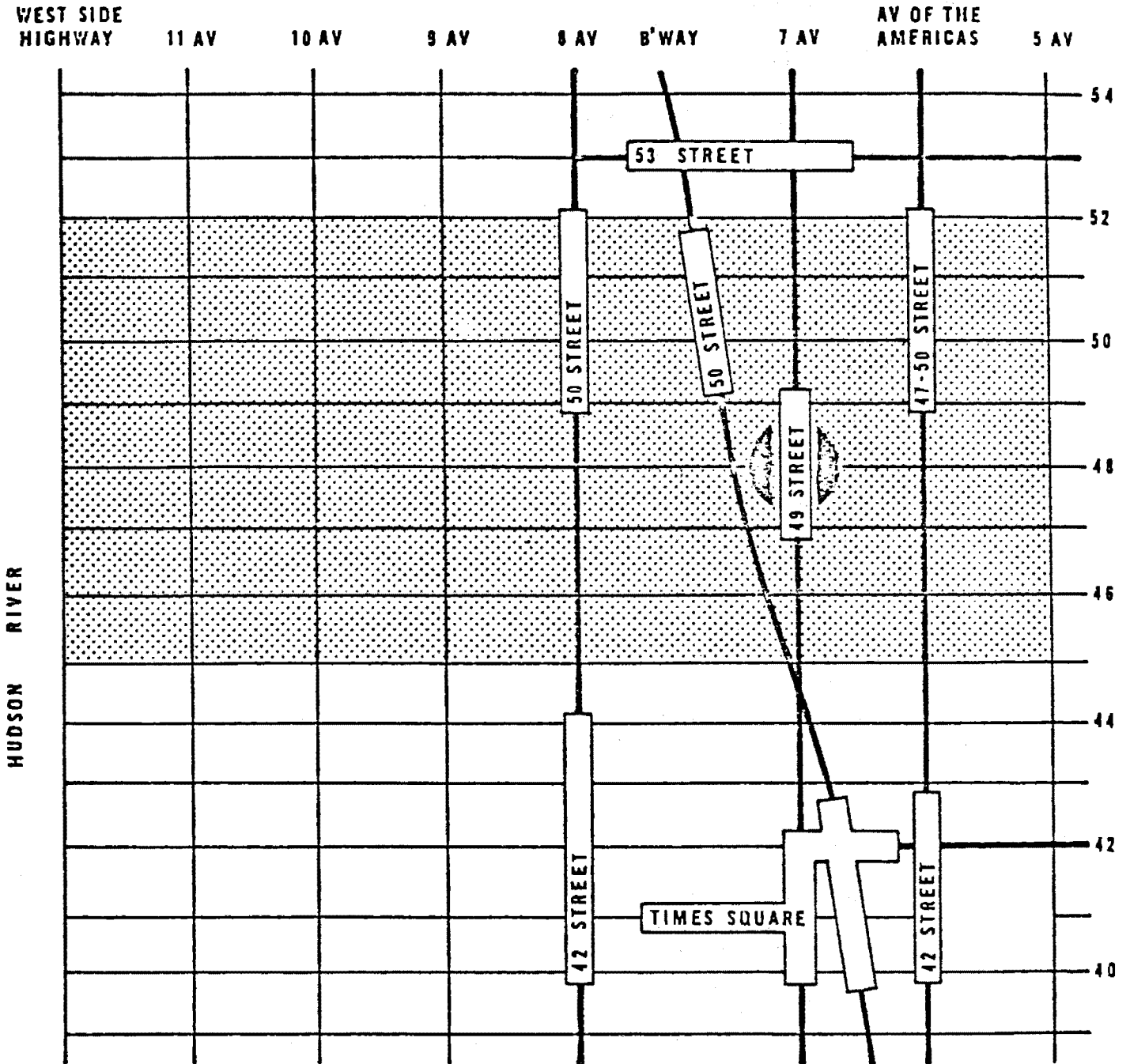
As shown in Exhibit E-2, the 49th Street Station is located in the heart of the New York City Transit System near the center of the Manhattan Theater District. This station serves as a gateway to Times Square; the area served by the station contains many major office buildings, hotels, theaters, restaurants, and stores.

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<sup>1</sup>The most substantial change that has occurred with respect to patronage at the 8th Street Station has been the distribution of passengers entering the station from the eastbound and westbound platform areas. The westbound platform now opens directly into the Gallery. Patronage from the westbound platform accounted for 41 percent of the total patronage in the spring of 1976 (prior to the opening of the Gallery). In the fall of 1977 and the spring of 1978, patronage from the westbound platform accounted for 62 and 61 percent of the total patronage, respectively.

EXHIBIT E-2

49TH STREET STATION - AREA OF INFLUENCE



Source: Acoustic Treatment 49th Street Station, New York City Transit Authority Engineering Department

The 49th Street Station is a four-track subway station constructed in 1919. Since this time, there have been no major station improvements. Prior to modernization, the station finish consisted of deteriorated glazed ceramic tile walls with concrete platforms and ceilings. Poor lighting and excessive noise levels resulting from trains passing through the station were among the most serious problems at the station. The noise levels prior to the station modernization project, as reported by NYCTA's Engineering Department, were typically 105 decibels (dBA) for express trains passing through the station and 100 dBA for local trains entering and leaving the station.

The 49th Street Station is in active use 24 hours a day, 7 days a week; it is a heavily traveled local station in the city. On a typical weekday over 14,000 patrons use this station.



### III. PROJECT DESCRIPTIONS

Both of the stations described in this case study were modernized after many years of neglect and deterioration. The focus of the modernization effort was slightly different for each station, however. In Philadelphia, the focus was on modernization to increase the aesthetic appeal and passenger safety and comfort and to improve the station design to accommodate anticipated increases in passenger volume following the development of the Gallery Mall. In New York, a principal focus was on the reduction of noise in the station and on design improvements to minimize crime and vandalism. In addition to these primary objectives, these station modernization projects addressed other secondary concerns described below.

#### PHILADELPHIA'S STATION MODERNIZATION PROJECTS (PA-23 AND PA-33)

In August 1971, UMTA awarded a capital grant to SEPTA (PA-23) to renovate the 8th Street Station. The cost of this project was approximately \$3.5 million, with the federal and local shares representing \$2.8 million and \$.7 million, respectively. Modernization of this station included:

- . waterproofing, ceiling, wall, and floor finishes, stairway and structural improvements, graphics, furnishings, and the installation of modern fare collection control devices and barriers;
- . electrical power and lighting improvements;
- . installation of new ventilation facilities;
- . plumbing improvements, including a high pressure wash down system; and
- . installation of a closed circuit television system.

This work, except for the installation of the closed circuit television system, was completed in July 1976. The closed circuit television system was completed in August 1977.

In August 1972, another grant (PA-33) was awarded to SEPTA for additional improvements to this station, primarily for the extension of the west-bound platform and selected acoustical improvements. The cost of this project was \$2.6 million, with the federal and local shares representing \$2.1 million and \$.5 million, respectively. This work was completed in August 1977.

## NEW YORK'S STATION MODERNIZATION PROJECT (NY-07)

In September 1968, UMTA awarded a capital grant to NYCTA for the modernization of the 49th Street Station (NY-07). The cost of the project was approximately \$2 million, with the Federal and local shares each representing \$1 million. Modernization of this station included:

- . a new architectural design, including a glazed brick finish for walls and a new terrazzo finish for floors of the platform and control areas;
- . improved graphics, making transit information and station signs more legible;
- . increased crime control through the installation of an intercommunication system between control areas and between change booths;
- . modified toilet facilities;
- . new concessions;
- . improved lighting, highlighted by various light intensities for stairs, the station platform, and the track area; and
- . acoustical treatment to lower the noise level in the station, including a sound absorptive ceiling, track barriers, and material beneath the platform edge.

Project work began in September 1973 and was completed in December 1976.

#### IV. STATION MODERNIZATION PROJECT IMPACTS

Station modernization improvements constitute one of the most visible products of the Rail Modernization Program. Together with new or rehabilitated rail cars, these improvements receive the greatest public exposure of the rail modernization investments. Their visual impact is illustrated in Exhibits E-3 through E-6, which show the results of the station modernization efforts in Philadelphia and New York.

Other impacts of station modernization efforts can be suggested; however, data documenting these impacts are sparse or nonexistent. For example, both the Philadelphia and New York station modernization projects would be expected to increase user comfort and convenience by the provision of more pleasant surroundings at the stations and improved graphics and signing. The extent of this increase in user comfort and convenience, however, has not been measured using either formal or informal survey techniques. Other impacts suggested by the nature of the improvements incorporated during the station modernization efforts are summarized below. Where data were available to document the extent of these impacts, these are also provided.

##### 8TH AND MARKET STREET STATION MODERNIZATION IMPACTS

As described in Section II, the focus of the station modernization project in Philadelphia was on increasing the aesthetic appeal of the station facility and on improving the station design to accommodate anticipated increases in passenger volume following the development of the Gallery Mall. Exhibits E-3 and E-4 illustrate the aesthetic impact of the investment on the 8th and Market Street Station. The impact of the station design modifications is illustrated by the distribution of passenger volumes by platform. Prior to the modernization project, the westbound platform accounted for 41 percent of the total patronage volume in this station. Following the modernization project and the opening of the Gallery Mall, over 60 percent of the passenger volume was accounted for on the westbound platform. The station modernization project facilitated the flow of this increase in passenger volume on the westbound platform, which now opens directly into the Gallery Mall. The increase in passenger volume on the westbound platform, however, is not a direct impact of the modernization effort. However, it is the result of the development of the Gallery Mall.

In addition to these primary impacts, other impacts resulting from this station modernization project include:

- increased accessibility for elderly and handicapped patrons due to the installation of a ramp to provide access to the westbound platform of the station;

**EXHIBIT E-3  
8TH STREET STATION PRIOR TO RENOVATION**



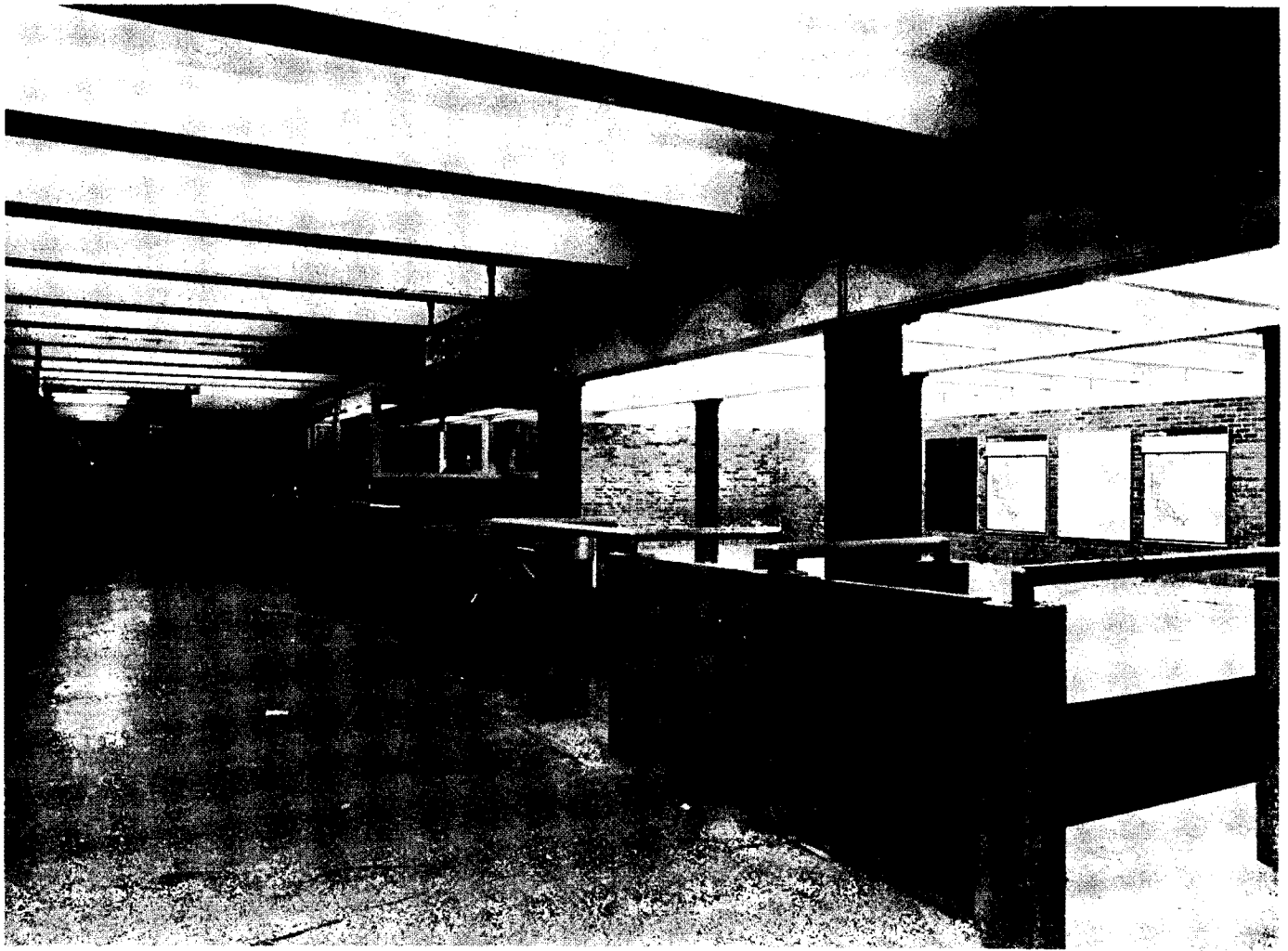
**EXHIBIT E-4**  
**8TH STREET STATION AFTER RENOVATION**



**EXHIBIT E-5  
49TH STREET STATION PRIOR TO RENOVATION**



**EXHIBIT E-6  
49TH STREET STATION AFTER RENOVATION**



- . increased safety due to the provision of an emergency lighting backup system which operates in the event of a power blackout; and
- . improvements to the maintainability of stations resulting from the installation of vandal-resistant materials.

#### 49TH STREET STATION MODERNIZATION IMPACTS

The principal focus of the rail modernization improvements to the 49th Street Station in New York was on reducing noise in the station and improving the station design to discourage crime and vandalism. Noise surveys conducted by NYCTA following the station modernization project indicated a 20 decibel reduction in noise levels for both express and local train traffic through the station. The sound absorptive materials installed to effect these reductions improved the acoustic environment of the station and thereby increased the comfort of users of the station.

As part of the station modernization effort, design changes included the location of the station booth on the platform so that the attendant has a full view of the platform. These changes also contributed to improvements in crime and vandalism control.

Finally, as with the Philadelphia modernization project, the installation of low maintenance materials in the 49th Street Station improved the maintainability of the NYCTA facility.



APPENDIX F

URBAN RAIL REHABILITATION AND MODERNIZATION  
FUNDING PROCESS CASE STUDIES

URBAN RAIL REHABILITATION  
AND MODERNIZATION CASE STUDIES

- I. INTRODUCTION
- II. OVERVIEW OF CASE STUDY FINDINGS AND CONCLUSIONS
- III. UMTA-FUNDED RAIL MODERNIZATION GRANT PROCESS: NEW YORK CITY TRANSIT AUTHORITY (NYCTA) CASE STUDY
- IV. NON-UMTA FUNDED RAIL MODERNIZATION IMPROVEMENT PROCESS: PORT AUTHORITY TRANS-HUDSON (PATH) CASE STUDY

## I. INTRODUCTION

The process undertaken by transit systems to finance rail rehabilitation and modernization varies by funding source(s), type of project, and the administrative structure of the individual transit agencies. These and other factors influence the activities of the rail modernization funding process.

### OBJECTIVES OF THIS REPORT

This report describes the findings of a study of the processes undergone by the New York City Transit Authority (NYCTA) and Port Authority Trans-Hudson Corporation (PATH) to finance rail transit rehabilitation and modernization. NYCTA illustrates the process undergone by a recipient of Section 3 grants from the Urban Mass Transportation Administration (UMTA).<sup>1</sup> PATH illustrates the process undergone by a transit authority whose rail modernization program is currently financed independent of UMTA capital grants.

The study included investigation of the activities, participants, and timing in NYCTA's and PATH's rail modernization programs from project identification through implementation. The principal objectives of this study were to:

- . illustrate the similarities and differences between the rail modernization funding process of NYCTA, an UMTA Section 3 recipient, and the Port Authority Trans-Hudson (PATH), a transit authority whose rail modernization program has been funded independent of UMTA Section 3 resources since 1968;
- . assess the overall structure and internal controls of the rail modernization funding processes of the two authorities;
- . examine the use of criteria by NYCTA and PATH for identifying rail modernization projects; and
- . investigate current project monitoring efforts carried out during and following the implementation of rail modernization projects by NYCTA and PATH.

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<sup>1</sup>The process for financing rail rehabilitation and modernization using Federal Aid to Urban Systems (FAUS) funds or sources other than UMTA Section 3 funds was not investigated, nor was the process for financing new route construction or surface transit improvements with UMTA Section 3 resources.

This study is not intended to comprehensively review the UMTA rail modernization grant process and recommend a proposed restructuring of UMTA activities. Opportunities to improve the UMTA grant process reported in this study reflect suggestions for improvement identified by people interviewed throughout the conduct of the study.

## STUDY APPROACH

The approach used in this assessment of the rail modernization funding process consisted of the detailed examination of two case studies. NYCTA was selected because it receives UMTA Section 3 funds and has developed a well-structured process for meeting federal requirements for grant preparation and project implementation, including a detailed process for project identification and ranking. PATH was selected because it is one of the only public transit authorities in the United States that currently finances its rail transit rehabilitation and modernization without federal assistance. The NYCTA and PATH case studies represent current rail modernization processes, illustrated by numerous grants and projects at various phases in the process. To facilitate comparison between the NYCTA and PATH rail modernization process, activities were addressed in both case studies, in terms of the same three phases, as described below:

- . The first phase, Pre-Application Phase, involves the identification of projects by operating divisions, budget approval activities, project application preparation (including preliminary design specifications), and initial cost estimates;
- . The second phase, Application Review and Approval Phase, consists of project evaluation by the authorities making the commitment of funds for project implementation; and
- . The final phase, Post-Application Approval, Project Implementation Phase includes:
  - . preparation of detailed project design specifications and contract documents;
  - . contractor selection and contract award; and
  - . project implementation.

## ORGANIZATION OF REPORT

This report is organized in the following three sections, plus the Introduction:

- . Section II - Overview of Case Study Findings and Conclusions;
- . Section III - UMTA-Funded Rail Modernization Grant Process:  
New York City Transit Authority (NYCTA) Case  
Study; and
- . Section IV - Non-UMTA-Funded Rail Modernization Grant Process:  
Port Authority Trans-Hudson Corporation (PATH) Case  
Study.

## II. OVERVIEW OF CASE STUDY FINDINGS AND CONCLUSIONS

### INTRODUCTION

This section provides:

- . an overview and comparison of the rail modernization processes for NYCTA and PATH; and
- . a summary of findings and conclusions regarding the rail modernization process for each of these two transit authorities, with a focus on UMTA Section 3 program implications.

An overview of the NYCTA and PATH grant processes is presented, together with a discussion of the similarities and differences between the two processes. The similarities between the processes of NYCTA and PATH are described in terms of the activities carried out by both transit authorities during the three phases of the process. The differences between the processes are identified in terms of the following factors which affect the rail modernization process:

- . institutional arrangements for system ownership and operation;
- . system size and the magnitude of the annual rail modernization program;
- . number of financing sources;
- . participants in rail modernization review and approval, based on system ownership, operation, and financing; and
- . UMTA requirements to qualify for financing of rail modernization projects with Section 3 funds.

As a point of reference, Exhibit F-1 provides a summary comparison of the characteristics of NYCTA and PATH which are particularly relevant to the rail modernization process evaluation.

The summary of findings and conclusions addresses the study objectives identified in the Introduction of this report and several opportunities to improve the current UMTA rail modernization funding process.

## EXHIBIT F-1

### COMPARISON OF NYCTA AND PATH CHARACTERISTICS RELEVANT TO THE RAIL MODERNIZATION PROGRAM EVALUATION

NYCTA		PATH
<b>INSTITUTIONAL ARRANGEMENTS</b>		
Owned by the city of New York & operated by NYCTA (part of MTA)		Owned and operated by the Port Authority of New York and New Jersey under a bi-state agreement
<b>SYSTEM SIZE</b>		
NYCTA operates: <ul style="list-style-type: none"><li>• 6200 rapid rail passenger cars</li><li>• Over 710 miles of mainline track</li><li>• 461 stations</li></ul>		PATH Operates: <ul style="list-style-type: none"><li>• 297 rapid rail passenger cars</li><li>• Over 13.9 miles of track</li><li>• 13 stations</li></ul>
<b>RAIL MODERNIZATION PROGRAM</b>		
Between 1965 and 1977 \$439 million were awarded to NYCTA through the Section 3 Grant program for rail modernization. These Grants contributed to a total NYCTA program effort amounting to about \$1.4 billion over the period 1972 to 1978.		Between 1962 and 1972 \$250 million was spent to renovate the Path System. Between 1972 and 1977 an additional \$12 million was spent or about \$2.4 million annually on PATH rail modernization.
<b>CAPITAL FINANCING SOURCES</b>		
Financed through: <ul style="list-style-type: none"><li>• Municipal bonds</li><li>• State general revenues – (and State Department of Transportation)</li><li>• State Transportation bond issue</li><li>• Federal FAUS money Federal Section 3</li></ul>		Financed through: <ul style="list-style-type: none"><li>• Net Revenues of other or Port Authority revenue Departments</li><li>• Bonds money</li></ul>
<b>RAIL MODERNIZATION PROCESS PARTICIPANTS</b>		
Project, financing requires approval of: <ul style="list-style-type: none"><li>• Rail Transit Executive Officer-NYCTA</li><li>• Senior Executive Officer - NYCTA</li><li>• MTA Board</li><li>• Mayor</li><li>• City Planning Commission</li><li>• City Comptroller</li><li>• City Board of Estimate</li><li>• City Council</li><li>• Local Boroughs</li><li>• State Division of Budget</li><li>• Governor</li><li>• Emergency Finance Control Board</li><li>• City OMB</li></ul>		Project, financing requires approval of: <ul style="list-style-type: none"><li>• PATH</li><li>• Port Authority Executive</li><li>• Port Authority Commissioner</li><li>• Governors of New York and New Jersey</li></ul>

## OVERVIEW AND COMPARISON OF THE RAIL MODERNIZATION PROCESS FOR NYCTA AND PATH

The rail modernization process of NYCTA and PATH are in many ways very similar. In both cases, the process includes similar overall activities which address similar issues and accomplish similar ends for both authorities. In general, however, the process for NYCTA, as compared to PATH, is more structured, more complex, and more time consuming. Exhibit F-2 summarizes the major similarities and differences between the NYCTA and PATH rail modernization processes during each phase of the process.

For purposes of analysis, the activities in the NYCTA and PATH processes have been identified in terms of three general phases:

- . Pre-Application Phase;
- . Application Review and Approval Phase; and
- . Post-Approval Project Implementation Phase.

The similarities and differences between the NYCTA and PATH processes in each of these phases are discussed below.

### Pre-Application Phase: Similarities Between NYCTA and PATH

The Pre-Application Phase of the rail modernization process for NYCTA and PATH is similar for both authorities in that:

- . projects are identified by the rail transit operating divisions;
- . operating divisions use similar criteria to justify and rank projects;
- . authoritywide annual capital budgets, based on identified improvements, are prepared and approved; and
- . applications for rail modernization projects are prepared.

For both NYCTA and PATH, the identification of rail modernization improvements is representative of a "bottom up" process (i.e., improvement needs are normally identified by the people who maintain and operate the transit system). These projects are subsequently reviewed by supervisory personnel, planning and engineering staff, and division chiefs.

NYCTA and PATH both use criteria to justify projects and to rank them in priority order for implementation. Both authorities are concerned most about



**EXHIBIT F-2**

**SIMILARITIES AND DIFFERENCES BETWEEN  
THE NYCTA AND PATH RAIL MODERNIZATION  
FUNDING PROCESSES**

<b>PHASE 1: PRE: APPLICATION PHASE</b>	
<p><b>Process Similarities</b></p> <ul style="list-style-type: none"> <li>• Operating divisions identify rail modernization improvement needs</li> <li>• Operating divisions use similar criteria to justify and rank rail modernization improvements</li> <li>• Authority-wide annual capital budgets are prepared and approved</li> </ul>	<p><b>Process Differences</b></p> <ul style="list-style-type: none"> <li>• NYCTA identifies significantly more rail modernization projects each year</li> <li>• There are more participants involved in the NYCTA process</li> <li>• The NYCTA application for rail modernization project financing is considerably more complex</li> </ul>
<b>PHASE 2: APPLICATION REVIEW AND APPROVAL PHASE</b>	
<ul style="list-style-type: none"> <li>• Application review and approval occurs throughout the year</li> <li>• Applications are submitted to approval authorities for evaluation of project merit and approval for the commitment of funds</li> <li>• Applications are rarely rejected</li> </ul>	<ul style="list-style-type: none"> <li>• NYCTA includes numerous projects in an application while PATH generally includes one</li> <li>• There are more participants involved in the NYCTA process</li> <li>• The NYCTA applications generally require more time for review and approval</li> </ul>
<b>PHASE 3: POST APPROVAL PROJECT IMPLEMENTATION PHASE</b>	
<ul style="list-style-type: none"> <li>• Final phase includes some three major activities</li> <li>• Detailed design specifications are prepared by inhouse engineering staff and signed by the chief engineer</li> <li>• Contractor selection requires open and free competition and contract award to the lowest responsive and responsible bidder</li> </ul>	<ul style="list-style-type: none"> <li>• There are more participants and approval requirements in the NYCTA process</li> <li>• Contract modifications are more complex for NYCTA than PATH</li> </ul>

system safety. Other criteria considered by NYCTA or PATH include reliability, opportunities to save energy, and/or opportunities to reduce costs. Rail modernization projects are justified by both authorities in terms of their potential to improve system performance with respect to these criteria. The case studies of NYCTA and PATH did not reveal, however, that rail modernization projects are justified in terms of the extent that such projects might improve system performance with respect to these or other criteria.

NYCTA and PATH projects must be included in and approved as part of an authoritywide annual and multiyear capital budget. However, in both authorities, approval of a rail modernization project as part of a capital budget does not imply a commitment of funds to implement a project.

Each year, NYCTA's Rapid Transit Department prepares a list of projects for a 3-year period and submits this to NYCTA's Chief Engineer. After review and modification, projects suggested for the first year become part of NYCTA's draft capital program. This program must be approved by the MTA Board and subsequently approved as part of New York City's annual capital budget. Certain rail modernization projects must also be approved as part of New York State's annual capital budget.

Similarly, PATH prepares an annual capital program and a 10-year capital forecast. The annual program and 10-year forecast are reviewed by the Comptroller of the Port Authority and incorporated into the Port Authority's annual capital program, which must be approved by the Port Authority Executive Director, the Authority's Board of Commissioners, and, finally, by the Governors of New York and New Jersey.

As stated above, no formal funding commitment is made to a rail modernization project when it is approved as part of an annual capital budget. For both NYCTA and PATH, approval as part of the capital budget only ensures that a project is eligible for a funding commitment. Both organizations require that preliminary design specifications, more detailed cost estimates, and a project justification be prepared as part of the application for a funding commitment.

#### Pre-Application Phase: Differences Between NYCTA and PATH

The most significant differences between NYCTA and PATH during this first phase of the rail modernization process are:

- . the number of projects identified;
- . the number of participants involved in each of the activities in the process; and

- . the complexity of the application that must be prepared to request a funding commitment to implement the project(s).

NYCTA identifies considerably more projects each year than PATH because the NYCTA rail transit system is considerably larger and somewhat older than PATH. NYCTA has 710 miles of mainline track, 6,200 passenger cars, and 461 stations as compared to PATH's 13.9 miles of track, 298 passenger cars, and 13 stations. Because its annual rail modernization program consists of many more projects, NYCTA has developed a more structured process than PATH to identify and evaluate each candidate project. In addition, because NYCTA identifies more projects each year, there are far more participants involved in the first phase of the rail modernization process for NYCTA than for PATH. To a large extent, however, the number of participants is also a result of (1) the institutional arrangements for system ownership and operation and (2) the obligation to be accountable to all external sources of financing.

The NYCTA rail transit system is owned by New York City and operated by NYCTA. Because it receives capital funds from the City, the State, and the Federal Government, representatives from each of these organizations are involved in preparing and approving budget requests and project applications. In addition, New York City Borough Board members are involved in the first phase of the NYCTA rail modernization grant process, as are members of the Tri-State Regional Planning Commission for New York, New Jersey, and Connecticut.

PATH, on the other hand, is owned and operated as a subsidiary corporation of the Port Authority of New York and New Jersey. Since 1968, PATH rail modernization has been financed through revenue bonds issued by the Port Authority. Consequently, only persons within PATH, the Port Authority, the Port Authority Board of Commissioners, and the Governors of New York and New Jersey are involved in the activities of the first phase of the rail modernization process.

The requirements to prepare an application for funds is one of the most significant differences between the activities of NYCTA and PATH during the first phase of the rail modernization process. NYCTA must prepare a far more complex grant application than PATH to meet the application requirements for UMTA Section 3 funds. Both NYCTA and PATH must include a project description, justification, and initial cost estimate in an application for a rail modernization project. In addition to this information, NYCTA applications must include information on:

- . planning activities;
- . anticipated environmental impacts;

- . 13(c) Labor and Title VI Certifications;
- . elderly and handicapped considerations;
- . long-term financing;
- . the public transportation system and the public transportation program;
- . labor and relocation;
- . civil rights assurances;
- . eligibility for application;
- . school bus assurances;
- . affirmative action program;
- . project implementation schedule; and
- . public hearings.

Grant applications to UMTA for Section 3 funds must address these statutory and administrative requirements.

Application Review and Approval Phase: Similarities Between NYCTA and PATH

The second phase in the rail modernization process for NYCTA and PATH is (Grant/Project) Application Review and Approval. The similarities between NYCTA and PATH during this phase of the process are that:

- . application review and approval occur throughout the year;
- . applications are submitted to approval authorities for evaluation of project merit and approval for the commitment of funds; and
- . applications are rarely rejected.

Generally, approval authorities are familiar with proposed projects since the projects were included in preceding multiyear capital improvement programs and were approved in the annual capital program. In addition, there is considerable appreciation by the respective approval authorities for the ability of NYCTA and PATH operating divisions to identify modernization needs to be financed with limited available resources. Rail modernization application

authorities may, however, request additional information to describe or justify a project.

Application Review and Approval: Differences  
Between NYCTA and PATH

The major differences between NYCTA and PATH with respect to rail modernization application review and approval are:

- . the number of projects in an application;
- . the number of participants involved in reviewing an application; and
- . the time required to review and approve an application.

As discussed above, NYCTA proposes far more rail modernization projects each year than PATH. As a consequence of the number of projects proposed, NYCTA generally consolidates numerous rail modernization projects and submits these projects in a single grant request to UMTA.<sup>1</sup>

Because NYCTA receives funds from City, State, and federal sources to finance projects, it must be accountable to more organizations than PATH, which currently finances rail modernization with revenue bonds issued by the Port Authority. Consequently, NYCTA rail modernization applications must be reviewed and approved by more people than PATH applications.

Before the delegation of grant approval responsibility to regional offices, an individual within the UMTA central office, either a transit representative or a division chief within the Office of Grant Assistance, took responsibility to oversee and coordinate NYCTA Section 3 grant review and approval activities. Grant application review also required the participation of the:

- . UMTA Office of Civil Rights;
- . UMTA Office of the Chief Counsel;
- . the Department of Labor; and
- . UMTA environmental analysts, if a project was anticipated to have environmental impacts.

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<sup>1</sup>After approval by NYCTA, City, Regional, and State authorities.

The delegation of Section 3 grant review and approval authority is not expected to significantly change Section 3 grant review activities or the number of participants involved in UMTA grant approval at this time. A primary effect of the delegation of UMTA Section 3 grant review and approval authority to UMTA regional offices is that grant review will largely be conducted in the regional offices, rather than in Washington, D.C.

PATH rail modernization applications, as compared to NYCTA applications, most frequently include only one project and, in most cases, must be approved by the:

- . Vice President and General Manager of PATH;
- . President of PATH;
- . PATH Board of Directors; and
- . the Governors of New York and New Jersey.

The PATH project approval process for small rail modernization projects is less complex, requiring fewer approvals than those listed above.

The impact of these differences in NYCTA's and PATH's rail modernization activities during the application review and approval phase is reflected in the time required to approve grant or project applications. Although the approval time varies with project complexity for both NYCTA and PATH rail modernization applications, because of the number of projects reviewed and number of participants involved, NYCTA applications generally require more time for approval than PATH applications.

#### Post-Approval, Project Implementation: Similarities Between NYCTA and PATH

The final phase of the rail modernization funding process for NYCTA and PATH consists of the same major activities:

- . preparation and approval of detailed design specifications and contract documents;
- . selection of a contractor and contract award; and
- . project implementation.

Each of these three activities is carried out in a similar manner and accomplishes similar results for both authorities.

Both NYCTA and PATH prepare detailed design specifications for modernization projects after the project is approved and a commitment for funding is made. Both transit authorities have in-house engineering staff who normally prepare these specifications. Detailed designs receive in-house review and must be signed by the Chief Engineer of NYCTA or PATH.

Contractor selection and award for rail modernization projects are very similar for NYCTA and PATH. Both have widespread advertising and open and free competition on contracts. Sealed bids are received and opened on a specified date. NYCTA and PATH award contracts for rail modernization projects to the lowest bidder unless it is proven that the contractor with the lowest bid is not fully responsive or is not qualified to complete the contract.<sup>1</sup>

### Post-Approval, Project Implementation Differences Between NYCTA and PATH

The activities of NYCTA and PATH in this last phase of the process are largely the same. There are two major differences, however, between the NYCTA and PATH during this phase:

- . there are more participants and approval requirements in the NYCTA process; and
- . contract modifications are more complex for NYCTA than for PATH.

There are more participants involved in the NYCTA process, partly because NYCTA projects are financed with New York City and New York State funds. Before a NYCTA contract can be awarded, approval and assurance of funding availability must be received from:<sup>2</sup>

- . the mayor of New York City through the issuance of a Certificate of Budget Expenditure (CBX) for use of funds from the City budget;
- . the State Division of Budget, through the issuance of a Certificate of Availability of Funds (COAOF) for use of state transportation bond funds; and

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<sup>1</sup>Both NYCTA and PATH indicated that it is unusual for a contract to be awarded to a contractor other than the lowest bidder. If a contractor is selected other than the lowest bidder, or if a contract is sole-source, both NYCTA and PATH must receive special approval from UMTA or the Port Authority Board of Commissioners.

<sup>2</sup>These aspects of NYCTA project implementation are explained in more detail in Section III of this report.

- . the Emergency Finance Control Board (EFCB) for all contracts over \$1 million.

The PATH process, on the other hand, is far less complicated, since assurance of capital funding availability does not involve participants outside of the Port Authority.

Contract modifications for NYCTA and PATH projects occur when a project encounters changes in condition, schedule, scope, or cost.<sup>1</sup> Because NYCTA capital projects are financed with city, state, and federal funds, contract modifications can involve numerous participants from each level of government who must approve or be informed about recommended changes. Competitively bid NYCTA contracts that require a budget increase of more than \$1 million require UMTA approval.<sup>2</sup> Contract budget increases of more than 5 percent require city approval.

For PATH, all contract modifications that involve a budget adjustment of up to 10 percent of the total contract amount can be approved by the Director of PATH. Budget increases of more than 10 percent require the approval of the Port Authority Board of Commissioners.

#### SUMMARY OF NYCTA AND PATH CASE STUDY FINDINGS AND CONCLUSIONS

As stated in an earlier section of this chapter, the objectives of this report are to:

- . illustrate the similarities and differences between the rail modernization funding process of NYCTA, an UMTA Section 3 recipient, and the Port Authority Trans-Hudson (PATH), a transit authority whose rail modernization program has been funded independent of UMTA Section 3 resources since 1968;

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<sup>1</sup>Contract modifications can also occur when there is a change in contract purpose. This requires a technical amendment which involves complex activities including the possibility of an amendment to the TIP, 13C and Title VI Certification, an impact assessment, and a public hearing. Because of their complexity, considerable effort is made to avoid such modifications.

<sup>2</sup>Prior to the September 11, 1978, memorandum from UMTA which simplified the UMTA requirements for pre-bid and pre-award review for third-party contracts, budget increases of more than \$100,000 on competitively bid contracts required UMTA approval.



- . assess the overall structure and internal controls of the rail modernization funding processes of the two authorities;
- . examine the use of criteria by NYCTA and PATH for identifying rail modernization projects and ranking them in priority order for implementation; and
- . investigate current project monitoring efforts carried out during the rail modernization funding process of NYCTA and PATH.

The previous section of this chapter discussed the similarities and differences between the rail modernization funding process of NYCTA and PATH. The next part of this chapter will address case study findings and conclusions with respect to the other three study objectives. The last section of this chapter presents several opportunities to improve the rail modernization process identified during the conduct of the case study.

### RAIL MODERNIZATION PROCESS STRUCTURE AND INTERNAL CONTROLS

This study of the NYCTA and PATH rail modernization processes revealed that both transit authorities have a well-structured process for the identification, approval, and implementation of rail modernization projects. Responsibility for conducting activities throughout the rail modernization process is assigned to divisions within NYCTA and PATH. The assignment of responsibilities appears to be well understood by individuals who participate in the various stages of the process.

Both NYCTA and PATH have internal controls for their rail modernization processes through the reviews and evaluations conducted by different authority staff in each phase of the process. Activities do not go unchecked, since the approval of a different division, entity, or supervisory person is required for each element in the process. The internal controls within both authorities is clearly illustrated in Chapters III and IV of this report.

UMTA is only minimally involved in the identification of rail modernization projects, since it is the responsibility of Section 3 fund recipients to identify and justify project needs. Comparison of the project implementation activities of NYCTA with those of PATH reveals few differences.

### USE OF CRITERIA BY NYCTA AND PATH TO IDENTIFY AND EVALUATE RAIL MODERNIZATION PROJECTS

This study included an investigation of the use of criteria by NYCTA and PATH to identify, justify, and rank projects for implementation. Currently,

NYCTA primarily uses the following three criteria, in order of decreasing importance: (1) safety, (2) reliability, and (3) energy savings. PATH uses four other criteria. In order of decreasing importance, they are: (1) structural integrity and personal safety, (2) operational improvements, (3) financial benefits, and (4) aesthetics.

Both NYCTA and PATH use criteria descriptively or qualitatively with respect to rail modernization improvements. Criteria are not explicitly used to:

- . measure and report on the base operating or performance conditions prior to implementation of a rail modernization improvement;
- . measure and identify the amount of improvement in operating or performance conditions anticipated to result from implementing specific improvements; or
- . evaluate projects after they are implemented to determine whether projects are achieving the desired results.

For example, a transit authority could identify the need for a rail modernization improvement because of deficient service reliability. Reliability could be measured and reported in terms of criteria such as schedule adherence. Alternatives to remedy the deficiency in schedule adherence could be identified. These alternatives might include various levels of track repair, signal improvement, or the purchasing of new vehicles. The alternatives could then be evaluated in terms of their cost and the amount of improvement in vehicle speed between stations each is expected to produce. Use of criteria in this manner will assist in cost-effectiveness decision making. After the selected alternative is implemented, the project could be evaluated to assess whether the expected level of speed increases were attained and to see that project cost estimates were not exceeded.

Use of criteria in the manner described above might be desirable, although there would be limitations to their use. Many situations would be too complex to use a simple application of criteria.

Possible opportunities to quantitatively use criteria in the rail modernization process should be identified both by transit authorities and UMTA. Use of quantitative evaluation criteria offers an important opportunity to assess the appropriateness of projects before they are implemented, as well as the effectiveness of projects after implementation.

## CURRENT RAIL MODERNIZATION PROJECT MONITORING EFFORTS OF NYCTA, PATH, AND UMTA

Project monitoring is most extensively carried out by NYCTA and PATH as part of project implementation. Projects are monitored by operating divisions, assisted by engineering departments to ensure that projects are completed on time, within budget, and according to project specifications. To date, UMTA's role in monitoring NYCTA projects has been limited. UMTA generally does not become involved unless problems arise which require a contract modification as a result of budget increases.

NYCTA's project monitoring activities are more complex and structured than those of PATH because NYCTA has more and larger projects to monitor. In general, however, monitoring is performed by both authorities to track the planned versus actual progress toward project implementation and to anticipate potential problems in order to preclude serious delays or cost overruns.

Most project monitoring efforts cease after project implementation is complete. Monitoring continues in a more limited manner during the first year or two after implementation, while the facilities and equipment are still under warranty. During this time, the contractor is responsible for maintenance and replacement, as required by the warranty.

Neither NYCTA or PATH indicated that project monitoring is carried out after modernization projects are complete to assess whether the project is fulfilling its intended objectives. Efforts are not made to return to the project application in order to review the stated justification for the project and assess project performance. The NYCTA operating divisions implied that there are not sufficient staff to conduct project monitoring despite the desirability of such activities.

Rather than monitoring project performance, both NYCTA and PATH focus their efforts on identifying performance deficiencies as they arise. Identification of deficiencies in system performance becomes the basis for identifying improvement needs. This process is described in detail in the NYCTA case study. The merits of the ongoing monitoring of projects, particularly in light of their intended objectives, deserves further consideration by NYCTA, PATH and UMTA.

## OPPORTUNITIES FOR IMPROVEMENT IN THE UMTA RAIL MODERNIZATION GRANT PROCESS

In this study, several important opportunities were identified to improve the effectiveness of the UMTA rail modernization grant process and UMTA's

role in the administration of Section 3 funds. These findings, and the opportunities for improvement, address the need to:

- . reduce UMTA rail modernization application requirements; and
- . monitor and evaluate the current decentralization of UMTA and expansion of regional offices.

Each of these opportunities is described in more detail below.

### Reduce UMTA Rail Modernization Application Requirements

The investigation of grant application preparation and review revealed that there are certain Section 3 grant application requirements that could be submitted on a one-time, annual, or as needed basis. Currently, all grant elements specified by statutory and administrative requirements must be included in each grant application. Much of the documentation is unchanged for different grant requests and may remain unchanged permanently or for several years. Modifying current grant application requirements could reduce the time required for grantees to prepare grant applications and for UMTA's review of applications.

The grant application elements that are most crucial are those that pertain to a particular grant request. These include:

- . project description;
- . project justification;
- . net project cost and grant funds;
- . labor findings;
- . environmental statement; and
- . public hearings.

The application elements should continue to be submitted with each request for funds.

Other application elements do not pertain to particular requests and might be submitted less frequently, possibly on an annual or as needed basis. These include elements such as:

- . applicant eligibility;

- . civil rights assurance;
- . public transportation description;
- . planning information;
- . maps on nondiscrimination;
- . flood hazard statement;
- . consideration of aged and handicapped; and
- . the affirmative action program description.

Currently, there is discussion within UMTA about the possibility of making revisions in Section 3 grant application requirements similar to those discussed above.<sup>1</sup>

Monitor and Evaluate the Current Decentralization of UMTA and Expansion of Regional Offices

UMTA is currently decentralizing many administrative responsibilities, including most activities associated with grant processing. In addition to the decentralization of responsibilities and staff from the Central Office, UMTA is expanding the number of personnel involved in grant processing.

The decentralization of responsibilities and the expansion of staff provide important opportunities to improve the efficiency of UMTA in both the processing of grant applications and the development of policies and guidelines. Specifically, the following benefits have been anticipated from this program:

- . decentralization of UMTA staff in the field is believed to present an opportunity to more effectively serve the needs of UMTA clientele by allowing UMTA to become far familiar with the projects and programs of the transit authorities.
- . expansion of UMTA staff members who process grants should assist in meeting the increasing workload that has developed over the past 10 years.

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<sup>1</sup>Revisions of this type to reduce annual submission requirements have been instituted for Section 5 grant applications to UMTA.

- . relieving the UMTA Central Office of many administrative responsibilities should present the opportunity for greater concentration on policy development, guideline preparation, and the monitoring and evaluation of ongoing programs.

Although these are anticipated benefits, UMTA has not established a mechanism to evaluate the effect of the decentralization program or staff increases. These programs should be monitored closely to assess whether they are achieving the expected results. Monitoring should be performed to assess whether:

- . grant applications are processed more quickly;
- . communication between applicants and UMTA representatives improves;
- . applicant needs are met more quickly; and
- . the UMTA Central Office becomes more effective in policy development (i.e., whether more and better policy guidelines are developed and program evaluations are conducted and acted upon).

The monitoring of the decentralization activities will also afford the opportunity to make needed modifications during the early post-implementation period. This will allow ongoing adjustments and improvements to be made during the UMTA decentralization efforts.

At present, certain opportunities for improvement related to the decentralization program have been suggested. The UMTA New York Regional Office identified a need for increased policy guidance from the UMTA Central Office to assist in implementing UMTA regulations and keep them apprised of new policy statements. This policy guidance might be extended to include staff training programs for new UMTA employees hired in regional offices as part of the UMTA decentralization activities.

Secondly, it was suggested that improved communications within the regional offices and between UMTA and each regional office will be critical to the success of the decentralization program. Actions should be taken to develop standardized procedures for keeping divisions within regional offices informed about grant processing and for informing the UMTA Central Office about overall grant processing activities. Special attention should be given to address such basic concerns as the routing of mail pertaining to grant applications within each regional office as well as major concerns such as policy guidance on grant processing and the impact of new federal regulations on grant review and approval. Implementation of the above suggestions could significantly effect the efficiency of grant processing by regional offices and the effectiveness of communication between UMTA offices.

### III. UMTA-FUNDED RAIL MODERNIZATION GRANT PROCESS: NEW YORK CITY TRANSIT AUTHORITY (NYCTA) CASE STUDY

This section describes the findings of a study of the process undergone by the New York City Transit Authority (NYCTA) to finance rail rehabilitation with Section 3 grants received from UMTA. This study included investigation of the activities and participants in NYCTA's rail modernization grant program from project identification through project implementation.

NYCTA's rail modernization program can be viewed as occurring in three phases:

- The first phase, Pre-Grant Application Phase, begins with the identification, by NYCTA, of necessary capital improvements and ends with the submittal of a capital grant application to UMTA, signed by the Mayor of New York City and the Chairman of the Metropolitan Transportation Authority (MTA).
- The second phase, Grant Application Review and Approval Phase, is carried out by the Federal Government to ensure that the grant conforms with all federal requirements for grant approval.
- The third phase, Post-Grant Approval, Project Implementation Phase, presently involves three major activities: (1) preparation of detailed engineering design specifications and contract documents, (2) selection of a contractor through competitive bidding and contract award, and (3) project implementation.

This section provides a detailed description of each of the three phases in the NYCTA rail modernization grant process. The description of these phases is preceded below by a brief history and background and review of the NYCTA organization.

#### HISTORY AND BACKGROUND

The rapid rail system in New York City is the largest and oldest rail transit system in the United States. The system includes over 710 miles of mainline track, 456 stations, and 6,674 rapid rail passenger cars. The rail transit system is owned by New York City and operated by NYCTA, which is part of the MTA, a state agency.

Until 1975, rail modernization and rehabilitation was financed predominantly through municipal bonds. Federal funds available for transit

capital improvements between 1964 and 1975 were used in New York City largely for construction projects of new subway lines. Since 1975, UMTA Section 3 funds and Federal Aid Urban Systems funds have been used to finance the cost of rail modernization projects for NYCTA.

Through May 1977, UMTA Section 3 rail modernization projects for NYCTA's rail transit system have totaled \$439 million.<sup>1</sup> This investment has been devoted to the following modernization efforts:

- . rolling stock modernization - 64.9 percent;
- . way and structure modernization - 28.5 percent;
- . station and terminal modernization - 2.3 percent; and
- . other modernization - 4.3 percent.

### NYCTA ORGANIZATION

In order to review the NYCTA rail modernization grant process, it is important to understand NYCTA's organization. As shown in Exhibit F-3, NYCTA is headed by the Chairman of the Board for both the Metropolitan Transportation Authority (MTA) and NYCTA. The Senior Executive Officer of NYCTA is responsible to the Board for all NYCTA activities.

NYCTA consists of the eight areas shown in Exhibit F-3, each headed by an executive officer or director. Capital requests for rail modernization projects are largely made by the Executive Officer for Rapid Transit, who is responsible for the operation of the rail transit system.

The Rapid Transit Department is made up of the following five operating departments:

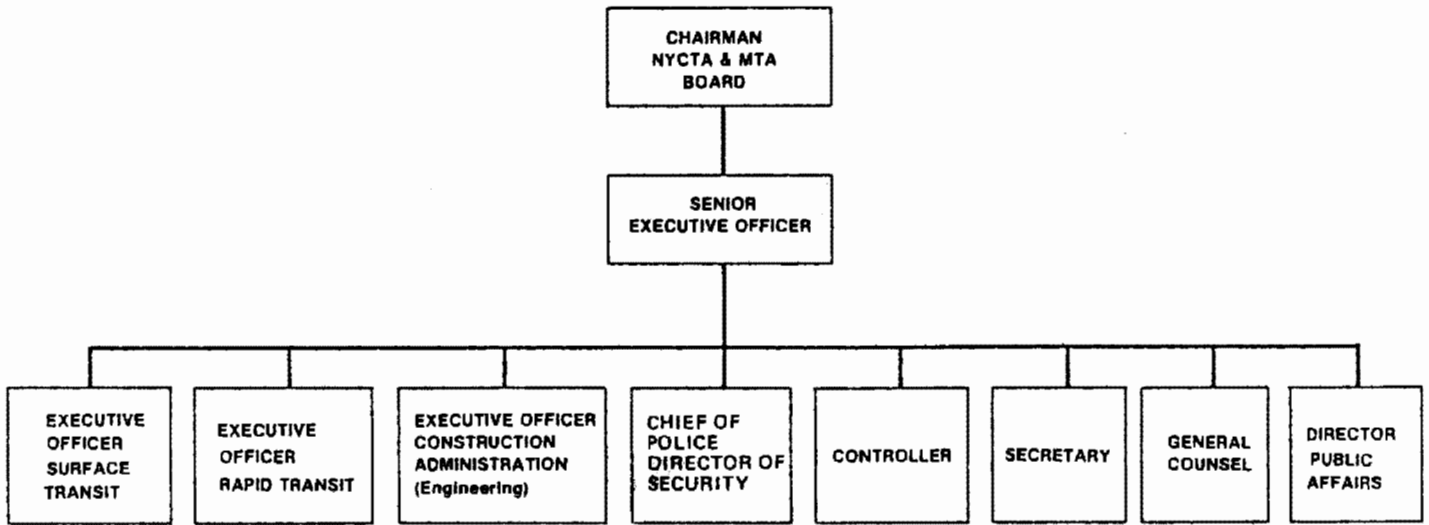
- . Car Maintenance;
- . Maintenance of Way;
- . Power;

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<sup>1</sup>UMTA Rail Modernization Program, The Distribution of Capital Grant Funds for Rail Rehabilitation and Modernization 1965-1977, July 1978, pp. II-18 - II-29.



**EXHIBIT F-3  
NEW YORK CITY TRANSIT AUTHORITY  
ORGANIZATION CHART**



SOURCE: Adapted from an organization chart provided by the NYCTA

- . Rapid Transit Transportation; and
- . Stations.

The operating departments within Rapid Transit are each the responsibility of a department head.

The operating departments consist of subdivisions, each headed by a subdivision superintendent. Maintenance of Way, for example, includes the following subdivisions:

- . track maintenance and replacement;
- . structures;
- . line equipment; and
- . signals.

These subdivisions are further divided into geographical zones headed by zone supervisors.

Preparation of a grant application for rail modernization projects is largely the responsibility of the NYCTA Engineering Department. A more detailed organization chart of this department is provided in Exhibit F-4. The executive officer for this department is also the Chief Engineer of NYCTA.

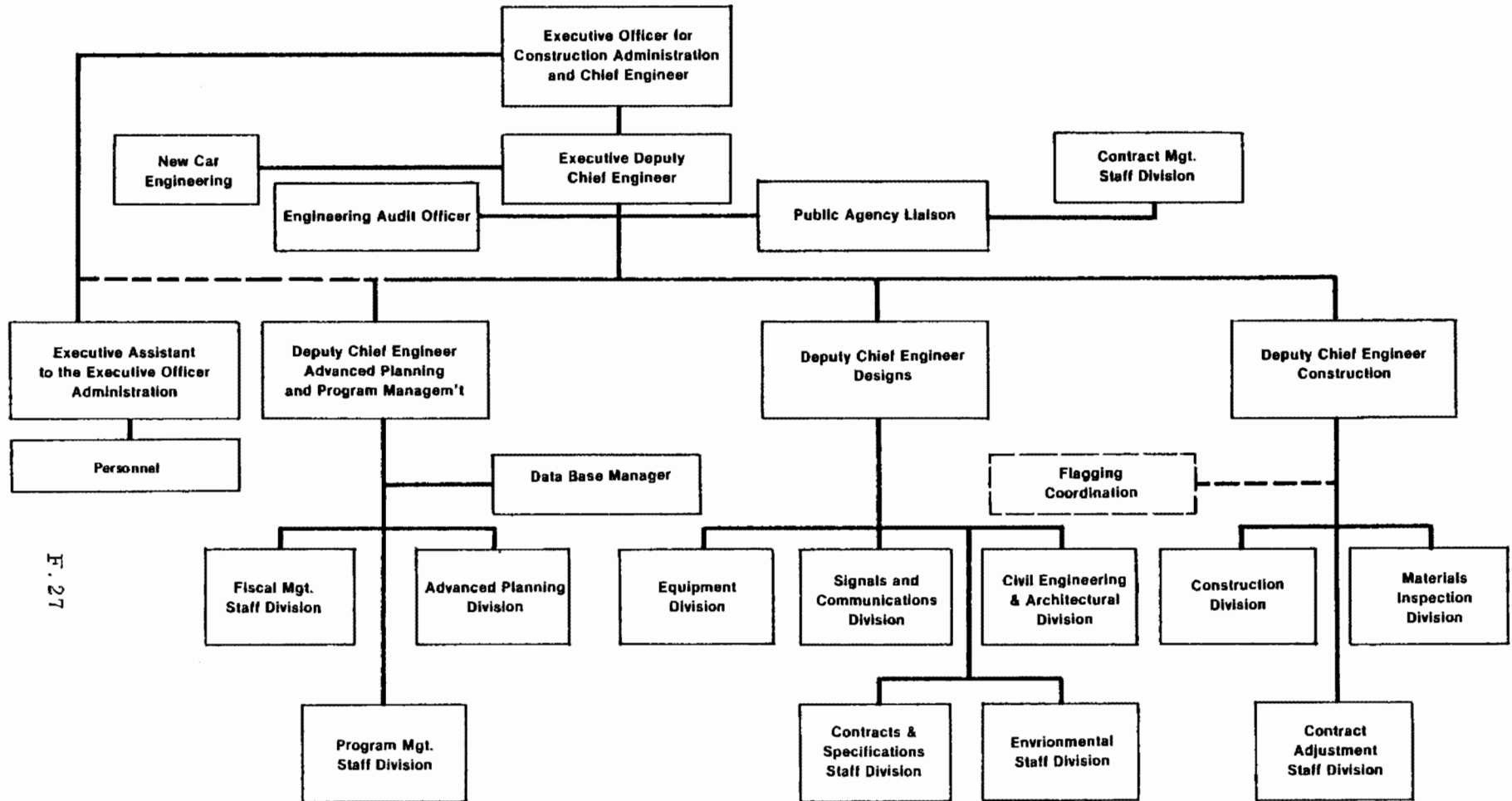
Since this report documents the Section 3 grant process for NYCTA rail modernization projects, the discussion below focuses on the activities in the NYCTA Rapid Transit and Engineering Departments, the major participants in the process. Other areas in NYCTA will be mentioned only as appropriate to fully describe the rail modernization grant process.

#### OVERVIEW OF NYCTA'S RAIL MODERNIZATION GRANT APPLICATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS

Exhibit F-5 provides a summary of the NYCTA process for financing the rehabilitation and modernization of its rail rapid transit system with UMTA Section 3 grant funds. The major participants in the process are NYCTA, MTA, the City of New York, the State of New York, the Tri-State Regional Planning Commission, and UMTA. As shown in the exhibit, the complete NYCTA grant application, review, approval, and implementation process for rail modernization extends over a period of more than 3 years. The exhibit displays the general timing of activities, which can vary from year to year.

EXHIBIT F-4

NYCTA ENGINEERING DEPARTMENT ORGANIZATION CHART

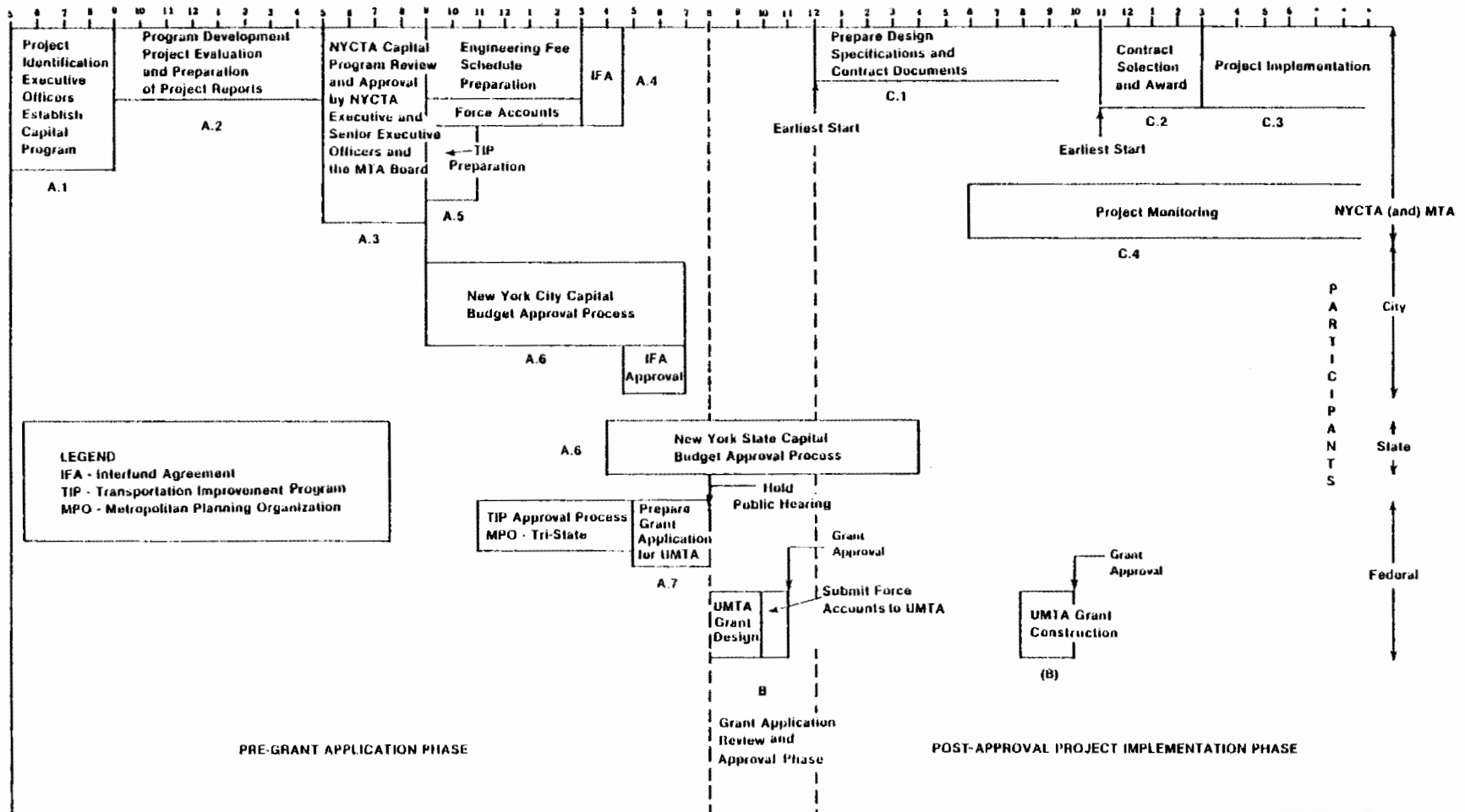


F. 27

SOURCE: Adapted from an organization chart provided by NYCTA.

EXHIBIT F.5

OVERVIEW OF NYCTA'S RAIL MODERNIZATION GRANT APPLICATION,  
REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS<sup>1</sup>



F. 28

<sup>1</sup>This process applies to rail modernization projects that (1) do not require property acquisition, (2) do not require an Environmental Impact Statement, and (3) are designed by the NYCTA Engineering Department. This includes the majority of projects funded by Section 3 grants.

Many of the activities in the process occur simultaneously in preparation for future grant applications. By virtue of the size of the NYCTA rail modernization program, NYCTA's grant process is relatively structured, orderly, and routine. At the same time, it is complex and time-consuming.

The details of the grant process are described below for each of the three phases in the process:

- . A - Pre-Grant Application Phase;
- . B - Grant Application Review and Approval Phase; and
- . C - Post-Grant Approval, Project Implementation Phase.

#### A - PRE-GRANT APPLICATION PHASE

The pre-grant application phase of NYCTA's rail modernization grant process includes the following activities:

- . A.1 - rapid transit project identification and first-draft capital program preparation;
- . A.2 - rapid transit project evaluation and preparation of project reports;
- . A.3 - NYCTA capital program, review, and approval;
- . A.4 - development of Force Accounts and Interfund Agreements (IFA) for reimbursement of engineering costs on approved projects;
- . A.5 - preparation and submittal of the Transportation Improvement Program (TIP);
- . A.6 - approval of NYCTA's capital budget through the City and state budget processes; and
- . A.7 - preparation and submission of the Section 3 grant application.

Some of these activities occur simultaneously although, as displayed in Exhibit F-5, they represent a general sequence of events. Each of the activities in the pre-grant application phase are discussed in more detailed below. Each activity is discussed in a subsection of this chapter identified with a letter and number as enumerated above and on Exhibit F-5.

## A.1 - Rapid Transit Project Identification and First Draft Capital Program Preparation

This first activity in the NYCTA rail modernization grant process involves the identification of rail modernization projects by the Rapid Transit Department. The identification of these capital projects is the basis of the first-draft capital program for the NYCTA Rapid Transit Department.

Each year, NYCTA executive officers must each prepare a draft capital program as part of the NYCTA budget process.<sup>1</sup> The amount of time required to prepare the first draft of the Rapid Transit capital program varies somewhat each year, although the activities generally require from 1 to 3 months.

Exhibit F-6 summarizes the process for project identification and the preparation of the first draft for the NYCTA Rapid Transit Department. This process begins when the Executive Officer of the Rapid Transit Department requests that each of the operating departments submit capital budget project requests and ends when the Executive Officer submits the first draft of the Rapid Transit Department capital budget to the NYCTA Engineering Department for review.

Each year, generally in mid-winter, each of the Rapid Transit operating departments are asked to develop and submit capital budget project requests for a 1-year and multiyear period beginning 2 years in the future. For example, the 1-year or "annual" program would be prepared for 1980-81, while the multiyear program would be prepared for 1981-82, 1982-83, 1983-84. The 1-year program provides a list of projects, ranked in priority order, accompanied by preliminary:

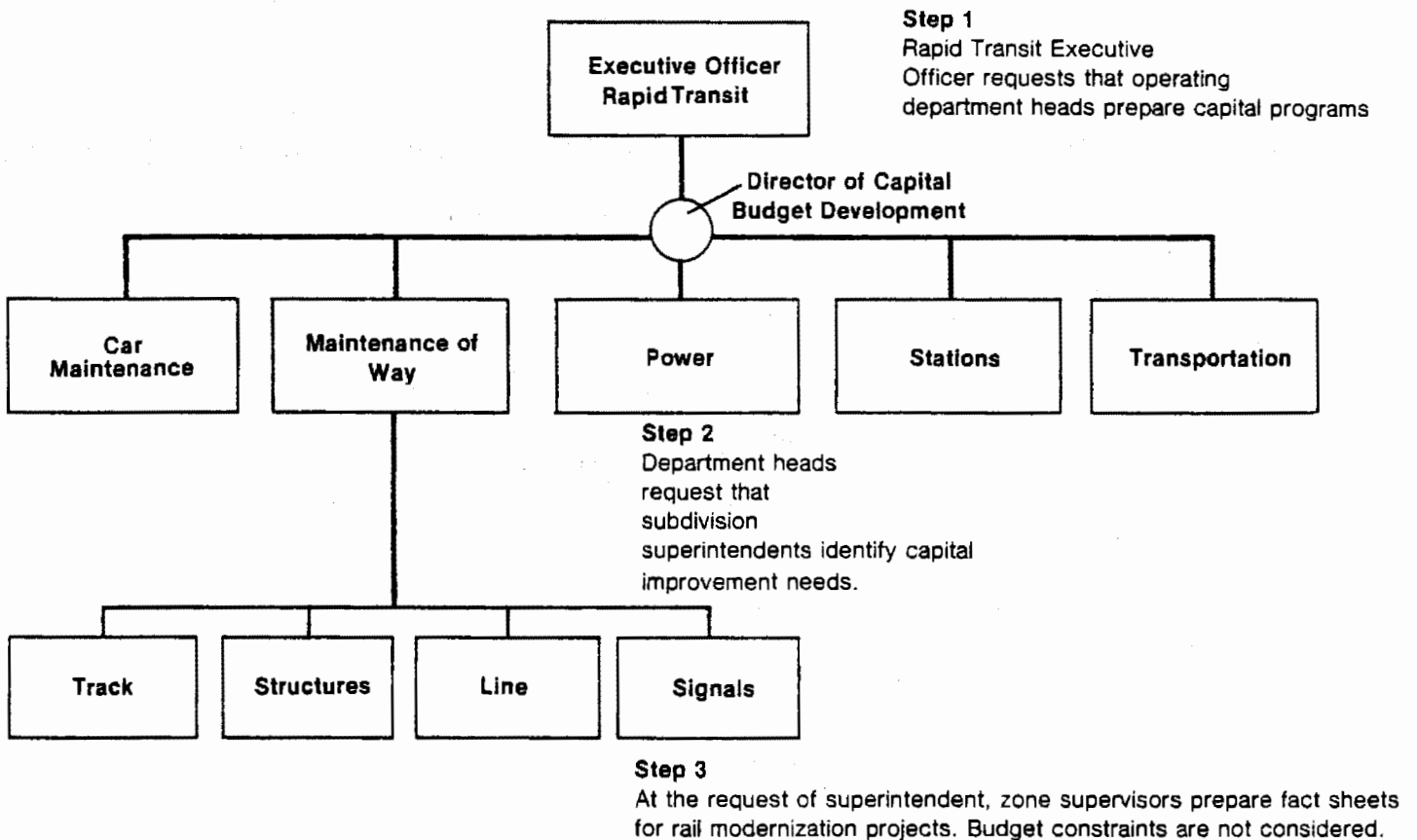
- . project descriptions;
- . order of magnitude costs for each project; and
- . project justifications.

The multiyear capital program provides a separate list of projects for 3 years, ranked in priority order.

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<sup>1</sup>Appendix A of this report includes a listing of NYCTA's ongoing capital program by requesting department. Rail modernization projects are predominantly requested from car maintenance, maintenance-of-way, power, stations, and transportation. Subsections A.3 and A.6 discuss the subsequent budget process activities of NYCTA, New York City, and New York State which affect the Section 3 rail modernization grant process.

**EXHIBIT F-6  
PROJECT IDENTIFICATION  
FIRST DRAFT CAPITAL PROGRAM PREPARATION**



**Step 4**

Subdivision superintendents rank projects in priority order and submit completed fact sheets to their respective department heads.

**Step 5**

Each department head prepares a department-wide list of projects, ranks projects in priority order, reviews the projects with the Director of Capital Budget Development, and subsequently makes needed modifications.

**Step 6**

The Director of Capital Budget Development prepares a first draft Capital Budget program for Rapid Transit which includes a list of projects ranked in priority order. The capital program reflects anticipated financing based on expected federal funds. However, more projects are identified than can be funded to allow flexibility.

**Step 7**

The Executive Office of Rapid Transit reviews the list of projects, makes desired modifications and submits the First Draft of the Capital Budget for Rapid Transit to the Chief Engineer who is the Executive Officer for Construction and Administration.

Preparation of the first-draft capital program for the NYCTA Rapid Transit Department is developed by the director of Capital Development, who works directly under the Executive Officer of Rapid Transit. To initiate the process, the Director distributed two types of fact sheets to each department head: one for equipment and one for facilities. Exhibit F-7 displays the questions on the reverse side of an equipment request fact sheet. The questions on a facilities request sheet are very similar. These questions are to be answered when preparing fact sheets to request rail modernization projects. Completed fact sheets serve as the basis for the description, justification, and cost estimate of rail modernization project sheets.

Department heads in Rapid Transit direct the superintendents of their subdivisions to identify capital improvements needs. Superintendents, in turn, generally request that zone supervisors prepare the initial fact sheets. Zone supervisors do not consider financial constraints when identifying rail modernization improvement needs.

Zone supervisors submit a completed fact sheet for each requested project to their subdivision superintendents. The superintendents then rank the projects for their subdivision in priority order. Three primary criteria are used to rank projects in order of importance: (1) safety, (2) reliability, and (3) energy savings. The nature and extent of a problem requiring a capital improvement and the extent of improvements anticipated by a recommended project with respect to each of these criteria is generally descriptively and not quantitatively stated.

Critical factors considered when ranking projects include:

- . current and potential hazardous conditions;
- . recent amount of equipment down-time;
- . potential life-cycle cost savings; and
- . recent and anticipated maintenance costs.

Once the projects have been ranked in priority order, the fact sheets for each subdivision are submitted by subdivision superintendents to the appropriate department head. Each department head then:

- . prepares a capital program for his entire department, integrating each subdivision request into an overall departmental request and ranking projects in priority order;
- . reviews the fact sheets with the Director of Capital Budget Development; and



## EXHIBIT F-7

### EQUIPMENT REQUEST FACT SHEET

MUST ANSWER THE FOLLOWING QUESTIONS:

#### Description of Line Item

- Basic function of equipment:   What is it?  
  What does it do?  
  What must it do?  
  What does it serve?  
  What must it serve?
  
- Does it serve any secondary functions?
- Note performance features it must attain.
- Note capacity of pumps, fans, cranes, etc.
- Note height of rise of escalators, elevators.
- Note automatic or manual operation, continuous or part-time use.
- Volume of passengers served?

#### Justification (Basis of Requirement)

- Does equipment make significant effectiveness change to system Yes/No?   How \_\_\_\_\_?
- Equipment needed to satisfy safety/reliability/Energy Saving requirements?   How? \_\_\_\_\_?
- Is equipment obligated by union-management or political commitments?
- Does this equipment improve on existing operations and maintenance?   Reduce maintenance time, equipment, personnel?  
  Correct unsafe or unreliable conditions?
- Does equipment need all of its features?   Why?
- Does it do more than is required?
- Are there any unnecessary features?
- Can this equipment design be used on all divisions?
- Does this equipment interface with other equipment, structures, systems or divisions?   Where?   How?
- Do similar installations exist elsewhere?   Where?
- Is any other department, railroad, agency buying this equipment at a lower cost?
- State the operating and maintenance benefits that will be received.
- State when last maintenance was performed.   Mean time between failures \_\_\_\_\_ . (MTBF)
- Lead time to procure?   Compatible with existing inventory?
- Equipment's impact on operations?
- Adverse consequence if not approved?
- Maximum time project may be deferred before serious consequences can occur?
- Are adequate services available to support new equipment, services or system?
- Can this equipment be procured in phases?   \_\_\_\_\_   How many? \_\_\_\_\_.

#### Cost/Economics:

- Cost of equipment?
- Does equipment effect substantial life cycle cost\* savings?   How much?
- What are the operating or maintenance economies achieved?
- How does this project reduce maintenance costs?   By how much?
- Show Initial Replacement cost vs. recurring operation and maintenance costs. (Consider Inflation)
- Amount of Additional operating and maintenance costs to present recurring costs?
- Are there less expensive ways to do job?   How?

\* Life Cycle Cost = Initial Installation Cost + Yearly Operating and Maintenance Costs

SOURCE: NYCTA Rapid Transit Department.

- . modifies department project priorities and provides supplemental information to the fact sheets as needed.

To a limited extent, department heads consider budget constraints when preparing the initial capital budget request for their departments. Based on the anticipated level of federal funds and the historical use of funds within Rapid Transit, department budget ceilings are estimated. However, more projects are included in initial requests than can be financed by anticipated funds. Each department intentionally includes additional projects to allow flexibility, since some projects may eventually be deleted after subsequent evaluation and unanticipated funds may become available.

Having completed their review, department heads submit completed fact sheets and lists of projects, ranked in priority order, to the Director of Capital Budget Development. The Director reviews and evaluates each request and combines departmental lists into one list of projects, ranked in priority order, which focus on the 1-year capital budget for the Rapid Transit Department. As before, more projects are included on the list than are expected to be financed. The Director then submits the completed list of projects for Rapid Transit to the Executive Officer of Rapid Transit for review and approval. Modifications can be made by the Executive Officer, including:

- . changes in priority order;
- . addition of projects; and
- . deletion of projects.

After review and approval by the Rapid Transit Executive Officer, the list of projects, ranked in priority order, constitutes the first draft of the Rapid Transit capital program. This draft program is then submitted to the NYCTA Chief Engineer. The submission of the first-draft capital program to the Chief Engineer completes the first step of NYCTA's rail modernization capital grant process.

The following exhibit and appendices illustrate the results of the first step in this process:

- . Exhibit F-8 is a fact sheet from the Maintenance of Way Department for rehabilitation of pumping facilities. The sheet identifies the project priority and includes descriptive information.
- . Appendix B includes a memo from the Maintenance of Way Department transmitting the 3-year capital budget program for the period 1979-1980 through 1981-1982.

**EXHIBIT F-8**

**COMPLETED RAIL MODERNIZATION FACT SHEET  
WITH INITIAL PROJECT INFORMATION AND PRIORITIZATION**

NEW YORK CITY TRANSIT AUTHORITY CAPITAL BUDGET PROGRAM				Page . of
DATE PREPARED	BUDGET YEAR	REQUESTING DEPARTMENT	EXECUTIVE OFFICER	PRIORITY
2/3/78	1979-80	Maintenance of Way	S. K. Kauffman	E.O. 3
LINE ITEM TITLE			BUDGET ESTIMATE	PHASE OF
Rehabilitation of Overage Pumping Facilities			1.5 million	

DESCRIPTION OF LINE ITEM:  
 LOCATION: 8080 1,2) Manhattan 1) IND  
 3) Bklyn-Man DIVISION 2,3) IRT ROUTE DESIGNATION  
 PRESENT AGE 1)40;2,3)60 YES. LIFE CYCLE IN YRS. 50

It is proposed to rehabilitate the pumping facilities; including pumps and associated discharge lines, at the following locations. All pumps will be automatic and have monitoring devices indicating back to a 24 hour manned location. Electric pumps should be supplied by multiple feeds.

The locations and pumps required are:

- (a) 124th St-8th Ave: 3-500 GPM (AC); 1-460 GPM (DC)
- (b) 116th St-Lenox Ave: 2-2000 GPM (AC); 1-300 GPM (AIR)
- (c) Clark St. Tube-Furman: 1-600 GPM (AIR); 1-50 GPM (AIR)  
 Center: 2-600 GPM (AIR); 1-50 GPM (AIR)  
 Old Slip: 2-600 GPM (AIR); 2-50 GPM (AIR)

: 1.5 M  
 TOTAL ESTIMATED COST

**BASIS OF REQUIREMENT:**

ADDITION TO SYSTEM: YES/NO CORRECTS DEFICIENCIES: YES/NO  
 SAFETY Yes RELIABILITY Yes ENERGY SAVINGS            OTHER           

The above part of a continuing program to update TA pumping systems to provide a safe and reliable facility.

The pumps are necessary to alleviate the subway of seepage water and handle major inflow problems which can occur during storms or water main breaks, etc.

The existing pumps date back as far as 1917. They are obsolete and only limited parts are available. Reliability of these units is rapidly decreasing with time. The probability of pump failure during a heavy water inflow condition is high. Such an occurrence would result in stoppage of passenger train movement and necessitate bringing in pump cars to remove water. Flooding would cause damage to roadbed and signal equipment. It is vital to the operation of a safe, reliable system that reliable pumping equipment of adequate capacity be provided at these locations.

BUDGET YEARS PREVIOUSLY REQUESTED:           

PROJECT IS A CONTINUING PROGRAM: YES/NO

CONTRACT NO.	PROGRAM YEAR FUNDED:	FEDERAL FUNDS:	FEDERAL PROGRAM:
		DATE RECEIVED	UMTA/FAUS

SOURCE: NYCTA Rapid Transit Maintenance-of-way Department.

- . Appendix C includes the Executive Officer's list of projects, ranked in priority order, for the 1979-1980 Rapid Transit capital budget program. The list includes (1) budget estimates for each project, (2) cumulative cost estimates, and (3) the original project ranking.

The next activity in the pre-grant application phase of the NYCTA rail modernization grant process is carried out predominantly by the NYCTA Engineering Department.

#### A.2 - Rapid Transit Project Evaluation and Preparation of Project Reports

This activity in the NYCTA rail modernization grant process involves the evaluation of each project for which a fact sheet was prepared by the Rapid Transit Department and the subsequent preparation of project reports. The Advanced Planning Group of the NYCTA Engineering Department has the lead role in evaluating projects and preparing project reports.

Project evaluation and report preparation begins with a review of the fact sheets prepared by the NYCTA Rapid Transit Department. As described before, fact sheets provide preliminary project information which serves to:

- . identify current problems which give rise to the proposed project;
- . present the solutions recommended by operating departments; and
- . provide initial cost estimates for each proposed project.

Each fact sheet is initially reviewed by Advanced Planning. Site visits are often conducted to gather additional information. If a project is specialized, such as a signal or power project, an appropriate specialized technical group conducts further detailed evaluations. Projects are evaluated to:

- . consider alternative approaches to solve identified problems and search for approaches that are more cost-effective;
- . coordinate or group projects that are related and offer the opportunity to share expenses and reduce costs;
- . identify conflicting projects or instances where implementing one project reduces the urgency of another project;
- . review and validate project cost estimates made by the Rapid Transit operating department and prepare somewhat more detailed cost estimates; and

- . prepare an initial scope of work.

Because no formal funding commitments have been made to projects, detailed engineering designs are not prepared.

In most instances, few changes are made to the recommendations in the fact sheets as a result of the project evaluations. If modifications are suggested, however, the Executive Officer of Rapid Transit must review and approve all revisions to the fact sheets.

Once projects are evaluated, project reports are prepared. Project reports provide a description of each project identified by the Rapid Transit Department. The report includes:

- . a summary sheet which includes project identification, cost estimates, a brief project justification, recommended action, and administrative information; and
- . a report which provides information to supplement the summary sheet.

Exhibits F-9 and F-10 illustrate a project report for a project requested by the Car Maintenance Department to improve car door operation.

The recommended action stated in the project report generally determines whether a project will be included in a capital grant application. In most instances, recommended projects ultimately become part of a grant application. Projects not recommended for implementation are generally not included in a capital grant application.

Once completed, all project reports may be reviewed by:

- . the Rapid Transit operating department which requested the project;
- . the Capital Budget Liaison for Rapid Transit; and
- . the Executive Officer of Rapid Transit.

These reviews are conducted to keep Rapid Transit informed about each project and to provide an opportunity for questions and comments. All project reports must be finally approved by the Division Engineer of Advanced Planning. However, a project report is not considered complete until a letter of approval is written to the Chief Engineer by the Executive Officer of Rapid Transit.

EXHIBIT F-9

SUMMARY OF CAPITAL PROJECT REPORT

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PROGRAM/PROJECT NO.  
CM-02-0004

REQUESTING DEPARTMENT  
Car Maintenance

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TITLE:

Car Door Modernization Program  
(Phase III - On-Going Program)

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ESTIMATED COST: \$ 6,840,000

COST BASE:  
January 1979

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PROJECT JUSTIFICATION

A major cause of transit delays can be attributed to door operator malfunctions with existing equipment requiring excessive maintenance. This modernization program will incorporate new modular components made possible because of the new concept of over center locking and door panel sensing. This door modernization program will result in the following benefits:

1. Reliability will be improved and it is estimated that the number of door failures will be reduced by approximately 60%.
  2. A decrease in delays and trains being removed from service.
  3. Decreased maintenance cost with less maintenance cost required on new components.
- 

RECOMMENDATION

Install new door operator components and rehabilitate train line control switches on approximately 1370 R-17 through R-42 series cars.

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Drawing Reference: File #

Dwg. #

Report Prepared by: H. Klaus

Date: MAY 18 1978

Engineer In-Charge: J. Litt

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APPROVED:

C. E. TURIN

DIVISION ENGINEER, PLANNING

## EXHIBIT F-10

### PROJECT REPORT: ONE PAGE SUPPLEMENTARY INFORMATION SHEET

#### CAPITAL BUDGET PROJECT CM-02-0004 REPORT CAR DOOR MODERNIZATION PROGRAM (PHASE III OF AN ON-GOING PROGRAM)

Prepared by: Herbert Klaus  
Civil Engineer

A major cause of transit delays can be attributed to car door malfunctions. This malfunction not only causes delays in service with resulting passenger inconvenience but is directly related to higher car maintenance costs. The present door operator components on R-17 through R-42 cars are trouble prone and in addition to excessive maintenance the various lock components require frequent checking and adjustment to keep car doors functioning. Furthermore, door lock components which are located under the seat on the car floor create additional problems of dirt and debris getting into the lock mechanism, causing it to fail.

In addition to the operator lock mechanism, train line control units also are a cause of door system failures. The control switch which provides for car door operation according to train makeup is an area of heavy maintenance, for moisture which enters through cab windows results in the oxidation of switch contracts causing failure. A part of this modernization program consists of silver plating the contacts and weather sealing the switch housing.

Since there are many different series of rapid transit cars now operating on the system any program of modernization necessarily requires that the upgrading of equipment be universal i.e., that they can be applied to any car series with a minimum of alteration.

Under this program door operator problems will be corrected by relocating the new equipment away from dirt and which will reduce both maintenance and adjustment. This will be possible because of the new concept of overcenter locking and door panel sensing other than the present arrangement of the lock bar and solenoid.

The new door operator kits will consist of modular components and the specifications will require that the units can be applied to any car door operator in a car with a minimum of wire connections.

Based on field testing this door modernization program will reduce the number of delays caused by door operator failures by approximately 60%. This will directly result in increased service reliability, increase passenger safety, and a decrease in present maintenance costs.

This is the third phase of a continuing program and under this phase approximately 1370 cars will receive door modernization and train line control switch rehabilitation. The estimated cost of this Phase III Program is \$6,840,000.

The Advanced Planning Division is responsible for preparing approximately 100 project reports annually. Since more than one grant application is submitted annually, preparation of project reports occurs throughout the year. Project reports are generally prepared about 1 to 1-1/2 years before a grant application is submitted to UMTA for review and approval.

### A.3 - NYCTA Capital Program Review and Approval

The review and approval of the complete NYCTA capital program is an important activity both in the NYCTA budget process and in the first phase of the NYCTA rail modernization grant process. All projects in the NYCTA capital program must be reviewed and approved by the NYCTA Executive and Senior Executive Officers and the MTA Board. In addition, the NYCTA capital program must later be approved as part of the New York City and state budget processes before projects can be implemented. Budget approval activities by the City and state are described in a later subsection in this first phase of NYCTA rail modernization grant process.

The capital program for the NYCTA Rapid Transit Department is a major element in the total NYCTA capital program. Rail modernization projects approved as part of the NYCTA capital program generally become the basis for Section 3 rail modernization grant requests. The capital programs prepared by the executive officers of Surface Transit, Security (Police), the Controller, and the Chief Engineer are the remaining elements of the NYCTA capital program.

The review and approval of the total NYCTA capital program includes:

- . preparation of a second-draft capital program for each department by the NYCTA Engineering Department;
- . review and approval of the second-draft capital program for the Engineering Department;
- . integration of all NYCTA department capital programs into one authoritywide program by the NYCTA Senior Executive Officer;
- . review of the authoritywide capital program by the NYCTA Senior Executive Officer and the Chief Engineer; and
- . submission of the complete NYCTA capital program to the MTA Board for approval.

The MTA Board may approve, reject, or modify the NYCTA capital program. Generally, however, the program is approved with few modifications.



The complete NYCTA capital program presented to the MTA Board generally reflects consideration of anticipated funding. As compared to the draft capital programs prepared for each department, the complete capital program is less overprogrammed, but it still allows some flexibility for additional funds and the deletion of projects.

NYCTA capital program review and approval by NYCTA and MTA officials occur over an approximately 4-month period about 1 year prior to the submission of a Section 3 rail modernization grant application to UMTA for review and approval.

After the total NYCTA capital program is approved by NYCTA and the MTA Board, the next activities in the pre-grant application phase of the NYCTA rail modernization grant process begins. These activities include:

- . development of Force Accounts and Interfund Agreements (IFA) for reimbursement of engineering costs on approved projects;
- . preparation and submission of the Transportation Improvement Program (TIP); and
- . approval of NYCTA's capital budget through city and state budget processes.

These activities proceed concurrently.

#### A.4 - Development of Force Accounts and an Interfund Agreement (IFA) for Reimbursement of Engineering Costs on Approved Projects

This step in the NYCTA grant process includes the estimation of the engineering and administrative costs for each rail transit capital project for which city and federal assistance will be requested. UMTA reimburses up to 80 percent of these expenses for approved capital projects, provided that NYCTA identifies the reimbursable expenses. New York City finances the remaining 20 percent.

NYCTA identifies the federal share of the reimbursable engineering and administrative costs in documents called Force Accounts, which are submitted to UMTA. The cost estimates in a Force Account identify the number of hours required by wage level and position for each individual project. Reimbursement and administrative costs for engineering on Section 3 capital projects are available to all UMTA funding recipients.

NYCTA identifies the total reimbursable engineering and administrative costs in an Interfund Agreement (IFA). The IFA presents an aggregate estimate of the total engineering and administrative expenses for all capital projects included in an annual capital program. IFAs which are unique to New York City are approved as part of the City's budget process.

NYCTA identifies the reimbursable engineering and administrative costs on approved capital projects as follows:

- . the NYCTA Engineering Design Divisions identify the number of engineers and the administrative costs required, by wage level and position, for each capital project;
- . cost estimates prepared by the Engineering Design Division are submitted to the NYCTA Program Management Division for review to ensure that the wage rates and positions are comparable to those within the competitive market;
- . after review by Program Management, the engineering and administrative cost estimates are submitted to the NYCTA Fiscal Management Division, which completes the estimates by:
  - . including overhead costs such as fringe benefits; and
  - . preparing the formal reimbursable cost estimates for submission to UMTA as Force Accounts and submission to New York City for the IFA.

Estimation of engineering and administrative costs and preparation of Force Accounts and the IFA occur over a 5- to 7-month period about 6 months prior to grant application submission to UMTA.

#### A.5 - Preparation and Submission of the Transportation Improvement Program (TIP) for Approval

This step in the NYCTA rail modernization grant process involves the preparation of a Transportation Improvement Program (TIP) and its submission to FHWA and UMTA by the Tri-State Regional Planning Commission. Preparation and submission of a TIP is required by the 1975 joint UMTA/FHWA Planning Regulations. Each year, a TIP must be prepared and submitted by a Metropolitan Planning Organization (MPO). The TIP identifies a multiyear program of all transportation projects for which federal funds will be requested in a metropolitan area. The Tri-State Regional Planning Commission is the designated MPO for the New York, New Jersey, and Connecticut metropolitan area.

EXHIBIT F- 11

OVERVIEW OF NEW YORK CITY CAPITAL BUDGET  
APPROVAL PROCESS

October

The NYCTA capital budget approved by NYCTA and the MTA Board is submitted to the mayor, OMB and Community and Borough Boards for comment and recommendations.

MTA responds to comments and recommendations.

March

The City Council and Board of Estimate make recommendations to the Mayor on the NYCTA capital budget.

Mayor issues the Executive Capital Budget for New York City.

April

City Planning Commission and Comptroller issue reports on the city capital budget proposed by the Mayor.

Public hearings are held on the Mayor's capital budget for the city.

May

The city capital budget is adopted by the Board of Estimate and City Council.

June

Deadline for vetoes of items in the city capital budget.

July 1

The city capital budget becomes effect.

Approved city capital budget is distributed with  
Approved rail projects are eligible for assistance from  
New York City.

The NYCTA Program Management Division prepares NYCTA's part of the Tri-State Regional TIP. The NYCTA program is reviewed and approved by the following organizations prior to being submitted to UMTA as part of the Tri-State Regional TIP:

- . the subregional Technical Staff Committee;
- . NYC Transportation Coordinating Committee;
- . Tri-State Standing Committee on Transportation; and
- . the Full Tri-State Commission.

After adoption by the Tri-State Regional Planning Commission, the region-wide TIP is submitted to FHWA and UMTA for concurrence. Generally, the TIP is somewhat overbudgeted to ensure that sufficient projects are planned to make full use of any unanticipated monies that may become available. Once the TIP is approved by UMTA, the capital projects identified in the first year of the multiyear program become eligible for funding by UMTA.

TIP preparation by the NYCTA Program Management Division occurs over a 1- to 2-month period immediately following the approval of the NYCTA Capital Program by MTA. TIP approval by UMTA and FHWA then occurs over the next 6-7 month period immediately preceding the preparation of the UMTA Section 3 grant application.

#### A.6 - Approval of the NYCTA Capital Budget Through the City and State Budget Process

The NYCTA capital budget must be approved as part of the New York City and New York State budgets since these entities contribute the local match for federal funds received to finance rail projects. The activities in city and state budget processes which directly relate to the NYCTA rail modernization grant process are briefly discussed below.

##### New York City Capital Budget Process

The complete NYCTA capital budget must be approved as part of the New York City capital budget.<sup>1</sup> Exhibit F-11 provides an overview of the NYCTA capital budget.

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<sup>1</sup>Expenditures for rail modernization capital projects financed with Section 3 UMTA funds is one element of the NYCTA capital budget.

In early fall, after NYCTA and the MTA Board have approved the NYCTA capital budget, the NYCTA budget is submitted to the Mayor, the City Office of Management and Budget (OMB), and Community and Borough Boards for review and comment. In early spring, the Board of Estimate<sup>2</sup> and the City Council make their recommendations to the Mayor on the NYCTA capital budget.

By mid-April, the Mayor issues the Executive Capital budget for New York City. Throughout April and May, the City Planning Commission and the City Comptroller issues reports on the proposed City Capital budget and public hearings are held.

After recommended modifications are made, the capital budget for New York City is adopted. The budget becomes effective by July 1 and is distributed within NYCTA during the first week in July. Rail modernization projects approved as part of the City capital budget are eligible to receive assistance from the City.

### New York State Capital Budget Process

Exhibit F-12 highlights the state capital budget approval process for rail modernization expenditures financed with Section 3 funds. Each year, generally in early August, the State Division of the Budget (SDOB) requests that MTA identify capital needs to be financed with the 1967 \$600 million bond issue. Funds from the bond issue are the local match for Section 3 funded rail transportation capital improvements.

By mid-September, MTA generally submits the capital requests prepared by NYCTA to the SDOB. These capital requests are those included in the NYCTA capital program and approved by NYCTA and the MTA Board. In mid-fall, a meeting is held in Albany between SDOB, MTA, and NYCTA to review the NYCTA rail modernization capital requests.

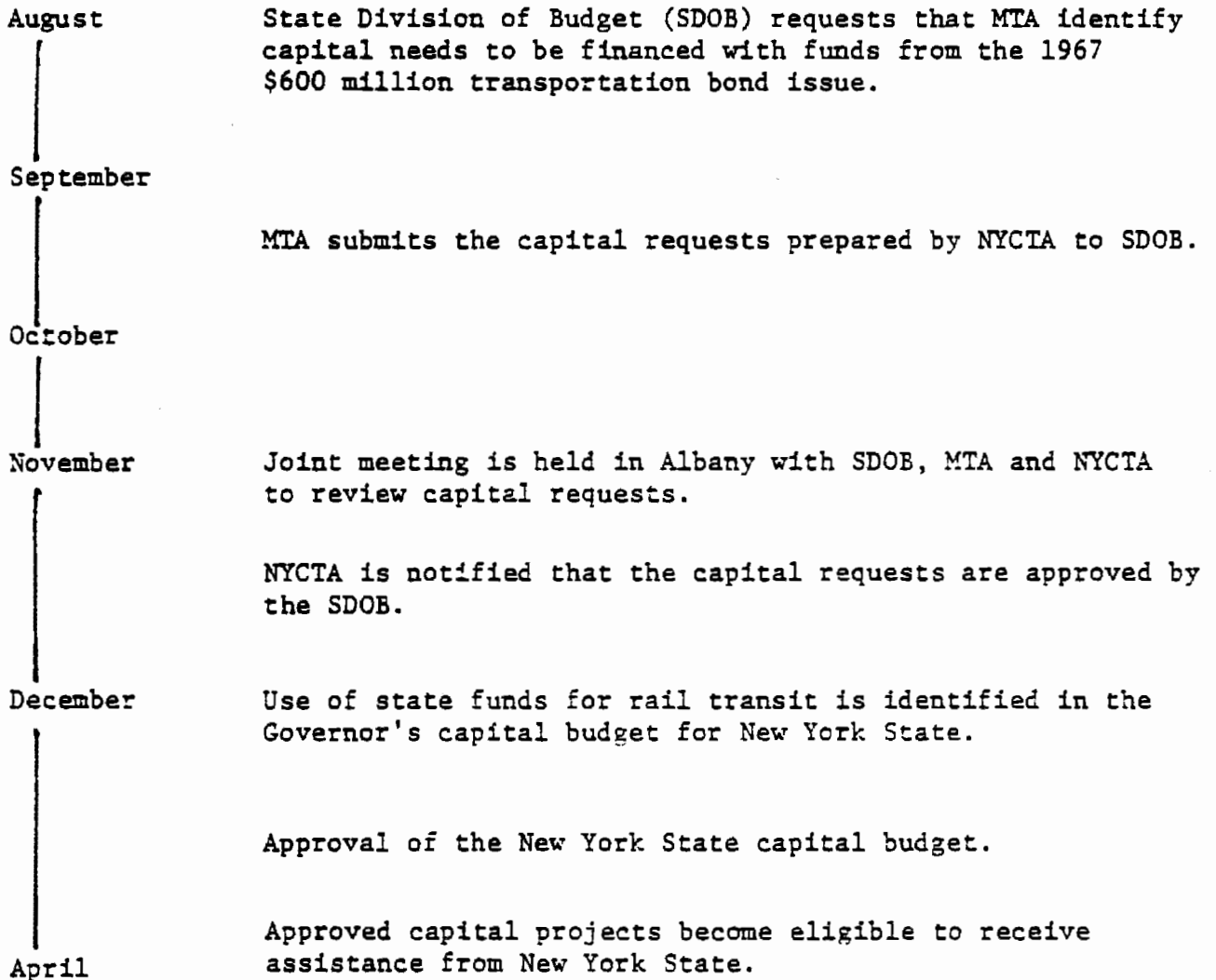
Around mid-November or early December, NYCTA is notified by the SDOB that the requests are approved. Revisions are rarely made by the SDOB to NYCTA rail modernization capital requests. On occasion, SDOB requests that NYCTA provide additional information to justify specific projects. Once use of state funds for rail capital projects is approved, the

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<sup>2</sup>The Board of Estimate is made up of important elected officials in New York City, including the Mayor, the Comptroller, the President of the City Council, and the presidents of the five boroughs.

EXHIBIT F-12

OVERVIEW OF STATE CAPITAL BUDGET PROCESS



the projects are eligible to receive state support. Use of state funds for rail transit is identified in the Governor's capital budget for New York State, which becomes effective on April 1.

#### A.7 - Section 3 Grant Application Preparation and Submittal

The preparation and submittal of a Section 3 grant application is the last step in the first phase of the NYCTA rail modernization grant process. The preparation of an NYCTA rail modernization grant application does not begin until after the Tri-State Regional TIP has been approved by UMTA, generally in mid-to-late spring. The application includes only those projects:

- . approved by the MTA Board;
- . identified in city and state annual budgets; and
- . included in the first year (annual element) of the TIP.

The NYCTA Advanced Planning Division has the lead role in preparing the grant application. This is the same division that is responsible for preparing project reports.

UMTA's External Operating Manual specifies the elements that must be included in a grant application and the actions that must be taken prior to grant application submittal. Appendix 3 of the EOM includes a sample application for a capital improvement grant. The sample includes instructions for applicants and identifies all required grant elements.

Exhibit F-13 summarizes the 28 elements that must be included in each Section 3 grant application to satisfy federal statutory or administrative requirements. Section 3 grant elements are considered safeguards to protect:

- . the environment;
- . labor;
- . civil rights;
- . the elderly and handicapped;
- . private transportation services; and
- . the public's right to comment.

## EXHIBIT F-13

### WHAT UMTA LOOKS FOR ON AN APPLICATION

1. Letter of application
2. Eligibility of applicant—only one applicant
3. Resolution
4. Civil Rights Assurance
5. Legal Opinion
6. Project Description
  - Project consists of
  - Project estimated cost—line item—good cost estimates
  - Assurance of competitive bidding
  - Vendors warranty of compliance with air pollution control standards
  - Land acquisition assurance from sample format
  - Eligibility of project guide
7. Public Transportation System
  - Description of principal carrier
  - Fare structure of principal carrier
  - Ridership figures for five-year period
  - School children as part of ridership
  - Charter service of principal carrier
  - Financial arrangement between city and transit agency
  - Description of other carrier
  - Any competition of routes between applicant and other carriers
  - Protection of private transportation agency
  - Unified transportation program
  - Maps of system
  - Non-capital improvements
8. Project Justification
  - Benefits to carrier
  - Benefits to the urban area
  - Benefits to the ridership
  - Section 4(a) of the Urban Mass Transportation Act
  - Continuing need for the project
  - Line item justification
9. Revenue Financing
10. Net Project Cost and Grant Funds
11. Planning
  - Comprehensive planning
  - Transportation planning
  - Technical study planning evaluation
  - HUD advisory planning finding
  - State clearinghouse review comments
  - Regional clearinghouse review comments
12. Public Transportation Program
  - Development program—five-year
  - Maintenance program
  - Technical capacity of applicant
  - Provision of funds to meet deficits for five years
13. Use of project facilities—satisfactory continuing control
14. Labor and Relocation
15. Labor Finding—Section 13(c)
16. Maps—non-discrimination
17. Flood Hazard Statement
18. Public Hearings
  - Proof of publication 30 days prior to hearings
  - Proof of second published notice printed within 30 days prior to hearings
  - Copy of transcript of public hearings
  - Certification of transcript
  - Certification that opportunity has been afforded public for hearing—from applicant
19. Draft Environmental Statement
20. Section 4(f) DOT Act impact that restricts the use of park land or historic sites
21. Consideration of Aged and Handicapped
22. Consideration of UMTA technological developments when applicable
23. Section 164 charter school bus assurances
25. Project implementation schedule
26. Affirmative Action Program
27. A87 Cost Allocation Plan which outlines administrative costs in implementing the grants
28. Part I and III of Sample Format provided applicant

SOURCE: Mass Transit, May, 1978, p.16.



The elements also ensure that consideration has been given to:

- . adequate planning;
- . regional and statewide interagency coordination and co-operation;
- . project costs and financing needs; and
- . project justification in light of community and system benefits.

Projects are identified in NYCTA grant applications in 11 categories. These categories were selected by NYCTA to make the application easily understood by those reviewing the application. Exhibit F-14 is a sample summary sheet of projects in a grant application for Fiscal Year 1978. The sheet identifies the total cost of the federal and local share for each of the 11 categories of projects.

The grant application is somewhat overbudgeted to allow NYCTA to take advantage of any unanticipated funds that may become available. If provisions were not made to include a number of projects beyond the expected level of funding, NYCTA would not be eligible to utilize the unanticipated funds.

After the Section 3 grant application is prepared by the NYCTA Engineering Department, NYCTA and MTA hold public hearings. Hearings are required by the Federal Government to allow public comment on grant applications. Response must be made to all public comments on the grant. Although possible, it is rare that a Section 3 grant application is modified as a result of public hearing comments.

After the hearings are held, a hearing transcript is prepared and a resolution is made that the MTA Board approves the grant application. The Board generally passes the resolution to accept the grant application at its first monthly meeting after the hearings. Once the resolution is passed, the grant application is finalized and can be officially processed by UMTA.

Submission of a complete Section 3 grant application, including all required grant elements and proper documentation of public hearings, is important to NYCTA since incomplete grant applications cannot be approved by UMTA.

Submission of the Section 3 grant application to UMTA completes the first phase in the NYCTA rail modernization grant process. The activities in the next phase are largely the responsibility of UMTA.

EXHIBIT F- 14

SUMMARY:

CAPITAL IMPROVEMENT PROGRAM  
FOR THE  
NEW YORK CITY TRANSIT SYSTEM  
FOR FISCAL YEAR 1978\*\*

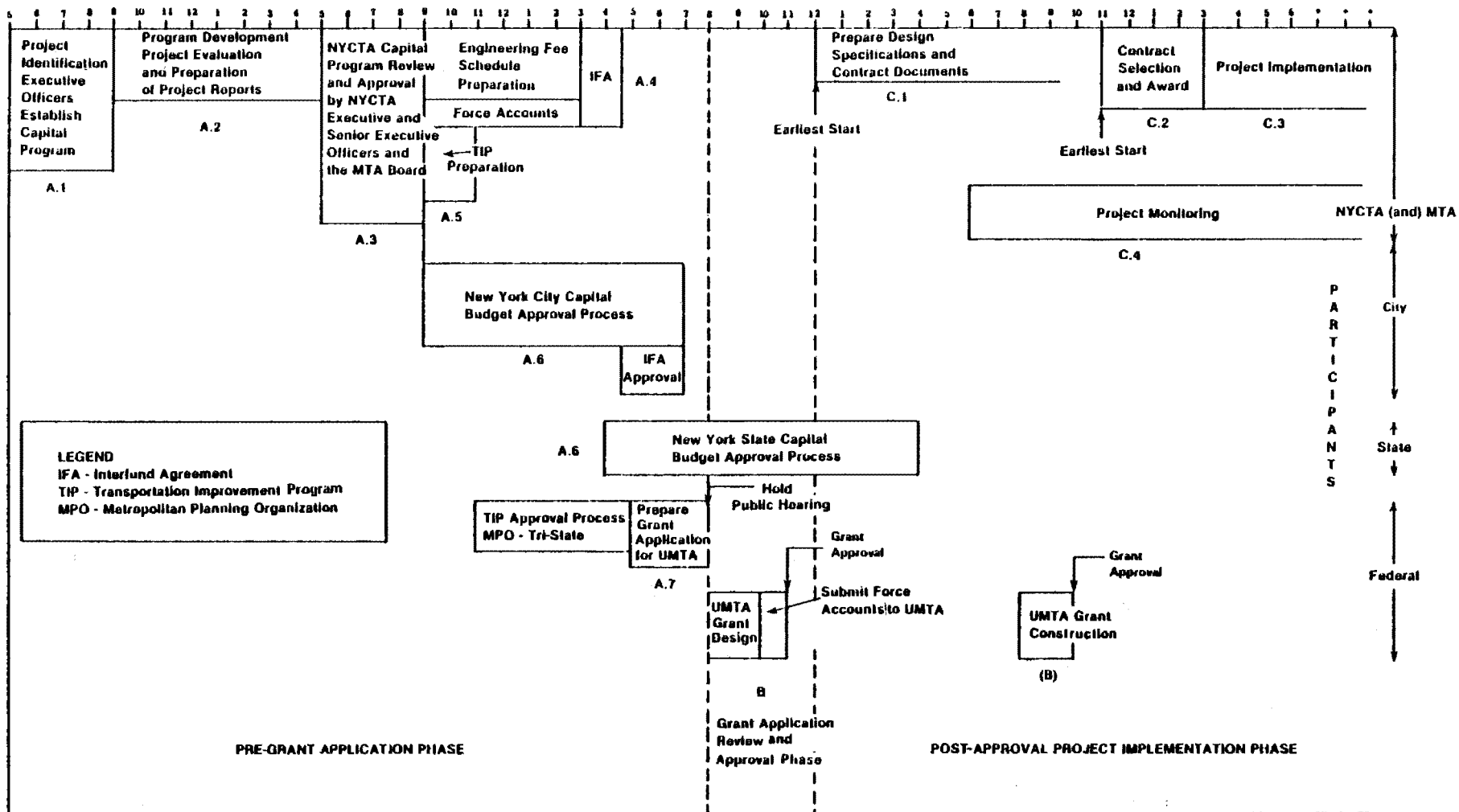
CATEGORY	<u>TOTAL COST</u>	<u>FEDERAL SHARE</u>	<u>LOCAL SHARE</u>
I. Rehabilitation of			
a. Line Structures	\$ 13.20	\$ 10.56	\$ 2.64
b. Track	5.00	4.00	1.00
c. Line Equipment	1.80	1.44	0.36
II. Signals and Communications	63.10	50.48	12.52
III. Power Equipment and Substation Modernization	23.50	18.80	4.70
IV. Station Improvements	17.62	14.10	3.52
V. Rapid Transit Cars	25.90	20.72	5.18
VI. Buses	31.00	24.80	6.20
VII. Rehabilitation and Modernization of Shops, Yards and Maintenance Facilities	14.53	11.70	2.93
VIII. Rehabilitation and Modernization of Surface Maintenance and Storage Facilities	4.30	3.44	0.86
IX. Service Vehicles	0.54	0.43	0.11
X. Agency Administration and Requirements	9.63	7.70	1.93
XI. Emergency Power Equipment, Auxiliary Lighting and Communications	<u>4.00</u>	<u>3.20</u>	<u>0.80</u>
TOTALS	\$214.22	\$171.37	\$42.85

\*\* New York City Fiscal Year 1978 - July 1, 1977 - June 30, 1978

SOURCE: NYCTA Grant Application for Fiscal Year 1978.

EXHIBIT F-15

OVERVIEW OF NYCTA'S RAIL MODERNIZATION GRANT APPLICATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS<sup>1</sup>



F. 51

<sup>1</sup> This process applies to rail modernization projects that (1) do not require property acquisition; (2) do not require an Environmental Impact Statement, and (3) are designed by the NYCTA Engineering Department. This includes the majority of projects funded by Section 3 grants.

## B - GRANT APPLICATION REVIEW AND APPROVAL PHASE

The second phase is the process for securing Section 3 funds for NYCTA's rail modernization program, which consists of federal review and approval of a grant application. Exhibit F-15, which replicates Exhibit F-5 in the introduction to this chapter, displays this second phase (B) in relation to the other activities in the NYCTA rail modernization grant process. The amount of time required for Section 3 grant application review and approval varies both with the complexity of each grant application and the backlog of applications that must be reviewed and approved.

UMTA is the federal agency most extensively involved with Section 3 rail modernization grant review and approval. The U.S. Department of Labor is also involved with Section 3 grant approval, since the Secretary of Labor must ensure that fair and equitable arrangements are made to protect the interest of employees affected by the provision of federal financial assistance for mass transit.

Until January 1978, UMTA conducted grant review and approval in Washington, D.C. In 1971, UMTA initiated a program of regionalization of administrative functions. Initially, UMTA regional offices participated in activities involving transit planning, and review of project design specifications and contract modifications. UMTA initiated more extensive decentralization of responsibilities in January 1978, with a greater delegation of authority to the regional office in Philadelphia. This office was to serve as a model to the other nine regional offices. Grant review and approval were among the important UMTA responsibilities that are now being largely delegated to the regional offices.

It is important to note that the process for Section 3 rail modernization grant review and approval is largely unchanged by the move to regional offices. Grant applicants must continue to submit the same information in their applications and all 28 grant elements identified in Subsection A.7 must be reviewed prior to grant application approval. The primary change in Section 3 application review with the regionalization UMTA administrative functions is that the review will be performed by UMTA personnel in the field offices, rather than in the central Washington, D.C., office.

The remainder of this section provides:

- . an overview of the Section 3 rail modernization grant review and approval process as it was carried out prior to the major efforts to decentralize UMTA administrative functions; and
- . an overview of the UMTA decentralization activities and the anticipated benefits of this program.

Information reported in this chapter was gathered from primary and secondary sources. Interviews were conducted with persons involved in grant application review in Washington, D.C., and the New York Regional Office. In addition, the following literature was reviewed: (1) pertinent sections of the UMTA External Operating Manual, (2) the UMTA order explaining the delegation of authority for regional directors, and (3) journal articles on Section 3 grant approval activities and the expansion of UMTA regional office authority.

## Current Decentralization Activities and Anticipated Benefits of Decentralization

### Decentralization

In January 1978, UMTA expanded the authority of its regional office directors. Regional offices will be responsible for all aspects of planning and grant process activities, including:

- . planning certification;
- . plan approval;
- . grant application approval;
- . grant management; and
- . post-grant audits.

The UMTA order of August 1978, delegating authority to regional office directors, states that regional directors are fully responsible for all grants under \$5 million. Grants of over \$5 million must have final approval from UMTA's Central Office. The reservation of authority for projects requiring more than \$5 million allows the UMTA Administrator and Associate Administrator for Transit Assistance to be involved in nonroutine projects, particularly new rail construction or major system modifications such as station redesign.

Most Section 3 rail modernization grant applications from NYCTA request more than \$5 million. Consequently, full responsibility for these grants will not be held by the UMTA regional office director. It is expected, however, that NYCTA rail modernization grant applications will be handled much like grant applications that request less than \$5 million. Substantive review will occur in the New York Regional Office and the grant approval letter will be prepared and sent to Washington for final action.

## Anticipated Benefits of Decentralization

The intent of the delegation of authority to UMTA regional offices is to:

- . expand staff in the field where it is believed UMTA can more effectively serve the needs of its clients; and
- . relieve the UMTA Central Office of many administrative responsibilities so that it can focus on policy development and the monitoring and evaluation of ongoing programs .

Expansion of UMTA staff in the regional offices is believed to be an efficient and effective way to better serve UMTA's clientele since the expansion of field offices should:

- . allow grants to be processed more quickly; and
- . improve the familiarity of transit representatives with applicants, their plans, programs, and the projects for which grants are requested.

Expansion of regional offices will also relieve the UMTA Central Office of many administrative responsibilities. In the past the UMTA Central Office has been largely involved with grant processing activities and has been unable to address other pressing issues. UMTA has consequently been criticized for its lack of guidelines and administrative controls needed to:

- . assist all applicants in carrying out UMTA policy and regulations; and
- . perform monitoring and evaluation of ongoing programs and more effectively identify opportunities to improve the planning and grant processes .

Once relieved of most grant processing responsibilities, it is anticipated that the UMTA Central Office will be better able to perform these policy-related activities .

## Grant Review and Approval Process: Prior to Decentralization

Section 3 grant review authority was delegated to UMTA regional offices beginning in early 1978. However, in June 1978, when the information for this case study was collected, the UMTA Central Office was still performing grant processing activities for NYCTA grant requests. Consequently, this section describes the UMTA Section 3 grant review and approval process as

## EXHIBIT F-16

### HOW UMTA MAKES A GRANT

#### Step 1

Request application forms from the associate administrator of Office of Transit Assistance, John Taylor, Urban Mass Transportation Administration, Room 9306, 400 7th St., Washington, D.C., 20590 (202/426-4020).

#### Step 2

The original and five copies of the application are sent to the above address, then logged in by the Office of Administration where it receives a project number and copies are sent to: Department of Labor (2 copies); UMTA's Office of Civil Rights (1 copy); UMTA Regional Office (1 copy); UMTA Office of Chief Counsel (1 copy).

#### Step 3

The master application is sent to the Office of Grants Assistance within the Office of Transit Assistance where it is sent to the appropriate division chief who is responsible for certain regions. At the same time, the Office of Civil Rights and the Office of the Chief Counsel begin reviewing the application.

#### Step 4

The division chief either reviews the application or assigns it to a transportation representative who works directly with the applicant and is the person who oversees the grant throughout the process. All questions concerning the status of the grant are answered by the representative assigned to the applicant.

#### Step 5

The application is reviewed and a list of additional information, items needing clarification and questions concerning justification for the grant is prepared.

#### Step 6

The transportation representative coordinates with the Office of Planning (now the Office of Planning, Management and Demonstration) to verify that the application has met the planning requirements of the Urban Mass Transportation Act.

#### Step 7

The representative then writes a review letter requesting the needed information and informing the applicant that a 10(c) certification is needed from the Department of Labor. The applicant is given the name and number of the Department of Labor person to contact, but then must work directly with Labor.

#### Step 8

The Washington transportation representative then makes an on-site inspection (unless the representative is familiar enough with the property from previous inspections).

#### Step 9

Once the additional information, including the 10(c) certification, is received back by UMTA, the grant is reviewed by the division chief, then sent to the Office of Civil Rights, the Office of Chief Counsel and the Office of Administration to verify adequate funding is available. It then goes to the division director of the Office of Grants Assistance where the associate administrator will sign to approve the grant if it is under \$5 million. Otherwise, the application goes to the associate administrator for review, then to the administrator (Richard S. Page) for his signature.

#### Step 10

The last step is the formal announcement of the grant through a press release.

SOURCE: Mass Transit, May, 1978 p. 18.

it was carried out by the UMTA Central Office prior to the delegation of grant review authority. As noted above, it is intended that the process for grant review and approval will be largely unchanged when it is performed in the UMTA regional offices.

Exhibit F-16 identifies the 10 steps for Section 3 grant approval as performed by the UMTA Central Office. Grant review and approval activities were submitted by an applicant to the Associate Administrator for Transit Assistance and subsequently logged in and assigned a project number by the UMTA Office of Administration. Copies of the application were then sent to the participants in the review and approval process so that they could proceed concurrently.

The Office of Grant Assistance previously had the lead role in Section 3 grant processing. This office includes division chiefs responsible for regional areas of the United States. Division chiefs are familiar with all of the UMTA activities in the regions for which they are responsible. Each division chief is assisted by transit representatives.

Under the earlier system, either the division chief or a transit representative responsible for the application:

- . performed the administrative and substantive review of most grant elements;
- . answered questions about grant status; and
- . sought to expedite grant processing by the other participants who had to review and approve grant elements.

One of the first activities performed by a division chief or representative responsible for a grant was to review the grant application to determine if it was complete. Each of the 28 elements identified in Section A.7 of this report (Grant Preparation and Submission) had to be properly submitted in the application. A grant could not be awarded if the application was incomplete. If sections were missing or incomplete, applicants were notified and asked to make necessary additions and modifications to complete their application.

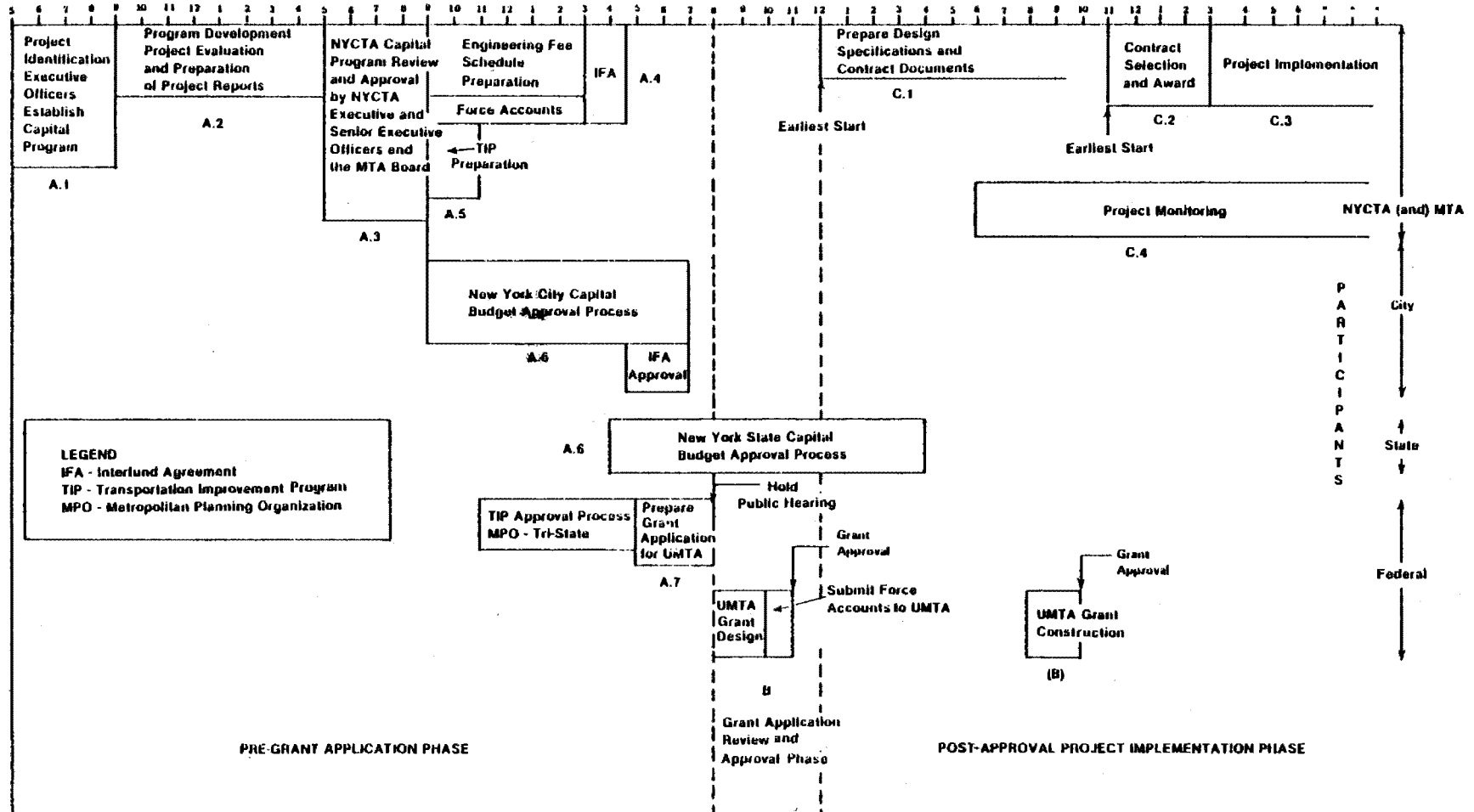
While all elements had to be thoroughly reviewed, certain grant elements generally received special attention including the:

- . 13c certification;
- . environmental statement;



EXHIBIT F 17

OVERVIEW OF NYCTA'S RAIL MODERNIZATION GRANT APPLICATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS<sup>1</sup>



F. 57

<sup>1</sup> This process applies to rail modernization projects that (1) do not require property acquisition, (2) do not require an Environmental Impact Statement, and (3) are designed by the NYCTA Engineering Department. This includes the majority of projects funded by Section 3 grants.

- . project description;
- . project justification; and
- . project cost and financial.

Each of these elements is unique to a particular grant and projects within a grant.

A 13c Labor Certification guarantees that a federal grant to a transit agency will not adversely affect local transit employees. A labor certification must be included with each Section 3 grant application regardless of the effect of the grant on local labor conditions. The applicant must then work directly with the Department of Labor during review and approval of the 13c labor certification.

An Environmental Statement identifies potential impacts of projects financed with federal funds. An environmental statement must be prepared for each Section 3 grant application either as a negative declaration, in instances where there are not impacts, or as a draft environmental impact statement (EIS). Usually, rail modernization projects require only a negative declaration.

Project description, justification, cost, and financing information must be adequately documented in a Section 3 grant application to allow full assessment of the project's merit. The applicant must identify:

- . project characteristics in terms of location, size, and important attributes;
- . project benefits accrued to the transit system, the urban area, and transit passengers; and
- . project net cost, grant funds, and nonfederal financing requirements.

Once a Section 3 grant application was complete and all application elements were reviewed and approved (including the Civil Rights Assurance and legal opinion which were approved by UMTA's Offices of Civil Rights and the Chief Counsel, respectively), the final steps in the grant application review and approval were taken prior to grant award. These steps included:

- . contacting the UMTA Office of Administration to verify that adequate funding was available;

- . preparing an approval letter to be signed by the Associate Administrator for Transit Assistance if the grant was less than \$5 million or by the UMTA Administrator if the grant was more than \$5 million; and
- . preparing press releases and notification of the grant award.

There was not set time period for performing the Section 3 grant review and approval activities by the UMTA Central Office. The amount of time required to review and approve a grant application ranged from 3 months to 1 year on the average, depending on the complexity of a particular grant and the number of applications being processed at a particular time.

### C - POST-GRANT APPROVAL, PROJECT IMPLEMENTATION PHASE

This section describes the final phase in the NYCTA rail modernization grant process. The post-grant approval, project implementation phase includes four major activities:

- . C.1 - preparation of detailed engineering design specifications and contract documents;
- . C.2 - contractor selection and contract award;
- . C.3 - project implementation; and
- . C.4 - project monitoring.

As displayed in Exhibit F-17, which replicates Exhibit F-5 in the overview of this chapter, the first three activities in this phase occur sequentially. Project monitoring occurs throughout the phase. Each of these four activities is discussed below in a subsection identified with a number and letter as enumerated above and in Exhibit F-17.

#### C.1 - Preparation of Design Specifications and Contract Documents

The first major activity in the final phase of the NYCTA rail modernization grant process involves preparing design specifications and contract documents for the rail modernization projects. For most projects, UMTA prefers that engineering design specifications be prepared under one grant and project construction under a second grant. Proceeding in this manner encourages more accurate construction cost estimates and tends to minimize cost overruns and construction grant modifications.

Preparation of design specification and contract documents for NYCTA rail modernization projects involves:

- . preparation of draft drawings and manuscripts;
- . review and comment by in-house interests, utilities, New York City, and New York State;
- . resolution of comments;
- . assemblage of final drawings for signature of NYCTA chief engineer;
- . legal review and approval; and
- . approval by the NYCTA Senior Executive Officer.

NYCTA is the major participant in preparing design specifications and contract documents. Utility companies must often also be involved in reviewing rail modernization design specifications to ensure that there will be no disruption in utility service due to rail transit project construction.

Until September 11, 1978, UMTA concurrence on contract documents and design specifications for rail modernization projects was required. UMTA's requirements for administrative and technical pre-bid and pre-award review of third-party contracts have recently been modified.<sup>1</sup> UMTA's pre-bid concurrence is now required only for:

- . all sole-source contracts over \$10,000, including contracts which specify a brand name;
- . all negotiated contracts and all change orders on competitively bid contracts over \$1,000,000;
- . contracts proposed to be awarded to other than the low bidder under formally advertised procurements;
- . contracts which require budgeting or funding action by UMTA;<sup>2</sup>

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<sup>1</sup>This change in policy affects major U.S. cities (i.e., cities with over 500,000 population).

<sup>2</sup>These include contracts for which the lowest bidder proposes an amount greater than that approved and budgeted by UMTA.

- . force account work by authority force in excess of \$25,000; and
- . proposed contracts which are (1) of special interest to UMTA, (2) considered sensitive and may be subject to close public scrutiny, (3) unique and require special evaluation, and (4) requested by the grantee to be reviewed.

NYCTA's experience since UMTA changed its pre-bid concurrence requirements indicates that the new policy will result in important time savings.

The total amount of time required for NYCTA to prepare design specifications and contract documents varies with the complexity of each project.

## C.2 - Contractor Selection and Contract Award

After the contract documents and design specifications for the rail modernization project design have been approved, NYCTA can proceed with contractor selection and contract award, which is the second major activity in this phase of the NYCTA rail modernization grant process. This activity requires interface between NYCTA and the City and the State for contract approval and assurance that project financing is available.<sup>1</sup> NYCTA's Public Agency Liaison is responsible for NYCTA interaction with external organizations.

Contractor selection by NYCTA involves:

- . Advertising Contract Specifications. All NYCTA contracts must be free and open to all bidders. Contracts cannot be restricted to a supplier or group of suppliers.
- . Receiving Bids. Sealed bids are received by NYCTA. A deadline is set, by which time all bids must be submitted.
- . Opening and Evaluating Bids. NYCTA must award the contract to the lowest responsible and responsive bidder. Qualification hearings are held to assess whether the lowest bidder (1) responded to contract specifications; (2) has the capabilities to complete the contract; and (3) has met the Minority Business Enterprise (MBE) requirements. NYCTA must prepare a contract award letter and provide UMTA documentation of the selection process, including contractor selection criteria.

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<sup>1</sup>As a result of the September 11, 1978, change in UMTA's pre-bid and pre-award requirements, UMTA review is required before contract award only in the special circumstances described below.

Under certain circumstances contractor selection is more complex; in these instances, UMTA must be involved in contract award activities. This happens if:

- . a contract of more than \$10,000 is let sole-source, only one bid is submitted to NYCTA, or NYCTA wants to award a contract to other than the lowest bidder. NYCTA must then conduct a pre-audit or cost price analysis to justify the contract award to UMTA.
- . the lowest bidder's contract prices is higher than the budget estimated by NYCTA for the project. NYCTA must then request a budget revision from UMTA.

A contract cannot be awarded until New York City and the State are informed about the project and each have approved the local funding. Contract approval is needed from the Mayor and City and State budget offices. The New York City Department of Transportation (NYCDOT) and the Office of Management and Budget (OMB) must submit reports to the Mayor recommending contract award.

Two budget approvals are needed for all NYCTA rail modernization projects. A third approval is needed for contracts over \$1 million. First, a Certificate of Budget Expenditure (CBX) must be issued by the Mayor of New York City. This letter authorizes that funds are available for the contract from the City budget. Secondly, a Certificate of Availability of Funds (COAOF)<sup>1</sup> must be issued from the State Division of Budget to MTA. This authorizes use of funds from the \$600 million state bond issue for rail transit improvements. Finally, an Emergency Finance Control Board (EFCB). Approval is needed for all contracts over \$1 million. The EFCB is a New York State "watch dog" agency charged with the monitoring of New York City finances.

After the needed two or, most typically, three financial approvals are received, the following administrative activities occur:

- . the contract is registered by City and State comptrollers;
- . the contract is delivered to the contractor; and
- . UMTA is informed about contract delivery and project status.

---

<sup>1</sup>Appendix D is a copy of the COAOF beginning May 1969 as amended through May 1978. It presents project allocation information and the balance of the \$600 million bond issue still available.

Exhibit F-18 provides a flow chart of contractor selection and contract award activities. Exhibit F-19 identifies the timing of each of these activities. Exhibit F-19 is used by NYCTA for project monitoring. The time required for contractor selection and contract award generally conforms to the average times displayed in the left-hand column.

### C.3 - Project Implementation

A final activity in the rail modernization grant process is project implementation. Project implementation commences after the contract has been delivered to the contractor and UMTA has been informed about contract delivery. The construction division of the NYCTA Engineering Department oversees project implementation to ensure that design specifications are followed.

Often, contracts for rail modernization projects must be modified during project implementation. Contract modifications may be necessary when:

- . there is a change in condition, a change in regulations, or an omission in the original contract;
- . additional funds are needed to complete a project within the initially specified project scope; or
- . there is a change in project scope or purpose.

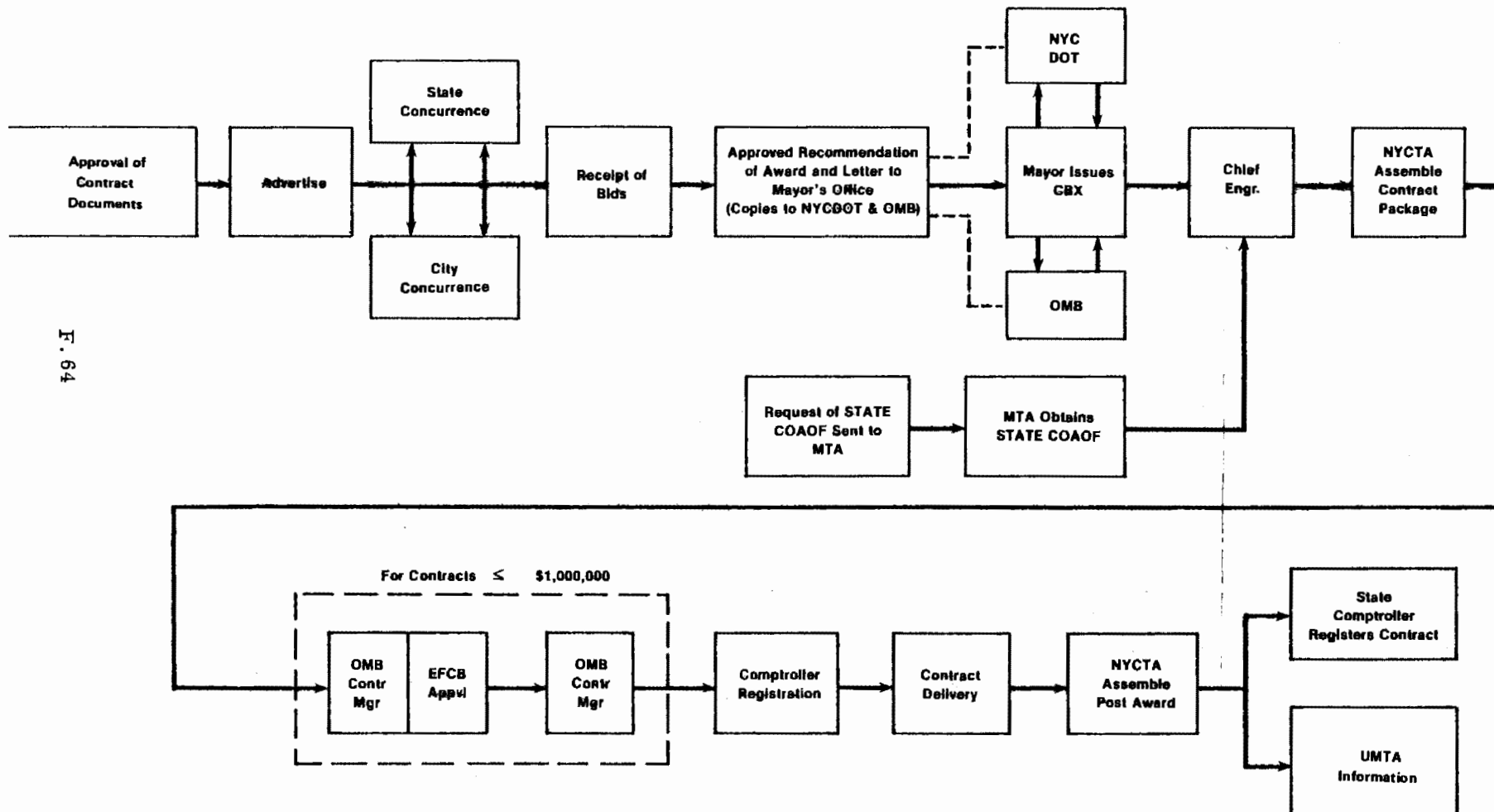
Contract modifications in the first two situations are more easily accommodated than in the third situation. In the first two situations:

- . Contract modifications of less than \$1,000,000 (on competitively bid projects) can be made by NYCTA with City and State approval.
- . Contract modifications of more than \$1,000,000 require written approval by UMTA, the State, and the City.
- . Contract modifications involving more than 5 percent of the total contract require City approval, including the Board of Estimates.

Contract modifications for a change in project scope or purpose are considered technical amendments. These are far more complex. A technical amendment represents a different project and may require an amendment to the TIP, 13C, and Title VI certification; an impact assessment; and public hearings. A considerable effort is made by NYCTA and UMTA to avoid these complex contract modifications.

EXHIBIT F-18

STEPS REQUIRED FOR TRANSIT AUTHORITY TO DELIVER A CAPITAL CONTRACT



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EXHIBIT F-19

ESTIMATED TIME FOR PROCESSING CONTRACTS

(Design Completion to Contract Delivery)

1. <u>Start Design</u> (Design time dependent on type of contract/purchase)	Contract Processing Dates	Accelerated Process. Date
2. <u>Contract Drawings &amp; Specs Completed Sent to UMTA for approval.</u> <sup>1</sup> (Start Processing)  (2 months)	Time _____	_____
3. <u>T.A. Receives UMTA Approval Advertise Contract.</u>  * (2 months)	_____	_____
4. <u>Open Bids. Evaluate Bids; Hold Qualification Hearings; Prepare Award Letter.</u>  ( $\frac{1}{2}$ month)	_____	_____
5. <u>Send Award Letter To City for CBX.</u>  (2 month)	_____	_____
6. <u>Receive CBX Letter From City.</u>  ( $\frac{1}{2}$ month) -	_____	_____
7. <u>Send Cash Flow: Award Package to EFCB. Request EFCB Approval.</u>  (1 month)	_____	_____
8. <u>Receive EFCB Approval. Request Registration No. of Contract by NYC Controller; and NYS Certificate of Availability.</u>  (1 week)	_____	_____
9. <u>Controller Registers Contract. Receive NYS Certificate of Availability. DELIVER CONTRACT.</u> (Complete Processing Time)	_____	_____

45 DAYS

\* AVERAGE. (TOTAL TIME TO PROCESS CONTRACT = 7 mos., 1 wk.)

SOURCE: NYCTA Engineering Department

<sup>1</sup>Subsequent to UMTA Notification on September 11, 1978 this step is generally longer required except for specified rail modernization projects.

A presentation and inspection are generally held when a contract is completed. NYCTA operating divisions examine and accept the completed or delivered rail modernization project. Once a project is complete and accepted by NYCTA, an UMTA audit is performed of the completed contract.

The amount of time required for project implementation varies with the complexity of each project.

#### C.4 - Monitoring of Post-Grant Approval Activities

Monitoring of post-grant approval activities is an ongoing effort throughout the final phase of the NYCTA rail modernization grant process. The NYCTA Engineering Department monitors each of the three major elements of the post-grant approval, project implementation phase (described in Subsections C.1 through C.3) for all rail modernization projects. Monitoring is performed to:

- . report on project status and identify whether project implementation is on schedule and within the budget;
- . provide early recognition of problems to preclude major contract modifications or slowdowns in project implementation; and
- . identify the need for contract modifications to allow project completion.

There are two types of monitoring activities performed for rail modernization projects implemented by NYCTA. The first type of monitoring is performed for all rail modernization projects and the second type is performed only for projects with a budget or schedule problem. Exhibits F-20 through F-22 provide examples of the three computerized monitoring reports prepared monthly for each NYCTA rail modernization project, as shown below:

- . Exhibit F-20 reports on the preparation of design specifications. It shows an example of a status report for a group of Section 3 rail modernization projects from the NYCTA Car Maintenance Division.
- . Exhibit F-21 is used by NYCTA to monitor Section 3 rail modernization project status through contractor selection and the contract award, and includes the anticipated and actual dates on contract delivery and project completion.
- . Exhibit F-22 provides an example of the monitoring report prepared for reporting on Section 3 rail modernization project completion and NYCTA evaluation and project acceptance.

EXHIBIT F-20

RAIL MODERNIZATION PROJECT MONITORING REPORT  
PREPARATION OF DESIGN SPECIFICATIONS

PAGE 24

PAGE 18

DATE : JUN 12 1978

ENGINEERING DEPARTMENT  
CM DIVISION

LIST INCLUDES CONTRACTS WHICH HAVE NOT BEEN SENT FOR CONCURRENCE

PROJECT/BUDGET	SCHED	DRAWINGS COMPLETE	TECH.SPECS COMPLETE	SPECS COMPLETE	ADOPTED	FEDERAL CONCUR REGLEST
=====						
0 (77-78E)		NY-03-0095) CAR DOOR RETROFIT 600 CARS				
BID	2,640,000	ORIG.				
CONTCY		SCHED				
TA.LABOR		-----				
UTILITY						
		PRES.				
TOTAL:	2,640,000	SCHED				
=====						
B30462 (75-76T)		NY-03-0095) REPLACE MACHINE TOOL				
BID	240,000	ORIG.	2-77	2-77	3-77	3-77
CONTCY	12,000	SCHED				
TA.LABOR	8,000	-----				
UTILITY			100%	95%		
		PRES.				
TOTAL:	260,000	SCHED		5-78	6-78	6-78
=====						
B30471 (75-76T)		NY-03-0095) REPLACE MACHINE TOOL				
BID	200,000	ORIG.	2-77	2-77	3-77	3-77
CONTCY	10,000	SCHED				
TA.LABOR		-----				
UTILITY			100%	95%		
		PRES.				
TOTAL:	210,000	SCHED		5-78	6-78	6-78
=====						
B30483 (76-77)		NY-03-0095) REPLACE MACHINE TOOL 252				
BID	475,000	ORIG.		4-78	5-78	6-78
CONTCY	25,000	SCHED				
TA.LABOR		-----				
UTILITY				95%		
		PRES.				
TOTAL:	500,000	SCHED		5-78	6-78	
=====						
B31406 (76-77)		NY-03-0095) PURCHASE BAT CHAR ANALYZER 207 ST				
BID	95,000	ORIG.		3-78	3-78	4-78
CONTCY	5,000	SCHED				
TA.LABOR		-----				
UTILITY				85%		
		PRES.				
TOTAL:	100,000	SCHED				
=====						

SOURCE: NYCTA Engineering Department.



EXHIBIT F-22

RAIL MODERNIZATION PROJECT MONITORING REPORT  
CONSTRUCTION AND COMPLETION

\*\*\*\*\*  
PROJECT T-005 ADD FAC FOR LINES IN OPERATION  
\*\*\*\*\*

\*\*\*\*\*  
PAGE 3  
\*\*\*\*\*

CONTRACT NUMBER	CONTRACT DESCRIPTION	EXPENDITURES AUTHORIZED	DATE OF ADOPTION	DATE OF BID	DATE OF AWARD	CBX NO. MAYORS APPROVAL	ACTUAL DATE OF DELIVERY	CONTRACT UAL DATE	FIELD PROG %	FINAL COMPLE DATE	CONTRACT ACCTANCE DATE
		TOTAL			795,920,00						

C30334	0061 TEMP DEWATERING SYSTEM 116TH & LENOX AVE T. MORIARTY & SON, INC.	136,209.00	4/29/75	6/13/75	10/17/75	6520. 1/20/76	3/12/76	3/12/76	40.0		
--------	--	------------	---------	---------	----------	------------------	---------	---------	------	--	--

C30340	0059 REMEDY WATER CONDITIONS VAN LDC, NEWKIRK AVE MACLERIO CONTRACTING CO.	1,012,665.00	5/13/75	7/18/75	8/18/75	6503 10/09/75	11/05/75	11/05/77	97.0		
--------	---	--------------	---------	---------	---------	------------------	----------	----------	------	--	--

C30343	0060 REHAB CONC. STRUCTURE FLUSHING LINE INT PRUDE CONSTR. CORP.	1,078,850.00	8/18/75	10/10/75	11/13/75	6539 1/29/76	3/29/76	3/29/77	99.0		
--------	---	--------------	---------	----------	----------	-----------------	---------	---------	------	--	--

C30347	0062 REHAB SEA BEACH LINE CONCRETE STRUCT.-FENCE W DOYLE-BALDANTE INC.	535,260.00	10/20/75	5/07/76	6/28/76	6601 11/18/76	1/06/77	3/06/78	50.0		
--------	---	------------	----------	---------	---------	------------------	---------	---------	------	--	--

C30358	0252 REHAB, CONCRET STRUCT SEA BEACH LINE	50,000.00	6/06/77	10/00/77							
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NY-23-0010		CITY SHARE			50,000.00						
		STATE SHARE			250,000.00						
		FEDERAL SHARE			700,000.00						
		TOTAL			1,000,000.00						

C30451	0063 INSTALL WATER LINES A1 239TH ST YARD H&O CONTRACTING CORP.	184,500.00	5/02/75	6/27/75	2/02/76	6563 5/04/76	6/04/76	2/04/77	96.0		
--------	--	------------	---------	---------	---------	-----------------	---------	---------	------	--	--

C30550	0066 CONCRETE PLATFORM SHEEPSHEAD BAY STATION WARSHAW/RCB	48,360.00	9/03/76	3/11/77	3/30/77	6798 6/24/77	8/01/77	8/01/78	.0		
--------	--	-----------	---------	---------	---------	-----------------	---------	---------	----	--	--

NY-23-0010		CITY SHARE			48,360.00						
		STATE SHARE			241,800.00						
		FEDERAL SHARE			677,040.00						
		TOTAL			967,200.00						

C30553	0281 REPL WOOD PLT WITH CONCR SLABS NEW LOTS AVE PAUS	48,921.60	1/22/76	12/03/76	12/13/76	6721 1/17/77	2/02/77	8/02/78	7.0		
--------	---	-----------	---------	----------	----------	-----------------	---------	---------	-----	--	--

SOURCE: NYCTA Engineering Department.

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ECOV-112

In addition to the preparation of these three computerized project status reports for all rail modernization projects, NYCTA monitors projects on an as-needed basis through management by exception. This monitoring activity is coordinated through the Program Management Division of the NYCTA Engineering Department, as are the above-described monitoring activities.

It is the responsibility of operating or engineering divisions within NYCTA to identify budget and schedule problems on rail modernization contracts. Each month, separate Management Action Report (MAR) meetings are held to discuss contract problems for design, construction, and support. MAR meetings are intended to result in requests for revisions to the contract schedule or budget. These monitoring activities continue until a project is complete. A final type of project monitoring occurs for most NYCTA rail modernization projects after the project is complete. Project performance is monitored by NYCTA operating divisions utilizing the facility or equipment throughout the warranty period, which is generally 1 to 2 years. During this period, the contractor is responsible for making repairs or replacements required under warranty. Once the warranty period is over, the contractor is released from responsibility and generally systematic monitoring of performance is discontinued until a problem arises. To date, UMTA has not been extensively involved in these project monitoring activities after the project is complete.

#### IV. NON-UMTA FUNDED RAIL MODERNIZATION IMPROVEMENT PROCESS: PORT AUTHORITY TRANS-HUDSON (PATH) CASE STUDY

This section describes the findings of a study of the process undergone by the Port Authority Trans-Hudson (PATH) to finance the rehabilitation and modernization of the PATH rail system. This study included investigation of the activities and participants in PATH's rail modernization program from project identification through project implementation.

The funding process for rail modernization improvements for PATH is similar to the NYCTA process but, in many ways, is less complex. Rather than addressing the process for obtaining rail modernization grants, as does the NYCTA case study, this case study discusses the process for financing individual rail modernization projects. While NYCTA prepares rail modernization grant applications for Section 3 funds (which often include numerous projects), PATH prepares and approves rail modernization financing on a project-by-project basis. For purposes of comparison, the PATH funding process is described by referring to the same three fundamental phases identified in the NYCTA Section 3 rail modernization grant process, as follows:

- . The first phase, Pre-Project Application Phase begins with the annual preparation by PATH of its 10-year capital improvement forecast and annual budget, which are approved as part of the Port Authority program. Once the budget has been approved, projects can be recommended for implementation.
- . The second phase, Project Review and Approval Phase includes project approval activities that occur within PATH and Port Authority to obtain a commitment to fund a project.
- . The third and the final phase, Post-Funding Approval, Project Implementation Phase involves (1) preparation and approval of engineering design specifications and contract documents, (2) selection of a contractor and contract award, and (3) project implementation.

This section provides a detailed description of each of the three phases in the PATH rail modernization funding process. The description of these phases is preceded below by a brief history and background and review of the Port Authority organization.

## HISTORY AND BACKGROUND<sup>1</sup>

Port Authority Trans-Hudson (PATH) is a 13.9-mile rapid transit system connecting Newark, Harrison, Jersey City, and Hoboken, New Jersey, with New York City via tunnels under the Hudson River. PATH has been a subsidiary corporation of the Port Authority of New York and New Jersey since September 1, 1962, when it was acquired from the bankrupt Hudson and Manhattan Railroad (H&M).

PATH invested \$262 million in the revitalization and operation of its rail transit services between 1962 and 1977; \$250 million had been invested by 1972. PATH rail modernization projects have been financed largely through consolidated revenue bonds issued by the Port Authority. UMTA Section 3 grants, received in 1965 and 1968, assisted in financing power conversion equipment, way and structure improvements, the purchase of rail cars, and the construction of Journal Square Transportation Center in Jersey City.<sup>2</sup> Since 1968 PATH has not received a federal capital grant from UMTA.

## PORT AUTHORITY ORGANIZATION

Exhibit F-23 presents the Port Authority organization chart. The Authority has seven line departments:

- . aviation;
- . industrial development;
- . marine terminals;
- . rail transportation (PATH);
- . terminals;

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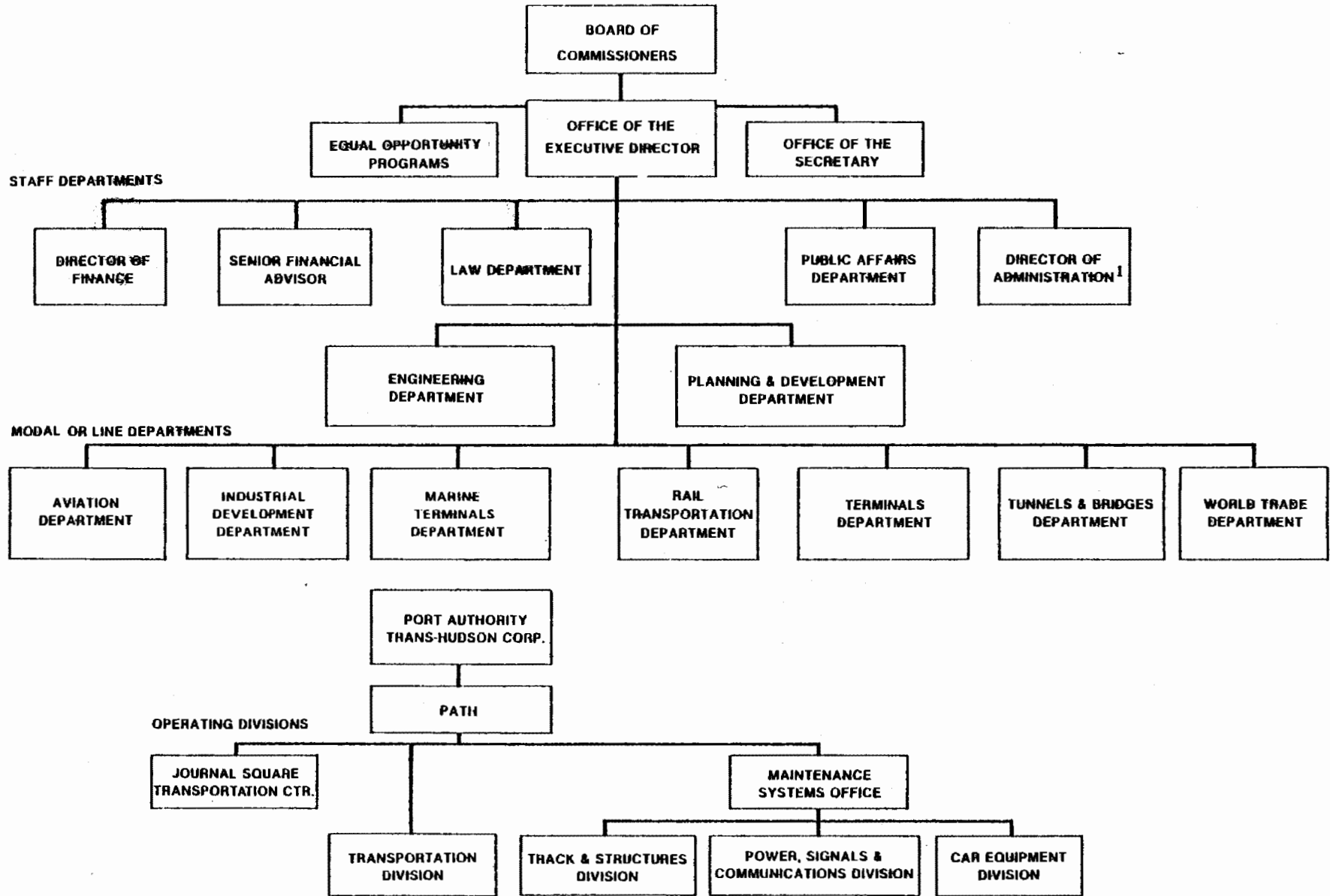
<sup>1</sup>Information in this section is based on reports provided by PATH.

<sup>2</sup>On June 29, 1965, UMTA approved a Section 3 grant for \$5.1 million for PATH rail cars and some minor signal, track, and station modernization. On March 26, 1968, a second Section 3 grant was approved for construction of the Journal Square Transportation Center in Jersey City. The center includes a modernized PATH station, a consolidated bus terminal, auto parking levels, and a new operations control center serving the entire PATH system. A total of \$39,166,000 in Section 3 grants has been approved for the Journal Square facility since 1968.



EXHIBIT F-23

PORT AUTHORITY OF NEW YORK AND NEW JERSEY  
ORGANIZATION CHART



F. 73

SOURCE: Adapted from an organization chart provided by PATH.

<sup>1</sup>Includes the Medical, Personnel, Management Services, and General Services Department and the Police Division.

- . tunnels and bridges; and
- . world trade.

Each of these departments is headed by a director who reports to the Executive Director of the Port Authority. Each of the mode or line departments has an operations division which is part of the Port Authority, with the exception of PATH; PATH operations are held as a subsidiary corporation. However, the President of PATH is the Executive Director of the Port Authority Rail Transportation Department, and the Vice President and General Manager of PATH is the Director of the Port Authority Rail Transportation Department.

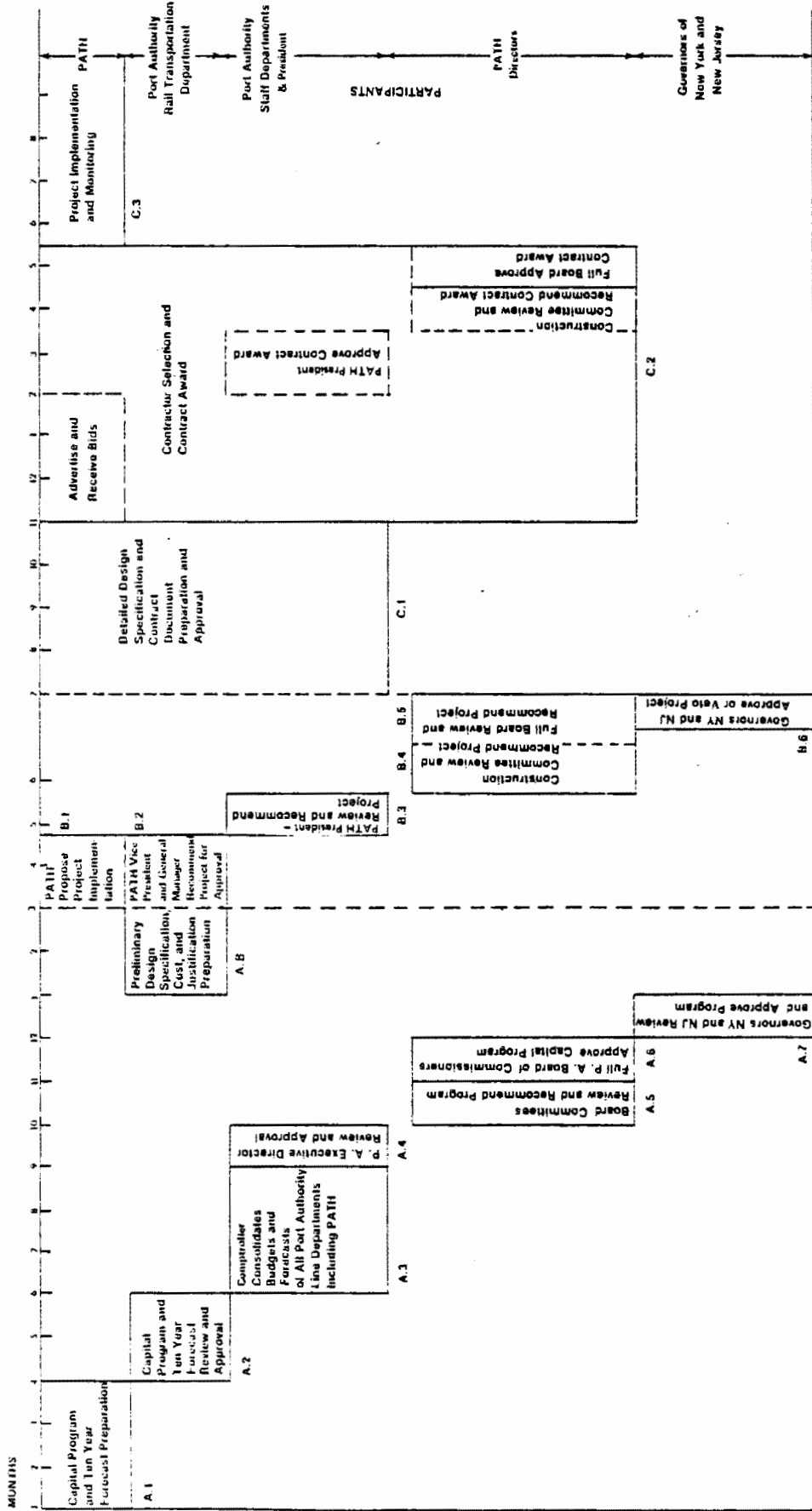
The Port Authority includes 12 staff departments or divisions which provide support services to all of the line departments. These are:

- . Finance;
- . Law;
- . Public Affairs;
- . Medical;
- . Personnel;
- . Management Services;
- . General Services;
- . Engineering;
- . Police;
- . Planning and Development;
- . Equal Opportunity Programs Unit; and
- . the Office of the Secretary.

These departments are involved in various capacities in the PATH rail modernization funding process.

EXHIBIT F-21

OVERVIEW OF PATH'S RAIL MODERNIZATION PROJECT PREPARATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS



## OVERVIEW OF PATH'S RAIL MODERNIZATION GRANT APPLICATION REVIEW, APPROVAL, AND IMPLEMENTATION CYCLE

Exhibit F-24 provides a summary of the process for financing rehabilitation and modernization of PATH's rail rapid transit system. The exhibit represents the process for the majority of projects, which are those over \$200,000.<sup>1</sup> As shown in this exhibit, the complete PATH application, review and approval, and implementation process for rail modernization projects can extend over a 2-year period. The exhibit displays the general timing of activities which varies, of course, with the size and complexity of a project. Many of the activities in the process occur simultaneously with the preparation, approval, and implementation of other projects.

The details of the process are described below for each of the three phases of the process:

- . A - Pre-Project Application Phase;
- . B - Project Application Review and Approval Phase; and
- . C - Post Project Approval, Project Implementation Phase.

### A - PRE-PROJECT APPLICATION PHASE

The pre-project application phase of PATH's rail modernization funding process includes the following activities:

- . A.1 - annual capital program and 10-year forecast preparation;
- . A.2 - annual capital program and 10-year forecast review and approval;
- . A.3 - program and forecast consolidation for all Port Authority line departments, including PATH;
- . A.4 - Port Authority Executive Director review and approval;
- . A.5 - Board of Commissioners Budget Committee review and recommendation of the capital program to the full Board;

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<sup>1</sup>The process for projects less than \$200,000 is described in later sections of this case study.

- . A.6 - Board of Commissioners approval of the Port Authority capital program;
- . A.7 Governors of New York and New Jersey review and approval of the capital program for the Port Authority; and
- . A.8 - Preliminary project design specification, cost, and justification preparation for PATH projects.

As displayed in Exhibit F-24, the listing shown above represents a general sequence of events. Each of the activities in the pre-project application phase are discussed in more detail below. Activities A.1 through A.7 are discussed together under the heading "Annual Capital Program and 10-year Forecast Preparation and Approval." A.8 is discussed under the heading "Preliminary Design Specification Preparation."

#### A.1-A.7 - Annual Capital Program and 10-Year Forecast Preparation and Approval

Each year, the seven line departments in the Port Authority (see Exhibit F-23) must prepare and justify an annual capital program and 10-year capital forecast. The annual capital program represents the first year of the 10-year forecast. The departments compete, in a sense, for the same Port Authority funds and must therefore justify their requests.

The annual capital program and 10-year capital forecast prepared by PATH and the other Port Authority line departments, identify all capital funding needs for projects in the three following categories:

- . authorized projects;
- . projects requiring authorization; and
- . projects in proposed work programs.

The 10-year forecast presents information concerning each project, including:

- . project status (defined by the above categories);
- . project description and justification; and
- . initial cost estimate.

Exhibit F-25 is an example of a capital project included in the current 10-year forecast for PATH. This is a project to revise the ventilation system. The project requires authorization to proceed.

**EXHIBIT F-25**

**STATION VENTILATION:  
PATH PROJECT REQUIRING AUTHORIZATION**

- Authorized Project
- Project Requiring Auth.
- Major Work Program
- Priority

Title STATION VENTILATION - PHASE II  
All dollars in thousands  
HOBOKEN & 33rd STREET

Capital  II-1  
Operating  Item No.

Construction Cost	10 Year Total	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Program Start	Date Comp	Total Const Cost
a) Director's Office														
b) Engineering Dept.	1312		400	316	300	296						1/80	12/83	1312
c) Property Acquisition														
d) PATH Forces														
1) Material														
2) Labor (by Division)														
<b>Total</b>	1312		400	316	300	296								1312

F. 78

Project Description & Justification (include work remaining)  
Project includes major revisions in present ventilation system with the extensive addition of duct distribution systems and new fans. Present interest in improving the PATH-Gimbels-Madison Square Garden underground complex by various City Agencies may accelerate the need for this work at 33rd St. At Hoboken a major planning effort by the City and State may also make it desirable to perform this work in the near future.

Detail of Expenditures in 1979 and 1980

	1980	1981	1982	1983
33rd St.	400	316		
Hoboken			300	296

Project Leader J. F. Delaney  
Source of Estimate Engr. Dept. - 1978 Prices

Date Prepared 5/9/78

SOURCE: provided by PATH.

In general, projects in the 10-year forecast are not explicitly ranked in priority order. There is, however, an implicit ranking of projects identifiable by the recommended year for project implementation. Project priority is established based on the following criteria (listed in order of importance):

- . structural integrity and personal safety improvements;
- . operational improvements;
- . financial benefits; and
- . aesthetics.

The annual capital program and 10-year forecast are prepared and approved over an approximately 9-month period. Preparation generally begins in mid-spring and the annual capital program is approved by the beginning of the following calendar year. The annual capital program for the Port Authority, which includes the requests of each line department, must be approved by the Port Authority Board of Commissioners and the Governors of New York and New Jersey. The 10-year forecast does not require Board or Governor action.

The steps and approximate timing of capital program preparation and approval are briefly outlined below:

- . A.1 - April - PATH and other Port Authority line departments prepare their proposed capital program for the upcoming year and their 10-year forecast.
- . A.2 - June - Line department directors review and approve the proposed annual budget and 10-year forecast for their departments and submit the proposals to the Port Authority Comptroller.
- . A.3 - August-September - The Comptroller consolidates the budgets and 10-year forecasts from all Port Authority line departments for review and approval by the Executive Director of the Port Authority.
- . A.4 - October - The Executive Director of the Port Authority reviews the 10-year forecast and the proposed annual capital program.
- . A.5 - December - The proposed annual capital program is sent to the Committees for approval.

- . A.6 - January - After Committee approval, the annual capital program is sent to the full Board of Directors for approval.
- . A.7 - January - The annual capital program is passed and the new fiscal year begins.

There are generally few obstacles encountered during the budget approval process, since participants at all levels are informed in advance of potential problems and these are generally resolved informally.

No formal commitment has been made to projects that are included in the annual budget. However, while there are exceptions, most projects proposed for the upcoming fiscal year will be funded and implemented. Under certain circumstances, projects not included in the budget may get funded. These circumstances include:

- . emergencies, when unanticipated projects must be completed particularly for safety purposes and for maintaining uninterrupted service operations. If quite large these projects can cause other projects to be deferred.
- . instances when all budgeted capital funds have not been spent and projects not in the annual budget are recommended for implementation.

Preparation and approval of the annual capital budget and 10-year capital forecast for the Port Authority are the main activities in the pre-project application phase of the PATH rail modernization funding process. Once these activities are complete, preliminary project designs, detailed cost estimates, and a project justification must be prepared for each project.

#### A.8 - Preliminary Design Specification, Cost, and Justification Preparation

To implement a project approved as part of the annual capital program, PATH and other Port Authority line departments must first have the project approved or authorized through a defined Port Authority Process. Before a project can be approved, preliminary engineering designs, more detailed cost estimates, and a project justification must be prepared. The project descriptions and cost estimates prepared for the Port Authority annual capital program are generally not sufficient for considering a project for approval and for the commitment of funds.



## B - PROJECT REVIEW AND APPROVAL PHASE

The second phase in the process for PATH rail rehabilitation and modernization consists of review and approval of a project application within PATH and by the Port Authority. Project review does not generally require involvement of outside participants other than the Governors of New York and New Jersey, who may veto projects. In certain instances, however, legislation must be passed in both states.

Exhibit F-26, which replicates Exhibit F-24 in the overview of this chapter, presents the major activities in the second phase of the PATH rail modernization funding process. The exhibit presents an approximate representation of the timing of activities in this phase. The actual timing can vary with the complexity of a project. Each activity in this phase of the PATH process is described below.

Review and approval of PATH rail modernization projects vary for projects of different sizes and different contracting arrangements (competitive bid or sole source). The process is most complex for projects of over \$400,000 and most simple for competitively bid projects of less than \$25,000.

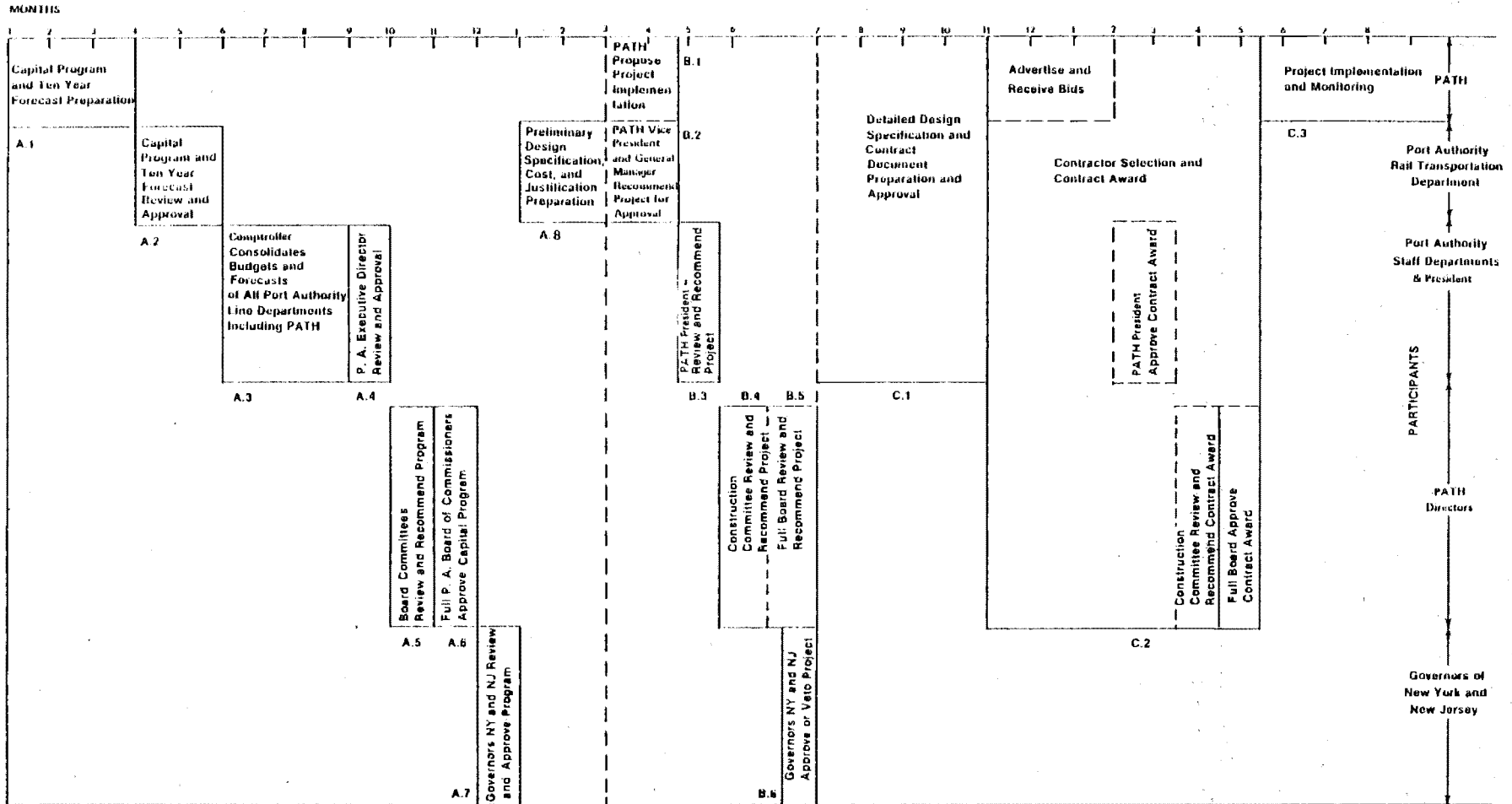
Exhibit F-27 displays the approval process for all capital projects of more than \$400,000. This exhibit illustrates the hierarchy of the approval process. Each participant reviews and approves the rail modernization project and recommends the project for approval by the next higher participant. After the project has been approved by the PATH Board of Directors, it is submitted to the Governors of New York and New Jersey. The Governors have a statutory right to veto Port Authority and PATH projects. If 10 working days pass and there has been no veto, the project is considered approved.

At each level of review and approval, participants are briefed on the project. Briefing becomes most formalized at the Committee and Board of Directors level. PATH committees include Board members who review issues and recommend action to the full Board of Directors. Each month, both the PATH Construction Committee and the full Board of Directors meet. Issues are usually addressed by a committee one month in advance of the full Board.

An agenda item is prepared for the Construction Committee to inform members about the capital project for which approval is requested. The agenda requests that the Committee recommend that the Board authorize a project. Exhibit F-28 is a copy of an agenda item to the October 28, 1970, Committee meeting which requested Committee action on a rail modernization project for the communications system.

EXHIBIT F-26

OVERVIEW OF PATH'S RAIL MODERNIZATION PROJECT PREPARATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS



**EXHIBIT F-27**

**PATH REVIEW AND APPROVAL PROCESS FOR RAIL MODERNIZATION PROJECTS**

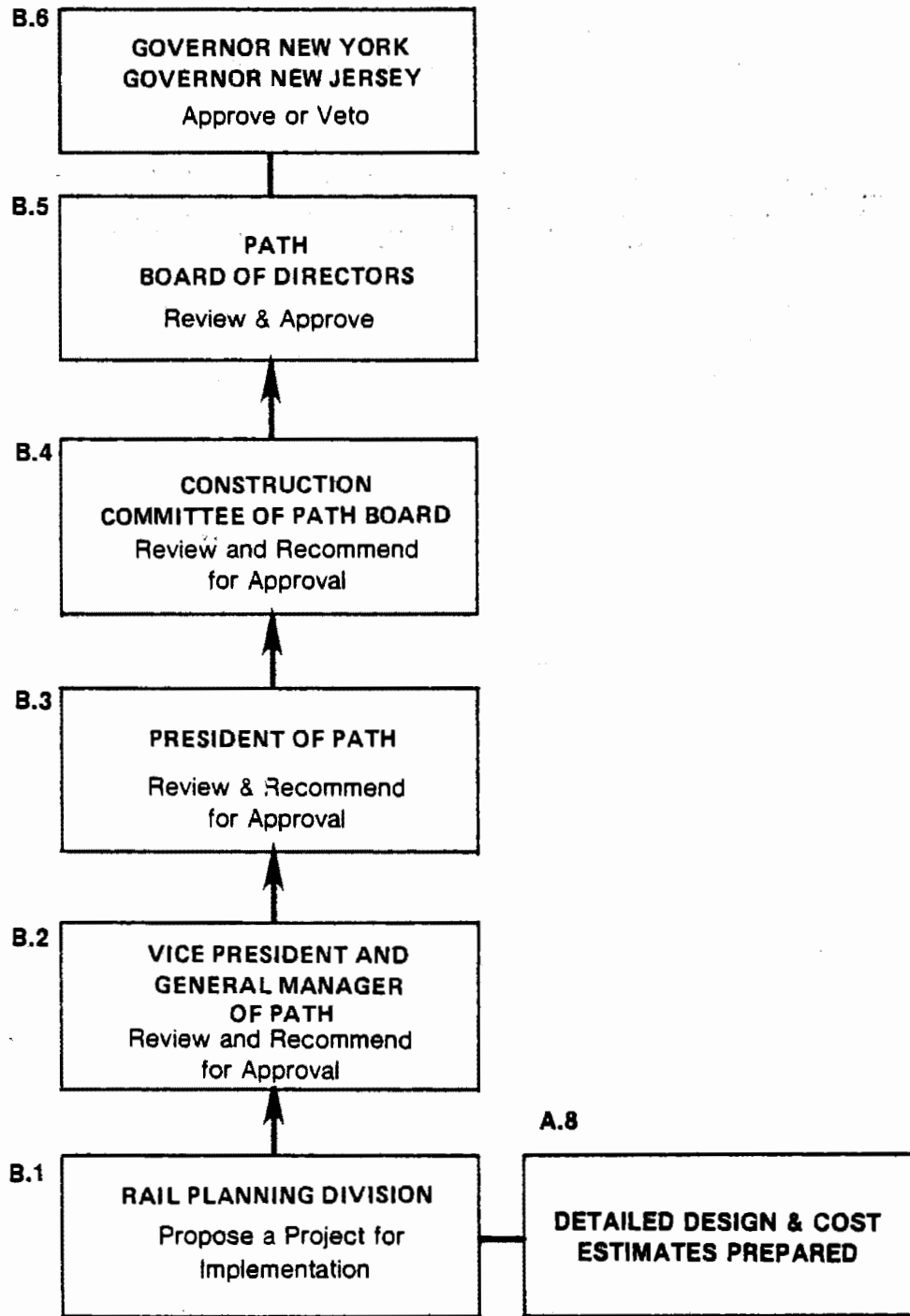


EXHIBIT F-28

PATH CONSTRUCTION COMMITTEE MEETING AGENDA:  
REQUEST FOR PROJECT RECOMMENDATION TO THE FULL BOARD OF COMMISSIONERS

(PATH- CONSTRUCTION) AGENDA OCT 23 1970

TITLE NO. 2 - REHABILITATION AND MODERNIZATION OF PATH COMMUNICATIONS  
SYSTEM - PROJECT AUTHORIZATION

**RECOMMENDATION:** That the Committee recommend to the Board that the Board authorize a project for the rehabilitation and modernization of the communication system at the estimated total cost of \$774,700 including \$198,900 for purchase of materials and payments to contractors, an allowance of \$3,700 for extra work, \$70,800 for contingencies, \$310,100 for PATH forces, and an allowance of \$191,200 for engineering, administrative and financial expenses.

**REPORT:** Since acquisition, a considerable amount of staff time and effort has been expended on maintaining communications cable and other equipment in the tunnel areas to provide the maximum reliability possible, given the age and advanced deteriorated condition of most of the existing system. Although some new cable has been installed, the work primarily involved maintenance until such time as an overall program of rehabilitation and modernization could be developed for the tunnel phone systems which is generally over sixty years old.

At present, the Operations Control Center which is the communications center for the operation of the system is located at Hudson Terminal in lower Manhattan. The demolition of the 30 Church Street Building, in which Hudson Terminal is located, necessitates the relocation of the Control Center to the Journal Square Transportation Center site. The new Control Center will house the latest technological advances in train operations and mechanical and electrical systems monitoring equipment. Communications is a key element in the safe and efficient operation of the system and is vital to the effectiveness of the Control Center function.

To complete the transfer of these communications functions to the new site at Journal Square, a significant amount of cable would have to be purchased and installed just to permit the antiquated communications system currently in use to be controlled from that location. Since the mere transfer of control to Journal Square will require installation of most of the cable without any improvement in the reliability of the ancillary equipment, staff recommends that the entire system be replaced at this time, with a modern system utilizing the latest available communications equipment and techniques.

The recommended project provides the lease and installation of Telephone Company equipment for the primary operational and administrative telephone system. The scope also includes the purchase and installation of cable and equipment for this system and for specialized sub-systems. These sub-systems include the interlocking phone systems necessary for the issuance of clearance cards, the intercom system required for immediate communication between the control center and personnel in operating towers, a tunnel telephone system, and, cable, amplifiers and speakers for the public address system for passenger information at stations throughout the system.

With the exception of a relatively minor contract for the construction of a duct bank within the Journal Square Transportation Center and certain work to be completed by the New Jersey Bell Telephone Company, the installation work will be performed by PATH forces.

Construction Committee approval and recommendation for project approval by the full Board are recorded in meeting minutes. Exhibit F-29 presents a copy of the minutes from the October 28, 1970, Committee meeting to recommend the PATH communications system rehabilitation project to the PATH Board of Directors for approval.

Projects approved and recommended by the Committees are included on the following full Board meeting agenda, which is similar to the Committee meeting agenda presented in Exhibit F-28. The agenda for the full Board meeting would state that the PATH Construction Committee recommended that the Board authorize a project. If the full Board approves the project, a Board resolution is prepared. This resolution is included in the Board minutes which are sent to the Governors of New York and New Jersey, who can approve or veto the project. In almost all instances, the 10 working day veto period passes and the project is approved.

Approval of all PATH rail modernization projects of up to \$400,000 may be approved by the Construction Committee of the PATH Board without full Board approval (whether projects are competitively bid or let sole source).

PATH rail modernization projects of less than \$200,000 may not require Board or Committee approval. Competitively bid contracts of up to \$200,000 may be approved by the President of PATH without action by the Directors. Sole-source PATH capital projects of more than \$75,000, however, must all receive approval by the PATH Construction Committee.

#### C - POST-FUNDING APPROVAL - PROJECT IMPLEMENTATION PHASE

Following Port Authority authorization to commit funds for a PATH rail modernization project, PATH proceeds with project implementation. Implementation of PATH rail modernization projects includes three major activities:

- . C.1 - detailed engineering design specification and contract document preparation and approval;
- . C.2 - contractor selection and contract award; and
- . C.3 - project implementation.

Exhibit F-30, which replicates the exhibit presented for the earlier two phases, displays the participants and general timing of activities for this final

EXHIBIT F-29

PATH CONSTRUCTION COMMITTEE RESOLUTION:  
RECOMMENDATION OF PROJECT TO THE FULL BOARD OF COMMISSIONERS  
(PATH-CONSTRUCTION) MINUTES OCT 28, 1970

2. Rehabilitation and Modernization of PATH Communications System - Project Authorization

It was reported to the Committee that since acquisition, a considerable amount of staff time and effort has been expended on maintaining communications cable and other equipment in the tunnel areas to provide the maximum reliability possible, given the age and advanced deteriorated condition of most of the existing system. Although some new cable has been installed, the work primarily involved maintenance until such time as an overall program of rehabilitation and modernization could be developed for the tunnel phone systems which is generally over sixty years old.

At present, the Operations Control Center which is the communications center for the operation of the system is located at Hudson Terminal in lower Manhattan. The demolition of the 30 Church Street Building, in which Hudson Terminal is located, necessitates the relocation of the Control Center to the Journal Square Transportation Center site. The new Control Center will house the latest technological advances in train operations and mechanical and electrical systems monitoring equipment. Communications is a key element in the safe and efficient operation of the system and is vital to the effectiveness of the Control Center function.

To complete the transfer of these communications functions to the new site at Journal Square, a significant amount of cable would have to be purchased and installed just to permit the antiquated communications system currently in use to be controlled from that location. Since the mere transfer of control to Journal Square will require installation of most of the cable without any improvement in the reliability of the ancillary equipment, staff recommends that the entire system be replaced at this time, with a modern system utilizing the latest available communications equipment and techniques.

The recommended project provides the lease and installation of Telephone Company equipment for the primary operational and administrative telephone system. The scope also includes the purchase and installation of cable and equipment for this system and for specialized sub-systems. These sub-systems include the interlocking phone systems necessary for the issuance of clearance cards, the intercom system required for immediate communication between the control center and personnel in operating towers, a tunnel telephone system, and, cable, amplifiers and speakers for the public address system for passenger information at stations throughout the system.

With the exception of a relatively minor contract for the construction of a duct bank within the Journal Square Transportation Center and certain work to be completed by the New Jersey Bell Telephone Company, the installation work will be performed by PATH forces.

Recommendation was made that the Committee recommend to the Board that the Board authorize a project for the rehabilitation and modernization of the communication system at the estimated total cost of \$774,700 including purchase of materials and payments to contractors, an allowance for extra work, contingencies, PATH forces, engineering, administrative and financial expenses.

Approved and recommended to the Board.

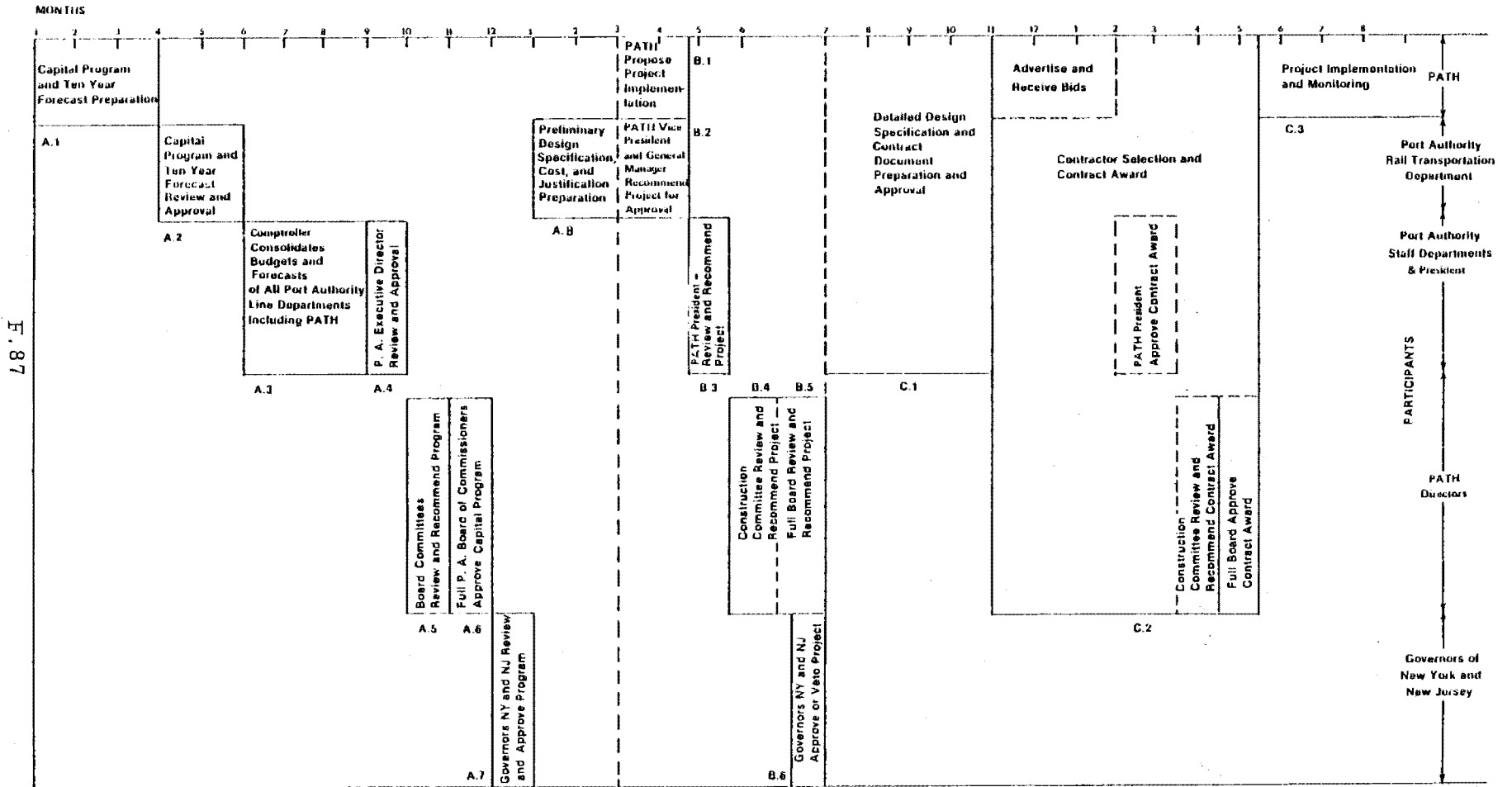
SOURCE: provided by PATH.

Approved:

\_\_\_\_\_  
Acting Chairman

EXHIBIT F-30

OVERVIEW OF PATH'S RAIL MODERNIZATION PROJECT PREPARATION, REVIEW, APPROVAL, AND IMPLEMENTATION PROCESS



phase in the PATH rail modernization funding process. Each of the activities in this phase of the process are briefly described below.

### C.1 - Detailed Engineering Design Specifications and Contract Documents Preparation and Approval

Final detailed design specifications and contract documents are generally not prepared for a PATH rail modernization project until after a project has received funding approval. For very small projects, detailed design specifications may not be necessary.

Detailed engineering design specifications for PATH rail modernization projects can be prepared by:

- . Rail Transportation Department engineers;
- . Port Authority engineers from specific staff departments; or
- . a consultant or contractor.

Generally, Rail Transportation Department (RTD) engineers prepare the designs. In instances where the rail modernization project is particularly large or if the RTD engineers are unavailable, engineers from the Port Authority Engineering Department will participate in design preparation for PATH rail modernization projects. Consultants are sometimes used. Only when there is an unusual work backlog or if additional expertise is needed will PATH rail modernization projects be designed by an outside firm under contract.

All contract documents for PATH rail modernization projects must be reviewed before a contract can be advertised. It is the responsibility of the RTD to ensure that the contract documents are reviewed by Port Authority staff departments including:

- . Finance;
- . Law;
- . Risk Management; and
- . EEO.

Once detailed design specifications are prepared and approved by the Chief Engineer of the Port Authority and all contract documents have been prepared and reviewed by the necessary staff departments, the contractor selection can begin.



## C.2 - Contractor Selection and Contract Award

Contractor selection and award for PATH rail modernization projects include the following activities:

- Advertise and Receive Bids - Once engineering design specifications and contract documents have been approved, the contract can be advertised and bids received. PATH utilizes open and competitive bidding on contracts whenever possible.
- Open and Review Bids - Sealed bids are opened on a specified date and the apparent low bidder is announced. A review is then conducted to ensure that the contractor is qualified and that the bid is fully responsive to contract requirements. RTD engineers and planners perform the review in conjunction with Port Authority staff departments, including Engineering, Finance, Law, and EEO.
- Hold Low Bid Interview - An interview is held with the contractor that submitted the lowest bid. Issues that need clarification are discussed and questions are asked to ensure that the contractor is fully qualified and responsive to contract requirements.
- Award Contract - If exception is not taken to the contractor, the contract is awarded to the lowest bidder subsequent to committee and Board approval, when required.

Contracts are generally awarded with 45 days from the date that bids are opened. Only in unusual circumstances do these activities require additional time.

## C.3 - Administration of Project Implementation

Once a contract has been awarded, implementation of the rail modernization project can begin. The Rail Planning Division of RTD generally has overall responsibility for administering project implementation. Often Rail Planning is assisted by Port Authority staff departments, including Engineering.

Contractor performance during project implementation is monitored for most PATH modernization projects on a weekly or biweekly basis by a construction supervisory group in the RTD. The construction supervisor, who is familiar with the project, including its budget and schedule, works closely with the contractor to ensure that projects are completed on time, within budget, and according to project specifications.

Contractor performance on extremely large, complex PATH projects is monitored through a more sophisticated monitoring approach called the critical path method (CPM). The project schedule and costs are closely tracked through a computerized monitoring system which presents actual versus planned performance toward project implementation.

A third type of project monitoring is performed during the implementation of PATH projects. This monitoring is conducted for all projects, independent of project size or complexity. The Port Authority monitors the costs to administer each project. These costs are largely incurred in the time expended by PATH and other Port Authority employees to prepare final design specifications and oversee project implementation. A computerized report is prepared monthly in conjunction with this monitoring activity.

## APPENDIX A

### LIST OF CAPITAL PROGRAMS BY REQUESTING DEPARTMENT

#### CAR MAINTENANCE

CM 01 Individual Projects Car Maint  
 CM 02 Car Door Modernization  
 CM 03 Shop Modern./Renab.  
 CM 04 Traction Motor Fault Detectors  
 CM 05 Mechanical And Motorized Equip  
 CM 06 Retrofit Cars With Air Condit  
 CM 07 Subway Car Replacement  
 CM 08 Car Sign Modification

#### CONTROLLER

CT 02 Management Information Systems

#### MAINTENANCE OF WAY

MW 01 Individual Proj. Maint. of Way  
 MW 02 Automatic Treadle-Escalators  
 MW 03 Escalator Replacement  
 MW 04 Escalator Rehabilitation  
 MW 05 Elevator Modernization  
 MW 06 Maint. Equip. And Machinery  
 MW 07 Auto Trucks and Service Veh.  
 MW 08 Employee Facilities  
 MW 09 Yard Rehabilitation  
 MW 10 Work Train and Special Equip.  
 MW 11 Contact Rail Replacement  
 MW 12 Water Conditions Remedy  
 MW 14 Relay Code System Replacement  
 MW 15 Signal Compressor System Mod.  
 MW 16 Emergency Alarms Replacement  
 MW 17 Tele. Cable Equip. Modern.  
 MW 18 Tunnel Lighting Rehabilitation  
 MW 19 Pumping Facilities Renab.  
 MW 20 Wooden Platform Replacement  
 MW 21 Grade Time Signaling At Term.  
 MW 22 Line Structure Rehabilitation  
 MW 23 Plat. Roofs And Canopies Repl.  
 MW 24 Vent Plant Rehabilitation  
 MW 25 Power Facilities Rehab.  
 MW 26 Mainline Track Rehabilitation  
 MW 27 New Maintenance Facilities  
 MW 28 Track Switch Replacement  
 MW 29 Heating and Boiler Replacement  
 MW 30 Disch., Fire And Water Line Repl.  
 MW 31 Yard Lighting  
 MW 32 Protection Barrier And Fencing  
 MW 33 Shop And Bldg. Rehabilitation  
 MW 34 Turnstiles Replacement  
 MW 35 Solid State Code System Repl.  
 MW 37 Drip Pan Replacement  
 MW 38 Track Lubricator Installation  
 MW 40 Signal Cable And Mess Wire Repl.  
 MW 41 Roofing Repair and Replacement

#### ENGINEERING

EN 01 Individual Projects Eng.  
 EN 02 Noise Abatement  
 EN 03 Vent Plant Modernization  
 EN 04 New Queens Route  
 EN 05 Abrasive Warning Strips  
 EN 06 Adopt. A-Station Program  
 EN 07 Improved Signage  
 EN 08 Station Lighting Modernization  
 EN 09 Signal System Modernization

#### POLICE

PL 01 Individual Projects-Police  
 PL 02 Closed Circuit TV Surveillance

#### POWER

PW 01 Individual Projects-Power  
 PW 02 Substation Enclosures IRT-BMT  
 PW 03 Substation Equip. Mod. IRT-BMT  
 PW 04 Substation Equipment Mod. IND

#### SURFACE

SF 01 Individual Projects-Surface  
 SF 02 New Buses  
 SF 03 Bus Radios  
 SF 04 Mechanical And Motorized Equip.  
 SF 05 Auto Truck and Service Vehicle  
 SF 06 New Depots And Facilities  
 SF 07 Depot Modern./Renab.  
 SF 08 Bus Washor Modernization  
 SF 09 Bus Storage Enclosures  
 SF 10 Bus Hoist Modernization  
 SF 11 Security And Safety  
 SF 12 Firewall Removal  
 SF 13 Boiler Replac. And Conversion  
 SF 14 Fuel Storage Tanks

#### STATIONS

ST 01 Individual Projects-Stations  
 ST 03 Employees Facilities  
 ST 04 Inter-Communication System

#### TRANSPORTATION

TR 01 Individual Projects-Transport.  
 TR 02 Employee Facilities

SOURCE: Provided by NYCTA Engineering Department.

APPENDIX B

NEW YORK CITY TRANSIT AUTHORITY  
OFFICE OF THE EXECUTIVE OFFICER  
RAPID TRANSIT

JAN 9 1978

FROM: Steven K. Kauffman, Executive Officer, Rapid Transit  
TO: John T. O'Neill, Executive Officer and Chief Engineer  
SUBJECT: 1979-80 EXECUTIVE OFFICER PRIORITY LIST

Attached, herewith, is the revised 1979-80 Executive Officer Priority List. It is my understanding that upon completion of the development of scopes for the listed projects by the Engineering Department a reevaluation of priorities will be made by me for final submission to your office.

STEVEN K. KAUFFMAN

Steven K. Kauffman  
Executive Officer  
Rapid Transit

OLB1:sh

cc: T. Sergio  
C. Turin  
F. Palotta  
J. Apanasevich  
RT File

SOURCE: Provided by NYCTA Rapid Transit Department.

APPENDIX B (CONTINUED)

NEW YORK CITY TRANSIT AUTHORITY

1 YEAR CAPITAL BUDGET PROGRAM

1979-80

Description	Budget Estimate \$ Million		Dept. Prior.
	Per Item	Cumula- tive	
1. Remedy Water Conditions	5.0		MW 1
2. Rehabilitation of Line Structures, (Crown St., etc.)	6.50		MW 4, MW 8, MW 34
3. Rehabilitation of Overage Pumping Facilities	1.5		MW 2
4. Furnish and Install Power Rectifier Equipment (P-221)	16.5		PWR 1
5. Replace Ventilating Equipment	4.0		MW 3
6. Door Modernization and Reliability	8.05		CM 2
7. Replace Messenger and Signal Cable	3.0		MW 5
8. Replace 75 lb Contact Rail with 150 lb	4.5		MW 6
9. Construct & Renovate Enclosures for P-222	5.4		PWR 2
10. Replace Telephone Cable	1.5		MW 7
11. Replace Power Cable & Construct CB Houses	5.0	(60.95M)	MW 8
12. Air Conditioning Retrofit	18.5		CM 1
13. Rehabilitation of Overage Escalators	0.5		MW 13
14. Noise Abatement - Rehab. of Mainline Track	4.0		MW 9

(83.95M)

## APPENDIX B (CONTINUED)

1979-80

Description	Budget Estimate \$ Million		Dept. Prior.
	Per Item	Cumula- tive	
15. Replacement of Overage Fire, Water & Discharge Lines	3.0	(86.95M)	MW 10, MW 56
16. Replace Overage Escalators and Elevators	2.5		MW 11
17. Shop Equipment for Coney Island Shop	0.25		CM 3
18. Replacement of Track Switches with AREA Switches	4.0		MW 12, MW 33
19. Intercommunication System - Phase 3 of 3	1.1		STA 1
20. Replace Special Equip. & Work Trains	3.2		MW 14, MW 61
21. Expand Communication Facilities in Command Center for Div. A.	4.5		RT 3
22. Modernization of Signal Equipment	15.0	(117.500M)	MW 15
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23. Replace Maintenance Equipment & Machinery	1.0		MW 16
24. Auto/Truck & Service Vehicle Program	0.275		MW 17
25. Rehabilitation of Tunnel Lighting	5.0		MW 19
26. Shop Equipment for 207th St. Shop	0.25		CM 4
27. Construct Maintenance Facilities at Three Locations	3.5		MW 21, MW 24
28. Modernization of ENY Yard Track & Equipment	15.0		MW 25
29. Replace Roofing at Various Locations	1.2		MW 20, MW 26
30. Erect Barriers	0.6	(144.325M)	MW 23, MW 57

## APPENDIX B (CONTINUED)

1979-80

Description	Budget Estimate \$ Million		Dept. Prior.
	Per Item	Cumula- tive	
31. Replace Overage Turnstiles	1.0		MW 24, MW 47
32. Car Signage	3.8		CM 5
33. Rehabilitation of Three Shops	1.5		MW 27, MW 13
34. Replace Overage Heating Systems	1.25	(151.875M)	MW 18, MW 53
35. Construct Central Reporting Points for RR Porters	0.5		STA 2
36. Rehabilitation of Employee Facilities	0.7		MW 29
37. Purchase Power Rect. Equip.	4.62		PWR 3
38. Rehabilitation of Yard Lighting	1.0		MW 22
39. Replacement of Solid State Signal Code Systems	6.0		MW 26
40. Rehabilitation of Station Lighting	4.5		MW 28, MW 45
41. Modernization of Pit Lighting; Pelham & 240th St.	0.275		CM 6
42. Noise Abatement - Installa- tion of Track Lubricators	2.0	(171.47M)	MW 31
43. Construct Access & Control Area at Grand Central, Flushing Line	3.795		STA 4
44. Convert Hand Throw Switches To Tower Operation, Rock'wy Line	1.3		RT 4
45. Additional Lighting Westchester Yard	0.12		RT 7
46. Talk-back Systems Various Yards	0.3		RT 8

(176.985M)

## APPENDIX B (CONTINUED)

1979-80

Description	Budget Estimate \$ Million.		Dept. Prior.
	Per Item	Cumula- tive	
47. Rehabilitate Terminal Crew Quarters at Woodlawn	0.25		RT 10
48. Sewerage and Drainage System, Pelham	0.275		CM 7
49. Replacement of Drip Pans	0.6		MW 30, MW 55
50. Fluorescent Lighting - "F Line" - B'klyn.	1.00	(179.11M)	STA 3
51. Replace existing three (3) escalators at 181st St. Sta. with two (2) new escalators	1.00		MW
52. Replace Wooden Walkway Rkwy Pkwy LL Line	0.2		STA 6
53. Rehabilitate 86th St. Station Lex. Ave. Line	1.9		STA 11
54. Installation of Continuous Welded Rail	2.5		MW 32
55. Public Address System - All Shops	0.18		CM 8
56. Relocate Car Wash at 207th St.	0.275	(185.165M)	CM 9
57. New Telephone Cable - White Plains Road Line	1.500		RT 8
58. Rehabilitate Woodlawn Terminal Crew Quarters	.500		RT 9
59. Install Escalator at B'dway - E.N.Y. Station, "A" Line	.800		STA 7
60. Install Talk-back Systems, Various Yards	1.000		RT 11
61. Install Escalator Between 4th Ave. "F" Line (B-2 Div.) and 9th St. Station (Div. B-1)	.800		STA 8



APPENDIX B (CONTINUED)

1979-80

Description	Budget Estimate \$ Million		Dept. Prior.
	Per Item	Cumula- tive	
62. Rehabilitate Grand Central Station (Phase I of III)	2.00		STA 10
63. Revise Various Radio Base Stations, Div. A & B	1.500		RT 12
64. Install New Escalator at Queensboro Plaza Station	1.200		STA 9
65. Rehabilitate Times Square Station	2.00		STA 12
66. Improve Lighting Various Yards (Westchester, 174th St., etc.)	1.00		RT 13, 16
67. New Control Area, Stairway, Escalator, 72nd St. Station, B'way-7th Ave. Line	4.00	(201.465M)	STA 5

## APPENDIX C

COPIES SENT TO

NEW YORK CITY TRANSIT AUTHORITY

DATE  
FROM: C. Kalkhof, Assistant General Superintendent  
Maintenance of Way  
TO: T. G. Sergio, Capital Budget Liaison  
SUBJECT: 3 YEAR CAPITAL BUDGET PROGRAM 1979-80, 1980-81 and 1981-82

The Maintenance of Way Department's 3 year Capital Budget Program, commencing 1979-80, is attached. This program supersedes the 5 year program that was transmitted with our letter of May 31st. That 5 year program should be voided and copies destroyed to avoid possible confusion in the future.

The 3 year program is in project priority order. We have attached, at the end of the program, an unprioritized list of individual projects for the year 1979-80. These projects comprise drop-outs from the 1978-79 program and most probably do not represent a final tabulation of projects that we will require for the 1979-80 Capital program.

Next spring, when the final submission for the Capital Budget program is due, we will complete the individual project list and assign priorities by number and letter. For example, if an individual project is to be placed in priority order between continuing projects 19 and 20 it will be assigned the priority 19A. If there are two projects to be placed there, they will become 19A and 19B and so forth, if there are more than two.

Fact sheets for all projects listed for the 1979-80 fiscal year will be prepared and sent to you for review during the next six months. This will enable you to consult with the Engineering Department to obtain accurate estimates of our project requests and, therefore, better plan the Rapid Transit program.

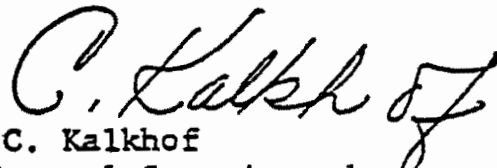
In many cases, the estimates we have given are only "orders of magnitude" and estimates must be obtained from the Engineering Department based on the information we will transmit to you in the fact sheets. We will indicate on the fact sheets those estimates which we feel are accurate and do not require Engineering Department review.

SOURCE: Provided by NYCTA Rapid Transit Department.

APPENDIX C (CONTINUED)

- 2 -

The 10 year Capital Budget program outlining our maximum funding requirements to upgrade our System to "maintainable" levels over the period 1978-79 through 1987-88 will be forwarded to you by July 1, 1977.



C. Kalkhof  
Assistant General Superintendent  
Maintenance of Way

541/DRN/pl  
Attach.

cc: W. H. Anderson  
I. M. Berger  
F. C. Gatto  
All Supts., M/W  
R. Kopera  
D. R. Newman  
File

APPENDIX C (CONTINUED)

PROJECT PRIORITY	DESCRIPTION	MAINTENANCE OF WAY DEPARTMENT 3 YEAR CAPITAL BUDGET REQUEST 1979-80 THROUGH 1981-82 SUMMARY		
		1979-80	1980-81	1981-82
	1. REMEDY WATER CONDITIONS	\$ 5M	\$ 5M	\$ 5M
	2. REHABILITATION OF OVERAGE PUMPING FACILITIES	1.5M	1.5M	1.5M
	3. REHABILITATION OF OVERAGE VENTILATING PLANTS	4M	3M	3M
	4. REHABILITATION OF LINE STRUCTURES	5M	5M	5M
	5. REPLACEMENT OF DEFECTIVE SIGNAL CABLE & MESSENGER WIRE	3M	3M	4M
	6. REPLACEMENT OF 75# CONTACT RAIL WITH 150# RAIL	4.5M	5M	2M
	7. REPLACEMENT OF DEFECTIVE TELEPHONE CABLE	1.5M	1.5M	1.5M
	8. REPLACEMENT OF OBSOLETE POWER CABLE & CONSTRUCTION OF CB HOUSES	4M	2.5M	-
	9. REHABILITATION OF MAINLINE TRACK	7M	7M	7M
	10. REPLACEMENT OF OVERAGE DISCHARGE, FIRE & WATER LINES	2.5M	2.5M	2.5M
	11. REPLACEMENT OF OVERAGE ESCALATORS & ELEVATORS	2.5M	1.75M	1.8M
	12. REPLACEMENT OF TRACK SWITCHES WITH A.R.E.A. SWITCHES	2.5M	3.5M	2.5M
	13. REHABILITATION OF OVERAGE ESCALATORS	.5M	.5M	.5M
	14. PURCHASE OF NEW OR REPLACEMENT OF OBSOLETE SPECIAL EQUIPMENT & WORK TRAINS	2.8M	3.45M	2.6M
	15. MODERNIZATION OF SIGNAL EQUIPMENT	25M	20M	25M
	16. PURCHASE OR REPLACEMENT OF MAINTENANCE EQUIPMENT & MACHINERY	1M	1M	1M
	17. PURCHASE NEW OR REPLACEMENT AUTOMOTIVE TRUCKS	.275M	.25M	.2M

F.100

APPENDIX C (CONTINUED)

3 YEAR CAPITAL BUDGET REQUEST  
1979-80 THROUGH 1981-82 SUMMARY

PROJECT PRIORITY	DESCRIPTION	1979-80	1980-81	1981-82
18.	REPLACEMENT OF OVERAGE HEATING SYSTEMS AND BOILERS	\$ .25M	\$ .75M	\$ .4M
19.	REHABILITATION OF TUNNEL LIGHTING	5M	6M	3M
20.	REPLACEMENT OF ROOFING	.9M	.6M	1.5M
21.	CONSTRUCTION OF ADDITIONAL MAINTENANCE FACILITIES	2M	2M	1.5M
22.	REHABILITATION OF YARD LIGHTING	1M	1M	1M
23.	ERECTION OF BARRIERS TO PREVENT MISSILE THROWING	.3M	.25M	.25M
24.	REPLACEMENT OF OVERAGE TURNSTILES	.5M	.7M	1M
25.	REHABILITATION OF YARDS	15M	15M	15M
26.	REPLACEMENT OF SOLID STATE SIGNAL CODE SYSTEMS	6M	6M	10M
27.	REHABILITATION OF SHOPS	1M	1M	1M
28.	REHABILITATION OF STATION LIGHTING	3M	3M	4M
29.	REHABILITATION OF EMPLOYEE FACILITIES	.7M	.7M	.7M
30.	REPLACEMENT OF DRIP PANS	.3M	-	-
31.	INSTALL TRACK LUBRICATION	2M	2M	2M
32.	INSTALLATION OF CONTINUOUS WELDED RAIL	2.5M	2.5M	2.5M
CONTINUING PROJECT TOTALS:		\$113.025M	\$107.95M	\$107.95M

U.S. GOVERNMENT PRINTING OFFICE: 1980-308-935/6775

F. 101

