U.S. Department
of Transportation
**Federal Railroad
Administration**

NORTHEAST CORRIDOR:
ACHIEVEMENT AND POTENTIAL

United States Department of Transportation
November 1986

Submitted in accordance with Section 703 (1)(E) of the Railroad Revitalization and Regulatory Reform Act of 1976, as amended.

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

November 4, 1986

The Honorable George Bush
President of the Senate
Washington, DC 20510

Dear Mr. President:

In response to Section 703(1)(E) of the Railroad Revitalization and Regulatory Reform Act of 1976, I am pleased to submit to you an updated comprehensive report on the Northeast Corridor Improvement Project.

Sincerely,

Elizabeth Hanford Dole

Enclosure

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WASHINGTON, D.C. 20590

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The Honorable Thomas P. O'Neill, Jr.
Speaker of the House of Representatives
Washington, DC 20515

Dear Mr. Speaker:

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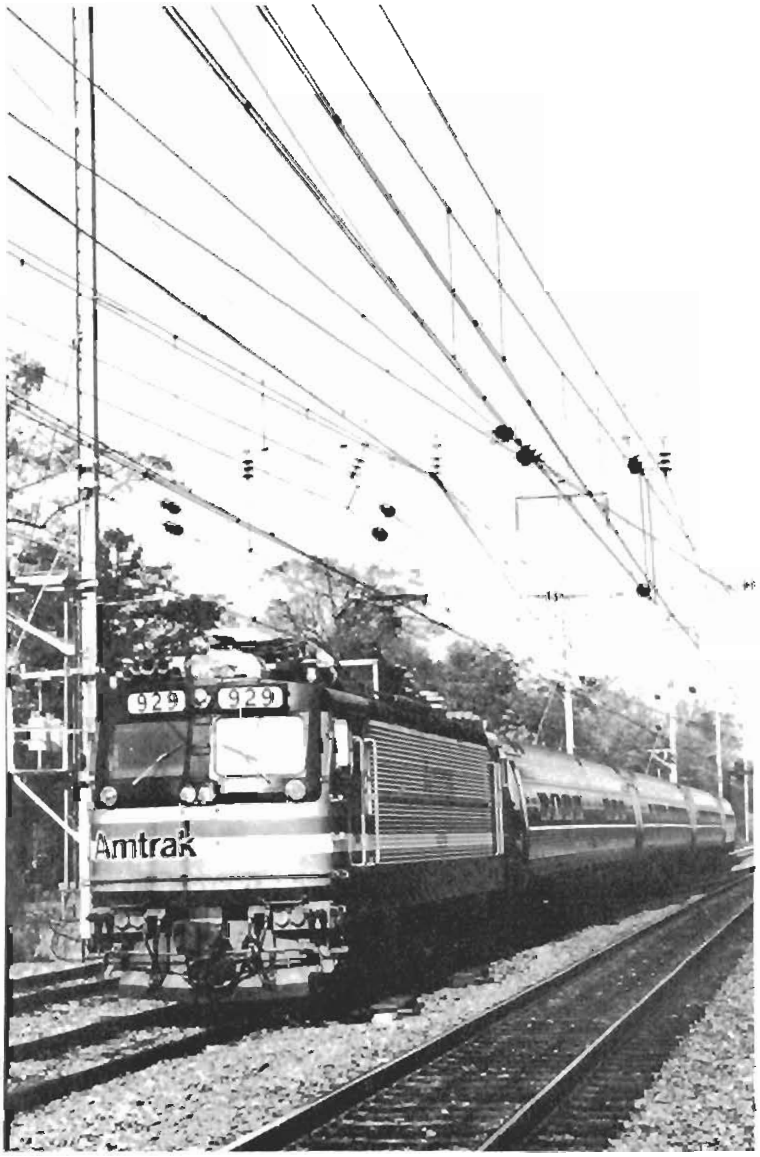
Executive Summary



A Metroliner Service train speeds through the Northeast Corridor over continuous welded rail laid on concrete ties. The Northeast Corridor is the busiest and fastest segment of railroad in America.

EXECUTIVE SUMMARY

The Northeast Corridor Improvement Project (NECIP) -- in its size, complexity, cost, and successful outcome -- represents the largest Federal investment in intercity rail passenger service in this century. This report describes the NECIP, assesses its accomplishments, and offers a perspective on the future of Amtrak's service in the Corridor.

BACKGROUND

In the 1960's, the Northeast Corridor (NEC) region, stretching from northern Virginia to southern Maine, housed the densest population in the United States. Its metropolitan areas had grown so close together, their social, commercial, and industrial activities had become so closely linked, that some observers discerned the outlines of a super city, a "megalopolis," which in its immensity faced the same transportation congestion on the regional level as its component cities did on their local level. Transportation experts in the NEC began to look to regional rail transportation as a viable alternative to the overcrowded air and highway modes linking Boston, New York, Philadelphia, Washington, and the important cities in between.

The Pennsylvania and New Haven railroads had, since the nineteenth century, invested millions of dollars of private capital in a passenger railroad along the Northeast Corridor. The Pennsylvania (PRR), with its formerly vast resources, had made its New York -- Washington line a showpiece; it had installed multiple heavy- duty tracks, added electric traction, realigned curves, built grade-separated junctions analogous to the cloverleafs of modern highways, and erected grand stations.

Since the 1940's, the financial decline of the Northeastern railroads had starved the NEC main line of capital and led to the deterioration of its physical components and services, with consequent declines in ridership and financial results. Proponents of improved high speed rail in the NEC held that Federal investment in capital improvements would help not just to reverse the deterioration in the once-proud facility, but to increase its capabilities, particularly in terms of scheduled trip times between New York, Washington, and Boston. As the years of planning and discussion sped by, the facility itself continued to deteriorate; inflation caused construction costs to balloon; the management of corridor services and the ownership of its facilities, formerly in the hands of two private companies, became more and more fragmented among commuter, freight, and intercity passenger entities with conflicting priorities. By the time Congress had authorized and funded the project, the physical facility that had held so much promise had literally begun to disintegrate at its northern and southern termini. So advanced was the physical degradation that the twin goals of achieving substantial trip time reductions and restoring the Corridor to its best capabilities of the 1940's had, paradoxically, become contradictory. The former could be done completely, but only by temporizing on essential maintenance items; the latter could be accomplished, but only by omitting many trip-time improvements.

Overcoming all these institutional, engineering, and financial complexities, the NECIP succeeded in providing the capability of offering a transportation product in the NEC that constitutes the Nation's first rapid transit *system on a regional scale. This report documents that achievement, and looks at the future.*

THE ACHIEVEMENT

As a coordinated set of improvements to the fixed railroad plant, the NECIP has enabled Amtrak to offer faster, more reliable, and more comfortable service between Boston, New York, and Washington. (See Table ES-1.) Amtrak itself has capitalized on its expanded capabilities by acquiring new equipment and by offering the public an improved transportation product.

The Federal Railroad Administration (FRA) of the U. S. Department of Transportation was responsible for the general management of the NECIP, for which DeLeuw, Cather/Parsons was the engineering management contractor. Amtrak participated substantially in both the planning and the construction phases of the Project as the principal operator and construction contractor.

THE PRODUCT

By 1986, at a cost substantially below that authorized by Congress, the NECIP will have made possible trip times of 2 hours, 36 minutes between New York and Washington with four intermediate stops -- four minutes faster than the legislated goal of 2 hours, 40 minutes. Between New York and Boston, trip times in 1986 will have improved from their 1976 levels by up to 10 percent. Amtrak will have achieved these tighter schedules while improving on-time performance. Accompanying these schedule and reliability accomplishments has been a coordinated effort by the NECIP, Amtrak, and local authorities to upgrade every aspect of rail passenger convenience and comfort. New and renovated parking garages, intermodal connections, station buildings, and train equipment have enabled passengers to reach the rail system comfortably and to enjoy their trips.

FIXED PLANT IMPROVEMENTS

The fixed plant improvements constituting the NECIP have made possible Amtrak's swifter and more reliable schedules, have contributed to passenger comfort, and have renovated many antiquated system components for more economical maintenance and operation. The fixed plant improvements are listed in Table ES-2 and described below:

Way and Structures

The NECIP has provided a reconfigured, high-quality roadbed for safe, efficient, comfortable operation at reduced trip times. Where economically feasible, the NECIP has rationalized the track layout of the Corridor to reduce congestion among all services. The worst conditions in tunnels and bridges have been corrected. Improvements to the track structure, many of which represented technical advances in the United States, formed the largest single element of the NECIP, and have provided the stability and geometric precision that are essential to economical, safe, and comfortable high speed operations.

TABLE ES-1

THE NECIP IN BRIEF

What is the NECIP?

The Northeast Corridor Improvement Project (NECIP) is a $2.19 billion Federal investment in upgraded intercity railroad passenger service on Amtrak's main line between Boston, New York, and Washington. The upgrading has enhanced all aspects of Amtrak's NEC facility: way and structures, power and control, fencing and grade crossings, service facilities, and stations.

What was its schedule:

Mandated in the Railroad Revitalization and Regulatory Reform Act of 1976, the Project began in that year, reached its construction height in 1980-81, and was substantially complete by the end of calendar 1984. Remaining work, including some important trip-time reductions, will continue through 1986.

What will it achieve?

The NECIP will have given Amtrak the fixed facilities necessary to achieve significant trip time reductions between major cities, for example:

	Trip Time (Hours:Minutes)		
	1976	1986	Percent Improvement
Between New York and Washington:			
Via Metroliner Service	3:00	2:36	12
Via Conventional Service	3:40	2:57	18
Between New York and Boston:	4:24	3:57	7

While speeding up its schedules, Amtrak has improved its reliability.

	Percent of Trains On Time		
	1976	1986	Percent Improvement
Via Metroliner	53	89	36
All trains combined	74	85	11

The NECIP will have also upgraded passenger convenience and comfort. For example, it has enhanced or rebuilt 13 stations and sparked parking additions. It has also markedly upgraded the ride quality of trains.

	In 1976:	In 1986:	Percent Increase
Number of parking spaces close to NEC stations	5149	7909	54

Federal Role:

The U. S. Department of Transportation, Federal Railroad Administration, planned, coordinated, managed, and funded the entire Project. It supervised the prime engineering management contractor (DeLeuw, Cather/Parsons) and negotiated implementing agreements with Amtrak and the many interested State, local and Federal agencies.

Amtrak's role:

Amtrak owns and operates the NEC and has contributed to the NECIP's success by managing the major portion of the construction, by participating in planning of both improvements and related operations, and by upgrading its own equipment and marketing the service.

The bottom line:

A world class facility . . . a modern, efficient rapid transit system which links the improved public transit and commuter rail systems of the constituent metropolitan regions.

Table ES-2

FIXED PLANT IMPROVEMENTS CENTRAL TO THE NECIP
(Status as of project completion)

WAY AND STRUCTURES

Section Improvements:	o	Curves realigned at 22 locations
	o	36 interlockings (crossover points) built new or reconfigured, 7 interlockings removed
	o	Roadbed drainage improved or restored throughout NEC
Tunnels:	o	In Baltimore & Potomac Tunnel, Baltimore: complete track replacement and structural improvements including new drainage facilities. Track rehabilitation in New York City tunnels.
Bridges:	o	202 bridges rehabilitated (including 10 movable bridges); 10 bridges replaced (including 2 movable bridges).
Track Improvements:	o	Concrete ties installed in 410 track-miles
	o	735,000 wooden ties installed in 650 track-miles
	o	Continuous welded rail installed in 535 track-miles
	o	634 track-miles resurfaced for high-speed operation
	o	Track structure rehebilitation of 65 interlockings
	o	Advanced equipment provided to meet Amtrak's future track upkeep and upgrading needs

POWER AND CONTROL

Electrification:	o	Between Queens and New Rochelle, New York: Conversion of power supply to 12.5kV, 60Hz, with major rehabilitation of catenary system
	o	Between Queens, New York, and Washington: Selective repair of critical elements of existing catenary system
Signaling:	o	64 mechanically-locked interlockings converted to all-electric operation
	o	Proportion of track-miles signaled for bi-directional operation increased from 25 percent to 56 percent
	o	Centralized traffic control introduced between Washington and Wilmington, and in Boston vicinity.

OTHER ESSENTIAL PROJECT ELEMENTS

Grade Crossings:	o	Two-thirds of NEC highway grade crossings extant prior to NECIP eliminated, including last remaining public crossings between Washington and New Haven
Service Facilities:	o	New, renovated, or augmented facilities installed at Washington, Wilmington, New York, New Haven, and Boston for all levels of equipment repair, inspection, storage, washing, and servicing
	o	Four new maintenance-of-way bases constructed to support Amtrak's track upkeep
Stations:	o	Three new stations constructed (Providence, RI, Stamford, CT, New Carrollton, MD), ten existing stations improved or rehabilitated
	o	At existing stations: improvement of passenger safety, comfort, processing, and platform access; rehabilitation of essential building systems and repair work to assure continued occupancy; and provision of access to handicapped
	o	With shared state/local funding: improvement of commuter facilities in 12 stations, parking additions at 6 stations

Power and Control

The NECIP has performed essential work on the electrical catenary system between Washington and New York, and is rebuilding the power supply and catenary between New York and New Rochelle. Between Washington and Wilmington, Delaware, and between Cranston, Rhode Island, and Boston, the NECIP is installing a centralized traffic control system and replacing the antiquated mechanical apparatus of interlockings with modern electrical devices. Essential signal rehabilitation and replacement has taken place throughout much of the rest of the Corridor.

Grade Crossings and Fencing

Between New Haven and Washington, a joint Federal/state program partially funded by the NECIP has eliminated all rail/highway grade crossings. North of New Haven, eleven public grade crossings remain. Congress has required the retention of five additional crossings in Connecticut. Where essential for public and railroad safety, the NECIP has provided fencing of the right-of-way.

Service Facilities

To support economical upkeep, the NECIP has constructed maintenance of way bases at Odenton and Perryville, Maryland, Adams, New Jersey, and Providence, Rhode Island, and has upgraded or built equipment servicing facilities at Boston, New Haven, New York, Wilmington, and Washington.

Stations

The NECIP has built, restored, or rehabilitated thirteen stations throughout the Corridor for more efficient operations and improved passenger comfort. In the process, the project architects won ten prestigious design awards testifying to the scrupulous aesthetic care devoted to the station efforts.

OPERATING RESULTS OF NEC SERVICE

The $2.19 billion Federal investment in NECIP has provided for significantly improved rail service and has enabled Amtrak to compete more effectively with other modes. Rail ridership has only recently reacted strongly to the improved service. The delay in this reaction stems partially from price competition with other modes; from the fare policy that Amtrak has chosen to adopt in order to meet mandated revenue-to-cost ratio goals; and from the time it has taken the public to recognize the improvements in Amtrak's NEC product after several years of construction-related service disturbances. Also, other economic factors, such as the strength of the national economy, have impacted ridership levels.

Although slow to appear, the ridership increases have proven to be substantial. For example, in FY 1985, patronage in the New York -- Washington city pair alone was 23 percent over FY 1983. In the New York -- Boston market, where Amtrak has experimented successfully with creative fares, traffic grew by 41 percent over the same two-year span. As the improved product, coupled with

Amtrak's marketing initiatives, continues to enhance traffic volumes, the positive implications of the NECIP for Amtrak's revenue base will become apparent.

BENEFITS BEYOND AMTRAK SERVICE

NECIP has contributed to many benefits that do not pertain directly to intercity passenger rail transportation: the enhancement of railroad freight and commuter services; urban redevelopment; minority contracting and employment; and general employment levels.

Railroad Freight and Commuter Enhoncements

The NECIP has invested hundreds of millions of dollars in track and other facilities shared by intercity passenger, commuter, and freight trains. Exemplifying these shared improvements is the major reconfiguration and simplification of the track and signal layout in South Philadelphia, which has made all rail services through the area faster and more reliable.

Urban Redevelopment

The NECIP's station program has sparked or complemented major urban redevelopment efforts in such cities as Providence, Stamford, Wilmington, and Baltimore.

Minority Contracting and Employment

Almost 18 percent of the dollar value of contracts for NECIP work went to minority contractors, an achievement commended as worthy of "special recognition" by the U. S. Commission on Civil Rights in a report which it has recently released. In addition, between 28 and 38 percent of the employees working on the Project were members of minority groups.

General Employment

At its peak, the NECIP provided over 3,000 jobs, mostly in the NEC region. Over the life of the project, the NECIP generated a total of approximately 26,000 man-years of effort.

THE POTENTIAL

Despite its success in providing Amtrak with a physical basis upon which to operate modern intercity service in the NEC, the NECIP has not sought to rehabilitate completely every component of Amtrak's fixed plant and to realize all feasible trip time reductions in the Corridor. Amtrak will therefore need to consider two types of fixed plant investments: first, rehabilitation projects that would reduce operating and maintenance costs and sustain service quality, safety, and revenues; second, further trip time improvements, the justification for which will depend on Amtrak's ridership growth, the demo-

graphic, economic, and commercial trends in the Corridor, and worsening congestion in other modes.

NEAR-TERM INVESTMENT CHOICES

The two largest rehabilitation items remaining on the NEC are the replacement of the existing power generation and supply system and the complete modernization of the signal system.

Electrification

The antiquated 25 cycle power supply system in the NEC continues to deteriorate. If left uncorrected, this deterioration will lead to excessive maintenance costs and could ultimately engender service interruptions affecting Amtrak and the local commuter authorities. Amtrak and interested agencies at all levels of state and local government could jointly undertake a thorough engineering and economic study of Amtrak's New York -- Washington power system to assess the total public costs and benefits (both operational and financial) of alternative electrification strategies. Such alternatives could include: maintenance of the status quo; renewal and modernization of the existing 25 cycle system; and replacement of the present system with commercial frequency power at 60 cycles. The study could also address potential funding sources for electrification improvements.

Signalling

An old electro-mechanical signal system remains in place in many of the most complex and densely used se tions of the Corridor. To reduce future maintenance costs, and to enhance service reliability, Amtrak and the agencies concerned could initiate a long-term, cooperative study of the signal system and of the complicated track layouts that it controls. The study would determine the likely future service needs of NEC users, the optimal program of track layout and signalling modifications and renewals to meet those needs safely, the most efficient means of scheduling such improvements under the stress of NEC operations, and funding options.

Freight/Passenger Separation

To preserve ride quality on the NEC at a reasonable cost, and to upgrade still further the safety and reliability of intercity passenger operations, Amtrak may wish to facilitate the removal of some or all through freight service from the Corridor south of New York. Any such changes in freight operations would reflect carefully considered business decisions by, and would require very close cooperation among, Amtrak, the NEC freight operators (Conrail and the Delaware & Hudson), the Chessie System, and possibly other carriers.

TRANSPORTATION TRENDS AND PROJECTIONS IN THE NEC

Amtrak, with its enhanced service capabilities in the NEC, now has the opportunity to prove whether improved high speed rail can become a major contributor to the transportation of very large masses of people. Such concrete proof is now beginning to emerge: in four key city-pair markets, passenger volume was higher by 23 percent in the first seven months of FY 1985 than in the same period two years ago. To confirm the potential of rail, continued ridership growth is all the more necessary because demographic and economic trends offer ambivalent indications about the future. While population and income in the Eastern Seaboard region are expected to grow through the year 2000, the long-term population growth rate of some metropolitan regions lying at the heart of the NEC rail market slowed between 1970 and 1984. Yet congestion in other modes is growing at those very same locations, and the FAA forecasts increases in operations at major NEC airports of from 60 to 75 percent by 1990. Such contradictory trends underline Amtrak's need to build on its recent patronage increases if still further trip time improvements are to be justified.

OPTIONS FOR PRODUCT IMPROVEMENT

Improvements to the NEC product beyond 1986 levels may come about in two ways: (1) marketing experiments and vehicle initiatives not requiring fixed plant investments; and (2) enhancements of the fixed plant for trip time purposes.

Amtrak already has much freedom to adjust its trip times, frequencies, passenger amenity levels, and fares. It has some flexibility to alter equipment scheduling and, over a longer term, to adjust its fleet composition. In varying combinations, these freedoms could contribute to a product that is at once more attractive to passengers and more remunerative for Amtrak. For example, in 1986 Amtrak could theoreticaly operate a nonstop train between Washington and New York on a 2 hour, 22 minute schedule with no additional fixed plant investment. (This assumes two locomotives and, if approved by the FRA Office of Safety, a 125 mph speed limit.)

A financial analysis of a range of fixed plant improvements suggests that additional trip time savings would raise passen er traffic volume by 3 to 13 percent in total, but that the resultant improvements in Amtrak's profitability would not provide a material financial return on the initial capital investments required (Table ES-3). Between New York and Washington, these investments would be relatively large per minute saved because the NECIP has already performed virtually all the lower-cost, time-saving fixed plant improvements in the southern half of the Corridor. North of New York, some opportunities still exist to improve travel times at a comparatively low cost per minute saved.

The forecasts are essentially extrapolations of Amtrak's historical ridership and cost patterns; if Amtrak is able to score dramatic patronage increases and cost reductions in the coming years, the prospective financial and ridership benefits of additional fixed plant investments will improve markedly. The NECIP has given Amtrak many tools with which to effect such ridership and efficiency gains. The rest is up to Amtrak.

TABLE ES-3

FINANCIAL ANALYSIS OF FIXED PLANT TRIP TIME INVESTMENTS
(Dollars are constant 1985)

Alternative Number	Components of alternative in each half of NEC: New York - Washington: Description	New York - Washington: Trip Time	New York - Boston: Description	New York - Boston: Trip Time	Initial Capital Costs ($ Millions)	Comparison with Alternative A (No Investment[b]): Forecast Year 1995: Increase in Passenger Miles (Percent)	Forecast Year 1995: Improvement in Operating Results ($ Millions)	Net present Value[a] Better or (worse) than Alternative A ($ Millions)
A	No investment[b]	2:36	No investment[b]	3:58	0	0	0	0
B	No investment[b]	2:36	Upgrade New Rochelle --New Haven	3:40	60	3%	5	(86)
C	Inexpensive reconfigurations/realignments	2:29	Electrify New Haven --Boston	3:14	512	8%	4	(449)
D	Costlier curve realignments	2:23	Electrify and realign New Haven -- Boston	3:09	932	9%	2	(808)
E	160 mph system	2:16	160 mph system	2:51	4620	13%	29	(2992)

[a] Discounted cash flow at 10% interest over 20 years. Both initial capital investments and annual operating results are included in this calculation.

[b] That is: nothing beyond the existing $2.19 billion NECIP.

REPORT MANDATE

Excerpt from Railroad Revitalization and Regulatory Reform Act of 1976, as amended:

Sec. 703. The Northeast Corridor improvement project shall be implemented by the Secretary in order to achieve the following goals...

(1)(E): Within 2 years after the date of enactment of this Act, the submission by the Secretary to the Congress of a report on the financial and operating results of the intercity rail passenger service established under this section, on the rail freight service improved and maintained pursuant to this section, and on the practicability, considering engineering and financial feasibility and market demand, of the establishment of regularly scheduled and dependable intercity rail passenger service between Boston, Massachusetts, and New York, New York, operating on a 3-hour schedule, including appropriate intermediate stops, and regularly scheduled and dependable intercity rail passenger service betweeen New York, New York, and Washington, District of Columbia, operating on a 2 1/2-hour schedule, including appropriate intermediate stops. Such report shall include a full and complete accounting of the need for improvements in intercity passenger transportation within the Northeast Corridor and a full accounting of the public costs and benefits of improving various modes of transportation to meet those needs. If such report shows (i) that further improvements are needed in intercity passenger transportation in the Northeast Corridor, and (ii) that improvements (in addition to those required by subparagraph (A)(i) of this paragraph) in the rail system in such area would return the most public benefits for the public costs involved, the Secretary shall make appropriate recommendations to the Congress. Within 9 years after the date of enactment of this Act, the Secretary shall submit an updated comprehensive report on the matters referred to in this subparagraph...

INTRODUCTION

In the 1960's and early 1970's, population growth and burgeoning intercity travel demand in the Northeast Corridor (NEC) -- the Nation's most densely populated area, stretching from Boston to New York and Washington -- was threatening to outstrip the capacity of the highway and air systems. Meanwhile, the transportation mode capable of accommodating the increasing demand in an environmentally beneficial way -- intercity rail -- was steadily deteriorating physically, operationally, and financially. The Federal Government addressed this paradoxical situation in the Railroad Revitalization and Regulatory Reform Act of 1976, which established the Northeast Corridor Improvement Project (NECIP), a coordinated set of improvements to the fixed plant of Amtrak's Boston -- New York -- Washington main line. Ultimately funded at $2.19 billion and managed by the Federal Railroad Administration (FRA) of the U. S. Department of Transportation, the NECIP, in conjunction with new equipment and other improvements under Amtrak's direct jurisdiction, was intended to provide Amtrak with the physical capability to operate a fast, reliable, comfortable, and economically sound rail passenger service in the Corridor.

Although some work remains to be done, the NECIP as a whole is now substantially complete. This report, responding to a Congressional mandate, offers an account of the achievements of the Project and a perspective on the future of intercity passenger transportation in the Corridor region.

The achievements of the NECIP (addressed in Part I) are impressive from many viewpoints. Since improved passenger service, rather than physical improvements and expenditures for their own sakes, motivated the NECIP and the associated Amtrak investments, Chapter One evaluates the Project's accomplishments from the passenger's point of view. Chapter Two then specifies the NECIP's engineering achievements in some detail. Chapter Three reviews the ridership trends in NEC services; these trends reflect not just the benefits of the NECIP but also the national economic picture and Amtrak's own efforts to improve its ratio of revenues to costs. Finally, the NECIP addressed goals outside the realm of intercity rail passenger service: Chapter Four measures the NECIP's performance in urban development, minority participation, and general employment levels, as well as the effects of the Project on rail freight and commuter services.

Part II of the report scrutinizes future passenger transportation needs in the NEC, both rail and non-rail. The Amtrak main line from Washington to Boston dates back to the mid-nineteenth century, and its physical condition at the outset of the NECIP necessarily varied significantly from one component to the other (track, bridges, signals, and the like) and from place to place. In adhering to its $2.19 billion budget, the NECIP had to replace and rehabilitate components selectively, in keeping with the Project's goals. Chapter Five lists major investments that were not of sufficient National priority for inclusion in the NECIP, but that may eventually merit the attention of Amtrak. The last two chapters assess the justifications for and the costs and benefits of possible improvements in Amtrak's NEC product beyond the level made possible by the NECIP. In large measure, the NEC improvements represented a Federal reaction to demographic and travel patterns as planners projected them in the

1960's and 1970's; it is therefore reasonable to ask whether the patterns in all modes have confirmed those expectations, and whether they are likely to do so in the future (Chapter 6). In conclusion, Chapter Seven responds to the specific Congressional request for an appraisal of the costs and benefits of reductions in rail trip times beyond those achieved or achievable under the NECIP.

Part I: The Achievement

The NECIP has provided Amtrak with the ability to offer a passenger service in the Northeast Corridor that exploits the potential of the rail mode for reliability, convenience, and passenger comfort. While enhancing on-time performance in all services, Amtrak has already substantially reduced scheduled travel times, particularly for travelers on conventional (lower-fare) trains. Between New York and Washington, the NECIP will have made possible a 2-hour, 36-minute trip time (with four stops) -- four minutes better than that required by Congress -- at a cost substantially below the authorized level. Station and track improvements under the NECIP, coupled with transit and parking investments by local authorities and Amtrak's own advances in train equipment and information services, have enhanced the comfort and aesthetics of the travel environment experienced by the Corridor rail passenger. Underlying these advances in passenger convenience and comfort have been $2.19 billion in physical improvements to the fixed plant of the NEC: way and structures, power and control, service facilities, and stations. Many of these investments encompass innovations in railroad technology with applications far beyond the Corridor itself. The effects of the investments in physical improvements on rail ridership and revenues in the NEC are beginning to appear. Finally, the Project has contributed to broader benefits such as urban redevelopment, minority participation, increased employment, and enhancements to rail freight and commuter services.

Chapter One: The Product

Chapter Outline

Trip times and reliability
- *Trip times*
  - *Marketing and geographical factors*
  - *Results*
- *Reliability*
- *Frequency*

The passenger experience
- *Information systems*
- *Access to/egress from stations*
- *The station environmant*
- *The train environment*
  - *Equipment design*
  - *Service facilities*
  - *Ride quality*

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Station pages:
New Carrollton
Baltimore Pennsylvania Station
Wilmington Station
Philadelphia 30th Street Station
Newark Pennsylvania Station
New York Pennsylvania Station
Stamford Station
New Haven Union Station
New London Union Station
Providence Station
Boston South Station

Chapter One

THE PRODUCT

In choosing a mode for an intercity trip, a prospective traveler must weigh a host of factors, both quantifiable and subjective. To attract and retain passengers, therefore, intercity rail must offer not just competitive trip times, on-time performance, and departure frequencies, but also a comfortable and aesthetically pleasing environment at every stage of the journey. The NECIP has succeeded on both fronts: scheduled trip times are both shorter and more reliable, and the passenger environment has advanced to twentieth century standards.

TRIP TIMES AND RELIABILITY

Door-to-door trip times significantly influence a traveler's selection of a mode. Because the NEC stations have strategic locations at the center of major cities, -- in particular, because Amtrak is the only intercity mode with unencumbered high-speed access to the heart of Manhattan, -- rail has always had an inherent time advantage over other modes for center-to-center, short- and medium-distance trips. In essence, the NECIP has extended that inherent time advantage to longer distances by reducing station-to-station travel times considerably. Just as important, the NECIP has enabled Amtrak to adhere to these swifter schedules with a high degree of reliability, and Amtrak has extended the benefits of high-speed service to many more trains serving economy-minded passengers.

TRIP TIMES

Of all the criteria applied to the NECIP, station-to-station trip times have received the most public attention and generated the most controversy, even though many other factors strongly influence ridership and economics. This section assesses the NECIP's trip time achievements, which have been substantial, in light of the rail travel market.

Marketing and Geographical Factors

The Passenger Railroad Rebuilding Act of 1980 specifically established "potential ridership" as a prime criterion for choosing among trip time improvements in the Corridor: "those activities [benefiting] the greatest number of passengers [were to be] completed before those involving fewer passengers." Table 1-1 sets the stage for an evaluation of the NECIP's trip time achievements in light of this criterion; it shows the key city-pair markets in the Corridor in descending order of passenger-miles generated. (It is assumed here that current ridership is the best surrogate for "potential ridership" in the range of trip time reductions presently contemplated for the Corridor.) The table also shows distances involved in each city pair. Of the 17 city pairs generating 78 percent of Corridor ridership, the nine pairs south of New York produce 60 percent of the passenger-miles; the five pairs north of New York account for 13 percent of the passenger-miles; and the three pairs crossing New

TABLE 1-1

AMTRAK NEC RIDERSHIP AND DISTANCES BY CITY-PAIR, 1984

City-Pair	Percent of Passenger Miles: This Pair	Percent of Passenger Miles: Cumulative	Percent of NEC Passengers	Distance (Miles): South of New York	Distance (Miles): North of New York	Distance (Miles): Across New York
New York[a] - Washington	22	22	12	224		
New York - Philadelphia	16	38	23	89		
Washington - Philadelphia	8	46	9	135		
Baltimore - New York	7	53	5	184		
Boston - New York	7	60	4		231	
Wilmington - New York	3	62	3	115		
Providence - New York	3	65	2		188	
Boston - Washington	2	67	1			455
Trenton - New York	2	70	5	57		
Philadelphia - Baltimore	2	71	2	95		
Boston - Philadelphia	2	73	1			320
Trenton - Washington	1	74	1	167		
Wilmington - Washington	1	75	1	109		
New London - New York	1	76	1		126	
Boston - New Haven	1	77	1		156	
New Haven - Washington	1	77	1			299
New Haven - New York	1	78	1		75	
42 Next Flows Below 1% but greater than 0.1% (Av. 0.30% each)	12	90	21			
311 Other Flows (Av. 0.04% each)	9	100	7			

NOTE: Excludes multiride passengers
[a]/ Includes Newark

York result in only 5 percent of the passenger miles.

These marketing facts reflect demographic and historic realities. The Corridor, for better or worse, is divided into two parts (Figure 1-1). South of New York, the population density is greater and the major cities (New York, Newark, Philadelphia, Wilmington, Baltimore, and Washington) are arrayed in an almost perfectly straight line, so that trip-time improvements benefiting one city pair usually benefit others. North of New York the population is less concentrated and, unfortunately from a rail standpoint, the cities are arranged in a parallelogram, only the southern portion of which coincides with the NEC main line. Historically, the non-linear arrangement of population centers in New England combined with the economics of railway location and the vagaries of corporate relationships to force the principal rail line between New York and Boston to follow an indirect route via Providence with an extremely difficult alignment along the Connecticut coast. Neither the present main line, nor any other feasible main line in New England, would have been able to serve as many high-volume markets simultaneously as does the New York -- Washington route. As a result of the inability to concentrate markets, the high cost of curve realignments along the Connecticut shore, and other factors, the New Haven Railroad had neither the justification nor the wherewithal to bring the northern half of the Corridor up to the standards achieved by the Pennsylvania Railroad south of New York. Therefore, at the beginning of the NECIP, the total cost of achieving air-competitive schedules in the northern half of the Corridor was far higher than in its southern half. Moreover, whereas Amtrak owns and operates the entire NEC south of New York, it has complete control only over the New Haven -- Providence segment in the north. Physical and operational control by Metro North and the Connecticut Department of Transportation between New Rochelle and New Haven, and ownership of the NEC in Massachusetts by the Massachusetts Bay Transportation Authority (MBTA), add institutional complexities to the inherent geographic and demographic restraints on Boston -- New York trip time reductions.

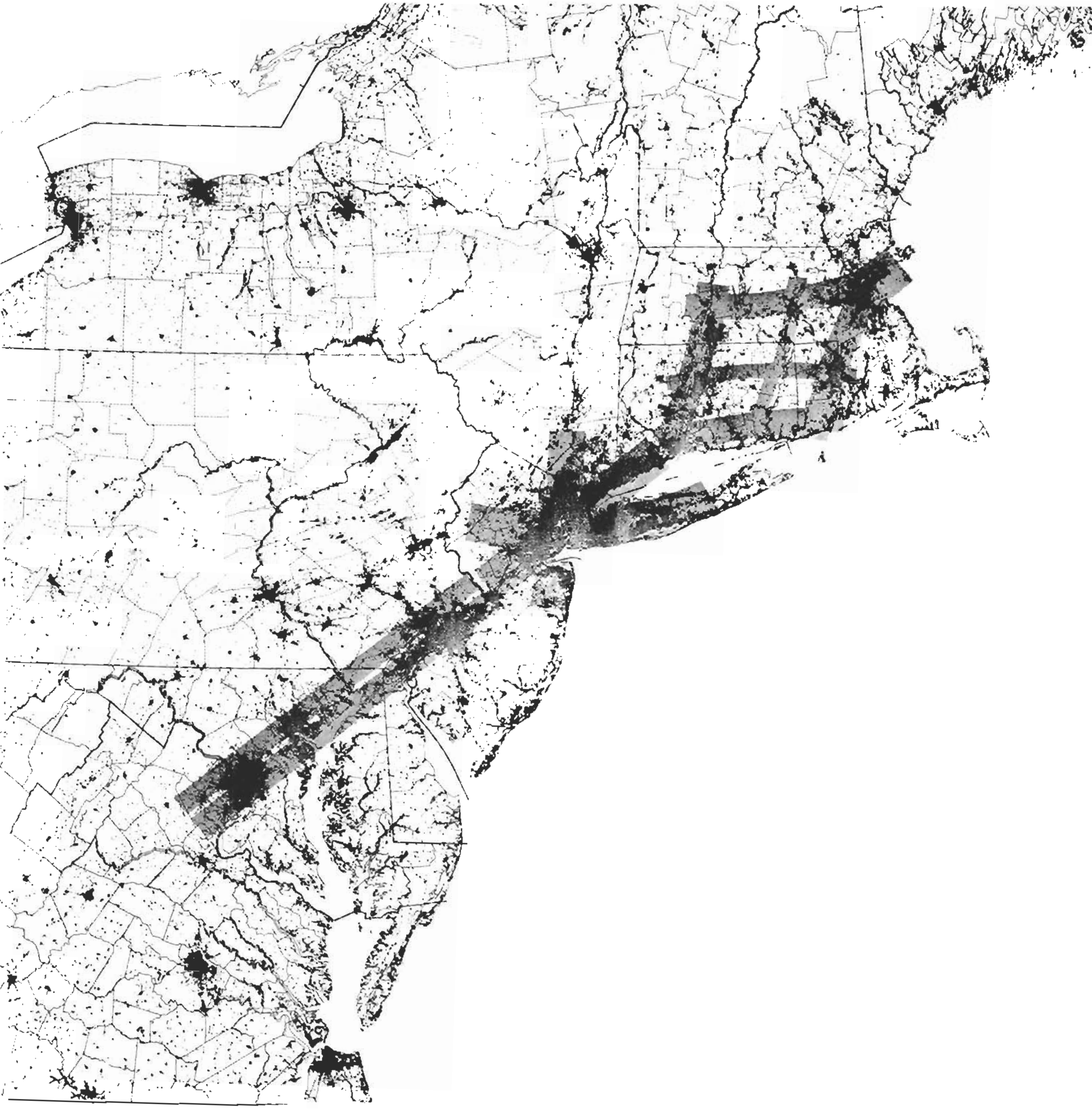
Results

For the eight city-pairs generating over two-thirds of the passenger-miles on the NEC, Table 1-2 traces the trends in trip times between 1976, the last year before major NECIP construction, and the reference year 1984. (Scheduled trip times have increased in some cases between 1984 and 1986. However, these increases reflect primarily institutional factors noted above, and not the capability of the improved facility.) Trip times in 1980 are included to show the effects of Corridor construction at its peak. These increased trip times hurt ridership, and are discussed further in Chapter 3. As the final elements of the NECIP are placed in service, and as Amtrak judiciously alters its product in the NEC while maintaining reliability, schedules can become better still. For this reason, Table 1-2 includes an estimate of trip times at project completion, based on Amtrak's 1984 schedules minus an allowance for trip time improvements which can occur between October 1984 and project completion. Table 1-3 shows the derivation of this estimate. Whether Amtrak reflects all the trip time improvements in its schedule, or simply uses them to assure still better on-time performance, is an Amtrak management decision.

Between Boston and New York, Amtrak may be able to achieve materially better times than those forecast while preserving acceptable on-time performance, if and only if Metro North (the commuter service agency operating

Figure 1-1

TRAVEL PATTERNS IN THE NORTHEAST CORRIDOR



Source: Northeast Corridor Transportation Project Report, U.S.D.O.T., 1971.

TABLE 1-2

TRIP TIME SAVINGS DUE TO NECIP IN HIGHEST-VOLUME MARKETS

		Scheduled Trip Times								Percent Reductions in Average Trip Times	
	Percent of NEC	Actual 1976		Actual 1980		Actual 1984		Project Completion		Actual 1984	Project Completion
City-Pair	Passenger-Miles[a]	Best	Avg.	Best	Avg.	Best	Avg.	Best	Avg.	vs. 1976	vs. 1976
New York - Washington	22										
Metroliner		3:00	3:02	3:38	3:49	2:49	2:53	2:36	2:40	4.9	12.1
Conventional		3:40	3:50	4:10	4:21	3:10	3:21	2:58	3:10	12.6	17.4
New York - Philadelphia	16										
Metroliner		1:15	1:18	1:29	1:36	1:11	1:14	1:04	1:07	5.1	14.1
Conventional		1:30	1:40	1:44	1:50	1:24	1:28	1:17	1:21	12.0	19.0
Philadelphia - Washington	8										
Metroliner		1:42	1:44	2:03	2:07	1:38	1:40	1:29	1:31	3.8	12.5
Conventional		2:10	2:10	2:26	2:29	1:47	1:52	1:38	1:41	13.8	22.5
New York - Baltimore	7										
Metroliner		2:24	2:27	2:57	3:04	2:17	2:21	2:05	2:09	4.1	12.2
Conventional		3:00	3:08	3:25	3:33	2:37	2:44	2:25	2:32	12.8	19.1
Boston - New York	7	4:25	4:40	4:45	4:57	4:09	4:31	3:58	4:20	3.2	7.1
New York - Wilmington	3										
Metroliner		1:34	1:36	1:48	1:54	1:30	1:32	1:23	1:25	4.2	11.5
Conventional		1:47	1:59	2:01	2:09	1:41	1:47	1:34	1:40	10.1	16.0
Providence - New York	3	3:21	3:37	3:56	4:02	3:33	3:38	3:19	3:24	none	6.4
Boston - Washington	2	8:15	8:33	9:15	9:23	7:34	7:57	7:07	7:30	7.0	12.3

[a] Passenger-miles are expressed on a metropolitan area basis; i.e., New York includes Newark and Metropark; Washington includes New Carrollton. Trip times, however, are between the principal stations.

Source: Derived from Amtrak timetables.

TABLE 1-3

TRIP TIME ESTIMATES AT PROJECT COMPLETION

Schedules for NEC trains fall exclusively within Amtrak's purview. For analytical purposes, this report has adopted the following method for projecting Amtrak's schedules at project completion. All times are in hours:minutes.

	New York - Washington				Boston - New York (Single Service)	
	Metroliners		Conventional Trains			
	Best Time	Avg. Time	Best Time	Avg. Time[b]	Best Time	Avg. Time[b]
Number of Intermediate Stops Assumed:	4	5	6	7	4	8
Actual Amtrak Schedules as of 10/28/84	2:49	2:53	3:10	3:21	4:09	4:31
Less: Anticipated effect of trip time improvements[a], to be completed between 10/28/84 and project completion:	0:13	0:13	0:12	0:11	0:11	0:11
Estimated Amtrak schedules at project completion:	2:36	2:40	2:58	3:10	3:58	4:20

Further details appear in Appendix B. Times for other city-pairs in 1986 have been estimated in accordance with the above procedure.

[a] Source: Trip Time Report, November, 1983, prepared by FRA and DeLeuw, Cather/Parsons with input from Amtrak.

[b] Average times are the average of northbound and southbound. Average times for trains other than Metroliners exclude the overnight "Night Owl."

the New Rochelle -- New Haven segment of the NEC) provides appropriate levels of maintenance and efficient, equitable dispatching for intercity trains serving the citizens of southwestern Connecticut, Westchester County, and New York City. Between November 1982 and April 1983, Amtrak attempted to operate a New England Metroliner service on a 3 hour, 55 minute schedule. Although reliability was very poor at the beginning, the trains averaged 79 percent on time during their last two months of operation. (As a yardstick for comparison, on-time performance for the NEC as a whole averaged 83 percent in the third quarter of calendar 1984.)

South of New York City, Amtrak operates two services dedicated to two distinct market segments: for time-sensitive passengers, primarily business travelers, Amtrak provides premium "Metroliner" service at a higher fare and with more amenities; for cost-conscious travelers, Amtrak offers a conventional service. Because these services south of New York constitute different products from a marketing standpoint, Table 1-2 and similar Tables indicate the times for each. North of New York, in keeping with the lower volume and the inability of rail to compete with air trip times, Amtrak offers a single service only.

Between 1976 and project completion, the NECIP will have enabled Amtrak to improve its average trip-times in key markets south of New York by 11 to 14 percent for Metroliner service, and by 16 to 23 percent for conventional trains, which have already attained the best schedules in their history. North of New York, however, the trip time benefits are expected to be far more modest (6 to 7 percent).

The schedule improvements shown in Table 1-2 understate the benefits of the NECIP to NEC train operations: Amtrak between 1976 and 1984 not only achieved the trip time savings discussed above, but also improved reliability and comfort dramatically, as detailed in the next section.

RELIABILITY

"You always have the idea with trains that you'll be late, you'll get stuck, the schedule won't work out." This complaint, uttered during an attitude survey of NEC travelers in 1970 [1]* exemplifies the public image of rail service prior to the NECIP. The survey concludes: *"Criticisms of rail travel were more often offered with a note of bitterness than was the case for any other mode. The anger ... can be given a positive interpretation. It is ... a demonstration that [travelers] believe that better things are possible."*

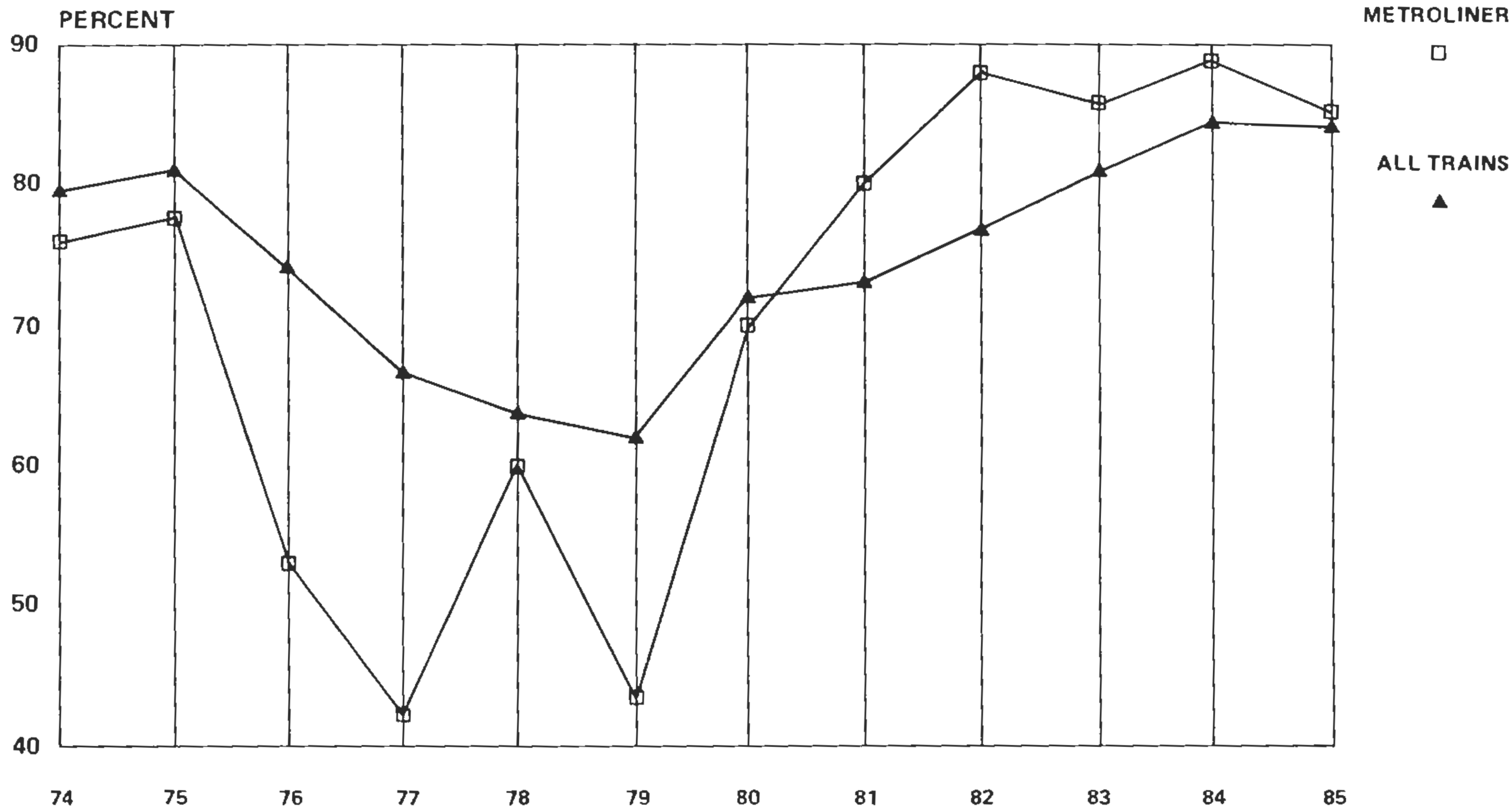
In the 1970's, the public had good reason to consider rail travel unreliable. As Figure 1-2 shows, on-time performance of both Metroliners and conventional trains between 1974 and 1976 was often below 80 percent. Public bitterness over this unreliability had a firm basis as well, since rail in the NEC has always had a potential for all-weather reliability that no other mode can match. When the plant and equipment are properly designed, maintained, and operated, intercity rail -- with its unique self-steering mechanism, its centralized control capabilities, its exclusive right-of-way, and its independent portals to the great cities -- can often operate when other modes cannot, as it did in the great snowstorm of 1983.

* Footnotes appear at the back of each chapter.

FIGURE 1-2

NEC ON-TIME PERFORMANCE

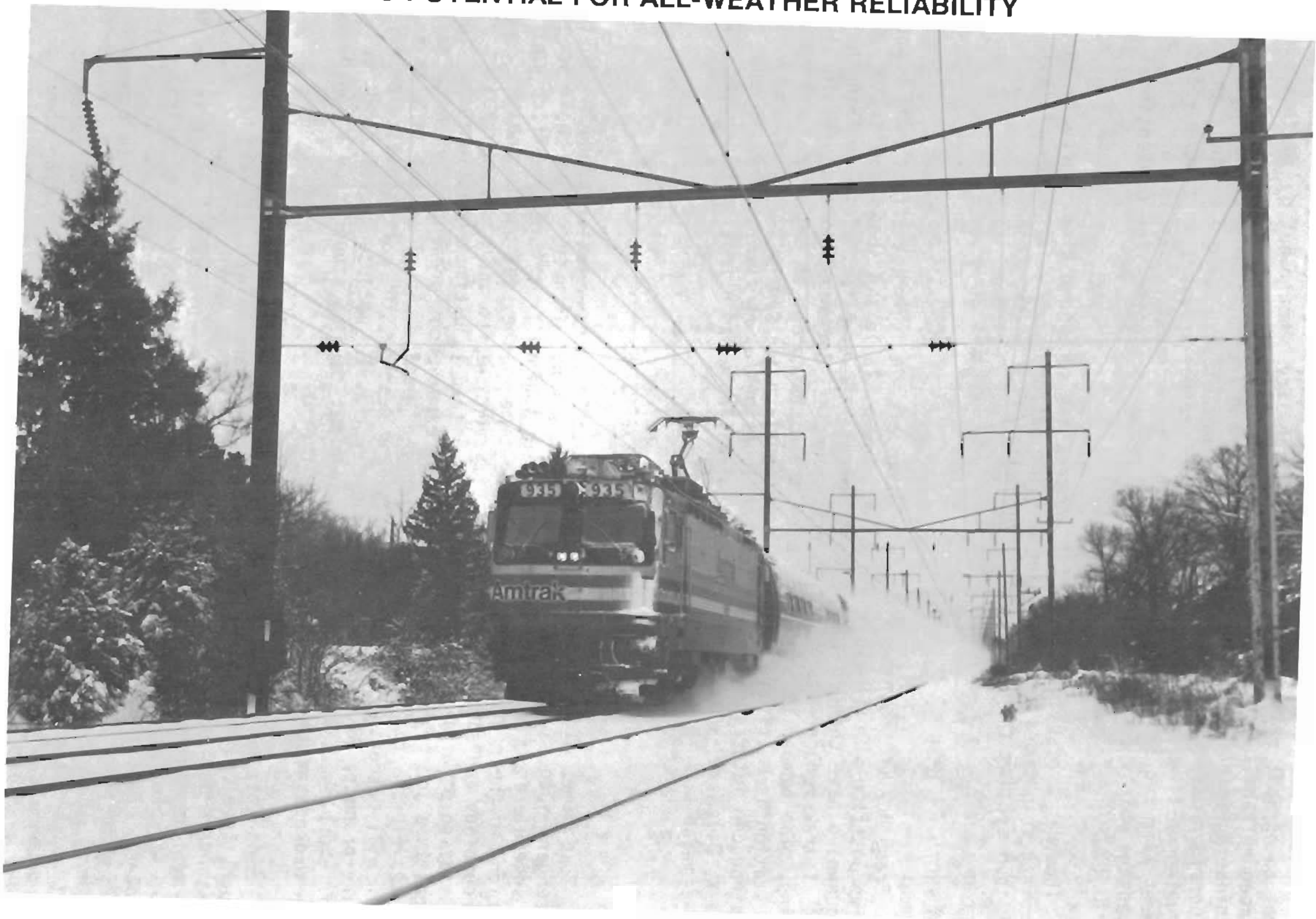
AMTRAK PASSENGER TRAINS



SOURCE: AMTRAK MONTHLY REPORT

Photo 1-1

RAIL'S POTENTIAL FOR ALL-WEATHER RELIABILITY



Amtrak trains made it through when a major snowstorm enveloped the eastern seaboard in February. All other transportation stopped.

Source: Amtrak Annual Report for 1983.

The NECIP, in concert with Amtrak's new equipment, has better enabled Amtrak to exploit rail's potential for reliability. Contributing to this enhanced reliability has been Amtrak's train planning unit, a mechanism for coordinating intercity passenger, commuter, and freight train scheduling with all Corridor users to assure achieveable timetables. Figure 1-2 shows the improving on-time performance of Amtrak's Corridor services in recent years. Between 1976 and 1984 this improvement has been dramatic, ranging up to 36 percentage points for Metroliners and 10 percentage points for conventional trains [2].

Thus, as a result of the NECIP, Amtrak has succeeded simultaneously in improving trip times and upgrading on-time performance, a far more difficult task than meeting trip-time goals, or reliability goals, alone.

FREQUENCY

Frequency of train service in a given city-pair market affects the competitive position of rail vis-a-vis other modes. Table 1-4 shows how train frequencies have changed in the most important city-pairs. Between 1976 and 1984, Amtrak reduced its Metroliner frequencies, but added some conventional trains. The number of stops for many trains has grown as Amtrak has opened a new station at Baltimore/Washington International Airport, Maryland, and has reintroduced intercity service to such locations as Aberdeen, Maryland and Newark, Delaware, which the Penn Central Railroad had effectively deleted from its timetable.

THE PASSENGER EXPERIENCE

Trip times alone do not make a marketable transportation product. Instead, passengers judge a mode by their entire experience with it: from their inquiry for schedule and fare information, to their journey from home or office to station, to their processing and waiting time at the station, to their surroundings and comfort on the intercity vehicle, to their disembarkation at the station of arrival, and to their local trip to ultimate destination. These stages in a journey constitute a chain of experiences presented by the mode to the traveler; a failure in the efficiency or comfort level at any link in the chain will detract from, or sometimes even destroy, the marketability of the entire product, however fast the mode may travel. Because travelers discuss their experiences with each other, a mode may develop a poor reputation based on such weaknesses that may take years to remedy.

Such was the case with intercity rail in the NEC before the NECIP. Although travelers complained about slow service and delays, it was the substandard quality of the entire passenger experience that aroused the most vehement reactions in a major 1970 survey of travelers by all modes in the NEC [1]. *"Getting service or information struck some respondents as nearly hopeless. Delays were said to bring no apologies or explanations . . . If getting to the railroad station is fairly difficult, or parking is expensive or absent . . . those are powerful reasons for finding a different mode. . . The most salient association to rail travel involves dirtiness. The number of respondents who used the word 'dirty' or even 'filthy' in talking about their travel was so large that no list of selected quotes could express the extent.. The seating in trains, grossly inadequate temperature control, and jouncing and*

TABLE 1-4

RAIL FREQUENCIES IN KEY CITY-PAIR MARKETS

City-pair	Average Trains per Weekday (Each Direction) Actual 1976	Actual 1980	Actual 1984	Project Completion	Percent Increase (Decrease) in Frequency Project completion vs 1976
Boston - New York	8	10	9	9	13
New York - Washington					
Metroliner	13	13	10	10	(23)
Conventional	10	14	16	16	60
New York - Philadelphia					
Metroliner	13	13	10	10	(23)
Conventional[a]	18	22	24	24	no change

[a] Includes New York - Philadelphia "Clockers" plus New York - Washington conventionals.

Source: Amtrak timetables

bumping were all harshly criticised."

The NECIP -- in conjunction with Amtrak's own significant efforts and those of local agencies -- has addressed the old weaknesses of rail travel in virtually every aspect of the passenger experience. Table 1-5 summarizes those achievements, and the balance of this section elaborates on them.

INFORMATION SYSTEMS

"The airlines are the ones that are catering to the people . . . But call Union Station and try to get information about the trains, you get spotty information, even gruff treatment." . . . "When was the last time you saw a train ad?" [1]

Since the passenger experience in most instances begins with a phone call, Amtrak's progress in improving its national information/reservations network has benefited its NEC services directly. A national toll-free number, 1-800-USA-RAIL, enables residents anywhere in the NEC region to gain 24-hour access to fare, schedule, and train arrival/departure information. The quality of real-time information on the computer will increase as Amtrak places in service its new centralized traffic control system, as well as the fiber-optics communication system, undertaken by private enterprise under the aegis of Amtrak and the NECIP (see Chapter 2). Thus, no longer will inaccessibility of information hamper passenger entry into the system.

Amtrak's nationwide program to provide better access to ticketing has also made travel in the NEC easier: the number of travel agents authorized to sell Amtrak tickets has increased from 3,000 in 1976 to 11,181 in 1984, and Amtrak has negotiated with selected airlines to provide information, reservations, and ticketing access through the airlines' computer systems installed in travel agency offices. Finally, Amtrak's advertising budget in the NEC, $225,000 in 1976, had grown to $2,600,000 by 1984. These Amtrak initiatives make it possible for the public to know that Amtrak has a product to sell.

ACCESS TO/EGRESS FROM STATIONS

In the NEC, travelers spend a relatively high proportion of their door-to-door travel time in getting to and from stations and airports. Hence, the ease and speed of access to and egress from line-haul station facilities will influence travelers' choices among modes, particularly for trips under 250 miles, which constitute the bulk of NEC travel. Although rail is well situated at the heart of the NEC's cities, several of which are experiencing a resurgence of downtown residential and business activity, this inherent advantage has its limitations. First, for anything other than downtown-to-downtown trips, a local access/egress trip of some length at one or both ends of the journey will be necessary. Second, downtown locations are by definition crowded, placing parking at a premium; unless well-located parking is provided, access to the rail mode may prove an obstacle for many travelers. Of course, parking shortages and uncertainties also affect the other public modes, including air.

The NECIP has cooperated with local and regional authorities and with Amtrak in a comprehensive effort to capitalize on the inherent access advantages

TABLE 1-5

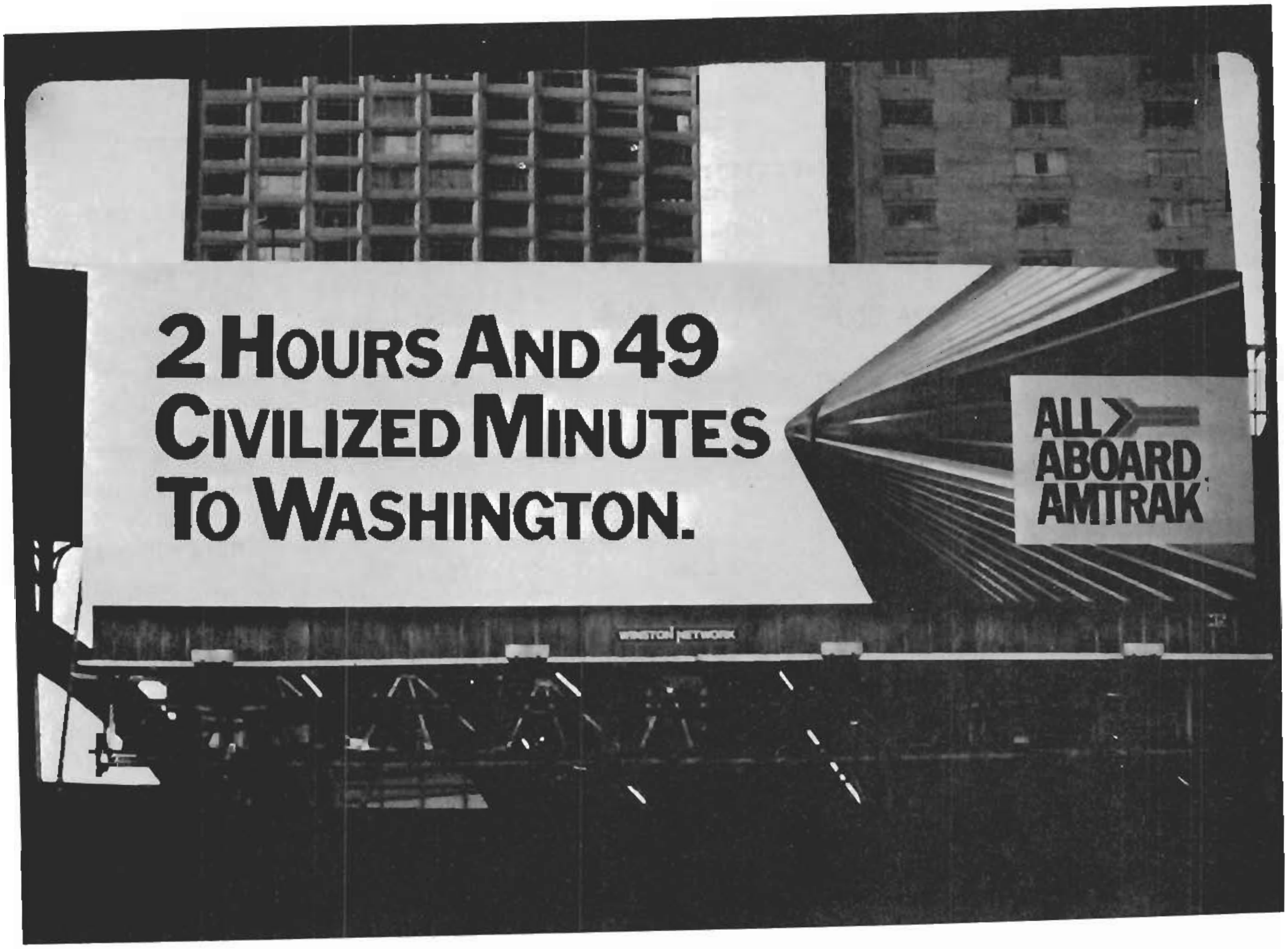
THE EVOLVING PASSENGER EXPERIENCE IN THE NEC

Aspect	Before NECIP 1976	1984	After NECIP	Cause of Change
INFORMATION	Amtrak's advertising budget in the NEC			Amtrak's intensified marketing efforts
	$225,000	$2,600,000	$2,500,000[p]	
ACCESS TO/ EGRESS FROM STATIONS	Number of parking spaces close to Amtrak stations			50/50 NECIP/ local funding of access improvements
	5149	5360	7907	
	Number of Amtrak NEC stations served directly by urban rail mass transit			Local/UMTA projects in Washington and Boston; NECIP New Carrollton Station
	4	6	7	
STATION ENVIRONMENT	Number of Amtrak NEC stations constructed or renewed in the past 10 years[a]			Most involved combination of NECIP, local, and Amtrak efforts
	2	10	16	
ON-TRAIN ENVIRONMENT	Percent of revenue passenger equipment built since 1971			Amtrak has replaced much of its 1976 fleet with modern equipment
	20%	85%	85%	

p = projected

[a] Includes stations not receiving NECIP funding.

Photo 1-2



STRATEGICALLY-POSTED BILLBOARD IN NEW YORK CITY exemplifies Amtrak's aggressive approach to marketing its improved transportation product in the NEC . . .

of intercity rail. Specific arrangements and accomplishments have necessarily varied from one metropolitan area to another, and are discussed in Table 1-6.

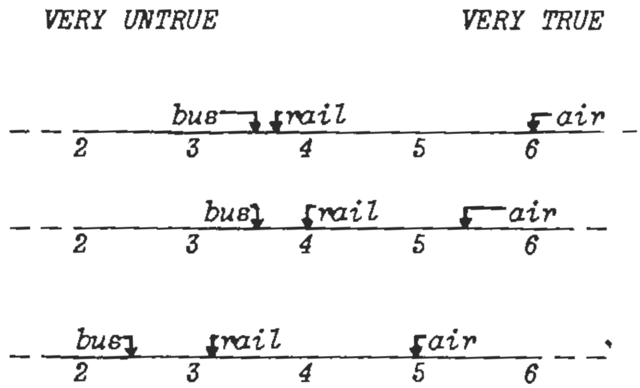
THE STATION ENVIRONMENT

Question to NEC travelers in 1970: On a scale of 1 (very untrue) to 7 (very true) how would you rate air, rail, and bus on the following questions?

Everything about the terminal will seem modern and up-to-date

Everything in the terminal will be clean

I would have . . . surroundings in the terminal that would make me feel I was someplace special



Conclusion: "Railroad stations are perceived as being dirty or dingy . . . dirty stations are resented and contribute to negative feelings about railroads and rail travel . . . " [1]

Studies preparatory to the NECIP estimated that the average passenger spends on the order of 20 to 30 minutes per trip inside railroad stations [3]. These minutes come at strategic points in the passenger experience -- just before and after the line-haul trip. For this reason the station environment constitutes a crucial link in the passenger's perception of the rail mode; it sets the tone of the journey and is the last memory of the rail system per se.

The NECIP, together with associated projects of local agencies and Amtrak, has transformed the station environment. For deterioration, oppressiveness and inefficiency, the NECIP has substituted modernity, cheerfulness, and expeditious passenger processing. NECIP has rehabilitated old stations, restoring their former grandeur and making them urban showpieces; it has renovated newer stations; and it has built new stations in cooperation with local authorities. The numerous design awards (Table 1-7) won by the project architects testify to the success of the NECIP in its station upgrading efforts. The following pages describe the site-specific improvements to the station environment on a station-by-station basis.

THE TRAIN ENVIRONMENT

"Trains are old -- wear and tear. Planes are new." [1]

Passenger comfort on board a train encompasses all the senses: the visual environment, from decor to cleanliness to lighting; noise levels; tactile sensations, such as seating, ambient temperature levels, and ride quality; even smell and, for longer journeys, taste. A transportation system that neglects any one of these environmental factors will have difficulty in marketing its product.

TABLE 1-6

ENHANCEMENTS TO RAIL ACCESSIBILITY IN THE NEC

Metropolitan Area (Station name if different)	Parking Spaces Added by Completion with NECIP Cooperation	Intermodal Access Improvements
Washington, D.C. Area		New Metrorail system, with direct access to Amtrak at both Union and New Carrollton Stations, provides rapid transit throughout the Washington area.
(Union Station)	0 (see Note A)	
(New Carrollton)	900	Construction of new parking garage on a portion of the existing Washington Metro surface parking areas. Adjacent to the Amtrak station.
Baltimore (Pennsylvania)	0 (see Note B)	Repairs to paving, walks and lighting. Garage and major access improvements have been proposed but are not funded.
Wilmington	517	Repair to paving and sidewalk; sidewalk canopy installed along Front Street. Construction of parking garage adjacent to station.
Philadelphia (30th Street)	0	New Center City Connection expands the range of commuter stations directly accessible to NEC passengers via convenient transfer at 30th Street. New Airport High Speed Line provides direct access from 30th Street to Philadelphia International Airport. Changes to vehicular access around the station and reestablishment of direct access to the Market Street subway and renovation of commuter rail platforms will be accomplished under future projects with cost-shared funds.
Trenton	0	No changes under NECIP.
Metropark	0	No changes under NECIP.
Newark, New Jersey (Pennsylvania)	0	Replacement of five stairs on Market St. to enable direct pedestrian access to platforms. Improved access to buses, taxis, and limousines with new entrances and flow patterns, including graphics and signage. Vehicular access improvements have been turned over to NJ Transit for construction.

TABLE 1-6 (Page 2)

ENHANCEMENTS TO RAIL ACCESSIBILITY IN THE NEC

Metropolitan Area (Station name if different)	Parking Spaces Added by Completion with NECIP Cooperation	Intermodal Access Improvements
New York (Pennsylvania)	0	Cost-shared improvements to facilitate access to subway and rail.
Stamford	300	The construction of a new station, garage, and intermodal facilities reorganizes and consolidates access between rail and bus, taxi, limousine, automobile and pedestrians.
New Haven	430	The renovation of this station includes improvements to vehicular access including specific areas for taxicabs and local bus, as well as a parking garage. An intercity bus terminal and airport limousine service facilities will be provided at the west end of the station. The station improvements will serve commuter rail service.
New London	361	An expanded parking garage and revised vehicular circulation will service the New London Transportation Center which contains railroad, local bus, intercity bus and taxicab facilities. New London is unique since it is also adjacent to and forms an intermodal link to three ferry services to Long Island, Block Island and Fisher's Island.
Providence	250	Construction of a 400-car underground garage in front of relocated new station (former station had 150 spaces). Bus service will be provided between the new station and old station (part of Kennedy Plaza development).
Boston (South)	0	Vertical communication for access to Red Line and air rights developments, parking, and intercity bus facility. The latter improvements would be built under separate, non-NECIP contracts.
Total Parking Spaces Added with NECIP Cooperation	2758	

Note A: At Union Station, Washington, the D.C. Government is now building a 1300-space parking garage to be turned over to the Union Station Redevelopment Corporation for management and operation. The allocation of those spaces to Amtrak passengers and other users is to be determined. (This project is independent of the NECIP.)

Note B: Under the rubric of matching NECIP/local funding, the potential exists for additional parking facilities at Pennsylvania Station, Baltimore.

TABLE 1-7

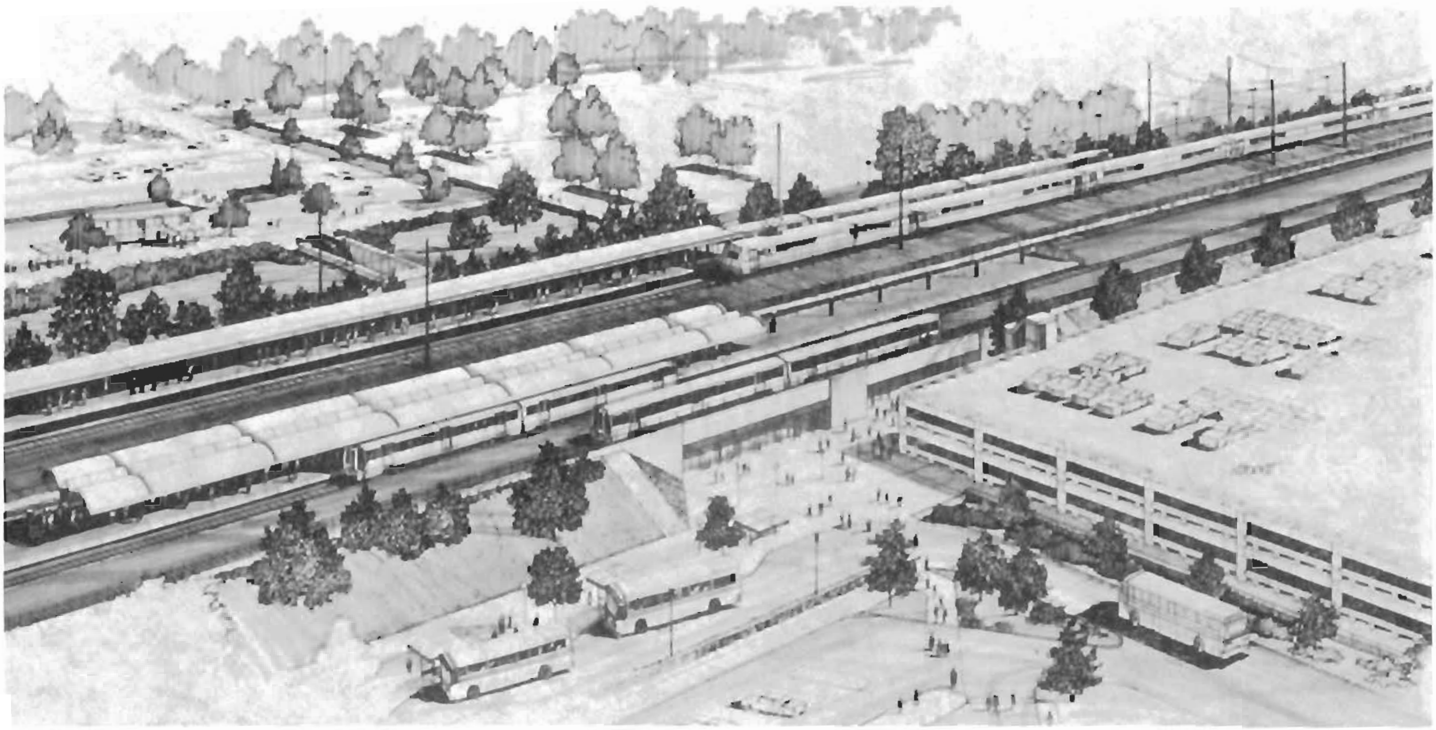
TRANSFORMING THE STATION ENVIRONMENT:

DESIGN AWARDS WON BY NECIP ARCHITECTS

(Skidmore, Owings & Merrill)

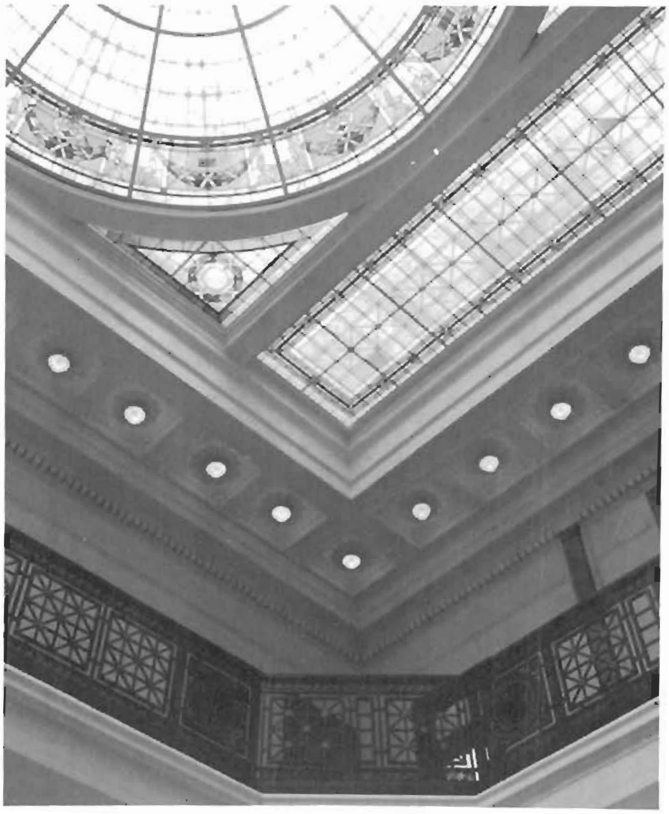
Station	Year	Award (Sponsor)
Baltimore Pennsylvania	1984	**First Award for Achievement of Excellence in Historic Preservation and Architecture** (Washington Chapter, American Institute of Architects)
	1984	**Honorable Mention, Adaptive Re-Use Category, Interior Design Competition** (co-sponsors: Institute of Business Designers and Interior Design magazine)
	1984	**Federal Design Achievement Award**
	1983	**Design Excellence Award, National Organization of Minority Architects** (Leon Bridges Company)
	1981	**Merit Award for Achievement** of Excellence **in Historic Preservation and Architectural Design** (Washington Chapter, American Institute of Architects)
Providence Station/ Capital Center Project	1983	**Citation** (30th Annual Progressive Architecture Awards Program)
	1981	**Urban Design and Planning Award** (28th Annual Progressive Architecture Awards Program)
Wilmington	1979	**First award for Achievement of Excellence in Historic Preservation and Architectural Design** (Washington Metropolitan Chapter, American Institute of Architects)

In addition to the honors listed above, the NECIP architects' work on the Providence and Wilmington station projects won awards from a panel of independent judges in the Federal Railroad Administration's design competition, "The Railroad and Its Environment," in 1980.



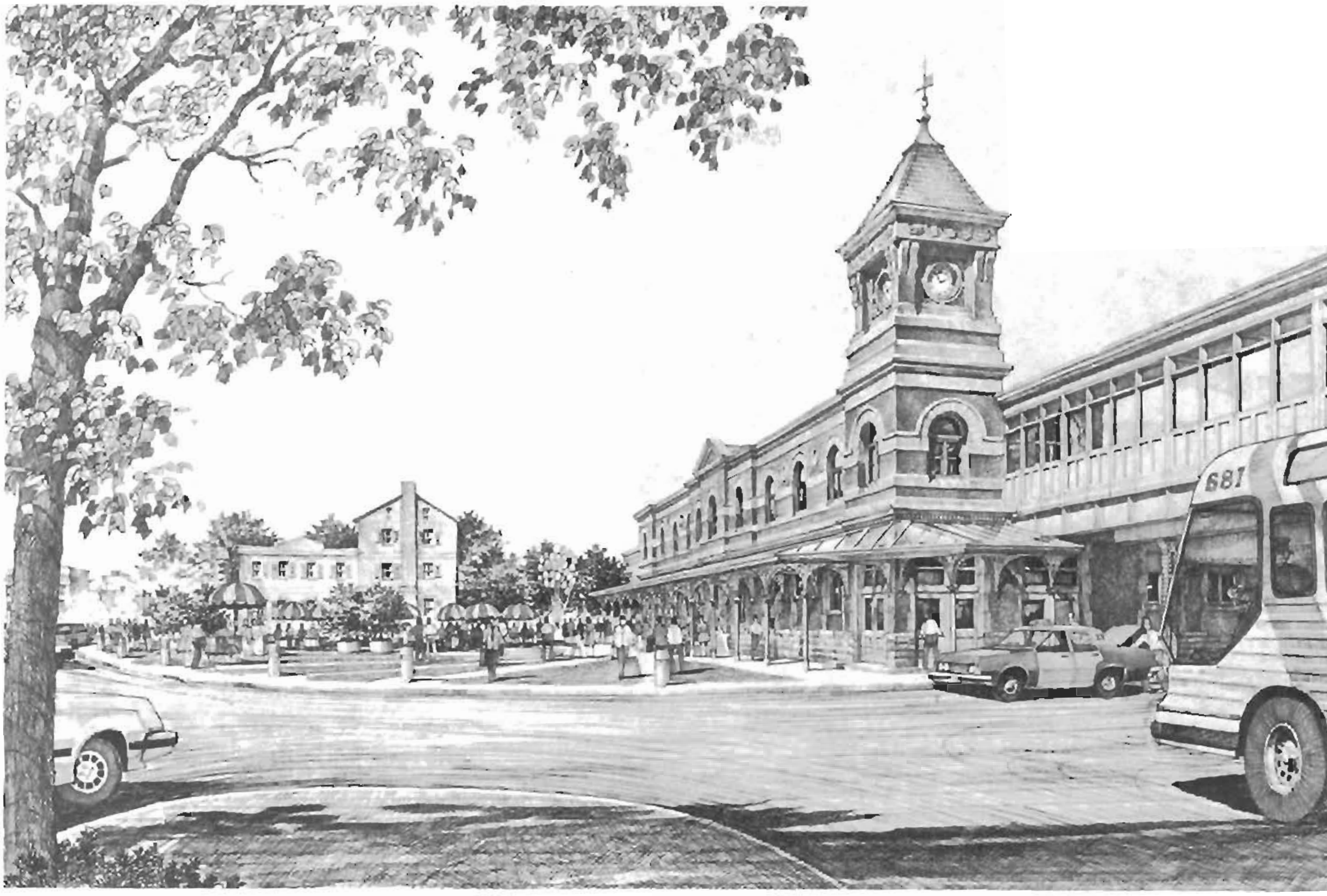
The New Carrollton Station is a joint facility serving both Amtrak and Metrorail, Washington, D.C.'s rapid transit system. Part of the Northeast Corridor Improvement Project, the chief design goal was to provide for a contemporary and efficient intermodal transportation facility. Elements of this facility included new escalators, stair and elevator access for handicapped persons; installation of station directional and informational sign systems; and adequate parking, including dropoff and pickup and long-term parking spaces. The parking structure will be jointly funded by Prince George's County, Washington Metropolitan Area Transit Authority and the Federal Railroad Administration.

New Carrollton Station



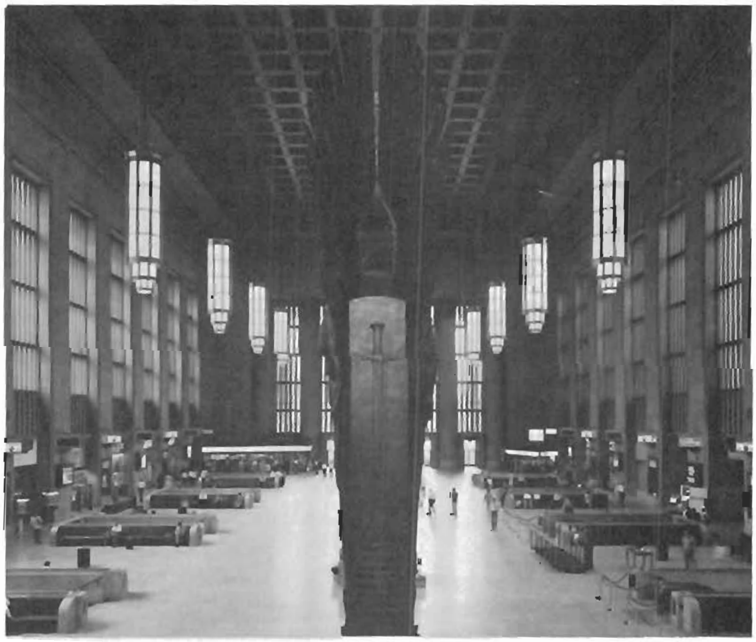
Baltimore Penn Station

This station, placed on the National Register of Historic Places in 1975, was designed by Kenneth M. Murchison and completed in 1911. The station is most noted for its two-story main hall with Sicilian and Pentellic marble walls, a ceiling of three exquisite leaded glass domes, and combined waiting and circulation areas in the concourse. The scope of the program for Baltimore Pennsylvania Station included the restoration and refurbishment of these and other significant architectural features, as well as the introduction of new elements to correct life-safety deficiencies and to provide complete accessibility for handicapped persons. Expanded ticketing facilities, new escalators and station directional signage are among the other revisions completed. Yet for all the improvements made to the station, the most significant aspect of the project is that this wonderful public space has been restored to the community of Baltimore. The community began to participate in the project, and the City of Baltimore provided joint funding with the Federal Railroad Administration for certain site improvements, including new street lights, sidewalk repairs and reglazing of the station canopy.



Wilmington Station

Wilmington Station was the last major railroad facility to be designed by Frank Furness. The challenge of the Federal Railroad Administration and the design architect was to provide major functional changes to the station in order to meet modern requirements, as well as to restore its significant architectural features and character. Wilmington Station was placed on the National Register of Historic Places in 1976. Passenger and Amtrak support facilities were expanded and upgraded to include: improved pedestrian and handicapped access; lighting and directional signage; improved sidewalk dropoff and pickup areas; enlarged lower level waiting area; enlarged and reorganized ticketing and baggage areas; and additional concession space. In addition, a parking garage is being constructed adjacent to the station to accommodate 520 vehicles.



Philadelphia 30th Street Station

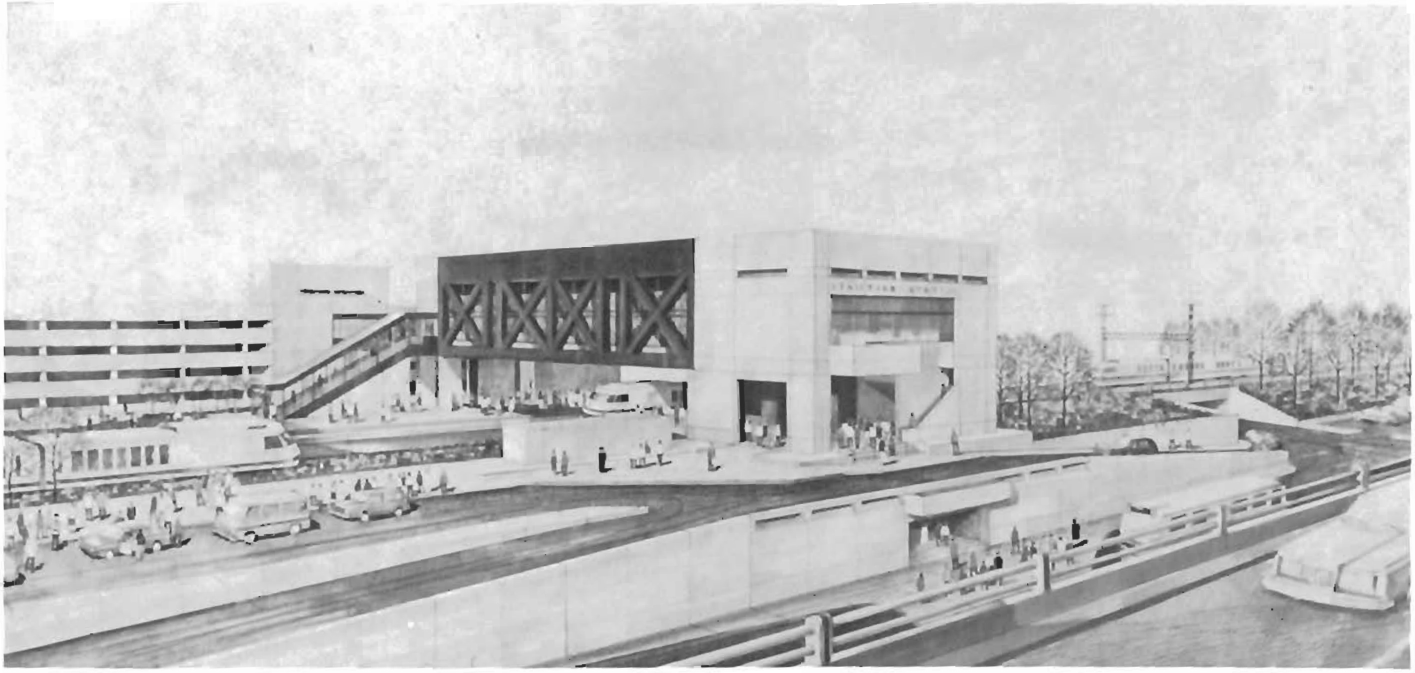
The Northeast Corridor Improvement Project includes improvements to Philadelphia 30th Street Station which will return the station to its rightful status as a major transportation and urban center. Designed by Graham, Anderson, Probst and White, the station opened in 1934 as the headquarters for the Pennsylvania Railroad and was placed on the National Register of Historic Places in 1978. Richly appointed, the major interior feature of the station is the main concourse measuring 290 feet by 136 feet which has an ornamental ceiling nearly 100 feet from the floor. Together with the cross-axial south arcade and the north waiting room the station is a striking reminder of the grandeur of early twentieth century railroad facilities. Major improvements by the Federal Railroad Administration consist of the renovation of the mechanical and electrical systems, a new roof, and necessary structural repairs. Additional architectural renovation consists of improved lighting (including the complete refurbishing of the main concourse chandeliers), new signage, restoration of architectural finishes, new elevators to train platforms, and relocation of ticketing facilities. Relocating the ticketing facilities to their original location allows Amtrak to open the entire ground floor to redevelopment as a major retail commercial center. These improvements are an integral part of an overall station program jointly funded by the City of Philadelphia, Amtrak, and the Federal Railroad Administration.

Newark Penn Station

The Northeast Corridor Improvement Project has included restoration and renovation of Newark Pennsylvania Station, one of the few large Art Deco structures remaining in the country. In addition to preserving the unique character of the historic structure, the design provided for reorganizing of the station's functions for greater efficiency and more attractive passenger services. A monumental facility designed by the architectural firm of McKim, Mead and White and built in 1937, Pennsylvania Station was added to the National Register of Historic Places in 1978. Architectural changes will remove the many alterations to the original building, replace missing elements, refurbish original significant features, and provide new elements compatible with the original architect's design. Key improvements will include renovation of existing ticketing facilities as well as the installation of new ones in the waiting room, the replacement of outmoded escalators to the platform, and the replacement of unattractive interior walls with new storefronts closely coordinated with the historic interior of the station. The Federal Railroad Administration and its architects have worked with Amtrak to develop a program and standards for retail tenants that will support and enliven the station.

New York Penn Station

A multi-modal terminal with facilities for Amtrak, New Jersey and Long Island commuters, and underground connections to four New York City subway lines, New York Pennsylvania Station is the largest rail passenger terminal in the United States. Design goals of the Northeast Corridor Improvement Project for this station are primarily targeted towards improving pedestrian circulation and passenger orientation. These goals will be accomplished by improving platform access, upgrading platforms and installing a new signage and graphic system as well as a new train information board. New stairs and escalators, and improved lighting and public address systems will enhance the passenger experience.

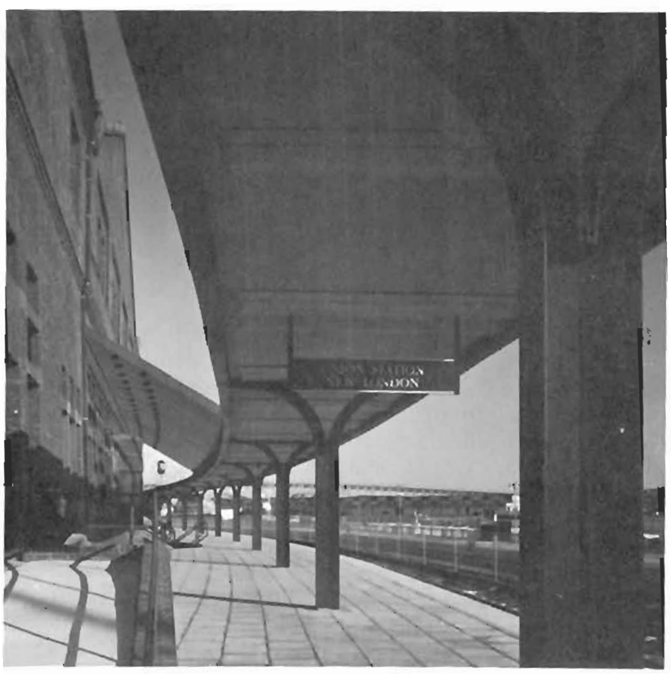


Stamford Station

Stamford Station will be a major new intermodal terminal serving Amtrak passengers and commuters. The site, split into two parcels by an 80′ right-of-way, is located just south of the Connecticut Turnpike; thus it will be conveniently accessible by car. Circulation for both vehicles and pedestrians will be enhanced as a new overtrack structure replaces the two outmoded buildings. Adequate parking is to be constructed. Passengers can proceed directly from their vehicles into the station. The new station is also designed such that it does not preclude expansion of the railroad. Joint funding is being provided by the Federal Railroad Administration, the City of Stamford, the State of Connecticut and the Urban Mass Transportation Administration.

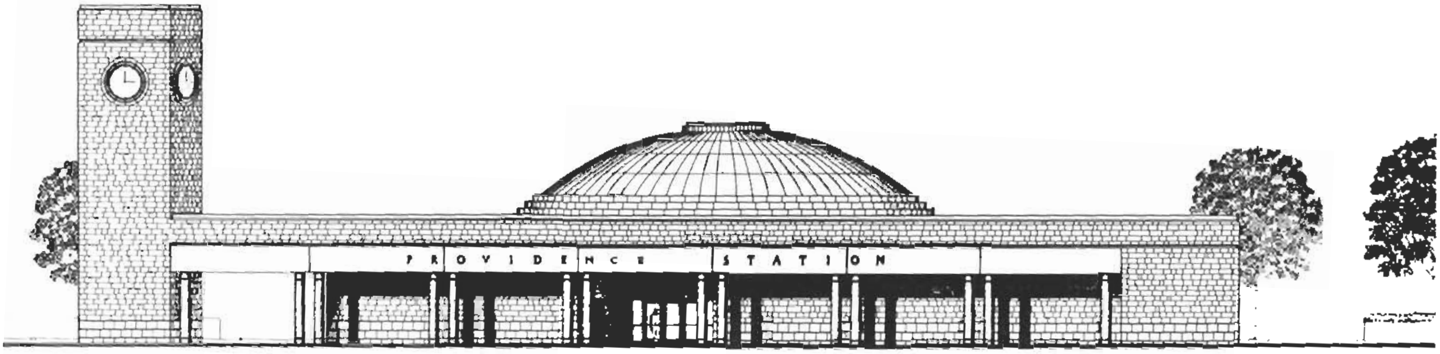
The Northeast Corridor Improvement Project will substantially upgrade and revitalize New Haven Union Station, which was added to the National Register for Historic Places in 1975. Changes to the station, in keeping with its historic character, are to include modification of the existing undertrack passageway to train platforms and the installation of new escalators. The overall renovation and restoration of other station spaces are designed to create an attractive and functionally efficient environment for all station patrons. Provision is also made for station directional signage and complete accessibility for handicapped persons. The upper floors are being rehabilitated for commercial use; a new parking structure will be built east of the station.

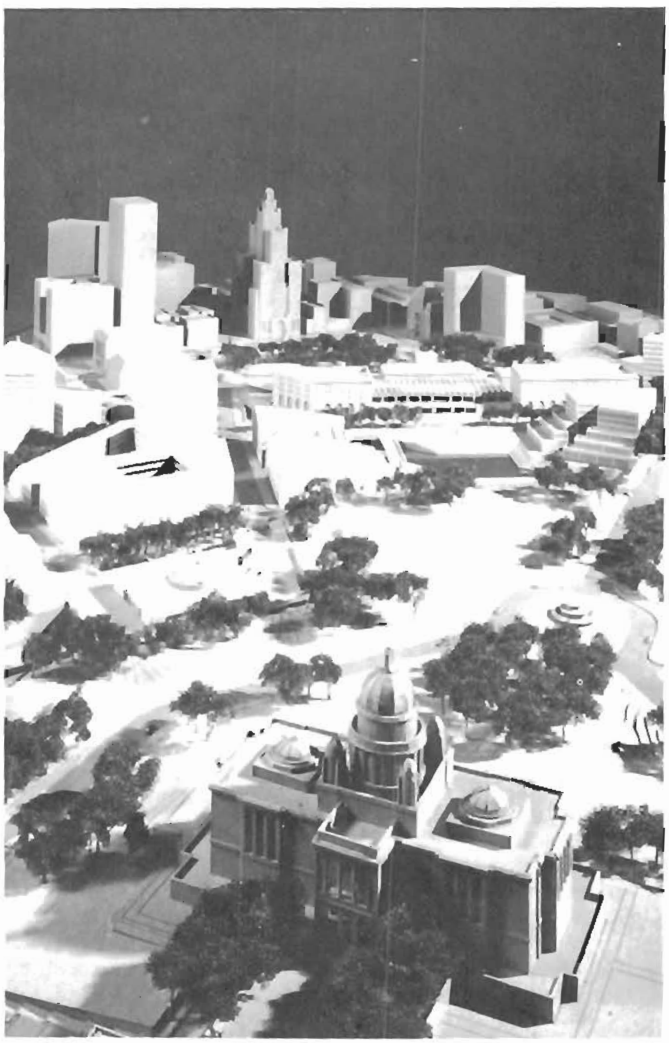
New Haven Union Station



New London Union Station

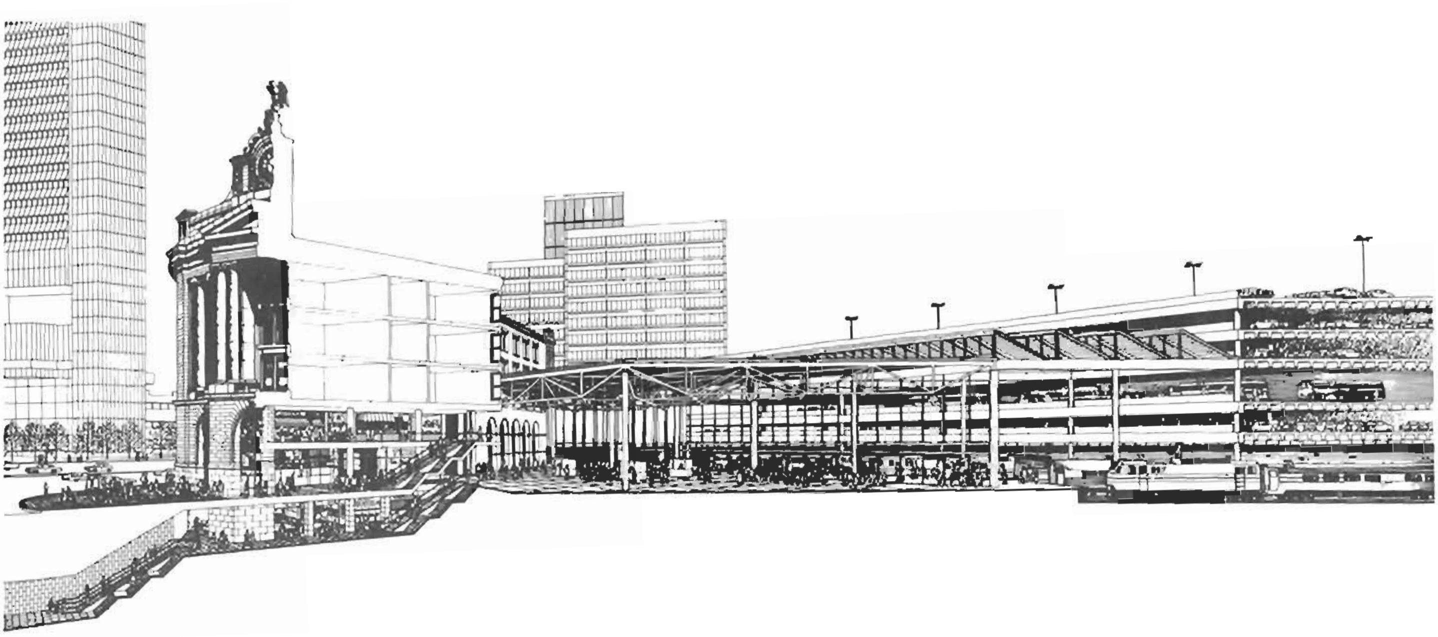
Built in 1886 and designed by architect Henry Hobson Richardson, New London Union Station was placed on the National Register of Historic Places in 1971. This Romanesque-revival building was Richardson's last major work and the largest station he designed during his career. As part of the Northeast Corridor Improvement Project, design goals for New London Union Station included preserving the historic significance of the station and improving passenger comfort and safety. A new low-level platform and new platform canopy more sympathetic to the old station building were provided. Water Street was realigned in front of the station to provide a more adequate drop-off and pickup area and taxi stand. An existing parking garage was expanded to accommodate 900 vehicles with funds from the City of New London and the State of Connecticut. The project was completed in 1983.

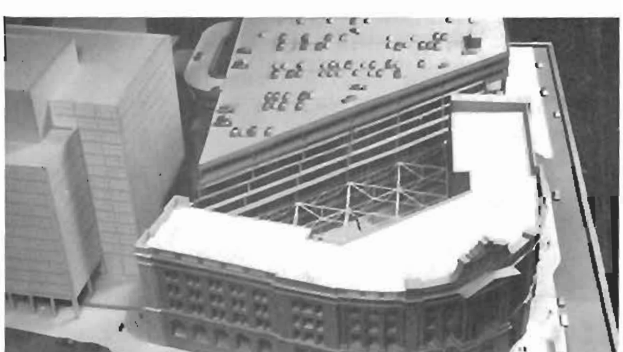




Providence Station

The Capital Center Project, an extensive urban revitalization plan for Providence, is an outstanding example of federal resources coupled with local initiative to provide station site development that complements city and state plans for the surrounding area. The new station is to be located approximately 600′ south of the Classic State House; its image is respectful of that structure while establishing its own presence and importance. Rail travel is encouraged by improved pedestrian and vehicular access between the new station and the community: an entry plaza will be constructed above the parking structure with a station access drive, automobile pickup and dropoff, taxi queuing and pedestrian walkways. A two-level, 400-space parking structure is to be provided. Landscaping will be extensive. Improvements for the Capital Center Project are being funded by the Federal Railroad Administration, Federal Highway Administration, State of Rhode Island, Providence Redevelopment Authority and Capital Properties, Inc.





Boston South Station

The cooperative efforts of the Federal Railroad Administration, the Massachusetts Bay Transportation Authority, the Urban Mass Transit Authority, and the Boston Redevelopment Authority have resulted in a comprehensive renovation of Boston South Station. This urban terminal was once the largest railroad station in the country and, for a time, handled a total annual patronage of approximately 38 million. The first phase of this program will include relocating the tracks, rehabilitating the headhouse, and developing a new concourse. The reorganization of the station will result in more efficient operations; hence, greater passenger convenience. Provision for handicapped access and a uniform system of station graphics and directional signage will support the design goals of the Northeast Corridor Improvement Project. In a second phase air rights development, including an intercity and commuter bus facility, parking, and potential commercial uses, will be constructed.

As a result both of far-sighted decisions by Amtrak and of the NECIP, the on-board passenger environment in the NEC has improved markedly. Amtrak has replaced hand-me-down equipment from its predecessor railroads with a new generation of locomotives and cars, and the NECIP has endowed Amtrak with the ability to maintain that advanced equipment at high levels of cleanliness and comfort. The NECIP has rebuilt most of the NEC track to modern standards, thus (in conjunction with better maintained vehicle suspension systems) assuring a smooth ride.

Equipment Design

In 1976 the Amtrak NEC revenue fleet consisted of 61 of the former self-propelled Metroliners (average age: 9 years), 196 cars provided by Amtrak's predecessor railroads (average age: 26 years), and 147 new Amfleet cars. The old Metroliners, while successful in demonstrating the persistence of demand for rail service in the late 1960's and early 1970's, had inherent weaknesses: their electrical systems were sophisticated but unreliable, with frequent power, heating, and air conditioning failures; their weight (about 85 tons) and suspension systems, in reaction to a roadbed that fell somewhat short of geometric perfection, yielded a ride quality that was worse than that of conventional trains; and their maintenance costs were excessive. The rest of the revenue equipment, much of which had initially been designed to high standards, had suffered from poor maintenance of passenger-environment (as opposed to safety) factors, and was showing its age. Faded, haphazardly repaired decor; shabby interiors *("the first word I think of is 'smeary'")*; steam heating and battery-powered air conditioning systems that worked erratically; -- these formed the legacy of years of neglect.

Amtrak took decisive action to reverse the situation in the NEC. It procured a fleet of 642 new Amfleet cars of which approximately 300 are available for Corridor use; these new cars incorporate some recent developments in transportation equipment design. Amtrak likewise acquired 47 reliable, high-technology AEM-7 locomotives that permitted the complete replacement of the old Metroliners as well as older locomotives.

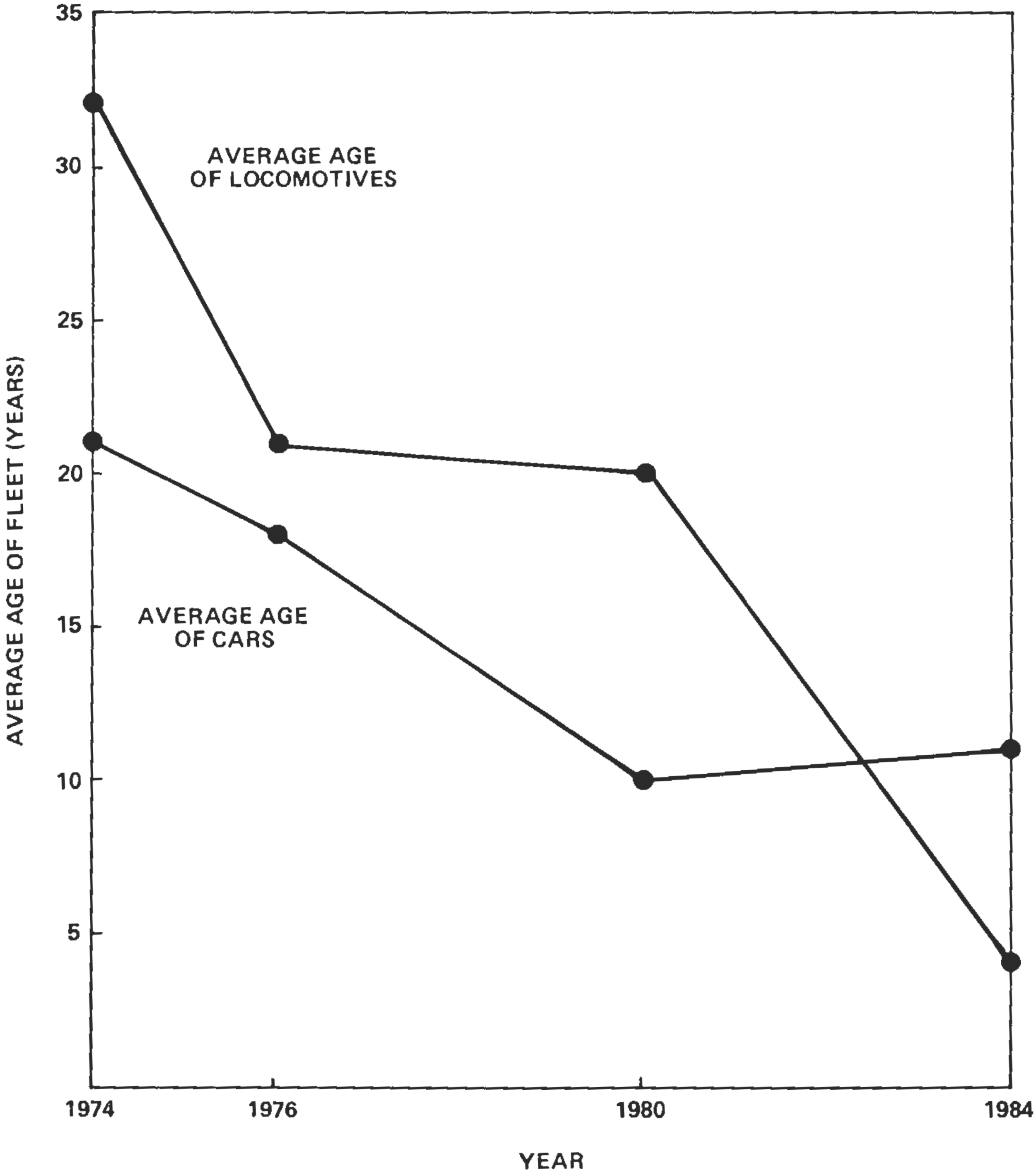
The new fleet represents a revolution in equipment on the NEC. Between 1976 and 1984, Amtrak reduced the average age of its NEC cars by almost 40 percent, and of its electric locomotives by over 80 percent (Figure 1-3). Without Amtrak's progress in the equipment area, the fixed plant improvements of the NECIP would be futile because Amtrak would not have a modern transportation product to market.

Service Facilities

Without proper service facilities to perform cleaning, repairs, and overhauls of cars and locomotives, even the newest fleet would soon deteriorate. As described in detail in Chapter 2, the NECIP has provided Amtrak with just such facilities, thereby allowing the maintenance of equipment that will provide a high-quality passenger environment in the future.

FIGURE 1-3

AMTRAK'S EQUIPMENT REVOLUTION IN THE NEC

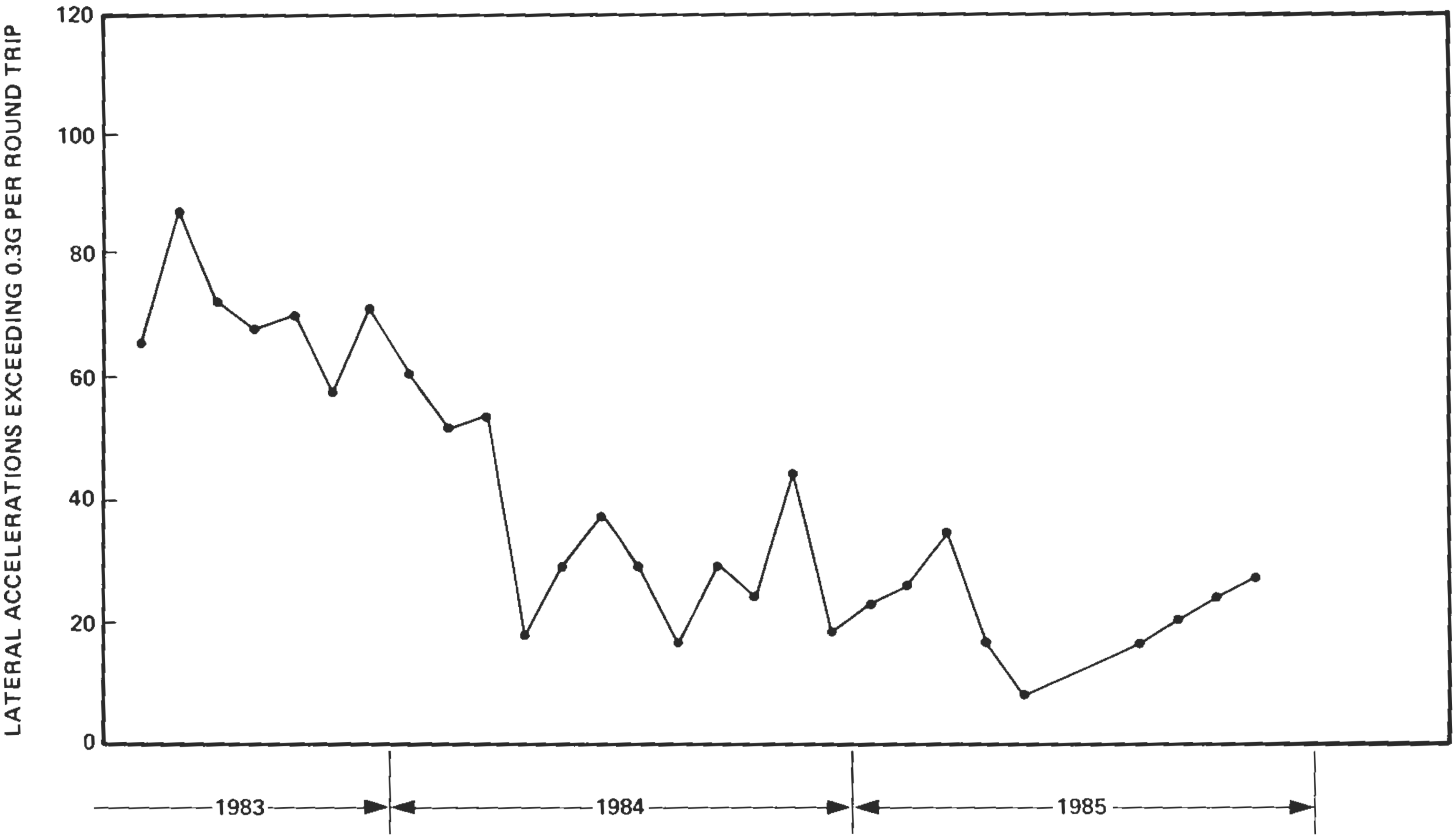


Ride Quality

Ride quality, as perceived by the passenger, is a function of track geometry (the proper placement of rail and ties), vehicle suspension characteristics, and train speed. Since a primary goal of the NECIP was to reduce station-to-station trip times, and since higher speeds at selected locations were required to do so, both vehicle suspension characteristics and track geometry had to be improved if the ride quality was to be maintained or upgraded. Because the NECIP devoted considerable resources to the track structure, and to improved service facilities for vehicles, ride quality has improved dramatically, as illustrated in Figure 1-4. For example, lateral accelerations over 0.3g were reduced from 60 per round trip in June 1983 to 30 in September 1984.

FIGURE 1-4

RIDE QUALITY IMPROVEMENTS, 1983-85



FOOTNOTES TO CHAPTER 1

[1] The Needs and Desires of Travelers in the Northeast Corridor, prepared by National Analysts, Inc. for U.S.D.O.T., February, 1970, published by National Technical Information Service PB Number 191027.

[2] Trains between New York and Washington, and between New York and Boston, are considered on time if they arrive no more than 10 minutes late. Trains covering longer distances (e.g., through trains between Boston and Washington) have slightly longer allowances.

[3] Analysis of the Locations and Functions of the Terminal Interface System, prepared by Peat, Marwick, Livingston and Co. for U.S.D.O.T., December 1969 (p.5.5.16).

Chapter Two: Fixed Plant Improvements

Chapter Outline

- Way and Structures
  - Section improvements
    - Track layout revisions (by geographic area)
    - Track curvature adjustments
    - Elimination of maintenance trouble-spots
    - Results of section improvement program
  - Bridge program
    - Movable bridges
    - Fixed bridges
  - Tunnels
    - Baltimore & Potomac Tunnel, Baltimore (by component)
    - Other tunnel improvements
  - Track improvement
    - Concrete ties
    - Wood tie installation
    - Rail installation/joint elimination
    - High speed surfacing and rail grinding
    - Interlocking rehabilitation program
    - Track undercutting
    - Other
- Power and control
  - Electrification
  - Signaling and train control system
  - Communications
- Separation
  - Grade crossing elimination
  - Fencing
- Service facilities
  - Maintenance-of-equipment facilities
  - Maintenance-of-way bases
- Stations
- Epilogue to Chapter 2: Lessons learned

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Table 2-3: Vital statistics -- NEC signals before and after NECIP
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Table 2-5: Funding for station improvements

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Chapter 2

FIXED PLANT IMPROVEMENTS

At the core of any transportation system is its physical plant -- its vehicles and fixed facilities. It is the engineering achievements of the NECIP that have made possible Amtrak's swifter and more reliable schedules, that have made worthwhile Amtrak's investment in new locomotives and cars, and that have helped to set the stage for ridership increases (see Chapter 3). This chapter explores the transformation of the Northeast Corridor fixed plant in some detail, as befits the most intensive railway upgrading project in the Nation's history.

As Table 2-1 shows, the project elements of the NECIP address five major functional areas: **way and structures**, including all project elements intended to redesign, upgrade, and better support the track in the Corridor; **power and control**, subsuming the electrical systems that move the trains and control their operation; **separation** elements isolating high speed operations on the NEC from their surroundings; **service facilities**, enabling Amtrak to maintain its new locomotives and cars and its renovated fixed facilities on an economical, timely basis; and **stations**, improving the convenience and comfort of passenger arrivals and departures.

In several of these functional areas, the achievements of the NECIP went far beyond the actual physical improvements themselves. The NECIP fostered totally new technological developments in some areas and in others introduced to the United States advanced technology pioneered overseas. Details of these technological breakthroughs and new applications follow in the appropriate sections, but it is important here to note the variety and depth of the NECIP's engineering advances, many of which have applications to freight and passenger railroad operations throughout the country. Examples of these advances include the track laying machine, the wheel impact monitoring device, and the centralized electrification and traffic control system.

The following sections analyze each of the functional areas of the NECIP in turn. An epilogue to this chapter discusses the lessons learned during the planning, design, and construction of the NECIP.

WAY AND STRUCTURES

The way and structures group, at $1.09 billion, accounted for over half the NECIP budget -- and for very good reason: the provision of a well-designed, well-supported, high quality roadbed was indispensable to the reliable, safe, and comfortable operation of trains at more competitive schedules. The **section improvements** project element dealt with the layout, alignment, and special characteristics of the way and subgrade on the 456-mile NEC; **tunnels** and **bridges** elements upgraded these critical supporting structures; and the **track improvement** project element brought the track itself up to an unprecedented standard of construction and geometric precision.

TABLE 2-1

FUNCTIONAL GROUPING OF NEC PROJECT ELEMENTS

Group	Function	Project Elements	Funding ($ millions)
WAY AND STRUCTURES	Provide a reconfigured, high-quality roadbed for safe, efficient, comfortable operation at reduced trip times	Section improvements	169.2
		Tunnels	54.2
		Bridges	178.8
		Track improvements	691.3
		Group Total	**1093.5**
POWER & CONTROL	Provide improved electrical systems to propel and direct train operations	Electrification	85.1
		Signalling and Communications	344.1
		Group Total	**429.2**
SEPARATION	Isolate the NEC from its environment to protect train operations, neighbors, and motorists	Grade crossing elimination	14.0
		Fencing	6.5
		Group Total	**20.5**
SERVICE FACILITIES	Provide facilities for efficient maintenance of equipment, way, and structures	Group Total	**174.2**
STATIONS	Improve quality of passenger experience in entering and leaving NEC system; enhance efficiency of station operations	Group Total	**191.1**
PROGRAM ENGINEERING AND MANAGEMENT		Group Total	**281.5**
		TOTAL NECIP	**2190.0**

SECTION IMPROVEMENTS

The entire 456-mile right-of-way between Boston and Washington was divided into discrete sections; each section was analyzed for the following:

o Opportunities to revise the track layout to expedite and simplify the complex routing and operations of the three users -- Amtrak, the commuter agencies, and the freight operators.

o Opportunites to ease track curvature for higher speeds and a smoother ride; and

o Opportunites to eliminate maintenance trouble spots of long standing, usually involving drainage.

Specifics on each of the above objectives follow, as well as examples of work done in important segments of the NEC.

Track Layout Revisions

Every time a high speed train has to switch from one track to another on the NEC, precious minutes are lost. Figure 2-1 shows why: the NEC consists of several tracks; trains can change from one track to another only at locations that are, on average, spaced five to six miles apart -- "interlockings." These interlockings consist of several switches and crossovers so placed that any train can usually move between any pair of tracks. The names of interlockings ordinarily represent nearby towns, settlements, or geographic features, either as they were called in the nineteenth and early twentieth centuries (when many interlockings were first installed), or as they are known at present. Often the interlocking name is a convenient abbreviation of the place name (examples: "Vern" for Severn, "Shell" for New Rochelle).

Whereas trains can run straight through an interlocking at normal speeds, they can divert to other tracks only at low speeds through the types of switches that are standard on the NEC. Thus, a 120 mile per hour train takes two to three minutes more to change tracks at an interlocking than to run straight through it. Before the NECIP, time-consuming diverging moves on the NEC normally resulted from two causes:

o The established path for high-speed trains sometimes incorporated a diversion at a given location (see Location A in Figure 2-1, for example); or

o Congestion among Metroliner, conventional intercity, commuter, and freight trains occasionally forced Amtrak to divert intercity passenger trains to normally low-speed tracks on an ad hoc basis.

Both the deliberate and ad hoc diversions reflected one essential fact: The track layout inherited by Amtrak in 1975 from the Penn Central and its predecessor railroads evolved to accommodate train movements and service patterns that existed between 1900 and 1940. Over the years, Amtrak's predecessors abandoned many routes and altered their service patterns to meet changing requirements, but they did not change the basic track configuration. The result was unwanted congestion, speed restrictions, and time-consuming

Photos 2-1

NORTHEAST CORRIDOR PASSENGER RAIL IMPROVEMENTS

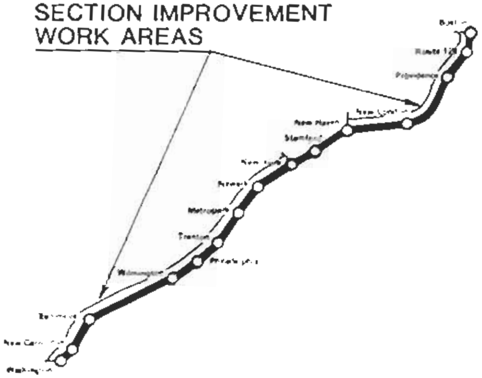
SECTION IMPROVEMENT WORK

54th STREET and
ARSENAL RETAINING WALL

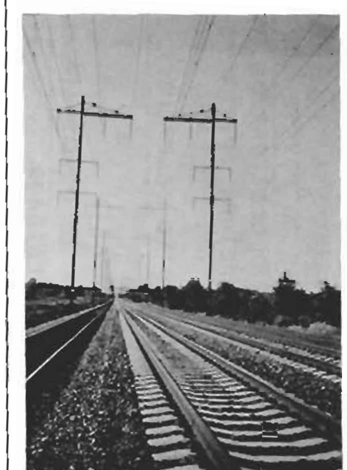
NEAR WASHINGTON, D.C.
CURVE "401"

IMPROVE RIDE QUALITY, INCREASE TRAIN SPEED AND SHORTEN TRIP TIME FOR 800 TRACK MILES, WASHINGTON TO BOSTON.

- CONSISTS OF TRACK AND CURVE REALIGNMENT, INTERLOCKING RECONFIGURATION, CATENARY AND DRAINAGE IMPROVEMENTS
- INSTALLED NEW CONTINUOUS RAILS, NEW WOOD AND CONCRETE RAIL TIES, REHABILITATED BALLAST.
- COST: $151.0 MILLION



54th STREET and
ARSENAL RETAINING WALL



NEAR TRENTON, N.J.

FIGURE 2-1

ESSENTIALS OF NEC OPERATIONS

NOTE: The NECIP has REDUCED the number of situations typified by Interlocking "A" and INCREASED the number of instances exemplified by Interlocking "B". The result: faster, more reliable service.

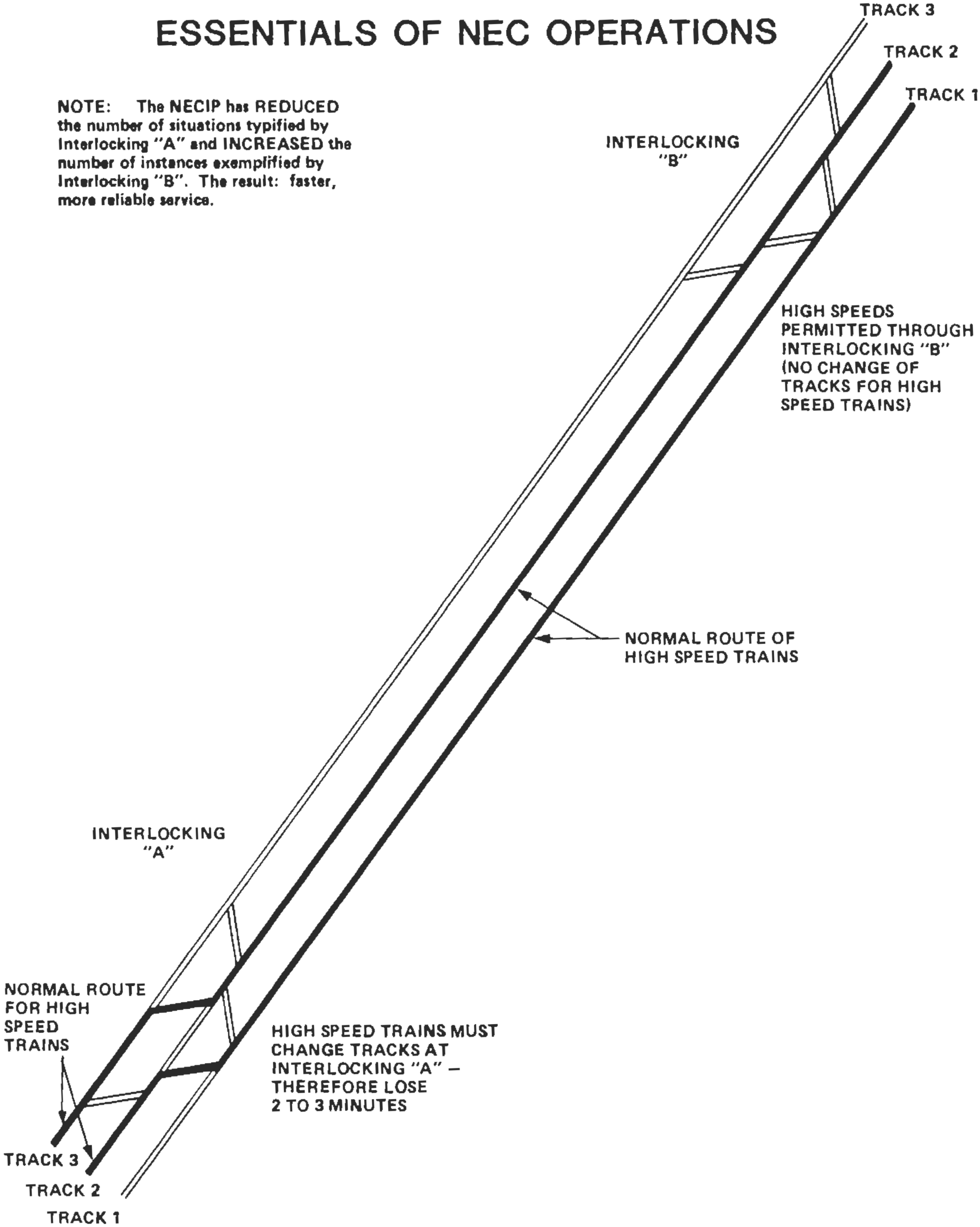


Photo 2-2

New interlocking completed under Section Improvements program, with wayside signals.

diverging moves at interlockings. The track configuration in 1976, not including siding and "runaround" tracks, can be summarized as follows:

- o Washington to Wilmington: Double track with very long passing tracks
- o Wilmington to Newark, NJ: Four tracks (up to six tracks at locations of highest traffic density)
- o Newark to New Rochelle: Two tracks
- o New Rochelle to New Haven: Four tracks
- o New Haven to Boston: Double track with passing tracks

In order to make optimal use of the capital investment available for high speed passenger service, the NECIP designated two tracks as high speed tracks to be used primarily by intercity trains. A complete operating analysis of high speed passenger, commuter, local freight and through freight train service had shown serious conflicting movements occurring between Washington and Wilmington (110 miles); over several miles in South Philadelphia; at a major junction ("Harold") east of Penn Station, New York; at a major junction ("Shell") at New Rochelle; at New Haven Station; and between Canton Junction and Boston (15 miles).

In conjunction with the various commuter agencies, Conrail, Amtrak, and other interested parties, the NECIP developed a new track configuration. Between New York and Washington, where the Conrail freight yards were located on the east side of the railroad, the NECIP placed the two designated high speed passenger tracks in the center in four-track territory, with freight and commuter trains sharing the outside tracks. To reduce conflicting moves over the two and three tracks between Wilmington and Washington, the NECIP removed four interlockings, added three, and totally reconfigured 18 interlockings to place the two designated tracks on the west side of the railroad and the remaining freight tracks on the east side. Previously, a southbound freight had to cross over in front of northbound trains and mesh with southbound traffic to the next yard, where it again had to slow down and again cross in front of northbound trains. The complicated procedure was further aggravated by the limited clearances and gantlet track used in the Baltimore and Potomac (B&P) Tunnel in Baltimore.

Plates I and II* show the track configuration (simplified) of the Corridor between Washington and Wilmington before and after the NECIP and the resulting changes in track usage by freight and passenger trains. A number of the interlocking changes were made to move switches and crossovers off curves in order to reduce high maintenance costs and provide a smoother ride for passengers.

As is the case at high speed interlockings, track layout revisions at low speed station areas can have marked effects on trip times. Figure 2-2 shows why: a given speed increase in low speed ranges produces proportionately

* Plates appear together in a section following this page.

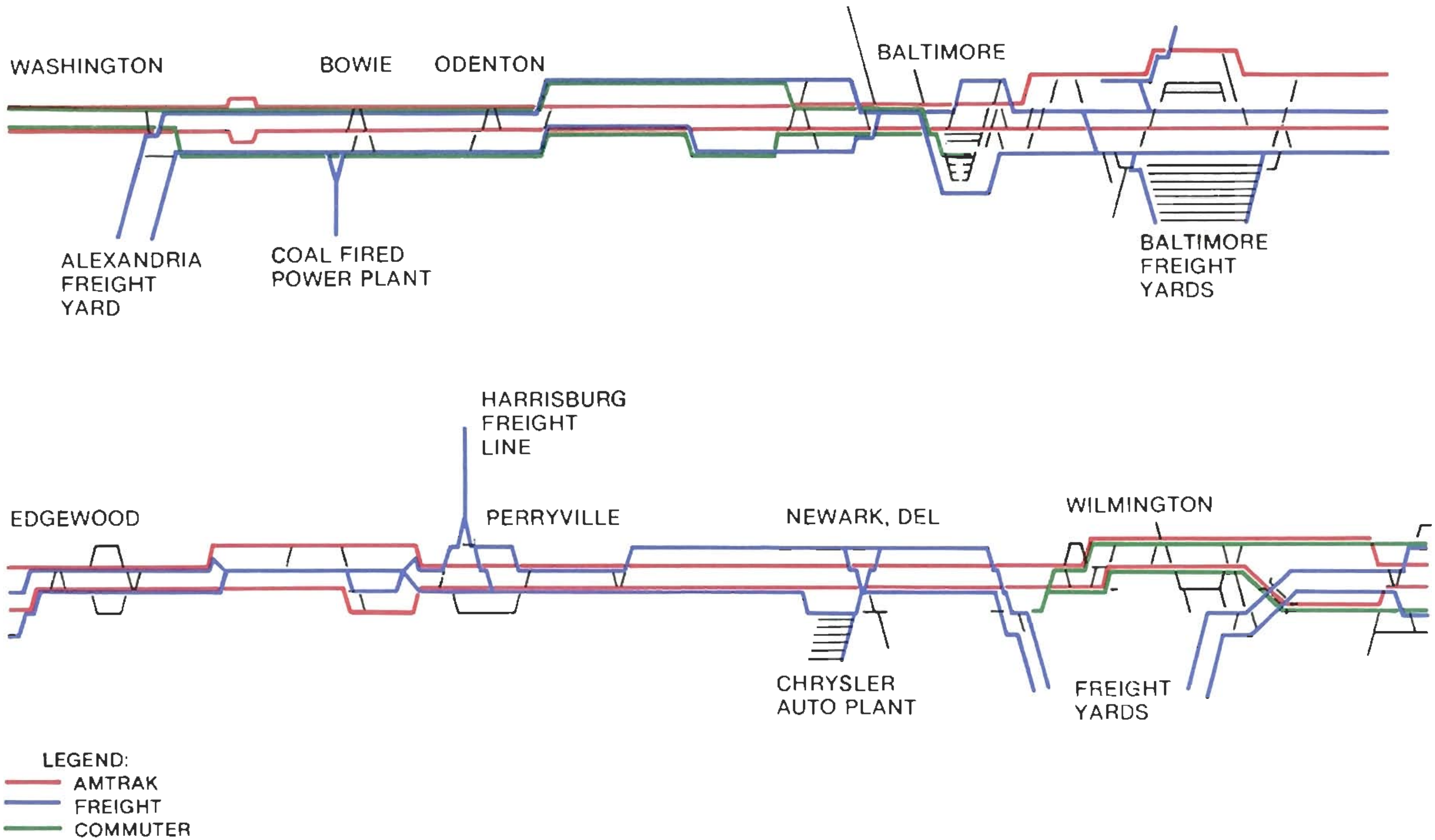


PLATE I
WASHINGTON, DC TO WILMINGTON, DELAWARE
FREIGHT AND PASSENGER TRACKS
1975

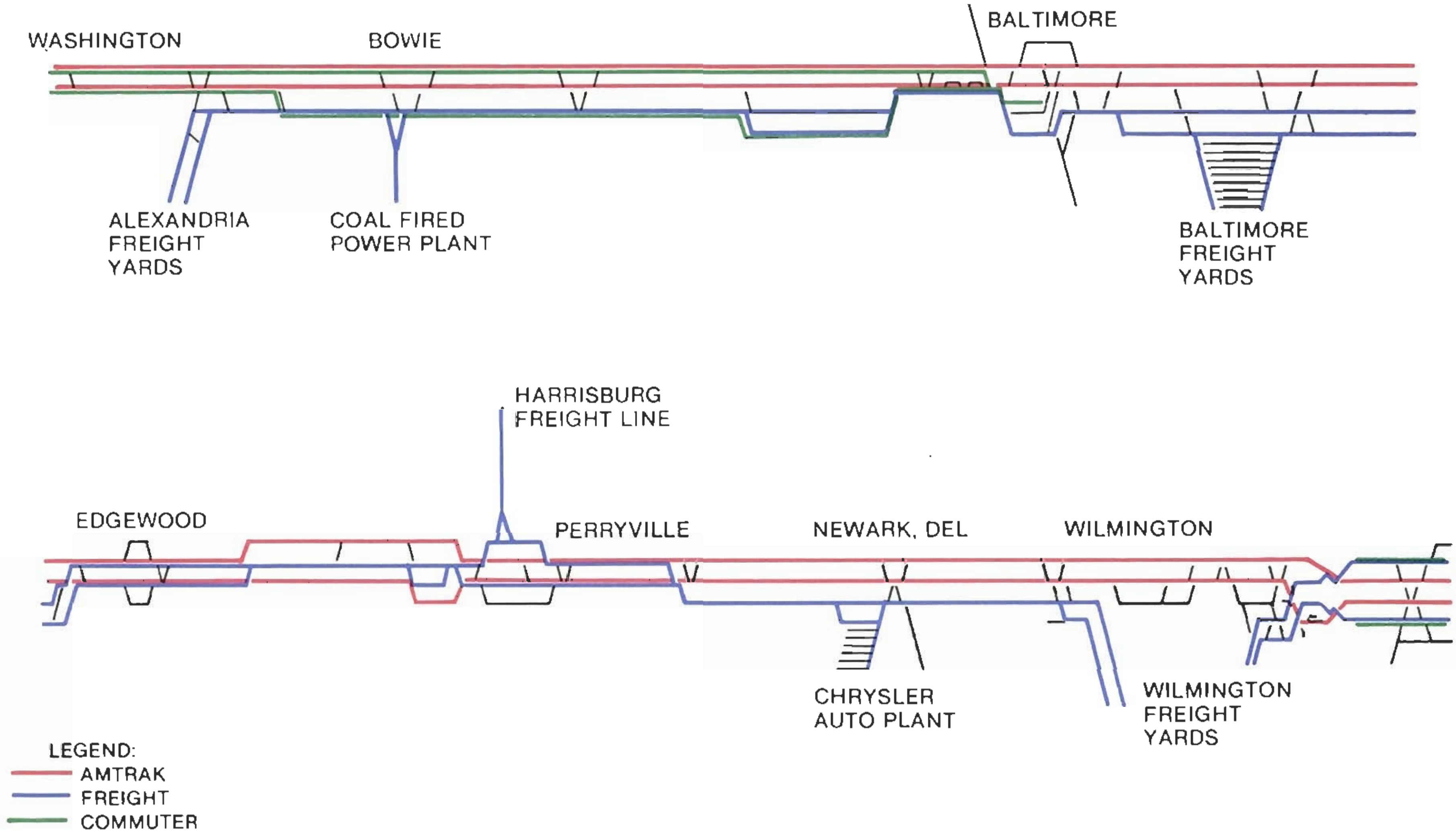


PLATE II
DESIGNATED PASSENGER AND FREIGHT TRACKS
WASHINGTON, DC TO WILMINGTON, DELAWARE
1985

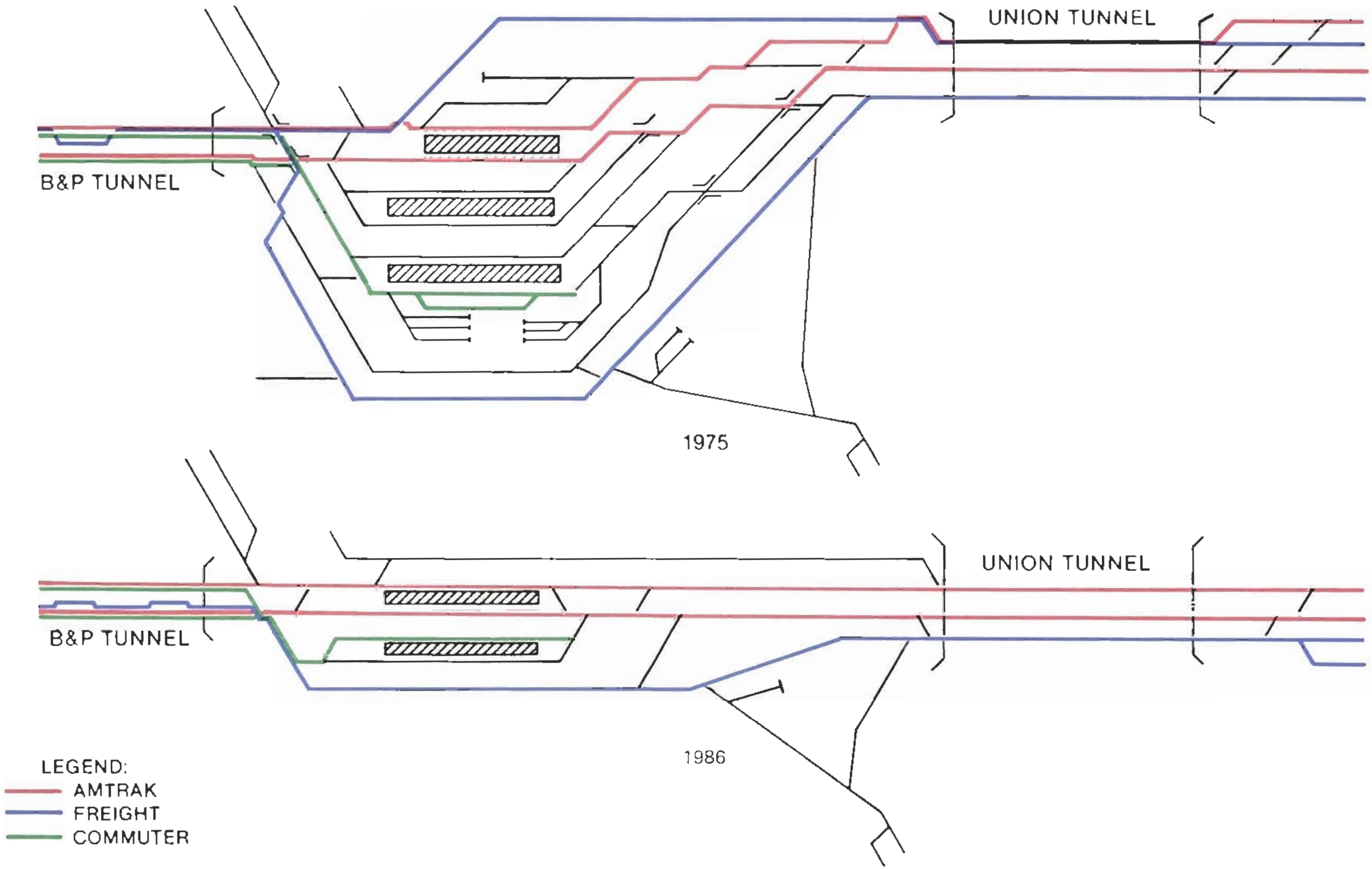


PLATE III
BALTIMORE STATION
1975 AND 1986

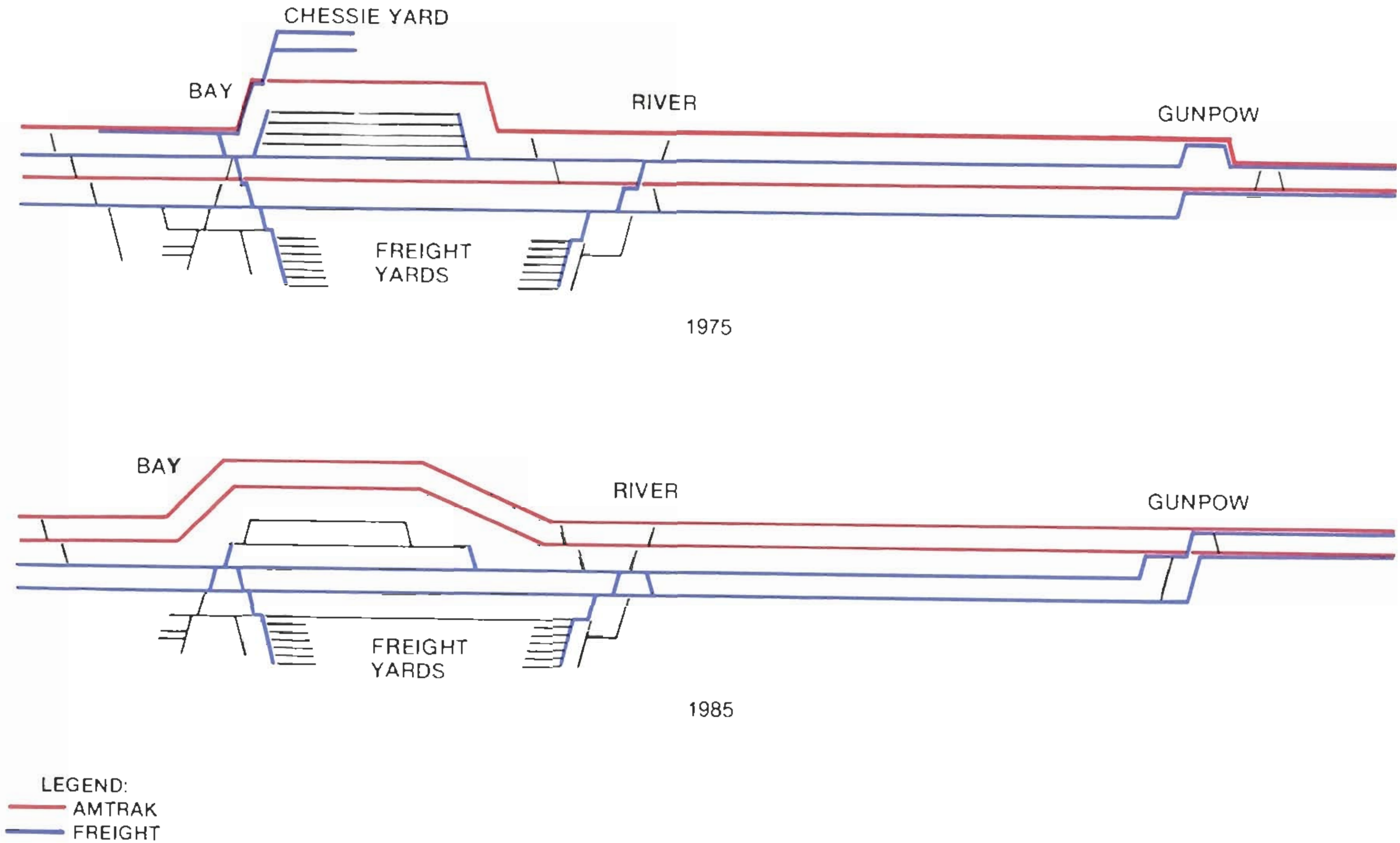
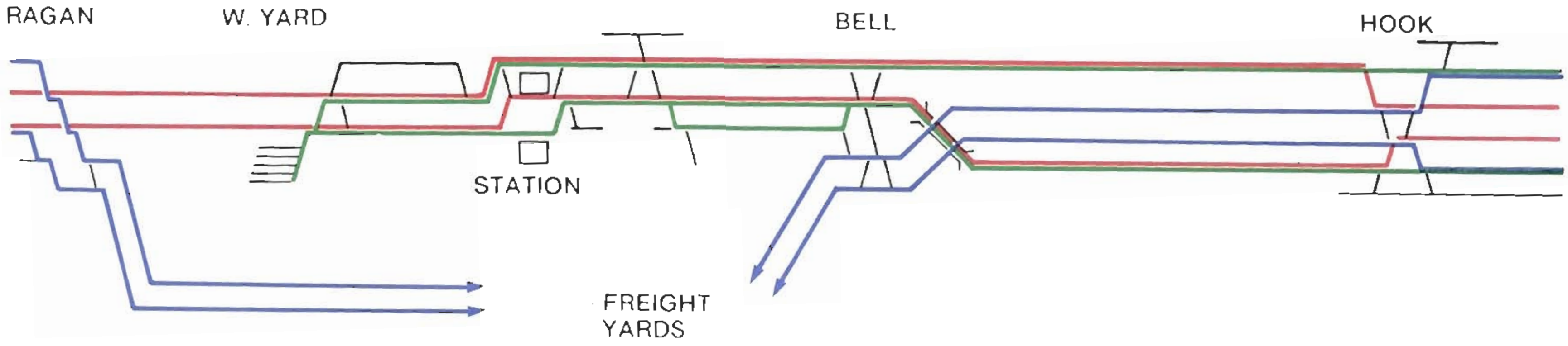
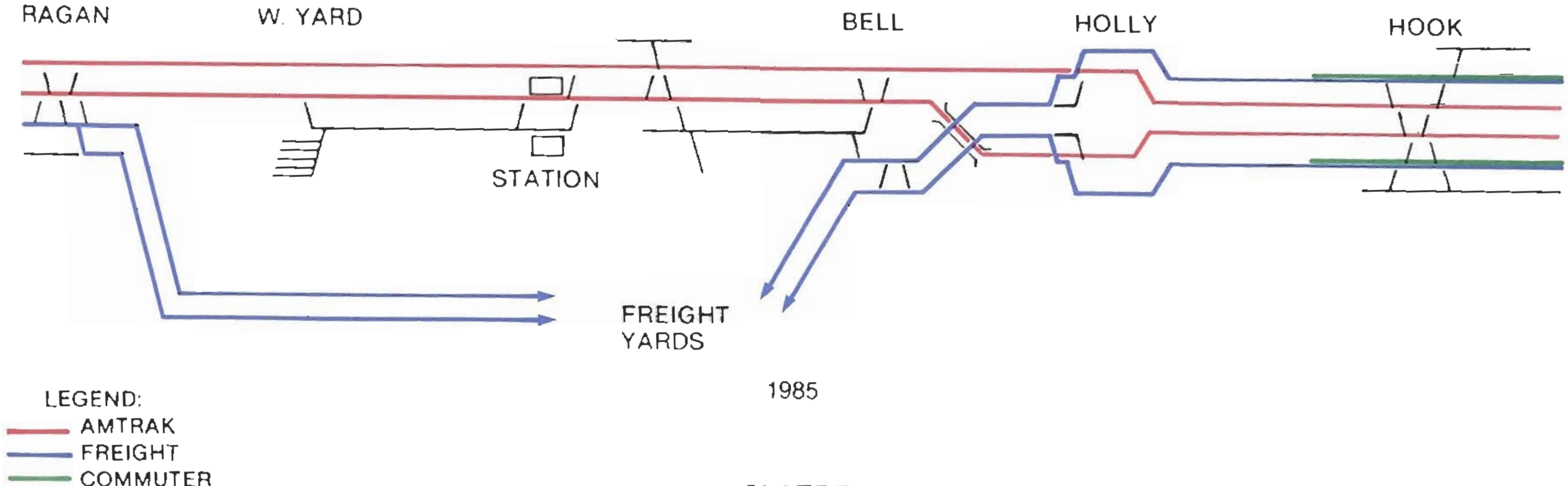


PLATE IV
BALTIMORE FREIGHT YARDS
1975 AND 1985



1975



1985

PLATE V
WILMINGTON, DELAWARE
1975 AND 1985

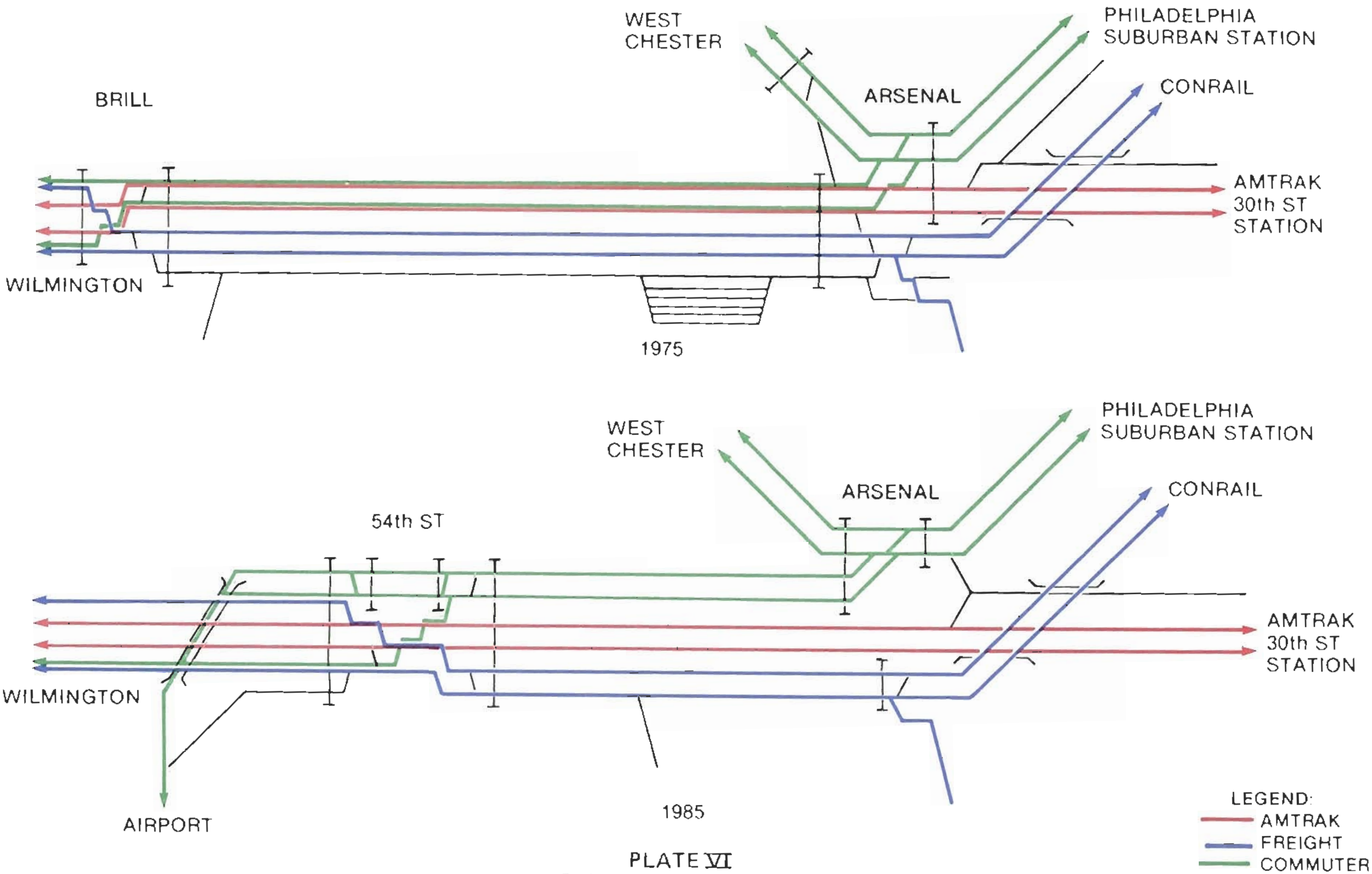
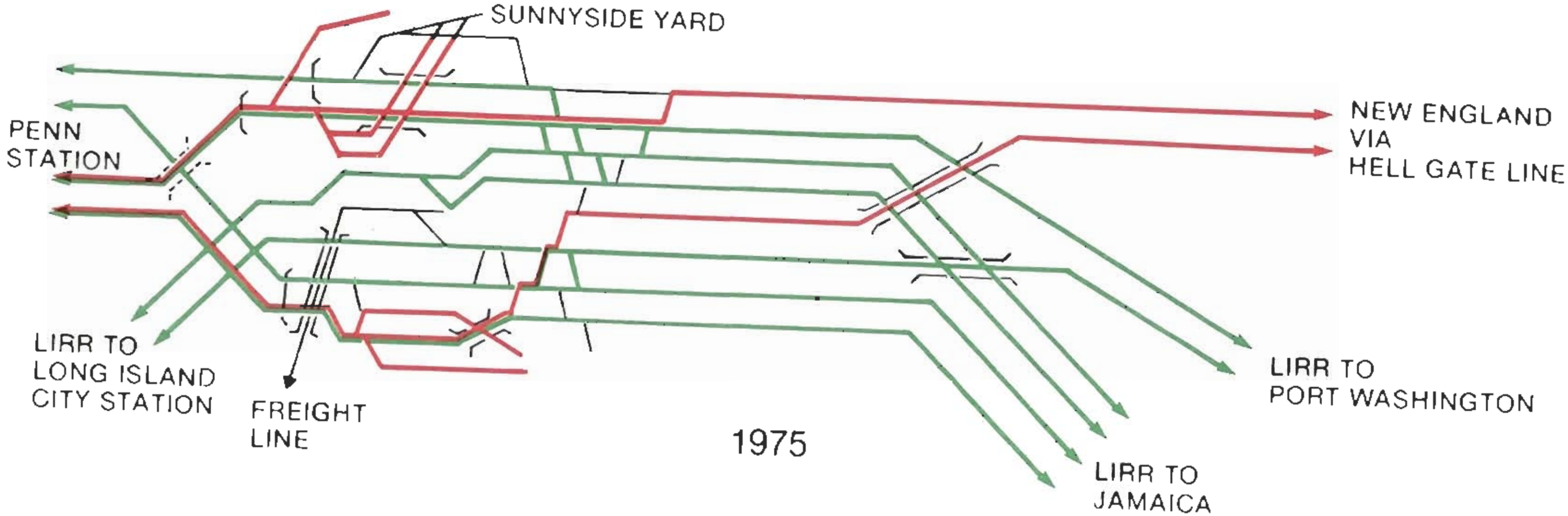


PLATE VI
SOUTH PHILADELPHIA
1975 AND 1985



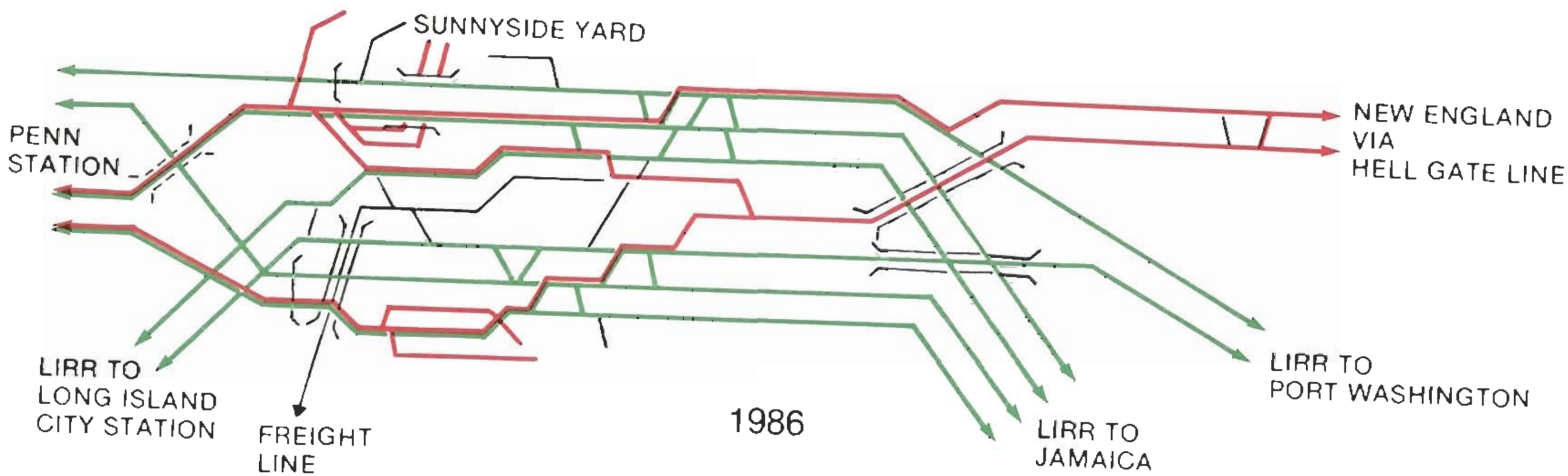


PLATE VII
HAROLD INTERLOCKING
1975 AND 1986

LEGEND:
AMTRAK
COMMUTER

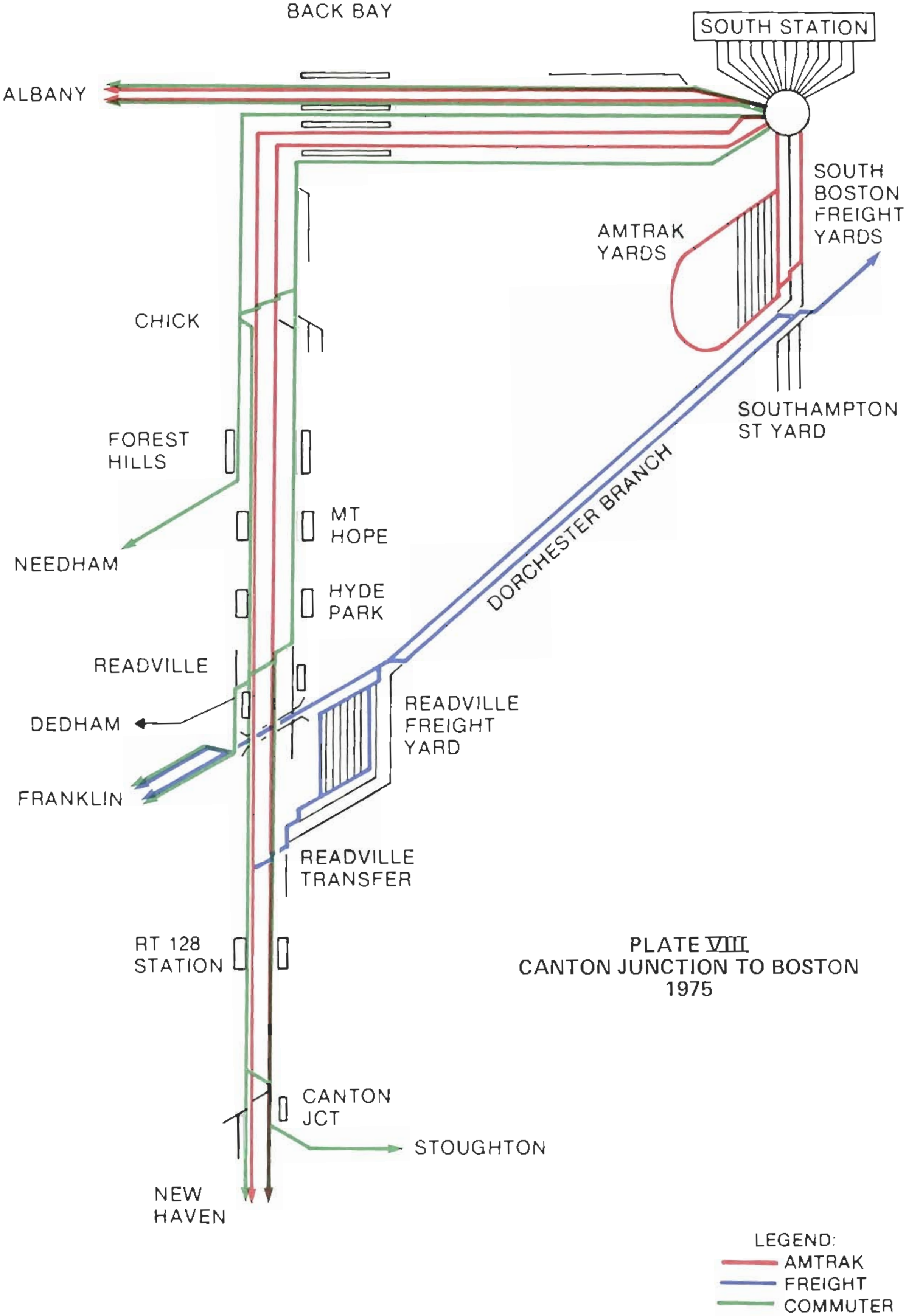


PLATE VIII
CANTON JUNCTION TO BOSTON
1975

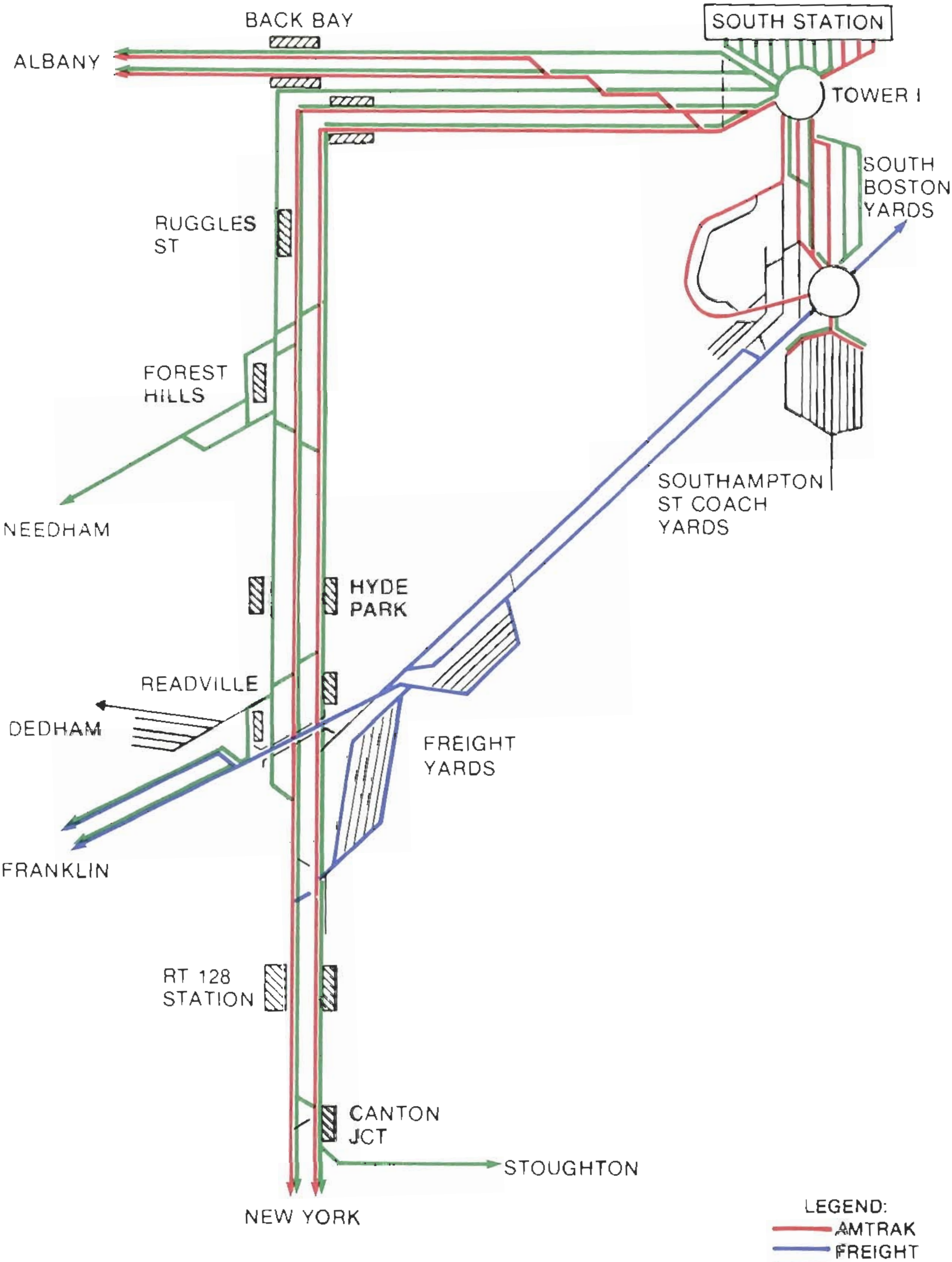
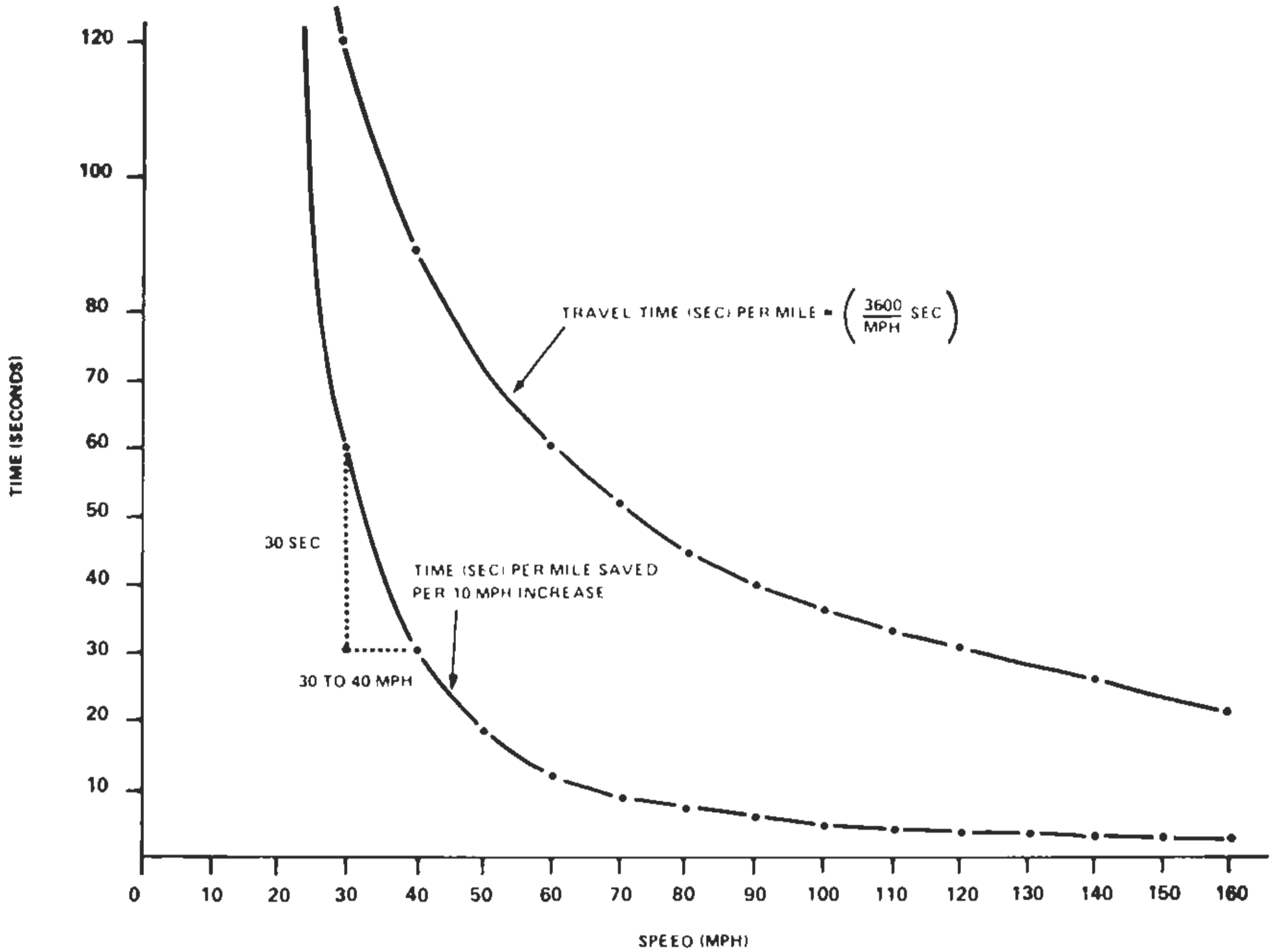


PLATE IX
CANTON JUNCTION TO BOSTON
1986

FIGURE 2-2

RELATIVE IMPORTANCE OF SPEED CHANGES



greater time savings than the same increase at a high speed range. Thus, an increase in speed from 30 mph to 40 mph in a station area can save 20 seconds per mile.

Table 2-2 shows some typical time savings achieved through the redesign of track layouts in both high- and low-speed areas.

Prominent results of the section improvement program follow, in geographical order from south to north.

Washington to Baltimore

When the NECIP is complete, interlocking changes will have occurred at Washington Terminal, New Carrollton, Bowie, Odenton, and Baltimore. The changes at Washington Terminal will move crossovers off a curve, thus allowing speeds to be increased from 20 to 45 mph. In conjunction with the construction of a station at New Carrollton, the NECIP installed a gantlet track to provide extra clearances for freight trains. The NECIP reconfigured Bowie Interlocking to provide universal capability and move crossovers off a curve on the north end. Two interlockings at Odenton, both on curves, were consolidated into one located on straight track. In South Baltimore, the NECIP eliminated one interlocking and moved another interlocking away from a curve to permit higher operating speeds. Where feasible and cost-effective, alignment improvements occurred; for example, at Curve 401 in Anne Arundel County, Maryland, the NECIP work permitted the maximum authorized speed to be increased from 90 to 120 mph. All the section improvement projects included renewal of the drainage system to keep the track structure dry.

Baltimore Station and Vicinity

In the Baltimore Station area, a massive track reconfiguration (including the removal of many superfluous switches and tracks) will provide an alignment adequate for 40 mph operations instead of the present 15 mph. (See Plate III.)

The NECIP completely replaced the track structure in the B&P Tunnel south of the station in a project that included the construction of a new concrete slab floor, the installation of an improved drainage system, and the repositioning of the gantlet track to the eastern track to facilitate freight moves. (The "Tunnels" section, below, has further details.)

Baltimore Freight Yards

The Conrail freight yard, located about 5 miles north of the Baltimore Station, was a source of conflicting freight and passenger moves prior to the NECIP. Plate IV shows how the NECIP reconfigured the track to keep the passenger trains on the west side of the railroad. Conrail and the Chessie System assisted by relocating their freight car interchange; this eliminated the need for slow-moving freight trains to cross main line tracks.

TABLE 2-2

TYPICAL TIME SAVINGS DUE TO TRACK LAYOUT REVISIONS

LOCATION	ACTION	SPEED INCREASE FROM	SPEED INCREASE TO	TOTAL TIME SAVED MINUTES
Washington Terminal	Move crossovers at interlocking near station off a curve	20 mph	45 mph	1
Baltimore Station	Remove many redundant switches and tracks and simplify approaches to station	15 mph	40 mph	3
Wilmington	Install new Holly Interlocking to eliminate crossover move for Amtrak trains at Hook	45 mph	100 mph	1
Philadelphia	Total reconfiguration of old "Arsenal" and "Brill" interlockings south of 30th St. Station	50 mph	75 mph	1
New York (Queens)	Reconfigure Harold Interlocking, shared with Long Island Rail Road	30 mph	45 mph	3

Perryville, Maryland

North of Perryville, the NECIP rearranged two very troublesome interlockings and moved them off curves to permit higher speeds for both passenger and freight service. Since only two tracks exist between these two interlockings, and since Perryville is the junction point with Conrail's main freight line from Baltimore to the west, these improvements materially reduced conflicts at a major bottleneck.

Wilmington Station and Vicinity

The NECIP reconfigured six of the seven interlockings in the vicinity of Wilmington to improve passenger train performance and reduce conflicting freight train moves. Plate V shows how the reconfigurations eliminated slow speed diverging moves for high speed passenger trains and eased congestion. The most significant improvement in running time (over one and one quarter minutes) resulted from the installation of Holly Interlocking, which eliminated a 45 mph crossover move for all Amtrak trains at Hook, and enabled trains to operate instead at 100 mph.

These actions in the Wilmington area improved passenger train travel times by nearly 3 minutes.

South Philadelphia

Prior to the NECIP, a two-mile segment of the Corridor in South Philadelphia experienced severe interference among intercity, commuter, and freight trains. The City's planned introduction of the Philadelphia Airport High Speed Line, making use of a portion of the Corridor in this troublesome area, would have exacerbated the congestion problem. Moreover, water stood continuously on the roadbed at the Brill area, and a major earth slide at Arsenal posed a chronic maintenance problem. FRA developed a comprehensive track reconfiguration plan (Plate VI) in the South Philadelphia area to permit efficient passage of the airport trains while at the same time obtaining better separation and more efficient routing of the intercity, commuter, and freight traffic. Accordingly, the City and FRA planned and implemented a cooperative construction program and shared equally in its $30 million cost. The new configuration, now complete, replaced the old Brill Interlocking and most of Arsenal interlocking with a new interlocking at 54th Street ("Phil"), the design of which specifically addressed the new traffic requirements. The work also included a long retaining wall to prevent the railroad from eroding into the river, as well as a drainage system to eliminate the water problem in the Brill area.

Major benefits have accrued to all users of this facility. Faster trip times are now possible, and conflicts among the disparate operations have lessened. Amtrak has reduced its running times by 1 minute in each direction, and no longer has to share tracks with commuter trains. With the elimination of special curved crossovers at Arsenal, maintenance costs have declined and speed limits have improved from 50 to 75 mph. Commuter train speeds rose from 30 to 45 mph at Arsenal and from 30 to 45 mph northbound at 54th Street. The new layout provided "pocket tracks" at 54th Street and between 54th Street and Arsenal to permit airport trains to pass each other and to facilitate funneling the Marcus Hook, West Chester and airport services onto the two track commuter line leading downtown. The new configuration provided for more efficient freight moves at higher speeds, while the retaining wall eliminated alignment problems on the freight tracks at Arsenal. The reconfiguration of South Philadelphia therefore represents a jointly planned and funded NECIP/local effort that has paid off for all the agencies involved.

North Philadelphia

Portions of Zoo Interlocking will undergo modification to eliminate diverging moves by Amtrak trains without impairing commuter or freight services. The proposed elimination of North Philadelphia interlocking can occur whenever SEPTA reroutes its service to Chestnut Hill via the former Reading Railroad Line.

Trenton Station Area

The NECIP moved a portion of the interlocking at the north end of the Trenton Station (Fair) from a very low, wet, and unstable area with high maintenance costs and perpetual slow orders to a relatively high, dry, and stable area one-half mile north. To improve train operations and raise speed limits, one interlocking (Millham) was eliminated and a new interlocking (Fairham) installed.

Metropark Area

The Metropark Station in Iselin, New Jersey became more accessible to intercity trains through the installation of high speed crossovers from the center tracks to the outside tracks. This provided immediate access to the platforms and reduced trip time for all trains scheduled to stop at Metropark.

Newark Area

The NECIP installed a new interlocking, Bergen, on the double track main line between New York and Newark, New Jersey. Located adjacent to, and west of, the North (Hudson) River Tunnels, the new crossovers have improved the operating flexibility of this busy passenger railroad.

New York City

Harold Interlocking in the Queens section of New York controls the junction of the Hell Gate Line to New England and the Long Island Rail Road commuter line to Penn Station. It is a very large and complex junction, serving about 600 trains per day, most of which are commuter trains. Many changes in traffic patterns have occurred since its construction in 1910. A cooperative effort of Amtrak, the Long Island Rail Road, and the FRA is resulting in a reconfiguration (Plate VII) that will reduce the number of diverging moves for Long Island Rail Road commuter trains and increase the speed of Amtrak trains to and from New England from 30 to 45 mph. The remaining Long Island Rail Road diverging moves will also increase in speed from 30 to 45 mph. The NECIP also installed a new interlocking, Gate, just east of Harold Interlocking. Gate enables Amtrak trains to cross over between the two main line tracks five miles further west than they could previously. This new capability reduces train delays and increases operating efficiencies.

As part of the rehabilitation of the Hell Gate Line through the Bronx, the NECIP removed Market Interlocking from its poorly drained, unstable, high-maintenance location, thus eliminating a permanent slow order. A new interlocking at Pelham Bay, 4 miles to the east, provides Amtrak with the operating flexibility formerly available at Market.

New Haven to Canton Junction, Massachusetts

Relatively minor track configuration changes occurred at eight interlockings to improve speeds or to reduce maintenance requirements. Changes at New London permitted all trains to stop on the track adjacent to the station and thus avoided the need for passengers to walk across the tracks to board eastbound trains. The new Providence station necessitated the construction of two new interlockings in Providence, Rhode Island.

Canton Junction to Boston

The 15 miles from Canton Junction to Boston South Station presented major operational challenges as 150 daily trains over six different routes, as well as empty equipment using a nearby maintenance facility, funnelled into and out of South Station. The huge South Station complex (built in 1898) had been reduced over the years from 28 tracks to 13 tracks as its owners responded to traffic declines and cash shortages. For the same reasons, the owners had further reduced capacity by selling the Dover Street Yard to the MBTA for a subway maintenance shop. The 13 remaining station tracks thus also served as a storage yard for commuter trains.

The Massachusetts Bay Transportation Authority (MBTA) is designing and constructing improvements between Back Bay Station and the Forest Hills commuter station. This section of railroad was, for the most part, constructed on a massive earth-filled stone viaduct. Under MBTA's Southwest Corridor Project, this wall has been removed and the railroad depressed below the grade of adjacent streets and lots. In addition, MBTA is moving the rapid transit "Orange Line" into this same depressed section and dismantling the former Orange Line viaduct that dominates Washington Street.

The NECIP is contributing $62 million to the Southwest Corridor Project and is funding all the railroad signals at a cost of approximately $6 million. The NECIP is also providing the funds for construction between South Station and Back Bay Station and between Forest Hills Station and the Rhode Island State Line.

Plates VIII and IX schematically show the old and new track configurations; the extremely complex interlockings at South Station and Southampton Street Yard appear as simple circles. While this massive reconfiguration did not significantly increase the speed of Amtrak trains, it did reduce congestion by raising the diverging speeds of commuter trains at Canton Junction, Forest Hills and Jamaica Plain. The new track configuration for South Station includes a totally revised, simplified interlocking leading to an 11 track station equipped with high level platforms. The new station will have 30 percent more usable track footage than the former facility; the simplified layout will also provide more direct train access to the station, lower track and signal maintenance costs, and lessen the risk of derailment. Expedited train operations in the station vicinity will speed up equipment turnaround for all services, and increase capacity. A totally new Southampton Street Yard will provide storage and maintenance of both Amtrak and commuter trains. Construction costs have been shared by the FRA and MBTA on a site-specific basis with the FRA providing the interlocking signal systems and bi-directional signals on all tracks.

Track Curvature Adjustments

When a train rounds a curve, physical forces press both cars and passengers toward the outside rail. Thus, the degree of curvature influences both train speed limits and passenger comfort. Track engineers over the years have devised complex techniques to ease the speed restrictions and passenger discomfort through curves: raising the outer rail through the curve (banking or superelevation), lengthening or introducing transition curves (spirals) that make gradual the change from straight track to the curve itself, gradually raising the outer rail in advance of the curve itself and -- where feasible -- reducing the maximum degree of curvature. The NECIP screened the entire route for opportunities to apply these engineering techniques in a judicious manner, and made cost-effective adjustments to curves for passenger comfort and higher train speeds. In some cases, the curvature adjustments were so minor (measured in inches) as to be included in the track upgrading program rather than under the rubric of section improvements.

Elimination of Maintenance Trouble-Spots

Even the best-maintained railroad has specific locations where subgrade and drainage conditions lead to excessive upkeep costs. The NEC prior to the NECIP was no exception, especially in view of its accumulated maintenance deferrals.

A wet roadbed hastens the deterioration of a track structure. Because the wet subsoil will not properly support the loads applied through the track, surface irregularities develop and slides sometimes occur. Excessive water also speeds degradation of the ties. Although the NEC main line once included an adequate drainage apparatus of ditches and storm drains, they had fallen into disrepair by the 1970's. In restoring this indispensable drainage system, the NECIP has cleaned and repaired old facilities where feasible, and has dug new ditches and installed pipes as appropriate. This essential activity will reduce future track structure failures and contribute to lower maintenance costs for Amtrak.

Results of Section Improvement Program

With the section improvement program now substantially complete, major work remained as of November, 1986 only between South Station and Back Bay Station in Boston; in the station area in Baltimore; at Zoo Interlocking in Philadelphia; and at New York Avenue Interlocking in Washington, D.C. The total cost for the section improvement projects is $169.2 million.

BRIDGE PROGRAM

The $178.8 million bridge program is virtually complete, and will result in the replacement of 10 bridges and the rehabilitation of 202 bridges.

Movable Bridges

At the onset of the program, the most urgent bridge problem on the Corridor was the high level of deterioration on 12 major movable bridges. The mechanisms for swinging or lifting these movable spans to permit passage of boats had become unreliable because of the combined effects of age, wear, and inadequate maintenance, thereby resulting in increasingly frequent delays for Corridor trains (and/or boats).

The 12 movable bridges in the NECIP (see Figure 2-3) account for $80 million, almost half the bridge budget. Completely new bridges have replaced the old and deteriorated swing bridges at Shaw's Cove and Mystic River in Connecticut at a cost of approximately $38 million.

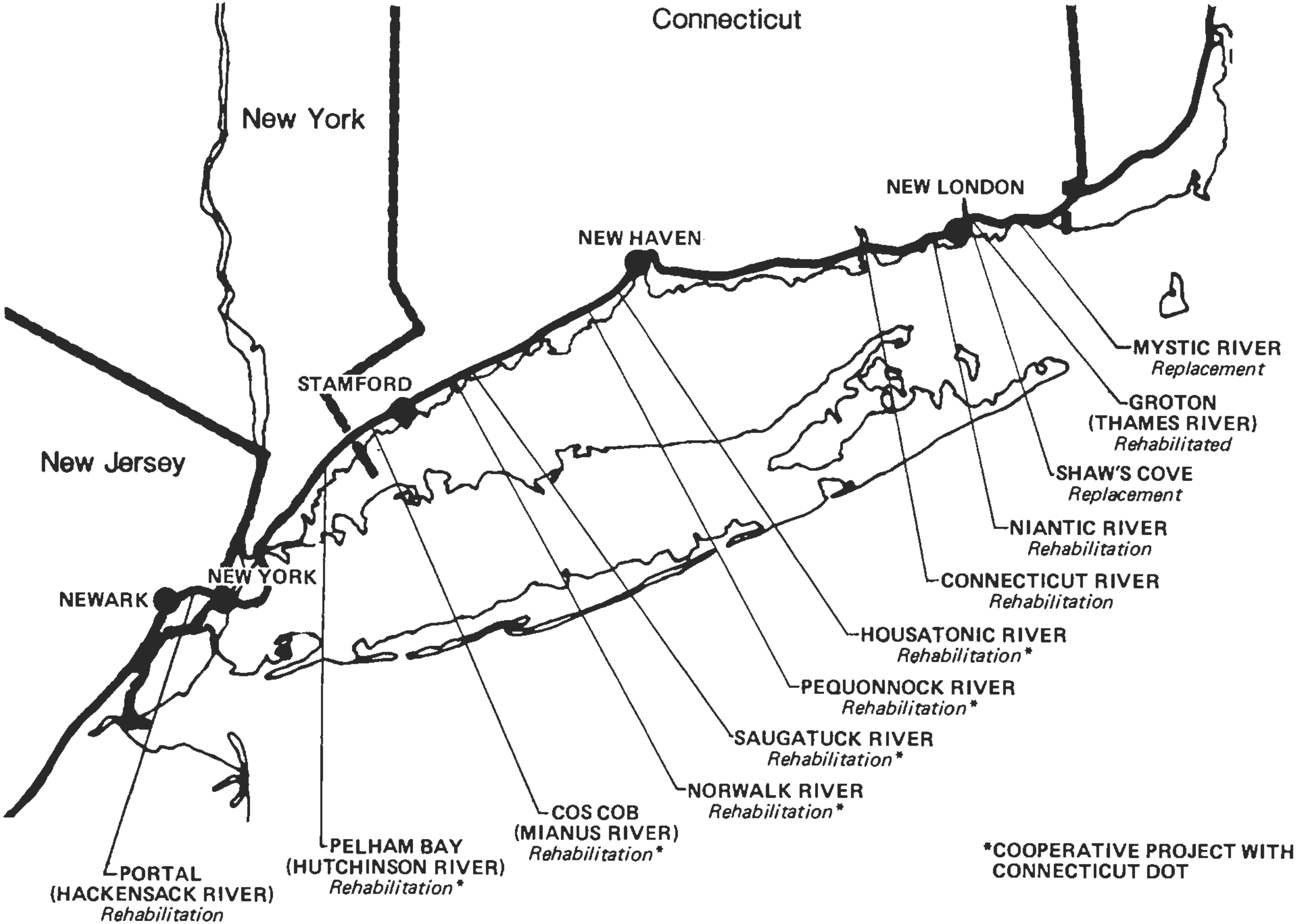
Of the ten remaining movable bridges in the program, the NECIP rehabilitated five directly, and addressed the other five cooperatively with the Connecticut Department of Transportation. The five movable bridges directly rehabilitated by the NECIP were the Portal, Pelham Bay, Connecticut River, Niantic River, and Groton bridges. In some cases (Connecticut River and Groton), the NECIP has completely replaced the electrical and mechanical systems, while in others, the NECIP has undertaken a selective program of replacing some components while repairing the rest. In general, the old gearing and wiring required replacement as the bridges' openings were never quite certain. Major improvements have included the replacement of obsolete electrical controls with modern controls and the installation of modern rail and expansion joints. The NECIP has also performed such structural work as has been necessary to offset deterioration and damage suffered by the bridges over the years. Most of the structural work has focused on the floor systems and bracing, the areas of worst corrosion. Specialized repairs have also occurred on major girders of the movable spans.

Under a cooperative agreement with the Federal Railroad Administration, the Connecticut Department of Transportation (ConnDOT) will repair five other movable bridges in order to improve the reliability of the movable spans. Since ConnDOT will devote relatively little attention to the approach spans, there will remain much structural work and track work (including miter rails) to be done in the future by Metro North and ConnDOT.

The ConnDOT/FRA cooperative program will replace the electrical system on two bridges, will rehabilitate it on two others, and will include mechanical rehabilitation on all five. Four movable bridges will have segmental and track girder work; the rim bearing swing bridge at Norwalk will receive a new set of pony wheels and a new track and ring-gear.

FIGURE 2-3

MOVABLE BRIDGES – THE HEART OF THE NECIP BRIDGE PROGRAM



NORTHEAST CORRIDOR PASSENGER RAIL IMPROVEMENTS

MYSTIC RIVER BRIDGE

OLD SWING SPAN

NEW DOUBLE TRACK SWING BRIDGE FOR CONNECTICUT'S MYSTIC RIVER.

- A 262 FOOT, 1,400 TON SWING BRIDGE, ELECTRICAL/MECHANICAL CONTROL SYSTEM, APPROACH SPANS AND 1 MILE TRACK REALIGNMENT.
- REPLACES THE 1918 BRIDGE
- COST: $17.0 MILLION

NEW SWING SPAN

FLOAT IN OF SWING SPAN

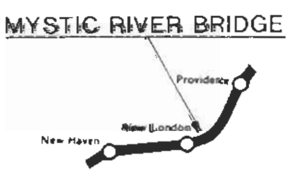
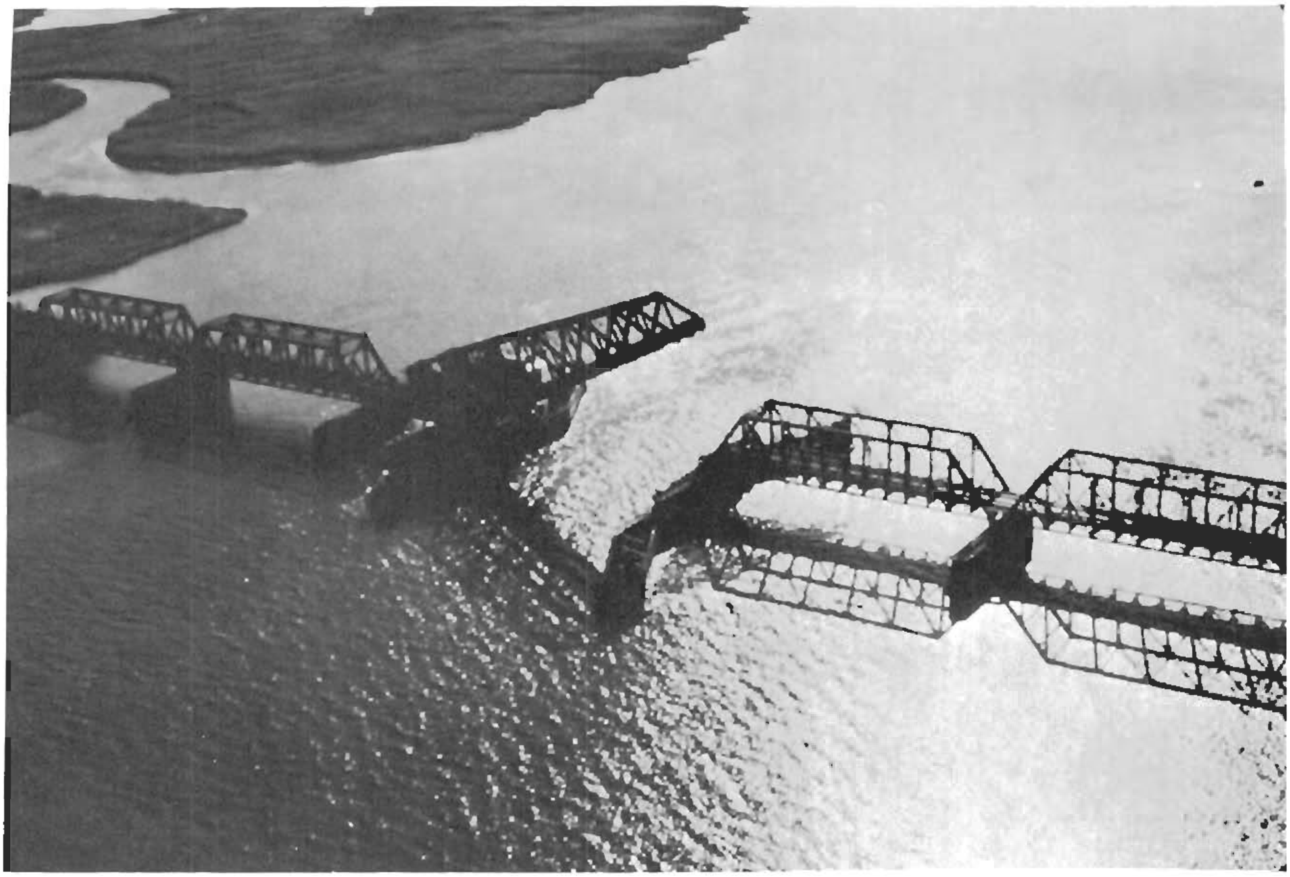


Photo 2-4



The Connecticut River Bridge at Old Saybrook benefited from NECIP improvements.

Fixed Bridges

The fixed bridge program has resulted in the replacement of eight short span bridges and the strengthening of 192 others. In most of the replacements, badly deteriorated steel plate girder bridges have given way to precast, prestressed bridge deck units or to a steel wide-flange stringer bridge encased in a reinforced concrete slab to a special Amtrak design. Some of the bridge upgradings have combined repairs and replacements: new beams have replaced the beams supporting one track, while supporting members for the other track have simply been strengthened. (The term "replacement" in regard to the fixed bridges usually means replacement of the superstructure but reuse of the existing masonry substructure.)

The repairs themselves have consisted of added cover plates, web reinforcement, stiffener repairs, new bracing, rivet replacement, new stringers (or new stringer top flanges on a floor beam-girder structure), new bearings, bridge seat repair, and masonry joint pointing. With several exceptions, steel bridges have been painted after repairs are completed. On a very limited basis, bridges with ballasted decks have received new waterproofing and new ballast.

TUNNELS

The principal tunnels of the NEC are in Baltimore (Baltimore & Potomac and Union Tunnels) and in New York/New Jersey (North -- that is, Hudson -- and East River Tunnels). Of these, the Baltimore & Potomac (B&P) Tunnel received the most attention owing to its exceptionally poor condition. In keeping with the philosophy of the NECIP, essential repairs and renewals took place in these tunnels to assure service reliability.

Baltimore & Potomac Tunnel, Baltimore

Because of its advanced state of deterioration and hostile environment (78 trains a day operated through the tunnel during reconstruction) this tunnel posed one of the most complex engineering challenges to the NECIP. The drainage system, the track structure, and the tunnel lining had deteriorated by 1976 to such a point that derailments in or near the tunnel, especially of freight trains, had become frequent. Between 1976 and 1983, 4 significant derailments occurred due to track deficiencies at this location, which has always been one of the most congested bottlenecks in the Corridor. Clearances in the tunnel force many freight trains to operate over a special "gantlet" track installed between the two passenger tracks to take advantage of the additional clearances in the center of the tunnel. During such freight operations over the gantlet track, the entire tunnel is occupied so that it is in effect a single track operation. In the past, when this normal congestion was added to the effects of derailments, bad track, and poor drainage conditions, NEC operating efficiency suffered. Clearly, the NECIP had to address the problem in some manner.

Recognizing the difficulties inherent in the B&P Tunnel, the former Pennsylvania Railroad had gone so far as to prepare plans for a parallel tunnel and acquire a portion of the right-of-way. Yet other projects had exerted a stronger pull on the railroad's capital and the parallel tunnel was never undertaken. The same thing happened to the NECIP, which could justify neither a parallel tunnel, nor a major clearance revision to eliminate the gantlet track, in view of the limited resources at hand. Yet the NECIP could fully justify a concerted effort to assure system integrity at this location, and therefore undertook the following work:

Resolve Water Infiltration and Drainage Problems

Underground springs and flooding plagued the B&P Tunnel from the year it was built (1873). Further compounding these problems were leaks from deteriorated water and sewer lines running along, over, and under the tunnel. The first step in the NECIP rehabilitation project was the development of a new drainage system, replacing the center track drains that had long since lost their effectiveness. Key elements of the new system were three large impoundment chambers or sumps built at critical water collection points, additional weep holes in the tunnel walls, and troughs to collect and convey the drainage to collection sumps.

Track and Invert Improvements

With drainage improvements in place, the next step was the repair or replacement of the existing invert -- the concrete slab supporting the track. The track and slab were removed; a new foundation slab was poured and prepared for track structure placement; track panels were placed, lined and graded; and encasement concrete was placed using on-track equipment.

Project Completion

Rehabilitation of the tunnel invert and one track reached completion in November 1982 with the installation of signal hardware and catenary adjustments. The project had taken 32 weeks of construction at a cost of $12 million. Work on the second track ended in August 1983, thus completing the upgrading of a vital link in the Northeast Corridor. Although the freight clearance problems and the gantlet track remain in place, the integrity of the tunnel structure and of its track have benefited greatly from the upgrading. Train operations through the tunnel are therefore safer, more reliable, and more comfortable for passengers than they have ever been.

Other Tunnel Improvements

Other tunnel improvements in the NECIP included the installation of fire-lines in the East River Tunnel in New York; the replacement of existing wood tie and ballast tracks in the entire North (Hudson) River Tunnel, and in two of the four East River Tunnels, for a time saving of 3 minutes; the replacement of existing fans and selected drain pumps in both the East and North River Tunnels; and the renewal of the drainage in a short tunnel in East Haven, Connecticut.

TRACK IMPROVEMENT

The $691.3 million track improvement program element has provided the NEC with a stable, geometrically precise, enduring track structure providing safety and passenger comfort.

Photos 2-5

NORTHEAST CORRIDOR PASSENGER RAIL IMPROVEMENTS

B&P TUNNEL REHABILITATION

A 19TH CENTURY (110 YEAR OLD) 1.3 MILE RAILROAD TUNNEL.

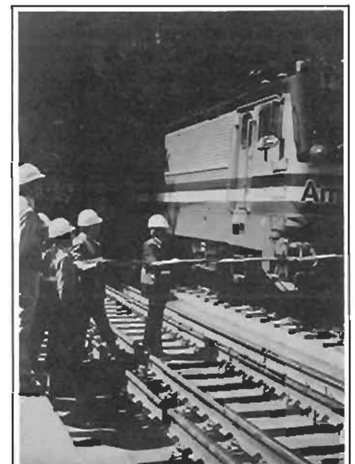
SEVERE RESTRICTIONS AND FREQUENT INTERRUPTIONS TO RAILTRACK DUE TO DETERIORATED WALLS, TIES, DRAINAGE, AND FLOODING, REQUIRED COMPLETE REHABILITATION WHILE MAINTAINING RAIL TRAFFIC.

- REPAIR ENTIRE INTERIOR WALL

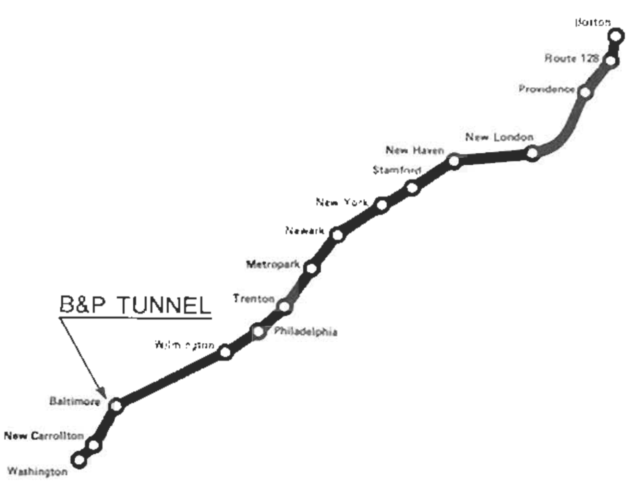
  RESTORE DRAINAGE SYSTEM
- REPLACE CONCRETE INVERT SLAB
- PROVIDE TWO TRACK SERVICE WITH NEW CONTINUOUS WELDED RAIL, TIES AND LIGHTING.
- EXTEND TUNNEL LIFE BY 20 – 30 YEARS.
- COST: $15 MILLION vs RELACEMENT AT $200 M TO $400 M.

BEFORE REHABILITATION

AFTER REHABILITATION



DEDICATION



Now essentially complete, the track improvement program encompassed the entire Amtrak route between Washington, D.C. and Boston, Massachusetts (except for state-controlled sections between New Rochelle, New York, and New Haven, Connecticut). While correcting 30 years of deferred maintenance prior to the conveyance of the NEC to Amtrak, the program not only rehabilitated a deteriorated line but also brought the track structure up to unprecedentedly high standards. With the exception of certain items accomplished by contractors (rail grinding and some undercutting), Amtrak's own employees performed all the work in the track improvement program. Figure 2-4 offers evidence of the program's success, as it reduced the number of slow orders in the NEC from almost 200 in 1976 to effectively none today.

To support the track improvement effort, the NECIP provided Amtrak with machinery and methods that often represented the first, or most extensive, application of advanced technologies in this country. In the future, this new equipment will continue to enhance the efficiency and quality of Amtrak's track programs.

Concrete Ties

Standard railroad track construction in the United States has historically consisted of jointed steel rails on wood ties. (Ties maintain the rails at proper gauge and transmit the load from the rails to the ballast.) Although European railways had used concrete ties for several decades, American railroads had installed them in only limited instances prior to the NECIP. Ample economic and technical justification existed for an investment in concrete ties for the Corridor because of their anticipated longer life vis-a-vis wood ties (a projected average of 40 versus 25 years), and owing to the improved geometric stability and reduced maintenance burden that concrete ties would provide. By the end of the project, approximately 410 track miles of concrete ties will have been installed in high speed areas of main line tracks.

The concrete ties have indeed provided improved track stability. Figure 2-5 shows an actual measurement of gauge (spacing between rails) as recorded on a track geometry car. As the car passed from wood to concrete tie track, the gauge readings showed a dramatic improvement. Indeed, the concrete tie program has proven so successful that Amtrak began installing another 40.6 track-miles of concrete ties in 1985 with Congressional funding above the $2.19 billion NECIP, as well as Jobs Bill funds (see Table 5-1). Amtrak's goal is ultimately to install concrete ties on all designated high speed tracks between New York and Washington.

Installation System

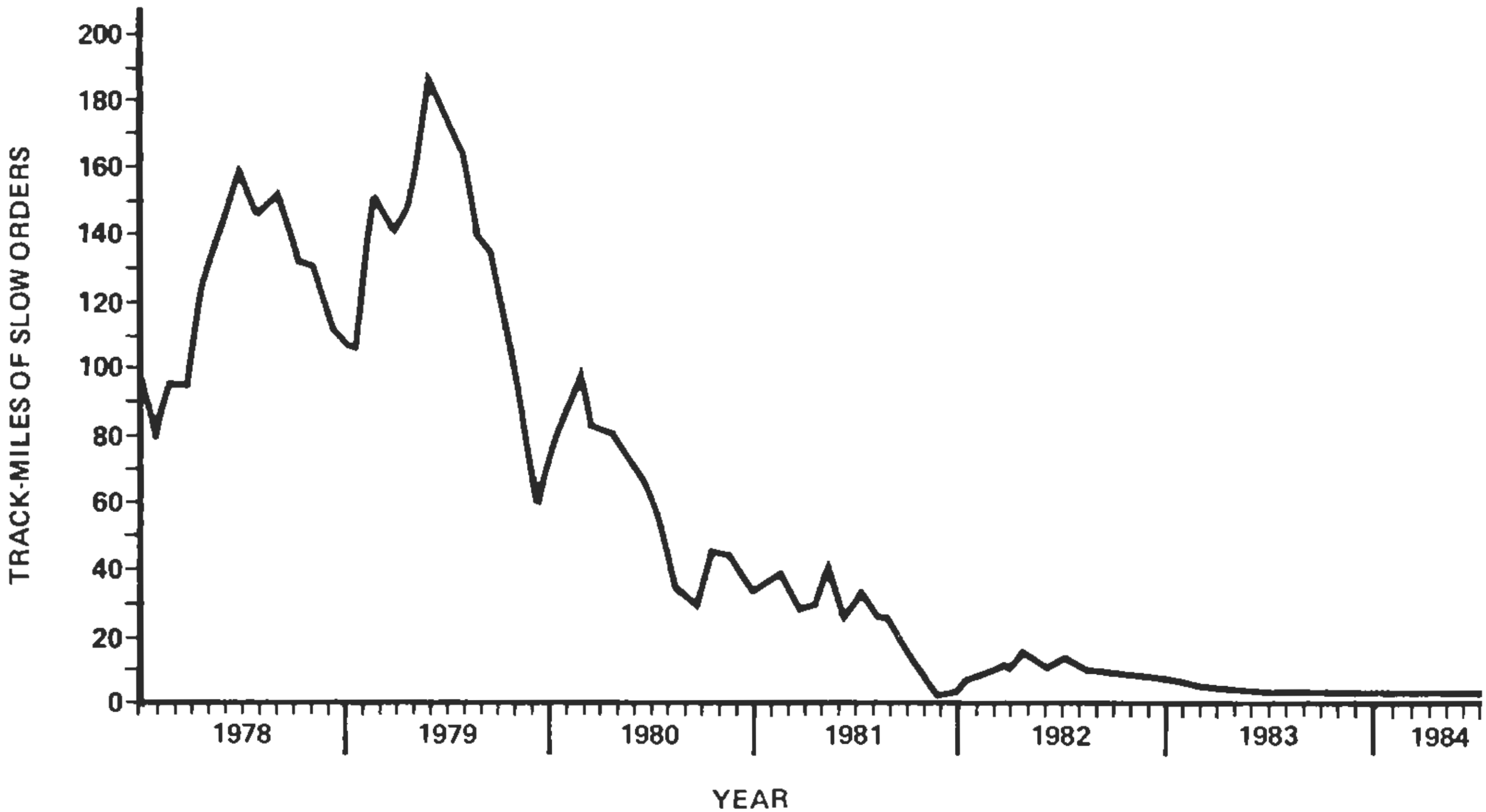
Unlike the conventional wood tie system, which fixes the rail to the ties with relatively loose-fitting spikes, the concrete tie system secures the rail to the ties by means of a specially designed fastener in combination with a pad having flexibility in the vertical direction. The design provides rigidity in the lateral direction, thereby resisting lateral irregularities in the track, while providing the necessary vertical cushioning to prevent the cracking of the ties and pulverizing of the ballast from wheel impact loads.

FIGURE 2-4

NORTHEAST CORRIDOR

SLOW ORDER STATUS

WASHINGTON TO BOSTON



NOTE: Slow orders are theoretically "temporary" speed restrictions due to track deterioration rather than to the inherent capabilities of the track alignment.

Figure 2-5

CONCRETE TIES ENHANCE GEOMETRIC PRECISION OF NEC TRACK STRUCTURE

To the right is an actual output plot from a track geometry measurement car as it passed from wood to concrete tie track near Aberdeen, Maryland. At mile-post 63, where concrete replaces wood, the amplitude of the tracing lessens markedly -- proof that concrete ties assure a more consistent track geometry. (The greater the amplitude, the greater the departure from the established gauge.)

TRANSITION POINT FROM WOOD TO CONCRETE TIES

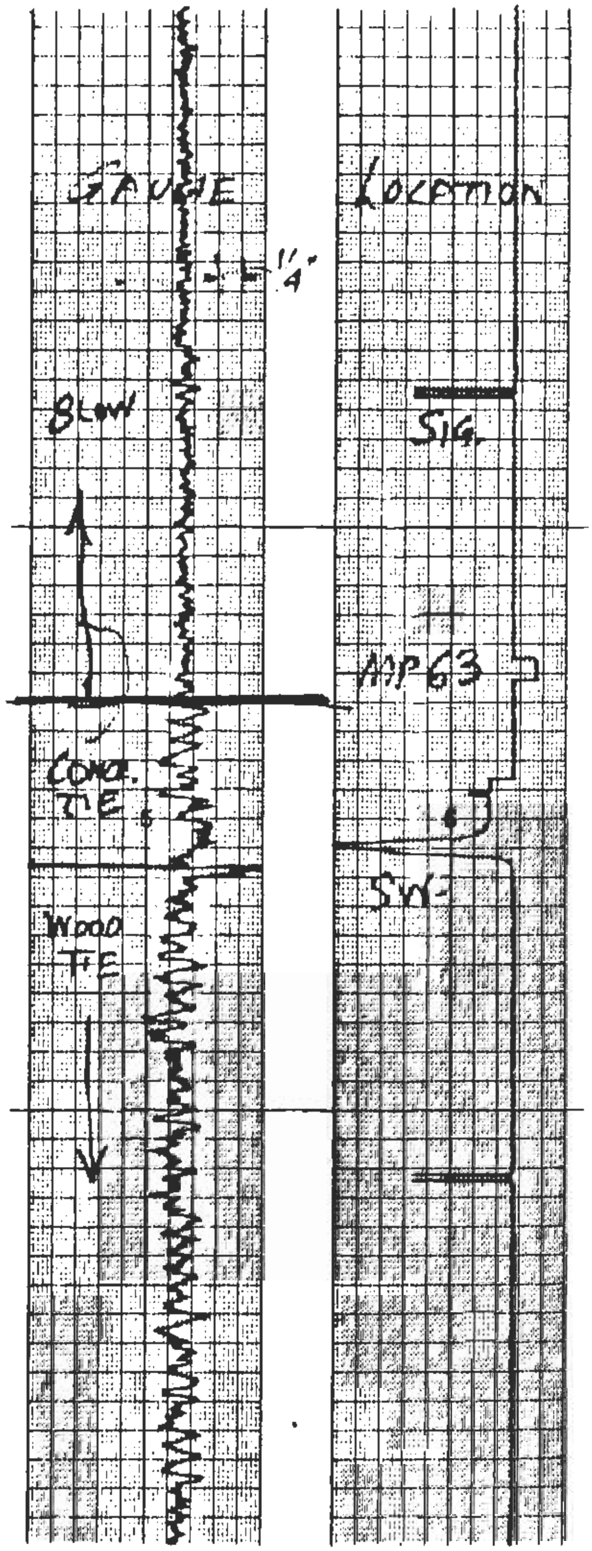
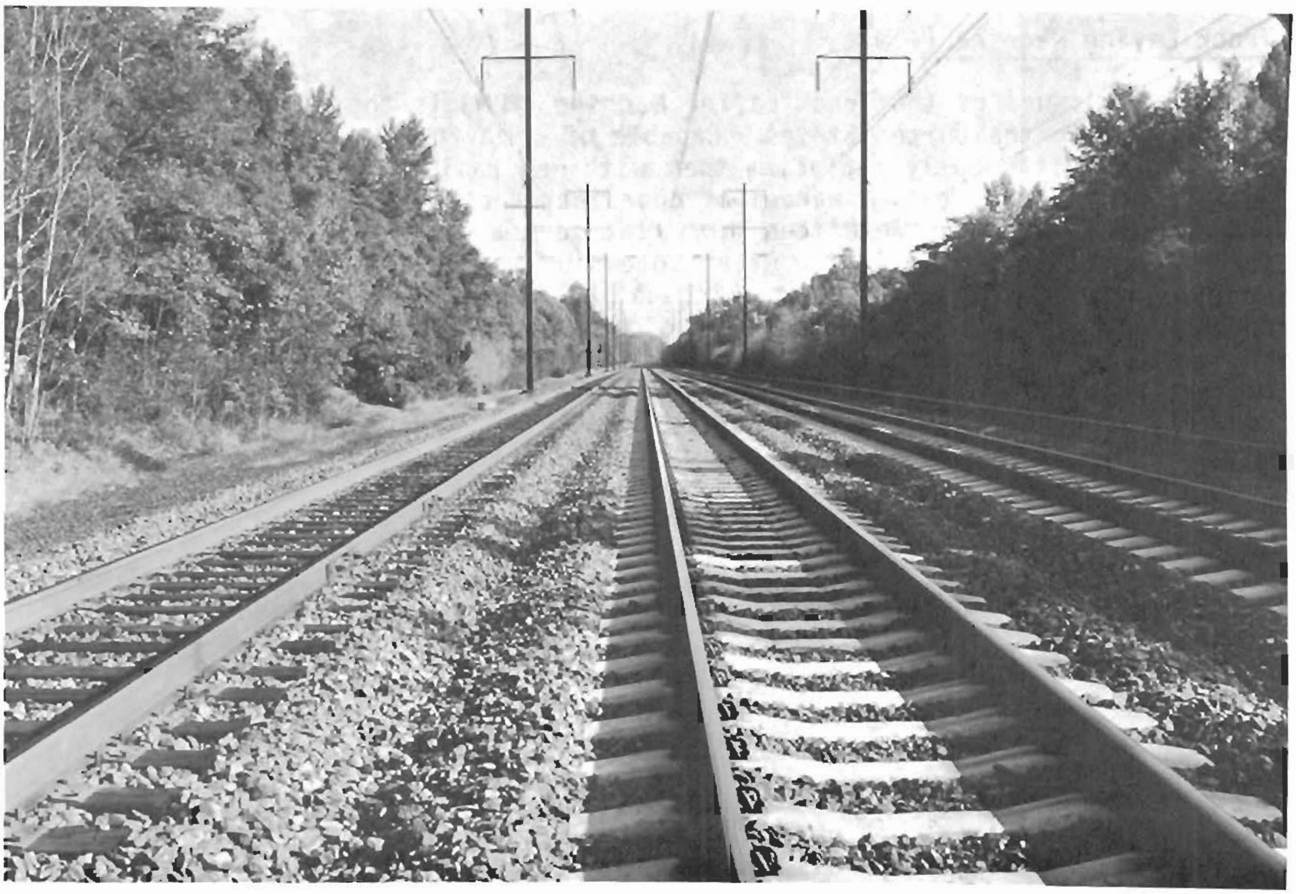


Photo 2-6



Typical concrete tie installation in multiple-track territory between New York and Washington.

The development of the flexible pad to provide adequate cushioning while maintaining track strength for heavy freight loads was a major technical achievement in the concrete tie program. Early pads provided adequate strength, but not enough cushioning to fully protect the tie/ballast system in certain areas. To determine the optimum pad stiffness, a wheel impact detection system was installed in the track. The wheel impact detector also led to improvements in wheel maintenance procedures.

Track Laying Machine (TLM)

Amtrak's use of the Track Laying Machine (TLM) is the first such application in the United States. Capable of removing the old rails and wood ties and simultaneously replacing them with new rails and concrete ties, the quarter mile long TLM is a marvel of coordinated activity. A system of gantry cranes unloads the concrete ties from flat cars and places them on a conveyor for placement on the ballast. After unloading the concrete ties, the cranes move a load of wood ties for stacking on the vacated flat cars. Old spikes, anchors and plates also are loaded onto cars, while new pads and rail clips are installed on the concrete ties. In replacing the track *in toto*, the TLM threads old rails to the side and threads new continuously welded rail on to the concrete ties. The TLM is followed by several machines that drive the rail clips firmly into place and surface and align the track.

Amtrak can also use the TLM for partial renewal, rather than total replacement, of the track structure. The TLM can install wood ties as well as concrete; it can install continuous welded rail over existing ties in place at jointed rail; and it can substitute concrete ties for wooden ties underneath high-quality existing rail.

Wood Tie Installation

The NECIP has installed some 732,000 wood ties in approximately 650 track miles of the Corridor. Defective wood ties were replaced in track sections not designated as high-speed areas for passenger trains, and where extensive tie replacement was not necessary. This installation produced a reliable track structure capable of being economically maintained. Wood tie renewals were particularly heavy in the first three years of the NECIP. In addition to eliminating deferred maintenance, the installation of wood ties helped to remove pre-NECIP slow orders and provided a high quality track over which trains could operate while concrete ties were being installed. Thus, once the TLM program began, the level of wood tie renewals declined.

Rail Installation/Joint Elimination

Before the NECIP, rail surface and profile had become permanently deformed at many joint locations, resulting in a ride that was uncomfortable to passengers and damaging to the vehicle and track structure. At other locations, the rails were worn and the gauge misaligned. The NECIP undertook the replacement of aged rail to prevent rail failures, to provide upgraded rider comfort, and to permit adherence to track geometry standards. Of the 550 miles of rail replaced with continuous welded rail (CWR), 300 miles were installed utilizing the TLM

Photo 2-7

Track laying machine -- the first major American application of state-of-the-art European technology for complete track renewal.

and 295 using conventional rail installation equipment. Additionally, approximately 11,000 bolted rail joints in existing CWR stretches and unbonded insulated joints were replaced with field welds and bonded insulated joints. These programs have eliminated rail joint gaps and provide continuous support -- a fundamental improvement that will reduce maintenance cost, improve the efficiency of the signal system, increase ride comfort, and decrease the load impact on the track structure.

High Speed Surfacing and Rail Grinding

The NECIP surfaced 634 miles of track and ground 835 track-miles of rail to provide a smoother and quieter ride, to decrease the impact loading of trains, and to increase the useful life of rail. All new rail on the Corridor was ground.

The grinding operation will enhance ride comfort and provide a rail surface that supports track geometry standards. Imperfections and corrugations in the rail create excessive noise and vibration in the vehicle, thus annoying the passengers and damaging the vehicle. Also, the increased impact loading on the track structure accelerates the deterioration of the track geometry.

The surfacing program, coupled with other replacements and renewals of the track structure, has resulted in a dramatic improvement in track geometry, as shown in Figure 2-6.

Interlocking Rehabilitation Program

Interlockings have a disproportionate effect on ride quality: tracks within interlocking limits, comprising about 5 percent of the Corridor mileage, have accounted for 70 percent of the excessive acceleration readings in the NEC in recent ride quality tests. To reduce such irregularities, track switches must be installed and maintained to high standards.

Switch maintenance was one of the principal elements of deferred maintenance that FRA and Amtrak engineers faced in 1976 when the NECIP began. Switch components such as frogs, guard rails and switch points were worn and in need of replacement. Switches contained many rail joints and, as with other sections of track, the switch rail joints were deformed and led to a rough ride for passengers. For the most part, the track adjacent to the switches ("within interlocking limits") was also jointed and supporting ties were deteriorated. The longer ties (switch timbers) supporting switches were in need of replacement. In sum, each interlocking represented a microcosm of the track problems that were affecting ride quality throughout the NEC: track components needed replacement to ensure dependable, safe, high speed operations. Interlockings were thus a major location for slow orders (restrictions to prevent train operations at normal speeds). Accordingly, to supplement the interlocking reconfiguration program (discussed above under "Section Improvements"), the NECIP undertook a comprehensive interlocking rehabilitation effort of which the principal elements were:

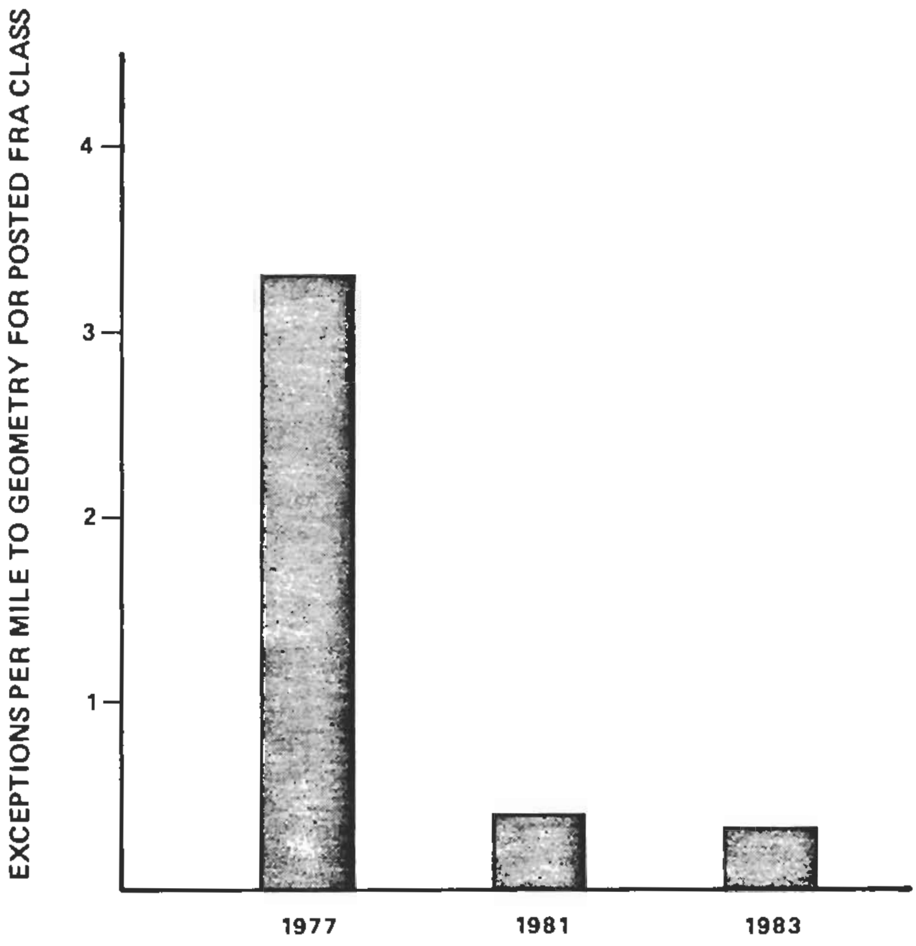
- Installation of welded switches (turnouts) to replace existing switches

- Rehabilitation of existing turnouts to replace worn components

FIGURE 2-6

TRACK GEOMETRY COMPARISON

BEFORE AND AFTER NECIP WORK



NOTE: Based on a sample of 84 miles of representative track sections.

- o Replacement of defective wood ties within interlocking limits
- o Renewal of defective switch timbers
- o Installation of CWR within interlocking limits

The program, when completed, will have rehabilitated 65 interlockings. Switch renewals represent the largest element in the program, which applied two methods, "conventional" and "panel." In the conventional method, individual pieces of rail and individual timbers from the existing switch are replaced in kind by new components. The program has renewed 186 switches in this manner. The panel method, which simply exchanges complete switch assemblies, has renewed 103 switches. Overall, panel renewal results in a more uniform turnout, and train operations are less disturbed than if normal techniques are used.

To facilitate the renewal of track and switches under the heavy traffic densities prevaling in the NEC, the NECIP procured two panel renewal systems: the Geismar Switch Exchanger and the SRS switch and panel exchange system. Since the NECIP programmed over 400 panels to be installed (as part of either the rehabilitation or reconfiguration of interlockings), this effort represented a major breakthrough in applied trackwork technology in the United States.

Prior to installation, the turnouts/crossovers were constructed as close to the installation point as possible on level portions of the right-of-way. The actual installation work took place at night in keeping with detailed work plans prepared by Amtrak engineers.

As the first step in the installation process, the existing track/turnout was prepared; secondly, the existing track/turnout was removed by the panel exchanger, complete with ties/timbers and placed on the right-of-way; thirdly, the new panels were installed in place, and finally, the panels were surfaced and the interlocking was ready to be put into operation after appropriate signal functions were performed.

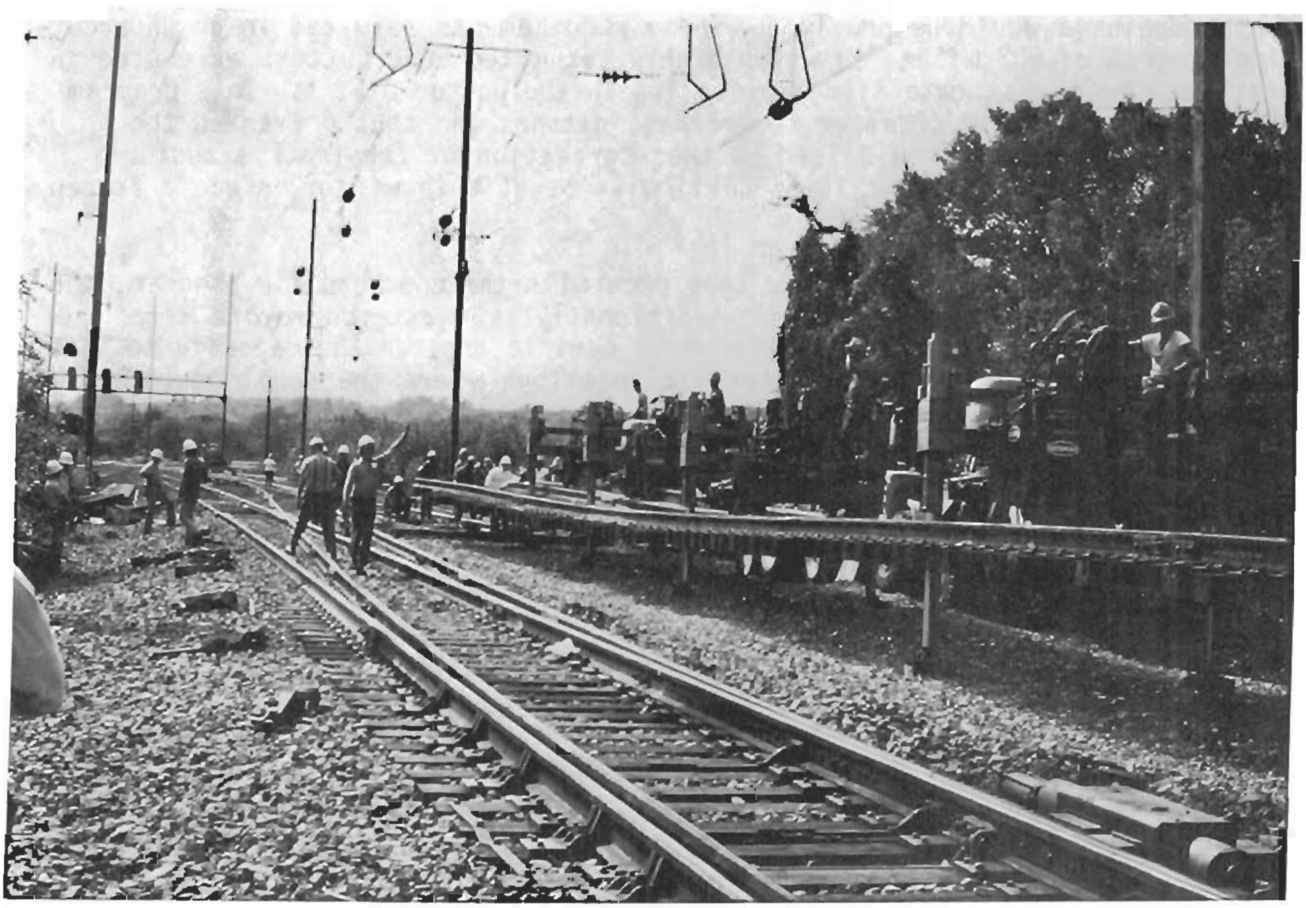
In the interlocking rehabilitation effort, the NECIP renewed ninety-two switches and installed approximately 168,000 linear feet of switch timber (about 13,000 individual timbers), 34,500 ties, and 37.5 miles of CWR.

As a result of all this activity, Amtrak has upgraded the existing interlockings. To sustain ride quality, Amtrak in its normal maintenance programs will have to exercise special vigilance over these interlockings; since the switches remain the weakest link in the track structure, their alignment and profile will require continuous monitoring and maintenance to minimize the bounces and sways that spill coffee and disturb passengers.

Track Undercutting

The standards for concrete tie track established for the NEC required 12 inches of clean ballast to cushion the system and provide for free flowing drainage. Railroad practice elsewhere in the United States is to add new ballast over the old, thus raising the level of the tracks. In the NEC, this approach was not practicable because of clearance requirements relative to the overhead catenary and open deck bridges (bridges with ties installed on steel

Photo 2-8



Track panel renewal -- the modern NECIP way of rehabilitating interlockings quickly and to high standards.

girders, hence not able to be raised). Because the track could not be raised, the NECIP track program included the undercutting and cleaning of the ballast on all tracks that would have concrete ties installed. In addition, in three and four-track territory, at least one outside track was undercut to ensure that proper drainage would be provided. These requirements resulted in an undercutting program of 507 miles, in which highly automated undercutters were used in what was their most extensive application in the United States. This program allowed the free flow of water to drainage ditches and thus prevented the ponding of water that would lead to the degradation of the track structure. Clean, well-drained ballast is of particular benefit in winter, since a frozen track structure damages vehicles.

To undertake the program and keep pace with the concrete tie program, the NECIP procured three undercutters. Additionally, 49 waste conveyors were purchased and were installed on side dump cars to provide the capacity to load the spoil created by the undercutters in locations where the spoil could not be dumped along the right-of-way.

Shoulder ballast cleaning and selective undercutting have been standard railroad maintenance practices for years; however, the NECIP established the first cyclical undercutting program to ensure that 12 inches of clean ballast were continuously provided in concrete tie track.

Other

In addition to work performed as part of the Section Improvements, Amtrak performed miscellaneous activities to upgrade the right of way.

Drainage Improvements

Selected roadway ditches were cleaned and/or modified to provide adequate lateral and longitudinal drainage, and to improve the flow of surface drainage away from the track structure. In addition, selected culverts were cleaned, repaired, or replaced. Areas requiring drainage improvements are being identified by field inspection and ongoing detailed engineering design.

These improvements were required to provide a well-drained track structure and subgrade. Drainage is essential to the track stability required for high-speed operation. Particular emphasis was placed on cuts and areas established as potential problem sites. At a minimum, the ditch line will comply with a standard roadway ditch cross section.

Subgrade Stabilization

Approximately 11 track miles of subgrade were stabilized.

The subgrade is the foundation which supports the ballast and track structure. If this foundation is unstable, it usually requires excessive maintenance and may lead to sudden subsidence creating poor ride comfort and ultimately unsafe operating conditions. Through analysis of the stability of the fill material, it was decided to use a combination of lime injection, grouting and fill reconfiguration to correct these problem areas.

Debris-Removal

The right-of-way is being cleaned of accumulated overgrowth brush, track debris, maintenance-of-way scrap and trash. This program was implemented because the debris constitutes an impediment to maintenance, a hazard to safe rail operations, an eyesore to passengers, and possibly a problem to personnel working in the vicinity.

POWER AND CONTROL

The Northeast Corridor was electrified between Washington and New Haven betweem 1908 and 1938. Most signals and other train control equipment date back to the 1920's and 1930's; some units were installed as early as the turn of the century. This vintage signalling, traffic control and communications equipment has contributed to inefficient operation on a main line carrying the most complex blend of high-density intercity passenger, commuter, and freight trains in the Nation.

Improvements in electrification, signalling and train control, and communications account for approximately 20 percent of total NECIP project expenditures, or $429.2 million. In the final program, electrification accounted for $85.1 million, and signaling, train control, and communications for $344.1 million.

ELECTRIFICATION

The NECIP performed a program of essential maintenance on the existing electric power distribution system from Washington to New York, with the most critically deteriorated areas receiving priority. Typical elements included repairing old circuit breakers, replacing catenary messenger wire and 90 miles of worn contact wire, modifying steady assemblies for higher speed, and increasing catenary tension. Approximately 1000 loop hangers were installed to permit higher operating speeds on selected sections of catenary.

The program also included the rehabilitation of the entire catenary system between Harold Interlocking in Queens and New Rochelle (30 track-miles built in 1912), in conjunction with the installation of new commercial power substations by the NECIP from Harold to New Rochelle. This work was under construction in 1985.

In addition, the NECIP substantially completed design work for, but did not construct, an electrification project at commercial frequency between New Haven and Boston.

SIGNALING AND TRAIN CONTROL SYSTEM

At the start of NECIP, traffic on the Northeast Corridor was controlled primarily by interlockings operated from control towers, in accordance with routing instructions received by phone from central dispatchers. This system

Photo 2-9

Work area on top of wire train, used for maintaining the intricate catenary which supplies electric power to Amtrak's trains. The passing high-speed train on the right emphasizes that virtually the whole of the NECIP was performed under traffic . . .

was expensive and labor-intensive. In addition, approximately three-quarters of the track-miles were signaled for operation in one direction only. Written train orders were required to move trains in the reverse direction if required for maintenance or removal of a disabled train.

The NECIP signal program includes the expansion of the existing direct communication of speed restrictions to the engine cab ("cab signals"), supplemented with wayside signals. Of course, this system meets all Federal requirements for high-speed operation. Replacement of over 200 route-miles of deteriorated cables has restored system reliability to the level required for high speed service. Reverse signaling, permitting operations in either direction along a section of track, has been installed on high-speed tracks at many locations.

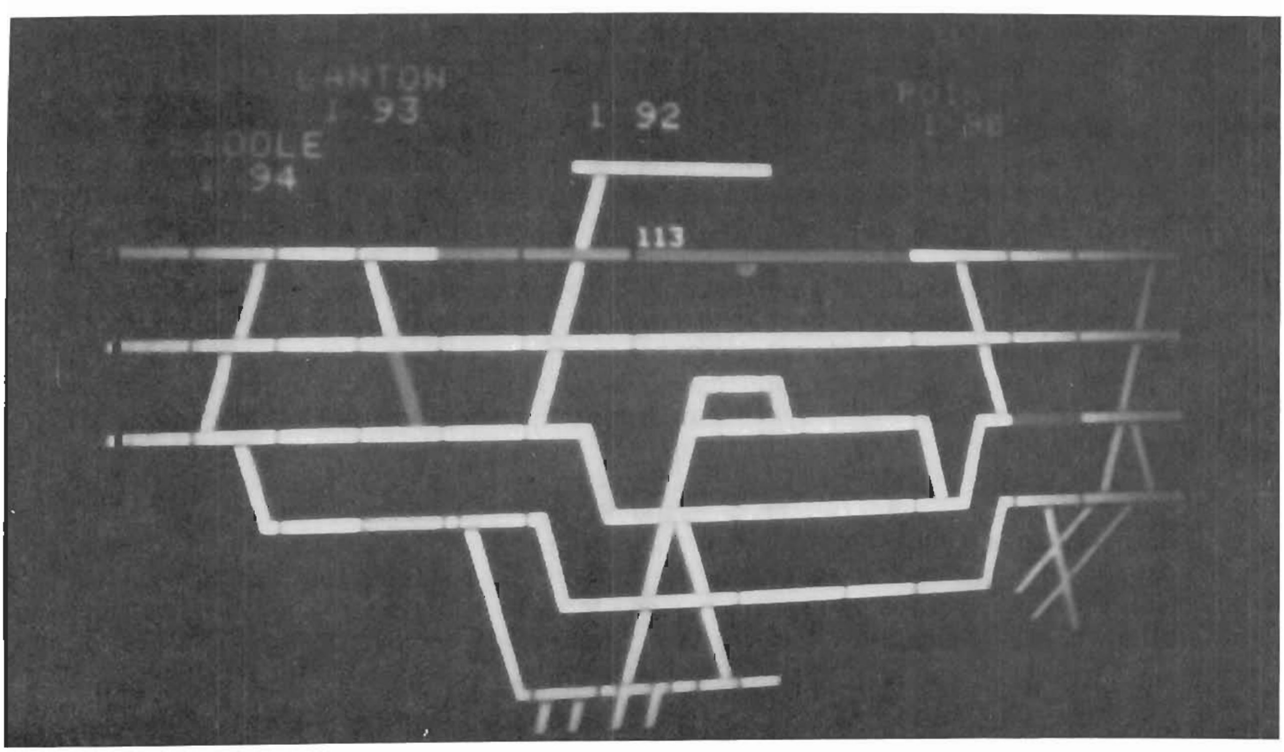
Centralized electrification and traffic control (CETC) systems, permitting full remote control of all interlockings and (in electrified territory) substations, are being installed in two segments of the Corridor: Washington to Wilmington, Delaware, and Cranston, Rhode Island, to Boston. The control center for the southern segment is in Philadelphia; the northern segment, which is not electrified, will be controlled from Boston.

Major improvements were made from Washington through Wilmington, where all interlockings are now relay-locked. Modern interlockings use electrical relays to perform the functions previously performed by the heavy steel lock rods in the old mechanical interlocking systems. Use of electrical relays, frequently numbering in the hundreds, permits an interlocking to be remotely controlled from a central control point.

The 15-mile long Hell Gate Bridge line from New York City to New Rochelle, New York, is being equipped with bi-directional signals and four-aspect cab signals on both main tracks. Significant improvements are being made from New Haven to Boston where 94 percent of the interlockings will be relay locked and all main line tracks from Canton Junction, Massachusetts to Boston, Massachusetts will be equipped with bi-directional signals and four-aspect cab signals. Standard four-aspect cab signals were installed in four segments not previously equipped: Baltimore Station area, Hell Gate Line, Providence Station area, and the Boston terminal zone. Additional improvements included installing over 330 miles of new express signal cable to replace old corroding paper insulated lead covered cable. Approximately 520 old failure-prone centrifugal track relays on designated high speed tracks were replaced with new units of totally different design. New hazard detectors were procured to replace or augment facilities designed to protect against overheated bearings, high/wide loads or dragging equipment. To enhance Amtrak's ability to consider possible future improvements, all new signal equipment would be compatible with a conversion of the electric traction system to 60-cycle commercial power, and with additional signal aspects to increase line capacity.

The signal system operates from a 100 Hz power distribution system. This system required total replacement from Canton Junction to Boston due to age and lack of capacity. New motor-generator sets were installed from Washington to New Rochelle to correct age related problems and to eliminate the low frequency (97-98 Hz) problems caused by the original induction motors.

The NEC enters the electronic age . . . Above, CETC control console with touch sensitive control screens and communications panel. Below, track occupancy diagram on projection TV.



The old and the new: Above, the control levers and lock rods of an old mechnical interlocking (see Chapter 5). Below, the electrical relays controlling a new interlocking built by the NECIP.

Table 2-3 presents the essential statistics on the NEC signal system before and after the NECIP.

COMMUNICATIONS

Communications along the Corridor in 1976 took place over railroad-owned cables, leased circuits and assigned radio channels. The private cables were 50 or more years old and deteriorating, so that a replacement system was absolutely necessary. New technology provided the required replacement: after several private communications companies expressed an interest in meeting Amtrak's communications needs in exchange for right-of-way for a fiber optics cable, Amtrak negotiated a contract with MCI to use a small number of fibers in their New York-Washington cable located in the Corridor duct system. The fiber optics system will handle Amtrak communications associated with ticketing, maintenance, and CETC controls.

The radio communications system in 1976 consisted of one channel for both maintenance and train operations. Each interlocking tower had a small limited range (4-6 miles) base station for communicating with trains. Maintenance forces used similar radios and frequently required the tower operators to relay messages to other forces. The introduction of CETC is eliminating many of the manned interlocking towers, yet radio communications will still be required between trains and the CETC center, while maintenance forces will have to talk to each other by radio. A second radio channel was obtained and dedicated to maintenance forces, thus removing many non-operational communications from the operations radio channel. In the larger metropolitan areas (New York, Philadelphia, etc.) this reduction was unfortunately offset by Conrail's conversion of radios on the former Reading, Jersey Central, and Erie-Lackawanna to the operating channel they share with Amtrak. Any long term solution Amtrak decides to pursue will likely involve a single channel dedicated to all Amtrak, commuter, and freight communications on the main line. This would require agreement with Conrail to assure that Conrail communications in yards off the main line and on other lines close to the Corridor are handled by other channels.

SEPARATION

Two NECIP program elements were directed at separating the high-speed railway corridor from adjacent neighborhoods and cross traffic: elimination of at-grade crossings, and fencing. Approximately $20.5 million was allocated to these elements.

GRADE CROSSING ELIMINATION

In 1975, public roads crossed the Northeast Corridor at grade in 49 locations. While protective devices such as gates and flashers reduced the hazard to motorists, accidents still could and did occur. If trucks with heavy or flammable cargoes were involved, the train and its occupants were at risk.

A total of $103 million was authorized under the 1970 Federal Highway Act (23 US Sec. 322), the Surface Transportation Act, and the 4R Act (mandating NECIP) to eliminate all at-grade intersections on the Corridor. NECIP funding is $14 million.

TABLE 2-3

VITAL STATISTICS: NEC SIGNALS BEFORE AND AFTER NECIP

	Washington-Wilmington	Wilmington-New York City	New York City-New Rochelle[c]	New Rochelle-New Haven	New Haven-Boston	NEC Total
Route-Miles	110.6	114.6	18.9	56.7	156.0	456.8
Interlockings:						
Number Prior to NECIP[a]	35	31	7	17	34	124
NECIP Actions:						
Removed	4	5	1	1	7	18
Added	3	6	1	0	5	15
Reconfigured	18	3	1	7	16	45
No change	13	23	5	9	11	61
Number After NECIP[b]	34	32	7	16	32	121
Number mechanically operated:						
Prior to NECIP	31	29	7	15	22	104
After NECIP	0	20	3	0	2	25
Automatic Block Signals (Track-Miles)						
Single Direction						
Prior to NECIP	206.4	278.6	38.0	197.2	279.4	999.6
After NECIP	0	216.0	10.8	0	243.9	470.7
Bi-Directional						
Prior to NECIP	126.1	114.2	0	0	27.9	268.2
After NECIP	333.4	179.7	27.2	197.2	63.4	800.9
Cab Signals (miles)						
Prior to NECIP	332.0	395.7	10.8	0	285.3	1023.8
After NECIP	333.4	395.7	38.0	197.2	307.3	1271.6

a "Prior to NECIP" = 1975
b "After NECIP" = 1986
c Improvements in this sector are not part of the NECIP; funding and work is by the States of New York and Connecticut with UMTA assistance

As a result of these programs, the railroad is now free of highway grade crossings between Washington and New Haven. As shown in Table 2-4, however, sixteen at-grade public crossings remain in place between New Haven and Boston. Five crossings were retained at the direction of Congress (including one crossing in New London that replaced three crossings in conjunction with the realignment for Shaw's Cove Bridge). There is no special funding for the remaining eleven crossing projects, but some of them can be eliminated through the use of funds available to state transportation agencies from the Federal Highway Administration. All remaining crossings will be protected by gates and flashers.

In addition, property owners have crossing rights at 19 locations between New Haven and Boston. Seventeen of these crossing rights are being eliminated, generally by the purchase of the rights.

FENCING

The NEC right-of-way lacks protection over most of its length from vandals and other intruders. Some sections have never been fenced; elsewhere fences have suffered from neglect or vandalism. The NECIP provided $6.5 million to construct a total of 22.4 miles of fences adjacent to parks, school yards and other locations where children were likely to venture onto the tracks. Using Jobs Bill financing, Amtrak is also installing fencing worth $4 million at additional locations from Washington to Boston.

SERVICE FACILITIES

There are two basic types of maintenance activities required on the Northeast Corridor to protect NECIP investments to improve passenger services: maintenance of the equipment or rolling stock, and maintenance of the fixed plant. These needs are being met in the modernization and expansion of equipment maintenance facilities in Washington, Wilmington, and Boston; additional facilities in New York and New Haven; and four maintenance-of-way bases in Maryland, New Jersey, and Rhode Island. Total cost of these improvements is $174.2 million.

MAINTENANCE OF EQUIPMENT FACILITIES

To keep Amtrak equipment serviceable for high speed operation and to prepare for a new fleet of locomotives, Amtrak in 1976 required a major improvement in equipment maintenance, repair, and service functions.

A major deficiency was lack of adequate facilities in Washington and Boston, impacting system capability for rapid and efficient turnaround of equipment. Storage capacity was limited and permitted only outdoor servicing and inspections.

Further renovation was required at the Wilmington, Delaware, heavy repair facility, which had seen little improvement since 1900. Additional deficiencies existed at the New Haven and New York facilities. At New Haven, which has served as the locomotive change point (electric to steam or diesel) since 1914,

TABLE 2-4

STATUS OF GRADE CROSSING ELIMINATION PROGRAM

State	Crossings Eliminated	Crossings Elimination in Process	Crossings Retained at Direction of Congress	Crossings Elimination Unfunded
Maryland	15			
Delaware	4			
Connecticut	4		5*	6
Rhode Island	9	1		5
Massachusetts	1			
	33	1	5	11

* Includes three crossings replaced in conjunction with Shaw's Cove Bridge project

** Includes one crossing replacement under construction.

Photo 2-12

The NECIP installed fencing where it would do the most good. Above is a typical situation: high-density urban development bordering on the electrified NEC. Fencing keeps children away from the double danger of the trains below and the electric wires above . . .

the existing fueling and sanding facility had experienced frequent oil spills resulting in oil-saturated soil, contaminated groundwater and a very unpleasant environment. At New York, the electric supply system to support vehicle servicing badly needed renovation and modernization.

The largest project in the NECIP support facilities program is the $56.2 million upgrading and modernization of the Ivy City Yard in Washington, D.C. Upon completion, this project will provide an all-weather, enclosed car repair shop, a new locomotive repair shop with appropriate welfare facilities (e.g., showers and locker rooms) for all employees, a wheel truing building with blow pit, a new fueling, sanding and inspection facility for locomotives, a new car washing facility and additional car storage capacity.

At the other Corridor terminus, Amtrak's new facility in Boston will include an enclosed facility for running repairs, service and inspection, and wheel truing as well as an increased capacity for storing rolling stock. The facility, which will also service commuter equipment of the MBTA, is anticipated to be completed and operational by the end of 1988 at an estimated total cost of $32.1 million, to which the NECIP will contribute $23 million.

Amtrak's Wilmington Shops are being rehabilitated and expanded at a cost of approximately $23 million. The only remaining major element of construction is a new wheel shop which will be completed in 1988. The electric motor repair shop has been expanded and modernized, and new sanitary, storm, and industrial waste sewer systems have been installed throughout the site. This system was connected to a new wastewater treatment facility for treatment before discharge to the local sanitary system. Wilmington improvements also included complete external cladding of structural surfaces with insertion of heavy insulation to improve the energy efficiency of this large building complex.

The NECIP has provided a new locomotive fueling, sanding and inspection facility with additional storage tracks at New Haven, as well as a new wheel truing facility at Sunnyside Yard, New York.

An important aspect of the service facilities program is the tripling of Amtrak's wheel truing capability, which will improve ride quality and decrease the amount of maintenance required for the track structure. By coupling this increased wheel maintenance capacity to a program to monitor and detect wheel impacts on the rail (mentioned earlier in this Chapter under Track Improvements), the efficiency of wheel truing will be greatly enhanced.

A major consideration in the design of all equipment maintenance facilities was to reduce the time required to service and inspect the equipment. By doing so, a potential for 2-hour turnarounds (or even better) at Corridor termini could be realized, thus resulting in a better utilization of existing equipment. The end result of the total program will be decreased heavy maintenance costs due to more frequent inspection and maintenance, a smaller fleet with its associated cost savings, an overall improvement in on-time performance due to fewer failures in route, and a substantial return on the investment in the form of increased utilization and longer operating life of the equipment.

NORTHEAST CORRIDOR PASSENGER RAIL IMPROVEMENTS

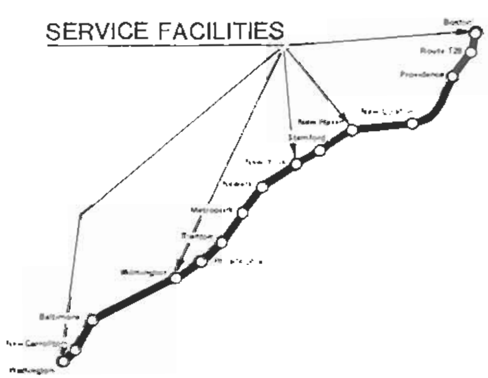
PASSENGER CAR AND LOCOMOTIVE SERVICE FACILITIES

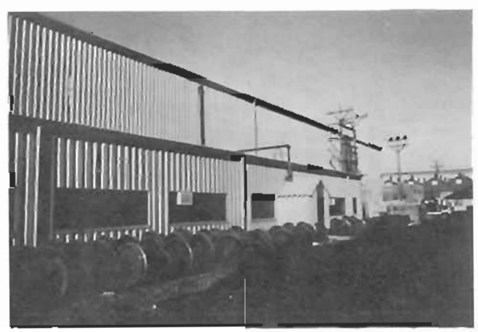
NEW ROOF and SIDING
LOCOMOTIVE BUILDING

REPAIR SHOP and
ANNEX BUILDINGS

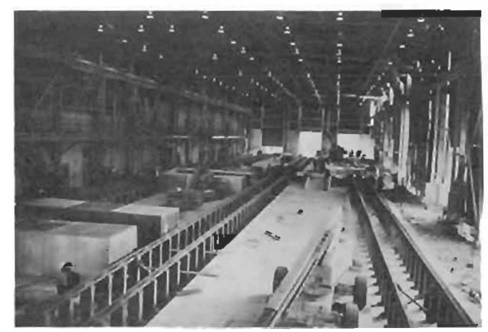
IMPROVE RUNNING EQUIPMENT OPERATING RELIABILITY AND REDUCE TRAIN TURNAROUND TIME.

- PROVIDES AT 5 LOCATIONS, NEW SHOPS AND SUPPORT FACILITIES FOR MAINTENANCE AND REPAIR OF RAILROAD RUNNING EQUIPMENT.
- COST $117.0 MILLION





NEW ROOF and SIDING,
WHEEL BUILDING



INTERIOR REPAIR SHOP
SHOWING FIRST THREE TRACKS

MAINTENANCE-OF-WAY BASES

Maintenance-of-way (MOW) bases support the maintenance of track, bridges and buildings, signals, and electric traction. At the inception of the NECIP, facilities and personnel for these maintenance tasks were segmented and scattered, frequently without support facilities, or with inadequate or makeshift structures. A program to improve these facilities and combine the four maintenance disciplines into centralized facilities for each M/W division was therefore included in the NECIP.

Four MOW bases were constructed at Providence, Rhode Island; Adams (North Brunswick), New Jersey; Perryville, Maryland; and Odenton, Maryland. These bases are now part of the overall system to support the operation of the railroad and are needed to efficiently protect the investment being made.

Features which these bases have in common are administrative offices; employee welfare facilities; work staging areas; storage building and secure storage areas inside and outside the building; vehicle and equipment parking; support facilities for camp (mobile gang) rail cars; layover and storage areas for work train equipment; and materials handling areas. An additional shop building equipped with lift tables and an overhead crane was provided at the Providence, Adams, and Perryville bases to facilitate the repair of MOW equipment.

The total cost of this portion of the facilities program was approximately $26 million, with construction costs ranging from $5.7 million for the Perryville facility to $7.5 million at Providence. The Odenton and Providence bases were completed in July and August 1982, respectively. The Perryville base was completed in May 1983 and the Adams base in October 1983.

STATIONS

Thirteen passenger stations at major population centers throughout the Corridor are benefiting from improvements under the NECIP, at a combined project cost of $191.1 million. Ten existing stations are being or have been rehabilitated/upgraded and all-new facilities have been constructed at New Carrollton, Maryland, and are under construction in Providence, Rhode Island and Stamford, Connecticut. Commuter as well as intercity passenger facilities are being improved at 12 stations and added parking facilities are being provided at six stations through the shared funding provisions of NECIP.

Chapter 1 describes the results of the station program from the passenger viewpoint. Full details on the stations are available in a separate report, NECIP Station Program. Table 2-5 provides further information on the funding of the NECIP station program.

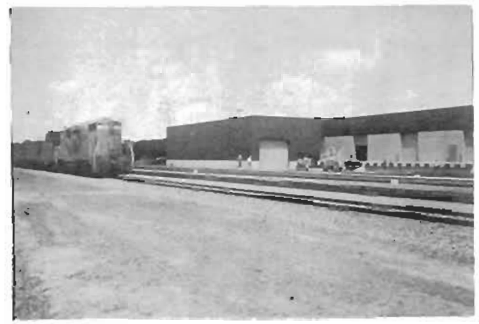
The improvements undertaken at the NECIP stations were generally of two types: 100 percent Federally funded, and cost shared. Improvements that were directly related to high speed rail passenger service, such as high level platforms, ticketing and station operations facilities, and structural and other improvement necessary for the successful and secure use of the station, were considered eligible for 100 percent Federal funding under the 4R Act. Improvements that were related to, but not specifically part of, high speed rail service, such as parking structures, access to stations, and commuter transit

NORTHEAST CORRIDOR PASSENGER RAIL IMPROVEMENTS

Photo 2-14

MAINTENANCE OF WAY [MOW] FACILITIES

PROVIDENCE

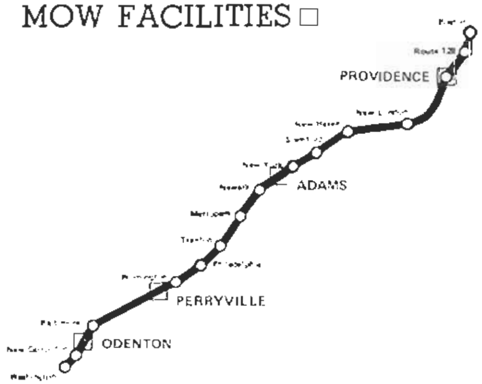


ADAMS

MAINTAIN CORRIDOR FACILITIES ALONG 809 TRACK MILES TO PROVIDE DEPENDABLE ALL WEATHER SERVICE.

- PROVIDE AT 4 LOCATIONS SHOPS AND SUPPORT FACILITIES TO MAINTAIN AND REPAIR TRACK STRUCTURES, BRIDGES, SIGNALS AND COMMUNICATIONS, CATENARY AND ROUTE ALIGNMENT.
- COST $38 MILLION

MOW FACILITIES □



PERRYVILLE

ODENTON

TABLE 2-5

NORTHEAST CORRIDOR IMPROVEMENT PROJECT
FUNDING FOR STATION IMPROVEMENTS
(Millions of Dollars)

	100% Federally Funded Improvements	Cost Shared Federal Portion	Cost Shared Local Portion	100% Locally Funded Improvements	Total Federal Contribution
Washington Union Station [a]	$ 1.6	$ --	$ --	$ --	$ 1.6
New Carrollton Station	7.1	4.4	4.4	4.2	11.5
Baltimore Pennsylvania Station	7.0	2.6	2.6	--	9.6
Wilmington Station	10.4	3.4	3.5	--	13.8
Philadelphia 30th Street Station	5.0	3.3	3.4	--	8.3
Trenton Station	1.6	.1	.2	--	1.7
Metropark Station	.1	.5	.5	--	.6
Newark Station	17.4	2.7	2.8	--	20.1
New York Pennsylvania Station	3.5	2.6	2.6	--	6.1
Stamford Station	9.0	5.2	5.2	2.5	14.2
New Haven Station	13.4	5.1	5.1	3.0	18.5
New London Station	.9	1.9	1.9	--	2.8
Providence Station	20.7	5.8	5.8	9.7	26.5
Boston South Station	25.8	3.9	4.1	28.1	29.7
Corridor-wide Signage, Train Information Systems, and Standard Items	4.6	--	--	--	4.6
Design and Construction Management	21.5	--	--	--	21.5
Total	$149.6	$41.5	$42.1	$47.5	$191.1

[a] The Union Station Redevelopment Corporation, rather than the NECIP, is responsible for improvements and related development at this location, for which funding is being derived from several sources including the NECIP contribution shown above.

facilities, were considered cost shared. Funding for those improvements was shared on a 50-50 basis between the Federal and state, regional, or local government or other responsible party. In some cases, states and localities provided 100 percent of the funding for additional work in conjunction with the NECIP station projects.

SPECIAL ACKNOWLEDGEMENT

The Federal Railroad Administration wishes to acknowledge the special contribution made to the Northeast Corridor Improvement Project by the Japanese National Railways (JNR). The JNR was consulted in the conceptual design phase of the project because of their experience with the Shinkansen lines -- the first high speed rail services to be introduced in the world. During the design and construction phases of the NECIP, the U.S. and Japanese Governments cooperated under an agreement through which the JNR provided over twenty manyears of consultation at no cost to the U.S. Government. One hundred sixty-seven JNR engineers visited the project on ninety-five separate assignments, reviewing design and construction plans, railroad operations, testing, and maintenance procedures over a period of six years. Ninety U.S. engineers and project officials also visited Japan to observe JNR facilities. In a number of very important cases, JNR people made extremely valuable suggestions, saving the project millions of dollars in construction cost and leading to more efficient operations. JNR has indeed made a lasting contribution to rail service in the U.S. through this invaluable assistance. Of comparable benefit was the exchange of working level experience among railway engineers and managers and the consequent gain in cross-cultural international understanding.

EPILOGUE TO CHAPTER 2: LESSONS LEARNED

In designing and constructing the fixed plant improvements described above, the NECIP has balanced successfully many competing goals and dealt with an institutional framework far more complex than that faced by the predecessor railroads when they performed their own NEC projects earlier in this century. Yet such a success cannot be free of difficulties, and the question remains: what has the NECIP to teach future sponsors and managers of public projects of this scale and complexity? Among the widely applicable lessons of the NECIP are the following:

Preparation of the scope of the project must be thorough and complete before final funds are committed. It is essential that scope, funding, and project schedule be realistic and coordinated.

In the early stages of planning, estimates do not reflect the detailed scrutiny necessary to obtain firm and reliable figures. Preliminary studies should establish the most economical way of reaching the desired goals. Indeed the goals themselves may be modified to harmonize with available finances. Evaluation of alternatives is a vital part of this process.

Each part of a major program of this kind interacts with other parts, and a period of time is needed for proper recycling of plans as conflicts emerge. Once the final scope has been established and timetables set, any changes will usually bring increased costs and delay the project. A system of control of changes, governing physical and financial aspects, is vital, and must be vigorously enforced. All parties involved should take part in this process.

The project manager needs the broadest possible understanding of the objectives of the program, so that technical issues are solved in that broader context.

During the project there should be periodic reviews of the physical and financial situation. An integral part of this process is establishing, at the earliest possible stage, an estimate of cost to completion, even though initially the data will be approximate. A policy group should decide major program changes to keep them within cost and achievement of broad objectives.

There are factors outside the control of the engineering managers and these are best handled separately. For example, in periods of substantial inflation, such as that which characterized the early years of this project, it might be better to make budget decisions in constant dollars and add allowances for inflation as the work proceeds.

A project of this nature is affected by the attitudes and relationships of a number of interested parties, such as State and local governments and other Federal agencies, all of whom are involved in and affected by the results. Clear agreement with such concerned parties must be established at a very early stage.

Finally, there must be a recognition that there will be a need for compromise and change. The objective must be to complete a balanced project in which major objectives are achieved, but in which over time, there will have been many minor amendments. Such was the case with the NECIP: changes occurred, but the Project adhered to its essential goal of enabling Amtrak (by means of fixed plant improvements) to provide a high quality service that would stimulate growth in rail patronage. Chapters One and Two have demonstrated the quality of the transportation product and of the underlying improvements; the next chapter will explore the operating results of Amtrak's NEC service.

Chapter Three: Operating Results

Chapter Outline

Conceptual framework: The NEC as a business

Travel demand, modal split, and rail revenue
- *Causative factors*
  - *Total travel demand*
  - *Components of intercity travel demand*
    - *City-pair markets*
    - *Characteristics of the competing modes*
    - *Market segments*
- *Evolving characteristics of the modes in selected markets*
  - *Trip time factors*
    - *Station-to-station schedules*
    - *On-time performance*
    - *Frequencies*
    - *Access/egress times*
    - *Synthesis: trip time competition among modes*
  - *Fares*
- *Resultant trends in patronage*
  - *Year-to-year changes in total passenger traffic*
  - *Redistribution of ridership in the New York -- Washington market*
    - *Metroliner versus air*
    - *Metroliner versus conventional rail*
  - *New York -- Boston market*

Overall financial results

List of Displays

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Chapter 3

OPERATING RESULTS OF NEC SERVICE

Although receiving government funds and responding to public service needs, Amtrak is a business enterprise that must seek constant improvements in its operating and financial condition. Like any other business, it must strive to increase its revenues, reduce its operating expenses, and improve its net results. The NECIP, as described in previous chapters, has given Amtrak powerful tools to function as a business in the Corridor: a product that it can market competitively, and a plant that it can operate efficiently. This chapter places those tools in context and outlines some of Amtrak's own advances thus far.

CONCEPTUAL FRAMEWORK: THE NEC AS A BUSINESS

Figure 3-1 provides a conceptual framework for this chapter. In brief, the financial results of Amtrak's NEC operations come about in the following manner:

o The strenth of the regional economy and the distribution of population generate a total demand for travel in the city-pair markets served by the NEC (see Table 1-1 for a listing of the more prominent markets).

o In each market, each of the modes offers a product having certain trip time, reliability, frequency, passenger experience, and fare level characteristics (operating costs in the case of automobile).

o Would-be travelers make their choices among modes based on their individual priorities (importance of cost, speed, convenience, and comfort to them) and the characteristics of the modes. The collective result of their choices is a demand level for each mode ("modal split").

o Rail revenues are the product of the demand for rail service and its fare levels.

o Rail operating expenses are the product of (1) the volume of operations necessary to meet the demand level while assuring the promised product, and (2) the unit costs associated with measures of volume.

o The financial results of operations, in the simplified framework, reflect the relationship of operating revenues to expenses.

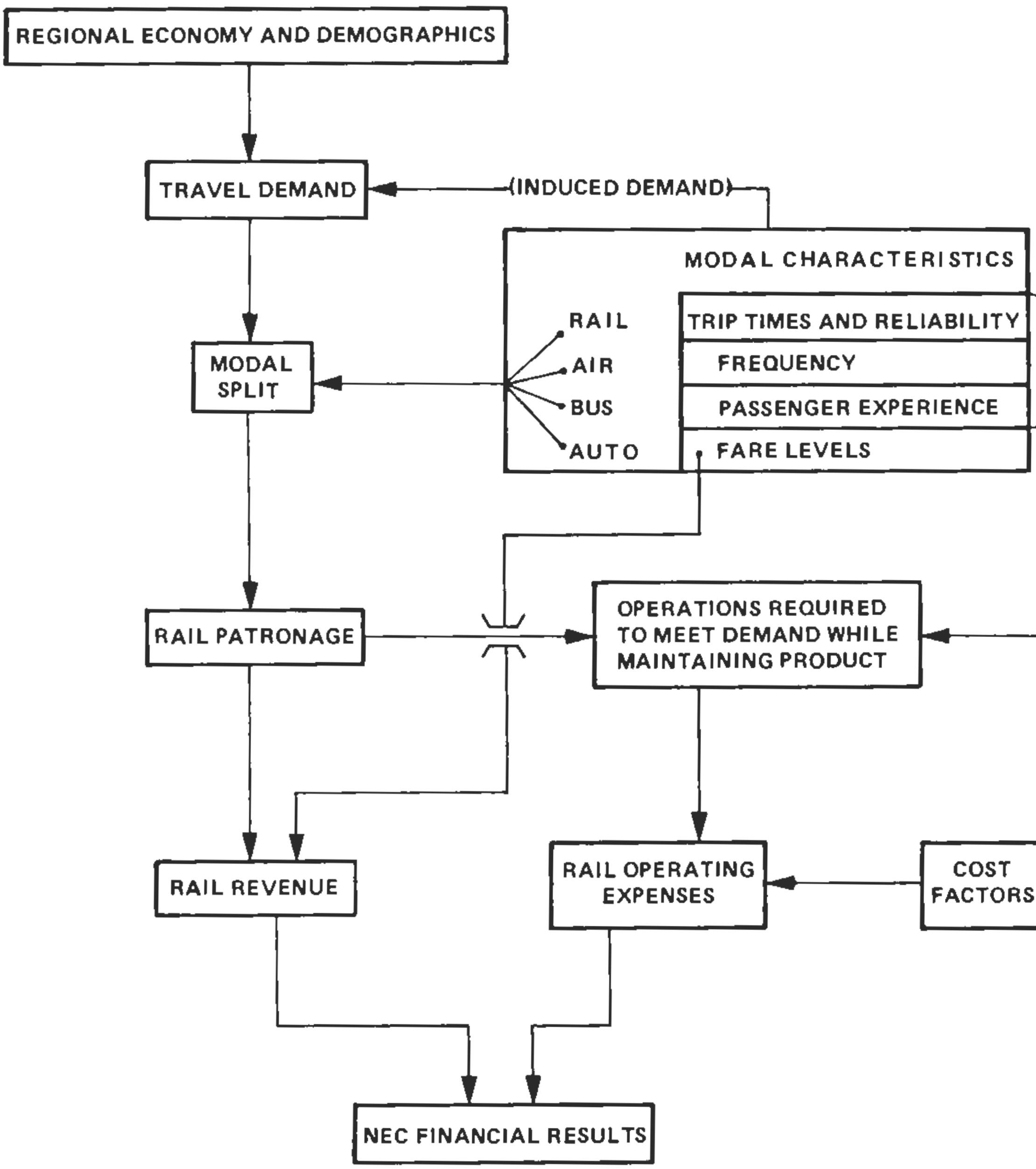
The following sections analyze the NEC in recent years according to the above framework.

TRAVEL DEMAND, MODAL SPLIT, AND RAIL REVENUE

This section analyzes historical trends in rail ridership and rail revenues through 1985. To place the following discussion in perspective, Figure 3-2 shows

FIGURE 3-1

CONCEPTUAL FRAMEWORK: THE NEC AS A BUSINESS



the overall trend in NEC passenger counts since 1978. (Consistent statistics for total NEC ridership are not available before 1978.) As the chart indicates, total rail ridership in the Corridor has fluctuated around the 10 million mark throughout this period, and by 1984 was essentially at the same level as in 1978. Overall, conventional train patronage increased, and Metroliner business decreased, between 1978 and 1984. The following discussion explores the reasons behind these complex patterns.

CAUSATIVE FACTORS

As indicated in Figure 3-1, rail patronage in the NEC reflects total travel demand and the characteristics of all modes serving NEC markets.

Total Travel Demand

In the absence of recent detailed transportation censuses of the NEC, conclusions regarding changes in total intercity travel demand must come from partial data. Figure 3-3 exemplifies the available information; combining rail and air patronage in the New York -- Boston and New York -- Washington city-pair markets for 1976 and 1983, the table shows growths of 43 percent and 18 percent, respectively. Chapter 6, discussing congestion in air and highway modes, also evidences increasing total demand for travel. In such a climate of increasing demand, the relative performance of the various modes must reflect passenger response to their comparative product and price characteristics in the markets served.

Components of Intercity Travel Demand

Summary statistics of patronage by mode -- number of trips, passenger-miles generated, total revenues -- obscure the basic circumstances of intercity passenger marketing in the NEC. For neither rail nor any other mode draws its traffic from a single, homogeneous "market" spread out over the Corridor; rather, there are many markets each of which consists of clearly distinguishable segments. This section therefore analyzes the NEC into its constituent city-pair markets, discusses the competitive characteristics of the various modes in each such market, and demonstrates how each of the city-pair markets subdivides into segments based on trip purpose and other factors.

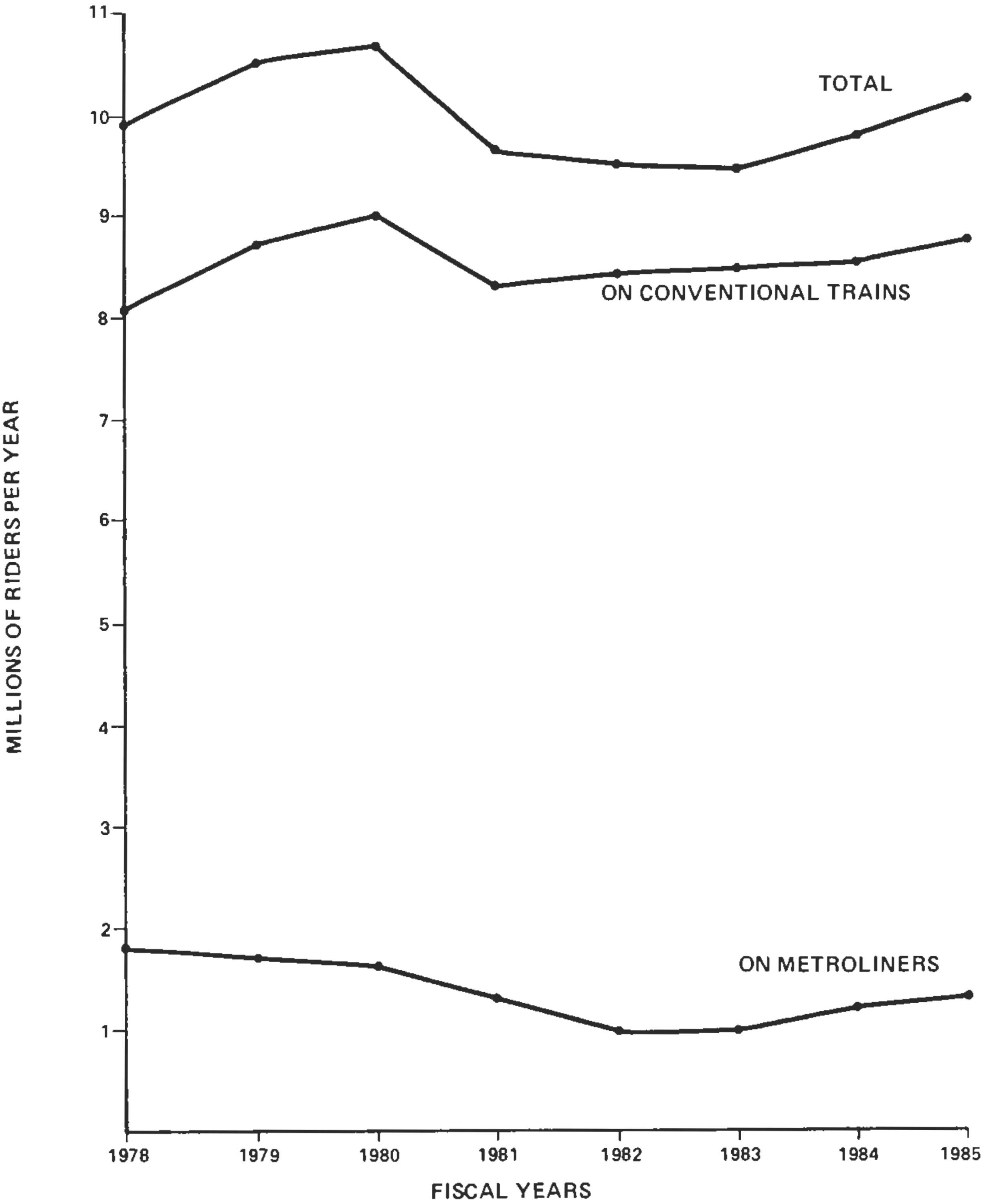
City-Pair Markets

Over the NEC main line, Amtrak now serves approximately 370 city-pair combinations, each of which is a "market" for the purpose of this discussion. Of these city-pair markets, 17 generate 78 percent of Amtrak's NEC passenger miles; the five highest-volume markets among the 17 produce 60 percent of the NEC passenger-miles, as Table 1-1 indicated. These five critical markets, with their traffic volume percentages, are:

- o New York - Washington (22 percent)
- o New York - Philadelphia (16 percent)

FIGURE 3-2

RIDERSHIP ON NEC MAINLINE SERVICES, 1978–1985

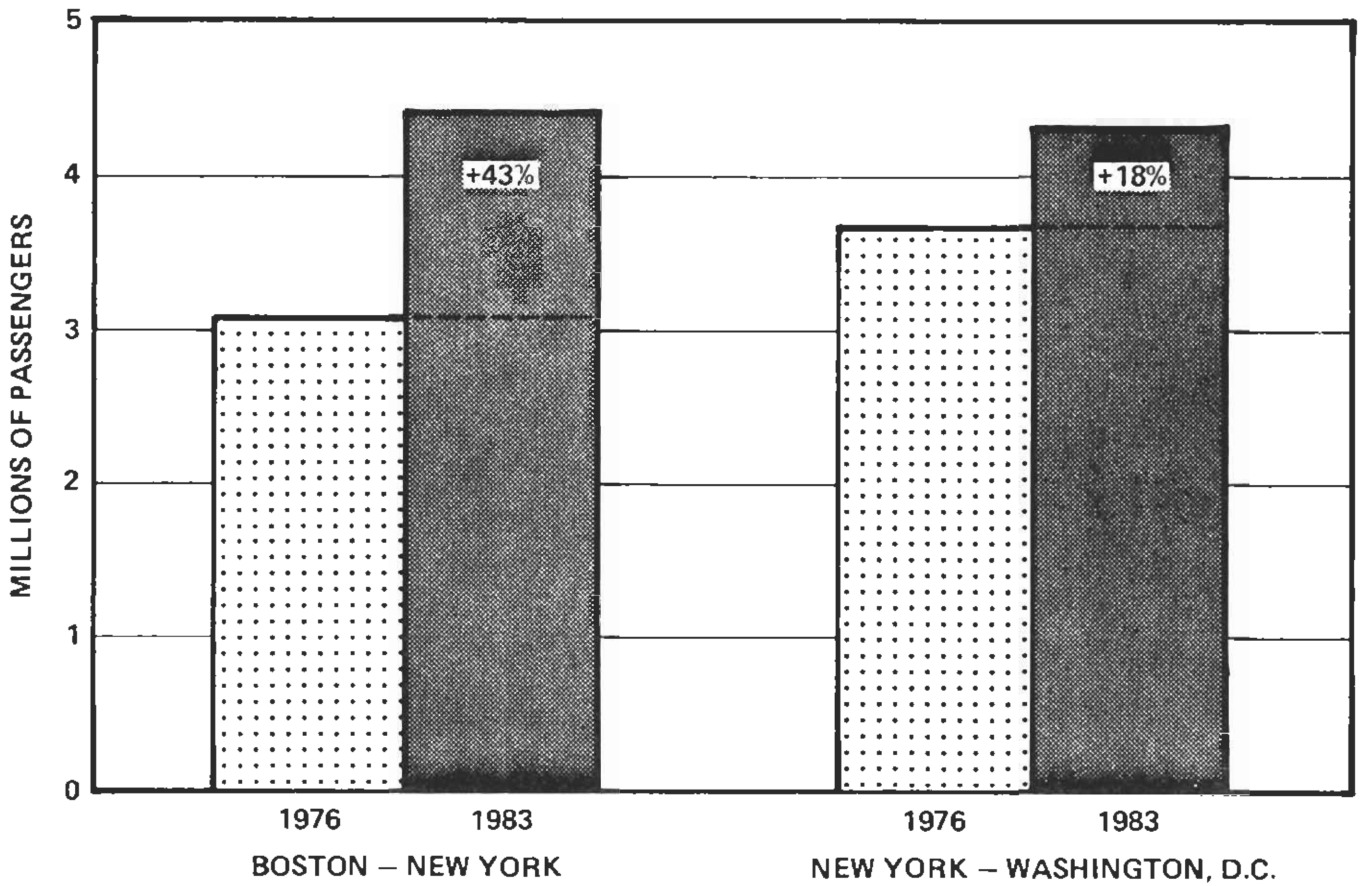


SOURCE: AMTRAK MARKETING DEPARTMENT (1)

FIGURE 3-3

EXAMPLES OF TOTAL TRAVEL DEMAND INCREASE IN THE NEC 1976 THROUGH 1983

COMBINED RAIL PLUS AIR DEMAND IN TWO KEY CITY PAIRS



- o Washington - Philadelphia (8 percent)
- o New York - Baltimore (7 percent)
- o New York - Boston (7 percent)

The historical analysis later in this chapter will focus on the two markets singled out in the NECIP's enabling legislation for trip time measurement: New York - Washington and New York - Boston.

Characteristics of the Competing Modes

Within a given city-pair market, the competing intercity passenger modes confront potential travelers with a set of characteristics including:

- o Scheduled station-to-station trip times
- o Reliability
- o Frequency
- o Price
- o Passenger experience factors such as --
  - Access times to and from stations
  - Passenger environment (comfort, convenience, "hassle")

Reliability and frequency ultimately affect traveler's perceptions of door-to-door trip times: the less reliable a mode, the greater the time-cushion a traveler must add to his or her schedule; the less frequent a mode's departures, the sooner a traveler must depart (on average) to meet a fixed appointment in the destination city. Access times to and from stations also directly affect door-to-door trip times, as exemplified in Table 3-1. This analysis therefore reduces the competitive characteristics of the modes to three: trip times, price, and passenger environment.

With regard to trip times, the relative positions of the modes differ from market to market, primarily on the basis of trip length. As distances grow shorter, air cannot compete with the other modes on the basis of trip times: for example, travelers on the 90 mile trip between New York and Philadelphia have few intercity air options. As trips grow longer, on the other hand, the ground modes face stiff air competition; for trips between Washington and Boston, for example, the schedules of the ground modes cannot compete with those of air. In a given city-pair market, the access/egress situations at particular rail, bus, or air terminals may directly affect the competitive posture of the modes. For example, as far back as 1970, many travelers from Washington reported "they could not use the train because there was no parking at Union Station" [2] -- a situation which persists today, although parking is under construction there. In terms of price, air has traditionally charged the highest fares in all markets, followed by rail, followed by bus. Of course,

TABLE 3-1

EXAMPLE OF TRAVELER'S IMPLICIT TRIP TIME CALCULATIONS

PEAK HOUR BUSINESS TRIPS TO NEW YORK
(HOURS:MINUTES)

WASHINGTON TO NEW YORK

	Metroliner (Best Time)[c]	Air (Via LaGuardia)	Air Better/(Worse) than Rail: Hours: Minutes	Air Better/(Worse) than Rail: Percent
Access to main mode at Washington [a]	0:30	0:45	(0:15)	(50)
Travel by main mode	2:36	1:20	1:21	49
Taxi in New York [a,b]	0:25	1:10	(0:45)	180
Total Trip Time	3:31[d]	3:15[d]	0:16[d]	8

BOSTON TO NEW YORK

	Conventional NEC Train (Best time)	Air (via LaGuardia)	Air Better/(Worse) than Rail: Hours: Minutes	Air Better/(Worse) than Rail: Percent
Access to main mode at Boston [a]	0:30	0:45	(0:15)	(50)
Travel by main mode	3:58	1:20	2:38	66
Taxi in New York [a,b]	0:25	1:10	(0:45)	(180)
Total Trip Time	4:53	3:15	1:38	33

Notes: [a] Assumed times. Would vary according to individual traveler's ultimate origin and destination.

[b] Substitution of airport bus to Manhattan and taxi to ultimate destination would add approximately 15 minutes to total time by air.

[c] Best time is estimated capability at project completion.

[d] When the relatively high Metroliner on-time performance and the actual level of air delays are considered, Metroliner service may actually be the fastest way from Washington to Manhattan.

the relative cost of an auto trip depends on the number of people making it. Passenger environment factors, although important, are both complex and subjective, and are not susceptible to generalization.

Market Segments

Within a given city-pair market, travelers and their trips exhibit a wide variety of characteristics in several dimensions. Travelers, for example, fall into different income level categories; as income level rises, passengers tend to be more sensitive to trip time and passenger experience factors, and less sensitive to price. This is merely a tendency, not an absolute; depending on trip purpose, a given higher-income traveler may indeed be willing to sacrifice a small time saving for a large fare reduction, and a lower-income passenger may be willing to pay a premium for a large time saving. Travelers may also be categorized in terms of their age and physical condition; for those suffering from restrictions, the passenger environment may outweigh all other competitive factors.

Similarly, trips may be characterized by purpose, specific origin and destination within the metropolitan areas concerned, size of party, amount of baggage accompanying passengers, and trip complexity (number of destinations and need for independent transportation at destinations). Of these dimensions, the most important is trip purpose: business trips are usually paid for by employers and undertaken, at least partially, on the employer's time. For these reasons, business trips usually display high sensitivity to trip time and low sensitivity to price. Personal trips, on the other hand, tend to be more price-sensitive and less time-sensitive than business trips; again, this is not an absolute. Not only will many passengers trade time for price and vice-versa, but there are also certain special-purpose personal trips, such as weddings and funerals, that imply time-sensitivity.

Within the metropolitan areas comprising a given city-pair market, the specific origin and destination of a trip may affect modal choice where trip times are important. For example, in certain markets in which rail and air have roughly comparable door-to-door trip times, downtown-to-downtown trips may be more susceptible to rail competition than trips between two suburban locations, particularly if the suburban locations have easy access to airports. Similarly, auto may be able to compete with rail trip times for trips between suburban Philadelphia and the suburbs of Baltimore or Washington, even though downtown-to-downtown trips are much faster by rail. Regardless of origin, trips with destinations in midtown or downtown Manhattan tend to attract passengers of all types to rail because of the unencumbered rail access to Penn Station and the very convenient connections at Newark with rapid transit to the Wall Street area.

The presence of certain other trip characteristics tends to favor automobile travel, which has unique cost characteristics and flexibilities. It is the only mode which needs no intermediate transfers, which has an infinitely variable schedule, and for which the perceived marginal "fares" for additional travelers amount to zero. Large parties in general, and family groups in particular, have completely different economic characteristics than single travelers, and the automobile is often the preferred mode for obvious reasons. Where heavy baggage is involved, where multiple destinations exist, or where travelers need a car at destination, auto travel is often the only answer -- again, depending on trip purpose and other factors.

Because so many dimensions exist within a given market, it is possible to devise numerous market segments by selecting typical combinations of the traveler and trip characteristics listed above. (For example, downtown-to-downtown business trips consisting of individual travelers; or, personal trips by individual travelers at moderate income levels.) For the sake of simplicity, however, it is possible to divide each market into three segments.

- Automobile-bound -- family trips and others with special characteristics (e.g., suburban or rural origins and destinations, huge baggage requirements, need for car at destination) making public transportation impractical.

- Susceptible to public transportation:

  - Time-sensitive (e.g., most business trips, some personal trips)
  - Price-sensitive (e.g., most personal trips)

Again, these segments are composites of many types of travelers and trips, so that the sensitivities are not absolute: much of the time-sensitive market is also sensitive to price, and much of the price-sensitive market is also sensitive to time. In addition, there exists a category of induced demand -- time and price sensitive -- that simply could not exist in the absence of fast travel at rock-bottom fares; this will all be discussed below.

EVOLVING CHARACTERISTICS OF THE MODES IN SELECTED MARKETS

Over time, modal split in a given city-pair market will reflect the reactions of the various market segments to changes in the products and prices of all modes. For the crucial New York - Washington and New York - Boston markets, this section traces the evolving characteristics of all modes in recent years. In the marketing strategy effected by Amtrak since the early 1970's, rail in the New York - Washington city-pair comprises two modes: Metroliner service for the time-sensitive segment, and conventional service for price-sensitive travelers.

Trip Time Factors

Perceived trip times for each mode consist of station-to-station schedules, reliability factors, frequencies, and access/egress times.

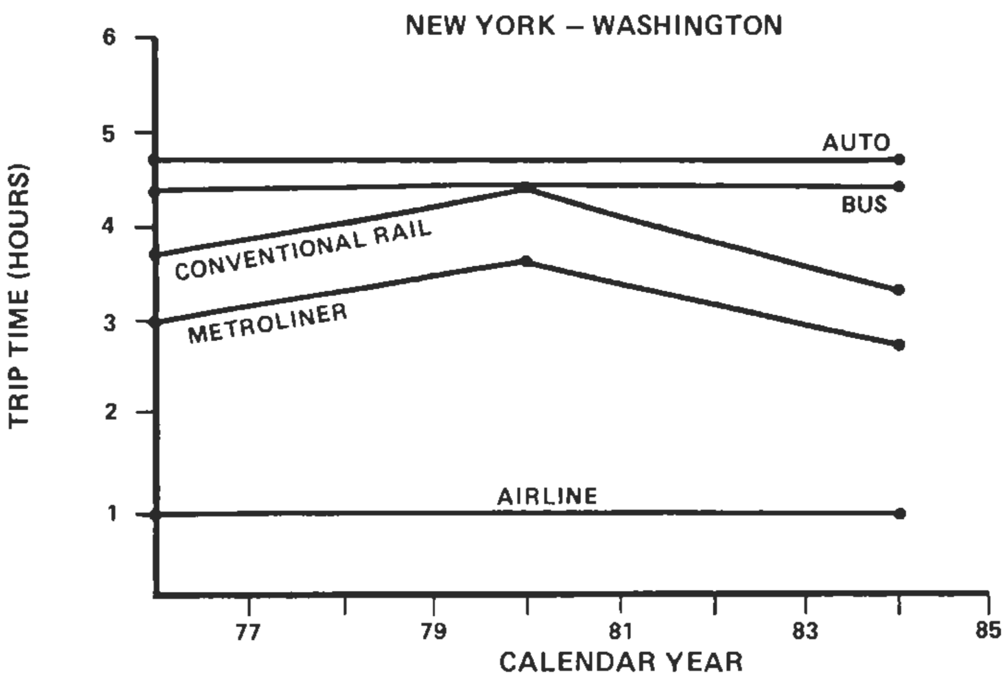
Station-to-Station Schedules

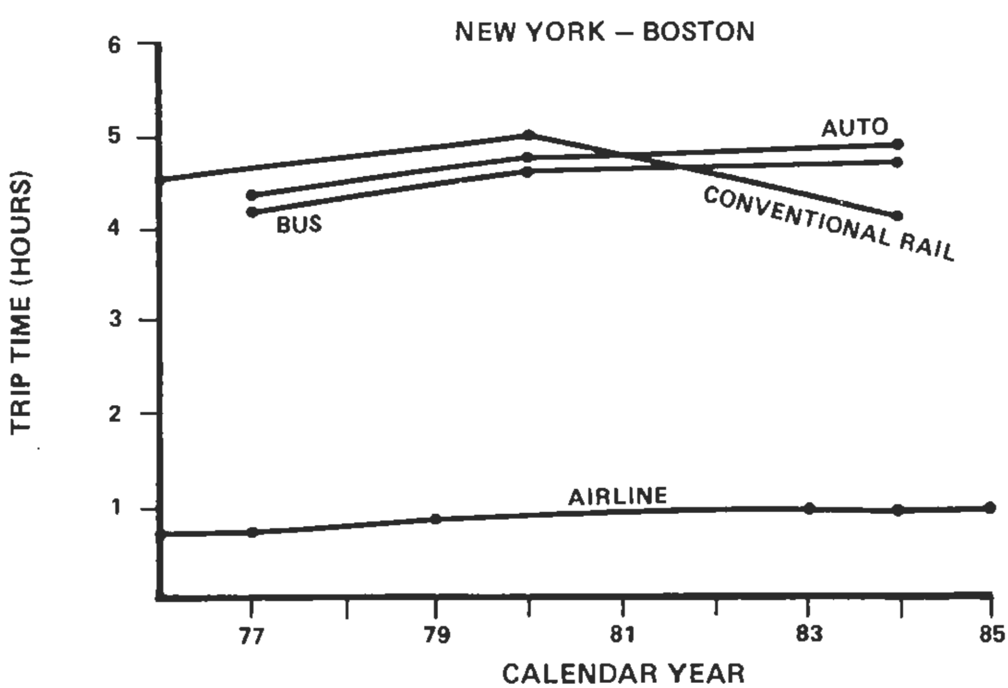
For the two key city-pairs of New York -- Boston and New York -- Washington, Figure 3-4 shows trends in scheduled, station-to-station trip times. Depending on the market, bus, auto, and air schedules have remained constant or become slightly longer; rail is the only mode with trip time improvements, which have been particularly dramatic in the conventional services. Especially to be noted is the lengthening of rail trip times in 1979 and 1980 to compensate for NECIP construction. Slight air trip time increases reflect growing congestion at Corridor airports.

FIGURE 3-4

SCHEDULED TRIP TIMES BY MODE

NOTE: These are station-to-station timings. Total trip times, door-to door, will be longer for all public transportation modes.





On-time Performance

Amtrak's on-time performance has improved in recent years (see Figure 1-2). Comparable reliability reports for air and highway modes are not available; however, as Chapter 6 indicates, increasing congestion at airports and highway bottlenecks has detracted from the on-time performance of those modes.

Frequencies

The frequency data from public timetables in Figure 3-5 shows how Metroliner frequencies have decreased, and conventional frequencies have increased slightly, since 1976 as Amtrak has striven to meet its cost/revenue goals. Deregulation of air has yielded many more daily flights since the 1970's. Under existing conditions, in which several airlines schedule their flights to depart at the same time and suffer consequent take off delays, the actual choice by air is among a greater number of airlines, each offering a basic schedule of one flight per hour, or less. In the case of the only important market in which rail/air competition exists (New York -- Washington), the air services are also fragmented over three widely separated airports at each end, still further reducing the opportunities for any given traveler. Similarly, perceived frequencies for bus service are also less than the totals shown in Figure 3-5 because the two principal bus companies offer varying types of nonstop, express, and local services, all of which figure in the totals.

Access/Egress Times

As Chapter 1 points out, access and egress times between home or office and stations are an important determinant of modal choice by passengers. Ideally, each passenger will subconsciously or explicitly add the station-to-station trip times published by the line-haul mode to the specific access/egress times experienced by her or him. An example of this kind of addition appears in Table 3-1; of course, the table reflects center-city focused trips, and relative results could be different for trips between two suburban locations. Still, on a downtown-to-downtown basis, the NECIP has allowed rail to achieve near-parity with air on trip-times in the New York -- Washington market (224 miles). On the same basis, rail is clearly superior to air over shorter distances south of New York (as in the 180-mile Baltimore -- New York market). North of New York, rail does not even come close to time parity with air, and (in view of its indirect route and difficult alignments as explained in Chapter 1) cannot do so in the absence of additional vehicle and trip-time investments (see Chapter 7).

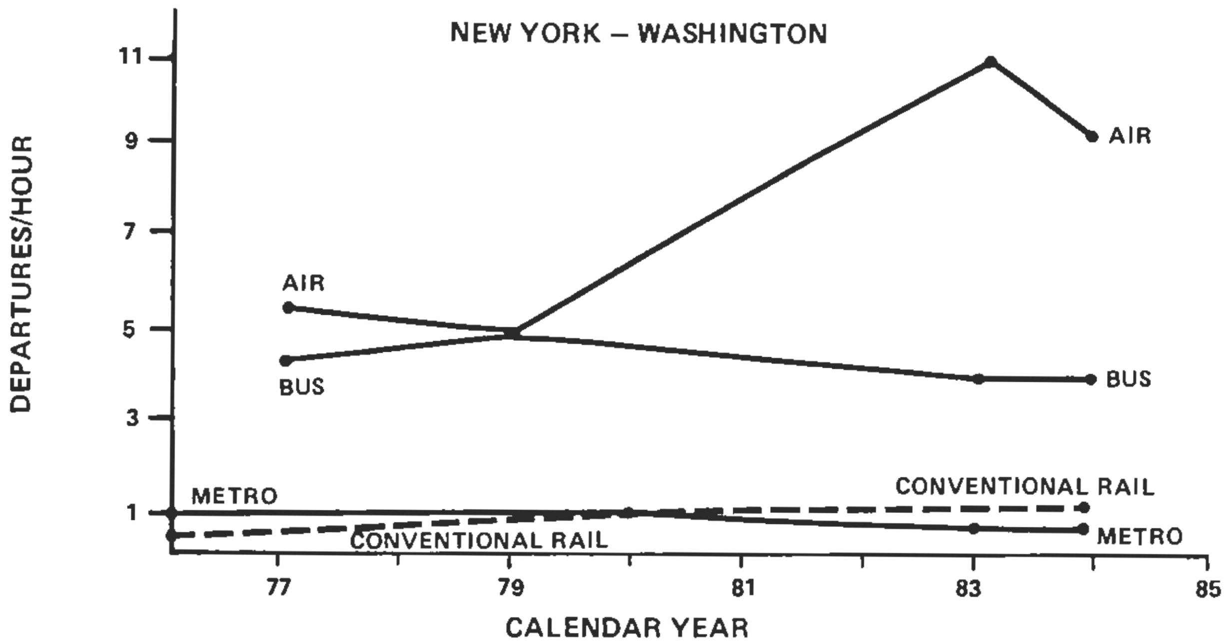
Synthesis: Trip-Time Competition among Modes

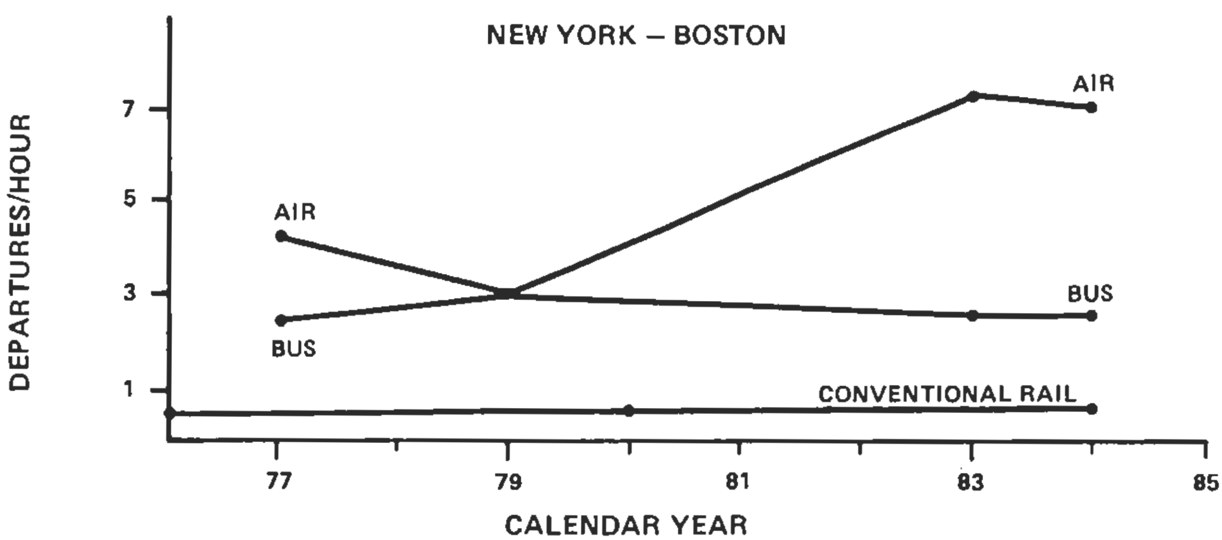
At present, only air and rail compete with each other for time-sensitive traffic between New York and Washington. Rail/air competition in the New York -- Washington market does not depend on station-to-station trip times alone; rather, it reflects a combination of line-haul timings with other trip-time factors including access/egress times and reliability (in both of which rail has advantages over air) and frequency. As the charts show, rail in recent years

Figure 3-5

DEPARTURE FREQUENCIES BY MODE, 1976 - 1984

(DEPARTURES PER HOUR IN EACH DIRECTION DURING WORKING DAYS)





lost and regained its ability to compete with air on trip times, with one exception: owing to frequency reductions, Metroliner service faces difficulties in catering to the time-sensitive market segment during hours outside the morning and evening business peaks. All these trends find expression in the patronage results presented further below.

In the New York -- Boston market, air is in a class by itself with respect to trip times, and rail must compete with other surface modes. Because rail frequencies are so low (departures approximately once every two hours), rail in the next few years will not be significantly faster than auto, with its unrivaled door-to-door access, and bus, with its high frequencies. Rail must in addition bear the burden of its history of trip time and reliability disimprovements, which Amtrak has only recently reversed. Since rail is competing within a price-sensitive market, and cannot offer materially better trip times as an inducement, it must compete with bus and auto on other factors.

Fares

Although the traditional pricing relationships among modes have held constant insofar as standard fares are concerned (Figure 3-6), the discount air fares offered since the onset of airline deregulation have been very effective in increasing airline competition in the NEC. These discount fares have pervaded different markets at different times, and they have fluctuated very rapidly. The situation as of December 1984, depicted in Table 3-2, typifies the fare competition that Amtrak has been facing in recent years.

Between New York and Washington, the airlines in December 1984 were making virtually no attempt to capture the price-sensitive market segment as defined above: there was only one flight from New York to Washington National Airport at less-than-conventional rail rates. Rather, airline price competition appeared to be directed at the price-sensitive fringes of the time-sensitive market segment -- for instance, some personal trips. The lowest airline fares ($29.00 one way, only 4 percent higher than Amtrak's excursion rate) were available only at suburban locations in the greater Washington/Baltimore area; these would attract travelers with origins and destinations near the outlying airports, as well as some passengers whose trips might not take place at all in the absence of the airlines' unique combination of cheap fares and fast service (induced demand).

Between New York and Boston, where Amtrak offers only nine trains each way per day, the six off-peak airline flights at almost one-fifth less than the conventional rail round trip fare constituted significant competition for the price-sensitive segment.

RESULTANT TRENDS IN PATRONAGE

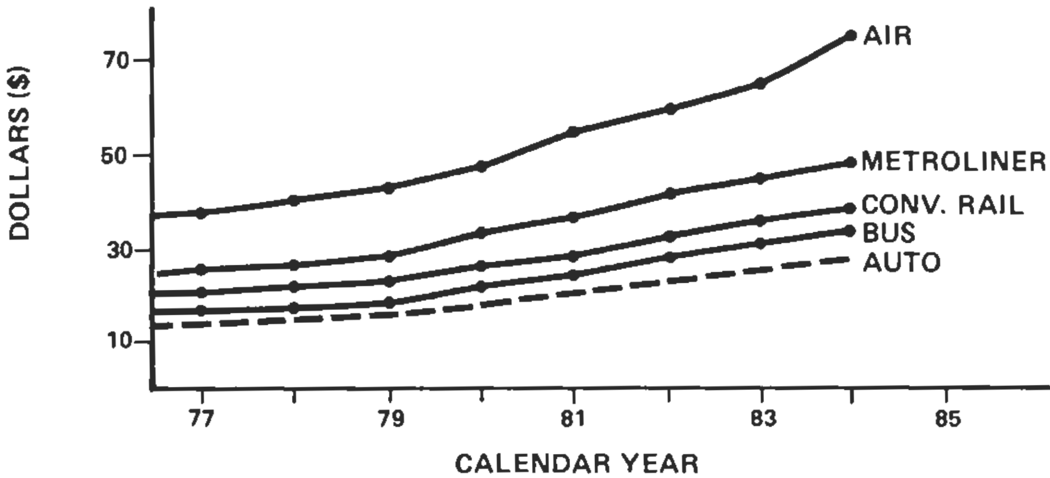
In recent years, Amtrak's NEC ridership levels have reflected the collective response of the markets and segments served to the evolving product and price characteristics of rail and its competing modes. This section

Figure 3-6

STANDARD ONE WAY FARE TRENDS BY MODE, 1976-1984

ONE WAY TRIP FARES BY MODE (CURRENT DOLLARS)

NEW YORK - WASHINGTON



NEW YORK - BOSTON

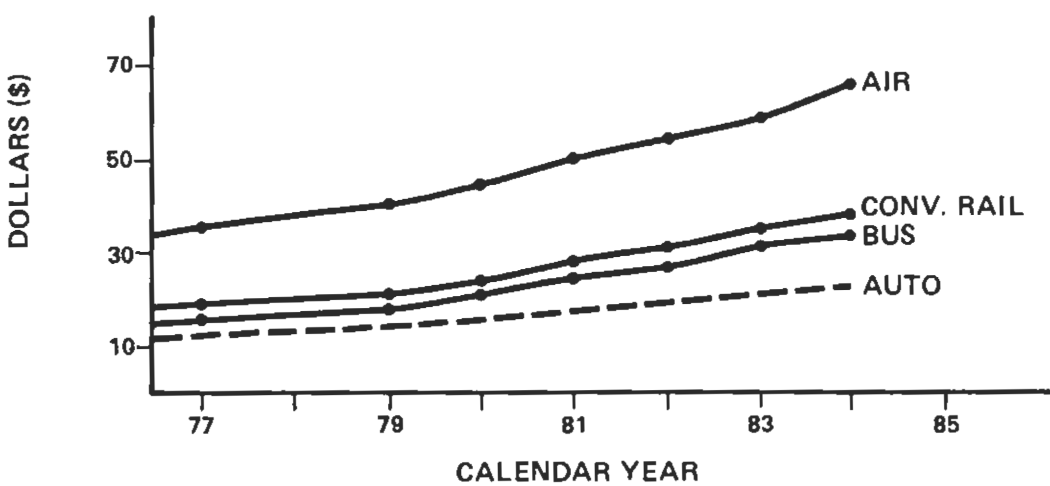


TABLE 3-2
RAIL/AIR PRICE COMPETITION IN TWO KEY MARKETS - DECEMBER 1984

From[a]	To	Airline Tickets Honored	Total Daily Flights	Number of flights at fares equal to or lower than Amtrak's: Standard One-Way: Metroliner	Standard One-Way: Conventional	Round Trip: Conventional	Round Trip: Weekend
New York	Washington National	Standard	41	7	0	0	n/a
New York	Washington National	Off-peak	5	4	1	0	n/a
New York	Washington suburban[b]	Standard	9	9	9	0	n/a
New York	Boston	Standard	44	n/a	15	0	0
New York	Boston	Off-peak	9	n/a	9	6	6

[a] New York = Newark and LaGuardia Airports

[b] Dulles and Baltimore/Washington International Airports

discusses the year-to-year trends in total traffic volumes and analyzes the fluctuations in the New York -- Washington and New York -- Boston city pair markets.

Year-to-Year Changes in Total Passenger Traffic

Figure 3-2 demonstrated the essential facts about rail ridership in the NEC since 1978; while total patronage has exhibited interesting fluctuations from one year to the next, it remained essentially unchanged over the whole period. Yet the distribution of the ridership altered markedly; Metroliner trips declined by one fourth, and conventional trips increased by ten percent, between 1978 and 1984.

Over the six-year period, the most dramatic yearly change was the drop in ridership by over one million (9.7 percent) between fiscal 1980 and 1981. Trip-times in all markets toward the end of FY 1980 were at their longest in recent history due to the NECIP construction programs (average: 4:25 New York to Washington conventional, 3:49 for Metroliner). As Figure 3-4 indicated, conventional rail trip times by the beginning of FY 1981 were no better than for bus and auto between New York and Washington, and were much worse than for highway modes between New York and Boston. This situation persisted with only minor improvements throughout FY 1981. At the same time, on-time performance -- although better than in the late 1970's -- was averaging only 67 percent for all trains, and 64 percent for Metroliners, for the last quarter of FY 1980. The average for all trains in FY 1981 was only 73 percent, even at the extended schedules then in effect. Moreover, FY 1981 saw the introduction of both new discount airlines (New York Air and People Express) in the New York -- Boston city pair, and of New York Air between New York and Washington. Yet, as Figure 3-6 showed, standard rail fares were continuing to increase despite a weakened product. Finally, growth in the Nation's economy slowed considerably in the early 1980's, a factor inhibiting both business and personal travel. That rail ridership should have suffered was not surprising under all these circumstances: in several key city pairs, total patronage had already begun to decline in 1980, and merely continued to plummet in 1981 (a 24.7 percent decline was recorded by the Washington -- New York city pair between FY 1979 and FY 1981; a 30.5 percent decline at the same time in the Boston -- New York city pair).

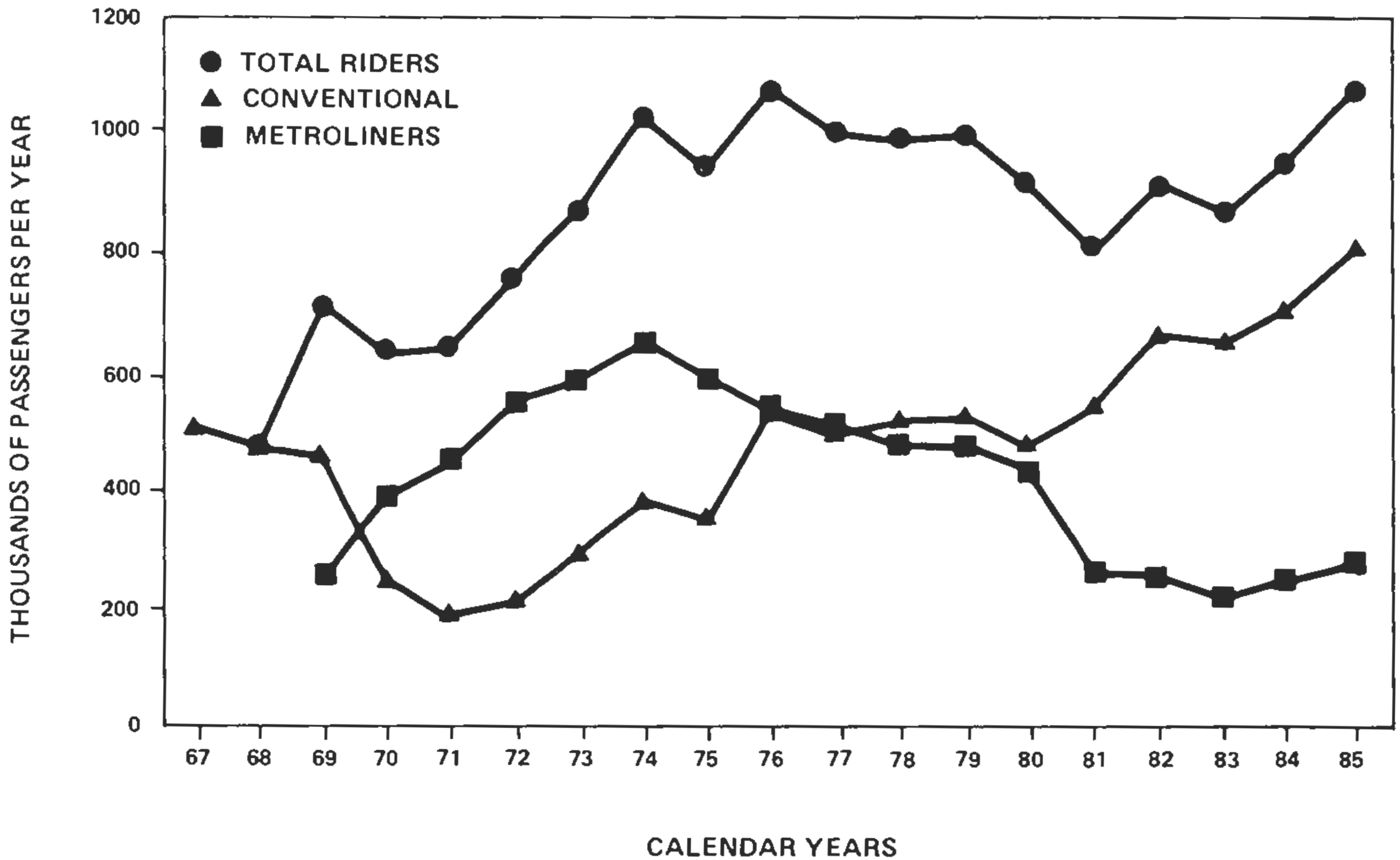
Figure 3-2 shows that, by 1985, Amtrak had surpassed its total 1978 NEC traffic levels by 2 percent. Amtrak has achieved its traffic gains to date despite the inroads of discount airlines and the freshness in traveler's memories of the difficult years of the late 1970's and early 1980's.

Redistribution of Ridership in the New York -- Washington Market

Figure 3-2 clearly revealed the decline of Metroliner and the rise of conventional traffic over the 1978-84 period. This phenomenon merits a closer look; Figure 3-7 explores the critical Washington - New York market over an 18-year period (1967-1985). One fact is immediately apparent from the chart:

FIGURE 3-7

AMTRAK RIDERSHIP
CITY PAIR MARKET: WASHINGTON D.C.–NEW YORK CITY



SOURCES: FRA STAFF PAPER, "THE NEW YORK TO WASHINGTON PASSENGER MARKET: FOURTEEN YEARS OF TRAIN/AIR DATA," BY ROBERT L. WINESTONE, MAY 1981. YEARS 1980 AND LATER ARE FROM AMTRAK'S MARKETING DEPARTMENT. (1)

Amtrak has reversed declines of the early 1980's in this, its most important NEC city pair.

Yet, as Figure 3-7 indicates, Amtrak's ridership characteristics in the New York -- Washington market have changed significantly. In 1974, when Metroliner patronage peaked, it represented 63 percent of the rail total; by 1984, it amounted to only 26 percent of the total. What happened?

As mentioned above, the Metroliner and conventional services in the New York -- Washington city pair essentially represent two modes with different marketing characteristics: Metroliner service caters to the time-sensitive segment (which, as a composite of millions of travelers with individual priorities, contains a wide range of price sensitivities); conventional caters to the price-sensitive segment (which is also a composite containing time-sensitive elements). Thus Metroliner patronage faces competition on multiple fronts: in the dimensions of trip time and price with both air and conventional rail.

Metroliner versus Air

With regard to price, Table 3-2 indicated that the discount airlines' competition with Metroliner service has focused on elements of the time-sensitive segment other than business travelers on expense accounts. In terms of perceived trip times, the competitive stance of Metroliner service suffered multiple blows in the late 1970's and early 1980's. On-time performance, which had approached 80 percent in 1975, sank below 50 percent in 1977 and 1979, and did not recover until 1981 (Figure 1-2). Scheduled running times reached 3 hours, 49 minutes (average) in 1980 (Figure 3-4) -- totally outside the competitive range with air. Frequencies, which had been hourly throughout the business day, declined to 10 per day in 1981.

Table 3-3 suggests that the elimination of three late-morning Metroliners in each direction between New York and Washington in 1981 led to a loss of some 480 Metroliner passengers per day during the affected time periods. Since the conventional trains during those mid-morning periods experienced patronage declines as well, it is likely that the Metroliner business switched to air. This interpretation gains credence against the backdrop of overall ridership gains at unaffected time periods.

Because most of the components of perceived Metroliner trip time declined in the 1977-81 period, and because the Metroliner "mode" addresses itself to the time-sensitive market, the decline of Metroliner patronage in that period can be ascribed in large measure to a transfer of passengers to air. By the same token, the recovery of Metroliner trip times in all aspects save frequency allowed the Metroliner "mode" in FY 1984 to post its first annual gain since 1974.

Metroliner versus Conventional Rail

"When I travel to New York, why should I cost the State additional public funds for a Metroliner ticket when I can get there almost as quickly, at much

TABLE 3-3
RIDERSHIP EFFECTS OF METROLINER SERVICE CUTBACKS IN OCTOBER, 1981

Trains Eliminated

Departing New York Train No.	Time	Departing Washington Train No.	Time
107	9:30 a.m.	107	10:00 a.m.
109	10:30 a.m.	110	11:00 a.m.
111	11:30 a.m.	112	12:00 noon

"Affected Time Period"

Departing New York	Departing Washington
8:30 a.m. through 12:30 p.m.	9:00 a.m. through 1:00 p.m.

(includes departures preceding and following those of eliminated trains)

Effects on Ridership During Affected Time Period

	Average Daily Passengers Leaving New York and Washington			
			Ridership (Decrease)	
Type Train	In August 1981	In March 1982	Number	Percent
Metroliner	1207	726	(481)	(40%)
Conventional	3819	3686	(133)	(3%)

Ridership Trends Exclusive of Affected Time Period

	Average Daily Passengers Leaving New York and Washington			
			Ridership Increase	
Train Type	In August 1981	In March 1982	Number	Percent
Metroliner	2809	3074	265	7%
Conventional	9350	9604	259	3%

Source: Detailed Amtrak train-by-train ridership records.

less taxpayer expense, on a conventional train?" -- Comment of a highly placed state transportation official in March, 1985.

The above comment typifies the reaction of many well-informed travelers to the diminishing time differential between Metroliner and conventional services. If persons traveling on expense accounts can arrive at that conclusion, it is hardly surprising that many personal travelers who value their time highly have nevertheless forsaken the Metroliner for conventional trains.

Table 3-4 analyzes the Metroliner and conventional markets in the New York -- Washington city pair for three important years: CY 1974, the peak year for Metroliner traffic; CY 1978, the first year that conventional traffic exceeded Metroliner patronage; and FY 1984, the most recent full year for which statistics are available. The table indicates the following probable causes for the "crossover" in business:

o The ratio of Metroliner to conventional fares was slightly greater in 1984 than in 1974. Yet:

o Metroliners in 1984 were only 14 percent faster than conventional trains as opposed to 22 percent faster in 1974. Meanwhile, the extended Metroliner trip times in the late 1970's and early 1980's had reached 3:49 by 1980. Today's conventional trains are therefore 28 minutes faster than the Metroliners at their worst. Furthermore, as another psychological factor, the cost per passenger hour saved on the Metroliner was $41.79 in 1984 versus $16.62 in 1978; this can be partially accounted for by inflation, but the value of the differential to passengers may be higher when conventional trains are at the four hour mark (as in 1978) than when conventional trains, at 3:21, are beginning to approach parity with air.

o The service quality improvements over the past decade, both under the NECIP and managed by Amtrak, have affected conventional service much more than Metroliner. The introduction of Amfleet equipment, designed to mimic the Metroliners in many ways, coincided with the achievement by conventional trains of ridership equality with the Metroliners (mid-to-late 1970's).

Thus, the decline of Metroliner patronage vis-a-vis that of conventional trains through 1983 resulted from a crossover between these two rail "modes" as well as from a transfer of passengers from Metroliner to air. The simultaneous increases in 1984 in both conventional and Metroliner traffic indicated a growing traveler awareness that the Metroliners were now almost competitive with air on trip times, could compete with air with regard to comfort, and generally offered lower fares than the airlines.

Amtrak's experience in 1985 was built upon the gains achieved in 1984. Traffic for 1985 was over 10 percent higher than for 1984, with total traffic of 1,080,000 passengers between the New York-Washington city pair, the heaviest traffic since 1976.

TABLE 3-4

Analysis of Metroliner/conventional Differential
New York - Washington City Pair

	1974	1978	1984
RIDERSHIP (percent of total rail)			
Metroliner	63	48	26
Conventional	37	52	74
TIME DIFFERENTIAL (average times)			
Metroliner timing (hours:minutes)	3:02	3:20	2:53
Conventional timing (hours:minutes)	3:54	3:57	3:21
Metroliner time as percent of conventional	0.78	0.84	0.86
FREQUENCY DIFFERENTIAL			
Metroliner daily frequency (one direction)	15	13	10
Conventional daily frequency (one direction)	10	12	16
Conventional frequency as ratio to Metroliner	0.67	0.92	1.60
FARE DIFFERENTIAL			
Metroliner Coach Fare (One Way)	$20.00	$26.00	$47.50
Conventional excursion fare (one half of round trip)	$12.00	$15.75	$28.00
Metroliner fare as ratio to conventional	1.67	1.65	1.70

Sources: "The New York to Washington Passenger Market" (FRA 1981)
"History of Running Times, Passenger Trains, NEC" October 28, 1984.

New York -- Boston Market

Figure 3-8 shows the combined effects on Boston -- New York rail patronage of the trip-time disimprovements in 1979 and 1980 and the intensified price competition with air in the mid-1980's. In recent months, ridership has begun to react favorably to the improved trip times and passenger comfort provided by the NECIP, as well as to Amtrak's new discount fares.

Taking decisive action to combat the traffic erosion caused by the airlines' fare reductions, Amtrak in August 1985 instituted a peak-hour one-way fare of $25.00 between New York and Boston -- a discount of almost one-third off the regular $36.50 tariff. (This fare is unavailable only during the traditional holiday overload periods.) Amtrak also created a weekend fare of $19.00 one way, 15 percent below the 30-day off-peak round trip fare. Proving the price-sensitivity of the Boston -- New York market segment now available to Amtrak, these new fares (coupled with the service improvements made possible by the NECIP) boosted rail ridership by 44 percent in the first seven months of FY 1985 over the same period in 1984. Together with Amtrak's successful marketing initiatives, the additional trip-time improvements to be completed by 1986 should further enhance Amtrak's competitive stance against other modes.

OVERALL FINANCIAL RESULTS

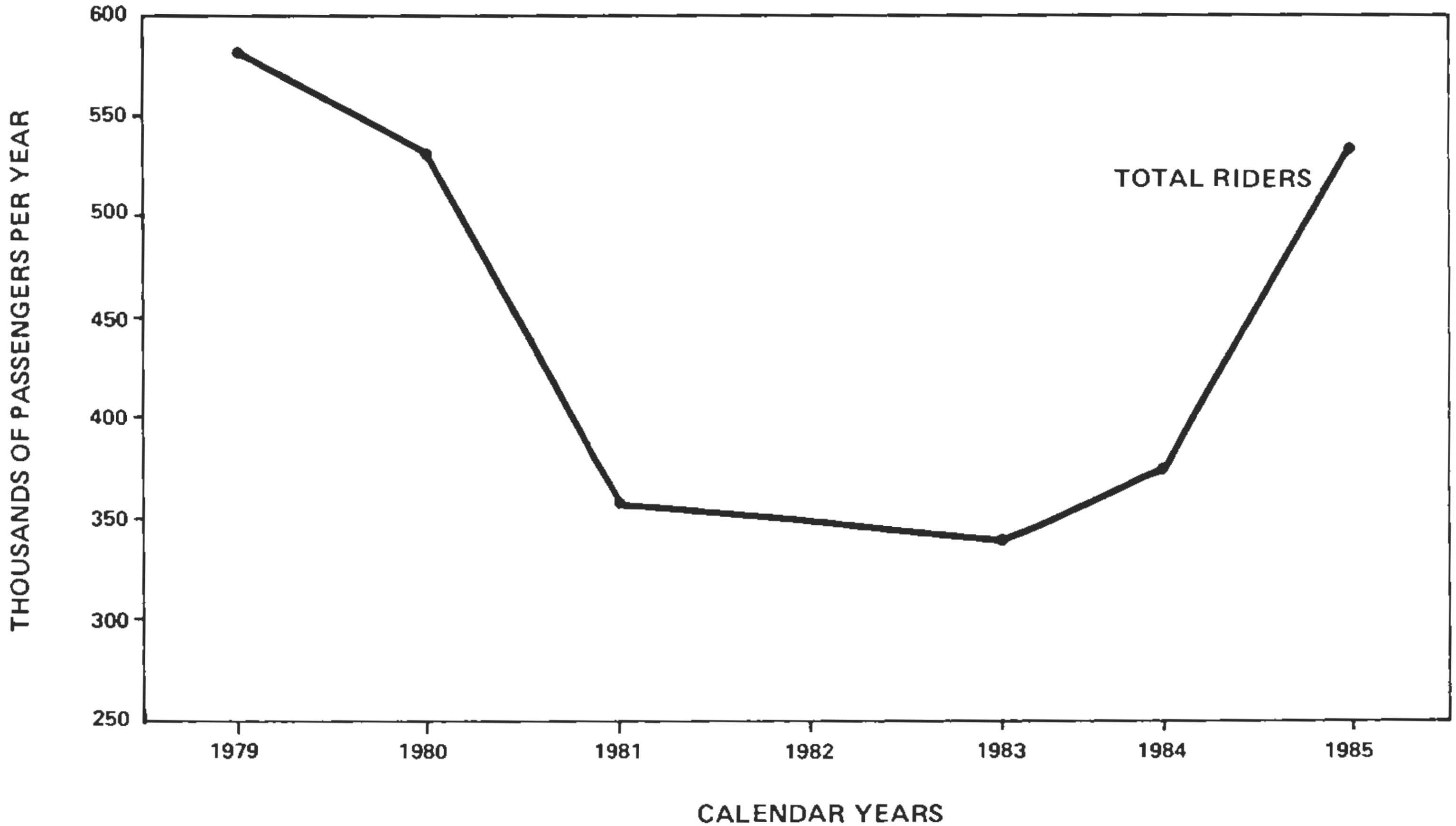
Table 3-5 summarizes statements of NEC financial operations prepared by Amtrak for the fiscal years during which the bulk of NECIP construction occurred. These overall results of NEC operations must be approached with extreme caution because they represent allocations of expenses among numerous types of services. This is inevitable in a multi-purpose facility such as the NEC. The table does not include depreciation costs, which are not a cash expense, in operating expenses; allocations of corporate-level expenses are also excluded.

The investment in NECIP is beginning to pay dividends. Although operating expenses continue to exceed revenues, operating ratios, i.e., the ratio of expenses to revenues, have shown a significant drop, going from 2.1 in 1981 to 1.76 in 1985. This result was achieved by controlling operating costs and increasing revenues through the provision of a better service.

As discussed in Chapters 1 and 2, rail passenger service in the NEC now represents a product which can attract ridership increases, and a fixed plant which can promote significant economies. Yet Amtrak faces many constraints, particularly in the area of operating costs, that make expense reductions a challenge. Amtrak must, however, continue to make progress with respect to both patronage levels and operating economies.

FIGURE 3-8

AMTRAK RIDERSHIP
CITY PAIR MARKET: BOSTON–NEW YORK



SOURCE: AMTRAK MARKETING DEPARTMENT (1)

TABLE 3-5

SUMMARY OF ALLOCATED NEC FINANCIAL RESULTS DURING NECIP CONSTRUCTION PERIOD -- 1977-1985

($ Millions)

	1977	1978	1979	1980	1981	1982	1983	1984	1985
REVENUE	$ 89	$ 94	$106	$117	$135	$143	$156	$177	$196
OPERATING EXPENSE [1]	$168	$183	$192	$212	$283	$268	$288	$330	$347
CASH FLOW FROM OPERATIONS	$ 79	$ 89	$ 86	$ 95	$148	$125	$132	$153	$150
RATIO OF OPERATING EXPENSES TO REVENUE	1.89	1.95	1.81	1.81	2.10	2	1.85	1.86	1.76

NOTE: [1] Excludes depreciation, taxes, insurance, and corporate overhead. Expenses are allocated among the many train services on NEC and elsewhere.

SOURCE: Amtrak Annual Route Profitability Reports.

Footnotes to Chapter 3

[1] "Ridership" in Figure 3-2 consists of on-train counts of --

- o All riders on Amtrak trains operating between NEC main line points

- o All riders on Amtrak short-distance trains that serve not only NEC main line city pairs but also such non-main line points as Springfield, Massachusetts and Harrisburg, Pennsylvania

- o On longer distance services such as the Montrealer and the Palmetto (Washington -- New Haven -- Montreal and New York -- Washington -- Savannah, respectively), only those passengers between NEC main line points

- o Passengers traveling on Amtrak trains with multiple-ride commuter tickets are <u>included</u> if they fit the above three categories.

[2] National Analysts, Inc., The Needs and Desires of travelers in the NEC, p. 53. This report also provides an astute analysis which forms the basis for the discussion of the marketing factors in the following paragraphs.

Chapter Four: Benefits Beyond Amtrak Service

Chapter Outline

Enhancement of related transportation modes
- *General improvements benefiting all services*
- *Specific improvements benefiting non-Amtrak services*
  - *Section improvements*
  - *Bridges*
  - *Tunnels*
  - *Stations*

Nontransportation benefits
- *Urban development -- examples:*
  - *Pennsylvania Station, Baltimore*
  - *Wilmington Station*
  - *Stamford Station*
  - *Providence Station*
- *Minority participation*
  - *Business opportunities*
  - *Employment*
- *General employment levels and training*
  - *Employment*
  - *Training programs*

List of Displays

Figure 4-1: Providence Station/rail relocation project
Figure 4-2: Employment levels due to NECIP

Chapter 4

BENEFITS BEYOND AMTRAK SERVICE

In authorizing the NECIP, the Railroad Revitalization and Regulatory Reform Act ("4R Act") established two implicit categories of goals for the Project: first, goals pertaining specifically to intercity railroad passenger service in the NEC; second, goals related either indirectly, or not at all, to upgrading the intercity rail passenger product. This chapter focuses on the second category of goals, which included the improvement of related transportation modes (especially rail freight and commuter services) as well as the advancement of social objectives extending far beyond the realm of transportation.

ENHANCEMENT OF RELATED TRANSPORTATION MODES

Amtrak's NEC main line fulfills several important functions in addition to intercity passenger service. Between Washington and Baltimore, between Wilmington and New Haven, and between Providence and Boston, it carries high volumes of commuter trains, intersects with many other commuter routes, and, at key metropolitan stations, connects with still other forms of urban mass transportation. Especially south of New York, the NEC provides local freight service to many on-line industries, and it accommodates very substantial volumes of through freight tonnage -- over forty million gross tons annually at certain locations south of Philadelphia. The 4R Act insisted that the NECIP improve, rather than detract from, these related transportation services; the NECIP has amply fulfilled that requirement, as the examples below illustrate.

GENERAL IMPROVEMENTS BENEFITING ALL SERVICES

Chapter Two provides details on the physical improvements completed under the NECIP. Since the NEC is in many respects a common facility, many of the NECIP project elements have automatically benefited commuter and freight, as well as intercity passenger, services. For example, improvements to bridges and the track structure have provided a more stable roadbed for all services; betterments to signalling and communications will allow Amtrak to operate the entire NEC more efficiently; the grade crossing and fencing programs have upgraded the safety of all operations; and the new service facilities will allow Amtrak to maintain the plant much more effectively, for the benefit of all users. The specific effects of these large project elements on non-intercity services will, of course, vary from location to location, but their overall impact will be beneficial.

SPECIFIC IMPROVEMENTS BENEFITING NON-AMTRAK SERVICES

Chapter Two also discusses many specific NEC accomplishments with directly identifiable benefits to non-Amtrak services. Examples are as follows:

Section Improvements

o Between Washington and Wilmington: A new track configuration is placing the freight tracks on the east side of the railroad to reduce conflicting moves. Result: more efficient operations for all services.

o South Philadelphia: A completely new track configuration, including better drainage and a retaining wall, has achieved better separation and more efficient routing of intercity passenger, freight, and commuter traffic. Results: a more stable structure for freight tracks; higher speeds for, and reduced interference among, all services. As Chapter 2 points out, this reconfiguration project is an ideal example of joint planning, funding, and implementation by the NECIP and local interests.

o Queens, New York: The reconfiguration of Harold Interlocking will reduce diverging moves and increase speeds for both Amtrak intercity and Long Island Rail Road commuter trains.

o Boston: A NECIP investment of $62 million in the Southwest Corridor Project is helping to make possible the relocation of "Orange Line" rapid transit and the provision of a rebuilt right-of-way for commuter and intercity passenger service from Boston to Forest Hills. A new South Station track layout will provide for improved station operations for all trains.

Bridges

o Connecticut: A cooperative program with Connecticut DOT to upgrade five movable bridges will enhance reliability and, potentially, train speeds in the heavily travelled commuter-and-intercity territory west of New Haven.

Tunnels

o Baltimore: The rehabilitation of the Baltimore & Potomac Tunnel has increased safety, reliability, and ride quality for all services.

Stations

Virtually every NEC station also serves commuter trains, and many provide connections to local transit services. At several locations, joint efforts have produced especially significant results for all users. Typical examples would include:

o Boston: a new South Station will provide an efficient terminal for both MBTA commuter and Amtrak intercity trains, with potential for still further intermodal development not funded by the NECIP.

o Providence: a completely new station will provide for all operations (see section below).

o New Carrollton (Capital Beltway), Maryland: a completely new station provides very convenient connections among commuter, intercity, and rail rapid transit services.

For descriptions of station improvements benefiting both commuter and intercity passengers throughout the Corridor, see Chapter 1.

NON-TRANSPORTATION BENEFITS

The following sections demonstrate the success of the NECIP in contributing to certain non-transportation benefits.

URBAN DEVELOPMENT

Many NECIP stations are located in deteriorated urban areas. Thus, a major benefit of the NECIP station program has been the generation of urban renewal around the station sites, by means of coordinated and cooperative efforts of the Federal Government, state and local agencies, and private concerns. While many of the NECIP stations can fit this characterization, four are excellent examples: Baltimore, Wilmington, Stamford, and Providence.

Pennsylvania Station, Baltimore

Baltimore's Pennsylvania Station is located in the block bounded by Charles, St. Paul and Lanvale Streets and the Jones Falls Expressway. This location is approximately at the geographic center of Baltimore and one mile north of the central business district (CBD).

The Baltimore City Government has become renowned in recent years for the successful redevelopment of its downtown area. Although the Inner Harbor area, just south of the CBD, has received the most attention, the City has targeted such other areas as the North Charles Street corridor for revitalization. Thus far, redevelopment on Charles Street has extended north from the CBD to a point just south of the Baltimore Station. The City therefore approached the FRA with the idea of a joint effort to encourage the redevelopment to move further north past the station, while at the same time enhancing the station.

While the FRA had funded major renovations inside the station, the NECIP had included minimal work for exterior improvement due to lack of availability of 100-percent Federal funding. By means of a reimbursable agreement, the City and FRA jointly designed and funded a project for site enhancement at the station and along the adjacent Charles Street between Mt. Royal Avenue and Lanvale Street. One of the prime concerns was adequacy of site and street lighting to provide a feeling of security for pedestrians and to deter street crime. Now that the site improvements are substantially complete, the station environs at night are now almost as bright as in the daytime. It is still too early to determine the effects of these site enhancements on the City's redevelopment efforts, but the benefits to rail passengers using the adjacent parking facilities are already apparent.

Wilmington Station

Wilmington Station is located at the intersection of French and Front Streets, four blocks south of Wilmington's CBD and one block north of the Christina River. Early in the NECIP program, FRA successfully negotiated with the Delaware Transportation Authority and the Wilmington Parking Authority for commuter improvements in the station and a joint-use parking garage, respectively. At the start of the NECIP program, the area surrounding the station housed surface-level parking, deteriorated housing and commercial buildings, and street-front shops, some of which were barely surviving and some of which were closed.

Responding to deteriorated conditions in portions of the downtown area, the Wilmington City Government initiated the idea of the "Wilmington Gateway." This is an area of redevelopment which runs from Brandywine Creek north of the CBD to the Christina River south of the CBD. Development has proceeded at the Brandywine Creek end and is currently moving toward the Christina River adjacent to Wilmington Station.

Since the FRA's initial involvement, the City has razed buildings in the blighted area around the station and realigned streets, utilizing FHWA funds to improve traffic and funnel it to the "gateway" area. The City envisions that the renovated station and new joint-use parking facility will be the hub of development at the south end of the "gateway." Recently, Wilmington Waterways, a private entity, was incorporated to spearhead development in the station area. Proposed development includes park-type areas, shops, motel, offices, and water-oriented uses.

Stamford Station

A third example of station-spurred development is expected to occur at Stamford Station. Unlike the previous two examples, however, Stamford Station will be a new facility, the construction of which is under way. Along with the new station, a parking facility, cost-shared between the State of Connecticut, the City of Stamford, and the FRA, is being constructed.

The old station, which has been partially demolished, consisted of two separate buildings which were on opposite sides of the tracks, each serving one direction of travel. At the start of the NECIP, the south terminal building had been closed for over ten years due to its deteriorated state, and the north building provided all passenger services, such as they were. The station site is just southwest of the CBD and adjacent to the Connecticut Turnpike. The surrounding area includes rental car storage facilities, a vacant school building, vacant lots, an automobile dealership, small retail facilities, and the edge of an old residential area beginning just south of the station.

Enhanced by the new station, the surrounding area is now amenable to development, some of which has already begun west of the station. The station provides a direct connection to New York City, not only via Amtrak to Pennsylvania Station, but via the Metro-North commuter rail service serving Grand Central Terminal from the Connecticut suburbs. This service also brings increasing numbers of commuters to Stamford. Owing to this heavy traffic, it is likely that other lots adjacent to the station will be developed with possible motel, office and retail uses in the near future, thus expanding Stamford's CBD.

Stamford is also a prime example of a true intermodal facility. The new over-the-track station will enhance both long-haul and commuter rail service; limousines will make scheduled trips to the New York airports; taxi services will be available; and, as part of the project, the State and City in conjunction with UMTA are providing for car pools, van pools, and buses.

Providence Station

An archetype of station-generated development is the Providence Station and rail relocation project. Initially, the NECIP intended merely to renovate the existing historic station. However, at the specific request of the State of Rhode Island, the City of Providence, the Providence and Worcester Railroad, and the Providence Foundation, FRA agreed to relocate the railroad right-of-way and build a new station.

The relocation promised benefits both to local interests and to Amtrak. The new plan would provide over thirty acres of development parcels adjacent to the existing central business district. Although this land area would have been available under the original station renovation concept, the old railroad right-of-way would have separated it from the CBD. With the railroad right-of-way moved approximately 700 feet to the north (Figure 4-1), the development area will be contiguous with the CBD and will eliminate the blighted barrier that the railroad used to pose between the CBD and the Rhode Island State Capitol complex.

Amtrak will also profit from the relocation. Trip times will benefit from the elimination of a major slow-speed curve. The new station, smaller and more efficient than the existing station, will be easier and far less expensive to operate. (The State will maintain the old historic station pending designation of a developer for the mixed-use revitalization of the station complex.) Despite these trip time and operating expense advantages, the cost to the NECIP will be well within the budget established for the discarded renovation concept.

Construction of the FRA-funded station project is well under way and is scheduled for completion in the fall of 1985. The concept received awards for excellence in both urban planning and architectural design (see Chapter 1). Proposed development is already in the planning stage, and the City will be able to expand in a coordinated and orderly process.

An extensive amount of coordination and cooperation was required and successfully accomplished to initiate the project and make the development potential a reality. It was necessary to reach formal agreement among five organizations (FRA, the State of Rhode Island, the City of Providence, the Providence and Worcester Railroad, and Amtrak). The issues of the agreement dealt with such matters as the scope of work and the delineation of responsibilities for design, construction administration, funding, and overall coordination. Relocation of the right-of-way affected property owned by various entities. It was necessary to reach separate agreement between these parties for trading parcels so that all owners, at the conclusion, would be in a situation that closely approximated prerelocation status.

From the inception of the relocation concept to the start of construction, the project developed smoothly and quickly. With due regard to the high sensi-

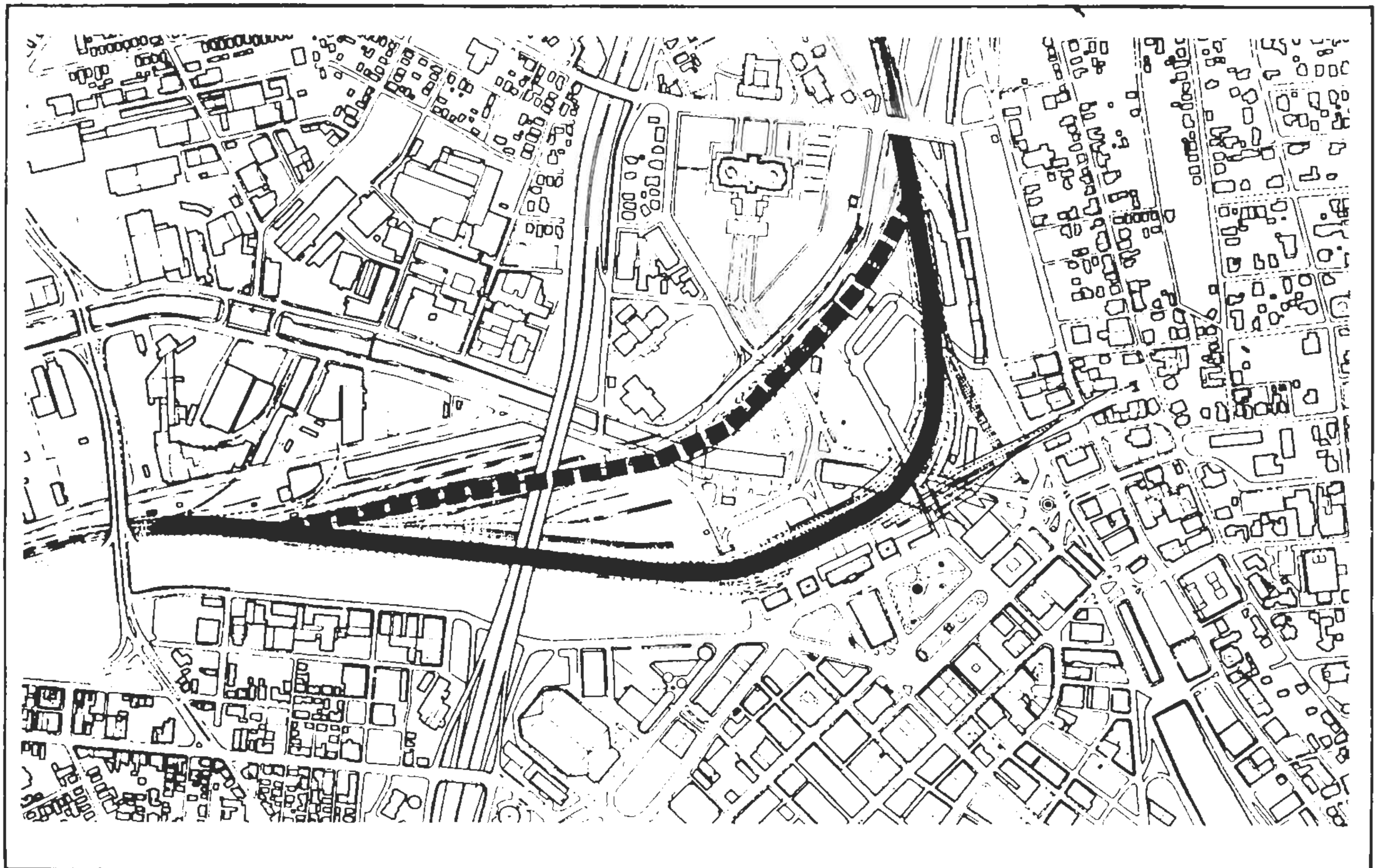


FIGURE 4-1

PROVIDENCE STATION/RAIL RELOCATION

tivity of land ownership, the respective owners expeditiously negotiated and signed a master property conveyance agreement. Thus, within thirty months of redirection, the design was complete; the project was under construction; and agreements were signed. The achievement was possible because all the interested parties understood the positive effects of the project, both on rail passenger service and on the metropolitan area.

Now under discussion in Providence is a second major local initiative: the proposed shifting of the confluence of the Woonasquatucket and Moshassuck Rivers as part of an overall waterfront plan to reestablish the prominence of the rivers. In such a river relocation, much of the decking that has concealed the rivers would be removed and replaced by an extension of the new boulevard access to Memorial Square. Dredging of the rivers would lessen the threat of flooding. River walks would be provided to encourage pedestrian activity and movement between the CBD and the redevelopment area. This proposal would build upon the momentum already established by the station relocation and associated downtown development.

MINORITY PARTICIPATION

Title IX of the 4R Act required the Secretary to carry out programs to assure minority participation in business opportunities and employment related to the NECIP. As used in the 4R Act and the balance of this report, the term "minority" includes women.

Business Opportunities

Upon passage of the 4R Act, the Secretary of Transportation established a 15 percent goal for NECIP contracting with minority business enterprises. This goal was subsequently incorporated into the FRA/Amtrak contract as well.

Since the inception of the NECIP, businesses owned by members of minority groups have been awarded contracts or subcontracts totalling $197 million, or 17.8 percent of the total of $1,106 million in contract awards through September 1984 -- well in excess of the Secretary's goal. Over 600 firms owned by members of minority groups have shared in this work.

Of the various types of contracts included in the preceding totals, construction and architectural/engineering contracts had the highest concentration of minority participation. Construction contract awards through FY 1984 totalled $400 million, of which firms owned by members of minority groups received $85 million, or 21 percent. Minority-owned firms had the prime construction contracts with FRA on such projects as the Philadelphia 30th Street Station electrical repair, Southampton Yard demolition, Boston South Station emergency repairs, New London Station, Trenton Station, Port Chester Bridge, Metropark Station, the Wilmington Station roof and canopy, and repairs to the King and French Street bridges, also in Wilmington. With Amtrak, minority-owned firms had prime construction contracts for the following projects: right-of-way cleanups; Baltimore Station roof and air conditioning; fencing along the Hell Gate Bridge route; section improvements from Baldwin to Brill Interlockings, Pennsylvania; New Carrollton Station; Ivy City (Washington) car wash; and Philadelphia 30th Street Station roof repair.

Minority-owned firms participated in each of the 88 architectural/engineering design contracts. These 64 minority-owned firms received $27 million, or 30 percent of the total $88 million awarded in design contracts as of September 30, 1984.

In a report recently released [1], the U.S. Civil Rights Commission confirmed the success of the NECIP in promoting minority business involvement. For example:

> ". . . this report finds among other things that the 15 percent goal -- a genuine goal, not a set-aside or quota -- for minority and women-owned enterprise participation in NECIP has been exceeded. It concludes that this success was feasible largely because there was a shared commitment to the goal within FRA/NECIP management. Our study of NECIP underscores the important role that high-level Federal administrators play in any successful effort toward enhancing the participation of minorities and women in mainstream economic activities . . . The Department of Transportation, the Federal Railroad Administration, and Amtrak are to be commended for this achievement." [2]

> "It deserves a special recognition that this voluntary goal has been met and exceeded . . . and also demonstrated what committed leadership can accomplish for the growth and increased participation of M/WBE."[3]

> "This [15 percent] is the highest percentage goal and NECIP is the largest of any Federal project employing such a goal. The goal has been exceeded to date: approximately 17 percent of NECIP contracts or sub-contracts has been awarded to M/WBEs."[4]

> "Federal agencies should take NECIP's accomplishments into account when setting their own small disadvantaged business subcontracting goals under P.L. 95-507."[5]

Employment

Equal employment opportunity on the basis of merit and without regard to race, color, religion, sex, age, national origin or any physical or mental handicap is required by Title IX of the 4R Act and various Federal statutes, and is the responsibility of all NECIP participants.

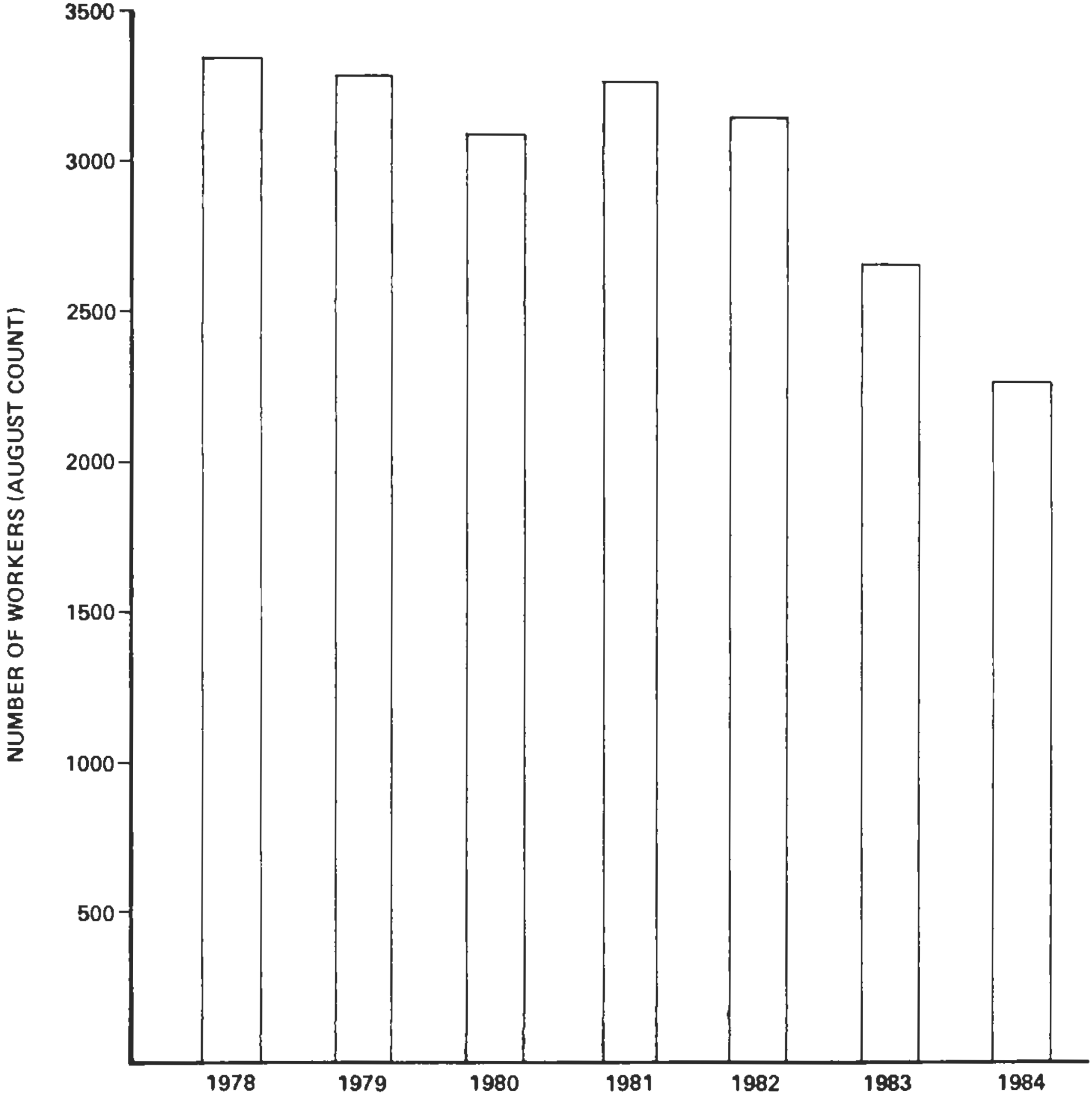
Overall, direct employment of members of minority groups (as defined above) on the NECIP has ranged from 28 percent to 38 percent on a month-by-month basis since the inception of the Project, again a notable achievement.

GENERAL EMPLOYMENT LEVELS AND TRAINING

The NECIP contributed to the economic vitality of the NEC region and the Nation by providing a contribution to general employment levels. In addition,

FIGURE 4-2

EMPLOYMENT LEVELS DUE TO NECIP



NOTE: Workers counted include those of: U.S. Department of Transportation (NECIP Program Offices), its contractors and subcontractors
De Leuw, Cather/Parsons and its Architectural/Engineering and consultant subcontractors
Amtrak (NECIP Program Offices), its force account labor, and its construction subcontractors
Excluded are workers for materials suppliers.

training programs conducted as a result of the NECIP upgraded Amtrak's labor force.

Employment

At its peak, the NECIP provided over 3,000 jobs (as shown in Figure 4-2), mostly in the NEC region. Over the life of the project, the NECIP generated a total of approximately 26,000 man-years of effort.

Training Programs

The NECIP required a pool of skilled railway construction workers able to safely and economically undertake the wide range of construction assignments necessary to reconstruct the Corridor's physical plant.

Because the existing railroad industry labor pool was too small to handle the quantity and scope of projects to be accomplished, the NECIP in March 1976 initiated the first of a series of training programs. During the early years of the Project, skills training programs received emphasis. Courses at various levels trained maintenance-of-way track, bridge, and building foremen; communications and signal employees; equipment operators; maintenance-of-way mechanics; and electric traction linemen. The program also taught skills in structural welding (for NECIP bridge rehabilitation); track welding; operating rules and first aid; CPR (for maintenance-of-way employees); and pole top rescue (for electric traction employees).

While the need for maintenance-of-way skills training continued throughout the Project, the focus of the training programs began to shift from maintenance-of-way type craft skills toward the higher-technology electronic and electro-mechanical skills required for support of the new signalling systems, movable bridges, and the highly complex centralized electrification and traffic control (CETC) system. Each of these training programs introduced new skills and hardware to the Amtrak work force, and, in some cases, the need for entirely new job classifications. As part of the overall NECIP procurements, each project element included within its scope of work detailed training and documentation requirements, thus providing Amtrak with professionally produced training programs.

Footnotes to Chapter Four

[1] U.S. Commission on Civil Rights, "Participation of Minority and Women Contractors in the Northeast Corridor Improvement Project (NECIP)."

[2] Ibid., Walter Washington transmittal letter at page 3.

[3] Ibid., report at page 1.

[4] Ibid., p. 79.

[5] Ibid., p. 82.

Part II: The Potential

The first part of this report recorded the accomplishments of the NECIP as perceived by the passenger, analyzed the physical improvements that made the enhanced transportation product possible, and assessed Amtrak's operating results in recent years.

What of the future?

When the final trip time improvements become operational, Amtrak will have a railroad of world class -- a facility capable of efficiently and safely providing fast, reliable, frequent, and comfortable passenger service. Yet the NECIP, for all its accomplishments, was never expected to bring about a complete rehabilitation of every major component of the railroad. Neither could the NECIP afford to realize the trip time dreams of the NEC transportation planners of the late 1960's and early 1970's.

Therefore, Amtrak (along with other Corridor users and affected state and local government agencies) will still face some NEC-related problems and challenges in the late 1980's and beyond. Typical issues concern the electrification and signalling systems in the Corridor as well as the future of through freight service therein. Chapter 5 shows how these matters can directly affect Amtrak's future operating and financial prospects. The long-term challenges facing Amtrak will revolve around one central question: how can Amtrak increase its NEC ridership while improving its financial results in the Corridor? Chapter 6 explores the trends in transportation, economics, and demographics which may influence Amtrak's ability, or guide its creative marketing efforts, to enhance patronage profitably. Chapter 7 then assesses the costs and benefits of specific approaches which Amtrak may adopt as it meets the challenge of the post-NECIP era.

Chapter Five: Near-Term Investment Choices

Chapter Outline

Way and structures
- *Section improvements*
- *Tunnels*
- *Bridges*
- *Track*

Power and control
- *Electrification*
  - *Technical background*
    - *Power generation and supply*
    - *Power distribution*
  - *Institutional background*
  - *Sample alternatives*
    - *Alternative 1: status quo*
    - *Alternative 2: rebuild the existing system in kind*
    - *Alternative 3: replace with commercial power*
- *Signaling and train control*

Service facilities

Freight/passenger separation
- *Freight service in the Corridor*
- *Effects on passenger service*
  - *Comfort and economics*
  - *Safety and reliability*
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Chapter 5

NEAR-TERM INVESTMENT CHOICES

The NECIP, although intensive, was not a complete modernization or even a rebuilding of Amtrak's unique transportation resource in the NEC. Given the patchwork history of the Corridor, the inconsistent standards of its construction and maintenance by Amtrak's predecessors, the antiquity of many of its components, and the decades of neglect before 1976, such a total, simultaneous rebuilding would have exceeded the bounds of any reasonable budget. Instead, the NECIP achieved its goal -- enabling Amtrak to supply a vastly improved transportation product -- by applying basic principles of engineering economy. These principles are simple: make those investments first which yield the highest return, measured in this instance by product improvement. Chapter One, outlining the effects of the NECIP on trip time, reliability, and the passenger experience, amply documents the NECIP's success in setting priorities both among and within project elements.

Amtrak now has the responsibility for sustaining its improved transportation product. Adhering to the new standards of service quality will, of course, require Amtrak to apply well-planned, efficiently organized maintenance efforts to its physical plant. To that purpose, the NECIP itself supplied Amtrak with such essential tools as up-to-date track renewal equipment, maintenance-of-way bases, and equipment shops. Yet Amtrak, like any large corporation, will be continually comparing its annual operating and maintenance budgets in specific cost areas with opportunities to make capital investments that will reduce future expense levels. For instance, Amtrak may find that building a new maintenance-of-way base at a given location will produce annual savings of a given dollar amount. Amtrak will compare these annual savings with the initial investment required, and will compare the financial return of the proposed maintenance base with the prospective returns of other types of promising projects. Similarly, Amtrak may find that replacing a given bridge would eliminate escalating maintenance costs, impending slow orders, or emergency repairs. Carefully weighing competing investment opportunities against their benefits and against each other, Amtrak will commit its scarce capital resources to those projects promising the highest yield per dollar spent.

The NECIP, in the course of its planning and design, identified many investment opportunities that were of insufficient immediate National priority for inclusion in the NECIP itself, but that are likely to merit Amtrak's attention in the years to come. These investment opportunities fall into two categories.

o Investments primarily intended to reduce future operating expenses or safeguard revenues, either by providing a predictable stream of annual cost savings or by avoiding possible failures of major NEC components. This chapter treats such opportunities.

o Investments primarily intended to yield an improved transportation product in terms of trip times, reliability, and the passenger experience. Such investments appear in Chapter Seven.

Table 5-1 summarizes options for near-term investment opportunities that Amtrak may choose to consider. These improvements, most of which affect the track, bridges, and service facilities, could help Amtrak to sustain its improved NEC service on an economic basis. Because these items are primarily routine improvements to the plant, Amtrak can decide whether to include some or all of them over a period of years in its regular capital improvement program and within the context of its entire set of investment choices.

In addition to the project elements shown in Table 5-1, the separation of freight and passenger service in the NEC could be considered by Amtrak as one possible investment choice in the years to come. Such a separation could help in maintaining the improved service by removing heavy freight loadings from the track structure.

WAY AND STRUCTURES

Additional improvements in Way and Structures that may reduce future maintenance expenses could be considered.

SECTION IMPROVEMENTS

The reconfiguration of interlockings at County, Shore/Ford, Hudson/Dock, and Hunter would eliminate unnecessary switches and crossovers, thus reducing maintenance expenses. It would also relieve the congestion that can develop at those locations.

TUNNELS

Installation of evacuation and fire protection facilities (including water lines and lighting) in the East River tunnels in New York City, as mandated by the City's Fire Department. Additional major renovations of the mechanical and electrical systems (ventilation, drainage and pump systems) in the Hudson and East River tunnels would provide improved reliability in the coming years.

BRIDGES

Rehabilitation of bridges south of New York that have been neglected in past years. Not on this list are "orphan" highway bridges crossing the NEC for which ownership and maintenance responsibility is in dispute. The maintenance and rehabilitation of these highway bridges will have to be addressed, although not necessarily by Amtrak.

Table 5-1

NEAR-TERM INVESTMENT OPPORTUNITIES

NOTE: Projects listed below have not been determined to be economically justified. Moreover, the cost estimates are preliminary ones indicating only orders of magnitude.

Group	Project Element	Description	Preliminary FRA Cost Estimates (1984 $ Mil)
WAY AND STRUCTURES	Section Improvements	Reconfigure County, Shore/Ford, Hudson/Dock, and Hunter Interlockings.	
		Group Total	$25
	Tunnels	Install New York (East River) tunnel evacuation and fire protection facilities.	18
		New York (East River) Tunnel electrical and mechanical rehabilitation.	6
		Group Total	25
	Bridges	Bridges south of New York (including Hi-Line).	53
		Union and Warren Street Bridges.	5
		Group Total	58
	Track Improvements	102.8 track miles of concrete ties, continuous welded rail (CWR) and undercutting between Washington and New York.	60
		Renew 120.1 track miles of existing CWR with new CWR on concrete tie track between Washington and New York.	33
		High speed surfacing, rehabilitation of interlockings, roadbed stabilization, undercutting.	43
		Group Total	136

Continued on next page

TABLE 5-1 (Continued)

Group	Project Element	Description	Preliminary FRA Cost Estimate (1984 $ Mil)
POWER & CONTROL	Electrification	Make cost-effective investment to assure steady power supply and reduce maintenance costs.	$122
		Group Total	122
	Signaling and train control	Install reverse signaling between Philadelphia and Morrisville on number 2 and 3 tracks.	13
		Replace obsolete mechanically locked interlockings with remotely controlled interlockings, provide bi-directional signals on all remaining main tracks and provide compatibility with a 60Hz electric traction system.	290
		Extend centralized traffic control to reduce operating costs:	
		Between Wilmington & Philadelphia	5
		Between Philadelphia & New Rochelle	21
		Group Total	329
SERVICE FACILITIES	New York Service Facility	Rehabilitate and expand service facility, provide enclosed car washer and track renewals.	21
	MOW Bases	Provide MOW bases at Philadelphia, Sunnyside and Cedar Hill.	12
		Group Total	33
STATIONS	Philadelphia 30th Street Station	Upgrade antiquated structural/electrical/mechanical systems.	13
		Facility needed to provide parking for riders of Airport line and bus as well as Amtrak.	6
		Group Total	19

TRACK

As shown in Table 5-1, identified track improvements would consist of 102.8 miles of concrete ties, continuous welded rail (CWR) and undercutting between Washington and New York, 120 miles of new CWR on concrete tie track between Washington and New York, and high speed surfacing, interlocking rehabilitation, and roadbed stabilization. Taken as a group, these improvements would essentially complete the program of providing high quality concrete tie track on the designated high speed tracks between Washington and New York, thus permitting the maintenance of uniformly high ride quality at minimum annual expense. Amtrak could also evaluate a thorough rehabilitation of interlockings that were not included in the NECIP as a way of maintaining ride quality on an economic basis. Roadbed stabilization and undercutting in selected areas would also serve the same purpose.

POWER AND CONTROL

The electrical systems in the NEC, installed from 50 to 60 years ago, have become outmoded technically and deteriorated physically. Although the NECIP lacked sufficient funds to deal with these systems thoroughly, they will require intense study by Amtrak and, in some instances, may require significant investments on the part of all Corridor users.

ELECTRIFICATION

Between New Haven, New York City, and Washington, the NEC is electrified: an intricate system of overhead wires provides motive power in the form of electricity to the trains. (Between Boston and New Haven, Amtrak must use Diesel locomotives, which generate their own power.) The New York -- Washington portion of the electric traction system poses a particularly complex set of institutional, technical, operational, and financial problems. The system powers intercity trains operated by Amtrak and commuter trains operated by regional and state authorities; it is integrated with similar systems on commuter branch lines; it is technically nonstandard and uses a special type of electric current; it contains antiquated components that are prone to failure and expensive to replace; its further deterioration could hamper efficient operations, lead to higher operating costs, and reduce revenues; and its renewal or modernization may cost well over one hundred million dollars, the allocation of which among users will engender considerable controversy.

Because of all the institutional complexities and high costs attendant on this issue, the NECIP could not make major investments in electrification. This section provides background and discusses the alternatives for the electric traction system on the NEC that were gathered by the FRA during its nine-year role as NECIP manager.

Technical Background

Between 1928 and 1935, the Pennsylvania Railroad (PRR) completed one of the outstanding American engineering achievements of the early 20th century: the electrification of the New York-Washington portion of the NEC. This was part of an even larger scheme to electrify all high-density freight, intercity passenger, and commuter lines east of Harrisburg. The PRR designed its massive electrification as a unit so that it was (and is) difficult to compartmentalize the system in the subsequent fragmentation of the railroad among commuter, intercity passenger, and freight owners and operators.

Essentially, the electrification project dealt with two elements: power generation and supply to the railroad, and power distribution to the trains.

Power Generation and Supply

Due to the constraints on locomotive design early in this century, the Pennsylvania Railroad built its system at a frequency of 25 cycles per second (Hz) rather than at what was to become the commercially standard 60 Hz. The railroad had to contract with power companies in the Corridor for special 25 Hz generators, sometimes shared with other transportation companies.

After more than 50 years of service, this system of power generation is deteriorating rapidly. After one of the three generators supplying the local New York area disintegrated, the two remaining generators were removed from service when major fatigue cracks were found. Fortunately, temporary connections could be made to a few remaining 25 Hz generators whose load had been reduced by recent conversions of subway rectifiers to the 60 Hz commercial power supply. The replacement generators are nearly as old as the ones that failed. Conrail's conversion of all electrified freight service to Diesel power has assisted Amtrak in coping with the power generation problem.

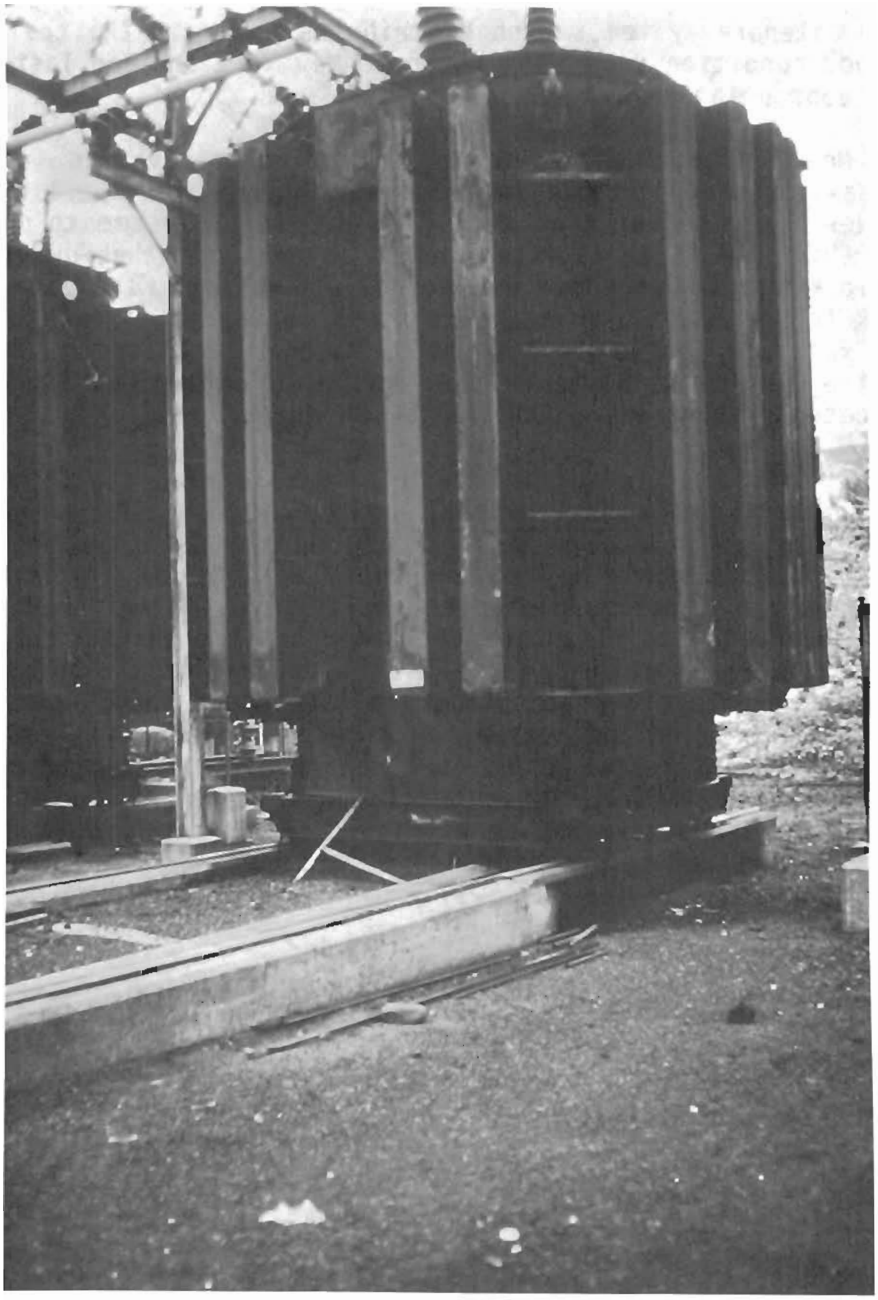
The railroad has five points of 25 Hz power supply south of New York City with 10 generators actually supplying power. Four generators in Philadelphia have been removed from service within the last 15 years due to age-related problems. All of the remaining 10 generators are 50 to 60 years old and have been experiencing an increasing number of age-related problems. The 25 Hz power is sent over a railroad-owned 138,000 volt transmission line to more than 30 substations where the voltage is reduced to about 12,000 volts for use on the catenary. These substations contain transformers and circuit breakers that are between 50 and 60 years old and failing with increasing frequency.

This degradation will have two kinds of effects on electrification users:

o As generators and substations continue to deteriorate, maintenance expenses will grow. Amtrak and the commuter authorities will experience this growth directly at their own facilities, and indirectly through power rate increases from the electric companies.

o If past trends continue, there is a possibility of generator and transformer failures that could detract from service reliability at best, and cause service stoppages at worst (particularly if two or more pieces of electrical equipment fail simultaneously).

Photo 5-1



Corroded electric traction transformer. Its condition is typical of many components of the half-century old electric power system on the Corridor.

Power Distribution

In contrast to the generators and transformers that supply power to the railroad, the catenary system, which distributes power to the trains, is in relatively good condition from Washington to New York and can last for many more decades with appropriate maintenance.

Between New York and New Haven, the situation is reversed. The local authorities have assured a stable future power supply by converting the New Rochelle -- New Haven sector from an old 25 Hz, 11 kV system to 60 Hz, 12.5 kV, a conversion which the NECIP is extending to cover the Amtrak-owned link between Harold Interlocking in Queens and New Rochelle. However, the catenary system from New York to New Haven used standard steel messenger wire which is heavily corroded and failing. The NECIP has funded catenary replacement from New York to New Rochelle, while the States of New York and Connecticut are planning to replace the catenary from New Rochelle to New Haven.

Institutional Background

The deterioration of the NEC power supply affects electric traction users on the NEC, owners and operators of electrified lines interlinked with the NEC, governmental agencies with financial and other relationships to electrification users, and the power companies. Table 5-2 lists many of the affected parties. Owing to this complex skein of institutional interests in NEC electrification, any detailed specification and evaluation of alternatives will require joint study by Amtrak and interested agencies at appropriate levels of government, and any financial plan for implementation will necessitate joint participation. Such concerted decisions have proven difficult. Nevertheless, a failure to conduct a joint study and to proceed with a solution will imply a selection of the status quo alternative (see below), with its own costs and risks.

Sample Alternatives

The following three alternatives now exist for dealing with the NEC electrification dilemma. Further engineering work would doubtless produce additional creative solutions.

Alternative 1: Status Quo

This alternative would simply treat the system as an ongoing maintenance problem, and would repair failures as they arise, on an emergency basis, and with whatever spare parts are at hand. For any evaluation of this alternative, minimum information needs would be as follows:

o Future maintenance costs for the existing system.

o Probability of failures of major system components, both singly and in combination; cost and service impact of those failures.

Table 5-2

INSTITUTIONS CONCERNED WITH NEC ELECTRIFICATION SOUTH OF NEW YORK

Agency/Company	Role	Likely Concerns
Amtrak	Owns and operates NEC main line and portion of Harrisburg-Philadelphia passenger line. Operates commuter service for Maryland DOT	Significant total investment required under all alternatives for fixed plant (most vehicles are already compatible with all alternatives)
Commuter Authorities:		
Southeastern Pennsylvania Transportation Authority (SEPTA) and New Jersey Transit (NJT)	Operate frequent commuter services on NEC main line Own and operate commuter branch lines that are linked to various degrees with NEC electric traction system	Significant total investment required under all alternatives for fixed plant Some alternatives would require conversions of vehicles (costs would vary between agencies and among vehicle series)
Maryland Department of Transportation (MDOT)	Contracts with Amtrak for operation of a small commuter service between Baltimore and Washington	(Same concerns as Amtrak, although with lesser exposure)
Federal Agencies of U.S.D.O.T.		
Urban Mass Transportation Administration (UMTA)	Has provided operating and capital funding to commuter agencies	Commuter authority exposure to funding requirement for both fixed plant investment (on NEC and on branches) and vehicle replacement/modification
Federal Railroad Administration	Manager of NECIP	Amtrak's potential investment needs for fixed plant
Conrail	Presently operates dieselized freight service over Amtrak's NEC	Would depend on Conrail's future plans for re-use or continued non-use of electric traction
Power Companies	Provide power to Amtrak for distribution over NEC electrified lines	Future of remaining 25 cycle generating facilities and investments to assure NEC power supply at either 25 cycles or commercial frequency

o The present ability of Amtrak, the commuter agencies, and the power companies to deal with system failures in terms of inventories of spare parts and major components; lag times and costs to produce such components in the event of inventory shortages.

Alternative 2: Rebuild the Existing System in Kind

Nonstandard and outmoded though it may be, the existing system has proven its technical soundness over the past fifty and more years. If the PRR electrification at 25 cycles can be shown to provide fully adequate power for future NEC traffic densities and characteristics at reasonable operating and maintenance costs, and if the total investment required over time to rebuild and rehabilitate its components systematically can be shown to be less than that of other options, then this alternative might prove viable. Proper study of Alternative 2 would require detailed engineering inspections of and estimates for the existing system.

Alternative 3: Replace with Commercial Power (60 cycles)

The NECIP completed about one-half of the conceptual and design work prerequisite to a complete replacement of the PRR power supply system with commercial power. Existing studies show that conversion of the New York-Washington segment to modern commercial power at 60 Hz would involve building 12 substations at an estimated cost of $50 million. Amtrak's equipment is already capable of accepting the new frequency and voltage; conversion of the commuter cars used by the New Jersey Department of Transportation and SEPTA and built since 1960 to dual power capability is estimated to cost $72 million. This total conversion of all modern commuter equipment to dual power (11 Kv 25 Hz or 25 Kv 60 Hz) capability would permit the commuter agencies involved to use their fleet of cars without regard to what power is available on which route.

The recent experience of Metro North in its conversion of the New Rochelle -- New Haven segment to commercial power (albeit at 12.5 kV) may provide useful corroborative data for these estimates.

Because of the advancing deterioration of the NEC power supply south of New York, and the resulting maintenance cost escalations and risks of service disruption, the institutions concerned should conduct a joint, impartial, comprehensive analysis of the total long-term public costs and benefits of alternatives similar to those outlined above. The study would subject all alternatives to a uniform financial test (such as net present value). In a second phase, such a study would develop an implementation strategy addressing mechanisms for achieving the desired outcome and equitable cost allocations among user agencies, each of which should pay its own way. The completion of such a study would allow all the parties to know the costs and risks involved in each option, and would at the very least allow them to develop contingency plans and budgets to deal with the status quo alternative.

SIGNALING AND TRAIN CONTROL

The NECIP provided installation of a modern, remotely controlled signal system on major portions of the Corridor. The segment from Washington to Wilmington will be completely modernized and will also be provided with a highly efficient CETC system. A fully modernized signal system employing CTC will also be installed between Cranston, Rhode Island and South Station in Boston.

At other locations, the Corridor retains 25 mechanically locked interlockings which are among the most complex and expensive in North America. Among these are Penn Station, New York; Newark, New Jersey Station; Rahway, New Jersey Station; Trenton, New Jersey Station; New Haven Station and several large junctions in Philadelphia, Pennsylvania. In the course of initial design work, the NECIP developed, but ultimately lacked the funds to implement, plans to deal with the remaining 50- to 80-year-old signal equipment.

This old apparatus is designed to be fail safe; that is, a failure will result in the display of a more restrictive signal. This action will cause trains to be delayed and on-time performance to suffer, but it will be safe. Some of the old mechanical interlocking systems are prone to jam due to worn parts or dirt in the mechanisms. Jamming will cause train delays, but safety should not suffer.

In conjunction with the electrification study, Amtrak and other parties to NEC operations should consider jointly conducting a comprehensive study of the signal system to determine the actions necessary both in the near future and over the long term to ensure a safe and efficient signaling system. Such a study could address the projected costs of maintaining the existing signal system, the probability of failures and impact on safety and cost, and a "present value" comparative analysis of various levels of near-term programs versus a phased implementation of a cooperative general signal plan analogous to the original NECIP signal program. That program called for making every interlocking remotely controllable with relay locking, expanding CETC to cover the rest of the Corridor, providing bi-directional signals on all tracks, providing compatibility with a 60 Hz electric traction system, and ultimately activating a more efficient and safe seven-aspect cab signal system.

Long-term planning for the signal system would have to take into consideration the present and future needs of all users. In the intricate multiple track territory north of Wilmington, each major location (prominent examples are Pennsylvania Station, New York, and Zoo Interlocking, Philadelphia) would require years of cooperative study by all users to develop a coordinated plan for operations, track, and signals, and a staging plan to implement these changes under heavy traffic.

Once the NEC users agree on a general, cohesive plan for all major stations and junctions, the future of less complex intermediate interlockings will follow suit. Therefore, while the original NECIP signal plan provides the best surrogate available for estimating the cost of additional signal improvements,

Photo 5-2

Hand-operated interlocking connected to switches by pipes, vintage 1906. The NECIP converted some, but by no means all, of these antiquated facilities to modern electric operation.

firm estimates will have to await the outcome of the cooperative process described above.

Extrapolation of cost data on the original NECIP signal program and application to the remaining work of appropriate inflation factors indicates that the remaining NECIP plan signal work would cost in the vicinity of $290 million. This amount would cover the signal work only and would not pay for any related track reconfigurations. It would be relatively easy to add CETC to the rest of the Corridor after the above signal work is done in the field. Extending the Philadelphia CETC from Wilmington, Delaware, to New Rochelle, New York, is projected to cost about $26 million over and above the $290 million for signals. With support from the NECIP, Amtrak and the Long Island Rail Road are developing further improvements to the signal system in the Penn Station -- Queens area which would ultimately be compatible with CETC.

SERVICE FACILITIES

The rehabilitation and expansion of the New York service facility at Sunnyside Yard, which was deleted from the NECIP, would provide a terminal facility for more efficient maintenance of Amtrak rolling stock and is another option which Amtrak could evaluate. The New York facility, after completion, would provide state-of-the-art capability to maintain and service the equipment indoors. At present, work at Sunnyside is done outdoors throughout the yard, an incongruity for a modern high speed passenger railroad.

FREIGHT/PASSENGER SEPARATION

To preserve ride quality on the NEC at a reasonable cost, and to upgrade still further the safety and reliability of intercity passenger operations, Amtrak may wish to facilitate the removal of some or all through freight service from the Corridor south of New York. (The Boston -- New York portion carries insignificant through freight volumes.) This section describes the existing freight operation in the Corridor, reviews its effects on passenger service, presents some options for its removal, and assesses the costs and benefits of those options.

FREIGHT SERVICE IN THE CORRIDOR

Amtrak's NEC main line has always carried important volumes of freight. At the local level, the NEC and its branches have attracted much industry; most of these local services, provided by Conrail, will continue indefinitely. Most of the freight tonnage on the NEC, however, is intercity in nature; over the years, the Corridor became a standard route for freight from the Southeast and Midwest to the large cities of the Middle Atlantic and Northeastern states. Parallel lines exist to serve much of this intercity freight traffic: CSX has its own line from Washington to the Philadelphia region; Norfolk Southern (NS) has direct access to the Hagerstown, Maryland area; at Philadelphia and Hagerstown, Conrail has its own high quality lines connecting to most Northeastern points while avoiding the NEC main line. Most of Conrail's own Midwestern traffic to New York and New England, formerly routed via Philadelphia, Trenton, and the NEC, now proceeds via the upgraded line through Reading and Allentown, Pennsylvania, far removed from the Corridor.

Progress to date suggests that the freight problem on the Corridor is by no means insoluble. Owing to recent merger activity in the railroad industry, and to the upgrading of parallel routes in the NEC region, freight car-miles on the Corridor have declined by about two-fifths from their 1977 levels. Delays experienced by freight trains on the NEC, where passenger trains have dispatching priority, have encouraged the freight railroads to make use of the new and upgraded alternate routings. Yet the freight tonnage reduction in the NEC has been unevenly distributed (Figure 5-1): although freight has fallen to a fraction of its 1977 volume north of Philadelphia, it has persisted at a high level south of that city. In fact, between Baltimore and Perryville, Maryland, freight in 1983 accounted for nearly five times the gross tonnage generated by Amtrak's passenger operations (Figure 5-2), and an analogous imbalance exists over the entire southern half of the 224-mile New York -- Washington route.

EFFECTS ON PASSENGER SERVICE

This disproportionate freight tonnage over the Nation's only high speed passenger railroad has implications for passenger comfort, economics, safety, and reliability.

Comfort and Economics

To provide high speed service with satisfactory ride quality requires Amtrak to maintain its track to very precise geometric tolerances. Yet freight tonnage -- with its high axle loadings, often imperfectly trued wheels maintained by scores of owners, and unit trains with their particular dynamics -- subjects the track to daily punishment far greater than that inflicted by passenger service. In 1983, Amtrak installed a wheel impact detection system (see Chapter 2 and Appendix D) at a Maryland track location which experiences heavy freight and passenger traffic. The purpose of the installation was to identify cars with unacceptable wheels so that Amtrak could take appropriate corrective action. Based on the detection system output, Figure 5-3 demonstrates that freight produces from eighty to nearly one hundred percent of the unacceptable loadings on the track structure. (Amtrak is now studying a possible increase in the number of wheel impact detectors so as to reduce the number of unacceptable freight cars entering the Corridor.)

Owing to this daily freight-induced degradation, to the need to keep tracks open for operations and to the practical limitations on Amtrak's maintenance forces and equipment, Amtrak cannot perpetually maintain all its track to the precise geometric levels requisite to optimally comfortable high speed passenger service. Even if Amtrak had the resources to perform such frequent and intensive maintenance, the cost would be high. Therefore, to the extent that freight tonnage is reduced, Amtrak will be able to sustain its high quality track structure on a more economic basis and to more exacting geometric tolerances than at present.

In addition to promoting better ride quality and lowering Amtrak's annual cost to maintain its track to the Class 6 (high speed passenger) standards of FRA's Office of Safety, the removal of significant freight traffic would permit Amtrak to rationalize its plant by eliminating track and switches solely dedicated to freight service. Such a rationalization would lead to still greater maintenance economies in the future.

Figure 5-1

ANNUAL NORTHEAST CORRIDOR FREIGHT TONNAGE

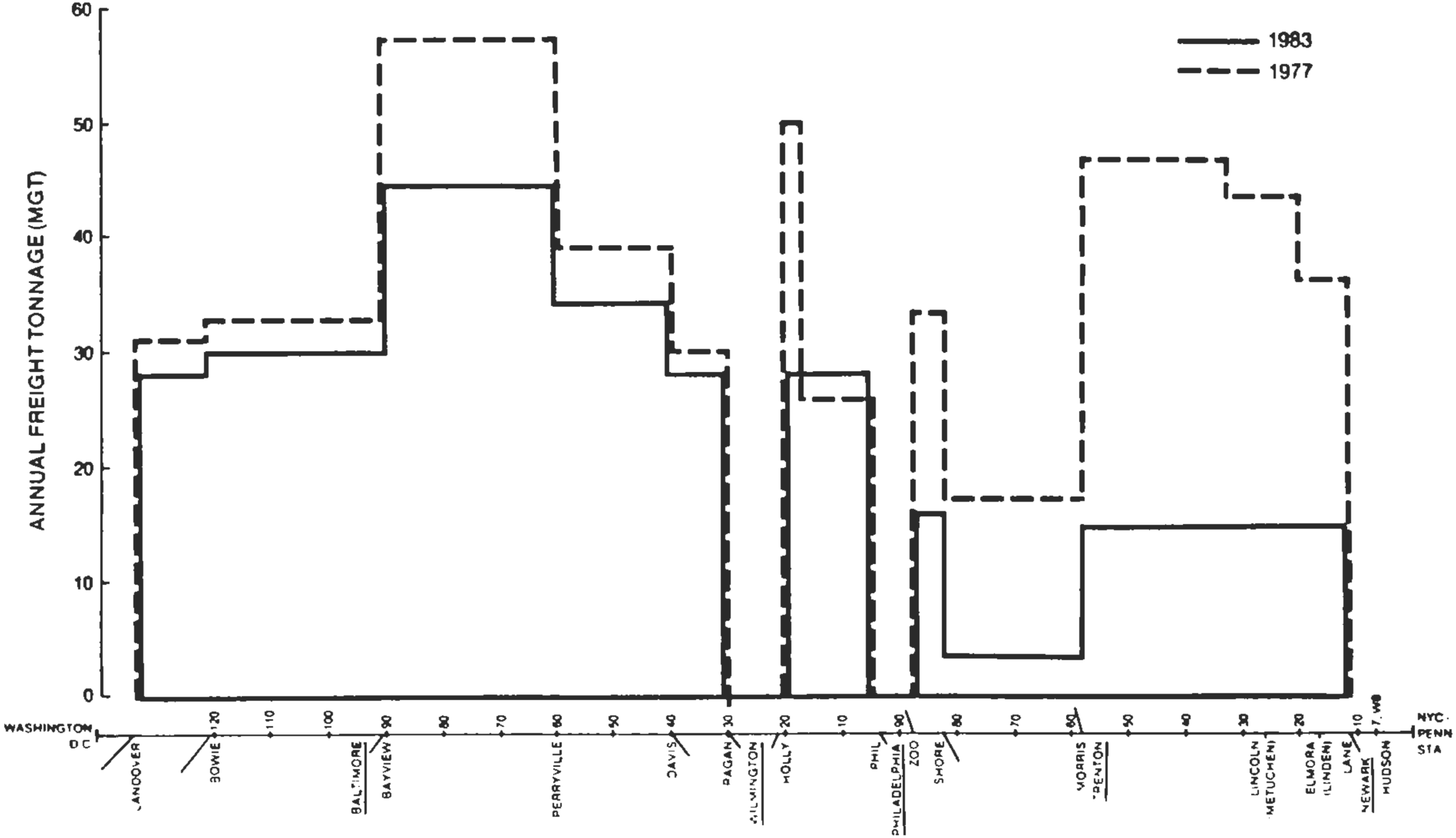


FIGURE 5-2

NORTHEAST CORRIDOR TONNAGE BY TYPE

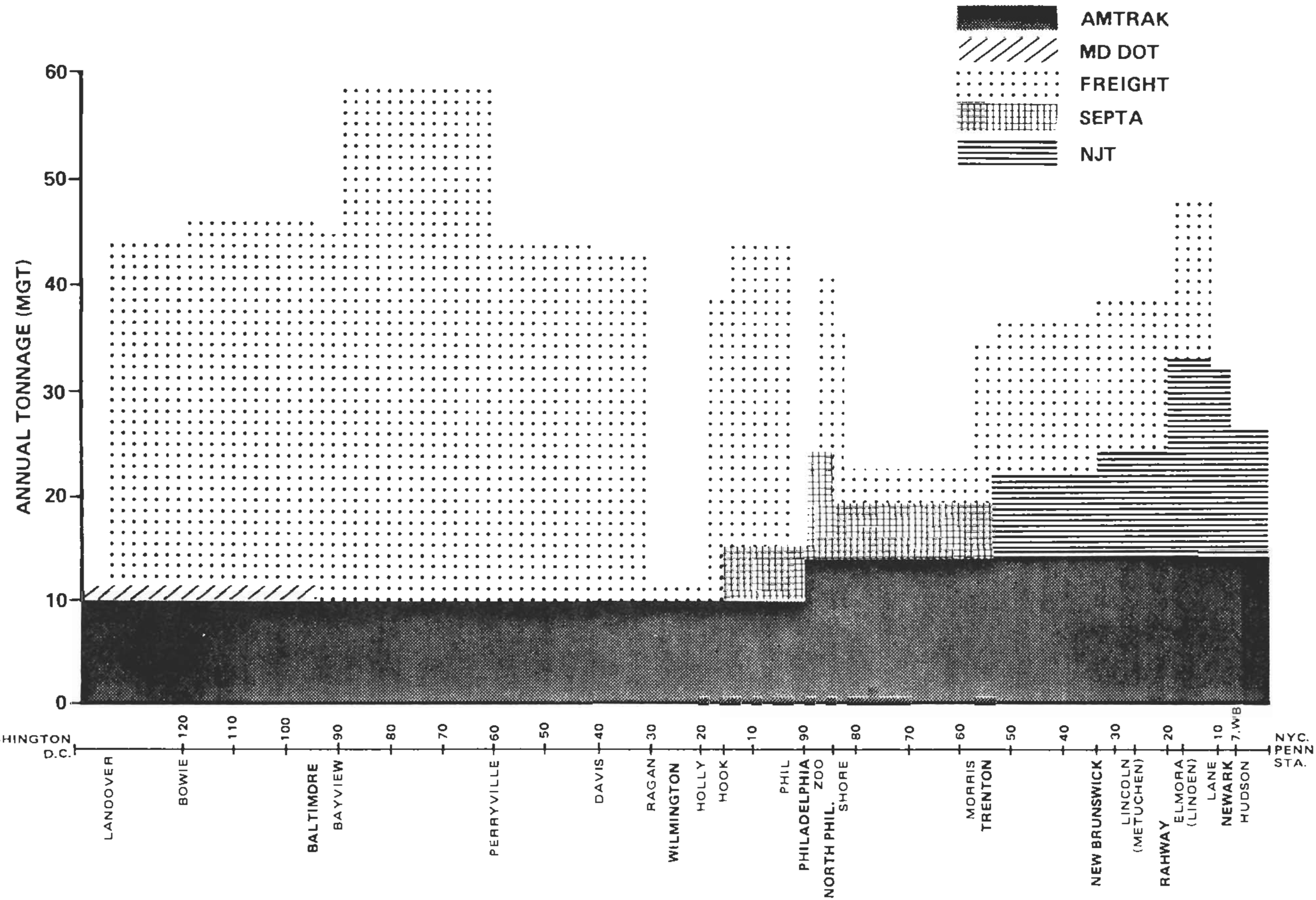
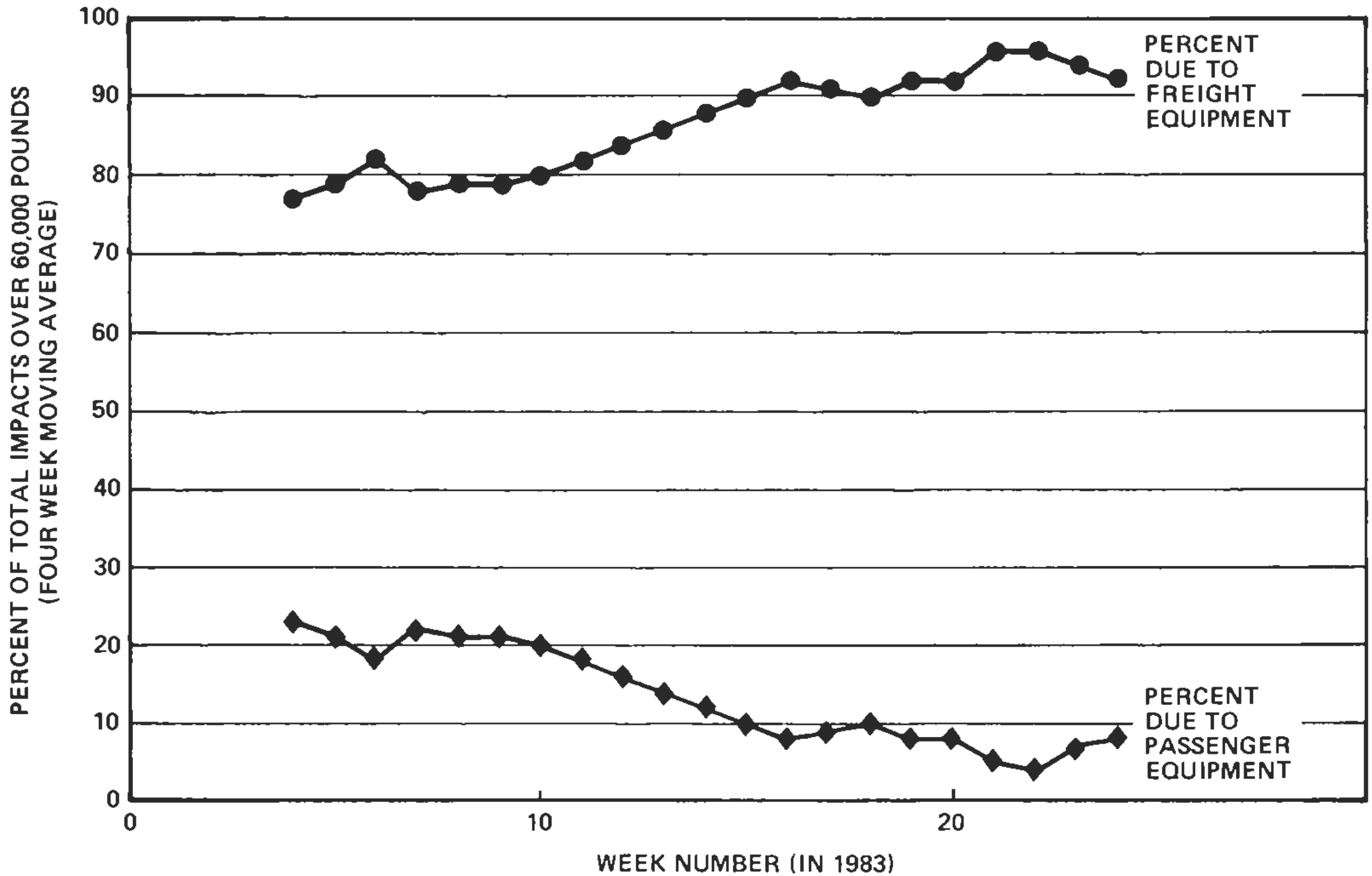


FIGURE 5–3

PERCENT OF WHEEL LOAD IMPACTS OVER 60,000 POUNDS FROM FREIGHT VERSUS PASSENGER TRAINS



Safety and Reliability

Whereas Amtrak has total control over the maintenance level of its own equipment, it cannot control the scores of owners of freight cars and locomotives operating over the Corridor. Neither (from an economic and time point of view) can it subject every piece of non-Amtrak equipment to a complete safety inspection, including nondestructive testing of wheels, axles, and other components, prior to its entry onto Corridor trackage. The Corridor indeed contains many features, such as hotbox and dragging equipment detectors, to avoid catastrophic freight derailments; yet the potential remains for freight-related safety problems, which could adversely affect intercity passenger and commuter trains.

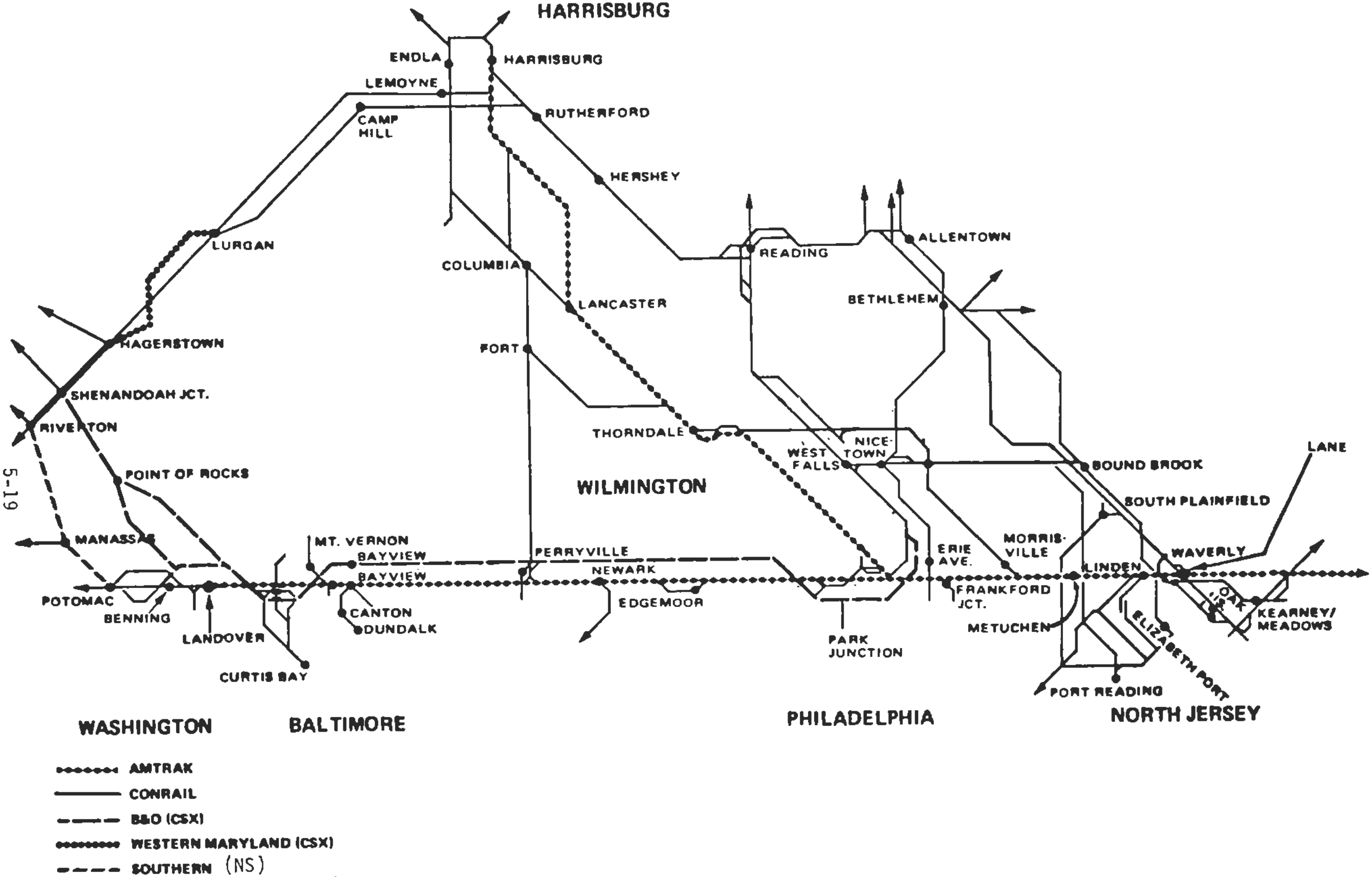
On-time performance of Amtrak trains would likewise benefit from the removal of freight. Amtrak's train planning unit in Philadelphia carefully coordinates the schedules of intercity passenger, commuter, and freight trains with the local authorities and with Conrail and the D&H. Nevertheless, the divergent speed, acceleration, and braking characteristics of passenger and freight trains create a potential for serious interference among services. While passenger trains normally have priority, the nature of mixed railroad operations will sometimes lead to situations in which freight delays snarl the entire system. The separation of freight from passenger trains would therefore lead to greater reliability for passenger services.

OPTIONS FOR FREIGHT/PASSENGER SEPARATION

Essentially, two complementary approaches exist for the removal of freight from the NEC: (1) traffic diversion by market forces, and (2) Amtrak initiatives to shed freight tonnage. Because freight traffic patterns reflect the institutional structure of the railroad industry, significant traffic diversion has already taken place owing to the deregulation and mergers of recent years and Conrail's massive upgrading of its own lines in the NEC region. A natural consequence of the proposed purchase of Conrail by NS would be the diversion of still more through traffic to the Shenandoah Valley route via Roanoke, Virginia, Hagerstown, Maryland, and Harrisburg, Pennsylvania (Figure 5-4). To supplement these independent actions of the freight railroads, Amtrak might actively work with Conrail or its successor, the D&H, the Chessie System, or others, to foster the transfer of significant portions of through freight traffic from the NEC to the parallel Chessie line, an approach which could require capital investments. The first approach, reflecting many private

Figure 5-4

FREIGHT ROUTES BYPASSING AMTRAK'S NORTHEAST CORRIDOR



decisions, is not within the province of this report; the latter approach, involving an active Amtrak role, merits further consideration here.

Figure 5-5 is a schematic displaying all the scheduled Conrail and D&H freight trains in the Corridor. These operations are complex because they involve different types of trains (general freight, piggyback, mail/express, locals, and unit coal) originating and terminating at many points (some as far away as Chicago and St. Louis), entering and leaving the Corridor at various locations, and occasionally stopping at certain yards along the NEC to switch cars.

By comparing the service pattern depicted in Figure 5-5 with the existing physical facilities of and connections between the Amtrak and Chessie routes, FRA has developed a set of hypothetical options for removing progressively greater proportions of freight traffic from the Corridor. (For convenience, each option groups a number of related items together; some of these items might ultimately be grouped differently to form intermediate steps.) Table 5-3 summarizes the options in terms of their physical contents, the trains affected (by ultimate origin/destination and by entrance/exit locations on the Corridor), and the tonnage removed. Typical items included are capacity improvements to the Chessie System and connections between Conrail and Chessie facilities.

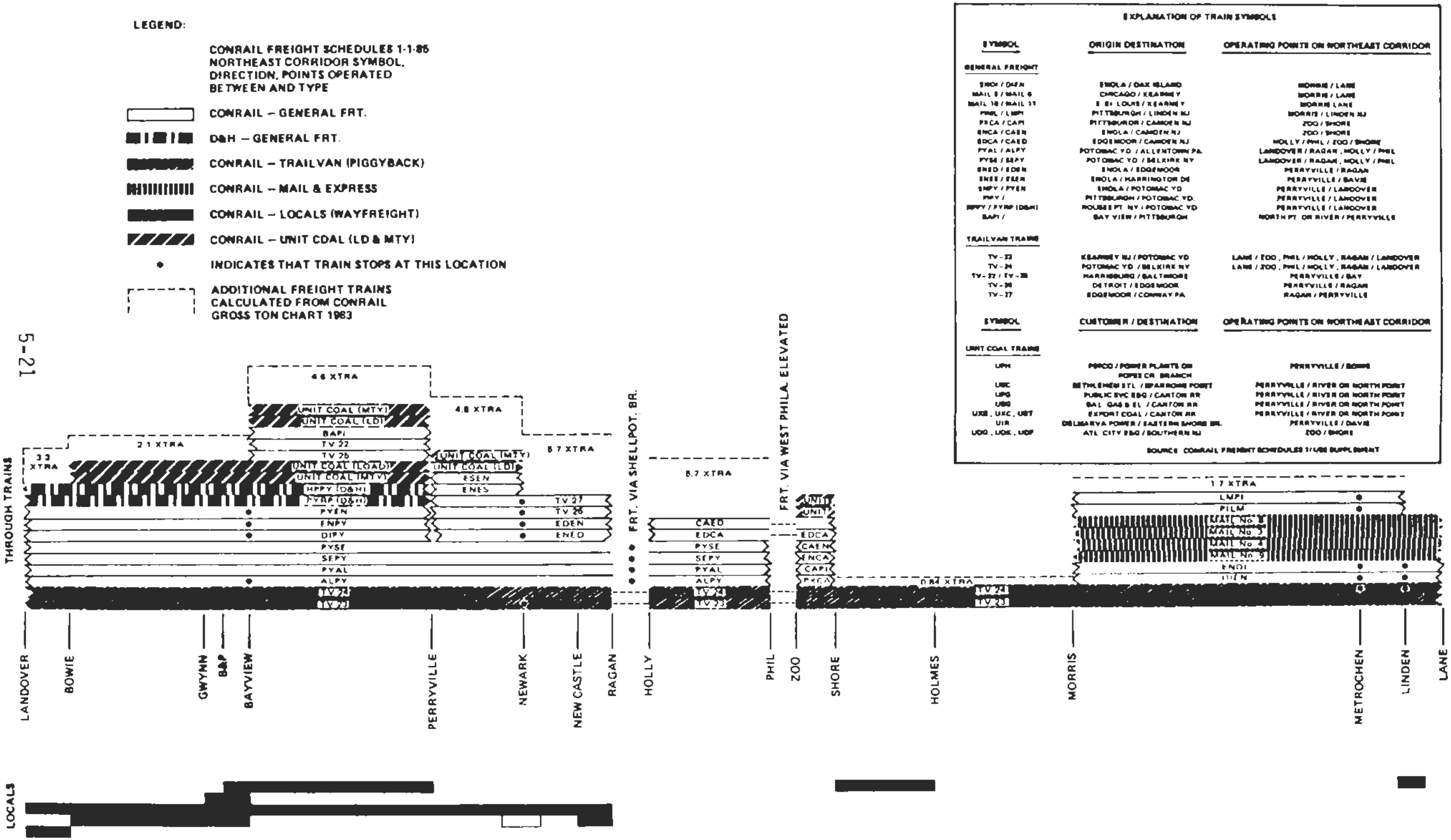
Between New York and Washington, Amtrak now has no highway grade crossings; the Chessie has 63. In response to community reactions in the course of past analyses of this topic, Option (b) provides for the relocation of the Chessie System in Newark, Delaware, with the removal of three crossings there. In all options, sixty crossings would remain. Although these crossings would receive modern flashing signals and gates, diversion of Conrail and D&H freight to the Chessie System could raise the issues of increased safety risks and interference with highway traffic flows.

To determine the feasibility and cost of a given option would require a very complex analysis of its positive and negative impacts on Conrail and the Chessie System in terms of engineering, operations, and economics. With regard to Chessie's capacity constraints, for example, all the options assume sufficient capacity in Chessie's tunnels through Baltimore to handle the freight trains transferred from the NEC. This assumption would require detailed validation or the development of remedial actions, some of which might prove expensive (a new Baltimore tunnel under Presstman Street could cost on the order of $250 million, for instance). The possible improvements to Conrail in northern New Jersey in Option (c) could affect that carrier's operations by making some movements more circuitous. Thus, if further study were to confirm the technical and operational feasibility of an option, the economic implications would require evaluation by the carriers involved. Such economic issues are beyond the scope of this report, which confines itself to very preliminary capital cost estimates.

Table 5-4 presents the capital costs of the options, which are arranged as much as possible in order of decreasing benefits (ton-miles removed) per investment dollar. The last column summarizes the effects of this arrangement: whereas Option (a) removes 29 gross ton-miles annually per initial dollar of capital cost, Option (h) diverts only 2 ton-miles per dollar.

FIGURE 5-5

SCHEDULED FREIGHT TRAINS IN THE NEC, 1985



EXPLANATION OF TRAIN SYMBOLS

SYMBOL	ORIGIN DESTINATION	OPERATING POINTS ON NORTHEAST CORRIDOR
GENERAL FREIGHT		
ENOI / OIEN	ENOLA / OAK ISLAND	MORRIS / LANE
MAIL 3 / MAIL 4	CHICAGO / KEARNEY	MORRIS / LANE
MAIL 10 / MAIL 11	E. St. LOUIS / KEARNEY	MORRIS LANE
PILM / LMPI	PITTSBURGH / LINDEN NJ	MORRIS / LINDEN NJ
PICA / CAPI	PITTSBURGH / CAMDEN NJ	ZOO / SHORE
ENCA / CAEN	ENOLA / CAMDEN NJ	ZOO / SHORE
EDCA / CAED	EDGEMOOR / CAMDEN NJ	HOLLY / PHIL / ZOO / SHORE
PYAL / ALPY	POTOMAC YD / ALLENTOWN PA	LANDOVER / RAGAN, HOLLY / PHIL
PYSE / SEPY	POTOMAC YD / SELKIRK NY	LANDOVER / RAGAN, HOLLY / PHIL
ENED / EDEN	ENOLA / EDGEMOOR	PERRYVILLE / RAGAN
ENES / ESEN	ENOLA / HARRINGTON DE	PERRYVILLE / DAVIS
ENPY / PYEN	ENOLA / POTOMAC YD	PERRYVILLE / LANDOVER
PIPY /	PITTSBURGH / POTOMAC YD.	PERRYVILLE / LANDOVER
HPPY / PYRP (D&H)	ROUSES PT. NY / POTOMAC YD	PERRYVILLE / LANDOVER
BAPI /	BAY VIEW / PITTSBURGH	NORTH PT. OR RIVER / PERRYVILLE
TRAILVAN TRAINS		
TV-23	KEARNEY NJ / POTOMAC YD	LANE / ZOO, PHIL / HOLLY, RAGAN / LANDOVER
TV-24	POTOMAC YD / SELKIRK NY	LANE / ZOO, PHIL / HOLLY, RAGAN / LANDOVER
TV-22 / TV-25	HARRISBURG / BALTIMORE	PERRYVILLE / BAY
TV-26	DETROIT / EDGEMOOR	PERRYVILLE / RAGAN
TV-27	EDGEMOOR / CONWAY PA	RAGAN / PERRYVILLE
SYMBOL	**CUSTOMER / DESTINATION**	**OPERATING POINTS ON NORTHEAST CORRIDOR**
UNIT COAL TRAINS		
UPH	PEPCO / POWER PLANTS ON POPES CR. BRANCH	PERRYVILLE / BOWIE
UBC	BETHLEHEM STL. / SPARROWS POINT	PERRYVILLE / RIVER OR NORTH POINT
UPG	PUBLIC SVC E&G / CANTON RR	PERRYVILLE / RIVER OR NORTH POINT
UBG	BAL. GAS & EL. / CANTON RR	PERRYVILLE / RIVER OR NORTH POINT
UXB, UXC, UXT	EXPORT COAL / CANTON RR	PERRYVILLE / RIVER OR NORTH POINT
UIR	DELMARVA POWER / EASTERN SHORE BR.	PERRYVILLE / DAVIS
UDG, UDE, UDF	ATL. CITY E&G / SOUTHERN NJ	ZOO / SHORE

SOURCE: CONRAIL FREIGHT SCHEDULES 1/1/85 SUPPLEMENT

TABLE 5-3
OPTIONS FOR TRANSFER OF NEC FREIGHT TRAFFIC TO PARALLEL CSX LINE

Option Description[a]	Number of Trains	Trains Removed[b] by Routing: Train Routing: End Point Yard[c]	Portion via NEC: Between	Portion via NEC: And	End Point Yard[c]
(a) Construct connection between Conrail's Port Deposit Branch and the CSX main line to the south at Aiken, MD (near Perryville)[d]; capacity improvements to CSX[e] between Washington, D.C. and Aiken, MD including improved junction at Hyattsville, MD	6	Alexandria, VA	Landover, MD	Perryville, MD	Harrisburg, PA[f]
(b) Improve tracks no. "Zero" and "Five" on NEC main line between Zoo, Shore, and Holmes Interlockings in northern Philadelphia.	8	Harrisburg[r,q]	Zoo (PA)[m]	Shore (PA)[m]	Camden, NJ
(c) Conrail improvements at Linden, NJ and Metuchen, NJ and line improvements between these points and Oak Island Yard, Newark, NJ.	2	Harrisburg[f]	Trenton, NJ[p]	Linden, NJ	Oak Island (NJ)[n]
	2	Harrisburg[f]	Trenton, NJ[p]	Lane (NJ)[n]	Oak Island (NJ)[n]
	4				
(d) Option (a) plus: Bypass of Newark, DE on CSX line; connection between CSX and Conrail's West Philadelphia Elevated line at Grays Ferry in south Philadelphia; clearance improvements on Conrail's line in Philadelphia.	3	Alexandria, VA	Landover, MD	Philadelphia, PA	Albany, NY[h]
(e) Option (d) plus: Connection between CSX and Conrail's Bay View Yard in Baltimore; additional capacity improvements[e] to CSX.	5	Baltimore, MD	Bay I/L[j]	Perryville, MD	Harrisburg, PA[f]
	1	Alexandria, VA	Landover, MD[g]	Perryville, MD	Pittsburgh, PA
	1	Alexandria, VA	Landover, MD[g]	Philadelphia, PA	Allentown, PA
	7				
(f) Option (e) plus: Connection between Conrail's Port Deposit Branch and the CSX main line to the north at Aiken, MD; grade-separated connection between new Chessie bypass at Newark, DE and Conrail's line to Delmarva; additional capacity improvements to CSX[e] between Aiken, MD and Newark, DE.	4	Harrisburg, PA	Perryville, MD	Newark, DE	Delmarva points
	4	Harrisburg, PA	Perryville, MD	Ragan (DE)[k]	Wilmington, DE
	8				
(g) Option (f) plus: Add second track to Conrail/CSX connection at Grays Ferry in south Philadelphia; additional CSX capacity improvements[e] between Wilmington, DE and Philadelphia.	2	Wilmington, DE	Wilmington, DE	54th Street (PA)[m]	Camden, NJ
	2	Alexandria, VA	Landover, MD	Lane (PA)[n]	Meadows Yard (NJ)[n]
	4				
(h) Make specific changes to provide alternate (non-NEC) local freight service and rationalize trackage and facilities within NEC accordingly.	19 (local)	Specific local trains operating primarily within Landover-Wilmington segment of Corridor			

Footnotes:
a - Appendix E provides further details on the physical description of each option.
b - These are daily trains (a few operate less frequently) in both directions.
c - Yard names: Alexandria, VA: Potomac; Harrisburg, PA: Enola; Albany, NY: Selkirk; Baltimore, MD: Bay View; Pittsburgh, PA: Conway; Wilmington, DE: Edgemoor; Camden, NJ: Pavonia.
d - At a cost of $6 million less, the connection between Amtrak and CSX could be constructed at Oakington, MD, 4 miles south of the Susquehanna River Bridge. This would, however, leave heavy freight traffic on the 2-track bridge, a Corridor bottleneck.
e - "Capacity improvements to CSX" include upgraded track, structure, interlocking, signal, and communications facilities as appropriate.
f - And points north and west.
g - Stopping at Bay View Yard, Baltimore, to switch cars
h - Also Allentown, PA
j - Baltimore, MD
k - Wilmington, DE
m - Philadelphia, PA
n - Newark, NJ
p - Morris Interlocking
q - As well as NEC points south of Philadelphia

TABLE 5-4

ANALYSIS OF FREIGHT TRANSFER OPTIONS
(Based on Scheduled Freight Trains only in 1985)

Option[a,b]	Freight Removed			Remaining Freight		Initial Capital Cost (Millions of Dollars)		Gross Ton-Miles Removed Annually per Dollar of Capital Cost	
	Incremental MGTM[d]	Cumulative MGTM[d]	Cumulative Percent of Total	MGTM[d]	Percent of of Total	Incremental	Cumulative	Incremental	Cumulative
Existing situation	0	0	0	3474	100	0	0	0	0
(a) Aiken (southbound) connection[c]	893	893	26	2581	74	23	23	39	39
(b) NEC improvements in northern Philadelphia	88	981	28	2493	72	3	26	29	38
(c) Conrail improvements in northern New Jersey	257	1238	36	2236	64	13	39	20	32
(d) Newark, DE bypass and Philadelphia connection	523	1761	51	1713	49	34	73	15	24
(e) Bay View connection[c]	613	2374	68	1100	32	88	161	7	15
(f) Aiken (northbound) and Newark, DE connections[c]	382	2756	79	718	21	48	209	8[e]	13
(g) Upgraded Philadelphia connection[c]	473	3229	93	245	7	25	234	19[e]	14
(h) Local freight and rationalization	245	3474	100	0	0	110	344	2	10

Notes:
[a] See Table 5-3 for fuller description
[b] This table treats all options as cumulative: they assume completion of all previous options. "Incremental" figures merely represent the additional cost and benefits of a given option over all the previous options.
[c] Includes additional Chessie capacity improvement
[d] Million gross ton-miles
[e] This option appears here on the list because, despite its relatively high incremental payoff, it requires the prior completion of less remunerative options.

Chapter Six: Transportation Trends and Projections in the NEC

Chapter Outline

Rail demand -- projections and reality
- *Delayed traveler response*
- *The rail product and its pricing vis-a-vis other modes*
- *Conclusion: Expectations versus reality*

Will total travel demand continue to grow in the NEC?
- *Total demand trends and their meaning*
- *Demographics*
- *Economic factors*

Characteristics of future travel demand

Will the airlines and highways be able to cope with future demand levels?
- *Airport congestion*
- *Highway congestion*

Conclusion

List of Displays

Table 6-1: Demand model trip-time assumptions versus reality
Table 6-2: Population trends in Amtrak's principal sources of NEC ridership
Table 6-3: Declining importance of central cities in Amtrak's prime ridership sources
Table 6-4: Nonmanufacturing employment trends in NEC central cities
Table 6-5: Office space expansion in core areas of major cities
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Figure 6-1: NEC ridership -- total of four important city pairs
Figure 6-2: Population trend and projection -- NEC States
Figure 6-3: Past and projected growth in real disposable income, NEC States
Figure 6-4: Projected and actual highway traffic growth at typical intercity locations

Chapter Six

TRANSPORTATION TRENDS AND PROJECTIONS IN THE NEC

Past studies of intercity transportation in the NEC [1] have traditionally projected burgeoning travel demand, pointed to growing congestion in the highway and air modes, emphasized the unused capacity and benign environmental characteristics of rail, and concluded that investments in high-speed rail would offer an attractive solution to the mobility dilemma of the Northeastern megalopolis. In funding the NECIP, the Congress endorsed that argument to the extent of $2.19 billion. Yet the traditional line of reasoning merits careful scrutiny now, for two reasons. First, the Congress has mandated such an evaluation as part of this report. Second, as Chapter Seven indicates, opportunities exist to further improve rail transportation in the NEC, particularly between Boston and New York. This chapter therefore analyzes some of the concepts underpinning the traditional justification for NEC investments. Questions explored are:

- Has improved rail service attracted the patronage promised in past NEC demand projections? If not, why not, and what lessons does this offer for future planning?

- Will total travel demand continue to grow by the year 2000?

- What will be the characteristics of that increased demand -- will it be susceptible to rail competition, or will it gravitate naturally to other modes?

- Will the airlines and highways be able to cope with future demand increases?

RAIL DEMAND -- PROJECTIONS AND REALITY

In the 1960's and 1970's, efforts to project intercity travel demand in the Northeast Corridor, by mode and in total, consumed millions of Federal dollars and produced sophisticated technical advances in transportation forecasting. Simply put, the conclusions of these studies as they relate to this report were two: first, passenger traffic in the NEC would grow substantially; second, improved rail would attract significantly increasing numbers of riders, thus allowing the Nation to defer committing resources to environmentally disruptive and politically controversial highway and airport construction.

The lack of a detailed transportation census for the NEC in the 1980's effectively prevents more than a cursory critique of the first conclusion (see the next section). With regard to the second conclusion, Amtrak's ridership statistics thus far permit only the most preliminary evaluation, for several reasons: the new NEC product has not yet been in place long enough to attract its full market share; trip times now in effect do not consistently equate to those assumed by the models; and Amtrak must compete within a newly deregulated travel environment. As a result, rail in the 1980's has only begun to attract the ridership increases foreseen in the 1960's and 1970's. For example, in

1977, demand models developed under contract to the Federal Railroad Administration (FRA) forecast 14.7 million passengers over a completed NEC main line in FY 1982; in reality, only 9.5 million riders materialized over a line still in the throes of construction. By 1984, with the trip time improvements still not fully operational, actual main line ridership had grown to 9.8 million -- still only two-thirds of the projection for a finished system in 1982 [2].

On the assumption that the inner workings of the models themselves were conceptually proper, three factors may be adduced as causing the inconclusive results thus far:

DELAYED TRAVELER RESPONSE

As mentioned in Chapter 1, although most NECIP elements were substantially complete at the end of the 1984 work season, some remaining projects incorporating up to thirteen minutes in trip-time savings south of New York, and up to eleven minutes north, are not yet finished. The forecast model, on the other hand, assumed a 1982 completion date. Thus, the product has not had the time to "catch on" with the public that the models would have assumed. Moreover, memories of the temporary service deterioration during the height of NECIP construction (1979-81) remain fresh in travelers' minds and still inhibit ridership growth.

Nevertheless, recent monthly volume figures reveal that, as the NECIP has approached completion and as the product has improved, passenger-miles have indeed increased (Figure 6-1). In fact, for the fiscal year ending September 1984, passenger-miles in four crucial markets were nine percent higher than for FY 1983. The same trend persisted into FY 1985: over the seven months ending April 1985, the same four markets generated 23 percent more passenger miles than in the comparable period two years earlier. This emerging pattern suggests that rail patronage will continue to grow as the NECIP completes the last of its trip-time improvements and as the public becomes aware of the better service and forgets not just the longer schedules of the 1979-81 era but also the preceding decades of declining service quality and poor reliability.

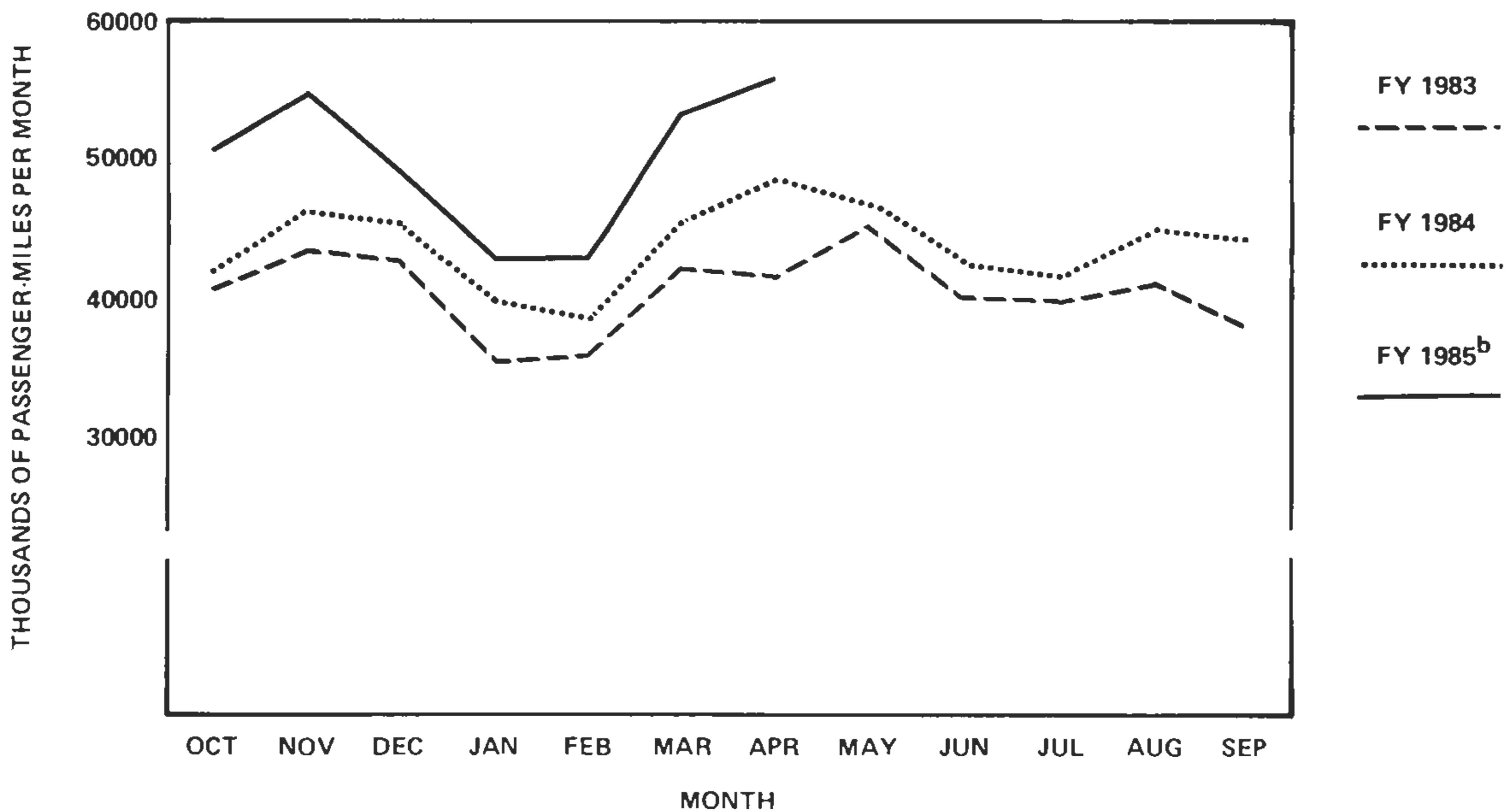
THE RAIL PRODUCT AND ITS PRICING VIS-A-VIS OTHER MODES

The demand models of the late 1970's assumed a rail product even more appealing to passengers than that available either at the end of 1984 or at the completion of the NECIP in 1986. For instance, although the best trip times between New York and Washington can be slightly better at project completion than the models assumed, both existing and projected schedules north of New York are inferior to those anticipated in the models (see Table 6-1). In addition, other modes have changed their products and prices in ways unanticipated by the models: as depicted in Chapter 3, air deregulation and the discount air fares of the early 1980's harmed the competitive position of rail. The models did not foresee, for example, that almost half the flights between New York and Boston would offer fares ranging from 15 to 46 percent below the standard rail fare, as is the case today. Even if air fares increase vis-a-vis rail, the market inroads of air will have altered travel habits for some years to come.

FIGURE 6-1

AMTRAK NEC RIDERSHIP

TOTAL OF FOUR IMPORTANT CITY-PAIRS[a]



SOURCE: Amtrak data on ridership monthly over NEC

a City pairs included: New York to Washington; New York to Philadelphia; New York to Boston; Philadelphia to Washington.

b First seven months' actual ridership for FY 1985.

TABLE 6-1

DEMAND MODEL TRIP-TIME ASSUMPTIONS VERSUS REALITY

Key City Pairs	Trip-Times (Hours:Minutes) As Assumed by Demand Model for 1982	Actual Best Times, 1984		Estimated Best Times Project Completion	
		Hours: Minutes	Percent Better (Worse) than Assumption	Hours: Minutes	Percent Better (Worse) than Assumption
New York - Washington	2:40	2:49	(5.6)	2:36	2.5
Boston - New York	3:40	4:09	(13.2)	3:58	(8.2)

Note: Appendix A explains the changes in NECIP budgets and goals that produced the discrepancy between forecast and actual Boston -- New York trip times.

Sources: Two Year Report on the Northeast Corridor (p. 7D, table D-8); Table 1-3 in this report.

CONCLUSION: EXPECTATIONS VERSUS REALITY

Because the demand models assumed that all NECIP trip-time improvements would be in place by 1982, because the NECIP product (particularly north of New York) will not be quite as appealing to travelers as the models anticipated, and because airlines captured considerable patronage during the era of low air fares, rail passenger volume has not yet approached the levels projected for 1982. Yet the ridership increases in FY 1984 and FY 1985 give every indication of sustained growth; as the final trip time improvements become operational, and as Amtrak markets its evolving product with increasing vigor and subtlety, ridership should increase markedly.

Even after project completion, the trip times north of New York will be too long for effective competition with air, and only marginally competitive with the cheaper bus and auto modes. There will therefore be limitations on ridership growth in the Boston -- New York and intermediate markets. Rail probably has a potential to capture significant volumes north of New York, but the NECIP on completion is not likely to realize that potential fully; such a realization could require further trip time investments of the types discussed in Chapter Seven.

WILL TOTAL TRAVEL DEMAND CONTINUE TO GROW IN THE NEC?

The NEC is already the most densely populated corridor in the whole United States. Nowhere else in the country are there standard metropolitan statistical areas (SMSA's) with population densities over 2,000 per square mile, and only 6 SMSA's outside the NEC have over 1,000. Of these, three are in California, and the other three in the area of the Great Lakes.

Since total demand for intercity travel is a function of population and economic activity, useful indicators of future demand are past trends in the modes themselves, recent population and economic growth, and projections by reputable demographers and economists. Available information for these indicators yields an ambivalent prognosis for total travel demand in the NEC.

TOTAL DEMAND TRENDS AND THEIR MEANING

As discussed above, the absence of a recent transportation census in the NEC forces analysts to rely on surrogate data for total travel demand in recent years. Figure 3-3 indeed displayed significant increases in combined air and rail ridership in the New York -- Washington and Boston-- New York markets; the sections below will describe traffic growth at specific rural highway checkpoints, as well as increasing air traffic delays. Yet these surrogate statistics are merely indicative, rather than conclusive, regarding both total demand for intercity transportation and rail's ability to increase its market share. For example, recent newspaper articles portray the surge in air travel as having been induced by the discount fares: "With the arrival of People Express, the no-frills airline that offers fares as low as $19 [between New York and Boston]. . . a new kind of traveler has emerged. 'I call this the sofa trade,' said Terry Underwood, a vice president of Greyhound Bus Lines. 'They are people who otherwise might have sat back and watched TV. But now they are becoming a little more mobile, because for them $19 is not a lot of money to go and do some shopping or have some chowder."

The New York Times concludes: "The fare war in the Northeast is changing consumers' shopping habits. In the weeks before Christmas, hundreds of Bostonians and Washingtonians went to New York for quick holiday buying sprees -- some for a weekend, some for only a day at a time. [3]" To the extent that the resulting increase in total travel reflects trips newly made possible by the combination of cheap air fares and fast air trip times, the induced demand will not be amenable to capture by rail north of New York. Between New York and Washington, however, as Amtrak trip times become more competitive with those of air due to the final NECIP improvements, Amtrak may be able to capture some of this new demand for discretionary "day trips."

DEMOGRAPHICS

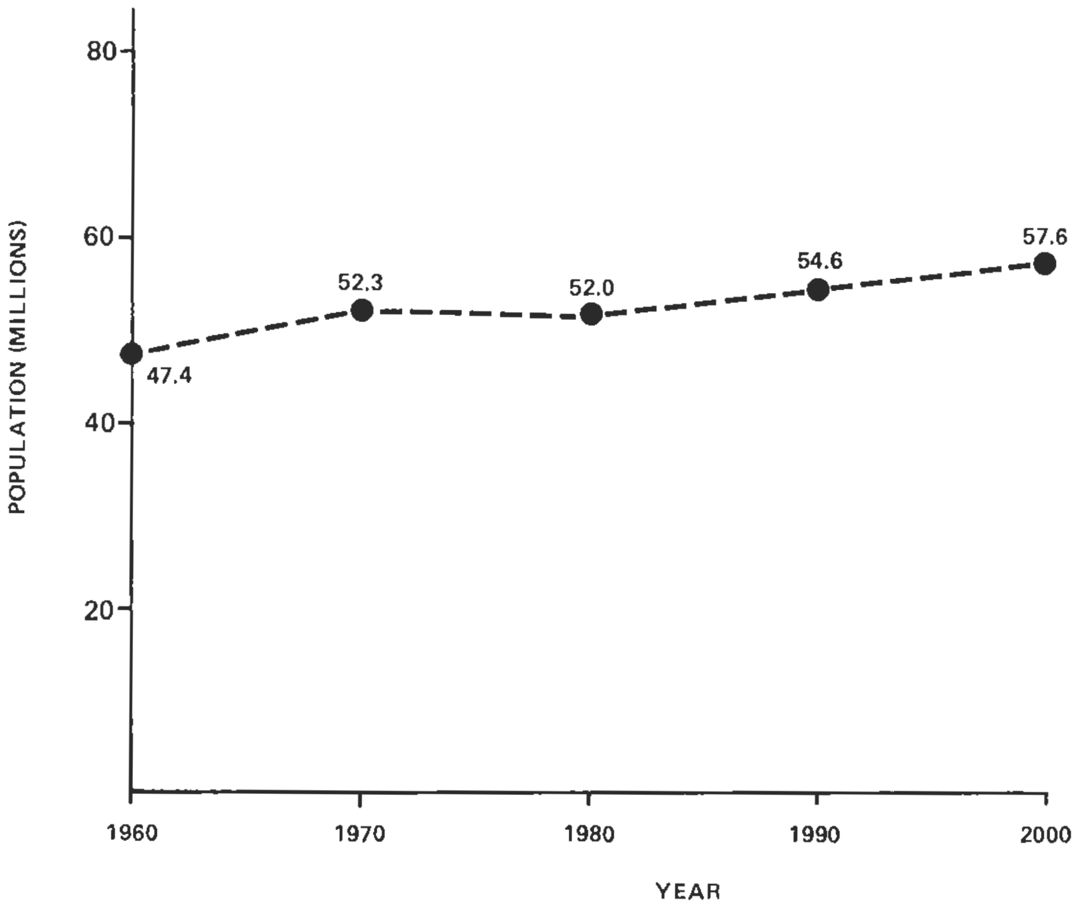
Although total population in the Eastern Seaboard has grown slightly since 1960, and is expected to increase slowly through the year 2000 (Figure 6-2), census statistics for the metropolitan areas essential to Amtrak's business yield less favorable results. Seventy percent of all Amtrak NEC trips either start or terminate in the New York - Newark - Jersey City Standard Consolidated Statistical Area (SCSA); next in importance to Amtrak are Philadelphia - Wilmington - Trenton (involved in 58 percent of NEC trips), Washington (29 percent), Baltimore (10 percent), and Boston (9 percent). Population in these principal sources of Amtrak's NEC ridership increased by 10 percent over the 20-year period from 1960 to 1980, as Table 6-2 shows. Between 1970 and 1980, the total population of these important metropolitan areas declined by almost 3 percent; the most crucial metropolitan area, New York/Newark/Jersey City, declined by over 5 percent, while Washington and Baltimore continued to show moderate growth. However, recent Census Bureau statistics indicate a resumption of population growth in varying degrees in the major NEC urban agglomerations in the 1980's. If the uneven growth rates of the most recent census decades persist, substantial travel demand increases in the NEC will have to come either from increased propensity to travel on the part of a metropolitan population that is static or declining in some locations, or from such rural or metropolitan areas as experience solid growth.

ECONOMIC FACTORS

Increased inclination to travel can reflect both induced demands as detailed above, and economic well-being. For that reason, Figure 6-3, which shows steady historical and projected growth in disposable income for the Eastern Seaboard region, tends to counteract the ambivalent population trends addressed above. Information is therefore available to support either optimistic or pessimistic conclusions regarding future travel demand in the NEC. Such an ambiguous situation would encourage cautious analysts to rely heavily on current and future demonstrations of actual ridership increases by Amtrak as indicators of long-term growth potential for NEC rail service.

FIGURE 6–2

POPULATION TREND AND PROJECTION: STATES DIRECTLY SERVED BY NEC MAINLINE



NOTE: INCLUDES THE DISTRICT OF COLUMBIA, MARYLAND, PENNSYLVANIA, DELAWARE, NEW JERSEY, NEW YORK, CONNECTICUT, RHODE ISLAND, AND MASSACHUSETTS.

SOURCE: DATA RESOURCES, INC. (1990 AND 2000 FORECASTS ARE "TRENDLONG 0985")

TABLE 6-2

POPULATION TRENDS IN AMTRAK'S PRINCIPAL SOURCES OF NEC RIDERSHIP

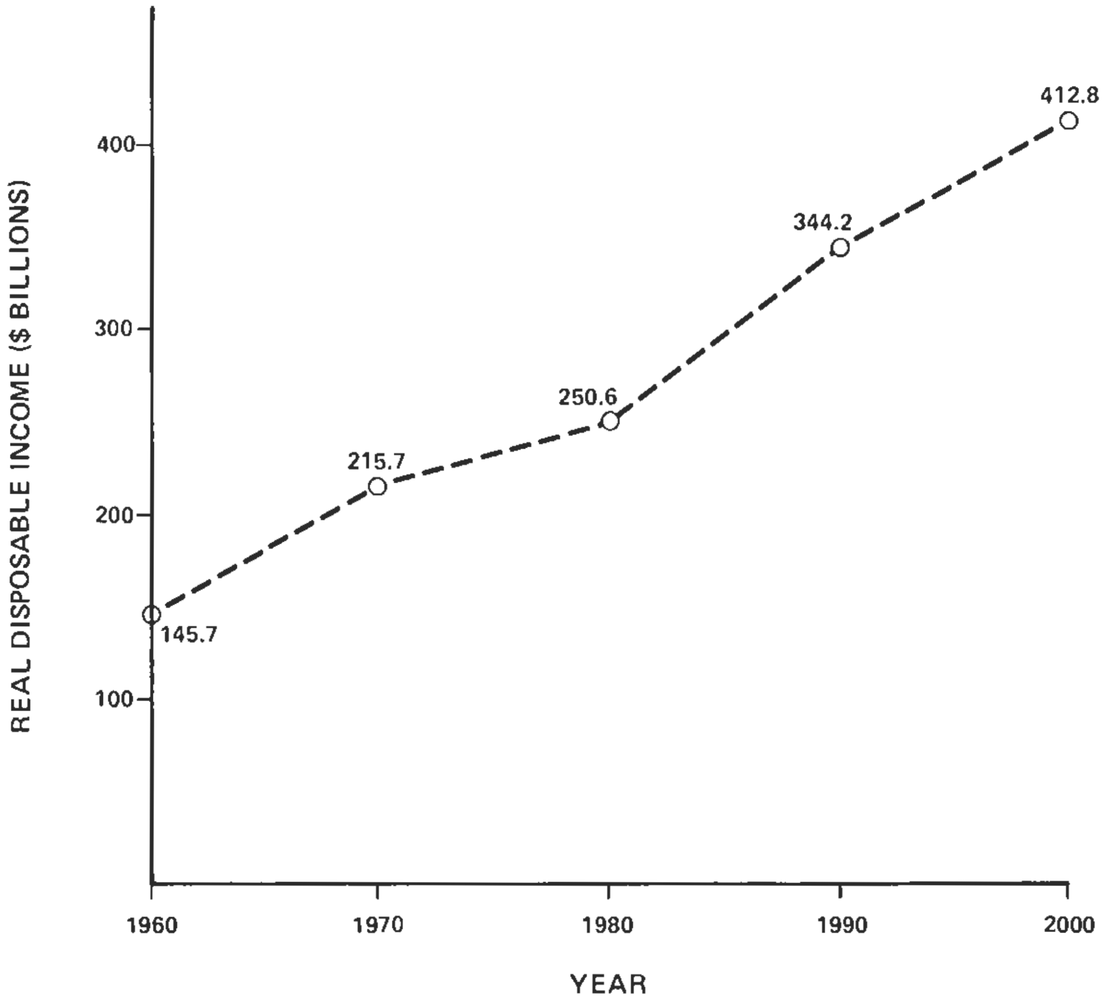
Metropolitan area	Percent of Passengers Affected	Population (Millions) 1960	Population (Millions) 1970	Population (Millions) 1980	Percent Increase(decrease) 1960-1980	Percent Increase(decrease) 1970-1980	Percent Increase(decrease) 1980-1984
Washington (SMSA)	29	2097	2910	3060	45.9	5.2	5.5
Baltimore (SMSA)	10	1804	2071	2174	20.5	5.0	2.1
Philadelphia/Wilmington/ Trenton (SCSA)	58	5024	5628	5549	10.5	(1.4)	1.3
New York/Newark/ Jersey City (SCSA)	70	15405	17035	16120	4.6	(5.4)	1.5
Boston (SCSA)	9	3193	3526	3448	8.0	(2.2)	1.4
Total		27523	31170	30351	10.3	(2.6)	1.9

Source: *Statistical Abstract of the United States*, 1981 edition, pp. 18-20, except for "percent increase (decrease) 1980-84" which is derived from a special Census Bureau report, "Patterns of Metropolitan Area and County Population Growth," 1985.

Note: SMSA = Standard Metropolitan Statistical Area
SCSA = Standard Consolidated Statistical Area
Both are as defined by the Office of Management and Budget as of June 1981

FIGURE 6-3

PAST AND PROJECTED GROWTH IN REAL DISPOSAL INCOME: STATES DIRECTLY SERVED BY NEC MAINLINE (CONSTANT 1972 DOLLARS)



NOTE: INCLUDES THE DISTRICT OF COLUMBIA, MARYLAND, PENNSYLVANIA, DELAWARE, NEW JERSEY, NEW YORK, CONNECTICUT, RHODE ISLAND, AND MASSACHUSETTS.

SOURCE: DATA RESOURCES, INC. (1990 AND 2000 FORECASTS ARE "TRENDLONG 0985")

CHARACTERISTICS OF FUTURE TRAVEL DEMAND

In many city-pair markets, rail can mount stiff competition against other modes for trips the end points of which are widely dispersed throughout the metropolitan areas concerned. Yet because of Amtrak's station locations, rail is particularly well positioned to accommodate travel between center cities. For this reason it is useful to examine the question: as travel demand grows, to what extent will it focus on the suburbs rather than the cities proper?

Demographic trends offer only a partial answer to this question. Between 1960 and 1980, the five largest cities in the Corridor lost from 10 to 19 percent of their populations, while the suburbs experienced growth ranging from 11 to 82 percent (Table 6-3). Yet the cities held their own in terms of nonmanufacturing employment -- the kind that generates intercity business travel. Boston, which suffered the largest percentage loss in population over the two decades (19 percent), experienced a one percent increase in nonmanufacturing employment; New York City lost only 2 percent of its jobs outside factories (Table 6-4). Specifically, business headquarters and supporting establishments such as R&D centers have increased their staffs over the long term in several NEC cities. "Between 1954 and 1972, employment in headquarters establishments grew rapidly in Boston [and] Washington," reported HUD in 1980. In absolute terms, the office job growth in New York (together with that in Chicago) was larger than that of any other major metropolitan area in the Nation [4]. More recent comparisons of office space availability show growth of between 25 and 64 percent in several NEC core cities over the 1970-1978 period (Table 6-5). Finally, hotel room availability for transient guests in Manhattan increased by 3 percent between 1979 and 1984, an indication of increasing business and pleasure travel to the metropolis [5].

Thus, although population in the 1960-80 period has shifted to the suburbs, commercial activity within the cities has grown or at least remained constant. Hence, there is a potential for travel demand growth at both suburban and downtown end points. This mixed result indicates that, in a given city pair market, some segments have become more susceptible to rail competition, while in others Amtrak will have to work harder to compete with the attributes of other modes.

How can Amtrak respond to the growing travel needs in suburban locations? Specific responses in all areas (trip-times, frequencies, pricing, and passenger experience) must reflect intense study of each city-pair market. In general, the NECIP itself has reduced door-to-door travel times by rail, thus expanding rail's zone of time-competition with other modes in each metropolitan area. During the original Metroliner demonstration, stops were added at two strategically-sited suburban locations (Capital Beltway near Washington, and Metropark in Northern New Jersey); this approach, while useful, has reached its limit of applicability because added stops negate the trip-time benefits of the NECIP.

Another response to population shifts is to upgrade the quality of parking at and intermodal access to the central city stations, as described in Chapter 1. Of the large NEC markets, the NECIP and local authorities were able to provide cost-shared funding for parking additions only in the Washington metropolitan area. Amtrak may wish to evaluate opportunities for parking additions elsewhere in light of the population trends shown in Table 6-3.

TABLE 6-3

DECLINING IMPORTANCE OF CENTRAL CITIES IN AMTRAK'S PRIME RIDERSHIP SOURCES

Metropolitan Area	Population growth(loss), percent, 1960-1980			Percent of population within central city			
	Total SMSA	Within Central City	Outside Central City	1960	1970	1980	Percentage point (decrease) 1960 - 1980
Washington (SMSA)	46	(17)	82	36	26	21	(15)
Baltimore (SMSA)	21	(16)	35	48	44	36	(12)
Philadelphia (SMSA)	9	(16)	29	46	40	36	(10)
New York/Newark SMSA[a/]	(3)	(10)	16	72	69	67	(5)
Boston (SMSA)	3	(19)	11	26	22	20	(6)

Source: Statistical Abstract of the United States, 1982 edition, pp. 18-23.

a/ Total of Newark SMSA and New York SMSA.

TABLE 6-4

NONMANUFACTURING EMPLOYMENT TRENDS IN NEC CENTRAL CITIES

City	Nonmanufacturing Employment: Number of employees 1960	1970	1980	Nonmanufacturing Employment: Percent increase (decrease) 1960 - 1980	For comparison: population increase(decrease) 1960-1980 (Percent)
Washington	320,418	318,562	284,692	(11)	(17)
Baltimore	260,736	262,408	248,673	(5)	(16)
Philadelphia	526,674	548,207	494,142	(6)	(16)
New York City (5 boroughs) plus Newark	2,540,715	2,620,479	2,486,135	(2)	(10)
Boston	217,920	219,867	219,432	1	(19)

Source: U. S. Bureau of the Census, County & City Data Book, city section 1983 (column 79 less column 80), 1972 (column 338 less column 339), and 1962 (column 336 less total, columns 338 and 339).

TABLE 6-5
OFFICE SPACE EXPANSION IN CORE AREAS OF MAJOR CITIES, 1970 - 78
(Millions of square feet)

City	Office Space 1970	Office Space 1978	Percent Increase
Baltimore	8.0	10.0	25
Philadelphia	24.1	32.2	34
Newark	2.8	4.6	64
Boston	28.5	38.0	33

Source: The President's National Urban Policy Report ,1980, U. S. Department of Housing and Urban Development

WILL THE AIRLINES AND HIGHWAYS BE ABLE TO COPE WITH FUTURE DEMAND LEVELS?

The traditional argument for additional NEC investments laid great emphasis on impending capacity constraints on the highway and air modes and the need to avoid the environmental disruptions accompanying increases in highway and air capacity. The questions therefore arise: have past warnings of highway and air saturation come about? Will the existing air and highway situation worsen in the foreseeable future? Are the options for dealing with such capacity problems in other modes (e.g., expansion of airports by adding runways) quite as monolithic and environmentally unacceptable as the old NEC reports argued?

Capacity in a transportation system is a function of time, place, and economics. In addition, there is a difference between permanent capacity limitations (e.g., lack of runways) and temporary ones (e.g., insufficient airplanes, busses, or rail cars at a given place and time). At certain times of the year, every mode is operating at or near its capacity; the day before Thanksgiving usually pushes the public transportation system in the NEC to its limit. When snow grounds all flights and hampers highway travel, rail often encounters a sudden influx of passengers in excess of its temporary capacity. Congestion also varies according to place; New York City, Philadelphia, Boston, and Washington generate far more airport backups than do smaller locations. The intercity highway network commingles with the urban networks at major beltways, thus creating a capacity constraint on all types of travel. Ultimately, the capacity question boils down to one of economics: does it make economic sense to invest in fixed plants and vehicles to provide fully adequate capacity for intercity travel at all times, in all modes, and at all locations? Put another way: are there solutions to the capacity dilemma in the Corridor other than providing more capacity?

To this last question, the answer is, of course, "yes". Pricing of service to smooth out peaks is one way to approach the situation. Another is to do nothing -- to allow travelers to respond to the delays and discomforts of crush load travel times by avoiding or postponing their trips, or by changing modes. According to transportation theory, changes in product (for example, much greater delays in a mode such as air) will cause a redistribution of passengers among modes and lead to a new equilibrium.

In such an environment of growing airline and highway congestion, Amtrak's improved NEC already offers capacity in many markets to absorb travelers seeking to avoid the difficulties of other modes. Should airway and highway congestion grow beyond the bounds of present peak periods and locations to such a degree as to materially increase the prevailing trip times in the Corridor, then rail (as Chapter Seven notes) affords opportunities of many kinds for trip time reductions vis-a-vis the air and highway modes.

The following sections deal in turn with airline and highway congestion in the NEC.

AIRPORT CONGESTION

According to a recent report [6] by the Congressional Office of Technology Assessment (OTA), the Federal Aviation Administration (FAA) by 1981 considered both Philadelphia International and Washington National airports to be "congested," that is: traffic had reached 160 percent of Practical Annual Capacity [7]. By 1990, the other very large airports in the NEC region (BWI, Boston, Kennedy, and LaGuardia) will have passed the congestion threshhold, and Providence will join them by the year 2000. The increasing congestion has already resulted in significant flight delays at major NEC airports at peak hours, as Table 6-6 demonstrates. Of the 13 U. S. airports with the highest mean delay per operation, five are in the NEC. Moreover, the OTA warns that "delay averaging can be deceptive, in that it may diminish the apparent severity of the problem. Combining data for peak and slack periods obscures the impact of delay at times of heavy demand. If delays at peak periods alone were examined, delay would be much longer, and there would be a much greater incidence of extreme delays of 30 minutes or more." According to the report, four of the NEC airports will face increases in operations of from 63 to 74 percent between 1982 and 1991.

However, OTA has not concluded that alarm is justified, and offers several avenues of hope. "In reviewing the history of the airport capacity problem," the report asserts, "OTA found several past studies that projected a crisis of airport capacity in which demand would completely overwhelm existing facilities. Yet airports, working with FAA and airline management and aided by advancing technology, have repeatedly modified designs and procedures and continued to accommodate new demand."

OTA goes on to suggest many ways to alleviate congestion; they range from "demand management," which would involve either using the mechanism of price to "modulate" demand, or regulating use through operational ceilings and slot restrictions. In fact, with the encouragement of the U. S. Department of Transportation, the airlines have already begun to cooperate in reducing delays by means of some of the concepts summarized in the OTA report. For example, nationwide flight delays exceeding 15 minutes fell by 55 percent between October and November 1984. The Secretary of Transportation attributed an important part of the improvement to schedule alterations to more than 1300 flights using five airports, two of which were in New York City and Newark, New Jersey. [8] Airline managements have agreed to continue these cooperative efforts without additional DOT participation because the response from their passengers was favorable.

Technology, according to OTA, could relieve delay to some extent, but "adequate future capacity cannot be assured by technology alone." Finally, the report goes on to mention capacity increases, but points out that "the constraints. . . are numerous," including "availability and cost of land, community concern about noise, and the complexity and difficulty of the planning and decision making process."

HIGHWAY CONGESTION

In the densely populated areas where the need for new highway capacity is greatest, the ability to meet that need is constrained by the lack of suitable alignments for new construction. This is certainly true of the Northeast Corridor. Interstate 95 and the turnpikes serving New York City are already overloaded, and congestion becomes worse year by year. The beltways around the major cities are all approaching the saturation point, and there are substantial delays on access roads to the main cities. Although highway departments have made some incremental improvements to existing highways to alleviate bottle-

Table 6-6

EXISTING DELAY AND PROJECTED GROWTH IN OPERATIONS AT SELECTED NEC AIRPORTS

		Actual Operations (thousands)		
	Mean Delay 1982 Minutes per (Operation)	Actual Operations 1982	Forecast Operations 1991	Increase in Operations 1982 - 91 (Percent)
Washington (National)	7.1	304	516	70
Philadelphia	6.1	328	571	74
Newark	6.9	215	N/A	N/A
New York (LaGuardia)	9.5	308	502	63
Boston	7.5	296	516	74

Note: Baltimore (BWI) information does not appear in the source.

N/A = Not available in source.

Source: U. S. Congress, Office of Technology Assessment, Airport System Development, August 1984, pp. 53 and 122.

necks, completely new construction in the most heavily congested areas is quite difficult to achieve. Even though the cause of this congestion is largely local traffic, intercity travel suffers from it, and it is reasonable to assume that the congestion and delay at critical links used for intercity trips will become greater in future years. The congestion on the approaches to the cities may be amenable to mitigating measures (better transit systems, park and ride, kiss and ride, and central city parking restrictions); yet these measures may not keep pace with the increasing pressure. In such circumstances both intercity bus and automobile would become less attractive through increasing trip times and lower reliability.

Figure 6-4 indicates historical and projected growth at a number of intercity highway locations. While the information collected by state highway departments and toll facility authorities reflects different dates and projection periods, one clear pattern emerges: traffic increases. A paper published in January 1982 (Summary of Recent National and State Highway Travel Forecast Studies) reviews recent forecasts of highway travel. Compound annual growth rates approaching two to four percent are predicted on a national level. A study by the New York State D.O.T. (August 1980) predicts a compound annual growth rate for highway traffic in that State of two percent, amounting to an increase of 38 percent between 1979 and 1995.

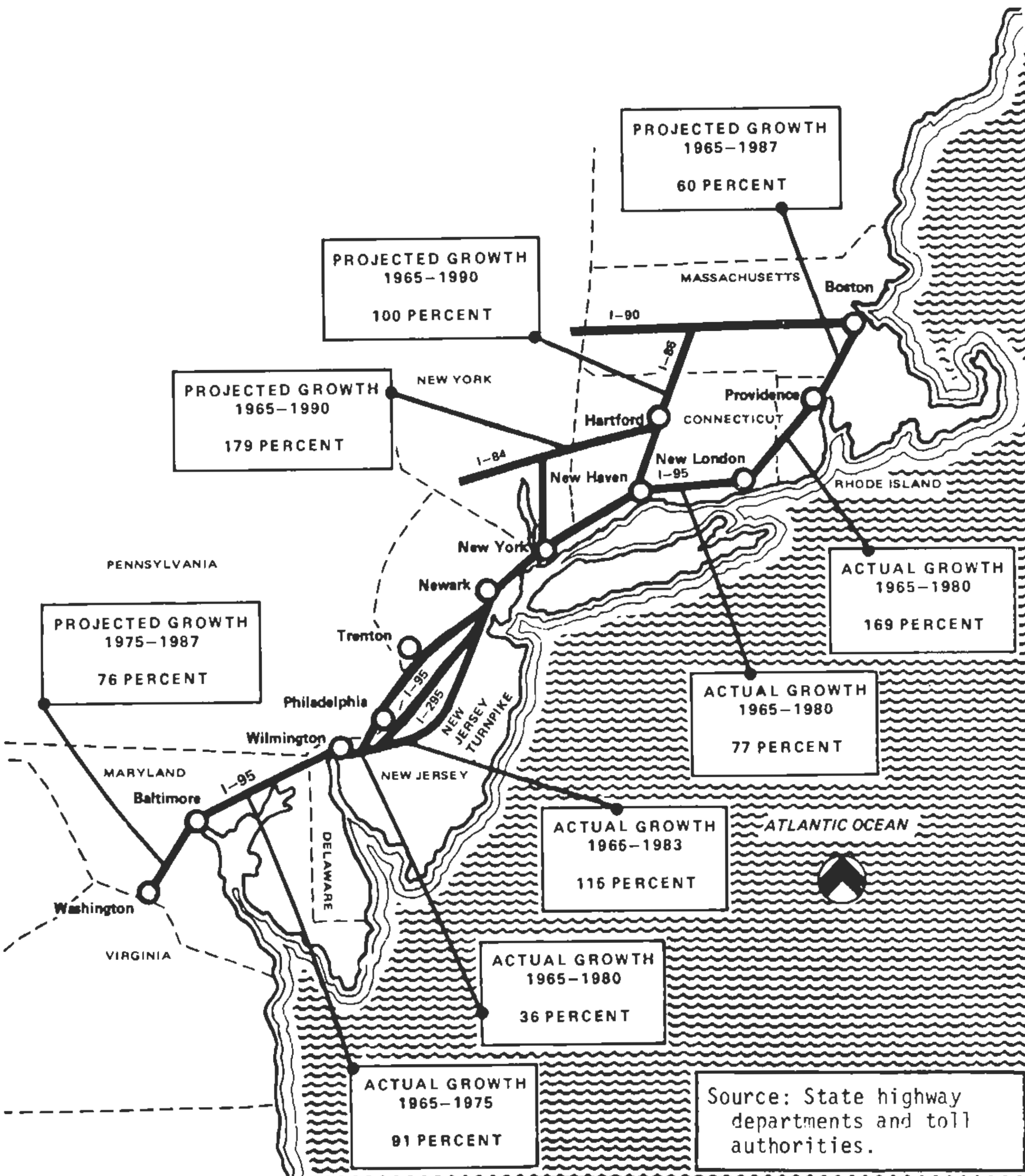
Travelers' responses to increasing peak-hour highway congestion will vary. They may change their times of departure to avoid urban rush hours, and they may in many instances be able to alter their routes to avoid notorious bottlenecks. In any event, State, local, and Federal authorities are not likely to base their highway planning decisions on the needs and desires of intercity drivers and bus passengers whose volumes, while substantial, are much less significant than those of local constituents.

CONCLUSION

The traditional line of reasoning for further NEC investment has not yet had the opportunity to be either validated or disproven by the facts. In effect, therefore, it remains to be seen whether indeed rail can ultimately attract the sizeable patronage foreseen during the lengthy studies preceding the NECIP, whether rail's marketing abilities can sustain significant growth despite ambiguous population trends, and whether rail can effectively compete with other modes. Rail ridership has not yet increased to the extent foretold, but the improved rail product in the NEC is different from and has been in place for less time than the models had assumed. Intercity travel can be expected to increase on the Corridor; yet the increasing dispersion of travel origins and destinations constitutes a marketing challenge to Amtrak. The central cities, Amtrak's greatest source of business and nonbusiness travel, are diminishing in population both absolutely and vis-a-vis the suburbs, but in some cities business and residential activity has been increasing, a trend that works to rail's advantage. Finally, capacity constraints on highway and air have increased, but their effects seem to be limited to certain locations at certain times of the week and year, and to some slight increases in scheduled times. These capacity problems in other modes will help Amtrak by showing the improved rail product in a better light. If capacity problems and resultant schedule lengthenings in other modes spread throughout the year

Figure 6-4

PROJECTED AND ACTUAL HIGHWAY TRAFFIC GROWTH AT TYPICAL INTERCITY LOCATION



and to more locations in the Corridor, then rail will always be available to carry many more riders and, if appropriate, to receive the further improvements discussed in Chapter Seven.

FOOTNOTES

[1] For example, Improved High Speed Rail in the NEC, U.S.D.O.T., 1973. The Two Year Report on the NEC (U.S.D.O.T., 1978) embraced the traditional line of reasoning for, but shrank from recommending outright, additional improvement levels.

[2] Two Year Report on the Northeast Corridor, P. 70, Table D-8, "Intermediate (most likely)" projection for NEC main line city pairs only. Actual 1982 and 1984 data is from Amtrak. (See Chapter 3 for further information).

[3] The New York Times, "Reduced Air Fares in East Change Travel Habits and Business Plans," by James Barron, December 25, 1984

[4] U. S. Department of Housing and Urban Development, The President's National Urban Policy Report, 1980, p.3-13.

[5] Telephone conversation, 2/22/85, with Mr. Albert Gomes, Senior principal - Washington Office, Pannell, Kerr, Forster (publishers of hotel industry analyses).

[6] Airport System Development, U.S. Congress -- Office of Technology Assessment, August 1984; summary report is their report number OTA-STI-232.

[7] "Practical annual capacity ... is defined as that level of operations which results in not more than 4 minutes average delay per aircraft in the normal peak 2-hour operating period," according to FAA criteria as reported in Airport Systems Development, p. 46.

[8] The Baltimore Sun, "Flight Delays Show Sharp Drop in November," December 5, 1984, p. N6.

Chapter Seven: Options for Product Improvements

Chapter Outline

Improvements other than fixed plant investments
- *Marketing initiatives*
  - *Trip times*
  - *Frequencies*
  - *Parking*
  - *Other passenger experience factors*
  - *Fares*
- *Vehicle improvements*
  - *Acceleration*
  - *Higher speeds through curves*
  - *Maximum operating speed*
- *Recapitulation: Possibilities short of fixed plant investments*

Fixed plant investments
- *New York -- Washington options*
- *New York -- Boston*
- *Comprehensive fixed plant improvement alternatives*

Financial analysis of alternatives
- *Procedures and assumptions*
- *Results*
- *Conclusion*

List of Displays

Table 7-1: Trip time benefits available from completed project
Table 7-2: Theoretical effects of tilt vehicles on NEC trip times
Table 7-3: Example of Amtrak's future flexibility
Table 7-4: Fixed plant improvement options, New York -- Washington
Table 7-5: Incremental analysis of New York -- Washington options
Table 7-6: Fixed plant improvement options, New York -- Boston
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Table 7-8: Comprehensive improvement alternatives for entire NEC
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Table 7-11: Comparative benefits of trip time investments, north and south

Figure 7-1: Metroliner load factors
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Photo 7-1: Cover of Transit Guide -- Amtrak's Northeast Corridor
Photo 7-2: Dense urban development in southern half of NEC

Chapter 7

OPTIONS FOR PRODUCT IMPROVEMENT

As a result of the NECIP and associated improvements by Amtrak and local authorities, Amtrak now offers a marketable transportation product in the NEC. Chapter Five mentioned some possible additional investments that Amtrak will have to evaluate with the primary goals of sustaining the existing product and providing a more attractive financial result. Yet Amtrak will, of course, continue to evaluate opportunities to improve its product and financial performance over the 1986 level. Moreover, if intercity travel demand growth, coupled with escalating airport and highway congestion, takes place in the NEC, and if Amtrak achieves the material gains in patronage that would confirm its ability to make full use of the resources provided by the NECIP, then investments to improve NEC rail service will merit consideration.

Improvements to the NEC product beyond 1986 levels may come about in two ways: (1) marketing experiments and vehicle initiatives not requiring fixed plant investments; and (2) fixed plant investments building upon the achievements of the NECIP. This chapter lays out improvement options under each of these two rubrics and evaluates the costs and financial effects of a typical range of options. In so doing, the chapter responds to the Congressional directive for an investigation of additional levels of investment.

As a basis for comparison, Table 7-1 summarizes the final product as introduced elsewhere in this report. Estimated trip times at project completion are the actual trip times operated by Amtrak as of October 29, 1984, less the anticipated effects of incremental improvements still to be completed by the NECIP under existing funding levels. As the operator of the service, Amtrak will, of course, retain sole discretion over the schedules that it actually publishes. As indicated in Chapter 1, Amtrak may well be able to adhere to even better schedules than those shown between Boston and New York provided that it receives the full cooperation of Metro North in the dispatching of trains and the maintenance of fixed facilities between New Haven and New Rochelle.

IMPROVEMENTS OTHER THAN FIXED PLANT INVESTMENTS

One of the chief advantages of a rail system like the NEC is its susceptibility to incremental improvements, even to low-cost experimentation. It is not an all-or-nothing system. In the late 1960's, for instance, in an experiment funded jointly by the Federal Government and the Pennsylvania Railroad at approximately $100 million [1], a new type of service (the original Metroliners) was introduced. This demonstration proved the marketability of high speed rail in the NEC, even with a passenger experience that was inferior by today's standards. One of the outstanding accomplishments of the NECIP is that it has brought Amtrak to a new plateau of development, from which the carrier is free to experiment with such marketing initiatives and vehicle improvements as those described in this section in various combinations. Thus future demonstration projects and experiments by Amtrak will allow it to gauge the market, the investment, and the likely operating costs for a wide variety of improvements short of fixed facility investments.

TABLE 7-1

TRIP TIME BENEFITS AVAILABLE FROM COMPLETED PROJECT

	New York -- Washington				New York -- Boston	
	Metroliner		Conventional			
	Best	Average	Best	Average	Best	Average
Trip Times[a/]	2:36	2:40	2:58	3:10	3:58	4:20
Average Intermediate Stops	4	5	6	7	4	7
Reliability (Percent on time)	90%	90%	85%	85%	85%	85%
Frequency (Daily trains each direction)	3	10[b/]	1	16[b/]	1	9[b/]

Passenger Experience is assumed to be equal to or better than that offered at present.

Fare levels are assumed to be equal to existing levels, taking inflation into account.

a/ See Table 1-3 and Appendix B for derivation.

b/ Includes trains making "best" time. Frequencies reflect schedules in effect as of October 29, 1984.

MARKETING INITIATIVES

This report upholds the basic philosophy that the entire transportation product -- not merely trip times and reliability but also the passenger experience -- falls within Amtrak's marketing purview. Thus, as a business enterprise seeking to better its financial results, Amtrak will have many opportunities to alter its product by means of marketing experiments requiring little or no capital investment. Of course, such marketing initiatives would be management decisions by Amtrak; they appear here only to indicate the degree of flexibility given to Amtrak by the NECIP.

Trip Times

Amtrak may wish to experiment with various nonstop or skip-stop services at peak hours between high-volume markets. Each stop omitted from a given train's schedule will improve that schedule by 2 1/2 minutes on the average; that rule of thumb, if applied to the 1986 trip-times in Table 7-1, would yield a potential 2 hour, 26 minute timing between New York and Washington for a train making no intermediate stops (2:29 with one stop). Such a timing, by the reasoning in Table 3-1, would allow rail in the Washington-New York market to offer door-to-door timings much closer to those of air (particularly in view of growing airport congestion), and should therefore permit rail to capture many more of the 9500 daily air passengers between the two metropolitan areas [2] than would otherwise be possible. Such experiments might require Amtrak to revamp its schedules considerably, possibly eliminating separate trains for Metroliner and conventional services at some or all hours of the day.

Frequencies

At present the services between Boston and New York, and New York and Washington, have very different frequency characteristics (see Table 7-1).

There are two separate services, appealing to separate markets, between New York and Washington: conventional (16 trains each way daily) and Metroliner (10 trains each way daily). Between New York and Boston, Amtrak provides a single service with 9 trains each way daily. [3]

Mathematical models have traditionally shown a relationship between frequency and patronage. If this relationship is true, then adjustments to frequency could improve revenues at minimal cost increases. For example, converting the present total number of New York -- Washington trains to a single class of service (in which two amenity levels could be offered on the same trains) would effectively result in a half-hourly service frequency throughout most of the day. Such a step would almost double the existing frequency for conventional passengers, and almost triple the existing Metroliner frequency. The reduced time-interval between trains would improve the perceived trip times: a traveler needing to be at the destination city at a specific time will have to plan to arrive 30 minutes early on average given hourly train frequencies, but only 15 minutes early on average given half-hourly train frequencies. Similarly, travelers will be able to allow for less access time to the originating station, since a missed train will result in only a 30-minute penalty rather than a full hour.

Parking

Although the NECIP, with local cooperation, has increased parking capacity at several stations (see Chapter 1), parking at other key stations is either inconvenient, inadequate, or nonexistent. Such parking limitations discourage ridership; parking additions, on the other hand, could generate an additional $1.4 million per year in passenger transportation revenue per hundred spaces, plus parking fees. (This is based on an average of 2 people per car, 2-day trips, average fares of $40.00 per round trip, and full occupancy of each new space.) As a property owner, Amtrak is in a unique position to work with private developers and local authorities to seek parking and other access improvements at station areas.

Other Passenger Experience Factors

Amtrak has a great deal of control over every aspect of the passenger environment both on trains and in stations, and has ample opportunity to explore different levels of amenities -- food service, decor, and the like. Amtrak is also in complete control of the volume and content of information given to the general public. Although the NEC is the first megalopolitan rapid transit system in the country, binding together the various metropolitan commuter rail and transit systems in a vast network, Amtrak's connectivity with urban transportation systems has yet to be fully exploited. In that regard, Amtrak has many opportunities to experiment with creative, if unproven, ideas such as through ticketing at off-line commuter rail stations and the inclusion of local transit or commuter rail data in Amtrak's computerized information systems. Amtrak already publishes information on station parking and local transit services on the first page of its NEC timetable, and FRA and Amtrak have cooperated in the publication and distribution of an experimental travelers' guide to intracity transportation in NEC metropolitan areas.

Fares

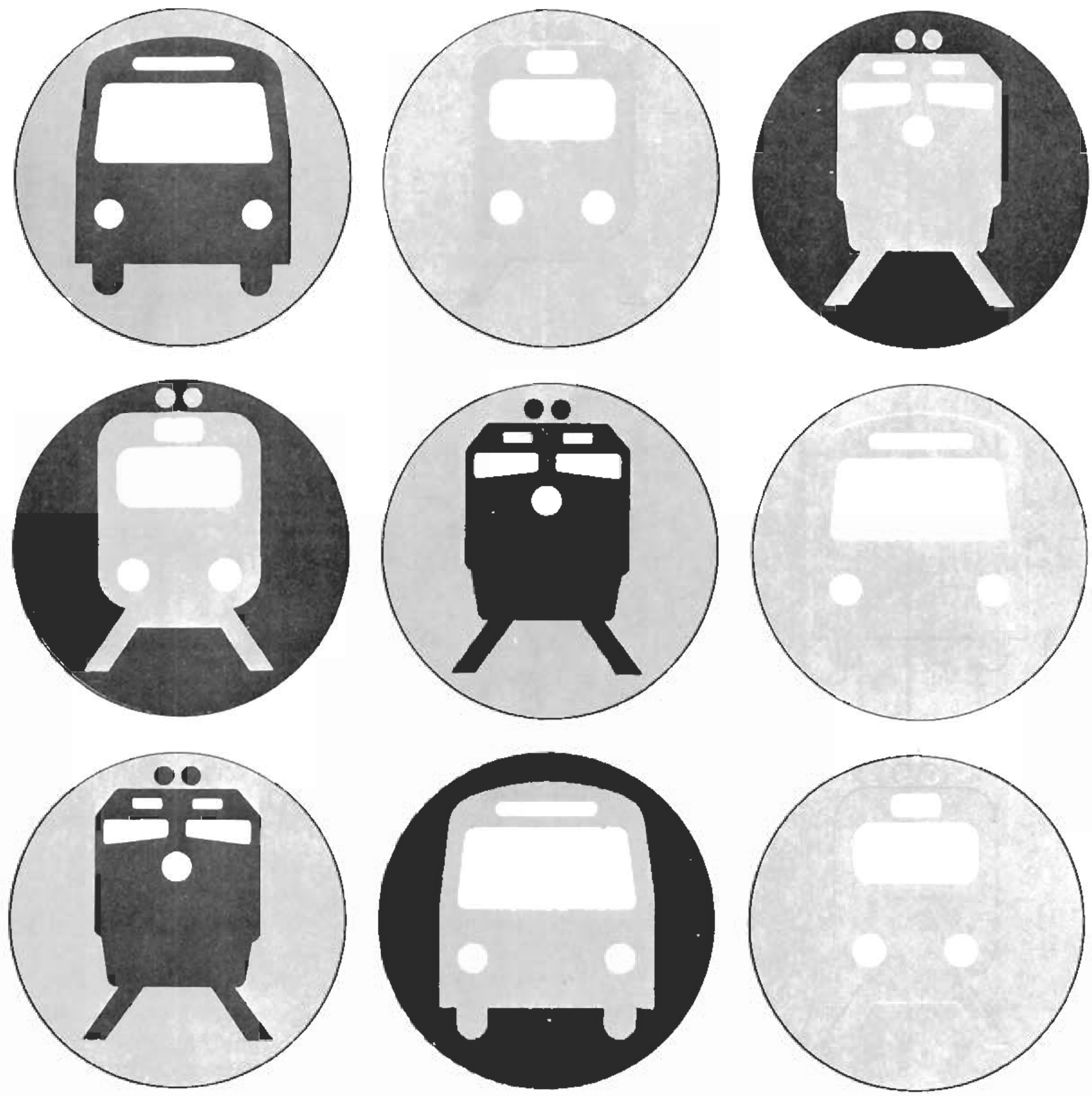
Fares are also under Amtrak's exclusive control. In view of the constantly changing fare relationships with other modes, there is obviously much room here for investigation and experimentation. One particular subject of experimentation might be Amtrak's load factors: as shown in Figure 7-1, Metroliner load factors between such points as Wilmington, Baltimore, and Washington, are relatively low. Analogous situations exist for other services and other segments of the NEC. In part this situation reflects the very nature of the NEC with New York, the great "gravitational" attraction, at the center and lesser population centers at the periphery. The essence of the intercity passenger business, with its daily, weekly, and seasonal peaks and valleys of travel demand, also sets a practical ceiling on the load factors obtainable on even the highest-volume segments of the Corridor. Nevertheless, under specific conditions, Amtrak could use such fare adjustments as peak/off-peak pricing and per-mile rate alterations to encourage traffic when empty seats are available, and to reach markets where the standard fare would be too high. In doing so, it is necessary to ensure that "promotional" fares do not abstract riders who would otherwise have traveled at the full fare.

Photo 7-1

Transit Guide Amtrak's Northeast Corridor

A Bus, Subway and Train Guide
to Cities in Amtrak's Northeast Corridor
Washington, DC • Philadelphia • New York • Boston
and Points Between

Amtrak

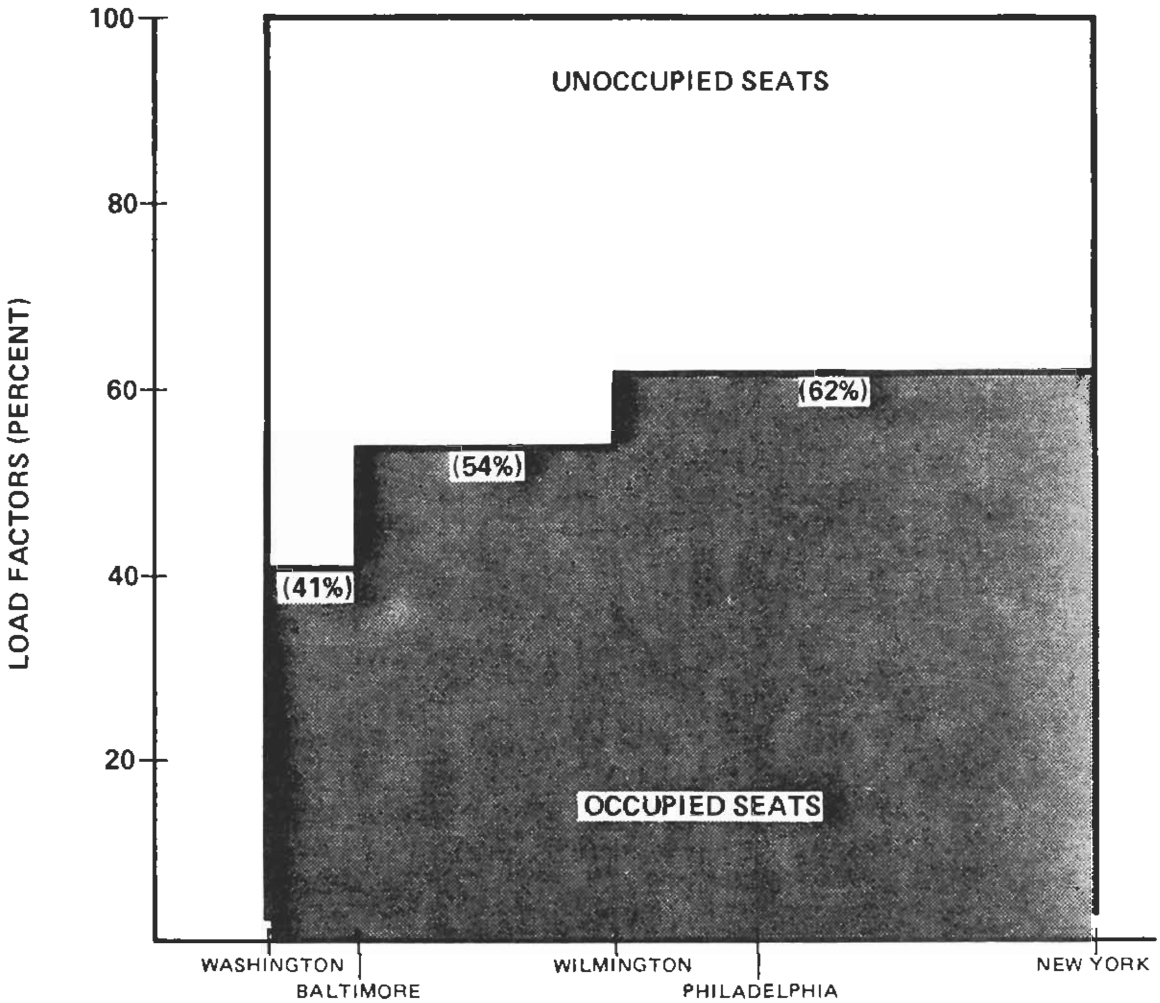


Amtrak has only begun to exploit the connectivity of its NEC system with metropolitan commuter rail and transit services. The guide depicted above, a joint FRA/Amtrak project, was an important first step in realizing the potential of the NEC as rapid transit for Megalopolis . . .

Figure 7-1

METROLINER LOAD FACTORS

(PERCENT OF SEATS OCCUPIED BY SEGMENT)



NOTE: LOAD FACTORS ARE FOR OCTOBER AND NOVEMBER 1984

SOURCE: AMTRAK MARKETING DEPARTMENT

VEHICLE IMPROVEMENTS

Numerous possibilities exist for trip-time reductions due to vehicle innovations. These essentially deal with three vehicle characteristics: acceleration, ability to maintain passenger comfort through curves, and maximum operating speed. Each characteristic, with theoretical options to improve it, is discussed below in turn.

Acceleration

Figure 7-2 shows the percentage of time spent in successively higher speed ranges within the New York-Washington segment of the Corridor. If NEC trains could accelerate more quickly, a higher percentage of time would be spent at higher speed ranges, even without track improvements to eliminate or reduce slower speed sectors.

With the present equipment on the Corridor, Amtrak could achieve higher acceleration by running shorter trains, or by adding another AEM-7 electric locomotive (Diesel north of New Haven) to each train. Operating New York-Washington trains with two AEM-7 locomotives would result in a 2-minute average trip time saving. By adding an additional Diesel north of New Haven, a 3-minute average time saving would be achieved. In addition to upgrading train performance, two-locomotive trains could reduce turnaround times at terminals if -- as experience elsewhere seems to indicate -- technical considerations would permit operation of the locomotives at either end of each train in a push-pull arrangement. Such a step would both rationalize terminal operations, hence costs, and allow Amtrak to provide a given level of service with fewer locomotives and cars than would otherwise be necessary. With or without push-pull arrangements, operating trains with two locomotives would have the additional advantage of permitting Amtrak to run much longer trains while improving or at least maintaining trip times. (In fact, Amtrak already assigns two locomotives to its very longest trains.)

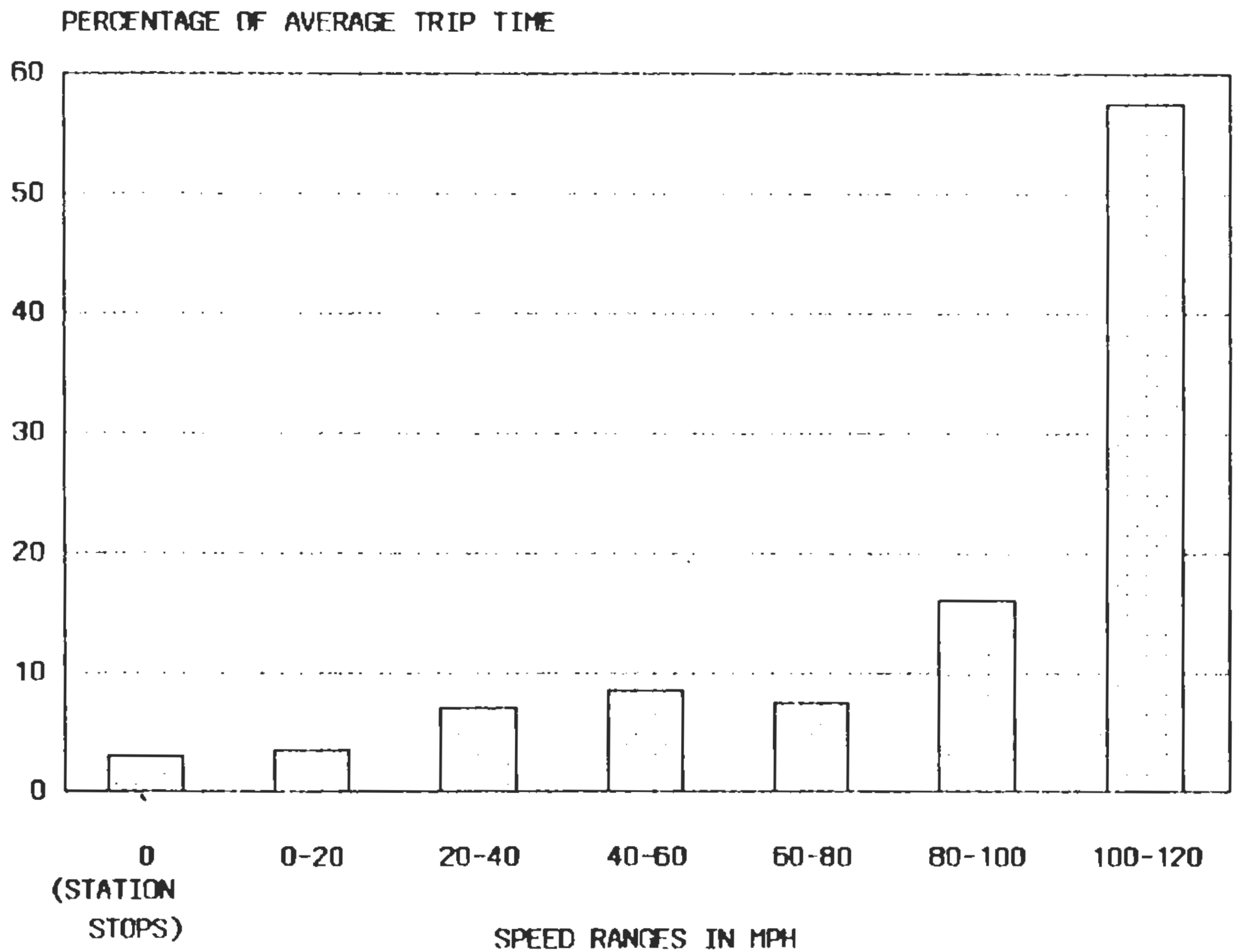
The capital cost of providing an extra AEM-7 locomotive on every train will vary according to the number of trains and the utilization of Amtrak's present fleet. As a rough estimate, if Amtrak requires 10 trainsets to operate a high speed New York-Washington service, then additional capital costs of a second locomotive would be ten times the $4 million cost of one AEM-7 with spare parts, or $40 million, at maximum. With an average of 2 minutes saved per train, this step would have a capital cost of $20 million per minute; better equipment utilization through push-pull operation could reduce this capital cost, particularly if reduced car requirements counterbalance the need for more locomotives.

Amtrak would, of course, have to compare the operating and capital cost savings and revenue gains from two-locomotive consists with their added expenses. Better acceleration would raise electric power costs. There would be twice as many locomotive-miles operated, with consequent (although not necessarily proportional) equipment maintenance cost increases, eased somewhat by the existence of the modern facilities provided by the NECIP.

Figure 7-2

NEC TRIP TIMES AT SPEED LEVELS

NEW YORK — WASHINGTON, D.C.



Higher Speeds Through Curves

In theory, tilt technology could permit trains to operate at higher speeds through existing curves at acceptable levels of passenger comfort. In a tilting train, the vehicles provide their own banking through lift devices or, in passive systems, a pendular suspension. Thus far, engineers around the world have not succeeded in demonstrating a high speed tilting train that would offer a passenger comfort level equal to or better than that of conventional American equipment, that would be totally reliable, that could be purchased at a reasonable cost, and that would entail low operating and maintenance expenses. If a tilting train, satisfying all these operating and economic criteria, could be developed or adapted for NEC applications, it could have the effects on trip times shown in Table 7-2.

Maximum Operating Speed

A hypothetical "no-cost" option for reducing New York to Washington trip time would be an increase in the maximum authorized speed from 120 mph to 125 mph. This would not require a regearing of the AEM-7 locomotives, and would provide a reduction in trip time of 2 minutes. Amtrak is submitting an application for such a speed increase to the FRA Office of Safety, which will review the matter and issue its determination; this report expresses no opinion on the safety implications and advisability of a 125 mph speed limit.

Modifying the AEM-7 locomotive for 135 mph speeds would improve New York - Washington trip times by only one minute over the 125 mph level, largely because such a regearing would detract from acceleration performance. This additional minute would be quite costly: it would require at least $60 million in fixed plant improvements (to the signalling and catenary systems and to bridges), plus up to $30 million for 135 mph trucks for the Amfleet cars. Even after these expenditures, 135 mph operations could adversely affect ride quality and maintenance costs by subjecting the existing vehicles to sustained performance conditions far more rigorous than those for which they were originally designed.

To increase maximum authorized speeds to 160 mph would require entirely new and advanced vehicles, and a large fixed plant investment including signalling and electrification adjustments and curve realignments. Cost estimates for the 160 mph options are provided as part of the related fixed plant options in the next section.

RECAPITULATION: POSSIBILITIES SHORT OF FIXED PLANT INVESTMENTS

The sections above have presented examples of Amtrak's opportunities to improve the 1986 product without additional fixed plant investment. Numerous permutations and combinations of these opportunities exist. For instance, at project completion, Amtrak would hypothetically be capable of operating nonstop 125 mph trains with two locomotives between New York and Washington at a trip time of 2:22, as developed in Table 7-3. Such a trip time would equate to door-to-door parity with air and, given the better on-time performance of rail, would represent a clearly superior mode of travel for downtown trips. If interwoven skillfully into a comprehensive schedule addressing all city-pair markets, such improved services might contribute to the overall profitability of the NEC.

TABLE 7-2

THEORETICAL EFFECTS OF TILT VEHICLES ON NEC TRIP TIMES

	Time savings (minutes) over conventional equipment	
	At 120 mph maximum speed	At 160 mph maximum speed
NEW YORK - WASHINGTON	5 to 7	12 to 15
NEW YORK - BOSTON	25	not applicable; requires new right-of-way

Note: The above savings would be dependent on the development of economical, reliable equipment meeting the very high standards necessary to operate comfortably and safely at speeds of 120 mph or higher.

TABLE 7-3

EXAMPLE OF AMTRAK'S FUTURE FLEXIBILITY

Best New York -- Washington rail trip time at project completion		2:36
Less: Time savings due to --		
Nonstop operation	0:10	
Two locomotives	0:02	
125 mph operation, if approved by FRA Office of Safety	0:02	
Total time savings		0:14
Improved New York -- Washington trip time hypothetically possible at project completion		2:22

Comparison with Air (see Table 3-1 for basis):

Approximate door-to-door air trip time		3:15
Station-to-station rail trip time as developed above:	2:22	
Add: Approximate access/egress time in New York and Washington	0:55	
Improved door-to-door rail trip time		3:17
Resultant rail time (disadvantage)		(0:02)

Note: This equates to rail superiority for many if not most downtown trips, since the access times in Table 3-1 are only approximate and Amtrak has potential for better on-time performance than air.

FIXED PLANT INVESTMENTS

This section describes and provides cost estimates for comprehensive fixed plant improvement alternatives which Amtrak may wish to consider for the NEC. Each alternative comprises one specific option for the New York -- Washington section, and one specific option for the New York -- Boston portion of the Corridor. This approach reflects the completely different physical characteristics of the two halves of the Corridor, and their unequal competitive positions vis-a-vis air for time-sensitive traffic.

Such trip-time improvements through fixed plant investments would be costly. In formulating the NECIP designs in keeping with the principles of engineering economy, FRA sought constantly to achieve the greatest possible trip time improvement per dollar invested. Thus, south of New York, the NECIP has already achieved all the inexpensive time savings, so that every additional minute saved will require a relatively large investment. Even though rail has almost achieved trip time parity with air in the New York -- Washington market, the cost for the few additional minutes needed to consolidate the rail mode's position vis-a-vis air would be very high indeed. North of New York, the problem would be the huge gap remaining between rail and air trip times. Although each additional minute saved would be relatively cheap, the total investment required merely to approach parity with air would be large. Thus, a far more realistic goal in the New York -- Boston market would be rail superiority over the highway modes, since the existing time differential is not great.

Trip time estimates for 120 mph options assume none of the marketing or vehicle improvements described in the sections above; for 160 mph options, new conventional (non-tilting) vehicles are assumed. The very preliminary cost estimates for all the options presented below do not include the investment opportunities identified in Chapter 5 for the purpose of sustaining NEC service on an economic, secure basis. Capital costs for vehicles are excluded from the New York -- Washington and New York -- Boston options as laid out below, but are included in the comprehensive financial comparisons at the end of the chapter.

NEW YORK -- WASHINGTON OPTIONS

Table 7-4 presents four trip-time options for the New York -- Washington portion of the NEC. **Option S1** would assume no further trip-time improvements beyond the product made possible by the $2.19 billion NECIP. Options S2 through S4 are arranged in order of increasing cost, increasing time savings, and decreasing cost-effectiveness in terms of dollars spent per minute saved.

Option S2 would consist of two remaining low-cost track reconfigurations (at North Philadelphia and at Pennsylvania Station, New York), as well as a set of curve realignments, mostly within the existing right-of-way, that would provide relatively high trip-time benefits in relation to their cost.

Option S3 would include the two track reconfigurations from Option S2, plus a group of major curve realignments entailing large civil engineering projects, often outside the existing right-of-way. These realignments would be so expensive that the 6 minute saving over Option S2 would cost an additional $220 million, almost $40 million per additional minute saved. (In contrast, the

TABLE 7-4

FIXED PLANT IMPROVEMENT OPTIONS, NEW YORK - WASHINGTON

Option Number	Option Description[c]	Fixed Plant Capital Costs ($ Millions)[d]	Trip Time Savings (Minutes)	Dollars Spent (Millions) on Fixed Plant per Minute Saved	Resultant Trip Times[a] (hours:minutes) Station to Station	Resultant Trip Times[a] (hours:minutes) Door to Door[b]	Airline Trip Times (Door to Door)[b]	Approximate Door-to-Door Rail Time Advantage (Disadvantage)[e] vis-a-vis Air
S1	1986 Product: Fixed plant at completion of NECIP	0	0	n/a	2:36	3:31	3:15	(0:16)
S2	Inexpensive track reconfigurations and curve realignments for 120 mph speeds	80	7	11.4	2:29	3:24	3:15	(0:09)
S3	More costly curve realignments for 120 mph speeds	300	13	23.1	2:23	3:18	3:15	(0:03)
S4	160 mph system	1,000	20	50.0	2:16	3:11	3:15	0:04

[a] These are best trip times and assume 4 stops. Note that any of these options could include nonstop service on selected trains between New York and Washington; for those trains, trip times would improve by 10 minutes (both door-to-door and station-to-station), and rail performance vis-a-vis air would be better by 10 minutes as well.

[b] Door-to-door times reflect Table 3-1, and are based on assumptions centered on downtown-to-downtown trips. In any such comparison as the differential between air and rail decreases, the importance of the exact origin and destination of each trip increases. (See also note [e] below.)

[c] Options S1, S2, and S3 assume existing vehicles. Option S4 assumes new 160 mph non-tilting vehicles. All options add vehicles in future years in accordance with demand increases. The capital costs for these vehicles figure in the comprehensive financial analysis data later in this chapter but are excluded from Tables 7-4 through 7-8.

[d] Cost estimates do not include items described in Chapter 5 (electrification and signalling work and freight/passenger separation) which would be performed for reasons of economics and safety rather than for trip-time purposes.

[e] The rail "disadvantage" perceived by the traveler will diminish (1) as rail reliability improves relative to that of air and (2) rail service frequencies increase vis-a-vis those of air.

first seven minutes saved in Option S2 would cost just $11 million per minute -- see Table 7-5). Photo 7-2 reveals the reason for this escalating cost: many of the curves in the New York -- Washington sector are in urban and suburban areas, where right-of-way acquisition is highly expensive.

Both options S2 and S3 would preserve the 120 mph speed limit now in effect, where alignment and other conditions permit, between New York and Washington. **Option S4** would raise that speed limit to 160 mph and would effect such curve realignments and such adjustments to the electrical catenary and signalling system as to permit 160 mph over long stretches of the Corridor. This option would assume a new fleet of non-tilting vehicles capable of operating efficiently at 160 mph. As mentioned above, Option S4 would not include the costs of freight/passenger separation as described in Chapter 5, which must be judged on its own merits irrespective of its implications for future trip times. However, as a practical matter, Option S4 would require as a prerequisite the removal of virtually all through freight from the southern half of the Corridor.

Even excluding vehicle and freight removal expenditures, Option S4 would cost on the order of $1 billion. The $700 million spent over and above the Option S3 level would result in an additional trip time saving of 7 minutes, for a cost of $100 million per additional minute saved. (Table 7-5).

Of course, numerous intermediate points would exist between options 1 through 4, and further trip time savings would be possible with expenditures over $1 billion.

NEW YORK -- BOSTON

Table 7-6 presents five trip-time options for the New York -- Boston portion of the NEC. **Option N1** would assume no further trip time improvements beyond the product made possible by the $2.19 billion NECIP. Options N2 through N5 appear in order of increasing cost, increasing time savings, and decreasing cost-effectiveness.

All options for trip time improvement north of New York would require the wholehearted cooperation of Metro North, which operates and maintains the Corridor between New Rochelle and New Haven. Unless Metro North works harmoniously with Amtrak in designing mutually beneficial facility improvements, in scheduling train services, in planning operating procedures, in according proper dispatching priority to intercity trains, and in maintaining the railroad's fixed plant to high-speed standards, no amount of investment will ensure reliable, swift service between New York and Boston. Thus, just as institutional issues will determine Amtrak's ability to schedule even better trip times than those shown in Table 1-3, so will institutional relationships determine the feasibility and usefulness of further investments for trip time reduction.

Option N2 would upgrade the Metro North line between New Rochelle and New Haven. It would include major track configuration changes at "Shell" Interlocking in New Rochelle, at Stamford Station, and at New Haven Station, and an increase in the maximum authorized speed between New Rochelle and New Haven from

TABLE 7-5

INCREMENTAL ANALYSIS OF NEW YORK - WASHINGTON OPTIONS S1 THROUGH S4

	Additional Dollars Spent Millions	Additional Time Saved (Minutes)	Dollars Spent per Additional Minute Saved (Millions)
Option S2 versus Option S1	80	7	11.4
Option S3 versus Option S2	220	6	36.7
Option S4 versus Option S3	700	7	100.0

Photo 7-2

DENSE URBAN DEVELOPMENT in southern half of NEC, as exemplified above in Baltimore, contributes to high incremental costs of additional trip time savings beyond those achieved by the NECIP . . . (The same situation exists between New York City and New Haven.)

TABLE 7-6

FIXED PLANT IMPROVEMENT OPTIONS, NEW YORK - BOSTON

Option Number	Option Description[c]	Fixed Plant Capital Costs $ Millions[d]	Trip Time Savings Minutes	Dollars Spent (Millions) on Fixed Plant per Minute Saved	Resultant Trip Times[a] (hours:minutes) Station to Station	Door to Door[b]	Airline Trip Times (Door to Door)[b]	Approximate Door-to-Door Rail Time Advantage (Disadvantage) vis-a-vis Air
N1	Completed Project: fixed plant at completion of NECIP	0	0	n/a	3:58	4:53	3:15	(1:38)
N2	Upgrade New Rochelle-New Haven segment (requires cooperation of Metro-North)	60	18	3.3	3:40	4:35	3:15	(1:20)
N3	Electrify between New Haven and Boston (includes Option N2)	400	44	9.1	3:14	4:09	3:15	(0:54)
N4	Electrify and realign simultaneously between New Haven and Boston for 120 mph speeds (includes Option N2)	600	49	12.2	3:09	4:04	3:15	(0:49)
N5	160 mph system	3,000	67	44.8	2:51	3:46	3:15	(0:31)

[a] These are best trip times and assume 4 stops. Any of these options could include nonstop service between New York and Boston, with a 10 minute improvement in trip times; but the rail disadvantage vis-a-vis air would still be 21 minutes even in Option N5.

[b] Based on Table 3-1.

[c] Option N1 and N2 assume existing vehicles. Option N3 and N4 would extend electrified service with AEM-7 locomotives over the whole route. Option N5 assumes new 160 mph non-tilting vehicles. All options add vehicles in future years in accordance with demand increases. The capital costs for these vehicles figure in the comprehensive financial analysis later in the chapter but are excluded from Tables 7-4 through 7-8.

[d] It should be noted that construction cost experience reported by the TGV Company for the Paris-Lyon line suggests costs of less than half of the $3 billion estimated for Option N5.

79 mph to 110 mph. A flyover at Harold (Long Island) would be a potential addition to this option [4].

Option N3 would consist of electrification of the remaining portion of the Corridor between New Haven, Connecticut and Boston, Massachusetts. As noted and described in Chapter 2, the design for the electrification was produced by the NECIP. Modern electrification and compatible modern signaling would provide for a maximum speed of 120 mph, matching the Washington-New York segment of the Corridor, and would provide full bi-directional signaling on all mainline tracks. Option N3 would also include the New Rochelle -- New Haven upgrading subsumed in Option N2.

The trip time savings for option N3 would be 26 minutes over the N2 level, produced by a 9 minute time savings from elimination of the electric-to-Diesel engine change at New Haven Station, and a 17 minute time savings from the increased speed and acceleration of the electric locomotive.

Option N4 in Table 7-6 would consist of Option N3, plus very significant curve realignments performed at the same time as the electrification. As Table 7-7 reveals ("Option N4 versus Option N3"), the realignments would cost $200 million over and above the electrification alone, but would yield only 5 minutes in additional time savings at a cost of $40 million per additional minute saved. This would compare with $13 million per additional minute saved due to the electrification alone ("Option N3 versus Option N2"). The incremental cost of the realignments would be even greater, however, if they were to be performed after the electrification is complete, since the electric catenary poles fix the railway alignment; for this reason, the realignments would deserve serious consideration along with the electrification.

Option N5 would consist of a very high speed railroad operating at a maximum of 160 mph. Such high speeds would necessitate the construction of a new right-of-way between the New Haven and Providence vicinities, possibly along portions of Interstate 95, to bypass the sinuous Shore Line route. This option would save an additonal 18 minutes over N4, but at an incremental fixed plant cost on the order of $2.4 billion ($133 million per additional minute saved). Even with nonstop service between Boston and New York, rail would still offer marginally worse trip times than air unless, as seems likely, air delays increase in future years. Yet by giving rail an incomparable time advantage over the bus and auto modes, Option N5 would still create significant rail traffic increases. It should be noted that construction cost experience reported by the TGV Company for the Paris-Lyon line suggests costs of less than half of the $3 billion estimated for Option N5.

Beyond Option N5, the only other possible area of still further trip time reduction via the Shore Line route would be the 75-mile stretch between New York and New Haven. Here, a difficult alignment makes high speeds impossible, but heavy urban and suburban development virtually eliminates any possibility of realignment.

COMPREHENSIVE FIXED PLANT IMPROVEMENT ALTERNATIVES

Table 7-8 matches fixed plant options south and north of New York to arrive at comprehensive fixed plant investment alternatives for the entire Corridor.

TABLE 7-7

INCREMENTAL ANALYSIS OF NEW YORK - BOSTON OPTIONS N1 THROUGH N5

	Additional Dollars Spent (Millions)[a]	Additional Time Saved (Minutes)	Dollars Spent per Additional Minute Saved (Millions)
Option N2 versus Option N1	60	18	3.3
Option N3 versus Option N2	340	26	13.1
Option N4 versus Option N3	200	5	40.0
Option N5 versus Option N4	2,400	18	133.3

a See footnote d, Table 7-6.

TABLE 7-8

COMPREHENSIVE IMPROVEMENT ALTERNATIVES FOR ENTIRE NEC

Alternative Number	Options Included in this alternative		Resultant Station-to-Station Trip Times		Approximate Time Advantage (Disadvantage) Versus Air		Fixed Plant Capital Cost (Millions Of Dollars)[a]	Total Minutes Saved, Boston Washington	Dollars Spent (Million) On Fixed Plant Per Minute Saved
	New York - Washington Option	New York - Boston Option	New York - Washington	New York-Boston	New York-Washington	New York-Boston			
A	S1: Completed Product	N1: Completed Product	2:36	3:58	(0:16)	(1:38)	0	0	n/a
B	S1: Completed Product	N2: Upgrade New Rochelle - New Haven	2:36	3:40	(0:16)	(1:20)	60	18	3.3
C	S2: Inexpensive reconfigurations/realignments	N3: Electrify New Haven - Boston	2:29	3:14	(0:09)	(0:54)	480	51	9.4
D	S3: Expensive curve realignments	N4: Electrify and realign New Haven - Boston	2:23	3:09	(0:03)	(0:49)	900	62	14.5
E	S4: 160 mph system	N5: 160 mph system	2:16	2:51	0:04	(0:31)	4,000	87	46.0

a See footnote d, Table 7-6.

These comprehensive alternatives, in turn, comprise the basis for the financial analysis presented below.

FINANCIAL ANALYSIS OF ALTERNATIVES

This section assesses the effects of the hypothetical fixed plant alternatives developed above on the ridership and financial results of the NEC. Although closely interlinked, these two criteria -- ridership and financial performance -- respond to different public objectives. According to the traditional line of reasoning for NEC investments (as summarized in Chapter 6), increased rail ridership in the NEC is intrinsically good because it helps to moderate the rate of growth in other modes' congestion, transfers passengers to an environmentally benign and potentially oil-independent mode, opens attractive travel opportunities to many who can afford neither automobile ownership nor regular airline fares, and contributes to the vitality of the center cities. Proponents of this view cite the superb intercity rail systems of the United Kingdom and continental Europe as examples of successful public investments in transportation systems that have intrinsic social value beyond price.

On the other hand, a purely financial approach would require that further NEC trip time investments generate future flows of increased profits (decreased losses) sufficient to outweigh the initial capital commitments involved. To the extent that such investments fail to meet a stringent financial criterion, public authorities must determine whether the projected ridership increases and concomitant benefits to society outweigh the costs.

This report contains forecasts that may be useful to decision-makers as they consider either ridership, or financial results, or both criteria together. To be meaningful, such forecasts must adopt a long-term perspective: 1995 is the primary forecast year. Yet forecasts are merely the result of mathematical operations on many basic assumptions regarding the economy, population, other modes, and the rail mode; eminent economists have difficulty in projecting any one of these factors, and as the assumptions multiply and the projection period lengthens, the opportunities for error increase.

A summary of the procedures, assumptions, and results of the financial analysis follows.

PROCEDURES AND ASSUMPTIONS

The conceptual framework of the financial analysis reflects the flow chart in Figure 3-1. All amounts are in 1985 dollars.

For Alternatives A through E, a complex mathematical model has projected rail patronage and revenue in 1995 for each city-pair market and for the Corridor as a whole. Among these alternatives, the only factor that varies significantly is trip times between city-pairs. Assumptions in other areas remain constant, and include the following:

o Moderate growth in population and personal income for the region taken as a whole.

o Rail service on an integral basis, i.e., Metroliner and conventional passengers carried in the same trains rather than in separate trains as at present. The result: half-hourly frequencies between New York and Washington. Additional trains between New York and Philadelphia, and a few "locals" to service low-demand points. North of New York, nine daily trains in each direction.

o Continued improvement in the overall rail passenger experience and in Amtrak's marketing efforts.

o Rail fares equivalent to those of today.

o Other modes' characteristics -- trip times, reliability, frequency, passenger experience, and fares -- as at present.

For each alternative, the forecasting process has converted rail passenger projections and service characteristics into such operating measures as train-miles, car-miles, locomotive-miles, and seat-miles. Total operating expenses are simply the product of these operating measures and the appropriate unit costs, plus certain fixed costs (effectively independent of traffic volume). To develop the requisite unit costs, actual Amtrak operating expenses by account for 1983 have been divided by the applicable units produced in that year, and the result has been adjusted for inflation to 1985 dollar levels. These unit costs remain constant for Alternatives A through D; for Alternative F (160 mph), appropriate adjustments take the higher speed level into account. Operating expenses for this analysis do not include depreciation, so that the results of operations constitute a surplus/shortfall of funds rather than a net income forecast.

Ridership, revenues, and operating expenses between 1986 and 1995 result from interpolation (based on the forecast for Alternative A, which is the NEC on completion of the $2.19 billion NECIP); results between 1995 and 2005 reflect an extrapolation process.

Capital expenditures for fixed plant would encompass the amounts developed earlier in this chapter. To perform a financial comparison of alternatives on the basis of a discounted flow of funds, it is essential to allocate capital expenditures to specific years. The following hypothetical allocations are for analytical purposes only and do not constitute funding recommendations of any kind.

Alternatives B through D would assume that the fixed plant investment will occur between 1986 and 1989, with expenditures timed to peak in 1988. Full service at the new trip times would begin in 1990. Alternative F, by virtue of its magnitude and potential environmental impacts, would reach completion in 1994, with construction peaking in 1992 and 1993, and full service operation in 1995.

Since the primary purpose of the analysis is to compare fixed plant investment levels, vehicle costs do not appear in Tables 7-4 through 7-8. However, the comprehensive financial analysis below perforce includes capital costs for vehicles in years appropriate to each alternative. Thus, patronage growth in all alternatives would require periodic additions of locomotives and cars; the analysis assumes these additions to take place in proportion to car-mile increases at five-year intervals beginning in 1990. Alternatives C and D, extending electrification to Boston, would require additional electric locomotives initially, and Alternative E would require an entirely new fleet to be purchased in 1994.

RESULTS

By the means outlined above, the forecasting process developed revenues, operating expenses, operating surplus/shortfall, and capital investment (for fixed plant and vehicles separately) for each alternative in each year between 1986 and 2005. To the annual net flow of funds (the sum of operating surplus/shortfall and capital investments) a 10 percent discount rate was applied to derive the discounted flow of funds for each alternative. Since Alternative A represents FRA's best estimate of the likely outcome in the absence of a post-NECIP fixed plant investment program, the Alternative A results serve as a baseline against which to judge the other alternatives. Therefore, the net present value of each of the alternatives is the difference between its discounted flow of funds and that of Alternative A. Table 7-9 summarizes the results of the analysis.

From a purely financial point of view, Alternatives B through E would not pay their way under the assumptions contained in this analysis. Although the annual operating shortfalls of Alternatives B through D would be marginally better than those of Alternative A, these modest yearly benefits -- on the order of $2 to $5 million -- would offer an insufficient return on the initial capital investments required. While the 160 mph alternative (E) would generate an annual operating result that would be $29 million better than that of Alternative A, the near-term capital cost of E, $4.6 billion, would dwarf the annual long-term operating benefits.

Although fixed plant investment alternatives B through E would not promise strictly financial returns, they would produce rail patronage gains ranging from 2 to 7 percent in terms of number of riders, and from 3 to 13 percent based on passenger-miles. To the extent, therefore, that increases in rail traffic constitute an intrinsic benefit to society, then the alternatives would grow more beneficial as they become more ambitious. Passenger-miles would increase at a faster rate than the number of passengers because the decreased trip times, by allowing rail to compete more effectively with other modes over greater distances, would result in a longer average trip length.

The relationship between passenger-mile increases and minutes of time savings remains essentially constant over the range of trip times in this analysis: each minute saved on the Corridor would produce 2.5 million additional passenger miles for Alternatives B through D, and 2.3 million for Alternative E. This proportionality between passenger-mile increases and minutes of time savings yields the following effects:

o Alternative C, in which the electrification north of New Haven produces the largest single trip time improvement, would generate the most marked incremental increase in passenger-miles.

o Just as the improvement alternatives would concentrate most of the trip-time savings north of New York, so would most of the ridership increases occur in the New York - Boston segment. In fact, of the additional 210 million

TABLE 7-9

RESULTS OF FINANCIAL ANALYSIS OF NEC FIXED PLANT IMPROVEMENT ALTERNATIVES
(Dollars amounts are in Millions)

	ALTERNATIVE				
	A	B	C	D	E
INITIAL CAPITAL COSTS [a] ($ Mil):					
Fixed Plant	0	60	480	900	4000
Vehicles [a]	0	0	32	32	620
Total	0	60	512	932	4620
TRIP TIMES (hours:minutes):					
New York - Washington	2:36	2:36	2:29	2:23	2:16
New York - Boston	3:58	3:40	3:14	3:09	2:51
ANNUAL RESULTS (1995 for example):					
Statistics:					
Train-Miles (thousands)	7851	7851	7851	7851	7851
Riders (thousands)	14985	15275	15605	15735	15985
Passenger-miles (millions)[b]	1676	1721	1802	1829	1886
Financial ($ Million):					
Revenues	296	303	311	314	400
Operating expenses	419	421	430	435	494
Operating Surplus (Shortfall)	(123)	(118)	(119)	(121)	(94)
Annual Surplus (Shortfall) better (worse) than Alternative A by:	0	5	4	2	29
NET PRESENT VALUE ($ Million) 1986 THROUGH 2005: Discounted flow of funds better (worse) than that of Alternative A by:	0	(86)	(449)	(808)	(2992)

[a] Investments during construction period preparatory to startup of improved service. This line excludes vehicles acquired after construction is complete to handle traffic growth.

[b] Passenger miles are the summation of all city-pair markets within the NEC.

passenger miles generated by Alternative E over Alternative A, fully 64 percent would occur north of New York.

o Because the alternatives in sequence would yield shorter and shorter trip times, each minute saved would represent a greater and greater proportional improvement: a minute reduced from Alternative A, which requires 156 minutes between Washington and New York, represents a smaller percentage improvement than a minute reduced from Alternative D, which has a 143 minute Washington - New York timing. Yet the passenger-mile yield per minute saved remains constant, or even decreases. The result is diminishing returns. Between Alternatives B and C, a 4.7 percent increase in passenger miles would result from a 8.8 percent decrease in trip times, for an elasticity quotient of .53; between Alternatives B and C, an analogous calculation yields an elasticity of 0.47.

Moreover, since the order of the alternatives embodies an increasing cost per minute saved (each of which generates essentially the same number of passenger-miles), future passenger-mile increases show diminishing returns with respect to dollars invested. Table 7-10 attempts to combine the two criteria discussed above, ridership and finances, by treating annual traffic improvements as a "return" on the resources committed to each alternative. If the additional annual passenger miles (over Alternative A) of each alternative are divided by the net present value of that alternative, the resultant passenger-mile increase per million dollars of resources committed shows a marked drop as the alternatives become more expensive.

These results lead naturally to one more question: in which half of the Corridor do fixed plant trip time investments yield the greater return in terms of ridership and revenues? The following factors are germane to this question; Table 7-11 provides supporting data.

o For all alternatives, fixed plant investment costs would be lower per minute saved in the north than in the south. The first eighteen minutes of improvement in the north would cost only $3.3 million per minute, less than one third the cost per minute of the cheapest option south of New York.

o Per minute saved, improvements in the south produce on average 2.8 million additional passenger-miles; in the north, the passenger-mile benefit is about 2.0 million. One possible explanation for this differential is that the few minutes saved in the south fall within the critical zone of time-competition between rail and air, whereas the improvements in the north are within the zone of time-competition for the relatively less time-sensitive auto and bus traffic. As the time savings grow and as rail consolidates its time superiority over air in the New York - Washington market, the volume gain per additional minute saved begins to decline slightly.

o In Alternatives C, D, and E, the incremental yield (additional revenue per additional passenger-mile produced) is higher in the south than in the north. This simply reflects the expansion in the south of Metroliner-class traffic, which is more sensitive to time than to price and can bear heavier rates. In the north, rail can compete increasingly with auto and bus on the basis of trip times; but since much auto and most bus traffic is highly price sensitive, rail faces limitations on its ability to raise fares.

TABLE 7-10

COMBINED RIDERSHIP/FINANCIAL EVALUATION OF ALTERNATIVES

(Annual passenger-mile benefit per million dollars of resources committed)

	Alternative				
	A	B	C	D	E
INCREMENTAL TO ALTERNATIVE A					
Annual ridership benefit: annual passenger-mile increase over Alternative A (millions)	0	45	126	153	210
Initial resource commitment: Negative NPV of this alternative vis-a-vis Alternative A (millions of dollars)	0	86	449	808	2992
Quotient: thousands of additional passenger-miles generated yearly per million dollars of resources committed	0	523	281	189	70
INCREMENTAL TO PREVIOUS ALTERNATIVE					
Annual ridership benefit: annual passenger-mile increase over previous alternative (millions)	0	45	81	27	57
Initial resource commitment: amount by which NPV of this alternative is worse than that of previous alternative (millions of dollars)	0	86	363	359	2184
Quotient: thousands of additional passenger-miles generated yearly per million dollars of incremental resources committed	0	523	223	75	26

TABLE 7-11

COMPARATIVE BENEFITS OF TRIP TIME INVESTMENTS, NORTH AND SOUTH

Alter-native	Initial Fixed Plant Investment per Minute Saved (Millions of Dollars		Annual Passenger-Miles Added per Minute Saved (Thousands)		Incremental Yield (Revenue Added per Passenger-mile Added) (Cents)		Annual Passenger-miles Added per Million Dollars of Fixed Plant Investment (Thousands)		Annual Revenue Added as Percent of Initial Fixed Plant Investment	
	South	North	South	North	South	North	South	North	South	North
A	0	0	0	0	0	0	0	0	0	0
B	0	3.3	0	1944	0	17.1	0	583	0	10.0
C	11.4	9.1	2857	1977	15.0	11.5	250	218	3.8	2.5
D	23.1	12.2	2769	1980	13.9	11.3	120	162	1.7	1.8
E	50.0	44.8	2650	1970	15.1	10.6	53	44	0.8	0.5

Notes: Passenger-miles "South" are the summation of all city-pair markets lying between New York and Washington, inclusive; passenger-miles "North" are the summation of all city-pair markets between Boston and New York, inclusive. Passenger-miles and revenues for trips crossing New York are excluded from this chart.

"North" = New York -- Boston. "South" = New York -- Washington

Annual forecast data is for 1995. All figures for Alternatives B through E are incremental to Alternative A.

The first eighteen minutes of time savings in the north (Alternative B) provide the highest return in terms of annual passenger-miles generated (583,000) per million dollars of capital investment. In Alternative B, the annual revenue increment expressed as a percentage of initial capital investment -- a crude-but-useful yardstick for comparison of north and south -- is also higher by a factor of 2 than that of any other alternative.

At all other levels of investment, the lower capital costs in the north and the higher traffic and revenue yields in the south cancel each other out, so that neither half of the Corridor offers promise of a return significantly better than that of the other.

CONCLUSION

Viewed in the large, these results (which echo those of the Two-Year Report on the Northeast Corridor of 1978) encompass projections into the future of Amtrak's actual ridership history and cost experience. In both the revenue and expense areas, equations depicting the future have been tailored to fit data generated in the past. In order to improve the revenue and expense projections, Amtrak must augment its ridership or effect a fundamental transformation in every aspect of its cost structure in the NEC; preferably, Amtrak must do both. The NECIP has given Amtrak the basic tools with which to effect many, if not most, of these changes. The rest is up to Amtrak.

Footnotes to Chapter Seven

[1] Interview (12/17/84) with Dr. Robert A. Nelson, former Director of the Office of High Speed Ground Transportation, FRA. Under the demonstration contract, the Government contributed $9.6 million, and the Pennsylvania Railroad (succeeded by the Penn Central) agreed to invest $75 million in related roadbed improvements and vehicles.

[2] FAA data, 3.447 million New York -- Washington air passengers in 1983 divided by 365.

[3] Frequencies reflect schedules in effect as of October 29, 1984. On April 28, 1985, Amtrak added an eleventh Metroliner round trip to its New York - Washington daily schedule.

[4] The trip time estimates for the completed project in Tables 1-3, 7--1, and B-2 already include a reconfiguration (<u>without</u> flyover) at Harold. Appendix F discusses the potential costs and benefits of such a flyover, which is <u>not</u> included in Option N2 but which might be a useful addition thereto.

NORTHEAST CORRIDOR:
ACHIEVEMENT AND POTENTIAL

Appendices

United States Department of Transportation
November 1986

Submitted in accordance with Section 703 (1)(E) of the Railroad Revitalization and Regulatory Reform Act of 1976, as amended.

APPENDICES

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Appendix A: Chronology and Funding History of the NECIP

Appendix B: Derivation of Trip Times for Completed Project

APPENDIX A

CHRONOLOGY AND FUNDING HISTORY OF THE NECIP

The following is a list of the major events in the history of the NECIP, together with the budgetary history of the Project.

The 1960's — In response to growing public and Congressional awareness of increasing transportation congestion in the NEC region, the Federal Government undertakes studies and demonstration programs.

Comprehensive reports included: The Executive Task Force on Transportation in the Northeast Megalopolitan Corridor; the Washington-Boston Transportation Study by the Department of Commerce; and the Northeast Corridor Transportation Project Report.

Congressional Hearings culminated in the High speed Ground Transportation Act of 1965.

Numerous reports focused on specific issues, including: future travel demand; the potential that new technology (e.g., vertical and short take-off and landing aircraft, tracked air cushion vehicles and magnetic levitation vehicles) had for solving the problem of transportation congestion; and the economics of expanding the facilities of one mode versus the others.

The Northeast Corridor Rail Passenger Demonstration, a joint project of D.O.T. and the railroads to test passenger response to Metroliner and Turbo equipment, began.

September 1971 — U.S. D.O.T. releases its report, "Recommendations for Northeast Corridor Transportation"

Findings: Given congestion at airports and on highways, and the huge Federal investment needed to expand either, the Report recommends improvements to the rail system to exploit its unused capacity.

Service goals (non-stop): 2 hours New York to Washington, 2 hours 45 minutes New York to Boston; top speed - 150 mph.

Cost Estimate: $700 million

January 1974 — The Regional Rail Reorganization Act of 1973 becomes law.

Sec. 601 (d)(3) instructs the Secretary of Transportation to "begin the necessary engineering studies and improvements" for the Corridor.

Funding: $12.5 million authorized but approximately $7 million spent.

February 1976 — The Railroad-Reorganization and Regulatory Reform Act (4R Act) of 1976 becomes law

This law established the Northeast Corridor Improvement Project. It authorized funds, set trip-time goals and fixed a completion date. Unfortunately each of these critical elements - dollars, scope and schedule - stood independent of the others. Understanding this fundamental flaw in the legislation is essential to an understanding of all that has gone on since its passage.

NECIP funding was the result of political compromise, not engineering estimates. The 3R Act sponsored engineering studies all assumed service goals based on the 150 mph system identified in the September 1971 Recommendation. Congress was aware of this assumption and realized that such a system would cost $4 billion, or more. The Administration would not, however, support such a funding level. The negotiations that ensued finally settled on $1.75 billion. Unfortunately, this amount was not related to trip time goals, also reached through compromise, (2 hours 40 min. NY - Washington and 3 hours 40 min. NY - Boston). The goals in turn were unrelated to the schedule. The preliminary engineering work, although fully appropriate to the 100 mph system it assumed, did not provide a basis for establishing a coherent, self-contained, cost-effective program at much lower levels of investment. This work was, however, the base for much of the early engineering work on the NECIP.

Amtrak inherited from the bankrupt Penn Central a seriously delapidated rail line - the Northeast Corridor. Before conveyance of the property, Conrail made every effort to select the best equipment and most experienced management personnel.

Fall 1976 — The Northeast Corridor Improvement Project office is established within FRA.

Secretary Coleman was determined that FRA, and not Amtrak, control the Project. This insistence resulted in a split of authority between the project management and the owner/operator of the service, a built-in institutional complication that took some years to resolve.

In an effort to limit the number of full-time Federal employees hired by FRA, the Federal Highway Administration (FHWA) was directed to transfer engineers to the Corridor Project. Although the transfer was voluntary, the engineers were still FHWA employees and knew that their career goals meant returning to FHWA.

October 1976

The architectural/engineering consortium of DeLeuw, Cather/Parsons (DC/P) is competitively selected.

DC/P immediately set out to hire a complete staff of engineers, planners, procurement specialists, computer programmers, etc. Mindful of the five year deadline imposed by the 4R Act DC/P had, by early 1977, nearly 900 people on their payroll.

While indispensable and inevitable, the hiring of a program management contractor added a third major organization, and still further institutional complexities, to the project structure.

April 1977

NECIP produces the $3.5 billion Baseline Implementation Master Plan (BLIMP).

The baseline program was to provide for the future capability of a 150 mph operation. It was an attempt to estimate the cost of the engineering studies completed prior to the passage of the 4R Act, and to provide a baseline from which the $1.75 billion program could be developed. The plan included 900 miles of dedicated, high speed, concrete tie track with over 300 curve realignments; 34 bridge replacements and 721 bridge rehabilitations/repairs; and right-of-way fencing of the entire length of the Corridor. Corridor-wide electrification of 25kV, 60 Hz with new or retensioned catenary was planned along with the new speed signals and Centralized Traffic Control (CTC) from Washington to Boston and a complete, Corridor-wide microwave communications system. also planned was the rehabilitation of 12 stations and the construction of three (3) new stations, 14 maintenance-of-way bases and 5 new equipment service facilities.

Table A-1 (Column 1) shows the BLIMP estimate by program element, and traces the many budgetary changes in the NECIP discussed below.

Budget Assumptions of BLIMP

- 9% Inflation
- February 1981 Program Completion
- Legislative Emphasis - Safety, Reliability, Trip Times and Provision for Future Improvements

TABLE A-1

NECIP PROGRAM COST TRENDS (APRIL 1977 TO PRESENT)

($ in Millions)

NECIP Subsystem	(1) BLIMP 4-77	(2) $ (3)-(1)	(3) IMP 8-77	(4) Cost Growth (5)-(3)	(5) 8-78 Est.	(6) $ (7)-(5)	(7) Redirection Study 1-79	(8) Cost Growth (Note 1) (7)-(5)	(9) 8-79 Est.	(10) $ (11)-(9)	(11) DMP 3-80
Section Improvements	404.7	-253.5	151.2	57.5	208.7	-124.1	84.6	-21.4	63.2	+6.9	70.1
Track	868.3	-420.1	448.2	291.5	739.7	- 17.7	722.0	+189.9	911.9	-102.8	809.1
Bridges	396.9	-154.4	242.5	77.7	320.2	- 80.6	239.6	+ 76.9	316.5	- 61.1	255.4
Electrification	425.8	-191.0	234.8	199.2	434.0	- 84.1	349.9	+ 55.4	405.3	-106.8	298.5
Signals	260.6	- 97.3	163.3	124.9	288.2	- 28.5	259.7	+105.4	365.1	+ 26.2	391.3
Communications	33.0	- 8.3	24.7	12.7	37.4	-3.8	33.6	- 0.5	33.1	- 23.8	9.3
Fencing	99.8	- 51.3	48.5	13.8	62.3	- 15.7	46.6	- 5.0	40.8	- 19.5	21.3
Grade Crossings	3.6	+0.4 (4)	4.0	12.0	16.0	0	16.0	+0.2 (1)	16.2	-0.2	16.0
Stations	451.6	-304.9	146.7	36.4	183.1	-16.3	166.8	+28.2 (1)	195.0	0	195.0
Service Facilities	244.3	-142.5	103.8	81.3	185.1	-25.2	159.9	+27.7	187.6	-39.5	148.1
Tunnels	34.6	-16.2	18.4	11.3	29.7	0	29.7	+7.3	37.0	-6.4	30.6
Program Management & Systems Engrg.	275.0	-116.6	158.4	137.2	295.6	0	295.6	+1.7	297.3	-16.0	281.3
Program Total	3502.2	-1757.7	1744.5	1055.5	2800.0	-396.0	2404.0	+465.0	2869.0	-343.0	2526.0 (2)

NECIP Subsystem	(12) Subsystem Revision (Note 1)	(13) Cost Growth	(14) Inflation Adjustment (Note 3)	(15) 11/80 Est. (12) + (13)+(14)	(16) Cost Reduction	(17) $310M Budget Adj.	(18) Total $ (16)+(17)	(19) Restructured Program 2/81 (15)-(18)	(20) Present Program 2/82
Section Improvements	177.1	5.2	6.5	188.8	-12.3	-	-12.3	176.5	149.2
Track	671.6	24.2	10.0	705.8	- 4.7	-	-4.7	701.1	691.3
Bridges	232.8	20.1	20.0	272.9	-46.9	-40.0	-86.9	186.0	170.0
Electrification	266.4	10.0	34.0	310.4	-80.3	-145.0	-225.3	85.1	85.1
Signals	431.5	87.0	60.3	578.8	-143.1	-100.0	-243.1	335.7	339.3
Communications	5.6	2.0	0.5	8.1	- 3.3	-	-3.3	4.8	4.8
Fencing	11.3	0	0.2	11.5	- 5.0	-	-5.0	6.5	6.5
Grade Crossings	16.0	0	0	16.0	0	-	-	16.0	14.0
Stations	192.4	7.5	16.0	215.9	-22.6	-25.0	-47.6	168.3	191.1
Service Facilities	162.2	17.9	26.5	206.6	-38.7	-	-38.7	167.9	174.2
Tunnels	49.7	7.1	7.0	63.8	-3.2	-	-3.2	60.6	54.2
Program Management & Systems Engrg.	283.4	0	0	283.4	-1.9	-	-1.9	281.5	281.5
Program Total	2500.0 (2)	181.0	181.0	2862.0	-362.0	-310.0	-672.0	2190.0	2190.0

(1) Reflects scope reassignments among subsystems as well as cost estimate growth.
(2) Subsystem redefinition moved scope and budget. Difference between total of $2526 and $2500 is a reduction in reserves.
(3) Adjusts costs to completion using inflation factors of 13%/yr. for construction and 8-10%/yr. for Amtrak force account in lieu of previously directed 7% factor for all elements.
(4) Includes $75.5 million of local share funding not assumed in BLIMP estimates. Effective scope reduction equals $219.4 million.

August 1977 — NECIP (FRA and DC/P) prepare Implementation Master Plan (IMP)

Between April and August of 1977 a $1.75 billion program was developed to achieve the legislated goals. During this time, a total of $1.75 billion was deleted from the BLIMP of projects which were not necessary to meet the goals of the 4R Act. A description of the reductions follows:

- \- $ 97.3M - Signalling, Centralized Traffic Control (CTC) between Wilmington and New York.
- \- $191.0M - New or retensioned catenary between Washington and New York.
- \- $142.5M - Selected improvements at service facilities.
- \- $156.4M - 356 Bridges.
- \- $253.5M - 101 Curve Realignments.
- \- $ 51.3M - 781 Miles of fencing.
- \- $ 8.3M - Communications along the Corridor.
- \- $304.9M - Station improvements.
- \+ $ 0.4M - Private grade crossings elimination
- \- $420.1M - 475 Miles of concrete ties. 868 Miles of CWR and other track work.
- \- $ 16.2M - Tunnel improvements.
- \- $116.6M - Program management.

Total: - $1757.7M (See Column 2 in Table A-1)

Preparation of the IMP, incorporating the above reductions, began immediately after completion of the BLIMP. It was the first attempt to produce a $1.75B program which would achieve the goals and meet the schedule of the 4R Act. The IMP included over 425 miles of high-speed concrete tie track with over 200 curve realignments and 51 new or reconfigured interlockings; 35 bridge replacements and 365 bridge rehabilitation/repairs; and 114 miles of right-of-way fencing. Corridor-wide electrification at 25kV 60Hz for 120 mph speeds was planned (except in the Metropolitan Region where the MTA/CDOT conversion to 12.5kV 60Hz would remain) along with new speed signals from Washington to New Rochelle and New Haven to Boston. Centralized Traffic Control (CTC) was to be installed from Washington to Wilmington, from New York to New Rochelle, and from New Haven to Boston, and a complete Corridor-wide microwave communications system was planned. Also included was the less ambitious rehabilitation of 12 stations and construction of three (3) new stations, 13 maintenance-of-way bases, and six (6) new equipment service facilities. (The IMP estimates for the above items appear in Column 3 of Table A-1).

Budget Assumptions of IMP

- 7% Inflation
- February 1981 Program Completion Date
- Legislative Emphasis - Safety, Reliability and Trip Times.

January 1978 — Secretary Adams calls for Redirection Study

NECIP announced that the cost and time estimates accompanying the Implementation Master Plan were far too low. When Secretary Adams learned this he changed the FRA management of the NECIP and ordered a "Redirection Study." His instructions were that the Project office identify a realistic scope of work, set a schedule that all parties could agree to and take into consideration the needs of other corridor users (i.e., freight and commuter operators).

August 1978 — NECIP issues interim cost estimates.

While the Redirection Study was still underway, an interim cost estimate was prepared (Column 5 in Table A-1).

Between August 1977 and August 1978 the estimated cost of the project had grown from $1,744.5 to $2.8B. The reasons for this increase of $1.05B are summarized below:

Reasons for Increase in the Budget

- $375.5M - Changes in Cost Estimates
- $390.0M - Scope Changes
- $290.0M - Additional Escalation

$1055.5M (Completion date extended two years)

January 1979 — FRA Issues Redirection Study

The Redirection Study Program was the result of a comprehensive analysis of the requirements of the Northeast Corridor with regards to all users and proposed those projects which would most efficiently and economically allow achievement of the legislated goals. It was a close examination to determine which items were essential to build the proposed system and how long it would take to build them.

The major differences between this program and IMP were: a decrease in unnecessary speed related projects with an emphasis on alternative, less expensive ways to meet trip time goals; more emphasis on projects improving system reliability such as equipment service facilities; and more emphasis on projects which were advantageous to freight and commuter service.

The reduction in scope of $396 million from the IMP included the following deletions (See Columns 6 and 7 of Table A-1).

- $124.1 - 150 Curve realignments
- $ 17.7 - Track improvements - wood tie installation.
- $ 80.6 - 145 Bridges.
- $ 84.1 - Electrification improvements.
- $ 28.5 - Signalling improvements.
- $ 3.8 - Communications along the Corridor.
- $ 15.7 - Fencing
- $ 16.3 - Stations (less ambitious Washington Union Station).
- $ 25.2 - Four (4) maintenance-of-way bases.

Total $396.0

Budget Assumptions of Redirection Study

- o 7% Inflation
- o 1983 Program Completion
- o Legislative Emphasis - Safety, Reliability, and Trip Times

August 1979 — NECIP Prepares New Estimate

The Redirection Study had concentrated on the system requirements and their effect on future operations. Between August 1978 and March 1979 a draft Corridor Master Plan (CMP) was completed based on the $2.404 billion program level. The problems that existed with this draft made it evident that the budget was not adequate. In March 1979 the Project Director ordered a 'bottoms up' estimate to be done jointly by Amtrak, DCP, and FRA to determine the actual cost of the $2.404 billion program. The effort took six months of continual meetings where every project, schedule, and cost was agreed upon by all parties. The result was a $2.869 billion cost estimate, and the reasons for the $465 million increase are summarized below. (See Columns 8 and 9 of Table A-1).

Reasons for Increase in the Budget (As of August 1979)

- o $276 million - Changes in cost estimates
- o $106 million - Scope changes
- o $ 83 million - Additional escalation

$465 million

March 1980 — NECIP Publishes $2.526 Billion Corridor Master Plan (CMP)

In response to continuing cost escalation, the NECIP prepared a new estimate (Columns 10 and 11 of Table A-1).

The March 1980 CMP was the first published Master Plan for the Project. The program included a major track renewal effort, curve realignments and interlocking reconfigurations capable of sustaining the trip time goals, and 230 bridge rehabilitations or replacements. Conversion of electrification on the south end was deleted, but the new electrification north of New Haven remained. Improvements remained at 15 stations, and construction was planned for four equipment service facilities and four maintenance bases.

Scope deletions made by the CMP, with the express approval of the Secretary, were as follows:

- \- $ 6.9 - Section improvements
- \- $102.8 - Track maintenance
- \- $ 61.1 - 18 Bridges
- \- $ 0.2 - Private grade crossing elimination
- \- $106.8 - Conversion of electrification to commercial power from Washington to New York
- \+ $ 26.2 - Additional cost of signal system
- \- $ 23.8 - Communications along the Corridor
- \- $ 19.5 - Fencing
- \- $ 39.5 - Five maintenance-of-way bases and one service facility

- $ 6.4 - Selected tunnel improvements

- $ 16.0 - Program management

Total $343.0 Million

Budget Assumptions of CMP

- o 7% Inflation

- o 1985 Completion date

- o Legislative Emphasis - Safety, Reliability, and Trip Times

May 1980 — The Passenger Railroad Rebuilding Act of 1980 Becomes Law

Funding was set at $2.5 billion, trip-times were reduced in importance, and the completion date extended to 1985. All these changes reflected the realities incorporated in the CMP.

November 1980 — NECIP Issues Revised Cost Estimate

The $2.526 billion Program was based on a 7% escalation rate. It soon became evident that inflation was well above this level. Between May 1980 and November 1980 the estimates were revised to include a 12 to 13% escalation rate. The NECIP also had experienced icnreased costs, primarily in the signal system. The $2.5 billion increased to $2.862 billion. (The $26 million in the $2.526 billion program was deleted by using reserves.) The reasons for the $362 billion increase are summarized below (See columns 12, 13, 14, and 15 of Table A-1).

Reasons for Increase in the Budget

- o $141 Million - Changes in Cost Estimates

- o $ 40 Million - Scope Changes

- o $181 Million - Additional Escalation

$362 Million

February 1981 — NECIP is Restructured to Counteract Cost Escalations and to Support President's Economic Recovery Program

Reviews were held between November 1980 and January 1981 to determine the way to counteract the $362 million cost increase announced in November 1980 so as to maintain the program cost of $2.5 billion. Recommendations had been made but not yet executed when in February 1981 the Administration reduced the program by a further $310 million for a total reduction of $672 million. A reanalysis was then completed to accommodate both reductions in a coordinated manner, in keeping with an evolving emphasis on passenger comfort, safety, convenience, and reliability as opposed to trip time reductions per se. The reductions of $362 million and $310 million are summarized below. (See Columns 17, 18, and 19 of Table A-1.)

$362M (to reduce NECIP cost to $2.5 billion authorized)

- $12.3 - Section improvements, speed related curves
- $ 4.7 - Track
- $46.9 - Bridges
- $80.3 - Electrification between New Haven and Boston
- $143.1 - Speed related signaling
- $ 3.3 - Communications
- $ 5.0 - Fencing - overhead bridges for North End electrification
- $22.6 - Stations
- $38.7 - Service facilities
- $ 3.2 - Tunnels
- $ 1.9 - Program Management

$310M (to reduce NECIP cost from authorized level to budgeted level)

- $40.0 - Connecticut DOT bridges
- $145.0 - Electrification between New Haven and Boston
- $100.0 - Speed related signals
- $25.0 - Washington Union and Route 128 Stations

February 1982 — Reallocations Within Existing Funding Levels Produce Present NECIP

In February 1982 some relatively minor reallocations of budgets among the various program elements took place.

The present $2.19 billion Program includes major track renewal, and emphasis on reconfiguration of interlockings but less emphasis on trip time related curve realignments, and the rehabilitation or replacement of 212 bridges. Installation of new electrification north of New Haven was deleted as well as speed signaling. Improvements are planned at 13 stations, and construction of four equipment service facilities and four maintenance bases remain. The emphasis of the program has shifted away from speed oriented improvements. Safety and reliability remain the primary goals as well as planning improvements where the greatest number of passengers will be benefited.

Budget Assumptions

- 12-13% Escalation used in the Budgets
- 1986 Program Completion Date
- Legislative Emphasis - Safety, Reliability, and Improvements between New York and Washington

Appendix B

Derivation of Trip Times for Completed Project

Table B-1: New York -- Washington

Table B-2: Boston -- New York

Table B-1

ANALYSIS OF TRIP TIME IMPROVEMENTS IN 11/83 REPORT

NEW YORK - WASHINGTON

		Time savings by project in minutes		
			To be completed at end of project	
Location	Project	Completed by 10/84	NECIP Control	Amtrak Control
NY-Newark	Portal Bridge	0	0.25	
	Curve 240.2 to 80 mph			0.03
	Curve 243/245 to 55 mph			0.20
	North River Tunnel to 70		0.31	
	High Line Signals		0.75	
Newark-Trenton	Curve 249 to 90 mph			0.22
	Curve 252/263 to 70 mph			0.15
	Signals Lincoln-Millham-Fair		0.58	
	Millham-Fair to 120 mph, Curve 279/380 to 105	2.30	0.36	
	Signals Dock to Hunter		0.08	
	Signals Hunter-No. Elizabeth		0.13	
	Signals Elmora-Union		0.25	
Trenton-30th St.	Signals Morris-Croydon		0.45	
	Curve 293 to 110 mph			0.13
	Curve 289/299-1/299-2			0.23
	Curve 303A to 50 mph			0.17
	Signals Cornwells Heights		0.08	
	Signals Holmes-Frankford		0.13	
	Zoo-North Philadelphia		1.23	
30th St.-Wilmington	54th St. Interlocking	1.13		
Wilmington-Baltimore	Curve 327-328			0.60
	Curve 342 to 95 mph			0.08
	120 mph Ragan-Northeast		0.50	
	Curve 342 rail MAS* Northeast-Perryville			0.27
	120 mph Oak-Aberdeen Edgewood-Magnolia	0.50		
	Reconfigure Bay, Biddle, B&P, Union Jct.		2.85	
Baltimore-New Carrollton	Reconfigure Fulton Interlocking	0.40		
	120 mph MAS* Grove-Seabrook/ Magruder Branch		1.57	
New Carrol-lton-Wash	NY Ave/Curve 415/WU7	—	1.06	—
TOTALS		4.33	10.58	2.08

Total additional time saving at project completion: 10.58 plus 2.08 = 12.66 minutes

Table B-2

BOSTON -- NEW YORK

The effect of these improvements at Harold and the bridges, together with alignment improvements at Providence Station and elimination of current construction speed restrictions, should permit a 3:58 timetable with 90 percent reliability. This estimate, which FRA believes to be conservative, is based on the following breakdown:

	Trip Time Improvements (Minutes)		Trip Time Decrements (Minutes)
	Direct Time	Congestion Effect	
Harold	1	2	
Bridges	4		
Providence	2		
Elimination of Construction Speed Restrictions		4	
Effect of congestion from increased commuter traffic between Boston and Canton Junction			2
Total	7	6	-2

Grand Total = 7 + 6 - 2 = 11 minutes

Estimated Trip Time = 4:09 - 0:11 = 3:58