U.S. Department of Transportation

Commuter Rail State-of-the-Art

A Study of Current Systems

December 1992

NOTICE

Commuter Rail State-of-the-Art:

A Study of Current Systems

Final Report
December 1992

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METRIC / ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32) (5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5	6	7	8	9	10

CENTIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 25.40

QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and/or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10 286.

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COMMUTER RAIL STATE-OF-THE-ART: A STUDY OF CURRENT SYSTEMS

INTRODUCTION

The purpose of this research study is to compile a state-of-the-art document on current commuter rail systems in the United States. A survey was conducted to collect the relevant information from existing and proposed commuter rail agencies. Each of the existing commuter rail systems (12) presented in this report is profiled in terms of system characteristics and detailed information on operations, fare collection, stations, maintenance facilities, patronage, railcars, and feeder systems. Numerous charts profile commuter rail systems and trends, and compare commuter rail with other mass transit systems. Information in this report provides a base of information with which transportation planners can make informed decisions related to current and future transportation projects. The information in this report is a result of an extensive literature search.

Commuter rail is defined as a passenger railroad service that operates within metropolitan areas on trackage that usually is part of the general railroad system. The operations, primarily for commuters, are generally run as part of a regional system that is publicly owned, or by a railroad company as part of its overall service [1,2].

In the United States the term commuter rail is nearly universal; in San Francisco it is shortened to "commute" service. On Long Island it is simply "the railroad" or "the Long Island".

In Europe the word "regional rail" is used in France, "outer suburban service" is used in England, and "S-Bahn" is used in Germany, Switzerland, and Austria. The term "regional rail" is also used in North America.

In the period after World War II, commuter rail patronage declined substantially as automobile ownership became widespread in parallel with the completion of regional highway networks. Privately owned railroad systems cut back commuter rail service, and as a result of an inability to keep revenues in line with the cost of providing service, equipment and service deteriorated. However, in recent years commuter rail has been significantly improved with the modernization of stations and equipment. Publicly articulated service standards of high reliability are marketed.

Limited mobility is a problem that many cities are currently confronted with in the United States (U.S.). City and regional traffic congestion is on the rise, causing greater travel times and increasing the amount of air pollution, which cannot continue upon the implementation of the new air pollution laws. A 1989 report indicated that 40 percent of urban roads were congested in 1970; by 1990, it could reach 77 percent [3]. Also, land used for automobile parking is limited as well as expensive.

In many American cities, urban street systems and parking facilities are hard-pressed to accommodate the growing numbers of automobiles. In addition, increasingly dispersed residential and employment areas are also contributing to the difficulties in providing cost-efficient transit service. Only incremental improvements can be made to our metropolitan road systems. Thus commuter rail service, which is being provided in a number of areas or could be provided on existing railroad lines, has become an increasingly attractive alternative for transportation planners.

Ridership on existing commuter systems has grown significantly in the past decade. For example, one completely new service started in 1989 in Miami - Palm Beach; a new commuter service was implemented as an overlay on the existing intercity service in Southern California, and two completely new services started this year serving the Northern Virginia - Washington, D.C. market, and the Los Angeles region [2]. Existing commuter services are being expanded in several locations.

CHAPTER 1. CHARACTERISTICS

This chapter discusses commuter rail in general and highlights some of its distinguishing characteristics. Commuter rail service is characterized by long average trip length (U.S. average: 22 miles), long station spacings (2.6 miles), high speed, and a greater degree of passenger comfort (a seat for every passenger is expected) than found on other transit modes [4]. The systems are typically operated by public transit agencies on railroad right-of-way which usually have some mixture of grade separation and signalized grade crossings. The most distinguishing characteristic of commuter rail is its use of existing railroad rights-of-way. Therefore, for new systems, land acquisition and construction costs are reduced, and disruption to the surrounding environment can also be minimized. Another unique characteristic of commuter rail is its relatively low energy consumption rate. The U.S. Energy Department estimated the energy consumption rates (BTU per passenger mile) for the following transportation modes [5]:

Mode	BPU/Passenger Mile
Automobile	3,598
Transit Bus	3,415
Transit Rail	3,585
Commuter Rail	3,155

It is clear that commuter rail is very efficient in terms of energy consumption.

Most commuter rail networks consist of a line or number of lines radiating from the Central Business District (CBD) with stations located at suburban town centers. Park and Ride, Kiss and Ride, bus feeders, and walking are generally used as access modes. Central city and other stations are sometimes combined with intercity rail or rapid rail stations. Commuter rail serves predominantly suburb-to-CBD commuter travel, and typically has heavily peaked traffic and highly directional passenger flows.

Commuter rail trains are comprised of single level or double-decked cars. There is a wide variety of choices in equipment available for commuter use. Cars in commuter service in the U.S. today include:

(1) cars propelled by locomotives,
   a) either pulled by locomotives, or
   b) equipped with cab cars for push pull operations, and

(2) self propelled vehicles
   a) operated as a single units, or
   b) as multiple unit trains, or
   c) with trailer cars in various combinations

(3) each of the above combinations is operated by
   a) electricity, or
   b) diesel engines

(4) single level cars include those with access to
   a) only low level platform
   b) only high level platform

c) both low and high level platforms

(5) cars known by commuters as "double deck" actually fall into three separate categories as follows:
   a) duplex arrangement - aisle at standard floor height and seats located two steps above or below
   b) gallery arrangement - aisle at standard floor height and access to gallery by four circular staircases
   c) bi-level - two complete floors across the full width of the car containing seats with access via a third level over the trucks of each car

[note that each of these types is available for each type of operation indicated under item 1, 2, 3, and 4.]

(6) "double deck cars" configurations exist for
   a) access only low level platform
   b) access only high level platform
   c) access to both low and high level platforms

(7) door arrangements are available at
   a) ends of cars only
   b) mid-point of cars only
   c) quarter point of cars only
   d) both ends and mid-points of cars.

The general data, plan view, dimensions, weight and capacity, and other pertinent information of a Metro-North (New York) single level push-pull commuter car manufactured by Bombardier Inc. are shown in Appendix A. The general data, plan view, dimensions, weight and capacity, and other pertinent information of a Tri-Rail (South Florida) bi-level commuter car manufactured by UTDC Inc. are shown in Appendix B.

Commuter rail trains can be pulled or pushed by a locomotive (electric or diesel), or also self-propelled with high horsepower electric locomotives outperforming diesel by a large margin. The general data, dimensions, weight and supplies, curve negotiation, and other pertinent information of a Metra (Chicago) F40PH diesel locomotive manufactured by General Motors are shown in Appendix C. The general data, dimensions, weight and supplies, curve negotiation, and other pertinent information of a NJT (New Jersey) GP40FH-2 diesel locomotive remanufactured by Morrison-Knudsen Corporation are shown in Appendix D. The general data, plan view, and other specification information of a self-propelled gallery car manufactured by Bombardier Inc. are shown in Appendix E.

A self-propelled, electric-powered SEPTA (Philadelphia) commuter train is shown in Exhibit 1. The interior view of a SEPTA (Philadelphia) commuter car is shown in Exhibit 2. The layout of a SEPTA (Philadelphia) commuter rail station and its parking lot is shown in Exhibit 3. Adequate parking at the suburban stations is critical to the success of any commuter rail system.

A diesel locomotive-hauled, bi-level Metra (Chicago) commuter train is shown in Exhibit 4. A diesel locomotive-hauled, bi-level Tri-Rail (South Florida) commuter train is shown in Exhibit 5. The upper-level view of a Tri-Rail bi-level commuter car is shown in Exhibit 6. Exhibit 7 shows the CalTrain (San Francisco) commuters disembarking from a train. A simple platform design of a Caltrain station is shown in Exhibit 8.

Commuter trains serve high-level rapid-

Exhibit 1. A Self-Propelled, Electric-Powered SEPTA (Philadelphia) Commuter Train.


Exhibit 2. An Interior View of a SEPTA (3/2 seating) Commuter Rail Car.

Exhibit 3. The Layout of a SEPTA Commuter Rail Station.

Exhibit 4. A Diesel Locomotive-Hauled, Bi-Level Metra (Chicago) Commuter Train.

Exhibit 5. A Diesel Locomotive-Hauled, Bi-Level Tri-Rail (South Florida) Commuter Train.

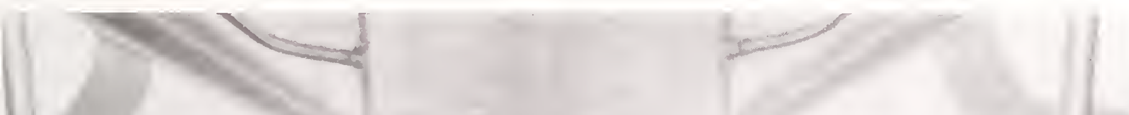
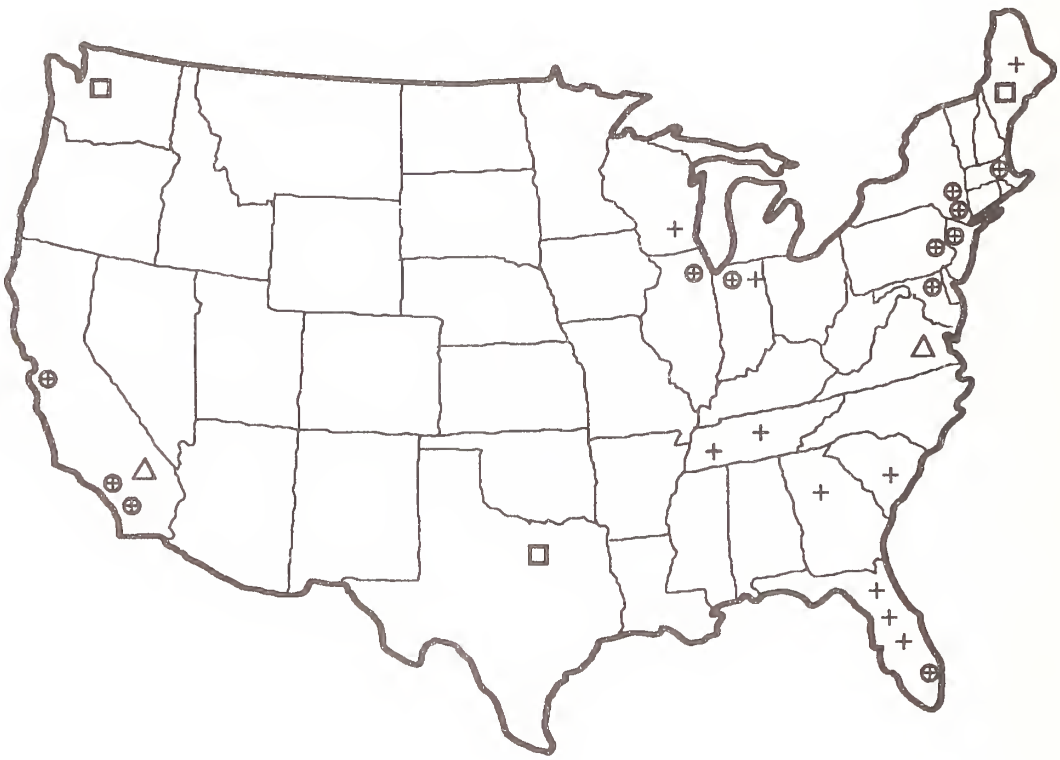


Exhibit 6. The Upper-Level View of a Tri-Rail Bi-Level Commuter Car.

Exhibit 7. The CalTrain (San Francisco) Commuters Disembarking from a Gallery Car.

Exhibit 8. A Simple Platform Design of a CalTrain Station.

transit type station platforms or simple low-level, suburban station platforms. In addition, the trains may run with few cars or many cars, depending on demand. In short, commuter rail is exceptionally flexible and adaptable to local conditions [6]. For longer distance commuting travel, the only competitive form of land transit besides the automotive or van is the express bus. Ferry services also have relatively long commute distances. Existing and proposed commuter rail systems in the United States (U.S.) are shown on Figure 1 [6]. Technical, operational, and system characteristics of different rail transit modes are shown in Table 1 [4].



⊕ Existing Systems

Metropolitan Transportation Authority
Regional Transportation Authority
New Jersey Transit Corporation
Southeastern Pennsylvania Transportation Authority
Massachusetts Bay Transportation Authority
California Department of Transportation (L.A.)
Maryland Department of Transportation
Northern Indiana Commuter Transportation District
Tri-County Commuter Rail Authority
Connecticut Department of Transportation
Orange County Transportation Commission
California Department of Transportation (S.F.)

△ New Systems

Virginia Railway Express
Southern California-Metrolink

□ Proposed Systems

Dallas, Texas
Seattle, Washington

\+ Under Consideration

Bath, Main
Burlington, Vermont
Charleston, South Carolina
Atlanta, Georgia
Nashville, Tennessee
Memphis, Tennessee
Tampa, Florida
Orlando, Florida
Jacksonville, Florida
Cleveland, Ohio
Milwaukee, Wisconsin

Figure 1 Existing and Proposed Commuter Rail Systems in the U.S.

Table 1. Technical, Operational, and System Characteristics of Different Rail Transit Modes

	Light Rail	Rapid Rail	Commuter Rail
Vehicle/train characteristics			
Minimum train composition	1	1	1
Maximum train composition	4	10	16
Vehicle length (ft)	46-98	48-75	66-85
Vehicle capacity (seats/vehicle)	25-80	32-84	80-125
Vehicle type	Single-level	Single-level	Single-level or Bi-level
Fixed facilities			
Fare collection	Vehicle/Station	Vehicle/Station	Vehicle/Station
Access control	None or Full	Full	None or Full
Power supply	Overhead (d)	3rd Rail/Overhead	Overhead/3rd rail Diesel hauled or Diesel self-propelled
Operating characteristics			
Maximum speed (mph)	60	75	100
Avg. Operating speed (mph)	11-25	16-38	25-44
Capacity (persons/hr)	6,000-20,000	10,000-30,000	8,000-35,000
Cost per passenger-mile (a)	$.42	$.33	$.27
Revenue per passenger-mile (b)	$.14	$.15	$.13
Revenue/Cost Ratio (a/b)	0.33	0.45	0.48
Passenger-mile/employee (c)	139,643	248,905	335,959
Passenger-mile/vehicle-mile (c)	23.5	21.4	33.9
Kilowatt Hour/car-mile (c)	10.1	6.1	9.2
Kilowatt Hour/car-hour (e)	100	150	250
Systems aspects			
Avg. station spacing (miles)	0.5	1.0	2.5
Average trip length	short to Long	Medium to Long	

(a) Preliminary 1990 U.S. operating cost per passenger-mile, source: [4].
(b) Preliminary 1990 U.S. operating revenue per passenger-mile, source: [4].
(c) Urban Mass Transit Administration (UMTA) 1990 Urban Mass Transit Statistics.
(d) SEPTA's Norristown Line has characteristics of both light and rapid rail. It uses 3rd rail power collection.
(e) Source: E.L. Tennyson, P.E..

CHAPTER 2 DATA COLLECTION

Commuter Rail statistical information collected during this research effort is provided in a series of tables in this chapter. All pertinent literature related to equipment, facilities, operations and maintenance of commuter rail systems was retrieved through a computerized search of transportation data bases. Various statistics were collected on existing commuter rail systems through Federal Transit Administration (FTA) reports, American Public Transit Association (APTA), and railroad industry publications.

In addition, a survey was conducted in late 1991 to collect pertinent information on 12 existing commuter rail operations in the United States. The survey forms are shown in Appendix F. Nine commuter rail agencies responded to survey requests, and their operational statistics are discussed in this paper. The following information on current commuter rail systems was collected:

1. Length of the system
2. Number of stations
3. Type of feeder systems
4. Maximum & average operating speeds
5. Weekday/weekend service schedules
6. Vehicle characteristics (dimensions, capacity,etc.)
7. Guideway characteristics
8. Power source (diesel or electric locomotive)
9. Station configuration (open or closed)
10. Facilities to accommodate handicapped
11. System costs
12. Ridership statistics
13. Revenue data
14. Cost breakdown
15. Maintenance facilities
16. Employment figures

For the three agencies who did not respond to the survey requests, data was collected from FTA 1990 Section 15 Report and other sources. System description for the 13 commuter rail services is shown in Table 2 [7,8]. Weekday and weekend service schedules are shown in Table 3. The results of the survey are shown in Table 4.

Table 2. System Description for Existing Commuter Rail Systems in the United States.

No.	Name of the System	Largest City	Route Miles	No. of Stations	Contracted Operator
1	Long Island Rail Road (LIRR)	New York	319.1	134	No
2	Metro-North (M-N)	New York	338.1	120	No
3	Metropolitan Rail (Metra)	Chicago	499.5	233	partially
4	New Jersey Transit (NJT)	New York	781.0*	160	No
5	Southeastern Pennsylvania Transp. Authority (SEPTA)	Philadelphia	282.0*	159	No
6	Massachusetts Bay Transportation Authority (MBTA)	Boston	244.0	101	Yes
7	CalTrain Peninsula Commuter Service (PCS)	San Francisco	47.0	28	Yes
8	Maryland Rail Commuter (MARC)	Washington, D.C.	187.0	38	Yes
9	Northern Indiana Commuter Transp. District (NICTD)	Chicago	88.0	27	Yes
10	Tri-County Rail (Tri-Rail)	Miami	66.4	15	Yes
11	Orange County Commuter (OC)	Los Angeles	128.0**	n/a	Yes
12	Connecticut DOT (Conn)	New Haven	32.8	7	Yes

* Source: [4].
** FTA 1990 Section 15 Annual Report, Source: [5].

Table 3. Service Schedules for Existing Commuter Rail Systems in the United States.

No.	Name of the System	Number of Trains/Day/Direction		
		Weekday	Saturday	Sunday
1	Long Island Rail Road (LIRR)	357 EB 366 WB	230 EB 233 WB	230 EB 233 WB
2	Metro-North (M-N)	244 SB 250 NB	147 SB 150 NB	143 NB 145 NB
3	Metropolitan Rail (Metra)	330	148	81
4	New Jersey Transit (NJT)	285 [4]	128	108
5	Southeastern Pennsylvania Transp. Authority (SEPTA)	180 [4]	124	87
6	Massachusetts Bay Transportation Authority (MBTA)	187	53	28
7	CalTrain Peninsula Commuter Service (PCS)	27	13	10
8	Maryland Rail Commuter (MARC)	35	0	
9	Northern Indiana Commuter Transp. District (NICTD)	19 WB 21 EB	10 WB 11 EB	10 WB 11 EB
10	Tri-County Rail (Tri-Rail)	12	9	0
11	Connecticut DOT (Conn)	6/am/WB 8/pm/EB	0	

Table 4. Results of the Survey.

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
1.Route Miles	319.1	338.1	499.5	244	47	187	88	66.4	32.8
No. of stations	134	120	233	101	28	38	27	15	7
2.Feeder Systems:	Yes	Yes	Yes	Yes	Yes	Yes	n/a	Yes	Yes
3.Service Schedules									
(no. of trains/day/direction)									
Weekday schedule	360	244	660	374	54	70	19	12	7
Weekend schedule: Sat.	232	147	296	106	26	0	10	9	0
Sun.	232	143	162	56	19	0	10	0	0
4.Vehicle characteristics:									
Dimensions(ft):Length	85	85		85	85	85	85	84	85
Width	10.5	10		10'6"	11	10.5	10'6"	9'10"	10.5'
Height	13.2	14		12'8"	15'11"		13'1"	15'11"	13.5'
# of axles	4	4		4	4	4	4	4	4
Seating capacity	120	120			148	121	93	162	66
vehicle capacity	150	150		140	248			438	81
(spaces/vehicle)									
Single (S) or Bi- (B)level vehicle	S	S	Both	Both	B	S	S	B	S
Train composition:Minimum	4	4	2	4	3	2	1	4	2
(No. of cars) Maximum	12	12	11	9	6	8	8	10	4
Handicapped Facilities	No	No		Yes	No	Yes	Yes	Yes	Yes
Distance bet. Truck center(ft)	59.4			59.5	59.5	59.5	59.5	64	60
Weight: tare/gross(tons):	47.5	54			55.8	99.4	59	48.66	64.5

Table 4. (Continued, 2/6)

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
Maximum speed (mph)	80	95		102	100	125	80	79	100
No. of locomotives	62	71	125	52	20	15	1	6	5
Coaches	150	107		310		87			10
MU	934	677	206			13	41		
Bi-level	10	0	682	75	73		6	21	
5.Fixed facilities									
Guideway:									
Shared w/freight train	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
or /dedicated service			Yes						
Exclusive R-O-W(% of Length)	100	62.9	100	0	100	0	98	0	0
Fare collection:at station	Yes		Yes			Yes	Yes	Yes	
on vehicle	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Power supply: Diesel	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Overhead		Yes	Yes			Yes	Yes		
Third	Yes	Yes	Yes						
Station access controi: none	Yes	Yes	Yes	Yes	Yes			Yes	Yes
Full						Yes	Yes		
Handicapped facilities	Yes	Yes	Partial	Yes	Yes	Yes	Yes	Yes	Yes
6.Operational characteristics:									
Maximum speed (mph)	80	95		79	100	125	79	79	90
Operation speed (mph)		90			70	110			83

Table 4. (Continued 3/6).

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
Max. frequency: Peak hour	34	53		10	5	28	4	2	2
(# of trains/hour/direction)									
Off-peak hour	0	13		6	1	14	1	2	0
Max. capacity:	37000	36090		10360	3600	3500	6400	3504	325
(persons/hour/direction)									
Reliability: High	Yes	Yes	Yes		Yes		Yes	Yes	Yes
Medium				Yes		Yes			
Low									
7.System aspects									
Network &area coverage:Radial	Yes	Yes	Yes	Yes		Yes	Yes	Yes	
or Limited CBD coverage		Yes			Yes		Yes		Yes
Average station spacing(miles)	2	3	2.1	2.4	2	4.5	3	4.4	5.46
Average trip length (miles)		27.8	21.3	28	24	30	28.4	32	32.8
Transferability : Good	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Poor							Yes		
8.Ridership & Oper. Statistics									
Annual ridership (Million):									
1990	72.4	57.95	72.2	19.2	6.34	3.46	3.48	1.44	
1989	75.4	57.34	71.2	18.5	5.62	2.7	3.43	0.78	
1988	75.1	55.89	69.8	16.3	5.6	2.23	3.5	NA	
Annual passenger miles: 1990	1938*	1544	1540	348.4	149.7	102	98.2	64.5	
(million) 1989	2019	1535	1511	330.1	132.5	81.6	96.8	32.1	

Table 4. (Continued, 4/6).

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
1988	2010*	1360	1477	291.3	132	66.9	96.6 1	NA	
Annual vehicle miles: 1990	56.7	39.6	32.7	13.2	727		2.2	1.5	
(million) 1989	57.6	40	31.8	13.1	730		2.4	1.17	
1988	57.7	38.3	31.1	10.9	732		2.4	NA	
Average Weekday ridership:									
(thousand) 1991	245.6		270.9	74.6		16	12.2	7.11	911
1990	253.6	202	271.1	71.7	21.8	13.6	12.3	5.53	
1989	264.1	201	269.5	69.1	18.7	10.7	11.9	3.11	
Average weekend ridership:									
(thousand) 1991	62.9		48.6	11.3	8.4	0	2.1	5.33	
1990	64.6	62	47.4	10.4	7.17	0	2	NA	
1989	68.4	60.2	44.5	9.3	4.78	0	1.9	NA	
passenger fare ($/trip):1991	4.03		2.26	1.66	1.42	3	2.86	2	2
1990	4.04	3.92	2.25	1.74	1.48	3	2.84	2	
1989	3.54	3.58	2.17	1.5	1.52	3	2.74	2	
9.Revenue & costs (Miilion$)									
Annual farebox revenue: 1990	292.7	221.5	155.4	33.3	9.95	10.2	9.8	2.85	0.34
1989	266.7	199.9	152.3	27.8	8.99	8.16		1.69	
1988	265.9	194	148.5	23.5	8.86	6.84		NA	
Total annual operating costs:									
1990	669.5	433.7	308.2	82.3	23.6	17.2	18.1	13	5.07
1989	653.9	408.6	291.6	78.4	22.3	15.1	7.7	12.8	

Table 4. (Continued, 5/6).

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
1988	616.6	376.7	276.2	75.8	22	12.1	5	NA	
Transportation costs: 1990	209.3	155.2	136.3	30.7	11.3		7.55	7.7	2.43
1989	200.4	140	124.5	29.6	11.2			8.9	
1988	189.4	124.4	116.3	27.4	11			NA	
Maintenance of equip. cost:									
1990	165.8	95	73.2	22.5	2.94		3.38	NA	1.12
1989	161.7	89.3	71.8	21.3	1.96			NA	
1988	154.6	85.9	66.7	21.9	1.94			NA	
Maintenance of way costs: 1990	95.9	80.6	50.9	18.5	0.56		2.9	2.7	0.66
1989	97.8	79.8	48.4	17.4	0.56			2.25	
1988	94.9	74	47.8	16.7	0.56			NA	
Administrative costs: 1990	140	102.9	47.8	10.6	2.7		4.28	2.63	0.86
1989	136.1	99.5	47	10.1	2.55		7.72	1.56	
1988	123.1	92.4	45.4	9.8	2.61		5	NA	
Annual Gov't subsidies: 1990	357	189.2	137.6	NA	13.7	1.62	7	13.14	1.86
(million) 1989	364.1	191	126.9	NA	13.3	1.63	8	11.13	
1988	331	193.5	125.5	NA	13.2	1.65	4	NA	
10. Employment statistics:									
General & administrative: 1990	848	1715		31	51	10	47	12	5
(no. of persons) 1989	824	1703		27	48	8	10	7	
1988	830			27	49	7	10	NA	
Transportation 1990	1910	980		424	151		75	NA	15

Table 4. (Continued, 6/6)

	LIRR	Metro-N	Metra	MBTA	PCS	MARC	NICTD	Tri-Rail	Conn
(trains & engine crews) 1989	1852	1004		418	139			NA	
1988	1848			392	132			NA	
Maintenance of equip. 1990	1800	1527		362	56		50	NA	23
1989	1822	1488		342	37			NA	
1988	1854			328	36			NA	
Maintenance of way 1990	1589	1611		315			50	NA	
1989	1623	1622		289				NA	
1988	1671			240				NA	
Total employees 1990	6784	5833		1132	258		222	37.5	43
1989	6762	5817		1076	224			29.5	
1988	6869	5780		986	217			NA	

* Estimate

CHAPTER 3 EXISTING SYSTEMS

Each of the 12 existing U.S. commuter rail systems is discussed and profiled separately in Chapter 3, and then compared with one another in Chapter 4. There are 12 existing commuter rail systems in the U.S. and two in Canada. The Miami - Palm Beach Tri-Rail, represents the first new commuter rail start-up in North America in decades at it's opening on January 9, 1989. Since then, four more new commuter rail services have been added: (1) Orange County, California, (2) New Haven, Connecticut, (3) Northern Virginia to Washington, D.C., and (4) Los Angeles, California. Trends of commuter rail ridership and passenger miles are shown in Figure 2 and 3 [5].

1. New York

The Metropolitan Transportation Authority (MTA) in New York has two separate commuter rail divisions: the Long Island Rail Road (LIRR) and the Metro-North Commuter Railroad. The LIRR which ranks as the third oldest railroad in the U.S., has long enjoyed the status of the nation's busiest passenger railroad. LIRR operates a commuter rail system on ten routes operating from three New York City terminals to Long Island points. Metro-North operates a commuter rail system on three principal routes from New York city's Grand Central Terminal. Park-and-ride lots are provided at most suburban stations, and local bus systems provide connecting services at many stations.

1-a. Long Island Rail Road

The Long Island Rail Road (LIRR) was chartered on April 24, 1834 with construction of the line beginning in 1835. In 1836 the company leased the Brooklyn and Jamaica Railroads, and in the same year authorized construction of the Hempstead Branch. Construction of this branch was completed in 1846.

The LIRR operates a commuter rail system of 325 route-mile serving 140 stations on ten routes operating from three New York City terminals to Long Island points as shown in Figure 4 [4].

Equipment

The LIRR's electrically powered services are operated with a fleet of 764 high-performance M-1 Metropolitan electric MU cars, and 174 similar M-3 cars supplied by Transit America during 1985-86. After electrification and extension, LIRR was able to increase its level of service to Ronkonkoma by more than a third. The use of electric operation permitted a reduction of almost 30 minutes in running times to Penn Station. Push-pull trains in LIRR's non-electric services are operated by a fleet of some 50 General Motors Electro-Motive Division GP-38-1 and MP15AC diesel electric units, and 223 passenger cars, most of which are converted from former electric MU units. A small fleet of locomotive hauled bi-level cars seating 180 or 190

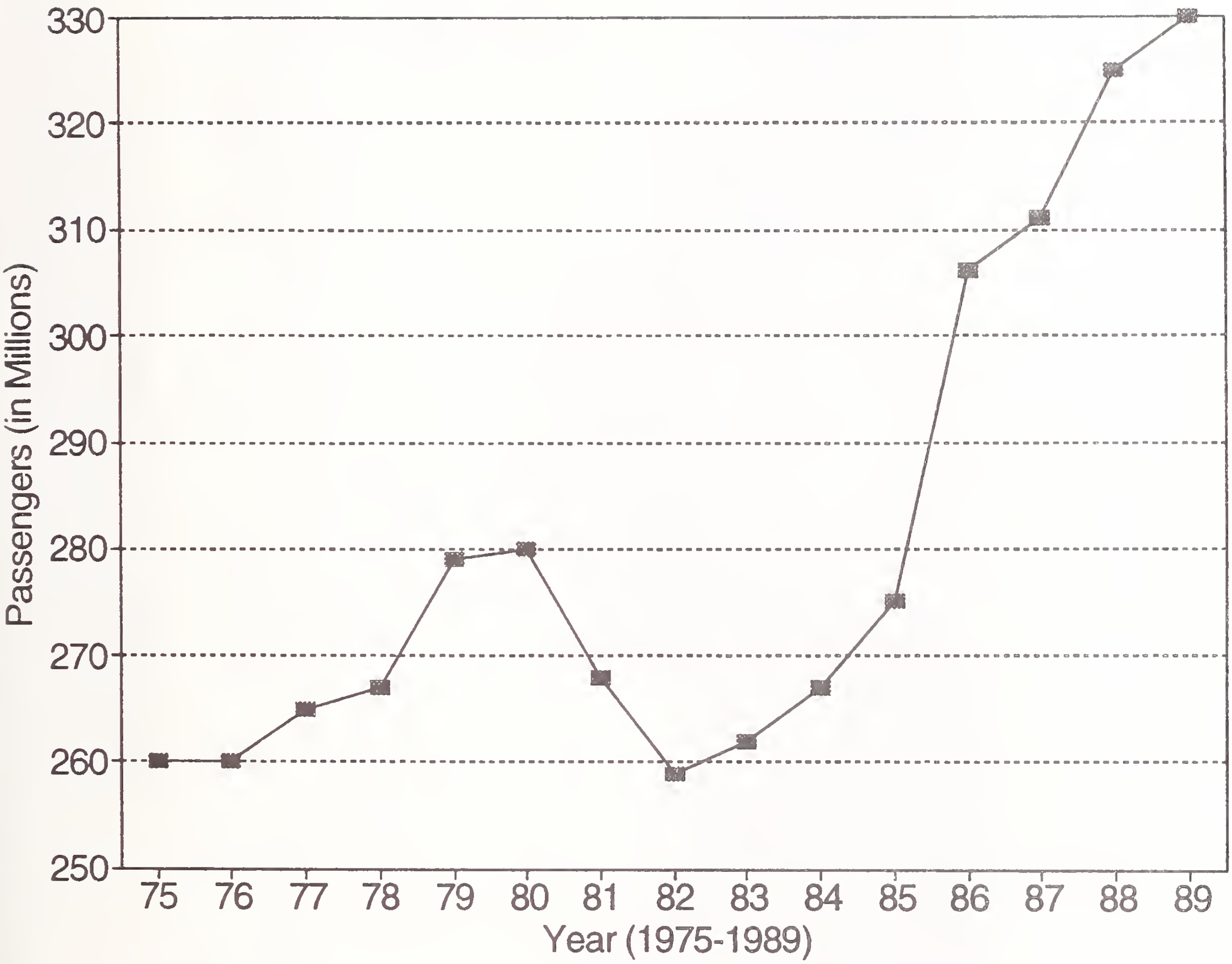


Figure 2 Commuter Rail Ridership in the United States (4).

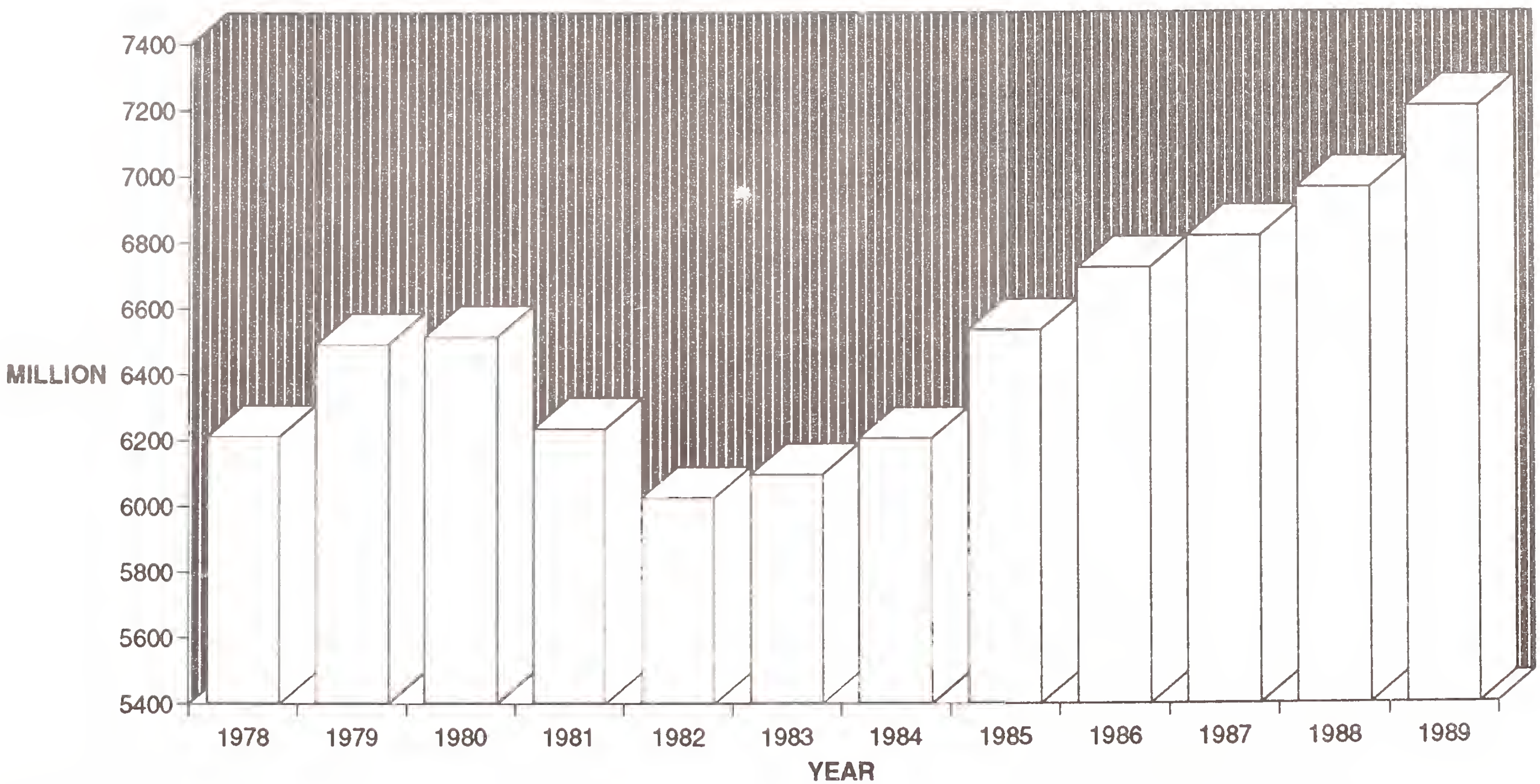
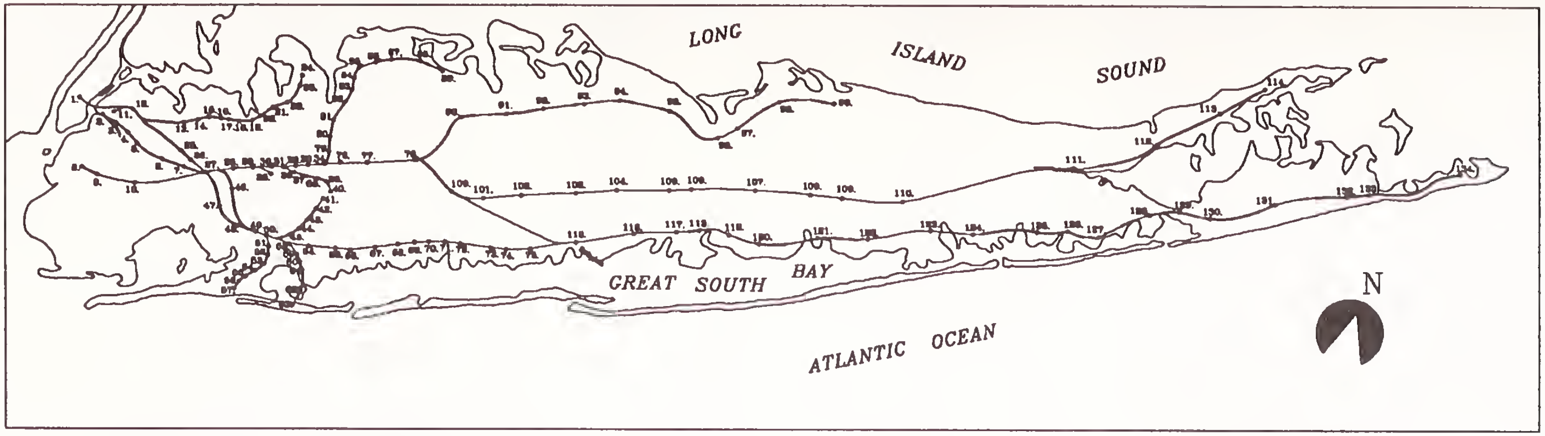


Figure 3 Trend of Commuter Rail Passenger Miles in the U.S. [4]



LONG ISLAND RAIL ROAD:

1. Pennsylvania Station
2. Long Island City
3. Penny Bridge
4. Haberman
5. Fresh Pond
6. Glendale
7. Richmond Hill
8. Flatbush Av
9. Nostrand Av
10. East New York
11. Hunterspoint Av
12. Woodside
13. Shea Stadium
14. Flushing-Main St
15. Murray Hill
16. Broadway
17. Auburndale
18. Bayside
19. Douglaston
20. Little Neck
21. Great Neck
22. Manhasset
23. Plandome
24. Port Washington
25. Forest Hills
26. Kew Gardens
27. Jamaica
28. Hollis
29. Queens Village
30. Bellerose
31. Floral Park
32. New Hyde Park
33. Merillon Av
34. Mineola
35. Belmont Park
36. Stewart Manor
37. Nassau Blvd
38. Garden City
39. Country Life Press
40. Hempstead
41. West Hempstead
42. Hempstead Gardens
43. Lakeview
44. Malverne
45. Westwood
46. St. Albans
47. Locust Manor
48. Laurelton
49. Rosedale
50. Valley Stream
51. Gibson
52. Hewlett
53. Woodmere
54. Cedarhurst
55. Lawrence
56. Inwood
57. Far Rockaway
58. Lynbrook
59. Centre Av
60. East Rockaway
61. Oceanside
62. Island Park
63. Long Beach
64. Rockville Centre
65. Baldwin
66. Freeport
67. Merrick
68. Bellmore
69. Wantagh
70. Seaford
71. Massapequa
72. Massapequa Park
73. Amityville
74. Copiague
75. Lindenhurst
76. Carle Place
77. Westbury
78. Hicksville
79. East Williston
80. Albertson
81. Roslyn
82. Greenvale
83. Glen Head
84. Sea Cliff
85. Glen Street
86. Glen Cove
87. Locust Valley
88. Mill Neck
89. Oyster Bay
90. Syosset
91. Cold Spring Harbor
92. Huntington
93. Greenlawn
94. Northport
95. Kings Park
96. Smithtown
97. St. James
98. Stony Brook
99. Port Jefferson
100. Bethpage
101. Farmingdale
102. Pinelawn
103. Wyandanch
104. Deer Park
105. Brentwood
106. Central Islip
107. Ronkonkoma
108. Holtsville
109. Medford
110. Yaphank
111. Riverhead
112. Mattituck
113. Southold
114. Greenport
115. Babylon
116. Bay Shore
117. Islip
118. Great River
119. Oakdale
120. Sayville
121. Patchogue
122. Bellport
123. Mastic-Shirley
124. Center Moriches
125. Speonk
126. Westhampton
127. Quogue
128. Hampton Bays
129. Southampton Campus LIU
130. Southampton
131. Bridgehampton
132. East Hampton
133. Amagansett
134. Montauk

Figure 4. New York's Long Island Rail Road (LIRR) System Map.

passengers each began operating in 1990.

Ridership

The Long Island operates some 723 daily trains, with reduced weekend and holiday service. Commuter rail ridership dropped from 273,000 a day in 1987 to 245,600 in 1991. This drop in ridership can be partially related to the Wall Street cut backs and related employment causing approximately 4 percent loss of commuters. Operational statistics for LIRR are shown in Table 5.

Parking and facilities

Park-and-ride lots and bus connections at most suburban stations promote intermodal commuting, while connections with the New York subway system are available at all three terminals and several other stations in New York City.

1-b. Metro-North Commuter Railroad

Line of service

Metro-North operates three principal routes from New York City's Grand Central Terminal as shown in Figure 5. The 74-mile Hudson line provides service to Poughkeepsie, New York (N.Y.), while the 77-mile Harlem line reaches Dover Plains, N.Y.. The 72-mile New Haven line provides service to New Haven, Conn. The 87 mile Port Jervis line and the 31-mile Pascack Valley line are west of the Hudson River, and operate from Hoboken, NJ, to Port Jervis and Spring Valley respectively. The Hudson, Harlem, and New Haven line track within New York is owned by Metro-North, while trackage in Connecticut is owned by the Connecticut Department of Transportation.

Ridership

Ridership has grown annually since 1984, reaching a total of 57,953,000 riders in 1990. Metro-North operates 494 weekday trains, with reduced weekend and holiday service on all lines from Grand Central Terminal. Except for Saturday service on the Port Jervis line, the two routes west of the Hudson operate on Weekdays only. Metro-North services about 120 stations on its routes from Grand, and another 13 stations in New York reached by the lines west of the Hudson. Operational statistics for Metro-North are shown in Table 6.

Parking and facilities

Park-and-ride lots are provided at most suburban stations, and local bus systems provide connecting services at many stations.

Fare collection

Metro-North employs a zone fare system, with fares collected manually on trains.

2. Chicago, Illinois

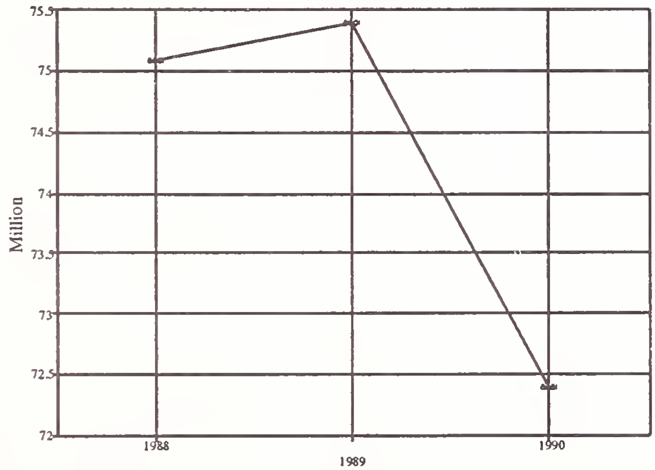
Chicago's commuter rail system is operated by Metropolitan Rail (Metra) under the budgetary and policy oversight of the Regional Transportation Authority. Chicago has long had an excellent hub and spoke rail network between suburbs and downtown, as shown in Figure 6. Park-and-ride lots are available at almost all of Metra's suburban stations.

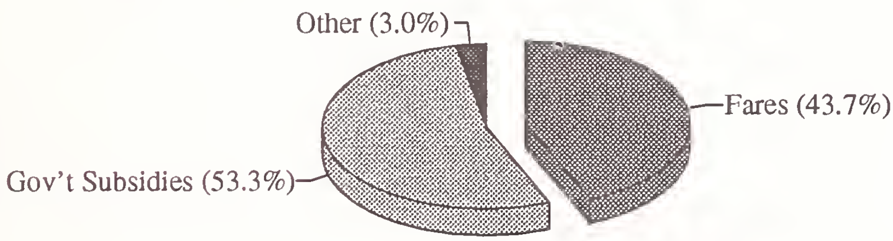
Table 5. Operational Statistics for LIRR.

New York-The Long Island Rail Road

	1988	1989	1990
Annual Ridership (Million)	75.1	75.4	72.4
Annual Passenger Miles (Million)	2010*	2019	1938*
Farebox Revenue (Million)	265.9	266.7	292.7
Government Subsidies (Million)	331	364.1	357
Other Revenue (Million)	19.7	23.1	19.8
Total Operating Expenses (Million)	616.6	653.9	669.5

Trend of Ridership





Sources of Operating Funds

* Estimate.

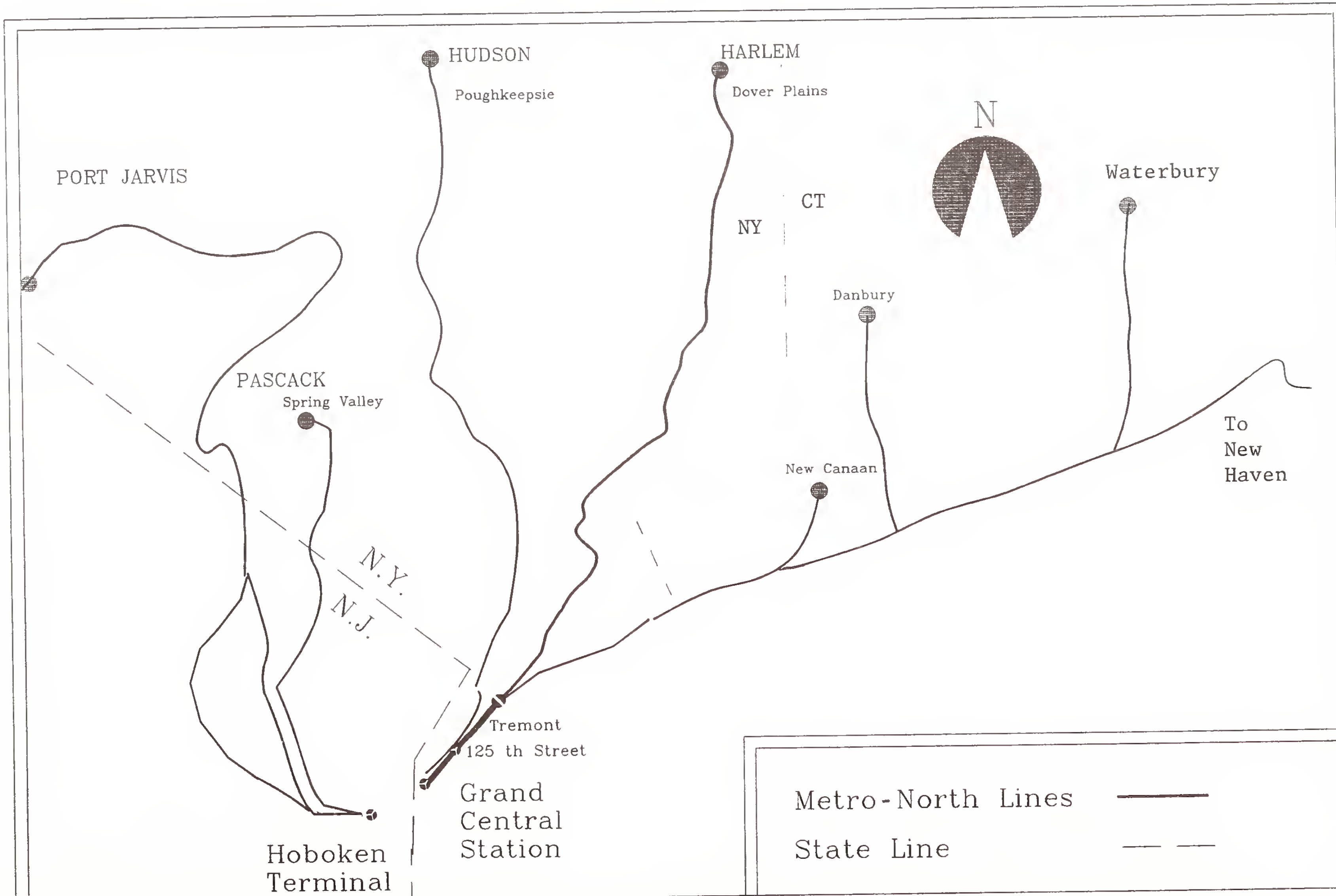
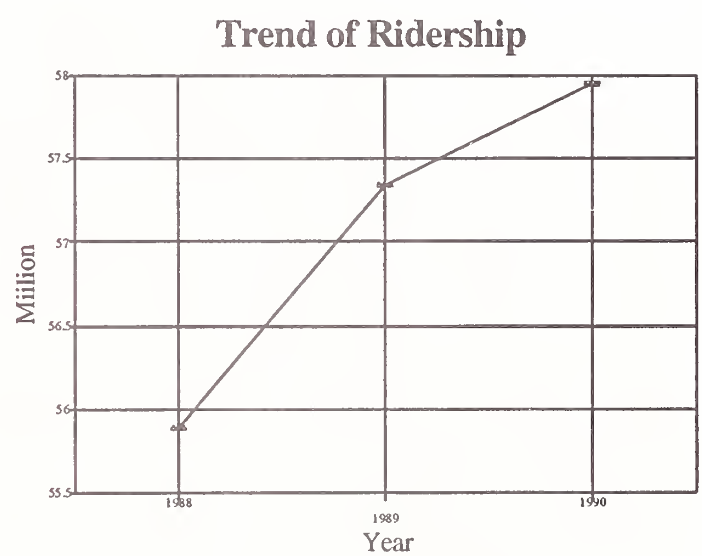


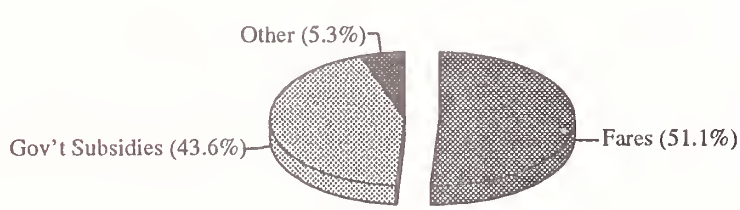
Figure 5. New York's Metro-North (M-N) System Map

Table 6. Operational Statistics for Metro-North.

New York, Metro-North Commuter Railroad

	1988	1989	1990
Annual Ridership (Million)	55.89	57.34	57.95
Annual Passenger Miles (Million)	1360	1535	1544
Farebox Revenue (Million)	194	199.9	221.5
Government Subsidies (Million)	193.5	191	189.2
Other Revenue (Million)	0	17.7	23
Total Operating Expenses (Million)	376.7	408.6	433.7





Sources of Operating Funds

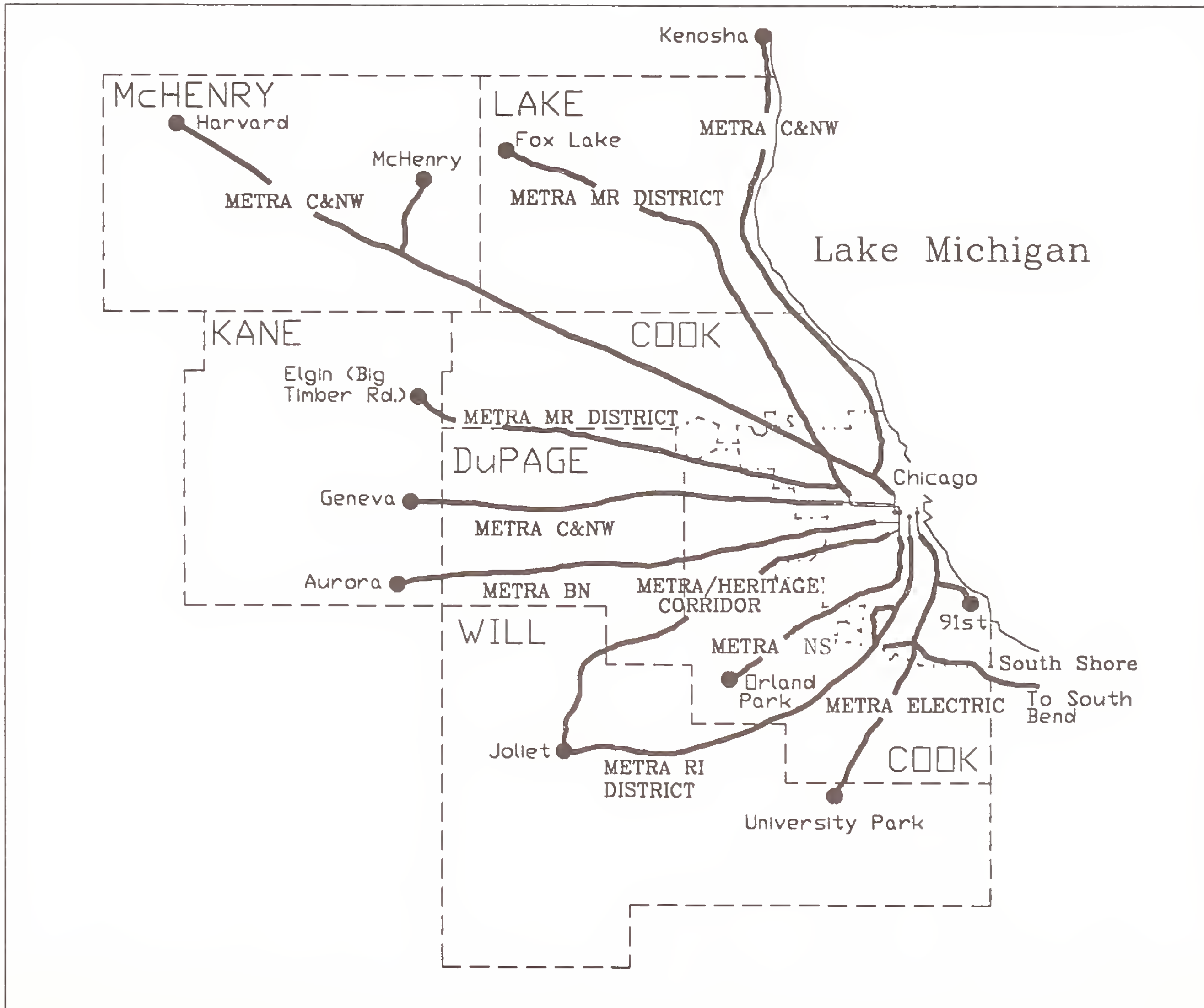


Figure 6. Metra System Map-Chicago

Line of service

Metra operates a 499.5 route-mile commuter rail system serving about 233 stations on 13 lines radiating north, west, and south from downtown Chicago [9]. Most of the Metra's lines are operated in non-electric, diesel locomotive hauled operations. A fleet of 682 bi-level gallery cars in diesel-hauled push-pull trains are used on these routes. These are divided between nearly 300 LAHT steel cars built by St. Louis Car and Pullman-Standard during 1955-61, and almost 400 stainless steel bi-levels built by Budd at various times between 1950 and 1980.

Services are operated from Chicago's Madison Street Station over Chicago & North Western lines to Geneva, Harvard, and Kenosha. The Milwaukee District, Burlington Northern, Heritage Corridor, and Norfolk Southern routes operate from Chicago's Union Station extending service northwest to Fox Lake, west to Elgin and Aurora, and southwest to Orland Park and Joliet [9]. Service to Joliet is also operated over Metra's Rock Island District from La Salle Street Station.

Metra electric routes & equipment

Metra Electric routes operating from Randolph Street Station reach South Chicago, Blue Island, and University Park, south of Chicago. Service to Hegewisch, is provided over the Chicago South Shore & South Bend routes in conjunction with Northern Indiana Commuter Transportation District (NICTD) which serves northwestern Indiana points.

Metra Electric lines are operated with a fleet of 206 electric MU cars supplied by St. Louis Car and Bombardier during 1970-79. Metra Electric routes, the former Illinois Central Gulf suburban system, are electrically operated with a 1.5 kv dc system.

Ridership

Metra operates a total of some 660 daily trains, with reduced service on most lines during weekends. Commuter ridership reached almost 72.3 million trips in 1990. Operational statistics for Metra are shown in Table 7.

Connecting to other systems

An extensive system of connecting bus services is operated by RTA's PACE suburban bus system, while connecting bus and rapid rail transit services in metropolitan Chicago are provided by the Chicago Transit Authority (CTA). More than 860 parking lots serve these stations. These lots provide more than 54,000 commuter parking spaces.

Fare system

Metra uses a zone fare system, with one-way, ten-ride, weekly, and monthly tickets available that are good on any Metra line. With the exception of the Metra Electric system, which utilizes automated off-train fare collection, Metra employs a conventional on-train fare collection system. A monthly link pass permits METRA riders to use almost all of these connecting PACE and CTA services.

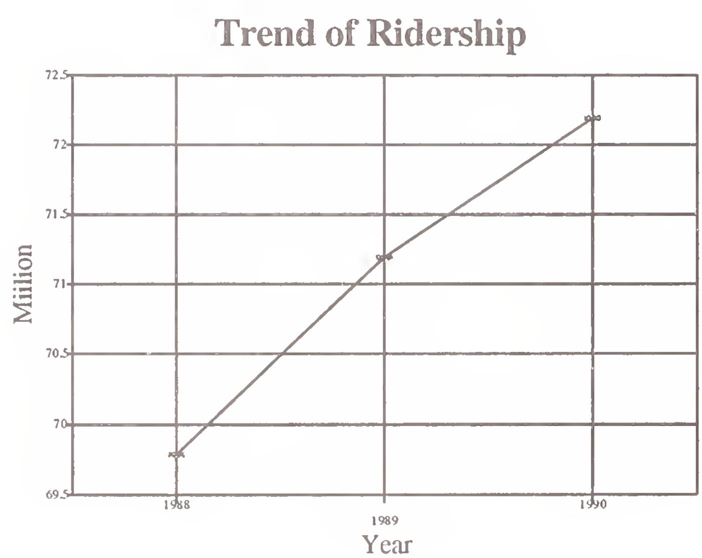
Future plan

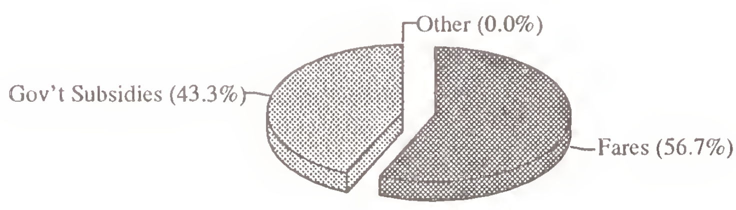
Metra is proposing a $4.5 billion plan for

Table 7. Operational Statistics for Metra.

Chicago, Metra

	1988	1989	1990
Annual Ridership (Million)	69.8	71.2	72.2
Annual Passenger Miles (Million)	1477	1511	1540
Farebox Revenue (Million)	165	173.9	180
Government Subsidies (Million)	125.5	126.9	137.6
Other Revenue (Million)	0	0	0
Total Operating Expenses (Million)	276.2	291.6	308.2





Sources of Operating Funds

improving, expanding, and better coordinating transportation services under the Future Agenda for Suburban Transportation (FAST) plan. The plan calls for $3.8 billion going for improvements to existing systems and the remainder put into rail service extensions and creation of new lines. Not included are costs of an extension of Metra Electric service to the proposed Lake Calumet airport, since the cost would be covered in the airport budget [10]. The largest item in Metra's $3.8 billion budget would be for rail-highway grade separation, budgeted at almost $1.3 billion. Metra is proposing grade separation at 216 locations on existing lines and at 13 points on lines targeted for service extensions.

3. New Jersey

New Jersey Transit (NJT) operates a 781 route-mile commuter rail system. It provides service over 10 principal routes from three terminals in the New York/New Jersey metropolitan area. Several lines radiate out from the Hoboken, New Jersey terminal. In addition, NJ Transit also provides service between Atlantic City 46 miles to Lindenwold, New Jersey.

Line of services

NJ Transit services between Philadelphia and Atlantic City in southern New Jersey area as shown in Figure 7. NJ Transit provides service over ten principal routes from three terminals. The 58-mile Northeast Corridor Line provides service in Amtrak's Northeast Corridor between New York's Penn Station and Trenton. The 66-mile North Jersey Coast Line provides services to Bay Head from Penn Station in Newark, Hoboken and Penn Station, New York City, while the 54-mile Raritan Valley Line serves High Bridge from Newark. The Morris and Essex electric Lines originating at Hoboken provide service over a 40-mile route to Dover with branches to Montclair and Gladstone. The 50-mile Boonton Line connects into the Morris & Essex to serve Dover and Netcong via an alternate route.

The Main Line and Bergen County Lines, provide service over two routes between Hoboken and Suffern, with service beyond Suffern to Port Jervis, NY. The 30-mile Pascack Valley Line serves Spring Valley, NY, from Hoboken. The track is owned by NJT with the exception of the Amtrak-owned Northeast Corridor line, a segment of the Raritan Valley lines that is owned by the Conrail, and the Conrail owned line between Suffern and Port Jervis.

Ridership and equipment

NJ Transit carries 140,000 daily riders on 565 trains. Recently, a fleet of ASEA Brown Boveri ALP44 electric locomotives similar to Amtrak AEM-7s was placed into service on the Long Branch and Northeast Corridor line.

NJ Transit is the first transit operator to use ac propulsion for its commuter rail equipment with an ac traction motor conversion program for its entire 230 car Arrow III M.U. fleet under an overhaul program. The system's minimum crew size for a two-car train or less is an engineer and a conductor, while the minimum crew for trains of three or more cars is an engineer, conductor, and one trainman, with additional ticket collectors being assigned as deemed necessary for revenue collection purposes.

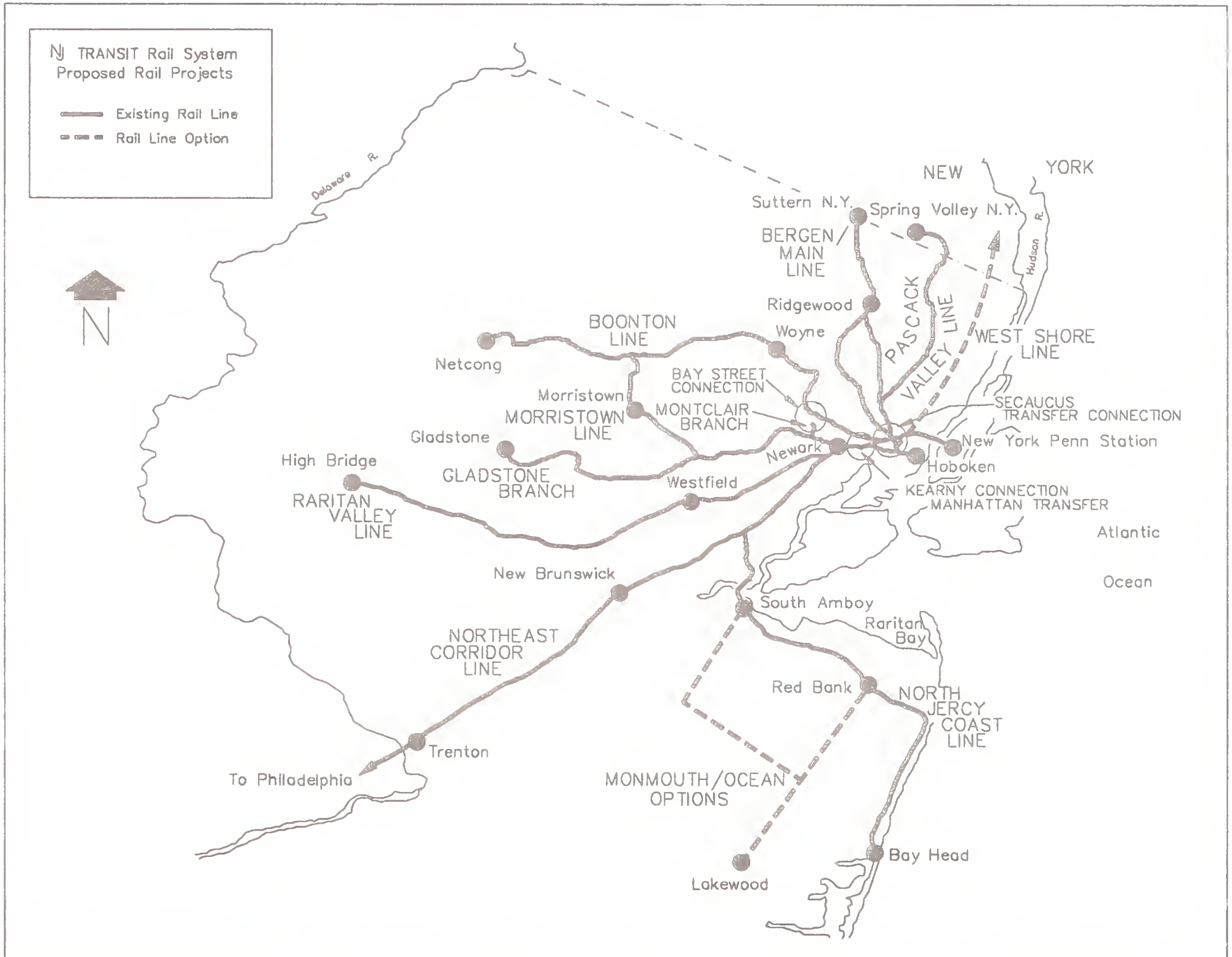


Figure 7. New Jersey Transit (NJT) System Map

Fare collection

NJ Transit's fare structure is based upon point-to-point distance-based fares, with one-way, round trip excursion, ten trip, weekly, and monthly tickets available.

Parking facilities

Park-and-ride facilities are provided at NJ Transit stations, with over 30,000 spaces presently available, and more under construction.

Connecting to other systems

Bus connections are provided at many stations by NJ Transit's own bus services or other carriers.

Funding support

The balance of operating funds comes from FTA grants and the State of New Jersey. Additional capital funds are provided from the New Jersey Transportation Trust Fund and the Port Authority of New York and New Jersey.

4. Philadelphia, Pennsylvania

Existing lines

The Southeastern Pennsylvania Transportation Authority(SEPTA) operates a 291-route-mile Regional Rail Division that serves 159 stations on 13 routes radiating from downtown Philadelphia as shown in Figure 8.

The $315 million Center City Commuter Tunnel, which linked commuter routes that once terminated at Reading Terminal and Suburban Station, was completed in 1984. This link permitted SEPTA to join its former Reading Company and Pennsylvania Railroad commuter lines into a comprehensive regional rail system. Trackage operated by SEPTA is largely divided between SEPTA and Amtrak-owned track, with 15 route miles of service operated over Conrail track.

Equipment

SEPTA operates some 458 weekday trains, with a reduced service level on weekends with 11 kv, 25Hz ac overhead power supply.

SEPTA's self-propelled electric M.U. car fleet totals 336 cars. Each of these M.U. cars are capable of speeds up to 100 mph. They also have 35 Bombardier and 7 AEM-7 locomotives. [11]

Ridership

The SEPTA's annual unlinked passenger trips dropped slightly in Fiscal Year 1990 (25.7 million), from the previous year (26.8 million), with the average weekday ridership on the system reaching over 91,000. Operational statistics for SEPTA are shown in Table 8.

Fare collection

A zone fare system is used, with one-way, ten-trip, weekly, monthly, and reduced off-peak fares available. Fares are collected on the trains. Additional fare collectors are added when train size reaches three or five cars.

5. Boston, Massachusetts

The Massachusetts Bay Transportation

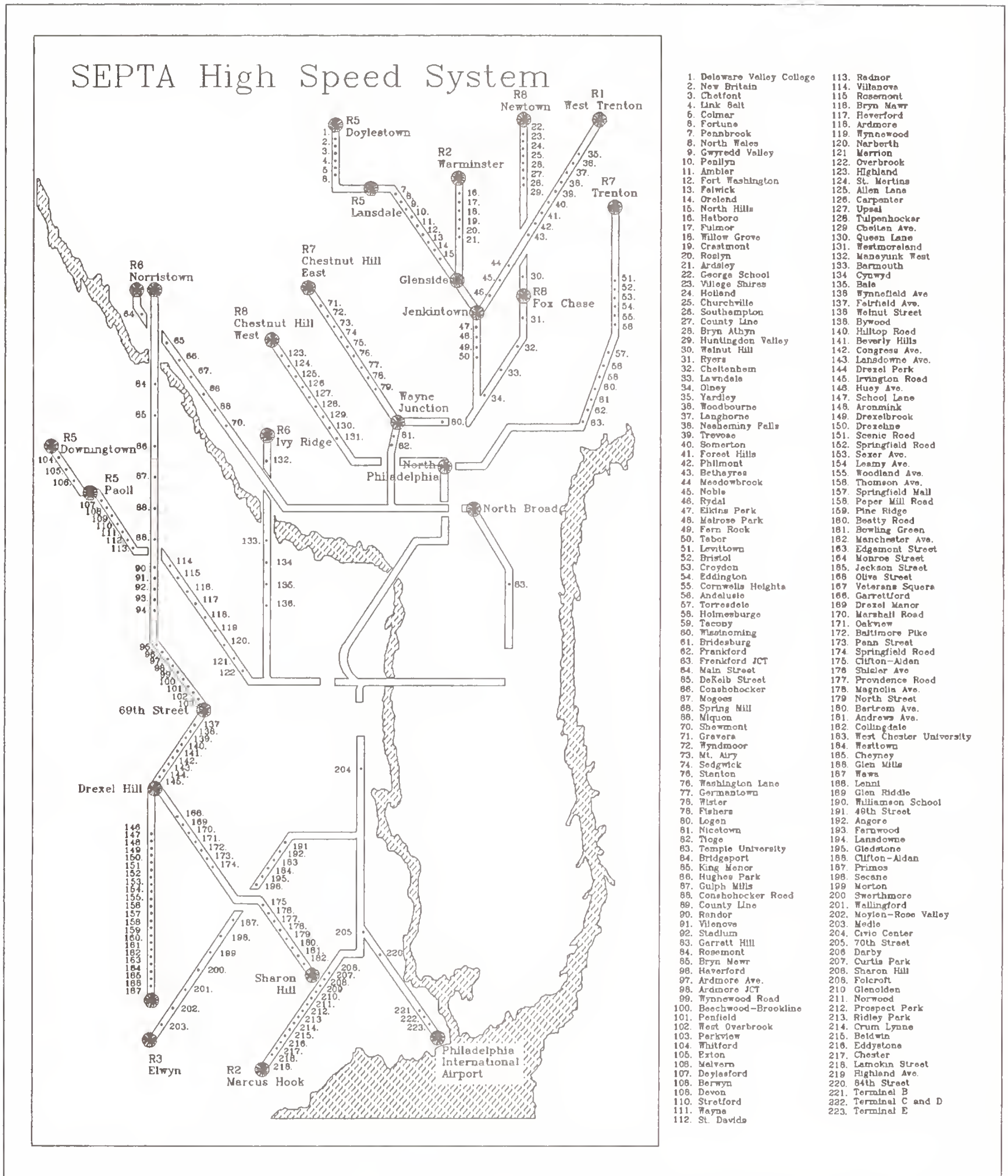


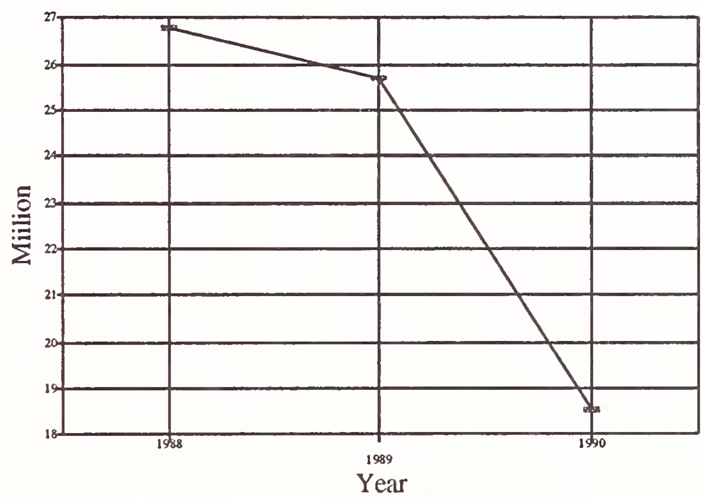
Figure 8. Philadelphia's SEPTA System Map

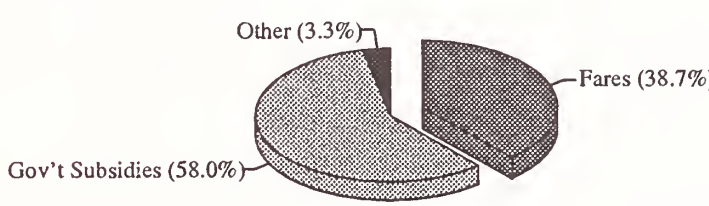
Table 8. Operational Statistics for SEPTA.

Southeastern Pennsylvania Transportation Authority (SEPTA)

	1988	1989	1990
Annual Ridership (Million)	26.8	25.7	18.5
Annual Passenger Miles (Million)			357
Farebox Revenue (Million)			61.1
Government Subsidies (Million)			91.6
Other Revenue (Million)			5.2
Total Operating Expenses (Million)		97.7	157.9

Trend of Ridership





Sources of Operating Funds

Authority (MBTA) operates all three rail transit modes in the Boston metropolitan area, including a commuter rail system of 244 route-miles serving 101 stations on 13 routes radiating from downtown Boston. MBTA operates a total of 374 daily trains, with reduced service on most lines on weekends.

Line of services

MBTA commuter rail services are operated northward from North Station to terminals at Gardner, Lowell, Haverhill, Ipswish, Rockport, and from the South Station reach west and south to Framingham, Needham, Franklin, Fairmount, Stoughton, and to Providence as shown in Figure 9. Commuter rail to rapid rail transit connections are available at several close-in suburban stations and the Boston terminals. The MBTA lines are contract operated by Amtrak.

Ridership

The MBTA commuter rail ridership is increasing. There were 71,700 trips in 1990 and 74,600 in 1991. Operating statistics for MBTA are shown in Table 9.

Equipment

Amtrak operates all trains for MBTA and maintains right-of-way. A three-person train crew is standard, with an additional trainman for every two coaches. The equipment of MBTA's commuter rail division includes 26 F40PH-1C and 18 F40PH locomotives built by General Motors' Electro-Motive Division, and 19 Electro-Motive F10 and F7 locomotives rebuilt from F3 and F7 units. Rolling stock includes 58 Pullman-Standard push-pull coaches delivered during 1978-1979, 67 recently delivered Messerschmidt-Bolkow-Bohm and 40 Bombardier push-pull coaches. The Bombardier coaches are fitted with 3-2 seating. All of the newest coaches are handicapped accessible. In 1989, 56 Bombardier coaches were delivered, and MBTA ordered 75 bi-level cars by Kawasaki in 1991.

Fare collection

Fares are collected on-board trains.

Extension

The Boston commuter rail system has been steadily upgraded in recent years. Bridges and signal systems are being rebuilt, and miles of track have been reconstructed. Stations are being rebuilt or replaced. MBTA is completing final design and selection procedures for extending service on its Ipswich line to Newburyport, but state budget problems have postponed other service extensions to Framingham/Worcester and Stoughton/New Bedford/Fall River [12].

Funding support

MBTA's commuter rail farebox revenues cover more than 40 percent of the operating expense, with the balance coming from the state and MBTA member towns and cities. Capital improvement funding comes from a combination of FTA grants and state transportation bonds.

6. San Francisco

California's Department of Transportation (CalTrans) operated the CalTrain Peninsula Service between downtown San Francisco and San Jose until July 1,1992. Recently, a

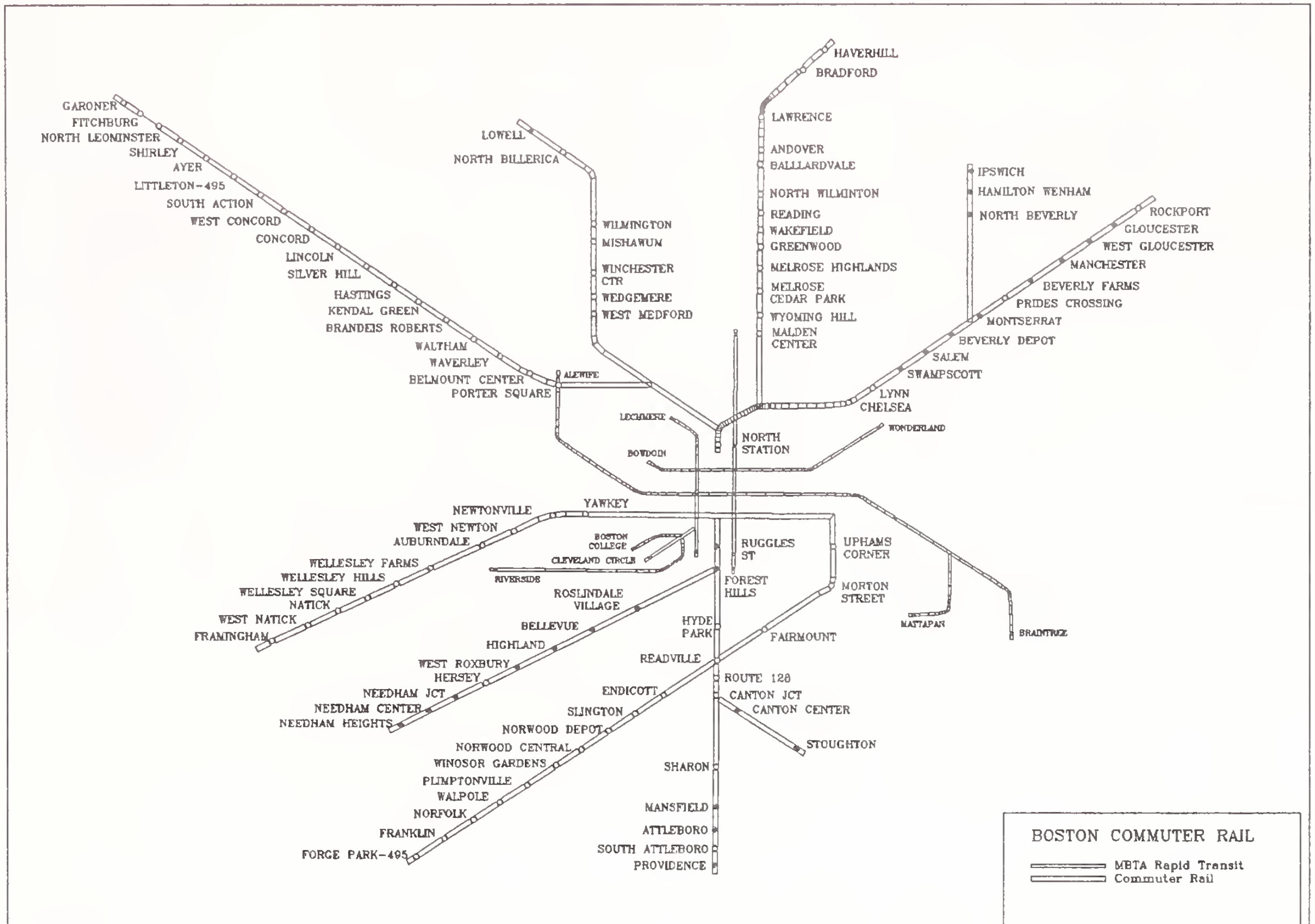
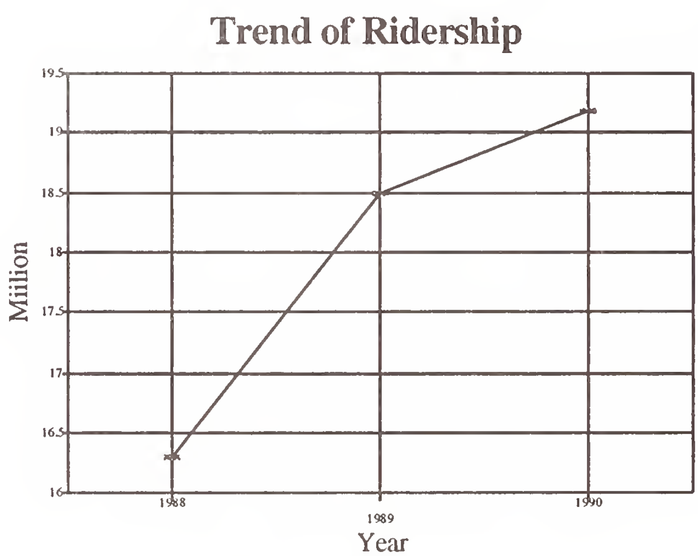


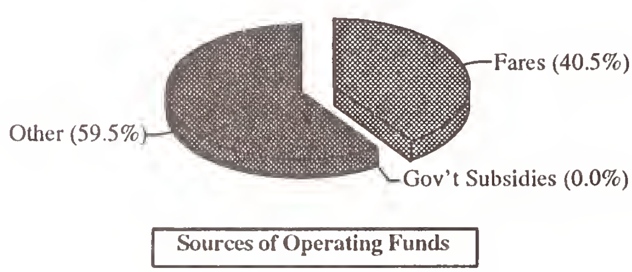
Figure 9. Boston's MBTA System Map.

Table 9. Operational Statistics for MBTA.

Boston, Massachusetts Bay Transportation Authority (MBTA)

	1988	1989	1990
Annual Ridership (Million)	16.3	18.5	19.2
Annual Passenger Miles (Million)	291.3	330.1	348.4
Farebox Revenue (Million)	23.5	27.8	33.3
Government Subsidies (Million)			
Other Revenue (Million)	52.3	50.6	49
Total Operating Expenses (Million)	75.8	78.4	82.3





Joint Powers Board (JPB) made up of San Francisco, San Mateo, and Santa Clara counties successfully negotiated purchase of the line from Southern Pacific. Several trains operate beyond San Jose to Gilroy in the rush hour. Operating and funding responsibility for the service shifted from CalTrans to the JPB on the above date. SAMTRANS, the San Mateo County Transportation Agency, took over management responsibilities for the JPB. Under the new agreement, the counties are committed to service expansion [2]. The JPB has awarded an operating contract to Amtrak, to operate 60 daily Peninsula Commuter Service (PCS) trains between San Jose and San Francisco. Amtrak took over the PCS operation from Southern Pacific July 1, 1992 [13].

<u>Line of service</u>

At the time of this study, CalTrain operated a single 47-mile route with 26 stations extending south from San Francisco to San Jose over Southern Pacific's Peninsula Line as shown in Figure 10. The service was extended for selected Peninsula trains miles south of downtown San Jose to Tamien and Gilroy July 1, 1992. The service is linked to the San Jose light rail system at Tamien, 2 1/2 miles south of San Jose.

<u>Ridership</u>

Total ridership was 6.34 million in 1990. By the end of 1990 traffic had reached a weekday average of almost 21,700 passengers, a 27% increase over that of 1987. CalTrain operates a total of 54 daily trains on weekdays with reduced service on weekends. Operational statistics (1990) for CalTrain are shown in Table 10.

<u>Fare collection</u>

Single ride tickets and monthly ride tickets are available, and fares are based on a "zone" system. The 1990 crew size was four persons, with an additional brakeman for trains of four or more cars and helper conductors as required to collect fares. The Amtrak operation has reduced this crew size by going to one person in the cab.

<u>Funding support</u>

The balance of operating expenses are provided from FTA, the State Transportation Fund, and local transit districts. Less certain is a $600 million project to extend commuter service to a new, more centrally located terminal in downtown San Francisco, with connections to BART.

<u>7. Maryland Rail Commuter</u>

The Maryland Rail Commuter (MARC) service is under the jurisdiction of the Mass Transit Administration. MARC operates over a 187-mile route serving 38 stations on four routes, two of which are in the Baltimore-Washington Corridor. Service was recently extended north of Baltimore to Perryville, Maryland. Baseball trains are run on weekends.

<u>Line of service</u>

MARC operates services over three routes originating at Washington's Union Station, two of which are in the Baltimore-Washington Corridor as shown in Figure 11. The 75-mile Penn line provides Washington-Perryville service over Amtrak's Northeast Corridor main line, while the 37-mile

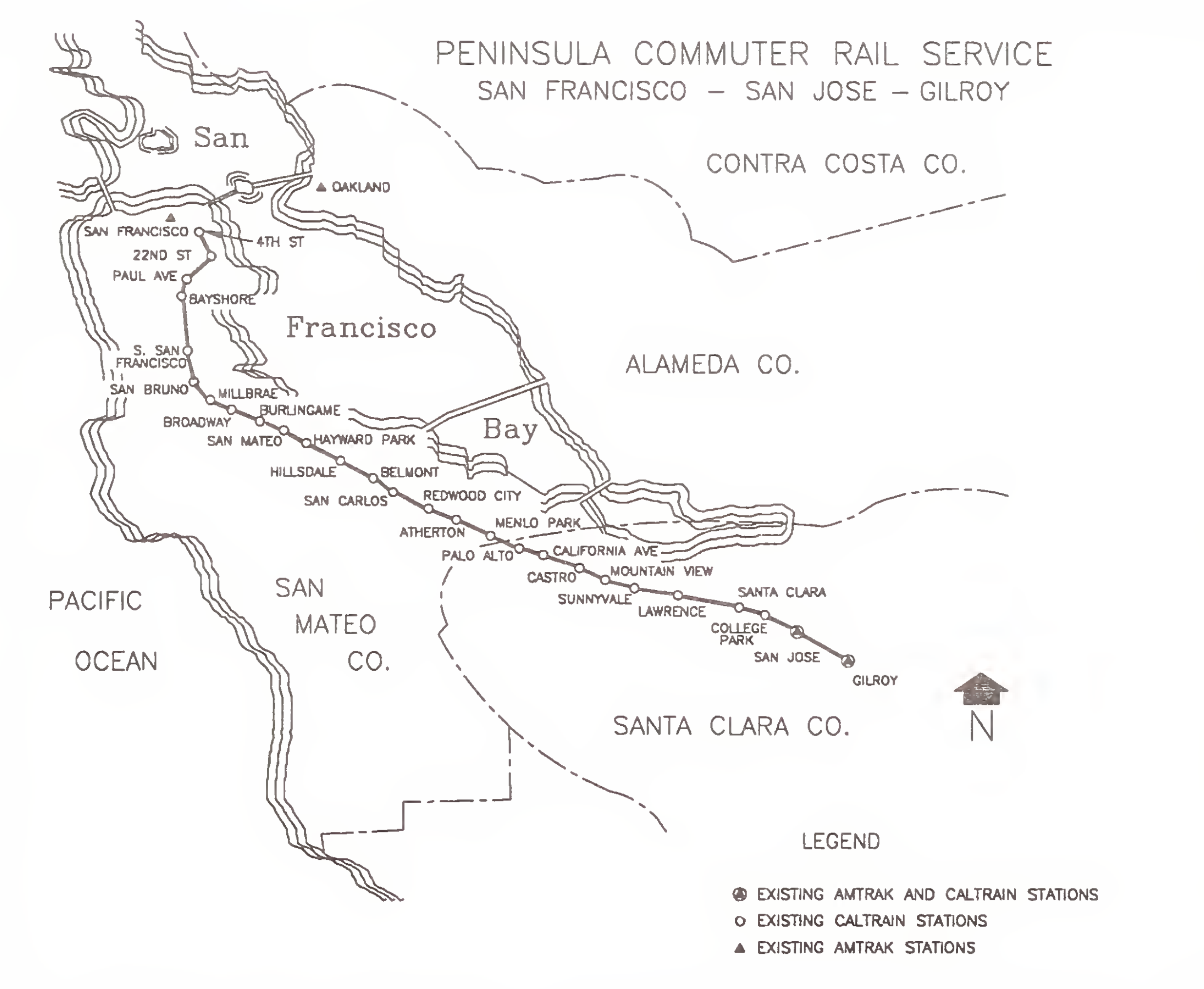
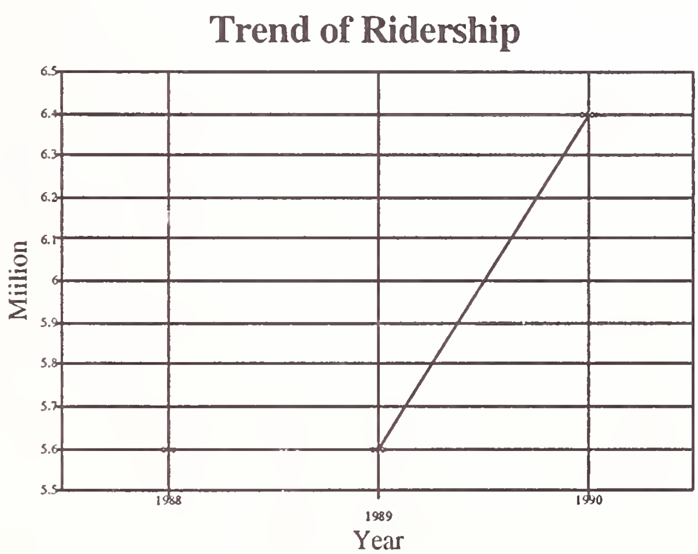


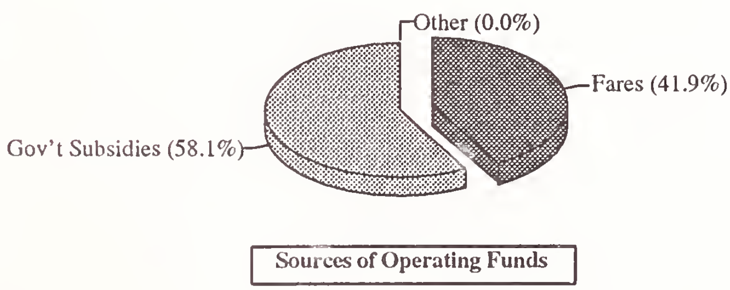
Figure 10. San Francisco's CalTrain (PCS) System Map.

Table 10. Operational Statistics for CalTrain.

San Francisco, Peninsula Commuter Service (PCS)

	1988	1989	1990
Annual Ridership (Million)	5.6	5.6	6.4
Annual Passenger Miles (Million)	132	133	150
Farebox Revenue (Million)	8.9	9	9.9
Government Subsidies (Million)	13.2	13.3	13.7
Other Revenue (Million)	0	0	0
Total Operating Expenses (Million)	22	22.3	23.6





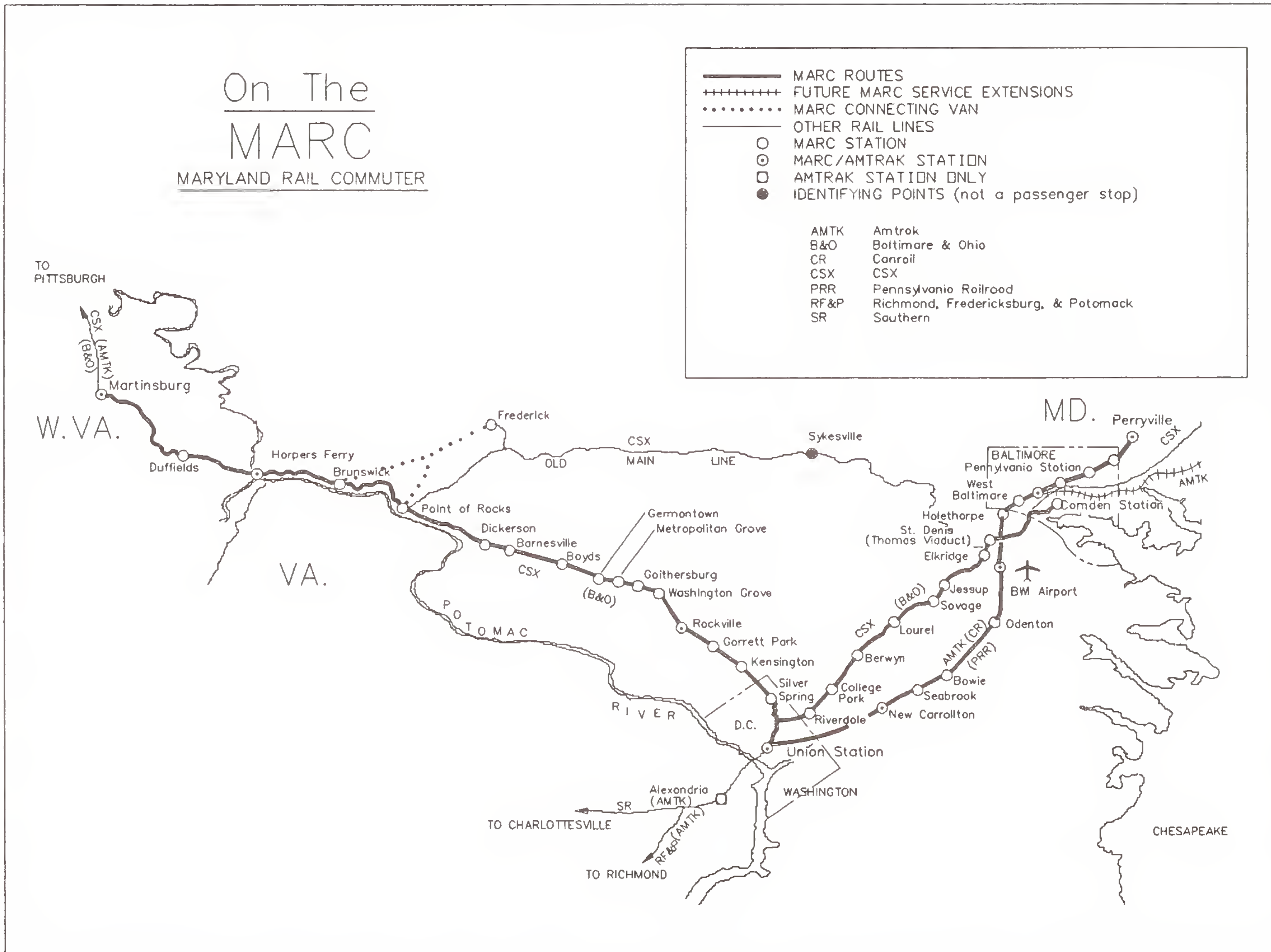


Figure 11. Maryland's MARC System Map

Camden Line provides service over the CSX line between Washington and Baltimore, serving eight stations on each the Penn and Camden lines. The 73-mile Brunswick Line has 16 stations on a CSX line to Martinsburg, West Virginia.

Equipment

The Penn Line service is electrically powered at 11kv 25Hz ac, while the balance of the system is diesel-operated. Penn Line services utilize four GM Electro-Motive Division/ASEA AEM-7 locomotives, and 6 GM GP39H-2 and 5 GM F9PH diesel-electric locomotives rebuilt by Morrison-Knudsen during 1988-1989. All locomotives are fitted for push-pull use and are equipped to provide head-end power.

Rolling stock for MARC's locomotive-hauled trains include 22 MARC-I coaches rebuilt from former sleeping cars, and 28 MARC-II self propelled diesel control and trailer cars built during 1985-87 by Sumitomo. A fleet of 14 rebuilt Budd RDC cars is also operated on Camden and Brunswick line service. As MARC traffic continues to grow, additional electric and diesel locomotives and coaches will be required to meet the demand.

Stations

Maryland's MARC commuter service is linked with the Washington Metro at Washington's Union Station, in addition to Washington Metro stations at New Carrollton, Rockville and Silver Spring. Free park-and-ride lots are provided at most stations. MARC and Frederick County, Maryland, established a shuttle van service which links Frederick, Maryland, with MARC's Brunswick Line trains at Point of Rocks. Railway schedules are coordinated with local bus service. Rockville and New Carrollton provide "cross platform" connections with Washington's Metrorail. A similar connection is now in use with Baltimore's new Central Corridor light rail line at Camden Station.

Ridership

From the low point of 5,400 daily passengers in 1983, the ridership now averages more than 15,000 daily riders. Both short and long range plans are under way to expand service, either through new lines or new trains. MARC runs 70 trains per day Monday through Friday. The train crew includes an engineer, conductor, and assistant conductor, with an additional assistant conductor on high ridership trains (six cars). Operational statistics for MARC are shown in Table 11.

Fare collection

MARC's fare structure provides for one way, round trip, weekly, and monthly tickets based on a zone fare system adopted in 1988, with collection or inspection on-train by conductors. One way and round trip tickets are sold on board the train by conductors, while all types of tickets are available from agents at 15 of MARC's 33 stations. Monthly tickets are also available through a "Ticket by Mail" program.

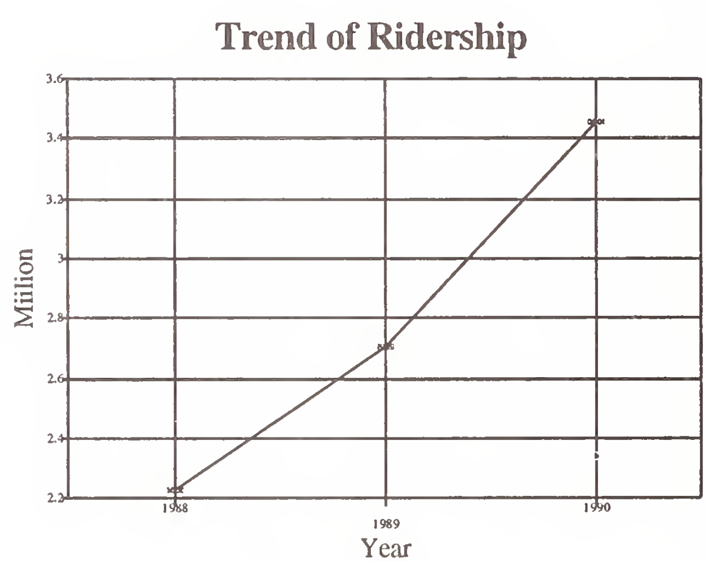
Funding support

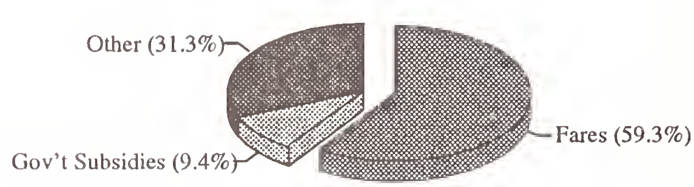
Capital and operating costs not covered by fare revenues are provided from FTA grants and Maryland Trust Fund. MARC is now moving ahead with a $122 million six-year capital program for CTC installations, additional equipment, and new stations that

Table 11. Operational Statistics for MARC.

Maryland Rail Commuter Service (MARC)

	1988	1989	1990
Annual Ridership (Million)	2.23	2.7	3.46
Annual Passenger Miles (Million)	66.9	81.6	102
Farebox Revenue (Million)	6.84	8.16	10.2
Government Subsidies (Million)	1.65	1.63	1.62
Other Revenue (Million)	3.61	5.31	5.38
Total Operating Expenses (Million)	12.1	15.1	17.2





Sources of Operating Funds

will permit service expansions on its existing lines.

8. Northern Indiana Commuter Transportation District

The Northern Indiana Commuter Transportation District (NICTD), often overshadowed by Metra, became a true operating entity of its own in 1989. It purchased the right-of-way of the Chicago, South Shore and South Bend Railroad from the Illinois-Indiana state line to South Bend, Indiana. Frequent service is provided between downtown Chicago and Gary, Indiana with limited service to Michigan City and South Bend. Operating deficits in the Illinois portion are shared with Metra.

Line of service

Between Chicago and South Bend NICTD provides service over a single 88-mile route, serving 7 stations in Illinois and 20 in Indiana.

Equipment

Service is operated over the METRA Electric system between the Randolph Street Station, Chicago and Kensington, while the balance of the route is operated over the Chicago South Shore and South Bend Railroad, which is also electrified at 1.5 kv dc.

Forty one of the single-level stainless steel electric MU cars of NICTD's total commuter rail fleet were built by Nippon Sharyo in 1981. Also, NICTD currently has more electric MU cars on order.

Ridership

Commuter ridership was 3.47 million in 1990, with a daily average of 12,200. NICTD operates 40 daily trains, with reduced weekend service. The train crew includes a motorman and conductor, with additional collectors based upon train size. Operational statistics for NICTD are shown in Table 12.

Extension (proposal) and Funding Support

NICTD plans to add high-level platforms at Hammond and East Chicago stations. This change could cut an estimated eight minutes from Chicago-Gary running times. NICTD has also expanded its fleet of 41 electric MU cars to 58.

9. Miami, Florida

South Florida's Tri-County Commuter Rail (Tri-Rail) connects the three major cities and airports in Southeast Florida: West Palm Beach Airport in the north, the Ft. Lauderdale-Hollywood Airport in Broward County, and the Miami International Airport in the south. Miami is the destination for most of the system's riders.

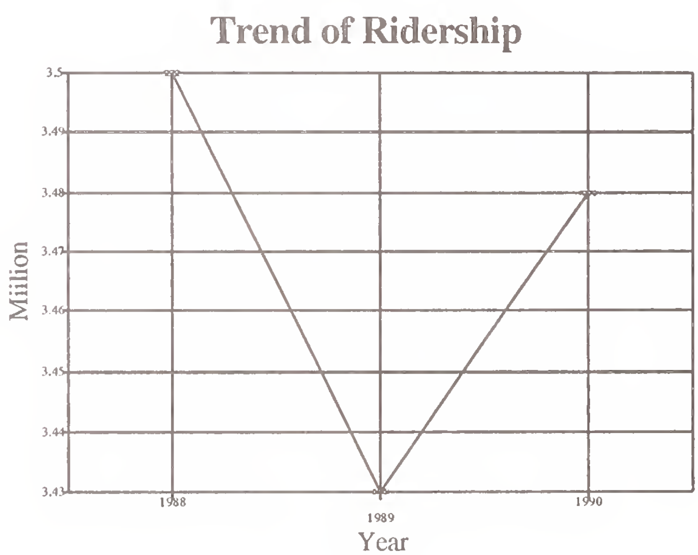
Routes and stations

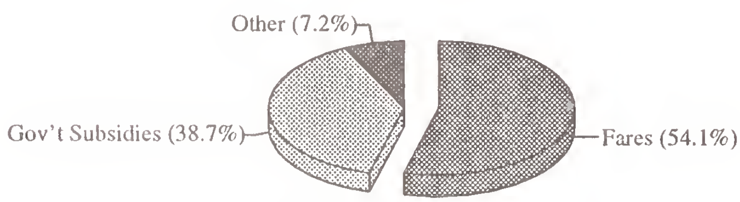
Tri-Rail began operations on Jan. 9, 1989, over a 67-mile route serving 15 stations as shown in Figure 12. Tri-Rail service is parallel to I-95 and uses an existing railroad line that Florida's Department of Transportation purchased from CSX. Tri-Rail was planned to reduce the number of vehicles travelling along I-95, which is expected to exceed its capacity of 250,000 vehicles per day by the year 2010.

Table 12. Operational Statistics for NICTD.

The Northern Indiana Commuter Transportation District (NICTD)

	1988	1989	1990
Annual Ridership (Million)	3.5	3.43	3.48
Annual Passenger Miles (Million)	96.6	96.8	98.2
Farebox Revenue (Million)	NA	NA	9.8
Government Subsidies (Million)	4	8	7
Other Revenue (Million)	NA	NA	1.3
Total Operating Expenses (Million)	NA	NA	18.1





Sources of Operating Funds

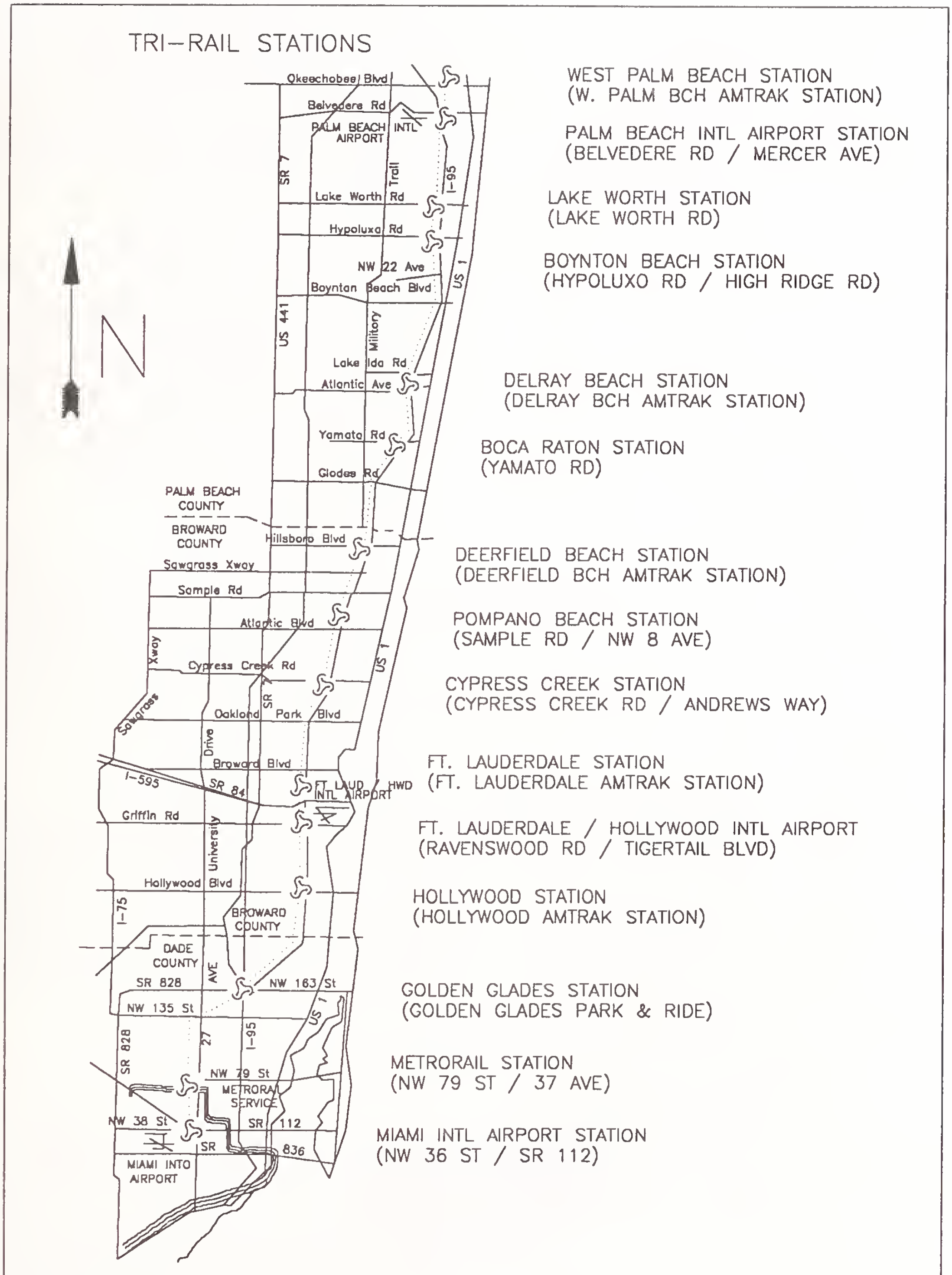


Figure 12. South Florida's Tri-Rail System Map.

Ridership

The average daily Tri-Rail ridership increased to 9,297 in February 1992, showing an increase of 17 percent over the previous year. Operational statistics for Tri-Rail are shown in Table 13. Tri-Rail operates a total of 24 daily trains, with reduced weekend service.

Equipment

Each train consists of a locomotive, three coaches, and a cab car. Bi-level cars are used. Each bi-level car seats 162 people (see Appendix B), and is equipped with two wheelchair tie-downs. Tri-Rail uses five former Conrail GP-40 locomotives, rebuilt by Morrison-Knudsen. The locomotive can pull up to 10 bi-level commuter cars. Each coach is equipped with pneumatically operated two-leaf sliding pocket doors located at both ends on each side.

Funding support

Tri-Rail will need additional capital investment of about $100 million to $300 million in order to improve its level of service. The Federal Highway Administration (FHWA) initially provided 90% of the funds for the start-up and operating expenses. The state and Dade, Broward and Palm Beach counties funded the balance. The current annual operating budget is funded $4 million from FHWA, $8 million from Florida Department of Transportation (FDOT) and $2 million from the state of Florida through oil overcharge funds.

Fare collection

Fare collection utilizes a barrier-free "proof of payment" system. Currently, a flat $3 fare is charged ($5 for round trip), regardless of the distance traveled. Shuttle buses link Tri-Rail with stations at west Palm Beach, Fort Lauderdale, and Miami International Airports. Rail fares include both feeder and shuttle services. Parking is free at any Tri-Rail station.

10. New Haven, Connecticut

Connecticut DOT began service from Old Saybrook to New Haven on May 29, 1990 on the Northeast Corridor line. Commuter rail service is provided using a 33-mile route serving seven stations.

Line of service

The Old Saybrook to New Haven service is shown in Figure 13. Nine weekday rush hour trips, five southbound and four northbound are operated. Amtrak is the contract operator.

Transfer system

Almost one-fourth of all riders connect with Metro-North New Haven trains for points further west. Shuttle bus connections provide free transfers for pass riders. Private shuttles also appear to have attracted ridership.

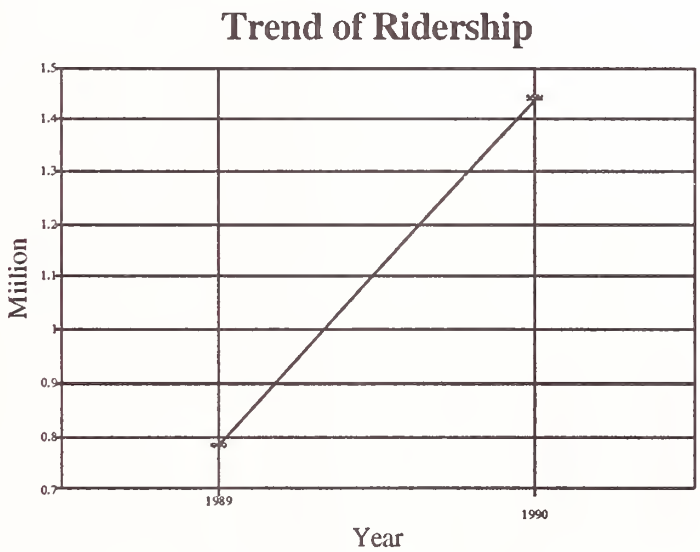
Equipment

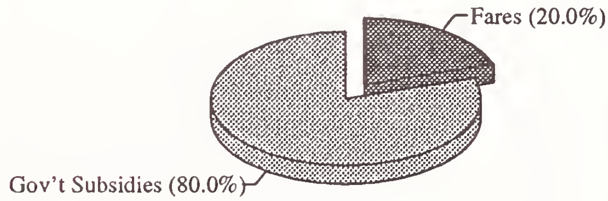
Service is provided by two F7 engines and 10 coaches purchased by ConnDOT from Pittsburgh, supplemented by three leased locomotives. ConnDOT has received 20 new Bombardier coaches of which 10 are used for Metro-North services west of New Haven, and 10 for Shore Line East expansion, possibly to New London.

Table 13. Operational Statistics for Tri-Rail.

Miami, Tri-county Commuter Rail Authority (Tri-Rail)

	1989	1990
Annual Ridership (Million)	0.78	1.44
Annual Passenger Miles (Million)	32.1	64.5
Farebox Revenue (Million)	1.69	2.85
Government Subsidies (Million)	11.13	11.4
Other Revenue (Million)		
Total Operating Expenses (Million)	12.8	13





Sources of Operating Funds

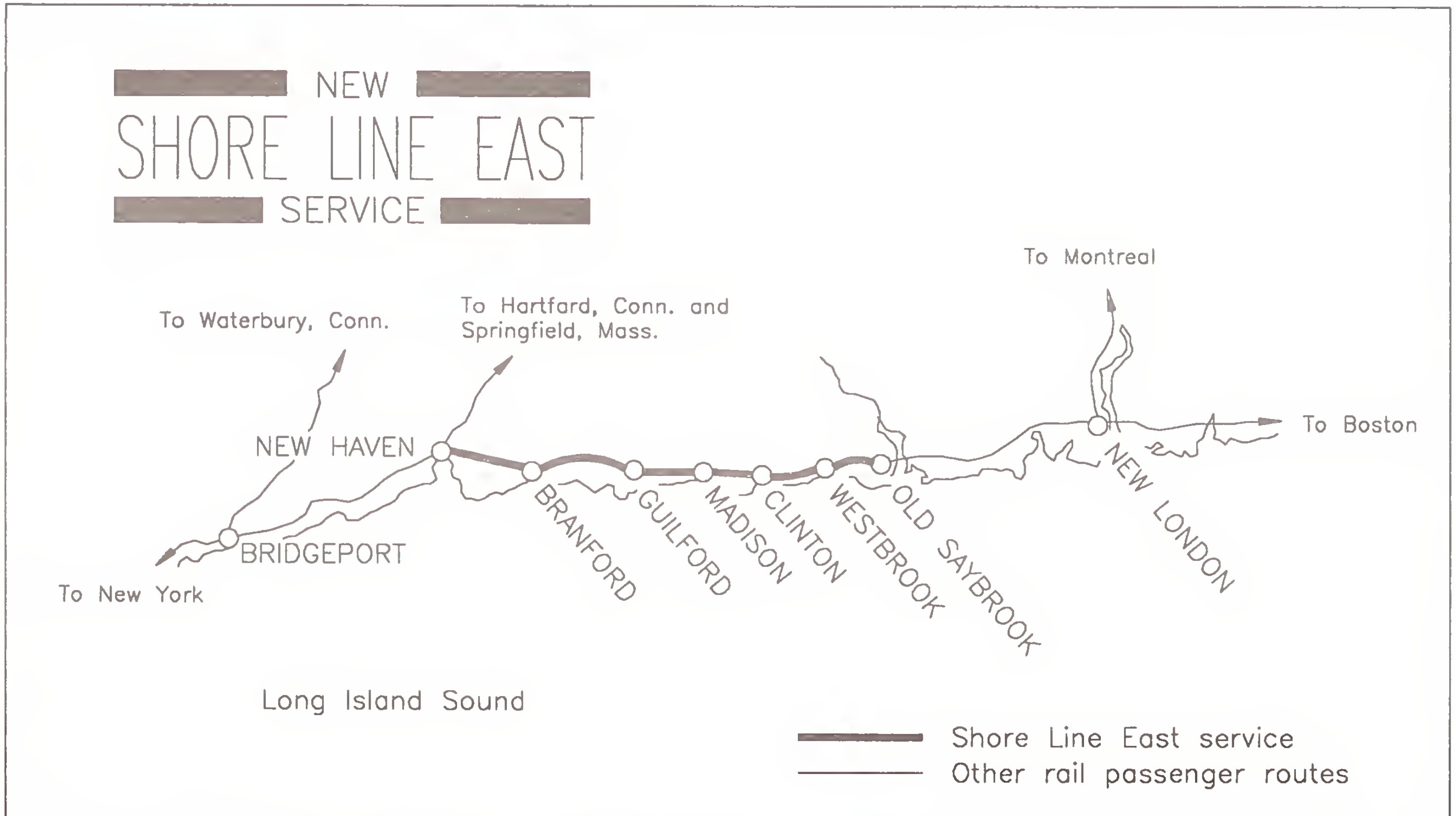


Figure 13. Connecticut's Shore Line East System Map.

11. Orange County, California

California's newest commuter rail operation - Orange County Transportation Authority (OCTA) began carrying passengers between Orange County and Los Angeles on April 30, 1990. The single round-trip service augments existing Amtrak San Diegan Commuter Rail (SD) service from San Diego to Los Angeles, running from San Juan Capistrano to Los Angeles in the morning and returning at night. Two shuttle bus routes funded by the city of Los Angeles (LA), provide connecting service for LA bound passengers. Caltrain currently has loaned Orange County four gallery cars for this service.

The monthly OCTA ridership reached 14,103 in March 1992, which more than quadrupled since May 1990, its first month of operation, when 3,000 passengers used the service connecting San Juan Capistrano and Los Angeles. OCTA, a member of the five-county Southern California Regional Rail Authority, plans to add eight more daily trains between Oceanside and downtown Los Angeles by late 1993 [14]. The OCTA voted on April 13, 1992 to spend $11.7 million for new rolling stock, additional stations, and new trackage rights for its two year old rail commuter program. OCTA also voted to pay Los Angeles County $3.7 million toward the cost of a rail maintenance facility.

The rail funds are part of a total of $100 million which OCTA decided to commit in an effort to "jump-start" Orange County's lagging economy. The money comes from a 20-year, half-cent sales tax (Measure M) which Orange County voters approved in November 1990 [15].

CHAPTER 4 COMPARISON OF EXISTING SYSTEMS

This chapter compares the various commuter rail. Operational statistics based on the 1990 FTA Section 15 Annual Report are shown in Table 14 [8]. The Long Island Rail Road (LIRR) is the largest and one of the oldest rail systems in the nation. It is clear from Table 14 that the top six systems differ significantly from the bottom seven in terms of size and operations. The trend of annual ridership for the nine systems who responded to the survey is shown in Figure 14. The LIRR, RTA (Metra), and MTA (Metro-North) carry most of the commuter traffic in the United States.

The operating expense in dollars per passenger-mile for 12 commuter rail systems is shown in Figure 15 [8]. Two of the smaller commuter rail services (bottom 7): California's Peninsula Commuter Service (PCS) and Maryland Rail Commuter (MARC) had the lowest operating expense per passenger-mile ($0.17). Chicago's Metra had the lowest operating expense per passenger-mile ($0.18) among the six major commuter rail systems. PCS, MARC, and VRE are all run by contract rail operators. Nearly 70 percent (9 out of 13) of the commuter rail services are run by contract operators. Some of these contractors are freight railroads. Some commuter agencies have engaged Amtrak (PCS, MARC, MBTA, Conn) and still others have selected independent private operators (Tri-Rail). The average operating expense rate was $.27 per passenger-mile in Fiscal Year 1990, the lowest of all public transit systems (38 percent less than bus) [8].

The operating expense per vehicle revenue mile for 12 commuter rail systems is shown in Figure 16 [8]. With the exception of Connecticut's new Shore Line East commuter service (Conn), the rate is relatively uniform. The average rate for most of the other commuter rail services was around $10 per revenue vehicle mile in Fiscal Year 1990.

The ratio of passenger trips per vehicle revenue mile for 12 commuter rail systems is shown in Figure 17 [8]. Chicago's Metra, Philadelphia's SEPTA, and San Francisco's PCS had the highest passenger trips per vehicle revenue mile (2.2 to 2.4) while South Florida's Tri-Rail had the lowest rate (0.9). The passenger trips per vehicle revenue mile rate depends upon the following two factors:

(1) Load factor, and

(2) Average trip length.

The higher the load factor and the shorter the average trip length, the higher the passenger trips per vehicle revenue mile rate, and vice versa. The average rate for most of the other commuter rail services was around 1.4 passenger trips per vehicle revenue mile in Fiscal Year 1990.

The passenger miles per vehicle revenue mile for 12 commuter rail systems are

Table 14. Operational Statistics for Existing Commuter Rail Systems based on 1990 Section 15 Report [5].

No.	System	Operating Expense (10^6)	Annual Unlinked Trips (10^6)	Passenger Miles (10^6)	Average Weekday Unlinked Trips	Annual Vehicle Revenue Miles (10^6)	Total Fleet	Vehicles Operated in Maximum Service	Peak to Base Ratio	Spare
1	LIRR	$605.37	93.478	1,989.61	332,000	56.204	1,194	1,034	1.7	15%
2	M-N	423.05	57.953	1,543.95	201,853	35.522	808	696	3.1	16%
3	Metra	127.29	33.542	717.74	131,872	15.772	513	478	4.6	7%
4	NJT	290.90	48.796	1,091.86	7,406	36.647	846	680	n/a	24%
5	SEPTA	152.77	25.669	356.79	91,708	11.713	351	273	4.3	29%
6	MBTA	82.30	19.208	348.39	77,340	13.186	345	273	n/a	26%
7	PCS	21.49	5.437	123.48	19,119	2.451	93	68	1.3	37%
8	MARC	17.21	3.456	102.76	13,555	2.582	63	58	4.8	9%
9	NICTD	16.99	2.748	77.07	10,032	1.858	48	42	1.9	14%
10	Tri-Rail	12.71	1.082	32.13	4,227	1.173	23	20	4.0	15%
11	ConnDOT	0.56	0.022	0.44	899	0.024	12	10	n/a	20%

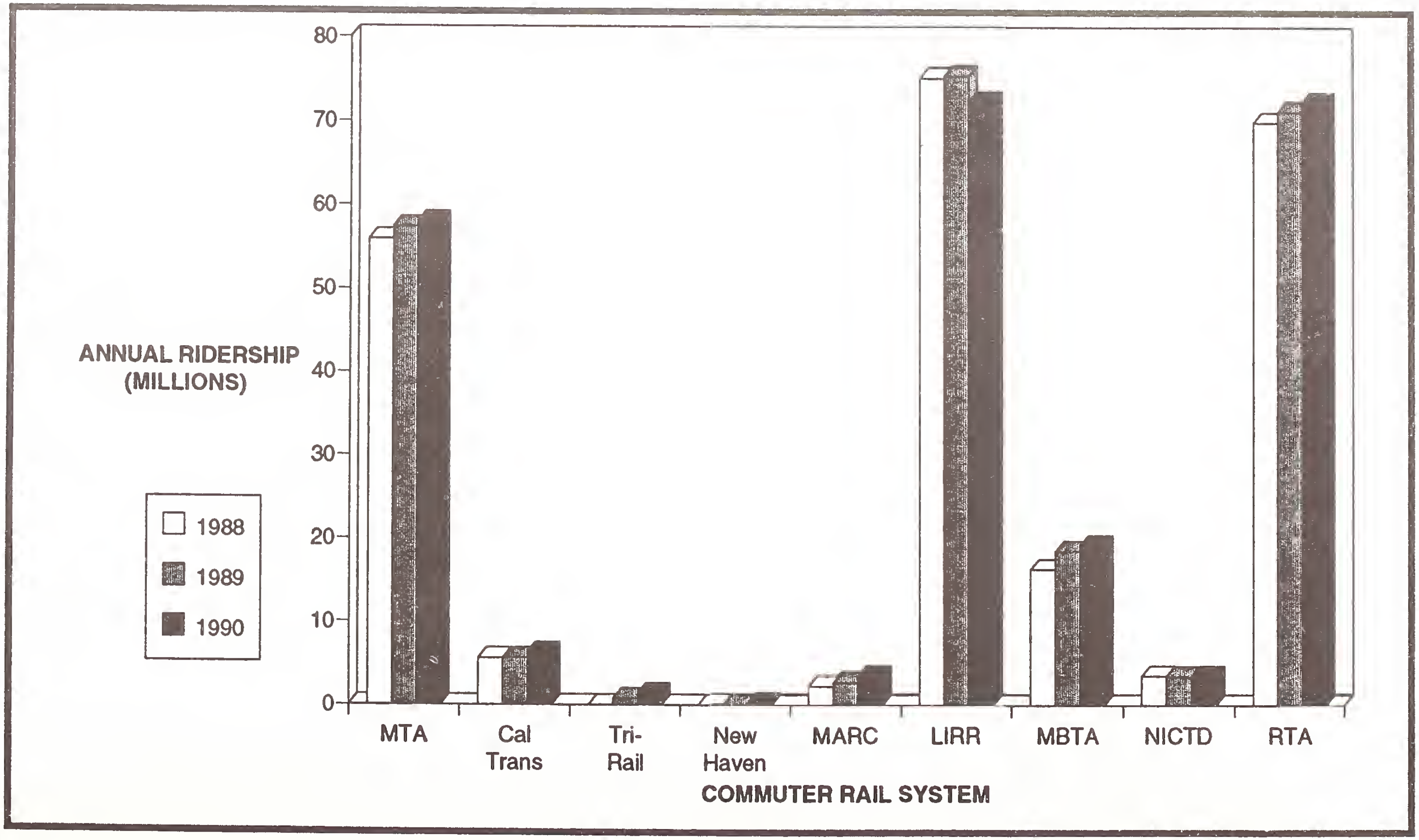


Figure 14. Annual Ridership Trends for Nine Commuter Rail Systems in the United States.

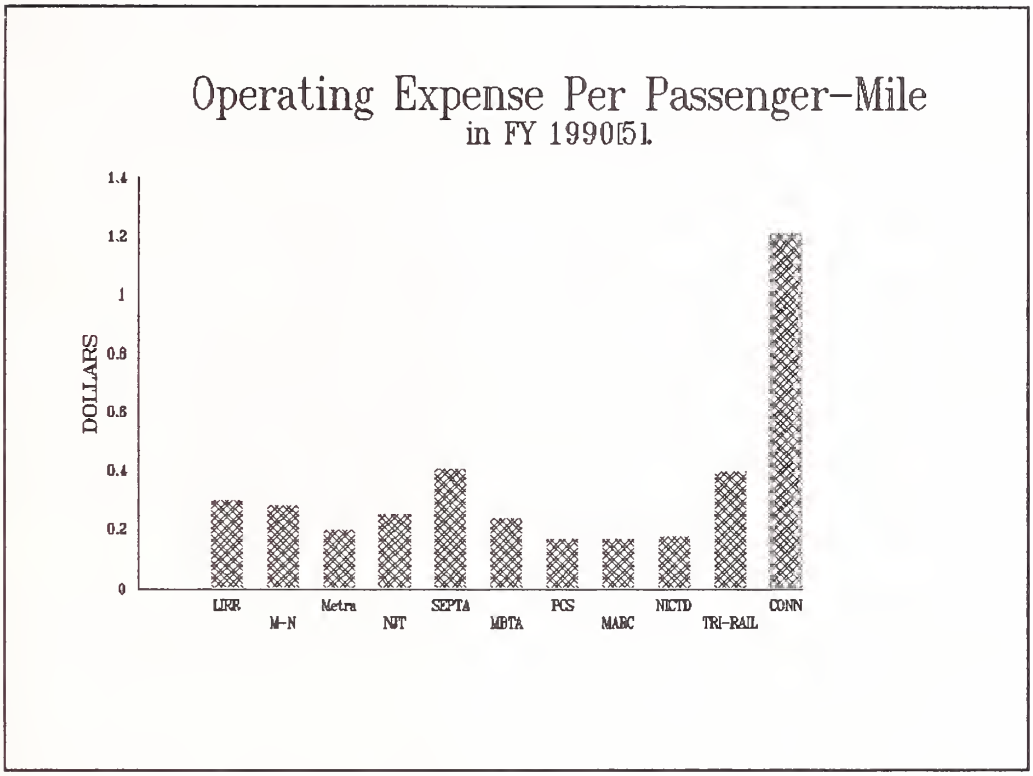


Figure 15. The Operating Expense Per Passenger-Mile in FY 1990 [5].

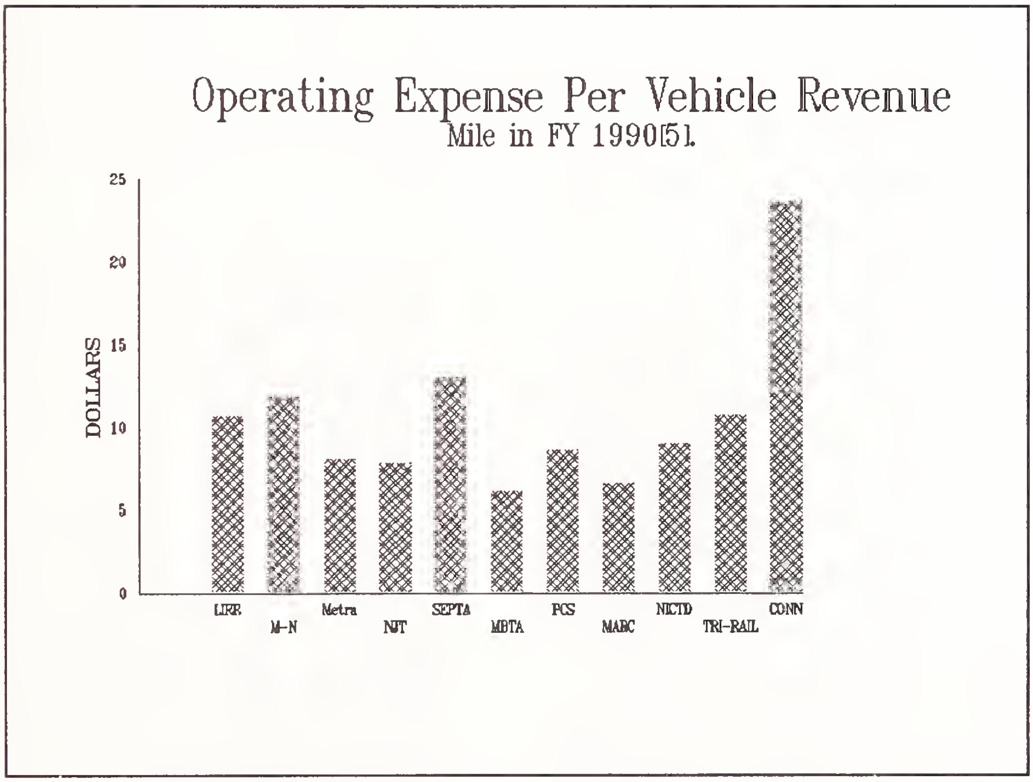


Figure 16. The Operating Expense Per Vehicle Revenue Mile in FY 1990 [5].

shown in Figure 18. San Francisco's PCS and Chicago's Metra had the highest passenger miles per vehicle revenue mile (50.41 and 45.71 respectively) while Connecticut's service (Conn) had the lowest rate (19.13). This passenger miles per vehicle revenue mile rate can be used as the "load factor." Generally speaking, the higher the load factor, the more efficient the operation is, such as the PCS and Metra operations. The average rate for most of the other commuter rail services was around 35 passenger miles per vehicle revenue mile in Fiscal Year 1990.

The farebox revenue per passenger mile for 8 of the commuter rail systems surveyed is shown in Figure 19. The LIRR and Metro-North had the highest farebox revenue per passenger mile ($.15 and $.14 respectively) while South Florida's Tri-Rail had the lowest rate ($.04). The farebox revenue per passenger mile rate basically reflects the ticket price charged to the commuters. The low fare charged by Tri-Rail ($2 flat fare) is clearly the reason that Tri-Rail lags so far behind on this statistic. The average revenue for commuter rail was $.122 per passenger-mile in Fiscal Year 1990, the lowest of all public transit systems (31 percent less than bus).

The average passenger trip length for 8 of the commuter rail systems surveyed is shown in Figure 20. The two new commuter rail services (Tri-Rail & Conn) had the highest average trip lengths (32 and 32.8 miles respectively) while Chicago's Metra had the lowest average trip length (21.3 miles). The average trip length for most of the other commuter rail services was 22 miles in Fiscal Year 1990 [8].
The number of employees per million passenger miles for 7 of the commuter rail systems surveyed is shown in Figure 21. The ratio for Connecticut's service seems to be high. It is suspected that the discrepancies in reporting procedures may have caused this difference. The ratio of farebox revenue with respect to the total operating expense for 9 of the commuter rail systems surveyed is shown in Figure 22. As expected, the two new commuter rail services (Tri-Rail & Conn) had the lowest farebox revenue/cost ratios (0.22 and 0.07, respectively) while MARC had the highest farebox revenue/cost ratio (0.59). The average revenue/cost ratio for all commuter rail services was 45.4 percent (0.454) in Fiscal Year 1990 [5].

Caution must also be exercised in interpreting this data because some reported numbers may be different from agency to agency. The cost recovery ratio typically ranges from 22 percent (Tri-Rail) to 59 percent (MARC). The farebox revenue for most established commuter rail systems is above 40 percent. A new system usually takes time to build up its ridership as experienced by South Florida's Tri-Rail. Operating and administrative statistics (fact sheet) for an established commuter rail system are shown in Table 15.

The comparison of different modes of public transit systems is shown in Table 16. It is clear from Table 16 that commuter rail has the lowest cost per passenger-mile ($.269) when compared with all the other major transit modes. However, since commuter rail's revenue per passenger mile is also the lowest ($.122), the revenue/cost ratio for commuter rail is less than the RRT and electric bus. Commuter rail has the highest operating speed (32.1 mph) and the second highest passenger growth (+20%) during the last five years. Overall, commuter rail compares favorably with most other modes of public transit systems.

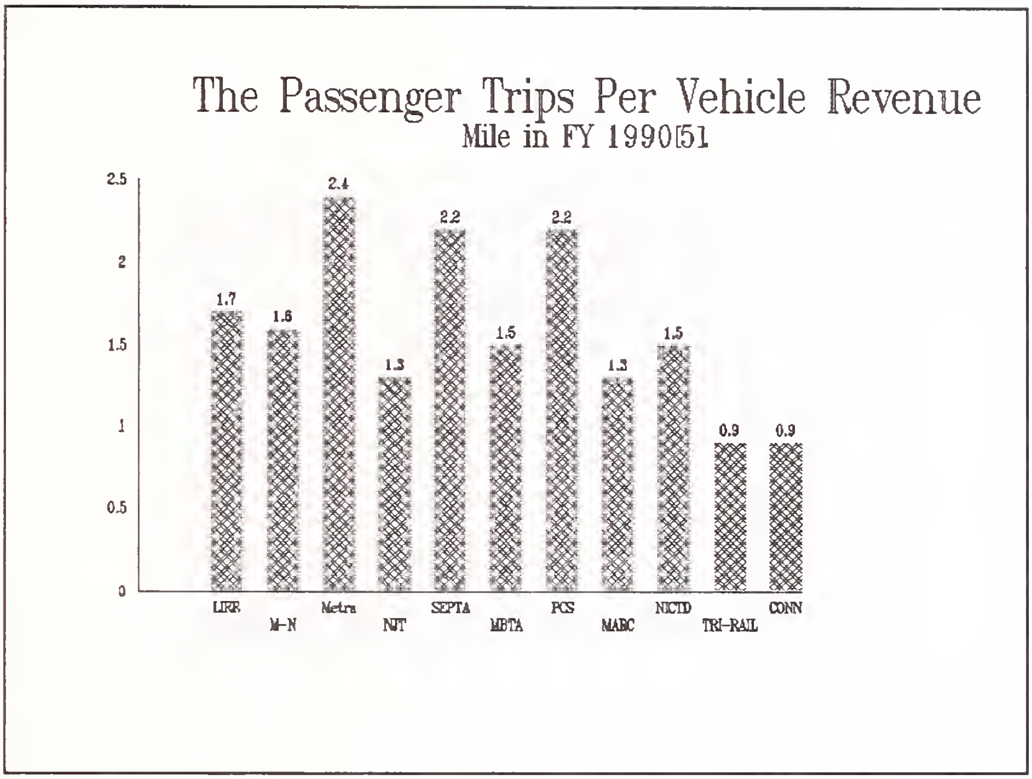


Figure 17. The Passenger TRips Per Vehicle Revenue-Mile in FY 1990 [5].

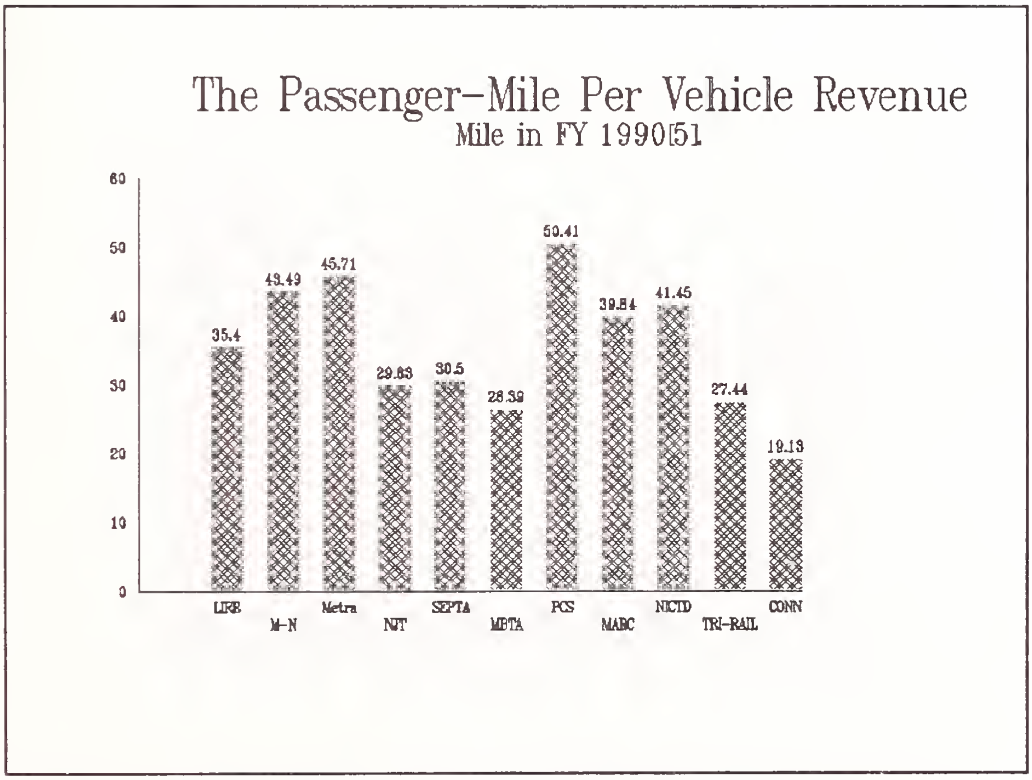


Figure 18. The Passenger-Miles Per Vehicle Revenue Mile in FY 1990 [5].

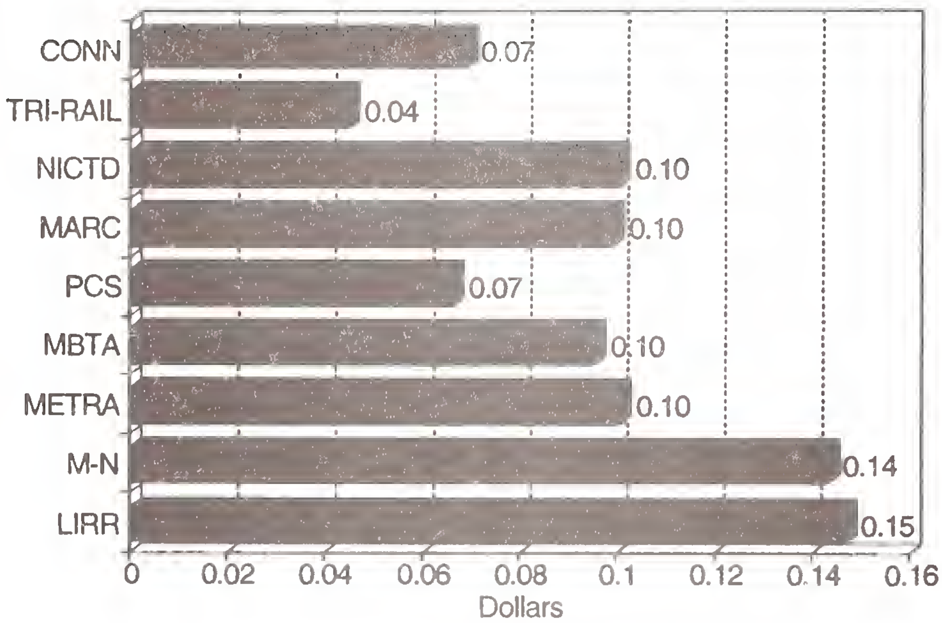


Figure 19. The Farebox Revenue Per Passenger-Mile in 1990.

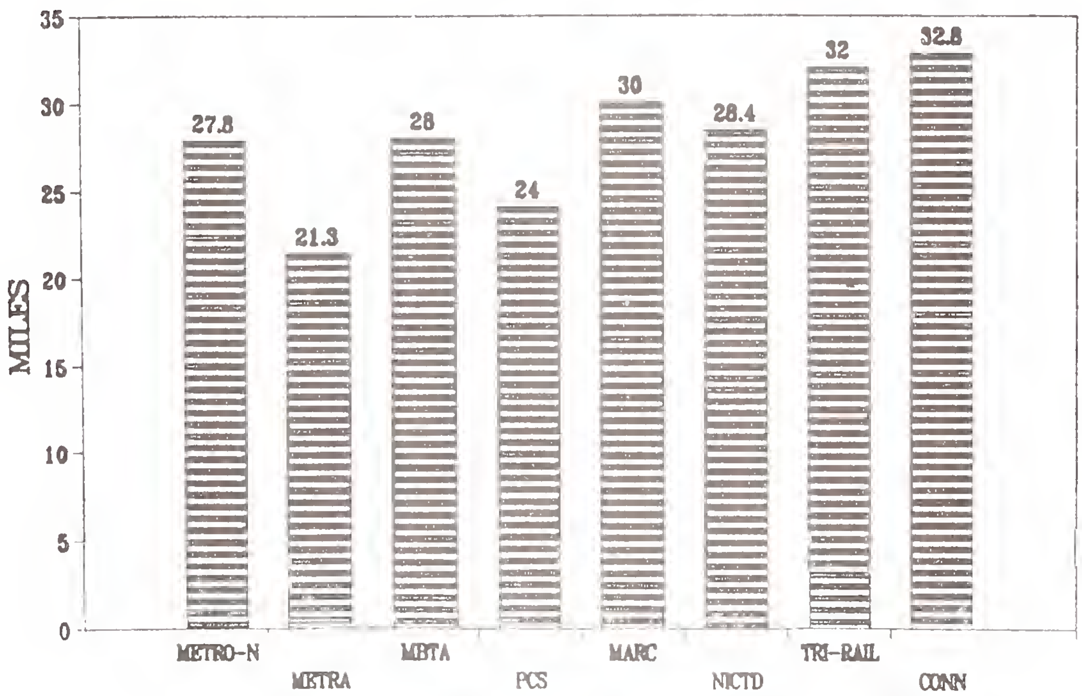


Figure 20. The Average Passenger Trip Length in 1990.

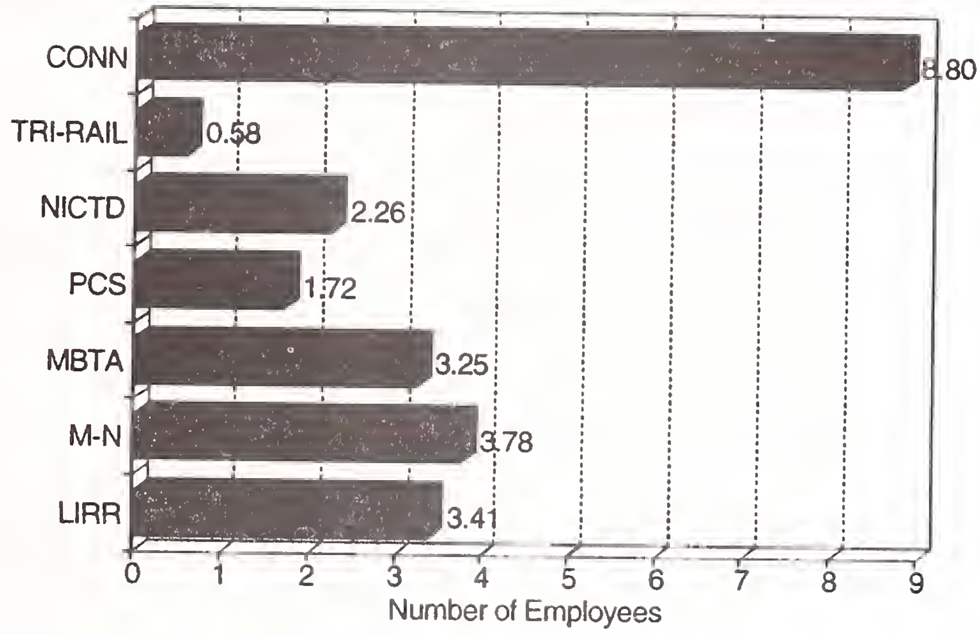


Figure 21. The Ratio of Employees Per Million Passenger-Mile in 1990.

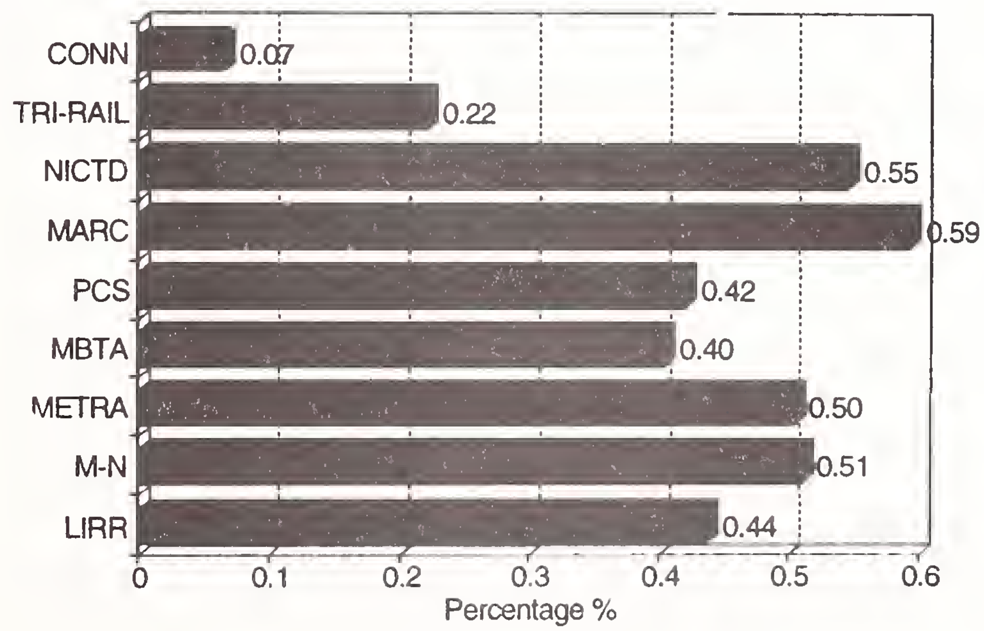


Figure 22. The Ratio of Farebox Revenue/Operating Expense in 1990.

Table 15. The Operating and Annual Statistics of An Established Commuter Rail System (MARC in Maryland).

Operating Statistics

	System	Penn	Brunswick	Camden
Daily Trains	69	41	14	14
Daily Ridership	16,000	8,000	5,200	2,800
Stations	34	8	17	9
Operator	n/a	Amtrak	CSXT	CSXT
Personnel	120	35	> 85 <	

Annual Statistics

	FY 1988	FY 1989	FY 1990
Operating Expenses	$12,024,689	$15,053,687	$17,212,905
Operating Revenues	6,643,551	8,066,394	10,081,452
Operating Deficit	5,381,138	6,987,303	7,131,138
Cost Recovery	55.2%	53.6%	58.6%
Ridership	2,231,600	2,702,100	3,456,400

Capital Program

($ Millions)

	FY 90	FY 91	FY 92	FY 93 - 96
Rolling Stock	$7.5	$18.1	$8.8	$45.5
Stations	4.3	20.5	9.2	9.8
Facilities	0.6	4.4	4.4	2.3

Rolling Stock Fleet

Locomotives		Passenger Cars	
Diesel	11	Self Propelled Diesel Cars	15
Electric	4	Trailer Cars	69
		Cab Cars	18
Total	**15**	**Total**	**102**

Total Rolling Stock Fleet: 117 Vehicles

Source: MARC

Table 16. Comparison of Different Modes of Public Transit Systems Based on 1990 Section 15 Report [5].

	Commuter Rail	RRT	LRT	Diesel Bus	Electric Bus
Cost of Operation (Millions)	$1,939.5	$3,825.0	$237.1	$9,185.0	$108.6
Operating Revenue (Millions)	$ 876.5	$1,851.2	$106.9	$3,766.9	$ 52.8
Revenue/Cost Ratio	45.4%	48.3%	45.1%	40.9%	48.5%
Passengers (Millions)	329.0	2,346.0	176.0	5,754.0	126.0
Passenger-Miles (Millions)	7,207.0	11,475.0	571.0	21,127.0	193.0
Average Trip Length (Miles)	21.9	4.9	3.2	3.7	1.5
Vehicle-Miles (Millions)	212.6	536.7	24.3	2,153.4	13.8
Vehicle-Hours (Millions)	6.6	28.9	2.2	168.2	1.8
Average Speed (mph)	32.1	18.6	11.2	12.8	7.8
Passenger-Miles per Vehicle-Mile	33.9	21.4	23.5	9.8	13.9
Employees (Full Time Equivalent)	21,452	46,102	4,089	164,499	1,924
Passenger-Miles per Employee	335,959	248,905	139,643	128,432	100,312
Cost per Passenger-Mile	$.269	$.333	$.415	$.435	$.563
Revenue Per Passenger-Mile	$.122	$.161	$.187	$.178	$.273
Active Vehicles	4,415	10,419	913	59,753	832
Passenger Growth Last 5 Years	+20%	+2.5%	+33%	+1%	-11%

RRT = Rapid Rail Transit
LRT = Light Rail Transit

CHAPTER 5 NEW AND PROPOSED SYSTEMS

1. Northern Virginia

The Northern Virginia Transportation Commission and Rappahannock Transportation Commission have initiated commuter service on two lines radiating out of Washington, D.C.; a 64 mile line to Fredericksburg, Virginia, and a 33 mile line to Manassas, Virginia as shown in Figure 23. Cars and locomotives are being delivered, station construction is nearly complete, and Virginia Railway Express (VRE) has become the newest North American commuter rail system as of June 22, 1992. The start-up cost of this system is shown in Table 17.

Routes of operation

Commuter rail service operates over routes between Washington's Union Station to Manassas, and Fredericksburg. Both routes originate from Washington's Union Station. A 55-mile line serves Fredericksburg via the Richmond, Fredericksburg & Potomac Railroad, while a 35-mile Manassas line operates via the Norfolk Southern Railroad.

Equipment

VRE has acquired a fleet of 10 remanufactured diesel electric locomotives and 38 new single-level passenger cars. Four daily push-pull round trips operate on each line [5]. Used coaches purchased from the MBTA are being rehabilitated.

Stations and facilities

The Northern Virginia Transportation Commission has built simple concrete platforms for its stations. Park-and ride facilities will be provided at almost every suburban station. The Manassas line will have a total capacity of approximately 2,100 automobiles, while those on the Fredericksburg line will accommodate nearly 1,400 automobiles [16].

Ridership estimation

Ridership is projected initially to be 2,500 daily passengers.

2. San Diego, California

The Northern San Diego County Transit Development Board plans to start service on a new 43-mile commuter line, linking Oceanside and San Diego by the fall of 1992 [17].

Service

Service will consist of four morning peak-hour trains from Oceanside to San Diego and four evening peak-hour trains out of San Diego. Service will be gradually expanded to comprise six trains in each direction during peak hours and hourly service during non-peak hours.

Equipment

Figure 23. System Map for the Virginia Railway Express (VRE)

The planned train consist will be a locomotive and four 85 ft, 160-seat bi-level cars, although expanded service may have as many as ten cars per train.

Table 17. Start-up Cost for New Commuter Rail Systems.

	Tri-Rail	VRE (a)
Length (mile)	67	95
Cost of R-O-W (million)	$264	(b)
Other Costs (million) (c)	$59	$105
Total Start-up Cost (million)	$323	$105
Total Start-up Cost per Mile (million)	$4.82	$1.11 (d)

(a) VRE: Virginia Railway Express
(b) Right-of-way owned by the host railroads.
(c) Other costs include equipment purchases, shared facilities, and stations.
(d) Excluding right-of-way cost.

Ridership

Ridership is estimated to be 3,950 daily riders by the year 1995, rising to 5,560 in the year 2000 and 8,260 by the year 2010.

3. Southern California

Six heavily populated Southern California counties are moving ahead rapidly with plans for what will be the most extensive new commuter rail network under development in the United States. "Metrolink" is the service name. It will be operated by the Southern California Regional Rail Authority (SCRRA), comprising the five county transportation commissions (Los Angeles, San Bernardino, Riverside, Orange, and Ventura), and three San Diego agencies (North County Transit District, San Diego Association of Governments, and the Metropolitan Transportation Development Board).

By 1995, the six counties expect to have in place a 10-line commuter rail system of some 420 route miles. This line will serve the entire Southern California region as shown in Figure 24. The new system is funded largely from two major statewide transportation bond issues approved by voters in 1990, and from transportation sales tax measures, that have been approved in almost all of California's heavily populated counties. On June 18, 1992, Southern California transit agencies announced that they had reached an agreement with the Santa Fe Railroad for purchase of 340 miles of right-of-way, trackage rights, and additional properties for a total price of $500 million [18].

Metrolink began service on October 26, 1992. Amtrak will operate 120 miles of commuter rail (diesel hauled trains) linking Los Angeles to San Bernardino County, Ventura County, and the Santa Clarita Valley [19]. The start-up cost of Metrolink

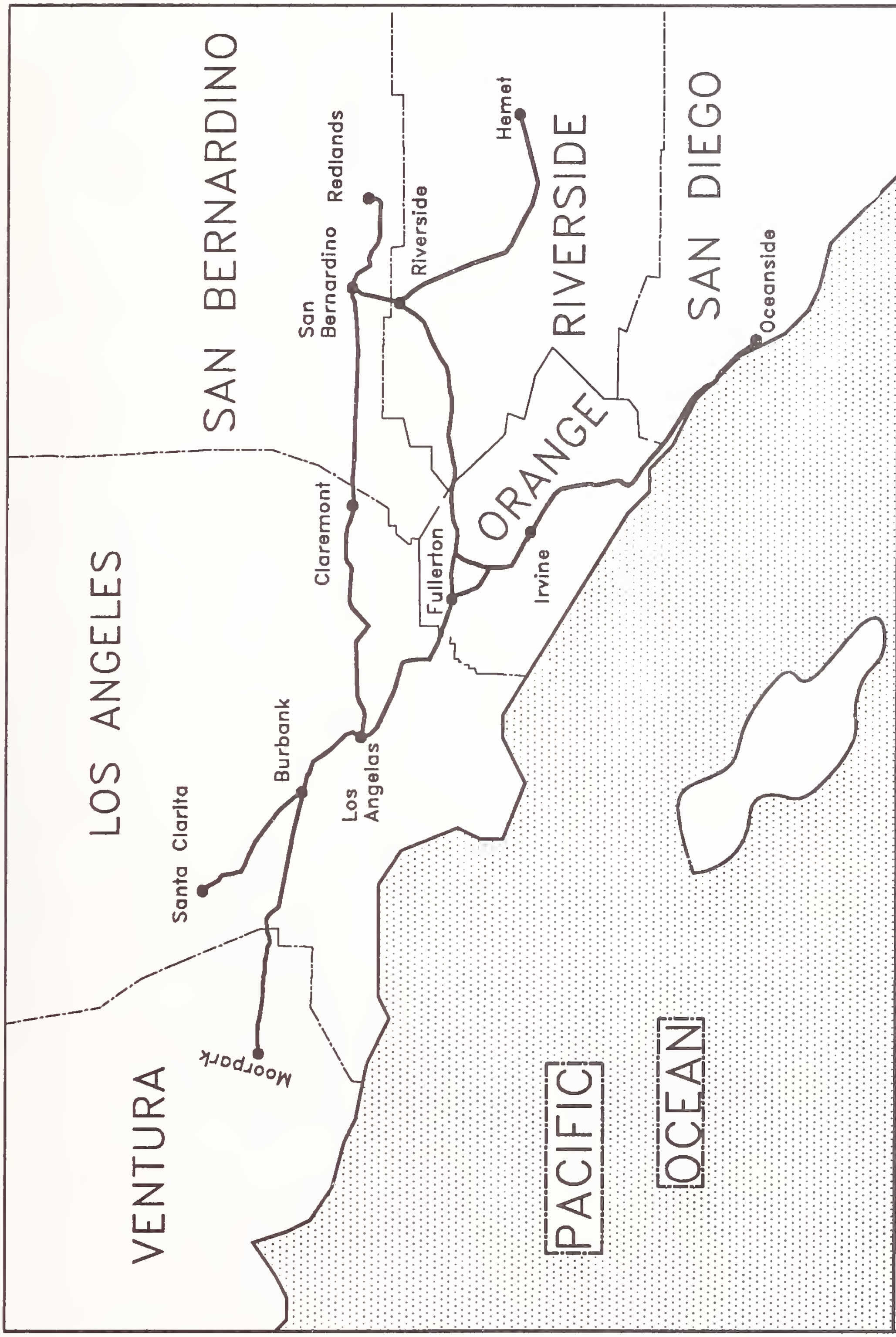


Figure 24. Southern California Commuter Rail Regional System.

Table 18. Southern California Commuter Rail Service Routes.
(Source: From Southern California Commuter Rail System Plan Draft Report).

Route Origin/Destination	Track Segments (Current RR Owner)	Miles	Start-up Ridership Forecast (1992-1995) in Round Trips	Estimated Start-up Date	Number of Stations	Start-up Capital Costs** (in $M)
San Bernardino/LA Northern Route	(SF/SP) SF Foothill Line from Sbd to Claremont via Fontana; SP Baldwin Park Branch from Claremont to LA	57	2,245	1992	13	$115*
Santa Clarita/LA	(SP) Saugus Line via San Fernando & Burbank	35	1,344	1992	6	$52*
Moorpark/LA	(SP) Coast ML via Chatsworth & Burbank	46	1,699	1992	8	$86*
Oceanside/LA	(SF) San Diegan Route	87	2,235	1993	14	$103
Sbd/Irvine Eastern Route	(SF) Sbd Sub Trans ML from SBd to Atwood	59	1,599	1995	14	$122
SBd/Irvine Western Route	(SF) SBd Sub Trans ML from SBd to Fullerton	n/a	n/a	1995	n/a	n/a
SBd/LA Southern Route	(SF) SBd Sub Trans ML via Commerce	63/72 (RV/SBd)	1,800	1995	12	$54
Hemet/Riverside with Proposed Thru Service to LA	(SF) San Jacinto B/L via Ryan Airport & the UC Riverside	40	753	1995	10	$50
Redlands/SBd	(SF) B/L to Mentone	13	n/a	n/a	5	n/a

Ridership forecasts are based upon different fare assumptions.
* No station costs included in estimate ** Includes shared facilities n/a = not available
SBd = San Bernardino, SF = Santa Fe, LA = Los Angeles, SP = Southern Pacific, RV = Riverside,
UP = Union Pacific, Sub = Subdivision, Trans = Transcontinental, ML = Mainline, B/L = Branch Line.
(Source: From Southern California Commuter Rail System Plan Draft Report).

is shown in Table 18.

4. Dallas, Texas

Dallas Area Rapid Transit (DART) may implement a 42 route-mile commuter rail project that will connect Dallas and Fort Worth, with a link to Dallas-Fort Worth International Airport [2]. If agreement between DART, the Fort-Worth Transit Authority, and the cities of Fort-Worth and Dallas is reached soon, the service could begin by 1993.

The initial service will consist of a 10 mile line from Dallas' Union Station to South Irving Transit Center with three intermediate stations. DART hopes to provide initial rush-hour service by mid-1993, using push-pull diesel hauled trains of two to three coaches of self propelled RDC's. Future plans include an eight-mile addition to link Dallas with Dallas/Forth Worth Airport as shown in Figure 25 [11].

5. Seattle, Washington

Seattle is studying a 32-mile commuter rail service between the King Street Station and Tacoma. A tentative start date of revenue service is in 1995 [2,17]. The projected 32 mile route would operate from Seattle to Puyallup, near Tacoma, over Burlington Northern tracks as shown in Figure 26. The entire project is expected to cost about $160 million, including both start-up costs and operating costs over the first five years. Five trains would operate in the direction of peak period traffic while three would operate an opposite direction. The planned level of service includes a total of 16 daily trains, eight in the morning and eight in the evening peak periods.

6. Cleveland, Ohio

The Greater Cleveland Regional Transit Authority (RTA) has been considering the development of commuter rail service serving downtown Cleveland for several years. Several years ago, a BRE-Leyland rail-bus was operated in a month-long demonstration commuter service over Norfolk Southern tracks between Cleveland, Euclid and Mentor, Ohio. RTA received proposals for the planning and operation of services with either rail buses or push-pull equipment in as many as five existing rail corridors linking Cleveland with such near-by communities as Ashtabula, Aurora, Akron, Strongsville, and Lorain.

The development of commuter rail continues to be considered by both RTA and the Northeast Ohio Area-Wide Coordinating Agency, the Cleveland-area metropolitan planning organization.

7. Atlanta, Georgia

The Metropolitan Atlanta Rapid Transit Authority (MARTA) completed a commuter rail study in December 1987. The study considered commuter rail service over the Norfolk Southern on a 105-mile route south to Macon that would be linked with MARTA's South Line at East Point Station, and on an 87-mile route to the east over CSX tracks to Greensboro that would connect with MARTA's East Line at Avondale station. Four inbound trains in the morning peak flow and four outbound trains in the evening are planned for each line.

Other Systems

In addition to the above new and proposed

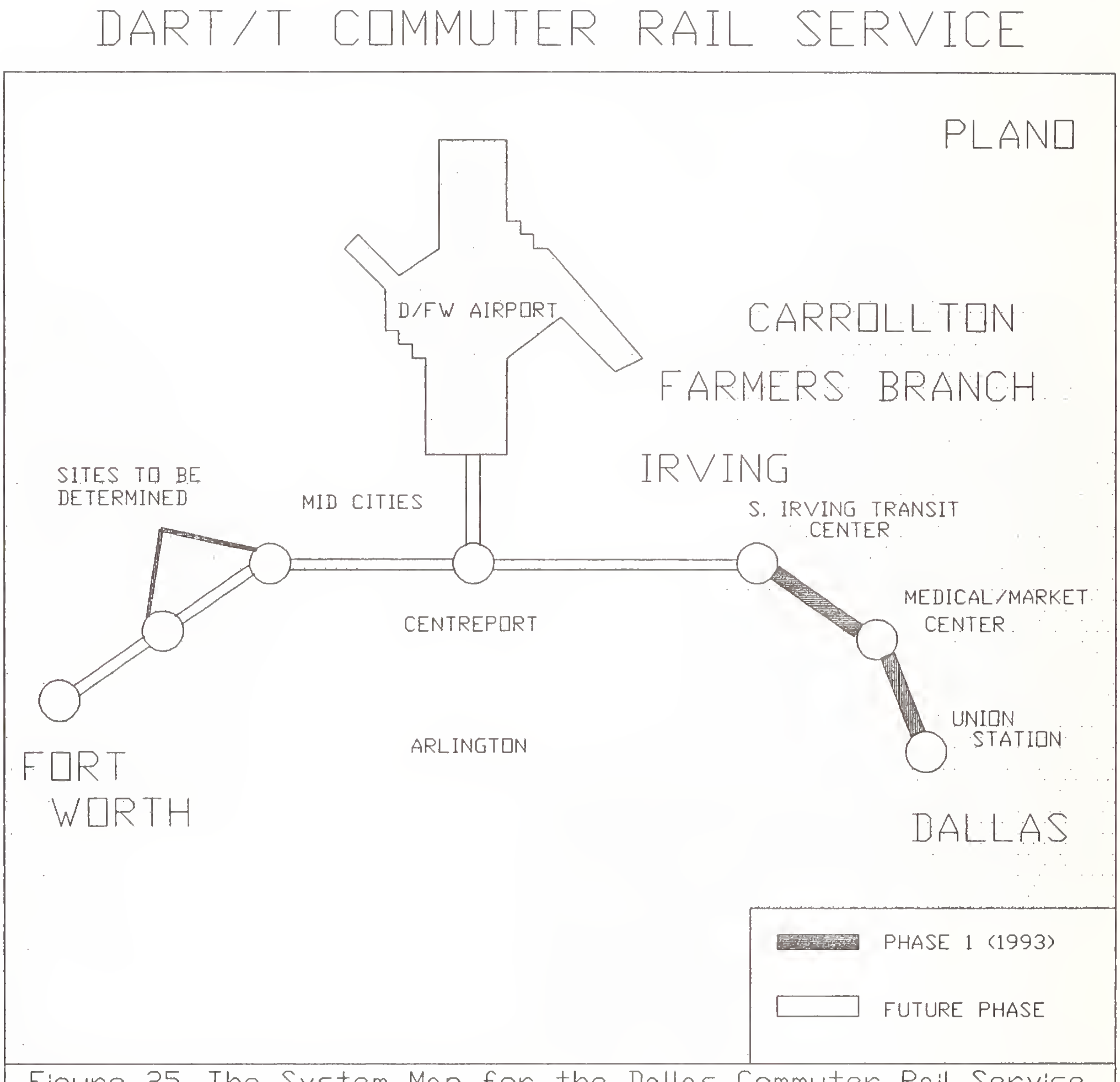


Figure 25. The System Map for the Dallas Commuter Rail Service.

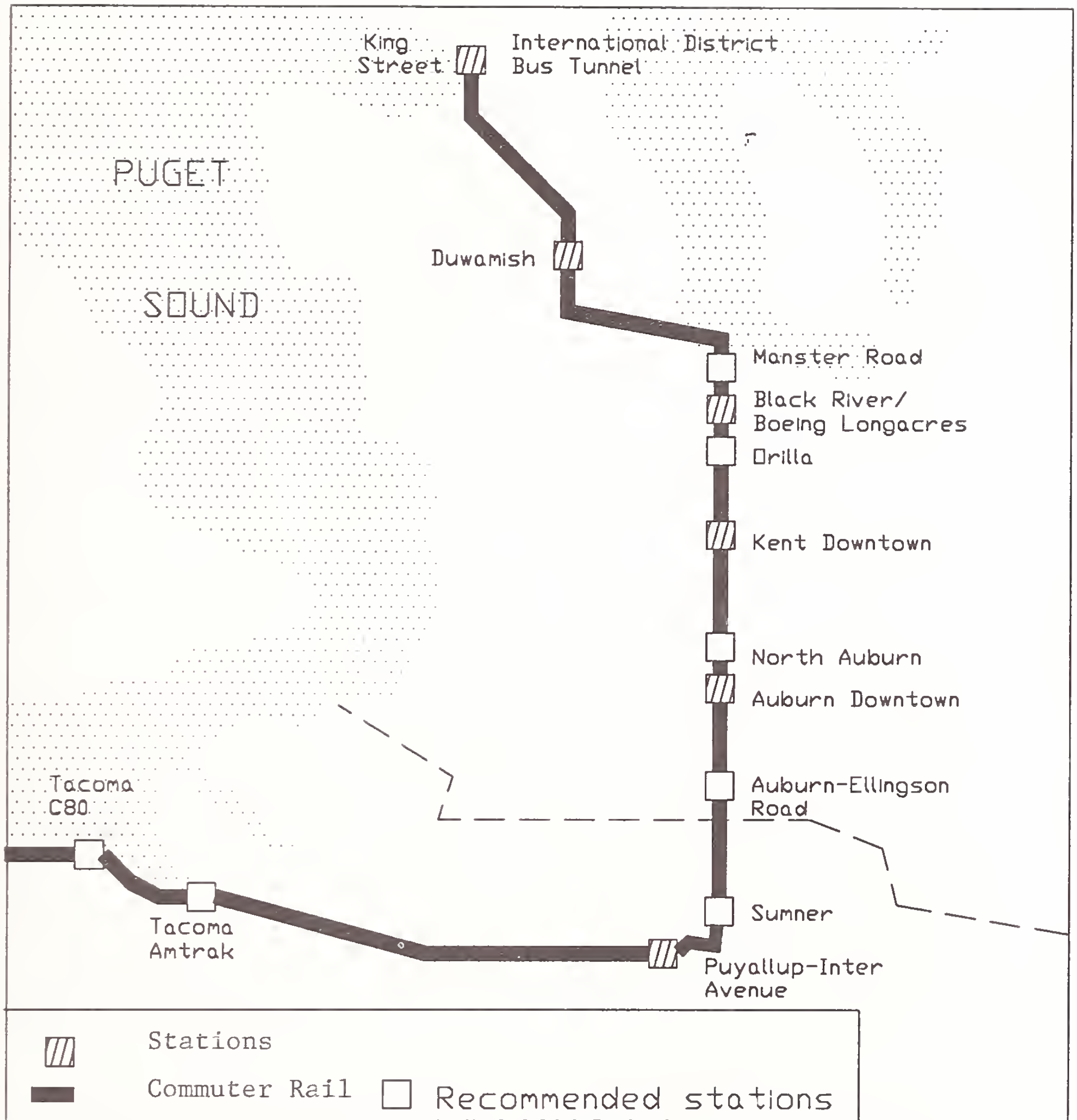


Figure 26. System Map for the Proposed Seattle Comuter Rail Service.

systems, transit planners in the following nine (9) cities are considering commuter rail as a potential part of the solution to local transportation problems [2]:

Bath, Maine
Burlington, Vermont
Charleston, South Carolina
Nashville, Tennessee
Memphis, Tennessee
Tampa, Florida
Orlando, Florida
Jacksonville, Florida
Milwaukee, Wisconsin

CHAPTER 6 CURRENT TRENDS

1. Bi-Level Cars

The trend toward higher capacity cars continues as a means of absorbing increases in ridership without adding costly cars, to limit the crew size, and because of station platform length limitations. Higher capacity is achieved in two ways: (1) use of bi-level cars and (2) use of 3 and 2 seating design. A car with 80 seats can be changed to 120-125 seats by the use of 3 and 2 seating arrangement. Virtually all cars operated by the MTA in the New York region use the 3 and 2 seating arrangement.

Bi-level commuter rail cars may become the standard for commute service in the 1990s. Orders for such cars are coming from authorities across the United States which previously operated traditional, single-level trains. Even two agencies in "single-level" Northeast Corridor territory - the Massachusetts Bay Transportation Authority (MBTA) and the Long Island Rail Road- have ordered double-deck cars.

Bi-level trains can carry more passengers per car, improving revenue-to-cost ratios. Capacity can be increased by one-third without the necessity of operating longer trains. However, double deck cars present problems in scheduling due to longer station dwell time, but this can be mitigated by careful use of zone schedules and other operating techniques. Currently, bi-level railcar operators in the U.S. include Metra, CalTrain (PCS), MBTA, LIRR, Orange County, California and Florida's Tri-Rail.

2. Circumferential Route

Considerable momentum is being generated toward institution of commuter-rail service on two-lines in the Chicago Metropolitan area - one a circumferential link. The latter proposal arises out of Sears, Roebuck & Company's move of most of its Merchandise Group personnel from the Sears Tower in downtown Chicago to a new campus in the Schaumburg area northwest of the city. By 1992, some 5,000 people will be working in the new location, bounded on two sides by the Elgin, Joliet & Eastern railroad and the Northwest Tollway. A similar idea has been proposed in Philadelphia using the ex-Pennsylvania Railroad (now Conrail) Trenton Cutoff.

3. Connection to Airports

South Florida's Tri-Rail is the first commuter rail system designed to connect three major airports (Miami, Ft. Lauderdale, and Palm Beach) along it's corridor. A new multi-modal transportation center is currently being planned in Miami to connect Miami International Airport with Tri-Rail, Metro Rail, Amtrak trains, local buses, and the proposed Florida High Speed Rail system. In addition, MARC and SEPTA are already serving their respective airports. The proposed DART in Dallas also has plan to extend commuter rail service to nearby Dallas-Fort Worth airport.

4. Dedicated Funding Sources

Operating statistics show that nearly half of the operating cost of a commuter rail system needs to be subsidized, a figure comparable to other mass transit modes. Therefore, a dedicated funding source is important for the continued operation of any commuter rail system. The new systems in Northern Virginia and Southern California both have such dedicated funding sources through transportation bond funds and/or sales tax.

5. Contract Operator

Some commuter rail services hire contractors to run their services. Some agencies contract with freight railroads, some have engaged Amtrak, and still others have selected independent private operators. In an era of limited public resources, many new systems seriously consider the alternative of using a contract operator to run their systems. The names of the operators for existing commuter rail operations are shown in Table 19.

6. Joint Development at Stations

In an effort to achieve the greatest penetration of the potential market, adequate supply of station parking is critical. Today's suburban station sites can become activity centers which, with commercial use, can offer conveniences to commuters that reduce the number of auto trips and add to the systems utility. Successful implementation of the joint-development concept will ensure the steady growth in the number of commuter rail riders. Examples include dry cleaners, day care centers, health/fitness clubs, convenience stores, bookstores, video rentals, restaurants, etc.

Table 19. Operators for Existing Commuter Rail Systems [6].

	System		Operator
1	Long Island Rail Road (LIRR)		LIRR
2	Metro-North (M-N)		M-N
3	Metropolitan Rail (Metra)	*	Metra, BN, CN&W, NS
4	New Jersey Transit (NJT)		NJT
5	Southeastern Pennsylvania Transp. Authority (SEPTA)		SEPTA
6	Massachusetts Bay Transportation Authority (MBTA)	*	Amtrak
7	CalTrain Peninsula Commuter Service (PCS)	*	Amtrak
8	Maryland Rail Commuter (MARC)	*	Amtrak, CSX
9	Northern Indiana Commuter Transp. District (NICTD)	*	NICTD
10	Tri-County Rail (Tri-Rail)	*	UTDC
11	Connecticut DOT (Conn)	*	Amtrak, M-N

CHAPTER 6. SUMMARY AND CONCLUSIONS

The main points that emerge from this study are as follows:

1. Commuter rail is a viable, reasonable cost transit alternative where railroad lines are potentially available.

2. Commuter rail service can be an effective growth tool in regional planning, particularly where employment centers are major traffic generators.

3. Implementation of new service requires investment in new or used locomotives and cars, station and parking facilities, and an operating agreement with a host railroad.

4. Right-of-way purchase is the single most expensive item in start-up cost, therefore, shared facility agreement may be more cost effective for new system.

5. Contract operators are cost effective for most agencies and the trend for contract operation is expected to be continued. New operations are generally run by contract operators.

6. The average operating expense for all commuter rail was $.27 per passenger-mile in Fiscal Year 1990, the lowest in all public transit systems (38 percent less than bus).

7. The revenue/cost ratio for commuter rail (45.4 percent) is lower than the RRT (48.3 percent) but higher than bus (40.9 percent). It is about the same as LRT (45.1 percent).

8. Overall, commuter rail compares very favorably in terms of energy efficiency and the revenue/cost ratio with other modes of public transit.

9. Transit planners in several cities are considering commuter rail as an integral part of the solution to local transportation problems.

10. Bi-level commuter railcars may become the standard of the 1990s, where clearance allows, due to their high capacity and lower operating expense.

11. A dedicated funding source is necessary to offset operating deficits.

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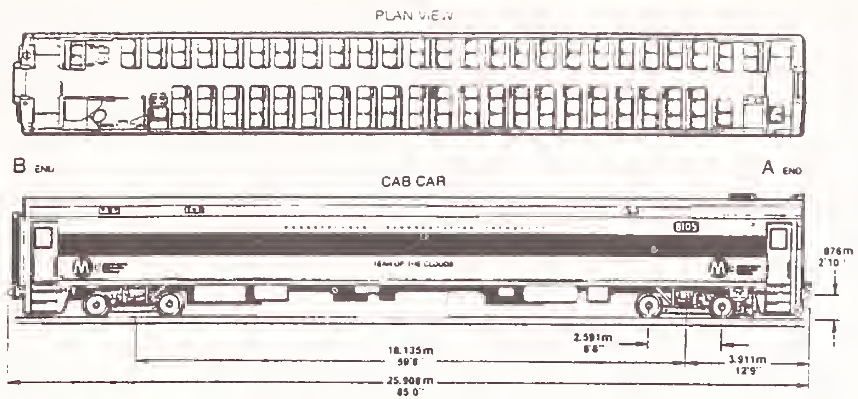
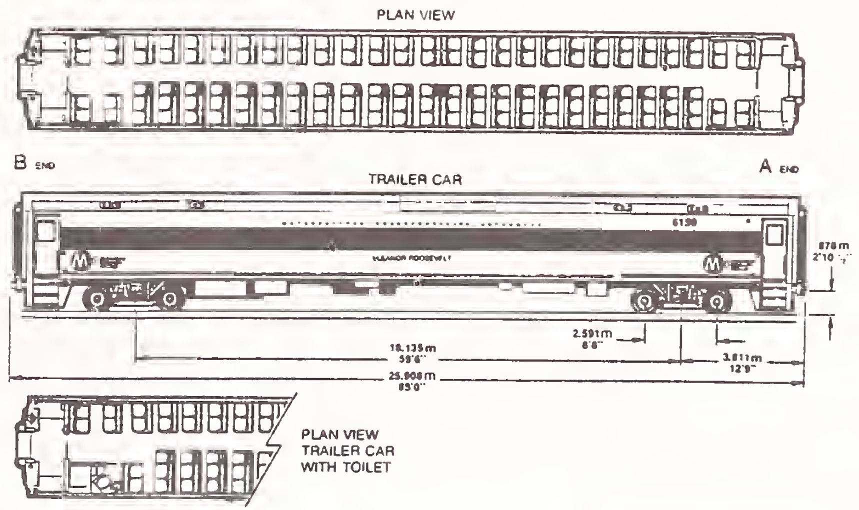
APPENDICES

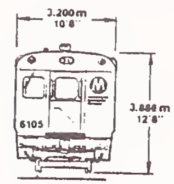
APPENDICES

Push-Pull Commuter Car

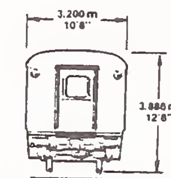
OPERATED BY THE METRO-NORTH COMMUTER RAILROAD, NEW YORK, N.Y.







«A» END
CAB CAR



«A» and «B» END
TRAILER CAR
«B» END
CAB CAR

General Data

Type of Vehicle	Push-Pull Commuter Car
Operator	Metro-North Commuter Railroad
Date of Order	December 1983
Quantity Ordered	19 (5 cab cars and 14 trailer cars)

Electrical System

Power Trainline	480 VAC/60 Hz
Low Voltage (emergency)	64 VDC
Lighting (passenger area)	120 VAC

Dimensions

	Metric	Imperial
Length (over coupler faces)	25 908 m	85' 0"
Width (over side sheets)	3 200 m	10' 6"
Width (end doorway)	0.838 m	33"
Width (side doorway)	0.813 m	32"
Overall Height	4 236 m	13' 10 3/4"
Height (rail to roof)	3.886 m	12' 8"
Height (rail to floor)	1 295 m	4' 3"
Doorway Height (end)	1 968 m	6' 5 1/4"
Doorway Height (side)	1.918 m	6' 3 1/2"
Wheel Diameter (new)	0 813 m	32"
Truck Wheelbase	2.591 m	8' 6"
Truck Centers	18.135 m	59' 6"
Track Gauge	1.435 m	4' 8 1/2"

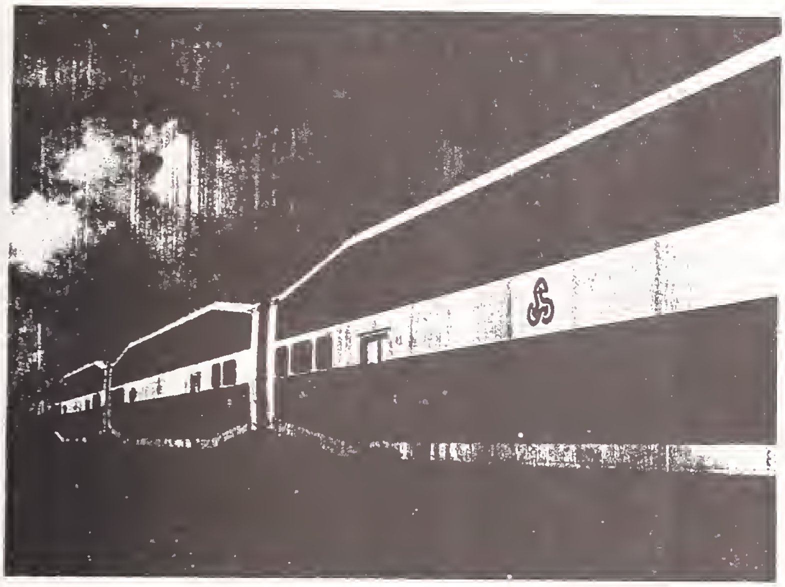
Weight and Capacity

	Metric	Imperial
Cab Car Weight (empty)	41,045 kg	91,200 lb
Cab Car Weight (with seated load)	49.500 kg	109 335 lb
Trailer Weight (empty)	38,410 kg	84,000 lb
Trailer Weight (with seated load)	47,635 kg	104 305 lb
Trailer Weight (empty with toilet)	39,000 kg	85,800 lb
Trailer Weight (with seated load and toilet)	47 877 kg	105,330 lb
Buff Load	363,000 kg	800,000 lb
Seated Passengers per Cab Car	118	
Seated Passengers per Trailer	131	
Passengers per Trailer with Toilet	126	
Passengers per Cab Car (crush)	177	
Passengers per Trailer (crush)	196	
Passengers per Trailer with Toilet (crush)	189	

Miscellaneous

Truck Type	Cast Steel Frame
Primary Suspension	Steel Coil Springs
Secondary Suspension	Air
Braking	Pneumatic Air Brake (Electro-pneumatic for emergency braking)
Ventilation	Yes
Heating	Electric Strip Heaters
Air Conditioning	Yes
Carbody	Aluminum with Steel Underframe
Number of Trucks	Two
E & H Toilet	Yes (cab car only)
E & H Seating	Yes (2 seats in cab car)
Slip-Slide Protection	Yes
Parking Brake	Yes

UTDC



Florida Bi-Level Commuter Coach

These Bi-Level (double-decked) commuter rail coaches provide rail service from downtown West Palm Beach to Miami. Operating through Palm Beach, Broward and Dade Counties, the service provides a much needed alternative for commuters who use Highway I-95. The busy Interstate is undergoing extensive reconstruction. The commuter line has 15 stations on the 96 kilometre (60 mile) line.

This UTDC Bi-Level, one of the largest commuter rail coaches in the world, has a crush load capacity of over 400 passengers. The design is a marked departure from the suspended seating (gallery) principle upon which most North American double-decked commuter coaches are based. The UTDC Bi-Level has two full decks with intermediate end decks over the trucks (bogies), an arrangement that permits higher ceilings and better seat, stairway, and door positioning.

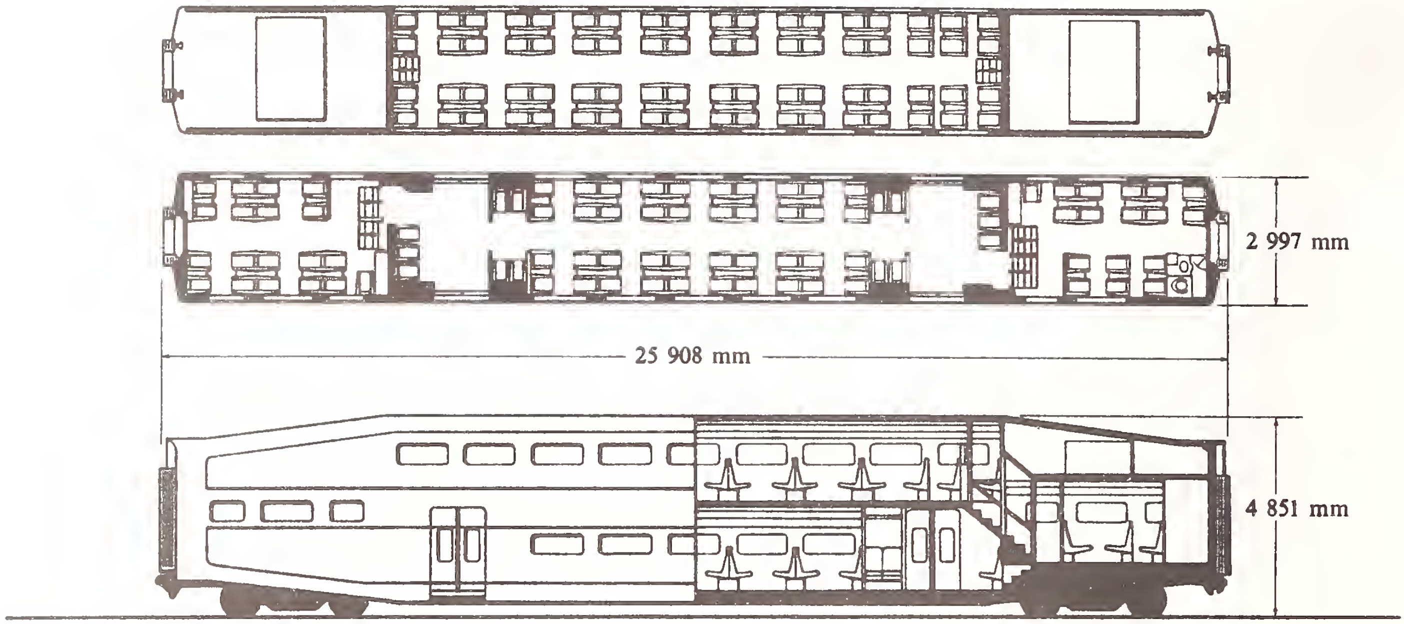
The low-level platform doors, located at the quarter points, let a full carload of passengers on or off the coach within 90 seconds and minimise platform congestion. In addition, Bi-Level cab cars permit push/pull train operation that reduces turnaround times and operating costs.

THE ORDER	
Customer	• Florida Department of Transport (FDOT)
Operator	• Tri-County Commuter Rail Organization (TCRO)
Total order	• 18 vehicles (6 cab cars)
In service	• January, 1989
Configuration	• single vehicles
Train consist	• up to 10 vehicles

BODY	
Underframe	• low-alloy, high-tensile steel
Superstructure	• aluminum alloy structure and sheathing, painted
Floor	• plymetal covered with carpet
Doors	• two pneumatically operated two-leaf sliding pocket doors per side; service doors at each end
Side windows	• fixed, tinted double glazed, meeting FRA Type II standards
Seats	• aluminum frames, molded fiberglass with cushion inserts

SUSPENSION, PROPULSION, BRAKING			
Trucks/bogies	• two per vehicle; cast steel with inboard bearings		
Suspension	• chevron rubber spring primary; air spring secondary		
Truck centres	• *64 ft 0 in*		19 507 mm
Wheels	• solid	*33 in*	838 mm
Wheel base	• *8 ft 6 in*		2 591 mm
Track gauge	• *4 ft 8.5 in*		1 435 mm
Propulsion	• locomotive hauled		
Gear ratio	• not applicable		
Gearbox	• not required		
Wheelslide protection	• provision for addition		
Service brakes	• pneumatic tread brakes and disc brakes		
Emergency brakes	• see "Service brakes"		
Parking brakes	• mechanical hand brakes		

VEHICLE CAPACITY		
Seating	• 162 non-cab (2 cab car wheelchair tie-downs)	159 cab
($4/m^2$)	• 298 non-cab	293 cab
($6/m^2$)	• 366 non-cab	360 cab
($8/m^2$)	• 433 non-cab	427 cab



PASSENGER COMFORT	
Heating	• electric convection floor heaters, overhead air heaters
Air conditioning	• two self-contained units, one at each end of vehicle
Washrooms	• one per coach car

VEHICLE DIMENSIONS		
Length over couplers	• *85 ft 0 in*	25 908 mm
Length over body ends	• *84 ft 4 in*	25 704 mm
Width	• *9 ft 10 in*	2 997 mm
Height, rail to roof	• *15 ft 11 in*	4 851 mm
Height, rail to floor	• *2 ft 1 in*	635 mm
Empty weight	• *109 000 lb*	49 441 kg
Headroom, centre aisle	• *6 ft 7 in*	2 006 mm
Doorway width	• *4 ft 4 in*	1 321 mm
Doorway height	• *6 ft 6 in*	1 981 mm
Step height - above standard low platform	• *10 in*	254 mm
- above top of rail	• *18 in*	460 mm

VEHICLE PERFORMANCE		
Maximum design speed	• *100 mph*	161 km/h
Maximum operating speed	• *84 mph*	135 km/h
Service acceleration	• locomotive hauled	
Service braking*	• *1.5 mphps*	0.67 m/s^2
Emergency braking*	• *1.8 mphps*	0.80 m/s^2
Minimum horizontal curve radius	• *250 ft*	76 m
Minimum vertical curve radius	• *2 000 ft*	610 m

*on level tangent track

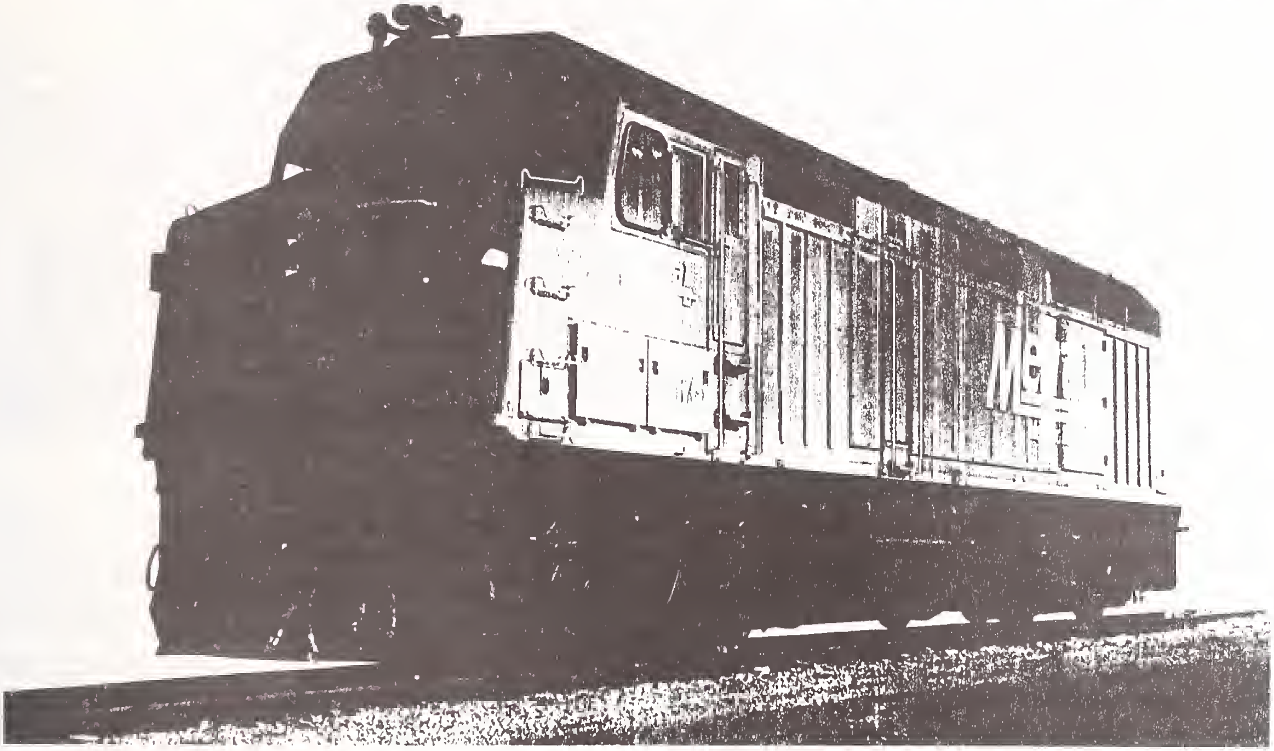
ELECTRICAL AND CONTROL SYSTEMS	
Power supply	• 480 V, 3 ph, 60 Hz head end power
Power collection	• not applicable
Low-voltage power supply	• 36 VDC, nickel-cadmium emergency battery
Auxiliary power supply	• static battery charger and low-voltage power supply
Interior lighting	• fluorescent

ENVIRONMENTAL CONDITIONS			
Extreme temperature range	• *+32 to +91 F*		0 to +33 C
Wind speed	• average	*40 mph*	18 m/s
	• peak gust	*68 mph*	31 m/s
Maximum interior vehicle noise level	• 70 dBA static		

• UTDC Inc., Taylor Kidd Blvd., P.O. Box 70, Stn. A, Kingston, Ont., K7M 6P9 (613) 384-3100
• UTDC Corporation, 344N Woodward Ave., Suite 301, Birmingham, MI 48009 (313) 642-6600

Lavalin

General Motors Locomotives



F40PH

3000 HP Passenger Locomotive

With over 300 units now in passenger and transit service worldwide, the General Motors model F40PH brings proven dependability to your system. The durable D77 DC traction motors have a proven performance record. Head-end power from the 16-645E3C main engine mean just one engine to maintain. The blended brake system extends wheel and brake shoe and life to reduce operating costs and downtime. Plug-in microprocessor modules provide up-to-date wheel slip control for optimum tractive efficiency.

The F40PH is available with a modernized cab including console design for improved comfort, visibility and safety, plus new truck suspension for increased rider comfort in high-speed service.

people moving people

GM

GM Locomotive Group

General Motors Locomotives

F40PH

3000 HP Passenger Locomotive

MODEL
F40PH 3000 horsepower four-motor diesel-electric locomotive. AAR designation (B-B).

TRACK GAUGE
Standard gauge.

NOMINAL DIMENSIONS
Distance, end plate to centerline of bolster:

Hood end	9' 6"
Cab end	9' 6"
Distance between bolster centers	33'
Distance, front end plate to rear end plate	52'
Four wheel truck – wheel base	9'
Width over handholds	10' 7-13/16"
Overall height over cooling fanguard exhaust silencer	15' 7-1/8"

DRIVE

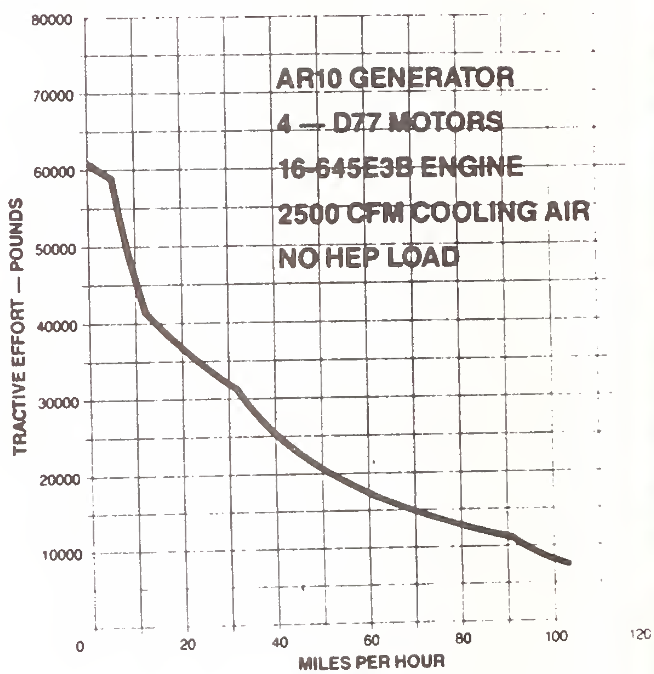
Driving Motors	4
Driving Wheels	8
Diameter Wheels	40"

WEIGHTS AND SUPPLIES

Basic nominal weight on rails (fully loaded)	260,000 lbs. max.
Fuel	1800 USG
Sand	20 ft^3
Cooling water	257 USG
Lubricating oil	395 USG

CURVE NEGOTIATION
Truck swing limits single unit curve negotiation to a 41° curve of 140' radius. Certain options and modifications may have an effect on minimum curve radius and/or overall locomotive clearances.

TRACTIVE EFFORT — SPEED CURVE
3000 HP F40PH LOCOMOTIVE
57: 20 G.R. — 40" WH.



people moving people

Diesel Division,
General Motors of Canada Limited
P.O. Box 5160, London, Ontario N6A 4N5
Phone (519) 452-5117 Fax (519) 452-5332

GM Locomotive Group

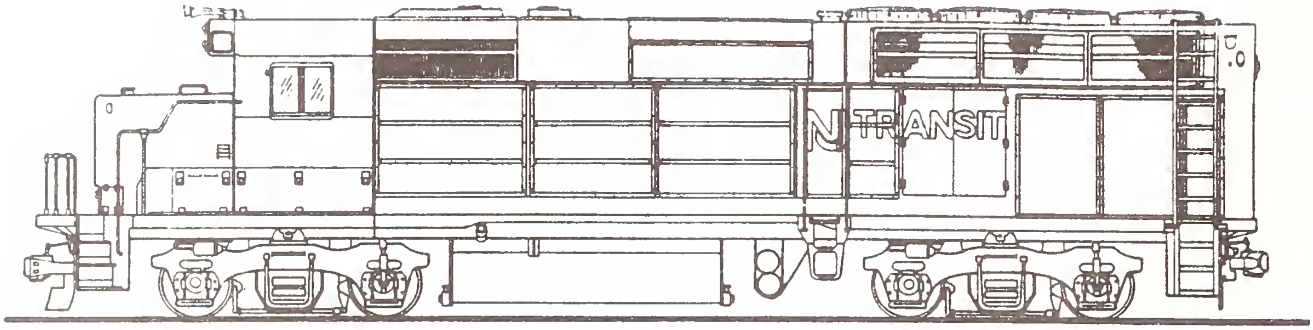
MORRISON KNUDSEN CORPORATION

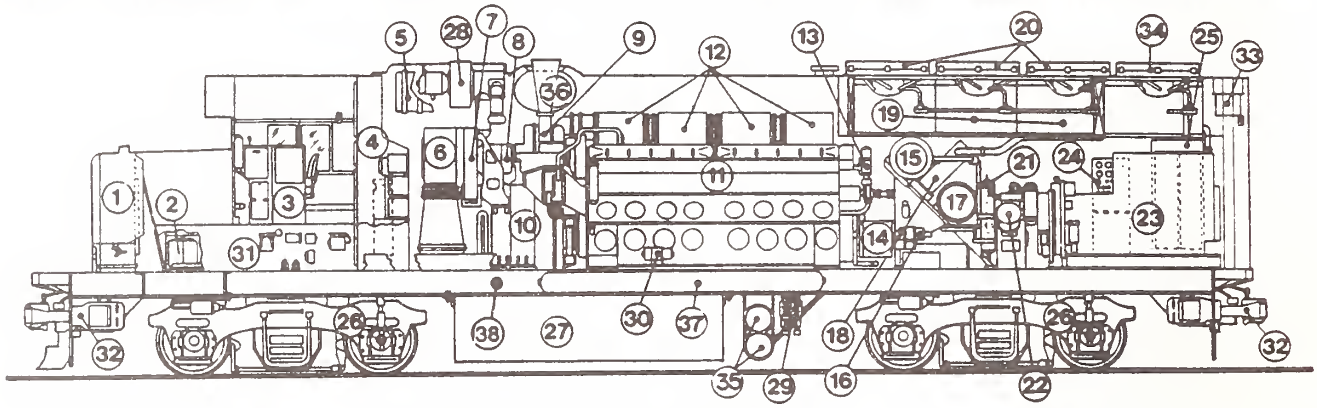
New Jersey Transit

GP40FH-2 Locomotive

Model Designation GP40FH-2
Locomotive Type .... (B-B) 0440
Locomotive Horsepower 3000
Diesel Engine
  Model 645E3
  Type .... Turbocharged
  Number of Cylinders 16
  Cylinder Arrangement .... 45° "V"
  Cylinder Bore
    and Stroke .... 9-1/16" × 10"
  Operating Principle .... 2 Stroke Cycle, Turbocharged, Unit Injection, Water Cooled
  Full Speed .... 904 RPM
  Idle Speed
    Normal .... 300 RPM
    Low .... 235 RPM
Main Generator Model AR10A4/D14
  Traction Alternator
    (Rectified Output) AR10
    Number of Poles 10
    Nominal Voltage (DC) 600
    Max. Cont. Rating 4,200A
  Companion Alternator D14
    Nominal Voltage (AC) 215
    Number of Poles 16
    Frequency (At 900 RPM) .... 120 Hz

Auxiliary Generator Voltage (DC) 74
  Rating 18kW
Traction Motors
  Model D77B
  Number 4
  Type .... DC, Series Wound Axle Hung
  Max. Cont. Rating 1,050A
Driving Wheels
  Number .... 4 Pair
  Width Over Cab Sheeting .... 10' 0"
  Width Over Carbody
    Access Steps .... 10' 8"
  Height, Top of Rail to Top
    of Cooling Fan Guards .... 15' 4-3/4"
  Distance Between
    Coupler Faces .... 59' 2"
  Distance, Pulling Face of Coupler
    To Bolster Centerline .... 12' 7"
  Distance Between
    Bolster Centers .... 34' 0"
Minimum Curve Negotiation Capability
  140 ft. Radius – 42° Curve –
    Single Unit With Single Shoe
  240 ft. Radius – 24° Curve –
    Two Units Coupled
  315 ft. Radius – 18° Curve –
    Unit Coupled to Standard
      87 ft. Passenger Car
Head End Power Unit
  Cummins Diesel Engine





1. Sand Box (Front/Rear)
2. Battery
3. Control Stand
4. Electrical Cabinet
5. Inertial Air Filter
6. Traction Motor Blower
7. Generator Blower
8. Auxiliary Generator
9. Turbo Charger
10. Main Generator
11. Diesel Engine 16-645E3
12. Exhaust Manifold
13. Engine Governor
14. Lube Oil Strainer
15. Engine Water Tank
16. Fuel Pump
17. Lube Oil Filters
18. Lube Oil Cooler
19. Radiators
20. Radiator Cooling Fan
21. Fuel Filter
22. Air Compressor
23. HEP Plant
24. HEP Relay Cabinet
25. HEP High Voltage Cabinet
26. Truck
27. Fuel Tank
28. Inertial Air Discharge Fan
29. Air Dryer
30. Auxiliary Lube Oil Pump
31. Air Brake Compartment
32. Coupler/Draft Gear
33. HEP Cooling Expansion Tank
34. HEP Cooling Fan
35. HEP Air Start Reservoirs
36. Exhaust Silencer
37. Main Air Reservoirs
38. Emergency Fuel Cut Off (Both Sides)

Model KTTA-19C
Type . . . . 4 Stroke Cycle
Aspiration . . . . Twin-Turbocharged
Number of Cylinders 6
Cylinder Bore . . . . 6.25 in.
Cylinder Stroke . . . . 6.25 in.
Full Speed . . . . 1800 RPM
Lubricating Oil . . . . 12.1 gal.
Cooling System . . . . 100 gal.
50/50 Ethylene Glycol

Marathon Alternator
Model . . . . 202 BAT 61633W
Frame Size 680
Nominal Voltage . . . . (AC) 480v
Frequency at 1800 RPM . . . . 60 Hz
Frequency at 900 RPM . . . . 30 Hz
Control Voltage (DC) 74
Rating (Standard) . . . . 494 Kw

Gear Ratio	Top Speed* MPH	Minimum Continuous MPH
57:20	102	16.3

* Based on 2471 maximum rpm for traction motors.

WB0 8114 Gardner-Denver
Air Compressor
Basic
Type . . . . 2 Stage
Number of Cylinders 3
Capacity
(At 900 RPM) . . . . 254 cu. ft./min.
Air Compressor Cooling . . . . Water
Lube Oil Capacity . . . . 10-1/2 gal.

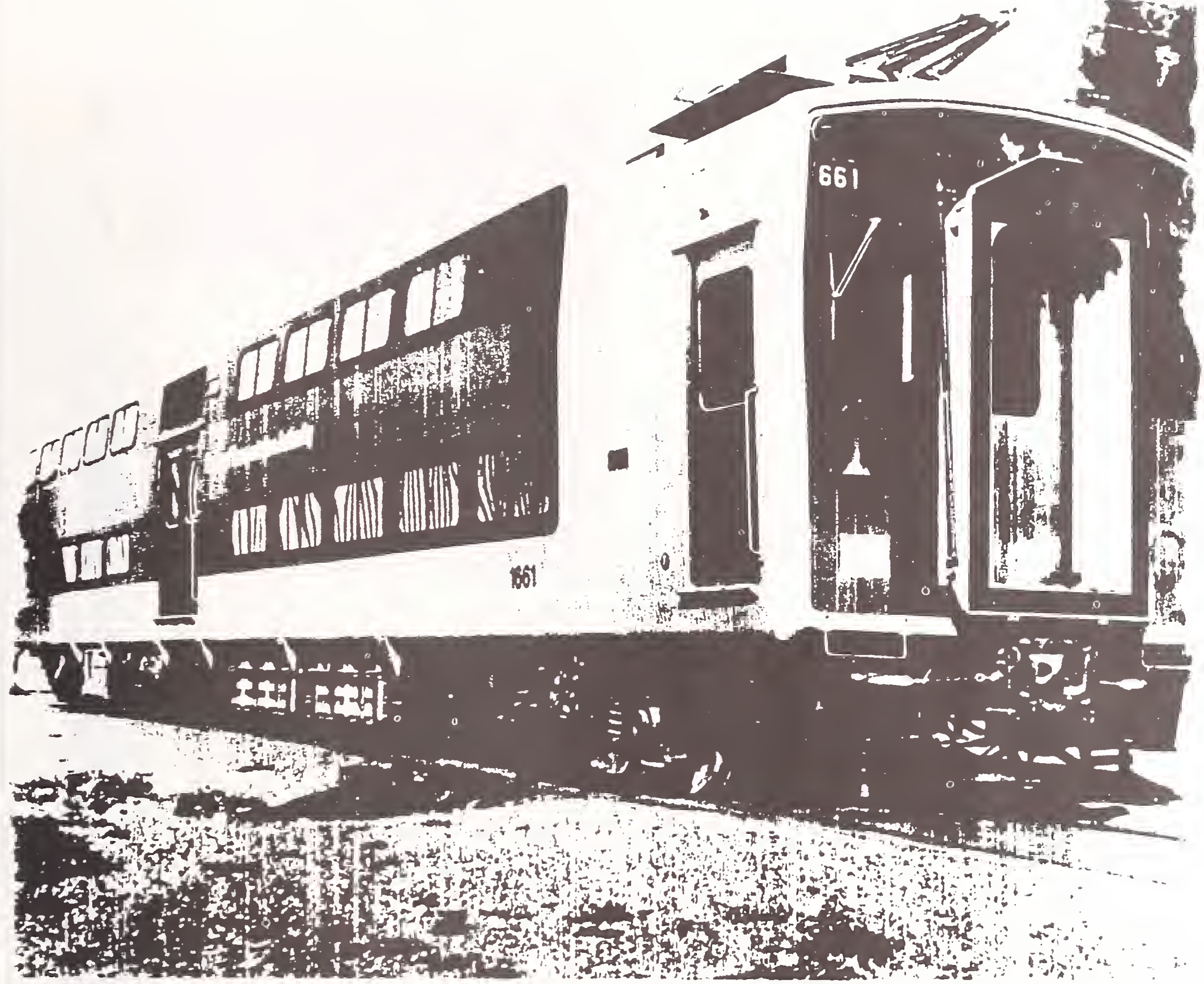
Storage Battery
Number of Cells 32
Voltage 64
Rating (8 Hour) . . . . 420 Amp Hr.

Supplies
Lubricating Oil Capacity . . . . 243 gal.
Cooling Water Capacity . . . . 275 gal.
Fuel Capacity . . . . 2500 gal.
Sand . . . . 38 cu. ft.

Air Brakes Type 26L/CS2
Approximate Weight
on Rails . . . . 289,000 lbs.
Weight on Drivers 100%

MORRISON KNUDSEN CORPORATION
RAIL SYSTEMS GROUP

P.O. BOX 73/BOISE, IDAHO U.S.A. 83729
PHONE: (208) 386-5950/FAX: (208) 386-5967

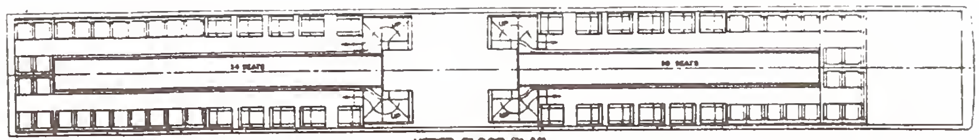


SELF-PROPELLED GALLERY CAR

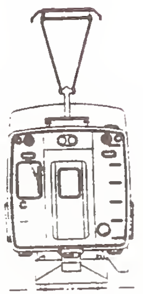
Operated by the Illinois Central Gulf Railroad

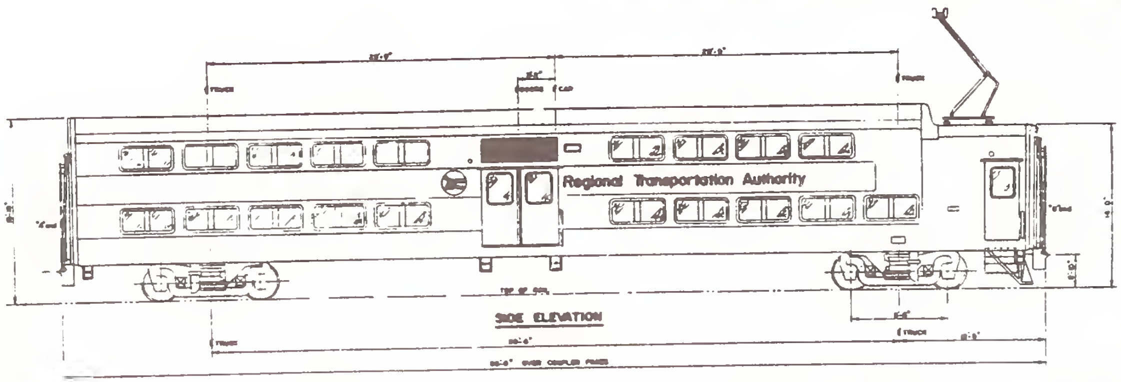
BOMBARDIER

Bombardier Inc.
Mass Transit Division

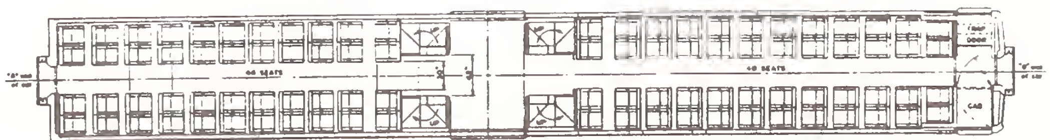


UPPER FLOOR PLAN





SIDE ELEVATION



LOWER FLOOR PLAN

SPECIFICATIONS

Type of Vehicle	Self-propelled gallery car
Operator	Illinois Central Gulf Railroad

DIMENSIONS	Metric	Imperial
Length, over coupler faces	25.908 m	85'0"
Width, over threshold plates	3.200 m	10'6"
Width, doorway	1.994 m	6'6½"
Height, rail to roof	4.826 m	15'10"
Height, rail to floor	1.310 m	4'3$^{9}/_{16}$"
Minimum pantograph operating height	4.978 m	16'4"
Maximum pantograph operating height	7.518 m	24'8"
Doorway height	2.032 m	6'8"
Wheel diameter (new / worn)	0.914 m/0.838 m	36"/33"
Truck wheelbase	2.591 m	8'6"
Truck centers	18.136 m	59'6"
Track gauge	1.435 m	4'8½"

WEIGHT AND CAPACITY	Metric	Imperial
Empty weight	63500 kg	140 000 lb
Gross weight (normal)	74470 kg	164 180 lb
Crush load weight	81500 kg	179 680 lb

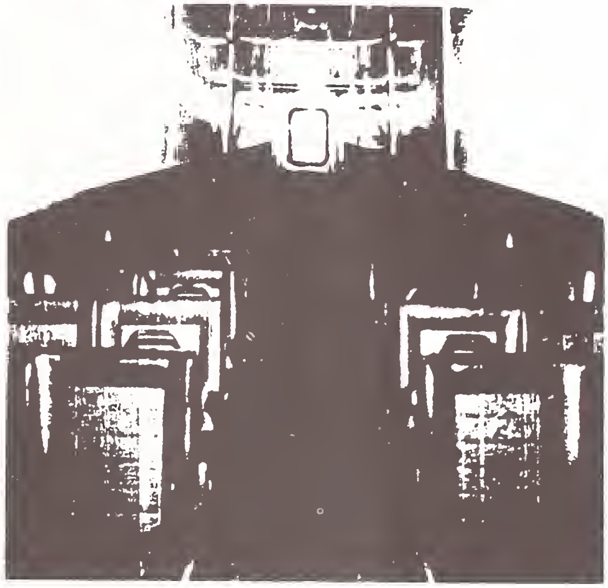
Buff load	363 000 kg	800 000 lb
Number of seats (upper / lower)	64/92	64/92
Total number of passengers (normal)	156	156
Total number of passengers (crush)	256	256

PERFORMANCE CHARACTERISTICS	Metric	Imperial
Maximum speed	120 kmh	75 mph
Acceleration rate (from 0 mph to 30 mph)	0.61 m/s²	1.38 mphps
Braking rate — service (from 50 mph to 15 mph)	0.67 m/s²	1.50 mphps
Braking rate — emergency (from 60 mph to 0 mph)	1.01 m/s²	2.25 mphps
Jerk limit	0.89 m/s³	2 mphpsps
Minimum radius horizontal	97.5 m	320'
Minimum radius vertical (crest)	610 m	2000'
Minimum radius vertical (sag)	610 m	2000'

ELECTRICAL SYSTEM	
Nominal line voltage	1500 VDC
Low voltage power supply	MA set 30, 208 VAC and 72 VDC
Traction motor, cont. rating	GE#1258, 150 hp (112 kw) at 750 VDC
Traction motor, 1-hr rating	160 hp (119 kw) at 750 VDC
Number of motors / truck	Two

MISCELLANEOUS	
Gear ratio	4.07:1
Gearbox type	GE#GA66, parallel drive
Truck type	GSI, cast steel frame
Primary suspension	Steel coil springs
Secondary suspension	Air
Brakes	Hydraulic and electro-dynamic
Motor control	Motor driven cam
Power collection	Pantograph
Low / high level loading	High
Ventilation	Yes
Heating	Yes
Air conditioning	Yes
Carbody	LAHT steel
Number of trucks	Two
Number of powered trucks	Two

Upper level interior



Lower level interior

The Highliners were designed by the St.Louis Car Company for operation on the Illinois Central Gulf Railroad's commuter lines in the Chicago area. Following the initial order of 131 such cars in 1970, an additional 36 cars were ordered from Bombardier in 1976 and placed into service beginning in 1978. The cars not only offer a low weight-to-passenger ratio, but make more efficient use of manpower than conventional single level cars

The car bodies, constructed of low alloy - high tensile steel, feature two levels for seated passengers, both of which may be monitored by railroad personnel from the first level for ticket taking, etc. Access to the upper level is via stairwells located at the center of the car.

Used in commuter service, the cars serve numerous communities to the south of Chicago. One route, South Chicago, operates on a boulevard median strip while another, to Blue Island, operates for a considerable distance on single track.

The cars have been designed and built to operate in the severe winters experienced in Chicago, with temperatures of -20°F and snowfalls of 20 inches and more.

BOMBARDIER

Bombardier Inc.
Mass Transit Division
1350 Nobel Street
Boucherville, Québec, Canada J4B 1A1
Telephone: (514) 655-3830
Telex: 055-61576

SS2/0984/5M

SURVEY OF COMMUTER RAIL SYSTEMS IN THE U.S.

Urbanized Area:____________________ State:_____________

Name of the Operating Agency:__________________________________

1. Length of the system in route miles:____________, No. of stations:_______

2. Type of feeder systems: 1) Bus___, 2) LRT___, 3) RRT___, 4) Other________

3. Service schedules:
   1) Weekday schedule (no. of trains/day/direction):__________
   2) Weekend schedule (no. of trains/day/direction): Sat._______, Sun._______

4. Vehicle characteristics:
   1) dimensions (ft.): length_____, width____, height____, # of axles_____
   2) seating capacity: ______
   3) vehicle capacity (spaces/vehicle):______
   4) Single level:_______ or Bi-level vehicle______
   5) Train composition (no. of cars): Minimum_______, Maximum_______
   6) Facilities to accommodate handicapped: Yes___, No___
   7) Distance between truck centers (ft):_________
   8) Weight: tare/gross (tons): _________________
   9) Maximum speed (mph): __________
   10) No. of Locomotives______, Coaches______, MU______, Bi-level cars______

5. Fixed facilities:
   1) Guideway: Shared w/freight train_____, or Dedicated service______
   2) Exclusive right-of-way (% of length)_____________
   3) Fare collection: At station________, or On vehicle_________
   4) Power supply: a) Diesel locomotive____, b) Overhead____, c) Third rail____
   5) Station access control: None______, or Full______
   6) Facilities to accommodate handicapped: Yes______, No_______

6. Operational characteristics:
   1) Maximum speed (mph):__________, Operating speed (mph):_______
   2) Max. frequency (# of trains/hour/direction): Peak hour_____, Off-peak______
   3) Max. capacity (persons/hour/direction):_______________
   4) Reliability: High______, Medium______, Low______

7. System aspects:
   1) Network and area coverage: Radial______, Limited CBD coverage______
   2) Average station spacing (miles): ______________
   3) Average trip length (miles): ____________
   4) Relationships to other modes (transferability): Good_____, Poor______

8. Ridership & Operational Statistics:
   1) Annual ridership (thousands): '90__________, '89___________, '88__________
   2) Annual passenger miles (thousands) '90__________, '89___________, '88__________
   3) Annual vehicle miles (thousands) '90__________, '89___________, '88__________
   4) Average Weekday ridership: '91__________, '90___________, '89__________
   5) Average Weekend ridership: '91__________, '90___________, '89__________
   6) Passenger fare ($dollars/trip) '91__________, '90___________, '89__________

9. Revenue and costs ($ in thousands)
   1) Annual farebox revenue: '90__________, '89___________, '88__________
   2) TOTAL annual operating costs: '90__________, '89___________, '88__________
      - Transportation costs: '90__________, '89___________, '88__________
      - Maintenance of equip. costs: '90__________, '89___________, '88__________
      - Maintenance of way costs: '90__________, '89___________, '88__________
      - General & administrative costs: '90__________, '89___________, '88__________
   3) Annual gov't subsidies (thousands) '90__________, '89___________, '88__________

10. Employeement statistics (no. of persons):
   1) General & administrative: '90__________, '89___________, '88__________
   2) Transp. (train & engine crews) '90__________, '89___________, '88__________
   3) Maintenance of equipment: '90__________, '89___________, '88__________
   4) Maintenance of way: '90__________, '89___________, '88__________
   5) TOTAL employees: '90__________, '89___________, '88__________

Please attach a copy of the system map of your commuter rail system with your completed survey and return to:

Dr. L. David Shen, P.E.
Director, UMTA Grant 91-014 B-2
Dept. of Civil & Environmental Engineering
Florida International University
Miami, FL 33199

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THANK YOU FOR YOUR COOPERATION IN THIS IMPORTANT SURVEY

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