Miami-Dade Transit

Rail & Mover Rehabilitation

Phase II – Metromover & Operational Review
Final Report

This research was conducted pursuant to an interlocal agreement between
Miami-Dade Transit and the
Center for Urban Transportation Research

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April 10, 2002

ACKNOWLEDGEMENTS

The project team from the Center for Urban Transportation Research included Janet L. Davis and Stephen L. Reich. The team worked closely with a Mover Rehabilitation Task Force made up of Agency Rail Division personnel including Hannie Woodson (Chair), Danny Wilson, George Pardee, William Truss, Gregory Robinson, Bud Butcher, Colleen Julius, Sylvester Johnson, and Cathy Lewis.

A special acknowledgment of the Rail Maintenance Control Division is made for their significant assistance in assembling much of the data required.

EXECUTIVE SUMMARY

Project Purpose

The work was intended to assist Miami-Dade Transit (MDT) in documenting its rail rehabilitation needs and develop a plan to address those needs. The assessment included a review of the current condition of the Metrorail and Metromover systems, a comparison with other transit properties' heavy rail and people mover systems, and a recommended plan of action to carry the Agency forward into the next five years.

Special detail was devoted to the provisions of the labor agreements of the comparable transit properties as they related to contracting for outside services and the recruitment, selection and advancement of employees. Specific attention was given to those contract provisions resulting from the provisions of Section 13(c) of the Urban Mass Transportation Act of 1964.

Project Schedule

Phase I of the project began on March 24, 2000 and focused on Metrorail. The Phase I Final Report was completed on January 9, 2001. Phase II commenced on August 25, 2000.

Project Approach

The approach to the project included the formation of a Mover Rehabilitation Task Force composed of key personnel within MDT in addition to the project team. Status reports and presentation of data collected to date occurred monthly. FTA Section 15 data for Miami-Dade Transit (MDT) Metromover, Jacksonville Skyway (Skyway), and Detroit Downtown People Mover (DDPM) were analyzed and reviewed. Numerous Metromover and MDT staff were interviewed and all divisions were toured. The initial plan included site visits to other comparable people mover systems. Given the disparity in size and system-type of the two systems for which Section 15 data were available, the Mover Task Force determined site visits to people mover systems employing vehicles similar to MDT's would be more appropriate. The private concern contracted to operate and maintain those systems was concerned with proprietary information and, therefore, reluctant to provide the project team with any information that could be used to determine operating expenses and manpower requirements. Since those two factors were at the heart of the purpose of the visits, the plan to visit those properties was discarded. Similar vehicle data were not available for comparison.

Findings

Comparison with Other Systems

- After reviewing other people mover systems, CUTR determined that a system comparable to the Metromover system does not exist. Airport people-mover systems lack the complex switching and loop configurations employed at Metromover, and the two automated guideway systems in operation in Detroit, Michigan and Jacksonville, Florida lack the breadth and scope of the Miami Metromover. DDPM, the larger of the two systems, is less than half the size of Metromover.

Incident Analysis

- Metromover incidents occur in no consistent pattern – time of year, day of week, or time of day, although the time of occurrence has gradually grown to be earlier in the day.

- Although most deboardings occur at Government Center, this number appears to be disproportionately high because, when possible, passengers are transported to Government Center for deboarding to facilitate transfer to other destinations.

- In 2000, Third Street Station and Bayfront Park Station show the highest numbers of deboardings, while most other stations either maintained 1998 and 1999 levels or had very few deboardings.

- Stations with the highest numbers of incidents are Government Center, College North Station, Knight Center, Third Street Station, and Omni Station. College Bayside and Bayfront Park, which are not included in this list, recorded high incidents during 1998 and 1999.

- No apparent trends in terms of loops or high incident corridors were identified.

- There is no indication that the Omni Recovery Technician response time is longer than response time for technicians at other locations. Response time for the Brickell Recovery Technician appeared to be the longest.

- Over half of the time, service was resumed in one minute or less, and 90 percent of the time, service was restored within ten minutes or less.

Passenger Boardings

- The highest weekday and weekend boardings were reported at Government Center. Boardings at Bayfront Park followed Government Center on weekdays while Brickell Station boardings followed Government Center on weekends. Government Center and Bayfront Park both serve major employment centers. Government Center and Brickell provide connections to Metrorail.

- High volume stations occur throughout the entire system. The current configuration of five trains per loop provides short headways, frequent service, and meets current service needs.

Metromover Wayside

- Hi-cycle switches require more labor, more repairs, and more overhaul than lo-cycle switches.

- While the Wayside does show an increased need for PM and repair labor hours, CUTR and Bombardier Transportation were consistent in their positive analysis of the wayside condition, which is supported by where the technicians are spending their maintenance time - on vehicles and not on the wayside.

- No matter what measure is applied in the wayside overhaul, a "hot spot" that includes some combination of Switch 1, Switch 2, Switch 3, Switch 8 and Third Street Station is consistently identified as an area of high need. For rail overhaul, additional high need areas outside of the "hot spot" include: Omni Station, College North Station, and State Plaza Station. While the "hot spot" is in the area of Switch 1, from an overall system perspective, a corridor from Government Center to College North Station emerges not only for the total overhaul but also for the rail overhaul.

- Low rail overhaul costs included Freedom Tower, Park West, Switch 12, Switch 13, Switch 17, Switch 52, Switch 53, Switch 55, School Board, Switch 4, Riverwalk, Fifth Street, Eighth Street, Switch 7, Eleventh Street, Switch 10, Bicentennial Park, Bayfront Park, and Switch 21. Twelve of the nineteen low cost rail overhaul areas were located on the extensions.

Metromover Fleet

- Expansion of the Maintenance Shop was not commensurate with increase in need, when the fleet expanded from 12 to 29 vehicles.

- Vehicle reliability has improved since 1995.

- Since FY 1996, vehicle availability has improved, but is below the high recorded in FY 1994.

- Vehicles average 350,000 miles, with an average of 437,000 miles for Phase 1 vehicles and 283,000 miles for Phase 2 vehicles. While the average Phase 1 mileage is higher, during the study period it was observed that Phase 2 vehicles were accumulating mileage at a faster rate. Metromover staff have already started a rotation program involving only high mileage Phase 2 vehicles to extend their useful life

- Actual 2001 mileage increased at a rate of 13.8 percent, rather than the 9.8 percent reflected in the mileage projections.

- Vehicle PMs, including G Inspections, are not only completed 100 percent of the time but also are completed on time. The decline observed in vehicle repair labor hours coincides with an increase in G inspection and wayside PM and repair hours.

- During the study period, Phase 2 vehicles out performed Phase 1 vehicles. Phase 1 vehicles show not only a greater range in miles between failures but also a greater inconsistency in performance between vehicles. While Phase 2 vehicles were unable to exceed the maximum miles between failures logged by some Phase 1 vehicles, Phase 2 vehicles consistently achieved the Phase 1 minimum miles logged. All 17 Phase 2 vehicles exceeded 400 miles between failures, while only 9 of 12 Phase 1 vehicles achieved that level.

- Mothballing a portion of the fleet reduced vehicle availability; however, recovery from mothballing was faster than Metrorail's recovery. Metromover was able to return mothballed vehicles to service with minimal need for extended time in the shop.

- No consistent pattern was observed regarding removal of vehicles from service.

- Since 1998, the six most frequent vehicle malfunctions have remained the same with similar rates of frequency, and include: door, Automatic Train Operation, overspeed, no depart, power, and no arrive. Malfunction of the door was the overwhelming leader.

- Vehicle Malfunctions accounted for 84 percent of all incidents in 1998, 80 percent of all incidents in 1999, and 79 percent of all incidents in 2000.

- The condition of the vehicles rated "fair" overall.

Metromover Maintenance Staff

- When the system expanded, Metromover maintenance staffing did not increase commensurately with the increase in complexity added by the extensions.

- As noted in the Phase I Rail Rehabilitation Report, the hiring, selection and training processes currently in place create hardships for the Rail Division, especially in Rail/Mover Maintenance.
  - The requirement to select "qualifiable" candidates erodes productivity.
  - Candidates without an aptitude for vehicle maintenance are recruited – some candidates do not have the aptitude, or sometimes the interest, in the kind of work involved in their new positions.

- Turnover is exacerbated – unnecessary movement results from lack of appropriate minimum qualifications.
- Time for the development of job proficiency is lengthened.
- Efficiency is impeded.
- The effects of the selection and promotion processes are particularly significant with the Metromover Maintenance Technician due to the broad scope of the technical requirements of the position.
- The promotion of employees based almost entirely on seniority is causing unnatural career movement in the agency, contributing to high turnover and vacancy rates in "feeder" classifications while providing little screening of aptitude for what is in some cases a total career change.

- Metromover's vacancy rate is lower than the MDT overall vacancy rate.

Staffing Requirements

- Metromover Maintenance
  - Metromover is understaffed 19-21 positions based solely on the physical growth of the system.
  - Six additional Metromover Technicians are required to operate the Metromover Component Shop during two shifts on a daily basis.
  - Metromover Maintenance staffing needs include: 20-22 additional Maintenance Technicians, 4-5 additional Maintenance Supervisors, and 1 Rail Car Cleaner Supervisor to meet the maintenance needs of the existing system and operate the newly established Metromover Component Shop.

- Track & Guideway (Metrorail & Metromover)
  - Explore the transfer of responsibility for the top of the Metrorail guideway inspection to Transit Engineering and consider contracting-out graffiti removal and vegetation control. If responsibility for these activities remains within the jurisdiction of Track & Guideway, three additional Rail Structural Repairers are required.
  - Complete a cost analysis of contracting-out the Insert Replacement Program versus completing it in-house. If it is cost effective to complete the project in-house, additional staff required for the project includes: two crews of one Rail Structure & Track Supervisor and six Track Repairers each, for a total of two supervisors and twelve repairers.
  - Increased workloads within Rail Track and Structures dictate the need for four additional Track Equipment Operators, not only to operate equipment but also to maintain and repair equipment that is being used to a greater extent. The addition of one Track Shop Supervisor will provide continuous supervisory coverage for the Track Shop, which operates 24 hours a day, 7 days a week.
  - Rail Structure staff required to complete Remedial Action Reports based on time intervals established by the Florida Bridge Inspection Program totals two Rail Structure & Track Supervisors and eight Rail Structural Repairers. These ten additional positions

  should be approved based on a funding commitment from the Florida Bridge Inspection Program.
  - Identified additional staffing needs for the new Palmetto Station and rail extension include: two Rail Structural Repairers, two Guideway Inspection Specialists, four Track Repairers, and one Track Equipment Operator.

- Rail Maintenance Control
  - With an increased emphasis on workload measures, the role of Rail Maintenance Control in tracking and analyzing data has become more critical. Eight additional Rail Maintenance Control Clerks are required to meet Metrorail and Metromover's current needs.
  - A significant effort is required now to establish correct, viable databases that can be shared across divisions and minimizes duplication of data handling efforts. That role would be best filled by a Program Designer & Analyst position as a direct report to the Chief of Rail Maintenance Control.

System Condition

- Using 1987 UMTA Rail Modernization criteria modified for vehicles, wayside, and structures, Metromover staff rated subsystem level conditions on a scale of 1 (bad) to 5 (excellent).

- Vehicle condition averages by Phase ranged from "poor" to "fair" with an overall condition rating of "fair" for Phase 1 and Phase 2 vehicles.
  - Differential, Doors, Pneumatic, ATC, and Friction Brakes – 2 (Poor)
  - Electrical, Prop/Dyn Braking, Lighting, HVAC, Guidance, Suspension, Carbody, Communications, and Spring Brake – 3 (Fair)

- Phase 1 wayside and structures overall rated "fair" and Phase 2 wayside and structures rated "good".
  - Power Distribution, Phases 1 & 2 – 4 (Good)
  - System-Wide Controls, Phases 1 & 2 – 3 (Fair)
  - Structures, Phase 1 – 4 (Good) and Phase 2 – 5 (Excellent)

Financial

- MDT's operating expenditures grew at a rate of 2.3% from FY 1994 to FY 2000.

- Since FY 1994, Metromover operating expenditures have more than kept pace with inflation and have averaged 6.3% of the agency's total.

- Metromover ridership represents 1% of the entire MDT system.

- Construction of the Metromover Extensions in FY 1994 consumed over 50% of all of the

MDT's capital spending in 1994; this percentage has dropped to less than 1% in both FY 1999 and FY 2000.

- With a capital program of nearly $40 million, including $15 million for the Phase 1 vehicle midlife rehabilitation, MDT has made a significant commitment to ensuring the long-term viability of Metromover. If this program comes to fruition, the system will be positioned well. The current age of the system requires that this reinvestment take place.

- The projected capital, as it now exists with the Phase 1 vehicle midlife addressed, leaves few capital requirements not covered for Metromover.

Phase I Recommendations

In the Phase I Rail Rehabilitation Report, the project team indicated that a successful plan for the rehabilitation of Miami-Dade Transit's heavy rail system seemed contingent upon several organizational and management issues. Although additional financial resources would be required, in the project team's opinion, additional resources would not be maximized without some systemic changes.

Following the Phase II review, the project team reaffirms these recommendations, which are summarized below along with a brief statement of the status of the recommendations.

- The current process of contracting maintenance work to outside vendors needs to be revisited.
  STATUS:
  - MDT has established dialogue with the Transit Workers Union concerning procurement of work through contract.
  - Component and equipment contracts have been awarded to facilitate timely repairs.
  - MDT established a new Metromover Component Shop based on a cost-benefit analysis of contracted-out versus in-house repair.

- The Agency should revisit the present method of establishing that a candidate is "qualifiable" and should take an active role in providing an environment that rewards the professional development of the workforce.
  STATUS:
  - MDT established a 13(c) Strategic Task Force and developed a plan to improve recruitment and training processes that included the participation of the Transit Workers Union.

- The Agency should establish mechanisms that encourage innovation and investment in the workplace.
  STATUS:
  - MDT has brought together cross-functional groups to assist in program planning

and evaluation.

- The Agency should establish structure within the organization that provides consistency and continuity.
  STATUS:
  - MDT is taking advantage of the large amounts of data and information collected and has reformulated data analysis to identify trends.
  - MDT has established action plans to establish target goals and track performance.

- MDT should ensure that sufficient funding continues for enhanced vehicle maintenance activities and attempt to provide Metrorail with the capital infusion required to perform the rehabilitation activities mentioned in this report.
  STATUS:
  - The Office and Management and Budget has committed to pledging a portion of the local option gas tax to issue $140 million in bonds to fund the Metrorail and Metromover Rehabilitation programs.
  - The 2002 to 2007 capital program includes $119 million for the Metrorail vehicle rehabilitation beginning with planning and engineering funds in this fiscal year.

Phase II Recommendations

- MDT should provide the additional Metromover, Track & Guideway, and Rail Maintenance Control staff identified in the report as well as the operating funds necessary to fund those positions.

- MDT should ensure that sufficient funding continues and hold the schedule on the Metromover Phase I vehicle midlife rehabilitation.

- MDT should establish a universal location identification system map for the Metromover wayside to track incidents, repairs, and maintenance. The system should be integrated with the GIS component of the new computer system, and all entities involved in any type of reporting concerning the wayside, including Maintenance, Central Control, and Contractors, should be required to use the location identification system. Rail Maintenance Control should track this information and provide routine feedback to Metromover Maintenance regarding system trends and performance.

- MDT should have Transit Engineering evaluate the area referred to in the report as the “hot spot” and investigate potential engineering or design solutions in this area to minimize maintenance costs.

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SECTION II PHASE II - METROMOVER

Introduction

Miami-Dade Transit (MDT) entered into an agreement with the Center for Urban Transportation Research (CUTR) at the University of South Florida to assist MDT in documenting rail rehabilitation needs and develop a five-year approach to dealing with them. The work requested covers an analysis of both Metrorail and Metromover.

The effort includes an assessment of the financial and organizational needs required to protect these substantial public investments.

CUTR presented Phase I – Metrorail findings in a Final Report on January 9, 2001. This report represents CUTR's findings on the work involved with Phase II – Metromover. The project for Metromover was conducted in essentially four phases:

- Assessment of the current state
- Estimation of needs
- Comparison with other systems
- Recommendations for the next five years

Section II of this report will summarize the project team's findings for Metromover.

During the course of the project, MDT expanded the scope of work to include a more thorough operational review of specific Metromover activities and other operations within MDT. Items directly related to Metromover include the following and will be presented in Section II of this report:

- Metromover staffing
- Wayside replacement schedules
- Allocation of revenue vehicles
- Visits to other properties

The following operations will be reviewed in Section III:

- Track & Guideway staffing
- Rail Maintenance Control manpower needs

A Mover Rehabilitation Task Force, composed of Agency Rail Division personnel, met formally four times after the project began in August 2000 to track the progress of CUTR's work, review draft findings, and provide comments and guidance.

MDT Rail Maintenance Control Division assembled much of the data required. In addition, there was heavy reliance on the Federal Transit Administration's Section 15 data for

Metromover and the other people mover systems. The National Transit Data Base serves as the only source of comparative data available. While direct comparison of the systems using the data is difficult, the database does contain enough parameters that a good sense of the relative scale and performance of the peer people mover systems can be established. The most recent year for which all of the transit properties have reported in a consistent manner is 1998; however, data for Metromover were collected through 1999, and for 2000 in some cases.

Several dozen interviews with MDT executive staff, mover maintenance management, support function supervisors, and working supervisors were conducted over the course of Phase II. These interviews provided a broad perspective and detailed understanding of the challenges and inner workings of the Metromover Maintenance function.

Metromover was completed in its current configuration in May 1994, at an original cost of $381.3 million. With 8.8 miles of guideway, 29 vehicles, a substantial maintenance facility, a central control facility, and associated heavy maintenance equipment, this system represents a significant public investment.

The preservation of any public infrastructure investment typically represents a challenge to those responsible for its stewardship. The public (customers and elected officials) becomes accustomed to the service that it provides and is typically focused on investment decisions regarding new or enhanced services, while the operations personnel are challenged with keeping the system in proper running condition. It is sometimes easy to lose sight of the constant reinvestment that is required to keep any asset in good condition.

The policy and decision makers are faced with a myriad of competing needs, finite resources, and without intimate knowledge of the day-to-day problems facing the numerous operations. This report attempts to provide an objective assessment of the needs facing Metromover, recognizing that other competing needs within MDT and the County may or may not be as compelling.

This section of the report will focus on six major areas: System Overview, Metromover Maintenance, Metromover Vehicles, Metromover Wayside, Metromover Manpower Requirements, and Financial Aspects.

Chapter 1 - System Overview

The Miami-Dade Transit (MDT) Metromover is an electrically powered, fully automated people mover system, connecting with Metrorail at Government Center and Brickell Stations and with Metrobus at various locations throughout Downtown Miami. The 8.8-mile system provides service to 21 stations in the central downtown, Omni, and Brickell areas. With 29 mover vehicles, Metromover served over 14,000 passengers on weekdays with operating expenses of $15 million in FY 2000. Metromover provided in excess of 4.4 million passenger miles of service last year with an operating staff of 149. The average passenger trip length was slightly over one mile, and 1,035 service interruptions were reported.

To provide a context for the overview of the Metromover system, some comparative data from peer systems are presented. There are currently eleven automated guideway transit systems operated worldwide using the C-100 AEG Westinghouse/Adtranz vehicle. Seven of those systems are operated within the United States, and six of the seven provide shuttle service at airports in major US cities. Today, Metromover is the only non-airport people mover in operation in the US using the AEG/Adtranz vehicle. Attributes common to all eleven of the Adtranz vehicles include the following:

- 38 inch Wheel Diameter
- Propulsion Type
- 600 VAC 3 Ph Nominal System Voltage
- Trans/Rect Auxiliary Power Supply
- 250 Amps RMS Current/Power Rating
- Self Motor Ventilation
- Dynamic Electrical Braking System
- Air/Drum Friction Braking System
- Automatic Train Control (ATC) Operation

Attributes unique to individual systems include:

- Vehicle Weight
  - Minimum: 32,400 – 32,600 pounds (Metromover – 32,600)
  - Maximum: 52,400 – 58,713 pounds (Metromover – 57,200)
- Traction Motor
  - 1460P1
  - 1460ST
  - 1460SE (Metromover)
- Gear Unit Ratio
  - 13.42:1
  - 16.65:1 (Metromover)

- Acceleration/Brake Rate
  - 1.3/1.3
  - 2.0/1.3
  - 2.0/1.5
  - 2.0/1.8 (Metromover)
  - 2.2/2.2
  - 2.5/2.0

Since Adtranz provides maintenance services to all airport systems currently operating Adtranz vehicles, a request for information and tours of those operations was submitted to Adtranz. Adtranz considered much of the information requested by CUTR to be confidential, and, therefore, was unwilling to provide "any information that details the methodology Adtranz uses to determine staffing sizes required for its operation and maintenance organizations, intervals upon which maintenance is required for its specific technology, and the costs associated with those operations. Based on the competitive nature of the transit industry and the fact that operation and maintenance costs play a significant role in determining a successful bidder, Adtranz guards this type of information and considers it proprietary."[1]

Adtranz determined that the following systems most closely resembled Metromover and provided information outlined in Table 1 regarding each of these systems:

- Hartsfield Atlanta International Airport (Atlanta)
- Denver International Airport (Denver)
- Frankfurt Main International Airport (Frankfurt)
- Stansted (London) Airport (Stansted)
- Singapore DPM (Singapore)

Table 1 - Adtranz System Comparison

Mover System	*Hours Of Service*	*Annual Ridership (millions)*	*Annual Miles per veh*	*Vehicles*	*Stations*	*Miles*	*Location*	*Switches*
Atlanta	5:30 am-1:00 am	65.0	60,000	44	14	4.4	Tunnel	9
Denver	5:30 am-11:00 pm	23.8	50,000	22	8	2.5	Tunnel	16
Frankfurt	4:00 am-11:00 pm	25.0	40,000	18	3	2.4	Guideway	8
Stansted	5:00 am-1:00 am	10.0	Unknown	9	6	2.1	Tunnel	8
Singapore	Unknown	25.0	Unknown	19	14	9.8	Guideway	29

[1] March 19, 2001 correspondence from James J. Spakauskas, Vice President, ATS Marketing, Adtranz, Reference No.: MIBx-0002

Despite the fact that the above systems are most similar to Metromover, detailed comparison of those systems to Metromover is not possible in the absence of specific operating information. The only source of detailed operating information for automated guideway people mover systems appears to be the Federal Transit Administration (FTA) Section 15 Data Base. Peer systems reported in FTA Section 15 include the Jacksonville Skyway (Skyway), operated by the Jacksonville Transportation Authority (JTA), and the Detroit Downtown People Mover (DDPM), operated by the Detroit Transportation Corporation (DTC). While the comparison of Metromover to these systems is less than ideal since they operate different vehicles, comparable data are available.

The Skyway is an electrified, elevated, dual guideway monorail transit system. Bombardier, Inc. of Canada is providing an expansion of the Skyway as well as additional vehicles. Nine two-car vehicles will travel up to 35 mph and carry approximately 56 passengers per car. Six of eight stations are open at the present time. Service is generally available Monday through Saturday and for special events on Sunday. The DDPM opened shortly after the Metromover. The system operates seven days a week and consists of a 2.9-mile continuous loop that includes 13 passenger stations. Peak-day ridership of 54,648 during the first year of operation reportedly fell to 5,000 per day in 1997. While the system attributes vary greatly, comparisons can be drawn. Table 2 summarizes some of the more relevant characteristics of the peer systems.

Table 2 - Comparison of Selected Peer Characteristics, 1998

		Mover Vehicles		
Mover System	*Route Miles*	*Vehicles Available*	*Vehicles Operated*	*Operating Personnel*
Metromover	8.5	29	15	129
Skyway	1.8	4	2	12
DDPM	2.9	8	8	82

As can be readily seen, of the systems available for comparison, Metromover compares most closely with DDPM. It should be noted that "Vehicles Available" represents the total number of cars reported in the fleet, and "Vehicles Operated" is the number of cars that the agency wants available for service each day. Vehicles Operated or Vehicles Operated Maximum Service (VOMS), as it will sometimes be referred to in the report, is the same as the Peak Vehicle Requirement (PVR). Both represent the highest daily vehicle requirement plus any additional rolling stock required to be ready as backup.

Table 3 depicts a detailed comparison of the systems.

Table 3 - Peer Mover Systems

Mover System	*Vehicles Operated In Maximum Service*	*Vehicles Available For Maximum Service*	*Transit Service Supplied* *Annual Scheduled Vehicle Revenue Miles*	*Annual Vehicle Miles*	*Annual Actual Vehicle Revenue Miles*	*Actual Revenue Miles % of Annual*	*Annual Vehicle Hours*	*Annual Vehicle Revenue Hours*	*Transit Service Consumed* *Annual Unlinked Passenger Trips*	*Annual Passenger Miles*
Metromover	15	29	972,800	924,500	896,100	96.9%	84,900	82,300	4,052,900	4,078,100
Skyway	2	4	28,800	29,700	28,600	96.3%	2,700	2,600	117,600	105,700
DDPM	8	8	495,600	495,600	495,600	100.0%	42,700	42,700	1,989,100	2,826,700

While the systems' scales vary greatly, on a pro rata basis, one can begin to see where Metromover ranks in terms of use and level of effort to provide and maintain service. By taking the annual vehicle miles and dividing those miles by the number of vehicles required to "make service," Metromover ranks ahead of Skyway and is comparable to DDPM in this mileage comparison. If the entire fleet were used, Metromover would rank second with 31,879 miles. These comparisons are presented in Table 4. The difference in the miles is a function of the number of cars used as operating spares.

Table 4 - Annual Vehicle Miles per VOMS/VAMS

Mover System	*Annual Vehicle Miles*	*Vehicles Operated Maximum Service*	*Annual Miles per VOMS*	*Vehicles Available Maximum Service*	*Annual Miles Per VAMS*
Metromover	924,500	15	61,633	29	31,879
Skyway	29,700	2	14,850	4	7,425
DDPM	495,600	8	61,950	8	61,950

Metromover's 8.5 directional route miles are almost 5 times greater than the Skyway's and 3 times greater than DDPM's. A more relevant measure of system extent is that of passenger miles to directional route miles. Figure 1 depicts the relative comparison.

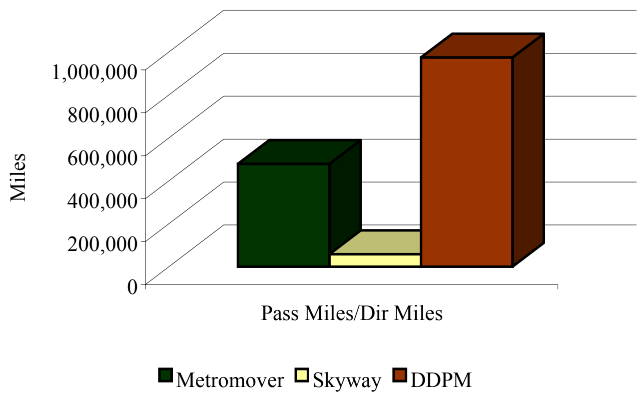


Figure 1 - Passenger Miles per Directional Mile

Metromover provides roughly 480,000 passenger miles of service annually for each of the 8.5 directional miles of the mover system. This is half of the miles provided by DDPM and almost ten times the number provided by Skyway.

Figure 2 shows the number of mover vehicles that each system has in total, compared to the number of route miles. Metromover slightly exceeds both Skyway and DDPM.

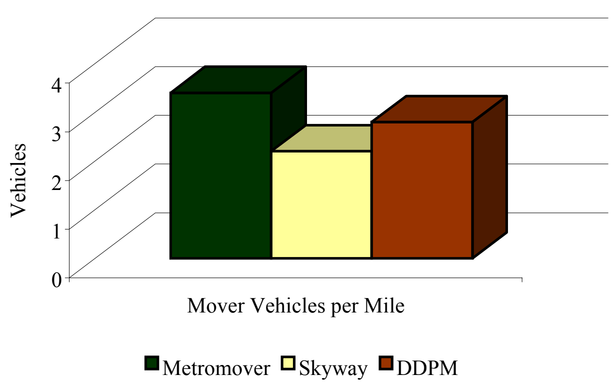


Figure 2 - Total Mover Vehicles per Mile

In 1998, Metromover carried approximately one percent of the passenger miles reported for the entire MDT. During that year, Metromover consumed 2.6 percent of the total capital and 6.6 percent of the operating expenses. In terms of total expenditures attributed to Metromover, the capital and operating expenditures reported equaled just over 6 percent of the total reported. A comparison of these percentages for the peer systems is presented in Table 5.

Table 5 - Mover Percentages of System Totals

1998	*Metromover*	*Skyway*	*DDPM*
Mover % of Passenger Miles	1.0	0.2	100.0
Mover % of Total Capital	2.6	81.0	100.0
Mover % of Operating Expenses	6.6	3.3	100.0
Mover % of Total Expenditures	6.1	34.0	100.0

Even though the relationship of total expenditures to passenger miles can be skewed in a particular year because of the nature of capital expenditures, the following charts are presented for Metromover for the last several years. The percentages seem high relative to the percentage of service provided in 1998. Figure 3 shows these percentages have decreased significantly since 1994, when completion of the Phase 2 extensions was accomplished.

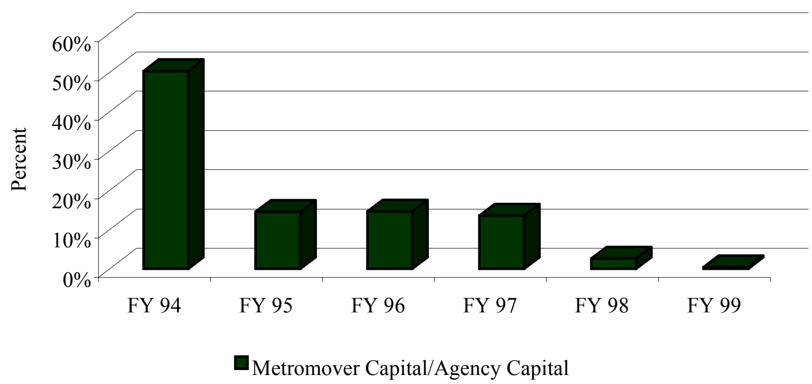


Figure 3 - Mover Capital as a Percentage of Total Capital

Operating expenditures, as a percentage of MDT's total operating expenditures, have remained relatively constant from FY 1994 to FY 1999. The six-year average is 6.1 percent. Figure 4 indicates the year-to-year change.

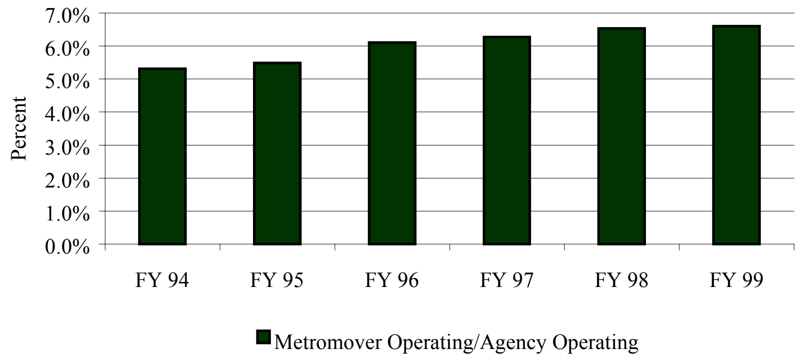


Figure 4 - Metromover Operating as a Percentage of MDT Operating

Examination of the maintenance investment in Metromover vehicles yields two comparisons. The first is a comparison of Metromover with the peer systems to the average annual maintenance expenditure per mover vehicle operated in maximum service. Next, the same comparison is made but on the basis of vehicles in the entire fleet. This analysis shows Metromover at the high end of the range of peer systems, based on vehicles operated in maximum service, and in the middle of the range based on the total fleet. The comparisons are illustrated in Figures 5 and 6.

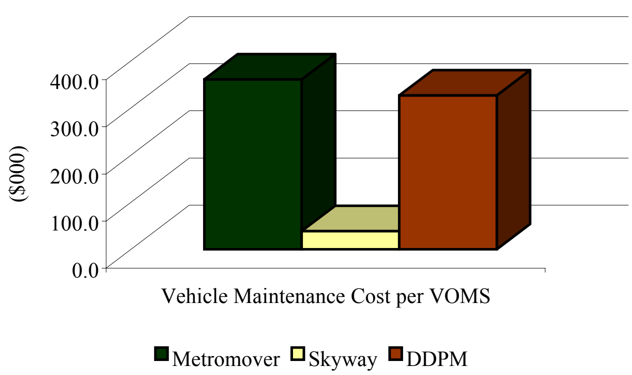


Figure 5 - Average Annual Vehicle Maintenance Cost per VOMS

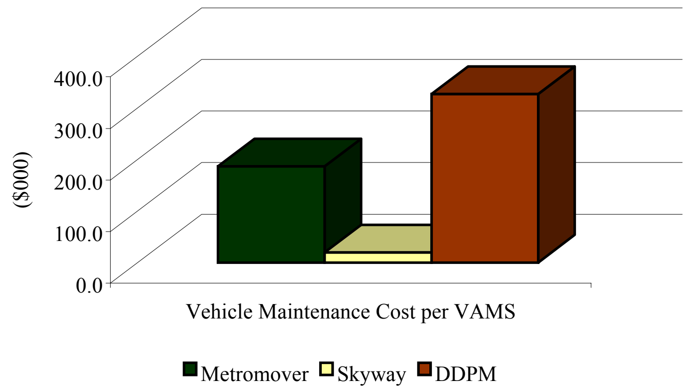


Figure 6 - Average Annual Vehicle Maintenance Cost per VAMS

Finally, a comparison of system performance is presented. While the more common "mean distance between failures" provides a desirable indicator, the difference in the definition of failure from one mover agency to another varies dramatically. The National Transit Data Base provides information on "service interruptions" for all of the agencies. Because the definitions of a major and minor service interruption changed during the study period, the total service interruptions figure is used here. Figure 7 shows the total service interruptions for Metromover from 1995 to 1999 to illustrate the Agency's trend.

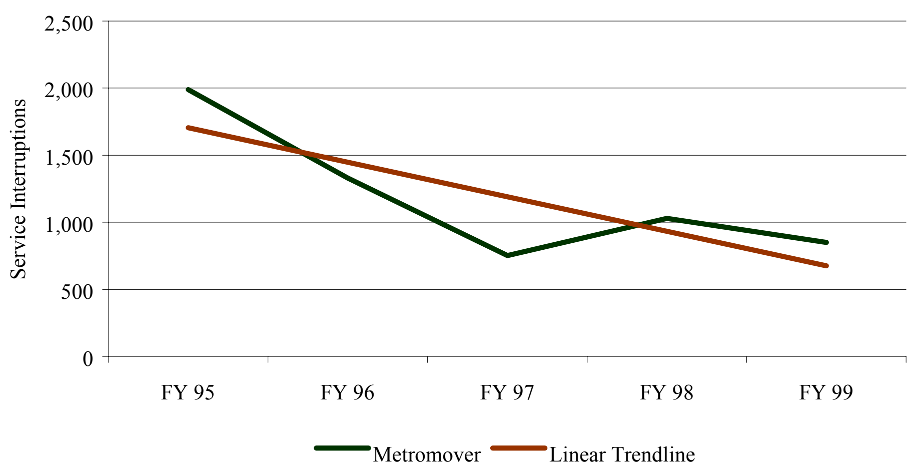


Figure 7 - Total Service Interruptions, Metromover

Table 6 provides the service interruption data for Metromover and the peer systems and includes annual passenger miles of service to facilitate comparison of the systems.

Table 6 - Total Service Interruptions and Annual Passenger Miles

	FY 95		*FY 96*		*FY 97*		*FY 98*	
Mover Systems	*Roadcalls*	*Passenger Miles*	*Roadcalls*	*Passenger Miles*	*Roadcalls*	*Passenger Miles*	*Roadcalls*	*Passenger Miles*
Metromover	1,988	4,456,000	1,329	4,226,400	751	4,278,800	1,029	4,078,100
Skyway	0	163,200	0	172,300	0	32,200	84	105,700
DDPM	1	2,659,200	0	2,911,500	1	2,431,300	0	2,826,700

If the "Section 15" data are accurate and close to being consistently reported, Metromover is at the low end of the peer group with Skyway and DDPM reporting very few, if any, service interruptions. Nonetheless, Metromover does show a positive trend in reduced service interruptions since FY 1995, as illustrated in Figure 7.

An overview of the respective responsibilities, analysis of manpower, identification of capital needs, physical assessment of the infrastructure, and other issues acknowledged are presented for Metromover in Chapter 2.

Chapter 2 - Metromover Maintenance

Metromover Maintenance operates under the guidance and direction of a General Superintendent, who reports to the MDT Transit Services Assistant Director. Within this Division are Vehicle Inspection and Heavy Repair, Train Control & Traction Power, and Metromover Maintenance. Vehicle Inspection and Heavy Repair as well as Train Control & Traction Power, were discussed in detail in the Phase I Rail Rehabilitation Report.

The Division Office consists of the General Superintendent, an Administrative Secretary, and two administrative staff. A total staff of 225 is assigned to the division, as indicated in Table 7.

Table 7 - Rail/Mover Maintenance Division

Rail/Mover Maintenance Division	*Positions*
Division Office	4
Vehicle Inspection & Heavy Repair	92
Train Control & Traction Power	59
Metromover Maintenance	70
Total	225

Metromover Maintenance

The Chief Supervisor, Repair and two Chief Supervisors, Metromover Maintenance direct Metromover Maintenance. Metromover maintenance operates 24 hours a day, 7 days a week, and is responsible for the following to maintain the automated guideway people-mover system:

- All preventive maintenance (PM) and corrective maintenance
  - Central Control Facility
  - Train Control rooms
  - Traction Power equipment
  - Wayside equipment
  - Guideway switches
  - Fleet of 29 Mover vehicles
- Inspections
- Cleaning
- Repairs
- Testing
- Performance & retrofits, including Engineering changes

Phase 1 of the Metromover system opened in April 1986 with 3.9 miles of guideway and 2 independently operated counter-rotating loops that served the Miami Central Business District

(CBD) through 9 stations and a 12-vehicle fleet. Approximately 36,000 vehicle hours of service were provided annually to downtown Miami. Loops and vehicles were both unidirectional. The Metromover Phase 2 system opened in May 1994 with two additional loops. Service miles of guideway increased to more than 10, and Metromover routes for normal service increased from 2 independent loops to 1 independent and 2 dependent loops. Stations increased from 9 to 21; the vehicle fleet increased from 12 to 29. Vehicle service hours to 3 business districts rose to 100,000 hours. The 3 loop-operating options in Phase 1 increased to 31 combinations of loop-operating options available to Central Control with all loops and vehicles bi-directional. MDT's new system is about three times greater than the original system. Table 8 presents a comparison of elements in the original and expanded systems.

Table 8 - Original and Expanded System Comparison

System	*Original*	*Expanded*	*Increase Factor*
Metromover Staff	30	73	2.4
Metromover Technicians	24	54	2.3
Vehicles	12	29	2.4
Stations	9	21	2.3
Guideway Miles	3.9	8.8	2.3
Vehicle Hours/Year	36,000	100,000	2.8
Switches	9	25	2.8
ATO High Cycle Switches	0	7	
Switch Cycles/Year	10,000	1,000,000	100.0
UPS Systems	1	3	3.0
Track Circuits	107	306	2.9
Collector Shoes	90	352	3.9
Directional Travel	1	2	2.0
Ridership per Weekday	10,000	15,000	1.5
Vehicle Miles/Year	440,000	970,000	2.2
Tires (Drive)	72	176	2.4
Power Demand (kw)	750	1,850	2.5
Elevator/Escalator	17	44	2.6
Presence Detectors	0	25	
Speed Ramps	18	50	2.8
MUX Cabinets	6	13	2.2
PDS Equipment	9	21	2.3
Active In Service Routes	2	3	1.5
Loop Route Options	3	31	10.3
Scheduled PM Inspections	1,424	2,958	2.1
Shared Guideway Miles (22%)	0	1.9	
Wayside Malfunction Reports/Year	96	250	2.6
Vehicle Malfunction Reports/Year	823	1,800	2.2

Work is scheduled over three shifts: 6 a.m.-2 p.m., 2 p.m.-10 p.m., and 10 a.m.-6 a.m. On the first two shifts, the supervisor functions as the main troubleshooter, and when two supervisors are on duty, one supervisor is assigned to the shop and one supervisor is assigned to recovery. Approximately 17 technicians are assigned to the 1st shift to perform PM and repair of the revenue system and mover vehicles. The 13 technicians on the 2nd shift also perform PM and repair of the revenue system and mover vehicles. The 12 technicians and 2 supervisors on the 3rd shift perform PM and repair of the wayside equipment. During normal hours of operation, four technicians and one supervisor are assigned to recovery. One technician is assigned to the Omni Extension, one technician is assigned to the Brickell Extension, and two technicians are assigned to the CBD. The supervisor assigned to recovery roves the system.

Metromover operates two maintenance areas. One is located at the intersection of First Avenue and First Street in the CBD and the other at the School Board Station on the Omni Extension.

A total of 70 of the 225 Rail Maintenance staff are assigned to Metromover Maintenance. Table 9 illustrates the distribution of those staff by classification.

Table 9 - Metromover Maintenance Staff

Classification	*Positions*
Chief Supervisor, Metromover Maintenance	3
Chief Supervisor, Repair	0
Secretary	1
Rail Maintenance Clerk	1
Metromover Maintenance Supervisor	6
Metromover Technician	50
Rail Vehicle Cleaner	8
Total	69

Metromover Vehicles

The original Metromover system opened in 1986 with 12 C-100 Series vehicles manufactured in 1985 by AEG Transportation System. Those vehicles will reach their 20-year milestone at the end of the 5-year planning period. In 1994, the Agency expanded the system by 5.0 directional route miles and purchased 17 new mover vehicles. Adtranz was selected to provide the additional vehicles, automatic train control, track-switching equipment, communications, data transmission system, and the entire power distribution system for both extensions. In order to insure the compatibility of all vehicles with the new wayside equipment on the two extensions, various modifications to upgrade the 1985 vehicles were accomplished after receipt of the new vehicles. The two generations of vehicles do contain different electronics, however, the outcome is the same. All vehicles are capable of running on the entire system.

The vehicle body is made of structurally reinforced fiberglass ends bolted to an aluminum body. The body shell is formed from three basic parts: two end sections (number 1 end and number 2 end) and a center section. Each end section has a large windshield, two clearance marks, two headlights, and a cutout section for coupler movement. The headlights are only on in the direction of travel or on loss of track power. These exterior lights draw their power from the battery. The vehicle windows are ¼ inch thick laminated safety glass and are manufactured in a manner that reduces noise transmission.

Each vehicle can carry up to 100 passengers, 8 of whom can be seated. The interior equipment includes end equipment compartments, manual control stations, air distributor, lights, emergency lights, emergency telephone handset and summary monitor stations, dynamic and static graphics, speakers, seats, stanchions, handrails, and fire extinguishers. The number 1 end compartment houses the Automatic Train Operation (ATO) electronics for the vehicle. The number 2 end compartment houses the communication system equipment, propulsion monitor panel, auxiliary control panel, door relay panel, and gauge panel. Each end compartment has a key-locked cover, which keeps passengers from being able to access the equipment. Maintenance personnel can access these compartments by unlocking the covers and sliding them off.

Two manual control stations, one on each end of the vehicle, are in the wall on the right side when looking out the windshield. This permits convenient operation of the controller along with clear visibility of the track. The manual controller is enclosed in the vehicle wall with a key-locked cover.

The electrical system underframe equipment consists of four current collector assemblies, an auxiliary control box, and a battery box. The current collectors obtain power from three power rails to operate the vehicle. Using collectors at both the front and rear of the vehicle provides for continuous current collection through the switches. The auxiliary control box distributes 575 VAC to the propulsion equipment, air compressor, lighting transformer, and battery charger. The lighting transformer and the battery charger are part of the auxiliary control box. The battery box provides 24 VDC of standby electrical power for emergencies. Two eight-volt batteries connect in series to provide the 24 VDC for vehicle control voltages.

The pneumatic system underframe equipment consists of an air compressor, an air control package, an auxiliary release package, two brake control packages, and miscellaneous vehicle and bogie piping. The air compressor provides air for operating the friction brakes, air springs, and the reverser. The auxiliary release package provides a backup source of air pressure for releasing the emergency brakes, in case there is a disruption in the normal air supply. There is one brake control package on each bogie, which controls the friction brakes of each axle.

Primary propulsion for the vehicles is supplied by a 600 VAC direct drive system. Vehicles are controlled in either automatic mode or manually. During "automatic control," train speed, stopping at stations, door control, and dwell time are performed without any assistance from an operator. Should it become necessary to manually control the vehicle, the control panel available in each vehicle contains all the controls necessary for an operator to operate the vehicle manually. Nonetheless, at all times while in passenger service, the vehicles operate under full Automatic Train Control (ATC) with ATO, Automatic Train Protection (ATP), and Automatic Line Supervision (ALS) with a maximum speed of 30 m.p.h. Vehicles normally operate as single vehicles; however, they can be coupled as two-car trains to meet special ridership demands.

Each vehicle is captive to the guiderail by an underframe guidance assembly, utilizing rubber guide tires that straddle and engage the guidebeam. The guidebeam is between the roadway surfaces throughout the system. This guidance system is rigidly attached to the bogie and steers the vehicle along the guidebeam. Allowing the rigid axle and the entire suspension system to pivot on the pivot bearing, which attaches the bogie to the underframe of the vehicle, effects steering. The guide structure is a welded steel frame attached to the underside of each bogie and supports the four-guidewheel assemblies, current collectors, antenna assemblies, and the ATC rail collectors. The four guidewheels bolt to the guidance structure so that each wheel is in contact with either side of the web of the guidebeam. A steel safety disc, slightly smaller than the diameter of the guidewheel, is just above the guidewheel and engages the upper flange of the guide beam, preventing derailment in the event of a collision or exceptional overturning forces.

The Metromover guideway consists of a two-track 1.9-mile loop through the core of the Miami Business District; a two-track 1.1-mile extension south from the loop through the Brickell Business District; and, a two-track 1.4-mile extension north from the loop to the Omni area. The completely elevated guideway includes the steel guidebeam, concrete running surfaces, power distribution system, and support structure.

In order to attain correct route sequencing and synchronization on the outer Miami Central Downtown Business (MCDB) loop, which is shared by both Brickell and Omni routes, the routing method for Metromover is on a first come-first serve basis. By making adjustments to the dwell times on inbound trains, a reasonable synchronization is attained. The system operates weekdays from 5:15 a.m. until 12:30 a.m. on the Inner Loop and until 10:30 p.m. on the Brickell and Omni Extensions. Metromover service on weekends and holidays provides minimum passenger service operations on a specified loop or loops. Service is coordinated to permit Metromover trains to meet Metrorail "last trains" at Government Center and Brickell Stations. Under normal operating conditions, all trains operating in revenue service stop at each station on the route. The normal dwell time is 15 seconds at all stations, except Government Center, Omni, School Board, Brickell, and Third Street. Dwell time at these stations is 20 seconds. The Metromover system is capable of providing five basic service routes: Inner Loop, Outer Loop, Brickell Loop, Omni Loop, and the Brickell/Omni Loop. Headways are 2 minutes on the Inner Loop and 3-5.5 minutes on the Brickell and Omni legs of the Outer Loop.

Service and Mobility Planning specifies the number of vehicles required by time of day in addition to the make-up of the consist, i.e., single vehicles or vehicles coupled in pairs. Rail Operations then prepares a Metromover Operational Plan that identifies the distribution of all vehicles within the fleet to passenger service, recovery, maintenance-assigned or inactive/stored status.

All vehicles, stations and guideway system elements are checked daily to insure operational safety and reliability. Maintenance personnel assigned to these activities report their findings to Central Control. All items that affect operational safety are corrected before the system element is released by maintenance for passenger service.

Each vehicle to be used in passenger service receives a daily inspection within a 24-hour period of use. Inspections normally occur at the School Board inspection area after the commencement of morning service. The inspection includes critical under car requirements, headlights, taillights, trip wires, doors, voice communications equipment, lighting, graphics, and similar emergency equipment. The vehicle ATC equipment is tested for normal operation on a weekly basis pursuant to Metromover operating policies.

All revenue and non-revenue movements are the responsibility of Central Control, located on the 5th floor of the Stephen P. Clarke Center. Central Control is staffed 24 hours a day, 7 days a week to provide supervision, control, communications, and coordination of Metromover operations. Non-revenue operating periods are used for vehicle maintenance, testing, facilities and system maintenance, and other non-revenue activities.

A complete sweep of the guideway is made prior to passenger service each morning to verify the guideway is free of foreign objects, and interlocking switches are functioning properly, and to ensure proper train detection in all track circuits. Sweep trains are driven at restricted speed under manual control and do not carry passengers.

A vehicle that fails is moved to the nearest tail track or to the maintenance shop. Metromover has one vehicle assigned to recovery; nonetheless, if a problem is encountered on the system and a vehicle cannot be returned to ATC mode, the vehicle closest to the malfunctioning vehicle becomes the recovery vehicle either to tow or push the disabled vehicle to the maintenance shop.

The system has a design capability of 30 miles per hour top speed, but operates at an average of 10 mph. Weekday boardings for September 2000 averaged 14,000. Table 10 provides a summary of mileage by vehicle type.

Table 10 - Metromover Mileage by Vehicle Type

	Phase I Vehicle				*Phase II Vehicle*				*Phases I & II Vehicles*		
Year Ending	*Cumulative Miles*	*Fleet Average*	*Annual Miles*	*Average Annual Miles*	*Cumulative Miles*	*Fleet Average*	*Annual Miles*	*Average Annual Miles*	*Cumulative Miles*	*Fleet Average*	*Annual Miles*
9/30/95	3,430,806	285,901	241,236	20,103	1,004,666	59,098	734,317	43,195	4,435,472	152,947	975,553
9/30/98	4,224,871	352,073	287,795	23,983	2,870,827	168,872	619,022	36,413	7,095,698	244,679	906,817
9/30/99	4,494,304	374,525	269,433	22,453	3,486,698	205,100	615,871	36,228	7,981,002	275,207	885,304
9/30/00	4,755,595	396,300	261,291	21,774	4,077,373	239,845	590,675	34,746	8,832,968	304,585	851,966
9/30/01	5,243,062	436,922	487,467	40,622	4,809,837	282,932	732,464	43,086	10,052,899	346,652	1,219,931
%/Total	52.2%		40.0%		47.8%		60.0%				

Metromover Maintenance Shop

The primary maintenance shop, located in the CBD, has 5 service tracks for 10 vehicles, 1 set of portable jacks, 2 sets of permanent jacks, outside storage for 9 vehicles, and 1 test track. All heavy maintenance and PM inspections are performed at this maintenance shop, which is capable of handling a maximum of 12 mover vehicles at any one time. This shop was designed to service the original 12-vehicle fleet. When the fleet expanded from 12 to 29 vehicles, 2 maintenance stubs were added to provide service for the additional 17 vehicles. Lack of sufficient maintenance space and vehicle lifts for a fleet of 29 vehicles, coupled with the fact that the shop is a "dead-end" shop that requires continual vehicle re-location, negatively impact the ability of maintenance to meet peak revenue service requirements of 17 vehicles each day. A significant number of labor hours are spent juggling vehicles into and out of the maintenance area. The School Board maintenance area offers some relief to inadequate repair space at the main maintenance shop. This area was originally designed for minor repairs and visual inspections only, but has been modified to allow maintenance personnel to perform limited vehicle PM inspections and minor repairs. The area houses a maintenance repair area for one vehicle in addition to the vehicle car wash. Vehicles are washed, minor repairs are accomplished, and daily inspections are conducted within this maintenance area, which also provides outside storage for six vehicles.

Metromover Vehicle Maintenance

Maintenance of the mover vehicles includes scheduled preventive maintenance, repair, and major component overhaul. The scheduled preventive maintenance program is designed to maintain car reliability by detecting and correcting potential defects before component failure. It includes servicing of equipment that requires lubrication, measurement, and adjustment. Mover vehicles are withdrawn from service at regular calendar intervals to perform scheduled preventive maintenance actions. Mover staff indicated that all current test equipment is based on the latest technology and is in good condition. Inspections range from a daily inspection that consists of a safety test, a visual inspection, and a functional test of safety-critical and passenger components to extensive electrical and mechanical inspections, completed at 37-day, 75-day, 225-day, 450-day intervals, and 900-day intervals. During fiscal years 1996, 1997, and 1998 the maintenance demand for vehicles equaled 2 vehicles for PM and 6 vehicles for repair, for a total maintenance requirement of 8 vehicles each day. In FY 1999, the total vehicle maintenance requirement continued to be 8 vehicles; however, the make-up of those 8 vehicles changed to 1 vehicle for PM, 6 vehicles for repair, and 1 vehicle for scheduled overhaul. PM inspections are categorized as shown in Table 11.

Table 11 - Preventive Maintenance Inspections

Inspection Type	*Inspection Interval*	*Inspection Activities*
Daily	24 Hours	Safety test of the carborne ATC equipment, Visual inspection of the interior and exterior of the car, Functional test of safety-critical and passenger convenience components
A	37 Days	Base level PM aimed at preventing the most common problems
B	75 Days	Type A + tasks aimed at more in-depth checks of the components
C	225 Days	Type A + Type B + more detailed checks of the friction brakes and electrical systems
D	450 Days	Type A + Type B + Type C
E	900 Days	Type A + Type B + Type C
F	4-5 Years	Type A + Type B + Type C + evaluates all of the major components with replacement as required
G	8-10 Years	Detailed evaluation of all components
S		Functional check of all components and systems to insure vehicle is ready for service after removal from storage

Records indicate that 100 percent of all daily, A, B, C, D, E and F inspections are routinely completed. G Inspections were not required until FY 1999. Since that time, all required G Inspections have been completed. Table 12 provides a summary of labor hours logged for inspections A-S in fiscal years 1998 through 2000.

Table 12 - Inspection Labor Hours

	Labor Hours		
Preventive Maintenance	*1998*	*1999*	*2000*
A Inspection	1,909	2,419	2,652
B Inspection	1,515	2,059	1,890
C Inspection	753	809	817
D Inspection	815	1,242	991
E Inspection	431	114	274
F Inspection	834	1,026	944
G Inspection	0	137	96
S Inspection	0	21	68
56-day Brake Inspection	1,018	1,001	1,080
Shop Equipment Inspections	179	182	173
Total Inspection Labor Hours	7,454	9,010	8,985

The F-Inspection represents the 4-5 year component overhaul corresponding to approximately 130,000 miles, while the G-Inspection represents the 8-10 year overhaul interval corresponding to approximately 260,000 miles. These overhauls include the braking system, HVAC equipment, guide wheels, doors, motor controls, and air system. Metromover Technicians complete these overhauls in-house with assistance from vendors.

Repairs result from planned inspections as well as failures identified during service. They include repairs or adjustments performed on a daily basis at the vehicle, subsystem, and component levels. A summary of labor hours for repairs reported in fiscal years 1998 through 2000 is presented in Table 13.

Table 13 - Repair Labor Hours

	Labor Hours		
Repairs	*1998*	*1999*	*2000*
Retrofits	0	466	333
Equipment Failures	9,795	7,990	7,238
No Trouble Found Revenue	120	136	41
No Trouble Found Non-Revenue	288	208	166
Graffiti/Vandalism	313	320	98
Lamps/Bulbs	338	159	71
Daily Inspection/Miscellaneous Tasks	34,403	35,498	46,750
Total Repair Labor Hours	45,257	44,777	54,697

In the past, the focus of the shop was clearly on vehicle PM and repair, as indicated in Table 14. In FY 1994, 88 percent of total labor hours were dedicated to vehicle PM and repair. Vehicle PM labor hours accounted for 20 percent of total FY 1994 labor hours, while vehicle repair labor hours were 68 percent of the total hours. By FY 2000, vehicle PM labor hours dropped from 20 percent to 10 percent of total labor hours, while repair labor hours showed a modest increase over 1999 repair hours. Wayside repair along with the F and G Inspections appear to have driven down the vehicle repair hours.

Table 14 - Labor Hours by Job Type, FY 1994-1999

Vehicle PM and Repair	*FY 1994*	*FY 1995*	*FY 1996*	*FY 1997*	*FY 1998*	*FY 1999*	*FY 2000*	*Average*
Vehicle Preventive Maintenance	8,860	11,690	5,834	6,509	6,620	7,847	7,945	7,901
PM % of Total Labor Hours	20.3%	17.4%	8.5%	8.6%	10.3%	11.8%	10.0%	12.4%
Vehicle F & G Inspection	0	0	96	0	834	1,163	1,040	448
F & G % of Total Labor Hours	0.0%	0.0%	0.1%	0.0%	1.3%	1.7%	1.3%	0.6%
Vehicle Repair	29,500	47,574	52,909	57,999	45,257	44,777	54,697	47,530
Repair % of Total Labor Hours	67.5%	70.9%	76.9%	76.2%	70.1%	67.3%	68.9%	71.1%
Vehicle PM and Repair % of Total Labor Hours	87.8%	88.4%	85.5%	84.8%	81.6%	80.9%	80.2%	84.2%
Wayside Equipment PM and Repair								
Wayside Equipment Preventive Maintenance	4,864	6,901	7,031	7,656	8,940	9,236	8,074	7,529
Wayside Equipment PM % of Total Labor Hours	11.1%	10.3%	10.2%	10.1%	13.8%	13.9%	10.2%	11.4%
Wayside Repair	462	910	2,958	3,917	2,909	3,484	7,642	3,183
Wayside Repair % of Total Labor Hours	1.1%	1.4%	4.3%	5.1%	4.5%	5.2%	9.6%	4.5%
Wayside Equipment PM and Repair % of Total Labor Hours	12.2%	11.6%	14.5%	15.2%	18.4%	19.1%	19.8%	15.8%
Total Labor Hours	43,686	67,075	68,828	76,081	64,560	66,507	79,398	66,591

The Cleaning Program within Metromover consists of two levels of interior and exterior cleaning, performed during off-peak revenue hours. Level One is accomplished daily and includes basic housekeeping of the interior of the car. Exterior washing is done three times each week via an automatic car wash as the vehicles receive daily inspections. Level Two is performed four times each year and includes detail cleaning of the car interior and exterior. Until recently, cleaning was accomplished at two locations, the Metromover Maintenance building and the School Board Inspection Shop by eight Rail Vehicle Cleaners under the direction of a Metromover Maintenance Supervisor. The vehicle cleaning policy was revised to include daily vehicle cleaning on the mainline on two shifts. The General Superintendent indicated that one new Rail Car Cleaner position is required to meet the expanded vehicle cleaning demands, and additional Rail Car Cleaners are required to support ridership increases and a PVR increase from 15 to 17 vehicles. One of the eight Rail Vehicle Cleaner positions is vacant.

In the shop, ten cars are cleaned daily, starting at 6:00 a.m. Three vehicles are washed and detailed during off-peak revenue service.

Following is summary of the activities included in the cleaning schedule:

- Vehicle Level One - Daily
  - Vacuuming floors, side panels and end cap seats
  - Cleaning of interior windows, panels, and seats
  - Vehicles with graffiti or vandalism are removed from service immediately

- Vehicle Exterior Washing – 3 Times/Week
  - Metromover Technician drives vehicle through the automatic car wash at the School Board Inspection Area as the vehicle is daily inspected
- Vehicle Level Two – 4 Times/Year
  - Interior detail cleaning (hand washing) of vehicle ceilings, light fixtures, seats
  - Polishing interior stainless steel with steel bright
  - Shampooing and vacuuming carpet

Guideway Station tracks, which are also included in the cleaning program, are cleaned on a semi-annual schedule.

It has been suggested that it would be more appropriate to provide a Rail Vehicle Cleaner Supervisor to oversee the activities of the Rail Vehicle Cleaners. A review of position descriptions for Rail Vehicle Cleaner Supervisors and Metromover Maintenance Supervisors indicates that a Rail Vehicle Cleaner Supervisor would oversee interior and exterior cleaning of rail vehicle equipment, the maintenance of various shop areas, and be responsible for ensuring that the rail vehicle is satisfactorily cleaned and presentable for revenue service. Emphasis would be in supervising a staff of rail vehicle cleaners who routinely clean the entire rail vehicle and maintenance shop. A Metromover Maintenance Supervisor is responsible for supervising the inspection, diagnosis, repair, and maintenance of Metromover vehicles and related wayside and central systems. Emphasis is on supervising a staff of technical subordinates, planning and scheduling repair and maintenance work, diagnosing the causes of equipment failures and developing procedures to prevent recurrence, enforcing safety practices and procedures, and coordinating Metromover maintenance activities with rail officials and representatives of equipment and service contractors.

It appears that a Rail Vehicle Cleaner Supervisor position would be a more appropriate classification for supervision of the Metromover Rail Vehicle Cleaners. Efforts of Metromover Supervisors' skilled supervisory work in maintenance and repair could be redirected. Another benefit is the assignment of the responsibility for vehicle cleaning to one specific supervisor whose duties are consistent with the subordinates supervised.

Metromover Wayside Maintenance

The Metromover guideway consists of three loops: the Brickell Loop, the Central District Loop, and the Omni Extension. The Brickell Loop contains 2 tracks for 1.1 miles with 6 stations. All stations serve northbound and southbound passenger service. Riverwalk Station and Fifth Street Station have side platforms, while Eighth Street Station, Tenth Street Station, and Brickell Station have island platforms. The Financial District Station is a stub end station on single track. The Central District Loop has 2 tracks for 1.9 miles. The Omni Loop contains 2 tracks for 1.4 miles with 6 stations. All stations serve northbound and southbound passenger service. Freedom Tower Station, Park West Station, Eleventh Street Station, Bicentennial Park Station (temporarily closed for budgetary reasons), and Omni Station have island platforms that serve both northbound and southbound traffic. School Board Station is a single track, stub end station.

Normal dwell time is 15 seconds, except at the following stations where the dwell time is 20 seconds: Government Center Station, Omni Station, School Board Station, Brickell Station, and Third Street Station. At the Brickell station passengers can transfer to and from Metrorail and Metrobus.

The power distribution system is powered by a three-phase alternating current (AC) system operating from a 13.2 KV Florida Power and Light feeder located at the Metromover maintenance facility. The 13.2 KV is stepped down to a 600 volts AC secondary power distribution system to feed all stations and the three-phase contact rail system. The three phase AC contact rail system is sectionized into separately controlled sections for each passenger station and station-to-station guideway element. To remove power from a specific contact rail section, two separate breakers must be open. Under emergency response conditions, activation of the emergency trip station at Central Control will remove contact rail power on the entire system.

Wayside repairs result from planned inspections as well as failures identified during service. They include repairs or adjustments performed on a daily basis at the system, subsystem, and component level.

Data presented in Table 14 indicated FY 2000 labor hours for wayside equipment PM, and repair increased from 12 percent of total labor hours in FY 1994 to 20 percent. Wayside equipment PM hours almost doubled, while wayside repair labor hours increased almost 800 percent. Given the 12 percent share of total labor hours in FY 1994, the growth in wayside PM and repair has been significant. Summaries of wayside equipment labor hours for PM and repairs reported in FY 1998 through 2000 are presented in Table 15 and Table 16. The areas of increased labor hours include Track and Structures and Automatic Train Control.

Table 15 - Wayside PM Labor Hours

	Labor Hours		
Wayside Equipment PM	*FY 1998*	*FY 1999*	*FY 2000*
Data Transmission System	23	14	31
Automatic Train Control	1,166	984	1,414
ATC – Switches	2,540	2,804	2,348
Track and Structures	1,265	1,480	1,503
Power Distribution System	2,043	2,188	1,812
Facilities	570	570	412
Miscellaneous (Relays, Stinger, etc.)	1,333	1,196	555
Total Wayside PM Labor Hours	8,940	9,236	8,075

Table 16 - Wayside Repair Labor Hours

	Labor Hours		
Wayside Equipment Repair	*FY 1998*	*FY 1999*	*FY 2000*
Data Transmission System	79	55	72
Automatic Train Control	379	517	648
ATC – Switches	961	704	520
Track and Structures	854	1,438	4,684
Power Distribution System	630	765	1,719
Facilities	6	5	0
Total Wayside PM Labor Hours	2,909	3,484	7,643

In terms of allocated positions, records show that 26 Technicians were assigned to Metromover in early 1993. A total of 13 Technicians were added to raise the total complement to 39 Technicians in anticipation of Phase 2 start-up. The 1994 Table of Organization shows a budget allocation of 54 Metromover Technicians. Allocated positions from 1993 until the present time are identified in Table 17. In terms of actual staffing, there has been a 14 percent reduction in maintenance supervisors and a 7 percent reduction in Metromover technicians since 1994, when the system was expanded and vehicles increased from 12 to 29.

Table 17 - Metromover Positions

Classification	*1993*	*1994*	*1998*	*1999*	*2000*	*2001*	*2001 vs 1994*
Metromover Maintenance Supervisor	7	7	7	6	6	6	-14.3%
Metromover Technician	39	54	51	51	51	50	-7.4%

A review of Section 15 data illustrates the relationship between labor hours for vehicle inspection and maintenance and the number of vehicles operated in maximum service (VOMS) as reflected in Table 18.

Table 18 - Inspection & Maintenance Hours per VOMS

Inspection & Maintenance Hours per VOMS	*FY 1994*	*FY 1995*	*FY 1996*	*FY 1997*	*FY 1998*	*Average*
Metromover	5,164	5,318	6,608	7,143	6,592	6,165
Skyway	1,931	1,553	1,754	265	644	1,229
DDPM	9,620	12,133	8,415	10,140	9,360	9,934

Based on Section 15 data, Metromover is well below DDPM and five times greater than Skyway in the dedication of inspection and maintenance hours per vehicle operated in maximum service. The wide range in labor hours most likely results from the significant differences in the systems themselves; it is difficult to draw conclusions from this small sampling of data.

Metromover Experience and Classification

The present day training program for Metromover Technicians is driven by MDT's interpretation of a 13(c) Arbitration Award. The 13(c) Arbitration Award indicated that the agency must hire candidates who are qualified or could become qualified via training. The 13(c) Arbitration Award clearly stops short of indicating the process by which a candidate can become qualified. In response to the Arbitration Award, MDT determined that it was the responsibility of the agency to provide the training in order to make the candidate qualified. Vacant positions are bid based on seniority. Successful candidates are introduced to their new positions at training programs that have been reduced over time to a total of five months. Unlike Metrorail, where the lead supervisor is assigned to provide the training program, for small classes, a former Metromover Technician currently assigned to the training division provides all training, which is a combination of classroom and on-the-job training. Larger classes do require the participation of Metromover Supervisors, as the training division is severely overburdened with a multitude of training demands precipitated by 13 (c). The candidates complete the training program and are then assigned to the maintenance shop, where they remain on probation for a period of one year.

In order to determine the levels of experience and education vehicle maintenance staff possess, a review of information concerning the former classification of the Metromover Technicians on duty in April of 1999 was conducted. That information shows years in classification ranged from 3 to 15 years with an average of 7 years. Education level ranged from 9 to 16 years with an average of 12.3 years. Only 4 of 46 (8.7%) were in their classification more than 10 years and 10 of 46 (21.7%) less than 5 years. Only 7 of 46 (15.2%) had 13 or more years of education. Well over half (56.5%) of the Metromover Technicians were former Mechanics, and one-third of those Technicians had less than 5 years in their current classification, while 92 percent of Metromover Technicians with former electronic or electrical experience had been in their current classification a minimum of 9 years. Over half of the current Metromover Technicians average only 4.4 years in their current classification. If current trends continue, as new employees enter the Metromover workforce, they will do so with little or no previous technical experience. Former classifications and years of experience are reflected in Figures 8 and 9.

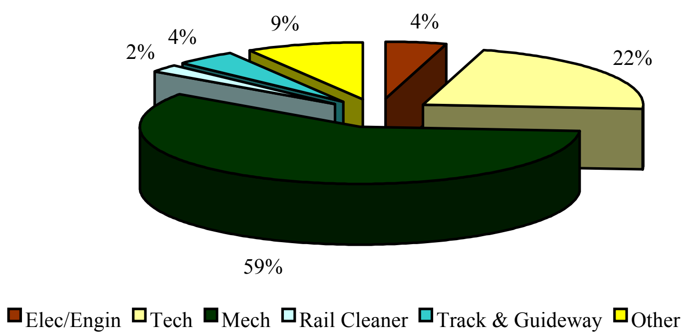


Figure 8 - Former Classification Percentage of Total

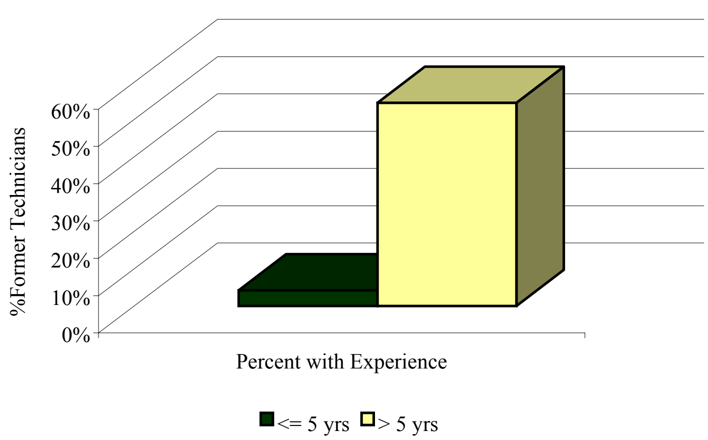


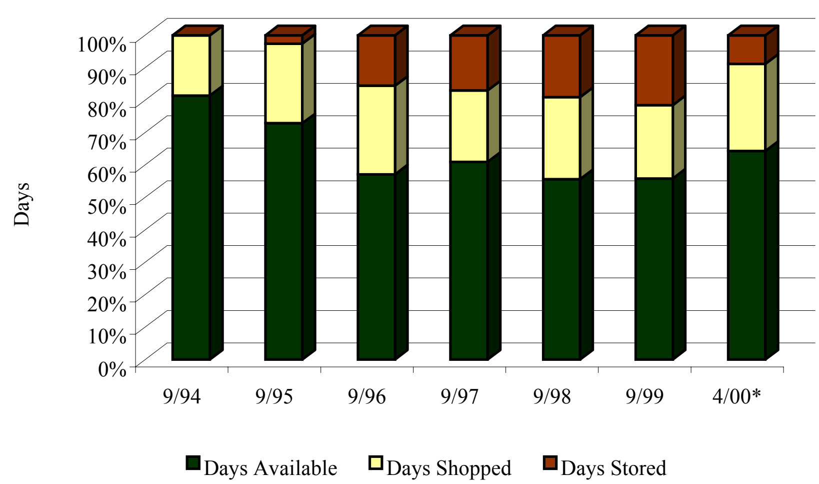
Figure 9 - Percent of Technicians with Technician/Electrician Experience

MDT recently organized a work group to review in detail their 13(c) agreements not only from an historical perspective but also to assess the impact of those agreements on the day-to-day operations of both Metrorail and Metromover maintenance. A detailed report including findings and recommendations was forwarded to the Director of MDT for his review and action.

Metromover Vehicle Availability

In early 1995, the agency made the decision to "mothball" 6 mover vehicles, which were not necessary to meet peak vehicle requirements for revenue service, so as to reduce maintenance shop needs which had risen to 25 percent of total days available. A total of three Metromover Technician positions were eliminated in conjunction with the fleet reduction of six vehicles.

Metromover rotated numerous vehicles through storage; nonetheless, five of the mover vehicles accumulated in excess of 4,500 storage days for an average storage period of 2.5 years each. The shop had a mover vehicle availability rate of 73 percent at the time those vehicles were mothballed. Mover vehicle availability fell below 60 percent in mid 1998 at which time the shop focused on returning those mothballed vehicles to service. By April 2000, all but one of the vehicles had been returned to service and the availability rate rose to 65 percent. As storage hours declined, shop hours increased slightly from 23 to 26 percent. When Metrorail undertook return of their mothballed rail cars to service, the rail cars required extensive repairs and moved from storage status to the shop. The subsequent effort required to bring these cars back from long-term storage diverted resources from other maintenance activities. The three Metromover Technician positions were not restored when the mothballed vehicles were returned to service. It appears that Metromover was able to return mothballed vehicles to service with minimal need for extended time in the shop. Figure 10 reflects the impact mothballing had on mover vehicle availability.



*Data Reflect 7 months

Figure 10 - Metromover Vehicle Availability

At issue here is the number of mover vehicles necessary to provide service versus the number of mover vehicles the Agency actually owns. While there continues to be debate over the "right" spare ratio for vehicles, Metromover has both benefited by and suffered from having 29 mover vehicles to care for on a system that "requires" 17 vehicles be available for service each morning; the shop's current requirement for vehicles operated in maximum service is 17 mover vehicles. When compared with other systems, Metromover ranks 1st in terms of vehicles operated in maximum service (VOMS), and 1st in terms of vehicles available for maximum service (VAMS). Metromover's ratio of operating vehicles to available vehicles is second to Skyway's and exceeds both DDPM's and Metrorail's as indicated in Table 19.

Table 19 - Operating Spare Ratios

	Metromover		*Skyway*		*DDPM*		*Metrorail*	
Year	*VOMS*	*VAMS*	*VOMS*	*VAMS*	*VOMS*	*VAMS*	*VOMS*	*VAMS*
1994	19	29	2	2	8	8	76	136
1995	20	29	2	2	6	6	80	136
1996	16	29	2	2	8	8	80	136
1997	15	29	1	1	8	8	86	136
1998	15	29	2	4	8	8	80	136
Ratio	1.9		2.0		1.0		1.7	

Metromover ranks 2nd in terms of total operating expenses per vehicle operated in maximum service for mover systems based on Section 15 Data as reflected in Table 20. Metromover operating expenses per VOMS exceed Skyway's and are about 75 percent of DDPM's.

Table 20 - Total Operating Expenses Per VOMS

Operating Expense Per VOMS	*FY 1994*	*FY 1995*	*FY 1996*	*FY 1997*	*FY 1998*	*Average*
Metromover	563,984	565,465	812,806	915,333	970,440	765,606
Skyway	359,900	356,300	393,650	660,900	462,400	446,630
DDPM	958,988	1,194,883	927,438	1,000,838	1,069,713	1,030,372

In terms of total operating expenses per vehicle available for maximum service, Metromover also ranks 2nd for mover systems. Metromover's operating cost per VAMS is closer to Skyway's than Metromover's cost per VOMS, and it is less than half of DDPM's as indicated in Table 21.

Table 21 - Total Operating Expenses Per VAMS

Operating Expense Per VAMS	*FY 1994*	*FY 1995*	*FY 1996*	*FY 1997*	*FY 1998*	*Average*
Metromover	369,507	389,976	448,445	473,448	501,952	436,666
Skyway	359,900	356,300	393,650	660,900	231,200	400,390
DDPM	958,988	1,194,883	927,438	1,000,838	1,069,713	1,030,372

According to Section 15 data, in 1994, 98,121 labor hours were provided for inspection and maintenance. During 1995, that number rose to 106,368, an 8.4 percent increase. Labor hours declined to 105,726 in 1996, a 0.6 percent decrease. Labor hours rose to 107,141 in 1997 and then dropped to 98,877 in 1998. Labor hours reported in 1999 totaled 101,185 hours, an increase of 3.1 percent compared to those reported five years ago in 1994. Labor hours are presented in Figure 11.

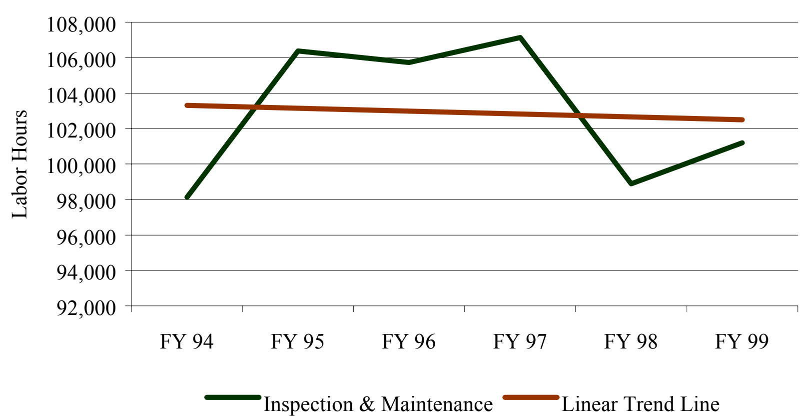


Figure 11 - Labor Hours for Inspection & Maintenance

Similar fluctuations in labor hours were seen at other properties. Nonetheless, Metromover's shop consistently reported fewer labor hours for each vehicle available for service than DDPM but more hours than Skyway as presented in Table 22.

Table 22 - Inspection & Maintenance Hours per VAMS

Hours per VAMS	*FY 1994*	*FY 1995*	*FY 1996*	*FY 1997*	*FY*	*Average*
Metromover	3,383	3,668	3,646		3,410	3,560
Skyway	1,931	1,553	1,754		322	1,165
DDPM	9,620	12,133	8,415		9,360	9,934

Inspection and maintenance hours per VAMS presented in Table 22 mirror those presented for VOMS. DDPM's allocation of hours per VAMS is significantly greater than Metromover's, and Metromover averages three times more inspection and maintenance hours per VAMS than does Skyway.

The total number of mover vehicles needed simultaneously in the peak periods to satisfy passenger demand while keeping per-car passenger loads at or below a pre-determined level is called the Peak Vehicle Requirement (PVR). Metromover recently began operating two 2-car pairs, resulting in a PVR of 17 vehicles. A PVR of 17 represents 59 percent of the fleet. Should Metromover decide to add a third 2-car pair, the PVR will increase to 18, which is 62 percent of the total fleet. Review of the vehicle availability data presented in Table 20 indicates Metromover has had some difficulty in meeting the peak vehicle requirement in the past. A total of 10,585 days are available annually for the fleet. Table 23 basically shows where the 29 vehicles were located (i.e., in the shop or in storage) during annual intervals.

Table 23 - Days Shopped - Stored - Available

Year	*Days Shopped*	*% of Total*	*Days Stored*	*% of Total*	*Days Available*	*% of Total*
9/94	1,970	18.6%	0	0.0%	8,615	81.4%
9/95	2,599	24.6%	273	2.6%	7,713	72.9%
	2,889	27.3%	1,832	17.3%	5,864	55.4%
9/97	2,250	21.3%	1,937	18.3%	6,398	60.4%
9/98	2,523	23.8%	2,091	19.8%	5,971	56.4%
9/99	2,393	22.6%	1,872	17.7%	6,320	59.7%
4/00	1,420	26.0%	494	9.1%	3,538	64.9%
Total	16,044	23.3%	8,499	12.3%	44,419	64.4%

A comparison of the availability of the Phase 1 vehicles to Phase 2 vehicles is presented in Tables 24 and 25.

Table 24 - Phase 1 Vehicle Availability

	Phase 1 Vehicles					
Year	*Days Shopped*	*% of Total*	*Days Stored*	*% of Total*	*Days Available*	*% of Total*
9/94	1,398	31.9%	0	0.0%	2,982	68.1%
9/95	1,552	35.4%	273	6.2%	2,555	58.3%
9/96	1,563	35.7%	1,026	23.4%	1,791	40.9%
9/97	1,028	23.5%	1,018	23.2%	2,334	53.3%
9/98	1,073	24.5%	1,123	25.6%	2,184	49.9%
9/99	1,533	35.0%	839	19.2%	2,008	45.8%
4/00	843	37.4%	269	11.9%	1,144	50.7%
Total	8,990	31.5%	4,548	15.9%	14,998	52.6%

In 1994, Phase 1 vehicles were approximately eight years old, and the new Phase 2 vehicles were put into service. Phase 1 availability dropped to an all-time low in September of 1996. The decline in availability is most likely the result of the retrofit work that was identified in the 1994 - 1996 summary of labor hours. In the three years following the retrofit work, approximately one fourth of the Phase 1 vehicles were stored. As with Metrorail, some of those vehicles moved to the shop after removal from storage. Early 2000 data do show a modest increase in availability; however, a shop rate of 37.4 percent is higher than any rate recorded previously.

Table 25 - Phase 2 Vehicle Availability

	Phase 2 Vehicles					
Year	*Days Shopped*	*% of Total*	*Days Stored*	*% of Total*	*Days Available*	*% of Total*
9/94	572	9.2%	0	0.0%	5,633	90.8%
9/95	1,047	16.9%	0	0.0%	5,158	83.1%
9/96	1,326	21.4%	806	13.0%	4,073	65.6%
9/97	1,222	19.7%	919	14.8%	4,064	65.5%
9/98	1,450	23.4%	968	15.6%	3,787	61.0%
9/99	860	13.9%	1,033	16.6%	4,312	69.5%
4/00	577	18.1%	225	7.0%	2,394	74.9%
Total	7,054	17.4%	3,951	9.8%	29,421	72.8%

Phase 2 vehicles, represented in Table 25, started to achieve relatively low availability rates during their third year of service. Those rates appear to be directly affected by the 13 to 17 percent storage rates rather than by significant shop rates, as is the case with the Phase 1 vehicles. The newer Phase 2 vehicles appear to spend less time in the shop than do the Phase 1 vehicles.

An indicator that perhaps best describes the shop's performance is that of mean miles between failures. Figure 12 reflects mean miles between failures averaged for Phase 1 vehicles, Phase 2 vehicles, and the total fleet. Phase 1 vehicles showed a significant increase in miles between failures in 1999 and 2000, in comparison to miles between failures reported in previous years. On the other hand, Phase 2 vehicles show a consistent gradual improvement since 1995. It is highly probable that early Phase 2 rates were low due to problems typical of new vehicles as they adjust to the system. The Phase 2 vehicles consistently performed better than the Phase 1 vehicles from 1995 through 1998.

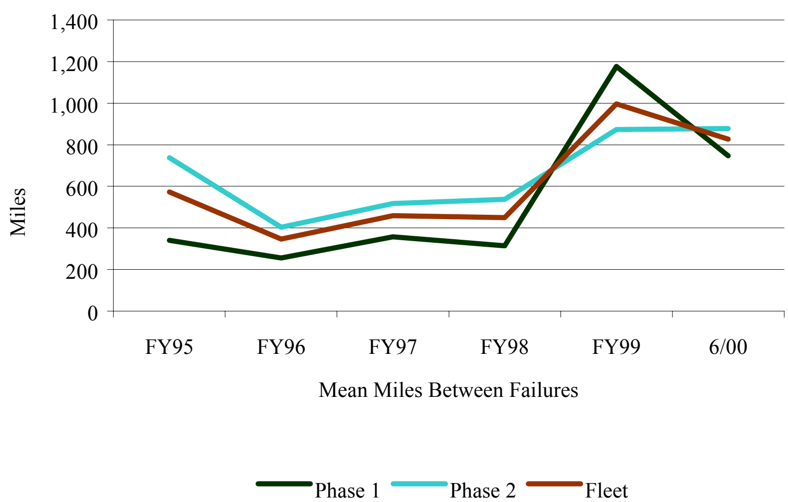


Figure 12 - Mean Miles Between Failures by Phase

Mean miles between failures from FY 1995 through June 30, 2000 were averaged for each mover vehicle. Those data are presented in Figure 13.

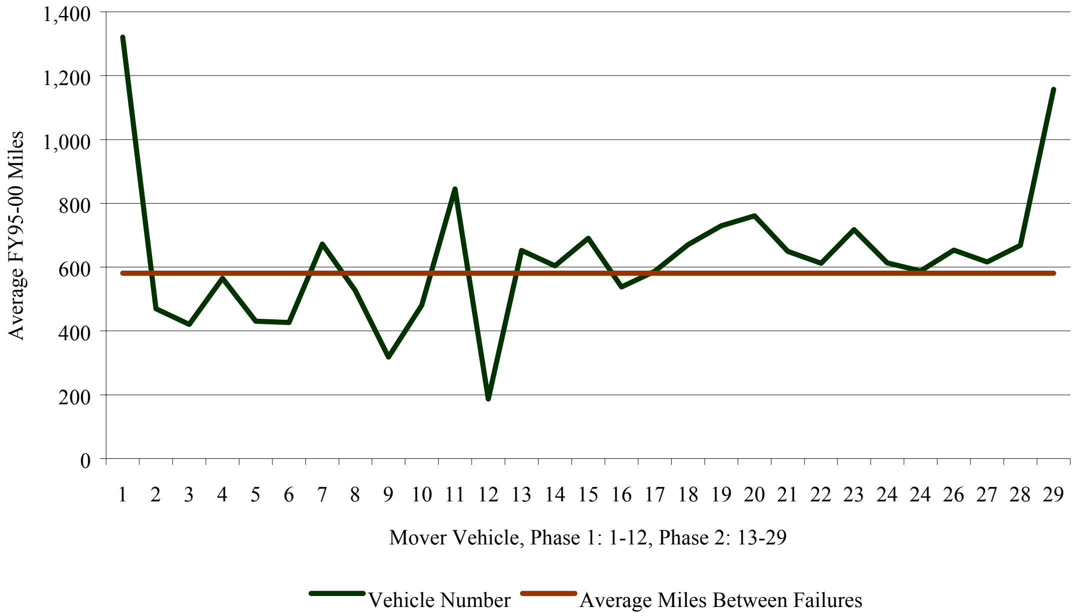


Figure 13 - Mean Miles Between Failures by Vehicle

These data also substantiate a difference in Phase 1 and Phase 2 mover vehicle performance. Phase 1 vehicles show not only a greater range in miles between failures but also a greater inconsistency in performance between vehicles. While Phase 2 vehicles were unable to exceed the maximum miles between failures logged by Phase 1 vehicles, Phase 2 vehicles consistently achieved the Phase 1 minimum miles logged. All 17 Phase 2 vehicles exceeded 400 miles between failures, while only 9 of 12 Phase 1 vehicles achieved that level.

To examine further the possible difference in performance between Phase 1 and Phase 2 vehicles, average annual mileage of the vehicles from FY 1995 through FY 2000 was examined. Figure 14 represents that data.

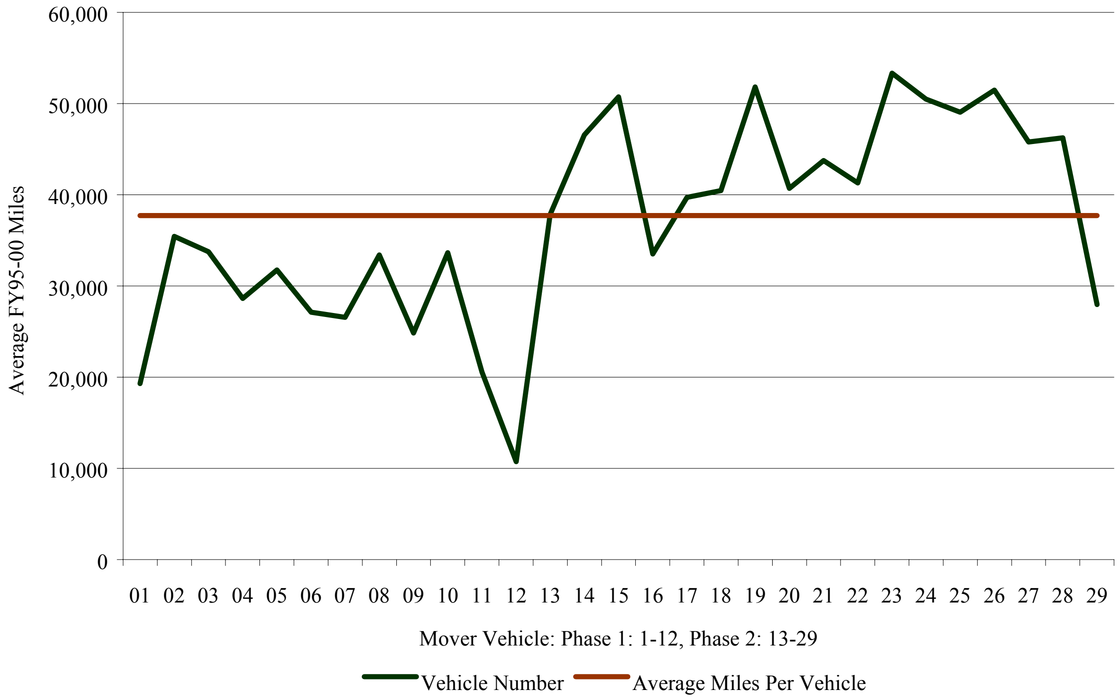


Figure 14 - Average Annual Mover Vehicle Miles

Phase 2 vehicles, with the exception of Vehicles #16 and #29, logged more miles than Phase 1 vehicles. A comparison of those average miles and mean miles between failures is presented in Figure 15. In order to provide a graphic representation of the data, mean miles between failures were increased by a factor of ten.

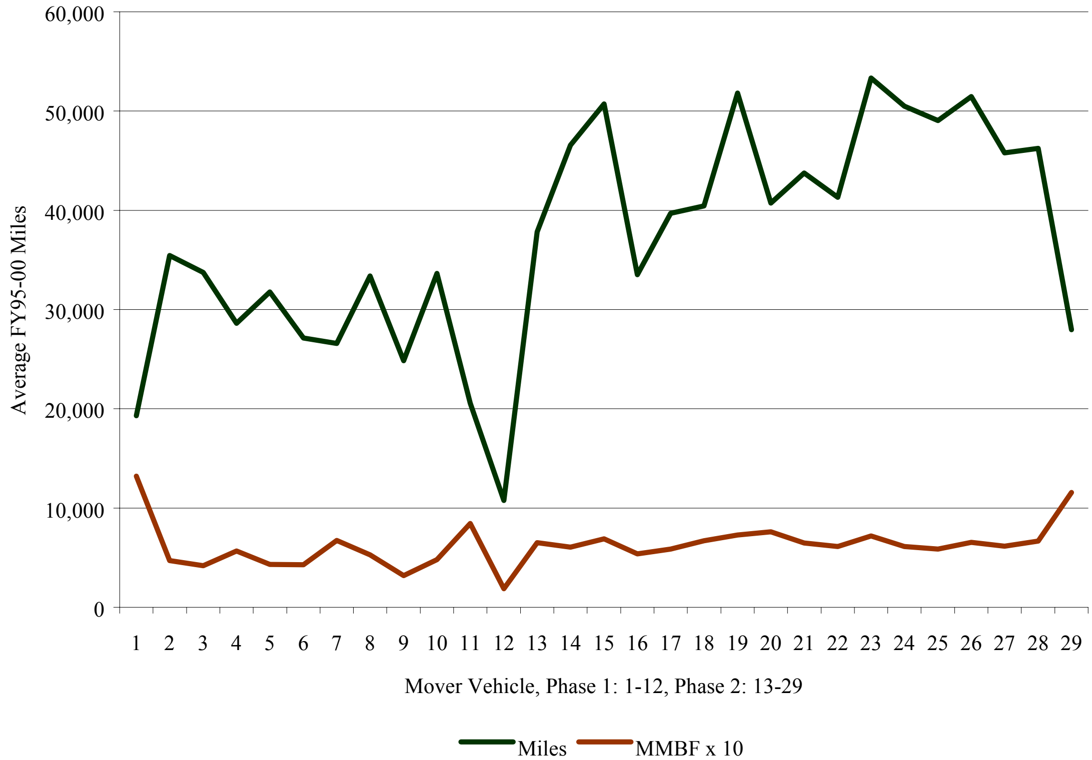


Figure 15 - Annual Mileage vs. Mean Miles Between Failures

With the exception of one vehicle, Phase 2 vehicles appear to be consistently more reliable than Phase 1 vehicles.

Metromover Vehicle Performance

Rail Maintenance Control in conjunction with Central Control reviewed Metromover Operations' Summary of Unusual Occurrences reports for four months (March, June, September, and December) over a period of three years (1998, 1999, and 2000). The data were consolidated into an incident report format that provided information on the factors, listed below, regarding Metromover vehicle performance and service interruptions.

- Date of Each Incident
- Day of Week the Incident Occurred
- Time of Incident
- Loop Affected by the Incident
- Number of Vehicles Held at a Station as a Result of the Incident
- Length of Delay Caused by the Incident

- Number of Vehicles Removed from Services Due to the Incident
- Time Service Resumed
- Station at which Passengers Were Deboarded
- Cause of the Delay
- Staff who Reported the Incident
- Nature of the Vehicle Malfunction Related to the Incident
- Location of the Incident
- Time Metromover Recovery Technician was Dispatched to and Arrived at the Incident

Figure 16 shows the number of incidents that were reported annually. Incidents in 2000 represent a 4 percent increase over 1999 incidents, and a 13 percent reduction in 1998 incidents.

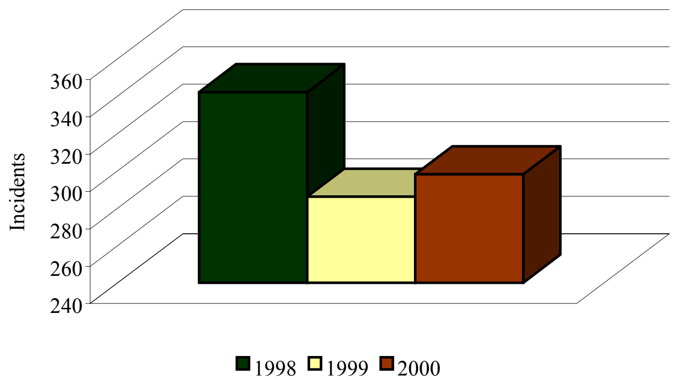


Figure 16 - Incidents by Year

There does not appear to be a significant difference in incidents based on month with the exception of December. Given the intense maintenance commitment that Metromover makes to supply vehicles for the Orange Bowl parade at the end of the year, the fact that December incidents are low is to be expected. Only 30 incidents were reported in December 2000 as indicated in Figure 17.

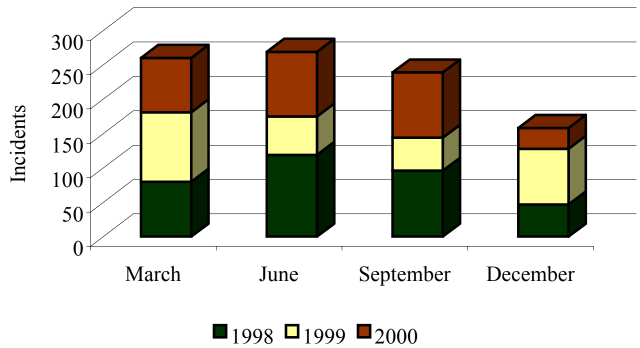


Figure 17 - Incidents by Month

Incidents, when viewed by day of the week as a percentage of the total week, show an increase in the percentage of incidents on Saturday and Sunday, in addition to a sizeable reduction in the percentage of incidents on Wednesdays. Incidents by day as a percent of the total week are presented in Figure 18.

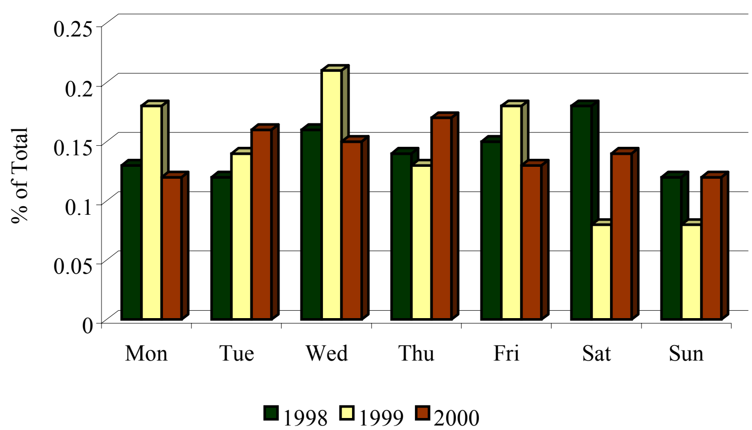


Figure 18 - Incidents by Day of Week as a % of Total

When daily incidents are viewed in terms of the number of incidents, rather than as a percentage of the total, Wednesday continues to stand out as a day with more incidents as seen in Figure 19.

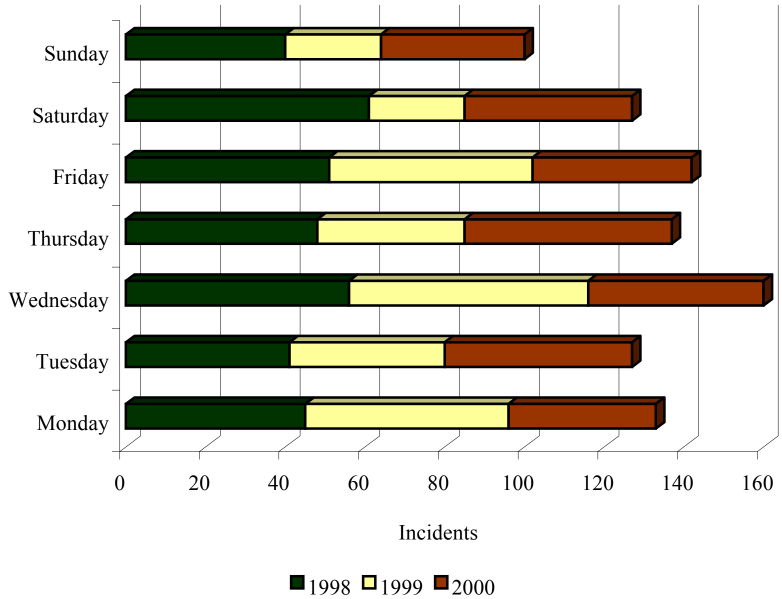


Figure 19 - Incidents by Day of Week

Incidents by time of day are displayed in Table 26. AM and PM peak hours are identified, and the highest percentages of hourly incidents for each year are presented in red text. Only in 1999, did the highest hour of incidents occur during peak hours. It is also interesting to note the reduction in the volume of incidents per hour reported in 2000 with the highest percentage of incidents at 8.7 percent, as compared with 10.5 percent in FY 1999, and 9.1 percent in 1998.

Table 26 - Incidents by Time of Day

	Time Of Incident	*Incidents* 1998	*% Of Total*	1999	*% Of Total*	2000	*% Of Total*
	05:15 - 06:04	23	6.7%	23	8.0%	19	6.4%
AM Peak	06:05 - 07:04	20	5.8%	11	3.8%	17	5.7%
AM Peak	07:05 - 08:04	12	3.5%	15	5.2%	15	5.0%
AM Peak	08:05 - 09:04	10	2.9%	10	3.5%	16	5.4%
AM Peak	09:05 - 10:04	11	3.2%	8	2.8%	12	4.0%
AM Peak	10:05 - 11:04	16	4.7%	14	4.9%	15	5.0%
	11:05 - 12:04	20	5.8%	15	5.2%	13	4.4%
	12:05 - 13:04	15	4.4%	11	3.8%	16	5.4%
	13:05 - 14:04	18	5.3%	20	7.0%	21	7.0%
	14:05 - 15:04	20	5.8%	15	5.2%	**26**	**8.7%**
PM Peak	15:05 - 16:04	24	7.0%	**30**	**10.5%**	21	7.0%
PM Peak	16:05 - 17:04	26	7.6%	23	8.0%	25	8.4%
PM Peak	17:05 - 18:04	28	8.2%	17	5.9%	24	8.1%
PM Peak	18:05 - 19:04	14	4.1%	12	4.2%	14	4.7%
	19:05 - 20:04	25	7.3%	21	7.3%	12	4.0%
	20:05 - 21:04	**31**	**9.1%**	16	5.6%	14	4.7%
	21:05 - 22:04	16	4.7%	18	6.3%	10	3.4%
	22:05 - 23:04	7	2.0%	6	2.1%	6	2.0%
	23:05 - 01:04	6	1.8%	1	0.3%	2	0.7%
	Total	342	100.0%	286	100.0%	298	100.0%

Loops affected by incidents are presented in Figure 20. It appears that problems negatively impacting the Brickell/Omni Loop in 1999 have been corrected. Figures from 2000 present a more normal distribution of incidents.

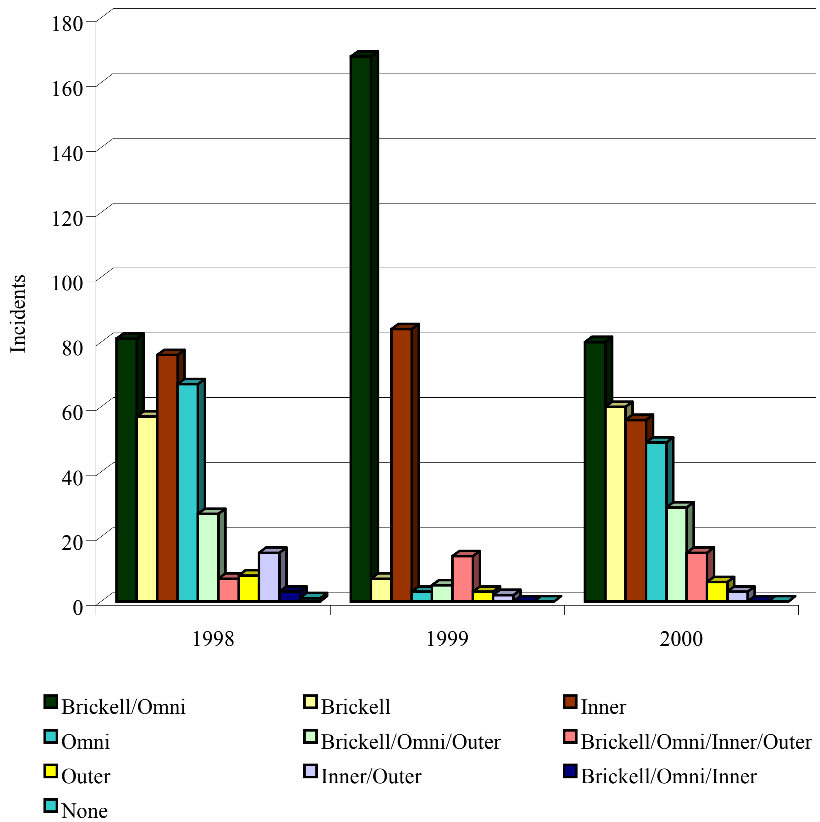


Figure 20 - Incidents by Loop Affected

The most frequently occurring minutes of delay were 6 and 7 minutes. Delays of 5-10 minutes accounted for over 50 percent of all delays. Delays in 2000 equaled 1999 delays of 6-9 minutes, and were slightly longer than 1998 delays of 5-8 minutes. The amount of delay is shown in Figure 21.

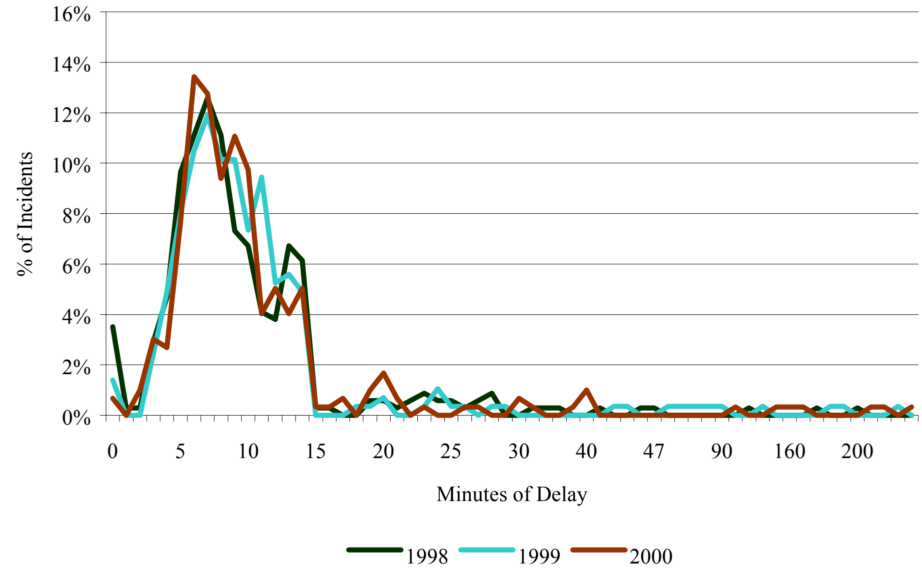


Figure 21 - Minutes of Delay

The number of vehicles held at an incident changed significantly between 1998 and 2000. In 1998, there were 237 incidents where 5 vehicles were held, as opposed to 45 incidents in 2000, and there were 190 incidents when 10 vehicles were held, as opposed to 26 incidents in 2000. Increases in one to four vehicles held were noted in 2000. Figure 22 illustrates these changes.

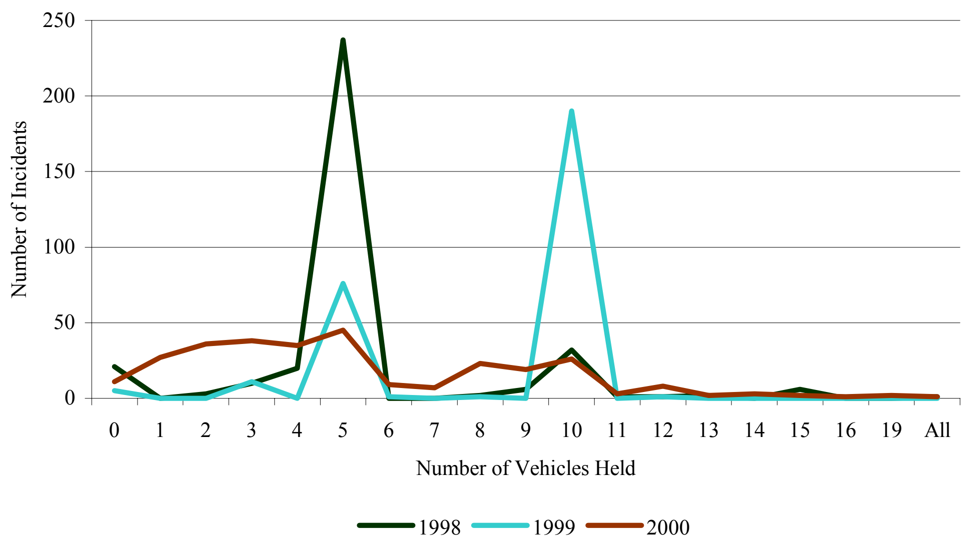


Figure 22 - Number of Vehicles Held at Station

Figure 23 illustrates each vehicle's percentage of total vehicles removed from service. In 2000, the number of times each vehicle was removed from service never reached three percent and generally fell below the high percentages recorded in 1998 and 1999.

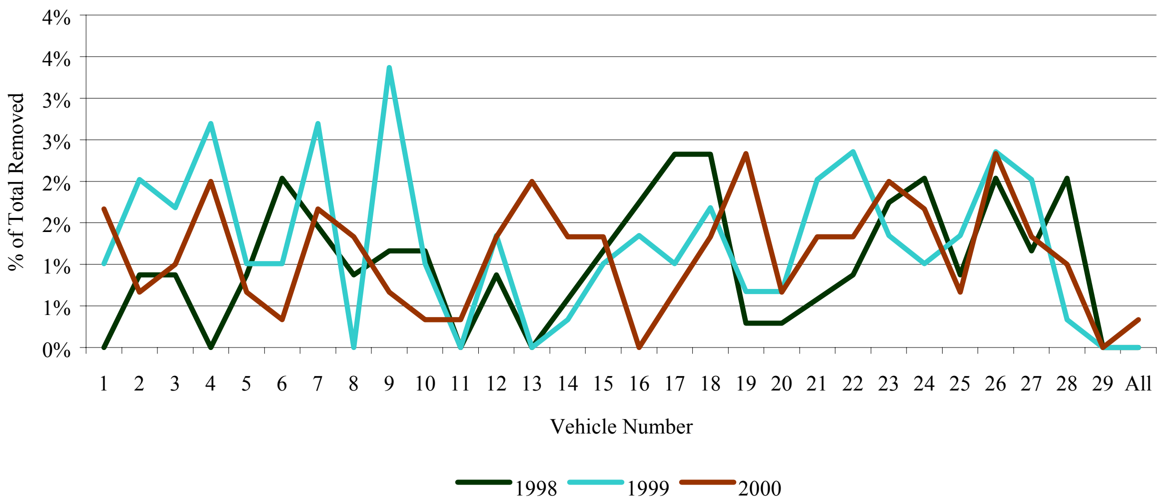


Figure 23 - % of Total Removals from Service

Removal of vehicles was required about one-third of the time. Figure 24 illustrates the relationship between vehicles removed from service and vehicles that continued to operate in service. This relationship appears to be consistent over the three-year period.

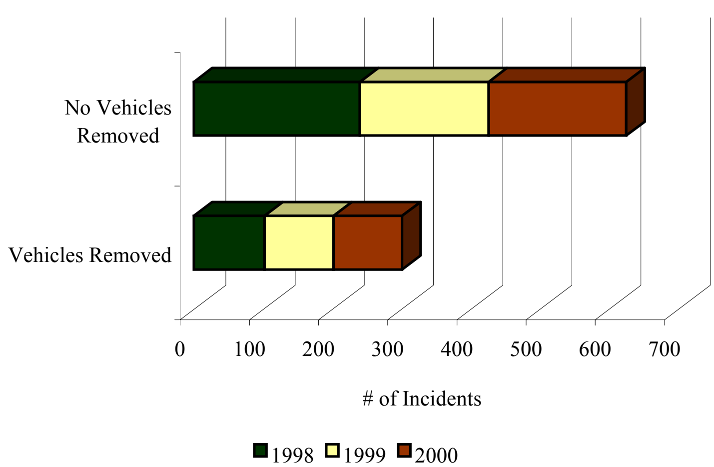


Figure 24 - Vehicles Removed from and Retained in Service

The Stations at which passengers were deboarded are illustrated in Figure 25. Government Center appears to be disproportionately higher because, when possible, passengers are transported to there for deboarding to facilitate transfer to other destinations. Third Street Station and Bayfront Park Station show higher numbers of incidents, while most other stations either remained the same or actually had very few deboardings.

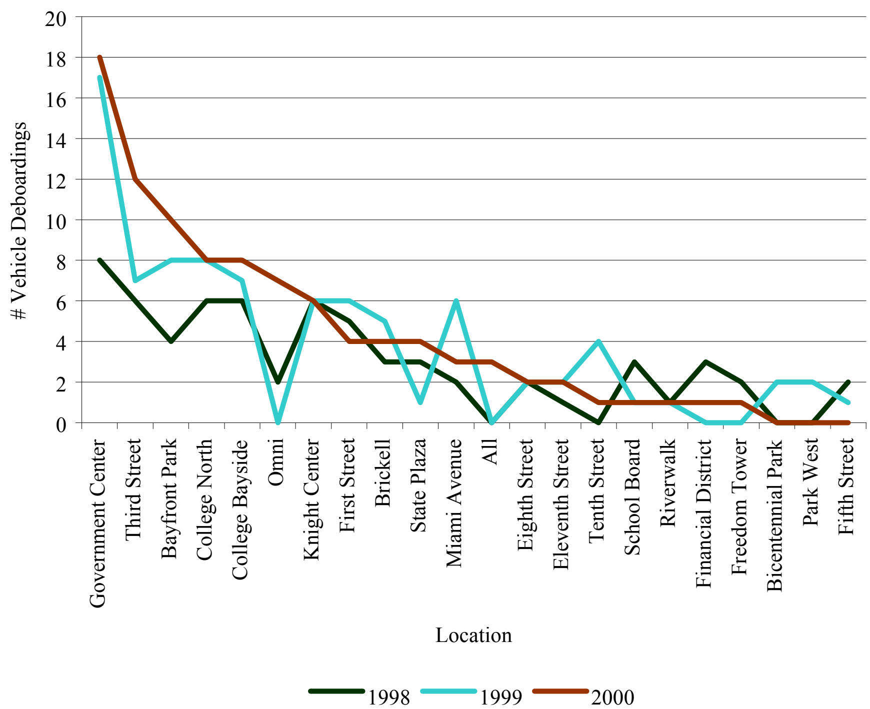


Figure 25 - Deboardings by Station

The nature of the malfunction is presented in Figure 26. Since 1998, the six most frequent malfunctions have remained the same with similar rates of frequency and include: door, Automatic Train Operation, overspeed, no depart, power, and no arrive.

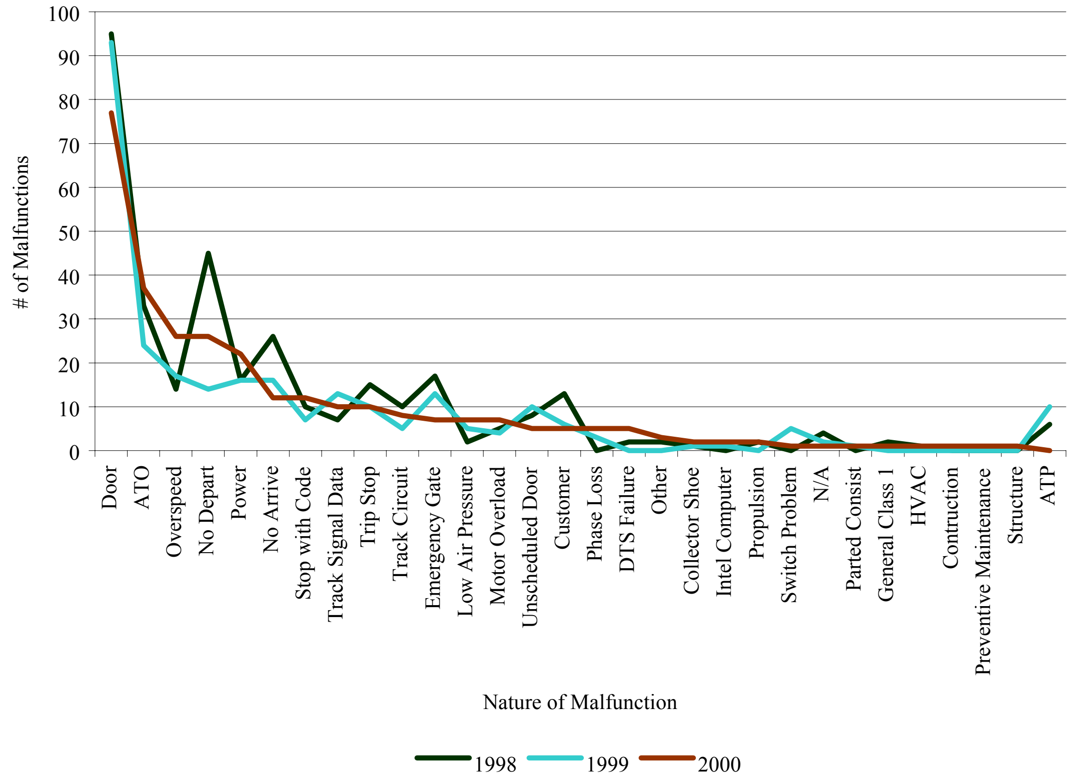


Figure 26 - Nature of Malfunction

Cause of delay is illustrated in Figure 27. Vehicle malfunctions accounted for 84 percent of all incidents in 1998, 80 percent of all incidents in 1999, and 79 percent of all incidents in 2000. There were 50 fewer incidents due to vehicle malfunction in 2000, as compared to 1998.

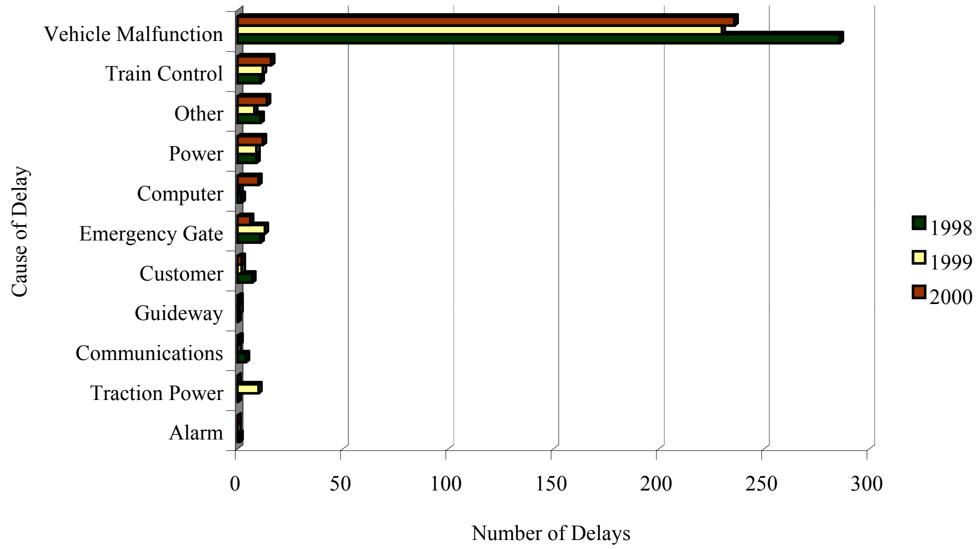


Figure 27 - Cause of Delay

Incidents per vehicle are illustrated in Figure 28. All Phase 1 vehicles except, vehicle 12, reported fewer incidents in 2000. Phase 2 vehicles 13, 15, 19, and 24 reported high numbers of incidents compared with 1998 and 1999. Incidents involving all vehicles increased from 0 in 1998 to 2 in 1999, and to 6 in 2000.

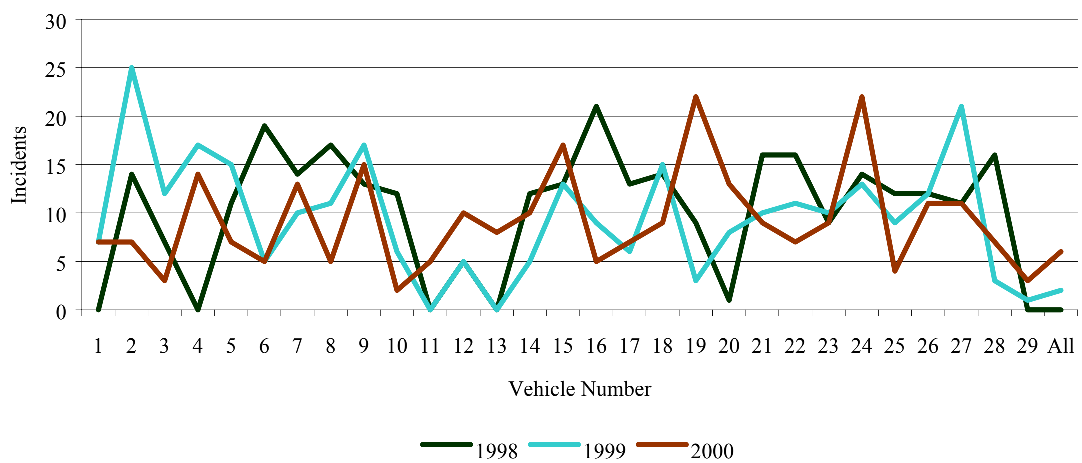


Figure 28 - Incidents by Vehicle

Location of incidents charted in Figure 29 indicates the stations with the highest numbers of incidents are Government Center, College North, Knight Center, Third Street, and Omni. College Bayside and Bayfront Park, which are not included in this list, recorded high incidents during 1998 and 1999.

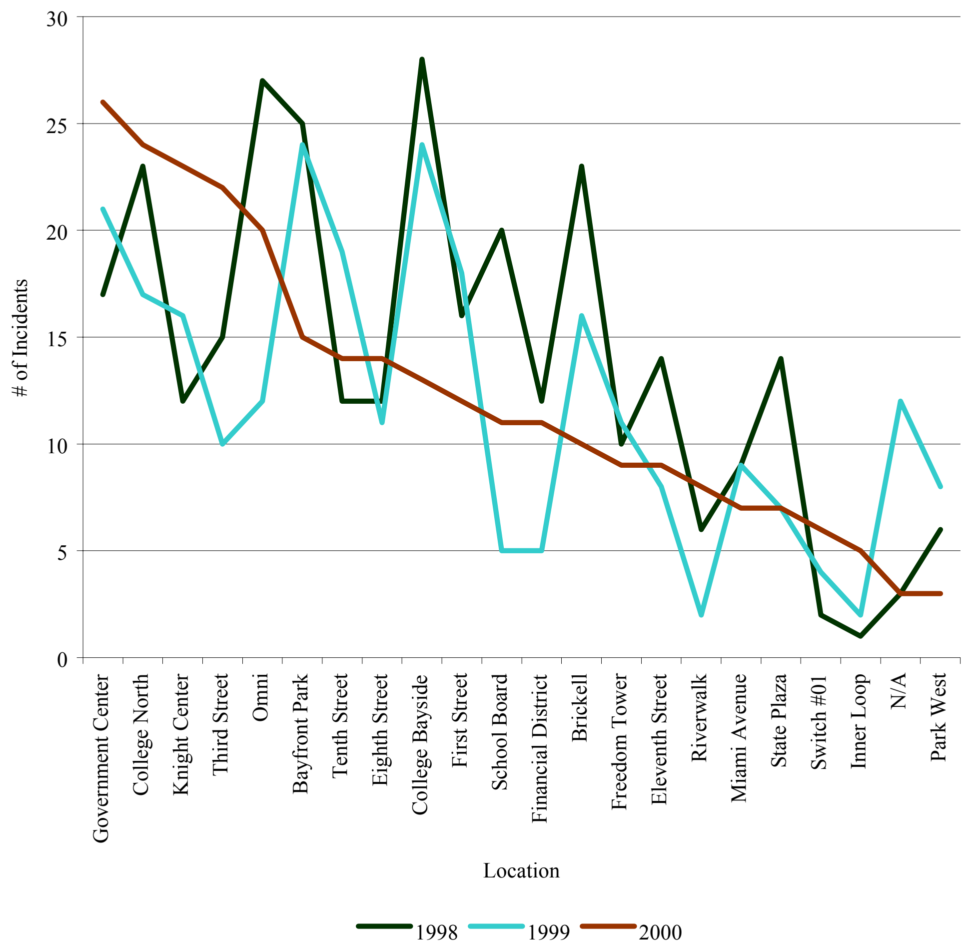


Figure 29 - Location of Incident

The following system map identifies the highest incident locations for 2000. No apparent trends, in terms of loop or high incident corridor, are seen regarding the location of incidents.

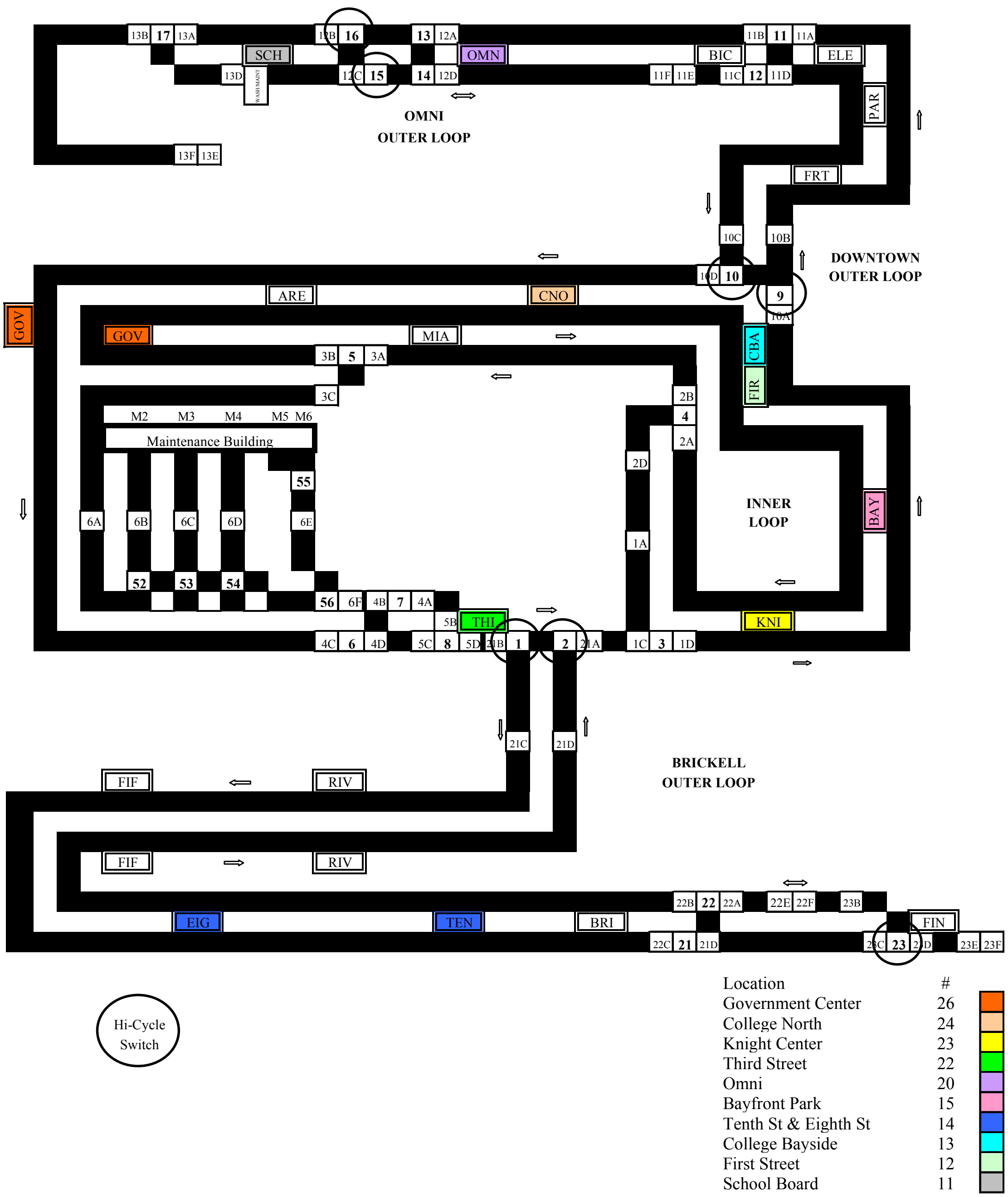


Figure 30 - High Incident Locations in 2000

During weekday revenue service on the first shift, four recovery technicians are on duty and are assigned as follows:

- Omni Loop – 1
- Brickell Loop 1
- Inner/Outer Loops – 2

The recovery technician assigned to the Omni Loop is also responsible for completing daily vehicle inspections at the School Board Maintenance Shop. Concern was raised that the response time of the Omni recovery technician was longer than the other recovery technicians' response times as a result of the additional inspection responsibilities. Two factors included in the incident log were the "time technician was dispatched to" the incident and the "time the technician arrived at" the incident. Unfortunately, these factors were not available from the Unusual Occurrence Reports until March 2000; therefore, the database contains only 157 entries. Additionally, there were several entries that showed disparities in the reported times (i.e., arrival time occurred prior to dispatch time). As a result, rather than simply computing an average time for the responses, the mode, the most commonly occurring time, was used as a benchmark for comparison. The most frequently occurring response time for all incidents was 5 minutes with 26 occurrences.

Figure 31 represents response times for the 157 incidents in terms of those responses that required less than 5 minutes, 5 minutes, or more than 5 minutes. Slightly over half of the responses were accomplished in less than five minutes. Response time was longest for the Brickell Loop, followed by the Omni Loop. There is no indication that Omni recovery technician response time is longer; in fact, the Omni recovery technician exceeded a 5-minute response time on 11 of 22 occasions, while the Brickell recovery technician exceeded a 5-minute response time on 19 of 33 incidents.

The General Superintendent expressed concern regarding the Recovery Technician performing vehicle inspections, and then responding to the general public for recovery in a disheveled state due to the nature of the inspection work. He recommended that an additional Metromover Technician position be funded to assist the Metromover Technician currently assigned to perform daily vehicle inspections; the Recovery Technician would no longer assist with daily inspections.

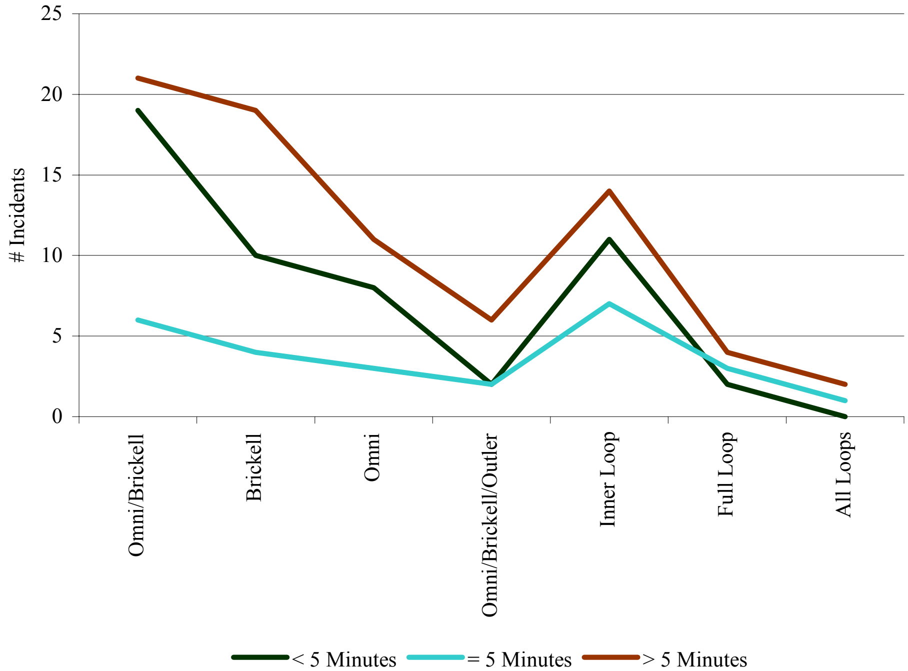


Figure 31 - Recovery Technician Response Time

There was also some discussion regarding stationing a Recovery Supervisor at Central Control to assist in restoring a failed vehicle to service. Interviews were conducted with maintenance and Central Control personnel. Both groups generally agreed that in those instances when Central Control is unable to return a vehicle to service, recovery assistance is needed at the site of the failure rather than at Central Control. There are clearly defined trouble-shooting procedures in place at Central Control, and Central Control personnel appeared to be familiar with the procedures and knowledgeable in all aspects of vehicle failures and failure management of the system. When those procedures are unsuccessful, hands-on assistance at the scene of the failure is required.

The final factor considered in the incident log was the amount of time required for resumption of service after arrival of the recovery technician. Over half of the time service was resumed in one minute or less, and 90 percent of the time, service was restored within ten minutes or less. Restoration of service is illustrated in Figure 32.

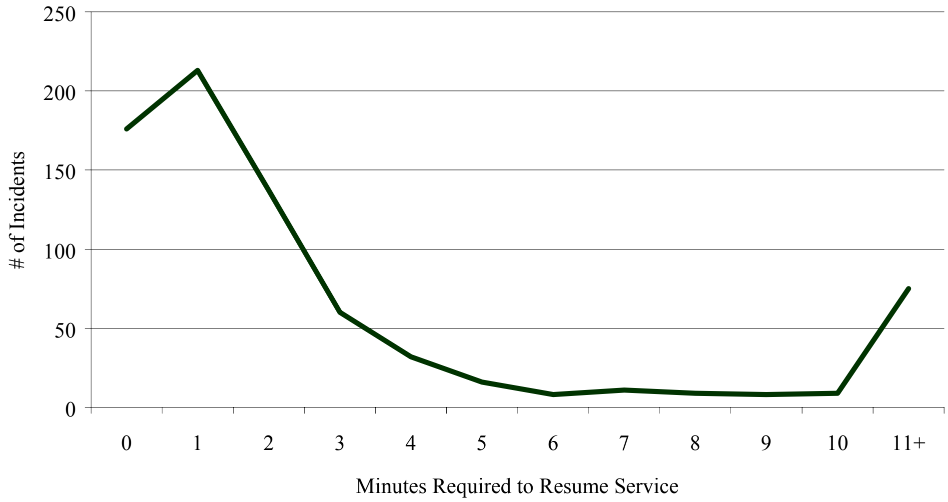


Figure 32 - Time Required to Resume Service

Metromover Vehicle Allocation

Metromover has historically operated five vehicles on each loop during weekdays and three vehicles per loop on weekends. While those vehicles have routinely operated as single car trains, two-car trains are used during special events, and, only recently, two of the vehicles were reconfigured as two-car trains, increasing the weekday revenue vehicle requirement to 17 vehicles. Headways remained unchanged since five "trains" continue to operate on each loop; however, ridership capacity was increased by virtue of the fact that those five trains now consist of 17 rather than 15 vehicles.

In the absence of agency data regarding boardings by hour for each individual station, boardings by station were viewed from two different perspectives to examine the allocation of five vehicles to each loop. The first consisted of an examination of each station's percent of the total boardings during FY 2001. Over 40 percent of total boardings occurred at Government Center, a key station on the Downtown Inner/Outer Loop. Government Center was followed by Bayfront Park Station, also on the Downtown Inner/Outer Loop, with 11 percent of total boardings. Brickell, a significant station on the Brickell extension, ranked third with 10 percent of the total boardings, followed by Omni Station, the most significant station on the Omni extension, with 6 percent of total boardings. A graphic presentation of the percent of total boardings by station is presented in Figure 33.

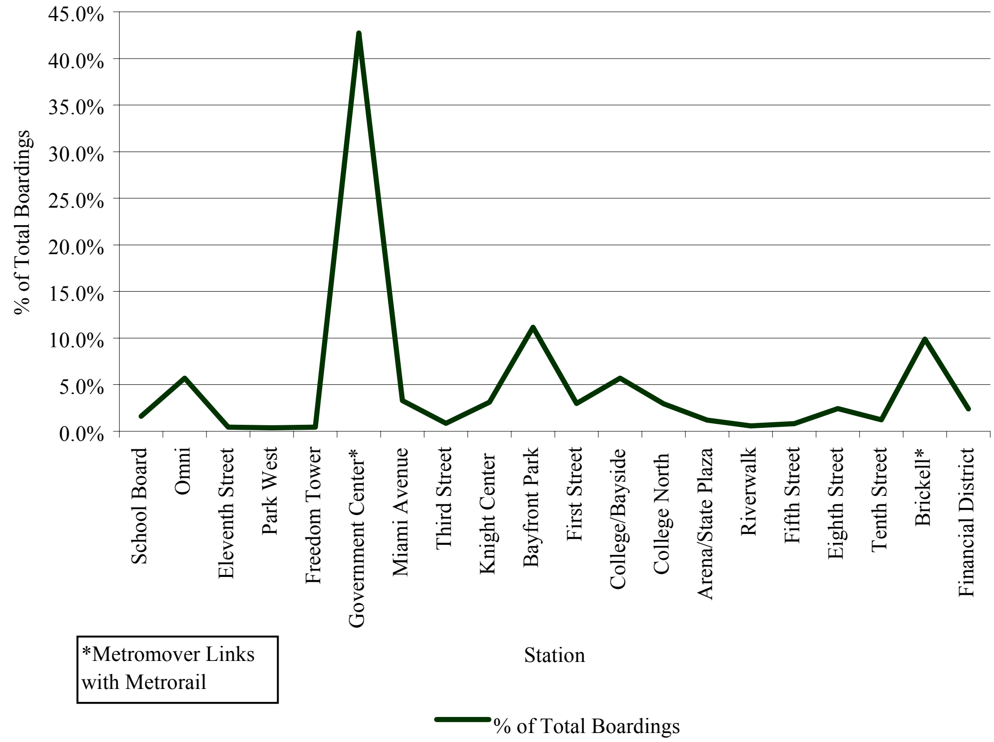


Figure 33 - Percent of FY 2001 Total Boardings by Station

The significance of boardings at stations other than Government Center is very difficult to determine simply because of the scope of the service provided at Government Center. To that end, station boardings by weekday, Saturday, Sunday, and Holidays were evaluated. Table 27 presents an overview of those data by station, sorted in a descending manner by number of total boardings. Each station was awarded between 1 and 20 points based on where boardings at that station fell in relationship to all other stations. Government Center received 20 points in each of the types of days, since it recorded the highest station boardings on weekdays, Saturday, Sundays, and Holidays. On the other hand, Fifth Street Station received a score of 1 for Saturday, Sunday, and Holidays, because it recorded the lowest number of station boardings on those days. Since there are 20 stations on the Metromover Loops, a score of 20 was chosen as the maximum score that could be earned.

Table 27 - FY 2001 Boardings by Station by Day

	Boardings				
Stations	*Weekday*	*Saturday*	*Sunday*	*Holiday*	*Total*
Government Center	1,706,608	174,954	136,768	57,479	2,075,810
Bayfront Park	486,135	26,893	20,981	8,381	542,390
Brickell	405,795	31,510	27,380	16,385	481,070
College/Bayside	221,768	25,638	23,094	6,545	277,046
Omni	219,900	26,073	24,380	6,633	276,986
Miami Avenue	142,224	9,854	4,903	2,632	159,613
Knight Center	133,554	9,309	6,519	2,430	151,811
First Street	116,564	13,911	11,981	2,783	145,239
College North	130,121	6,728	4,420	1,544	142,813
Eighth Street	107,945	4,989	4,344	1,315	118,593
Financial District	102,204	7,095	5,103	1,745	116,148
School Board	59,015	9,328	7,653	1,750	77,746
Tenth Street	55,292	2,429	1,743	671	60,135
Arena/State Plaza	48,707	5,300	3,488	1,113	58,609
Third Street	32,315	3,140	2,087	584	41,126
Fifth Street	37,141	1,873	1,149	390	40,553
Riverwalk	22,726	2,767	2,131	711	28,335
Freedom Tower	16,803	2,555	1,885	576	21,819
Eleventh Street	15,629	2,992	2,418	448	21,487
Park West	14,395	2,442	1,789	406	19,033

Figure 34 is a graphic representation of the ranking of the stations based on weekday, Saturday, Sunday, and holiday boardings. The stations on the Omni Extension, Downtown Inner/Outer Loop, and Brickell extension are identified. Metromover links with Metrorail at both Government Center and Brickell. Stations on all three loops fall into the highest boardings categories. In the absence of hourly boarding data, it is not possible to determine vehicle requirements for each area; however, these data indicate that high volume stations occur throughout the entire system. The five vehicles per loop today provide short headways with frequent service. They facilitate movement throughout the Metromover system and are coordinated with Metrorail and Metrobus schedules to facilitate transfers to both Metrorail and Metrobus. It would seem prudent, if possible, to maintain the existing level of service. As passenger requirements within specific areas rise, the coupling of a second vehicle to existing vehicles solves the need for additional capacity.

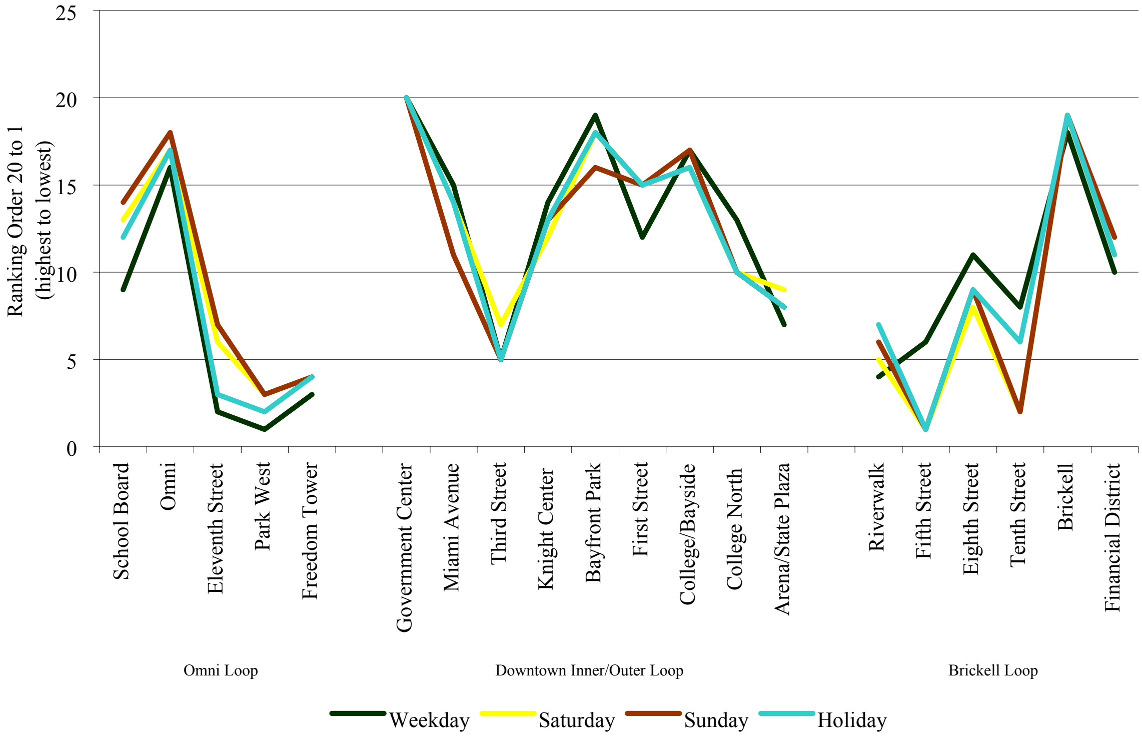


Figure 34 - Stations Ranked by Number of Boardings, FY 2001

Metromover Vehicle Condition

The Metromover Chief Supervisors were asked to evaluate the current condition of the mover vehicles, using a consistent set of definitions for establishing the condition of each subsystem. The ratings throughout this report were adapted from UMTA's Rail Modernization Report 1987 and provide one rating scheme for evaluating a rail system. The definitions used for assigning condition codes to the mover vehicles are presented in Table 28.

Table 28 - Definitions of Mover Vehicle Conditions

Condition Code	*Category*	*Definition*
1	Bad	Major deterioration
		Structural corrosion
		Extensive surface corrosion, cracks, rot
		Any failure – brakes, suspension, train control
		Frequent failures-doors, HVAC
		Obsolete-parts unavailable, interchangeable
2	Poor	Deterioration
		Surface corrosion
		Scratched, opaque windows
		Worn floor covering
		Frequent failures-doors, HVAC, motors
		Obsolete electronic equipment
3	Fair	Deterioration
		Scratched, opaque windows
		Worn floor covering, shock absorbers
		Occasional failures
		Obsolete electronic equipment
4	Good	Minor deterioration
		Worn seats, floors
		Some wheel flats
		Very few service failures
5	Excellent	Essentially new equipment.

Phase 1 and Phase 2 vehicle conditions were rated independently using a scale of 1-5 for condition ratings of bad, poor, fair, good, and excellent. The lower the numerical rating, the worse the vehicle condition. The project team rates the overall condition of both Phase 1 and Phase 2 mover vehicles as fair five systems rated “poor,” and most systems rated “fair.” The highest rating of “fair” was achieved in electrical, propulsion & dynamic braking, lighting, HVAC, guidance, suspension, carbody, communications, and spring brake. Table 29 provides a summary of the evaluations.

Table 29 - Ratings of Mover Vehicle System Conditions

	Rating	
Item	*Phase 1*	*Phase 2*
Electrical	3	3
Prop & Dyn Braking	3	3
Differential	2	2
Doors	2	2
Lighting	3	3
HVAC	3	3
Pneumatic	2	2
ATC	2	2
Guidance	3	3
Friction Brakes	2	2
Suspension	3	3
Carbody	3	3
Communications	3	3
Spring Brake	3	3
Average	3	3

The areas that rated "poor" included differential, doors, pneumatic, ATC, and friction brakes. The sensitive edge assembly and passenger interface lowered door ratings. Pneumatic ratings were negatively effected by air leaks, air control package and air compressor. The main ATC equipment and ATO systems drove down ATC ratings. Chambers and brake adjusters lowered friction brake ratings.

Bombardier Transportation, formerly Adtranz, recently completed a Health Check of the Metromover vehicles, ATC and wayside. Bombardier Transportation's findings[2] are consistent with Metromover Maintenance ratings. Bombardier reviewed the pinion seal modification proposed by Metromover and recommended some follow-up action prior to implementation. While vehicle doors were found to be in good condition, weak springs were discovered, which along with worn cable were not retracting, resulting in intermittent door closing problems. Bombardier indicated that the Phase I vehicles are equipped with the old style air dryers that allow moisture into the air system. Metromover is currently replacing these air dryers through scheduled maintenance. Bombardier recommended that level valves, air bags, and brake chambers be inspected, and replacement of valves and air bags, where necessary.

There was no significant difference in ratings between Phase 1 and Phase 2 vehicles.

As a result of the Health Check, Metromover Maintenance revised the vehicle PM schedule to include the following PM activities:

[2] Bombardier Transportation, Draft Miami-Dade Metro Mover DPM Vehicle Status Health Check, August 13, 2001

Vehicle Drive Shafts +600 hours
- Balancing Drive Shafts
- Re-chroming Yokes
- Replace Pinion Seals
- Replace High Speed Ramps + 500 hours

Vehicle Hardware Replacement + 200 hours
- Paint and Repair Motor Control Boxes
- Replace all Hardware with Stainless Steel Fasteners

Total additional Vehicle PM hours = 800 hours

A final issue that must be addressed regarding the fleet is the future use of the fleet. Using historic trend data and actual miles as of September 2000, fleet mileage has been projected over the next five years, as indicated in Figure 35.

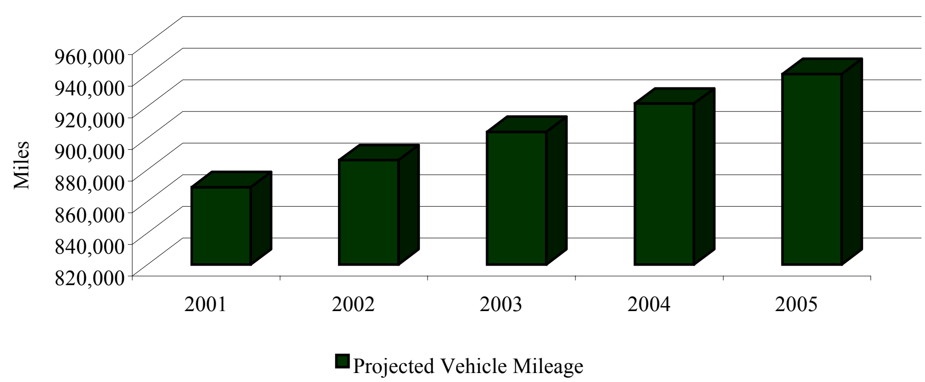


Figure 35 - Mover Vehicle Mileage, Projected 2001 - 2005

Based on these projected annual miles, an analysis of fleet mileage by vehicle phase was conducted. Assuming that cars will accumulate mileage in the future similar to miles accumulated in the past, the distribution of the 12 Phase 1 mover vehicles and the 17 Phase 2 mover vehicles by projected accumulated miles is reflected in Figures 36 and 37, respectively. The range between the maximum and minimum miles logged by both Phase 1 and Phase 2 mover vehicles continues to grow. Typical fleet management practice would distribute use across a fleet to avoid the replacement cost of large portions of the fleet all at once. Metromover operates two fleets, the original 1985 Phase 1 vehicles and the new 1994 Phase 2 vehicles. Current plans project a midlife overhaul of the Phase 1 vehicles that should occur at the twenty-year midlife or 734,000 miles. In the case of Metrorail, since there was little prospect that new rolling stock would be acquired, and given the lease-leaseback arrangement, the goal was to move toward extending the service life for all rail cars to 40 years. Normalization of vehicle mileage within Metrorail was a significant issue in that regard. Within Metromover from FY 1995 through FY 2000, Phase 1 annual growth per vehicle averaged 22,000-32,000 miles, while Phase 2 annual growth per vehicle averaged 34,000-44,000 miles. The Phase 2 vehicles, on average, logged more miles than Phase 1 vehicles logged. Based on the current rate of mileage growth, each Phase 1 vehicle will average nearly 388,000 miles at the end of FY 2005, and Phase 2 average miles per vehicle will approach 392,000 miles. As Phase 1 vehicles are removed from service for their midlife overhaul, Phase 2 vehicles will be used with greater frequency to fill the void. If current trends continue, the projected 392,000 average miles per Phase 2 vehicle could grow even higher. Given that Phase 2 vehicles will not experience their chronological midlife until 2014, fourteen years from now, efforts should be undertaken to minimize mileage within the Phase 2 fleet to ensure a fleet of sufficient size in the future and to maximize use of the Phase 1 vehicles until their midlife overhaul.

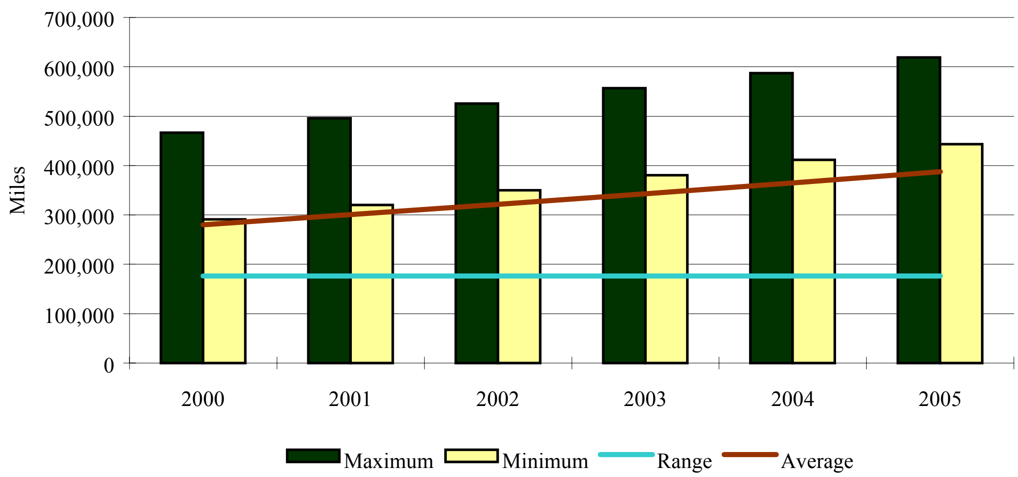


Figure 36 - Phase 1 Mover Vehicle Mileage Growth

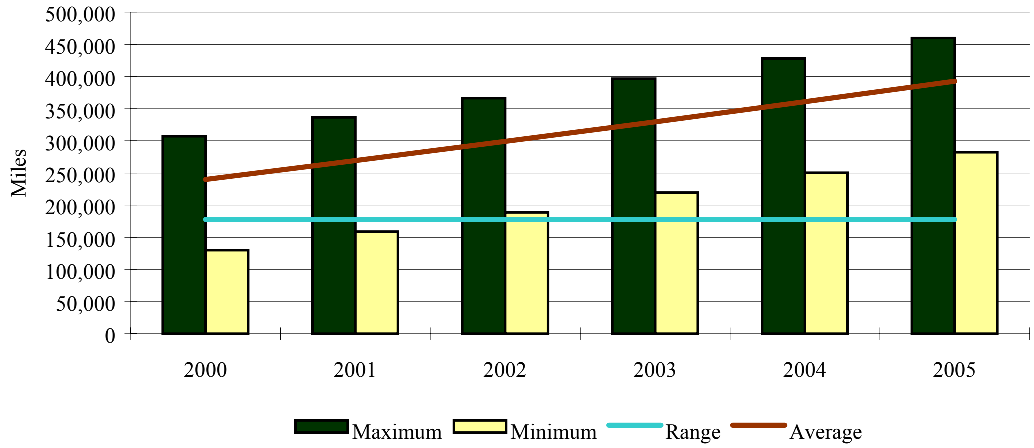


Figure 37 - Phase 2 Mover Vehicle Mileage Growth

Figures 38 and 39 reflect the impact on Phase 1 and Phase 2 mover vehicle mileage of a routine cycle of storing the four highest mileage Phase 2 vehicles for a period of 90 days followed by the storage of the four second highest mileage vehicles, and so on.

The storage program proposed is quite different than the mothballing program used by the agency previously. Under this proposed storage program, a vehicle could spend a maximum of 90 days in storage. The vehicle would receive its regularly scheduled inspection prior to storage and should be capable of being returned to service immediately at the end of the 90-day period, after receiving a storage inspection. By normalizing mileage, the agency should be able to achieve delay of a Phase 2 midlife overhaul until 2014. A short-term storage program also reduces manhours required for PM by eliminating the daily, 37-day, and 75-day inspections that active service vehicles would normally require. Savings would vary depending upon the number of vehicles stored and duration of the storage period. In this scenario, Phase 1 average vehicle miles increase from 388,000 to 407,000 miles, while Phase 2 average vehicle miles decrease from 392,000 to 377,000 miles. Varying the length of the rotation, the number of vehicles rotated, and the phase of vehicles participating in the rotation will yield a variety of results.

At the present time, Metromover maintenance is implementing the short-term storage program described above, and four high-mileage Phase 2 vehicles are in storage. A review of 2001 cumulative mileage figures shows that actual 2001 mileage increased at a rate of 13.8 percent, rather than the 9.8 percent reflected in mileage projections. The split of Phase 1/Phase 2 mileage continued to show a slight increase in Phase 2 mileage as a percent of the total mileage. Actual Phase 2 mileage in 2000 equaled 46.2 percent of total mileage; actual Phase 2 mileage in 2001 equaled 47.8 percent of total mileage; nonetheless, it appears that the use of Phase 1 vehicles increased significantly. Average Phase 1 vehicle mileage increased to 40,622 miles, and 11 of 12 Phase 1 vehicles fell in the top 12 high-mileage vehicles, compared with 10 of 12 Phase 1 vehicles in that category during 2000.

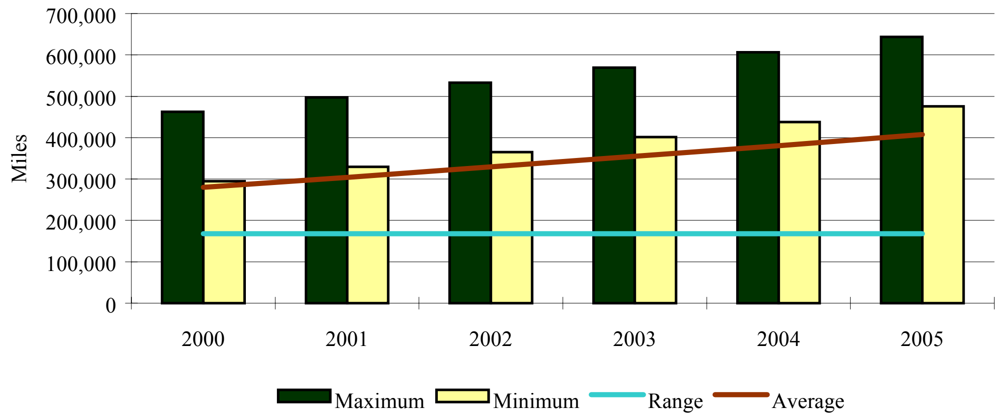


Figure 38 - Normalized Phase 1 Mover Vehicle Mileage

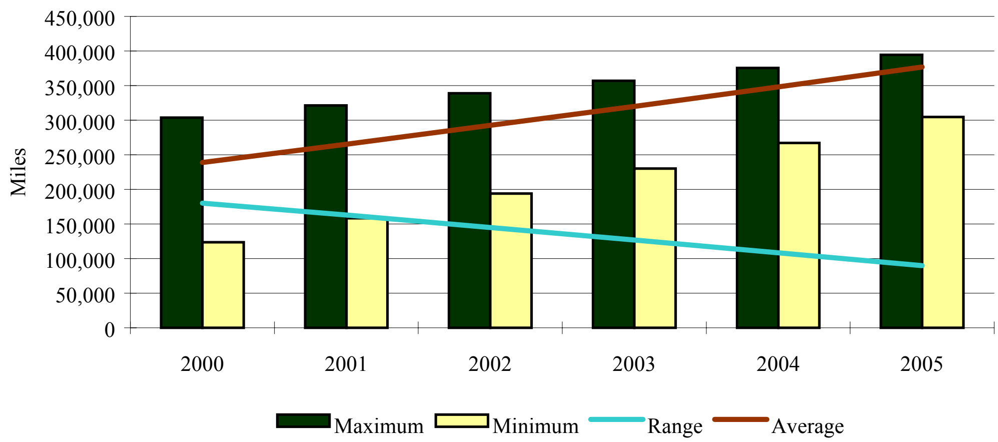


Figure 39 - Normalized Phase 2 Mover Vehicle Mileage

The Office of Management and Budget has committed to pledging a portion of the local option gas tax to issue $140 million in bonds to fund Metrorail and Metromover vehicle rehabilitation programs. The FY 2001-2008 MDT Capital Program identifies $15.4 million for the overhaul of Metromover Phase 1 vehicles beginning in FY 2003.

According to Adtranz, following a comparison study of rehabilitation versus replacement, the Hillsborough County Aviation Authority in 1992 began to replace all the original equipment that was supplied by Adtranz in 1971 with new equipment. The original equipment replaced under the program included Central Control, wayside automatic train control equipment, station doors, and four vehicles serving Airside C and Airside D.

The Greater Orlando Aviation Authority in 1996, after a comparison study of rehabilitation versus replacement, began to rehabilitate the twelve original vehicles supplied by Adtranz in 1981. The original vehicles had achieved their design life of 1,000,000 miles and were in need of major rehabilitation or replacement.

Following a comparison study of rehabilitation versus replacement, the City of Atlanta in 2000 began to replace the 24 original vehicles supplied by Adtranz in 1980. The original vehicles achieved their design life of 20 years and were in need of major rehabilitation or replacement.

MDT can take advantage of the rehabilitation versus replacement studies conducted by these three agencies prior to making their decision for Phase 1 vehicle overhaul. In response to a March 2000 request to Adtranz for information regarding typical work scope performed during remanufacture of Adtranz CX100 vehicle, Adtranz provided a budgetary estimate of $1.3 million per vehicle. All upgrades of the existing Phase 1 fleet must occur within the confines of the 8.8 miles of guideway that also serves the Phase 2 fleet. MDT invested substantial resources to insure Phase 1 and Phase 2 compatibility when the system was expanded in 1994, and despite that investment, Phase 1 vehicles have continually performed at a level lower than Phase 2 on the expanded system. Efforts must be taken to ensure MDT receives maximum benefits from new technology without denigrating the performance of the Phase 2 vehicles, which should remain in service until 2014.

Metromover Wayside Condition

The Metromover Chief Supervisors were asked to evaluate the current condition of the mover wayside power distribution system and system-wide controls using a consistent set of definitions for establishing the condition. The ratings throughout this report were adapted from UMTA's Rail Modernization Report 1987 and provide one rating scheme for evaluating a rail system. The definitions used for assigning condition codes to the mover power distribution system and system-wide controls are presented in Table 30 and Table 31.

Table 30 - Definitions of Mover Power Distribution Conditions

Condition Code	*Category*	*Definition*
1	Bad	Major equipment older than design life Spare parts unavailable Substation capacity inadequate for peak load
2	Poor	Single major substation component is state of the art, remainder nearing end of design Some spare parts unavailable
3	Fair	Equipment age midlife 50-75% of major components, remainder at end of design life Spare parts becoming unavailable
4	Good	Major equipment state of the art and in service 10+ years Minor component substitution required to restore equipment to original reliability
5	Excellent	Major equipment installed within past 10 years No problems exist

Table 31 - Definitions of Mover System-wide Controls Conditions

Condition Code	*Category*	*Definition*
1	Bad	Inoperative, worn-out or broken items incapable of proper operation
2	Poor	Poor physical appearance, dirty, worn materials Loose mountings, temporary repairs, evidence of repairs
3	Fair	Acceptable appearance, minor dust, repairs needed Repairs failed to return equipment to as-built condition
4	Good	Good appearance, clean No significant repairs, no substitute devices, no deterioration
5	Excellent	Brand new, no evidence of problems or repairs

The Chief Supervisor, Rail Structure Maintenance, was asked to evaluate the current condition of the mover structures using a consistent set of definitions for establishing the condition of each component. The definitions used for assigning condition codes to the mover structures are presented in Table 32.

Table 32 - Definitions of Mover Structure Conditions

Condition Code	*Category*	*Definition*
1	Bad	Structure has failed and/or deteriorated to the point that creates a serious hazard
2	Poor	Structure requires frequent major repairs to function as intended
3	Fair	Structure requires frequent minor repairs to function as intended
4	Good	Structure requires infrequent minor repairs
5	Excellent	Structure is brand new, no major problems exist

A summary of those evaluations is presented in Table 33.

Table 33 - Ratings of Mover Wayside Conditions

Systems	*Item*	*Rating Phase 1*	*Rating Phase 2*
Power Distribution	15 kv Switchgear	3	4
	600 v Switchgear	3	5
	Switchgear Cabinets	3	4
	Relays: Ground Fault	5	5
	Relays: Current Sen.Dec.	5	5
	Relays: Phase Detector	5	5
	Stinger System: Trolley	5	5
	Stinger System: Grounding	2	2
	Stinger System: Joy Plug Cord	4	4
	Power Rail	4	3
	Signal Rail	4	4
	Speed Ramp	3	4
	Average	4	4
System-Wide Controls	ATO Cabinets	4	4
	TX/RX Cabinets	3	4
	DTS Cabinets	4	4
	Vital Relays	3	3
	Power Supplies	2	3
	Switch Logic Cabinets	2	2
	Control Boxes	2	2
	Emergency Trip Boxes	2	2
	Average	3	3
Structures	Steel Girders	3	4
	Columns	4	5
	Concrete Running Pads	4	5
	Average	4	5
Wayside Overall	Power Distribution	4	4
	System-wide Controls	3	3
	Structures	4	5
	Overall Average	3	4

Phase 1 wayside overall rated “fair” while the Phase 2 wayside received an overall rating of “good.” The power distribution system rated “good” for both Phase 1 and Phase 2. The “fair” rating of the “stinger system: grounding” lowered the overall rating. All other subsystems rated “fair” to “excellent;” there were no “bad” ratings within power distribution. System-wide controls achieved “fair” ratings. “Poor” ratings were recorded for switch logic cabinets, control boxes, emergency trip boxes, and Phase 1 power supplies. The remaining subsystems rated “fair” to “good.”

Bombardier Transportation, formerly Adtranz, recently completed a Health Check of the Metromover vehicles, ATC, and wayside. Bombardier Transportation's findings[3] are consistent with Metromover Maintenance ratings. Bombardier noted that problems were encountered with power rail conditions and recommended replacement of all high-speed ramps and implementation of a high-speed ramp rebuild program. In terms of power rail configuration, Bombardier suggested that the power rail layout for both inner and outer loop be matched to improved reliability and availability and recommended that all power feed cable and PDS breaker buss bars be high pot tested and meggered every 48 months to identify potential cable and breaker problems. Bombardier also recommended a complete track mapping on both loops using Phase I and Phase II vehicles. Bombardier indicated that once the track map is completed, problems can be located from the system track plan, and the wayside junction boxes can be checked before vehicle signal levels are modified.

As a result of the Health Check, Metromover Maintenance revised the wayside PM schedule to include the following PM activities:

Switch Hi-Cycle Yearly Inspection
- Replace Lock Pin Cylinders + 800 annual hours
- Replace Beam Cylinders and tolerances of Cam Controller + 400 hours
- Replace Spherical Bearing +2,500 hours
- Replace High Speed Ramps + 500 hours

Power Feed and Power Rail
- Re-route and reinforce cable insulation between the "I" Beam and Support Brackets + 1,300 hours

Total additional Wayside PM hours = 5,500 hours

Phase 1 steel girders of Metromover were rated "*fair - structure requires frequent minor repairs to function as intended*." The last inspection cycle produced 3,700 conditions that require repair to ensure long-term durability, and 3,467 of the conditions were identified as "severe rust." The Track & Guideway General Superintendent indicated that although these conditions are minor at this time, based on overall impact on the existing integrity of the structure, they will continue to worsen if not repaired and estimated it will take approximately three years to address these conditions with existing staff. Phase 2 structures achieved an "excellent" rating. Track & Guideway committed in excess of 1,000 labor hours annually to the maintenance and repair of Metromover.

Metromover Wayside Maintenance and Repair

Metromover is evaluating the current allocation of manpower to maintenance and repair of the Wayside, which is accomplished today on the 3rd shift using a complement of twelve Metromover Technicians and two Metromover Maintenance Supervisors. Two of those twelve technicians are assigned to a special crew referred to as the switch crew. The appropriate size of

[3] Bombardier Transportation, Miami-Dade Metro Mover DPM ATC & Wayside Health Check, August 13, 2001

that switch crew, the possible need for a specific track crew, and a methodology for determining a schedule of rail replacement are issues that have been identified.

Switch Analysis

Switch PM and Repair logs were provided by Metromover Maintenance and were reviewed for Fiscal Years 1999 and 2000. Rail Maintenance Control in conjunction with engineering staff assigned to Metromover provided a summary of Metromover's Wayside Overhaul Program that contained complete fiscal year data for FY 1995 through FY 2000. Overhaul data were compiled from existing sources and were, therefore, subject to a variety of reporting differences. Data used from the overhaul program for the switch analysis were limited to data that referenced a switch as the location of the work and were identified by Metromover Maintenance as the type of work that would specifically involve a switch.

PM labor hours for switches are reported by area. Those areas include: Hi-Cycle, Zone 1, Zone 2, and Zone 3. Specific switches within each of those areas are illustrated in Table 34.

Table 34 - Switches by Area

Hi-Cycle	*Zone 1*	*Zone 2*	*Zone 3*
Switch 01	Switch 11	Switch 03	Switch 06
Switch 02	Switch 12	Switch 04	Switch 07
Switch 09	Switch 13	Switch 05	Switch 52
Switch 10	Switch 14	Switch 08	Switch 53
Switch 15	Switch 17	Switch 21	Switch 54
Switch 16		Switch 22	Switch 55
Switch 23			Switch 56

The switch PM/Repair and overhaul records as summarized in Table 35, indicate an increase in FY 2000 PM labor hours from 58 percent to 73 percent, and a decrease in overhaul labor hours from 21 percent to 6 percent. Total labor hours allocated for switch PM, repair, and overhaul declined from 3,602 hours in FY 1999 to 3,413 hours in FY 2000, approximately 5 percent.

Table 35 - Switch PM, Repair, and Overhaul Labor Hours

	FY 1999				FY 2000			
Switch	*PM*	*Repair*	*Overhaul*	*Total*	*PM*	*Repair*	*Overhaul*	*Total*
1-Hi-Cycle	737	23	30	790	857	49	99	1,005
2-Hi-Cycle		41	56	97		39	6	45
3-Zone 2	423	36		459	562	89		651
4		35	12	47		21	2	23
5		66		66		22	2	24
6-Zone 3	520	39		559	545	45		590
7		15		15		35		35
8		101	184	285		57		57
9-Hi-Cycle		51		51		106		106
10-Hi-Cycle		55		55		23	2	25
11-Zone 1	421	65	180	666	521	2		523
12		3		3		6	6	12
13		12		12			6	6
14		2	60	62		15	69	84
15-Hi-Cycle		17	64	81		34		34
16-Hi-Cycle		11	105	116		21		21
17		11	2	13		32	2	34
21		21	58	79			3	3
22		12	4	16		10		10
23-Hi-Cycle		15	6	21		49	7	56
52				0		12		12
53		69		69		22		22
54		25		25		3		3
55		8		8				0
56		7		7		32		32
Total	2,101	740	761	3,602	2,485	724	204	3,413
%/Total	58.3%	20.5%	21.1%		72.8%	21.2%	6.0%	

Switch PM labor hours by area are illustrated in Figure 40. Hi-cycle switches required the highest number of labor hours.

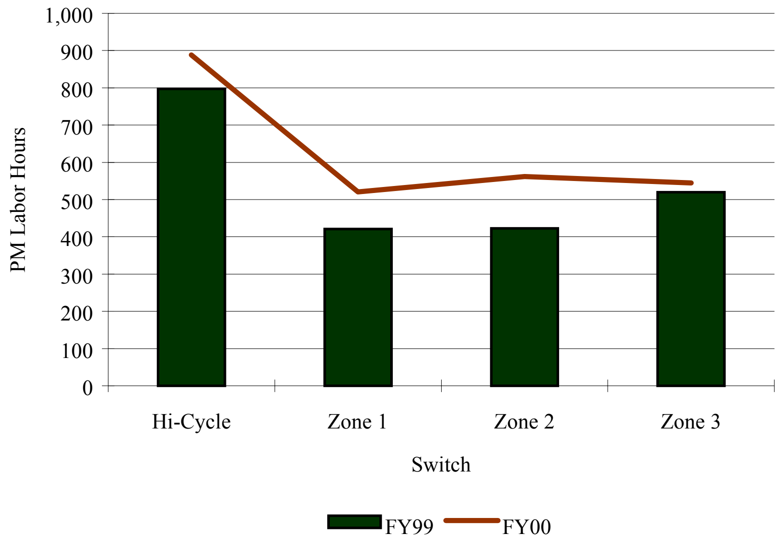


Figure 40 - Switch PM by Area

A comparison of labor hours for repair is presented in Figure 41. Lo-cycle switch 8 in FY 1999 and hi-cycle switch 9 in FY 2000 required the greatest number of repair labor hours. Switches that required no repair included switch 52 in FY 1999 and switches 13, 21, and 55 in FY 2000. Repair hours per switch ranged from 0 to 101 in FY 1999 and from 0 to 106 in FY 2000. A total of 740 switch repair hours were logged in FY 1999, as compared to 724 hours in FY 2000.

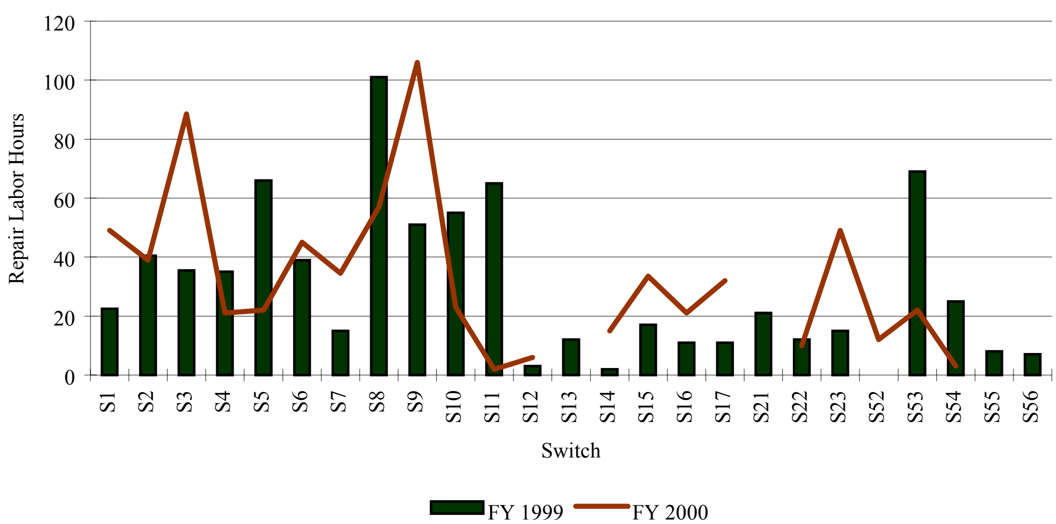


Figure 41 - Switch Repair Labor Hours

A graphic comparison of the hi-cycle and lo-cycle switches is presented in Figure 42. Repair hours required for hi-cycle switches appear to be consistently higher than hours required for lo-cycle switches. While individual lo-cycle switches showed a significant level of repairs in either FY 1999 or in FY 2000, hi-cycle switches tend routinely to show a higher repair labor hour requirement.

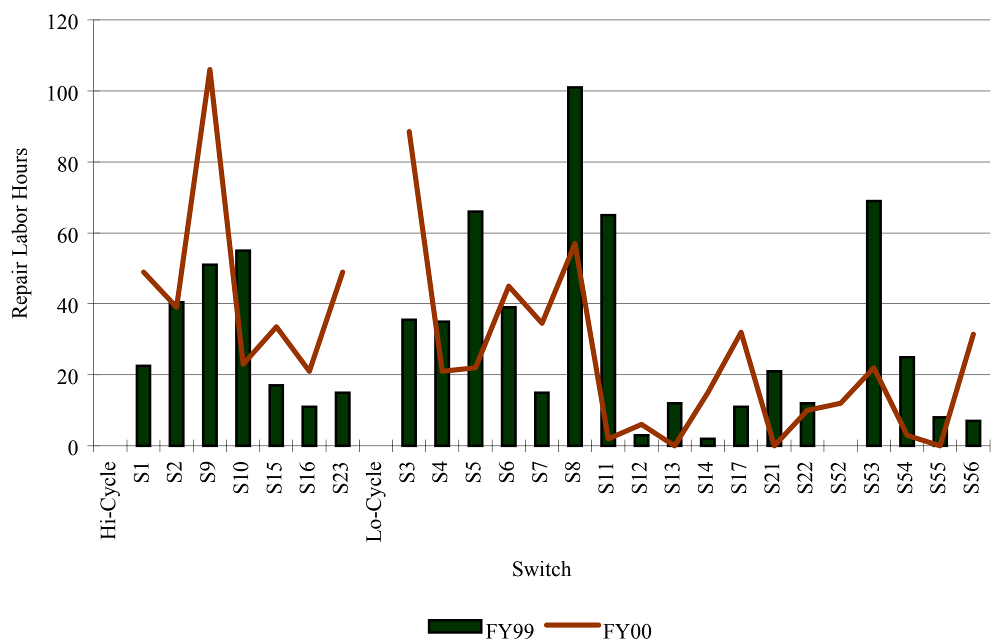


Figure 42 - Hi-Cycle and Lo-Cycle Switches Repair Hours

Given that switch PM is reported for the zone in which the switch is located rather than for the individual switch, it is difficult to compute the actual total labor hours including PM, repair and overhaul for each switch; however, it is possible to examine the average hours per switch within each zone. Each zone is outlined in Table 36. FY 1999 average total labor hours ranged from a high of 182 for hi-cycle switches to a low of 98 for lo-cycle switches in Zone 3; the range for FY 2000 was from a high of 189 for hi-cycle switches to a low of 99 for lo-cycle switches in Zone 3.

Table 36 - Average Total Labor Hours by Area

FY 1999 Total Labor Hours							
Hi-Cycle		*Zone 1*		*Zone 2*		*Zone 3*	
Switch 01	850	Switch 11	666	Switch 03	459	Switch 06	559
Switch 02	97	Switch 12	3	Switch 04	47	Switch 07	15
Switch 09	51	Switch 13	12	Switch 05	66	Switch 52	0
Switch 10	55	Switch 14	62	Switch 08	285	Switch 53	69
Switch 15	81	Switch 17	13	Switch 21	79	Switch 54	25
Switch 16	116			Switch 22	16	Switch 55	8
Switch 23	21					Switch 56	7
Total	1,271		756		952		683
Average	182		151		159		98
FY 2000 Total Labor Hours							
Hi-Cycle		*Zone 1*		*Zone 2*		*Zone 3*	
Switch 01	1,036	Switch 11	523	Switch 03	651	Switch 06	590
Switch 02	45	Switch 12	12	Switch 04	23	Switch 07	35
Switch 09	106	Switch 13	6	Switch 05	24	Switch 52	12
Switch 10	25	Switch 14	84	Switch 08	57	Switch 53	22
Switch 15	34	Switch 17	34	Switch 21	3	Switch 54	3
Switch 16	21			Switch 22	10	Switch 55	0
Switch 23	56					Switch 56	32
Total	1,323		659		768		694
Average	189		132		128		99

The average total labor hours for FY 1999 and FY 2000 per switch within each zone are graphically presented in Figures 43 and 44. The averages are relatively consistent between fiscal years, with the hi-cycle switches requiring the most labor and Zone 3 lo-cycle switches requiring the least labor.

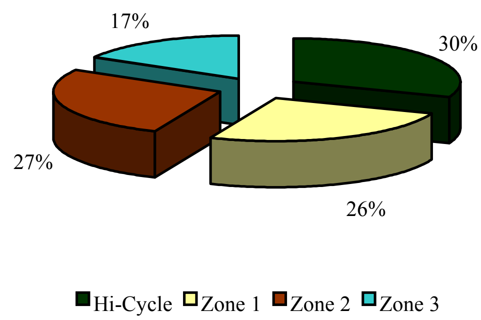


Figure 43 - FY 1999 Average Labor Hours per Switch

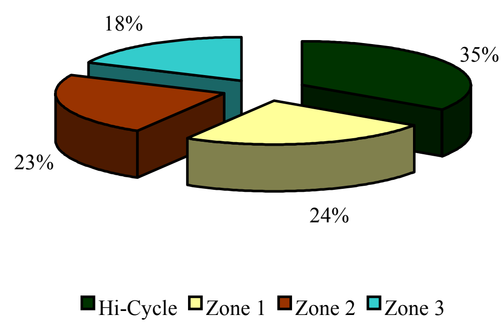


Figure 44 - FY 2000 Average Labor Hours per Switch

The relationship between PM, repair, and overhaul labor hours by zone is examined in Figures 45 and 46. During FY 1999, hi-cycle switches required the largest number of PM hours, but ranked second in the need for repair hours and third in the area of overhaul.

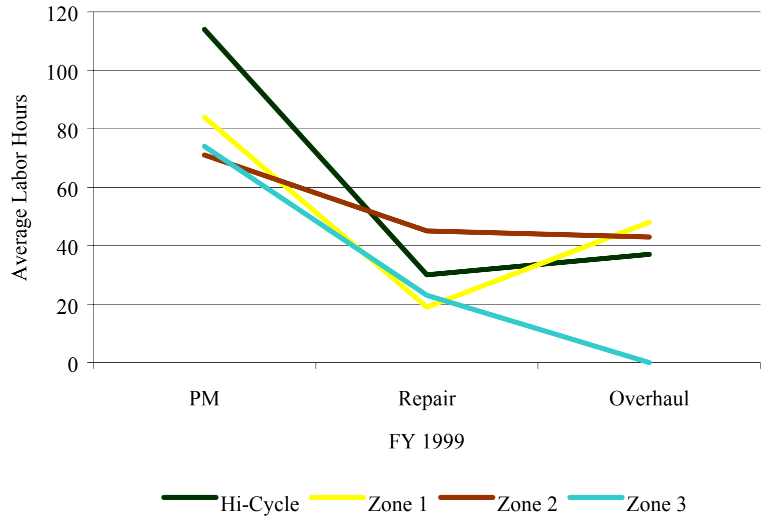


Figure 45 - FY 1999 Labor Hours by Area

In FY 2000, however, hi-cycle switches required the most labor hours in all categories.

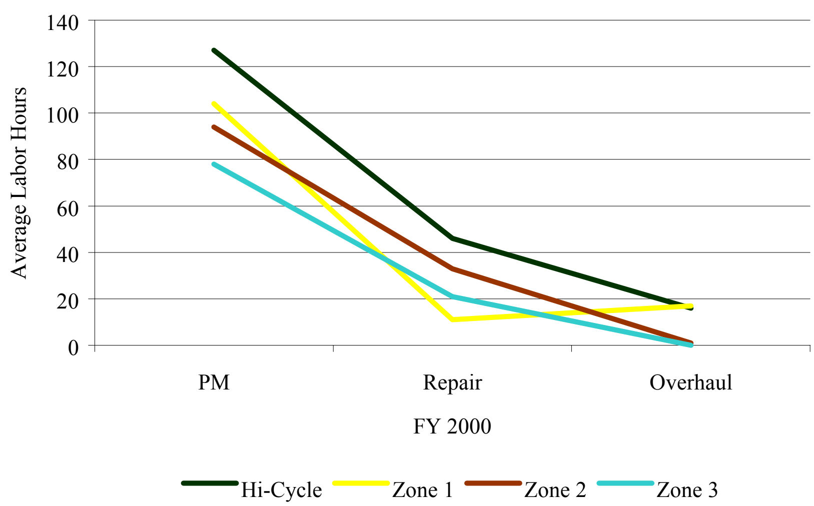


Figure 46 - FY 2000 Labor Hours by Area

These data confirm an increased labor need to maintain and repair hi-cycle switches. While it does appear that switch PMs are routinely performed, actual PM hours reported by Metromover

Maintenance are somewhat low in comparison to projected hours. The reports tend to indicate that labor requirements for daily hi-cycle switch inspections are being underreported. If that is the case, then labor hours dedicated to switch PM, repair, and overhaul could be expected to be somewhat higher than those hours reported today. Based on manpower analyses conducted to date, a switch crew of two technicians is incapable of performing switch PM, repair, and overhaul at today's level. Based solely on current labor hour requirements without regard for the window of availability for wayside access, the switch crew requires a minimum of three technicians.

Rail Analysis

Rail Maintenance Control provided a summary of Metromover's Overhaul Program in conjunction with engineering staff assigned to Metromover. While the summary provided data from Fiscal Years 1994 through 2001, complete fiscal year data were available only from FY 1995 through FY 2000. Furthermore, overhaul data were compiled from existing sources and were, therefore, subject to a variety of reporting differences, specifically regarding the location of the work. Metromover Maintenance reviewed the overhaul data and identified the various types of work that were involved in the overhaul. All of the detailed analyses presented in this report are made using those data from FY 1995 through FY 2000 that not only referenced a switch or station as the location of the work but also were based on the type of work identified by maintenance. In the course of the analysis it became apparent that the location listed as "maintenance" might have been used to capture costs and/or hours that did not fall into one of the other categories.

Overhaul data by fiscal years 1995 through 2000 are presented in Table 37 and Figure 47. The significant increase in overhaul costs identified in FY 2000 appears to be directly related to the increase in the cost of parts.

Table 37 - Wayside Overhaul by Fiscal Year

Wayside Overhaul	*FY95*	*FY96*	*FY97*	*FY98*	*FY99*	*FY00*	*FY95-00*
Work Orders	74	213	182	141	101	133	844
Parts Cost	$81,273	$102,434	$81,080	$100,339	$71,890	$205,389	$642,405
Labor Hours	389	2,791	2,558	2,028	1,964	3,046	12,775
Labor Cost	$13,531	$97,211	$89,078	$70,635	$68,406	$106,075	$444,936
Total Cost	$94,804	$199,645	$170,158	$170,974	$140,296	$311,464	$1,087,341

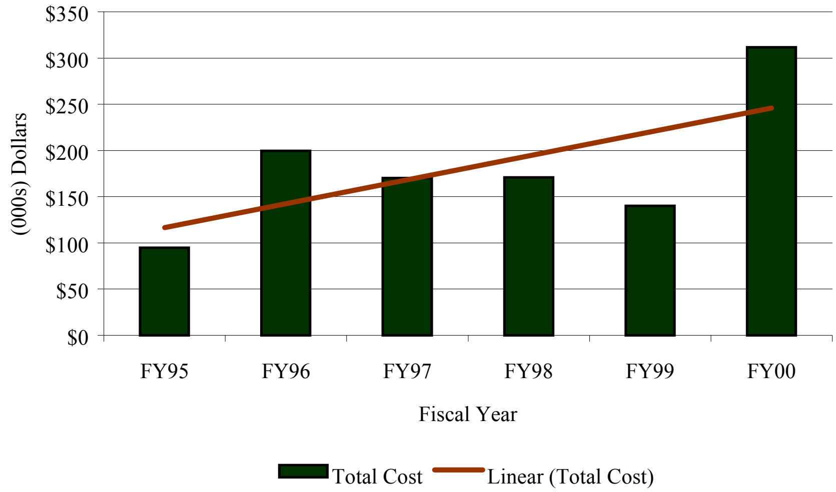


Figure 47 - Total Overhaul Cost by Fiscal Year

The overhaul program involves five categories of wayside work: ATO, hardware, interlockings, rail, and switches. Table 38 provides an overview of the data contained in the overhaul plan as it relates to those categories from FY 1995 through FY 2000.

Table 38 - Wayside Overhaul by Category

Type	*Work Orders*	*Parts Cost*	*Labor Hours*	*Labor Cost*	*Total Cost*
ATO	2	$9	41	$1,428	$1,437
Hardware	137	$44,621	1,783	$62,084	$106,705
Interlockings	194	$218,729	921	$32,061	$250,790
Rail	474	$221,690	9,693	$337,607	$559,297
Switch	37	$157,358	338	$11,755	$169,113
Total	844	$642,407	12,775	$444,935	$1,087,342

According to this information, rail led every category and represented the largest commitment of manpower and financial resources. When the categories are viewed in terms of each category's relationship to the overhaul program in total, several trends emerge. Figure 48 presents each category's percentage of the total overhaul program.

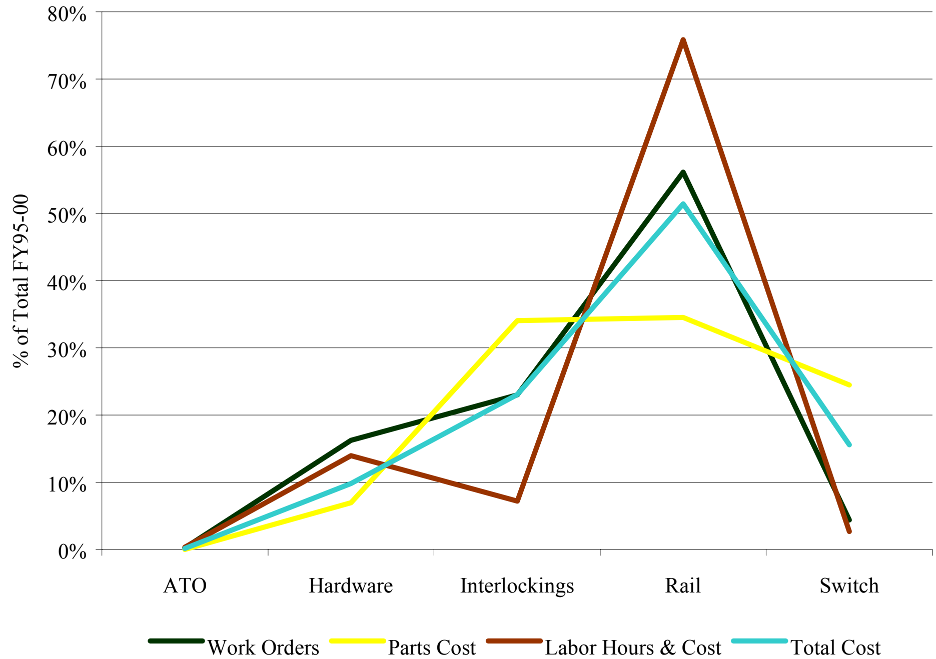


Figure 48 - Percentage of Overhaul Program by Category

While over 70 percent of the total labor within the overhaul program has been dedicated to rail replacement, slightly over 30 percent of parts costs were allocated to rail. Interlockings on the other hand, which consumed slightly over 20 percent of the labor, accounted for parts costs similar to those of rail, slightly over 30 percent of the total. Rail requires a greater investment of labor with less expansive parts. That relationship is further illustrated in the following Figures.

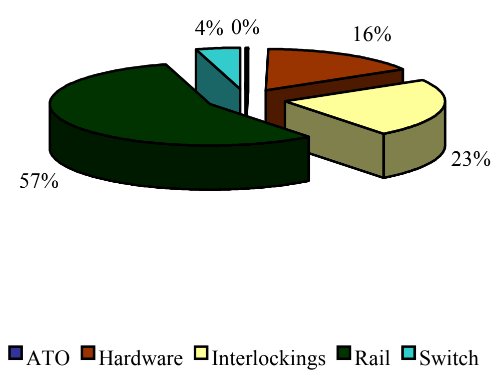


Figure 49 - Overhaul Program – Work Order % of Total

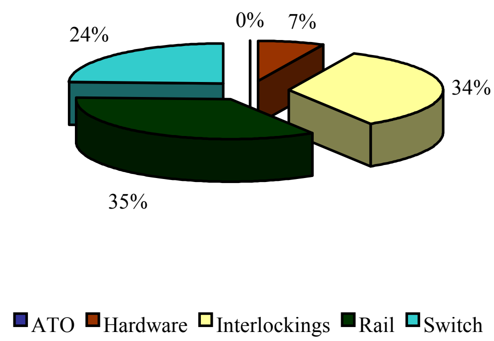


Figure 50 - Overhaul Program - Parts Cost % of Total

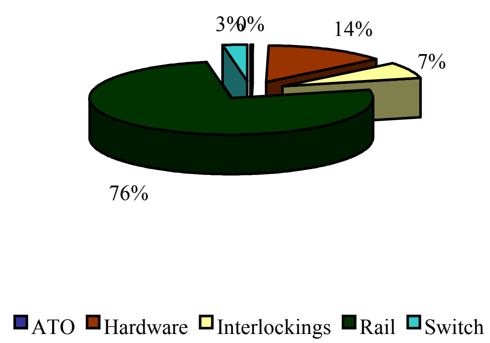


Figure 51 - Overhaul Program - Labor Hours % of Total

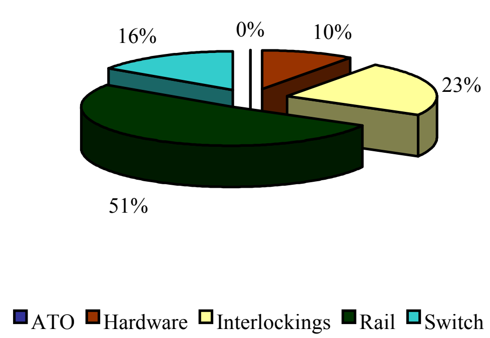


Figure 52 - Overhaul Program – Parts + Labor Costs % of Total

The following series of color-coded system maps presents data to identify those wayside areas that have incurred the highest expenses and/or most significant labor requirements. In each case, totals represent data that referenced a switch or station as the location of the work, and in the case of rail, is limited to those areas identified as rail overhaul by Metromover Maintenance.

Approximately 83 percent of total overhaul costs, and in excess of 85 percent of reported rail costs, are referenced in the following data. Of the 844 entries in the overhaul program, 474 related to rail work. Switch and/or station locations were identified for 651 of the 844 overhaul entries (77 percent) and 366 of the 474 rail entries (77 percent), and they form the basis of the following analyses.

The ten areas with the highest total parts and labor costs are identified in Figure 53. Third Street Station, Maintenance, Switch 1, and Brickell form the top tier of costs that ranged from $89,000 to $78,000. The highest cost in the next tier was $40,000 reported at Switch 2. Four of the locations, Third Street and Switches 1, 2 and 3, fall within close proximity to one another and are identified by a large red circle on the system map.

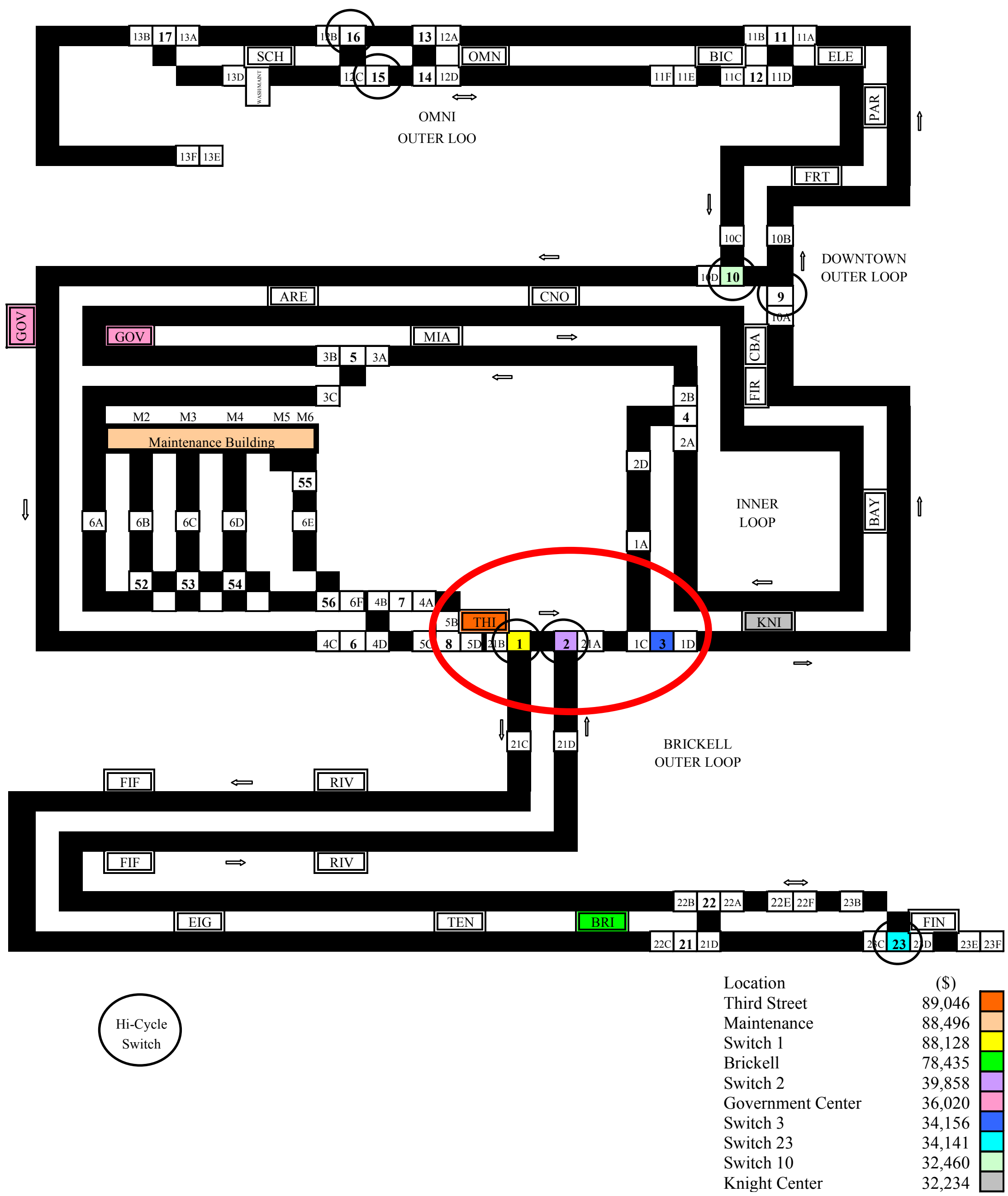


Figure 53 - Total Overhaul Costs – Top Ten Locations

Figure 54 illustrates the ten areas with the largest number of work orders. Brickell recorded the highest number for a total of 75 work orders. Switch 1 logged 58, and there were 49 work orders reported at Maintenance. Third Street Station, Switch 23, follows these areas and Government Center with work orders totaling 32 to 36. Locations in close proximity to one another include Third Street and Switches 1, 2, and 3 as identified by the red circle.

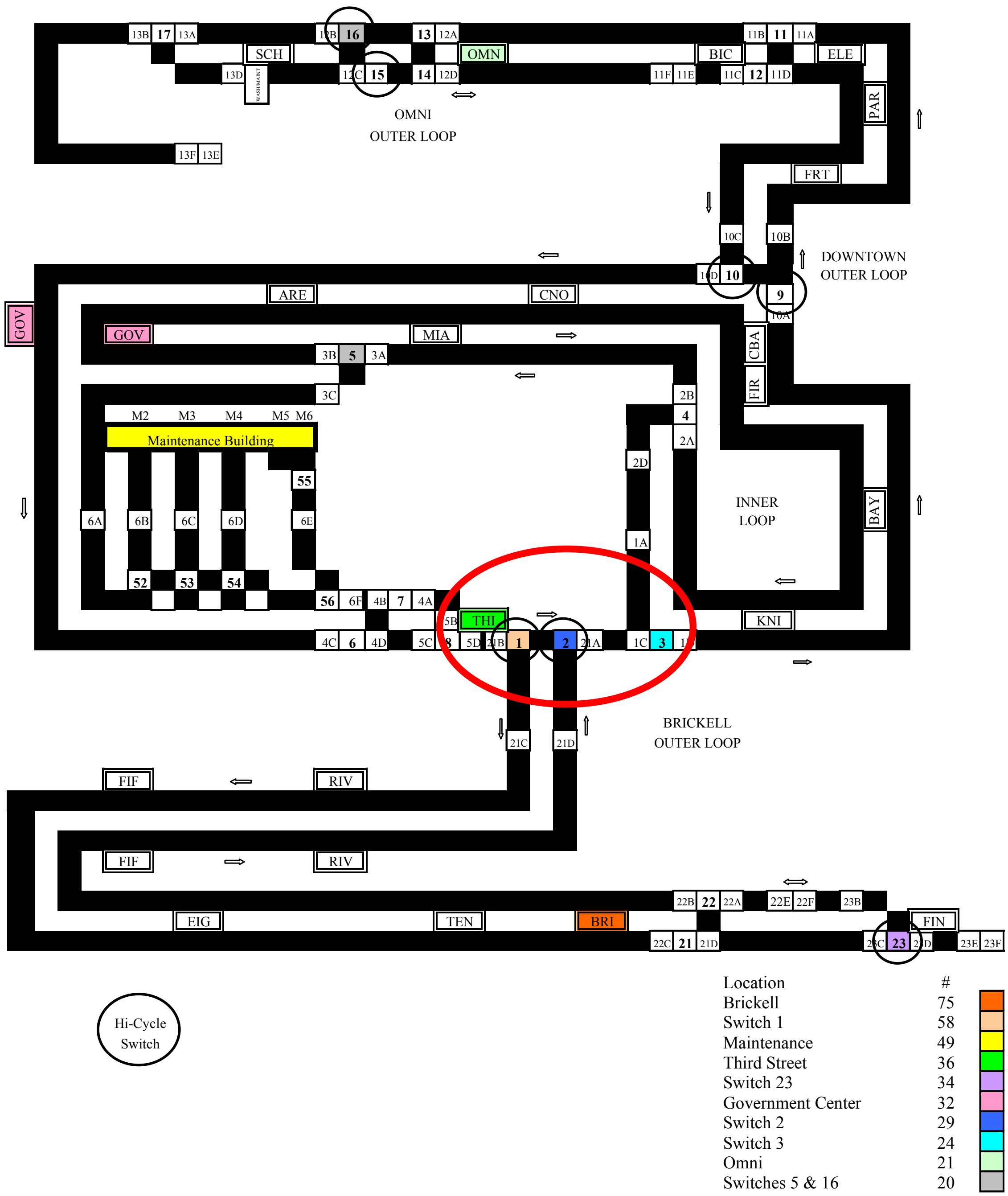


Figure 54 - Total Overhaul Work Orders – Top Ten Locations

The ten areas with the highest parts costs are shown in Figure 55. Maintenance led with $56,000, followed by Third Street at $52,000 and Switch 1 at $47,000. As with total costs and work orders, the area, including Third Street and Switches 1, 2, and 3, is identified along with Knight Center.

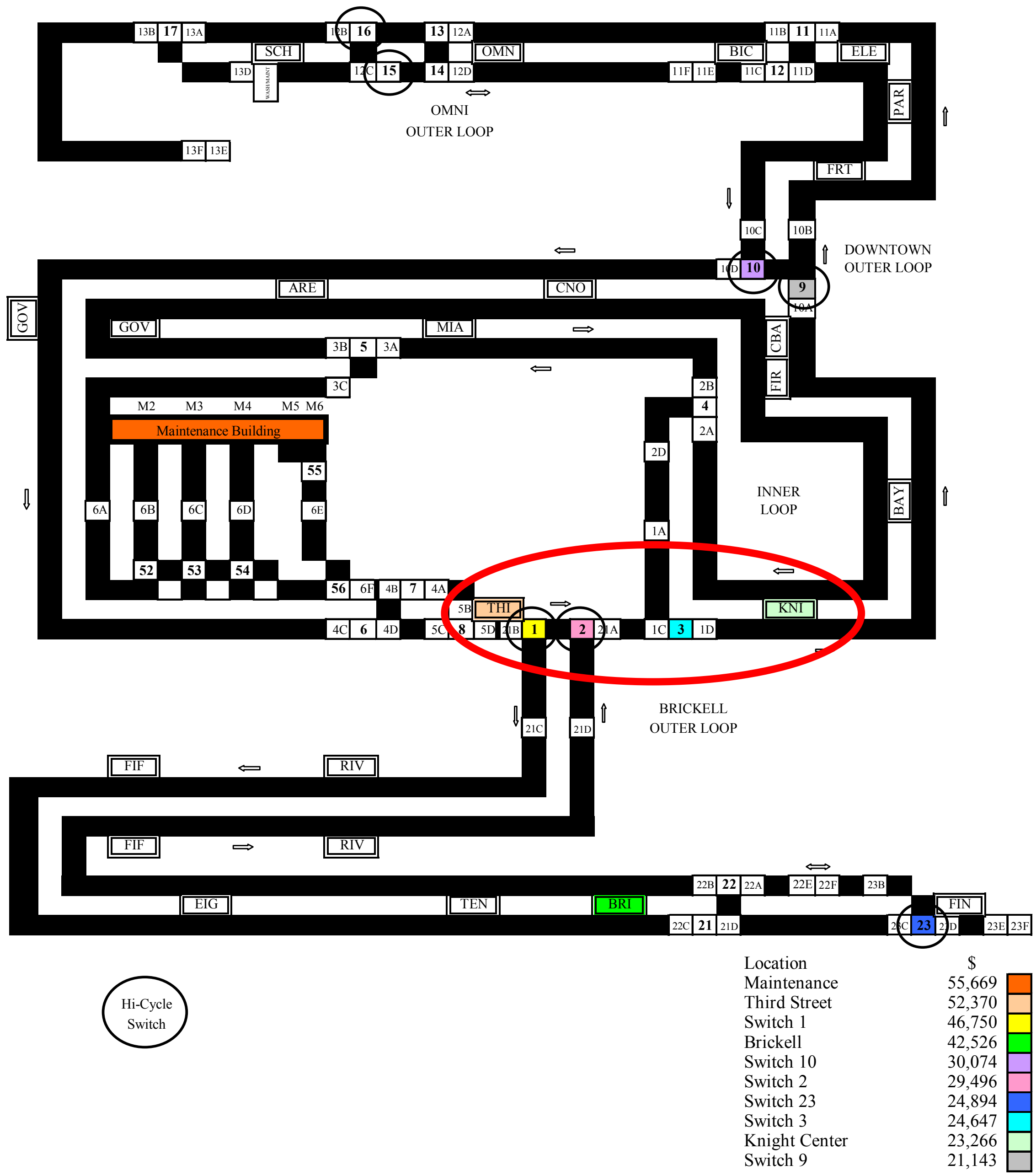


Figure 55 - Total Overhaul Parts Cost – Top Ten Locations

Highest labor hours, outline in Figure 56, were recorded for Switch 1, Third Street, and Brickell. In addition to the Third Street and Switches 1 and 2 corridor hi-lighted in the three previous system maps, a new corridor that includes Government Center, State Plaza Station and College North is identified.

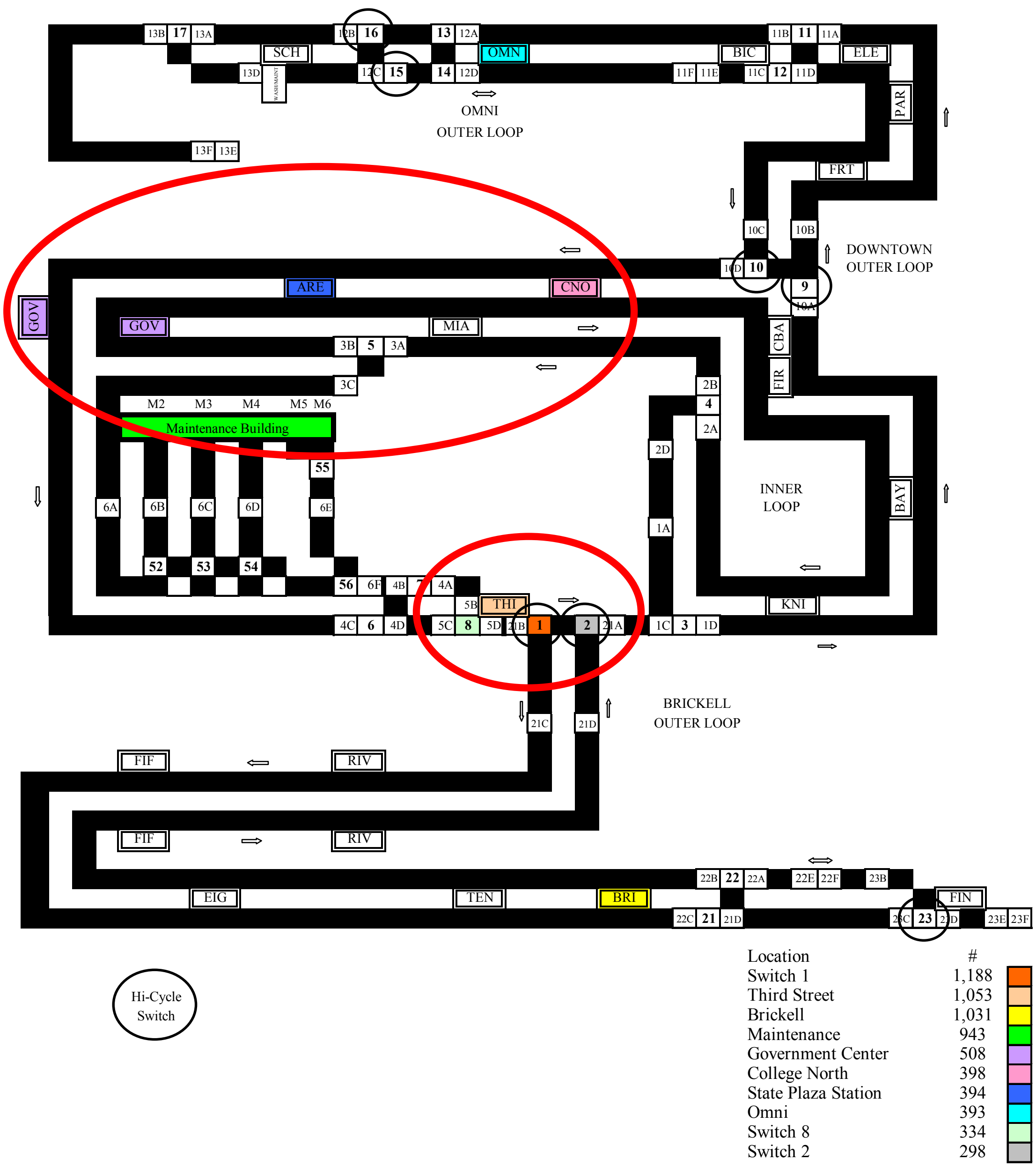


Figure 56 - Total Overhaul Labor Hours – Top Ten Locations

The next series of system maps represents rail-related expenses and labor requirements. As with the previous series, high maintenance stations and/or switches in close proximity are encircled in red. A dark green circle is used to indicate high rail maintenance areas that fall outside of the top ten overhaul categories.

Figure 57 illustrates total rail costs for the top ten locations. Switch 1 accounted for 13 percent of the total rail costs, and the three highest locations combined to equal 35 percent of those costs. A corridor including Third Street, Switch 1, 3, and 8 is evident. Versions of this same corridor appeared in all of the total overhaul system maps. State Plaza Station, College North, Omni, and Switches 3 and 8 did not rank in the top ten total overhaul costs but are included in the top ten rail cost locations.

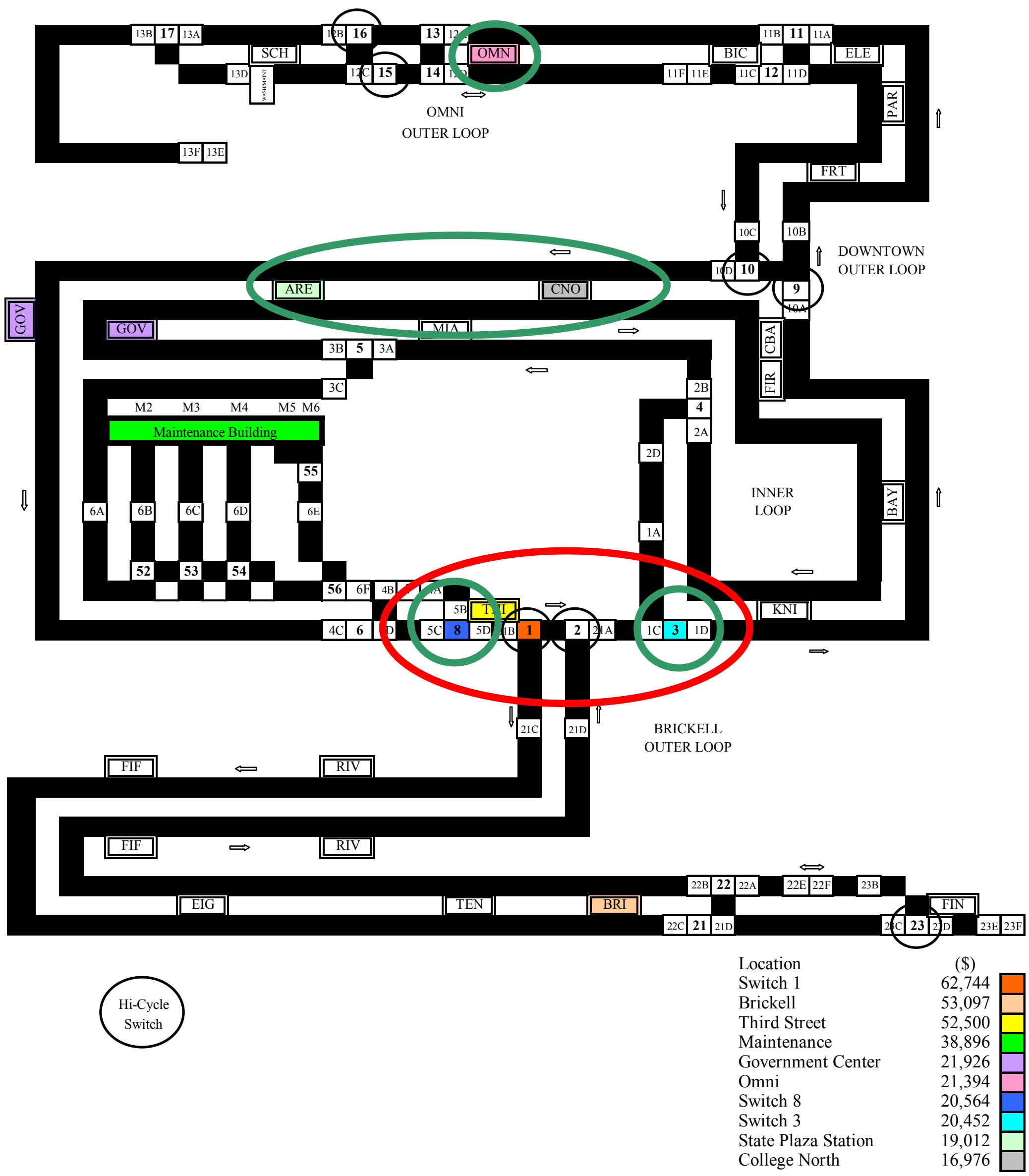


Figure 57 - Total Rail Costs – Top Ten Locations

In terms of the largest number of work orders, Figure 58 shows Brickell and Switch 1 leading the group, as was the case with total rail costs, followed by Third Street and Maintenance. While Government Center, State Park Plaza, College North, and Switch 5 constitute a corridor, only Government Center qualified in the top ten total overhaul work orders, and the total of work orders in those four locations exceeds Brickell by only three work orders.

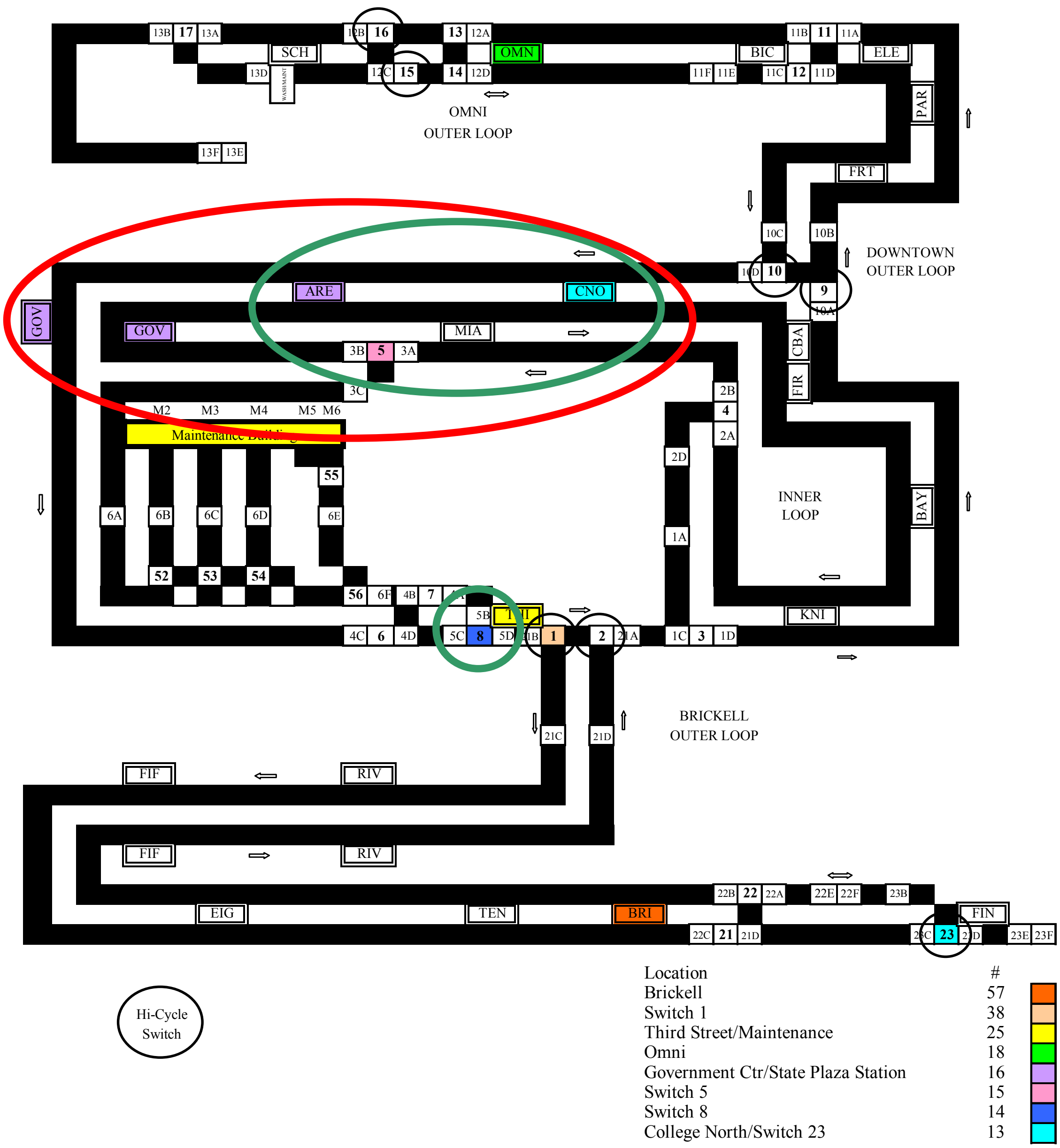


Figure 58 - Total Rail Work Orders – Top Ten Locations

Switch 1 and Brickell also rated the highest in total rail parts cost as seen in Figure 59. A corridor including Third Street and Switches 1, 3, and 8 is evident. Locations that were absent from the total overhaul top-ten include Omni, State Plaza Station, College North, and Switch 5. Unlike the situation observed in Figure 55, the combined costs of these locations easily exceeds the $28,000 reported at Switch 1, the highest rail parts cost location.

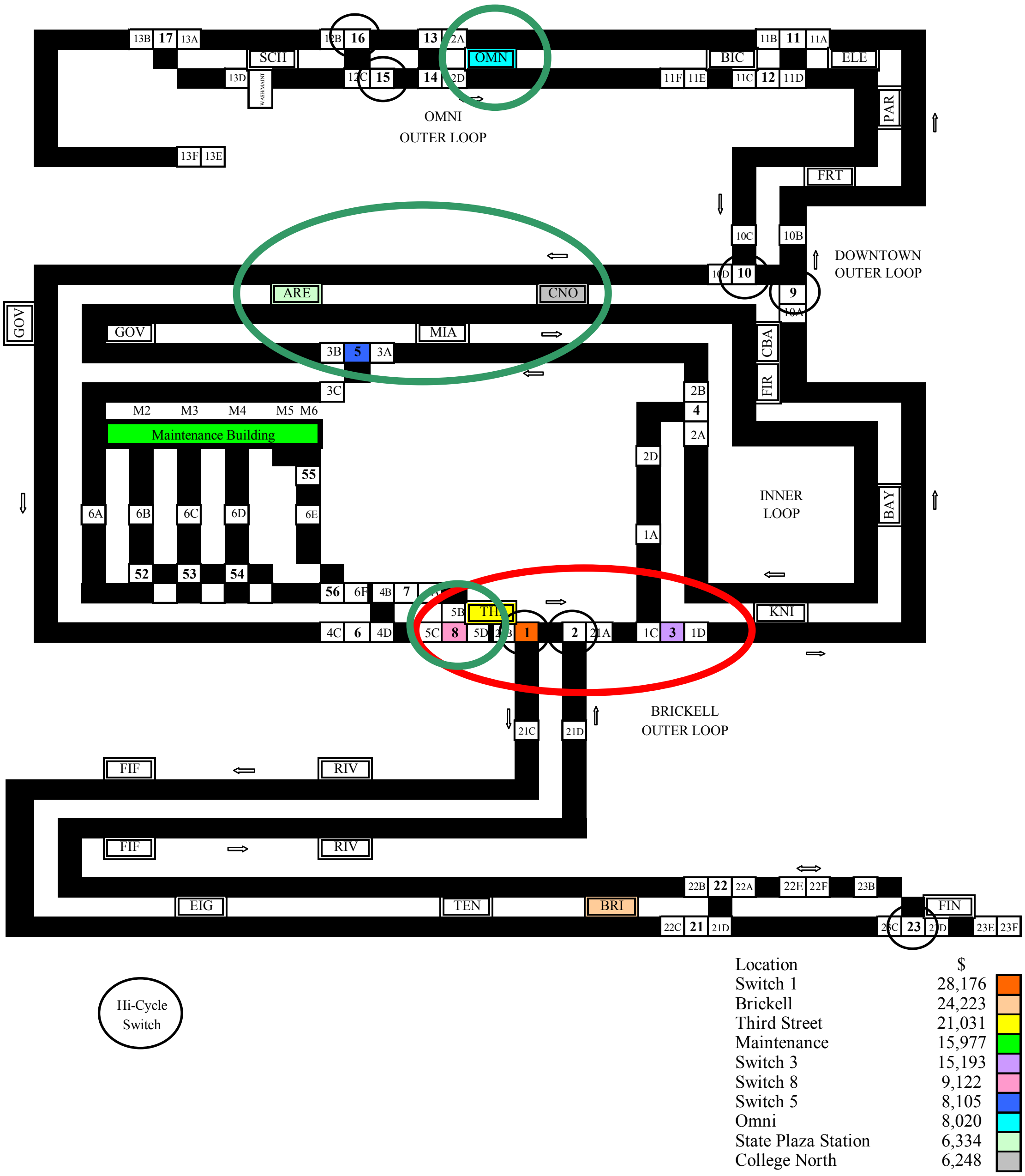


Figure 59 - Total Rail Parts Cost – Top Ten Locations

Total rail labor hours for the ten highest locations are identified in Figure 60. Switch 1 again remained at the top; however, Third Street replaced Brickell in the second spot. Two corridors are apparent, and only one location (i.e., Switch 5) failed to rate in the top-ten total overhaul. Labor hours for Switch 1, Third Street, and Brickell account for 34 percent of the labor hours represented here and 21 percent of the 12,775 labor hours included in the entire overhaul program.

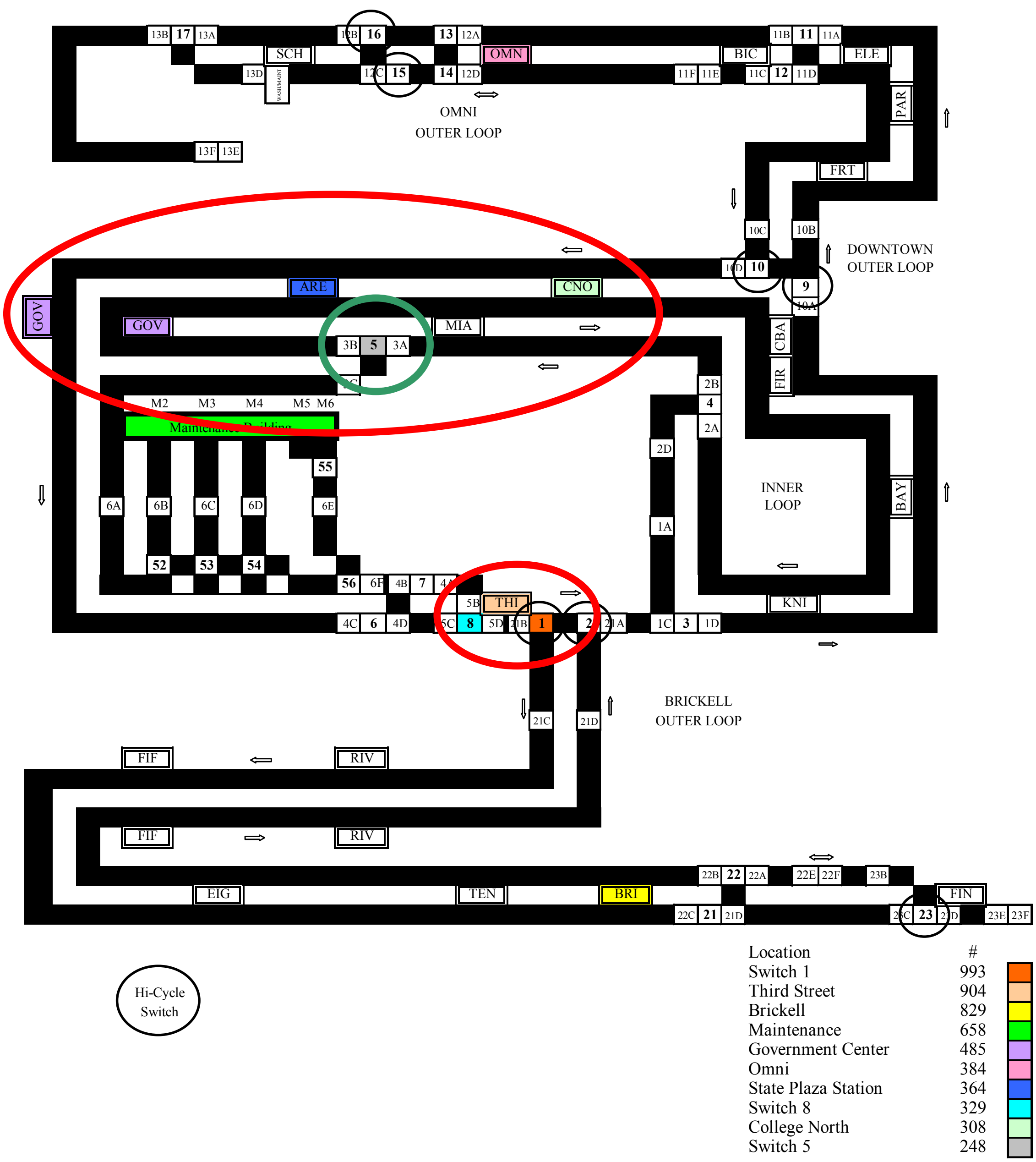


Figure 60 - Total Rail Labor Hours – Top Ten Locations

The following figures present graphic comparisons of total costs and labor hours for the overhaul program and the rail component of the overhaul program. They illustrate wayside maintenance efforts within the last six years, and identify locations that have required extensive work, as well as those locations that have required little or no work. With the exception of Switch 1, areas in close proximity to stations seem to be the most cost and labor intensive, and rail overhaul appears to consume most of the overhaul dollars and hours. Those locations where no overhaul costs occurred include: Park West, Freedom Tower, Switch 53 and Switch 55. The lowest total overhaul costs were reported at Eighth Street Station, Switch 7, Switch 13, and Switch 52.

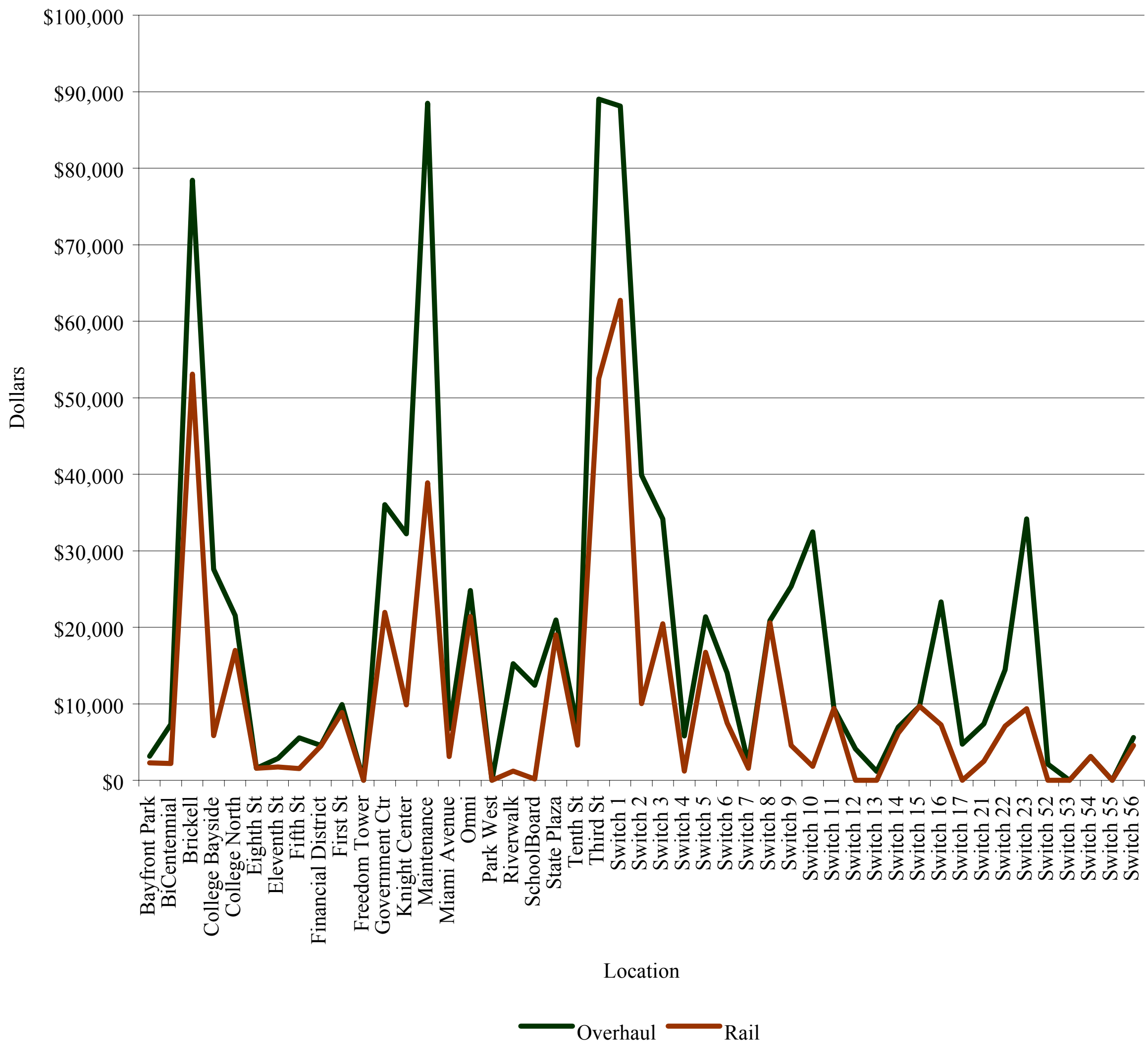


Figure 61 - Overhaul vs. Rail Total Costs

Locations that reported no rail overhaul include the two stations and two switches identified previously in addition to Switch 12, Switch 13, Switch 17, and Switch 52.

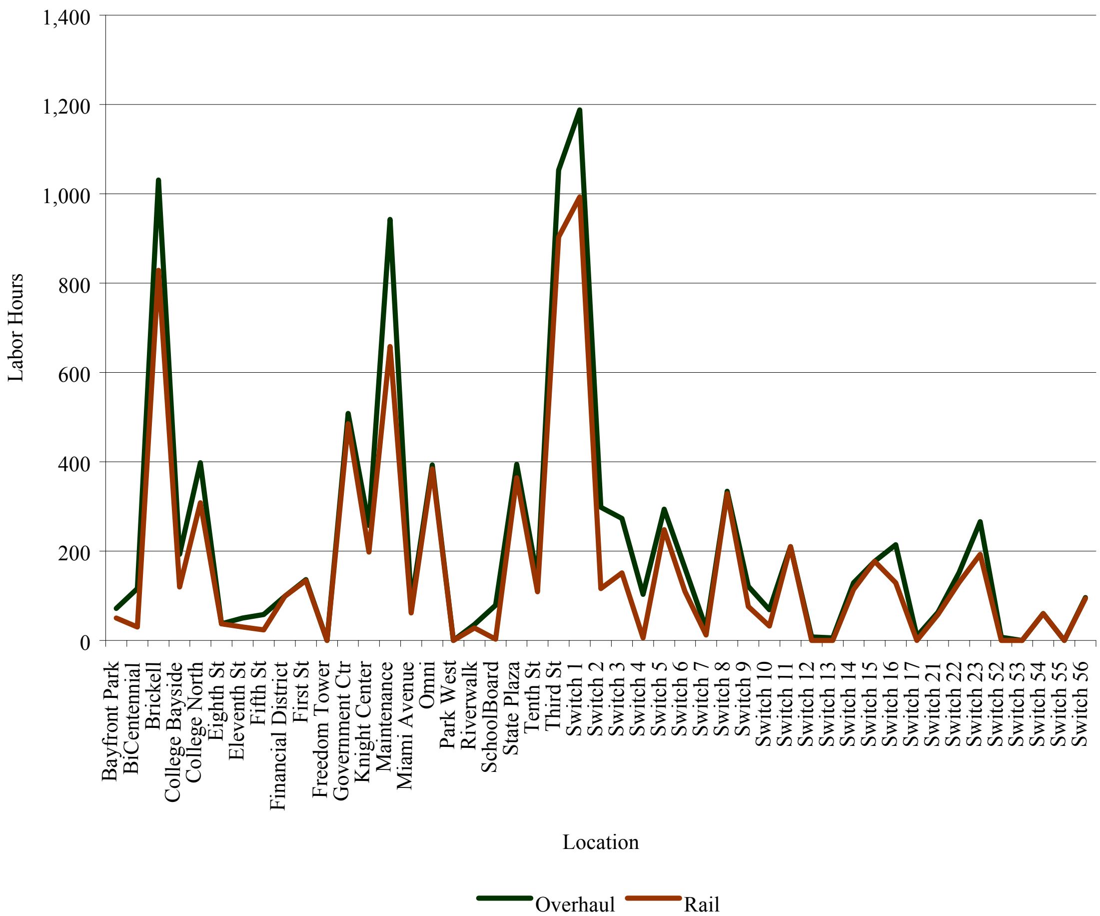


Figure 62 - Overhaul vs. Rail Labor Hours

In order to determine the frequency with which rail overhaul occurred at specific locations, the following chart, Table 39, was assembled to identify rail replacement that occurred during each fiscal year in the six-year window of overhaul data. Because the location points contained in the overhaul database are rather broad, it is not possible to determine how frequently the same section of rail was replaced. It is possible, however, to identify those locations in close proximity to rail replacement. Perhaps most significant are those stations and switches that show no rail overhaul in close proximity during the past six years.

Table 39 - Rail Overhaul Locations by Fiscal Year

Location	*FY 1995*	*FY 1996*	*FY 1997*	*FY 1998*		*FY 2000*
Bayfront Park						
Bicentennial						
Brickell						
College Bayside						
College North						
Eighth Street						
Eleventh Street						
Fifth Street						
Financial District						
First Street						
Freedom Tower						
Government Center						
Knight Center						
Maintenance						
Miami Avenue						
Omni						
Park West						
Riverwalk						
School Board						
State Plaza						
Tenth Street						
Third Street						
Switch 1						
Switch 2						
Switch 3						
Switch 4						
Switch 5						
Switch 6						
Switch 7						
Switch 8						
Switch 9						
Switch 10						
Switch 11						
Switch 12						
Switch 13						
Switch 14						
Switch 15						
Switch 16						
Switch 17						
Switch 21						
Switch 22						
Switch 23						
Switch 52						
Switch 53						
Switch 54						
Switch 55						
Switch 56						

Rail overhaul costs in proximity to stations from the perspective of each station's location on the extensions versus the inner/outer loop are shown in Figure 63.

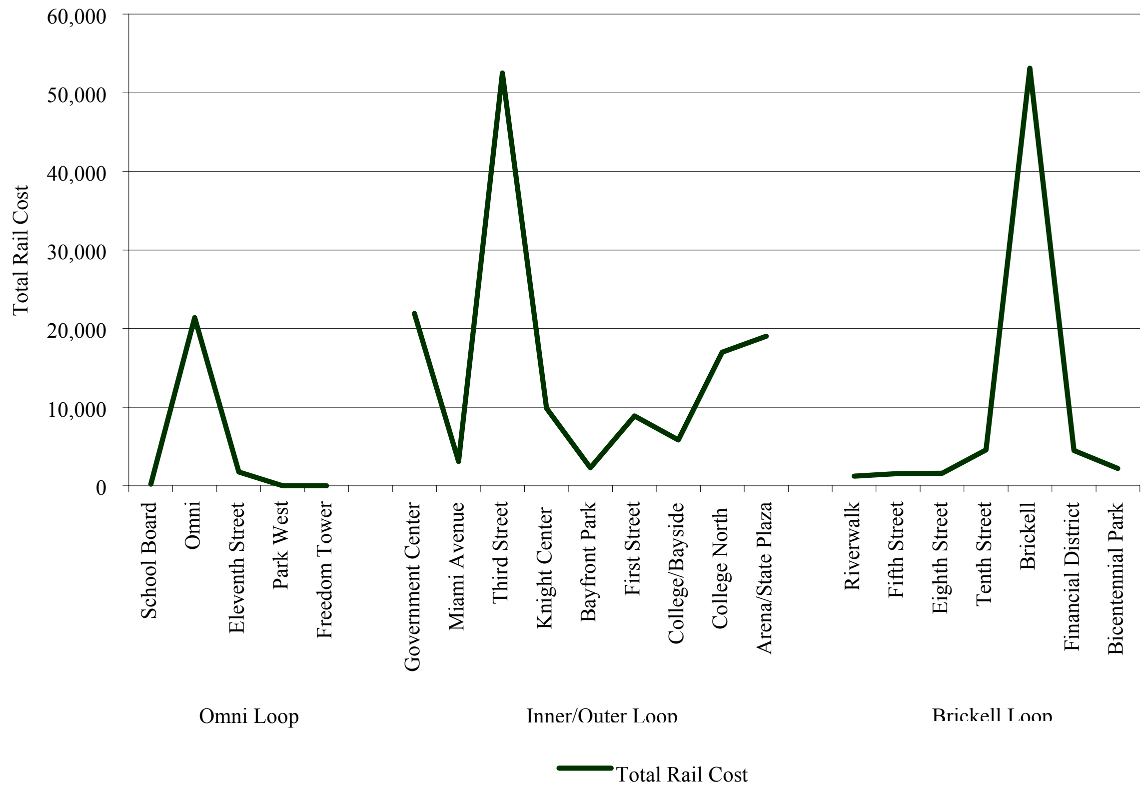


Figure 63 – Station Rail Overhaul Costs by Loop

Annual labor hours equivalent to 2-3 technicians were used to accomplish the total overhaul reported with 1-2 of those technicians necessary for the rail overhaul. If a track crew is established, it appears that at least 2-3 technicians will be needed on a full-time basis.

Mapping the wayside with specific location markers and coordinating the use of those location markers within maintenance and Central Control could certainly facilitate not only scheduling but also tracking all types of wayside overhaul.

Metromover Vacancy Rates

Vacancy rates were reviewed for the time period from FY 1998 through FY 2001 and are reflected in Table 40. The most notable vacancy rates occur with the Metromover Technicians and range from a low of 6.0 percent in FY 2001 to a high of 17.6 percent in FY 2000, which is the only year during the time period reviewed when Metromover's vacancy rate exceeded MDT's vacancy rate.

Table 40 - Metromover Vacancies and Vacancy Rates

Positions	*Vacancies FY 1998*	*% of Total*	*Vacancies FY 1999*	*% of Total*	*Vacancies FY 2000*	*% of Total*	*Vacancies FY 2001*	*% of Total*
Chief Supervisor, Metromover Maintenance	0 of 1	0.0	0 of 1	0.0	0 of 2	0.0	1 of 3	33.3
Chief Supervisor, Repair	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0
Rail Maintenance Clerk	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0
Secretary	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0	0 of 1	0.0
Metromover Maintenance Supervisor	1 of 7	14.3	0 of 6	0.0	0 of 6	0.0	0 of 6	0.0
Metromover Technician	5 of 51	9.8	8 of 51	15.7	9 of 51	17.6	3 of 50	6.0
Rail Vehicle Cleaner	0 of 8	0.0	1 of 8	0.0	1 of 8	12.5	0 of 8	0.0
Metromover Total	6 of 70	8.6	9 of 69	8.6	10 of 70	14.3	4 of 70	5.7
MDT Total	69 of 433	15.9	40/430	9.3	42/430	9.8	38/428	8.9

Significant improvement in vacancy rates occurred in FY 2001. The vacancy rate becomes even more critical for day-to-day operations when combined with absenteeism. According to the Chief Supervisors, absenteeism runs around 15 percent and current disciplinary procedures fail to offer measures to assist employees in improving attendance. Current sick leave policies allow 12 occurrences prior to any action. The Chief Supervisors indicated they could benefit from revised attendance control procedures.

Metromover Manpower Requirements

The Metromover Technician (MT) performs skilled electronic, electrical, mechanical and electro-mechanical tasks in the inspection, diagnosis, repair, and maintenance of Metromover vehicles, wayside systems, and central systems. Responsibilities include the following:

- Troubleshooting
- Determining causes of failure and completing complex repairs
- Performing modifications and retrofits
- Performing corrective and preventive maintenance

- Inspecting and adjusting system components of electronic, electrical, mechanical, electro-mechanical, hydraulic and pneumatic equipment, utilizing procedures, manuals, drawing, and schematics
- Exercising independent judgment in the diagnosis and repair of complex maintenance problems
- Providing advise and direction to other technicians in the performance of work assignments

The MT receives supervision from a technical supervisor who periodically reviews and inspects work in progress and assists with difficult or unusual problems. All MT positions are subject to pick every six months.

A total of 50 MTs are currently assigned to Metromover maintenance. According to previous records, 26 MTs were assigned to the Phase 1 Metromover system. That number increased to 54 shortly before Phase 2 opened. The number of MTs was reduced from 54 to 51 in 1998 and from 51 to 50 in 2001. Based on average labor hours dedicated to vehicles and wayside over the past seven years, approximately 80 percent of labor hours are dedicated to vehicle maintenance and repair, and 20 percent of labor hours are allocated to wayside maintenance repair. The change in the ratios of the prorated complement of Metromover Technicians to vehicles within the fleet and miles of wayside are reflected in Table 41. Both ratios have declined and are lowered even further when vacancy rates are taken into account. The 9.8 percent vacancy rate in FY 1998 would drive the technician to vehicle ratio from 1.414 to 1.276 and the technician to wayside ratio from 1.176 to 1.059. Since FY 1998, Metromover Technician vacancies have ranged from 6.0 to 17.6 percent.

Table 41 - Ratio of Metromover Technicians to Vehicles and Wayside

	Metromover Technicians						
Year	*Total*	*80% Vehicles*	*20% Wayside*	*# of Vehicles*	*Miles of Wayside*	*MT to Vehicle Ratio*	*MT to Wayside Ratio*
1992	26	21	5	12	4.0	1.750	1.250
1994	54	43	11	29	8.5	1.483	1.294
1998	51	41	10	29	8.5	1.414	1.176
2001	50	40	10	29	8.5	1.379	1.176

In 1992, an analysis of staffing needs was conducted to determine the annual Metromover Technician labor requirement. The analysis presented a comparison of three plans: MDT 1992 service plan, original "EIS" plan, and a revised plan due to the procurement of 17 rather than 15 new Phase 2 vehicles. Table 42 outlines the results of the analysis.

Table 42 - Annual Labor Requirement, September 1992

Item	*Service Plan* *1991 Service Plan*	*Original EIS Plan*	*MDT Plan Sep 1992*
DETERMINANTS			
Vehicle Hours Per Year (000s)	36.2	69.0	72.2
Number of Vehicles	12	27	29
Physical Guideway Miles	3.8	8.8	8.8
Vehicle Hours/Guideway Mile/Year	9,526	7,841	8,773
Switch Cycles/Year	9,260	705,255	690,000
Low Use Switches	9	20	20
High Use Switches	0	6	6
LABOR REQUIREMENTS			
Vehicle PM Program – Labor Hours	6,226	11,868	13,278
Vehicle Corrective Maintenance	5,321	10,143	11,348
Vehicle Related Field Activity	5,756	10,971	12,275
Vehicle Daily Clean/Insp	8,780	9,135	9,135
Wayside PM (No Switches)	3,511	8,131	8,131
Wayside Corrective (No Switches)	857	706	790
Wayside Daily Maintenance	3,078	7,128	7,128
Shop Support	420	1,015	1,015
Switch PM	542	3,840	3,840
Switch Corrective	142	10,862	10,626
Total Annual Work Hours	34,633	73,799	77,566
Equivalent Personnel	21	51	54
Recovery Crew (Fixed)	+4	22	22
Total Personnel	25	73	76
Difference from Current (25)	0	48	51

Based on the analysis, Rail Maintenance Control estimated 51 additional technicians were required to meet labor needs for the Phase 1 and Phase 2 systems. The total complement of technicians, including 22 technicians for recovery, equaled 76. Since the allocation of technicians for the Recovery Crew was "fixed" at 22, labor hour requirements for those recovery technicians were not included in the total work hours. Total work hours represented only technicians and cleaners.

It was anticipated that a Recovery Crew would be added to minimize delay time of service interruptions. A Recovery Crew composed of 22.4 technicians would provide a fixed standby crew of 8 technicians per weekday shift and 4 technicians per weekend shift. A total of 29.4

technicians would be required for programmed, scheduled PM based on existing program and labor standards. Unplanned, unscheduled corrective maintenance that varied with system usage would need 24.2 technicians. Total technicians required for the expanded system would equal 76. With a complement of 25 technicians already on board, a total of 51 additional technicians would be required.

Rail Maintenance Control also prepared a revised analysis of staffing needs. Using labor hour data from Rail Maintenance Control records for the most recent 12 months as reported by Metromover Maintenance via completed PMs, Daily Inspection and cleaning reports, Wayside Malfunction Reports, Vehicle Malfunction Reports, and other routine documentation of maintenance activity, they determined that the original EIS estimate of 54 technicians and cleaners was "off the mark" for two reasons. The assumed service plan did not appear to be practical, and the assumed demand for labor by the system seemed to be more optimistic than realistic for the current service level demand.

The Rail Maintenance Control revised analysis of staffing needs is presented in Table 43.

Table 43 - Revised Service Plan

	Revised Service Plan April 1993			
	Scenario 1	*Scenario 2*	*Scenario 3*	*Scenario 4*
Factors	*Current*	*Original EIS*	*Plan A*	*Plan B*
Loops	2	3	2	2
One-way Miles	3.8	10.7	8.8	8.8
Vehicles	12	29	29	29
PVR	9	27	17	20
Headways (Minutes)	1.2/4.0	3.0/3.5	3.0/4.0	2.5/4.0
Vehicle Hours/Year	36,000	69,000	87,000	93,600
Technician & Cleaner Labor Requirement	28.5	59	68	71

Metromover's current operations most closely mirror Scenario 4, and are outlined in Table 44. Based on the average rate of 1,261 hours per technician presented in Scenarios 1-4, the labor requirement for technicians and cleaners is 84. The original EIS used an average of 1,442 hours per technician to determine the labor requirement. Based on the EIS average rate of 1,442 hours per technician, the labor requirement for technicians and cleaners would be 74 as shown in Table 45. The average of 1,442 hours per technician is probably a more realistic labor rate per technician; a productive labor rate of 1,452 hours per position was used in the analysis of staffing needs for Metrorail in the Phase I Rail Rehabilitation Report.

Table 44 - Metromover Service Plan, 2001

Service Plan 2001 *Factors*	*Current Scenario*
Loops	3
One-way Miles	8.8
Vehicles	29
PVR	17
Headways (Minutes)	2.12-5.24
Vehicle Hours/Year	106,000
Labor Hours/Technician	1,261
Technician & Cleaner Labor Requirement	84

Table 45 - Metromover Service Plan, 2001 Revised

Service Plan 2001 *Factors*	*Current Scenario*
Loops	3
One-way Miles	8.8
Vehicles	29
PVR	17
Headways (Minutes)	2.12-5.24
Vehicle Hours/Year	106,000
Labor Hours/Technician	1,442
Technician & Cleaner Labor Requirement	74

Metromover has a current complement of 50 technicians who perform all vehicle and wayside PM/repair in addition to recovery. A review of the Metromover Technician Line-up effective July 9, 2000 provided job assignments for the 42 technicians on duty; 8 positions were vacant. Table 46 provides an overview of those 42 technicians' assignments for a week. Recovery assignments are hi-lighted in red since their duties are fixed, and the recovery crew is not subject to the assignment of other duties. Routine holidays, annual leave, and modest sick leave averaging a total of 25 days annually per technician would effectively eliminate 20 of these shifts per week.

Table 46 - Metromover Technician Line-Up

Shift	*Mon*	*Tue*	*Wed*	*Thu*	*Fri*	*Sat*	*Sun*
6 a.m.-2 p.m.	RCV	RCV	RCV	RCV	RCV	RCV	RCV
	RCV	RCV	RCV	RCV	RCV	RCV	RCV
	RCV	RCV	RCV	RCV	RCV	RCV	
	RCV	RCV	RCV	RCV	RCV		
	A/C Retro	A/C Retro	A/C Retro	A/C Retro	A/C Retro		
	A/C Retro	A/C Retro	A/C Retro	A/C Retro	A/C Retro		
	Daily Insp			Daily Insp	Daily Insp	Daily Insp	Daily Insp
	VEH	VEH	VEH	VEH	VEH		
	VEH	VEH	VEH	VEH	VEH		
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
		TS/REP	TS/REP	TS/REP			TS/REP
		TS/REP	TS/REP	TS/REP			
2 p.m.-10 p.m.	RCV	RCV	RCV	RCV	RCV	RCV	RCV
	RCV	RCV	RCV	RCV	RCV	RCV	RCV
	RCV	RCV	RCV	RCV	RCV	RCV	
	RCV	RCV	RCV	RCV	RCV		
			RCV/TS	RCV/TS	RCV/TS	RCV/TS	RCV/TS
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP		TS/REP
	TS/REP	TS/REP	TS/REP	TS/REP			
	TS/REP	TS/REP	TS/REP				
		TS/REP					
10 p.m.-6 a.m.	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP		
	TS/REP	TS/REP	TS/REP	TS/REP	TS/REP		
	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS
	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS
	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	TS/WS
		TS/WS	TS/WS	TS/WS	TS/WS	TS/WS	
		TS/WS	TS/WS			TS/WS	
		TS/WS	TS/WS			TS/WS	
		TS/WS	TS/WS			TS/WS	
	SWCR/REP	SWCR/REP	SWCR/REP	SWCR/REP			SWCR/REP
	SWCR/REP	SWCR/REP	SWCR/REP	SWCR/REP			SWCR/REP
	RCV/REP	RCV/REP	RCV/REP	RCV/REP			RCV/REP

Notes: RCV – Recovery*
A/C Retro – A/C Retrofit
Daily Insp – Daily Inspection
VEH – Vehicle PM/Inspection/Repair
TS/REP – Troubleshoot/Repair
RCV/TS – Recovery/Troubleshoot
TS/WS – Troubleshoot/Wayside
SWCR/REP – Switch Crew/Repair
REC/REP – Recovery/Repair
*Exempt from "Other Duties as Assigned"

System characteristics and FY 2000 actual labor hours were incorporated into the original EIS to determine manpower needs based on that methodology. Those manpower requirements are presented in Table 47.

Table 47 - Manpower Requirements

Item	*Service Plan* MDT Plan Sep 1992	*Service Plan* MDT Actual 2000	*MDT Health Check*
DETERMINANTS			
Vehicle Hours Per Year (000s)	72.2	106.0	
Number of Vehicles	29	29	
Physical Guideway Miles	8.8	8.8	
Vehicle Hours/Guideway Mile/Year	8,773	12,058	
Switch Cycles/Year	690,000	1,000,000	
Low Use Switches	20	18	
High Use Switches	6	7	
LABOR REQUIREMENTS			
Vehicle PM Program – Labor Hours	13,278	8,985	+800
Vehicle Corrective Maintenance	11,348	7,947	
Vehicle Related Field Activity	12,275		
Vehicle Daily Clean/Insp	9,135	46,750	
Wayside PM (No Switches)*	8,131	7,005	+5,500
Wayside Corrective (No Switches)	790	7,122	
Wayside Daily Maintenance	7,128		
Shop Support	1,015		
Switch PM**	3,840	2,951	
Switch Corrective	10,626	520	
Total Annual Work Hours	77,566	81,280	87,580
Equivalent Personnel (Techs & Cleaners)	54	56	61
Recovery Crew	22	11	11
Total Personnel	76	67	72
Current Personnel	25	58	58
Difference from Current Personnel	51	9	14

*Adjusted labor hours from 5,726 to 7,005 based on PM labor analysis
**Adjusted labor hours from 2,348 to 2,951 based on PM labor analysis

With today's weekday PVR of 17 and 2-4 minute headways, vehicles hours and miles logged far exceed original projections. In FY 2001, mover vehicles logged 1,219,931 miles. The highest previous number of annual miles reported during any year between FY 1995 and FY 2000 was 975,553 miles in FY 1995. FY 2001 represents a 25 percent increase in annual vehicle mileage compared to the FY 1995 annual mileage, and a 43 percent increase compared to FY 2000 annual mileage. The expanded use of the vehicles and the wayside is also compounded by the age of the system. The wayside is undergoing an overhaul by the Metromover in-house staff, and planning has begun for overhaul of the Phase 1 vehicles, which are approaching their midlife. Intensified maintenance activity is required now simply to maintain the system.

It does appear that additional Metromover Technicians are required based on the above analyses. Allocation of recovery crews must be established as the first step in the process of determining manpower needs. The original plan called for 22 on a fixed basis, and recovery crews' hours were not included in any of the previous analyses. Today's allocation of recovery crews from the MT complement totals 11. Recovery crews can be assigned as needed, and intensifying vehicle and wayside PM/repair should reduce the need for recovery. Table 48 summarizes the analyses.

Table 48 - Metromover Manpower Needs

	Service Plan Analysis					
			Current			*Current*
		RMC	*Service Plan*	*Scenario 3*	*Scenario 4*	
Analysis	*EIS*		*2001*	*Apr 1993*	*Apr 1993*	*2001*
Vehicle Hours Per Year (000s)	69.0	72.2	106.0	87.0	93.6	106.0
Metromover Technicians & Car Cleaners	51	54	61	68	71	74
Recovery Technicians	22	22	11	-	-	-
Total Staff Required	73	76	72	68	71	74
Total Current Staff	58	58	58	58	58	58
Total Additional Staff Required	15	18	14	10	13	16

Based on a recovery crew total of 11, and an average of 1,442 labor hours per technician, additional Metromover Technician positions required total 14 under the Service Plan Analysis and 16 under the Scenario Analysis.

Supervisor to subordinate ratios for the Metrorail/Metromover were examined by department and division for FY 1994 and FY 1998 through FY 2001. Supervisory ratios remained consistent and stable throughout those time periods and equaled a ratio of approximately 1 to 7.

Metromover's ratio of supervisory to subordinate personnel averaged slightly higher. Metromover's ratio increased from 1 to 9 in FY 1994 to 1 to 10 in FY 2001, including Rail Car Cleaning staff.

Given the nature of the additional positions identified, a specific supervisor to subordinate ratio for technical positions within Metromover should be reduced to a ratio equal to 1 to 7, similar to the ratio established within Metrorail for technical positions. The supervisor to subordinate ratio of 1 to 10 for the Rail Car Cleaners, who perform less technical duties than the Metromover Technicians, should provide an adequate level of supervision. Using those ratios, additional technical and supervisory staff requirements are as follows:

Table 49 - Metromover Technical and Supervisory Staff Requirements – System Growth

Additional Positions Required – System Growth	*Service Plan Analysis 2001*	*Scenario Analysis 2001*
Technical Positions		
Existing Metromover Technicians	39	39
Existing Recovery Technicians	11	11
Total Existing Technical Positions	50	50
Additional Technical Positions Required	14	16
Technical Supervisor Positions		
Total Technical Positions	64	66
Metromover Maintenance Supervisors Required (1 to 7 Ratio)	10	10
Existing Metromover Maintenance Supervisors	6	6
Additional Metromover Maintenance Supervisors Required	4	4
Non-Technical Supervisory Positions		
Rail Car Cleaners	8	8
Supervisors Required (1 to 10 Ratio)	1	1
Total Positions Required		
Metromover Maintenance Technicians	14	16
Metromover Maintenance Supervisors	4	4
Rail Car Cleaner Supervisor	1	1
Total Additional Positions	19	21

Primary factors included in the service plan analysis included system characteristics and labor hours by function. Based on actual labor hour requirements, the Service Plan Analysis indicates a need for 19 additional positions. The Scenario Analysis focuses on specific factors such as the number of loops, one-way miles, headways, PVR, and vehicle hours per year. That analysis showed a need for 21 additional positions. Manpower needs range from 19 to 21 based on a recovery crew of 11, an average of 1,442 labor hours per technician, and a supervisory ratio of 1 to 7 for technical positions.

In September 2001, a Metromover Technician was assigned to rebuild electrical and electro/mechanical assemblies. Due to the success of the program, a second technician was assigned to the newly created *Metromover Component Shop* in January 2002. The technicians' primary responsibilities are to support rebuilding of worn or defective parts resulting from major vehicle inspections (10 year overhauls) and rebuilding wayside track components and switch equipment. Metromover reports total savings to date of $92,000, greater control over repairs, and improved turn-around time on components rebuilt in-house. The General Superintendent indicated that six additional Metromover Technician positions would provide Metromover with sufficient staff for two shifts of operation and restore the two technician positions that were re-assigned from maintenance.

An overview of the savings achieved to date by the Component Shop is presented in Table 50.

Table 50 - Component Shop Savings

Description	*Parts Cost*	*Cost*	*Total Cost*	*Avg Unit Price*	*Savings*
Total	$6,833	$12,260	$19,094	$111,338	$92,244
% of Total Parts+Labor Cost	35.8%	64.2%			
Total Cost % of Average Unit Price			17.1%		
Average Cost per Item (49)	$139	$250	$390	$2,272	
Average Savings per Item (49)					$1,883
Average Cost per Labor Hour (1,202)*		$10.20			
Average Savings per Labor Hour (1,202)					$76.74

*1 Tech @ 4 months + 2 Techs @ 3months = 10 months @1,442 productive hours/year = 1,202 hours

Table 51 provides a summary of staffing needs, which range from 25-28, based on an allocation of six additional Metromover Technicians to the Component Shop.

Table 51 - Technical and Supervisory Staff Requirements with Component Shop

Additional Positions Required - Component Shop	*Service Plan Analysis 2001*	*Scenario Analysis 2001*
Technical Positions		
Existing Metromover Technicians	39	39
Existing Recovery Technicians	11	11
Total Existing Technical Positions	50	50
Additional Technical Positions Required - System Growth	14	16
Additional Technical Positions Required - Component Shop	6	6
Total Technical Positions Required	20	22
Technical Supervisor Positions		
Total Technical Positions	70	72
Metromover Maintenance Supervisors Required (1 to 7 Ratio)	10	11
Existing Metromover Maintenance Supervisors	6	6
Additional Metromover Maintenance Supervisors Required	4	5
Non-Technical Supervisory Positions		
Rail Car Cleaners	8	8
Supervisors Required (1 to 10 Ratio)	1	1
Total Positions Required		
Metromover Maintenance Technicians	20	22
Metromover Maintenance Supervisors	4	5
Rail Car Cleaner Supervisor	1	1
Total Additional Positions	25	28

Chapter 3 - Financial

Recent History

The Phase I Rail Rehabilitation Report discussed the historical and projected expenditure patterns for MDT. That analysis relied on budget numbers for FY 2000 and projections based on the Capital Program as it was then. For the purposes of this examination of the Metromover finances, actual FY 2000 and FY 2001 data were used. The future capital expenditure projections are based on the program dated June 25, 2001, and include significant funding increases for both Metrorail and Metromover in the upcoming years.

The period analyzed is from FY 1994 to FY 2007, the year in which the current capital program ends. The capital needs for Metromover will, in fact, be essentially met by the inclusion of the Phase I vehicle rehabilitation for $15.4 million starting in FY 2003. A historical look at the expenditure patterns for Metromover and the entire agency is presented first, followed by a review of projected expenditures for both capital and operating.

From FY 1994 to FY 2000, Metromover enjoyed an average annual operating expenditure increase of 6.3 percent. The growth in operating expenditures for the agency as a whole for that period was 2.3 percent. Operating expenditures for Metromover grew from $10.7 million in FY 1994 to over $15 million in FY 2000. This growth is illustrated in Figure 64.

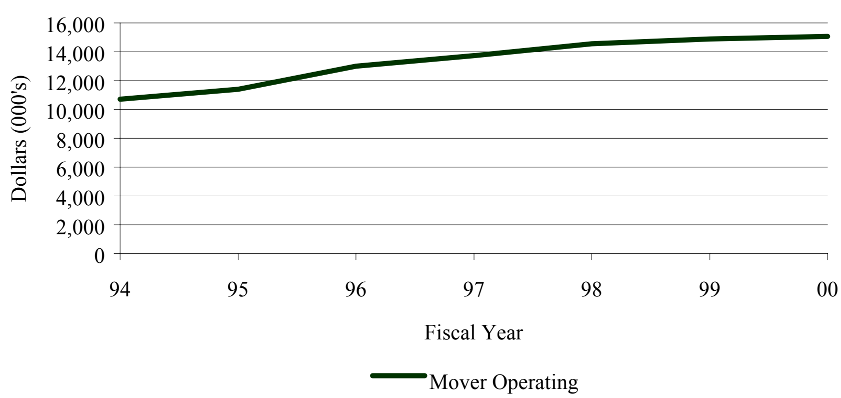


Figure 64 - Metromover Operating Expenditures

As stated above, the Metromover operating expenditure growth over the last seven years outpaced the growth in operating expenditures for the MDT. While these expenses represent only a fraction of the overall agency spending, the Metromover operating funding has outpaced inflation during the FY 1994 to FY 2000 period. Figure 65 provides a comparison of Metromover's agency-wide percentage of ridership (based on annual passenger miles served) with its share of operating funding.

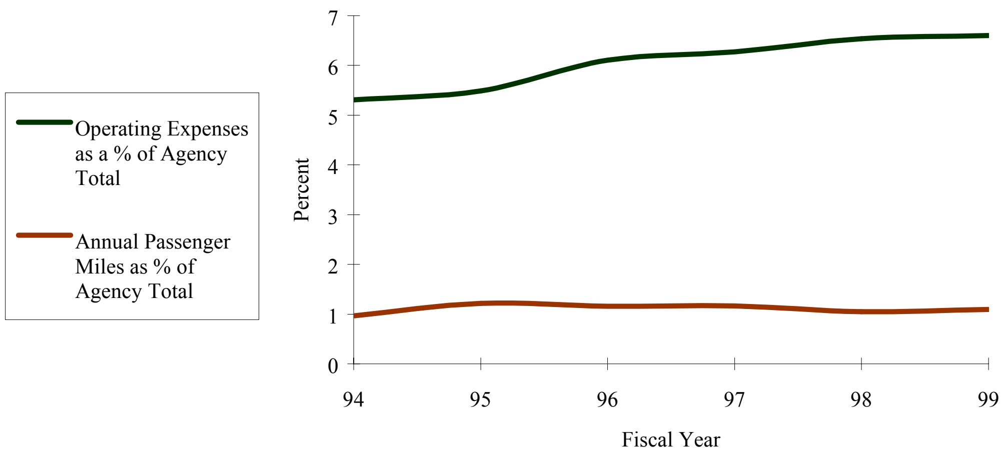


Figure 65 - Metromover % Operating and % Ridership

While the ridership represents around 1 percent of the entire MDT system, operating expenditures as a percentage of the MDT total averaged slightly over 6 percent. While this comparison is useful, the role that the Metromover serves in the entirety of the MDT system should not be overlooked. While the ridership comparison is based on annual passenger miles, many passengers transfer to or from another MDT mode to complete or begin a total transit trip. In FY 2001 for example, 1.1 million passengers transferred from Metrorail to the mover system representing 22.6 percent of the total Metromover boardings.

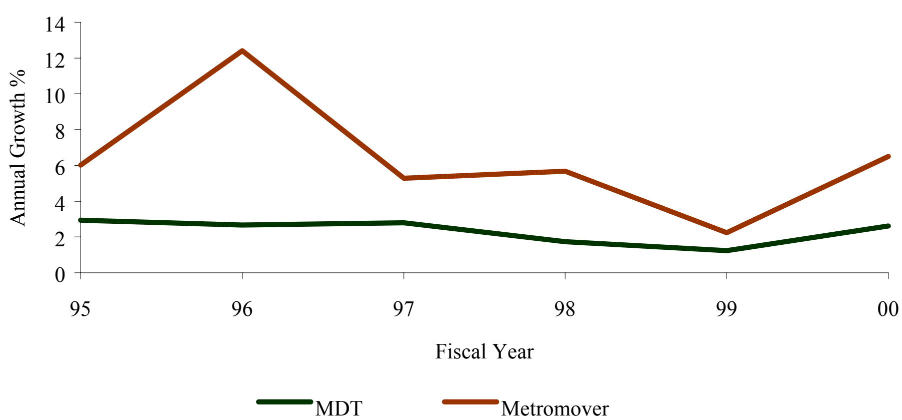


Figure 66 - Operating Expenditures Growth

Figure 66 graphically compares the differences in growth rates of the Metromover operating expenditures with those rates for all of MDT. The over 10 percent increase in annual operating expenditures that occurred from FY 1995 to FY 1996 is due to the additional costs associated with "new" Metromover extensions to Omni and Brickell that opened for service in May of 1994. When the operating expenses are viewed from a "constant dollars" perspective, which is adjusted for inflation, real growth has occurred. Figure 67 illustrates the growth in operating expenditures for Metromover in both actual and inflation-adjusted dollars.

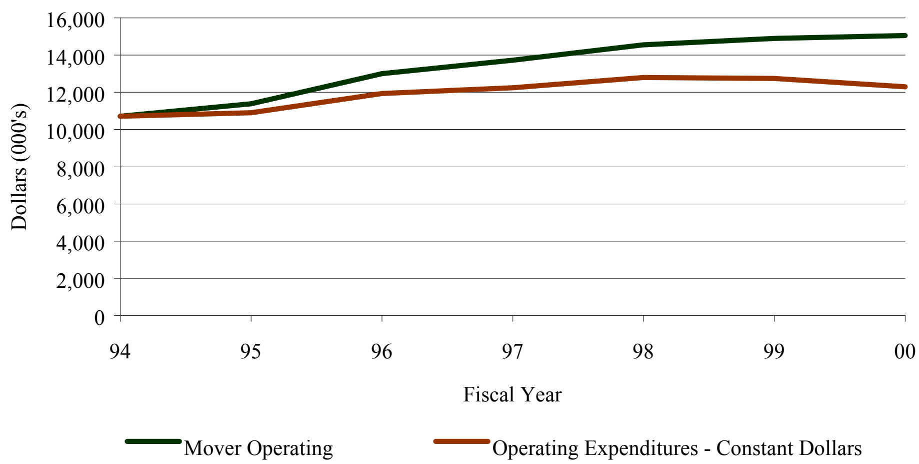


Figure 67 - Metromover Operating Expenses Actual & Constant Dollars

The $15 million of operating expenses in FY 2000 is the approximate equivalent of $12.2 million in 1994. Actual expenditures grew from $10.7 million in FY 1994 to over $16 million in FY 2001.

As expected, capital expenditures for Metromover fluctuated much more than operating costs. Aside from the normal variances in year-to-year capital expenditures expected based on a changing project mix, the final cash flow associated with construction of the Metromover extensions falls into the study period. Figure 68 depicts capital expenditures for Metromover for FY 1994 to FY 2000. By FY 1999 capital expenditures for the Metromover system were less than $200 thousand and rose to a modest $490 thousand in FY 2000.

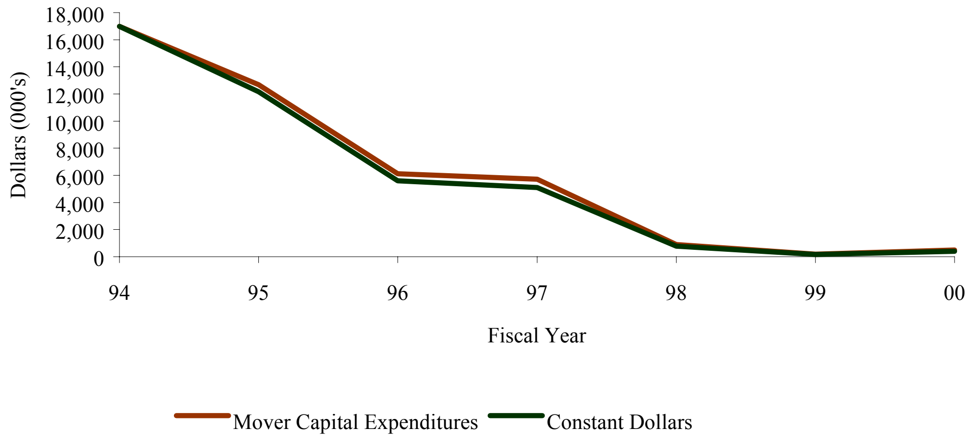


Figure 68 - Metromover Capital Expenditures

The next chart, Figure 69, compares the percentage of the MDT total capital and ridership to those of Metromover. Again, while these comparisons are useful to put funding levels into some perspective, the nuances of both the function of Metromover and the heavy capital infusion required to originally construct the system must be considered.

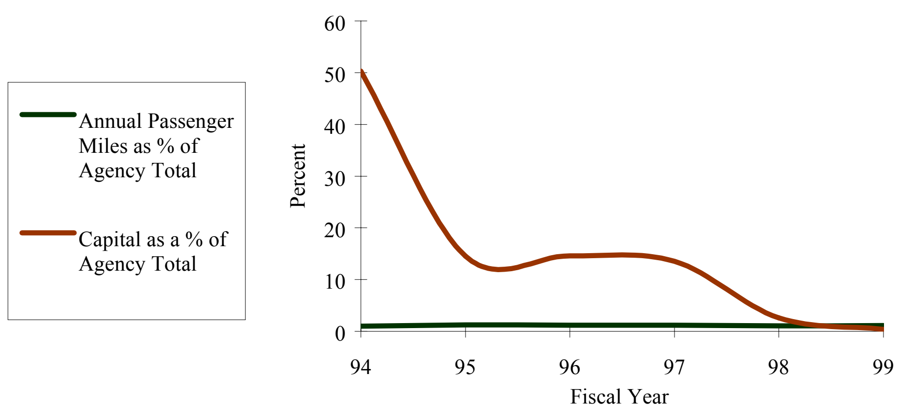


Figure 69 - Metromover % Capital & % Ridership

The Metromover construction was consuming over 50 percent of all of the agency's capital spending in 1994. This percentage has dropped to less than one percent in both FY 1999 and FY

2000. Based on the condition assessment included in this report, the system is in good shape and will not have required a significant capital investment for over four years.

As the Phase I vehicles approach their mid-life, the need for capital increases. The levels required, however, do not approach anything near those that were required for initial construction.

In summary, for the period since 1994, Metromover operating expenditures have more than kept pace with inflation and have averaged 6.3 percent of the agency's total. The capital required has steadily declined as start-up of the system was completed. Figure 70 puts both the operating and capital requirements for Metromover into an agency-wide context.

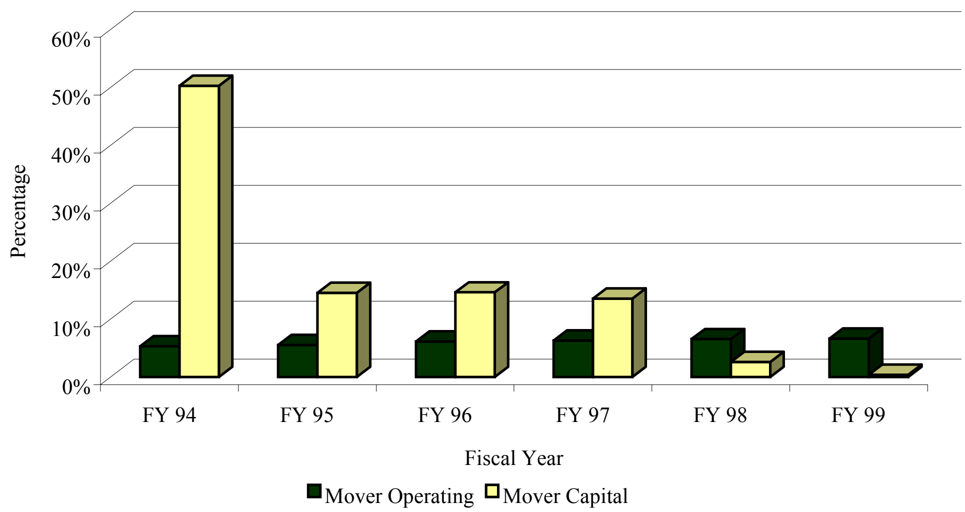


Figure 70 - Metromover Funding % of Agency Total

Future Outlook

The next section of this report looks out through FY 2007 to estimate the funding scenario for Metromover. The operating assumptions are built on the growth rates derived from using a five-year moving average beginning in FY 1997 and applied the FY 2001 expenditure figure in order to project FY 2002 through FY 2007. To project the constant dollar equivalent, a four percent inflation factor has been assumed. To project future operating funding for Metromover, the historic percentage of MDT funding was used to create a five-year moving average to project FY 2002 through FY 2007. For the capital expenditure forecast, the capital program dated June 2001 was used. When these assumptions are applied, the forecast for MDT operating expenditures is for an increase to more than $278 million by FY 2007. The average growth rate for the forecast period for operating is 2.5 percent. With an assumed inflation factor of four percent, there is the expected continued erosion of the operating program at the agency level as can be seen in Figure 71.

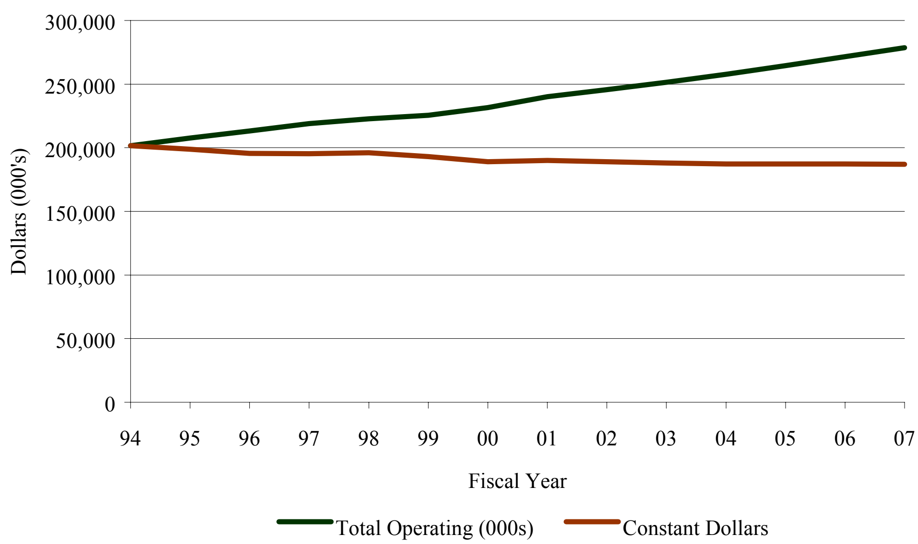


Figure 71 - MDT Operating Expenditures

For Metromover's future operating outlook, if the historic trends continue, the picture is somewhat more promising. The forecast predicts an average annual growth rate over the six years of 6.6 percent. This rate of growth is well ahead of the projected inflation rate. The projection is illustrated in Figure 72 along with the inflation-adjusted forecast.

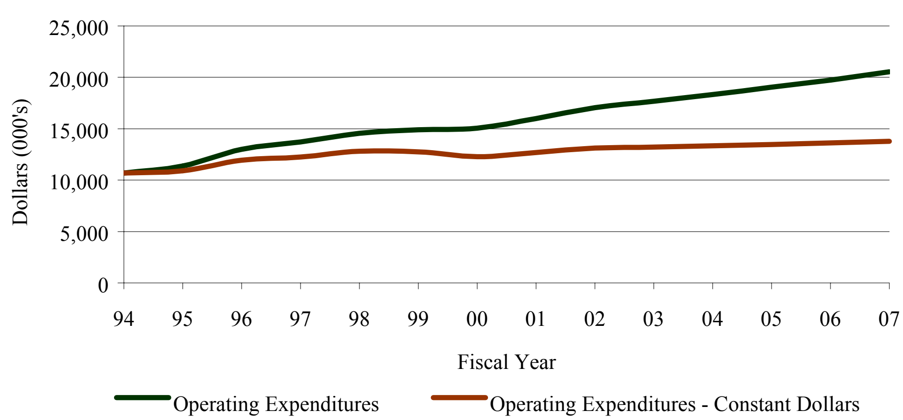


Figure 72 - Metromover Operating Expenditures

By FY 2007, the annual operating budget for Metromover would be $20.5 million and comprise 6.6 percent of the agency's projected operating fund. On a constant dollar basis, the FY 2007 figure represents a $3 million increase over the FY 1994 level. It should be noted that if the additional staff that has been recommended for Metromover Maintenance is approved, the incremental cost most likely could not be absorbed without increased operating funding. Using a total salary cost of $60,000 per position, the annual additional cost would represent $1.2 million if all 20 positions were added. This would represent a 7.5 percent increase over the FY 2001 operating expenditure level. The on-going impact of funding the positions is depicted in Figure 73.

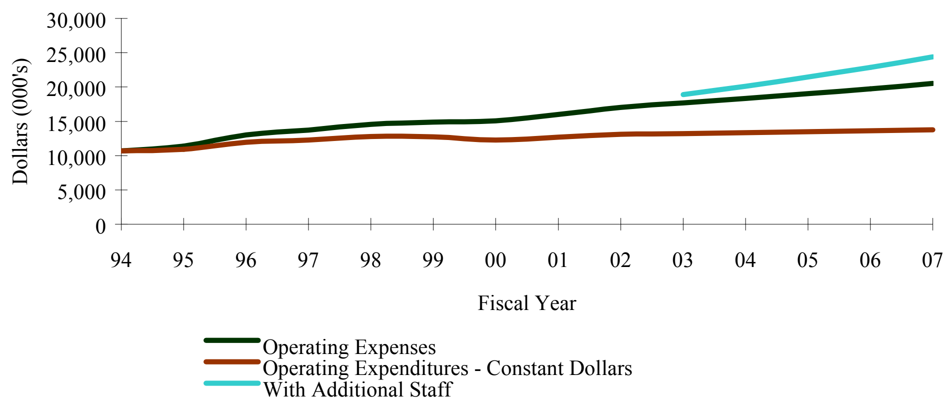


Figure 73 - Metromover Operating Forecast

There has been a dramatic change in the capital forecast since the Phase I Rail Rehabilitation Report was prepared for Metrorail. MDT's and the County's decisions to commit to a rehabilitation program for both the Metrorail and Metromover Phase I vehicles substantially improves the outlook for both systems. The previously major, un-funded need for Metromover was the vehicle mid-life program for the oldest of them. With this need addressed, the capital program, as it now exists, leaves few capital requirements not covered for Metromover. Figure 74 compares the FY 2001 to FY 2006 and FY 2002 to FY 2007 capital programs.

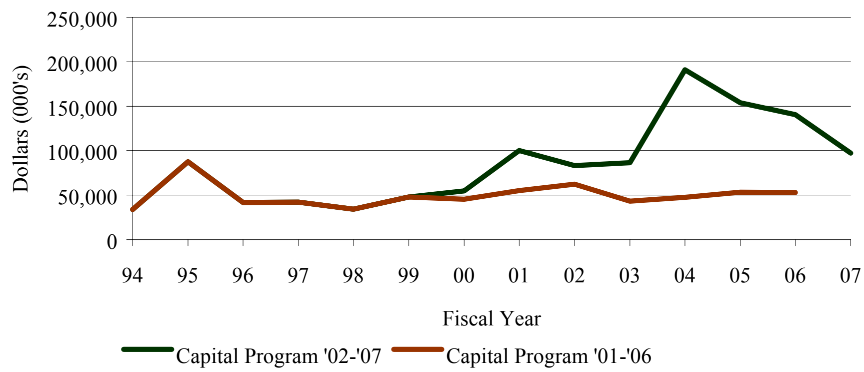


Figure 74 - Capital Program Comparison ’01 to ’06 vs. ’02 to ‘07

For the years FY 2001 to FY 2006, the new capital program represents an infusion of nearly $450 million in additional funding for MDT. This additional funding includes over $15 million for Metromover Phase I vehicle mid-life overhaul beginning in FY 2003. Other significant projects included in the program include continuation of the wayside overhaul program, security enhancements, power distribution enhancements, escalator replacements, and guideway steel painting.

Table 52 - Metromover Capital Program Projects FY 2002 to 2007

Metromover Project	*2002*	*2003*	*2004*		*2006*	*2007*	*Total*
Power Supply Replacement			777,497				777,497
Digitrip 910 Retrofit for Metromover Traction Power	665,138	665,138	665,137				1,995,413
Metromover Phase One Vehicle Overhaul		1,600,000	3,800,000	5,000,000	5,000,000		15,400,000
Vital Relay Replacement	500,000	500,000	450,000	600,000			2,050,000
Replace Metromover Uninterrupted Power Supply System	825,634						825,634
Fencing for Rail and Mover Locations (1/2)	5,743	5,743	5,743	60,760	15,000		92,989
Replace A/C System - Metromover	100,000	100,000	100,000	75,000	50,000	21,352	446,352
Outdoor Escalator Canopies	388,700	379,182	519,550				1,287,432
Metromover Wayside Overhaul	276,720	276,720					553,440
Metrorail/Metromover Uninterrupted Power Supply	180,000	180,000	180,000	121,650			661,650
Guidewheel Bearing Installation Room						50,000	50,000
Replace Elevators Inner Loop (20%)	80,000	168,917	168,917	168,917	168,917	226,809	982,476
Replace Escalators (50%)		1,616,750	1,616,750	1,616,750	1,616,750	1,616,750	8,083,750
Replace Vehicle Wash System (25%)	62,500	187,500	250,000	175,000	120,375	88,352	883,727
Metrorail/Metromover - Steel Girder Painting (75%)				4,125,000			4,125,000
Metromover Vehicle Lifts						50,000	50,000
Metromover Fork Lift						50,000	50,000
Metromover Roll-up Door					38,500		38,500
Station Ceiling Line Map Replacement						40,000	40,000
Station Ceiling Sign Cab. Replacement						50,000	50,000
Vehicle Destination Signs	136,000						136,000
Metromover CCTV - Inner Loop	251,882						251,882
Metromover CCTV - Upgrade		250,000	250,000	403,001			903,001
Total Funded as of 6-25-01	3,472,317	5,929,950	8,783,594	12,346,078	7,009,542	2,193,263	39,734,743

With a capital reinvestment program of nearly $40 million, MDT has made a significant commitment to ensuring the long-term viability of Metromover. If this program comes to fruition, the system will be positioned well. The age of the system requires that reinvestment take place. Figure 75 illustrates the capital investment over a 14-year period.

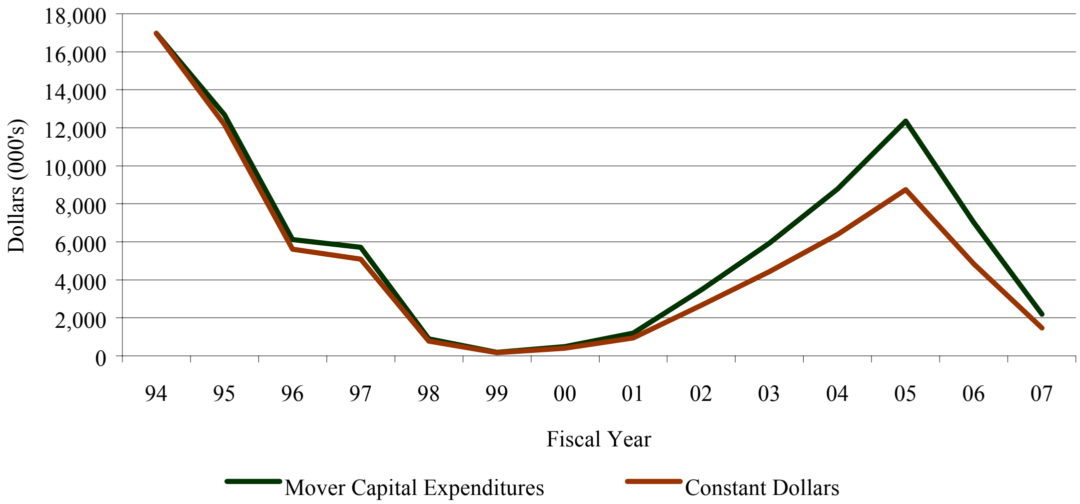


Figure 75 - Metromover Capital Expenditures

By FY 2007, the Phase II Vehicles will be 13 to 14 years old. By then, the planning for a midlife rehabilitation of the newer vehicles should have begun.

Even with this significant capital commitment, the Metromover capital and operating requirement will represent a small percentage of the MDT overall funding plan. Even in the peak capital year for Metromover, FY 2005, the $12 million will only represent slightly over eight percent of the MDT capital plan. Figure 76 demonstrates the portion of MDT's capital and operating funding Metromover would represent under the funding scenario outlined here.

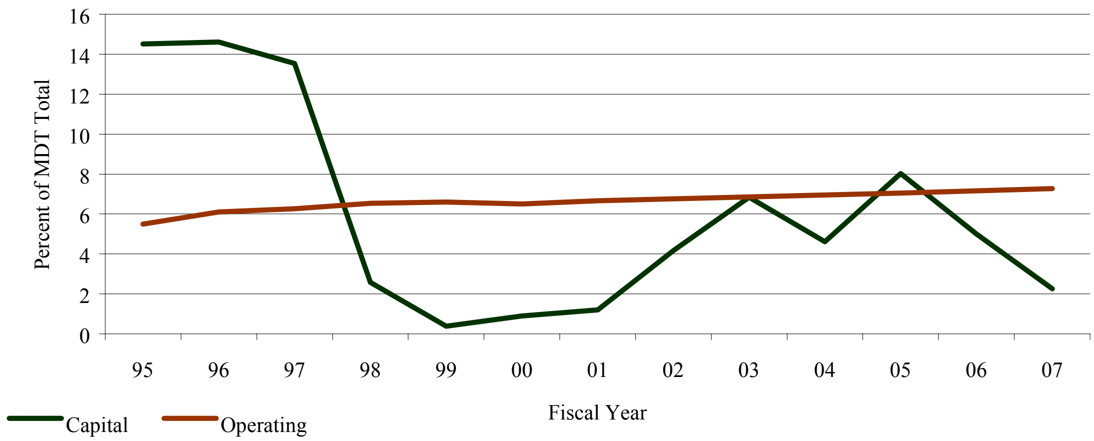


Figure 76 - Metromover Expenditures % of MDT Total

SECTION III: OPERATIONAL REVIEW

Chapter 1 - Track & Guideway Staffing

Track & Guideway, managed by a General Superintendent, is responsible for track inspection and maintenance, structural inspection and maintenance, and track and structure equipment maintenance. The Division Office consists of the General Superintendent, an Administrative Secretary, and a Rail Maintenance Clerk. A total of 87 staff is assigned to the division.

The Track & Guideway Division plans, directs, and coordinates all track and guideway maintenance requirements, provides support to Rail Transportation and Vehicle Maintenance Divisions, and works in close coordination with Train Control/Traction Power. The division consists of three departments: Rail Structure, Rail Track, and Rail Shop. Work is assigned to three shifts: 7 a.m.-3 p.m., 3 p.m.-11 p.m., and 11 p.m.-7 a.m.

Rail Structure

The Chief Supervisor of Rail Structure Maintenance directs the maintenance and repair of Metrorail and Metromover structures and related track. The division was established in 1983 prior to implementation of a Bridge Inspection Program, and the original budget included a total of three Rail Structural Repairer positions.

In 1984, Metrorail structures were inspected for the first time by an MDT consultant contracted to develop the Bridge Inspection Program. The first inspection was designed to establish a baseline for the future Bridge Inspection Program and identified 221 girder conditions for repair. Remedial Action Reports (RARs) were completed for those items and were forwarded to Track & Guideway for repair.

Prior to the next bridge inspection, which yielded a total of almost 9,000 conditions for repair, the complement of Rail Structural Repairers was increased from three to six. Responsibility for the Bridge Inspection Program became a joint effort of the Track & Guideway structural maintenance staff and Transit Engineering.

The complement of Rail Structural Repairers increased from six to nine in 1989 with two of the nine repairers assigned to the Bridge Inspection Program on a full-time basis. A service adjustment occurred in 1990 that reduced the number of repairers from nine to eight. A budget increase of four repairers, approved in 1994 to raise the complement to twelve, was nullified by a 1995 service adjustment that returned the complement of repairers to eight. Pursuant to the service adjustment, Track & Guideway indicated, based on the approved level of manpower, they would no longer be able to accomplish graffiti removal, respond to vegetation problems, or inspect the top of the Metrorail guideway; nonetheless, based on a review of recent labor hours, Track & Guideway continues to perform these activities, which require from one to three full-time staff annually. Track & Guideway also indicated that twelve rather than six months would be required to repair "priority 3" bridge inspection items.

A 1995 request for additional staffing to maintain the Metromover extensions was unsuccessful.

Current Staff assigned to Rail Structure Maintenance total 11, including the Chief Supervisor. Rail Structure Maintenance Staff are shown in Table 53. Two of the eleven positions are currently vacant.

Table 53 - Rail Structure Maintenance Staff

Rail Structure Maintenance	*Positions*
Chief Supervisor, Rail Structure Maintenance	1
Rail Structural Repairer	8
Rail Structure & Track Supervisor	2

Structure maintenance works from 7 a.m. to 3 p.m. five days a week. Structural maintenance is based upon conditions identified through the Bridge Inspection Program. The preventive maintenance (PM) program is based on the State of Florida Inspection Program. To date, ratings of the structure from the Florida Department of Transportation and the Federal Transit Administration have been excellent.

Rail Structure labor hours by job type from October 1996 through June 2000 are reflected in Table 54.

Table 54 - Rail Structure Labor Hours by Job Type

Job Type		*FY 1998*	*FY 1999*	*Average*	*FY 2000**
Remedial Action Reports (RAR)	649	3,661	5,668	3,326	4,473
RAR % of Total Labor Hours	20.1	28.1	34.1	30.4	20.3
Repairs	2,586	9,359	10,937	7,627	17,520
Repair % of Total Labor Hours	79.9	79.1	65.9	69.6	79.7
RAR + Repairs	3,235	13,020	16,605	10,953	21,993

*FY 2000 = Oct-Jun

Based on available manpower during FY 1998 through June 2000, labor hours per employee are indicated in Table 55.

Table 55 - Rail Structure Labor Hours per Employee

	# of Positions			*Hours per Position*		
Classification	*1998*	*1999*	*2000*	*1998*	*1999*	*2000*
Rail Structural Repairer	7 of 8	8 of 8	8 of 8	1,447	1,660	2,199
Rail Structure & Track Supervisor	2 of 2	2 of 2	2 of 2			

Rail Track

The Chief Supervisor of Rail Track Maintenance directs the activities of the track maintenance section. Track maintenance operates two shifts. Four crews provide coverage seven days per week on the third shift from 9 p.m. to 5 a.m. One crew works five days each week on the first shift from 7 a.m. to 3 p.m. Maintenance and repair of the track are based on information provided through a comprehensive inspection program. Guideway Inspection Specialists visually inspect the track two times each week and issue daily conditional reports that are prioritized by the Chief Track Inspection Supervisor and forwarded to the Chief Supervisor of Track Maintenance for repair. Upon completion of repairs, repair orders are returned to the Chief Track Inspection Supervisor for processing. Geometry inspection is performed four times each year through a contract service. Ultrasonic testing of the rail is performed twice a year. A total of 42 staff is assigned to rail track maintenance, including the Chief Supervisor of Rail Track Maintenance and the Chief Supervisor of Guideway Inspection. Six of the 42 positions are currently vacant. Track maintenance in the yard is accomplished on the first shift while all mainline work is done on the third shift when track is available during non-revenue service times. Rail Track Maintenance positions are identified in Table 56.

Table 56 - Rail Track Maintenance Staff

Rail Track Maintenance	*Positions*
Chief Supervisor, Rail Track Maintenance	1
Rail Track Repairer	29
Rail Structure & Track Supervisor	5
Chief Supervisor, Guideway Inspection	1
Guideway Inspection Specialist	4

Rail Track & Guideway labor hours by function from October 1996 through June 2000 are presented in Table 57.

Table 57 - Rail Track & Guideway Labor Hours by Function

Function	*FY 1997*	*FY 1998*	*FY 1999*	*Average*	*FY 2000**
Preventive Maintenance	64	80	64	69	80
PM % of Total Labor Hours	0.1	0.1	0.1	0.1	0.2
Repairs	47,292	55,642	36,227	46,387	42,751
Repair % of Total Labor Hours	85.0	86.9	81.2	84.7	86.1
Guideway Inspection	8,268	8,311	8,324	8,301	6,799
GIS % of Total Labor Hours	14.9	13.0	18.7	15.2	13.7
Total Labor Hours	55,624	64,033	44,615	54,757	49,630

*FY2000 = Oct-Jun

Based on available manpower from FY 1998 until June 2000, labor hours per employee are reflected in Table 58.

Table 58 - Rail Track Labor Hours per Employee

	# Filled versus Budgeted Positions			*Hours per Filled Position*		
Classification	*1998*	*1999*	*2000*	*1998*	*1999*	*2000*
Track Repairer	22 of 30	28 of 29	24 of 29			
Guideway Inspection Specialist	4 of 4	3 of 4	3 of 4	2,208	1,206	1,504
Rail Structure & Track Supervisor	3 of 6	6 of 6	6 of 6			

Rail Shop

The Chief Supervisor of Rail Shop directs the activities of the Rail Shop. The Rail Shop operates 24 hours a day, seven days a week over three shifts and is responsible for track vehicles and equipment maintenance, repair, fabrication, storing, and delivery of all track and structure materials. The Rail Shop conducts PM on equipment based on manufacturers' recommendations and time intervals, track system repairs, guideway structure repair, and all divisions of Rail Operations. Equipment maintenance and control records are computer controlled through a database allowing for equipment PM schedules and repair tracking from the shop office. The shop's corrective program is divided into two categories: minor repairs performed in-house and major repairs contracted to authorized factory representatives. The inventory includes 45 pieces of mobile heavy equipment, 130 pieces of mobile and light equipment, and an assortment of other small tools and equipment. Rail Shop staff totals 32 including the Chief Supervisor. Three of the 32 positions are currently vacant. Rail Shop positions are shown in Table 59.

Table 59 - Rail Shop Positions

Rail Shop	*Positions*
Chief Supervisor, Rail Shop	1
Rail Maintenance Worker	7
Track Equipment Operator	19
Track Shop Supervisor	5

According to the State of the Rail Report, existing equipment maintenance efforts are at approximately 50 percent of the required level as a result of: re-assignment of shop maintenance staff to track maintenance; increased use of equipment; a lengthy process required to use outside vendors for equipment repairs; extensions of grant funded equipment replacement cycles; and, the lack of a retraining program for equipment operators.

Rail Shop labor hours by job function are presented in Table 60.

Table 60 - Rail Shop Labor Hours by Function, FY 1997 - FY 2000

Function	*FY 1997*	*FY 1998*	*FY 1999*	*Average*	*FY 2000**
Preventive Maintenance (A-B-C-M)	338	416	279	344	501
PM % of Total Labor Hours	5.6	4.9	2.6	4.1	3.7
Repairs	5,752	8,090	10,505	8,116	13,020
Repair % of Total Labor Hours	94.4	95.1	97.4	95.9	96.3
PM + Repairs	6,090	8,506	10,784	8,460	13,521

*FY2000 = Oct-Jun

During the course of the Phase I study period, it was determined that Track Equipment Operators' hours were inconsistently reported in the field. Track & Guideway took steps to correct tracking methods. Actual FY 2001 labor hours are presented in Table 61.

Table 61 - Rail Shop Labor Hours

Function	*FY 2001*
Preventive Maintenance (A-B-C-M)	1,205
PM % of Total Labor Hours	5.5%
PM Equipment Repair	305
PM Repair % of Total Labor Hours	1.4%
Daily Workload	18,709
Daily Workload % Total Labor Hours	85.7%
Shop Daily Workload	248
Shop Workload % Total Labor Hours	1.1%
Track Daily Workload	1,354
Track Workload % Total Labor Hours	6.2%
PM + Repairs + Daily, Shop & Track Workload	21,821

Revised labor hours per position based on FY 2001 actual labor are presented in Table 62.

Table 62 - Rail Shop Hours per Employee

	# of Positions				*Hours Per Position*
Classification	*FY 1998*	*FY 1999*	*FY 2000*	*FY 2001*	*FY 2001*
Track Equipment Operator	11 of 19	16 of 20	18 of 19	19 of 19	992
Rail Maintenance Worker	5 of 7	5 of 7	5 of 7	3 of 6	

Labor Hours by Department

Table 63 illustrates FY 1997 through June of FY 2000 labor hours for each department within the Track & Guideway Division.

Table 63 - Track & Guideway Labor Hours by Department

Department	*FY 1997*	*FY 1998*	*FY 1999*	*Average*	*FY 2000**
Track	47,356	55,722	36,291	46,456	42,831
Guideway Inspection	8,268	8,311	8,324	8,301	6,799
Structure	3,235	13,020	16,605	10,953	21,993
Shop**	6,090	8,506	10,784	8,460	16,366
Total	64,949	85,559	72,004	74,171	87,989

*FY 2000 = Oct-Jun
**Shop numbers are understated for FY 1997 through FY 1999; FY 2000 figure represents 9 months of actual FY 2001 labor hours

Vacancy Rates

Vacancy rates from FY 1994 through FY 2001 are illustrated in Table 64.

Table 64 - Vacancy Rates

Classification	*94*	*V*	*Rate*	*98*	*V*	*Rate*	*99*	*V*	*Rate*	*00*	*V*	*Rate*	*01*	*V*	*Rate*
Administration															
General Superintendent	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%
Rail Maintenance Clerk	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%
Administrative Secretary 1	1	0	0.0%	1	0	0.0%									
Administrative Secretary							1	0	0.0%	1	0	0.0%	1	0	0.0%
MDTA Field Test Engineer	0	1	100.0%												
Vacancy Rate	3	1	25.0%	3	0	0.0%	3	0	0.0%	3	0	0.0%	3	0	0.0%
Total	4			3			3			3			3		
Rail Track															
Chief Supervisor, Rail Track	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%
Chief Supervisor, Guideway Inspection	1	0	0.0%	1	0	0.0%	1	0	0.0%	0	1	100.0%	1	0	0.0%
Rail Structure & Track Supervisor	2	1	33.3%	3	1	25.0%	4	0	0.0%	6	0	0.0%	5	1	16.7%
Guideway Inspection Specialist	3	1	25.0%	4	0	0.0%	3	1	25.0%	4	0	0.0%	4	0	0.0%
Track Repairer	7	10	58.8%	22	8	26.7%	28	1	3.4%	28	1	3.4%	25	5	16.7%
Vacancy Rate	14	12	46.2%	31	9	22.5%	37	2	5.1%	39	2	4.9%	36	6	14.3%
Total	26			40			39			41			42		
Rail Structure															
Chief Supervisor, Rail Structure	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%
Rail Structure & Track Supervisor	2	1	33.3%	2	2	50.0%	4	0	0.0%	2	0	0.0%	1	1	50.0%
Rail Structural Repairer	9	1	10.0%	7	1	12.5%	8	0	0.0%	8	0	0.0%	7	1	12.5%
Vacancy Rate	12	2	14.3%	10	3	23.1%	13	0	0.0%	11	0	0.0%	9	2	18.2%
Total	14			13			13			11			11		
Rail Shop															
Chief Supervisor, Rail Shop	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%	1	0	0.0%
Track Shop Supervisor	5	0	0.0%	3	2	40.0%	3	2	40.0%	5	0	0.0%	5	0	0.0%
Track Equipment Operator	8	6	42.9%	11	8	42.1%	16	4	20.0%	18	1	5.3%	19	0	0.0%
Rail Maintenance Worker	17	1	5.6%	5	2	28.6%	5	2	28.6%	5	2	28.6%	3	3	50.0%
Vacancy Rate	31	7	18.4%	20	12	37.5%	25	8	24.2%	29	3	9.4%	28	3	9.7%
Total	38			32			33			32			31		
Track & Guideway Vacancy Rate	60	22	26.8%	64	24	27.3%	78	10	11.4%	82	5	5.7%	76	11	12.6%
Total	82			88			88			87			87		
MDT Vacancy Rate	358	81	18.5%	364	69	15.9%	390	40	9.3%	388	42	9.8%	390	38	8.9%
Total	439			433			430			430			428		

Vacancy rates have significantly improved within the Track & Guideway Division; nonetheless, they continue to exceed the rates reported by the agency as a whole. In FY 1994, almost 1 in 4 positions allocated was vacant. In FY 2000, that number improved to 1 in 17 and then fell to 1 in 8 in FY 2001.

In the Phase I Rail Rehabilitation Report, Track & Guideway vacancy rates were discussed in detail. A study of filled positions completed by the Chief Supervisor of Rail Structure Maintenance found that over 74 percent of the Track & Guideway staff members were relatively new employees. It was determined that entry salary rates for Track & Guideway classifications were lower than those of Vehicle Inspection & Heavy Repair and Train Control & Traction Power. This lower salary rate at entry translates into larger differences in pay as an employee moves up to higher levels within the personnel system. A comparison of the number of employees who moved and the size of the department from which they came indicated a disproportionately higher number moved from Rail Vehicle Maintenance and from Track & Guideway. The movement within Rail Vehicle Maintenance was from less skilled jobs to those requiring more skill, and there was no movement from anywhere in the system into Track & Guideway. It was suggested that these positions were viewed as entry positions where employees remained only until they met criteria to move to other higher paying positions.

In the past, the two classifications within Track & Guideway with the highest vacancy rates were the Track Repairer and the Track Equipment Operator. A review of current vacancy rates yields slightly different results. In FY 1994, the vacancy rate for Track Repairers was almost 60 percent. In FY 2001, that rate was 17 percent. From FY 1994 until FY 2001, the vacancy rate for Track Equipment Operators decreased from 43 percent to zero, while the vacancy rate for Rail Maintenance Workers rose from 6 percent to 50 percent. The following table traces vacant positions in relationship to positions allocated for four classifications.

Table 65 - Overview of Vacancy Rates

Classification	*FY 1994 Vacancies*	*Total*	*FY 2001 Vacancies*	*% of*
Track Repairer	10 of 17	58.8%	5 of 30	16.7%
Rail Structural Repairer	1 of 10	10.0%	1 of 8	12.5%
Track Equipment Operator	6 of 14	42.9%	0 of 19	0.0%
Rail Maintenance Worker	1 of 18	5.6%	3 of 6	50.0%

Retention of Track Repairers and Track Equipment Operators no longer appears to be a problem, despite a significant increase in the number of the positions allocated within each of those classifications. The problem area today, in terms of vacancies, appears to be the Rail Maintenance Worker classification, where a significant reduction in the allocation of these positions has taken place.

System Expansion

In late 2002, the Metrorail system will expand 1.4 miles to include the Palmetto Station and rail extension, which will increase manpower requirements within Track & Guideway. Approximately 2.6 miles of mainline track will be added that will require:

- Track walk inspection – 2 times/week
- Curve lubrication – weekly
- Rail wear inspection – annually
- Interlocking inspection – monthly
- Ultrasonic rail testing – 2 times/year
- Track geometry testing – 3 times/year
- Direct fixation rail fastener anchor bolt inspection – every 4^{th} bolt annually
- Station pit cleaning – monthly
- Track inspection repair order for major failures projected at 6/year due to heavy volume of traffic over the turnout side of switches
- Girder inspection – additional RARs
- Top of girder inspection

Current Status

While it appears that an infusion of additional staff must occur now, it is difficult to determine the scope of the need, not only because staffing levels have been inadequate for an extended period of time but also because staff turnover has been excessive. Toward that end, the following recommendations are offered as a first step in the process of meeting Track & Guideway manpower requirements.

Manpower Requirements

Metrorail Top of Guideway, Graffiti Removal, and Vegetation Control

Based on an overview of labor hours, Track & Guideway has continued to perform these activities despite requested re-assignment of these activities to Transit Engineering.

> RECOMMENDATION: Explore the transfer of responsibility for the top of the Metrorail guideway inspection to Transit Engineering and consider contracting-out graffiti removal and vegetation control. If responsibility for these activities remains within the jurisdiction of Track & Guideway, based on labor hours required in the past, three additional Rail Structural Repairers should be allocated to facilitate completion of these tasks.

Rail Track

Staff required for the Insert Replacement Program includes two crews of one Rail Structure & Track Supervisor and six Track Repairers each, for a total of two supervisors and twelve repairers. The program will require a minimum of two years to complete.

> RECOMMENDATION: Complete a cost analysis of contracting-out this project versus completing it in-house. Given the level of staff required, the work might be accomplished in a shorter time frame by a contractor using a larger complement of employees. This type of work constitutes a project rather than a program; however, all employees hired will be retained after the project is completed. If it is cost effective to complete the project in-house, future projects should be identified for this work group prior to an employment commitment.
>
> The Track & Guideway General Superintendent indicated that the cost analysis of contracting-out would have to be with the constraints of available work time access to complete this work. He noted that a contractor would be faced with the same restrictions of track access as would be in-house forces, and a limited daily work time would basically prohibit using a larger work force due to these constraints. A contractor would have to be supported by a sizeable staff of in-house forces to provide flagging services, designate the location of the work needed, and assure correct repairs are accomplished. He indicated this work encompasses the entire system, and as such, would be more effectively approached as a program since the time required to complete the system would be lengthy, and areas would need to be addressed in order of need. He also stated that if it is cost effective to complete the project in-house, future projects exist and can be identified prior to an employment commitment.

Rail Shop

Staff requested for the Track Shop includes four Track Equipment Operators, two Track Shop Supervisors, and four Track Equipment Mechanics.

> RECOMMENDATION: There are currently 19 Track Equipment Operators and 6 Rail Maintenance Workers assigned to the Rail Shop. Seven of those Track Equipment Operators and three of the Rail Maintenance Workers are assigned to operate equipment while twelve Track Equipment Operators and three Rail Maintenance Workers are assigned to the shop. In 1994, the Rail Shop had a total of 32 staff in these 2 positions. Today, that number is 25. Equipment is becoming more

sophisticated, and the aging Metrorail system is expanding. Some procedures have been revised to provide system access during additional hours, thereby expanding the workday. Increased workloads within Rail Track and Rail Structures dictate the need for additional equipment operators not only to operate equipment but also to maintain and repair equipment that is being used to a greater extent. An increase from 19 to 23 Track Equipment Operators appears to be appropriate.

RECOMMENDATION: Look for ways to enhance track equipment operator availability within Track & Guideway while ensuring timely in-house PM and repair of equipment.

RECOMMENDATION: The Track Shop operates 24 hours a day, 7 days a week. The current allocation of 5 Track Shop Supervisors is insufficient to provide continuous coverage by a Track Shop Supervisor. The addition of one Track Shop Supervisor will provide continuous supervisory coverage.

RECOMMENDATION: The Track Equipment Mechanic position is a new classification designed to improve and enhance the maintenance capabilities of the shop. Given the current structure that includes equipment operation as well as maintenance by two different classifications, adding a third classification into the mix has the potential of creating organizational conflict, especially if the new position is considered to be either higher in rank or compensation. Track & Guideway should ask Classification and Compensation to study the proposed new position in relationship to the existing positions to identify potential benefits and/or conflicts.

RECOMMENDATION: Consider introduction of an incentive program for contracted-out specialized equipment repair and PM, based not only on timely turn-around of equipment by the contractor but also based on quality of performance of that equipment after repair.

Rail Structure

Rail Structure staff required to complete Remedial Action Reports based on time intervals established by the Florida Bridge Inspection Program totals two Rail Structure & Track Supervisors in addition to eight Rail Structural Repairers. Funding for the positions will be provided through Florida’s Bridge Inspection Program.

RECOMMENDATION: Approve positions based on verification of funding from the Florida Bridge Inspection Program.

Palmetto Station and Rail Extension

Track & Guideway identified a need for two Rail Structural Repairers, two Guideway Inspection Specialists, four Track Repairers, and one Track Equipment Operator to meet quantified maintenance and repair needs for the new Palmetto Station and rail extension.

> RECOMMENDATION: Approve positions after development of a Track & Guideway maintenance and repair schedule for the additional 2.6 miles of track.

Track & Guideway manpower recommendations are summarized in Table 66.

Table 66 - Track & Guideway Manpower Recommendations

Department	*Classification*	*Additional Positions*	*Area of Need*	*Action Required Prior to Approval*
Structures	Rail Structural Repairer	3	MR Guideway Inspection, Vegetation Control, Graffiti Removal	Attempt to transfer MR Guideway Inspection to Transit Engineering; Contract-out Vegetation Control and Graffiti Removal
Track	Rail Structure & Track Supervisor Track Repairer	2 12	Insert Replacement Project	Complete Cost-analysis of contracting-out versus in-house
Shop	Track Equipment Operator	4	Workload	
Shop	Track Shop Supervisor	1	Coverage	
Structures	Rail Structure & Track Supervisor Rail Structural Repairer	2 8	Fl Bridge Inspection Program	Confirm FDOT funding
Structures Track Track Shop	Rail Structural Repairer Guideway Inspection Specialist Track Repairer Track Equipment Operator	2 2 4 1	Palmetto Station and rail extension	Develop maintenance and repair plan for Palmetto Station and rail extension
	Total Additional Positions	41		

Chapter 2 - Rail Maintenance Control Manpower Needs

The Chief, MDT Rail Maintenance Control, who reports to the MDT Transit Services Assistant Director, manages Rail Maintenance Control. The Division was established in 1982 with a staff of three Transit Maintenance Production Coordinators and five Rail Maintenance Control Clerks to provide support to Vehicle Maintenance by issuing workload schedules and performing data entry of Vehicle Maintenance Reports (VMR). In the early 1990s, Maintenance Control assumed responsibility for support of System Maintenance, which included Communications as well as Train Control and Traction Power. Maintenance Control staff increased to four Transit Maintenance Production Coordinators and six Rail Maintenance Control Clerks. System Maintenance was reorganized with Communications reporting to Metromover and Train Control and Traction Power reporting to Vehicle Maintenance.

In 1991, Communications moved to Transit Engineering, and, in conjunction with the move, one Transit Maintenance Production Coordinator position and one Rail Maintenance Control Clerk position were re-assigned to Engineering. Nonetheless, Train Control and Traction Power reporting remained within Rail Maintenance Control.

At some point prior to 1994, the complement of Rail Maintenance Control Clerks was increased to six positions, and just recently, three additional Transit Maintenance Production Coordinators were approved as an efficiency measure for the division. The Division Office consists of the Chief and an Administrative Secretary. Table 67 identifies the 14 staff assigned to the division.

Table 67 - Maintenance Control Staff

Maintenance Control	*Positions*
Chief, MDTA Rail Maintenance Control	1
Administrative Secretary	1
Transit Maintenance Production Coordinator	6
Rail Maintenance Control Clerk	6

Rail Maintenance Control ensures that the information required to conduct the varied aspects of rail system maintenance is available, verifies by inspection of records and activities that operating maintenance actions and products conform to MDT specified requirements and standards, and routinely monitors and reports on performance of the various rail operations functions in the areas of quality, quantity, and timeliness of activities.

Maintenance Control serves as a primary source for maintenance related data and documentation. The Division currently provides support for Vehicle Maintenance, Communications, Train Control, Traction Power, Metromover, Track & Guideway, Rail Transportation, Facilities, Engineering, and the Change Review Board.

Maintenance Control objectives include:

- Scheduling all preventive maintenance requirements for each function of rail operations
- Collecting and processing data describing all work accomplished by the various operational functions
- Publishing all performance reports and information comparing required/planned actions to actual
- Maintaining the Rail Operations PM Program, plan, and records
- Maintaining equipment records and repair histories for all equipment
- Administering the agency's Change Control Program

CUTR noted in the Phase I Rail Rehabilitation Report that with an increased emphasis on workload measures, the role of Maintenance Control in tracking and analyzing data has become more critical. While Maintenance Control today provides a valuable role to MDT, it could enhance its effectiveness by taking better advantage of the data it collects. A wider distribution of the data and analysis to the operational entities could assist the operating divisions with their planning, scheduling, and, most importantly, their decision-making.

Maintenance Control Responsibilities

A discussion of Maintenance Control responsibilities was held with Transit Maintenance Production Coordinators, Rail Maintenance Control Clerks, and the Chief of Maintenance Control to assist in understanding the expanded role of Maintenance Control. Following is a summary of current responsibilities and functions:

- Absentee reporting initially done for Rail Transportation has now expanded to all sections
- Federal 1490 reporting involves recording daily hours for each Train Operator on a monthly basis; each Train Operator Report takes hours
- Expanded data collection and analysis for Track & Guideway now includes preparation of a Monthly Report
- Chairing the monthly Change Review Board in addition to maintaining the minutes and writing all procedures and obtaining Temporary Change Notice (TCN) approvals; associated activities are time consuming
- Coordination of all audits for the agency, i.e., APTA, FDOT, quality, and safety; seasonal in nature; major challenge is maintaining consistent data from one presentation to another
- Monitoring the growing Capital Grant Funding Program requires a major investment of time from December until April
- PM schedules for Rail Vehicle Maintenance, Metromover

Maintenance, Train Control and Traction Power, Track & Guideway totaling 3,000 packages per month

- Preparing an annual average of 500 PM schedules and tracking service disruptions for Facilities Maintenance; complete tool calibrations

- Document control for Engineering changes; TCNs require a great deal of work; received a 40 page TCN from Transit Engineering for Metromover wayside; Metrorail and Metromover mid-life overhauls will require extensive work

- Preparation of Standard Operating Procedures; complete for all sections; updating is not difficult; creating where procedures do not exist is difficult and time consuming

- Scheduling and tracking all equipment calibrations in addition to all equipment that has been contracted-out for repair within Rail Maintenance, Facilities, and Train Control & Traction Power

- Reporting requirements for FTA have dramatically increased, and mandated corrective action and tracking are now required with reporting on a monthly and quarterly basis; specific programs and projects identified include: implementation of SWAN, reconvening G Inspection Committee, tracking deferred maintenance, implementing GP-02 PM process, and tracking serialized equipment

- Metrorail's PVR has increased to 90 and Metromover's PVR has increased to 17; higher PVRs increase VMRs; Metrorail has seen an increase from 10 VMRs and work orders per day to 45 VMRs and shop work orders since the PVR increase; Metrorail system will expand in Fall 2002 when Palmetto Station and rail extension opens

- Facilities Maintenance has requested that Maintenance Control resume scheduling, tracking, and processing of PM inspections and elevator/escalator maintenance that totaled 549 in the past and add 1,975 pieces of bus specific equipment to PM process

- FTA demands timely credible reports; new reporting includes: inventory control, failure management reporting, rolling stock reporting, and management reporting

Maintenance Control Organization

Following is an overview of the structure Maintenance Control prior to approval of three additional Transit Maintenance Production Coordinator positions:

Table 68 - Maintenance Control Organization

Position	*Assignment*	*Subordinates*
TM Production Coordinator	Track & Guideway	1 RM Control Clerk
TM Production Coordinator	Rail Vehicle Maintenance Train Control	3 RM Control Clerks
TM Production Coordinator	Metromover Traction Power	2 RM Control Clerks

The organizational structure, as proposed by the Chief of Maintenance Control, including the three additional Transit Maintenance Production Coordinators, is presented in Table 69.

Table 69 - Revised Maintenance Control Organization

Position	*Assignment*	*Subordinates*
TM Production Coordinator	Rail Vehicle Maintenance SWAN Heavy Repairs	2 RM Control Clerks
TM Production Coordinator	Metromover	2 RM Control Clerks
TM Production Coordinator	Track & Guideway Capital Projects	1 RM Control Clerk
TM Production Coordinator	Rail Transportation Train Control Traction Power Vital Relays	1 RM Control Clerk
TM Production Coordinator	Special Projects Audit FTA Reporting Monthly Report Quality Assurance	
TM Production Coordinator	Facilities Maintenance Calibration Change Review Failure Management Rail Rehabilitation	
Computer Analyst/Programmer		

Extensive work was completed pursuant to FTA's request for an Action Plan to track items identified for follow-up in CUTR's Phase I Rail Rehabilitation Report. As a result of those efforts, Maintenance Control identified a total of 16.5 additional staff needed to assist with the follow-up work. Included in that total were 5.5 new Transit Maintenance Production Coordinators and 11 new Rail Maintenance Control Clerks.

The scope of responsibilities for the additional staff contained several project, rather than program, items. In the absence of adequate staff, several reporting functions contained errors or were incomplete. Additional staff would facilitate "clean-up" of those items so the movement forward could be on a solid base. While there appears to be a need for this work to be accomplished, once it is completed, the need for those staff required to complete the work subsides. Those project items included such things as recalculating service disruption methodology, establishing a base of serialized equipment, correction of the Mean Miles Between Failures methodology and update of the Metrorail and Metromover vehicle logs.

Table 70 presents an overview of a proposed organizational structure that integrates additional staffing needs, hi-lighted in red text, into the revised Maintenance Control organization. It identifies a need for 8, rather than 11, additional Rail Maintenance Control Clerks. A total of four of the new Control Clerks are assigned to assist recently approved Transit Maintenance Production Coordinators. While it does not show a need for additional Transit Maintenance Production Coordinators in excess of the three new Transit Maintenance Production Coordinators, it does show a need for a "Program Designer & Analyst" position. Coordination of effort is critical for efficient functioning of Maintenance Control. A significant effort is required now to establish correct, viable databases that can be shared across divisions and minimizes duplication of data handling efforts. That role would be best filled by a Program Designer & Analyst position as a direct report to the Chief of Maintenance Control.

Based on current responsibilities and Action Plan requirements, additional staff needs total nine.

Table 68 - Proposed Maintenance Control Organization

Position		
TM Production Coordinator	Rail Vehicle Maintenance SWAN Heavy Repairs G Inspection	2 RM Control Clerks 2 RM Control Clerks
TM Production Coordinator	Metromover Metromover Overhaul	2 RM Control Clerks 1 RM Control Clerk
TM Production Coordinator	Track & Guideway Capital Projects GP-02PM	1 RM Control Clerk
TM Production Coordinator	Rail Transportation Train Control Traction Power Vital Relays Train Control/Traction Power Tracking	1 RM Control Clerk 1 RM Control Clerk
TM Production Coordinator	Special Projects Audit FTA Reporting Monthly Report Quality Assurance Repair Order Workload Measure	2 RM Control Clerks
TM Production Coordinator	Facilities Maintenance Calibration Change Review Failure Management Rail Rehabilitation	2 RM Control Clerks
Computer Analyst/Programmer (Program Designer & Analyst)		

In an attempt to confirm the proposed allocation of additional staff, a detailed analysis of a document prepared by a previous Chief of Maintenance Control, regarding Maintenance Control tasks and assignments, was conducted. Unfortunately the document was not dated; nonetheless, it did contain references to all departments listed above as well as Facilities Maintenance. It consisted of a listing of tasks with associated hours required to complete those tasks by area on a monthly, biweekly, weekly, and daily basis. There were individual task listings for seven Rail Maintenance Control Clerks and two Transit Maintenance Production Coordinators. Annual hours were calculated based on the actual hours the task required and the frequency with which the task occurred during the year. The data were sorted and summarized to provide an overview of annual area requirements. The area referred to as "Rail/Mover Maintenance" was prorated and divided between "Rail Maintenance" and "Mover Maintenance" on the basis of a total of 165 vehicles in the combined fleets (i.e., Metromover's 29 vehicles were equivalent to 18 percent of the total vehicles, and Metrorail's 136 vehicles were equivalent to 82 percent of the total vehicles). Those hours were then added to either Rail Maintenance or Mover Maintenance and are reflected under the column entitled *Annual Adjusted* in Table 71. Likewise, the areas identified as "Facilities" and "All" were combined to form one category. Hours representing that combined category are presented under the *Annual Adjusted* column in Table 71, which presents an overview of the general distribution of each area's percentage of projected annual task requirements.

Table 71 - Allocation of Tasks by Area

Area	*Actual*	*% of*			*Adjusted*	*% of Annual*
Track & Guideway	146	7.8%	2,984	9.3%	2,984	9.3%
Train Control	191	10.2%	3,804	11.9%	3,804	11.9%
Rail/Mover Maintenance	210	11.2%	2,936	9.2%		
Rail Maintenance	301	16.1%	6,066	19.0%	8,486	26.5%
Mover Maintenance	407	21.8%	6,840	21.4%	7,356	23.0%
Facilities	37	2.0%	1,284	4.0%	9,348	29.2%
All	576	30.8%	8,064	25.2%		
Total	1,868		31,978			

Proposed Rail Maintenance Control Clerk assignments as a percentage of the total are illustrated in Table 72.

Table 72 - Allocation of Rail Maintenance Control Clerk Positions

Area	*Annual*	*% of Annual*	*Annual Adjusted*	*Adjusted % of Annual*	*RMCC Allocation*	*% of*
Track & Guideway	2,984	9.3%	2,984	9.3%	1	7.1%
Train Control	3,804	11.9%	3,804	11.9%	2	14.3%
Rail/Mover Maintenance	2,936	9.2%				
Rail Maintenance	6,066	19.0%	8,486	26.5%	4	28.6%
Mover Maintenance	6,840	21.4%	7,356	23.0%	3	21.4%
Facilities	1,284	4.0%	9,348	29.2%	4	28.6%
All	8,064	25.2%				
Total	31,978				14	

Personnel Needs

The allocation of Rail Maintenance Control Clerks appears to be appropriate. Additional staffing recommendations are summarized in Table 73.

Table 73 - Rail Maintenance Control Staffing Recommendations

Classification	*Additional*
Rail Maintenance Control Clerk	8
Program Designer & Analyst	1
Total	9