Miami-Dade County Transit Agency

Rail Rehabilitation

Phase I – Final Report

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

The report was prepared by:
Janet L. Davis
Stephen L. Reich

Center for Urban Transportation Research
University of South Florida, College of Engineering
4202 E. Fowler Ave., CUT 100
Tampa, FL 33620-5375

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A special acknowledgment of the 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 the Agency 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. Phase II commenced on August 25, 2000, upon completion of Phase I and focused attention on Metromover. Final report submission date was November 24, 2000.

Project Approach

The approach to the project included the formation of a Rail Rehab Task Force composed of key personnel within the Agency in addition to the project team. Status reports and presentations of data collected to date occurred every 2-3 weeks. FTA Section 15 data for Miami-Dade Transit Agency (MDTA) Metrorail, Baltimore (MTA), Washington (WMATA), Atlanta (MARTA), and Los Angeles (LACMTA) were analyzed and reviewed. Dozens of Metrorail and MDTA staff were interviewed and all divisions were toured. Site visits by the project team and two members of Metrorail staff were made to MTA, MARTA, and WMATA. A "draft" Phase I Report was submitted to the Rail Rehab Task Force, and Phase I findings and recommendations were presented to the Rail Rehab Steering Committee.

Findings

Of the systems reviewed, Metrorail compares most closely to MTA. Metrorail has fewer rail cars per route mile than MTA, LACMTA, and WMATA but has the second highest ratio of vehicles available for maximum service to vehicles operated during maximum service. Metrorail receives slightly less of a percentage of MDTA funding than its percentage of passenger miles provided. Metrorail's maintenance cost per vehicle is lower than WMATA's but higher than MARTA's and MTA's on a total fleet basis, and Metrorail was significantly less reliable than MARTA and WMATA.

The hiring, selection and training processes currently in place create hardships for Metrorail, especially in Rail/Mover Maintenance. The requirement to select "qualifiable" candidates erodes productivity, exacerbates turnover, and lengthens time for the development of job proficiency. The promotion of employees based almost entirely on seniority is causing unnatural career movement in the agency.

The current practice for approving use of outside vendors is significantly more rigorous than what is called for in the collective bargaining agreement. The interrelationship of the selection/recruitment processes and the contracting issue affect the estimate of manpower needs.

Metrorail is at the low end in the number of hours dedicated to maintaining its vehicles in comparison to other properties.

System condition averages ranged from poor to fair, with obsolescence and car body subsystems driving down the ratings.

MDTA's expenditures grew at a rate of 3.8 percent from FY 1994 to FY 2000; however, on a constant dollar basis, the level of MDTA total FY 2000 expenditures is lower than the FY 1994 level. Vehicle operations spending has been decreasing in absolute terms, and vehicle maintenance spending essentially has been flat. Metrorail capital investment in facilities has been rising while no significant capital investment has been made in rail vehicles. Additional capital needs for Metrorail are estimated at $200 million, with $60 million of the $200 million capital needs within the program period.

Rail vehicle overhaul is recommended for a FY 2003 construction start. In addition to the midlife overhaul of the rail vehicles, significant investment in the Train Control and Traction Power systems is included in the capital needs.

Recommendations

The current process of contracting maintenance work to outside vendors needs to be revisited.

- Begin dialogue with the Transit Workers Union to establish a process for the Agency to procure <u>types</u> of work through contract rather than on the basis of each item or routine activity.
- Establish mutually acceptable parameters between "buyers" and "users" to streamline specifications and contracts at the County level.
- Establish a process or checklist for use in evaluating new activities or programs under consideration for their potential as in-house versus contracted out projects. This could help to avoid the diversion of in-house talent to projects of sufficient magnitude or duration that would overburden the existing workforce and hinder completion of their other priorities. A sample checklist will be provided to the Agency.

- Consider participation in the Rail Car Consortium, a group of East Coast heavy rail service providers mutually interested in leveraging the buying power of the group to obtain replacement parts and components at reduced costs.
- Pilot a “blended” approach to contracting. This pilot program would involve a procurement approach that includes the training of Metrorail personnel while ensuring the expertise and warranty that a vendor might offer. The “blended” approach would have heavy involvement of a contractor at the front-end of the project and diminish over time as the Metrorail workforce becomes more proficient. Some on-site presence or inspection by the vendor would be required if a certification or warranty were involved. The gearbox rebuild would seem to lend itself to a “blended” approach.

MDTA should re-examine 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.

- Initiate a coordinated effort with representatives from Human Resources, Labor Relations, Finance, and Metrorail to establish minimum qualifications for rail maintenance classifications that include relevant technical training and experience.

- Develop a system of progressive advancement based on performance in addition to seniority.

MDTA should establish mechanisms that encourage innovation and investment in the workplace.

- Organize cross-functional groups to problem-solve common issues.
- Establish methods of performance assessment that provide employees with feedback on their performance and assist those employees in setting relevant goals for future performance.
- Using a recognized management tool such as Total Quality Management (TQM) or Organizational Cultural Change Program, take the steps necessary to create an environment that encourages individual units to develop legitimate measures of success within the overall framework of MDTA’s mission.

MDTA should establish structure within the organization that provides consistency and continuity.

- Establish a mechanism to take advantage of the large amounts of data and information collected to discover trends, evaluate results, identify needs, and formulate plans.

- Develop feasible work standards for Metrorail and use those standards to benchmark performance, not only in terms of quantity of work produced but also in the quality of that work.
- Re-evaluate restrictions on use of the mainline during revenue service to maximize access to the mainline for maintenance, testing, and training.
- Remove the remaining two pairs of rail cars from “mothball” status immediately.
- Establish a system for selecting vehicles for the “G” inspection that includes specific criteria as well as a timeline.
- Take action to normalize fleet mileage to ensure that all vehicles within the fleet achieve a 40-year car life.
- Establish an annual process to evaluate the progress made on the recommendations, if any, which are adopted.

MDTA should ensure that sufficient funding continues for the enhanced vehicle maintenance activities and attempt to provide Metrorail with a capital infusion required to perform the rehabilitation activities mentioned in this report.

- Ensure adequate funding for the continuation and ultimate completion of the “G” inspection.
- Give favorable consideration to Train Control and Traction Power projects that have been identified because of parts availability and obsolescence.
- Plan and start the Rail Car Modernization or Mid-life overhaul in FY2003. Funding in FY 2001 will be required to perform the preliminary engineering and specification development.
- Consider a 20-year needs study for Metrorail. Based on life cycles for the rail infrastructure, the needs study would provide executive management with a view beyond the six-year capital program and serve as the pool of projects that feeds the capital program updates.

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INTRODUCTION

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

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

This report represents CUTR's findings on the work involved with Phase I – Metrorail and Phase II – Metromover. The project for Metrorail 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 I of this report will summarize the project team's findings for Metrorail. A technical appendix to the report containing the detailed analysis will be provided with the final report.

A Rail Rehabilitation Task Force composed of Agency Rail Division personnel met formally eight times after the project began in April to track the progress of CUTR's work, review draft findings, and provide comments and guidance. The task force members also were involved in several other meetings and interviews, and two members accompanied the project team on technical visits to three other heavy rail properties that were chosen for comparison. Initially, the following four peer heavy rail systems were chosen: Metropolitan Atlanta Rapid Transit Authority (MARTA), Maryland Mass Transit Administration (MTA), Washington Metropolitan Area Transit Authority (WMATA), and Los Angeles County Metropolitan Transportation Authority (LACMTA). The start-up nature of LACMTA made comparison with that system difficult. Nonetheless, data were collected on LACMTA and will be presented where appropriate.

The MDTA Maintenance Control Division assembled much of the data required. In addition, given the tight time frame within which MDTA required the effort to be completed, there is a heavy reliance on the Federal Transit Administration's Section 15 data for Metrorail and the other systems. While there are certainly variations in methods of reporting, the National Transit

Data Base contains enough parameters that a good sense of the relative scale and performance of the peer heavy rail systems can be established. The latest year for which all of the transit properties have reported in a consistent manner is 1998; however, data for Metrorail were collected through 1999 and for the first half of calendar year 2000 in some cases.

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

Metrorail was completed in its current configuration in 1984 at an original cost of $1.03 billion. With 21 miles of mainline, 136 rail cars, a substantial rail yard and 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 with finite resources without an intimate knowledge of the day-to-day problems facing the numerous operations. This report attempts to provide an objective assessment of the needs facing the Rail Division, recognizing that other competing needs within MDTA and the County may or may not be as compelling.

While the scope of work for this project envisioned that equal attention would be given to rail vehicles, track and guideway, train control and traction power, and transportation, the direction of the task force and the complexity of the issues required the project team to devote what was perhaps a disproportionate level of effort on the rail vehicle part of the study.

The scope of work for this initiative also specified that particular attention be given to the issues of contracting repair work with outside vendors, personnel issues, and practices adopted as a result of the Section 13 (C) provisions of the Urban Mass Transportation Act of 1964.

This section of the report will focus on seven major areas: System Overview, Rail Transportation, Vehicle Inspection and Heavy Repair, Train Control and Traction Power, Track and Guideway, Maintenance Control, and Financial Aspects.

Chapter 1 System Overview

Metrorail is a 21-mile system with 21 stations stretching from the Dadeland South Station north to the current terminus at Okeechobee. With 136 rail cars, the system serves over 45,000 passengers daily. Operating expenses of just over $50 million were reported in 1999. Over 104 million passenger miles of service were provided last year with an operating staff of 422. The average passenger trip length was 7.7 miles, and 253 service interruptions were reported.

To provide a context for the overview of Metrorail, some of the comparative data with the peer systems will be presented. The peer systems chosen for the study were LACMTA, MARTA, WMATA, and MTA. While the system attributes vary greatly, comparisons can be made. Table 1 summarizes some of the more relevant characteristics of the peer systems.

Table 1 - Comparison of Peer Characteristics
Selected Characteristics, 1998

		Rail Cars		
System	*Route Miles*	*Vehicles Available*	*Vehicles Operated*	*Operating Personnel*
Metrorail	42	136	80	422
LACMTA	10	30	24	276
MARTA	92	238	176	1,354
WMATA	185	764	620	4,062
MTA	29	100	54	441

As can be readily seen, Metrorail compares most closely with MTA. In addition, Metrorail rail cars are almost identical to the MTA fleet having been jointly procured in the early 1980s. 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 peak revenue vehicle requirement plus any additional rolling stock necessary for use as transition vehicles or as maintenance back-up vehicles.

Table 2 depicts a detailed comparison of the systems.

Table 2 - Peer Heavy Rail Systems – 1998

System	*Transit Service Supplied*								*Transit Service Consumed*	
	Vehicles Operated In Maximum Service	*Vehicles Available For Maximum Service*	*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*	*Annual Unlinked Passenger Trips*	*Annual Passenger Miles*
Metrorail	80	136	5,741,940	6,212,430	6,072,490	97.7	259,800	236,510	13,482,520	104,301,740
MARTA	176	238	24,944,800	22,994,090	22,177,070	96.4	847,410	821,070	77,802,000	488,747,660
MTA	54	100	5,412,850	4,409,710	4,229,470	95.9	177,130	168,990	12,833,590	67,220,320
WMATA	620	764	42,266,980	46,886,920	44,788,100	95.5	2,270,460	2,109,820	213,044,900	1,077,145,700
LACMTA	24	30	1,653,110	1,663,330	1,646,460	99.0	83,080	78,930	12,269,210	24,118,090

While the systems' scales vary greatly, on a pro rata basis, one can begin to see where Metrorail ranks in terms of use and level of effort to provide and maintain service. By taking the annual actual vehicle revenue miles and dividing those miles by the number of vehicles operated in maximum service (VOMS), Metrorail ranks ahead of both WMATA and LACMTA and is comparable to MTA in this mileage comparison as indicated in Figure 1.

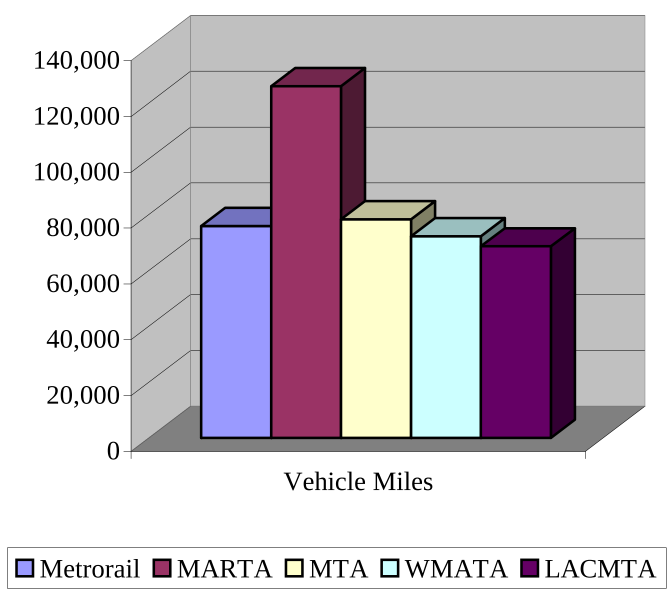


Figure 1 - Comparison of 1998 Annual Vehicle Revenue Miles per VOMS

If the entire fleet were used, the Metrorail would rank second with 45,680 miles. The difference in the miles is a function of the number of cars used as operating spares.

Metrorail's 42 directional route miles rank between the low of LACMTA's 10 and the high of WMATA's 185. A more relevant measure of the extent of the system in terms of the scope of service is that of directional route miles to passenger miles. Figure 2 depicts the relative comparison.

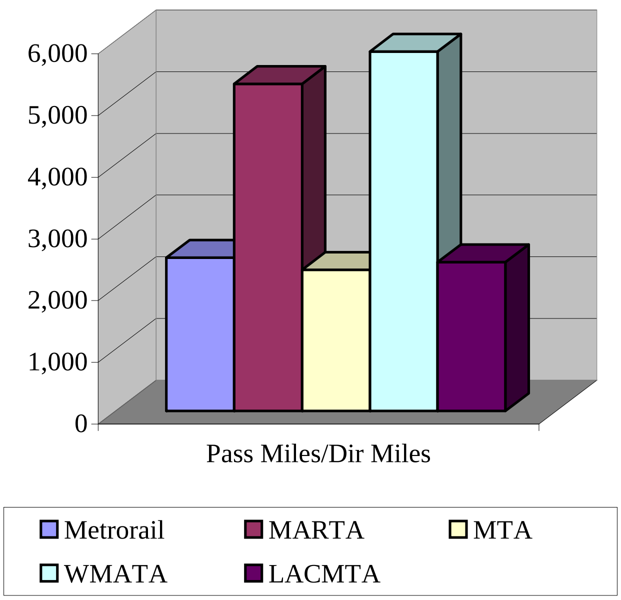


Figure 2 - Comparison of Passenger Miles per Directional Mile (in 000's)

Comparable with MTA and LACMTA, Metrorail provides roughly 2.4 million passenger miles of service annually for each of the 42 directional miles of the rail system. This is, however, less than half of the service provided by MARTA and WMATA measured on this basis.

Figure 3 shows the number of rail cars that each system has, in total, compared to the number of route miles. Again, Metrorail seems to be in the "middle of the pack" with no unusual attributes. Each of the systems with the exception of WMATA owns between 2 ½ and 3 ½ rail cars per directional mile of track. Even though WMATA exceeds the other systems, they are in the process of accepting a shipment of 192 more cars to add to the existing fleet.

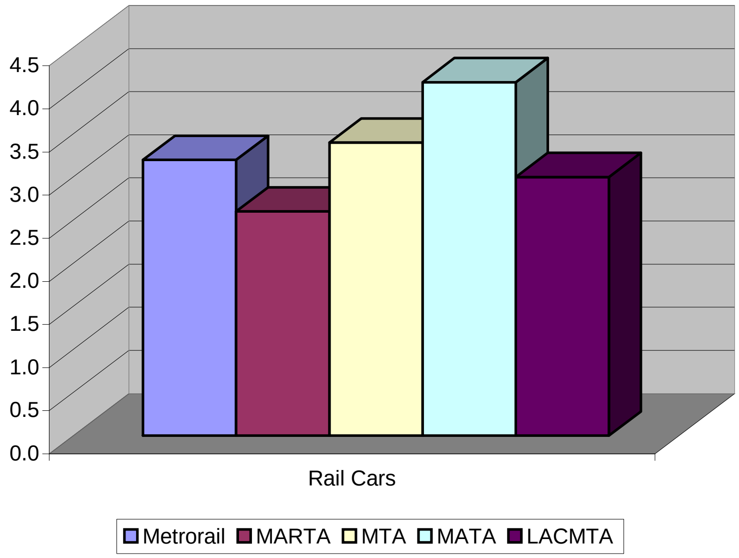


Figure 3 - Comparison of Total Rail Cars per Mile

In 1998, Metrorail carried nearly 27 percent of the passenger miles reported for the entire MDTA. During that year, rail consumed 42 percent of the total capital and only 22 percent of the operating expenses. In terms of total expenditures attributed to the rail system, the capital and operating expenditures reported equaled just under 25 percent of the total reported. A comparison of these percentages for the peer systems is presented in Table 3.

Table 3 - Comparison of 1998 Heavy Rail Percentages of System Totals

	Passenger Miles	*Total Capital*	*Operating Expenses*	*Total Expenditures*
Metrorail	26.8	41.9	22.1	24.8
MARTA	65.6	85.5	30.4	47.3
MTA	12.3	12.5	13.0	12.9
WMATA	72.7	81.7	55.0	65.2
LACMTA	1.6	0.4	4.5	3.8

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 Metrorail for the last several years. Although the percentage seems high relative to the percentage of service provided, Figure 4 shows these percentages have grown significantly since 1996.

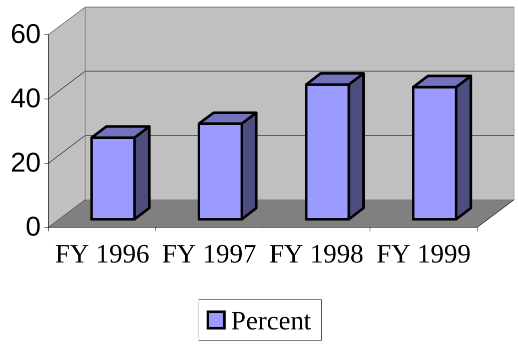


Figure 4 - Metrorail Capital as a Percentage of Total Capital

Operating expenditures as a percentage of MDTA's total operating expenditures have remained relatively constant from FY 1994 to FY 1999. The six-year average has been 22.3 percent. Figure 5 indicates the year-to-year change.

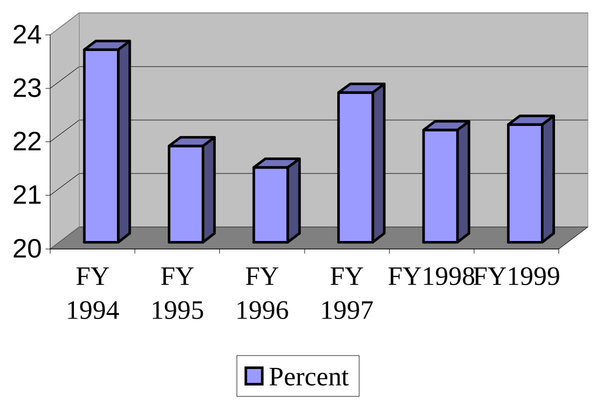


Figure 5 - Metrorail Operating as a Percentage of Total

An examination of the maintenance investment per rail car yields two comparisons. The first is a comparison of Metrorail with the peer systems to the average annual maintenance expenditure per rail car operated in maximum service (VOMS). Next, the same comparison is made but on the basis of vehicles in the entire fleet (VAMS). This analysis shows Metrorail on the high end of the range of peer systems using both methods. The comparisons are illustrated in Figures 6 and 7.

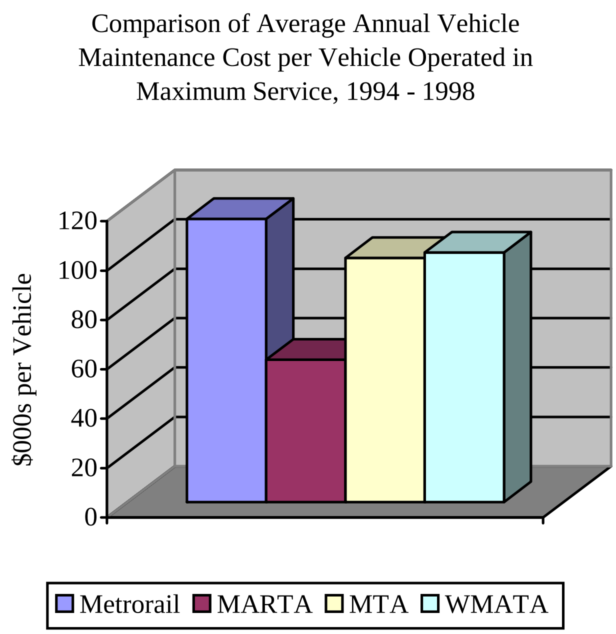


Figure 6 - Average Annual Vehicle Maintenance Cost per VOMS

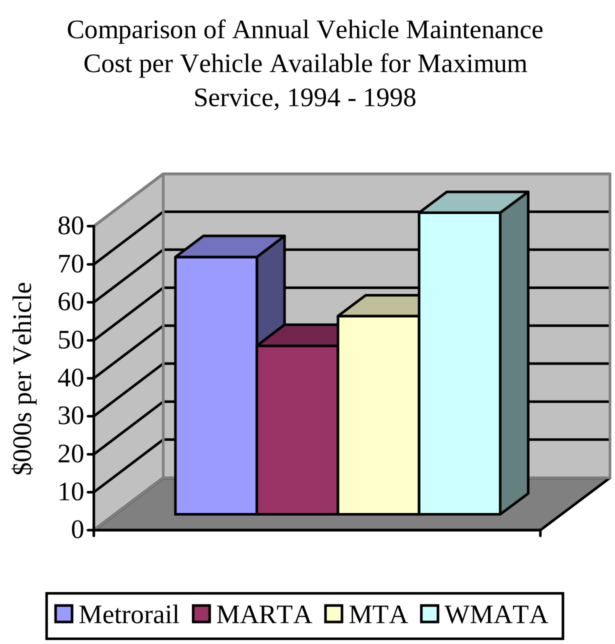


Figure 7 - Average Annual Vehicle Maintenance Cost per VAMS

A review of the operating costs in terms of vehicle miles and vehicle hours for Metrorail and its peers in 1998 shows that, while the cost per vehicle mile and the cost per vehicle hour fell within the middle of the group, Metrorail's maintenance expenses per passenger trip and per passenger mile were the highest reported as shown in Table 4. The number of maintenance employees in relationship to VOMS and VAMS is also presented in Table 4. Despite high maintenance expenses reported for passenger trips and miles, Metrorail had fewer maintenance employees per VOMS and VAMS than the other systems.

Table 4 - Operating Costs, Maintenance Expenses, and Maintenance Employees

	1998 Total Operating Costs	*Cost per Vehicle Mile*	*Cost per Vehicle Hour*	*Maintenance Expense per Passenger Trip*	*Maintenance Expense per Passenger Mile*	*Maintenance Employees per VOMS*	*Maintenance Employees per VAMS*
Metrorail	222,776,200	35.86	857.50	0.7196	0.0930	1.04	0.61
MARTA	318,120,848	13.83	375.40	0.1685	0.0268	1.03	0.76
MTA	260,456,250	59.06	1,470.42	0.3689	0.0704	1.38	0.74
WMATA	667,850,170	14.24	294.15	0.3541	0.0700	1.20	0.98

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 rail agency to another varies dramatically. The National Transit Data Base provides information on "road calls" for all of the agencies. Because the definitions of a major and minor road call changed during the study period, the total road calls figure is used here. Figure 8 shows the total road calls for Metrorail from 1995 to 1999 to illustrate the Agency's trend. Figure 9 provides the data for Metrorail and the peer systems but is normalized on the basis of passenger miles of service.

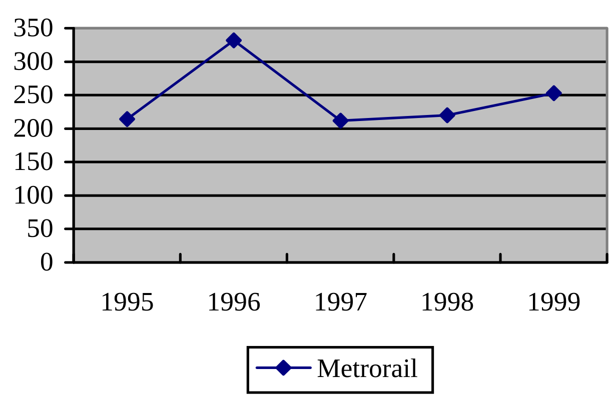


Figure 8 - Total Road Calls, Metrorail

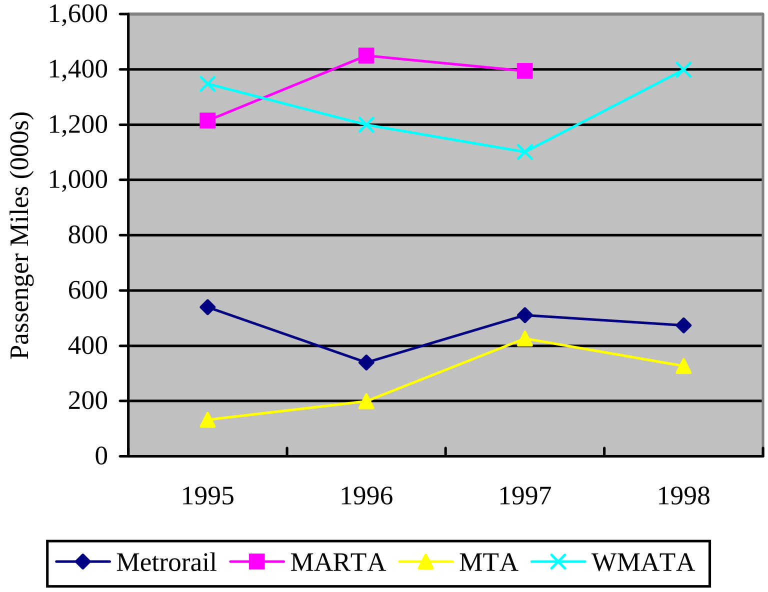


Figure 9 - Comparison of Passenger Miles Between Roadcalls

If the "Section 15" data are accurate and close to being consistently reported, Metrorail is showing a positive trend based on passenger miles between road calls but is at the low end of the peer group with MTA's figures indicating the lowest number of passenger miles between breakdowns.

With this system overview as a backdrop, each of the divisions of MDTA Metrorail, as shown in the following organization chart, is described in detail in the next sections. An overview of the respective responsibilities, analysis of manpower, identified capital needs, physical assessment of the infrastructure, and other issues acknowledged are presented for each Division.

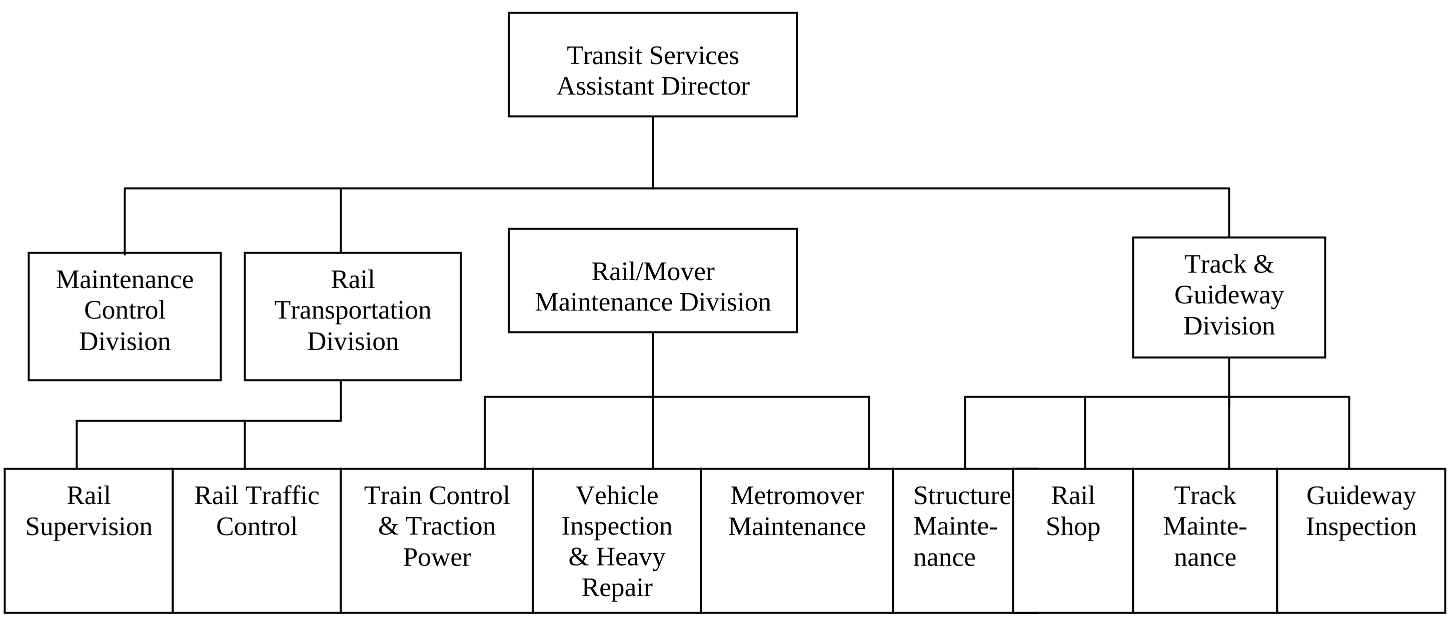


Figure 10 - MDTA Metrorail/Metromover Organization Chart

Chapter 2 Rail Transportation

Rail Transportation, managed by a General Superintendent who reports to the MDTA Transit Services Assistant Director, provides Central Control, Yard Control and Rail Supervision, including Train Operators, for Metrorail/Mover. The Division Office consists of the General Superintendent, an Administrative Secretary, and a Secretary position that is currently vacant. A total of 99 staff is assigned to the division.

Central Control and Yard Control are directed by the Chief Supervisor of Rail Traffic Control.

A. Central Control

Central Control operates 24 hours a day, 7 days a week and includes train control, communications, and power distribution systems. Central Control coordinates, monitors, and directs Mainline operations and is responsible for all revenue and non-revenue train movements made on the Mainline, including the Tail Track to the Yard Limits. Staffing consists of 21 Rail Traffic Controllers. At the present time, one of the 21 positions is vacant.

B. Yard Control

Yard Control also operates 24 hours a day, 7 days a week and includes the direction, monitoring and coordination of all trains and rail work equipment movement within Lehman Center Yard limits, Train Operator staffing and directing the make-up of trains, as well as coordination with Rail Vehicle Maintenance to maintain vehicle requirements. All movement of trains to the maintenance shop and wash area is controlled through Yard Control except for non-signaled/non-powered maintenance of way tracks. Yard Control is staffed by 8 full-time Rail Yard Masters.

In the current organizational structure, Rail Transportation has five full-time positions designated as Rail Station Monitors. Plans are underway to re-classify those positions to Rail Traffic Controllers, which would increase the complement of Rail Traffic Controllers from 21 to 26 positions. Re-classification will be accomplished in one of two ways. Rail Station Monitors will be automatically re-classified as Rail Traffic Controllers, and they will serve a probationary period to ensure they are qualified to perform the position functions, or they will be required to meet the minimum qualifications of the new position as a requirement for re-classification. A total of 35 employees perform Central/Yard Control functions.

C. Rail Supervision

Rail Supervision serves as first line supervision to Train Operators, provides support to Central Control, and monitors Train Operator performance both in direct train operator interaction and failure management activities.

A total of 11 Rail Supervisors report directly to the General Superintendent. In the past, these Supervisors reported to a Chief Supervisor of Rail Operations who, in turn, reported to the General Superintendent. Apparently, this position was eliminated as a result of budget reductions. The General Superintendent expressed interest in having this position re-instated with the new designation of Chief Supervisor of Rail Transportation. Rail Supervisors directly supervise a total of 50 full-time Train Operators and 2 part-time Train Operators. At the present time, 1 of the 50 Train Operator positions was vacant.

Metrobus serves as Metrorail's source for filling Train Operator positions. All successful candidates must complete a reading and comprehension test in order to qualify for entry. The Train Operators' training program spans 32 days and includes classroom, real time on the rail line, and a qualifications test. Training is provided by staff external to the Division and appears to be adequate. To fill vacancies expediently, the General Superintendent would prefer to hold 4-5 training sessions annually to create a pool of qualified Train Operators as opposed to the current process of providing training directly in response to vacancies. While this type of "batch" training can be more efficient, it often can be somewhat ineffective due to time delays between training and the actual start of the assignment. Given the length of the training program and the fact that all Train Operators come from Metrobus, it might be worthwhile to offer a pilot training program to evaluate the effectiveness of this type of training.

D. Vacancy Rates

Vacancy rates were reviewed for the time period from FY 1998 until the present time. In all classifications, those rates have remained relatively low for Rail Transportation as shown in Table 5 through Table 9.

Table 5 - Metrorail Rail Traffic Controller Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 23 vacant	0.0
1999	0 of 23 vacant	0.0
10/99-5/00*	1 of 21 vacant	4.8

*Staff show an allocation of 22 rather than the 21 positions reported by Metrorail

Table 6 - Metrorail Rail Station Monitor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 5 vacant	0.0
1999	2 of 5 vacant	40.0
10/99-5/00	1 of 5 vacant	20.0

These positions will be eliminated in the future as discussed previously

Table 7 - Metrorail Rail Supervisor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 11 vacant	0.0
1999	0 of 11 vacant	0.0
10/99-5/00	1 of 11 vacant	9.1

Table 8 - Metrorail Train Operator Vacancies

Fiscal Year	*Vacancies*	*%*
1998	3 of 49 vacant	6.1
1999	3 of 48 vacant	6.3
10/99-5/00	1 of 50 vacant	2.0

Table 9 - Metrorail Rail Transportation Vacancies

Fiscal Year	*Vacancies*	*Rail Transportation Total %*	*Metrorail/ Metromover Total%*
1998	4 of 99 vacant	4.0	16.0
1999	8 of 100 vacant	8.0	9.3
10/99-5/00	5 of 99 vacant	5.1	8.1

E. Operating Issues

Operating issues of concern to the General Superintendent included complaints from Train Operators regarding recurring maintenance problems. Operators identified issues such as observing the same problem on the same car despite maintenance intervention, water leaking during downpours, difficulty with sliding windows, and recurring mechanical problems.

Testing on the mainline during revenue service is another issue of concern. The window for non-revenue service spans only from 1 a.m. until 3:30-4:00 a.m. seven days a week. Train Operator testing, vehicle testing, and maintenance of the wayside systems all compete for that extremely limited window. While testing during revenue service is permissible, Metrorail/Metromover discontinued all testing during revenue service in response to an accident that occurred several years ago. Apparently, MDTA did consider the construction of a test track to facilitate testing; however, given the logistics and financial resources required to construct a facility capable of testing a vehicle in excess of 20 mph, the construction of a test track was never realized. The General Superintendent did offer that improvement in the coordination of manpower between the Track & Guideway Division and Train Control/Traction Power could help to minimize some of the limitations currently experienced by Rail Transportation. MTA allows single-track operation after 8 p.m. and on Saturdays when headways are 22 minutes or greater. While not as desirable from a maintenance point of view as having total system access, this does allow for an additional 14 hours of access for maintenance activities each week.

The final concern expressed by the General Superintendent has to do with the work train operator. Personnel assigned to operate the work train are not classified as Train Operators and have not received training required by Train Operators. Mandatory Train Operator training for work train operators would serve to improve their skills. At MARTA, only Train Operators are allowed to move trains. WMATA has a special operator classification assigned to operate the work train, and they allow all mechanics to operate trains over 3 stations.

To enhance Rail Transportation operations, the General Superintendent recommends creating the new position of "Administrative Officer" to assist the General Superintendent in managing the budget, disciplinary actions, paperwork, and coordination with MDTA. The General Superintendent is confident that the addition of this position in conjunction with the re-allocation of the Chief Supervisor of Rail Transportation, as discussed earlier, would improve management, direction and coordination not only within the Division but also with other divisions and agencies. As indicated in the introduction, a disproportionate amount of time was devoted to rail vehicles, and a detailed analysis of positions within Rail Transportation was not possible. There appears to be a need for an Administrative Officer to provide assistance to the General Superintendent. Although the proposed Chief Supervisor of Rail Transportation would create a balance between Control and Transportation, the position appears to add an additional layer in the organization at a time when supervisor-to-subordinate ratios are relatively low. If MDTA is unable to provide approval for re-allocation of the position, the project team suggests considering expansion of the role of the Chief Supervisor to include Control and Transportation.

In August 1991, Metrorail began preparations for Rail Modernization to enhance their current operations and upgrade equipment that was approaching obsolescence. Rail Modernization included:

- replacement of the central computer,
- upgrade of the communication lines and network,
- supervisory Control and Data Acquisition System (SCADA),
- new fiber optic carrier,
- projection system,
- ergonomic re-design of the existing Central Command Control Center, and
- integration of field equipment.

Rail Modernization is approaching completion. The Central Control computer has been replaced; the communication lines and network have been upgraded; and fiber optics have been installed. Two vehicles have been equipped with automated customer service passenger announcements, and a demonstration should be available in the near future. Numerous deficiencies in the 800 MHz radio system have been corrected to an acceptable level.

Chapter 3 Rail/Mover Maintenance

The following discussion deals solely with Rail Maintenance; issues associated with Mover will be addressed in Section II of this report.

Rail/Mover Maintenance operates under the guidance and direction of a General Superintendent who reports to the MDTA Transit Services Assistant Director. Within this Division are Vehicle Inspection and Heavy Repair, Train Control & Traction Power, and Metromover Maintenance. The Division Office consists of the General Superintendent and an Administrative Secretary. A total staff of 224 is assigned to the division, as indicated in Table10. That number will increase to 225 in FY 2001-2001 due to the addition of a Telephone Console Operator position.

Table 10 - Metrorail Rail/Mover Maintenance Division

Rail/Mover Maintenance Division	*Positions*
Division Office	2
Vehicle Inspection & Heavy Repair	93
Train Control & Traction Power	59
Metromover Maintenance	70

A. Vehicle Inspection & Heavy Repair

The Chief Supervisor, Rail Vehicle Repair and the Chief Supervisor, Repair & Inspection, direct Vehicle Inspection and Heavy Repair. Rail vehicle maintenance operates 24 hours a day, seven days a week and is responsible for preventive maintenance (PM), heavy repairs, running repairs, 8-10 year detailed evaluation of all components referred to as the “G” inspection, vehicle cleaning, and the operation of numerous repair shops in order to maintain a fleet of 136 heavy rail cars.

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. Approximately 21 workers are assigned to the 1st shift to perform PM and heavy repair. Their work is managed by three supervisors, each of whom is responsible for heavy overhaul, PM or running repair. The 2nd shift performs repairs identified during the previous shift’s PM inspections in addition to heavy repairs. A PM supervisor and a supervisor of running repair supervise the eleven workers on this shift. The nine workers on the 3rd shift perform daily inspection and manage the truck shop supervised by a PM supervisor and a running repair supervisor. A total of 93 of the 224 Rail Maintenance staff are assigned to vehicle inspection and heavy repair. Table 11 illustrates distribution of those staff by classification.

Table 11 - Metrorail Rail Maintenance Staff

PM/Heavy Repairs/Running Repairs	*Positions*
Chief Supervisor	2
Rail Maintenance Clerk/Office Support Specialist	2
Maintenance & Cleaner Supervisors	9
Electronic Technicians/ATP Technicians	31
Electricians	3
Mechanics	21
Machinists	7
Vehicle Cleaners	18

As stated in the introduction, much of the attention in Phase I of this study focused on the 136 rail cars, and when, or if, a mid-life overhaul should occur. With an assumed life of 40 years and/or 2 million miles, this issue is one of the most relevant in terms of cost and impact on service as MDTA looks forward to the next five years. The vehicles are, by far, the most complex of all of the major components of the rail system with the possible exception of the train control and traction power systems.

The attention to the vehicles is warranted, given that they will reach the mid-point of their expected life during the study period. It is typical for heavy rail systems to perform a midlife overhaul of rail cars not only to ensure the useful life is realized, but also to take advantage of newer technology, and enhance service, serviceability, and safety.

B. Rail Cars

The cars, manufactured in 1982 through 1984, will reach their 20-year milestone in two to four years, respectively, within the five-year planning period.

The cars are electric multiple unit rail cars constructed of stainless steel with fiberglass front-end caps manufactured by The Budd Company. They were designed and built to be operated in married pairs. Thus, when one car fails, two cars are automatically removed from service. One failure in a married pair affects peak vehicle requirements. There are two distinct types of cars, designated A and B. Because certain equipment is shared between the cars, they must be operated in pairs consisting of one A car and one B car. The pairs may be operated in trains composed of two to eight cars. Each married pair is equipped for independent two-way operation. Each A car contains the consist communications, public address equipment, and an air compressor unit used for the consist braking. Each B car contains the automatic train control system equipment, automatic train operation system equipment, a battery and a low voltage power distribution system.

The cab end of each car is designated the front (F) end of the car. The non-cab end of each car, which is coupled to the non-cab end of the other car, is designated the rear (R) end of the car. The F-end of each car is equipped with a fully automatic coupler to interconnect to another married pair and form a consist. When married pairs are brought together, the couplers fully engage mechanically and lock. Once the couplers are mechanically locked, all air (pneumatic) and electrical connections are automatically made through the coupler. The R-ends of each car are semi-permanently coupled via a draft bar and interconnecting electrical and pneumatic lines. The R-ends must be manually coupled.

Passenger access to the cars is normally though bi-parting doors located on the sides of the cars. Passage between pairs of cars or between the cars in a married pair is made through F-end doors or the R-end doors, respectively. There are three sets of bi-parting doors on each side of the car.

The cars are designed for DC power operation supplied by a 700 VDC third rail. Each car is equipped with four third-rail current collectors (two per truck) to transfer DC power from the contact rail to the main power terminals of the car. The 700 VDC from the third-rail current collectors is used to operate the truck traction motors, HVAC equipment, and the converter. Four traction motors (two per truck) are used for propulsion. The converter steps down power to run the consist controls and auxiliary equipment as well as charge the battery.

Control for the married pair, or consist, is from the lead cab. The control console contains all the switches, indicators, and circuit breakers to allow the operator to properly control and operate the consist. Control signals for a consist are transmitted to each car via a trainline from the lead cab. The cars are equipped with a friction brake subsystem that provides service braking, emergency braking, and parking braking.

Additional car features include:

- automatic train protection (ATP) equipment to provide continuous cab signals and overspeed indications,
- automatic train operation (ATO) equipment to maintain proper speed and provide automatic station stopping,
- air comfort system (cooling and heating) that is automatically regulated,
- radio/public address equipment to maintain a communications link with the operator and central control and with the operator and passengers,
- tinted safety glass windows with a sash that can be opened in case there is an air conditioning failure,
- a fail-safe device that opens doors automatically if anything obstructs their closing and that keeps them closed while the consist is moving, and
- Seat passenger load of 74 passengers; full passenger load of 148; and crush passenger load of 275 passengers.

Metrorail began service in May 1984. Rail cars operate 19 hours a day on a 21.5-mile double track, single line, electrically powered elevated rapid transit system with 21 stations. The system has a design capability of 70 miles per hour top speed but operates at a maximum speed of 58 mph to save on energy consumption; average speed is 31 mph. Weekday boardings for February 2000 averaged 49,500. Table 12 provides a summary of mileage and hours.

Table 12 - Metrorail Fleet Mileage & Hours

	Cumulative Mileage	*Annual Miles**	*Fleet Average*	*Cumulative Hours*	*Annual Hours*	*Fleet Average*
9/30/94	27,413,500	2,991,000	43,985	1,057,512	114,052	1,677
9/30/98	40,448,600	3,267,900	48,057	1,549,957	123,081	1,810
9/30/99	43,487,000	3,038,400	44,682	1,664,297	114,340	1,681
3/31/00*	45,106,200	3,238,400	47,624			

*Projected 12 months

Based on miles accumulated to date, the fleet should reach its midlife "in miles" within the next five to seven years.

C. Rail Car Maintenance

Maintenance of the rail cars includes scheduled preventive maintenance, heavy and running 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. Rail cars are withdrawn from service at regular calendar intervals to perform scheduled preventive maintenance actions. 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 45-day, 90-day, 180-day, and 360-day intervals. Two married pairs are scheduled daily for PM. PM inspections are categorized as shown in Table 13.

Table 13 - Metrorail Preventive Maintenance Inspections

Inspection Type	*Inspection Interval*	*Inspection Activities*
Daily	24 Hours	Safety test of car-borne ATC equipment, visual inspection of car interior and exterior, functional test of safety-critical and passenger convenience components
A	45 Days	Base level PM aimed at preventing the most common problems
B	90 Days	Type A + tasks aimed at more in-depth checks of the components
C	180 Days	Type A + Type B + more detailed checks of the traction motor, coupler, friction brakes, gear unit, and electrical systems
D	360 Days	Type A + Type B + Type C
G	8-10 Years	Detailed evaluation of all components
S		Functional check of all components and systems to ensure vehicle is ready for service after removal from storage

Rail vehicle maintenance staff spend about 22 percent of their time performing PM inspections, which are scheduled through Maintenance Control. Records indicate that 100 percent of all daily, A, B, C, and D inspections are routinely completed. Table 14 provides a summary of labor hours logged for inspections A-S in fiscal years 1998 and 1999.

Table 14 - Summary of A-S Inspection Labor Hours

	Labor Hours	
Preventive Maintenance	*1998*	*1999*
A Inspection	7,035	6,114
B Inspection	3,552	3,209
C Inspection	2,999	2,975
D Inspection	3,416	3,272
G Inspection	840	0
S Inspection	0	61
A-S Inspections	17,842	15,631

Running repairs are repairs that 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 level other than those categorized as heavy repairs. Heavy repairs include the removal, rebuilding, and replacement of truck assemblies, traction motors, gear units, brake systems and any subsystem overhaul. Repair hours accounted for 68 percent of total hours logged. A summary of labor hours for running and heavy repairs reported in fiscal years 1998 and 1999 is presented in Table 15.

.

Table 15 - Summary of Metrorail Running & Heavy Repair Labor Hours, 1998-1999

	Labor Hours	
Running & Heavy Repairs	*1998*	*1999*
Retrofits	72	62
Equipment Failures	15,491	18,361
No Trouble Found-Revenue	918	912
No Trouble Found Non-Revenue	247	323
Graffiti/Vandalism	1,021	1,437
Lamps/Bulbs	197	161
Daily Inspection/Miscellaneous Tasks	44,312	39,246
Repair TOTAL	62,258	60,502

The rail car shop is capable of handling a maximum of 20 rail cars at any one time. Assigned staff include the positions identified in Table 16. In May of this year, two of the 56 positions were vacant; as of September, the number of vacancies rose from two to seven.

Table 16 - Metrorail Rail Car Shop Personnel

PM/Running Repairs/Heavy Repairs	*Positions*
Rail Maintenance Clerk	1
Office Support Specialist	1
Maintenance Supervisors	7
Electronic Technicians	20
Electricians	3
Mechanics	16
Machinists	6
Technicians/ATP	2

D. "G" Inspection

The major component overhaul function provided by the maintenance staff is called the "G" inspection. The primary function of this inspection is the overhaul of components such as HVAC system, air brakes, motors, and electrical components. This is completed on an 8-10 year interval corresponding to approximately 400,000 vehicle miles. An average of 10.5 percent of maintenance hours are routinely dedicated to activities that fall within the parameters of the "G" inspection. Table 17 presents a summary of labor hours for "G" inspection type work accomplished in fiscal years 1998 and 1999. In the future, the "G" Inspection Team will do this work.

Table 17 - Metrorail "G" Inspection Work, 1998-1999

	Labor Hours	
"G" Inspection Work	*1998*	*1999*
Electronic Lab Repairs	3,698	4,009
Truck Shop Rebuild-Truck Assembly	2,365	2,080
Disassemble + Reassemble Axles	1,459	1,149
Motor Shop Repairs-PM Motors	2,729	1,836
Motor Shop-Other Mechanical Equipment	12	81
Air Brake Shop	499	750
Electrical Component Shop	162	188
"G" Inspection Total	10,924	10,093

A “G” inspection was completed on only 16 rail cars from January 1995 through March 1998. In FY 1999, a “G” Inspection Team was formed to re-institute the “G” Inspection. To that end, 9 of the 16 members of the “G” Inspection Team will man four repair shops, i.e., HVAC Shop, Electrical Component Shop, Airbrake Shop, and the Traction Motor Shop. Much of the overhaul work that will be done in-house through the “G” Inspection Team was previously completed outside of the shop on a contractual basis. The “G” Inspection Supervisor is a newly created position funded through a vacant position from Train Control/Traction Power. The remaining six members of the “G” Inspection Team are staff re-assigned from PM/Repair to work specifically on the “G” Inspection as indicated in Table 18. The team officially started their first “G” inspection on June 18, 2000, and by June 21, 2000, completed the remaining “G” work on a car pair that had been started over two years ago. Nine of the 16 “G” Inspection Team members are assigned directly to the Repair Shops as indicated in Table 19. The newly created position of “G” Inspection Supervisor is the only vacancy within the “G” Inspection Team at this time.

Table 18 - Metrorail "G" Inspection Team

“G” Inspection	*Positions*
“G” Inspection Supervisor	1
Mechanics	4
Electronic Technicians	2

Repair shops were set-up to support the “G” inspection and include the HVAC Shop, which completes all HVAC with the exception of compressors and electric motors; Electrical Component Shop, which is capable of rebuilding most electric propulsion and electric braking circuit components; Airbrake Shop, which is fully equipped with repair and test equipment and able to rebuild all pneumatic components except air compressors; Traction Motor Shop, which completes minor repairs such as bearing replacement and cleaning; and, the Seat Repair Shop, which is currently manned by light duty personnel who perform seat cover and foam cushion replacement.

Table 19 - Metrorail Repair Shop Personnel

Repair Shops	*Classification*	*Positions*
HVAC Shop	Electronic Technicians	2
Electrical Component Shop	Electronic Technicians	2
Air Brake Shop	Electronic Technician	1
Air Brake Shop	Mechanic	1
Air Brake Shop	Machinist	1
Traction Motor Shop	Electronic Technicians	2

In the past, the focus of the shop was clearly on PM and repair. As Table 20 indicates, 90 percent of labor hours were spent on PM and repairs.

Table 20 - Metrorail Labor Hours by Job Type, 1994-1999

	1994	*1995*	*1996*	*1997*	*1998*	*1999*	*Average*
Preventive Maintenance	23,326	19,461	17,984	20,118	19,926	17,959	19,796
PM % of Total Labor Hours	25.6	23.1	21.0	22.1	21.4	20.3	22.2
Repairs	58,154	56,481	60,691	61,266	62,258	60,502	59,892
Repair % of Total Labor Hours	63.8	67.0	70.7	67.2	66.9	68.3	67.3
PM + Repairs	81,480	75,942	78,675	81,384	82,184	78,461	79,688
PM + Repairs % of Total Labor Hours	89.4	90.1	91.7	89.2	88.3	88.6	89.5
"G" Inspection Work	9,613	8,329	7,148	9,846	10,924	10,093	9,326
"G" Inspection % of Total Labor Hours	10.6	9.9	8.3	10.8	11.7	11.4	10.5
Total Labor Hours	91,093	84,271	85,823	91,230	93,108	88,554	89,013

Value added to the vehicle maintenance process as a result of the “G” inspection will be gained over a long span of time. The Inspection Team has targeted completion of 1 pair every 3-4 weeks. Based on this schedule, the entire fleet of 136 cars will be completed within the next 4-6 years. Next year at this time, approximately 30 cars (including 16 cars completed from 1995-1998), 22 percent of the fleet, will have been overhauled. Until a significant number of the cars are overhauled, the need for repair activity as well as labor hours will actually grow as the vehicles continue to age. The maintenance staff is faced with an aging fleet in need of an increased number of repairs and a six-person reduction in the workforce. That situation coupled with the need for more PMs due to the decision to remove all vehicles from storage will even further hamper the division’s ability to meet peak vehicle requirements.

In December 1998, Maintenance Control issued a Fleet Reliability Report that provided a comparison of failures for the 8 married pairs on which “G” inspections were completed versus failures on 8 married pairs chosen randomly from the fleet. The report presented data from fiscal year 1994 through fiscal year 1998. A complete copy of the report was not available for our review. Information that we received contained data on only 6 of the 8 married pairs upon which “G” inspections were performed. Our review of the data contained in their report indicates the pairs chosen for the “G” Inspection showed slightly fewer miles and hours than the randomly selected cars on average; however, both the inspection cars and the randomly selected cars exceeded the overall fleet average in terms of miles. The inspected cars averaged 250 less hours than the fleet average. Table 21 provides a comparison of miles, hours and failures.

Table 21 - Metrorail “G" Inspection Miles, Hours & Failures

		Sep-94 Cumulative Hours		*Failures per Fiscal Year*					*Mar-00 Cumulative Hours*		*Since 1994*	
		Miles	Hours	1994	1995	1996	1997	1998	Miles	Hours	Miles	Hours
“G” Inspected Vehicles	Average	404,617	15,305	81	84	109	89	86	678,183	25,676	273,567	10,371
Comparison Vehicles	Average	406,013	15,748	64	82	104	102	96	713,125	27,498	307,113	11,750
Entire Fleet	Average	403,140	15,552						663,326	24,682	260,187	9,130

Prior to the inspection work in 1994, the pairs selected for inspection recorded an average of 81 failures compared to 64 for the pairs selected for comparison. Three pairs were inspected in 1995, and two pairs were inspected in 1996. Average failure rates for the pairs that did not receive a “G” inspection exceeded the rates of those that were “G” inspected for the first time in 1997. For purposes of comparison, a failure was defined as a problem in a major component that required the vehicle to be removed from service. A sixth pair received a “G” inspection in early 1998. During that year, a modest improvement in the performance of “G” inspected cars can be seen. Table 21 shows that the average miles and hours of all of the vehicles involved in the review exceed average fleet miles and hours logged since 1994. Despite the slight reduction in failures and the fact that the inspected vehicles exceeded average fleet use, insufficient data exist to draw any significant conclusion. Figure 11 illustrates this conclusion.

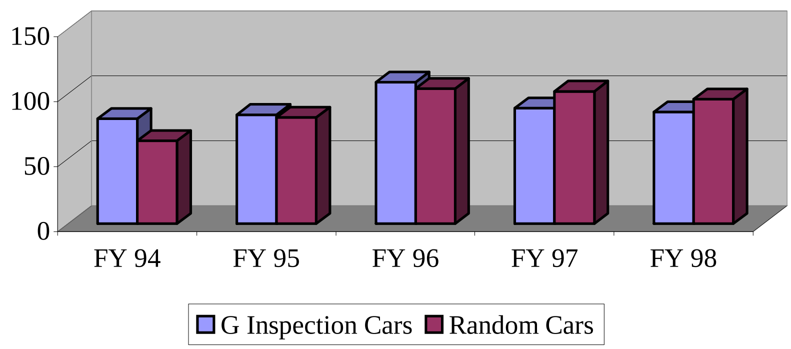


Figure 11 - Average Annual Failures

The agency has committed six positions from rail maintenance to the “G” Inspection Team in addition to the nine newly hired Electronic Technicians. Six of the current complement of 53 equates to 11.3 percent of the current workforce. Based on a six-year average of labor hours, “G” inspection work accounted for 10.5 percent of labor hours logged. Hours available for PM and repair started to drop as the “G” inspection began in June 2000.

Both Chief Supervisors expressed their concern regarding a reduction in their existing work force. In addition to the loss of six positions, they are facing the loss of the seasoned veterans who bid for the “G” inspection; the nine newly hired and trained Electronic Technicians will be performing PMs and running repairs. Miami allows workers to “bid on” jobs. The senior staff chose to man the repair shops for the “G” inspection. Current practices at MARTA and WMATA allow workers to bid only on work hours and location. Since MTA has only one maintenance shop location, MTA workers are allowed to bid only on work hours. Within those parameters, workers are assigned specific jobs. Their practices would have prevented the migration of the large number of seasoned veterans to the repair shops and “G” inspection. Rather, supervisors would have assigned workers on those shifts to those jobs.

E. Experience and Classification

Manpower requirements for the Maintenance Division were analyzed in depth. The case for additional positions appears to be legitimate based on the re-allocation of six positions to the “G” inspection which not only has reduced manpower availability for PM and repair but also has diminished the number of seasoned technicians available. The current situation will certainly negatively impact the technical capability of the PM/Repair workforce despite the movement of heavy repair work to the “G” repair shops. Factors that should be taken into account when determining the actual number of the positions include MDTA’s decision to initiate a short-term rotational storage program to normalize mileage, the Peak Vehicle Requirement, and the Agency’s ability to recruit and retain qualified technicians.

A review of Section 15 Data illustrates the relationship between vehicle maintenance hours and vehicles operated in maximum service (VOMS) as reflected in Table 22.

Table 22 - Vehicle Maintenance Hours per VOMS

Vehicle Maintenance Hours per VOMS	*1998*
Metrorail	1,957
MARTA	1,932
MTA	2,565
WMATA	2,497
LACMTA	6,033

Metrorail is at the low end in the number of hours dedicated to maintaining their vehicles in comparison to other properties. Metrorail is also at the low end in the number of maintenance personnel per VOMS and VAMS, as was shown in Table 4. The re-allocation of staff will drive this number even lower in the future.

Prior to reviewing the current training program, it is necessary to understand an Arbitration Award issued in response to a hearing in 1990 because the present day training program for Electronic Technicians, Mechanics, and Machinists is driven by MDTA’s interpretation of that 13 (C) Arbitration Award. The 13 (C) Arbitration Award indicated that MDTA 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, MDTA determined that the agency would provide the training to make the candidate qualified. Vacant positions are bid based on seniority. Successful candidates are introduced to their new positions at training programs that range in length from 3-4 months for Mechanics and Machinists to 6-8 months for an Electronic Technician. The Lead Supervisor, who is unavailable to the shop for the duration of the training program, provides all classroom training. Vacancies may only be filled when a training program is available, and only one training program is held at any given time, which results in all other vacant positions being placed on hold. During the program, the newly hired candidates are provided with classroom training that spans basic understanding of principles as well as the complex and sophisticated workings of a heavy rail car. The candidates complete the training program and are then assigned to the Maintenance Shop where they remain on probation for six months to one year.

To determine the levels of experience and education vehicle maintenance staff possess, a review of information concerning the former classification of ATP Electronic Technicians, Electricians, Electronic Technicians, Mechanics, and Machinists on duty in April of 1999 was conducted. That information shows years in classification ranged from 2 weeks to 16 years with an average of 7.9 years. Education level ranged from 11 to 18 years, with an average of 12.4 years. A total of 19 of 48 (39.6%) were in their classification more than 10 years and 18 of 48 (37.5%) less than 5 years. Only 7 of 48 (14.6%) had 13 or more years of education. ATP Electronic Technicians averaged 13 years of education, the highest level of any group; they were followed by Electronic Technicians with slightly less than 13 years, Mechanics with 12 years, and Machinists with slightly less than 12 years. Over a third (38.9%) of the Electronic Technicians were former Mechanics, and all of those Technicians had less than 5 years in their current classification, while all Electronic Technicians with 10 or more years of experience were former Electricians, Electronic Technicians, or held Engineering positions. This situation is of particular concern, given the fact that the Electronic Technicians with the least experience will now be responsible for preventive maintenance and running repairs due to the loss of nine seasoned Technicians to the “G” inspection. Former classifications and years of experience are reflected in Figure 12 and Figure 13.

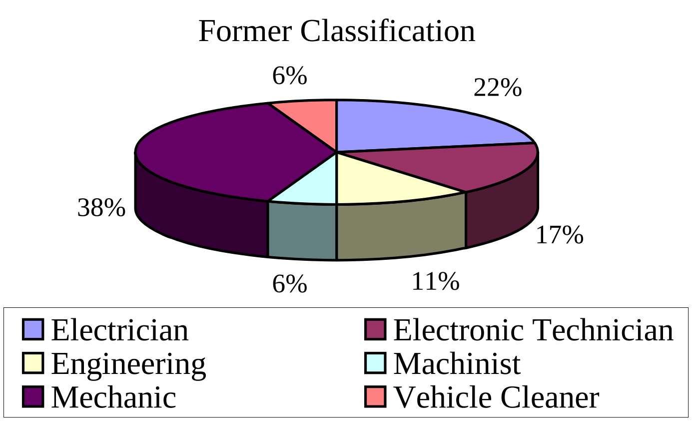


Figure 12 - Metrorail Former Classification, Percentage of Total

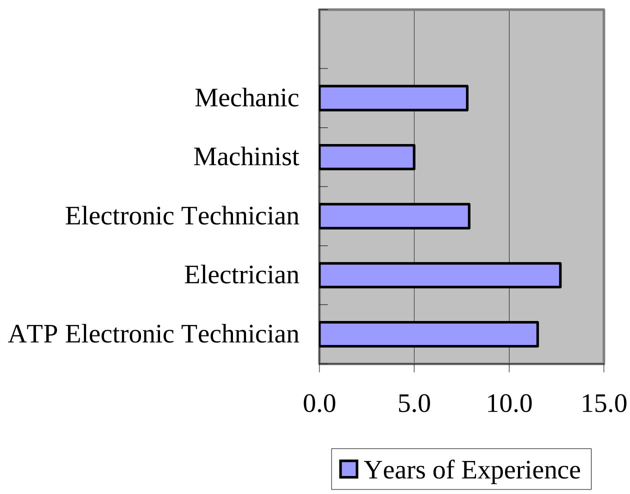


Figure 13 - Metrorail Average Years in Classification

Level of experience and education for the workforce were updated in September 2000. Tables 23 and 24 provide a comparison of that information which continues to show a declining level of experience within the workforce.

Table 23 - Metrorail Rail Maintenance Level of Experience and Education

	April 1999	*September 2000*
Years in Classification	2 wks – 16 years	1 yr - 17 years
Level of Education	11 - 18 years	11 – 18 years
ATP Technician	13.0	13.0
Electronic Technician	12.9	12.6
Mechanic	12.1	12.2
Machinist	11.9	11.8
Less than 5 Years Experience	18/48 (37.5%)	24/56 (42.8%)
More than 10 Years Experience	19/48 (39.6%)	21/56 (37.5%)
Education = 13+ Years	7/48 (14.6%)	9/56 (16.1%)
ETs with less than 5 Years Exp	38.9%	48.1%

Table 24 - Metrorail Electronic Technician Experience and Education

	ETs =< 5 Years		*ETs > 5 Years*		*All ETs*	
	4/99	9/00	4/99	5/00	4/99	5/00
Average Education	12.6	12.2	13.2	13.3	12.9	12.6
% Former ET/Electrician	11	0	89	90	100	100
Average Years in Class	3.8	2.5	12.0	12.4	7.9	6.1
% Total ET	50	63	50	37	100	100

A recent tour of three other properties yielded the following information regarding entry into the system and the type of training provided.

WMATA and MARTA require two years of technical training in addition to two years of relevant experience in order to enter the rail car maintenance system. Both agencies experienced difficulty in finding a sufficient pool of qualified personnel to meet their needs, and, as a result, initiated apprenticeship programs that waive the experience requirement but continue to require two years of technical training. WMATA requires that all staff enter their system as Helpers. They are promoted one step at a time, annually, from classes C, B, A to AA after completing a year of service in that class in addition to passing a written examination. MTA candidates are required to pass an examination, and the most senior person who achieves a passing test score is assigned to the position. MARTA recently began hiring apprentices from the internal ranks, recruiting employees who were currently in the system in other occupational groups who did not meet the minimum qualifications for technician and mechanic positions. Initially, these apprentices participated in a 2-½ year training program that included the entire first year of training in the classroom. They have recently revised their program to provide rotation between the classroom and the shop in three-month intervals. Their success with their in-house program has been rather limited; however, they report excellent results from a recruitment program that focused on naval and army bases as well as on local community colleges.

F. Rail Maintenance Shop

The rail maintenance shop can provide heavy repair, running repair, and PM to a maximum of 20 rail cars at any given time. The shop's capacity compares favorably to that of other properties surveyed. WMATA has a shop capacity of 22 vehicles at their Greenbelt Shop and 28 vehicles at their Brentwood Shop. The truck maintenance shop contains all of the fixed equipment required to rebuild truck assemblies including wheel, gear unit, and journal-bearing press operations. To improve the efficiency of the flow of work, the wheel press machine was relocated to the north side of the shop, and an additional crane was installed to service that area. Relocating the wheel press machine provided access to one of the two truck lifts that was too close to the wheel press machine to be used. The shop has a total of two truck lifts, three overhead 7.5-ton cranes, and three car lifts. An additional car lift would be beneficial to the shop, particularly since the "G" inspection has started. Projected cost for a new lift is $1.6 million, for which funds have not been programmed. Lifts are required for the "G" inspection, C and D inspections, HVAC overhaul, and to spin test trucks. MTA currently has two car lifts with an additional lift under construction. MARTA has two car lifts at each of its two shops with overhead 10-ton cranes the entire length of the shops. The wheel-truing machine located in the in-ground wheel-truing center is in need of repair; $75,000 has been allocated to rebuild the current machine. Action in this regard has been delayed due to the inability of the contractor to meet some procurement regulations. Grant funds will be used to procure an automated wheel-boring machine; necessary materials have been forwarded to procurement. Transit Engineering is developing specifications for a modest paint spray booth to be used to rehab end caps. Paint booths at other properties vary considerably. WMATA boasts a $5 million paint booth, while MTA has constructed their paint booth from PVC pipe and plastic sheeting. MARTA has no paint shop and does no body work. A Stress Wave Analysis System was recently procured for use in the inspection of bearings and gears in vehicle drive trains. A total of 14 cars have been tested to date.

Allocation of additional personnel for the “G” inspection has enabled the Metrorail maintenance staff to activate back shops to rebuild and overhaul a variety of components. Two Electronic Technicians have been assigned to the Electrical Component Shop where they will rebuild most electric propulsion and electric braking circuit components. The Traction Motor Shop, manned by two Electronic Technicians, will complete minor repairs such as bearing replacement and cleaning. All electrical motors are contracted out for major repairs due to the cost and technical expertise required. Both MARTA and MTA contract out all their electrical motors while WMATA, at the other extreme, contracts out less than 1 percent of their work. Other minor tasks such as armature balancing, undercutting mica, truing commutators, steam cleaning and drying are within Metrorail shop’s capability; however, labor required to support this type of work is not available. The necessary equipment, with the exception of a large oven to dry traction motors, is available. An Airbrake Shop staffed by an Electronic Technician, a Mechanic, and a Machinist is fully equipped with repair and test equipment. This shop is capable of rebuilding all pneumatic components except air compressors, which are contracted out. Two Electronic Technicians will do all the HVAC work except compressors and electric motors in-house in the HVAC shop. The final shop that has been established is the Seat Repair Shop. Seat covers and foam cushions are replaced using light duty personnel.

In terms of the type of inspections performed by the Metrorail shop, a “G” inspection of 16 rail cars was completed from 1995 to 1998, and a significant amount of the inspection was done on cars 163/164. The new “G” inspection group finished work on cars 163/164 on June 21, 2000, and started work on rail cars 211/212; target time frame for completion of a married pair is 3-4 weeks. Modification of the field controller and the mylar composite washer is included in the “G” inspection. The cost of the "G" inspection per pair is estimated at $225,508 including materials, contract cost, and labor. The shop has consistently completed 100 percent of all A, B, C, and D inspections.

Recent activities in the Metrorail maintenance shop include installation of an oil recovery system that is currently operational on MT-8. Sweiger Coil Systems, Inc has upgraded 423 traction motors. Installation of 116 of the 272 A/C evaporator motors supplied by Tampa Armature Works is complete. A total of 525 gear units have been rebuilt or purchased; units are still contracted out as the shop lacks sufficient funding and personnel to rebuild the units in-house. MTA contracts out 80 percent of their gearboxes. MTA staff indicated that they continue to repair 20 percent of their gearboxes in-house to keep their technicians’ skills up to date.

G. Rail Car Availability

In early 1995, the agency made the decision to “mothball” 12 married pairs, which were not necessary to meet peak vehicle requirements for revenue service, so as to reduce maintenance shop needs which had risen to 38 percent of total days available. The average tenure of those 12 pairs in storage was well over two years. Two pairs actually remained in storage until September of this year, over five years later. The shop had a rail car availability rate of 65 percent at the time those vehicles were mothballed. Rail car availability fell below 60 percent in mid 1997 at which time the shop focused on returning those mothballed vehicles to service. By March 1998, 10 of the 14 pairs had been returned to service and the availability rate rose to 66 percent. However, as storage hours declined, shop hours increased driving the availability rate to 55 percent. The downside of this approach is obvious to the project team. As with any piece of complex equipment left to remain idle for a period of years, the deterioration that occurs to it requires additional expense to bring it back into service. Furthermore, the temptation to cannibalize the mothballed cars to maintain an aging fleet that has undergone little significant upgrading is strong. While the action to store these cars was probably rationalized as a cost containment measure at the time, it was, in hindsight, short sighted. The subsequent effort required to bring these cars back from long-term storage diverted resources from other maintenance activities and clearly exceeded any manpower and material savings generated through the PM inspections that were not required to be performed by virtue of the "storage." By March 2000 availability again approached 60 percent. Figure 14 shows the benefits of returning the mothballed fleet to service, i.e., rail car availability.

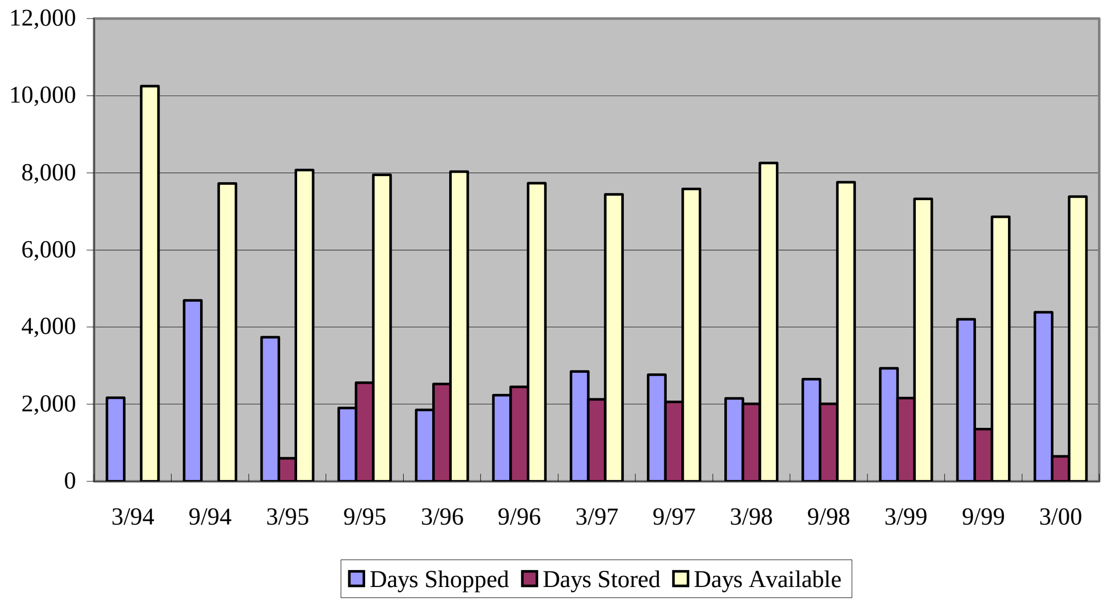


Figure 14 - Metrorail Rail Car Availability

At issue here is the number of rail cars necessary to provide service versus the number of rail cars MDTA actually owns. Like other transit properties commissioning systems at a time when the public is accepting of new rail starts, the policy decision was made to reduce the unit rail car cost by procuring a sufficient number of rail cars to provide an adequate fleet for the future system expansion that was envisioned at the time. Due to shifts in funding priorities and other local issues, transit properties were left with a fleet that was sized for a planned system that was not immediately realized. While there continues to be debate over the "right" spare ratio for vehicles, Metrorail has both benefited by and suffered from having 136 rail cars to care for on a system that "requires" 80 cars be available for service each morning. Metrorail ranks 3rd in terms of vehicles operated in maximum service (VOMS), and 3rd in terms of vehicles available for maximum service (VAMS). Metrorail's ratio of operating cars to available cars is second to that of MTA as indicated in Table 25. The shop's requirement for revenue service vehicles recently increased from 68 to 86.

Table 25 - Comparison of Operating Spare Ratios

	Metrorail		*MARTA*		*MTA*		*WMATA*		*LACMTA*	
	VOMS	*VAMS*	*VOMS*	*VAMS*	*VOMS*	*VAMS*	*VOMS*	*VAMS*	*VOMS*	*VAMS*
1994	76	136	238	238	48	100	588	764	16	30
1995	80	136	158	238	54	100	588	764	16	30
1996	80	136	165	240	54	100	586	764	16	30
1997	86	136	182	238	54	100	618	764	24	30
1998	80	136	176	238	54	100	620	764	24	30
Ratio	1.7		1.4		1.9		1.2		1.3	

Metrorail ranks 2nd in terms of annual operating expenses per vehicle operated in maximum service (VOMS) based on Section 15 Data, as reflected in Table 26.

Table 26 - Comparison of Annual Operating Expenses per VOMS

	Metrorail	*MARTA*	*MTA*	*WMATA*
1994	626,252	314,097	686,497	569,301
1995	566,435	505,258	623,049	580,657
1996	571,161	490,689	611,578	616,995
1997	581,266	542,949	592,714	548,699
1998	615,582	549,686	626,165	592,240

According to Section 15 data, in 1994, 104,329 labor hours were provided for inspection and maintenance. During 1995 that number dropped to 99,199, a 4.9 percent decrease. Labor hours continued a decline to 87,087 in 1996, a 12.2 percent decease in comparison to 1994 hours. Labor hours rose to 92,000 in 1997 and then dropped to 87,558 in 1998. Labor hours reported in 1999 totaled 96,859 hours, a decrease of 7.2 percent compared to 1994. Similar fluctuations in labor hours were seen at other properties. Nonetheless, Miami's shop consistently reported fewer labor hours for each vehicle operated in maximum service (VAMS) than other properties, as presented in Table 27.

Table 27 - Comparison of Labor Hours per VAMS

	Metrorail	*MARTA*	*MTA*	*WMATA*
1994	767	1,233	954	1,518
1995	729	1,213	860	1,420
1996	640	1,483	800	1,429
1997	676	1,532	839	1,284
1998	644	1,568	797	1,421
Average	691	1,406	850	1,414

Table 28 provides a comparison of Metrorail's labor hours and inspections per VOMS and per VAMS with three other properties, based on information obtained from Section 15 Data for 1998.

Table 28 - Comparison of 1998 Labor Hours per VOMS/VAMS

	Labor Hours	*VAMS*	*Per VAMS*	*VOMS*	*Per VOMS*
Metrorail	87,558	136	644	80	1,094
MARTA	373,284	176	2,121	238	1,568
MTA	79,677	54	1,476	100	797
WMATA	1,085,369	764	1,421	620	1,751

Metrorail's commitment of labor hours per vehicle within the fleet is less than half of MTA's and WMATA's and less than a third of MARTA's hours. The situation is more favorable when you view labor hours based on the vehicles operated rather than on vehicles available; nonetheless, Metrorail is still well behind MARTA and WMATA. Some of this difference can be attributed to agency practices on contracting work to outside firms.

The total number of rail cars 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). The PVR equals revenue cars plus transition cars plus maintenance vehicles. In 1999 Metrorail's PVR, as reported in Section 15, was 80 vehicles, i.e., 68 revenue cars plus 4 transition cars plus 8 maintenance spares, or 58.8 percent of the total fleet. According to the Chief Supervisors, there were times when it was difficult to meet this requirement. Review of the following information lends credence to the Chief Supervisors' assertion. Given that each of the 68 married pairs is available 180 days during a six-month interval, a total of 12,240 days is available annually for the fleet. Table 29 basically shows where the 68 pairs were located, i.e., in the shop or in storage during six-month intervals. At the time of this report, the number of revenue vehicles required for service had increased from 68 to 86. Assuming maintenance spares and transition cars are the same levels, the present PVR equals at a minimum 98 cars or 72.0 percent of the fleet. Table 29 indicates the highest rail car availability achieved since March 1994 is 66.5 percent, well below the new PVR of 72.0 percent.

Table 29 - Metrorail Days Shopped - Days Stored - Days Available

	Days Shopped	*% of Total*	*Days Stored*	*% of Total*	*Days Available*	*% of Total*
3/94	2,165	17.4	0	0.0	10,245	82.6
9/94	4,689	37.8	0	0.0	7,721	62.2
3/95	3,741	30.1	601	4.8	8,068	65.0
9/95	1,905	15.4	2,555	20.6	7,950	64.1
3/96	1,850	14.9	2,527	20.4	8,033	64.7
9/96	2,230	18.0	2,447	19.7	7,733	62.3
3/97	2,849	23.0	2,122	17.1	7,440	59.9
9/97	2,764	22.3	2,061	16.6	7,586	61.1
3/98	2,148	17.3	2,008	16.2	8,255	66.5
9/98	2,645	21.3	2,008	16.2	7,758	62.5
3/99	2,929	23.6	2,159	17.4	7,322	59.0
9/99	4,199	33.8	1,352	10.9	6,859	55.3
3/00	4,386	35.3	645	5.2	7,379	59.5
Total	38,500	23.9	20,485	12.7	102,349	63.4

Table 29 also reflects the impact that “mothballing,” as previously discussed, had on the shop. Shop hours increased, so mothballing was used as an option to reduce labor hours required for inspection, maintenance, and repair. As the smaller fleet generated an increased need for repair and maintenance, shop hours rose. Vehicles that had been mothballed for an extended period of time required significantly more than an “S” inspection to return to service; their movement was from storage to the shop, which caused an even greater increase in labor requirements.

An indicator that perhaps best describes the shop’s performance is that of mean miles between failures. Metrorail’s new rail car specification established a mean distance between failure (MDBF) rate of 12,420 miles. In September 1999, that rate equaled 7,800 miles. MDTA has seen a gradual decrease in the miles between failures. This rate is expected to improve as vehicles are overhauled through the “G” inspection. MTA reported a MDBF rate of 1,222 miles during 1996. The overhaul of their entire fleet has begun. MARTA logged 11,788 miles between failures in June 2000. Forty-eight of their 238 rail cars have been overhauled. WMATA reported 10,946 miles in 1997 after 268 of their 764 rail cars were overhauled. While these rates are not directly comparable due to each agency’s individual definition of “failure,” they do indicate that it is possible to extend the amount of miles between failures.

H. Rail Car Condition

The Chief Supervisor, Rail Vehicle Repair, Chief Supervisor, Inspection & Repair, and a Rail Vehicle Maintenance Supervisor were asked to evaluate the current condition of the rail cars 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 heavy rail system. The definitions used for assigning condition codes to the rail cars are presented in Table 30.

Table 30 - Metrorail Definitions of Rail Car Conditions

Condition Code	*Category*	*Definition*
1	Bad	Major deterioration in the form of structural corrosion, extensive surface corrosion, leaking roof, doors or windows, rotted flooring, broken or cracked truck frames, oil or water in the air system; any failure in service of the brakes, suspension or train control; frequent failures in service of doors, HVAC, motors, controllers or motor-alternator; obsolete because parts are unavailable for doors, HVAC, propulsion, brakes or electrical equipment, car is unable to interchange with others in the fleet of the same type.
2	Poor	Deterioration in the form of surface corrosion, scratched or opaque windows, worn floor covering and upholstery, worn truck components, including bearings, liners, wheels and axles, inaudible PA system; frequent failures in service of doors, HVAC, motors, controllers or motor-alternator; obsolete electronic equipment.
3	Fair	Deterioration in the form of scratched or opaque windows, worn floor covering, worn shock absorbers; occasional failures in service of doors, HVAC, motors, gears, controllers, motor-alternator; obsolete electronic equipment.
4	Good	Minor deterioration in the form of scratched windows, worn seats and floors, worn brake shoes, motor brushes and contactors, some wheel flats; very few service failures of any equipment.
5	Excellent	Essentially new equipment.

Table 31 provides a summary of their evaluation.

Table 31 - Ratings of Rail Car Subsystem Conditions

Airbrakes Subsystem	Rating
D1 Pilot Air Valve	5.0
Seated Check Valve	5.0
Service Reservoir	4.0
Main Reservoir	4.0
Pneumatic Brake Valves	2.0
A-1 Emergency Unit	2.0
D-4-S Compressor Assembly	2.0
Tread Brake Unit	2.0
Parking Brake Unit	2.0
Vent Valve #8	2.0
Average	3.0
Door Subsystems	
Sensitive Edge Assembly	3.0
DCDR	3.0
Gear Units (Lube)	3.0
Average	3.0
Trucks	
Axles	4.0
Bolsters	3.0
High Speed Coupler	3.0
Journal Bearings	4.0
Air Springs	2.0
Traction Motors	3.0
Gear Units	4.0
Side Frames	1.0
Average	3.0
Propulsion Subsystem	
Reverser XRC-482	3.0
Field Controller	3.0
Loop Controller	3.0
Power Brake Controller	3.0
Contactors, BC1,2,3,4 (UMD-125c)	3.0
Power Brake Relay	3.0
Semi-Conductor Box	3.0
Converter	3.0
BOL/BDC (UMA-34B)	2.0
Line Switch 1	2.0
Line Switch 2	2.0
Trucks	2.0
Propulsion Blower Motor	2.0
Average	2.6

HVAC Subsystems	
Resilient Mounts	4.0
Rebound Mounts	4.0
Compressors	3.0
Compressor Motors	3.0
Service Valves	3.0
Compressor Valves	3.0
Condenser Leaks	2.0
Expansion Valves	2.0
Liquid (line) Valves	2.0
Modulation Valves	2.0
Evaporator Motor (AC)	2.0
High Voltage Temp Control Box	2.0
Heater Strips	1.0
Average	2.5
Couplers & Draft Gear Subsystems	
Link Bar	4.0
Draft Gear & Yoke Assembly	3.0
Mechanical Coupler	2.0
Electric Coupler	2.0
E.C. Control Box	2.0
Coupler Limit Switch	2.0
Average	2.5
Controls Subsystem	
Master Controller	3.0
Door Open Contacts	3.0
Door Close Contacts	3.0
Recharge Contacts	3.0
ATO Start Contacts	3.0
Front End Controls	2.0
Mother Boards/Logic Box	1.0
F2 Units/ Front End Units	1.0
Average	2.4
Carbody Subsystems	
Roof	4.0
Floors	1.0
Windows	1.0
Seats	1.0
Upholstery	1.0
Liners	1.0
End Caps	1.0
Average	1.4
Overall Average	**2.6**

The project team rates the overall condition of the rail cars as "fair" to "poor," with many of the subsystems rated poor. The general areas that consistently rate a "poor" are car body subsystems where all components rated "bad," except the roof, the car's logic box, and front-end cab controls. It should be noted that the F-2 braking system gets "poor" marks due to a parts availability issue (obsolescence), frequency of repair, and wheel wear. Wheel wear requires replacement at 150,000 miles while MTA, with an upgraded H-2 system is logging 250,000 to 300,000 miles between wheel changes.

Many of the HVAC subsystems are rated "poor" as are the subsystems associated with the couplers. The most disturbing issue associated with the vehicle is that of the cracking side frames on the trucks. Several side frame cracks were discovered, and the wheel trucks were immediately taken out of service. Given the serious nature of this kind of failure, MDTA vehicle maintenance staff has been extremely diligent in inspecting these frames. Since MTA is seeing the same phenomenon with the same wheel truck, it can be expected that these failures will continue to appear as the fleet ages. It should be noted that, during the technical visit to MTA's system, the MDTA representative established contact with a vendor who has engineered a fix for the problem at a cost of between $6-7,000 per side frame.

Another issue of concern is cracking of the "slide plate" or the steel plate on which the wheel truck moves against the bolster as the truck turns. All bolsters are being inspected during PMs for this safety sensitive issue. As with the side frames, MTA has found similar cracks in their slide plates. Metrorail is attempting to tackle the problem in-house using one welder. The welder does possess the required certification; however, his work on the slide plates is outside of his classification. This fix was chosen because outside contractors were unwilling to commit to completion of a few repairs at a time. Given that two outside certifications are required during completion of the repair, it seems that this approach while cost efficient is certainly not effective from a repair completion perspective.

The car shell appears to be in "good" condition with no noticeable roof leaking or deterioration. The markings and decals are in very poor shape having suffered the ultraviolet weathering of South Florida. Metrorail recently started use of a new decal.

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 April 2000, fleet mileage has been projected over the next five years as indicated in Figure 15.

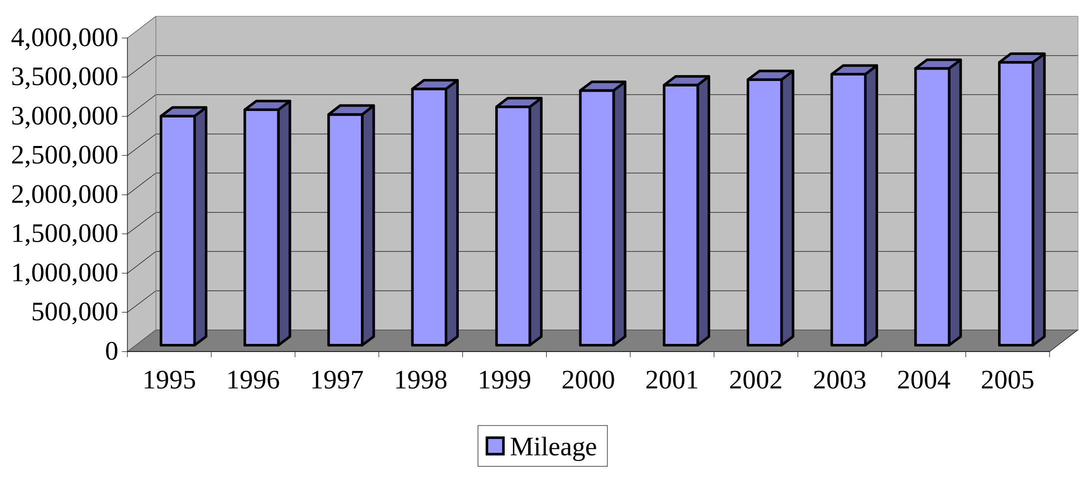


Figure 15 - Metrorail Rail Car Mileage, Projected 2000 –2005

Based on these projected annual miles, an analysis was conducted to project individual car mileage. Assuming that cars will accumulate mileage in the future similar to miles accumulated in the past, Figures 16 and 17 reflect the distribution of the 68 married pairs by projected accumulated miles. The range between the maximum and minimum miles logged by the rail cars 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. In this case, however, as there is little prospect that new rolling stock will be acquired and given the lease-leaseback arrangement, the goal should be to move toward having all cars last for 40 years. Figure 16 represents growth as it is occurring today. Figure 17 reflects the impact on the fleet of a routine cycle of storing the 12 highest mileage cars for a period of 90 days followed by the storage of the second 12 highest mileage cars and so on.

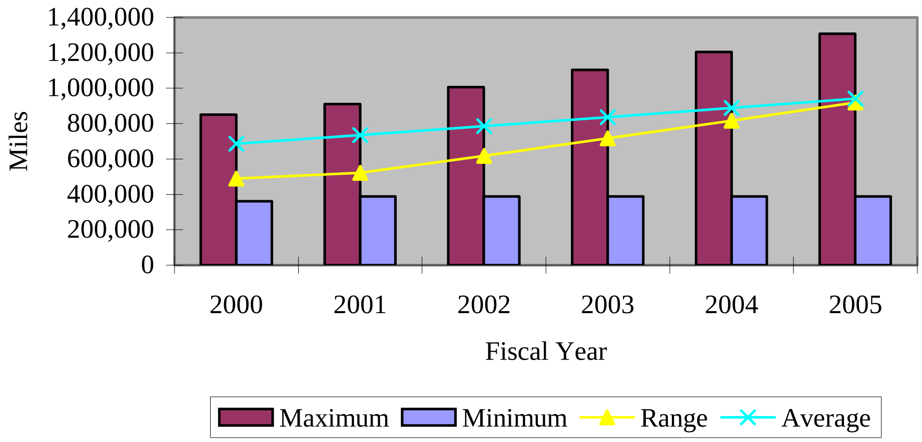


Figure 16 - Metrorail Current Rail Car Mileage Growth

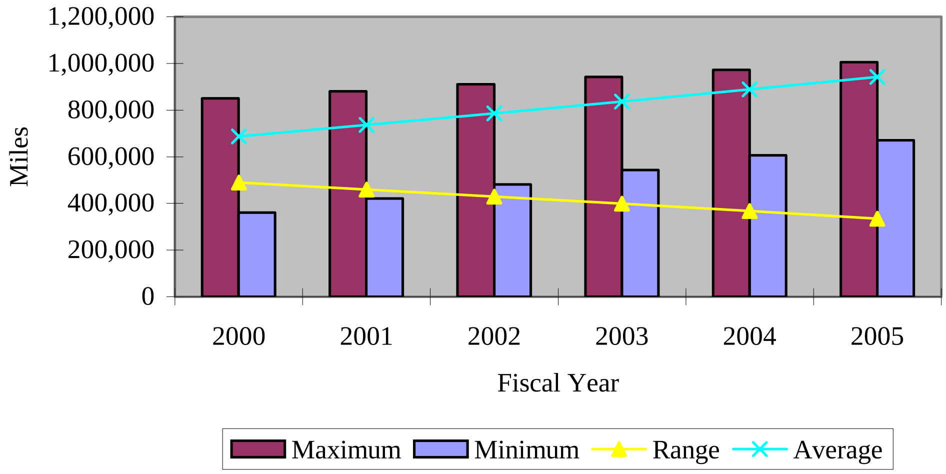


Figure 17 - Metrorail Normalized Rail Car Mileage

The storage program proposed is quite different from the mothballing program used by MDTA previously. With the 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. The high mileage vehicles essentially would spend 90 days in storage and then 90 days in revenue service prior to being returned to storage if their mileage continued to rate in the top twelve. The mandatory return to revenue service after a 90-day period in storage eliminates a vehicle remaining in storage indefinitely. By normalizing mileage, the agency should be able to achieve a 40-year car life. A short-term storage program also reduces manhours required for preventive maintenance by eliminating the 90-day running time vehicles would normally log. Savings would vary depending upon the number of vehicles stored and duration of the storage period.

The final program within Vehicle Maintenance and Heavy Repair is the Vehicle Cleaning Program that consists of three levels of interior and exterior cleaning performed during off-peak and non-revenue hours. Level One is accomplished daily and includes basic housekeeping of the interior of the car. Exterior washing is done three times per week as cars return to the yard after morning peak service. Level Two is performed four times each year and includes detail cleaning of the car interior. Level Three is an exterior acidic cleaning accomplished biannually. Two of the eighteen Rail Vehicle Cleaner positions are vacant.

I. Vacancy Rates

Vacancy rates were reviewed for the time period from FY 1998 up until the present time. All vacancies reported since FY 1998 are reflected in Table 32 through Table 36.

Table 32 - Metrorail Rail Vehicle Machinist Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 7 vacant	0.0
1999	1 of 7 vacant	14.3
10/99-5/00	2 of 5 vacant	28.6

Table 33 - Metrorail Maintenance Clerk Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 1 vacant	0.0
1999	1 of 1 vacant	100.0
10/99-5/00	0 of 1 vacant	0.0

Table 34 - Metrorail Office Support Specialist Vacancies

Fiscal Year	*Vacancies*	*%*
1998	1 of 1 vacant	100.0
1999	1 of 1 vacant	100.0
10/99-5/00	0 of 1 vacant	0.0

Table 35 - Metrorail Rail Vehicle Cleaner Vacancies

Fiscal Year	*Vacancies*	*%*
1998	1 of 18 vacant	5.6
1999	1 of 18 vacant	5.6
10/99-5/00	2 of 18 vacant	11.1

Table 36 - Metrorail Rail Vehicle Maintenance Vacancies

Fiscal Year	*Vacancies*	*Vehicle Maintenance Total %*	*Metrorail Metromover Total %*
1998	20 of 92 vacant*	21.7	16.0
1999	5 of 93 vacant	5.4	9.3
10/99-5/00	4 of 93 vacant	4.3	8.1

*"G" inspection positions were frozen

According to the Chief Supervisors, absenteeism runs between 12-15 percent, and current disciplinary procedures fail to offer measures to assist employees in improving attendance. Furthermore, current sick leave policies allow twelve occurrences prior to any action. The Chief Supervisors indicated they could benefit from revised attendance control procedures. WMATA requires a doctor's slip for illnesses of three days or more and after the 4th occurrence of sick leave use prior to return to work. WMATA also refers employees to the absenteeism manager after their 8th occurrence of sick leave use.

J. Unfunded Capital Needs

Vehicle Maintenance unfunded capital needs within the next 5 years total $1.6 million for a car lift needed for MT-5.

K. Manpower Needs

Prior to presentation of Phase I findings and recommendations, MDTA requested an analysis of manpower needs using an increased peak vehicle requirement of 108 vehicles. The PVR of 80 reported in the 1999 Section 15 data was recently increased to 86. The new proposed PVR is based on 90 revenue vehicles plus 4 transition cars plus 14 maintenance spares.

Two separate analyses were conducted using rail car availability and projected fleet mileage as primary factors in computing manpower needs.

Table 37 reflects the analysis based on fleet availability. Basic to this analysis was the number of available days per labor hour. This factor equals 0.160 and was calculated using 1999 available days of 14,180 and total labor hours of 88,554.

Table 37 - Metrorail Manpower Needs Based on Rail Car Availability

Revenue Cars	68	80	86	90
Transition Cars	4	4	4	4
Maintenance Spares	10	10	10	14
PVR	82	94	100	108
PVR Pairs	41	47	50	54
Days Needed	14,965	17,155	18,250	19,710
Labor Hours Needed @ 0.160 Availability	93,456	107,133	113,971	123,089
10.5% "G" Work Reduction	-9,813	-11,249	-11,967	-12,924
PM + Repair Labor Hours Needed	83,643	95,884	102,004	110,165
Labor Requirement @ 1,452 Hours	58	66	70	76
Existing Labor	47	47	47	47
Labor Needs	11	19	23	29

Based on the current allocation of positions, additional labor needs would be categorized as indicated in Table 38.

Table 38 - Metrorail Personnel Needs by Position

	Peak Vehicle Requirement			
Positions Needed	*68*	*80*	*86*	*90*
Electronic Techs, Electricians, ATP Techs	6	10	12	15
Mechanic	4	6	8	10
Machinists	1	2	3	4
Total	11	18	23	29

Table 39 reflects the analysis based on fleet mileage. Basic to this analysis was the number of revenue miles available per labor hour. This factor equals 34.31 and was calculated using 1999 fleet mileage of 3,038,400 miles and total labor hours of 88,554.

Table 39 - Metrorail Labor Needs Based on Fleet Mileage

Revenue Cars	68	80	86	90
Revenue Miles @ 44,682 Revenue Miles per Year	3,038,400	3,574,588	3,842,682	4,021,412
Labor Hours Needed @ 34.31 Revenue Miles per Labor Hour	88,554	104,181	111,995	117,204
10.5% "G" Work Reduction	-9,298	-10,939	-11,759	-12,306
PM + Repair Labor Hours Needed	79,256	93,242	100,236	104,898
Labor Requirement @ 1,452 Hours	55	64	69	72
Existing Labor	47	47	47	47
Labor Needs	8	17	22	25

Based on the current allocation of positions, additional labor needs would be categorized as indicated in Table 40.

Table 40 - Metrorail Personnel Needs by Position

	Peak Vehicle Requirement			
Positions Needed	*68*	*80*	*86*	*90*
Electronic Techs, Electricians, ATP Techs	4	9	12	13
Mechanic	3	6	7	9
Machinists	1	2	3	3
Total	8	17	22	25

Projected manpower based on fleet availability and projected mileage for varying peak vehicle revenue requirements are presented in Table 41.

Table 41 - Metrorail Manpower Needs

	Peak Vehicle Requirement			
Positions Needed	*68*	*80*	*86*	*90*
Electronic Techs, Electricians, ATP Techs	4 - 6	9 - 10	12	13 - 15
Mechanic	3 - 4	6	7 - 8	9 - 10
Machinists	1	2	3	3 - 4
Total	8 - 11	17 – 19	22 - 23	25 - 29

Supervisor to subordinate ratios for the Agency were examined by department and division for FY 1994 and FY 1998 – FY 2001. Supervisory ratios remained consistent and stable throughout those time periods and averaged slightly above 1 to 7 for Metrorail/Metromover Operations and Maintenance.

The Vehicle Inspection & Heavy Repair Division's ratio of supervisory to subordinate personnel averaged slightly higher than the Agency's ratio. That division's ratio equaled 1 to 9, including the "G" Inspection and Rail Car Cleaning staff.

Given the nature of the additional positions identified, a specific supervisor to subordinate ratio for those technical positions within Vehicle Inspection & Heavy Repair was calculated. The ratio equaled 1 to 7 based on the present allocation of 7 supervisors for the 47 technical positions. Using that ratio, supervisory needs are as follows:

Table 42 - Metrorail Supervisory Needs

	Peak Vehicle Requirement			
Positions Needed	*68*	*80*	*86*	*90*
Supervisory Positions	1 - 2	2 - 3	3	4

Vehicle Inspection & Heavy Repair's combined technical and supervisory personnel needs are indicated in Table 43.

Table 43 - Metrorail Technical and Supervisory Needs

	Peak Vehicle Requirement			
Positions Needed	*68*	*80*	*86*	*90*
Technical Positions	8 - 11	17 - 19	22 - 23	25 - 29
Supervisory Positions	1 - 2	2 - 3	3	4
Total	9 - 13	19 - 22	25 - 26	29 - 33

Chapter 4 Train Control & Traction Power

The Chief Supervisor, Traction Power & Train Control Systems, directs the activities of Train Control and Traction Power. Both Train Control and Traction Power operate 24 hours a day, seven days a week. A total of 59 staff performs Train Control/Traction Power functions.

Train Control & Traction Power operates three shifts: 7 a.m.-3 p.m., 3 p.m.-11 p.m., and 11 p.m.-7 p.m. With only four supervisors assigned to this operation, there are weekend shifts that lack a supervisor. Lead workers were added to help resolve that deficit. Lead workers receive financial compensation, and the positions are bid as part of the line-up. The Chief Supervisor indicated that lack of supervision has not been a problem. He suggested that higher performance expectations have actually resulted from the presence of fewer supervisors. He also reported that absenteeism and grievances within his department are lower than other departments within the division. The impact of the 13 (C) Arbitration Award has not been as negative within Train Control and Traction Power operations due to the fact that the majority of current employees have a great deal of longevity. Instituting minimum qualifications will benefit the operation in the long-term as senior employees are replaced by new employees entering the workforce.

Years of experience in classification ranged from 5 to 16 years, with an average of 12.7 years. Education level ranged from 12 to 16 years, with an average of 12.7 years. Thirty of 35 (85.7%) were in their classification ten or more years. The average tenure for those with less than 10 years of experience was 6.4 years. Nine of 35 (25.7%) had 13 or more years of education. Train Control averaged 12.9 years of education and Traction Power averaged 12.5 years.

Training consists of 14 weeks of classroom training followed by 12 months of on-the-job training that also serves as the probationary period. Train Control & Traction Power is required to provide personnel to conduct the training. The Chief Supervisor indicated there were no problems with the current training program.

A. Traction Power

The Traction Power System consists of 19 locations where both a Traction Power Substation and Unit Substation exist, three locations with only a Unit Substation, and three Gap Tie Substations. The 700VDC for the trains is sourced from Traction Power Substations. Each Traction Power Substation receives two 13.2kVAC feeds from Florida Power & Light. This alternating current is stepped-down and rectified by the traction power transformers and rectifiers and then distributed to each of the third rail sections associated with the particular station by 6000 ampere DC breakers. Two different Traction Power Substations feed most third rail sections so that an alternate source of power is available in case critical equipment needs to be removed from service due to maintenance or malfunction. In addition to providing the trains with necessary power, each Traction Power Substation also distributes the 13.2kVAC received from Florida Power & Light to the Unit Substation where it is stepped down to 480VAC for redistribution and use in the passenger stations. At the three locations (I-95, Culmer, and Okeechobee) where only a Unit Substations exists, Florida Power & Light 13.2kVAC feeds come directly into the Unit Substation where they are stepped down and redistributed in the usual manner. The Gap Tie

Stations are located where a need for only switching third rail power exists. By employing a Gap Tie Station where only DC breakers are found, the substantial extra cost of a complete Traction Power Substation is saved.

B. Traction Power Positions, Labor and Vacancies

Traction Power performs routine and corrective maintenance on traction power equipment, investigates and collects information on areas exhibiting potential for trouble, and conveys information to maintenance engineering for analysis. Areas of responsibility include: traction power substations, DC switchgear, AC switchgear, rectifiers, unit substations, high voltage AC switchgear for facilities electric power, cable connections from traction power substations to wayside third rail, and stinger systems for Rail and Mover vehicle maintenance. Table 44 identifies those positions assigned to Traction Power.

Table 44 - Traction Power Positions

Traction Power	*Positions*
Rail Technician Traction Power	24
Traction Power Supervisor	4

Vacancy rates were reviewed for the time period from FY 1998 until the present. In all classifications since 1998, those rates have remained relatively low for Traction Power. Vacancy rates within Traction Power are illustrated in Table 45.

Table 45 - Traction Power Rail Technician Vacancies

Fiscal Year	*Vacancies*	*%*
1998	7 of 24 vacant	29.2
1999	3 of 24 vacant	12.5
0/99-5/00	1 of 24 vacant	4.2

C. Power Distribution Condition

The Chief Supervisor and Field Test Engineer for Train Control & Traction Power were asked to evaluate the current condition of the power systems using a consistent set of definitions for establishing the condition of each system element. The definitions used for assigning condition codes to power distribution are presented in Table 46.

Table 46 – Traction Power Definitions of Power Distribution Conditions

Condition Code	*Category*	*Definition*
1	Bad	Major substation equipment is older than its design life and spare parts are not available. Equipment design is obsolete or substation capacity is not adequate for the peak load requirements
2	Poor	A single major substation component is "state of the art" and recently installed. The remainder is nearing the end of its design life. Spare parts are not available for some of the major components.
3	Fair	Age of equipment is nearing midpoint of useful life or from 50-75% of major substation components are "state of the art" and recently installed. The remaining equipment is nearing the end of its design life. Spare parts are becoming unavailable.
4	Good	Major equipment of substation is "state of the art" but has been in service for over ten years. Equipment may require little or minor component substitution to achieve original levels of reliability.
5	Excellent	Major equipment of substation is new (installed within the past ten years). No problems exist.

The condition ratings for the categories of circuit breaker houses, switching stations, and gap breaker stations are comparable to those defined above for the substations. Table 47 provides a summary of their evaluation:

Table 47 - Traction Power Ratings of Power Distribution Conditions

Item	*Rating*
Duct Banks	4.5
Third Rail	4.5
Feeder Cables	3.5
Rectifiers	3.0
Transformers	2.5
High Voltage AC Switchgear	1.0
Feeder Breakers	1.0
Auxiliary Support Equip	1.0
Circuit Breaker Houses	1.0
DC Switch Gear	1.0
Gap Breaker Stations	1.0
Overall	2.2

The most serious problems facing Traction Power are equipment and system obsolescence. The Chief Supervisor and Field Test Engineer strongly recommended that all future contracts contain a clause requiring that all traction power substation equipment be rebuilt and retrofitted to non-obsolete equipment with a 10-year non-obsolete clause in the contract. They also suggested that the contract should require use of the same contractor for the duration of the contract and should mandate installation of the same equipment. These contract requirements would prevent problems with parts/methodologies in the future.

D. Capital and Additional Personnel Needs

Traction Power capital and additional personnel needs within the next 10 years are indicated in Table 48.

Table 48 - Traction Power Capital and Additional Personnel Needs

Item	*Details*	*Start Date*	*Cost*	*Quantity*	*Total Cost*	*Capital Program*
AC Unit Substations	Rebuild and retrofit		$150,000	24	$3,600,000	
AC and DC Switchgear	Obsolete		$250,000	23	$5,750,000	
Battery Chargers, Surge & lightning protection MT1999RM8229	Replace battery chargers and add surge & lightning protection		$10,000	23	$230,000	$1,800,000
Pier Shunts	Install; design not yet complete	FY 2005	$25,000	10 years	$250,000	
Pier Grounding MT2000MT3501 MT2006MT3501 (Pier Grounding and Cathodic Protection Not included in calculation of need later in report)	Test and install pier grounds, as needed, throughout entire mainline; annual cost includes hiring five (5) personnel to test, install and maintain the grounding system		$240,000	Annual		$1,900,000

The Chief Supervisor indicated that Engineering has completed a manpower needs assessment as part of the proposed work plan. That plan shows a need for five additional staff to test, install and maintain the grounding system. While it is apparent that this work must be done, what is not apparent is who should do the work, in-house staff or a contractor. Given Train Control & Traction Power's positive record of retaining experienced people and the recent growth in the labor required for system repair, the Agency needs to consider the Chief Supervisor's request. Two alternatives exist for consideration. One alternative is to have the testing completed by a contractor to determine the scope and to evaluate personnel needs for in-house completion of the work. Apparently, sample testing has been conducted in several locations by a contractor in conjunction with Train Control rather than Traction Power personnel. Another alternative is to contract the entire project that is funded in the capital program. Manpower needs for Train Control & Traction Power will be discussed in detail after discussion of Train Control positions in Section F. of this Chapter.

E. Train Control

Train control is the process by which the movement of rail vehicles is regulated for safety and efficiency. The process is accomplished by a combination of elements located on the train, along the track, in the stations, and at remote central facilities. These elements interact to form a command and control system with three major functions:

- Train protection – prevention of collisions and derailments
- Train operation – control of train movement and stopping at stations
- Train supervision – direction of train movement in relation to the schedule

The mainline Automatic Train Control (ATC) System control equipment for each of the 21 stations is installed in a separate equipment room at each station. Each equipment room also contains a local control panel (LCP) that is used for maintenance and/or monitoring purposes. The LCP at each interlocking area on the mainline also permits local control of traffic route selection and locking through the respective interlocking when control is properly transferred from the Central Control Facility (CCF) train control console to the interlocking LCP in question. The track switches of the crossovers and turnouts are all electrically power-operated. The track switches and associated fixed wayside signals of each of the nine mainline interlocking areas are controlled by the route locking circuits, which include operator controls on the associated interlocking LCP.

Equipment rooms for each station area are connected via data transmission system (DTS) and cable transmission system (CTS) equipment to the CCF train control console and train status board. The CCF is housed in the Dade County Administration Building in the Stephen P. Clarke Center located in the downtown Government Center area. This facility contains the necessary equipment and operating personnel responsible for the overall safety and security of passengers, and for the daily operation of the trains, stations, yard and shop facilities, and supporting wayside equipment. This administration facility serves as the central location from which all Miami-Dade Transit operations are supervised, regulated, and controlled. During normal mainline operation, all train dispatching, routing, and scheduling are controlled from this remote facility. If maintenance must be performed at a particular interlocking, operation must be relinquished thereby transferring interlocking control from the CCF to the local mode. When this occurs, the interlocking switches and controls on the interlocking LCP become functional and the interlocking subsystems are locally controlled.

At the Okeechobee and Dadeland South terminal stations and the Earlington Heights short-line operating terminal station, an additional terminal supervisor's panel is provided in an enclosed station booth. This panel, in the LOCAL mode, controls the turnback modes (MANUAL/AUTO), dispatching, scheduling, and routing of trains. In the CCF mode, these functions are performed from the train control console in the CCF. Whenever the LCP at the terminal station is placed in the LOCAL or CCF mode, the terminal supervisor's panel must also be placed in the corresponding mode and vice-versa.

Through the actions of mainline ATC System train detection circuits, the positions of all trains on the mainline are automatically monitored. They are displayed on both the LCP at each station area equipment room and, through the DTS, and the associated CTS, this information is forwarded to the CCF and is displayed on the free-standing train status board. By means of this display, the CCF dispatchers can monitor the movement of all trains on the mainline as well as the status of auxiliary equipment such as mainline switch positions and power distribution equipment operation.

The Dadeland South and Okeechobee Terminal Stations contain automatic routing circuits associated with the stations' diamond crossover(s) to expedite train turnaround.

F. Train Control Positions, Labor and Vacancies

Train Control is responsible for all Metrorail preventive and corrective maintenance of: equipment rooms containing relays, relay logic; AF-400 electronic track circuits, power supplies, and local control panels; Central Control equipment such as mimic boards and train control consoles and related circuitry; and, wayside equipment on the mainline and in the Palmetto Yard that includes track switching machines, signal lights, and mini-bonds. Preventive maintenance is performed on daily, weekly, monthly, quarterly, semi-annual, and annual schedules. There are 2-4-6-year PMs for relays. Table 49 outlines positions assigned to Train Control.

Table 49 - Train Control Positions

Train Control	*Positions*
Rail Technician Train Control	25
Train Control Supervisor	4
Rail Maintenance Clerk	1

Vacancy rates were reviewed for the time period from FY1998 until the present. In all classifications since 1998, those rates have remained relatively low for Train Control. Vacancy rates are presented in Table 50 through Table 52

Table 50 - Train Control Rail Technician Vacancies

Fiscal Year	*Vacancies*	*%*
1998	7 of 26 vacant*	26.9
1999	1 of 26 vacant	3.8
0/99-5/00	2 of 25 vacant	8.0

*Vacant positions frozen

Table 51 - Train Control Supervisor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	1 of 4 vacant	25.0
1999	0 of 4 vacant	0.0
0/99-5/00	0 of 4 vacant	0.0

Table 52 - Train Control/Traction Power Vacancies

Fiscal Year	*Vacancies*	*Train Control Traction Power Total %*	*Metrorail Metromover Total %*
1998	15 of 60 vacant*	25.0	16.0
1999	4 of 60 vacant	6.7	9.3
10/99-5/00	3 of 59 vacant	5.1	8.1

*7 Vacant positions frozen

Labor hours for Train Control & Traction Power are presented in Table 53

Table 53 - Train Control & Traction Power Labor Hours

	1997	*1998*	*1999*	*2000**
Repairs	1,116	1,698	3,945	7,638
Repairs % of Total Labor Hours	1.8%	2.7%	5.3%	10.2%
Recovery & Miscellaneous Labor	30,900	30,900	39,065	34,840
Recovery & Miscellaneous Labor % of Total Labor Hours	48.6%	48.3%	52.3%	46.4%
Preventive Maintenance	31,509	31,415	31,741	32,582
PM % of Total Labor Hours	49.6%	49.1%	42.5%	43.4%
Total Labor Hours	63,525	64,013	74,751	75,060
Positions Required @ 1,664 Hours per Full-time Employee	38	38	45	45

*Projected FY 2000 based on 9 months actual data

Actual hours for repairs and PM increased while labor hours for recovery/miscellaneous labor decreased. In terms of job type as a percentage of total hours, those increased labor hours dedicated to repair and PM reduced the total hours dedicated to recovery/miscellaneous labor from an FY 1999 high of 52.3 percent to 46.4 percent in FY 2000.

MDTA used a standard of 1,664 labor hours per employee to calculate recovery and miscellaneous labor hours. Based on MDTA's labor hours standard of 1,664 labor hours per technician, full-time technicians required in FY 1998, FY 1999, and FY 2000 were 38, 45, and 45 respectively. Positions filled pursuant to MDTA's vacancy report for the same fiscal years showed totals of 36, 46, and 46. These data help confirm the accuracy of MDTA's labor hours standard of 1,664 hours per full-time equivalent within Train Control & Traction Power.

In addition to repair, recovery and PM, Train Control & Traction Power Rail Technicians also provided labor hours for the Cadweld Third Rail and Refurbish Interlocking Grant Projects. Labor hours dedicated to those grant projects rose from 2,000 hours in FY 1997 to more than 13,000 hours in FY 2000. Grant project labor hours equaled 14.8 percent of total labor hours within Train Control & Traction Power during FY 2000. Including those labor hours in the labor hours total reduces the overall percentage of labor hours dedicated to repair, recovery and PM in FY 2000. Repair hours decreased from 10.2 percent to 8.7 percent of total labor hours; recovery and miscellaneous labor fell from 46.4 percent to 39.5 percent of total labor hours; and PM dropped from 43.4 to 37.0 percent of total labor hours.

Specific labor hours and positions are indicated in Table 54 and grant project labor hours and positions are shown in Table 55.

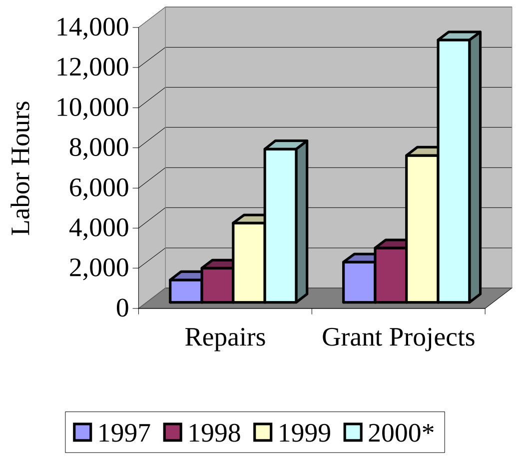
Table 54 – Labor Hours and Positions

Repair, Recovery & PM	*1997*	*1998*	*1999*	*2000**
MDTA Standard Labor Hours per Tech	1,664	1,664	1,664	1,664
Techs Available @ 1,664 Hours per Tech	38	38	45	45
Techs Indicated in Vacancy Report		36	46	46
Hours per Tech based on Vacancy Report		1,778	1,625	1,632

Table 55 - Grant Projects Labor Hours and Positions

Grant Projects	*1997*	*1998*	*1999*	*2000**
Refurbish Interlocking	0	0	3,120	3,067
Cadweld Third Rail	2,000	2,700	4,200	10,000
Grant Projects - Interlocking + Cadweld Third Rail	2,000	2,700	7,320	13,067
Techs Required		2	5	8

Train Control & Traction Power has experienced a greater need for repair, recovery, and PM labor hours. These increases coupled with the escalation in need for labor hours committed to complete grant projects are taxing current manpower levels. Increases in actual labor hours for repairs and grant projects within Train Control & Traction Power are reflected in Figure 18.



*FY2000 projections based on 9 months actual data

Figure 18 - Labor Hours: Repairs and Grant Projects

Train Control & Traction Power manpower requirements are presented in Table 56. These requirements represent the level of full-time staff needed to provide labor hours similar to those provided in FY 2000 for repair, recovery and PM, i.e., 75,060 labor hours, in addition to those staff required to provide 13,067 labor hours to complete grant projects. The actual staffing level is the level that has been adjusted to account for vacancies while the approved staffing level is the level of staff authorized within the budget.

Table 56 - Manpower Requirements

Manpower Requirements	*1998*	*1999*	*2000**
Repair, Recovery & PM	36	46	46
Grant Projects	2	5	8
Total	38	51	54
Staffing Level			
Actual	36	46	46
Vacancies	14	4	3
Approved	50	50	49
Manpower Need based on Actual Staffing			
Repair, Recovery & PM	0	0	0
Grant Projects	2	5	8
Total	2	5	8
Manpower Need based on Approved Staffing			
Repair, Recovery & PM	-14	-4	-3
Grant Projects	2	5	8
Total	-12	1	5

In order to provide the FY 2000 level of service with full-time positions, MDTA will need at a minimum 46 full-time Train Control & Traction Power Rail Technicians to provide repair, recovery, and PM. As noted earlier, repair hours within Train Control & Traction Power are escalating annually and have risen from 1.8 percent of total labor hours in FY 1997 to 10.2 percent of total labor hours in FY 2000. Given the age of the current systems and the problems already encountered with obsolescence, repair hours required should be expected to continue to increase. As repair hours escalate, the need for additional personnel will also escalate due to the fact that PM and recovery hours must remain relatively constant and cannot be used to offset increased repair needs.

Grant projects requiring levels of work similar to those completed in FY 2000 will require 8 full-time Train Control & Traction Power Rail Technicians.

At a minimum, Train Control & Traction Power needs a total of 54 full-time Rail Technicians, i.e., 5 positions in excess of the approved staffing level or 8 positions in excess of the actual staffing level as indicated in Table 56. Should it become necessary to adjust staffing levels due to changes in priorities for grant projects, repair schedules, PM requirements or new initiatives such as the grounding work, use of the standard of 1,664 labor hours per full-time employee would appear to be appropriate.

Supervisor to subordinate ratios for the Agency were examined by department and division for FY 1994 and FY 1998 – FY 2001. Supervisory ratios remained consistent and stable throughout those time periods and averaged slightly above 1 to 7 for Metrorail/Metromover Operations and Maintenance.

Train Control & Traction Power's ratio of supervisors to technicians averaged slightly lower than the Agency's ratio. That division's ratio equaled 1 to 6. Using that ratio, supervisory needs are indicated in Table 57.

Table 57 – Additional Technician and Supervisory Needs

Staffing Level	*Actual 2001*	*Approved 2001*	*Positions Recommended*	*Additional Positions*
Supervisors	8	8	9	1
Rail Technicians	46	49	54	5
Total	54	57	63	6

G. System-wide Condition

The Chief Supervisor and Field Test Engineer for Train Control/Traction Power were asked to evaluate the current condition of the system-wide controls using a consistent set of definitions for establishing the condition of each system element. The definitions used for assigning condition codes to system-wide controls are contained in Table 58.

Table 58 - Train Control Definitions of System-Wide Controls Conditions

Condition Code	*Category*	*Definition*
1	Bad	Inoperative. Obviously worn-out or broken items which would preclude proper operation.
2	Poor	Poor physical appearance. Dirty, worn materials, loose mountings, "temporary-type repairs," considerable evidence of repair.
3	Fair	Generally "acceptable" appearance. Minor amounts of dust acceptable. Circuit boards may evidence repairs; resoldering must be neat and all surfaces resealed. Can have some repairs and/or circuit modifications not up to the standard of the original as-built equipment.
4	Good	Good overall appearance. Clean, with no evidence of significant repairs to or substitution/replacement of devices. Circuit boards have no evidence of deterioration.
5	Excellent	Brand new. No evidence of problems or repairs.

The condition ratings for the categories of relay circuitry, microprocessors/computers, interior cabling, exterior lines and cables, impedance bonds, insulated joints, electro-mechanical devices, indicators/displays/static boards, and control units are comparable to those defined above for the circuit boards. Table 59 reflects the ratings of the Chief Supervisor and Field Test Engineer.

Table 59 - Train Control System-Wide Controls Condition Ratings

Item	*Rating*
Interior Cabling	5.0
Relay Circuitry	4.0
Exterior & Interior Housings	4.0
Cabinets	4.0
Enclosures	4.0
PC Boards	3.5
Exterior Lines and Cables-Mainline	3.0
Electro-mechanical Devices	2.5
Exterior Lines and Cables-Yard	2.0
Impedance Bonds	1.0
Indicators/Displays/Static Boards	1.0
Overall	3.1

As with Traction Power, the most serious problems facing Train Control are equipment and system obsolescence. The shift in labor hours from recovery/miscellaneous labor and PM to repair and grant projects as reported in Tables 53-55 is probably a direct result of this system obsolescence as was also the case in Traction Power. The Chief Supervisor and Field Test Engineer strongly recommended that all future contracts contain a clause requiring that all train control equipment be rebuilt and retrofitted to non-obsolete equipment with a 10-year non-obsolete clause in the contract. They also suggested that the contract should require use of the same contractor for the duration of the contract and should mandate installation of the same equipment. These contract requirements would prevent problems with parts/methodologies in the future.

H. Train Control Capital Needs

Train Control capital needs within the next 10 years are presented in Table 60.

Table 60 - Train Control Capital Needs

Item	*Details*	*Start Date*	*Years*	*Total Cost*	*Capital Program*
DC Power Supplies MT1999RM8208	Obsolete	FY 2001		$1,250,000	$770,000
Local Control Panels Mainline MT1999PM8228	Obsolete replacement parts	FY 2001		$1,000,000	$1,750,000
Switch Machines MT1999RM8210	Convert to Low Profile Type w/o Circuit Controller; convert 10 machines /yr	FY2003	6	$60,000	$225,000
Minibonds/Coupling Units MT1999RM8225	Eliminate grounding problems; 500 in system	FY 2004	20	$2,000,000	$760,000
Surge Suppression MT1999RM8229	Add to all train control rooms; $20,000 per room	FY 2004		$600,000	$318,000
Track Circuit Equipment	Retrofit	FY 2006	20	$1,500,000	
Non-Vital Relays MT1999RM8226	Replace at in-line locations	FY 2008		$1,750,000	$1,300,000

Chapter 5 Track & Guideway

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 track and guideway systems and the station structures must be maintained to permit revenue services at speeds up to 70 mph. Over 44 miles of mainline track and 7 miles of yard track with associated power rail are maintained by the Division. The Division also repairs and maintains 20 miles of elevated structure. The Division Office consists of the General Superintendent, an Administrative Secretary, and a Rail Maintenance Clerk. A total of 87 staff are assigned to the division.

The Track & Guideway Division plans, directs and coordinates all track and guideway maintenance requirements, provides support to Rail Transportation and the 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.

A. Rail Structure

The Chief Supervisor of Rail Structure Maintenance directs the maintenance of the Metrorail and Metromover structures. Rail structure maintenance previously worked seven days a week; however, staffing was diverted to track maintenance, which had become a priority. Rail Structure maintenance now 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, a joint effort of the Track & Guideway structural maintenance staff and Transit Engineering. 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. Staff assigned to Rail Structure Maintenance total 11, including the Chief Supervisor. Rail Structure Maintenance Staff are shown in Table 61.

Table 61 - Rail Structure Maintenance Staff

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

The General Superintendent and Chief Supervisor reported that adequate staffing is the single most critical issue facing them today. In order to rehabilitate the guideway, they feel it is necessary to increase staffing in the structure repair classification. Additional labor is needed in five primary areas: guideway drains, application of a protective coating to piers, vegetation control, and painting the metal acoustical barrier. Their estimate of additional needs is presented in Table 62.

Table 62 - Rail Structure Maintenance Personnel Needs

Rail Structure Maintenance	*Current Positions*	*Additional Positions*	*Total Positions*
Rail Structural Repairer	8	4	12
Rail Structure & Track Supervisor	2	1	3

Rail Structure 1994-1999 labor hours by job type are reflected in Table 63.

Table 63 - Rail Structure Labor Hours by Job Type

	1997	*1998*	*1999*	*Average*	*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

*FY2000 = Oct-Jun

Based on available manpower during FY1998 until the present time, labor hours per employee are indicated in Table 64.

Table 64 - 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			
Rail Structure & Track Supervisor	2 of 2	2 of 2	2 of 2	1,447	1,660	2,199

B. 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. Major projects pending or in progress include tie replacement program in the yard, switch tie replacement, rail replacement, plinth pad repair, switch frog replacement, insulated joints, concrete ties, and coverboard. A total of 42 staff are assigned to rail track maintenance, including the Chief Supervisor of Rail Track Maintenance and the Chief Supervisor of Guideway Inspection. Eight 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 65.

Table 65 - 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

In order to rehabilitate the track and retain optimum track conditions, the General Superintendent and Chief Supervisor's estimates of their needs for additional track repair staff are presented in Table 66.

Table 66 - Rail Track Maintenance Personnel Needs

Rail Track Maintenance	*Current Positions*	*Additional Positions*	*Total Positions*
Rail Track Repairer	29	10	39
Rail Structure & Track Supervisor	5	2	7
Guideway Inspection Specialist	4	0	4
Rail Track Equipment Operator	0	3	3
Field Test Engineer	0	1	1

Rail Track & Guideway labor hours by function FY 1997 through FY 2000 are presented in Table 67.

Table 67 - Rail Track & Guideway Labor Hours by Function

	1997	*1998*	*1999*	*Average*	*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 during FY 1998 until the present time, labor hours per employee are reflected in Table 68.

Table 68 - Rail Track Labor Hours per Employee

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

C. Rail Shop

The activities of the Rail Shop are directed by the Chief Supervisor of 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, supports 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 69.

Table 69 - 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; the 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. Following is a summary outlining additional shop staff needs identified in the State of the Rail Report. Included is a new classification, i.e., a mechanical classification to improve and enhance the maintenance capabilities of the shop. Those positions are reflected in Table 70.

Table 70 - Rail Shop Personnel Needs

Rail Shop	*Current Positions*	*Additional Positions*	*Total Positions*
Rail Maintenance Worker	7	4	11
Track Equipment Operator	19	2	21
Track Shop Supervisor	5	2	7
Track Equipment Mechanic	0	2	2

D. Labor Hours by Department

Rail Shop labor hours by job function are presented in Table 71.

Table 71 - Rail Shop Labor Hours by Function, FY 1997 - FY 2000

	1997	*1998*	*1999*	*Average*	*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

Rail Shop employees are reflected in Table 72. Labor hours are not reflected in terms of hours per employee due to the fact that Track Equipment Operators' hours are inconsistently reported in the field.

Table 72 - Rail Shop Employees

	# of Positions		
Classification	*1998*	*1999*	*2000*
Track Equipment Operator*	11 of 19	16 of 20	16 of 19
Rail Maintenance Worker	5 of 7	5 of 7	7 of 7

Table 73 illustrates FY 1997 through FY 2000 labor hours for each department within the Track & Guideway Division.

Table 73 - Track & Guideway Labor Hours by Department

Department	*1997*	*1998*	*1999*	*Average*	*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	13,521
Total	64,949	85,559	72,004	74,171	85,144

*Shop numbers are understated; Track & Guideway is aware of this issue and has restructured their process of tracking hours

Based on available manpower during FY1998 until the present time, labor hours per employee are indicated in Table 74.

Table 74 - Track & Guideway Labor Hours per Employee

	# of Positions			*Hours per Position*		
Classification	*1998*	*1999*	*2000*	*1998*	*1999*	*2000*
Filled Positions	49 of 68	60 of 68	58 of 67	1,746	1,200	1,468

E. Vacancy Rates

Vacancy rates for the time period from FY1998 until the present are illustrated in Tables 75 through 86.

Table 75 - Rail Structure & Track Supervisor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 2 vacant	0.0
1999	0 of 2 vacant	0.0
0/99-5/00	0 of 2 vacant	0.0

Table 76 - Rail Structural Repairer Vacancies

Fiscal Year	*Vacancies*	*%*
1998	1 of 8 vacant	12.5
1999	0 of 8 vacant	0.0
0/99-5/00	0 of 8 vacant	0.0

Table 77 - Rail Structure Vacancies

Fiscal Year	*Vacancies*	*%*
1998	1 of 11 vacant	9.1
1999	0 of 11 vacant	0.0
10/99-5/00	0 of 11 vacant	0.0

Table 78 - Track Supervisor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	3 of 6 vacant	50.0
1999	0 of 6 vacant	0.0
0/99-5/00	0 of 6 vacant	0.0

Table 79 - Guideway Inspection Specialist Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 4 vacant	0.0
1999	1 of 4 vacant	25.0
0/99-5/00	1 of 4 vacant	25.0

Table 80 - Track: Track Repairer Vacancies

Fiscal Year	*Vacancies*	*%*
1998	8 of 30 vacant	26.7
1999	1 of 29 vacant	3.4
0/99-5/00	6 of 30 vacant	20.0

Table 81 - Rail Track Vacancies

Fiscal Year	*Vacancies*	*%*
1998	11 of 42 vacant	26.2
1999	2 of 41 vacant	4.9
0/99-5/00	8 of 42 vacant	19.0

Table 82 - Shop: Track Shop Supervisor Vacancies

Fiscal Year	*Vacancies*	*%*
1998	2 of 5 vacant	40.0
1999	2 of 5 vacant	40.0
0/99-5/00	0 of 5 vacant	0.0

Table 83 - Track Equipment Operator Vacancies

Fiscal Year	*Vacancies*	*%*
1998	8 of 19 vacant	42.1
1999	4 of 20 vacant	20.0
0/99-5/00	3 of 19 vacant	15.8

Table 84 - Shop: Rail Maintenance Worker Vacancies

Fiscal Year	*Vacancies*	*%*
1998	2 of 7 vacant	28.6
1999	2 of 7 vacant	28.6
0/99-5/00	0 of 7 vacant	0.0

Table 85 - Rail Shop Vacancies

Fiscal Year	*Vacancies*	*%*
1998	12 of 32 vacant	37.5
1999	8 of 33 vacant	24.2
0/99-5/00	3 of 32 vacant	9.4

Table 86 - Track & Guideway Vacancies

Fiscal Year	*Vacancies*	*Track & Guideway Total %*	*Metrorail Metromover Total %*
1998	24 of 88 vacant	27.3	16.0
1999	10 of 88 vacant	11.4	9.3
10/99-5/00	11 of 88 vacant	12.5	8.1

F. Experience and Classification

While vacancy rates have improved within the Track & Guideway Division, they continue to exceed the rates reported by the agency as a whole. As noted earlier, adequate staffing was the major issue raised by the General Superintendent. Two years ago, more than 1 in 4 positions allocated was vacant. During the past two years that number has improved to 1 in 8. A review of the 81 filled positions in late August by the Chief Supervisor of Rail Structure Maintenance revealed that 60 of the 81 Track & Guideway employees had five or less years of experience in their current classification. In essence, over 74 percent of the Track & Guideway staff are relatively new employees. The General Superintendent offered a plausible explanation for the high vacancy rates. He indicated that Track & Guideway positions are compensated at a rate below positions within the other divisions. As a result, these positions are viewed as entry positions. Employees remain in these positions only until they meet the criteria to move to other positions. Filling vacant positions is difficult and time consuming. Training unskilled employees is even more demanding. Reduced efficiency and diminished productivity result from the continuous movement of employees into and out of Track & Guideway. Table 87 provides a summary of current classifications and their corresponding entry-level pay rates.

Table 87 - Current Classifications and Corresponding Hourly Pay Rates

Division – Area	*Classification*	*Salary $ per Hour*	*Area Range High*	*Area Range Low*
Vehicle Insp/Heavy Repair	Rail Vehicle Electronic Technician (8068)	15.94	15.94	11.01
	Rail Vehicle Technician/ATP (8059)	15.94		
	Rail Vehicle Electrician (8093)	13.19		
	Rail Vehicle Mechanic (8071)	12.57		
	Rail Vehicle Machinist (8056)	12.57		
	Rail Maintenance Clerk (8076)	12.03		
	Rail Vehicle Cleaner (8069)	11.01		
Train Control/Traction Power	Rail Technician Train Control (8060)	15.94	15.94	12.03
	Rail Technician Traction Power (8061)	15.94		
	Rail Maintenance Clerk (8076)	12.03		
Track & Guideway	Guideway Inspection Specialist (8054)	12.27	12.27	11.01
	Rail Structural Repairer (8065)	12.27		
	Track Equipment Operator (8066)	12.27		
	Track Repairer (8064)	11.48		
	Rail Maintenance Worker (8063)	11.01		
Maintenance Control	Rail Maintenance Control Clerk (8077)	12.54	12.54	12.54
Rail Transportation	Train Operators (8073)	12.16	12.16	12.16
Metromover Maintenance	Metromover Technician (8082)	15.94	15.94	11.01
	Rail Maintenance Clerk (8076)	12.03		
	Rail Vehicle Cleaner (8069)	11.01		

Entry salary rates for Track & Guideway classifications are 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 review of information regarding the former classification of 129 positions within Rail Maintenance in April 1999 shows the movement of employees throughout the system, as reflected in Table 88.

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Table 88 - Track & Guideway Former Classifications

Former Classification	*Number of Positions*	*% of Total*
Metrobus	42	32.6
Outside of Agency	31	24.0
Unknown	17	13.2
Rail Maintenance*	16	12.4
Track & Guideway	13	10.1
Metrofacilities	4	3.1
Train Control-Traction Power	3	2.4
Rail Transportation	2	1.6
Mover Maintenance	1	0.8

*16 Employees within Rail Maintenance moved to other positions within Rail Maintenance

A comparison of the number of employees who moved and the size of the department from which they came indicates a disproportionately higher number moved from Rail Vehicle Maintenance and from Track & Guideway as shown in Table 89.

Table 89 - MDTA Movement of Employees by Department

Department	*# Moved*	*Staff Allocation*	*% of Total*
Rail Vehicle Maintenance	16	93	17.2
Track & Guideway	13	87	14.9
Train Control-Traction Power	3	56	5.4
Rail Transportation	2	99	2.0
Metromover Maintenance	1	70	1.4
Total	35	405	8.6

Table 90 shows the movement of 13 Track & Guideway employees to Rail Vehicle Maintenance.

Table 90 - Track & Guideway Movement to Rail Vehicle Maintenance

Former Track & Guideway Classification	*#*	*New Classification*	*#*
Rail Maintenance Worker	5	Machinist	3
Track Repairer	5	Mechanic	7
Track & Guideway	2	Metromover Maintenance	2
Track Equipment Operator	1	Train Control-Traction Power	1

All 16 of the Rail Vehicle Maintenance employees who moved actually transferred into other positions within Rail Vehicle Maintenance as reflected in Table 91.

Table 91 - Rail Vehicle Maintenance Movement

Former Rail Vehicle Maintenance Classification	*#*	*New Classification*	*#*
Electrician	2	ATP Electronic Technician	1
Electronic Technician	2	Electrician	1
Machinist	1	Electronic Technician	5
Mechanic	6	Machinist	4
Vehicle Cleaner	5	Mechanic	1
		Metromover Maintenance	4

It does appear that there is movement from Track & Guideway to Rail Vehicle Maintenance; the movement within Rail Vehicle Maintenance is from less skilled jobs to those requiring more skill. There was no movement from anywhere in the system into Track & Guideway. This further substantiates the General Superintendent's observation. The two classifications within Track & Guideway with the highest vacancy rates are the Track Repairer and the Track Equipment Operator. Neither position appears to have a counterpart in other divisions within the agency; therefore, creating parity with other classifications requiring similar skill levels may not be feasible. These positions should be evaluated to determine if compensation rates are appropriate. If study of these positions verifies compensation rates are appropriate and determines they are entry level and require only basic skills at entry, a legitimate option to consider is allocating more positions to these classifications while at the same time budgeting a higher turnover rate than the 8 percent MDTA currently uses. This would allow the division to operate with a complement of staff at the level designated previously even with several positions vacant. Establishing legitimate qualifications for entry into higher classifications will also slow this movement, as employees interested in "moving up" will need to obtain mandatory technical training in order to be qualified. MARTA requires new employees to have a minimum of two years of railroad or track maintenance experience and one hundred percent of the track training is on the job. MARTA also offers an apprenticeship program for those who have formal training but no experience. At a minimum, the Division should explore possible incentives for retention.

G. Guideway

The guideway requires special attention as 20.96 miles of the 21.5 miles are elevated. Table 92 contains an inventory of the guideway and track features.

Table 92 - Track & Guideway Feature Inventory

Inventory	*Mainline*	*Yard*	*Total*
Length in Miles			22.26
Elevated Guideway in Miles			20.96
Aerial Structure Inventory			
Girders			
Prestressed Double – T Girders	2,263		2,263
Prestressed Box Girders	6		6
Post-Tensioned Box Girders	377		377
Steel Box Girders	102		102
Total Girders	2,748		2,748
Columns	2,361		2,361
Pier Caps	481		481
Retaining Walls	13		13

Inventory	*Mainline*	*Yard*	*Total*
Abutments	8		8
Concrete Decks	41		41
Elevated Stations	21		21
Drains			
Column Drains	2,361		2,361
Seal Glands in Linear Feet	33,288		33,288
Metal Acoustical Barriers in Linear Feet	12,600		12,600
Track Inventory			
Track			
Ballasted Track in Linear Feet			
Track with Concrete Ties	14,054		14,054
Track with Wood Ties	2,136		2,136
Track @ Hi-Rail Access Crossing	189		189
Track @ Vehicle Maintenance Access Crossing	98		98
Track in Special Trackwork	1,504		1,504
Ballasted Track Total	17,981		17,981
Track with Direct Fixation Landis Fasteners	224,670		224,670
Track in Special Trackwork with Wood Ties in Concrete	3,896		3,896
Total Track in Linear Feet	246,547	39,470	286,017
Inventory			
Length in Miles			22.26
Rail			
Total Rail in Linear Feet	493,094	78,940	572,0342
Cross Ties			
Ballasted Track (Each)			
Concrete	5,622	3,908	9,530
Wood	1,068	13,512	14,580
Special Trackwork	990		990
Total Ballasted Ties	7,680	17,420	25,100
Special Trackwork Wood in Concrete	2,550		2,550
Total Ties (Each)	10,230		27,650
Track Plates (Curves only – 25 Sections)			
Direct Fixation Landis Fasteners	179,736	288	180,024
Switches	52	59	111

Inventory	*Mainline*	*Yard*	*Total*
Power Rail			
Third Rail in Linear Feet	246,260	35,792	282,052
Coverboard			
Third Rail Coverboard in Linear Feet	246,260	35,792	282,052
Hi-Rail Access Locations	3		3
Ballast in Tons (Required for Resurfacing)	51	3,384	3,435
Grade Crossings			
Concrete Grade Crossings		3	3
Flange Timber & Asphalt		18	18
Total Grade Crossings		21	21

The Florida Department of Transportation and the Federal Transit Agency appraised the guideway structure as "good to excellent." The General Superintendent indicated that inspection condition ratings received from Engineering consistently fall within the middle of the range, i.e., every rating equals "3." A forced ranking system by the engineering forces performing the inspection would undoubtedly help the structures section of the Track & Guideway Division prioritize their projects. The General Superintendent previously requested a trend analysis of conditions reported through the bridge inspection program be developed to enhance the value of the inspections by prioritizing needs based on trends.

The General Superintendent and Chief Supervisor, Rail Structure, were asked to evaluate the current condition of the structures using a consistent set of definitions for establishing the condition of each element. The definitions used for assigning condition codes to the structures are shown in Table 93.

Table 93 - Track & Guideway Definitions of 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.

H. Structure Condition

The condition ratings for the categories of concrete spall and rebar, concrete cracks, leaking, leaching, and masonry are comparable to those defined above for the structures.

Table 94 presents a summary of their evaluation.

Table 94 - Ratings of Structure Conditions

Item	*Mainline Quantity*	*Rating*
Retaining Walls	13	4.5
Prestressed Double-T Girders	2,263	3.5
Prestressed Box Girders	6	3.5
Post-Tensioned Box Girders	377	3.5
Steel Box Girders	102	3.5
Columns	2,361	3.5
Pier Caps	481	3.5
Abutments	8	3.0
Concrete Decks	41	3.0
Column Drains	2,361	2.0
Seal Glands (lin ft)	33,288	2.0
Metal Acoustical Barriers (lin ft)	12,600	2.0
Overall		3.1

Overall the structures appear to be in good condition. Assertions in the State of the Rail Report that original construction and design issues caused maintenance issues were verified. The most bothersome of those left to be addressed is that of drainage, as it appears the drainage system inside the bridge piers is not functioning. Approximately 40 percent of the 2,361 column drains were clogged or misaligned. Half of those have been cleared, and another major rehabilitation effort was undertaken in June. It is probably impractical to repair the original drainage system inside the pier. An alternative is retrofitting an external system with the outfall pipe on the outside of the columns. While this fix is not as aesthetically pleasing as the original construction, it should be functional and easier to maintain. The importance of proper drainage cannot be overstated. It is possible that the onerous tasks of replacing the wooden rail ties at the crossovers and the removal of the unsightly pier stains through an engineering contract could have, at least, been postponed if proper drainage were occurring.

I. Vegetation Control

Vegetation control has become a serious problem. Parks and Recreation formerly maintained vegetation along the guideway. They subsequently discontinued this activity, and as a result, there is currently no program for vegetation control. Staff responds to handle outgrowth when it interferes with revenue service. During the past two years, vegetation control costs rose annually from $11,000 to $18,000, a 64 percent increase. During the first nine months of this fiscal year, staff labor costs totaled $15,000. As vegetation continues to grow unchecked, greater effort will be required to minimize the negative impact on revenue service. A program of vegetation control must be established. MTA controls their vegetation through an annual contract.

J. Track

After over 15 years of operation, the track system of Metrorail has reached a predictable state of wear. Track totals 246,547 linear feet on the mainline and 39,470 linear feet in the yard with rail totals double those of track. There are 25,100-ballasted ties and 2,550 special track work wood in concrete. Track & Guideway committed an average of 62.6 percent of their annual labor hours and labor costs to maintenance of track as shown in Table 95.

Table 95 - Track Labor Hours, FY 1997 - FY 1999

	Average 1997-1999			
	Hours	*% of Total*	*Cost*	*% of Total*
Track	46,456	62.6	1,059,651	62.6
Guideway Inspection	8,031	11.2	151,102	8.9
Structures	10,953	14.8	292,053	17.2
Shop	8,460	11.4	190,387	11.2
Total	73,900		1,693,193	

K. Tie Replacement

Perhaps the most intensive initiative undertaken by the Track Section is the tie replacement program. This program, in its fourth year, is 40 percent complete, and with the current allocation of staff, should be completed in 2003. Labor costs since 1997 for this single program exceed $1.2 million; labor hours equal 19.1 percent of all Track & Guideway labor hours since 1997.

L. Track Condition

The General Superintendent and Chief Supervisor, Rail Structure, were asked to evaluate the current condition of the track using a consistent set of definitions for establishing the condition of each element. The definitions used for assigning condition codes to track are illustrated in Table 96.

Table 96 - Track & Guideway Definitions of Track Conditions

Condition Code	*Category*	*Definition*
1	Bad	Rail condition unsatisfactory; Needs immediate replacement because it presents a serious hazard.
2	Poor	Frequent observable rail flaws (non-serious surface defects) or high wear (i.e., < 50% of original rail head section remaining); Rail which should be replaced within the next 1-5 years.
3	Fair	Some rail flaws or moderate wear (i.e., 50-75% of original rail head section remaining); Rail which should be replaced within the next 6-10 years.
4	Good	Few rail flaws or slight wear (i.e., > 75% of original rail head section remaining); Rail which should not require replacement within the next 10 years.
5	Excellent	Essentially brand new rail with no flaws and negligible wear.

The condition ratings for the categories of rail joints, fastening and anchor systems, ties and crossties, and ballast are comparable to those defined above for the track.

Table 97 and Table 98 summarize the General Superintendent's evaluation of the current condition of the mainline track system and the yard track system.

Table 97 - Ratings of Mainline Track Conditions

Item	*Mainline Quantity*	*Rating*
Track in Special Trackwork w/ Wood Ties in Concrete	(3,896)	5.0
Ballast (Tons)	51	5.0
Track Alignment		4.5
Track Gauge		4.5
Track Surface		4.5
Third Rail (lin ft)	246,230	4.0
Ballasted Track with Concrete Ties (lin ft)	14,054	3.0
Rail (lin ft)	493,094	3.0
Switches	52	3.0
Grade Crossings – Concrete		3.0
Coverboard – Third Rail (lin ft)	246,260	2.5
Coverboard - Hi-Rail Access Locations	3	2.5
Ballasted Track @ Hi Rail Access Crossings (lin ft)	189	2.0
Ballasted Track @ Veh Maint Access Crossing (lin ft)	98	2.0
Ballasted Track in Special Trackwork (lin ft)	1,504	2.0
Track with Direct Fixation Landis Fasteners	224,670	2.0
Track in Special Trackwork with Wood Ties in Concrete	(3,896)	2.0
Grade Crossings - Flange Timber & Asphalt		2.0
Ballasted Track with Wood Ties (lin ft)	2,136	1.5
Vegetation		1.0
Overall		3.0

Table 98 - Ratings of Yard Track Conditions

Item	*Yard Quantity*	*Rating*
Ballast (Tons)	3,384	5.0
Third Rail (lin ft)	35,792	4.0
Rail (lin ft)	78,940	3.0
Switches	59	3.0
Grade Crossings – Concrete	3	3.0
Coverboard – Third Rail (lin ft)	35,792	2.5
Grade Crossings - Flange Timber & Asphalt	18	2.0
Overall		3.2

Concrete ties, in the area of I-95, are developing signs of deterioration, cracks and spalled areas. Fastening system integrity is not affected at this time, but ties will have to be considered for replacement in the future.

Sixteen of the 20 curves on the mainline are approaching wear limits and require replacement. Four curves have been completed. Rail wear is perhaps the most critical component facing the track section today. A crew has been dedicated to complete this task. Historically, Metrorail has swapped rail rather than replace rail in the curves. Rail is available in 39-foot lengths, and some sections require lengths in excess of 1,800 feet. Welding is required. Each weld costs $100 and is very time consuming. When rail is swapped, fewer new welds are required; therefore, it is faster and cheaper in the near term, particularly with the limited window of non-revenue service time that affords approximately 4-4½ hours a day for access. However, the life of swapped rail is less than that of new rail and, given the labor investment in removing and replacing it, replacement rather than swapping is more cost effective in the long term. WMATA, MTA, and MARTA all replace rather than swap rail. The Division currently is making arrangements to have rail welded by the contractor who has been retained to weld rail for the Metrorail extension that is under construction. This will facilitate replacement of the rail in the curves with new rail rather than swapped rail. Currently, the backlog is estimated at three years.

A curve was replaced at Hialeah due to corrugation; replacement was required after grinding was repeated several times. Labor hours committed to rail grinding increased from 1,000 in 1997 to 4,800 in 1999. A curve at Allapattah is now beginning to show corrugation and will need replacement in the future. Neither WMATA nor MTA performs grinding in-house.

The condition of the coverboard appears to be marginal. Replacement of pedestals and brackets for the coverboard system-wide will begin as personnel become available. The 246,260 linear feet of coverboard on the mainline as well as 35,792 linear feet of coverboard in the yard will be replaced, rather than coated, within the next three to five years.

Despite current operating policies that ban food items on the station platforms, the public continues to dispose of food wrappers and containers on the platforms. This debris finds its way from the platforms to the track pits. Track personnel labor costs for station cleaning rose from $50,000 in 1998 to over $80,000 in 1999. This cost is in addition to those costs incurred by Transit Facilities, the group responsible for maintenance of the stations.

The area of the plinth pad or second pour concrete that supports the Landis Rail Fastener on approximately 50 percent of the supports is uneven and/or has voids that cause extensive wear on the fastener components and premature failure. The Track Section is unable to complete the preferred repair with existing staff; they have decided to re-align and re-shim to restore to the original condition. This project will take three years to complete.

The switch frogs are a maintenance problem due to the smaller wheel diameter of the transit car wheels, which produce a greater than normal impact on the frog points resulting in chipping and breakage of the frog points that requires welding. Welding costs rose from $1,000 in 1997 to $52,000 in 1999.

Four newly designed insulated joints were installed at Government Center and are working well. Installation requires 4 field welds, 2 per rail, for a total of 16 welds per station. Staff estimates that it will take three years to replace all existing joints at 22 stations.

M. Track & Guideway Capital Needs

Track & Guideway capital needs are presented in Table 99.

Table 99 - Track & Guideway Capital Needs

Item	*Details*	*Start Date*	*Annual Cost*	*Years*	*Total Cost*	*Capital Program*
Seal Glands	Marginal condition; 33,288 linear feet	FY 2006	$323,620	2	$647,240	$647,240
Metal Acoustical Barrier	Marginal condition; Clean and paint; 12,600 linear feet	FY 2000	$35,000	2	$69,000	
Rail Replacement	Replace worn rail	FY 2006		1		$550,000
Rail Fastener Replacement	Replace worn direct fixation fasteners	FY 2000	$992,640	5	$4,963,200	$4,963,200
Coverboard Replacement MT2000RM8501	Replace deteriorated coverboard	FY 2005	$792,263	5	$3,961,316	$3,961,316
Plinth Pad Repair MT19998504	Resurface plinth pad	FY 2000	$528,000	6	$3,168,000	$3,168,000
Mainline Frog & Switch Tie Replacement MT1999RM8505	Replace deteriorated ties in the crossovers	FY 2000	$531,666	6	$3,190,000	$3,190,000
Drainage MT1999RM8503	Clear guideway drains	FY 2000	$40,000	4	$160,000	$160,000
Palmetto Yard Road Crossing	Replace all road crossings in Palmetto yard	FY 2001	$32,000	3	$96,000	$96,000
Palmetto Yard Tie Plates; Switch and Turnout	Replace cut tie plates with Pandrol type plates; Replace switch rails, points, and plates	FY 2002	$178,000 $123,200	5 10	$891,000 $1,230,000	$891,000 $1,230,000
Crossing Frogs	Replace crossing frogs in crossovers	FY 2005	$250,000	4	$2,000,000	$2,000,000
Metrorail Pier Coating	Protective coating for Metrorail piers	FY 2007				$5,000,000
Metrorail Bearing Pad Replacement	Replace neoprene bearing pads on Metrorail piers	FY 2010				$5,000,000

The personnel request from Track & Guideway totaled 31 positions, an increase in staff of 36 percent. Despite some improvement, the Division has consistently recorded a higher vacancy rate than the MDTA average. As indicated earlier, vacancy rates are driven by the movement of staff out of Track & Guideway to vehicle maintenance where salary rates are higher. The need for additional personnel within this Division seems undeniable, given the current demand for their services, coupled with their turnover and vacancy rate. In the absence of systemic changes that include pay rate analysis and the introduction of minimum qualifications, Track & Guideway will maintain its status as a training ground for other divisions with personnel.

Chapter 6 Maintenance Control

Maintenance Control is managed by acting Chief, MDTA Rail Maintenance Control who reports to the MDTA Transit Services Assistant Director. The Division Office consists of the Chief, an Administrative Secretary, and a Telephone Console Operator. Table 100 identifies the 12 staff assigned to the division.

Table 100 - Maintenance Control Staff

Maintenance Control	*Positions*
Chief, MDTA Rail Maintenance Control	1
Administrative Secretary	1
Telephone Console Operator*	1
Transit Maintenance Production Coordinator	3
Rail Maintenance Control Clerk	6

*Position will move to Division 81 in FY2000/2001

Rail Maintenance Control assures 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 MDTA 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 interfaces with Vehicle Maintenance, Train Control-Traction Power, Track & Guideway, Metromover Maintenance, Operations, and other organizations. Maintenance Control is an important resource for maintenance information.

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; and maintaining equipment records and repair histories for all equipment. Maintenance Control plays a major role in the administration of the agency's Change Control Program.

A. Vacancy Rates

Two Transit Maintenance Production Coordinators (one of the three positions is vacant) and six Rail Maintenance Control Clerks perform Maintenance Control activities. Due to the Transit Maintenance Production Coordinator vacancy and an increasing workload, two to three available light duty personnel have been assisting the division on a full-time basis. The Acting Chief indicated that interviews were underway to fill the vacant position. The Transit Production Coordinator position and the Chief's position are the only two vacancies within the division, as illustrated in Table 101.

Table 101 - Maintenance Control Vacancies

Fiscal Year	*Vacancies*	*%*
1998	0 of 21 vacant	0.0
1999	4 of 17 vacant	23.5
0/99-5/00	2 of 12 vacant	16.7

B. Maintenance Control Responsibilities

The Acting Chief indicated the Division is spending $4,000 a month in overtime "just to keep up." Maintenance Control responsibilities have been expanded to include:

- rail transportation absenteeism reporting,
- federal 1490 reporting within Rail Transportation,
- expanded data collection and analysis for Track & Guideway,
- chairing the Change Review Board in addition to maintaining the minutes and writing all procedures,
- coordination of all audits for the agency, i.e., APTA, FDOT, quality, and safety,
- monitoring the growing Capital Grant Funding,
- PM schedules for Rail Vehicle Maintenance, Metromover Maintenance, Train Control-Traction Power, Track & Guideway totaling 3,000 packages per month,
- preparing PM schedules and tracking service disruptions for Facilities Maintenance,
- document control for Engineering changes,
- preparation of Standard Operating Procedures, and
- scheduling and tracking all equipment calibrations.

C. Personnel Needs

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 MDTA, 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. The Acting Chief recommended establishing a "quality assurance" section. The function should be evaluated because it is critical and growing.

The acting Chief presented a good case for the additional staff identified in Table 102.

Table 102 - Maintenance Control Personnel Needs

Rail Maintenance Control	*Current Positions*	*Additional Positions*	*Total Positions*
Transit Maintenance Production Coordinator	3	1	4
Rail Maintenance Control Clerk	6	3	9

The acting Chief's request for additional staff seems reasonable given the overtime expenditures, the routine use of three light-duty program staff, and the fact that the Maintenance Control workload will never be less than it is today. If additional personnel are approved for the Maintenance Control Division, perhaps the division could be reorganized to assume the new function of quality assurance. Maintenance Control continues to expand its responsibilities well beyond the present allocation of staff. Some type of relief will be required in the long term, especially as more functions are assigned to this area. On a final note, it appears the position of Chief, MDTA Rail Maintenance Control, has been vacant since 1998. Given the scope and breadth of the Maintenance Control role within the organization, it appears to be prudent to establish permanency in this position at this critical time in the Division's growth and development.

Chapter 7 Financial

MDTA has had total annual expenditures since the mid 1990s in the mid to upper $200 million per year range. Any significant change year-to-year has been driven by changes in capital spending. Figure 19 shows the overall agency expenditures for operating, capital, and total spending for Metrorail. Note that the fiscal year 2000 figures are the budgeted figures and not actual expenditures.

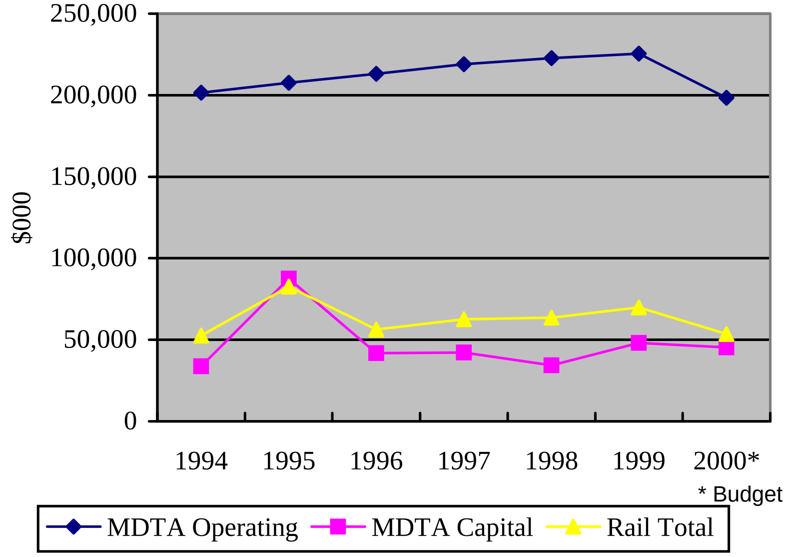

Figure 19 - MDTA Expenditures, FY 1994 - FY 2000

As the introduction of the report indicated, the growth of expenditures agency-wide has been modest at 3.8 percent on average over the last five years. The growth rate in Metrorail exceeded MDTA's rate and was 9.6 percent for the same period based on Section 15 reporting. That 9.6 percent is misleading, however, given that an increase in capital spending in 1995 was reported. Excluding that year, a rate closer to the overall Agency's growth emerges. Figure 20 illustrates various spending expenditure rates of change for the Agency from 1995 to 2000.

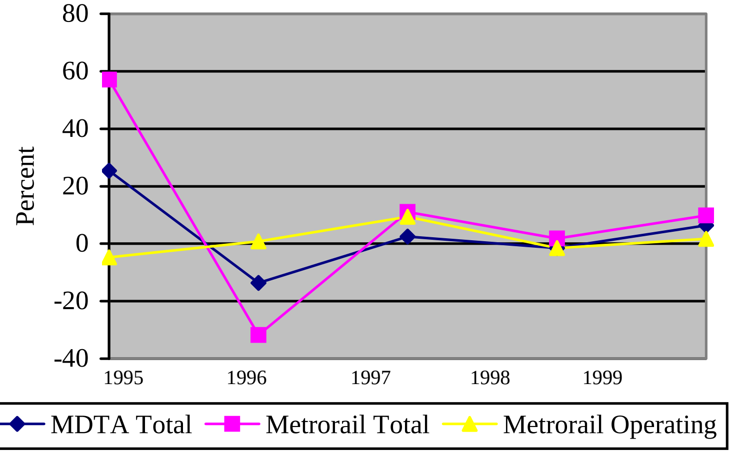

Figure 20 - MDTA Selected Expenditure Growth Rates

The annual fluctuation in spending is not unique to MDTA. The following graph shows the changes in annual total expenditure growth rates for the peer systems. Capital expenditures and the nature of that fluctuation mainly contribute to the changing rates.

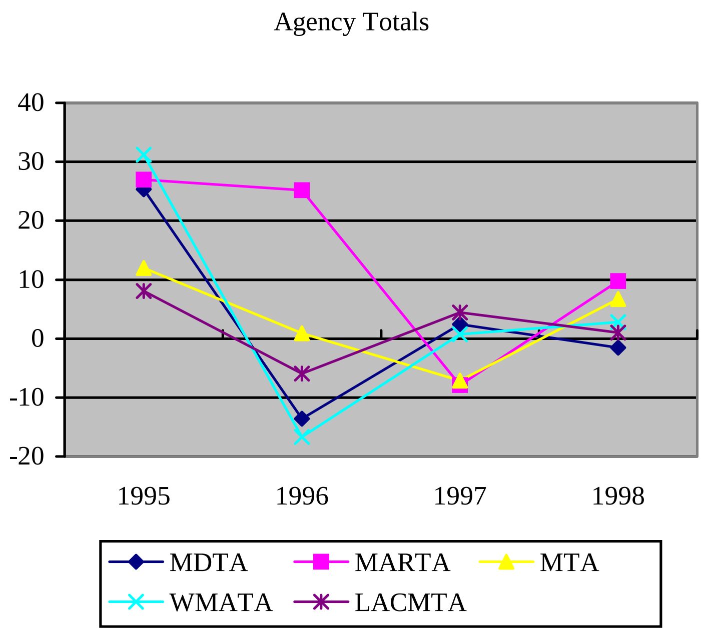

Figure 21 - Change in Annual Spending Rates

When only the operating trends are examined, a more steady and consistent pattern emerges. With the exception of MARTA in FY 1997, each of the systems seems to be moving closer to a "flat" or a modest two to four percent year to year operating growth rate.

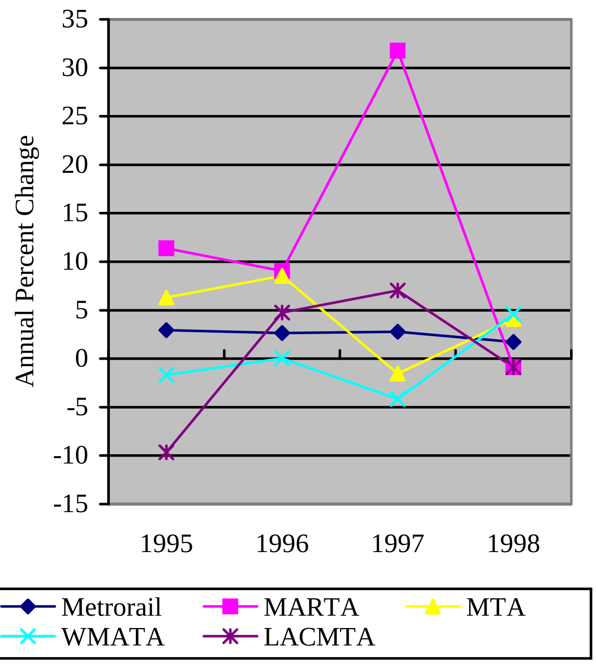

Figure 22 - Change in Operating Expenditures

Five year average annual growth rates for MDTA in total and for Metrorail from FY 1995 through FY 1999 are presented below.

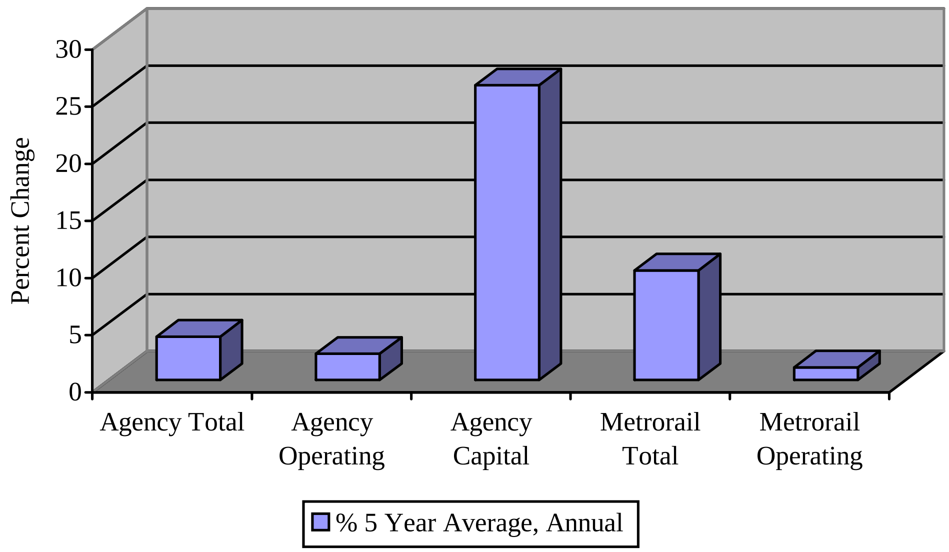

Figure 23 - Five-Year Average Annual Expenditure Growth Rates

For the same five-year period, the growth rate for Metrorail operating activities averaged 1.1 percent. It should be noted that salary adjustments for same period averaged 3.4 percent.

Another comparison of Metrorail spending to that of MDTA overall, is Metrorail's expenditures as a percentage of total MDTA spending over time. The percent of operating resources devoted to Metrorail has consistently held in the 20 percent to 23 percent range from FY 1994 to FY 2000. The rail capital has grown as a percentage of MDTA capital over the study period even excluding the infusion of capital in FY 1995. Reported Metrorail capital expenditures jumped from approximately $5 million in FY 1994 to over $37 million in FY 1995 as indicated in Figure 24.

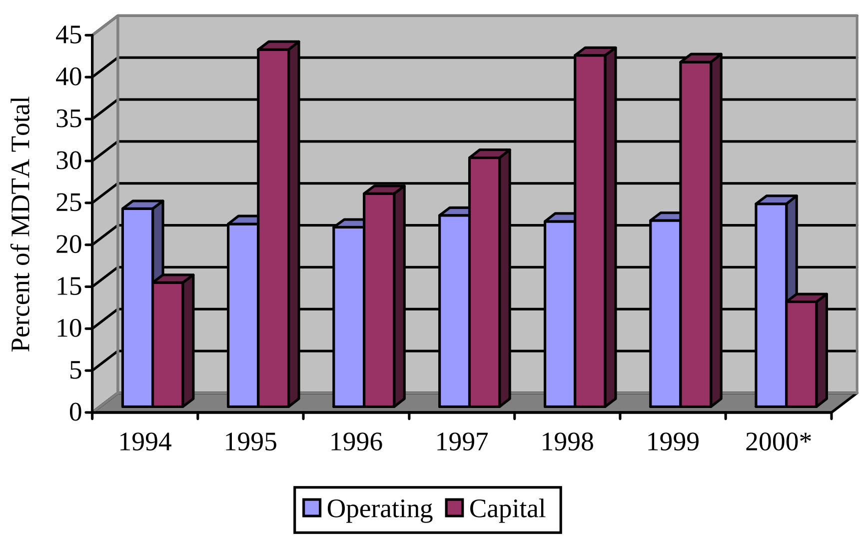

Figure 24 - Metrorail Spending as a % of MDTA Total

In terms of total rail expenditures as a portion of total MDTA spending, the percentage has ranged from 28 percent to 21 percent from 1994 to 1999. Taken in total, both operating and capital, the average is about 25 percent for the 5 years FY 1994 to FY 1999 as shown in Figure 25.

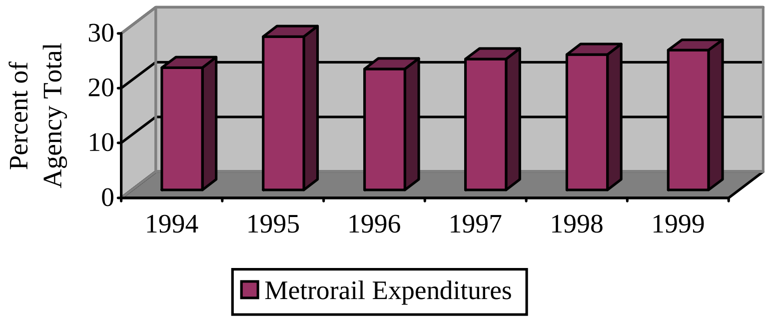

Figure 25 - Metrorail Funding as a % of MDTA Total

Total Expenditures for Metrorail (capital and operating) as a percentage of total MDTA expenditures for 1994 to 1999 compared with the percentage of passenger miles carried by Metrorail are presented in Figure 26. The graph demonstrates that Metrorail has received less of a percentage of the Agency funding than the percentage of passenger miles carried. This was the case for the peer systems in 1998 with the exception of LACMTA as shown in Table 3 in the introduction.

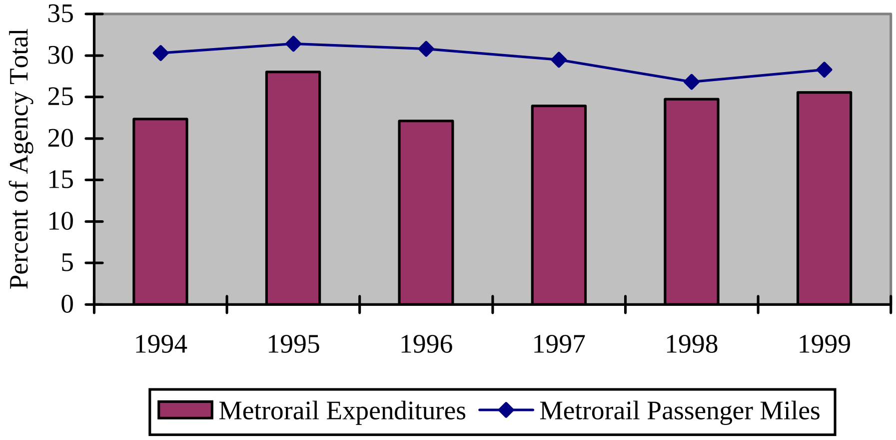

Figure 26 - Metrorail Passenger Miles & Funding

In term of constant dollars, it is clear that both MDTA and Metrorail have lost buying power over that time. Using the Consumer Price Index, MDTA and Metrorail's expenditures have been discounted to illustrate the buying power erosion over time. Figure 27 presents the constant dollar comparison for operating expenses and Figure 28 compares the capital expenditures. FY 2000 figures represent budget allocation rather than expenditures.

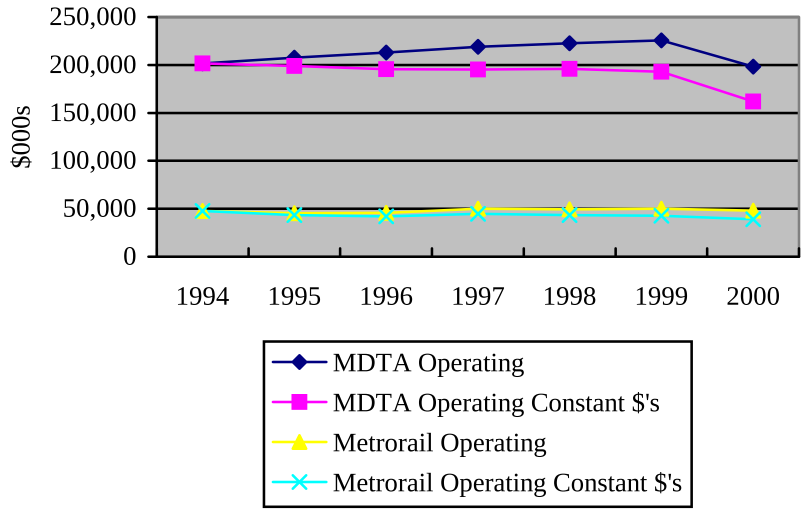

Figure 27 - Operating Expenditures, Actual vs. Constant Dollars

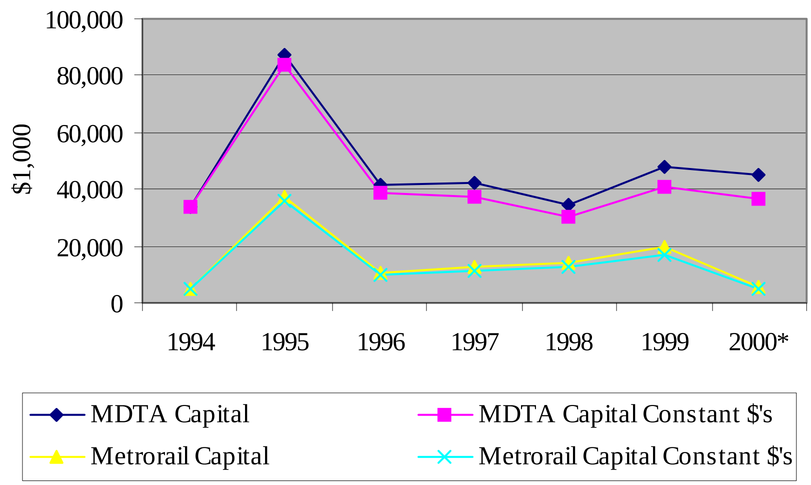

Figure 28 - Capital Expenditures, Actual vs. Constant Dollars

In terms of how the funding has been allocated among the rail categories, Figure 29 shows this allocation of operating funds from FY 1995 to FY 1999. Without accounting for inflation, the resources devoted to vehicle operations have decreased while the expenditures for general administration have been growing since FY 1996. The allocation to vehicle maintenance has been flat since FY 1997.

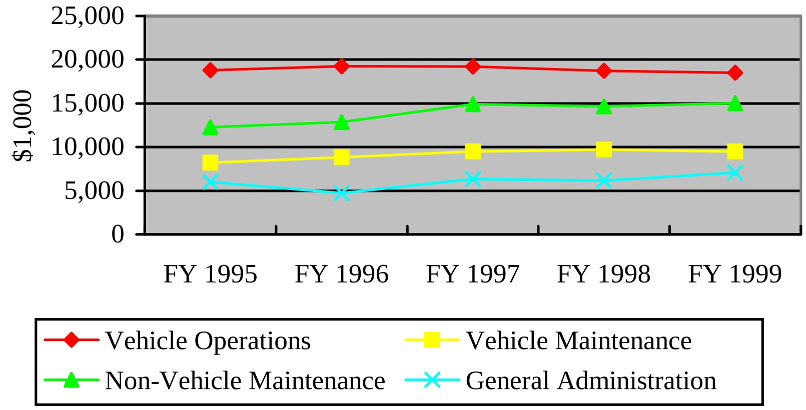

Figure 29 - Rail Operating Expenditures by Category

In looking at the relative allocations for Metrorail capital, FY 1995 is omitted in Figure 30 because of the extraordinarily high expenditure so that a more typical trend can be viewed. The reported expenditures of capital funds on rolling stock have declined since FY 1997 while funding for facilities has grown consistently since FY 1994. Because there may have been shifts in the categorization of the expenditures between capital and operating, the combined expenditures are presented in Figure 31.

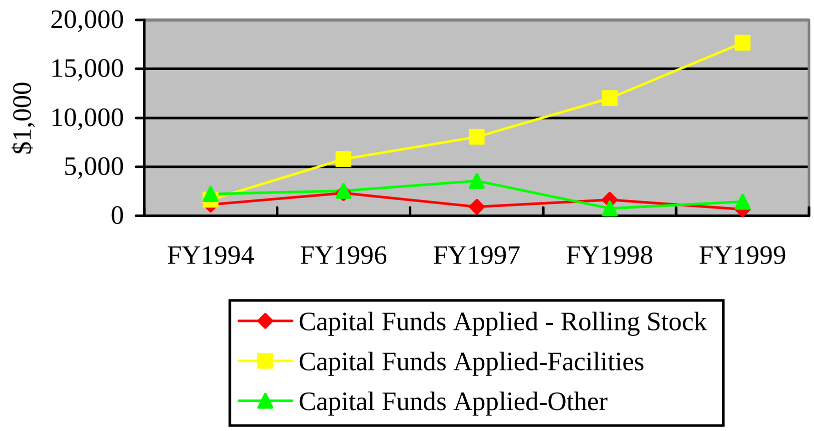

Figure 30 - Rail Capital Expenditures by Category

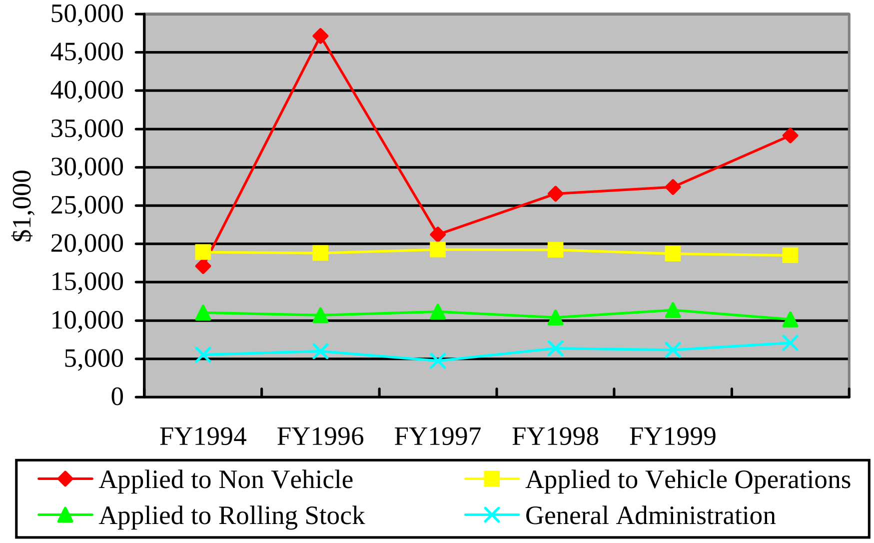

Figure 31 - Rail Expenditures by Category

While the peer systems used for comparison are certainly in various stages of development and age, it may be useful to compare on a percentage basis the allocation of capital and operating within the rail divisions. Figure 32 shows the five-year average distribution for capital expenditures among the rail categories for Metrorail and three of the peer systems. LACMTA is omitted because of its start-up status during the 1994 to 1998 period.

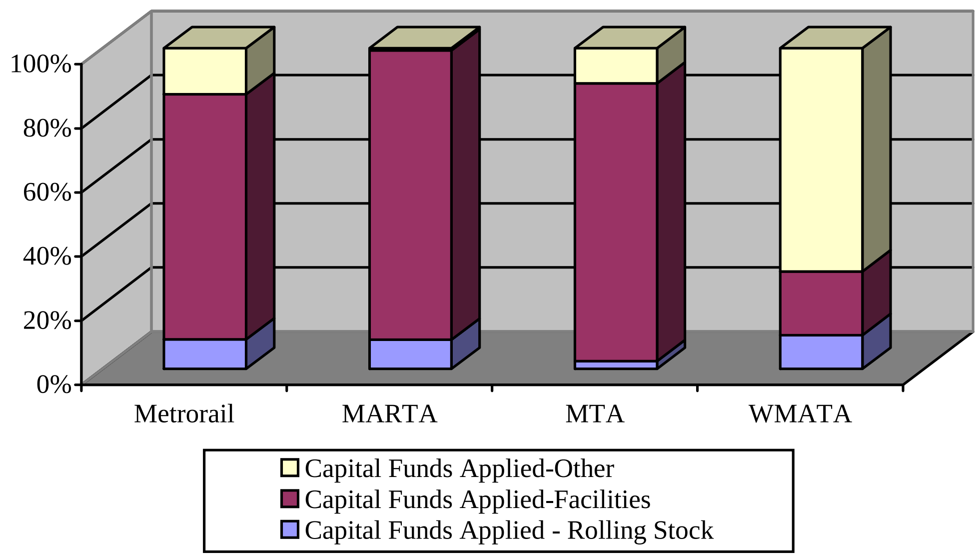

Figure 32 - Five-Year Average Capital Distribution

While there may in fact be reporting differences at the various rail properties in the definition of "facilities" and "other," the percentage of capital devoted to the rail vehicles ranges from a high of 10.5 percent in the case of WMATA to a low of 2.4 percent for MTA. It should be noted, however, that MTA has started the mid-life overhaul of their 100 cars at a cost of approximately $960 thousand per unit. This will certainly change the ratio of the capital allocation in the next few years. Similarly, WMATA is in the process of taking delivery of an order of an additional 192 CAF-constructed rail vehicles, which will significantly increase the allocation to rail vehicle capital as well.

A similar comparison for operating expenses is illustrated in Figure 33. There appears to be much more consistency in the allocation of operating funds within the rail divisions among the peer properties. Vehicle Maintenance as a share of all rail-operating costs for the five-year average is highest for Metrorail. When this figure is compared with the analysis presented in the "Rail Vehicle" section of the report that shows on a per car basis that Metrorail ranks low among the peers, it could suggest that rail in total may be under funded in comparison to other systems.

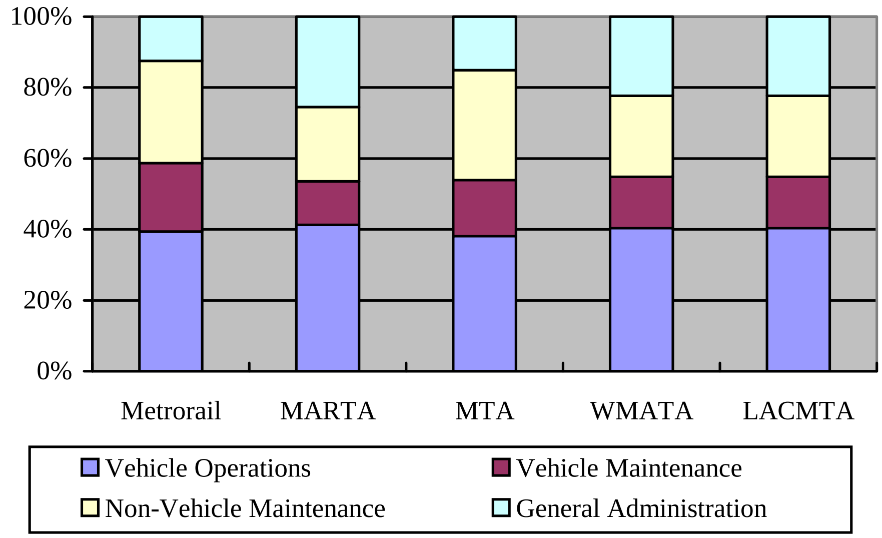

Figure 33 - Five-Year Average Operating Distribution

MDTA is working towards a quantification of its future funding requirements. One indicator of the level of funding that may be required is through an examination of the historic requirements and then a projection over the next five years of what level of funding is expected to be available. This can then be compared to the needs identified to make a judgement as to whether sufficient funding will be expected.

Using a five-year average of growth rates for the expenditures reported, a projection moving forward was made. The five-year average growth rate is applied to FY 2000, and then a five-year rolling average is applied to future years. Figure 34 includes these projections as well as the constant dollar estimates for those years based on a similar method of averaging the CPI using 1994 as a base.

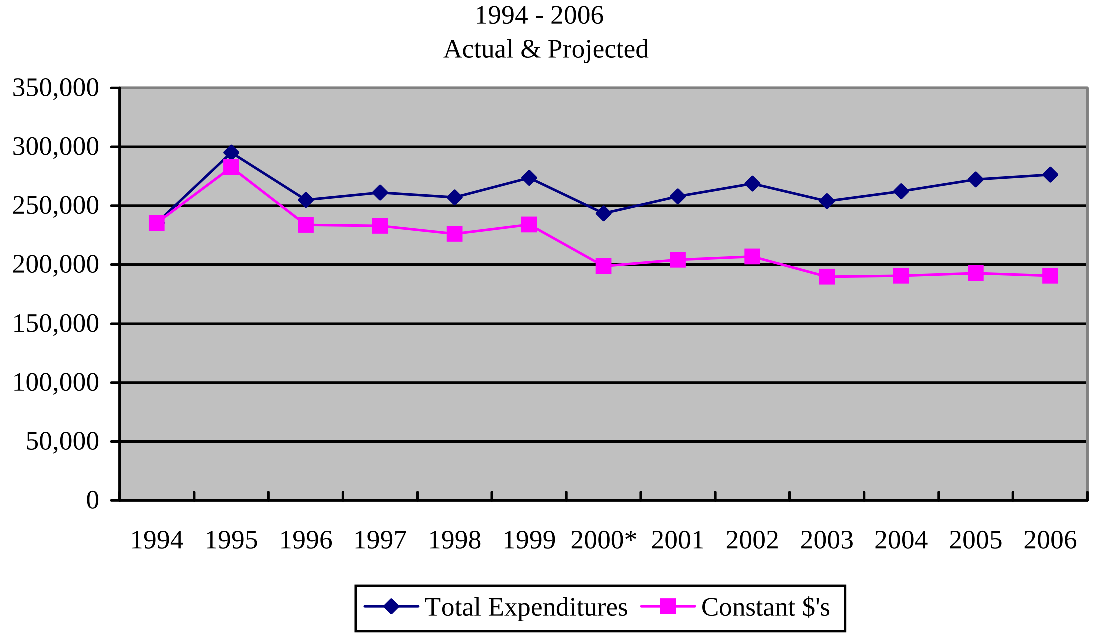

Figure 34 - MDTA Total Agency Expenditures

A similar methodology is applied to the Metrorail except that the projected capital portion of the total is taken from the March 2000 Capital Program. The projected expenditure pattern reveals the trend shown in Figure 35.

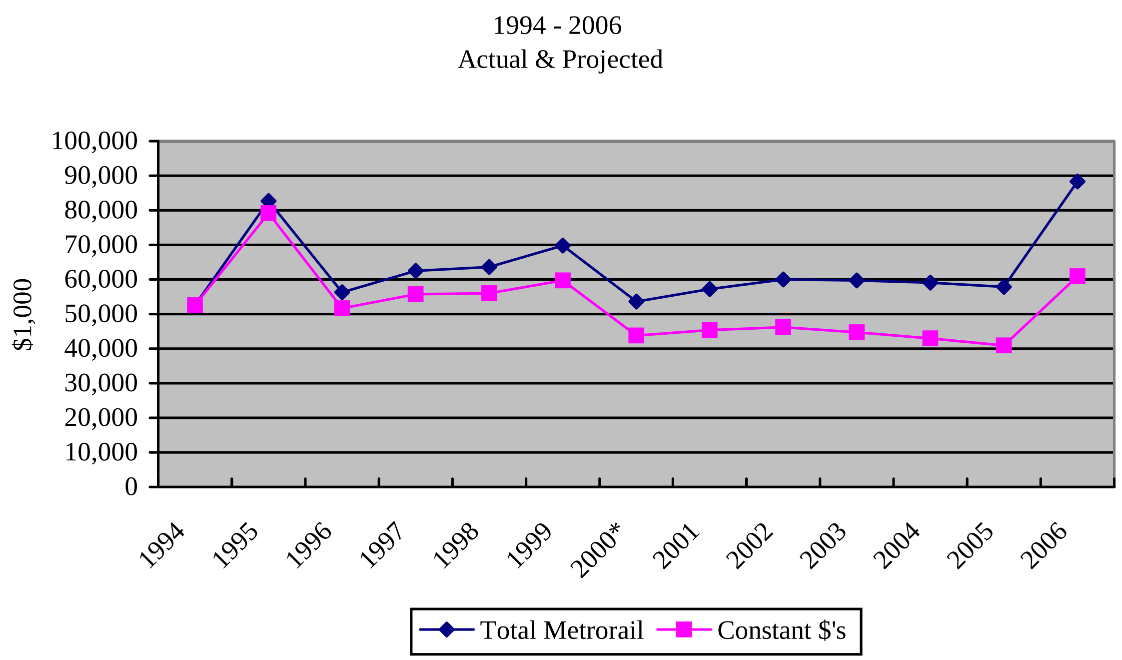

Figure 35 - Metrorail Expenditures

The significant “upswing” in the FY 2006 projection is caused by the recognition of the start of the vehicle mid-life overhaul beginning in that year with $30.6 million being carried in the program. Even with that infusion anticipated in FY 2006, on a constant dollar basis, Metrorail would be funded at the same level as in FY 1999. Also of note is that those funds would update less than 25 cars (18% of the fleet) based on the Baltimore specification and unit cost on a constant dollar basis.

It appears that in both MDTA in its entirety and for Metrorail specifically an infusion of additional financial resources will be required to maintain the existing level of operations and maintenance not to mention the funding required to prepare for and fund the vehicle mid-life overhaul. Theoretically, the mid-life overhaul should begin in FY 2002 based on a 40-year life, and preliminary funding for the engineering and specification-writing phases of this major project should be provided now.

An attempt is made here to quantify the “unfunded capital needs” for Metrorail. The unfunded figure assumes that the projects for rail included in the March 2000 Capital Program will in fact be affordable. The incremental costs of projects partially funded or total costs of projects identified by staff but not included in the Capital Program were totaled. Although the project team is awaiting some data on specific programs, many of the concerns raised by the managers are covered in part or in total in the capital plan.

What has been added is the incremental cost associated with the project team’s recommended schedule and scope of the rail car mid-life rehabilitation. Figure 36 includes engineering starting in the upcoming fiscal year and full rehab commencing in 2004 after a period of ramp up.

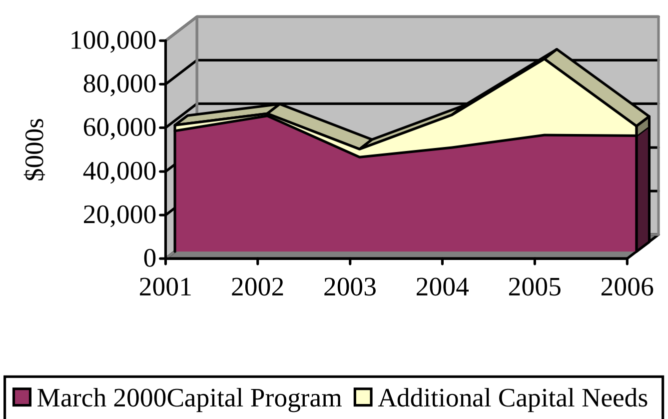

Figure 36 - Estimated Capital Needs vs. Total MDTA Capital Program

The chart depicted in Figure 36 is a little misleading in that the incremental capital costs are added to the capital program for agency in total and the six-year program period does not include the approximately $107 million balance to complete the rail car mid-life overhaul.

Capital projects included in the incremental needs are shown in Table 103.

Table 103 - Capital Enhancements

Un-funded Capital Identified	*Capital Enhancements (000's)*								
	FY 2001	*FY 2002*	*FY 2003*	*FY 2004*	*FY 2005*	*FY 2006*	*Balance to Compete*	*Total*	*FY 2001-06 Total*
Car Lift MT-5	1,600							1,600	1,600
AC/DC Switch Gear		500	500	500	500	500	3,200	5,700	2,500
AC Unit Substations Rebuilt/Retrofit		360	360	360	360	360	1,800	3,600	1,800
Replace DC power Supplies (incremental)	473							473	473
TC/TP Service Vehicles	400								400
Pier Shunts - Install					25	25	200	250	50
AF-400 Minibond Replacement BTC							1,500	1,500	0
Rail Car Modernization P.E.	100	100						200	200
Rail Car Mid-life (incremental)			2,831	14,157	33,977	3,377	107,593	161,935	54,342
Track Circuit Equipment						75	1,425	1,500	75
Total Estimated Un-funded Capital	2,573	960	3,691	15,017	34,862	4,337	115,718	176,758	61,440

In total, an additional $61 million in the program period would be required to fund these projects. The cost is $177 million, leaving $116 million to cash flow beyond the six-year program. When viewed in the context of just the rail capital plan, the incremental needs appear much more dramatic. It should be noted that the project team interpreted what programs and projects in the capital program are attributed to Metrorail. The relationship of "funded" to unfunded needs is depicted in Figure 37.

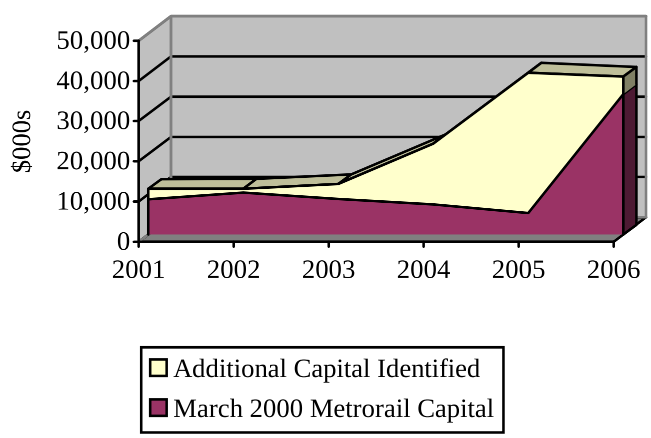

Figure 37 - Metrorail Capital Needs Identified versus Programmed

The majority of the additional capital costs associated with the rail car overhaul program fall outside of the program period. The cost is based on the estimate of the MTA project plus an additive for AC traction and the cost inflated to the start year of 2003. The inflated unit cost is

$1.416 million per car. After a ramp up of one car pair in 2003 and five pairs in 2004, a running production of 24 cars per year is assumed.

If this schedule was maintained and the funding was to be secured, the final rail cars would be placed back into service in 2009. For the last portion of the fleet, this would be 25 years after initial service. There should be no deviation from the “G” inspection, as this preventive maintenance activity should be performed every eight to ten years. Given that this process began in 1995 (16 pairs through 1999) it is conceivable that those “early G” cars would reach the time of recommended mileage threshold for an additional “G” before they entered a mid-life overhaul. This is true even on this accelerated schedule.

Chapter 8 FINDINGS AND RECOMMENDATIONS

Findings

General

Metrorail compares most closely to MTA, although MTA reports 19 more personnel and 36 fewer vehicles than Metrorail. Metrorail has fewer rail cars per route mile than MTA, LACMTA, and WMATA but has the second highest ratio of vehicles available for maximum service to vehicles operated during maximum service. A proposed peak vehicle requirement (PVR) of 108 vehicles reduces Metrorail's ratio to the second lowest.

Metrorail receives slightly less of a percentage of MDTA funding than its percentage of passenger miles. Metrorail's maintenance cost per vehicle is lower than WMATA's but higher than MARTA's and MTA's on a total fleet basis, and Metrorail was significantly less reliable than MARTA and WMATA. Total road calls for Metrorail increased from 212 in 1997 to 253 in 1999.

Recruitment, Selection and Advancement

The Arbitrator's ruling goes beyond anything seen in the peer properties. A reading of the decision and review of the practices indicate MDTA has gone well beyond the ruling. Furthermore, the hiring, selection and training processes currently in place create hardships for Metrorail, especially in Rail/Mover Maintenance. The requirement to select "qualifiable" candidates erodes productivity as a result of a front-end training requirement of 3 to 8 months, the loss of experienced shop supervision to training, and the selection of candidates without an aptitude for or an interest in vehicle maintenance. Turnover is exacerbated, and unnecessary movement results from lack of appropriate minimum qualifications. Time for the development of job proficiency is lengthened, which not only impedes efficiency but also affects the selection and promotion processes that are significant in a technical class like Electronic Technician.

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 for aptitude for what is, in some cases, a total career change.

Contracting-Out

The current practice for approving use of outside vendors is significantly more rigorous than what is called for in the collective bargaining agreement. The apparent lack of "blanket" approvals for types of work requires repeat visits to the Contracting-Out Committee for items that are always contracted. Productivity is lost by having staff develop the bargaining unit's proposals for work as well as by having the same items submitted repeatedly for consideration. Procurement frustrations have resulted in less-than-ideal decisions regarding work accomplished in-house versus by a vendor.

Manpower Needs

The interrelationship of the selection/recruitment processes and the contracting issue affect the estimate of manpower needs. Rail maintenance workforce proficiency is eroding, and the selection process is causing migration from Track & Guideway that continues to result in high turnover within the division. Contracting-out is necessary but it does not build the "knowledge, skills & abilities" of the workforce. Frequent changes in service demands and responses to budget constraints have made the planning process difficult for staff. Early rail car availability gains achieved from mothballing evaporated within a year, and, based on current patterns, the fleet mileage range will grow to nearly 1 million miles, with the highest vehicle mileage equal to 1.3 million miles by FY 2006. With a 12-pair rotation cycle, the mileage range could be reduced to 335,000 miles, with the highest mileage vehicle at 1 million miles by FY 2006.

Metrorail is at the low end in the number of hours dedicated to maintaining its vehicles in comparison to other properties. Rail Maintenance manpower estimated additional needs based on rail car availability range from 11 to 29, with revenue requirements of 68 to 90 vehicles. Based on revenue mileage, those estimated additional manpower needs range from 8 to 25, with revenue requirements of 68 to 90 vehicles.

System Condition

Using 1987 UMTA Rail Modernization criteria modified for each Division, subsystem level conditions were rated on a scale of 1 (bad) to 5 (excellent). System condition averages ranged from poor to fair, with obsolescence and car body subsystems driving down the ratings. Rail Cars received an overall 2.6. Car Body received the worst ratings. Train Control rated an overall 3.1, while Traction Power received an overall 2.2. Obsolescence lowered the ratings in both Train Control and Traction Power. Structures rated an overall 3.1, with Drainage and Barriers receiving the worst ratings. The Mainline Track rated 3.0 overall. The Ties and Curves drove down the ratings on the Mainline Track.

Financial

MDTA's expenditures grew at a rate of 3.8 percent from FY 1994 to FY 2000; however, on a constant dollar basis, the level of MDTA total FY 2000 expenditures is lower than the FY 1994 level. The growth rate for Metrorail operating expenditures has averaged 1.1 percent while salary increases averaged 3.4 percent. Metrorail capital has averaged $15 million annually from FY 1994 to FY 2000. Vehicle operations spending has been decreasing in absolute terms, and vehicle maintenance spending essentially has been flat.

Metrorail capital investment in facilities has been rising while no significant capital investment has been made in rail vehicles. Based on historic growth rates for operating and capital projections, in the six-year program, the constant dollar level of investment is expected to decline until the programmed start of the rail vehicle overhaul in FY 2006. Additional capital needs for Metrorail are estimated at $200 million, with $60 million of the $200 million capital needs within the program period.

Rail vehicle overhaul is recommended for a FY 2003 construction start. In addition to the midlife overhaul of the rail vehicles, significant investment in the Train Control and Traction Power systems was included in the capital needs.

Recommendations

At the request of MDTA, not only are the rehabilitation needs examined, but several other specific areas received attention as well.

A successful plan for the rehabilitation of MDTA's Metrorail seems contingent upon several organizational and management issues. Although additional financial resources will be required, in the project team's opinion, any additional resources will not be maximized without some systemic changes.

Contracting-Out

The current process of contracting maintenance work to outside vendors needs to be revisited.

According to the State of the Rail Report, the procurement process drives priorities for accomplishing repairs, i.e., jobs get done when the parts arrive regardless of job importance. The project team heard numerous complaints about poor quality parts, incompatible substitutions, and slow response times from vendors for service and support. Repeatedly, the County's "low bid" policy was blamed for the poor quality. The County's specification process may be flawed; nonetheless, rail vehicles are highly technical pieces of equipment that contain a variety of components, subcomponents, assemblies, and subassemblies. Developing specifications for parts and services is a demanding and technical process. Furthermore, the rail fleet is in its 17th year of service. Locating replacement parts must, at times, be a difficult journey.

Improving the flow of communication between procurement staff (the "buyers") and operating staff (the "users") probably would alleviate the majority of these problems. Supervisors could be required to "sign-off" all specifications and contracts prior to procurement. Specifications and contracts could include a "no substitution" clause. The "buyers" and the "users" need to establish parameters that are mutually acceptable to ensure not only that Metrorail gets the most for each dollar but also that Metrorail gets the right item for that dollar.

It appeared to the project team that the activity that contributed most to delay in the procurement process was the "Contracting-Out" Committee. Every item or service purchased outside of Metrorail must be approved in advance by a 12-member group that meets on a monthly basis. Apparently, this procedure was instituted to ensure that the union would have an opportunity to bid on all work that was contracted-out. If the union determines that they might be interested in offering a bid for the proposed procurement, a cost analysis with documenting materials is prepared by the Maintenance Supervisor for presentation by the union. It appears that significant efficiencies could be realized by modifying the current contracting-out process.

It is important for the in-house staff to continue performance of work and projects that may be out of the ordinary or technical in nature in order to maintain work force proficiency and morale. It is not productive, however, for a committee to review continuously and ultimately approve the same type of work repeatedly. Conversely, there are activities that in-house staff have undertaken that have not been presented to the committee for contracting-out consideration. In the project team's view, some of those activities, such as the tie replacement program, could have best been handled through an outside contract.

The project team recommends:

- **Begin dialogue with the Transit Workers Union to establish a process for the Agency to procure <u>types</u> of work through contract rather than on the basis of each item or routine activity.**
- **Establish mutually acceptable parameters between "buyers" and "users" to streamline specifications and contracts at the County level.**
- **Establish a process or checklist for use in evaluating new activities or programs under consideration for their potential as in-house versus contracted out projects. This could help to avoid the diversion of in-house talent to projects of sufficient magnitude or duration that would overburden the existing workforce and hinder completion of their other priorities. A sample checklist will be provided to the Agency.**
- **Consider participation in the Rail Car Consortium, a group of East Coast heavy rail service providers mutually interested in leveraging the buying power of the group to obtain replacement parts and components at reduced costs.**
- **Pilot a "blended" approach to contracting. This pilot program would involve a procurement approach that includes the training of Metrorail personnel while ensuring the expertise and warranty that a vendor might offer. The "blended" approach would have heavy involvement of a contractor at the front-end of the project and diminish over time as the Metrorail workforce becomes more proficient. Some on-site presence or inspection by the vendor would be required if a certification or warranty were involved. The gearbox rebuild would seem to lend itself to a "blended" approach.**

Recruitment, Selection, and Advancement

MDTA should re-examine 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.

MDTA's attempt to comply with the spirit of the 13 (C) Arbitration Award has hampered Metrorail's ability to function effectively. MDTA has chosen to provide training to candidates in order to make them "qualified." Candidates are selected on the basis of seniority rather than on the basis of previous training, experience or interest. Some of the recently hired Electronic Technicians have had little or no previous technical training. Unfortunately, some of the candidates complete the training programs only to discover that they would prefer a different type of work. Meanwhile, positions remain vacant during the training programs. Lead supervisors who are required to provide the training are unavailable to the shop throughout the training program, and other training programs have been placed on hold. MDTA has alternative training options available through local technical schools and community colleges. Candidates could be required to obtain various levels of training outside of MDTA to meet the "qualifiable" standard. WMATA and MARTA have effective programs that not only require that successful candidates possess technical training and experience but also offer a step-by-step advancement program grounded in skill development and performance. Either would serve as an excellent example in the development of recruitment and advancement programs.

The project team recommends:

- **Initiate a coordinated effort with representatives from Human Resources, Labor Relations, Finance, and Metrorail to establish minimum qualifications for rail maintenance classifications that include relevant technical training and experience.**

- **Develop a system of progressive advancement based on performance in addition to seniority.**

Management

MDTA should establish mechanisms that encourage innovation and investment in the workplace.

The workforce has shown an interest in trying new ways of doing things and has started to "think outside of the box." Management could help focus the staff who sometimes function as fire fighters, continually putting out fires. With guidance and direction, the staff could be motivated to develop a "fire prevention plan" that would assist them in their move forward and in their work toward providing quality service to their customers. If, for example, the operating recommendations that follow were adopted, the Rail/Mover Maintenance Division would need to be measured by more than the apparent single priority of "making 80 cars" for service each day. While there is no doubt that this is an essential parameter to ensure reliable customer service, if it is the only measure of the Division's success, it seems to the project team that other operational priorities with longer-term pay-offs will undoubtedly suffer. Said another way, "what gets measured is what gets done." If new maintenance practices that have potential long-term positive financial and service impacts are not monitored or given priority, then whatever it takes to make service will continue to drive decisions and practices.

The project team recommends:

- **Organize cross-functional groups to problem-solve common issues.**
- **Establish methods of performance assessment that provide employees with feedback on their performance and assist those employees in setting relevant goals for future performance.**
- **Using a recognized management tool such as Total Quality Management (TQM) or Organizational Cultural Change Program, take the steps necessary to create an environment that encourages individual units to develop legitimate measures of success within the overall framework of MDTA's mission**.

Some examples of cross-functional groups include Track & Guideway and Metrofacilities, which are both wrestling with trash and debris removal at the stations, or the Train Operators and Vehicle Maintenance, which share concerns regarding the cleanliness and safe operation of the rail cars.

Operations

MDTA should establish structure within the organization that provides consistency and continuity.

Well-defined policies and procedures are the backbone of a good organization. Those policies and procedures must be based on sound business practices that benefit not only the organization but also the workers within the organization. At this time, Metrorail is starting to move forward and the course that they now choose to follow is critical for their future development.

The project team recommends the following to assist the organization in achieving its goals:

- **Establish a mechanism to take advantage of the large amounts of data and information collected to discover trends, evaluate results, identify needs, and formulate plans.**
- **Develop feasible work standards for Metrorail and use those standards to benchmark performance, not only in terms of quantity of work produced but also in the quality of that work.**
- **Re-evaluate restrictions on use of the mainline during revenue service to maximize access to the mainline for maintenance, testing, and training.**
- **Remove the remaining two pairs of rail cars from "mothball" status immediately.**
- **Establish a system for selecting vehicles for the "G" inspection that includes specific criteria as well as a timeline.**
- **Take action to normalize fleet mileage to ensure that all vehicles within the fleet achieve a 40-year car life.**

- **Establish an annual process to evaluate the progress made on the recommendations, if any, which are adopted.**

Finance

MDTA should ensure that sufficient funding continues for the enhanced vehicle maintenance activities and attempt to provide Metrorail with a capital infusion required to perform the rehabilitation activities mentioned in this report.

While the study team is not in a position to weigh the relative needs across the entire agency, it is clear that a redoubled effort to protect the major public investment in Metrorail is required. The age of the system has not seriously affected customer service, thanks in some part to the tenacity of some of the staff to do whatever it takes. Age, wear, and obsolescence are beginning to take their toll on the organization’s ability to provide service. Whatever decisions are made regarding an approach to financing Metrorail, a long-term commitment to that approach will be essential for the rail divisions to succeed.

It is unrealistic to expect that the agency can guarantee that a project contemplated today for a start four or five years out will have the funding. However, it is extremely important that, if a decision is made to follow an approach, the staff have reasonable expectation that the resources will be available to carry out the program.

The project team recommends:

- **Ensure adequate funding for the continuation and ultimate completion of the “G” inspection.**

- **Give favorable consideration to Train Control and Traction Power projects that have been identified because of parts availability and obsolescence.**

- **Plan and start the Rail Car Modernization or Mid-life overhaul in FY2003. Funding in FY 2001 will be required to perform the preliminary engineering and specification development.**

- **Consider a 20-year needs study for Metrorail. Based on life cycles for the rail infrastructure, the needs study would provide executive management with a view beyond the six-year capital program and serve as the pool of projects that feeds the capital program updates.**

Although the scope of services for this project did not specifically require an evaluation of the mid-life overhaul, a program for rail rehabilitation cannot be pursued absent having a target for the start of this vital project. The experience that can be gained from the process in which Baltimore is now engaged is invaluable for MDTA. If the funding were to be secured through local, state, and federal partners, it may be worth serious negotiation with the existing MTA vendor for a follow-on contract. If the procurement law allows such an approach, it would be worth knowing if any economies for the agency could be realized because of the mobilization, engineering, and tooling that has already occurred to perform the modernization work on 100 rail cars.