

*Final Report to*



Metropolitan Transit Authority of Harris County

# **FY05-FY08 Performance Audit: System Maintenance Review**

Booz | Allen | Hamilton

in association with

**Matt & Associates**

**MFR, P.C.**

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## I. INTRODUCTION

## Introduction

### **BOOZ ALLEN HAMILTON WORKED WITH AGENCY STAFF TO CONDUCT THE FY05-FY08 PERFORMANCE AUDIT OF THE METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY**

- Quadrennial performance audits of Texas transit agencies are mandated by Section 451.454 of the Texas Transportation Code.
- The purpose of the performance audit is to provide:
  - Evaluative information necessary for state and local officers to perform oversight functions
  - Information useful to the transit agency for improving the efficiency and effectiveness of its operations.
- The performance audit is required to assess the Authority's:
  - Compliance with applicable state laws
  - Reporting of specified performance indicators
  - Performance in one of three areas (i.e., administration and management, transit operations, or system maintenance).

**THIS REPORT IS ONE OF THREE THAT PROVIDE THE PERFORMANCE AUDIT RESULTS**

- This report presents the results of the systems maintenance review audit of the Metropolitan Transit Authority of Harris County (METRO) for Fiscal Years 2005, 2006, 2007 and 2008, the period from October 1, 2004 through September 30, 2008.
- The detailed review of METRO's bus and rail maintenance functions complies with State performance auditing requirements, which stipulate that each of the three functional areas must be reviewed once in every three audit cycles. The FY01-FY04 performance audit provided a review of METRO's bus and rail transit operations; the FY97-FY00 audit examined administrative functions in finance and human resources.
- The results of the required legislative compliance review and performance indicator assessment have been provided in separate reports:
  - FY05-FY08 Performance Audit: Compliance Review
  - FY05-FY08 Performance Audit: Performance Indicators.

## **THE PERFORMANCE AUDIT IS INTENDED TO PROVIDE A BALANCED AND OBJECTIVE ASSESSMENT OF METRO'S PERFORMANCE**

- In order to provide a balanced perspective on METRO's performance, significant accomplishments and positive performance trends are discussed as well as opportunities for improvement. The audit is a look back over the past four years, from October 2004 through September 2008. Since current trends, objectives, and programs are more relevant as METRO moves forward, an effort has also been made to recognize and include the plans and activities that are currently underway at METRO and to articulate their implications for METRO's future.
- The audit provides a discussion of performance trends, accomplishments and challenges over the audit period, reviews and evaluates aspects of the activities that are key to METRO's maintenance functions, and suggests opportunities for METRO to improve its efficiency, effectiveness and/or productivity in its maintenance activities.
- While the scope of the audit is consistent with State requirements, METRO management and the auditors recognize that an accurate understanding of transit performance trends cannot be obtained by viewing maintenance functions in isolation. To obtain a complete and balanced view of the transit services METRO provides, it would be necessary to consider the performance of METRO's transportation and administration functions as well as its maintenance activities.

**THE PERFORMANCE AUDIT TEAM CONDUCTED A SITE VISIT AND INTERVIEWS WITH METRO STAFF TO DISCUSS BUS AND RAIL OPERATIONS AND PERFORMANCE TRENDS**

- The audit team visited METRO's headquarters, the Polk Street bus operating facility, the Central Shops at Kashmere, and the Rail Operations Center (ROC).
- Discussions were held with staff who are knowledgeable of METRO's fixed route bus and rail maintenance functions and maintenance information systems. Individuals who support the maintenance management systems were also interviewed, as were bus and rail transportation staff who are the maintenance departments' primary customers.
- METRO staff who participated in discussions for the audit's system maintenance review are listed on the next two pages.

**METRO STAFF INTERVIEWED FOR THE SYSTEMS MAINTENANCE REVIEW**

Senior Vice President, Operations	Associate Vice President, Operations
Senior Director, Rail Operations	Director, Maintenance Support
Director, Rail Maintenance	Senior Project Manager, Bus Technology, IVOMS
Chief, Track	Senior Project Manager, SEMA/SAP
Chief, Signals & Communications	Manager, Warranty
Superintendent, Rail Vehicle Maintenance	Manager, Technical Services
Rail Maintenance Training Specialist	Supervisor Advanced Technology
Lead, Traction Power	Technical Services Specialist
Project Manager, LRV	Fleet Management Specialist
LRV Maintenance Supervisor	Manager, Quality Assurance
Rail Maintenance Network Analyst	Maintenance Training Instructor/Coordinator
Rail Application Specialist	Maintenance Trainer ASE
Director, Rail Transportation	Superintendent, Central Support & Manufacturing
Superintendent, Rail Transportation	General Foreman Central Shops
Superintendent, Rail Control	Superintendent Maintenance, Polk Street
Director, Budget Operations	General Foreman, Polk Street
Manager, Operations Management Analysis	Senior Director, Transportation
Senior Operations Management Analyst	Director, Transportation Service Delivery
Operations Management Analyst	Superintendent, Bus Control Operations
Senior Vice President Public Safety, Chief of Police	Special Projects Manager
Assistant Chief of Police	Senior Operations Management Analyst
Chief Safety Officer	Manpower Administrator



**METRO STAFF INTERVIEWED FOR THE SYSTEMS MAINTENANCE REVIEW (CONTINUED)**

Senior Director, Employee Relations	Vice President, Information Technology & CIO
Director of Staffing and Diversity	Deputy CIO
Manager, Wellness Programs	IT Manager
Staffing Specialist	Project Leader SAP
Manager, Operating Budget (OMB)	IT, SAP Support
Lead Management Analyst (OMB)	Senior Management Analyst (OMB)

## THE PERFORMANCE AUDIT TEAM ALSO REVIEWED KEY DOCUMENTS AND DATA PERTAINING TO BUS AND RAIL MAINTENANCE

- Operating & Capital Budgets, FY04-FY09
- Business Plan & Budgets, FY04-FY09
- Budget Variance Reports (FY04-FY09)
- Quarterly Financial & Management Reports (FY05-FY08)
- Rail Rules and Procedures for Rail Operations (2008)
- Attendance Control Policy
- Attendance Control Guidelines
- Various operations and maintenance performance reports (e.g., Systemwide Roadcall Totals, Individual Fleet MDBF Performance Summary Report, Rail Performance Statistics, Rail Maintenance Performance Statistics, Rail Daily Run Summary, Rail Daily Summary Report)
- Operations Department management reports (e.g., Department of Operations Monthly Management Report, Bus Maintenance Division Superintendents Weekly Meeting Agenda, Operations Department Quarterly Reviews, Bus Maintenance Division Quarterly Management Review, Operations Dashboard)
- Special reports and analyses prepared by Operations (e.g., FY09 METRO Cost to Outsider Cost Comparison, FY08/09 Cost and Labor Comparison, FY09 Parts and Labor Worksheet, Capital Transmission List FY09, Capital Engine Changes FY09, Annual Rebuild Forecast FY09)
- Performance Review Services: Bus Parts Utilization (July 2008)
- IT End User Computing & Technology Handbook
- Information Technology Department Disaster Recovery & Business Resumption (2008)
- The METRO Starter (September 2008)
- METRO's website: [www.ridemetro.org](http://www.ridemetro.org)

**THE REMAINING SECTIONS OF THIS REPORT PROVIDE THE RESULTS, FINDINGS AND RECOMMENDATIONS OF THE PERFORMANCE AUDIT**

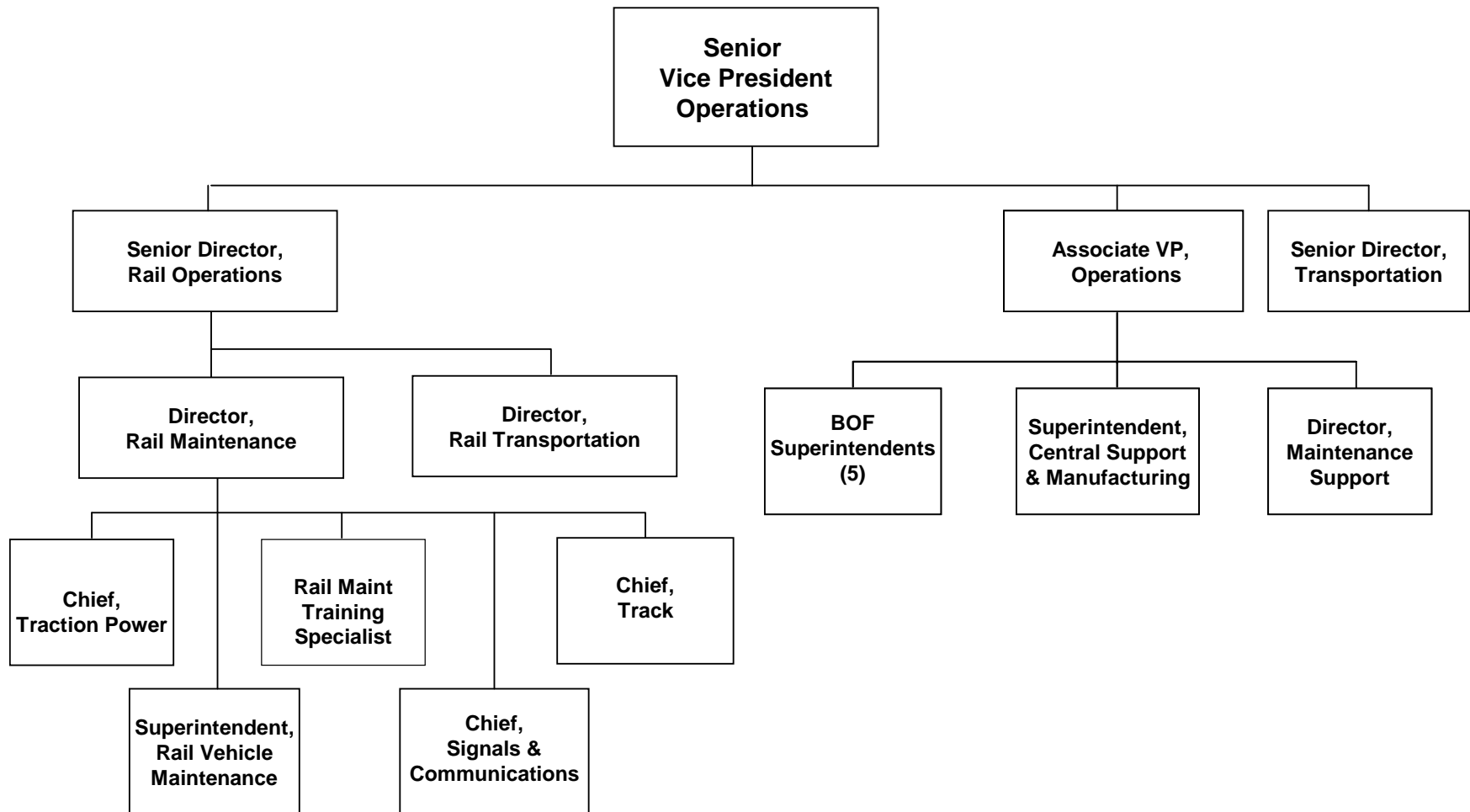
- **Section II: System Performance Overview** – to provide context for the system maintenance review, this section is a discussion of METRO performance results and trends for key performance indicators during the audit period.
- **Section III: System Maintenance Overview** – discusses the organizational placement of METRO’s bus and rail maintenance functions and the accomplishments and challenges of the audit period.
- **Section IV: Bus Maintenance Review** – presents the results of the review of METRO’s systems and procedures for maintaining the bus fleet during the audit period.
- **Section V: Rail Maintenance Review** – presents the results of the review of METRO’s systems and procedures for maintaining the rail system during the audit period.
- **Section VI: Maintenance Information Systems Review** – provides the results of the review of the information systems that support METRO’s maintenance activities.
- **Section VII: Recommendations** – discusses and recommends opportunities for improving the efficiency, effectiveness and/or productivity of METRO’s system maintenance functions and activities.

## **II. SYSTEM MAINTENANCE OVERVIEW**

## **METRO PROVIDES BUS, LIGHT RAIL, AND DEMAND RESPONSE SERVICE IN THE HOUSTON METROPOLITAN AREA**

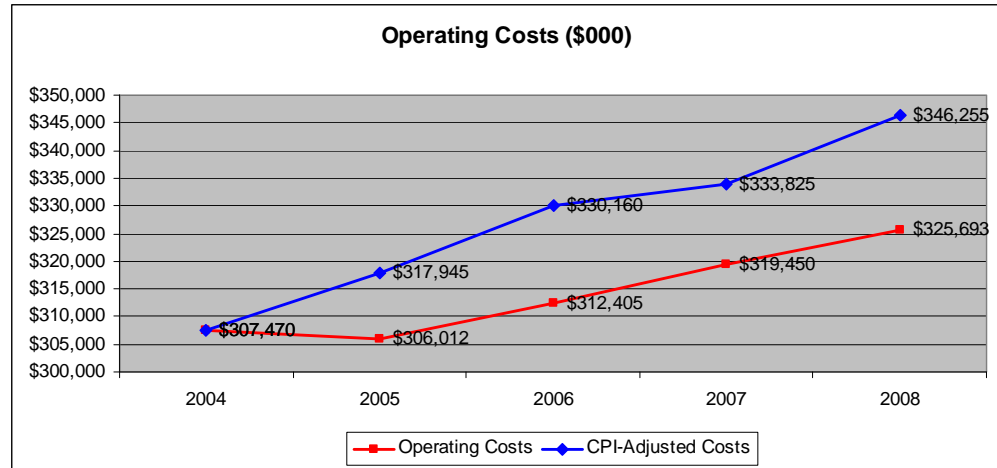
- METRO's fixed route bus services operate over a 1,285 square mile service area that includes the City of Houston, 14 other municipalities, portions of unincorporated Harris County, and small portions of surrounding counties.
- METRO's fixed route bus services carry over 84 million passenger trips annually throughout greater Houston with a fleet of over 1,200 vehicles:
  - METRO has over 100 local and commuter bus routes, 19 transit centers, and 28 park-and-ride lots. During the audit period, METRO also ran special event services in partnership with event sponsors, such as conventions and sporting events.
  - Bus services are partially directly operated and partially operated under contract. METRO has five operating facilities for its directly operated services (Fallbrook, Polk, West, Hiram Clarke, and Kashmere). Contracted services operate from METRO's Northwest bus operating facility.
- METRORail, METRO's light rail service, began operations in January 2004 and now carries nearly 12 million passenger trips annually with an 18-vehicle fleet. The METRORail line runs 7.5 miles and serves 16 stations, linking Downtown, Midtown, the Museum District, Hermann Park, the Texas Medical Center (TMC), and Reliant Park.
- METROLift, METRO's demand response service, provides pre-scheduled, curb-to-curb shared-ride transportation for persons with disabilities. METROLift serves about 1.4 million passenger trips annually.

**METRO'S BUS AND RAIL MAINTENANCE FUNCTIONS, ALONG WITH THE TRANSPORTATION FUNCTIONS, REPORT TO THEIR RESPECTIVE MODAL DIRECTORS IN OPERATIONS**



**OVER THE AUDIT PERIOD, METRO’S MANAGEMENT TEAM HAS CONTROLLED COST GROWTH**

- Total operating costs increased only 5.9 percent over the audit period, from \$307.4 million in FY04 to \$325.7 million in FY08. After a 0.5% drop in FY05, costs increased approximately 2% per year, well below the 12.6% growth in the CPI over the audit period. At audit period inflation rates, FY04 costs would have reached \$346.3 million by FY08 – 6.3% higher than what operating costs actually were in FY08.



- Constrained cost growth was a consequence of management’s efforts to control spending by holding budgeted costs at the FY04 budget level for two years. From FY04 through FY06, budgeted operating costs were held at \$273,990,000. Beginning in FY07, budgeted operating costs increased, but by only 5.2% in FY07 and 4.1% in FY08. Overall, the audit period growth in budgeted operating costs was well in line with the 12.6% inflation rate. The 10% growth for FY09 reflects an increase of 9,700 service hours, including introduction of METRO’s new Quickline service, as well as the challenges of increased costs, of which fuel alone accounts for 80%.

Fiscal Year	Operating Budget	% Change
2004	\$273,990,000	
2005	\$273,990,000	0.0%
2006	\$273,990,000	0.0%
2007	\$288,117,000	5.2%
2008	\$300,000,000	4.1%
2009	\$330,000,000	10.0%

## **MANAGEMENT HAS IMPLEMENTED A VARIETY OF INITIATIVES TO IMPROVE OVERSIGHT AND TARGET COST REDUCTIONS**

- Management has proactively controlled costs by eliminating unproductive bus routes and restructuring service to generate cost savings and improve the fare recovery ratio, while absorbing large increases in key transit service costs (e.g., fuel, healthcare, pensions). Today, METRO operates 30 fewer routes than it did in FY04. Actions such as these will provide on-going savings for the future.
- Throughout this time, to ensure that cost savings are realized, METRO has placed attention on developing, implementing, and reporting systemwide and departmental goals and objectives, and on holding managers and supervisors responsible for developing their budgets and for performance against and variances from budgeted goals and objectives. Along with managing their costs, superintendents have the authority to make choices, and have the data to evaluate options such as whether to purchase new or refurbish a part.
- Quality Assurance and Technical Services reviews alternative parts sources based on consumption and proposes alternatives. Alternate vendors of contracted components are reviewed annually to compare costs from internal METRO overhauls to external vendor sourcing; the analysis also considers MDBF per component.
- Each budget provides more and better information about METRO's performance targets. Quarterly Management Reports have been developed to track performance and report on it to the Board of Directors, while internal dashboard reports and weekly cost variance reports provide information to managers to assist them in managing their responsibilities.



**METRO IS REDUCING THE SIZE OF THE REVENUE AND NON-REVENUE FLEETS**

- The size of the active bus fleet has been reduced from 1,435 buses in FY04 to 1,232 buses in FY05 and further to 1,210 buses in FY08. In FY2007, METRO began procuring hybrid-diesel electric buses that have lower fuel consumption and substantially lower tailpipe emissions. Going forward, METRO intends to replace about 100 buses per year, to avoid the challenges of managing large one-time procurements and to smooth the age distribution of the fleet.

<b>Fleet Assignments</b>	<b>FY05</b>	<b>FY06</b>	<b>FY07</b>	<b>FY08</b>
Kashmere	136	141	137	136
Polk	187	196	194	184
Hiram Clarke	222	222	213	219
Fallbrook	203	192	195	184
West	254	242	261	276
Total Directly Operated	1,002	993	1,000	999
Northwest	230	225	211	211
Active Fleet	1,232	1,218	1,211	1,210
Inactive/Pending Sale	168	95	69	60
Total Fleet	1,400	1,313	1,280	1,270

- METRORail has operated with a fleet of 18 light rail vehicles since service was initiated in January 2004. Typically, 16 of the LRVs are in service at any time. The small size of the fleet appears to constrain METRO’s ability to increase service and grow ridership.
- The size of the non-revenue fleet was reduced from 435 to 371 vehicles over the audit period. An FY09 mandate will reduce the fleet further, to 348 vehicles. As vehicles are replaced, METRO is investigating the cost-effectiveness of hybrid technology in non-revenue vehicles and is pursuing smaller, more fuel-efficient vehicles for the non-revenue fleet.

## **MILES BETWEEN ROADCALLS, A KEY PERFORMANCE INDICATOR FOR MAINTENANCE, IMPROVED DURING THE AUDIT PERIOD**

- Miles between mechanical roadcalls for directly operated bus and rail services dropped 25% from 6,206 to 4,563 in FY05, but since then have improved annually, reaching 6,362 miles in FY08 – an improvement of 2.5% over the audit period. Reduced service levels, replacement of older buses, and increased roadcall training, including the use of the *Road Call Reduction Manual* to help operators troubleshoot bus problems have contributed to the reduction in bus mechanical roadcalls and the increase in miles between mechanical roadcalls.
- For directly operated bus services, the number of mechanical roadcalls increased from 7,264 in FY04 to 8,350 in FY05, but then dropped to 5,793 in FY08. Overall, the number of bus roadcalls fell 20.3% during the audit period, while total bus vehicle miles dropped 17.7%, resulting in a 3.2% improvement in miles between bus mechanical roadcalls.
- For FY04, when METRORail operated nine months of service, miles between roadcalls were reported to be 39,900. Beginning with FY05, the first full year of service, METRORail had 210 mechanical roadcalls and operated 855,000 vehicle miles, resulting in 4,072 miles between rail roadcalls. In FY08, this indicator increased to 6,935 miles between roadcalls, improving 70% over FY05.

## **AUDIT PERIOD ACCOMPLISHMENTS INCLUDE ACTIONS TO CONTROL MAINTENANCE COST GROWTH**

- METRO eliminated MEAD, the Maintenance Education Apprentice Development program and the journeyman program, and is implementing an ASE certification program. The training program also builds on METRO's practice of relying on vendors to provide training on new equipment, particularly buses. METRO also relies on vendors to provide the special tools required while equipment is still under warranty, permitting METRO to defer the purchase of those tools until warranties expire.
- METRO developed a part-time bus mechanic program that permits the Authority to hire retired METRO mechanics, giving METRO the ability to capitalize on the knowledge and skills of the most experienced mechanics.
- A Maintenance Training Specialist, who previously worked for Siemens, was hired to run METRO Rail's maintenance training program. He has enhanced the documentation, instituted a training program for all four maintenance disciplines, and initiated the "METRO Learning Center" using computer-based training. Employees now participate in a "Learning Management System," in which their maintenance competency is regularly demonstrated to their supervisors, who maintain records of each employee's skills.

## **A NUMBER OF TECHNOLOGY INITIATIVES WERE UNDERTAKEN OR IMPLEMENTED DURING THE AUDIT PERIOD**

- The Integrated Vehicle Operations Management System (IVOMS), which went into full operation in October 2007, includes automatic vehicle location, vehicle tracking, bus stop annunciation, and transit signal priority.
- The upgrade from SEMA to SAP for the bus maintenance management system, which was completed in November 2008, just after the end of the audit period, provides enhanced user reporting and data management.
- Zonar, an electronic vehicle inspection reporting system, is currently being implemented. Using portable transponders and Radio Frequency Identification (RFID) tags on the vehicles, it is currently being used for pre-trip inspections and work activities on both bus and rail vehicles. In the future, it could also be used for post-trip inspections.
- METRORail established an effective Intranet for its maintenance and training staff, which makes all plans, procedures, drawings, schematics, and other relevant documents available at computer kiosks throughout the ROC and gives vehicle technicians full access to M4 and the Intranet. Ethernet ports at remote facilities provide similar access for field technicians.
- A new GPS/AVL system is being tested on the light rail vehicles. This system could potentially replace the existing Train to Wayside Communications (TWC), which requires both on-board and wayside equipment, while providing increased functionality and requiring less maintenance.

## **DURING THE AUDIT PERIOD, METRO ALSO EXPERIENCED SOME CHALLENGES FOR MAINTENANCE**

- Hiring and retaining both bus and rail mechanics and cleaners has been an on-going challenge. While METRO has reduced the number of mechanic vacancies to about five, finding good candidates in a good economy (such as that experienced during the audit period) has always been difficult. In an effort to retain cleaners, METRO recently established a career path that provides them a chance to become mechanics.
- Although bus maintenance completed the upgrade from SEMA to SAP in November 2008, there are additional applications that could be interfaced with SAP to increase access to integrated data for improved decision-making, including INIT, Vehicle Location and Scheduling (CAD/AVL), IVOMS, Automatic Passenger Counters (APCs), and Pre-Trip inspections (Zonar). Improving the interfaces and creating a common database could allow METRO to automate the many spreadsheets that are currently used to manage information.
- With a fleet of 18 light rail vehicles, of which 16 are normally in service, METRORail is capacity-constrained to accommodate additional boardings as well as to meet maintenance requirements for the fleet.

### **III. BUS MAINTENANCE REVIEW**

**METRO OPERATES THREE TYPES OF FIXED ROUTE BUS SERVICES IN A 1,285-SQUARE MILE SERVICE AREA THAT INCLUDES A POPULATION OF 3.8 MILLION**

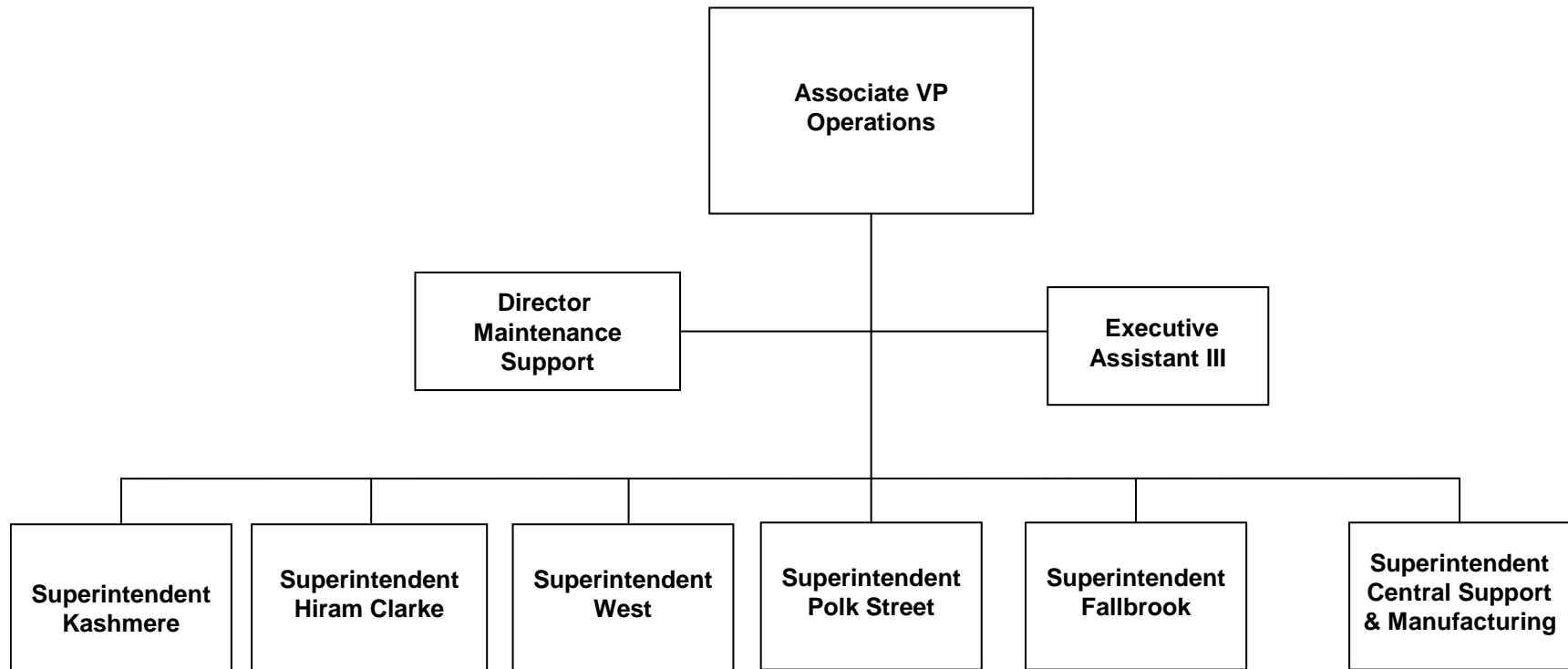
- METRO's local bus services operate primarily on city streets, making regular stops about every two blocks along the route. METRO currently operates approximately 77 routes in local service, including high-frequency shuttles and circulators serving the Texas Medical Center.
- In August 2008, METRO introduced Airport Direct, a service that provides non-stop 30-minute service between downtown Houston and George Bush Intercontinental Airport (IAH). Buses operate every 30 minutes, with the first bus leaving downtown at 5:30 am and the last bus leaving the airport at 8:40 pm. Including Airport Direct, METRO operates 78 local routes.
- Park & Ride services are provided by 32 routes that serve longer-distance commute riders traveling between 28 Park & Ride lots and key destinations in METRO's service area.
- METRO's fixed route bus services are operated using a 100-percent accessible fleet of 1,210 active buses, of which 999 are operated directly by METRO and 211 are operated by First Transit, under contract to METRO. In FY08, these bus services provided over 84.6 million boardings – or 22.3 boardings per capita for Houston's 3.8 million residents.

## **BUSES OPERATE FROM AND ARE MAINTAINED AT METRO'S BUS OPERATING FACILITIES**

- METRO'S daily bus operations and maintenance activities operate from six bus operating facilities (BOFs):
  - Five BOFs are owned and operated by METRO: Kashmere, Polk, West, Hiram Clarke, and Fallbrook
  - A sixth BOF, Northwest, is owned by METRO and operated under contract by First Transit, which operates the service and maintains the buses assigned to them.
- A mid-day storage facility located at Buffalo Bayou, in the downtown area, provides space for buses to layover, thereby reducing unproductive deadhead miles. A small force of 16 mechanics and one cleaner provide limited preventive maintenance for buses laying over at this facility.
- Bus Maintenance administrative responsibilities are located at Kashmere, as are METRO's Maintenance Central Shops and Maintenance Support:
  - Central Shops includes Unit Overhaul, the Body Shop, and Heavy Repair
  - Maintenance Support responsibilities include bus technology, technical services, warranty, quality assurance and support vehicle maintenance.
- This section of the audit focuses on the performance of METRO's bus maintenance functions, including the preventive maintenance and cleaning activities at the five directly operated BOFs and operations at the Central Shops at Kashmere. Audit site visits were conducted at Kashmere Central Shops and Polk BOF.



## BUS MAINTENANCE SUPERINTENDENTS REPORT TO THE ASSOCIATE VICE PRESIDENT, OPERATIONS



Source: METRO Organization Charts (Oct. 2008)

- The Associate Vice President, Operations is responsible for METRO’s bus maintenance functions, including Maintenance Support Services, Central Support & Manufacturing, maintenance at the five bus operating facilities that are owned and operated by METRO, and bus maintenance oversight at the facility (Northwest) that is operated under contract. Safety oversight and training is provided by the Department of Public Safety, which is a direct report to the President and Chief Executive Officer.

## **MAINTENANCE SUPERINTENDENTS ARE HELD ACCOUNTABLE FOR COST PERFORMANCE**

- One of METRO's most significant initiatives of the last four years has been the focus on controlling cost growth – and a key element of that initiative has been the involvement of all Superintendents in developing budgets and managing costs.
- On an on-going basis, Operations Management Support staff analyze payroll and budget reports and provide operating cost information to the Associate Vice President of Operations and the Senior Director of Transportation. If cost concerns are identified, Superintendents perform the necessary analyses, provide solutions, and participate in modifying practices to correct the problems.
- Along with making Superintendents responsible for managing their own budgets and managing maintenance at each of METRO's facilities, they are also expected to make choices based on their understanding of cost and productivity – effectively making them responsible for running a business that involves maintaining buses.
- Budget reports provided for Superintendents have increased during the audit period from monthly to weekly, giving Superintendents the opportunity to correct any adverse cost directions.

**MANAGEMENT STAFF LEVELS AT METRO’S BUS MAINTENANCE FACILITIES ARE IN LINE WITH OTHER LARGE TRANSIT SYSTEMS**

- METRO assigns a Superintendent of Maintenance Operations, who reports to the Associate Vice President Operations, and a General Foreman to each bus operating facility. They are supported by Supervisors who oversee the Mechanics (full-time and part-time mechanics and electronic specialists) and Cleaners assigned to each BOF.

Authorized Positions	Kashmere BOF	Polk BOF	West BOF	Hiram Clarke BOF	Fallbrook BOF	BOF Total
Superintendent	1	1	1	1	1	5
General Foreman	1	1	1	1	1	5
Supervisor	7	10	10	7	7	41
Executive Assistant	1	1	1	1	1	5
Mechanic <sup>(1)</sup>	39	63	69	61	52	284
Elec Specialist	1	1	1	1	1	5
<b>Total Mechanics</b>	<b>40</b>	<b>64</b>	<b>70</b>	<b>62</b>	<b>53</b>	<b>289</b>
Cleaner	23	29	34	29	30	145
<b>Total Mechanics &amp; Cleaners</b>	<b>63</b>	<b>93</b>	<b>104</b>	<b>91</b>	<b>83</b>	<b>434</b>
Toolroom Attendant	1	1	1	1	1	5
<b>Total Positions</b>	<b>74</b>	<b>107</b>	<b>118</b>	<b>102</b>	<b>94</b>	<b>495</b>
<b>Ratio: Mechanics to Supervisors</b>	<b>5.7</b>	<b>6.4</b>	<b>7.0</b>	<b>8.9</b>	<b>7.6</b>	<b>7.0</b>
<b>Ratio: Cleaners to Supervisors</b>	<b>3.3</b>	<b>2.9</b>	<b>3.4</b>	<b>4.1</b>	<b>4.3</b>	<b>3.5</b>
<b>Total Mechanics &amp; Cleaners per Supervisor</b>	<b>9.0</b>	<b>9.3</b>	<b>10.4</b>	<b>13.0</b>	<b>11.9</b>	<b>10.6</b>
<sup>(1)</sup> Mechanic Part Time (filled positions, included in authorized Mechanics)	1	2	2	0	0	5

Source: METRO Director Maintenance Support, updated by OMB

## **SUPERVISORY RATIOS AVERAGE 10.6 MECHANICS AND CLEANERS PER SUPERVISOR AT THE BUS OPERATING FACILITIES**

- As shown in the previous table, BOF Maintenance Supervisors, on average, manage 10.6 mechanics and cleaners. Supervisory spans of control range from a low of 9.0 at Kashmere to a high of 13.0 at Hiram Clarke.
- Supervisory ratios for mechanic only positions (i.e., excluding cleaners) at the BOFs range from a low of 5.7 at Kashmere to a high of 8.9 at Hiram Clarke. The average supervisory span across all five BOFs is 7.0 mechanics per supervisor.
- With one Electronics Specialist for each of the BOFs, technical support is limited to one five-day shift, even though all of the BOFs operate 24 hours per day and either 5 or 7 days per week.
- The ratio of cleaners to Supervisors averages 3.5 across all BOFs, from a low of 2.9 at Polk to a high of 4.3 at Fallbrook.

**ON AVERAGE, SHOP SUPERVISORS MANAGE 23.8 MECHANICS AND CLEANERS**

Authorized Positions	BOF Total	Heavy Repair	Body Shop	Unit Overhaul	Total Shops	Buffalo Bayou	Support Vehicle	METRO Total
Superintendent	5	1	0	0	1	0	1	7
General Foreman	5	1	0	0	1	0	1	7
Supervisor	41	1	2	1	4	2	2	49
Executive Assistant	5	1	0	0	1	0	1	7
<b>Mechanic <sup>(1)</sup></b>	<b>284</b>	<b>18</b>	<b>33</b>	<b>33</b>	<b>84</b>	<b>16</b>	<b>17</b>	<b>401</b>
Elec Specialist	5	0	0	0	0	0	2	7
<b>Total Mechanics</b>	<b>289</b>	<b>18</b>	<b>33</b>	<b>33</b>	<b>84</b>	<b>16</b>	<b>19</b>	<b>408</b>
Cleaner	145	3	3	5	11	1	2	159
<b>Total Mechanics &amp; Cleaners</b>	<b>434</b>	<b>21</b>	<b>36</b>	<b>38</b>	<b>95</b>	<b>17</b>	<b>21</b>	<b>567</b>
Toolroom Attendant	5	0	0	0	0	0	0	5
<b>Total Positions</b>	<b>495</b>	<b>25</b>	<b>38</b>	<b>39</b>	<b>102</b>	<b>19</b>	<b>26</b>	<b>642</b>
<b>Ratio: Mechanics to Supervisors</b>	<b>7.0</b>	<b>18.0</b>	<b>16.5</b>	<b>33.0</b>	<b>21.0</b>	<b>8.0</b>	<b>9.5</b>	<b>8.3</b>
<b>Ratio: Cleaners to Supervisors</b>	<b>3.5</b>	<b>3.0</b>	<b>1.5</b>	<b>5.0</b>	<b>2.8</b>	<b>0.5</b>	<b>1.0</b>	<b>3.2</b>
<b>Total Mechanics &amp; Cleaners per Supervisor</b>	<b>10.6</b>	<b>21.0</b>	<b>18.0</b>	<b>38.0</b>	<b>23.8</b>	<b>8.5</b>	<b>10.5</b>	<b>11.6</b>
<sup>(1)</sup> Mechanic Part Time (filled positions, included in authorized Mechanics)	5	0	0	0	0	0	0	5

Source: METRO Director Maintenance Support, updated by OMB

- Supervisory ratios for Maintenance Shop Supervisors range from a low of 16.5 mechanics in the Body Shop to a high of 33 in the Unit Overhaul shop, and average 21.0. Including both mechanics and cleaners, Maintenance Shop Supervisors are responsible for an average of 23.8 staff.

**ON AVERAGE, SHOP SUPERVISORS MANAGE 23.8 MECHANICS AND CLEANERS (CONTINUED)**

- Mechanic to Supervisor ratios for other (non-shop) facilities are 8.0 at Buffalo Bayou and 9.5 at Support Vehicle Maintenance, somewhat higher than the ratios at METRO's BOFs.
- Because there are few Cleaners at these facilities, the ratios of Cleaners to Supervisors tend to be quite low, ranging from 0.5 at Buffalo Bayou to 5.0 at Unit Overhaul, and averaging 3.2 across the section.

## **HIRING AND RETAINING MECHANICS AND CLEANERS HAS BEEN CHALLENGING**

- Like other transit agencies, attracting and retaining qualified, trained mechanics has been an on-going challenge for METRO. As recently as two years ago, METRO was short 30 mechanics.
- While METRO currently has only about five mechanic vacancies, finding good candidates in the good economy that Houston experienced during the audit period has always been difficult. The local oil and gas industry competes with METRO and their pay scales have induced mechanics to leave METRO, making both hiring and retention challenging. Other aspects of hiring that are challenging include pre-employment and background checks.
- Anecdotally, staff report that mechanics that have been with METRO for a year or more tend to stay with the Authority. In addition, a strategy that has proved helpful is having a Human Resources coordinator work with the BOFs to fill mechanic and cleaner positions.
- Turnover among cleaners has also been high. METRO has been able to hire cleaners, but retaining them has been more difficult. Therefore, a cleaner career path was recently established, providing them a chance to become mechanics by offering training and the opportunity to work through the maintenance mechanic levels, in conjunction with achieving ASE certifications. The program meets two of METRO's objectives: reducing turnover among cleaners and creating a home-grown cadre of mechanics.

## **METRO HAS BEEN RESOURCEFUL IN CREATING A PART-TIME MECHANIC CLASSIFICATION**

- METRO's most recent TWU agreement includes provisions that permit the use of part-time mechanics. Section 513 - Part-time Mechanics, includes the following stipulations:
  - Part-time Mechanics are limited to retired METRO mechanics.
  - Part-time Mechanics will be paid the current top hourly rate (i.e., the top rate at the time an individual is working as a Part-time Mechanic) for the mechanic classification held when last employed prior to retirement.
  - Part-time Mechanics can work a maximum of 1,000 hours per calendar year.
- METRO currently has 12 authorized part-time mechanic positions, of which five are filled. However, the labor agreement does not preclude hiring more part-time mechanics.
- This provision of the labor agreement gives METRO the ability to capitalize on the knowledge and skills of mechanics who are among the most experienced, by encouraging them to continue to work and be productive beyond retirement.



## **THE USE OF FAMILY MEDICAL LEAVE HAS INCREASED OVER THE AUDIT PERIOD**

- Mechanic staffing levels are affected by scheduled and unscheduled absences. Provisions of the Family Medical Leave Act (FMLA) are of particular concern to Bus Maintenance managers and supervisors.
- The Family Medical Leave Act of 1993 requires employers to provide up to twelve weeks of unpaid, job-protected leave during a 12-month period for care of a spouse, parent or child in the event of a serious health condition, the birth or adoption of the employee's child, or the employee's own serious health condition.
- FMLA also allows employees to take intermittent leave for chronic serious health conditions. In recent years, transit systems have experienced a higher level of intermittent use of FMLA leave as employees use it to avoid discipline for absenteeism.
- The Authority's Manager for Wellness Programs has recently reviewed METRO's experience with FMLA absences and is working with Transportation and Maintenance to develop guidelines to improve the management of the program.

**MAINTENANCE STAFF TRAINING PROGRAMS ARE CURRENTLY UNDERGOING MAJOR CHANGES DESIGNED TO IMPROVE STAFF SKILL LEVELS AND CONTROL COSTS**

- METRO previously used a training program referred to as MEAD (Maintenance Education Apprentice Development). However, the MEAD program and the Mechanic Journeyman Program were eliminated for cost reasons and due to management issues.
- METRO is investigating the ASE transit bus-specific certification program, through which technicians will be eligible to attain the Transit Bus Master Technician Certification. The certification program has been implemented on a limited basis. The ASE Program currently in place addresses six maintenance skill areas: brakes, diesel engines, drive trains, electric, HVAC, steering and suspension. Two more skill areas will be added in the near future: hybrid maintenance, and preventive maintenance and inspection.
- The Transport Workers' Union, which represents METRO's mechanics, has objected to the certification program, arguing that ASE mechanics should be compensated for their certifications.
- METRO has two in-house maintenance trainers and relies heavily on vendors to provide training on their products, including new bus fleets.

**SOME MAINTENANCE UNIT COSTS ARE HIGHER AT POLK THAN AT METRO’S OTHER BUS OPERATING FACILITIES**

- METRO staff designated one bus operating facility (Polk) for detailed review during the performance audit. The audit team conducted a site visit at Polk and subsequently compared FY08 maintenance cost indicators across METRO’s operating facilities.
- Several cost-based performance indicators have been used to compare Polk to METRO’s other operating facilities.

<b>FY 2008</b>	<b>Polk</b>	<b>Kashmere</b>	<b>West</b>	<b>Hiram Clarke</b>	<b>Fallbrook</b>	<b>BOF Total</b>
Gross Maintenance Costs	\$13,757,831	\$8,918,428	\$15,224,881	\$12,678,794	\$10,919,040	\$61,498,974
Maintenance Wages & Salaries	\$4,816,488	\$3,212,994	\$5,369,704	\$4,614,577	\$4,020,324	\$22,034,087
Vehicle Servicing Cost	\$1,368,301	\$1,078,287	\$1,452,257	\$1,548,932	\$1,346,580	\$6,794,357
Inspection Cost	\$7,437,013	\$4,671,851	\$8,566,834	\$7,163,650	\$5,885,903	\$33,725,251
Diesel Fuel	\$4,492,957	\$2,594,605	\$4,799,260	\$3,530,020	\$3,284,877	\$18,701,719
Cleaners	29	23	34	29	30	145
Mechanics	64	40	70	62	53	289
Supervisors	10	7	10	7	7	41
Total Vehicle Miles	8,694,578	5,182,888	9,325,729	6,731,739	6,847,164	36,782,098
Peak Buses	154	116	234	186	156	846
Active Buses	184	136	276	219	184	999
Gross Maintenance Cost/Vehicle Mile	\$1.58	\$1.72	\$1.63	\$1.88	\$1.59	\$1.67
Maint. Labor Cost/Active Bus	\$26,177	\$23,625	\$19,455	\$21,071	\$21,850	\$22,056
Fuel Cost/Active Bus	\$24,418	\$19,078	\$17,389	\$16,119	\$17,853	\$18,720
Inspection Cost/Active Bus	\$40,419	\$34,352	\$31,039	\$32,711	\$31,989	\$33,759
Servicing Cost/Active Bus	\$7,436	\$7,929	\$5,262	\$7,073	\$7,318	\$6,801
Servicing Cost/Servicer	\$47,183	\$46,882	\$42,713	\$53,411	\$44,886	\$46,858
Inspection Costs/Mechanic	\$116,203	\$116,796	\$122,383	\$115,543	\$111,055	\$116,696

Source: METRO Budget Variance Reports (FN-540 Budget Analysis reports) and OMB database

**THESE PERFORMANCE INDICATORS ARE DISCUSSED ON THE FOLLOWING PAGE**

**POLK IS ONE OF METRO'S TWO BUS OPERATING FACILITIES THAT OPERATES SEVEN DAYS/WEEK**

- Among the five directly operated facilities, Polk and West operate seven days a week.
- On a unit cost basis, FY08 BOF costs were generally highest at Polk. Except for maintenance cost per vehicle mile, all cost indicators were at or higher than the average of all five BOFs:
  - On a per bus basis, total maintenance cost, fuel cost and the cost of preventive maintenance inspections (PMIs) exceeded the average for the five directly-operated BOFs by approximately 20% to 30%.
  - Servicing costs per bus, servicing costs per servicer, and inspection costs per mechanic were right at the average for all five BOFs.
- However, at \$1.58 per mile, Polk's maintenance cost per mile was lower than for any of METRO's other facilities. Polk's gross maintenance operating costs and total vehicle miles are second only to West among directly operated facilities. Systemwide, METRO's maintenance cost per mile was \$1.67.

**POLK’S NON-COST METRICS ARE CLOSER TO THE NORM**

- Indicators that could be impacting maintenance costs at Polk (e.g., buses per mechanic or cleaner, the spare ratio and the fleet mix and age) are not out of line compared to the performance of METRO’s other BOFs. The specific fleet assignments could be impacting costs, but the average fleet age is slightly lower at Polk than at all but one other BOF (i.e., West), though the spare ratio is slightly higher.

<b>FY 2008</b>	<b>Polk</b>	<b>Kashmere</b>	<b>West</b>	<b>Hiram Clarke</b>	<b>Fallbrook</b>	<b>BOF Total</b>
Cleaners	29	23	34	29	30	145
Mechanics	64	40	70	62	53	289
Supervisors	10	7	10	7	7	41
Peak Buses	154	116	234	186	156	846
Active Buses	184	136	276	219	184	999
Active Bus/Mechanic	2.9	3.4	3.9	3.5	3.5	3.5
Active Bus/Service	6.3	5.9	8.1	7.6	6.1	6.9
Mechanics/Supervisor	6.4	5.7	7.0	8.9	7.6	7.0
Spare Ratio	19.5%	17.2%	17.9%	17.7%	17.9%	18.1%
Average Fleet Age	8.07	9.19	7.89	9.23	8.82	8.49

Source: METRO Director Maintenance Support, updated by OMB

- Other factors that could impact maintenance costs at Polk (e.g., service delivery characteristics such as excessive deadhead, high defect rates and other indicators of maintenance performance such as adherence to preventive maintenance (PM) intervals and mean distance between roadcalls) are discussed further below.

**BUSES ARE ASSIGNED TO BUS OPERATING FACILITIES BASED ON REVENUE SERVICE NEEDS AND BUS TYPES**

- METRO operates 1,210 buses, of which 999 are assigned to the five directly-operated BOFs. The remaining 211 are operated under contract by First Transit, at Northwest BOF.

Authorized Positions	Kashmere BOF	Polk BOF	West BOF	Hiram Clarke BOF	Fallbrook BOF	BOF Total
Days of Operation	5	7	7	5	5	N/A
Hours of Operation	24	24	24	24	24	N/A
Peak Fleet	116	154	234	186	156	846
Active Fleet	136	184	276	219	184	999
Flat Bays	8	12	9	18	29	76
Lift Bays	9	14	5	14	10	52
Bus Wash	2	2	2	3	3	12
Fuel Lanes	3	4	4	3	4	18
Parking Spaces	179	255	290	260	300	1,284
Mechanics	40	64	70	62	53	289
Cleaners	23	29	34	29	30	145
<b>Buses per Mechanic</b>	<b>3.4</b>	<b>2.9</b>	<b>3.9</b>	<b>3.5</b>	<b>3.5</b>	<b>3.5</b>
<b>Buses per Cleaner</b>	<b>5.9</b>	<b>6.3</b>	<b>8.1</b>	<b>7.6</b>	<b>6.1</b>	<b>6.9</b>
<b>Buses per Work Bay</b>	<b>8.0</b>	<b>7.1</b>	<b>19.7</b>	<b>6.8</b>	<b>4.7</b>	<b>7.8</b>
<b>Parking Availability</b>						
Spaces	43	71	14	41	116	285
%	24%	28%	5%	16%	39%	22%

Source: METRO Director Maintenance Support, Fleet Assignment Sheet (Sep30-08)

- The five BOFs each operate three shifts, 24 hours per day. Polk and West operate seven days a week; Kashmere, Hiram Clarke and Fallbrook operate five days a week. Service lanes at all five facilities operate between 7:00 pm and 3:30 am.

## **FACILITY CHARACTERISTICS VARY ACROSS METRO'S BUS OPERATING FACILITIES**

- As shown in the table on the previous page, the ratio of buses to mechanics ranges from 2.9 at Polk to 3.9 at West, and averages 3.5. The ratio of buses to cleaners averages 6.9 in a range from 5.9 at Kashmere to 8.1 at West.
- Each BOF provides work areas to perform vehicle inspections and running repairs, including a combination of lift bays and flat bays. The availability of work bays relative to the assigned fleet is highly variable, and ranges from 4.7 buses per bay at Fallbrook to 19.7 at West. In some cases, bus assignments are based on the ability of a facility to accommodate a specific fleet. For example, Polk cannot accommodate articulated buses.
- Parking spaces represent the bus capacity of each base. Parking availability calculations provide an indication of remaining capacity, which is very limited at West, with only 14 available spaces (5% of its capacity), while Fallbrook has 116 available spaces (39% of its capacity).

## **METRO'S PREVENTIVE MAINTENANCE INSPECTIONS ARE STRUCTURED AND REQUIRE SIGN-OFF BY A FOREMAN**

- METRO has developed and uses PM inspection forms for each bus type and for each of five inspection types. In addition to the PM checklist, the forms include a Foreman's Safety Item Checkoff List, which is completed by a foreman for each bus inspection, as well as a defect sheet where defects noted during an inspection are listed, along with repairs made. Major Inspection Guidelines are available for PM inspectors; they provide guidance for completing the inspection forms.
- METRO tracks preventive maintenance intervals and schedules inspections to meet a 6,000 mile standard, which is based on manufacturers' recommendations and METRO's experience. The A inspection is the basic inspection; additional activities are performed under four additional inspection types (B, C, D and E).
- At the request of METRO staff, one bus operating facility (Polk) was reviewed in greater detail than the other BOFs. Polk's preventive maintenance practices and mean distances between failures are discussed on the following pages.



**PREVENTIVE MAINTENANCE INTERVALS AT POLK WERE ANALYZED FOR ADHERENCE TO SCHEDULES**

- Maintenance Support staff provided data on maintenance intervals for all preventive maintenance inspections (PMIs) conducted at Polk during FY08. These data were analyzed to assess adherence to PMI schedules. Schedule adherence is checked because inspections that are performed early may result in unnecessary costs and inspections that are performed late may result in increased costs associated with deferred maintenance or not catching a defect before it becomes a problem.
- The results of the analysis indicate that PMI intervals at Polk averaged 6,349 miles, with a low of 4,064 miles and a high of 7,849 miles between PMIs. These results compare to METRO’s 6,000-mile standard for PMI intervals.

Active Buses	Miles	PMs	PM Intervals			
			STANDARD	Average	Low	High
186	8,342,154	1,314	6,000	6,349	4,064	7,849

Source: METRO Maintenance Support

- Among the 1,314 PMIs conducted at Polk in FY08, 73% (956) were performed within ±10% of the 6,000 mile interval. Thirteen (1%) were conducted early, at less than 5,400 miles, and 345 (26%) were completed late, at more than 6,600 miles.

**SYSTEMWIDE, 87% OF PMIS ARE CONDUCTED ON-TIME**

- METRO staff provided data on PMIs conducted during FY08 at the five other directly operated BOFs.

BOF	FY08 PMIs	Avg PM Interval	PMIs Conducted...					
			Early (%)		On-Time (%)		Late (%)	
Polk	1,314	6,349	13	(1%)	956	(73%)	345	(26%)
West	1,407	5,861	25	(2%)	1,371	(97%)	11	(1%)
Hiram Clarke	1,104	6,238	1	(0%)	1,029	(93%)	74	(7%)
Kashmere	837	6,421	3	(0%)	554	(66%)	280	(33%)
Fallbrook	1,080	6,042	2	(0%)	1,071	(99%)	7	(1%)
<b>Systemwide</b>	<b>5,742</b>	<b>6,182</b>	<b>44</b>	<b>(1%)</b>	<b>4,981</b>	<b>(87%)</b>	<b>717</b>	<b>(12%)</b>

- In 1997, at the time of the last maintenance performance audit, 50% of the PMIs were performed within  $\pm 10\%$  of the PM interval, which at that time was 4,000 miles. Since that time, the standard has increased to 6,000 miles and schedule adherence has improved considerably. Systemwide, the proportion of inspections performed on-time has increased to 87%, early PMIs have been reduced from 23% to 1% and the proportion of late inspections has dropped from 26% to 12%.
- At West, Hiram Clarke and Fallbrook, over 90% of PMIs were performed on-time in FY08. At Polk, 26% of the PMIs were late; at Kashmere, 33% were late. METRO staff explained that during FY08 there were problems at Polk with the Fleetwatch system that is used to track mileage and that aids in scheduling PMIs.

### **IN SOME CASES, PMI SCHEDULES SHOULD BE BETTER MONITORED**

- Although performance systemwide has improved markedly, the data suggest that Polk and Kashmere should be taking steps to reduce the number of late inspections. On average, each of the 186 buses at Polk was inspected seven times in FY08. Of those, almost two of the inspections were more than 600 miles beyond the standard. Assuming buses average 200 miles per day, late inspections are being conducted at least three days late.
- If Fleetwatch is the problem, it may be a question of developing an ability to better monitor PMI schedules. Since METRO depends on Fleetwatch to schedule PM inspections and the system has been unreliable at some BOFs, it appears that managers at those facilities need a back-up capability to monitor upcoming PMIs. That auxiliary system should not depend entirely on daily access to Fleetwatch, and should make it possible to be aware of and schedule buses that are due for PMIs over the next week.

Bus Maintenance...Operating Facilities

**DURING FY08, MECHANICAL FAILURES AND FAREBOXES ACCOUNTED FOR 65.9% OF TOTAL ROADCALLS**

Incident	FALLBROOK	HIRAM CLARKE	KASHMERE	NORTHWEST	POLK	WEST	TOTALS	%
Accident	179	216	149	214	321	328	1,407	9.4%
Bus Change	36	14	10	2	26	32	120	0.8%
Central Shops	20	23	13	0	24	14	94	0.6%
Operator Error	25	37	26	29	39	48	204	1.4%
Fleet Defect	1	7	2	62	10	8	90	0.6%
Unsanitary	36	59	61	38	112	68	374	2.5%
Farebox	417	661	407	231	844	795	3,355	22.4%
Not in Service	31	37	20	24	24	31	167	1.1%
Out of Fuel	0	0	0	0	0	0	0	0.0%
Mechanical	873	1,449	610	1,028	1,153	1,395	6,508	43.5%
Pre Trip Insp.	9	13	12	1	22	17	74	0.5%
No Trouble Found	137	107	67	130	144	80	665	4.4%
Road Damage	36	66	43	52	92	49	338	2.3%
Service Truck	3	5	1	0	1	1	11	0.1%
Tire	91	134	72	153	129	164	743	5.0%
Unnecessary	40	33	27	24	49	35	208	1.4%
Vandalism	32	59	75	19	114	54	353	2.4%
Weather Related	2	9	4	0	8	8	31	0.2%
Vendor Warranty	13	10	9	31	102	49	214	1.4%
R&D / Test Bus	0	1	0	0	0	0	1	0.0%
<b>Total</b>	<b>1,981</b>	<b>2,940</b>	<b>1,608</b>	<b>2,038</b>	<b>3,214</b>	<b>3,176</b>	<b>14,957</b>	<b>100.0%</b>

Source: METRO Road Call Dashboard, Oct-07-Sep-08 (note that Dashboard reports provide interim monthly, not final year-end data)

**DURING FY08, MECHANICAL FAILURES AND FAREBOXES ACCOUNTED FOR 65.9% OF TOTAL ROADCALLS (CONTINUED)**

- The types of roadcalls that METRO most commonly experiences are mechanical (43.5%), followed by roadcalls for fareboxes (22.4%). Non-mechanical roadcalls for accidents and tires accounted for another 14.4% of total incidents. The remaining 19.7% of roadcalls are spread over the 16 other roadcall categories shown on the previous page.
- The most common mechanical roadcalls are for electrical, climate control, engine, transmission, fuel system, cooling system, air system, hydraulic system, and brakes. Other categories include doors, wheelchair lifts, drive axle/shaft, turntable and body paint.
- Non-mechanical roadcall categories include roadcalls for accidents, bus changes, central shops, operator error, fleet defects, fareboxes, out of fuel, road damage, tires, vandalism, weather-related, vendor warranty, and R&D/test bus.
- Polk and West had the most roadcalls in FY08 (each experienced 21% of the system total); Kashmere had the fewest (11%). These trends help to explain Polk's relatively higher per-bus costs, discussed earlier on pages III-13 and III-14.

**BUS MILES BETWEEN ROADCALLS HAVE IMPROVED CONSISTENTLY SINCE FY05**

- Directly-operated total miles and roadcall data were provided by METRO to the auditors to use in calculating the State-mandated performance indicator: miles between roadcalls. Using these data, miles between roadcalls for directly-operated fixed route bus services dropped 26% during FY05, the first year of the audit period, and then improved annually through FY08. While performance improved only 3% relative to the base year, miles between roadcalls have increased consistently and by almost 39% since FY05:

	FY04	FY05	FY06	FY07	FY08	% Change
Total Miles	44,674,089	38,201,598	36,794,492	36,584,227	36,779,485	-17.7%
Roadcalls	7,264	8,350	7,005	6,190	5,793	-20.3%
Miles per Roadcall	6,150	4,575	5,253	5,910	6,349	3.2%

Source: OMB database

- Internally, bus maintenance staff have developed the Road Call Dashboard to report roadcalls and mean distance between failure (MDBF) due to mechanical causes resulting in roadcalls, using data from reported incidents, and including service provided under contract from Northwest BOF. The MDBF measure was developed during FY05. Goals were first set for the indicator in FY06. At that time, different and increasing targets were established for each quarter. In FY07, the goal was 5,000. It increased to 5,250 in FY08 and 6,000 for FY09.

**POLK’S MEAN DISTANCES BETWEEN MECHANICAL ROADCALLS WERE 4% LOWER THAN THE FY08 SYSTEMWIDE AVERAGE**

Facility	Miles Operated	Mech R/C	Mech/ Other R/C	Warranty R/C	Fleet Defect R/C	Subtotal Mech R/C	MDBF Mech R/C	Other R/C	Total R/C	MDBF All R/C
Fallbrook	6,847,164	871	23	12	1	907	7,549	826	1,733	3,951
Hiram Clarke	6,731,739	1,443	28	10	7	1,488	4,524	1,178	2,666	2,525
Kashmere	5,182,888	614	14	9	2	639	8,111	789	1,428	3,629
Polk	8,694,578	1,154	26	103	10	1,293	6,724	1,548	2,841	3,060
West	9,325,729	1,393	15	50	8	1,466	6,361	1,319	2,785	3,349
<b>Total - Directly Operated</b>	<b>36,782,098</b>	<b>5,475</b>	<b>106</b>	<b>184</b>	<b>28</b>	<b>5,793</b>	<b>6,349</b>	<b>5,660</b>	<b>11,453</b>	<b>3,212</b>
Northwest (purchased)	11,861,068	1,019	0	31	64	1,114	10,647	671	1,785	6,645
<b>Systemwide - Total</b>	<b>48,643,166</b>	<b>6,494</b>	<b>106</b>	<b>215</b>	<b>92</b>	<b>6,907</b>	<b>7,043</b>	<b>6,331</b>	<b>13,238</b>	<b>3,675</b>
<b>Systemwide - Average</b>	<b>8,107,194</b>	<b>1,082</b>	<b>18</b>	<b>36</b>	<b>15</b>	<b>1,151</b>	<b>7,043</b>	<b>1,055</b>	<b>2,206</b>	<b>3,675</b>

Source: METRO Maintenance Incident Performance Report, 2008

- For FY08, METRO set a target of 5,250 miles between mechanical roadcalls, of which the most common include electrical, climate control, engine, transmission, fuel system, cooling system, air system, hydraulic system, and brakes. Mechanical roadcalls exclude accidents, criminal mischief, road damage, and electronic farebox events. Mechanical roadcalls reported above also include those attributed to warranty work and fleet defects.
- Data reported in the Road Call Dashboards for FY08 indicate that METRO surpassed the 5,250 mile target at the systemwide level. At the facility level, all BOFs except Hiram Clarke easily met the target. In fact, the systemwide average was 6,349 for directly operated bus services and 7,043 for all bus services. For FY09, the target has been increased to 6,000 miles. Since all BOFs except Hiram Clarke exceeded that level in FY08, it appears that this is a comfortable target for the current year.
- Including non-mechanical roadcalls (e.g., vandalism, road damage, fuel, operator error), METRO averaged 3,675 miles between roadcalls in FY08.

**OVER THE LAST FOUR YEARS, METRO REDUCED SERVICE LEVELS AND THE SIZE OF THE BUS FLEET**

- METRO reduced the size of its active bus fleet from 1,232 buses in FY05 to 1,210 buses at the end of FY08. Over the same time, the peak fleet requirement remained relatively constant, except for a dip in FY06. As a result, the spare ratio has declined annually (except in FY06), dropping from just over 20% to 17.7% now.

<b>Fleet Assignments</b>	<b>FY05</b>	<b>FY06</b>	<b>FY07</b>	<b>FY08</b>
Kashmere	136	141	137	136
Polk	187	196	194	184
Hiram Clarke	222	222	213	219
Fallbrook	203	192	195	184
West	254	242	261	276
Total Directly Operated	1,002	993	1,000	999
Northwest	230	225	211	211
Active Fleet	1,232	1,218	1,211	1,210
Inactive/Pending Sale	168	95	69	60
Total Fleet	1,400	1,313	1,280	1,270
Peak Vehicles	1,024	1,007	1,024	1,028
Spare Ratio	20.3%	21.0%	18.3%	17.7%
Average Fleet Age	6.17	7.09	7.62	8.49

Source: Fleet Assignment Sheets (Oct-05, Sep-06, Sep-07, Sep-08)

- The decision to reduce the fleet size occurred in FY04, just before the beginning of the current audit period, when METRO’s management team held the budget at the same level for two years and when fixed route bus revenue service hours were reduced by over 10% and the rate of growth in costs was slowed to well under the rate of growth in the CPI.



**METRO’S BUS PROCUREMENT PLAN IS ADDING HYBRID BUSES TO THE FLEET**

- METRO’s current bus fleet includes a mix of diesel and hybrid buses, with hybrids accounting for a growing share of the fleet. METRO’s oldest hybrids are four 40’ New Flyers that were purchased in the 1996/1998 timeframe.

Bus #	Year	Make	Service	Fuel	Active	Distribution	Age (yrs)
3700-3760	1993/94	45' Neoplan	Suburban	Diesel	46	3.8%	15-16
4000-4156	1996/98	40' New Flyer	Transit	Diesel	145	12.0%	11-13
4103-4106	1996/98	40' New Flyer	Transit	Hybrid	4	0.3%	11-13
4500-4589	1996/99	60' Neoplan	Transit	Diesel	76	6.3%	10-13
4400-4589	1996/99	60' Neoplan	Suburban	Diesel	65	5.4%	10-13
4200-4327	1997/98	29' New Flyer	Transit	Diesel	77	6.4%	11-12
4700-4803	1999	45' New Flyer	Suburban	Diesel	101	8.3%	10
2800-2899	2000	40' New Flyer	Transit	Diesel	100	8.3%	9
2900-2949	2000	40' New Flyer	Transit	Diesel	50	4.1%	9
3200-3535	2001	40' New Flyer	Transit	Diesel	334	27.6%	8
4810-4948	2001/02	45' MCI	Suburban	Diesel	139	11.5%	7-8
4949-4973	2007	45' MCI	Suburban	Diesel	25	2.1%	2
3580-3589	2007	40' New Flyer	Transit	Hybrid	10	0.8%	2
3550-3589	2007	40' New Flyer	Transit	Hybrid	30	2.5%	2
5001-5102	2008/09	45' MCI	Suburban	Hybrid	8	0.7%	0-1
3601-3696	2008/09	40' Orion	Transit	Hybrid	0	0.0%	0-1
Total					1,210	100.0%	

- In 2007, METRO began purchasing hybrids again, and in Sep-08 about 38 were on the property. At that time, the Authority had just started receiving an order of 102 45’ MCI hybrids and eight had been accepted. METRO has also contracted with Orion for 96 40’ hybrid buses that will be received this year.
- The 334 New Flyers that METRO purchased in 2001 account for almost 28% of METRO’s current fleet. Another 42% of the fleet is 10-16 years old. One of METRO’s objectives is to purchase buses more regularly (i.e., annually) and avoid the gaps like the one from 2002 to 2007 when no buses were procured. However, as a result of past bus replacement practices, the fleet is aging – and will continue to age until a balance is re-established between the number of older and newer buses in the fleet.

## **NEW BUSES ARE RECEIVED, PROCESSED AND ACCEPTED BY MAINTENANCE**

- New buses are received and processed by Maintenance, with some shop support. Radios and fareboxes are installed by METRO, and some wiring and equipment are moved from older buses to new buses. Associated labor and material costs are capitalized. Most training on new buses is provided by equipment vendors.
- Fleet information is updated when the asset is entered into SAP, where the vehicle history is maintained and managed, including fleet campaigns. This initiates the warranty process and monitoring throughout the bus life cycle.
- Claims Management uses SAP to manage the work flow for all warranty claims. Warranty claims are aggressively monitored and accounted for in SAP. A cradle-to-grave approach to maintenance accounting and reporting accounts for cost per unit by fleet, system, component and vendor, making it possible to monitor warranty status and claim recoveries.
- Special tools are not purchased when a bus fleet is accepted since the warranty covers the repairs. Only after the warranty has expired does Maintenance purchase special tools and fixtures to maintain the components.
- Asset Disposal Reports (ADRs) are generated by Maintenance for proper decommissioning of assets.

**OVER THE AUDIT PERIOD, METRO'S NON-REVENUE FLEET WAS REDUCED SIGNIFICANTLY**

- Non-revenue fleet maintenance includes all service trucks, sedans, police sedans, and wreckers. Non-revenue vehicle maintenance recordkeeping is maintained in SAP's Fleetwatch which captures oil, fuel, mileage, PMI cards, and work orders.
- Over the audit period, the size of the non-revenue fleet was reduced from 435 to 371 vehicles. An FY09 mandate will reduce the fleet further, to 348 vehicles.
- Until recently, METRO maintained a large fleet of wreckers to address parking violations and to remove vehicles from HOV lanes. During the audit period, METRO disposed of 14 wreckers by subcontracting the service to a private firm. METRO will continue to maintain three heavy-duty tow trucks.
- Fleet Maintenance is scheduled to replace 40-45 non-revenue vehicles per year over a five-year period based on time or mileage in accordance with current guidelines. METRO is investigating the cost-effectiveness of hybrid technology in non-revenue vehicles and is pursuing smaller, more fuel-efficient vehicles for the non-revenue fleet.

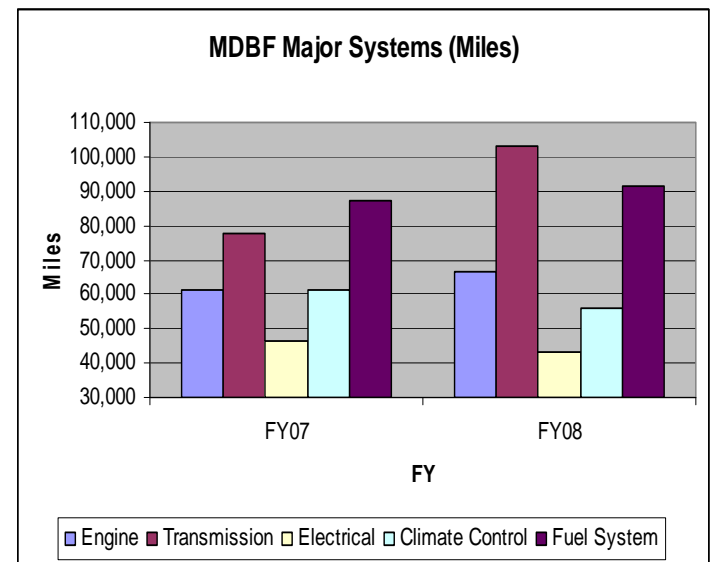
### CENTRAL SHOPS CONTRIBUTED TO IMPROVING TRENDS IN MDBF FOR MAJOR SYSTEMS

- MDBF reported for major systems is an indicator of the trends in central maintenance activities that can favorably affect overall system performance. Central Shops MDBF indicators improved in FY08 for engines, transmissions and fuel systems.

MDBF - Major Systems (MILES)	FY05	FY06	FY07	FY08
Engine	NA	NA	61,236	66,730
Transmission	NA	NA	77,586	103,190
Electrical	NA	NA	46,172	43,345
Climate Control	NA	NA	61,341	56,219
Fuel System	NA	NA	87,463	91,645

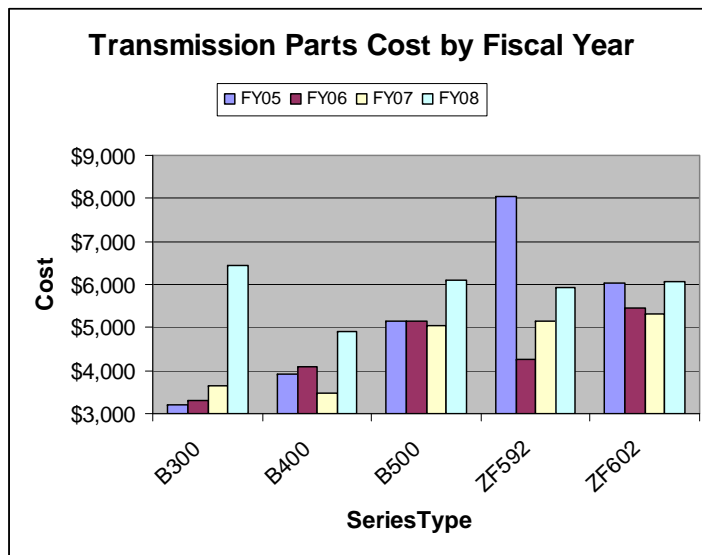
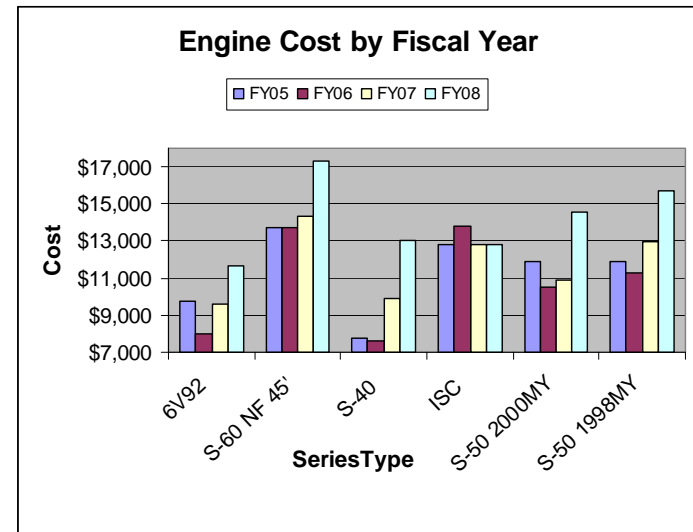
Source: METRO Operations Department

- These improvements correlate to the fluid analysis program. It appears that the number of fluid samples analyzed based on available data for both engines and transmissions also improved. However, the electrical and climate control areas indicate unfavorable trends, as indicated in the chart. The fluid analysis and the relevant work METRO is performing in Central shops helps with performance trends overall.
- The cost of repairs can be compared to MDBF trends to determine whether cost containment is a factor or cause related to the unfavorable trends.



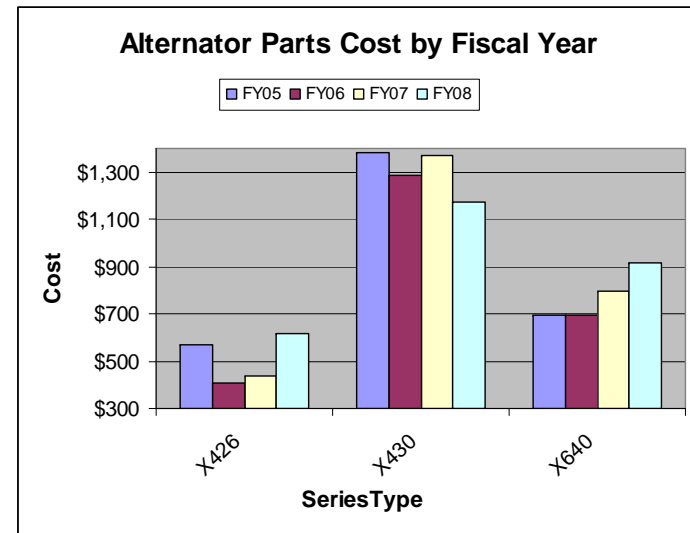
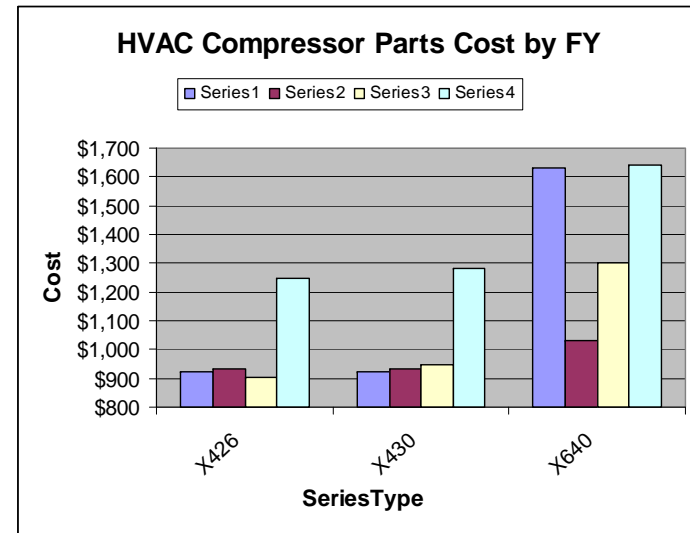
### THE CENTRAL SHOPS TRACK COSTS FOR MAJOR SYSTEM MATERIAL PARTS

- Overall Major Systems' costs reported by Central Shops increased over the audit period.
- Engine parts cost trends increased across all series except the ISC series, which remained relatively flat.
- Cost trends for transmission parts were variable over the audit period and by series. Overall, costs were generally higher in FY08.



**PARTS COSTS FOR HVAC COMPRESSORS AND ALTERNATORS ALSO INCREASED OVER THE AUDIT PERIOD AND IN FY08**

- Costs for HVAC Compressor parts increased over the audit period, with the largest percentage increase occurring in FY08, for all series. HVAC Compressor parts cost trends were similar for the X246 and X430 series. Costs for the X640 series fluctuated the most over the audit period, dropping in FY06 and then increasing substantially in FY07 and FY08. The X640 series has been the costliest of the various compressors.
- Alternator costs trends varied across series types, both in growth patterns and overall costs. The X430 is two to three times more costly than the other types, but is the only one that experienced reduced costs in FY08.



## **CENTRAL SHOPS HAVE IMPROVED THEIR MAINTENANCE REPORTING SYSTEMS**

- Central Shops includes specific shop areas for heavy repair, body work, batteries, engines, transmissions, and unit overhauls for METRO buses.
- One of Central Shops' roles is to provide testing support for the evaluation of proposed replacement parts. The support includes verifying dimensional tolerances, installation, load testing, and subsequently removing parts from components, as needed. Quality Assurance and Technical Services provide the formal test procedures and plans to Central Shops. The formal procedures document the tests that are used to determine whether "like parts" are Original Equipment Manufacturers (OEM) equivalent.
- Central Shops annually reviews production and labor requirements (work loads) for one year in advance to assist with budget development for both internal and contracted overhauls. Air brake, water pump, air compressor, and electric motor rebuilds are currently outsourced.
- A pilot program was tested during the audit period using a contracted vendor to provide and stock consumable parts shelves for maintenance shops. The vendor inventories and delivers twice weekly with a 99% fill rate. Parts are expensed to METRO when issued, saving some inventory cost.

## **CENTRAL SHOPS HAVE ALSO IMPROVED THEIR MAINTENANCE REPORTING SYSTEMS (CONTINUED)**

- A goal of Central Shops is to reduce the cost of component repairs and overhauls despite the increase in parts costs. Once parts costs are minimized, the only remaining factor of production to save on is labor.
- As an example of cost containment, the diesel engine rebuild labor hours in the Central Shops have been reduced from 120 to 65 hours. METRO overall costs to rebuild are very competitive with the costs of contracted suppliers. In some cases a contracted engine rebuild may have a slightly favorable cost, but METRO may also be impacted by delays from a contract rebuild.
- Central Shops prepares an annual rebuild forecast schedule for each of the BOFs covering major components (i.e. engines, transmissions, axles, A/C, etc.). A monthly breakdown is provided to the BOFs, and parts and labor costs are summarized and then compared to outside contract vendor costs for a similar unit repair. Central Shops continues to work closely with the BOFs to minimize downtime (less than 30 days) for campaign work.



## **METRO HAS A COMPREHENSIVE APPROACH FOR COMMUNICATING PERFORMANCE RESULTS**

- The annual business plan identifies initiatives, which are linked to specific departments and funded in the operating and capital budgets. Performance targets are derived from the business goals at the beginning of each fiscal year and include budget, accident, complaint, and service reliability targets. Performance against these initiatives is tracked through monthly performance reports and newsletters and Quarterly Management Reports.
- The Operations Department's monthly employee newsletter, *The METRO Starter*, provides METRO's status in goal attainment and results of performance indicators. Through reader-friendly graphs and tables, the publication indicates trends in goal-related indicators.
- Annual goals are set in consultation with METRO's President and CEO, in a bottoms-up approach. Departments draft goals and objectives during the budget development process and review them with the President and CEO. Quarterly Management Reports are developed by METRO'S Office of Management and Budget (OMB) to provide information for the Board and upper management that compares specific performance measures to established goals. Quarterly reviews are held at the Superintendent level by the Associate Vice President of Operations. At bi-weekly meetings, Superintendents track and report on assigned tasks, and informal meetings are convened if specific issues arise.
- Managers and Superintendents have access to interactive Dashboard reports, which include information used to manage costs. Monthly Dashboard Reports track service reliability, on-time performance, overtime, overtime cost, labor counts, attendance, commendations, complaints, bus counts, PMIs, roadcalls, service Interruptions, fuel use, accidents, and mileage information.

**METRO HAS A COMPREHENSIVE APPROACH FOR COMMUNICATING PERFORMANCE RESULTS (CONTINUED)**

- Each BOF develops its own daily reporting. Polk, for example, displays daily roadcalls for each BOF and cumulative totals near the mechanics' time clock. The feedback creates a sense of ownership for the results and competition with other BOFs.

## **METRO RECENTLY IMPROVED THE MAINTENANCE MANAGEMENT SYSTEM**

- In a recent initiative led by METRO IT staff, SEMA, the maintenance management system, was upgraded and replaced by SAP. The resulting user interface remains similar to the SEMA system for the end user, but it provides a more powerful reporting and data interface capability.
- SAP has the potential to manage information for decision support and METRO staff mentioned additional interface opportunities, to integrate data from several other sources, including fluid management, oil analysis, and roadcall Incidents. Additional data sets that could be interfaced with SAP include INIT, Vehicle Location and Scheduling (CAD/AVL), IVOMS, Automatic Passenger Counters (APCs), and Zonar (the on-board system for pre-trip inspections).
- Preventative maintenance inspection procedures are detailed and are documented in SAP. There are five maintenance mileage intervals: A = 6,000 miles, B = 12,000 miles, C = 24,000 miles, D = 48,000 miles and E = 96,000 miles. Quality Assurance (QA) follows up with periodic random inspections to ensure that PMs are completed on time.
- Repair actions are documented in SAP and a history of repairs is captured. If a component is under warranty, the action is flagged for QA review. When repairs are completed the actions are reviewed and closed by a maintenance supervisor. Work orders are also produced for parts issuance.

### **METRO RECENTLY IMPROVED THE MAINTENANCE REPORTING SYSTEM (CONTINUED)**

- The Maintenance reporting system tracks and flags warranty items for QA/Warranty review prior to filing claims. When a claim is appropriate, warranty parts are tagged and claims are submitted to the appropriate vendor. During the audit period, warranty claim values were credited to the appropriate Responsibility Center (RC), but during the audit site visit, staff explained that the practice has changed. Currently, warranty parts are credited to the parts account in the specific BOF, but cash adjustments are credited to a warranty account in Maintenance General and are no longer allocated to the appropriate RC, creating a potential disincentive for fully claiming parts warranties.
- The Maintenance reporting system is used to document transactions when components rebuilt by METRO are returned to shops for repairs and components rebuilt by vendors are returned to the appropriate vendor for claims.
- Maintenance reporting information makes it possible to review and update repair standards. Approximately 150 Standard Repair Times (SRT) are reviewed each year to set or update goals.

## **METRO STAFF ARE CONSIDERING WHETHER TO MODIFY SAP TO ALLOW SEAMLESS CONNECTIVITY WITH OTHER APPLICATIONS**

- METRO utilizes many Microsoft Excel spreadsheets to manage information that could be automated in reports from a common database source using SAP as the core. Many reports are issued daily, weekly, monthly, and quarterly, and METRO has improved the timeliness of important reports and provides good analysis of the information. If SAP reports were further developed, real time reports could be run by managers to access additional data on maintenance performance, efforts, and costs. A common transit database would improve METRO's ability to coordinate information and reports.
- As noted earlier, additional applications could be interfaced with SAP to increase access to integrated data for improved decision-making, including INIT, Vehicle Location and Scheduling (CAD/AVL), IVOMS, Automatic Passenger Counters, and Pre-Trip inspections (Zonar). SAP has the growth potential to manage information for decision support and METRO staff discussed improving the interfaces.

**METRO HAS TAKEN STEPS TO BECOME MORE EFFICIENT AND PRODUCTIVE SINCE THE 1997 MAINTENANCE AUDIT**

- METRO’s last quadrennial performance audit that included a maintenance focus was conducted in 1997, for the FY93-FY96 period. Based on the findings and recommendations of that audit, METRO has made notable progress in controlling costs and increasing productivity. The number of buses has been reduced and the number of maintenance staff assigned to each facility is lower.

<b>1996</b>	<b>West</b>	<b>Fallbrook</b>	<b>Hiram Clarke</b>	<b>Polk</b>	<b>Kashmere</b>	<b>BOF</b>	<b>Total</b>
Superintendent	1	1	1	1	1		5
General Foreman	1	1	1	1	1		5
Foreman	8	8	5	8	5		34
Mechanics	69	59	61	69	47		305
Service Workers	39	33	35	34	21		162
Service Writers	2	2	2	3	2		11
<b>Total</b>	<b>120</b>	<b>104</b>	<b>105</b>	<b>116</b>	<b>77</b>		<b>522</b>
Active Fleet	276	234	255	248	141		1154
Peak Fleet	225	192	217	193	110		937
Spare Ratio	22.7%	21.9%	17.5%	28.5%	28.2%		23.2%
Buses per Mechanic	4.0	4.0	4.2	3.6	3.0		3.8
Buses per Servicer	6.7	6.7	6.9	6.7	6.1		6.7

<b>2008</b>	<b>West</b>	<b>Fallbrook</b>	<b>Hiram Clarke</b>	<b>Polk</b>	<b>Kashmere</b>	<b>BOF</b>	<b>Total</b>
Superintendent	1	1	1	1	1		5
General Foreman	1	1	1	1	1		5
Supervisor	10	7	7	10	7		41
Executive Assistant	1	1	1	1	1		5
Mechanic	69	52	61	63	39		284
Elec Specialist	1	1	1	1	1		5
Cleaner	34	30	29	29	23		145
Toolroom Attendant	1	1	1	1	1		5
<b>Total</b>	<b>118</b>	<b>94</b>	<b>102</b>	<b>107</b>	<b>74</b>		<b>495</b>
Active Fleet	276	184	219	184	136		999
Peak Fleet	234	156	186	154	116		846
Spare Ratio	17.9%	17.9%	17.7%	19.5%	17.2%		18.1%
Buses per Mechanic	3.9	3.5	3.5	2.9	3.4		3.5
Buses per Servicer	8.1	6.1	7.6	6.3	5.9		6.9

- Productivity of Mechanics and Servicers is approximately the same overall, though comparisons by BOF show some notable variations.
- Systemwide, the spare ratio has been reduced from 23% to 18%.

**VEHICLE PRODUCTIVITY AND MAINTENANCE COST EFFECTIVENESS HAVE DECLINED SINCE THE LAST MAINTENANCE AUDIT**

- Over the same 12-year timeframe, service levels (i.e., revenue hours) have increased 11% and boardings have increased almost 8%, but total miles have been reduced by 13%:
  - The drop in vehicle productivity (miles per hour and per bus) is at least partially a consequence of increasing congestion on the streets of Houston.
  - Maintenance cost per mile increased 44% over the 12-year period, while the CPI grew by approximately 22%, about half the rate of the increase in cost per hour.
  - Boardings per hour, an indicator of service effectiveness, declined by less than 3%.

Directly Operated Bus Services	FY96	FY08
Total Miles	42,176,700	36,779,485
Revenue Hours	2,507,200	2,778,938
Active Buses (Directly Operated)	1,098	999
Peak Buses (Directly Operated)	915	846
Boardings	78,431,100	84,620,471
Miles per Hour	16.8	13.2
Miles per Bus	38,412	36,816
Maintenance Cost/Mile	\$1.16	\$1.67
Boardings per Hour	31.3	30.5

Source: FY96 data from NTD and 1997 Performance Audit

## **IV. RAIL MAINTENANCE REVIEW**

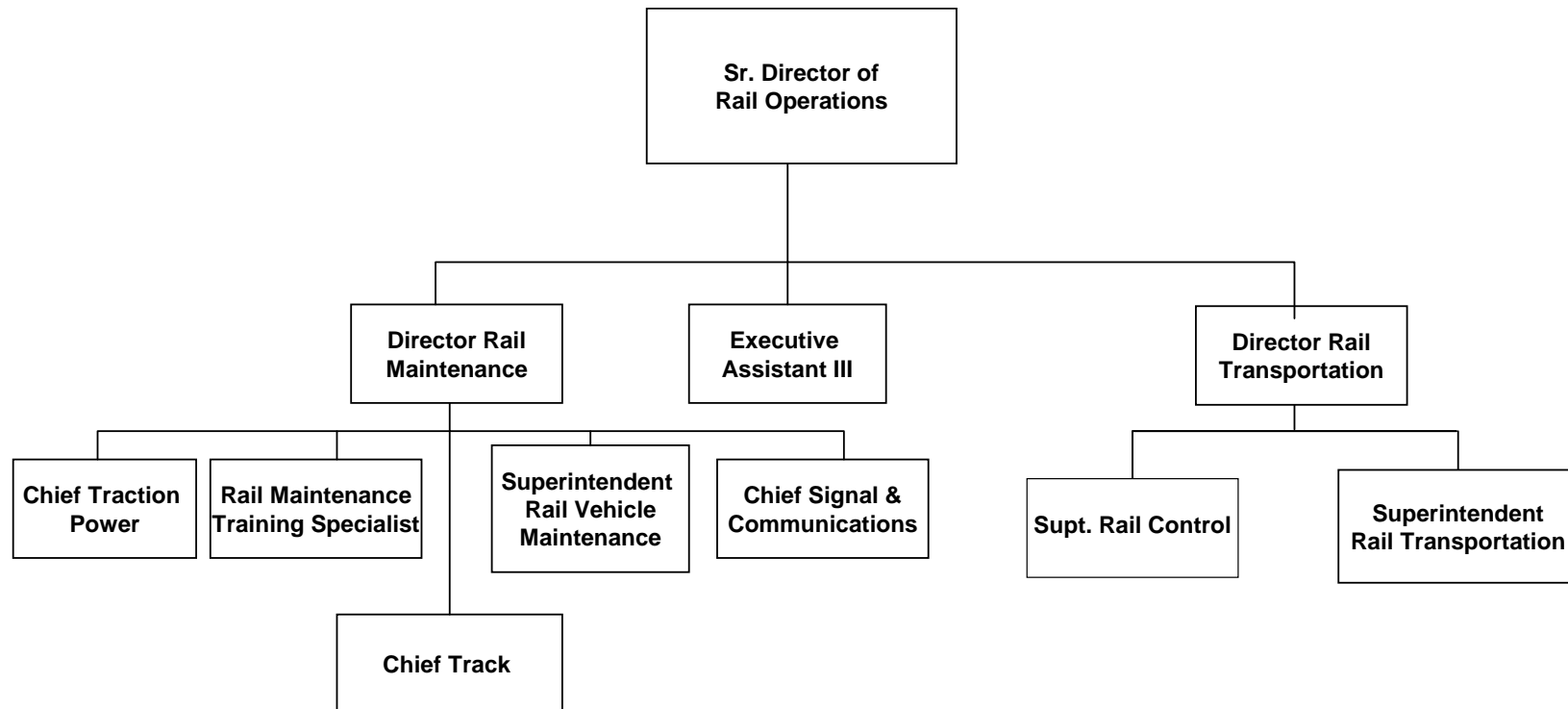


## **AT FIVE YEARS OF AGE, METRORAIL IS AN INTEGRAL PART OF METRO'S TRANSIT NETWORK**

- METRORail opened for revenue service on January 1, 2004. Using an 18-vehicle fleet, METRORail service operates seven days a week, from 4:30 am until after midnight on weekdays, and with later opening and closing times on weekends. Train headways range from 6 minutes on weekdays to 12 minutes on weekends and 20 minutes in the late evenings.
- METRORail's single line runs for 7½ miles, from UH-Downtown at the north end, through downtown Houston, the Museum District, Medical Center complex, and Reliant Park, to Fannin South. There are sixteen stations (some with parking), including several transit centers that allow easy connections with bus routes. The line is at-grade double-tracked, with crossovers at various locations. Except at end-of-line stations, interlockings are mostly manually controlled.
- METRORail has one operations and maintenance facility (the Rail Operations Center, or ROC), where maintenance and cleaning activities occur 24 hours/day, seven days/week. There are ten traction power substations and various communications and signaling structures. Vehicle and wayside maintenance are scheduled so that revenue operations will be minimally impacted.
- The Rail Control Center (RCC), located at the TranStar facility, controls all mainline activities and wayside access. The RCC is connected to all METRORail facilities by a fiber optic ring network, and houses the two Siemens servers for signaling, power, and support facilities. One of the servers is a backup. Rail Controllers are in direct contact with LRV Operators, Rail Field Supervisors, and maintenance crews on the wayside, and can monitor train locations via the Siemens IBIS Train-to-Wayside Communications (TWC) system. There is currently no backup RCC.

## METRORAIL IS ORGANIZED TO ACCOMPLISH ITS TRANSPORTATION AND MAINTENANCE RESPONSIBILITIES

- METRORail is led by the Senior Director, Rail Operations, who reports to METRO’s Senior Vice President, Operations. METRORail’s maintenance and transportation responsibilities are each led by a director. Both directors report to the Senior Director, Rail Operations.



- METRORail does not have its own Safety section. All METRO System Safety personnel work in METRO’s Department of Public Safety, which is a direct report to the President and Chief Executive Officer. The previous performance audit recommended that the Safety Manager be moved from Operations and that the position should report to the CEO.

## **RAIL MAINTENANCE IS RESPONSIBLE FOR MAINTAINING VEHICLES, SIGNALS & COMMUNICATIONS, TRACTION POWER, AND TRACK**

- METRORail's management team, which has been drawn from rail transit systems around the country, has established a skilled maintenance team that works closely with the transportation team to deliver reliable light rail service.
- METRORail currently has 149 authorized positions: four in Administration (including the Senior Director of Rail Transportation and the Directors of Rail Maintenance and Rail Transportation), 78 who report to the Director of Rail Transportation and 67 who report to the Director of Rail Maintenance. All staff are full-time employees.
- The Director of Rail Maintenance is responsible for five areas:
  - Rail Vehicle Maintenance, which provides preventive and corrective maintenance and interior and exterior cleaning for the rail vehicle fleet
  - Signals & Communications, which supports METRORail's communication and computer equipment and provides programming support for the M4 maintenance management system, training and METRORail's Intranet
  - Traction Power, which provides preventive and corrective maintenance for the overhead power system and substations
  - Track, which provides inspections and preventive and corrective maintenance for the track and roadbed
  - Training, which provides training for maintenance personnel, supports maintenance system safety, and test job applicants to ascertain their technical aptitude and experience.

**MAINTENANCE STAFFING INCREASED TO 68 WITH THE TRANSFER OF TRACK MAINTENANCE**

- METRORail Maintenance’s 68 staff persons are distributed across five functional groups:

METRORail Maintenance	Authorized Positions
Director	1
Rail Vehicle Maintenance	37
Signals & Communications	11
Traction Power	10
Track	7
Training	2
Total	68

- The authorized staffing level was virtually constant from FY05 through FY07, at 60-61 positions. In FY08, when the Track section was transferred to METRORail, the maintenance workforce increased to 68 positions. At the end of 2008, all budgeted maintenance positions were filled with the exception of two Track workers, which were being filled.
- Of the 149 METRORail positions, 77 are represented by the Transport Workers Union (TWU). The current TWU contract which includes both maintenance and transportation workers, expired on August 1, 2008. Negotiations were continuing at the time of the audit site visit; a contract was ratified by METRO’s Board on February 19, 2009.
- Of the 68 budgeted Maintenance positions, the 25 represented by the TWU are all in Rail Vehicle Maintenance. They include Servicers (7), Technicians (15), Body Mechanics (2), and Machinists (1). Maintenance positions unique to rail (e.g. those in Track, Power, and Signals & Communications) are salaried and are not represented by the TWU.
- The METRORail shop storeroom, which operates 24/7, is staffed and run by METRO’s Procurement Department, as are METRO’s bus storerooms.

**THE SIZE, AGE, AND RELIABILITY OF THE RAIL SYSTEM ENABLE ITS RELATIVELY LOW MAINTENANCE STAFFING LEVELS**

- METRORail’s maintenance structure and staffing levels appear to be appropriate for the age and size of its infrastructure and fleet. With only 18 revenue vehicles and 7.5 miles of double-track mainline, METRORail does not employ specialists to work exclusively on a component or subsystem. All technicians are trained to diagnose and repair all equipment in their discipline.
- The ratio of light rail vehicles to mechanics is 0.8 across the rail vehicle maintenance division. The ratio of vehicles to servicers is 2.6:

Rail Vehicle Maintenance	Authorized Positions	LRVs per Position
LRV Body Mechanic *	2	9.0
LRV Technician *	15	1.2
LRT Machinist *	1	18.0
LRV Electronic Specialist	4	4.5
Subtotal	22	0.8
Light Rail Servicer	7	2.6
Total	29	0.6

\* Represented position

- With the relatively small size of the METRORail operation, supervisory ratios are also low, ranging from 5.0 in Track to 3.0 in Signals & Communications and Traction Power, and averaging 3.9:

METRORail Maintenance	Supervisors /		Supervisory
	Leads	Maintainers	Ratio
Rail Vehicle Maintenance	5	22	4.4
Signals & Communications	2	6	3.0
Track	1	5	5.0
Traction Power	2	6	3.0
Total	10	39	3.9

**FILLING SOME POSITIONS HAS BEEN DIFFICULT, AND TURNOVER IN SKILLED POSITIONS IS A CONCERN**

- One of METRORail’s challenges has been hiring and retaining skilled workers, especially in Traction Power and Signals & Communications. Turnover in those areas is attributed primarily to opportunities to earn higher wages at local utilities and in the oil and gas industry.
- The positions of Chief, Track and the Rail Maintenance Training Specialist were filled late in the audit period, closing significant gaps in METRORail management staffing. Significant progress has been made in both track maintenance and training since these positions were filled:
  - Track staff have increased both track inspections and the preventive maintenance schedule and corrected pre-existing alignment problems. The track is now greased daily and it was recently ground for the first time. Two authorized track maintenance positions are being filled and more mentoring is being provided for track maintenance staff.
  - Additional training modules are being added to the system that was recently installed by the new training manager. Rail Maintenance Training also works with each maintenance group to test job applicants to ascertain their technical aptitude and experience in the discipline for which they are applying.

## **STAFFING LEVELS ARE ALSO MANAGED THROUGH OVERTIME AND OUTSOURCING**

- METRORail's maintenance employees work an average of 10% overtime each week. Given the labor and benefit costs of an additional position, this level of overtime is more cost-effective than increasing staffing levels, and provides flexibility to adjust to fluctuating workloads.
- Some LLRU (lowest level replaceable unit; e.g., circuit boards) repair is performed in-house, while some is sent to the manufacturer. METRORail also contracts out work that would not be cost-effective to perform in-house, such as wheel pressing, seat repair, rail inspection/grinding, and some overhead line work. The maintenance of radios, fare collection equipment, and station facilities is handled by other METRO departments, as is fare enforcement.

**MAINTENANCE SETS AND UPDATES ITS PERFORMANCE GOALS AS EXPERIENCE IS GAINED, AND GENERALLY MEETS ITS ESTABLISHED GOALS**

- METRORail has been defining performance indicators and establishing performance targets since it first opened for service in January 2004. Many of the targets have been changed as experience was gained during the first five years of operation. For example, the LRV target for miles between roadcalls, which was 10,500 miles in FY06, was reduced to 10,000 miles in FY07 and to 6,000 miles in FY08. Encouragingly, the METRORail achieved 13,182 miles between roadcalls in September 2008, at the end of the audit period.
- METRORail met most of its major performance targets in FY08. Except for LRV miles between service interruptions (SI) and LRV miles between roadcalls, most targets were also met in previous years. The targets for those two indicators were reduced for FY08.

**METRORail PERFORMANCE INDICATORS**

	FY05	FY06	FY07	FY08	FY08 Goal*
On-time percentage	98.55	98.62	98.4	96.54	96
Complaints/100k riders	1.4	0.52	0.27	0.28	1.2
LRV cost/mile	N/A	\$2.24	\$2.23	\$2.35	\$2.35
LRV miles between road calls***	4,072	3,472	5,079	6,935	6,000
LRV miles between SI	10,589	9,984	11,273	20,050	12,500
S&C avg. SIs per month	} 3.0**	3.5	3.3	2.08	5.0
Track avg. SIs per month		0.67	N/A	0.83	0.5
Power avg. SIs per month		1.25	0.5	0.0	0.58
* Many of METRO Rail's goals were changed during the audit period, based on experience with the new system					
** For FY05, all Maintenance-of-Way SIs were combined into one number					
*** LRV miles between road calls from OMB database and audit period performance indicators					

Source: METRORail Performance Statistics, September 2005 - September 2008, OMB database



**VEHICLE-CAUSED SERVICE INTERRUPTIONS ARE TRACKED AND HAVE IMPROVED OVER THE AUDIT PERIOD**

- Although earlier targets were not met and were lowered after FY06, performance results for vehicle miles between SIs and vehicle miles between failures have improved significantly over the past three years.
- The number of vehicle-caused SIs increased in FY06 over FY05, but has since been reduced by half. Most major vehicle systems have shown major improvement from FY06 to FY08 (data by system was not available for FY05). Although Auxiliary Electric and Trucks both increased as causes of service interruptions in FY08, both are still within reasonable limits.

**VEHICLE-CAUSED SERVICE INTERRUPTIONS BY SYSTEM**

System	FY05	FY06	FY07	FY08
Coupler	N/A	11	7	3
Doors	↓	39	24	15
Auxiliary Electric		0	0	3
Propulsion		11	15	2
Pantograph		0	6	1
Trucks		1	1	5
Friction Brakes		22	14	13
Cab Equipment		3	3	1
Total of these systems	N/A	87	70	43
Total of all systems	81	91	82	46

Source: METRORail Performance Statistics, September 2005 - September 2008

## **DOOR AND FRICTION BRAKE SYSTEMS ACCOUNT FOR 34% OF VEHICLE-CAUSED SERVICE INTERRUPTIONS**

- Over time, METRORail's monthly performance reporting has been more detailed. For example, prior to FY08, METRORail reported service interruptions by system, but not failures by system. In FY08, the greatest number of failures by system were Doors (19%), Friction Brake (15%), Cab Equipment (13%), Propulsion (12%), and Trucks (11%). All other system failures accounted for 10% or less of total failures. A fleet-wide campaign to replace pressure switches in the friction brake system is expected to reduce that system's high failure rate, but door problems continue to be an issue.
- At the end of FY08, the primary deficiency with vehicles was with the Door Controller Unit (DCU), with 33% of service interruptions and 19% of vehicle failures in FY08 being attributed to the door system. Overcrowding also exacerbates door failure problems and the number of failures has recently reached a level that would have triggered fleet-wide corrective action by the supplier, but did not reach this point until after the warranty on the door system had expired. METRORail is currently in discussion with Siemens, the vehicle supplier, regarding this problem. Otherwise, there are currently no open issues with Siemens regarding the vehicles, and the contract is essentially closed out.

**SERVICE INTERRUPTIONS ATTRIBUTED TO OTHER MAINTENANCE DIVISIONS ARE DECLINING – OR STEPS HAVE BEEN TAKEN TO ADDRESS THEM**

Service Interruptions	FY05	FY06	FY07	FY08	FY08 Goal
S&C Average per Month	3.00	3.50	3.30	2.08	5.00
Track Average per Month		0.67	N/A	0.83	0.50
Power Average per Month		1.25	0.50	0.00	0.58

- Once some initial overhead line problems were corrected, the Traction Power system has been very reliable, as has Signals & Communications. There are no operating penalties if one Traction Power substation is out-of-service, facilitating weekly substation inspections. In FY08, corrective maintenance required 27% of S&C labor time, and only 2% of Power labor time, while PM’s required 29% and 55%, respectively.
- Service interruptions attributed to Track problems were somewhat deficient in FY08. After the Track Department was brought into METRORail in FY08, a new Chief of Track was hired, at which time inspection and maintenance activities were significantly enhanced and some long-term track problems were corrected. The PM schedule has been increased, the entire line is now inspected by foot twice per week, curves are greased daily, and rail grinding is to be conducted at least once every three years. In FY08, corrective maintenance was responsible for only 1% of Track labor time, with PM’s and PM Repairs taking 85%.
- Overall, these indicators are encouraging. However, METRORail is still relatively new. Most of the initial bugs have been corrected, and none of the equipment is old enough to be wearing out. The importance of performance monitoring is demonstrated by the need for METRORail management and maintenance managers to remain vigilant for changes in failure rates that could impact reliability or performance.

### METRORAIL ON-TIME PERFORMANCE DECLINED SLIGHTLY IN FY08, BUT REMAINED ABOVE GOAL

- METRORail’s on-time performance has remained above the goal for the audit period:

	FY05	FY06	FY07	FY08	FY08 Goal
On-Time Performance (%)	98.55	98.62	98.40	96.54	96

- METRORail’s algorithm for calculating on-time performance requires only that a train be no more than one minute early or five minutes late *leaving* its departure station. En-route delays, or any departure delays due to factors outside METRORail’s control, are not counted.
- The on-time percentage would be more meaningful if en-route delays were factored into the calculation. Indicators should match the standards set for METRO’s bus operation, although the performance targets could be different.

**METRORAIL IS FORECASTING MAINTENANCE EXPENSES MORE ACCURATELY THAN WHEN IT STARTED OPERATING FIVE YEARS AGO**

- Total maintenance costs for METRORail, including labor and parts, varied widely during the audit period, and the difference between budget and actual expenses was initially significant. Changes in the labor force and inaccurate budgeting of parts contributed to this variability. The system first opened in FY04, and it has understandably taken some time for METRORail to stabilize its anticipated budget and correlate it with actual costs. Early periods of staff shortages, reductions in contract support services, and aggressive warranty reimbursements contributed to expenses being significantly under budget in FY05 and FY06. Over the last two years, budget variances have dropped to more reasonable levels.

**METRORail Maintenance Budget and Expenses**

	FY05	FY06	FY07	FY08
Budget, not incl RC 0681	\$6,858,589	\$6,995,685	\$7,218,752	\$7,563,735
Actual, not incl RC 0681	\$6,003,562	\$5,347,368	\$7,055,619	\$7,827,061
Budget, RC 0681	\$428,395	(\$189,007)	(\$4,031,995)	(\$4,150,116)
Actual, RC 0681	(\$434,757)	(\$112,811)	(\$4,140,849)	(\$4,703,799)
Budget, Net	\$7,286,984	\$6,806,678	\$3,186,757	\$3,413,619
Actual, Net	\$5,568,805	\$5,234,557	\$2,914,770	\$3,123,262
Variance, Net Budget	\$1,718,179	\$1,572,121	\$271,987	\$290,357

Source: Sep05-0600-Rail-ADI.XLS through Sep08-0600-Rail-ADI.XLS

- RC 681 (Rail General) recognizes reimbursements for subrogation recovery, cost recovery for right-of-way support activities, and capitalized operating expenses, reducing out-of-pocket costs of maintaining METRORail. Credits for Capitalized Operating Expenses credits represent FTA Section 5307 funds that are available for labor and non-labor costs of preventive maintenance, but there is no guarantee that they will continue in the future and an evaluation of the full cost of METRORail maintenance should exclude these credits.

**SOME REPORTING PRACTICES MADE EVALUATION OF METRORAIL COSTS DIFFICULT**

- METRORail operating costs dropped in FY06, but have increased annually since then, and by 14.7% overall, as positions have been filled, warranties have expired and contract support services have been reduced. At the same time, service levels (i.e., revenue miles) have remained relatively flat, fluctuating by less than 1% annually, and total miles have increased 8%:

METRORail	FY05	FY06	FY07	FY08	% Change
Total Operating Cost	\$18,329,310	\$17,640,564	\$19,357,053	\$21,030,633	14.7%
Total Maintenance Cost	\$6,003,562	\$5,347,368	\$7,055,619	\$7,827,061	30.4%
Revenue Miles	786,778	794,587	794,603	789,307	0.3%
Total Miles	855,130	906,240	924,350	922,322	7.9%
Operating Cost / Revenue Mile	\$23.30	\$22.20	\$24.36	\$26.64	14.4%
Maintenance Cost / Total Mile	\$7.02	\$5.90	\$7.63	\$8.49	20.9%
Maintenance % of Rail Costs	32.8%	30.3%	36.4%	37.2%	13.6%

- From FY06 through FY08, maintenance costs have accounted for an increasing share of total costs, rising from approximately 30% in FY06 to about 37% in FY08. Over the same period, maintenance cost per total mile increased 20.9% as the growth in costs exceeded the growth in total miles operated, and operating cost per revenue mile increased 14.4% since FY05. These two indicators of service efficiency exceeded the 8.9% growth in the CPI from FY05 through FY08.
- The audit team was not able to undertake an analysis of maintenance work hours vs. labor costs because METRORail’s maintenance labor hour data (including absences and overtime as well as productive time) were not available, reportedly because many of the positions are salaried. This is indicative of the newness, evolution, and lean nature of METRORail’s management team, but needs to be addressed.

**METRORAIL'S MAINTENANCE GOALS AND OBJECTIVES FOR FY09 TARGET CONTINUED PERFORMANCE IMPROVEMENTS AND SOME COST REDUCTIONS**

- Provide 16 vehicles for daily service.
- Detail 18 vehicles/month.
- Increase the vehicle MDBSI and continue with the same vehicle MDBF.
- Reduce LRV parts budget by 15%.
- Provide 99.9% track availability.
- Provide 98% S&C availability.
- Provide 99% traction power and OCS availability.

## **METRORAIL IS CHALLENGED TO INCREASE CAPACITY**

- METRORail operates a fleet of 18 Siemens S70 light rail vehicles and typically has 16 vehicles in service on weekdays. With ridership already at 2025 forecast levels and as much of the fleet in service as possible, there are few ways to increase capacity without significant additional capital investment.
- METRORail generally puts 16 of its 18 vehicles (89%) into service on weekdays, but with a 12-train schedule, only four trains have two cars. The remaining eight trains operate with a single car. Station lengths in the downtown area preclude lengthening trains beyond two cars, and headways could only be reduced to 4.5 minutes from the current 6 minutes before causing street gridlock.
- METRORail reworked the traffic signal preemption on Main Street, which reduced the end-to-end running time from 32 minutes to 29 minutes, and the number of trains required to operate the service from 13 to 12. As a result, it was possible to lengthen two trains and increase capacity, but no further significant run-time enhancements are feasible.
- METRORail has proposed a weekday schedule of eight 2-car trains running on 9-minute headways, which would provide somewhat more passenger capacity per hour than the current schedule of 1- and 2-car trains on 6-minute headways, but a decision has not been reached on implementing the proposal, due to concerns about increasing headways by 50%.



**CAPACITY CONSTRAINTS HAVE IMPACTED SERVICE DELIVERY – AND RIDERSHIP**

- METRORail’s capacity limitation has contributed to stagnation of ridership and vehicle miles for most of the audit period. Passengers per revenue vehicle mile, an indicator of service effectiveness, illustrates the effect of these capacity constraints. As revenue vehicle miles of service flattened out after FY06, passengers boardings did as well. Ridership increased 11% FY06, and although it has continued to grow since then, it was by much smaller amounts.

	FY05	FY06	FY07	FY08	% Change FY05-FY08
Unlinked Passengers	10,233,638	11,333,099	11,708,959	11,799,700	15.3%
Year-over-year % change		11%	3%	1%	
Revenue Vehicle Miles	786,778	794,587	794,603	789,307	0.3%
Year-over-year % change		1%	0%	-1%	
Passengers per Vehicle Mile	13.0	14.3	14.7	14.9	14.9%
Year-over-year % change		10%	3%	1%	

- Rail management believes that another 15 light rail vehicles could be used effectively to reduce headways, run two-car trains, and increase the spare ratio to make more cars available for maintenance. The existing maintenance facility, but not the existing staffing levels, could support a larger fleet. However, the acquisition of new vehicles appears to be unlikely until the light rail expansion being designed by METRO Solutions takes place.

**METRO CONTINUES TO ADDRESS THE TRAFFIC ACCIDENTS THAT ARE METRORAIL’S MAIN SAFETY CONCERN**

- In the five years of METRORail operations, there have been one fatality (a driver who ran a red light into a train) and a few serious injuries. Automobile drivers should be accustomed to METRORail’s presence, but after dropping in FY07, the number of traffic accidents increased FY08. Investigation showed that only two of the FY08 accidents could have been prevented by the LRV Operator.

	FY05	FY06	FY07	FY08
Traffic Accidents **	41	43	37	52
Vehicle Accidents	34	38	30	43
Preventable Traffic Accidents	3	1	0	2
Employee Accidents *	N/A	2	0	5.54

\* per 200,000 hours. FY06 entry is actual number for the year.  
 \*\* Traffic accidents from OMB data base and performance audit period performance indicators.

- METRO owns the traffic signals along much of the rail corridor and, in coordination with METRO’s Traffic Control Department and the City of Houston, has been reprogramming traffic signals in an effort to mitigate traffic accidents. After the signals were retimed in January 2008, METRORail experienced 19 left-turn accidents in the Central Business District. In November 2008, METRO modified the timing at some of the twenty intersections on Main Street between Pierce and Commerce streets to give green signals to the LRVs before they are given to automobiles. Since this retiming, no left-turn accidents have occurred in this area. Experience gained here will be applied elsewhere on the rail corridor, including the Texas Medical Center area, as appropriate.

## **METRO ADDRESSES ACCIDENT PREVENTION THROUGH ENGINEERING, EDUCATION AND ENFORCEMENT**

- In addition to the technical solutions that have been implemented, which also include flashing red in-pavement lights at intersections and enhanced traffic light fixtures, driver education is being provided through the media and other means, and officers have been assigned to problematic intersections to cite drivers who violate traffic signals.
- All employees received initial and periodic safety training and testing. Toolbox safety meetings for maintenance personnel take place on a regular basis.
- All contractor employees who work along the right-of-way receive safety training and testing. METRO regularly performs field checks to ensure that all contractor employees are safety certified.
- The number of employee accidents is well within the OSHA-mandated goal of 10.4 per 200,000 hours.
- Although METRORail has not established goals for the total number traffic accidents, annual goals have been set for the number of rail accidents.

## **METRORAIL ADHERES TO PREVENTIVE MAINTENANCE SCHEDULES FOR VEHICLES AND FIXED EQUIPMENT**

- Having just completed five years in service, METRORail and its equipment and infrastructure are still relatively new and most of the system is still highly reliable. Most of the initial vehicle defects have been corrected (under warranty), and the infrastructure is stable. As a result, a high percentage of maintenance work is preventive maintenance (e.g., in FY08, corrective maintenance accounted for only 13% of Vehicle Maintenance labor hours).
- METRORail has a stringent PM program for all of its vehicles and fixed equipment, and no faults were found with METRORail's adherence to its PM program. PM Work Orders are automatically generated by M4. Vehicles are scheduled for PMs every 5,000 miles, +/- 500 miles, which is somewhat more frequent than what was specified by Siemens. In FY07 and FY08, vehicles averaged fewer than 5,000 miles between PM. There are four different PM levels (5k, 10k, 20k, and 60k miles), which take 32, 34, 53, and 77 person-hours, respectively, to perform. The vehicles operate approximately 60,000 miles/year, resulting in one full PM cycle per vehicle per year. All but one vehicle has accumulated about 250,000 miles during the first five years of service.
- Due to the small fleet and the need to keep all vehicles in service to the maximum extent possible, Maintenance managers work closely with Transportation to spread the vehicle mileage and to ensure that no more than one vehicle requires preventive maintenance at the same time.
- PMs and inspections for wayside fixed equipment are scheduled and performed weekly, bi-weekly, monthly, quarterly, and annually.

## **METRORAIL USES MAXIMUS M4 TO SUPPORT ITS MAINTENANCE OPERATIONS**

- METRORail has effectively embraced IT processes throughout its maintenance practices. In-house staff actively develop IT enhancements to benefit the various maintenance departments.
- METRORail uses the Maximus M4 Maintenance Management system, while the rest of METRO uses SAP. This distinction does not cause significant trouble for METRORail, since the only real interface between the two systems is in the Storeroom, which is managed by the Procurement Department. However, an integrated IT solution will become important when the light rail network is expanded.
- Characteristics of METRORail's implementation of M4 include:
  - Enhancements to M4 to support Track, Power, and Signals & Communications
  - Use of M4 and Oracle reporting tools to generate management reports
  - Automatically generated Work Orders, based on parameters input by technicians and managers, including failures and time and/or mileage since the last PM. All vehicle work is inspected and signed off by a Maintenance Supervisor, and the Superintendent ensures that the process has been properly completed and all relevant data are entered into M4.

## **METRORAIL HAS ESTABLISHED SOME INNOVATIVE MAINTENANCE PRACTICES THAT HAVE PROVED VERY EFFECTIVE**

- METRORail has established a very effective Intranet for its maintenance and training staff, which contains all plans, procedures, drawings, schematics, and other relevant documents. Computer “kiosks” located throughout the ROC give vehicle technicians full access to M4 and the Intranet. Ethernet ports at all remote facilities provide similar network access to field technicians. File updates are performed as needed and records are kept, but there is no formal file naming or numbering convention at this time, which could lead to confusion as the system and quantity of documents grows. A more formal Document Control process could address this concern.
- Under a Department of Homeland Security (DHS) program, METRO has successfully instituted the Zonar fleet management system on its bus and rail vehicles to track inspection and work activities of both maintenance and transportation personnel. This system uses portable transponders and Radio Frequency Identification (RFID) tags on the vehicles to log staff inspections.

**WHILE METRORAIL CURRENTLY HAS NO PROBLEMS PROCURING PARTS, IT HAS BEEN PROACTIVE IN ADDRESSING POTENTIAL PARTS SHORTAGES**

- METRORail currently has no problems with parts shortages. Parts inventories are maintained on Stores' SAP system, which can automatically generate purchase requisitions through Procurement. METRORail administration monitors purchases to ensure timely ordering of long lead-time items and those that exceed the \$25,000 METRO management approval limit.
- There is also no problem with parts obsolescence. Siemens was not required to deliver schematics or parts lists for much of their proprietary equipment, but such documentation is in escrow.
- METRORail participates in the S70 User's Group, comprised of all North American operators of the Siemens S70 light rail vehicle (currently six agencies). The group meets semiannually, and actively exchanges their experiences and, when necessary, parts and resources.

## **METRORAIL HAS UNDERTAKEN SEVERAL INITIATIVES TO ENSURE CONTINUATION OF A HIGH QUALITY OPERATION**

- A Maintenance Training Specialist who previously worked for Siemens was recently hired to run METRORail's maintenance training program. He has enhanced the documentation, instituted a training program for all four maintenance disciplines, and initiated the "METRO Learning Center" using computer-based training. Employees now participate in a "Learning Management System," in which their maintenance competency is regularly demonstrated to their supervisors, who maintain records of each employee's skills.
- An ongoing wheel replacement project is 85% complete. A brake overhaul program is due to commence in February 2009, at about the 250,000 mile mark on most of the vehicles.
- A new GPS/AVL system is being tested on the vehicles, which could potentially replace the existing TWC loop system, providing more functionality and requiring less maintenance.
- In FY09, track switch machines will be replaced and generators will be installed at two signaling sites to provide uninterrupted power at critical interlockings and enhance reliability of wayside equipment.
- METRORail is currently on METRO's 800 MHz trunked radio system, which is shared with the bus operation, but would like to get on the more reliable Harris County radio network. METRORail management, in conjunction with METRO Police, is working to reprogram a grant and obtain \$800,000 to convert to the Harris County network. As of the end of FY08, METRORail has about 50% of the required funding in hand, and management is optimistic that sufficient funds will become available to complete the project.



**METRORAIL PLANS TO PERFORM ANNUAL COMPONENT OVERHAULS RATHER THAN ONE-TIME MID-LIFE VEHICLE OVERHAULS**

- For the long term, rather than schedule a mid-life overhaul of its vehicles, METRORail anticipates addressing different vehicle systems in each of the upcoming years. A tentative schedule has been created, looking forward to FY16:

Fiscal Year	Component(s)
2009	Auxiliary Power Brakes and Suspension
2010	Brakes and Suspension (continued)
2011	Doors
2012	Auxiliary Power Doors (continued) Couplers Articulation Traction Motors and Gearbox Center Truck Wheels
2013	Auxiliary Power HVAC Event Recorder Center Truck Wheels (continued)
2014	High Speed Circuit Breaker Journal Bearings / Power Truck Wheels
2015	Brakes and Suspension
2016	Auxiliary Power Traction Motors and Gearbox

- It is not yet known what the implications of eliminating a mid-life vehicle overhaul will be. However, the planned acquisition of more than 100 new LRVs to support METRO Solutions will become a factor in any long-term decision about the disposition of the current vehicle fleet and plans for its overhaul.

## **SOME OPPORTUNITIES TO FURTHER IMPROVE METRORAIL'S USE OF INFORMATION TECHNOLOGY WERE IDENTIFIED**

- METRORail has committed to M4 for its maintenance management system and has procured the RailFocus module, which is a rail asset management system. The module has not been implemented, due in part to the small size of the current rail network. An asset management system will be required as METRORail is extended, although RailFocus may not be the best choice since it would not provide integration with SAP.
- Some aspects of METRORail's implementation of M4 could be improved:
  - Although M4 does not provide automatic support for warranty claims, which are performed manually, it does have a warranty application, which METRORail uses.
  - Work Order labor hours are tracked, but there is no correlation between Work Orders and timesheet data. Linking the two would increase METRORail's ability to perform cost analysis at the employee level. Inasmuch as METRO is replacing its HR system and plans to replace the payroll system, the ability to link or compare data in the two systems could be considered.
  - Serial numbers are entered manually on M4 and there is an on-going initiative to provide serial numbers for more parts types. METRORail does not barcode serialized parts, but may consider doing so as the system grows and ages.
- The SAP software used by METRO'S bus maintenance operations also does not provide the work order and bar coding capabilities noted here. And although it does not interface with the warranty application used in bus maintenance, the recent SAP upgrade provides data access through integrated spreadsheet downloads of maintenance and inventory data.

## **METRORAIL IS FACING SOME CHALLENGES THAT WARRANT FURTHER DISCUSSION**

- Backup transit Control Centers have become highly favored in the post-9/11 environment, but METRORail currently has all of its RCC equipment at the TranStar facility, which is not on the METRORail alignment. Although TranStar is a very secure facility, it could become unusable to METRORail if either the facility itself, or its fiber-optic connection to METRORail, were disabled. Both Siemens servers, which monitor and control both Signaling and Power/Support equipment, are located at TranStar. METRORail S&C staff, who must currently respond to the RCC if any maintenance issues arise there, indicated a legitimate desire to move one of the Siemens servers to the ROC, which would be a simple activity and would still provide an on-line/ backup configuration that would support workstations at any location on the fiber-optic ring.
- METRORail's test track has been out of service for several years. Located along the Union Pacific Railroad mainline near the ROC, it has not been used since a METRORail vehicle collided with a Union Pacific maintenance truck. Currently involved in litigation, its restoration to service – or a new track to replace it – would benefit maintenance and prove invaluable when new vehicles are delivered under METRO Solutions Phase 2.

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## **V. MAINTENANCE INFORMATION SYSTEMS**

## **INFORMATION TECHNOLOGY IS ORGANIZED AROUND A BUSINESS SERVICE MODEL THAT EMPHASIZES THE AVAILABILITY OF INFORMATION**

- Information Technology (IT) is recognized as a strategic partner to assist departments in meeting METRO's performance goals. The Chief Information Officer (CIO) reports directly to METRO's President and CEO, which is indicative of the priority METRO places on IT.
- IT management has assigned staff to oversee key applications and systems including SAP, Oracle, and IVOMS, that are critical to maintenance data processing needs. IT also supports end users' access with a combination of standard reports, custom reports, and ad-hoc reporting tools that were in evidence during the course of the performance audit.
- The IT Department Disaster Recovery and Business Resumption Plan (August 2008) is in place and covers critical computing needs to support METRO's bus and rail maintenance activities. A remote site is under contract and ready to migrate mission critical applications in the event of a disaster, to minimize the impact on critical business functions that may suffer by excessive delays in data processing support. The disaster plan includes key maintenance applications by priority:
  - Tier 1: Data radio, satellite phones, cell phones, handhelds, Internet, e-mail, and Network Drives
  - Tier 2: SAP for daily maintenance, inventory and parts
  - Tier 3: Oracle Financials and Purchasing.
- Disaster Recovery and Business Resumption Plan lists the SAP application that is used by bus maintenance, but does not identify the Maximus M4 application used by rail maintenance.

## **A MAJOR IT ACCOMPLISHMENT WAS THE REMEDY OF MAINTENANCE USERS' DISCONNECT WITH THE SEMA VOYAGER APPLICATION**

- IT led the effort over the past two years to restore confidence and get maintenance buy-in to a major upgrade to SAP, effectively resulting in a new maintenance and inventory system that was deployed with the “Get Well” initiative:
  - SEMA Voyager, the product METRO previously used, had undergone two owner changes, did not effectively meet the needs of maintenance business processes, and was outdated due to the lack of upgrades over time.
  - IT determined that an SAP upgrade, with METRO the license holder, could provide expanded functionality, improved infrastructure, and flexibility to fix the problems with SEMA and also provide growth potential for future improvements.
- The key to the success of the SAP upgrade was IT’s facilitation and support of business process evaluation and re-engineering efforts, which ensured that the maintenance users’ defined needs were met and that the system worked:
  - Also critical to success was the IT-directed configuration and setup of the upgraded system based on maintenance requirements
  - In addition to supporting the SAP system, IT dedicates SAP support to the maintenance community and regularly meets with maintenance designees to improve, expand, and enhance the SAP implementation.
- Looking forward, IT needs to review the functionality and many new capabilities of the SAP upgrade and share their findings with maintenance staff to match with their needs for continued system improvements.

## **THE IT DEPARTMENT IS COMMITTED TO SUPPORTING USERS AND PROVIDING SYSTEM SUPPORT FOR MEASUREMENT OF METRO'S PERFORMANCE INDICATORS**

- IT provides dedicated support to IVOMS with respect to data maintenance and troubleshooting assistance for data used in calculating performance indicators, including:
  - Automated passenger count data collected from all revenue vehicles, which are used to generate ridership numbers and require IT support for the tremendous amount of data generated
  - On-time performance data that are captured and stored for historical purposes from all revenue vehicles.
- Dedicated IT staff support mileage capture, accumulation, and aggregation, which are important to calculating many performance indicators. They support the validation of daily automated data processing into the enterprise system and assist operations when problems are encountered with mileage data processing.
- In addition, the recent SAP upgrade design includes data access through integrated spreadsheet downloads of maintenance and inventory data for data analysis by business analysts throughout METRO.
- During audit discussions, maintenance staff expressed the interest in replacing the manual process for recording vehicle mileage with remote communications to improve accuracy and reduce the labor required to capture and validate data.

**ALTHOUGH MAXIMUS M4 SOFTWARE MEETS THE CURRENT NEEDS OF RAIL MAINTENANCE, IT IS NOT INTEGRATED WITH METRO ENTERPRISE SYSTEMS**

- Rail maintenance does not use SAP and instead uses the stand-alone M4 system for scheduling, inspections, and work orders:
  - M4 is not integrated with SAP inventory, but with only 18 rail vehicles, manual interfaces between systems are manageable and work in the short term. However, as METRO Solutions is implemented and the light rail system expands, the use of manual interfaces will be more difficult to manage
  - A replacement integrated enterprise system would provide more effective and efficient operations for rail maintenance. The greater data analysis capabilities realized with integrated systems would improve management capabilities for a larger rail operation, including METRO’s ability to analyze maintenance response efforts.
- METRO IT has experience assisting and facilitating enterprise system planning (e.g., SAP “Get Well”) that can be applied to an M4 replacement process. IT has demonstrated that:
  - It can assist with developing a technical approach required to integrate and scale to an enterprise system
  - It can assist rail business analysts to meet rail-specific needs within an enterprise application and enterprise structure.
- Integrating the rail incident management system with a maintenance enterprise solution should also be part of M4 migration planning. Business process planning should include data integration with the Train Controllers’ incident management system.



## **IT HAS USED EXISTING AVAILABLE TOOLS TO CREATE NEW WAYS OF MAKING INFORMATION AVAILABLE TO MAINTENANCE MANAGERS AND ANALYSTS**

- Using Microsoft Business Intelligence tools included with existing licensed database products, IT has developed dashboard reporting for maintenance managers:
  - The dashboards provide summarized performance data with drill down capabilities to the data without needing to search or ask for new reports
  - The dashboard reporting is a result of on-going meetings with maintenance staff to define requirements for which IT could provide solutions, and is demonstrative of IT's commitment to the user community
  - Senior management acknowledged the value of dashboard reporting but also indicated that at times it provided too much information for them.
- IT has initiated efforts to aggregate system data into data cubes for easier access and use by finance and OMB staff, making it easier for business analysts to integrate data from the Oracle financial and SAP systems and spend less time finding and accessing data and more time analyzing it.
- With its business service approach, IT should continue to provide innovative and simplified information delivery techniques to support METRO's continuing efforts to institute effective changes. Building on the success of recent initiatives, IT should work with Maintenance, Administration and Finance users to define information requirements for daily job performance throughout METRO, and to build dashboards and data cubes to help initiate changes needed to meet agency goals and departmental initiatives.

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## **VI. RECOMMENDATIONS**

## **AUDIT RECOMMENDATIONS ARE THE RESULTS OF FINDINGS IN KEY AREAS**

- Findings documented in previous sections of the system maintenance review indicate areas of positive performance as well as opportunities for improved effectiveness, efficiency and productivity. This section includes detailed recommendations to capitalize on these improvement opportunities. Rather than viewing the recommendations as negative, they should be balanced against METRO's positive performance results during the performance audit review period, as noted throughout this report.
- Maintenance performance recommendations are the results of findings made in reviewing bus and rail maintenance and the supporting management information systems.
- Recommendations resulting from the legislative compliance and performance indicator reviews are provided in the audit reports for each of those areas.

## **RECOMMENDATIONS OFFERED FOR METRO'S CONSIDERATION ARE BASED ON IDENTIFIED OPPORTUNITIES TO IMPROVE PERFORMANCE TRENDS**

- Recommendations applicable to performance efficiency, effectiveness and productivity in METRO's bus and rail system maintenance are identified below. For each recommendation, the context, specific implementation steps, and expected results are provided in the remainder of this section.
  - Recommendation 1: Review opportunities to interface other data sources to SAP to support improved maintenance management and decision-making.
  - Recommendation 2: Improve monitoring of preventive maintenance intervals in order to improve adherence to inspection schedules.
  - Recommendation 3: Review METRO's policy for allocating warranty claim credits to appropriate Responsibility Center accounts.
  - Recommendation 4: Update the Maintenance screens in SAP to easily view a vehicle's previous work order histories.
  - Recommendation 5: Standardize METRORail's performance indicators.
  - Recommendation 6: Implement more sophisticated rail maintenance practices and systems that are commonly used by larger rail systems.
  - Recommendation 7: Improve METRORail document control procedures.
  - Recommendation 8: Consider moving one of METRORail's Siemens servers to the ROC.
  - Recommendation 9: Develop a plan for a Maximus M4 migration strategy to implement an enterprise rail maintenance system.

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Recommendations

**RECOMMENDATIONS OFFERED FOR METRO'S CONSIDERATION ARE BASED ON IDENTIFIED OPPORTUNITIES TO IMPROVE PERFORMANCE TRENDS (CONTINUED)**

- Recommendation 10: Assist rail and bus divisions in evaluating opportunities to off-load daily mileage automatically through wireless communications.

## **RECOMMENDATION 1: REVIEW OPPORTUNITIES TO INTERFACE OTHER DATA SOURCES TO SAP TO SUPPORT IMPROVED MAINTENANCE MANAGEMENT AND DECISION-MAKING**

- **Issues/Opportunity** – With the replacement of the SEMA maintenance management system by SAP, an opportunity exists to improve reporting by integrating the data from several other sources. Currently fluid management, oil analysis, and roadcall data are integrated into SAP. SAP has the growth potential to provide improved information management for decision support and additional data that could be interfaced with SAP include: farebox data, INIT, Vehicle Location and Scheduling (CAD/AVL), IVOMS, Automatic Passenger Counters (APCs), and Pre-Trip inspections (Zonar).
- **Recommended Action:** METRO should undertake a review of the costs and benefits of implementing SAP interfaces and the potential benefits for information and system management. Overall fleet characteristics, maintenance management, SAP capabilities, parts availability and inventory system accuracy, and maintenance practices including use of work orders, types and numbers of roadcalls, bus cleanliness, and data recording and reporting practices should be maintained as they are areas that represent both achievements and concerns for METRO Maintenance staff. The review should provide sufficient detail to recognize and understand the variability in performance among METRO's five directly-operated BOFs.
- **Expected Results:** This review will assess the viability and advisability of reducing the effort currently expended preparing reports and transferring information between systems. If the decision is made to proceed with the integration, it will enable more comprehensive assessments of the reasons for METRO's performance trends and more a conclusive basis for decision-making and strategic planning.

## **RECOMMENDATION 2: IMPROVE MONITORING OF PREVENTIVE MAINTENANCE INTERVALS IN ORDER TO IMPROVE ADHERENCE TO INSPECTION SCHEDULES**

- **Issues/Opportunity:** METRO data on PM inspections for FY08 indicate that of the 5,742 PMIs conducted that year, 87% were performed on-time, 1% were conducted early, and 12% were considered late because they exceeded 6,600 miles since the previous inspection. Together, Polk and Kashmere accounted for 87% of the late PMIs. Adherence to preventive maintenance inspection schedules was checked because inspections that are performed early may result in unnecessary costs and inspections that are performed late may result in increased costs associated with deferred maintenance or not catching a defect before it becomes a problem. METRO staff explained that during FY08 there were problems with the Fleetwatch system that is used to track mileage and that aids in scheduling PMIs.
- **Recommended Action:** METRO should take steps to improve monitoring of preventive maintenance intervals on an on-going basis, particularly at Polk and Kashmere, with the objective of improving adherence to PM inspection schedules and conducting more inspections with  $\pm 10\%$  of METRO's 6,000-mile PMI standard. If Fleetwatch is the problem, it may be that there is a need to develop a back-up capability to monitor upcoming PMIs that does not depend entirely on daily access to Fleetwatch and makes it possible to be aware of and schedule buses that are due to be inspected over the next week.
- **Expected Results:** Performing more PM inspections on time (in the 5,400-6,600 mile window) by reducing the number that is performed late will reduce the costs associated with deferred maintenance or not catching a defect before it becomes a problem.

### **RECOMMENDATION 3: REVIEW METRO'S POLICY FOR ALLOCATING WARRANTY CLAIM CREDITS TO APPROPRIATE RESPONSIBILITY CENTER ACCOUNTS**

- **Issues/Opportunity** – Warranty claims were credited to the appropriate operating facility during the audit period but comments received during the review indicated that the value is currently being credited to Maintenance General (a responsibility center within Bus Maintenance) and not allocated to the appropriate operating facility.
- **Recommended Action:** METRO should consider re-allocating the warranty claims received from each of the RCs and allocate credit to the RC that originated the credit action.
- **Expected Results:** Responsibility Centers would be motivated to fully claim warranted parts if they received the credits.



#### **RECOMMENDATION 4: UPDATE THE MAINTENANCE SCREENS IN SAP TO EASILY VIEW A VEHICLE'S PREVIOUS WORK ORDER HISTORIES**

- **Issues/Opportunity** – SAP maintenance reporting screens have been migrated from SEMA and user interfaces were maintained during that transition. However, when a user opens a maintenance work order to view a vehicle's history, another application must be queried to obtain historical work previously performed on the vehicle. The ability to view historical work for a vehicle would improve users' abilities to recognize vehicle-specific trends and problems.
- **Recommended Action:** METRO should consider adding the ability for an SAP user viewing a work order to view work histories quickly and efficiently from the work order screen.
- **Expected Results:** Improving the ability to spot trends in vehicle repair histories could improve current or pending work actions and reduce costs by making it easier to recognize recurring problems.

## **RECOMMENDATION 5: STANDARDIZE METRORAIL'S PERFORMANCE INDICATORS**

- **Issues/Opportunity:** Over each of the five years of METRORail operations, the maintenance performance statistics reports have reported different metrics and goals. In part, this is a consequence of an organization that is evolving and only beginning to mature. The FY08 report was far more detailed than earlier years' reports, but the evolutionary process has made it difficult to make consistent, "apples to apples" comparisons of performance indicators across the years. Equally importantly, some valuable indicators are still not reported, such as warranty recoveries, labor hours, accidents, and vehicle failure rates – and in some cases, data are not available to monitor them (e.g., METRORail maintenance labor hours). This is an appropriate time to set standards for METRORail's performance reports, and coordinate performance reporting with the rest of the Authority so that similar key performance indicators are available for both bus and rail operations and maintenance. While it is understood that performance reports are likely to reflect annual initiatives and challenges, they should also consistently report indicators of key modal and functional performance.
- **Recommended Action:** METRORail should work with METRO's Quality Assurance/Quality Control staff to define key performance indicators, set goals, and define data gathering and reporting methodologies. Where applicable, these should be consistent with the indicators used for bus operations, although many of the goals will of necessity be different.
- **Expected Results:** A coordinated reporting program would provide more consistent results and enable better determination of performance trends and allocations of scarce resources.

## **RECOMMENDATION 6: IMPLEMENT MORE SOPHISTICATED RAIL MAINTENANCE PRACTICES AND SYSTEMS THAT ARE COMMONLY USED BY LARGER RAIL SYSTEMS**

- **Issues/Opportunity:** Many of METRORail’s maintenance practices suffice for a system of its current size, but would not be sufficient for a larger or more mature system. Both to streamline current maintenance practices and in anticipation of future expansion of Houston’s light rail network, METRORail should consider implementation of certain systems and data tracking/reporting techniques.
  
- **Recommended Action:** METRORail should investigate and consider implementation of the following commonly used maintenance practices and systems:
  - Automatic reporting of vehicle equipment failures
  - A system that detects and reports equipment failure trends
  - Expansion of the use of serial numbers for replacement parts, including a method of automating serial number logging by incorporating barcodes and readers
  - Automatic integration of METRORail’s daily report data into the Maintenance Management System.

As the light rail system is extended and additional vehicles are received, METRORail should also restore the LRV test track or construct a new one.

- **Expected Results:** A transit agency’s maintenance tasks become more complicated as the system matures or grows. Implementation of these more sophisticated systems will enable METRORail maintenance to function more efficiently in the near term, and will provide it with capabilities it will definitely need in the future.

## RECOMMENDATION 7: IMPROVE METRORAIL DOCUMENT CONTROL PROCEDURES

- **Issues/Opportunity:** METRORail has done an excellent job of developing its Intranet and making it available to the entire maintenance department. It currently contains many hundreds of documents, drawings, schematics, procedures, policies, etc., belonging to all four of the maintenance groups and the training function. However, it appears that this implementation has not been matched by appropriate document control practices. METRORail has specific personnel who maintain and upload the files, but the current size of the project requires a more formalized process and record keeping program. At this time, most of the documents only have names, not document numbers, making it easy to accidentally replace or delete the wrong document.
- **Recommended Action:** METRORail should enhance its document control procedures to ensure the timely and accurate uploading of documents on its Intranet, filing of hard copy versions, and recording of all such activities. These procedures should be well documented, so that other staff (with appropriate training and permission) can maintain the site. Consideration should also be given to putting some of the documents on FTP web pages, to avoid the need to update an HTTP menu each time a new document is uploaded. Finally, all METRORail documents, including those that are not on the Intranet, should be given a control identifier for easy and unambiguous reference. At a minimum, this identifier would indicate the responsible department and group and provide a location/system ID, sequence number, revision number, and brief description.
- **Expected Results:** Enhancing the document control processes will minimize errors, make it easier to find the proper document, instill confidence that the most recent version of the document is available, and set a standard for future growth of the system.

## **RECOMMENDATION 8: CONSIDER MOVING ONE OF METRORAIL'S SIEMENS SERVERS TO THE ROC**

- **Issues/Opportunity:** METRORail's signaling, power, and other controls and indications are all routed through two computer servers provided by Siemens. Although backup control centers have become highly favored in the post-9/11 environment, both of the METRORail servers are located at the RCC site, TranStar. One of the servers is on-line, while the other acts as a hot standby, but they do not need to be co-located. Operation of METRORail would be severely curtailed without at least one server available. Although TranStar is considered to be very secure, it could become unusable if either the facility or its fiber-optic connection to METRORail was disabled.
- **Recommended Action:** It is recommended that METRO evaluate the feasibility, costs and benefits of moving one of the Siemens servers to the ROC, taking into consideration the likely impacts of METRO Solutions Phase 2. Relocating one of the servers and keeping the other at TranStar would enhance system availability and allow continued operation should TranStar or its communication network suffer a fault. Moving a server to the ROC would be a simple activity and would still provide an on-line/backup configuration that would support workstations at any location on the fiber-optic ring. No loss of functionality would occur, while system availability would increase.
- **Expected Results:** Loss of either TranStar or the ROC, or communication with either facility, would not cause a loss of functionality of the Siemens servers. Additionally, S&C Maintenance could respond to a system problem more quickly with one server at the ROC.

## **RECOMMENDATION 9: DEVELOP A PLAN FOR A MAXIMUS M4 MIGRATION STRATEGY TO IMPLEMENT AN ENTERPRISE RAIL MAINTENANCE SYSTEM**

- **Issue/Opportunity:** Maximus M4 is a stand-alone software system that METRORail maintenance uses for work scheduling and work order management. M4 provides an acceptable Maintenance Management System, and METRORail has done an excellent job of expanding its capabilities to cover non-vehicle maintenance. The application meets the current needs of a rail fleet of only 18 vehicles, but the lack of integration of M4 with incident management/reporting, SAP material management, and other reporting systems will become a problem as METRO Solutions Phase 2 is implemented and METRORail grows. An enterprise approach should be taken to improve data integration and to ensure that METRORail's maintenance information system is incorporated in the IT Disaster Recovery and Business Resumption Plan.

SAP has been upgraded with increased functionality for vehicle maintenance, is integrated with Oracle financials, and provides an infrastructure that will give METRO new options and alternatives. METRO's IT group has begun to create new tools for maintenance managers and business analysts based on the upgraded SAP databases, which have been favorably received by the users. SAP is currently the material management application for Stores' support of METRORail, and could be an option for future migration given the enterprise integration prospects.

**RECOMMENDATION 9: DEVELOP A PLAN FOR A MAXIMUS M4 MIGRATION STRATEGY TO IMPLEMENT AN ENTERPRISE RAIL MAINTENANCE SYSTEM (CONTINUED)**

- **Recommended Action:** Unless the decision is made to develop an enterprise rail maintenance system as part of METRO Solutions Phase 2, METRORail users, METRORail IT staff, and METRO IT should begin a needs analysis and feasibility study for replacing M4. METRORail staff, who have indicated a desire to procure a rail-specific turnkey software package, should seriously consider the capabilities and benefits of the SAP package, which would provide an integrated Authority-wide enterprise solution. The operational concept should retain the existing successful maintenance philosophy. The solution should include an enterprise application that:
  - integrates with METRO’s infrastructure and that will support both planned and future fleet growth
  - integrates with the new Human Resources system
  - integrates with Oracle Financials for procurement and analysis
  - integrates and/or includes Rail Incident Management work flow
  - integrates with SAP’s materials management functions.
  
- **Expected Results:** Integration with METRO’s existing enterprise MMS will provide future benefits to METRORail as the constraints of the stand-alone M4 program will make it unworkable in an expanded system.

## **RECOMMENDATION 10: ASSIST RAIL AND BUS DIVISIONS IN EVALUATING OPPORTUNITIES TO OFF-LOAD DAILY MILEAGE AUTOMATICALLY THROUGH WIRELESS COMMUNICATIONS**

- **Issue/Opportunity:** The current practice of manually reading and recording mileage from odometers on rail vehicles and hub meters on buses is labor intensive and prone to error. Recognizing the importance of mileage data for statistical purposes and required reporting, considerable effort is expended to manually and reliably capture the data. By implementing wayside communications technology, mileage can be read automatically while the vehicle is being serviced, providing the ability to redirect the time saved to other activities directly related to servicing vehicles and meeting service standards. The wayside communications system also has the potential to support the download of other onboard data based on fault codes generated by electronic control modules to assist in prioritizing and scheduling maintenance work.
- **Recommended Action:** METRO should evaluate the cost and benefits of automating the capture of mileage from rail vehicles and buses at the service lane. A requirements and feasibility study should be performed, with the objective of identifying the costs and feasibility of implementing a system that reduces errors and labor to capture and manage mileage as well as on-board fault data, including any on-board equipment and communications infrastructure, and integration with existing systems.
- **Expected Results:** Automating mileage readings and downloads of other on-board systems data (e.g., engine fault codes) will reduce the errors incurred with the current system of manually reading and recording mileage, while providing an opportunity to integrate capabilities for automated processing with existing systems, and reduce the time required to manage, validate, and correct mileage data.