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M E M O R A N D U M

DATE: September 28, 1999

TO: Metropolitan King County Councilmembers

FROM: Don Eklund, King County Auditor

SUBJECT: Management Audit of Metro Transit Vehicle Maintenance Operations

Attached for your review is the management audit of Metro Transit Vehicle Maintenance Operations. The primary audit objectives were to evaluate the effectiveness of Metro Transit's vehicle maintenance policies, procedures, and practices and to compare Metro Transit's vehicle maintenance financial and operating performance to those of other major transit organizations. The audit includes a review of the Materials Management and Parts Inventory Section practices and internal controls for the parts inventory.

The general audit conclusions were that:

- Metro Transit's maintenance costs were higher than the peer transit system average due to high material costs, a complex, older fleet mix, and delayed bus procurements.
- Although the timeliness of Metro Transit's preventive maintenance inspection was excellent, the quality of the inspections program needs to be improved.
- While Metro Transit's Vehicle Maintenance Section's accident safety record was excellent, Metro Transit Service reliability declined during the past five years and was well below the peer system average due to its older fleet and inconsistent maintenance performance.
- Metro Transit's total material costs were substantially higher in 1997 than the peer transit system average and the unit costs per vehicle mile and maximum service bus were twice the cost of the peer system average.
- Metro Transit's material and parts inventory management practices were not effective, resulting in excessive parts purchasing, poor inventory performance, and inefficient use of taxpayer resources.

The Executive Response, included in its entirety in Appendix 3, indicated that the County Executive concurred with the audit recommendations. As indicated in the Executive Response, Metro Transit is addressing the recommendations regarding the continuous improvement of the reliability and cost-effectiveness of the maintenance, repair and parts inventory functions. The Auditor's Office appreciates the excellent cooperation received from the Department of Transportation and the Metro Transit Division during the audit process.

DE:SB:hlm:bus

MANAGEMENT AUDIT

METRO TRANSIT VEHICLE MAINTENANCE OPERATIONS

Presented to
the Metropolitan King County Council
by the
County Auditor's Office

Don Eklund, King County Auditor
Susan Baugh, Principal Management Auditor
Risa Sandler, Management Audit Intern

Report No. 99-07

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Abbreviations

APTA	American Public Transit Association
FTA	Federal Transit Administration
IBIS	Integrated Business Information Systems

REPORT SUMMARY

INTRODUCTION

The management audit of King County's Metro Transit Vehicle Maintenance Operations was initiated at the request of the Metropolitan King County Council, and included in the Council-adopted 1999 Auditor's Office work program. The audit was prompted by the Council's interest in an evaluation of maintenance procedures and practices following a Washington State Department of Labor and Industries compliance citation involving deferred maintenance of certain coaches, including two potential safety issues.

AUDIT OBJECTIVES

The primary audit objectives were to evaluate the effectiveness of Metro Transit's vehicle maintenance policies and practices, and to compare Metro Transit's vehicle maintenance performance to those of other major transit organizations.

GENERAL CONCLUSIONS

The general audit conclusions were that Metro Transit's accident safety record and timeliness of its maintenance inspections was excellent. However, maintenance costs were higher than the peer transit system average and service reliability was lower than average due to a complex, older fleet, delayed bus procurements, and inconsistent mechanical performance. In addition, Metro Transit's material and parts inventory management practices were not effective, resulting in high material costs, excessive parts purchasing, poor inventory performance, and inefficient use of public resources.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

FINDING 2-1 (Page 7) **Metro Transit's Unit Maintenance Costs Were Only Slightly Higher Than the Average of the Peer Transit Systems' Unit Costs, but Total Maintenance Costs Were Considerably Higher Than Average.**

Metro Transit's unit maintenance costs per vehicle mile, per peak

bus and active bus were only slightly above the peer system. However, Metro Transit's annual maintenance costs were 152.8% of the peer transit system average maintenance cost, and second highest among the peer transit group. An external factor contributing to Metro Transit's high maintenance costs included the relatively higher cost of living in the Puget Sound area; and the internal factors included higher service levels, excessive material expenses, an older fleet with high failure rates, and delayed bus procurements.

The accelerated implementation of the Six-Year Development Plan and record expansion of transit service helped curb the growth of unit maintenance costs during the past three years. The recent acquisition of economical buses also resulted in cost efficiencies.

The audit recommended that Metro Transit continue to promote uniformity in its fleet as older buses are replaced to reduce its maintenance costs, including materials costs, and to improve the reliability of its fleet.

FINDING 2-2 (Page 10) Although the Timeliness of Metro Transit's Preventive Maintenance Inspections Was Excellent, the Quality of the Inspections Program Needs to Be Improved.

Metro Transit's internal performance standard of 98.7 percent was established for the timeliness of preventive maintenance inspections. In 1997, Metro Transit completed 96.4 percent of its inspections on time. While the percentage of buses inspected "on-time" was slightly below the 98.7 percent standard, the overall timeliness of the inspection program was excellent.

However, the quality of Metro Transit's preventive maintenance inspections was inconsistent and could be improved based upon the findings of the Vehicle Maintenance Section's internal quality

assurance reviews. Specific issues identified in quality assurance reports included inconsistent inspection practices from base to base and inspector to inspector; no identification of significant repair items during the inspections; and delayed completion of some repair items. Metro Transit implemented a more broadly focused quality assurance program in 1998 that addresses inspections, maintenance operations, repairs, materials management, safety, and environment. Metro Transit's Vehicle Maintenance Section manager directly followed up important issues identified during recent quality assurance reviews.

The audit recommended that Metro Transit continue to refine the newly implemented quality assurance program to ensure that its inspections and maintenance standards are maintained and to improve service reliability, as discussed in Finding 2-3 below.

FINDING 2-3 (Page 14) Metro Transit's Vehicle Maintenance Section's Accident Safety Record Was Excellent. However, Metro Transit's Service Reliability Declined During the Past Five Years and Was Below the Peer System Average Due to an Older Fleet and Inconsistent Maintenance Performance.

Safety is a crucial vehicle maintenance objective at Metro Transit, so accidents due to mechanical failure were reviewed during the audit. The results indicated that only four accidents were caused by mechanical failures between 1992 and 1997, thus Metro Transit's mechanical safety record was excellent.

However, Metro Transit had the highest number of maintenance interruptions due to mechanical failures among the peer transit systems in 1997. Interruptions due to other transportation incidents were also very high, at 178 percent of the system average, and miles between trouble calls was 55 percent below the average. The significance of these reliability measures is that the quality and

consistency of Metro Transit's repair program needs to be improved.

The audit recommended that Metro Transit continue to implement its bus procurement program to improve the reliability of its fleet and implement more consistent reviews of completed inspections and repairs to ensure the effectiveness of maintenance services.

FINDING 2-4 (Page 18) **Metro Transit's Total Maintenance Work Hours Were Higher Than Average Based Upon Reported Work Hours, but Lower Based on Service Units. In Addition, Maintenance Management and Reporting Needs To Be Improved.**

Metro Transit's maintenance work hours were approximately 10 percent lower than the peer transit system average based upon the reported maintenance work hours per maximum service bus[1] and vehicle miles. Metro Transit reported 27% more work hours than the peer system average, but a 10 percent lower work hour rate per maximum service bus and vehicle miles than the peer transit systems. However, the reported work hours raise questions about the effectiveness of Metro Transit's maintenance operation, particularly given its low service reliability rates.

The low service reliability rates were also a concern because the Vehicle Maintenance Section's overtime expenditures have exceeded the annual overtime budget by approximately $0.5 million to $1.3 million during the five-year review period. While excess overtime expenditures are not unusual in the transit industry, Metro Transit's work hours and reliability statistics suggested that the maintenance function might not be appropriately managed and staffed. For example, the maintenance statistics and comparative

[1]The number of buses signed out for service during the evening rush hour.

analyses suggest that Metro Transit could improve its maintenance performance by limiting overtime assignments to priority workloads; establishing shop rate standards for routine repair and inspection activities; and through better management oversight and reporting including accountability and exceptions reporting.

The audit recommended that Metro Transit review its current maintenance practices to determine why its service reliability rates are not consistent with its lower work hour (e.g., higher productivity) levels. In addition, Metro Transit should use overtime resources to reduce mechanical problems that result in frequent interruptions and trouble calls rather than non-priority workload. Metro Transit should also establish shop rate standards for routine inspections and maintenance tasks, and improve its maintenance management information system to routinely identify exceptions to the established standards.

FINDING 3-1 (Page 31) Metro Transit's Materials Costs Were Substantially Higher in 1997 Than the Peer Transit Systems Average Costs and Twice the Peer Transit System Average Costs Per Vehicle Mile and Maximum Service Bus.

Approximately $22.8 million, or 48 percent of Metro Transit Vehicle Maintenance Section's $54 million annual budget, was allocated to materials costs during the past five years. The total and unit materials costs in 1997 were the highest among the peer transit systems. In fact, Metro Transit's total materials costs were 281 percent of the peer average, and the costs per total vehicle mile and maximum service bus were both double the transit system average.

The audit recommended that Metro Transit implement materials management practices that will effectively reduce costs to levels

consistent with the other peer transit systems. Cost-effective practices include selective purchasing practices for new fleets, reordering parts based on usage patterns, and reducing stock to minimum levels prior to ordering new parts.

FINDING 3-2 (Page 33) Metro Transit's Materials and Parts Inventory Management Practices Were Not Effective, Resulting in Excessive Parts Purchasing, Poor Inventory Performance, and Inefficient Use of Taxpayer Resources.

Metro Transit adopted a 100 percent parts availability standard for its six maintenance facilities and decentralized some materials and inventory management functions to give base supervisors and chiefs greater control over the parts required for scheduled repairs. However, maintenance personnel ordered new parts that were in stock at other bases, and quantities of stock that were higher than the recommended quantities. The result was that parts purchasing outpaced the demand for the parts available in the inventory. Metro Transit's ineffective parts practices resulted in a low inventory turn rate, which was substantially lower (62 percent to 75 percent) than the recommended inventory standard of four to six turns annually.

Factors that contributed to Metro Transit's low inventory turn rate included the purchase of discontinued parts that are not likely to be used, such as $1.9 million worth of Breda parts. Metro Transit also adopted a practice of *gradually* reducing surplus items in 1996 due to media criticism regarding the sale of $1.5 million of retired buses and surplus parts for only $80,000 or six percent of the original transaction value. The media and public perceived that Metro Transit's purchasing practices were wasteful due to the small amount of revenue generated from the sale of the surplus parts.

The Materials Management Section is now selectively purchasing parts from the original equipment manufacturers' recommended

parts lists and including vendor buy-back agreements in its procurement contracts. A greater effort is also being made to level out parts among the bases prior to ordering new parts. (Please see relevant recommendations after Finding 3-3.)

FINDING 3-3 (Page 38) **Metro Transit's Parts Inventory Practices and Internal Controls Were Inadequate and Inconsistent With Federal Transit Industry Inventory Control Standards.**

FTA Circular #5010.1B requires transit agencies to establish and maintain adequate internal controls to ensure that the grant-funded resources, including parts, are properly used and safeguarded. The FTA provisions specify that grantees: 1) adopt internal control policies, plans, and procedures that safeguard assets against waste, loss, and misuse; 2) ensure the accuracy and reliability of financial, statistical, and other reports; and 3) assure that personnel have the experience and training to perform assigned functions. Metro Transit's inventory management practices were not consistent with the FTA standards as reflected by its 79 percent inventory accuracy rate, which was below the recommended 90 percent inventory accuracy standard.

Practices that contributed to the low inventory accuracy rate included:

- Unsecured and unattended parts rooms during weekend shifts and unauthorized withdrawal of materials;
- Incomplete records of parts transactions; and
- Assignment of parts oversight functions to personnel who were unfamiliar with inventory management policies and practices.

The audit recommended that Metro Transit adopt best materials and parts inventory management practices to reduce its materials costs and improve both its inventory turn rate and inventory record

accuracy rate. In addition, Metro Transit should complete and adopt formal materials management and inventory policies and procedures for the decentralized materials management and inventory operations.

AUDITOR'S MANDATE

The Management Audit of Metro Transit Vehicle Maintenance Operations was conducted by the County Auditor's Office pursuant to Section 250 of the King County Home Rule Charter and Chapter 2.20 of the King County Code. The audit was performed in accordance with generally accepted government auditing standards, with the exception of an external quality control review.

1 INTRODUCTION

BACKGROUND

The management audit of King County's Metro Transit Vehicle Maintenance Operations was initiated at the request of the Metropolitan King County Council, and included in the Council-adopted 1999 Auditor's Office work program. The audit was prompted by the Council's interest in an evaluation of vehicle maintenance procedures and practices following a Washington State Department of Labor and Industries compliance citation involving deferred maintenance of certain coaches, including two potential safety issues.

The audit scope was expanded during the review process to include a review of the Metro Transit's Materials Management and Parts Inventory Sections policies and practices for two reasons. First, the Auditor's Office received complaints about Metro Transit's materials management and parts inventory practices, including the volume of new transit parts sold at King County auctions. In addition, Metro Transit's materials costs were substantially higher than the materials costs for other peer transit organizations.

The Vehicle Maintenance Section's Primary Function Is to Ensure That Sufficient Buses Are Available to Meet Scheduled Service Requirements.

In 1997, the Vehicle Maintenance Section maintained, repaired, and serviced a mixed fleet of approximately 1,374 buses,[2] including 236 dual-powered buses, 155 standard and articulated trolleys, 855 standard and articulated diesel buses, and 116

[2]Twelve (12) historic (unassigned) buses were included in the fleet total of 1,374 buses.

small diesel buses and vans. (Please see Appendix 1 for Metro Transit's fleet mix.)

In 1997, Metro Transit provided vehicle maintenance services 24 hours a day, 7 days a week, at 6 locations in central Seattle and in north, south, and east King County. The Vehicle Maintenance Section was staffed by 635 employees, and its annual expenditures were $54,992,060.

AUDIT OBJECTIVES

The primary audit objectives were to evaluate the effectiveness of Metro Transit's vehicle maintenance policies, procedures, and practices and to compare Metro Transit's vehicle maintenance financial and operating performance to those of other major transit organizations. In addition, the audit included a review of the Materials Management and Parts Inventory Sections practices and internal controls for the parts inventory.

AUDIT SCOPE AND METHODOLOGY

The audit scope was limited to the review and evaluation of Metro Transit's vehicle maintenance, including materials management and parts inventory, policies, procedures and practices. The methodology included the review of Metro Transit Vehicle Maintenance Section's goals and objectives; annual and monthly financial and operating reports; previous Metro Transit audits and studies; and performance data and vehicle maintenance work orders generated by maintenance and operating personnel.

Financial and operating data were also extracted from the Federal Transit Administration's (FTA) 1997 *National Transit Data Tables* for the comparative analysis of Metro Transit's vehicle maintenance operations to those of 12 peer transit systems. In addition, interviews were conducted with Metro's Vehicle Maintenance Section management and staff, other

transit managers, consultants, and representatives of the American Public Transit Association. On-site visits were conducted at each of the Vehicle Maintenance Section's maintenance bases and the Component Supply Center and Training Center.

Limitations Were Identified Regarding the Reliability of the FTA National Transit Data.

The reliability of the FTA transit data has been the focus of major studies and debates due to such factors as differing regional economic conditions and varying interpretations of reporting criteria. For example, an "arbitrary and poorly defined service area" is cited by Alan Tilotson's *"Comparative Transit System Performance: Improving on Section 15 Data*"[3] as one factor that is subject to broad interpretation by transit providers. For instance, Metro Transit's reported service area is illustrative of two accurate but different interpretations. Specifically, Metro Transit accurately reported a transit service area of 2,126 square miles in the most recently published FTA *Transit Profiles* based upon its authority to provide transit services throughout the county's geographic boundary. However, the blueprint of Metro Transit's fixed route service area covers only 840 square miles in King County, although limited van and paratransit services were provided outside the fixed route area.

Nevertheless, the FTA transit data are considered to be the best data available for the comparative analysis of transit agencies. In fact, the American Public Transit Association (APTA) uses selected financial and operating data reported in the FTA *National Transit Data Tables* to evaluate nominations from transit agencies for its annual Outstanding Achievement Awards

[3]Alan Tilitson, Comparative Transit System Performance: Improving on Section 15 Data, Newark, NJ, (not dated).

Program. APTA awards are given to those transit agencies that demonstrate superior operating efficiencies and effectiveness, in relation to their peers, during the past three years based upon the reported FTA data.

Twelve of the Nation's Thirty Largest Bus Providers Selected for Peer Transit Analysis.

The 12 transit agencies selected for the comparative review of vehicle maintenance operations are the same agencies selected for a Council-mandated consultant audit of Metro Transit's operations. The 12 agencies were selected from the 30 largest transit providers in the United States by the Doolittle and Associates Team, in consultation with the Transit Audit Oversight Committee and Metro Transit management. The Doolittle and Associates Team provided the FTA source data for the vehicle maintenance performance review to promote consistency between the consultant report on Metro Transit operations and the Auditor's Office report on vehicle maintenance.

2 VEHICLE MAINTENANCE OPERATIONS

Title 49 of the Federal Regulations Code, Part 18.32, requires all Federal Transit Agency (FTA) grantees, including Metro Transit, to maintain buses in good operating condition. This chapter focuses on the vehicle maintenance policies, procedures, and practices developed by Metro Transit to ensure that buses are available in good operating condition to meet scheduled service demands. Metro Transit's vehicle maintenance performance between 1993 and 1997 is reviewed based upon its internally established standards and historical trends, and based upon the 1997 financial and operating performance of the 12 comparable transit agencies. The 1997 FTA *National Transit Data Tables* are the most current source of comparative data. Selected work orders and inspection forms drawn from 13,900 preventive maintenance inspections and 120,000 orders for shop repairs completed in 1997 were also reviewed.

FTA Established Service Efficiency and Effectiveness Measures for Transit Maintenance Operations.

Performance measures are quantitative and qualitative indicators of the extent to which transit objectives are being achieved. The FTA has established quantitative performance measures for transit maintenance, including cost, service efficiency, and effectiveness measures. Metro Transit also established internal cost and service efficiency and effectiveness measures for its maintenance operations that are consistent with the FTA measures. In addition, Metro Transit developed and monitors qualitative performance measures, including customer satisfaction with mechanical dependability and interior bus cleanliness, as well as attainment of its annual goals.

The Transit Industry Has Not Developed Specific Performance Standards for Transit Maintenance Operations.

Performance standards or targets identify levels of performance that a transit service or program is projected to accomplish, consistent with objectives. The standards provide a basis for evaluating actual transit performance.

Neither the FTA nor the American Public Transit Association has developed specific standards to rate transit maintenance performance. APTA indicated that the transit industry is not interested in establishing standards "because the industry is too diverse and operates in too many radically different environments for performance standards to be meaningful." Instead, the detailed financial and operating data published in the FTA *National Transit Data Tables* are commonly used to develop benchmarks, based on size, transit modes, etc., to evaluate the efficiency or effectiveness of transit organizations.

Metro Transit has developed its own internal performance standards for some vehicle maintenance functions, including the percent of inspections completed within established service intervals and miles between trouble calls, which measure the timeliness of inspections and quality of both inspections and repairs, respectively. Metro Transit's Vehicle Maintenance Section routinely monitors its performance based on these internal standards and prior years' trends.

The findings and analyses related to Metro Transit's vehicle maintenance operations are presented below.

FINDING 2-1

METRO TRANSIT'S UNIT MAINTENANCE COSTS WERE ONLY SLIGHTLY HIGHER THAN THE AVERAGE OF THE PEER TRANSIT SYSTEMS' UNIT COSTS, BUT THE TOTAL MAINTENANCE COSTS WERE CONSIDERABLY HIGHER THAN AVERAGE.

One cost-effectiveness measure for maintenance operations in the transit industry is the ratio of vehicle maintenance expenses to total operating expenses. A ratio of approximately 20 percent is considered to be reasonable by the Federal Transit Administration. Exhibit A below displays Metro Transit's 1997 total and unit vehicle maintenance costs, including costs as a percent of total operating costs, and its cost trend during the past five years. In addition, Exhibit A also displays the comparison of Metro Transit's 1997 maintenance costs and to those of 12 transit organizations with large bus operations.

EXHIBIT A

Metro Transit and Peer Transit System Maintenance Costs

System	Maintenance Costs	Cost per Vehicle Mile	Cost per Peak Service Bus	Cost per Active Bus	Percent of Total Costs
King County Metro	46,763,609	$1.23	$52,308	$41,978	23%
Baltimore	32,246,145	1.36	41,878	33,625	22%
Cleveland	27,048,312	1.07	45,006	37,830	19%
Dallas	34,357,321	1.06	48,803	42,893	17%
Denver	34,935,699	0.91	50,195	41,149	23%
Houston	59,584,369	1.38	63,727	49,571	31%
Milwaukee	16,986,082	0.88	38,430	31,750	18%
Minneapolis	24,485,492	0.84	32,431	27,389	18%
Oakland	31,175,560	1.41	53,844	44,922	22%
Pittsburgh	37,246,634	1.21	49,268	40,885	24%
Portland	22,146,853	0.90	43,004	35,435	19%
San Francisco	27,223,296	1.95	75,202	59,963	22%
St. Louis	19,993,653	0.84	37,867	32,248	20%
Peer Average	$30,619,118	$1.15	$48,305	$39,805	21%
Metro Rank	2nd Highest	5th Highest	4th Highest	5th Highest	3rd Highest
Metro/Average	152.8%	107.2%	108.3%	105.5%	107%
% Change 1993-97	2.3%	15.9%	24.2%	18.6%	10.3%
% Change 1995-97	7%	3.8%	5.6%	4.4%	2.5%

Source: The Doolittle and Associates Team, 1999. Please note that Metro Transit's total vehicle maintenance cost was $54,992,060 in 1997. The $46,763,609 shown above includes 1997 diesel, trolley and street car maintenance costs only.

As shown in Exhibit A above, Metro Transit's unit maintenance costs per vehicle mile, per peak bus and active bus, were only slightly above the peer system. Metro Transit's unit costs were the fourth or fifth highest among the peer transit group. However, Metro Transit's annual maintenance costs were 152.8% of the peer transit system average maintenance cost, and second highest among the peer transit group due to its larger fleet size and higher service levels. Metro Transit's total maintenance costs as a percent of total operating costs were 23%, which was only slightly higher than the peer average of 21% and the 20% industry standard.

It is important to note that overall maintenance cost increases for the three- and five-year review periods were generally moderate, and that the annual unit cost increases were lower after the King County and Metro Transit consolidation. In fact, Metro Transit's accelerated implementation of its Six-Year Development Plan and record growth in transit service during the latter half of the five-year review period helped slow the growth of unit maintenance costs.[4] As shown in Exhibit A, the average annual unit maintenance cost per peak service bus increased by only 1.9% during the three-year period compared to 4.8% during the five-year period, and the average annual unit maintenance cost per vehicle service mile increased by only 1.2% during the three-year period compared to 3.1% during the five-year period.

Metro Transit's Materials Costs, Fleet Mix, and Delayed Bus Procurements Contributed to High Maintenance Costs.

Several external factors contributed to Metro Transit's overall higher maintenance costs, including the relatively higher cost of

[4]During 1997, Metro Transit added 21 new bus routes and 132,000 new service hours.

living in the Puget Sound area. However, numerous internal factors also contributed to high maintenance costs including excessive material expenses; a mixed, older fleet with high mechanical failure rates; and delayed bus procurements.

Metro Transit's materials management costs and practices are discussed in-depth in Chapter 3. However, parts expenses, which were double the cost for the peer transit systems average, were the primary contributor to Metro Transit's high maintenance expenses. In fact, Metro Transit's parts expenditures were approximately one-half of the annual vehicle maintenance budget.

Metro Transit's mixed, older fleet of foreign and domestic buses contributed to higher maintenance parts and staffing costs. Costs are further impacted by the design complexities of the dual-mode and trolley buses. As shown in Appendix 1, Metro Transit's current fleet is comprised of buses from 7 manufacturers. Metro Transit's mixed fleet requires a greater array and quantity of parts than those required for a standardized fleet. The mixed fleet also adds to the complexity and cost of the maintenance function, because mechanics need to be trained and skilled in repairing multiple-model buses. However, mechanics have varying interests and skills in maintaining different buses. In addition, maintenance costs for the unique, dual-mode Breda buses were generally twice the cost of maintaining Metro Transit's standard diesel buses.

Metro Transit's delayed bus procurements also contributed to higher maintenance costs as mechanical failure rates increased in relation to the fleet age. (Please see Finding 2-3 for more information on Metro Transit's service reliability.) From 1993 to 1996, the first four years of the five-year review period, Metro

Transit's fleet age steadily increased from a 9.87 years to 11.76 years. The fleet age declined to 7.89 years by 1997, when the new Gillig fleet was placed into service, an age that was more consistent with the national average fleet age. Metro Transit's average fleet age is expected to increase slightly to 8.74 years in 1998, and remain below six years through 2003.

Although Metro Transit's delayed bus procurements contributed to higher than average maintenance expenses during the five-year period, the new diesel buses were more economical than the former buses due to fewer breakdowns and single mode engines. In fact, maintenance efficiencies have already been achieved for the standard diesel buses. However, the costs and mechanical failure rates for the dual-mode Breda and trolley buses remained high.

RECOMMENDATION

2-1-1 Metro Transit should continue to promote uniformity in its fleet as older buses are replaced to reduce its overall maintenance costs, including materials costs, and to improve the reliability of its fleet. (Please see the recommendations in Chapter 3 regarding materials management practices and expenses, and after Finding 2-4 regarding service reliability.)

FINDING 2-2 **ALTHOUGH THE TIMELINESS OF METRO TRANSIT'S PREVENTIVE MAINTENANCE INSPECTIONS WAS EXCELLENT, THE QUALITY OF THE INSPECTIONS PROGRAM NEEDS TO BE IMPROVED.**

The Vehicle Maintenance Section developed an extensive preventive maintenance inspections program to ensure that buses are maintained to Metro Transit's standards and to avoid

costly and inconvenient service disruptions due to mechanical failures. The Vehicle Maintenance Section established a performance standard of 98.7 percent for the timeliness of its preventive maintenance inspections,[5] because FTA and Metro Transit policy requires buses to be in good operating condition. Approximately 13,900 preventive maintenance inspections were completed in 1997, averaging 10 preventive maintenance inspections per bus.

Based upon a review of the Vehicles Maintenance Section's Monthly Performance Reports issued between 1993 and 1997, inspections were consistently completed within the established inspection intervals. In 1997, 96.4 percent of the scheduled inspections were completed on time. While the percentage of buses inspected within the established interval was slightly below the 98.7 percent on-time standards and declined slightly during the past five years from a high of 98.5 percent, the overall timeliness of the inspection program was excellent.[6]

The Quality of Metro Transit's Preventive Maintenance Inspections Could Be Improved.

However, the quality of Metro Transit's preventive maintenance inspections was inconsistent and could be improved based upon the findings of the Vehicle Maintenance Section's internal quality assurance reviews.[7] The quality assurance inspection teams, who re-inspected a sample of recently inspected coaches assigned to each base, documented their findings in a series of *Quality Assurance Program Reports* published from 1989 to

[5]All buses were scheduled for inspection within 300 miles of the established inspection cycle (e.g., every 6,000 miles for Gillig buses and every 3,000 miles for all other buses.

[6]The Federal Transit Administration's Region X 1997 Triennial Review concluded that Metro Transit's preventive maintenance inspections program was timely based upon an analysis of buses sampled at two bases. However, the FTA did not evaluate the quality of the inspections program.

[7]The objective of the Metro Transit's quality assurance program was to determine whether the inspections and maintenance of buses followed a common standard based on its own Inspection Standards Manual, the original equipment manufacturers specifications, and good judgment.

1995 and 1998.[8] Specific issues identified in the reports included inconsistent inspection practices from base to base and inspector to inspector; no identification of significant repair items during the inspections; delayed completion of some inspection and preventive maintenance repair items; and deferred repairs for approximately one-third of the needed repair items, while coaches remained in tripper status (i.e., could be signed-out for scheduled service despite uncompleted repairs).

In an effort to determine the significance of issues raised in the quality assurance reports, audit staff as well as a base chief and mechanic who served on prior quality assurance inspection teams and assisted in Metro Transit's inspections training, were asked to evaluate specific issues identified in the last quality assurance report that was available for all six bases. Audit staff developed the rating criteria to describe the significance of repair issues, which were then refined by the base chief. The criteria and the aggregated ratings are shown in Exhibit B below.

EXHIBIT B

Metro Transit Quality Assurance Program
Inspection Issues

	Coaches Reviewed	Potential Safety Issues	Potential Road Call	Impacts Vehicle Operation	Reduces Component/ Part Life	Impacts Passenger Comfort	Impacts Operator Comfort	Low Priority Repair	Issues Rated
Atlantic Base	6	14	27	25	20	15	5	33	139
Central Base	5	17	8	17	17	16	3	3	81
East Base	7	29	10	25	30	24	1	7	126
North Base	6	11	17	10	25	25	4	12	104
Ryerson Base	7	40	16	27	36	38	11	17	185
South Base	7	22	43	46	46	54	16	29	256
TOTAL	**38**	**133**	**121**	**150**	**174**	**172**	**40**	**101**	**891**
Percent of Total Issues Rated		**15%**	**14%**	**17%**	**20%**	**19%**	**4%**	**11%**	**100%**

Source: Metro Transit Vehicle Maintenance Quality Assurance Review (1995) and completed survey forms (1997).

[8]Metro Transit's previous quality assurance program focused predominantly on inspections and was discontinued in 1995.

As shown in Exhibit B, the reviewers rated 891 specific inspection items identified during the 1995 quality assurance program for 38 sample coaches. The reviewers rated 133 of the 891 quality assurance items (15 percent) as potential safety issues and 121 items (14 percent) as potential road call issues. These issues were considered to be significant by the evaluators from both a safety and service standpoint. Another 224 items (37 percent) were rated as bus operations and component life issues; and 210 items (23 percent) were rated as passenger/operator comfort issues. These issues were considered to be important indicators of the effectiveness of the inspections and repair program. Only 101 items (11 percent) were considered to be low priority or insignificant issues by the reviewers.

These ratings suggest that 89% of the items identified during the inspections were important and that the quality and consistency of the inspections program needed to be improved. However, Metro Transit discontinued its quality assurance program after 1995 due to perceptions that the program was too narrowly focused and overly critical. The same year, the Washington State Department of Labor and Industries review of a Metro Transit employee's complaint concluded that the inspections program was not effectively supervised and the inspections training program was not effectively enforced, which could lead to potential safety problems. Following its own internal review, Metro Transit re-instituted mandatory inspections training, and implemented a redesigned, more broadly focused quality assurance program in 1998. In addition to inspections, the new quality assurance program addresses maintenance operations, repairs, materials management, safety, and environment. Metro Transit's Vehicle Maintenance Section management also directly followed up important issues identified during the recent quality

assurance reviews.

RECOMMENDATION

2-2-1 Metro Transit should continue to refine the newly implemented quality assurance program to ensure that its inspections and maintenance standards are maintained and to improve service reliability as discussed in Finding 2-3 below.

FINDING 2-3 **METRO TRANSIT'S VEHICLE MAINTENANCE SECTION'S ACCIDENT SAFETY RECORD WAS EXCELLENT. HOWEVER, METRO TRANSIT'S SERVICE RELIABILITY DECLINED DURING THE PAST FIVE YEARS AND WAS WELL BELOW THE PEER SYSTEM AVERAGE, DUE TO AN OLDER FLEET AND INCONSISTENT MAINTENANCE PERFORMANCE.**

Because safety is a crucial vehicle maintenance objective at Metro Transit and throughout the transit industry, accidents related to mechanical failures were also reviewed during the course of the audit. The results of the review indicated that Metro Transit's 1997 collision rate of 229 accidents was well below the peer transit system average of 360 accidents. In addition, very few accidents occurred as the result of verified mechanical defects or failures. The Metro Transit Safety Supervisor[9] reported that only four accidents were caused by mechanical failure between 1992 and 1997. Three accidents involved brakes and one involved a wheel separation. Thus, the Vehicle Maintenance's safety record was excellent, particularly given that Metro Transit's buses travel approximately 40 million miles annually.

Service Reliability Measures Are Important Indicators

[9]The Metro Safety Supervisor was consulted about accidents due to mechanical failure because the annual *Transit Safety Year-End Accident Summary* did not list accidents attributable to mechanical defects as a reporting category.

of Maintenance Effectiveness

Service reliability measures, including miles between trouble calls, are important indicators of the effectiveness of transit maintenance programs. Exhibit C below displays the 1997 service reliability data for Metro Transit and the 12 peer transit systems, and the percent change in service reliability during the past five years.

EXHIBIT C

Motor Bus Service Reliability
Total 1997 Motor Bus Incidents

System	Transportation Interruptions	Maintenance Interruptions	Miles Between Interruptions	Miles Between Trouble Calls
King County Metro	8,565	9,545	2,068	3,974
Baltimore	5,212	8,982	1,571	2,647
Cleveland	1,274	2,405	6,672	10,558
Dallas	4,560	3,544	3,795	9,139
Denver	10,565	2,249	2,937	17,025
Houston	8,132	8,035	2,604	5,381
Milwaukee	8,139	4,488	1,505	4,312
Minneapolis	421	2,139	10,943	13,588
Oakland	5,526	6,143	1,765	3,602
Pittsburgh	9,418	8,866	1,659	3,478
Portland	1,680	3,667	4,514	6,716
San Francisco	2,000	5,027	1,946	2,776
St. Louis	715	3,351	5,305	7,076
Average	4,804	4,908	3,768	7,192
Metro Rank	3rd Highest	1st Highest	6th Lowest	5th Lowest
Metro/Average	178.3%	194.5%	42.1%	55%
% Change 1993-97	34.2%	7.5%	-7.5%	1.2%
% Change 1995-97	7.6%	1.8%	-1.9%	0.3%

Source: The Doolittle & Associates Team, 1999.

As shown in Exhibit C above, Metro Transit had the highest number of maintenance interruptions, which were approximately twice the number of interruptions in bus service due to mechanical failure as the peer transit system average in 1997. Interruptions due to other transportation incidents were also very high, at 178 percent of the peer transit system average. Metro Transit's miles between trouble calls was the 5th lowest among

the peer transit systems and 55 percent below the average. (The miles between interruptions for the trolley buses was even lower at 1,423 miles compared to 3,974 miles for the diesel buses.) In addition, the miles between interruptions deteriorated by 7.5 percent during the five-year period, but the miles between trouble calls improved by 1.2 percent, as shown on the bottom of Exhibit C.

The significance of these service reliability measures is that the quality and consistency of Metro Transit's repair program needs to be improved. The reliability measures also suggest that Metro Transit signed out buses to meet service demands that were not in good operating condition, resulting in mechanical failures and inconvenient service disruptions for passengers. In fact, deferred repairs were not uncommon, and the Department of Labor and Industries study found that buses with mechanical problems remained in service up to five months before they were repaired.

While frequent service interruptions may trigger a review of spare ratios, (e.g., percent of buses that exceed the number of buses required for peak service), Metro Transit's spare ratio of 25.4 percent was 5.4 percent higher than the allowed spare ratio under the FTA guidelines. Public transit agencies that receive capital assistance from the FTA are required to hold spare ratios to no more than 20 percent of the total number of peak vehicles. The Transportation Research Bureau indicated that the more efficient public agencies operate with a spare ratio of 8 to 14 percent. Unfortunately, while Metro Transit's spare ratio was adequate from a statistical standpoint, many of its older buses were not available for service due to difficulties in obtaining the parts required for repairs, or fabricating required parts that were no longer available.

It should be noted that Metro Transit's miles between trouble calls increased by 0.3 percent, even with the implementation of a significant service expansion, primarily due to the reduced fleet age. In fact, the miles between trouble calls for the new Gillig fleet averaged 7,000 to 8,000 miles, which was well above the suggested transit industry consultant's management target of 6,000 miles between road calls that is used in other transit systems.

Perceived Satisfaction With Metro Transit's Mechanical Dependability Dropped off Dramatically With a 13 Percent Reduction Between 1996 and 1997, but Inside Cleanliness Improved by 8.5 Percent.

Customers' perceived satisfaction with various attributes of transit service was reviewed annually through a Metro Transit published Rider/Non-Rider Survey. Exhibit D below displays the survey results between 1993 and 1997 for the two transit maintenance ratings.

EXHIBIT D
Satisfaction With Transit Service Attributes
Percentage of Very Satisfied Respondents
(1993-1997)

Service Attributes	1993	1994	1995	1996	1997
Mechanical Dependability	59.7%	65.8%	66%	69%	56%
Inside Cleanliness	38.5%	38.5%	43%	43%	47%

Source: Rider/Nonrider Surveys, Northwest Research Group, Inc., King County Department of Transportation Transit Division (1993-1997)

As shown in Exhibit D, mechanical dependability and inside cleanliness were the only two categories related to maintenance services. The survey respondents' level of satisfaction with mechanical dependability improved between 1993 and 1996, but the rating dropped off dramatically with a 13 percent reduction between 1996 and 1997. In fact, the 56 percent rate dropped

3.7 percent below the customer satisfaction rating shown at the beginning of the review period. This is a concern because mechanical dependability of the buses was rated by transit riders as a "very" or "extremely" important travel related element of those considered, immediately after on-time performance and personal safety factors in decisions about whether or not to ride the bus.

Although inside cleanliness was also considered in the Rider/Non-Rider Survey, it was not highly ranked in terms of importance to transit riders. The survey respondents' satisfaction with inside cleanliness was lowest in 1993 with a 38.5 percent rating, but the rating consistently improved during the five-year audit review period. By 1997, respondents' satisfaction increased by 8.5 percent to 47 percent.

RECOMMENDATION

2-3-1 Metro Transit should continue to implement its bus procurement program to improve the reliability of its fleet and to reduce its spare ratio to 20% of the number of peak buses. In addition, Vehicle Maintenance management should implement more proactive and consistent reviews of completed inspections and repairs to ensure the effectiveness of maintenance services and reduce mechanical service interruptions. Metro Transit should also attempt to increase the miles between trouble calls for its diesel fleet to 4,500 to 5,000 miles for the total fleet, and to 6,000 as the age and complexity of the fleet is reduced.

FINDING 2-4

METRO TRANSIT'S TOTAL MAINTENANCE WORK HOURS WERE HIGHER THAN AVERAGE BASED UPON REPORTED WORK HOURS, BUT LOWER BASED ON SERVICE UNITS. IN ADDITION, MAINTENANCE MANAGEMENT AND REPORTING NEEDS TO BE IMPROVED.

Metro Transit's maintenance work hours were approximately 10 percent lower than the peer transit system average based upon the reported maintenance work hours per maximum service bus[10] and vehicle miles. Exhibit E below displays Metro Transit's and the 12 peer transit system work hours.

EXHIBIT E
Metro Transit Vehicle Maintenance Work Hours
Performance Measures and Peer Analysis

Transit Agency	Total Hours	Per Maximum Service Bus	Per 1,000 Total Vehicle Miles
King County Metro	1,036,750	1,160	27.3
Baltimore	734,224	954	30.9
Cleveland	814,704	1,356	32.1
Dallas	713,322	1,013	22.0
Denver	740,078	1,063	19.3
Houston	1,925,073	2,059	44.5
Milwaukee	475,321	1,075	24.6
Minneapolis	724,357	959	24.9
Oakland	672,181	1,161	30.4
Pittsburgh	1,137,824	1,505	36.9
Portland	517,005	1,004	21.0
San Francisco	752,466	2,079	53.9
St. Louis	599,297	1,135	25.3
Peer Average	817,155	1,280	30.5
Metro Rank	3rd Highest	6th Highest	7th Highest
Percent of Average	127%	91%	90%
1993-1997 Change	N/A	12.2%	4.7%
1995-1997 Change	N/A	2.9%	1.2%

Source: The Doolittle & Associates Team, 1999.

As shown in Exhibit E above, Metro Transit reported 27% more work hours than the peer system average, but a 10 percent lower work hour rate per maximum service bus and vehicle miles than the peer transit systems. However, the reported work hours

[10]The number of buses signed out for service during the evening rush hour.

raise questions about the effectiveness of Metro Transit's maintenance operation, particularly given its low service reliability rates shown in Exhibit C.

The higher work hour rates and number of work hours were also a concern because the Vehicle Maintenance Section's overtime expenditures have exceeded the annual overtime budget by approximately $0.5 million to $1.3 million during the five-year review period. While excess overtime expenditures are not unusual in the transit industry, Metro Transit's work hours and reliability statistics suggested that the maintenance function might not be appropriately managed and staffed. In addition, maintenance statistics and comparative analysis suggest that Metro Transit could improve its maintenance performance by limiting overtime assignments to priority workloads or emergent conditions instead of routinely assigning overtime hours, establishing shop rate standards, and through better management oversight and reporting.

Metro Transit's Backlog Report Did Not Accurately Reflect Mechanical Workload Priorities and Exceeded Available Staff Resources.

Typically, a repair backlog provides a reserve of lower priority work that can be completed when routine work demands slow down. The Vehicle Maintenance Section categorizes its maintenance backlog into 3 categories: non-project backlog, project backlog, and body shop (non-mechanical) repairs. Metro Transit developed a "backlog standard" for the routine, non-project backlog levels at each base, and a standard to maintain the non-project backlog between about .5 and 2.0 labor hours per assigned bus. No standards were established for the backlogged projects or body shop repairs.

A weekly management report is produced for each maintenance base that displays the estimated backlog hours for the three categories of repairs based upon open or incomplete work orders. Exhibit F below displays the one backlog standard and the work hours for the three backlog categories for the six maintenance bases. (Note that the Atlantic, Ryerson, and South bases do not have body shops, and the Ryerson base does not have a project backlog because its fleets will be retired within the next two years.)

EXHIBIT F
Comparison of Backlog Standard and Workload

Base	Buses Assigned	Backlog Hours Based on Standard	Routine Backlog Hours	Project Backlog Hours	Body Shop Hours	Total Backlog Hours
Atlantic	191	96 to 382	535	538	NA	1,073
Central	170	85 to 340	517	3,823	2,887	7,227
East	226	113 to 452	575	729	6,908	8,212
North	218	109 to 436	395	921	7,400	8,716
Ryerson	172	86 to 344	348	NA	NA	348
South	269	135 to 538	415	49	NA	464
All Bases	1,246	623 to 2,492	2,785	6,060	17,195	26,040

Source: Metro Transit Fleet Inventory, Vehicle Maintenance Plan, and Backlog Reports (1977).

As shown in Exhibit F above, the routine backlog hours were generally within or close to the established standard for three bases, and moderately higher than the standard for the three other bases. However, the project backlog hours doubled the workload for four of the six bases, and the total backlog of 6,060 hours was more than double the 2,492 backlog hours considered manageable system-wide for routine workload. As a result, project backlog at several bases was frequently scheduled as overtime workload since the work could not be completed during the standard workday.

However, the total project work hours reflect work orders routinely opened for one bus model (i.e., all Gilligs, New Flyers) or across the entire fleet, so that a substantial backlog is often created that may not be crucial to the safe operation of buses. While maintaining a backlog of lower priority projects for slower periods is reasonable, the backlog report should distinguish the work hours required for immediate repairs, repairs that can be reasonably deferred for a short period of time, or repairs that can be completed at any time.

The non-mechanical body shop work hours were also very high, and the 26,040 backlog hours were well above the available work hours given that only 14 FTEs were allocated to Metro Transit's three body shops. In fact, the body shop backlog would fully consume the estimated 26,320 work hours (minus holiday and leave time) available for 14 FTEs during an annual period without any other new or routine body shop repairs. Thus, the body shop backlog, as reported, is not realistic for Metro Transit's in-house resources and significantly inflates the overall reported backlog.

Metro Transit's Reported Backlog and Overtime Practices Raise Questions About the Management of Maintenance Staffing and Resources.

Metro Transit's reported backlog and use of overtime for lower priority reserve workload raises questions about the management of the maintenance function. For example, questions are raised about the reasonableness of paying overtime for non-critical workload, particularly when annual overtime appropriations are exceeded. Questions are also raised about whether the overtime resources might better be allocated to tasks associated with improving daily performance and reliability of routine bus service, such as identifying and correcting problems that result in high frequency repairs.

It should be noted that Metro Transit has a supervisor, 3 chiefs, and three to five lead workers at each base to manage maintenance personnel and the assigned workload. The current supervisor/chief/lead to staff ratio is 1:7.7 for the six bases, which is generous given the repetitive nature of the mechanical workload. Thus, it seems reasonable that the routine maintenance workload could be reasonably completed during the three daily shifts unless emergency conditions arise (e.g., storms), and any additional staff resources could be targeted to improved bus service reliability.

Metro Transit Has Not Established Shop Standards for Routine Maintenance and Repair Activities.

Metro Transit has not established shop standards for its routine maintenance repairs even though maintenance organizations generally use flat rate standards (i.e., manufacturer's suggested time standards for routine maintenance and repair activities), or develop internal shop standards based upon their own

equipment and facilities. Even though the Metro Transit Amalgamated Transit Union Local #587 collective bargaining agreement prohibits the adoption of time estimates contained in flat rate mechanic manuals, Metro Transit management retained the right to establish internal shop rate standards.

Although Metro Transit has not established its own standards, the mechanics themselves have developed informal shop standards. For example, the preventive maintenance inspectors maintained hand-written time guidelines in their inspection manuals, which suggest the length of time required to complete various types of inspections (e.g., at 3,000, 6,000, 15,000 mile intervals, etc.) for different buses. Mechanics also verbally quoted routine repair times that were consistently within a one-hour range for specific repairs, but these repair time standards were not available in writing.

Metro Transit's Labor Hour Detail Report creates a rolling standard of repair times for each reporting period based upon the average of all repair hours charged to the same repair code during the reporting period. This maintenance information system report is generally not considered reliable because an adequate number of repair codes are not available to distinguish among repair types. However, if an adequate number of codes were developed, the report and repair time data could be used for the initial development of Metro Transit's work standards.

The Maintenance Management Information System Does Not Provide Adequate Repair Scheduling or Performance Information for Management.

Metro Transit's management information system is a good work order system that provides historical maintenance and repair information. However, the management reports generated by the system do not accurately portray the effectiveness of the maintenance program. For example, repeated repairs are commonly reviewed by Metro Transit and other major maintenance organizations as a measure of effective maintenance performance, (i.e., the ability to correctly identify mechanical problems). Consequently, it was impossible to determine from the information system reports whether or not multiple repairs performed on the same vehicle were repeated repairs or similarly coded repairs that were for other repair items. In fact, the analysis of an extract of repeated repairs for major repair items (e.g., axles, brakes, and transmissions) and for high frequency repairs (wheelchair lifts, doors, and electric) indicated that the report was not a useful management tool due to coding issues. Approximately 66 percent of the items reported as repeated repairs for major repair items and 49 percent of the items reported as repeated repairs for high frequency repair items shown on one report were actually follow-up repairs for maintenance problems identified during maintenance inspections or roadcalls rather than repeated repairs.

Repair Codes Not Sufficiently Detailed to Easily Identify Frequency of Repeated Repairs

Although individual work orders were also reviewed to identify the frequency of repeated repairs, it was not possible to determine whether identical items were repaired given the codes used by the mechanics. For example, based upon an analysis of work orders for repair items with the same code, it was clear that multiple repairs were often grouped under one repair code

rather than broken down into a series of more specific repair codes. Exhibit G below, generated by the maintenance reporting information system, displays some obvious discrepancies in repair times that were identified during the audit.

EXHIBIT G
Differences in Unit Change and Replacement Hours and Cost Reflecting Potential Coding Errors

Item Description	High Hours	Low Hours	Difference High-Low	Average Hours
BRAKING SYSTEM				
Reline-2nd	10.0	2.0	8.0	4.17
Gasket(s)	6.0	0.5	5.5	1.39
Rocker Arm(s)	5.5	0.5	5.0	1.16
Motor Mount	8.0	1.0	7.0	3.25
Engine R&R	10.0	0.1	9.9	6.59
Belts	4.0	0.5	3.5	1.17
AXLE, DIFFERENTIAL PROPELLER SHAFT				
Seals/Wipers	7.0	1.0	6.0	2.16
SUSPENSION				
Level Valve	8.0	1.0	7.0	1.24
Transmission	9.5	0.1	9.4	4.42

Source: Extract from 1997 Maintenance Information Reporting System and 1997 work order forms. (Please see Appendix 2 for additional examples of repair coding discrepancies.)

As shown in Exhibit G, the repair times varied for similarly coded items for the same buses between a range of 3.5 and 9.9 hours. Based on the review of the actual work orders, the repair times varied because the work items were miscoded. For example, multiple items were often grouped together under one general repair code.

Similarly, coding issues were also identified for the inspections workload during the audit. That is, repairs were often completed and charged off to inspection codes rather than repair codes. As a result, it was not possible to determine whether the repair times were reasonable based on information generated by the

maintenance management information system. Thus, the information was not useful to the maintenance supervisors and chiefs.

It should also be noted that a maintenance management report was not available on the availability of buses, in good operating condition, for daily peak bus service. As noted earlier, the Vehicle Maintenance Section's highest priority is to ensure that a sufficient number of buses are available to meet daily service requirements. Given the importance of maintaining an adequate number of buses for service, it would be reasonable to develop a management report that specifically documents daily performance in relation to service requirements. This and other management information issues can be addressed as Metro Transit implements its new management information system.

Metro Transit Vehicle Maintenance Section's Goals and Objectives Were Not Meaningful.

Although Metro Transit's Vehicle Maintenance Section established goals and objectives for 1996-1997, the Vehicle Maintenance Manager indicated that many of the goals and objectives were not meaningful. Only one performance objective was quantified (e.g., increase the miles between trouble calls by five percent), but the Vehicle Maintenance Manager indicated that the five percent objective was unrealistic due to the frequency of mechanical breakdowns and electrical problems associated with Metro Transit's current fleet. Another noteworthy objective in 1996-97 was to convene a supervisory panel to determine measurement indicators and accountability values for customer complaints, trouble calls, base delays, coach out-of-service reports, mechanical backlog, and overtime hours. However, that objective was not achieved.

Many other important objectives were also established, such as

effectively managing the use of new technology to promote operational efficiencies and improve service effectiveness, or actively participating in defining the new government's procedures and in streamlining processes to ensure effective services. However, these objectives were so broadly structured that it was not possible to measure specific performance in 1996-97 in relation to the goals. Other than the important overarching goal of implementing the Six-Year Plan, which was achieved by the Vehicle Maintenance Section, the 1996-97 goals and objectives did not appear to be operationally useful.

RECOMMENDATIONS

2-4-1 Metro Transit should review its current maintenance practices to determine why its service reliability rates are not consistent with its lower work hour (e.g., higher productivity) levels.

2-4-2 Metro Transit should improve its maintenance backlog report to accurately reflect priority and non-priority workload. Overtime resources should not be used for non-priority workload. Consideration should also be given to using overtime to reduce mechanical problems that result in frequent interruptions and trouble calls.

2-4-3 Metro Transit should establish shop rate standards for inspections and maintenance tasks for its buses and bases. In addition, Metro Transit should ensure that its new maintenance management information system has a sufficient number of codes and management reports so management can routinely identify exceptions to the established standards and inconsistent maintenance and repair performance. A management report should also be developed to determine whether a sufficient number of buses were signed out to meet daily service requirements.

2-4-4 Metro Transit should develop meaningful goals and objectives that promote improved performance in the maintenance and repairs of its fleet.

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3 MATERIALS MANAGEMENT AND INVENTORY PRACTICES

Metro Transit's Materials Management and Parts Inventory Sections are responsible for purchasing parts to repair and maintain its buses in safe operating condition; identifying and coordinating the disposal of obsolete and surplus parts; and for maintaining an accurate parts inventory. The Materials Management Section purchases electrical components, engines, transmissions, and other parts valued at approximately $23 million annually to repair and maintain its active buses. The Parts Inventory Section maintains an extensive inventory of more than 22,000 items valued at more than $13.5 million at six maintenance bases and the component supply center parts room.

This chapter provides a comparative analysis of Metro Transit's total materials costs and unit costs to those of 12 peer transit systems. It also reviews the effectiveness of Metro Transit's materials and inventory management practices, including transit inventory controls.

Three Important Principles Adhered to by Agencies With Well-Managed Materials and Inventory Management Functions.

In the transit industry, a balance must be maintained between the availability of parts to meet maintenance and repair demands, the personnel costs for purchasing and inventory management, and the loss of maintenance work hours and, ultimately, service if needed parts are not available. Nevertheless, three important principles are commonly adhered to in organizations with well-managed materials and inventory

management functions: (1) parts inventories are maintained at reasonable levels; (2) no unnecessary items are purchased and added to the inventory; and (3) items that are no longer used are removed from the inventory.

Standards Were Established to Measure the Effectiveness of Parts Purchasing and Inventory Practices

Two standards are commonly used to measure the effectiveness of transit materials management and parts inventory practices and internal controls.[11] The first measure is the inventory turnover ratio (or number of inventory turns), which is the ratio of the total inventory purchase costs for the year and the actual inventory costs for the annual period at any given time. An inventory turnover rate between four to six turns annually is generally considered desirable, and Metro Transit Component Supply Center management indicated that four inventory turns per year were reasonable for a well-maintained transit parts inventory. Maximizing inventory turns is achieved by effective parts purchasing to maximize the availability and use of parts, and by minimizing obsolete and surplus parts inventory.

The second measure is the inventory record accuracy rate, which is the ratio of parts reported in the inventory system and the actual parts physically located on the shelf. Generally, a 95 percent inventory accuracy rate with a ± 5 percent tolerance is considered reasonable, and the Metro Transit Component Supply Center Base Supervisor indicated that a 98.5 percent inventory accuracy rate was a reasonable standard for a well-maintained transit parts inventory. Inventory record accuracy is maximized by recording all parts transactions properly and by safeguarding parts against waste, loss, and misuse. An accuracy rate below 90 percent generally means that the parts

[11]The following references address inventory record accuracy and turnover rates: Brooks, Roger B. and Wilson, Larry W., Inventory Record Accuracy: Unleashing the Power of Cycle Counting, (1995), pp. 22-23.
Waters, C.D.J., Inventory Control and Management, (1992), pp.11-21.

and quantity data are not reliable for purchase planning and maintenance scheduling purposes.

FINDING 3-1 **METRO TRANSIT'S MATERIALS COSTS WERE SUBSTANTIALLY HIGHER IN 1997 THAN THE PEER TRANSIT SYSTEMS AVERAGE COSTS AND TWICE THE PEER TRANSIT SYSTEM AVERAGE COSTS PER VEHICLE MILE AND MAXIMUM SERVICE BUS.**

Approximately 48 percent of Metro Transit Vehicle Maintenance Section's $54 million annual budget was allocated to materials costs during the past five years. Exhibit H below displays Metro Transit's 1997 total materials costs and unit costs per vehicle mile and per maximum service bus compared to the 12 peer transit systems.

EXHIBIT H
Comparison of Bus Maintenance Materials Costs

Agency	Total Material Costs	Percent of Total Maintenance Cost	Per Total Vehicle Mile	Per Maximum Service Bus
King County Metro	$22,794,831	48.7%	$0.60	$25,498
Baltimore	8,570,280	26.6%	$0.36	$11,130
Cleveland	7,185,896	26.6%	$0.28	$11,957
Dallas	12,745,845	37.1%	$0.39	$18,105
Denver	9,541,913	27.3%	$0.25	$13,710
Houston	17,892,461	30.0%	$0.41	$19,136
Milwaukee	3,061,588	18.0%	$0.16	$6,927
Minneapolis	4,594,043	18.8%	$0.16	$6,085
Oakland	6,972,148	22.4%	$0.32	$12,042
Pittsburgh	9,325,289	25.0%	$0.30	$12,335
Portland	6,480,070	29.3%	$0.26	$12,583
San Francisco	4,622,931	17.0%	$0.33	$12,771
St. Louis	6,353,280	31.8%	$0.27	$12,033
Peer Average	$8,112,145	25.8%	$0.29	$12,401
Rank	1st Highest	1st Highest	1st Highest	1st Highest
Percent of Average	281%	189%	206%	206%

SOURCE: The Doolittle & Associates Team, 1999.

As shown above, Metro Transit's 1997 materials costs were

$22,794,831, or 48% of the total maintenance budget. The material unit costs were $25,498 per maximum service bus, or $0.60 per vehicle mile. The total and unit materials costs in 1997 were the highest among the peer transit systems. In fact, Metro Transit's total materials costs were 281% of the peer average, and the costs per total vehicle mile and maximum service bus were both 106% more, or double the peer transit system average. In addition, Metro Transit's materials cost as a percent of maintenance were almost twice the cost of the peer transit system average of 25.8%.

Substantially Higher Material Costs Indicated that Materials Management Practices Were Not Cost-Effective

Metro Transit's substantially higher materials costs indicated that its materials management practices were not cost-effective. Finding 3-2 and 3-3 below discuss service factors contributing to Metro Transit's high materials costs, and recent efforts to reduce material costs through improved materials and parts inventory management practices.

RECOMMENDATION

3-1-1 Metro Transit should implement materials management practices, consistent with the Transportation Research Bureau, that will effectively reduce costs to levels consistent with the other peer transit systems. Cost-effective materials management practices include controlling the growth of the surplus inventory through selective purchasing practices for new fleets, restricting new purchases for all parts based on established usage patterns, and ensuring that stock is reduced to minimum levels at all bases prior to ordering new stock. (Please also refer to additional recommendations at the conclusion of Finding 3-3.)

FINDING 3-2

METRO TRANSIT'S MATERIALS AND PARTS INVENTORY MANAGEMENT PRACTICES WERE NOT EFFECTIVE, RESULTING IN EXCESSIVE PARTS PURCHASING, POOR INVENTORY PERFORMANCE, AND INEFFICIENT USE OF TAXPAYER RESOURCES.

The Vehicle Maintenance Section's primary objective is to ensure that a sufficient number of buses are available in safe operating condition to meet scheduled service requirements. The Materials Management and Parts Inventory Management Sections provide the parts required to maintain the buses in good operating condition. Ideally, the parts needed for both scheduled and unscheduled repairs should be available 100 percent of the time, according to Component Supply Center management.

Based on the results of a 1996 informal survey conducted by one Metro Transit vehicle maintenance base supervisor, 97 percent of the required parts were on hand to complete repairs. According to the Materials Management and Parts Inventory Chiefs, the 97 percent availability rate was not satisfactory to Vehicle Maintenance management, because buses could be withheld from service if the correct parts were not available for critical repairs.

The 97 percent parts availability rate was also considered to be unsatisfactory because the parts purchasing and inventory functions did not have the financial resource or storage constraints that are common in other non-transit organizations. The Materials Management Section had a substantial annual parts budget, and the parts rooms located at the maintenance bases were adequate to accommodate large quantities of parts, including surplus stock. In addition, it was not necessary to level

out inventories among the bases to maximize the use of space prior to purchasing new stock.

Parts Purchasing Outpaced the Demand for the Types and Quantities of Available Parts

Metro Transit adopted a 100 percent parts availability standard in 1997 for its six maintenance facilities and decentralized some materials and inventory management functions to give the base supervisors and chiefs greater control over parts required for scheduled repairs. However, maintenance base personnel ordered new parts that were already in stock at other bases and ordered stock in quantities higher than the quantities recommended by the Materials Management Section (i.e., three-month supply). The result of Metro Transit's decentralized inventory functions and focus on immediate parts availability was that parts purchasing outpaced the demand for the types and quantities of parts available in the inventory system-wide.

In addition, Metro Transit's ineffective parts purchasing practices resulted in a low inventory turn rate that averaged only one and a half turns annually during the past three years. The inventory turn rate was substantially lower (62 percent to 75 percent) than the generally recommended inventory standard of four to six turns annually. A recent Transportation Research Bureau publication confirmed that the better public transit agencies turned inventories four or more times annually.[12]

Metro Transit's low parts inventory turn rate was previously identified as an issue in a 1995 internal audit. The audit determined that 36 percent of the $4.9 million parts inventory in 1994 has not been used during the past 12 months, and 9 percent of the total inventory had not been used during the past five years. The audit recommended that Metro Transit reduce its

[12] Transportation Research Bureau, Research Results Digest (November, 1996), page 14.

parts inventory by eliminating obsolete and surplus items. Although parts have been eliminated from the inventory since the 1995 audit, the 1997 inventory turn rate remained well below the established standard because new parts purchasing continued to exceed repair demands, and obsolete and surplus parts were not sufficiently reduced.

New Parts Purchased Are Not Likely to Be Used, Including $1.9 Million of Breda Parts

Several other factors contributed to Metro Transit's continuously low inventory turn rate. New parts were also purchased when vendors discontinued manufacturing or supplying parts that are not likely to be used, such as $1.9 million worth of Breda parts. In addition, parts were fabricated in-house that reduced or replaced the demand for new stock already listed in the parts inventory. Because newly fabricated parts were not consistently entered into the Integrated Business Information Systems (IBIS) inventory system, some new parts were also reordered when less costly fabricated parts were still available for repairs.

Another important factor that contributed to the low inventory turn rate was Metro Transit's adopted practice of *gradually* reducing surplus items from the inventory. The practice of gradually reducing surplus stock was instituted in 1996 after the Valley Daily News published an article criticizing Metro Transit for selling $1.5 million of retired buses and surplus parts, including new packaged and crated parts, for only $80,000 or six percent of the original transaction value. The media and public perceived that Metro Transit's purchasing practices were wasteful due to the large number of surplus parts sold and the small amount of revenue generated from the sale of the surplus transit parts.

Sale Proceeds on Surplus Metro Transit Parts Were Only a Fraction of the Original Transaction Values, Resulting in a Loss of Taxpayer Resources.

In fact, the significant risk of overstocking parts is that the sale proceeds on Metro Transit surplus parts are generally only a fraction of the original transaction values, resulting in the inefficient use of taxpayer resources. King County Property Services estimated that the sale proceeds from surplus property generally averaged 10 percent of the original transaction value, so the six percent received on surplus parts from the 1996 auction was relatively consistent with the expected return. It was also consistent with the eight percent return ($46,515) received in June 1998 from the sale of surplus transit parts with an original purchase price of $611,800. Again, many of the surplus transit parts sold at the 1998 auction were still in the original packages and crates.

Practices Required to Balance Immediate Need for Parts and Long-Term Cost Effectiveness of Parts Purchasing

Rather than gradually reducing large quantities of surplus stock to avoid perception issues, Metro Transit could establish policies and practices that balance the immediate needs for parts and long-term cost effectiveness of the purchasing functions. For example, more cost-effective practices include controlling the growth of the surplus inventory through selective purchasing practices for new fleets, restricting new purchases for all parts based on established usage patterns, and by ensuring that stock is at minimum levels at all bases prior to ordering new stock. Parts quantities could also be reduced to reasonable levels before new parts are fabricated in-house. According to the Transportation Research Bureau, commercial firms and better managed public transit agencies also arranged quick delivery of parts from local dealers and guaranteed overnight delivery from an in-house or vendor warehouses.

Materials Management Section Is Now Selectively Purchasing New Parts

Because Metro Transit's newer fleets or major fleet components were procured from bus manufacturers in the United States, the Materials Management Section is now more confident that parts will be readily available when new orders are placed. Consequently, the Materials Management Section is now selectively purchasing parts from the original equipment manufacturers' recommended parts lists. That is, the Materials Management Section is reviewing past experience with different fleets to make decisions about the type and quantity of parts to stock rather than relying on the manufacturers' listings. In addition, the Materials Management Section is currently including vendor buy-back agreements in its procurement contracts, and is making a greater effort to level out parts among the bases prior to ordering new parts and as parts are reordered for the newly procured fleets.

Finally, a full-time transit parts specialist was recently assigned to the component supply center parts room to assist the Parts Inventory Chief with system-wide inventory improvements. The transit parts specialist will be responsible for reviewing the existing parts inventory to determine which surplus parts can be returned to vendors for credit and which surplus parts can be removed from the inventory and sold at County auctions.

RECOMMENDATION

Please see recommendations at the conclusion of Finding 3-3.

FINDING 3-3

METRO TRANSIT'S PARTS INVENTORY PRACTICES AND INTERNAL CONTROLS WERE INADEQUATE AND INCONSISTENT WITH FEDERAL TRANSIT INDUSTRY INVENTORY CONTROL STANDARDS.

The majority of the Metro Transit's parts for new buses are purchased with FTA grant funds. FTA Circular #5010.1B requires transit agencies to establish and maintain adequate internal controls to ensure that the grant-funded resources, including Metro Transit's parts inventory, are properly used and safeguarded. The FTA pro-visions specify that grantees: 1) adopt internal control policies, plans, and procedures that safeguard assets against waste, loss, and misuse; 2) ensure the accuracy and reliability of financial, statistical, and other reports; and 3) assure that personnel have the experience and training to perform assigned functions.

FTA Provisions Specify Safeguarding of Assets and Accurate and Reliable Reporting

Despite FTA provisions that specify safeguarding of assets and the maintenance of accurate and reliable reports, Metro Transit's 79 percent inventory accuracy rate was substantially below the recommended 90 percent inventory accuracy standard. Practices that contributed to the low inventory accuracy rate Included:

- Unsecured and unattended parts rooms and unauthorized withdrawal of materials;
- Incomplete records of parts transactions;
- And assignment of parts oversight functions to personnel who were unfamiliar with inventory management policies and practices.

These practices were not only inconsistent with the FTA policies, but were also inconsistent with commonly accepted materials management and internal control practices. The relevant Metro

Transit inventory management and internal controls issues are described in detail below.

Security at Metro Transit's Parts Rooms Was Inadequate.

The security at Metro Transit's base and component supply center parts rooms was inadequate. Metro Transit indicated that it was not financially feasible to staff the parts rooms at the six maintenance bases on the weekends,[13] or to staff the component supply center parts room at all, because the volume of repairs on the weekends was substantially less than the weekday repair volume. In addition, the majority of transit parts stored in the parts rooms could not be used for non-transit vehicles. Metro Transit's official policy was to lock the parts room doors throughout the weekends and to lock the component supply center parts room at all times. However, the locked door policy was not enforced at the maintenance bases or at the component supply center.

Open Door Policy for Parts Room Creates Condition in Which Parts Are Not Controlled

In fact, the parts room doors generally remained open because the base chiefs and lead mechanics, who were responsible for inventory management during weekend shifts, were frequently unavailable to sign out parts to mechanics. Thus, the open door policy creates a condition in which materials can be taken.

In addition, the mechanics, who independently signed out parts on the weekends, did not consistently note which parts were drawn from the inventory on the *Material Disbursed From Stock* form. Consequently, complete parts transaction data were not available and not entered into the Integrated Business Information Systems (IBIS) parts inventory. The open door practice not only led to inaccurate IBIS inventory counts, but also

[13]Metro Transit's part rooms are generally left unattended from Friday evening to Sunday evening.

to delays in reordering frequently used transit parts at specific maintenance bases, because the IBIS inventory system tracks the quantities of parts on hand.

Unless parts transactions are consistently and accurately entered into the IBIS inventory system, the system will not prompt reordering of depleted parts in a timely manner. The Transportation Research Bureau indicated that the better transit organizations keep meticulous track of their stock to avoid repairs being halted for lack of parts.[14] The Bureau reported that inaccurate inventory records contribute to parts shortages and disrupted repair schedules, excess inventory of parts that are not needed, lower work hours, poor delivery performance, and excessive expediting because maintenance personnel were required to react to situations rather than plan for the future.

Existing Policies and Procedures for the Materials Management and Parts Functions Were No Longer Relevant to the Decentralized Operation.

Metro Transit's existing materials and inventory management policies and procedures, which were developed in 1983, were also not relevant to the currently decentralized operation. Although bulletins were disseminated to address important materials management and part inventory concerns, no mechanism was developed to promote accountability and consistency among the many personnel who assumed responsibility for the function. For example, base supervisors, who were responsible for determining the status of missing records could be adjusted. It should be noted that inventory

[14] According to the Transportation Research Board, the methods used by the better transit organizations to track and reorder parts varied widely by complexity of the inventory, and ranged from computerized parts lists linked to a national warehouse to a simple scheme by which mechanics who found a low stock condition dropped a card on the stockman's desk.

errors of $139,194 (net)/$762,329 (gross)[15] were identified in 1996 and errors of $147,546 (net)/$651,472 (gross) were reported in 1997. The net and gross error figures as a percent of the overall value of the parts inventory were non-material.

Personnel Assigned to Parts Oversight on Weekends Were Not Trained in Inventory Management

Even though the FTA requires personnel assigned to parts inventory functions to be familiar with inventory management, Metro Transit assigned base personnel, who were generally not trained in inventory management practices and the IBIS inventory system, to routine parts tasks and oversight functions. This was a particular concern to the transit parts specialists who were responsible for troubleshooting parts problems with other maintenance personnel, including superiors who did not fully understand important IBIS inventory system weaknesses. For example, the IBIS system allows one base to transfer parts to or from a second base without the second base's knowledge. In fact, inconsistent parts inventory practices and oversight contributed to the uncertainty about the current parts stock, which was a common concern expressed by both Metro Transit management and staff.

The Component Supply Center base supervisor, who is responsible for Materials Management and Parts Inventory Sections, acknowledged that personnel assigned to the week-end parts function were not trained in inventory management and did not consistently adhere to accepted inventory practices. However, the supervisor believed that many current inventory accuracy issues were not driven by staffing limitations, but by the absence of clear policies and procedures for the decentralized parts operation. Metro Transit planned to develop new polices

[15]Gross inventory errors are calculated by adding together the difference between the total cost of the number of items physically counted and the cost of the items that were either above or below the number of items accounted for in the IBIS system. Net inventory errors are calculated by subtracting the total cost of the items not located during the cycle counts from the cost of the items located that were in excess of the number of items accounted for in the IBIS system.

and procedures, following the implementation of a new inventory management system, based on the best inventory management practices of other transit systems. Metro Transit is also considering reasonable enforcement mechanisms that could be established to encourage compliance with the new policies and procedures.

RECOMMENDATIONS

3-3-1 Metro Transit should conduct a physical inventory of its existing stock to develop accurate parts inventory records to ensure that inventory is maintained at reasonable levels (i.e., no unnecessary items are added to the inventory) and that materials costs are reduced to reasonable levels. A method should also be developed to account for parts that are fabricated in-house to avoid purchasing duplicate new parts that contribute to higher material costs.

3-3-2 Metro Transit should ensure that all items which are obsolete should be removed from the inventory in a timely manner.

3-3-3 Metro Transit should complete its review of other transit organizations to identify and adopt best materials and parts inventory management practices, including methods identified by the Transportation Research Bureau to reduce its materials costs and improve both its inventory turn rate and inventory record accuracy rate.

3-3-4 Metro Transit should complete and adopt formal materials management and inventory policies and procedures for the decentralized materials management and inventory operations. Adherence to adopted policies and procedures should be reinforced during management meetings, employee orientations,

staff meetings, and other training opportunities.

APPENDICES

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APPENDIX 1

METRO TRANSIT FLEET MIX

Coach Numbers	Coach Name	Coach Type	Number Assigned	Not Assigned	Total Coaches
900-1009	1979 AMG	40’ Trolley	102	7	109
1400-1550	1978 MAN	60’ Diesel	73	9	82
1600-1823	1979 Flyer	40’ Diesel	0	70	70
1850-1884	1980 Flyer	35’ Diesel	2	20	22
2000-2201	1982/83 MAN	60’ Diesel	201	0	201
3000-3159	1986/87 MAN	40’ Diesel	157	0	157
3185-3199	1997 GILLIG	35’ Diesel	13	2	15
3200-3544	1996/97 GILLIG	40’ Diesel	345	0	345
4000-4045	1987 MAN	60’ Trolley	46	0	46
5000-5235	1990-91 BREDA	60’ Dual Mode	236	0	236
5500-5520	1994/95 Champion	21’ Gasoline	9	0	9
5600-5688	1996/97 Champion	25’ Diesel	69	1	70
Total Fleet			1,253	109	1,362

Note: Twelve (12) of Metro Transit’s 1374 coaches are historic coaches that were excluded from the fleet count shown above.

Source: Metro Transit (September 30, 1997).

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APPENDIX 2

DIFFERENCES IN UNIT CHANGE AND REPLACEMENT HOURS AND COST REFLECTING POTENTIAL CODING ERRORS

Repair Entries	Repair Item	Item Verb description	Total Hours	Total Cost	High Hours	Low Hours	Hours Average	High Cost	Low Cost	Cost Average
AXLE, DIFFERENTIAL PROPELLER SHAFT										
20	402	DIFFERENTIAL	101.0	2,083.45	8.0	2.0	5.05	165.68	41.42	104.17
29	412	STUDS	42.0	870.93	4.0	1.0	1.45	82.84	10.36	30.03
171	415	SEALS/WIPERS	369.0	7,649.60	7.0	1.0	2.16	144.97	10.36	44.73
22	425	HUB	62.0	1,284.00	7.0	1.0	2.82	144.97	10.36	58.37
18	459	RING SEAL	29.5	598.98	4.0	1.0	1.64	82.84	10.36	33.28
BRAKING SYSTEM										
25	1000	1000/7000 BRAKE	58.0	1,201.21	8.0	1.0	2.32	165.68	20.71	48.05
61	1007	APPLICATION VALVE	148.8	3,080.73	6.0	0.3	2.44	124.26	6.21	50.50
85	1009	SLACK ADJUSTER	106.3	2,206.82	4.5	1.0	1.25	93.2	20.71	25.96
25	1012	S-CAM BUSHINGS	38.1	789.09	3.5	0.5	1.52	72.49	10.36	31.56
19	1017	LININGS-2ND AXLE	62.5	1,290.26	8.0	2.0	3.29	165.68	41.42	67.91
20	1048	COMPLETE RELINE-1ST	59.5	1,246.76	7.5	1.0	2.98	155.33	22.78	62.34
69	1049	COMPLETE RELINE-2ND	261.0	5,434.40	8.0	1.0	3.78	165.68	20.71	78.76
322	1049	COMPLETE RELINE-2ND	1,343.1	27,911.49	10.0	2.0	4.17	207.10	41.42	86.68
91	1050	COMPLETE RELINE-3RD	309.0	6,391.25	8.0	1.0	3.39	165.68	20.71	70.23
12	1071	ROTOR/DISC	19.7	411.09	6.0	1.0	1.64	124.26	20.71	34.26
53	1600	1600/7600 ENGINE	54.7	1,133.93	5.0	0.5	1.03	103.55	10.36	21.39
58	1603	LINES/FITTINGS	76.5	1,592.72	4.0	0.5	1.32	82.84	10.36	27.46
52	1609	FASTENERS	59.3	1,232.39	6.0	0.5	1.14	124.26	10.36	23.70
54	1612	FILTER (AIR)	32.9	682.59	4.0	0.5	0.61	82.84	10.36	12.64
113	1621	GASKET(S)	156.6	3,280.80	6.0	0.5	1.39	124.26	10.36	29.03
41	1622	SEAL(S)	76.4	1,630.98	6.0	0.5	1.86	136.68	10.36	39.78
210	1631	ROCKER ARM(S)	243.2	5,046.05	5.5	0.5	1.16	113.91	10.36	24.03
116	1645	MOTOR MOUNT	377.5	7,780.95	8.0	1.0	3.25	165.68	20.71	67.08
18	1648	TURBO	44.1	920.79	5.0	0.1	2.45	103.55	2.28	51.16
29	1655	HOSES/PIPING	29.8	616.20	3.5	0.5	1.03	72.49	9.32	21.25
185	1657	ENGINE R&R	1,220.0	25,400.44	10.0	0.1	6.59	207.10	2.07	137.30
146	1658	BELTS	170.2	3,542.81	4.0	0.5	1.17	82.84	10.36	24.27
36	1659	IDLER PUL ASSBL	36.9	765.30	4.0	1.0	1.03	82.84	20.71	21.26
20	1691	BRACKETS	14.0	290.01	3.0	0.5	0.70	62.13	10.36	14.50
SUSPENSION										
15	2500	SUSPENSION	34.5	714.53	6.0	0.5	2.30	124.26	10.36	47.64
127	2505	LEVEL VALVE	156.9	3,248.39	8.0	1.0	1.24	165.68	20.71	25.58
70	2509	BRACE ROD	254.0	5,242.89	8.0	0.5	3.63	165.68	10.36	74.90
36	2522	AIR BAG-3RD AXLE	1.0		8.0	1.0	1.82	165.68	20.71	37.51
68	2532	A-ARM BUSHING 1ST AXLE	238.0	4,929.07	8.0	1.0	3.50	165.68	20.71	72.49
105	2700	TRANSMISSION	464.0	9,650.99	9.5	0.1	4.42	196.75	2.28	91.91
15	2708	LINES/FITTINGS	18.3	379.03	7.0	1.0	1.22	144.97	20.71	25.27
TUNE UP										
27	7615	TUNE-UP	23.0	482.94	4.5	0.1	0.86	93.20	2.28	17.89

Source: Metro Transit Management

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APPENDIX 3

EXECUTIVE RESPONSE

King County Executive
RON SIMS

RECEIVED
SEP 17 1999
KING COUNTY AUDITOR

September 15, 1999

Don Eklund
King County Auditor
Room 402
COURTHOUSE

Dear Mr. Eklund:

Thank you for the opportunity to review and respond to your preliminary draft audit report of the Metro Transit Vehicle Maintenance Operations dated August 27, 1999. We appreciate the thoroughness and professionalism of the audit staff.

Members of my staff have reviewed the preliminary draft audit report and concur with the recommendations. Our staff has already made significant strides in addressing many of these recommendations as noted in our enclosed response. We will persevere to implement the remainder of the recommendations as we work toward continuous improvement and cost-effectiveness in this section. I want to emphasize the demonstrated long-term success of the Department of Transportation's Transit Division Vehicle Maintenance Section in providing safe and reliable buses on the road every day. The Transit Division operates and maintains over 1,250 buses carrying over 300,000 passengers daily. For the six years from 1992 through 1997, Metro Transit's bus fleet has logged an average of 40 million miles per year. During that time, only four accidents were attributed to mechanical failure. That safety record is a testament to the skills and effectiveness of the people who work in our Vehicle Maintenance Section. My office and the Department of Transportation are committed to providing safe, reliable and efficient transportation for the region.

For ease of presentation, our response is referenced to each of the recommendations contained in the Auditor's preliminary draft report.

Again, thank you for the opportunity to respond to your draft report.

Sincerely,

Ron Sims
King County Executive

Enclosure

KING COUNTY COURTHOUSE 516 THIRD AVENUE, ROOM 400 SEATTLE, WA 98104-3271
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Attachment

Executive Response to Draft Management Audit Report:
Metro Transit Vehicle Maintenance Operations

Vehicle Maintenance Operations

Recommendations

2-1-1 Metro Transit should continue to promote uniformity in its fleet as older buses are replaced to reduce its overall maintenance costs, including materials costs, and to improve the reliability of its fleet.

Executive Response:
Agree. Metro Transit continues to support uniformity of its fleet with its bus procurements, currently introducing 274 New Flyer (and has exercised an option for an additional 30 units) and 95 30' Gillig coaches. This is in addition to the 410 new 40' and 35' Gillig coaches introduced since 1996. By the end of 1999 we expect 70-80% of Metro Transit's current fleet to be less than four years old. We have already noted improved reliability and lower maintenance costs.

In addition, to promote equipment uniformity, these newer fleets incorporate standardized components including engines, transmissions, electrical systems, seats, signs and wheelchair lifts.

2-2-1 Metro Transit should continue to refine the newly implemented quality assurance program to ensure that its inspections and maintenance standards are maintained and to improve service reliability as discussed in Finding 2-3 below.

Executive Response:
Agree. In 1998, Metro Transit Division's Vehicle Maintenance Section introduced a more comprehensive and enhanced quality assurance program than the original program. Since then the Vehicle Maintenance Section staff have completed six quality assurance reviews. Vehicle Maintenance Section staff continue to refine the quality assurance program, particularly with the implementation of the new maintenance information system. The Vehicle Maintenance Section staff have scheduled an additional five "no notice" quality assurance reviews from now through June 2000 and plan to conduct two reviews at each base over a two year period. The quality assurance reports are submitted to Metro Transit's Vehicle Maintenance Section manager for review and action.

The mission of the quality assurance program is to ensure that Metro Transit provides customers safe, reliable, and clean transportation in a timely, cost effective, and environmentally sensitive manner with a workforce that values teamwork, communications and diversity. Our quality assurance process is designed as a tool to encourage continuous improvement at the worksites to assure that we will succeed in our assigned tasks. We are taking a broader look at business practices and procedures that is resulting in positive changes in the workplace.

In addition to our quality assurance process, we monitor vehicle maintenance activity on a monthly basis, including miles between trouble calls, inspection scheduling and completion,

Attachment

**Executive Response to Draft Management Audit Report:
Metro Transit Vehicle Maintenance Operations**

overtime, and budget expenditures, to continually ensure that we are moving to improve reliability, efficiency, and cost effectiveness.

2-3-1 Metro Transit should continue to implement its bus procurement program to improve the reliability of its fleet and to reduce its spare ratio to 20% of the number of peak buses. In addition, Vehicle Maintenance management should implement more proactive and consistent reviews of completed inspections and repairs to ensure the effectiveness of maintenance services and reduce mechanical service interruptions. Metro Transit should also attempt to increase the miles between trouble calls for its diesel fleet to 4,500 to 5,000 miles for the total fleet, and to 6,000 as the age and complexity of the fleet is reduced.

Executive Response:
Agree. As noted in our response to Recommendation 2-1-1 our bus procurement program is continuing. We are already seeing improved performance and reliability with the introduction of each new fleet of buses. In 1998 our diesel fleet averaged nearly 5,100 miles between trouble calls, without the complete fleet of Gillig coaches and no New Flyer coaches.

Metro Transit staff aggressively and regularly review the spares ratio and in 1998 worked diligently and successfully to reduce the spare ratio below the Federal Transit Administration limit. The spare ratio dropped from 25.5% in 1997 to 18.6% in 1998.

As noted in the response to Recommendation 2-2-1 we continue to refine and improve our quality assurance program. In addition, with the introduction of our newer fleets, we will develop new goals for miles between trouble calls for the year 2000 by fleet, as well as system-wide. We have also implemented a training program for our bus and waterfront streetcar inspectors.

2-4-1 Metro Transit should review its current maintenance practices to determine why its service reliability rates are not consistent with its lower work hour (e.g. higher productivity) levels.

Executive Response:
Agree. Metro Transit continues to review maintenance practices to look for ways to improve reliability while maintaining high productivity. As discussed in our response to Recommendation 2-3-1 the miles between trouble calls statistics will be tracked by fleet and new goals, by fleet and system-wide, will be established for the year 2000.

Some of the vehicle reliability problems will continue to plague us in the short term because of the age of certain fleets and their mechanical complexities. We expect overall improvement as we continue to introduce the new fleets.

Attachment

Executive Response to Draft Management Audit Report:
Metro Transit Vehicle Maintenance Operations

2-4-2 Metro Transit should improve its maintenance backlog report to accurately reflect priority and non-priority workload. Overtime resources should not be used for non-priority workload. Consideration should be given to using overtime to reduce mechanical problems that result in frequent interruptions and trouble calls.

Executive Response:
Agree. With the implementation of our new maintenance information system we will review/refine the backlog report to reflect type of work required. We will continue to review our overtime expenditures and assignments, to ensure overtime assignments are for priority work.

2-4-3 Metro Transit should establish shop rate standards for inspections and maintenance tasks for its buses and bases. In addition, Metro transit should ensure that its new maintenance management information system has a sufficient number of codes and management reports so management can routinely identify exceptions to the established standards and inconsistent maintenance and repair performance. A management report should also be developed to determine whether a sufficient number of buses were signed out to meet daily service requirements.

Executive Response:
Agree. Metro Transit is currently working on benchmarking various maintenance and repair tasks while ensuring that we don't sacrifice safety for speed of repair.

Metro Transit has a users group established for the new maintenance management information system that regularly meets and reviews the business needs of the system. The users group is currently evaluating the appropriateness and usefulness of the current coding structure and will provide recommendations for improvements and reporting needs.

Metro Transit currently uses two reports to monitor and manage the assignment of coaches and to ensure that a sufficient number of coaches were signed out to meet the daily service requirements. These include the Base Delay-Cancellation Report and the Dispatch Exception Report which are sent to top management on a daily basis. Management reviews these each day and takes quick action to remedy problems. Metro Transit will review the reporting options available from the various information systems to determine whether sign out information could be available and reported on a monthly basis for management review.

2-4-4 Metro Transit should develop meaningful goals and objectives that promote improved performance in the maintenance and repairs of its fleet.

Executive Response:
Agree. The Vehicle Maintenance Section plans to augment and refine its goals and objectives in the year 2000 to include measurable performance targets for fleet maintenance and repair.

Attachment

**Executive Response to Draft Management Audit Report:
Metro Transit Vehicle Maintenance Operations**

This will include quantifiable performance objectives designed to improve operational efficiencies and enhance service effectiveness.

Materials Management and Inventory Practices

Recommendations

3-1-1 Metro Transit should implement materials management practices, consistent with the Transportation Research Bureau that will effectively reduce costs to levels consistent with the other peer transit systems. Cost-effective materials management practices include controlling the growth of the surplus inventory through selective purchasing practices for new fleets, restricting new purchases for all parts based on established usage patterns, and ensuring that stock is reduced to minimum levels at all bases prior to ordering new stock.

Executive Response:
Agree. Metro Transit intends to develop, over the next 12-15 months, a plan for our materials management and inventory control practices. The development will consist of three phases:

(1) review of Metro Transit and other transit organizations' existing practices, policies, procedures, organizational structure, and goals and objectives;
(2) development of a plan to ensure that our materials management and inventory control functions are efficient and cost effective, that polices and procedures, and goals and objectives are clearly defined and documented, and that we have an organizational structure in place to support it; and
(3) implementation of the plan.

3-2 The Auditor refers to recommendations below.

3-3-1 Metro Transit should conduct a physical inventory of its existing stock to develop accurate parts inventory records to ensure that inventory is maintained at reasonable levels (i.e., no unnecessary items are added to the inventory) and that materials costs are reduced to reasonable levels. A method should also be developed to account for parts that are fabricated in-house to avoid purchasing duplicate new parts that contribute to higher material costs.

Executive Response:
Agree. Depending on the results of the plan discussed in our response to Recommendation 3-1-1, Metro Transit expects to conduct a physical inventory within the next six to twelve months.

Attachment

Executive Response to Draft Management Audit Report:
Metro Transit Vehicle Maintenance Operations

3-3-2 Metro Transit should ensure that all items that are obsolete should be removed from the inventory in a timely manner.

Executive Response:
Agree. As new fleets are introduced, Metro Transit is surplussing the parts associated with the retired fleets.

3-3-3 Metro Transit should complete its review of other transit organizations to identify and adopt best materials and parts inventory management practices, including methods identified by the Transportation Research Bureau to reduce its materials costs and improve both its inventory turn rate and inventory record accuracy rate.

Executive Response:
Agree. Metro Transit intends to complete this as part of the plan noted in our response to Recommendation 3-1-1.

3-3-4 Metro Transit should complete and adopt formal materials management and inventory policies and procedures for the decentralized materials management and inventory operations. Adherence to adopted policies and procedures should be reinforced during management meetings, employee orientations, staff meetings, and other training opportunities.

Executive Response:
Agree. Metro Transit intends to have this as an outcome of the plan discussed in our response to Recommendation 3-1-1.