Customer Service, Operations and Safety Committee

Board Action Item III-A

November 9, 2006

Rail Fleet Management Plan

Washington Metropolitan Area Transportation Authority
Board Action/Information Summary

☒ Action ☐ Information	MEAD Number:	Resolution: ☒ Yes ☐ No

PURPOSE

Request Board approval to update WMATA's Metrorail Fleet Management Plan which was last updated in 2004. This Plan provides for rail cars and facilities to support future growth of the existing system, and the extension of the rail to Dulles Airport and Loudoun County.

DESCRIPTION

The Metrorail Revenue Vehicle Fleet Management Plan which is attached, is a tool that provides proper planning for future Metrorail vehicle and facility needs, taking into consideration current and future ridership demand, approved expansion projects, scheduled and unscheduled maintenance, and the rail car renovation program. The Federal Transit Administration (FTA) requires that WMATA adopt an updated Metrorail Fleet Management Plan to incorporate the Dulles Extension project.

By adopting the Plan, the Board does not make any formal commitment to any project, or funding for any fleet expansion. The following is a summary of the improvements included in the Plan.

Rail Car Growth: This Plan includes the acceptance of the current rail car procurement of 184 rail cars, and describes the need for 128 cars for a two-phased extension to Dulles, scheduled for completion in FY15 and 130 additional rail cars for growth by FY14.

Current Fleet	948
6000 series procurement (FY07) (+184 cars)	1,132
Dulles Extension (FY12-15) (128 cars)	1,260
New Cars for growth (FY2011-14) (+130 cars)	1,390

Rail Car Storage Needs: The Dulles project anticipates the need for an additional 128 rail cars and will provide up to 226 additional storage spaces. The Fleet Plan shows that there are sufficient storage spaces to accommodate the rail cars needed for system growth to 130 cars.

• Current number of rail car storage spaces	1,316
Current rail Fleet with 6000 Series	1,132
Excess storages spaces	+184
• Service Expansion - Dulles:	
Additional storage spaces: 226	1,542
Additional rail cars: 128	1,260
Excess storage spaces	+282
• System Growth of 130 rail cars	
No additional storage spaces:	1,542
Additional rail cars: 130	1,390
Excess storage spaces	+152

Rail Car Maintenance Facility Needs: The Fleet Plan identifies the need for a total of 210 maintenance bays, 36 more than currently exist or are under construction. The Dulles project includes 18 new maintenance bays to support the 128 rail cars for the Dulles Extension. When the fleet is expanded for system ridership growth, in FY11-14, there will be a need for 18 additional maintenance bays. The exact yard expansion locations are not specified in the Plan. This would be done as part of an overall fleet expansion and funding agreement, similar to Metro Matters.

	Rail Cars	Bays Req.	Bays Avail.
• Number of maintenance bays (by FY08)	1,132	170	174
• Service Expansion - Dulles: (128 cars)			
Total bays after Dulles extension	1,260	190	192
• System Growth - 130 rail cars			
Total maintenance bays required	1,390	210	192

The Plan identifies the need for an additional 18 maintenance bays by FY12, but does not specify the exact location.

FUNDING IMPACT

The adoption of the Metrorail Fleet Plan is for planning purposes only and does not obligate the Authority or its Board of Directors to the Plan's projected requirements; therefore there is no funding impact.

RECOMMENDATION

Board approval of the Metrorail Fleet Management Plan.

PRESENTED AND ADOPTED:

SUBJECT: RAIL FLEET MANAGEMENT PLAN

PROPOSED
RESOLUTION
OF THE
BOARD OF DIRECTORS
OF THE
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

WHEREAS, Submission of a comprehensive Rail Car Fleet Management Plan is required by the Federal Transit Administration (FTA) in support of the Washington Metropolitan Area Transit Authority's (WMATA) application for a federal capital grant to purchase the new rail cars; and

WHEREAS, The WMATA staff has prepared the Metrorail Revenue Vehicle Fleet Management (MRVFM) Plans dated November 2006, to satisfy the federal grant requirement; and

WHEREAS, The MRVFM Plan documents the Authority's processes and procedures for operating and maintaining its fleet of rail cars through Fiscal Year 2015; and

WHEREAS, The MRVFM Plan is a tool that provides proper planning for future Metrorail vehicle and facility needs, taking into consideration current and future ridership demand, scheduled and unscheduled maintenance, and the rail car renovation program; and

WHEREAS, The MRVFM Plan is for planning purposes only and does not obligate the Authority or its Board of Directors to the Plan's projected requirements; and

WHEREAS, It is intended that the MRVFM Plan be updated prior to any future rail car rehabilitation project or rail car procurement; now, therefore be it

RESOLVED, That the Board of Directors adopts the updated Metrorail Revenue Vehicle Fleet Management Plan dated November 2006, and attached hereto, for planning purposes, without obligation to any of the plans' projected requirements and with the stipulation that the MRVFM Plan be updated prior to any future rail car rehabilitation project; rail car procurement; or rail facility project; and be it further

RESOLVED, That the Board of Directors concurs with forwarding the MRVFM Plan to FTA in support of the Federal Capital Grant for the purchase of rail cars; and be it finally

RESOLVED, That this Resolution shall be effective immediately.

Reviewed as to form and legal sufficiency,

Carol B. O'Keeffe
General Counsel

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N. W. ● WASHINGTON, D.C. 20001

DRAFT

October 27, 2006

METRORAIL REVENUE VEHICLE FLEET MANAGEMENT PLAN

NOVEMBER 2006

This Metrorail Revenue Vehicle Fleet Management Plan was developed by:

Office of Operations Planning and Administrative Support
Washington Metropolitan Area Transit Authority
600 Fifth Street, N.W. ● Washington, D.C. 20001

Contributors

The following WMATA organizations contributed data and information to this Fleet Management Plan:

Department of Metrorail Services:

Department of Planning and Joint Development:

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WASHINGTON METROPOLITAN
AREA TRANSIT AUTHORITY

METRORAIL REVENUE VEHICLE FLEET MANAGEMENT PLAN

NOVEMBER 2006

This document is a statement of the processes and practices by which WMATA establishes its current and projected Metrorail revenue vehicle fleet size requirements and operating spare ratio. It includes a description of revenue service planned to accommodate Metrorail system extensions and growth in rail ridership, as well as an assessment and projection of needs for rail vehicle maintenance. This plan is a living document which is based on current realities and assumptions, and is therefore subject to future revision. The intent is to update the plan on a regular basis and to have the plan become an input into the Authority's capital and operating budget preparation.

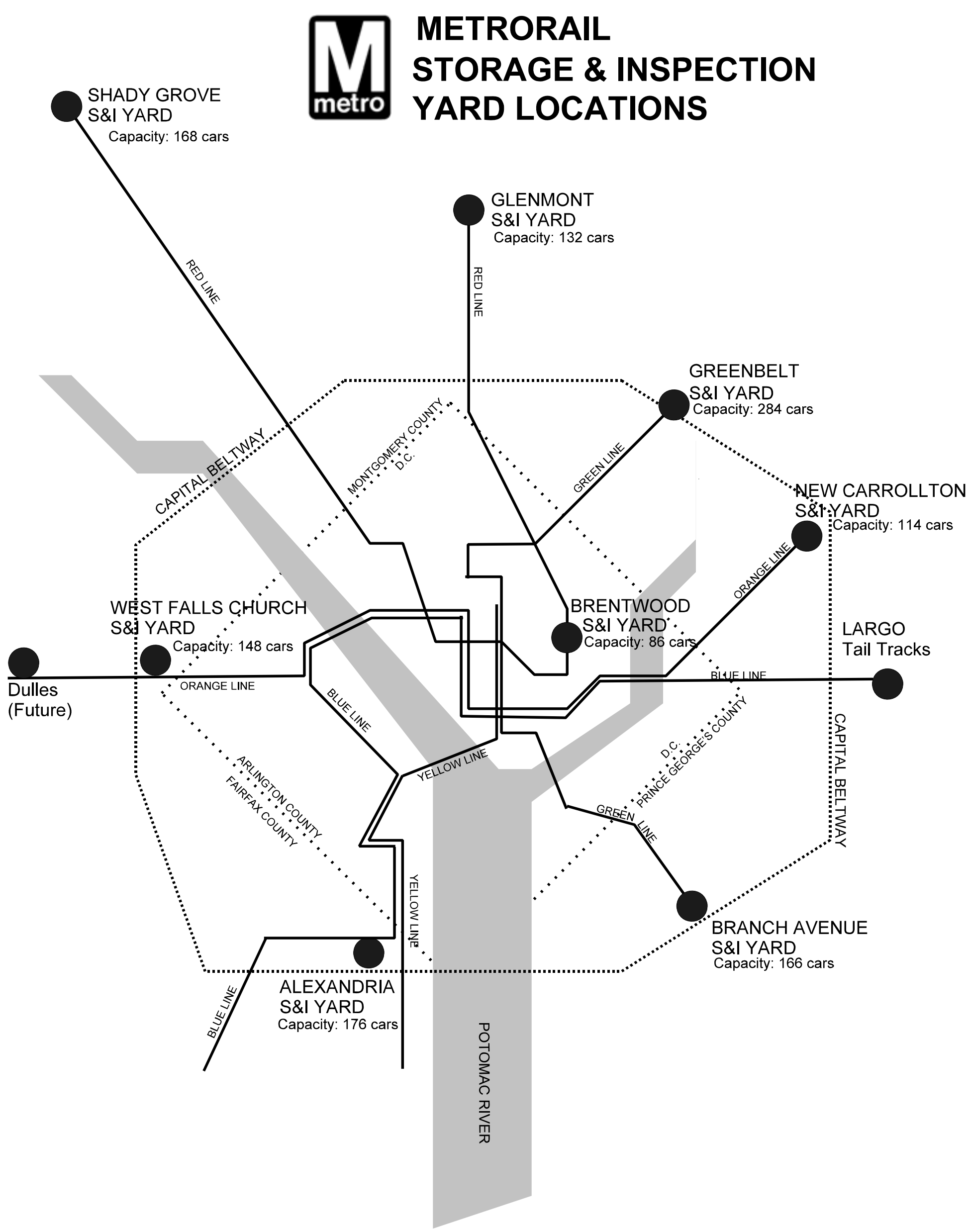
SECTION ONE

INTRODUCTION

The WMATA Metrorail system currently operates 106 miles of speed heavy rail rapid transit service, including 86 passenger stations, the majority of which include multi-modal transfer facilities. The system, as shown in Figure 1-1, includes five separate lines, Red, Blue, Orange, Yellow, and Green, which are in service for 18½ hours Monday through Thursday, 21½ hours on Friday, 20 hours on Saturday, and 17 hours on Sunday. There are eight storage and inspection (S&I) yards and two heavy repair shops in service. Triple tail tracks outbound of the Largo station serves as an overnight car storage location for a substantial number of cars. S&I yard locations are depicted in Figure 1-2.

FIGURE 1-1
Metrorail System Map

FIGURE 1-2


METRORAIL
STORAGE & INSPECTION
YARD LOCATIONS
SHADY GROVE
S&I YARD
Capacity: 168 cars
GLENMONT
S&I YARD
Capacity: 132 cars
GREENBELT
S&I YARD
Capacity: 284 cars
NEW CARROLLTON
S&I YARD
Capacity: 114 cars
LARGO
Tail Tracks
BRENTWOOD
S&I YARD
Capacity: 86 cars
WEST FALLS CHURCH
S&I YARD
Capacity: 148 cars
Dulles
(Future)
BRANCH AVENUE
S&I YARD
Capacity: 166 cars
ALEXANDRIA
S&I YARD
Capacity: 176 cars
RED LINE
RED LINE
GREEN LINE
ORANGE LINE
BLUE LINE
YELLOW LINE
CAPITAL BELTWAY
MONTGOMERY COUNTY
D.C.
ARLINGTON COUNTY
FAIRFAX COUNTY
PRINCE GEORGE'S COUNTY
POTOMAC RIVER

The system carried more than 932,000 unlinked passenger trips on an average weekday in FY 2006, and recorded 275 million unlinked passenger trips and nearly 1.6 billion passenger miles for the entire fiscal year.

Passenger fares consistently pay over 60 percent of Metrorail's annual operating cost. In terms of route mileage, number of stations, and ridership, Metrorail ranks as the second largest heavy rail rapid transit system in the United States. Operations are supported by state-of-the-art automatic train control, automatic fare collection, and communications systems.

CURRENT RAIL CAR FLEET AND OPERATING PRACTICES

The Authority's rail revenue car fleet, as of July 1, 2006, consisted of 948 vehicles, of which 292 (1000-series) were manufactured by Rohr Industries, 464 (2000, 3000, and 4000-series) were manufactured by Breda Construzioni Ferroviarie, 192 cars (5000 series) were manufactured by Construcciones y Auxiliar de Ferrocarriles, S.A. (CAF) . Thirty eight of the Breda 2000 and 3000 series cars are undergoing mid-life renovation and are not available for service.

In addition to this fleet, the Authority is currently receiving 62 cars of the base buy with 122 option cars from Alstom to follow. Fifty of the cars are scheduled to be in service delivery December 2006 with the remainder is to be in service by December 2008.

All Metrorail revenue cars operate in married pairs with an operating cab at each end. Each pair of cars is fully automated, and has a hydraulic friction brake system, a static converter low voltage system, automatic HVAC control, electronic flip-dot destination signs, and automatic couplers. As a result of these design features, the cars must operate in married pairs; no car can be operated as a single unit. Primary propulsion power is supplied by a 750 volt DC third rail system.

Scheduled train consists can vary from four to eight cars depending on the day of the week and the time of day. All Metrorail cars are 75 feet long, and all Metrorail passenger station platforms measure 600 feet in length. A station, therefore, can accommodate a maximum of eight-car trains, although six-car trains are considered the design optimum.

Rohr cars have 80 passenger seats and both Breda and CAF cars have 68 seats. The Alstom, 6000-series have 64 seats in the A-car and 66 seats in the B-car.

ORGANIZATION OF THIS DOCUMENT

Demand Analysis: In Section Two of this document the *demand* for revenue vehicles is summarized. Demand is analyzed in two components:

> **Passenger Demand**, in which the process for developing peak vehicle requirements (PVR) is reviewed, including forecast peak period ridership, system extensions, ready reserve cars (gap trains), and load factor policy, and
>
> **Maintenance Requirements**, including the process which defines car requirements for both scheduled and unscheduled maintenance, and for mid-life car rehabilitation.

Supply Analysis: Section Three addresses the *supply* of Metrorail revenue vehicles. It accounts for total cars owned by fiscal year, showing authorized and anticipated procurements, and cars available for service net of accident damaged vehicles and vehicles in long-term revenue collection.

Demand/Supply Balance: In Section Four the balance of the demand for vehicles and the supply of vehicles is discussed. The plan is also summarized.

Fleet Tables: In this document, *Figure 2-2: Passenger Demand for Revenue Vehicles; Figure 2-5: Maintenance Demand for Revenue Vehicles; Figure 3-3: Supply of Revenue Vehicles; and Figure 4-1: Vehicle Demand / Supply Balance* summarize the heart of the plan. Each table shows fleet status at the end of fiscal years 2006 through 2015. This span of years was chosen in order that the time frame of this plan match that of the Ten Year Capital Improvement Program adopted by the WMATA Board of Directors.

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SECTION TWO

THE DEMAND FOR REVENUE VEHICLES

QUALITY OF SERVICE

Quality of service is what ultimately determines the success of any transit system. This is especially true for Metrorail since strong commitments have been made in terms of the system's performance, and the public has come to expect a superior product in return for its investment.

Service quality is also important because the system is still growing and the transit market is still being developed. A large segment of WMATA's marketplace is discretionary. According to a recent WMATA survey, 80 percent of daily rail riders are in households with a vehicle available, and therefore are "choice" riders.* Quality of service is key to retaining and growing ridership in this market segment.

*"*WMATA Rail Passenger Survey 2002*"

** Metropolitan Washington Council of Governments *2002 Cordon Count*

According to the Metropolitan Washington Council of Governments, about 41 percent of commuter trips to the core area of Washington, D.C. are made using public transportation.** It would be necessary to build 30 additional highway lanes in the Washington transit zone in order to match Metrorail's people-moving capacity.

In order to maintain transit market share and to enhance its contribution to mobility and accessibility, to improved air quality, to reduced traffic congestion and to serve increased regional growth and travel demands, the Authority has committed to doubling transit ridership by 2025. *Based on the outcome of the Core Capacity Study and The Regional Bus Study it* is expected that 60 percent of this growth will take place on the existing system, while 40 percent will come from system expansion over the next quarter century.

In the Washington region, with its large number of "choice" transit riders, only quality service will retain our ridership base and allow it to grow.

Quality of service is considered to be a function of the following factors:

- Safety
- Speed
- Cleanliness
- Frequency
- Comfort
- Service Reliability

Frequency, comfort, and service reliability are related primarily to fleet size.

SECTION 2A
ESTIMATION OF PASSENGER DEMAND AND THE RESULTING PEAK VEHICLE REQUIREMENT

THE METRORAIL SERVICE PLANNING MODEL

The process WMATA uses to develop fleet size requirements includes ongoing evaluations of ridership vs. system capacity, plus an expanded 10-year needs assessment tied to procurements of rail vehicles. Fleet size requirements are updated on a periodic basis prompted by events such as opening of new rail segments, the implementation of a major overhaul program, or the procurement of new rail cars. The Metrorail service planning model is a multi-step process used by the Authority to develop its fleet size requirements. The elements are as follows:

Step One: Determine peak demand at the maximum load points by actual counts of present ridership and estimates of future demand. These demand estimates are made by WMATA professional staff. Passenger demand is projected 10 years into the future, and takes into account regional growth estimates from the Metropolitan Washington Council of Governments (COG). In addition to the opening of new system segments, passenger demand is influenced by pricing (fares) and system access measures. Using FY2006 as a base year, regional forecasts estimated an average rate of growth of three percent per year through 2015.

The regional model uses several factors to estimate transit ridership growth including regional population and employment growth as well has historical growth in transit riders. Taking these factors into consideration the regional travel demand model estimates that 20 year growth trends in transit ridership will average to nearly three percent per year, which is consistent with WMATA's average rate of growth.

Between 2000 and 2006 Metrorail's annual ridership increased from 163 million riders to approsimately 199.9 million, an average annual growth rate of 3.38% which is in line with projected growth rates used in this plan. WMATA's capacity is governed by crowding at nine maximum load (max load) points on the five lines. Ridership through these points typcially grown at a slower rate than the total system growth. The table below shows the average annual growth rate for peak period trips on each line's max load point.

Line	Location	Growth
Red	Dupont Circle to Gallery Place	2.47%
Blue	Rosslyn to L'Enfant Plaza	2.93%
Orange	Court House to L'Enfant Plaza	2.83%
Yellow	Pentagon to L'Enfant Plaza	2.24%
Green	Mt. Vernon to Waterfront	2.26%

It should be noted that while these growth rates are lower than 3%, higher growth in the peak period trips not going through a max load point and growth in off-peak travel will result in systemwide growth of approximately 3%.

Methodologies developed for the WMATA 10-Year Capital Improvement Plan outlined the procedure for monitoring passenger loading and managing those loads to ensure the fleet is capable of safely accommodating all passengers without leaving any left standing on the platform in the peak hour.

Step Two: Define and adopt passenger load standards. These standards are a statement of the quality of service the Authority wishes to provide to the public. Presumably, the more generous the standard in terms of seating capacity per passenger, the more attractive the service and therefore the higher the ridership. However, a more generous standard requires more rolling stock.

Step Three: Apply the adopted passenger load standards to the actual peak period ridership to derive the number of cars required at the maximum load points during the peak period.

Step Four: Select headways and car consists that meet load standard criteria. Headways are the scheduled time intervals between trains, and car consists are the number of cars per train. Because WMATA's cars are operated in married pairs, the schedule is constrained to operate in four-car, six-car, or eight-car trains. The required number of cars can be provided by any combination of headways and consists. Current Metrorail passenger demand requires headways of two to three minutes in downtown areas in peak periods.

Step Five: Determine line requirements. The chosen headway / consist mix and maximum load point requirements must be translated into line requirements. This recognizes other factors such as running time, put-in locations, and other operating constraints of the system.

Step Six: Determine the number of cars required for strategic gap trains. One method of helping to ensure service reliability is through the deployment of standby gap trains in strategic positions throughout the system. When a train must be taken out of service because of a mechanical malfunction or other operating problem, a gap train can be used to replace it and maintain the regular schedule. The number of gap trains (and the resulting number of cars) depends on the reliability of regularly scheduled service and on reliability objectives. This gap train requirement is discussed in greater detail in a subsequent section below.

**The average of several observations. A change in the PVR is made only if a consistent trend is detected over a period of time.*

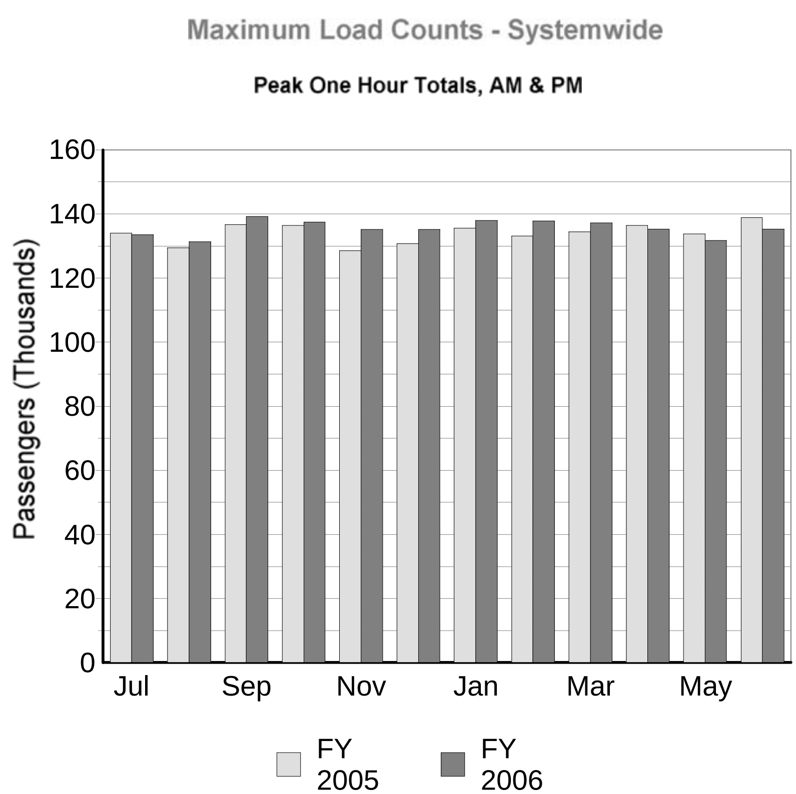
Step Seven: Determine total operating peak vehicle requirement (PVR). This is the sum of peak car requirements for all lines in the system plus gap trains. The PVR on each line is the number of cars required to carry the observed average passenger load* past the maximum load point in the peak direction in the peak hour, as determined in Step Three, plus the gap trains assigned to that line.

Step Eight: Determine the operating spare factor necessary to meet the total peak car requirement. This is usually expressed as a percentage of the scheduled fleet in excess of the daily schedule requirements. It provides a sufficient number of cars to be available for routine maintenance, and also assumes that a certain number of cars will be unavailable for service each day because of mechanical problems. Like gap trains, this factor also contributes to service reliability.

Step Nine: Determine the number of rail cars that will be off site for rehabilitation. The major impact included in the Plan will be the formal Breda mid-life rehabilitation.

Step Ten: Determine the total fleet requirement. This is the sum of the number of cars required for peak scheduled service, gap trains, and spares.

FIGURE 2-1
Metrorail Revenue Vehicle Fleet Management Plan



SEASONAL VARIATIONS IN PASSENGER DEMAND

**The arithmetic mean of all 24 data points Is 133.*

***The standard deviation is a measure of dispersion of the data. In this case the dispersion is slight - about 3.45% above and below the mean - indicating very little variation among the data points.*

Figure 2-1 shows maximum load point passenger counts for each month of fiscal years 2005 and 2006. The graph demonstrates that there is little seasonal variation in Metrorail's peak period ridership. The two year average* peak-period one-hour system-wide passenger demand during the period shown on the graph is about 133,000 passengers. The statistical standard deviation** of that same data is about 4,500 passengers. .

In terms of planning in-service car requirements to meet this demand, the only adjustment the Authority usually makes is to reduce train length on weekends in the winter months and increase train lengths during the mid-day hours in the summer. Otherwise, in-service car requirements remain stable throughout the year, especially in the peak periods.

PEAK VEHICLE REQUIREMENT

The Peak Vehicle Requirement (PVR) is the total number of rail cars needed simultaneously in the peak periods to satisfy passenger demand while keeping per-car passenger loads at or below a pre-determined level (Step Seven of the Metrorail Service Planning Model). On weekdays, the period of maximum ridership lasts for about 75 minutes in the morning peak period and about 90 minutes in the afternoon peak period. Passenger loads are measured at the maximum load points on each line, in the peak travel direction, throughout the entire peak period, and are evaluated in one hour and train level increments to determine appropriate headway and fleet requirements.

PASSENGER LOAD STANDARDS

The passenger load standard is the desired number of passengers per car under maximum load conditions, determined in Step Two of the Metrorail Service Planning Model previously outlined.

The Importance of Passenger Load Standards: The passenger loading standard affects both passenger comfort and operating efficiency, each of which is important in terms of the quality of service. In terms of comfort and convenience, the passenger load standard serves to determine:

- Ability to get on the first train going in the passenger's preferred direction of travel from any station.
- General probability of getting a seat
- General proximity to other standees

Operating efficiency is affected if insufficient capacity is provided to meet demand. If trains become too crowded, doors become blocked, dwell time is lengthened, and it becomes impossible to adhere to the schedule.

A study by the Texas Transportation Institute indicates that Washington, D.C.'s streets and highways are the third most congested in the country. Were the public to come to view Metrorail as an unattractive alternative to their cars, it would be prohibitively expensive for the region's state and local governments to accommodate the resulting increased automobile travel demand.

LOAD FACTORS

In this document, rail car passenger load factors are expressed in terms of the number of passengers per car.

The current primary load standard is 140 passengers per car and the peak secondary standard is 155 passengers per car.

An alternative loading measure is passengers per seat.

Assuming a weighted average of approximately 71 passenger seats per car, the current standards translate to per seat load factors as follows: Primary=1.97 (140/71) Secondary=2.18 (155/71).

See Appendix A for a complete table of load factor conversions.

Current Metrorail Passenger Load Standards: The current Metrorail passenger load standards are as follows:

> **Peak Primary Standard:** Not to exceed 140 passengers per car average of all trains passing the maximum load point in the peak direction in the peak one-half hour on each line.
>
> **Peak Secondary Standard:** Not to exceed 155 passengers per car on any single train passing the maximum load point on each line during the peak period.

The use of passenger load standards to evaluate service was begun by WMATA staff in 1982. The original standards and the evaluation process were reviewed by the Board of Directors at that time, and load standards have been employed at the Authority ever since. They have been revised from time-to-time in the last 15 years to better reflect the Authority's service policies and objectives.

Load Standard Objectives: The ideal quality situation would be to provide a seat for every passenger in the peak periods. While that objective may not be financially achievable, an improved standard of passenger comfort is possible. To further the goal of attracting greater Metrorail ridership by providing an improved quality of service, the Authority has established an objective of reducing its passenger load standards over a period of years to below 120 passengers per car in the peak hour . Experience following the opening of the Branch Avenue section of the Green Line taught us that an average of 120 passengers per car is the point where customers will refuse to board a train and will be left behind on the platform. Passenger demand and our ability to accommodate those demands become unmanageable beyond a peak hour average of 120 passengers per car.

Guidelines of Acceptability: The WMATA Board of Directors has further stated that it is the Board's policy and the Authority's goal to provide capacity sufficient to keep average passengers per car under 100 in the peak one hour and to ensure near equal and average peak passenger loading across all lines based on the average passengers per car (PPC). When average passenger loads rise above that level, Metro's customers perceive the trains to be unacceptably congested.

The plan presented in this document is structured to provide the number of cars necessary to achieve most of this reduction in peak passenger loads, while striking a balance between that reduction and the competing objectives of capital investment in revenue vehicles and operating budget levels. The plan assumes the current practice as the appropriate passenger loading level and that this level will be continued in the future. The achievement of the reduced load standard is dependent on the financial capability (capital and operating) of the Authority to obtain and operate the additional vehicles required.

FUTURE PASSENGER DEMAND AND FACTORS INFLUENCING PEAK PERIOD RIDERSHIP

Peak period ridership is the primary factor that determines PVR. Service demand changes over time and is particularly influenced by events such as the opening of new segments of the Metrorail system.

General Ridership Growth: As stated earlier, the Authority relies on the Council of Governments to project overall regional population and land use growth and transportation demand. This fleet management plan needs to take into account at least some portion of that growth in projecting WMATA's future fleet size requirements, particularly given the extremely long period of time required to purchase and deliver new rail cars. Hence the inclusion of general ridership growth as a factor influencing fleet size requirements. This plan assumes the current ridership level as the base and assumes a future growth of approximately two percent per year.

Events and Influencing Factors Accounted for in this Fleet Management Plan: The car requirements shown on Line 1 of Figure 2-2 reflect increasing passenger demand and future rail system extensions.

FUTURE SYSTEM DEVELOPMENT

Dulles Corridor Extension of the Orange Line: The Dulles Corridor Extension will add twenty-three miles and eleven stations in two phases to the Metrorail system, extending from a point inbound of West Falls Church Station through Tysons Corner, onto Reston-Herndon, through Dulles International Airport and into eastern Loudoun County. The Phase I is a projected completion date of FY13 and Phase II is projected to be complete in FY15.

Other Service Solutions:
The Authority is planning alternative solutions to improve its reliability and relieving overcrowding conditions. Ideas include:

- Restoring the spare ratio to 20%
- Restoring gap trains
- Elimination of 4-car train operation in the peak period

Yellow Line to Fort Totten

Extends the Yellow Line from Mount Vernon to Fort Totten. The Board of Directors approved an eighteen month District of Columbia reimbursable project to extend the Yellow Line from Mount Vernon to Fort Totten during off peak hours, beginning January 2007.

Red Line Turn Backs

Increase service between Shady Grove and Glenmont by eliminating turn backs at Grosvenor and Silver Spring. The Board of Directors approved an twenty one month Maryland reimbursable project to eliminate the Grosvenor Turnback during the off peak hours, beginning October 2006.

Blue Line Split

One half of Blue Line from Franconia Springfield would split from the current Blue Line at Pentagon and follow the Yellow and Green Line routes until reaching Greenbelt. This service pattern would improve reliability at the Rosslyn Portal on the Orange and Blue Lines.

Skip Stops

Eliminates stopping at certain stations providing faster service for majority of customers. Currently WMATA uses skip stops during the Washington Nationals' home games to quickly clear the platforms and transport customers to their destination.

FIGURE 2-2
Metrorail Revenue Vehicle Fleet Management Plan
PASSENGER DEMAND FOR REVENUE VEHICLES

		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Operating Requirements										
1	Scheduled in Passenger Service (Beginning of Year)	774	794	814	834	854	872	890	908	980	998
1a	System Growth	20	20	20	20	18	18	18	18	18	18
1b	System Expansion*	0	0	0	0	0	0	0	54	0	54
2	Scheduled in Passenger Service (End of Year)	794	814	834	854	872	890	908	980	998	1070
3	Gap Cars	42	44	46	48	50	52	56	56	56	56
4	Peak Vehicle Requirement (PVR)	836	858	880	902	922	942	962	1036	1054	1126

* Dulles Phase I in FY13 and Phase II in FY15

THE NEED FOR GAP TRAINS

When a train fails in service and must be removed from the line, it leaves a gap equal to its scheduled headway plus the time required to troubleshoot the train, bypass the failed system, and offload passengers. When removing a malfunctioning train, it is not unusual for the remaining interval (the gap) to be triple or more the scheduled headway. While there is no way to mitigate the high passenger loads in the immediate vicinity of the malfunction incident, it is crucial that the gap be filled as soon as possible; at least at the next turn back (preferably before), where a gap train is normally stored. The Authority sometimes uses a “skip stop” procedure for trains departing a terminal to reduce an especially large gap in service. Terminal supervisors may also re-block trains and spread departure times to compensate for gaps in service. These measures, when combined with the insertion of a gap train, can eliminate the effects of a service interruption in less than one train trip.

FIGURE 2-3a
Metrorail Revenue Vehicle
Fleet Management Plan

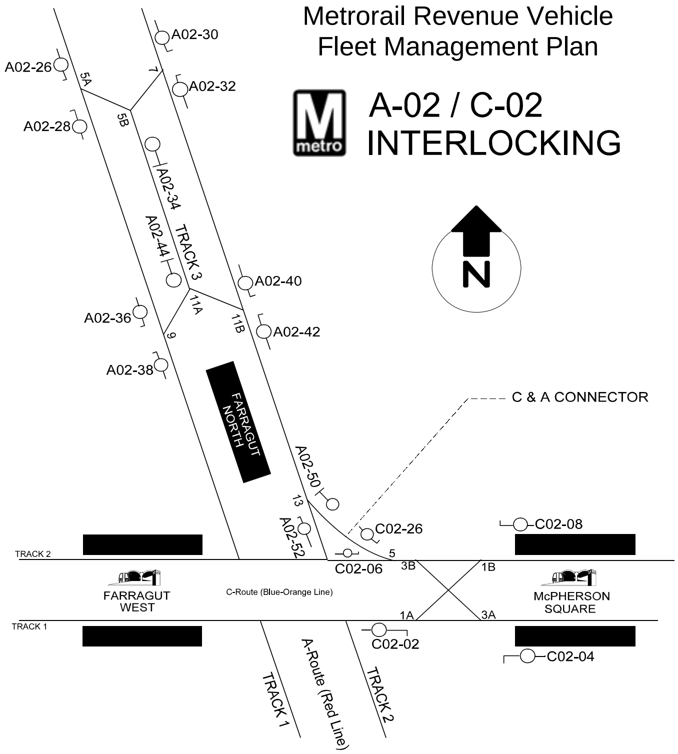
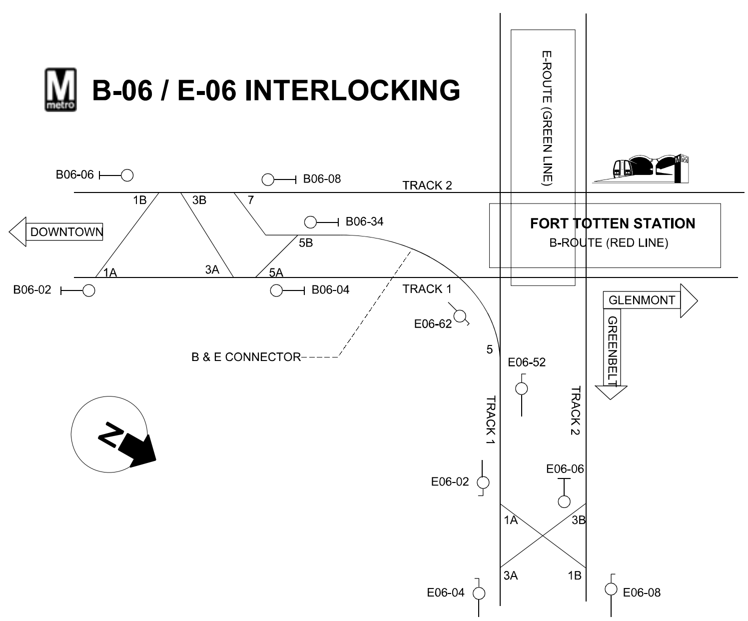


FIGURE 2-3b
Metrorail Revenue Vehicle
Fleet Management Plan



SCHEDULING AND OPERATING STRATEGIES USED TO REDUCE THE IN-SERVICE CAR REQUIREMENT

Short-Lining: The Authority attempts to take advantage of every opportunity to minimize the number of cars required to run the schedule. Short-lining is one way that the schedule is constructed to minimize car requirements and to place service where it is needed most. Seven mid-route turnbacks are built into Metrorail system and are available for short-lining. These turnbacks are constructed in the form of pocket or third tracks, each eight cars long, placed between the two main line tracks. The seven mid-line pocket tracks in the system are located as follows:

Red Line: Silver Spring: just outbound of the station
Red Line: Farragut North: just outbound of the station
Red Line: Grosvenor: just outbound of the station

Blue / Orange Line: At the D&G Junction: about midway between Stadium Armory and Minnesota Avenue stations

Orange Line: West Falls Church: at the station platform

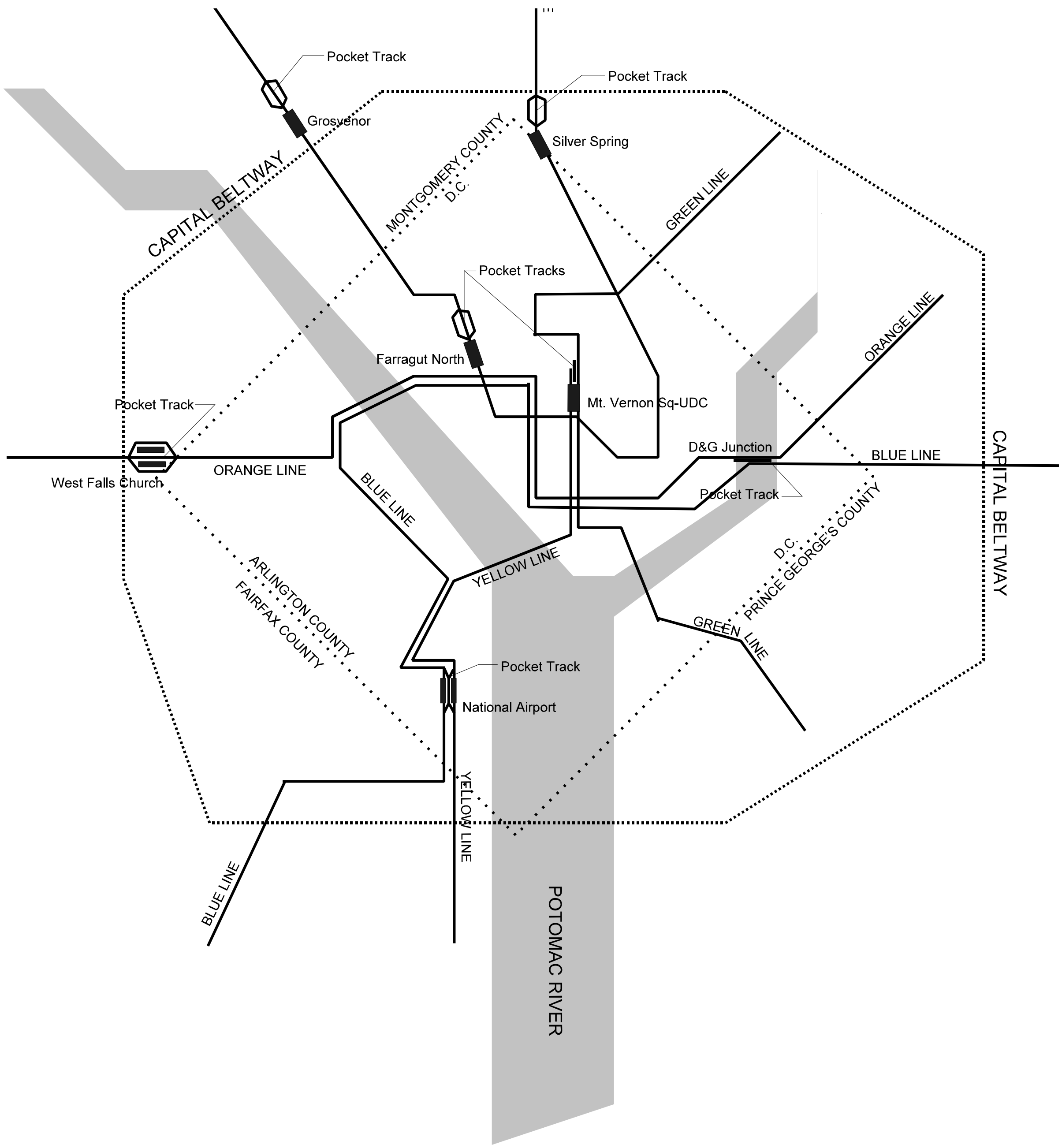
Blue / Yellow Line: National Airport: at the station platform

Yellow / Green Line: Mt. Vernon Square - UDC: just outbound of the station

Figure 2-3a illustrates the third track at Farragut North and Figure 2-4 shows the location of each mid-line pocket track. Our current studies of potential future improvements to the existing Metrorail system are analyzing the impact of adding additional pocket tracks and interconductivity connections that would provide flexibility to address varied boarding patterns.

In the current peak period schedule, about half of the Red Line trips operate between Silver Spring and Grosvenor only. The bifurcation of the Blue and Orange lines at Stadium-Armory and Rosslyn enables WMATA to provide a reduced level of service outbound of those stations and greater service downtown. The same is true of the Blue-Yellow Line at Pentagon and King Street and of the Yellow-Green Line L'Enfant Plaza. The Yellow Line's northern terminus is at Mt. Vernon Square-UDC. Beginning in 2007, the off-peak terminus will be shifted to Ft. Totten.

Figure 2-4
Location of Pocket Tracks



Tripper Trains: When there is an imbalance in passenger volumes between ends of an operating line (such as on the Orange and Green Lines), in addition to varying the car-consist on each end of the line, "tripper trains" are used to serve the passenger flow in the heavier direction. Tripper trains are trains that operate only a single trip in each of the two daily peak periods to accommodate high ridership on one end of a line. This approach is used extensively on the Orange Line.

Drop Back Operators: In peak periods, when headway intervals are short, the scheduled time between a train's arrival and its next departure is not sufficient to permit the operator to walk from arrival end to departure end and depart on time. A scheduler can compensate for this difficulty by scheduling additional train operators in the peak periods such that when each train arrives in a terminal and opens its doors, a second operator can board and take control of the train on the departure end. As soon as the operator on the arrival end alights, the train is ready to depart. The arriving operator then has time to walk to the opposite end of the terminal platform where he in turn enters the trailing cab of the next train to arrive and becomes its departure operator. This labor-intensive scheduling scheme is called "drop-back" operation. WMATA uses the drop-back scheduling technique extensively to maximize the use of limited fleet resources.

Road Mechanics: Metrorail employs "Road Mechanics" (AA-level car maintenance mechanics) to troubleshoot trains that experience operating degradation or failure while in passenger service. The Road Mechanics are assigned in shifts during all hours of passenger service. They are stationed at strategic points throughout the system, and are in constant contact with the Metrorail Operations Control Center.

Every Metrorail Train Operator is taught how to recognize carborne system failures and how to bypass failed systems to enable a malfunctioning train to be removed from the main line. In addition, a new Vehicle Monitoring System designed to provide detailed information to the train operator on carborne system failures, was installed in the 5000-series cars. The system is being installed in the 2000 and 3000-series cars as they undergo their mid-life rehabilitation.

SUMMARY OF OPERATING PEAK VEHICLE REQUIREMENTS

The forecast PVR is shown on Line 4 of Figure 2-2. Line 2 of the figure shows the number of vehicles required to serve passenger demand. The gap cars shown on line 3 are the strategic reserves necessary to maintain a consistent and acceptable level of service. Line 4 is the total peak vehicle requirement.

SECTION 2B
ESTIMATION OF FLEET DEMAND RESULTING FROM CAR MAINTENANCE REQUIREMENTS

Metrorail's 30 years of operating experience has presented a tremendous challenge to WMATA's Department of Metrorail Services. The combination of aging pains, system expansion and continuing ridership growth are major challenges now and for the future. In December 2000 a contract to perform mid-life rehabilitation on the aging Breda 2000 and 3000-series rail cars was awarded. This work is being performed in Hornell, NY by Alstom Transportation, Inc.

Two types of maintenance are performed on the rail car fleet:

- **Operating Maintenance** including:
  - Scheduled (preventive) maintenance
  - Unscheduled (corrective) maintenance
- **Car rehabilitation**

Scheduled maintenance is done to keep equipment in good working order and to prevent in-service failures. Some car components are overhauled on a schedule dictated by known failure rates and life cycle expectations.

Scheduled preventive maintenance of rail transit vehicles is essential to providing safe, reliable, and attractive service. Preventive maintenance is especially critical to providing quality service at a time when capital funding programs are facing heavy scrutiny and reduction, and when operating budgets are being stretched. The rail car is a major capital investment that must be well maintained to maximize its service life and to reduce capital and operating expenditures. To accomplish this task, a scheduled maintenance program has been implemented by the Office of Rail Car Maintenance.

No matter how carefully the preventive maintenance program is constructed and adhered to, however, and no matter how meticulously car mechanics do their preventive maintenance tasks, the fact remains that cars will occasionally fail in service. Reality demands, therefore, that WMATA plan for a certain portion of the fleet to be out of service because of unexpected failures of carborne systems and components. Preventive maintenance reduces the unexpected in-service failure rate.

SCHEDULED PREVENTATIVE MAINTENANCE

Mid-life car rehabilitation is essential to extend the life of the vehicle. Without rehabilitation, the expected life of a heavy rail transit car is at least 25 years. If a vehicle is renovated at its 15th to 20th year, its expected life will be extended more than 15 to 20 additional years.

Figure 2-5 shows the scheduled and unscheduled maintenance requirements envisioned by the plan.

The Metrorail transit car scheduled maintenance program is designed to maintain car reliability by detecting potential defects and allowing them to be corrected before they fail. It also permits servicing of equipment requiring lubrication, measurement, and adjustment. Rail cars are withdrawn from service at regular mileage-based intervals to permit the following preventive maintenance actions:

- Inspection of equipment to determine its condition compared with established standards.
- Routine service: lubricating, replacing filters, replenishing fluids, and making adjustments.
- Cleaning of exterior and interior surfaces and equipment.
- Scheduled replacement of electrical and mechanical equipment.

FIGURE 2-5
Metrorail Revenue Vehicle Fleet Management Plan
MAINTENANCE DEMAND FOR REVENUE VEHICLES

		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
1	Peak Vehicle Requirement(PVR)	836	858	880	902	922	942	962	1036	1054	1126
	MAINTENANCE REQUIREMENTS										
	Operating Maintenance										
2	Scheduled Maintenance	56	56	58	58	60	62	62	68	68	74
3	Unscheduled Maintenance	112	116	118	122	124	126	130	140	142	152
4	Sub-Total: Operating Maintenance	168	172	176	180	184	188	192	208	210	226
5	Planned Operating Spare Ratio (OSR)	20.1%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.1%	19.9%	20.1%
6	Mid-Life Car Rehabilitation	38	38	38	38	38	0	38	38	38	38
7	Maintenance Total	206	210	214	218	222	188	230	246	248	264
8	Total Operating Demand	1004	1030	1056	1082	1106	1130	1154	1244	1264	1352
9	Total Fleet Demand	1042	1068	1094	1120	1144	1130	1192	1282	1302	1390

NOTES:
Line 5: OSR = Line 4 / Line 1
Line 8: Total Operating Demand = Line 1 + Line 4
Line 9: Total Fleet Demand = Line 1 + Line 7

TRAIN FAILURE DEFINITIONS AND ACTIONS

Safety-Related Failures: A number of safety-related conditions require that a train be removed from service. The Metrorail transit car is designed with a number of fail-safe system interlocks. This means that a failure or fault in a safety-critical carborne system (such as friction brakes, propulsion, or automatic train control) causes the train to go into fail-safe mode, which normally brings the train to a full stop. The train cannot be moved again until the fault is cleared or the failed system is bypassed. Moving a failed train with safety systems bypassed requires that passengers be discharged and the train removed from service. Faults of the door control system, the friction brake system, propulsion/dynamic brake system, and automatic train control system account for a majority of the carborne equipment failures that cause a train to be removed from service.

Safety is first in all operational decisions. Whenever there is an indication of a problem with safety-related carborne equipment, the car is removed from service. This action eliminates all known risks to passengers and to the system, and is consistent with WMATA's System Safety Program Plan.

Other Types of Failures: In addition to safety-related conditions, WMATA removes trains from service as the result of a number of other situations not specifically addressed by Metrorail's safety rules and procedures. For example:

- If a train has a car or cars not producing sufficient HVAC cooling in summer weather, it will be removed from service as soon as possible.
- If a train's automatic leveling bellows are malfunctioning such that the passenger door sills are above or below the platform edge or the platform gap exceeds a certain width tolerance, the train is removed from service as soon as possible.
- A train on which excessive vandalism or graffiti are discovered is removed from service as soon as possible.*
- If a train's wheels have flat spots producing a rough, noisy ride, it will be removed from service as soon as possible.
- If, at a station platform, a train's passenger doors are opened on the wrong side of the train (the non-platform side), or if a train's passenger doors are opened outside the limits of a station platform, the train normally will be removed from service immediately and sent to a yard where it can be inspected. While incorrect door openings usually are the result of operator error, WMATA again takes the safest approach and verifies that the train is in good working order before placing it back into service.
- Trains are removed from service whenever they are involved in a collision incident with persons or objects, even though there may be no apparent damage to the train. This permits the train to be inspected before being put back into service.

**NON-MECHANICAL FAILURES*

As described in the section titled "Maintaining Service Reliability: Gap Trains", the incidence of non-mechanical type failures is less than ten percent.

CAR REHABILITATION

Car rehabilitation is the third maintenance component of this fleet management plan. After 15 years of service life, a WMATA rail car will have traveled nearly one million miles. Many critical parts will wear out and basic overhauls will not be enough to maintain the expected performance. Many critical repair parts will not be available due to advances in technology. A rail car will not be maintainable without a mid-life rehabilitation or rehabilitation.

The 300 Rohr cars purchased from 1974 through 1978 had major elements in the rehabilitation program completed in 1997. Other critical components have been replaced or rehabilitated as part of the Emergency Rail Rehabilitation Program (ERRP).

The Authority's 2000-series and 3000-series Breda cars entered service between 1983 and 1988. They are now at mid-life, and significant rehabilitation of major systems is necessary to maintain their operational reliability. A contract was awarded in December 2000 to Alstom Transportation, Inc. of Hornell, New York to renovate these cars and restore them to like-new condition. Work involves the replacement of interior liners, under-floor cabling, and other systems and equipment such as: propulsion, lighting, communications, destination signs, friction brake hydraulic, pneumatic, and electronic control equipment; heating, ventilation, and cooling equipment; semi-permanent couplers between married pairs; and door system components that are nearing the end of their useful lives. In addition, trucks and front-end couplers will undergo mid-life inspection and rehabilitation.

Rehabilitation work must be performed by an outside contractor off of WMATA property since WMATA does not have the facilities to support this program. Figure 2-12, Line 6 shows how the rehabilitation process will affect the supply of vehicles during the period covered by this Fleet Management Plan.

At full production, it is expected that a steady level of 38 cars will be unavailable for revenue service at any given time because they are:

- Undergoing preparation for removal from WMATA property to be sent to the rehabilitation facility or entering the rehab process
- In production at the rehabilitation or rehab facility
- Undergoing acceptance testing after being returned to WMATA

It is anticipated that vehicles entering the rehabilitation process will be out of service for an average of four to seven months. This time frame and car count are based on the procurement specifications and the final contract.

The 4000-series, which entered service between 1992 and 1994 will be nearing their mid-life in the years 2009 to 2011. A specific decision on the mid-life rehabilitation plan for this series will be made at a future date; however, the same figure of 38 cars out of service is being used for the current program.

RAIL CARS OUT OF SERVICE: THE OPERATING SPARE RATIO

For planning purposes, WMATA uses a nominal operating spare ratio of 20 percent, calculated as follows:

FIGURE 2-6
Metrorail Revenue Vehicle Fleet Management Plan
CALCULATION OF THE OPERATING SPARE RATIO (OSR)

(Total Operating Demand – PVR*) ÷ PVR = Planned Operating Spare Ratio

(Cars required for scheduled and unscheduled maintenance) ÷ PVR = Planned Operating Spare Ratio

As seen in Figure 2-5, the number of cars required for maintenance spares ranges from 168 in FY 2006 to 226 in FY 2015 if peak vehicle requirements increase as projected. This results in a planned OSR of about 20 percent over the life of this fleet management plan.

Approximately one-third of the maintenance spares will be used to support scheduled maintenance programs. The approximately two-thirds required for unscheduled maintenance takes the married pair configuration into consideration. A failure on one car causes two cars to be removed from service. However, the reliability resulting from the scheduled maintenance programs makes the 20 percent OSR acceptable.

It should be noted that the lower fleet spare ratio reflects the increasing rail car requirement driven by ridership growth during these years prior to the assumed delivery date of the next rail car purchase. Although Figure 2-5 reflects rail car needs, due to the impact on the spare factor, the needed level of service may not be able to be provided.

FLEET SPARE RATIO

The Operating Spare Ratio excludes cars which are away from the property for rehabilitation, and therefore are not "available" for service. The Fleet Spare Ratio, discussed in Section Three of this document, is a similar measure which encompasses all vehicles in the fleet, including those which are away for rehabilitation.

**** VEHICLE SHORTAGE***

As will be seen in Section Four, it is necessary also to include in the numerator of this equation the shortage of vehicles due to a demand for a given year exceeding the supply. This impact, discussed in Section 4, may show up as a reduced operating spare ratio.

THE DISPOSITION OF CARS THAT HAVE FAILED WHILE IN PASSENGER SERVICE

When a train is removed from peak service for a failure of any kind, the entire train is out of operation for a number of hours. Typically it is sent back to the yard where it can be inspected and the failed component can be identified. The Yardmaster can then break the train apart and reassemble the good order cars for return to service in the next peak period. If the defective cars are returned to the yard quickly enough, it may be possible to repair them and return them to service in the next peak period also.

If the bad order cars can be identified while the train is at a main line terminal, it may be possible to break the train apart and place the remaining cars back into service, but this is the exception rather than the rule.

- The consist cut would require a spare train operator in the terminal to remove the cars left behind. No extra operators are scheduled and none are regularly available.
- The consist cut would consume several minutes of valuable terminal time, and would require a place to store the bad order cars until they could be removed to a repair facility. Terminals are severely restricted operating spaces in WMATA's two-track system.
- Requiring the Terminal Supervisor to direct such an ad hoc operation would distract from the timely execution of his other train dispatching duties.

It is most efficient and service-conscious to replace the entire malfunctioning train with a gap train, if one is available, and return the bad order train to a yard where it can be repaired sooner and in a more orderly fashion. After a consist cut is made at a terminal, it is most likely that the bad order cars would have to sit idle in the terminal (if a place were available in the tail tracks to store them) until after the peak period has ended, when personnel might become available to return them to the yard. Quickly transporting malfunctioning cars to a yard aids in a more rapid return to service.

Environmental Conditions Affecting the Operating Spare Ratio

The OSR is not adjusted to account for varying environmental conditions. While changing weather conditions and seasonal variations may affect operating reliability, the car maintenance program attempts to compensate in ways other than by changing the spare ratio. Each fall Metrorail undergoes extensive winterization, and modifications have been made to the rail cars to reduce weather-related failures (eg. special screens have been installed over air intakes to prevent their becoming clogged with blowing snow, for example). Operating procedures are also modified to compensate for cold weather and wet or icy conditions.

The Effect of Maintenance Policy on the Spare Ratio: A Summary of Maintenance Requirements

In its 30-year history of operation, WMATA's rail car maintenance program has resulted in one of the best maintained fleets of rail cars in North America. An aggressive cleaning program keeps interiors and exteriors clean and graffiti free. No rail car is released for service with graffiti, and none are allowed to remain in service once significant graffiti or vandalism are detected. The electrical and mechanical maintenance program is proactive.

Past Experience: The necessity of an adequate spare ratio was highlighted in late 1982 when the issue of car utilization was studied. New system segments had opened without a concomitant increase in fleet size, and the maintenance spare factor had dropped to about 12 percent. As a result, the in-service failure rate skyrocketed, service quality deteriorated, and WMATA experienced first-hand the effect of an inadequate fleet size. It was at that time that the 20 percent minimum operating spare factor policy was established.

Current Spares Requirements: To maintain the current level of performance requires that at least one-third of WMATA's rail car maintenance effort be expended on scheduled maintenance and component overhaul. A nominal operating spare ratio of about 20 percent of the scheduled peak is required to run the total car maintenance program. This results in approximately two-thirds of the maintenance spares being held out of service for unscheduled maintenance.

To maintain this level of effort, WMATA’s maintenance program is planned over seven days each week on three shifts each day. Seven repair shops are strategically located to support each rail line. Included in the six are two shops capable of performing heavy repair and overhauls. The other five are limited to inspections and running maintenance.

RAIL CAR REPAIR SHOP FACILITIES

There are currently seven Metrorail car maintenance repair facilities in operation. Figure 2-7 is a list of the shops with year opened, primary line supported, capacity, and function.

FIGURE 2-7
Metrorail Revenue Vehicle Fleet Management Plan

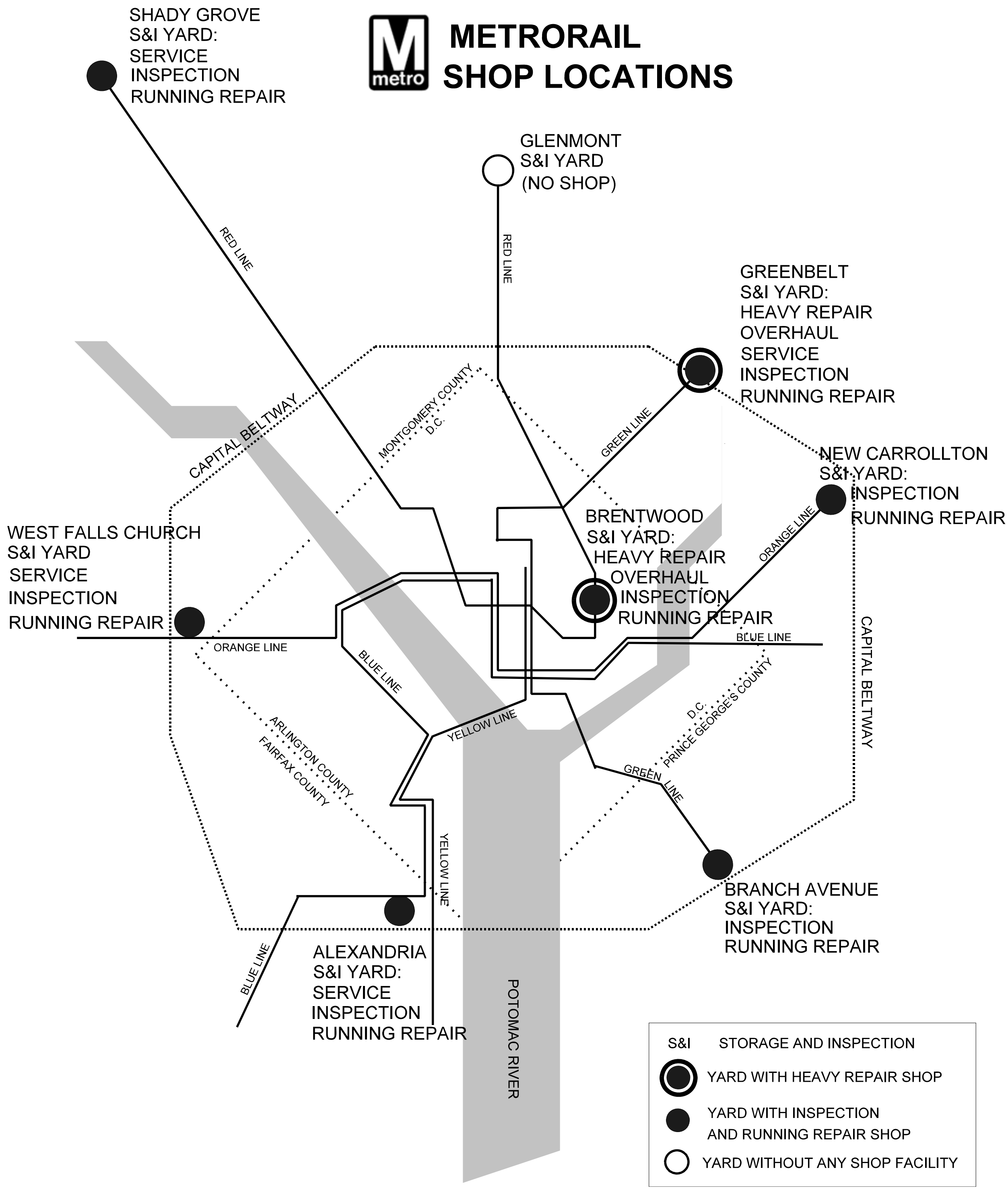
RAIL CAR REPAIR SHOP FACILITIES

Shop	Line	Year Opened	Capacity	Function
Alexandria	Blue Yellow	1981	20	Servicing, Inspection and Running Repair
Branch	Green	2002	8	Inspection and Running Repair
Brentwood	Red	1974/2009	40	Heavy Repair, Overhaul, Inspection and Running Repair
Greenbelt	Green	1996	22	Servicing, Inspection Running Repair, Heavy Repair and Overhaul
New Carrollton	Blue Orange	1978/2006	28	Servicing, Inspection and Running Repair
Shady Grove	Red	1983/2009	36	Servicing, Inspection and Running Repair
West Falls Church	Orange	1986	20	Servicing, Inspection and Running Repair
		Total Car Capacity	174	

Note: Glenmont yard does not have a shop.

Figure 2-8 depicts these facilities in their relative locations on the Metrorail system.

FIGURE 2-8
Metrorail Revenue Vehicle Fleet Management Plan



There are a total number of 174 repair spaces available which is less than the 180 cars projected to be out of service for operating maintenance during peak service in FY 2009. While not an ideal condition for expeditious maintenance turnaround, consideration is given to the fact that approximately 15 percent of running repairs can be performed outside of the repair shop.

FUTURE CONSIDERATIONS OF REPAIR SHOP AND STORAGE FACILITIES

The present capacity of Metro's repair shop facilities is barely adequate to service the existing rail car fleet. While temporary measures can be used to accommodate a short term deficiency, a long term solution must be developed to address future needs. In addition, although there may be theoretical capacity to store most of the projected fleet, the available storage capacity is not necessarily in the most efficient and appropriate location to serve the required operations.

Maintenance Space: In addition to new rail cars, the Capital Improvement Program calls for the addition of 18 new maintenance spaces in shops throughout the system, as follows:

> **West Falls Church:** Eight additional maintenance spaces will be needed in FY 2013 to bring the total to 182.
>
> **Dulles:** Ten additional maintenance spaces are required in FY 2015 to bring the system total to 192. A minimum of 226 are required system-wide with delivery of sixty 7000-series in FY 2014 and remainder of the Dulles cars in FY 2015.

Figure 2-9
Metrorail Revenue Vehicle Fleet Management Plan
Summary of Rail Car Shop Space Requirements

		No. of Cars	**Bays Needed**
By Fleet Size:			**Total**
Current Fleet		948	146
With 184 (6000 Series)		1,132	174*
With Dulles (128 cars)		1,260	190
With 130 (7000 Series)		1,390	210
By Location:			**Total**
Present Number of Maintenance Bays			174
Long Term Expansion (FY 2015)	West Falls Church		8
	Dulles		10
Total			**192**

* Includes current construction of 12 at Brentwood and 16 at Shady Grove

Shop space industry standard: The number of maintenance bays should equal 15% of the total number of cars in the fleet.

***New Carrollton: 40*
Shady Grove: 60
Dulles: 184

Car Storage: According to the SAP, the growth of the Metrorail transit car fleet to 1,390 cars will consume most of the available storage capacity. However, the storage is not in the right spots to support train dispatch. The additional 184 storage spaces will improve operational efficiency.** Figure 2-10 rail car fleet storage capacity by location.

Figure 2-10
Metrorail Revenue Vehicle Fleet Management Plan
Rail Car Fleet Storage Capacity

Existing Condition

Location	Existing Storage Capacity	Fleet Need w/Alstom Cars*	Excess Storage Capacity
Alexandria	176	180	-4
Branch Ave	166	62	104
Brentwood	86	76	10
Glenmont	132	144	-12
Greenbelt	284	158	126
Largo	42	42	0
New Carrolton	114	114	0
Shady Grove	168	176	-8
West Falls Church	148	180	-32
Total	1,316	1,132	184

* Does not include the rehab float.

Projected Fleet Growth

	Increase In Cars	Including Rehab Float	Without Rehab Float
Current: (6000 Series)		1,132	1,094
With Dulles(FY13/15)	128	1,260	1,222
With 7000 Series Options (FY 12 - 14)	130	1,390	1,352

Summary Comments
With a fleet size of 1,390 and storage capability of 1,402 (1,274 + 128 at Dulles) we are at capacity to store all cars. A future analysis will be done to evaluate the operating efficiency of the location of the storage to determine if additional spaces could reduce operating costs.

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SECTION THREE

THE SUPPLY OF REVENUE VEHICLES

THE EXISTING METRORAIL TRANSIT CAR FLEET

As of July 1, 2006, the Metrorail transit car fleet consists of 948 vehicles as shown in Figure 3-1.

FIGURE 3-1
Metrorail Revenue Vehicle Fleet Management Plan
CURRENT TRANSIT CAR FLEET

Manufacturer	Series	Number Owned	Years Purchased
Rohr Industries	1000	300[1]	1974-1978
Breda Construzioni Ferroviarie	2000 / 3000	366[2]	1983-1988
	4000	100	1992-1994
Construcciones y Auxiliar de Ferrocarriles, S.A. (CAF)	5000	192	1998-2003
Alstom	6000	62/122	2006-2009
Total		1094	

[1]Four Rohr cars are dedicated to revenue collection, four were accident destroyed (1982 and 1996).
[2]38 Breda cars are undergoing rehabilitation; two are accident damaged and are being used as training vehicles in the Fire & Safety Test Center at WMATA's Carmen E. Turner Maintenance and Training Facility in Landover, MD. Two Breda cars were destroyed in 2004.

TEN-YEAR CAPITAL IMPROVEMENT PROGRAM

One element of WMATA's ten-year capital improvement program is called System Access and Capacity Program (SAP). The SAP calls for the addition of 312 rail cars beyond those added for system expansion in order to address general growth in ridership. This fleet management plan is intended to support and be in accord with the SAP.

Fleet Size: The Authority is currently in the process of deploying the initial Alstom 6000 series cars. This procurement provides 62 growth cars by 2007 and an additional 122 rail cars from the 6000 series options, bringing the service fleet total to 1,132 (1094 plus the 38 rehabs) by December 2009.

An additional 128 cars for Dulles and 130 growth cars will be needed by 2015 to complete the car service fleet expansion program, taking the fleet total to 1,390 cars. One objective of the SAP's 300-car growth plan is to facilitate the operation of 75 percent of peak period trains as 8-car consists.

PLANNED RAIL CAR

The purchase of additional transit cars is required to support both

PROCUREMENT

system expansion and projected ridership growth. The procurement schedule for the 6000-series cars is shown in Figure 3-2, below.

FIGURE 3-2
Metrorail Revenue Vehicle Fleet Management Plan
6000-SERIES RAIL CAR SCHEDULE

PROGRAM ELEMENTS	DATE
Board Approval to Advertise	April 2001
Bid Advertisement	May 2001
Receive Proposals	November 2001
Contract Award	July 2002
Service Date	
- first 86 cars	FY07
- additional 72 cars	FY08
- remaining 26 cars	FY09

We expect the first 50 cars to be in service December 2006 and assume a delivery of 6 per month. This results is the first 86 cars placed into service in FY07, 72 more cars placed into service during FY08, and the remaining 26 cars of the 184 car procurement going into service in FY09. The 6000-series procurement, with the full option, will satisfy the Authority's estimated fleet needs through FY10. In the years FY10 to FY13 the entire Rohr fleet will reach the end of its 35 year service life and will need to be replaced. This will be the first transit vehicle replacement activity to be undertaken by WMATA since revenue operations began.

FIGURE 3-3
Metrorail Revenue Vehicle Management Plan
SUPPLY OF REVENUE VEHICLES

		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
1	Peak Vehicle Requirement (PVR)	836	858	880	902	922	942	962	1036	1054	1126
	VEHICLE SUPPLY										
2	Vehicles Owned	958	958	1044	1116	1142	1142	1142	1202	1292	1336
3	Planned Procurement*	0	86	72	26	0	0	60	90	44	64
4	Subtotal: Vehicles Owned	958	1044	1116	1142	1142	1142	1202	1292	1336	1440
	Adjustments to Vehicle Supply										
5	Accident Damaged Vehicles	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
6	Revenue Collection Vehicles	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
7	Total Vehicle Supply	948	1034	1106	1132	1132	1132	1192	1282	1326	1390
8	Fleet Spare Ratio (FSR)**	13.4%	20.5%	25.7%	25.5%	22.8%	20.2%	23.9%	23.7%	25.8%	23.4%

* Line 3 = 6000 series (184 cars in FY06 - FY08); Dulles (64 cars in FY13 and 64 cars in FY15); 7000 series (130 cars in FY 12 - FY14)
** Line 8 = (Line 7 - Line 1)/ Line 1

ADJUSTMENTS TO VEHICLE SUPPLY

Accident-Damaged Vehicles: Figure 3-3, Line 5 shows the impact of the accident-damaged vehicles to the fleet. Six rail cars sustained damage and are no longer in service . Inasmuch as they are not available for service, accident-damaged vehicles are subtracted from the fleet size before the spare ratio is calculated. They are not included in the spare ratio.

**MONEY TRAIN MODIFICATION*

Seats, carpets, wind screens, and stansion bars are removed, steel plates with tie-down rings are fitted over the floors, bump rails are installed to keep carts away from interior liners, and shotgun racks are installed for the use of security personnel.

The money carts are extremely heavy, and can cause considerable damage to the interior of a vehicle outfitted for regular passenger service.

Revenue Collection Vehicles: The Metrorail system is designed such that transport of money and fare media between the passenger stations and the treasury building is best accomplished by train. Treasurer's facilities are directly accessible by train, and the money carts (wheeled vaults) in each station are stored in lockers at the platform level for easy access by money collection trains. Since money distribution and collection is done during late evening revenue hours when passenger trains are still in service, safety and operating considerations dictate that the money trains must have the same operating characteristics as the passenger trains among which they must run.

In the past WMATA has wrestled with the issue of the most cost effective way to distribute and recover cash and fare media from the Metrorail stations. The following options have been considered by the WMATA Board of Directors:

- Armored trucks operating on surface streets
- Rail cars built specifically for revenue transport
- Regular rail passenger vehicles that have had their interiors modified to accommodate the money carts.*

After a thorough cost-benefit analysis, it was concluded that modifying regular passenger cars to serve as revenue collection vehicles would have the least impact on the Authority's capital and operating budgets. As a result of the analysis, the WMATA Board of Directors authorized the conversion of four Rohr cars for use as revenue collection vehicles.

As the time approaches when more revenue collection vehicles are required, the Authority will review these options and conduct another cost-benefit analysis of all options. For the purpose of this Fleet Management Plan, it is assumed that the same conclusion will be reached. The plan calls for the conversion of two additional Rohr cars sometime beyond FY 2007.

FLEET SPARE RATIO

Section Two of this document contains a discussion of the Operating Spare Ratio (OSR), which is WMATA's primary measure of the efficiency of fleet utilization. The OSR considers only vehicles that are *available* for passenger service. All the cars undergoing rehabilitation at a location away from WMATA property are not immediately available for service and therefore are specifically excluded from the OSR calculation. Figure 2-5, Line 6 shows the number of cars undergoing rehabilitation for each year of this Fleet Management Plan.

Although the OSR reflects the efficiency of use of vehicles actually available for service, some regulatory and funding agencies are interested in seeing calculated a second spare ratio, defined as follows:

FIGURE 3-4
Metrorail Revenue Vehicle Fleet Management Plan
CALCULATION OF THE FLEET SPARE RATIO (FSR)

$$(\text{Total Vehicle Supply} - \text{PVR}) \div \text{PVR} = \text{Fleet Spare Ratio}$$

In Figure 3-3, the Total Vehicle Supply shown on Line 7 encompasses all cars in the fleet, including those in the rehabilitation program. (This figure, however, excludes the two categories of "Adjustments" discussed above.) This Total Vehicle Supply figure, minus the PVR, divided by the PVR, equals the Fleet Spare Ratio (FSR) shown on Line 8.

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SECTION FOUR

REVENUE VEHICLE DEMAND / SUPPLY BALANCE

Figure 4-1 is a summary showing the balance of demand for transit cars and the supply of cars for the period of this Metrorail Revenue Vehicle Fleet Management Plan. As discussed in the foregoing sections, this fleet management plan is a snapshot of an ongoing planning process. It takes into account the passenger demand for vehicles in revenue service and the demand that is placed on the fleet by scheduled and unscheduled maintenance requirements. The plan ties these operating and maintenance requirements to the supply of vehicles in both the present fleet and with the addition of anticipated new vehicle procurements.

The plan anticipates that the peak period passenger service requirement will rise from 836 cars at the end of FY 2006 to 942 cars by FY 2011 and 1126 cars by FY 2015. It assumes that 42 cars will be needed in FY06 to provide strategic gap trains and the length of the gap train will increase in proportionally to match the 8-car train operation. It assumes that the operating maintenance car requirement will rise to 188 cars by FY 2011, and to 226 cars by FY 2015. It assumes an aggressive mid-life car rehabilitation program that will remove significant numbers of cars from service for extended periods of time.

On Line 17 of Figure 4-1, WMATA is shown to have a significant deficiency in the number of vehicles available for passenger service in the years FY 2006 - FY 2007. This deficiency reflects the need for additional service to respond to the growth in ridership during those years and the delays with the 6000 series fleet. The deficiency can be addressed in one of two ways:

- Defer maintenance of the fleet and place the full complement of cars into passenger service every day, or
- Continue to maintain the fleet as prescribed and operate fewer cars than is indicated by passenger demand.

The Authority has chosen the latter course of action as being the wisest and most prudent. It does, however, result in higher passenger loads and significant overcrowding. On the upside, proper fleet maintenance assures a higher degree of reliability for the cars that are placed into service. It is WMATA's position that a reliable albeit overcrowded service is preferable to a spacious but unreliable operation.

The receipt and deployment of 6000 series cars beginning in FY 2007 will represent a significant step toward satisfaction of the Metrorail fleet size requirement for the near future.

FIGURE 4-1
Metrorail Revenue Vehicle Fleet Management Plan
VEHICLE DEMAND/SUPPLY BALANCE

		FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
	Operating Requirements					**VEHICLE DEMAND**					
1	Scheduled on Line	794	814	834	854	872	890	908	980	998	1070
2	Gap Cars	42	44	46	48	50	52	54	56	56	56
3	Peak Vehicle Requirement (PVR)	836	858	880	902	922	942	962	1036	1054	1126
	Maintenance Requirements										
	Operating Maintenance										
4	Scheduled Maintenance	56	56	58	58	60	62	62	68	68	74
5	Unscheduled Maintenance	112	116	118	122	124	126	130	140	142	152
6	Sub-Total Operating Maintenance	168	172	176	180	184	188	192	208	210	226
7	Mid-Life Car Rehabilitation	38	38	38	38	38	0	38	38	38	38
8	Maintenance Total	206	210	214	218	222	188	230	246	248	264
9	Total Operating Demand	1004	1030	1056	1082	1106	1130	1154	1244	1264	1352
10	Total Fleet Demand	1042	1068	1094	1120	1144	1130	1192	1282	1302	1390
	Vehicles Owned					**VEHICLE SUPPLY**					
11	Revenue Vehicles Owned	958	958	1044	1116	1142	1142	1142	1202	1292	1336
12	Projected Procurement	0	86	72	26	0	0	60	90	44	64
13	Subtotal: Vehicles Owned	958	1044	1116	1142	1142	1142	1202	1292	1336	1400
14	Accident Damaged Vehicles	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
15	Revenue Collection Vehicles	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
16	Total Vehicle Supply	948	1034	1106	1132	1132	1132	1192	1282	1326	1390
17	**BALANCE:**	-94	-34	12	12	-12	2	0	0	24	0
18	Actual Operating Spare Ratio	20.1%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.1%	19.9%	20.1%
19	Fleet Spare Ratio	13.4%	20.5%	25.7%	25.5%	22.8%	20.2%	23.9%	23.7%	25.8%	23.4%

Service shown is as of the end of the Fiscal Year (June 30)

Notes:
Line 9: Total Operating Demand = Line 3 + Line 6
Line 10: Total Fleet Demand = Line 3 + Line 8
Line 18: Operating Spare Ratio = (Line 6 + Line 17) ÷ Line 3
Line 19: Fleet Spare ratio = (Line 16 - Line 3) ÷ Line 3
* Reflects the 7000 series procurement of 50 cars in FY2013 and 30 cars in FY2014 (1256 + 50 + 30)

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APPENDIX A

PASSENGER LOAD FACTORS

The following load factors assume a weighted average of 71 passenger seats per car in the current WMATA rail car fleet. The passengers per seat figures are calculated by dividing the passengers per car figures by 71

FIGURE A-1 PASSENGERS PER SEAT CONVERSION TABLE

Pax Per Car	Pax Per Seat	Pax Per Car	Pax Per Seat	Pax Per Car	Pax Per Seat
155	2.18	135	1.90	115	1.62
154	2.17	134	1.89	114	1.61
153	2.15	133	1.87	113	1.59
152	2.14	132	1.86	112	1.58
151	2.13	131	1.85	111	1.56
150	2.11	130	1.83	110	1.55
149	2.10	129	1.82	109	1.54
148	2.08	128	1.80	108	1.52
147	2.07	127	1.79	107	1.51
146	2.06	126	1.77	106	1.49
145	2.04	125	1.76	105	1.48
144	2.03	124	1.75	104	1.46
143	2.01	123	1.73	103	1.45
142	2.00	122	1.72	102	1.44
141	1.99	121	1.70	101	1.42
140	1.97	120	1.69	100	1.41
139	1.96	119	1.68	99	1.39
138	1.94	118	1.66	98	1.38
137	1.93	117	1.65	97	1.37
136	1.92	116	1.63	96	1.35

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APPENDIX B

GAP TRAINS

MAINTAINING SERVICE RELIABILITY GAP TRAINS

This fleet's missed trips seriously degrade customer service. Metrorail is a two-track system that does not permit easy recovery from equipment failure. The weekday peak period headway is two to three minutes on all lines in the downtown area. Maintaining that short headway interval is crucial to keeping passenger loads within acceptable limits. The ripple effect of a peak period service delay can inconvenience many thousands of passengers on a line, whose trips are lengthened, who experience crush loads, and who may be unable to board overcrowded trains. Crush loaded trains make boarding and alighting difficult and thereby lengthen station dwell times, further exacerbating the delay in service. Minor service interruptions can result in passenger loads that exceed the allowable standard, and the feedback the Authority receives in the form of passenger complaints is immediate. Metrorail's riders do not hesitate to let us know when the quality of service does not meet their high expectations.

The average gap train use is about 346 incidents per month or about 11 per day. Approximately 85 percent of all gap train deployments are to replace trains with mechanical problems. The remaining 15 percent of gap train deployments are for non-mechanical problems, including:

- **To relieve occasional unanticipated platform overcrowding.**

- **To maintain schedule under degraded operation conditions; especially those that sometimes remain even after a malfunctioning train has been replaced.** As discussed in the section titled "Train Failure Definitions and Actions", in addition to hard failures, gap trains are used to replace trains that are experiencing minor or intermittent malfunctions, but have not actually failed. In this case the gap train is used to avoid an anticipated failure and preserve passenger comfort and convenience.

- **To replace trains that have been vandalized or soiled by the public.** A number of non-mechanical conditions are defined as failures by WMATA. For example, a gap train may be used to replace a train that has excessive graffiti or vandalism, or which has been soiled by a sick passenger and requires cleaning before it can be allowed to continue in service. This type of event accounts for about 42 percent of the non-mechanical uses.

It is conceivable that a gap train standing ready on one line could be used to fill a gap in service that has occurred on another line. Such a use is most likely to occur where two lines run on a common track: on the southern end of the Blue-Yellow Line, the southern end of the Yellow-Green Line, or the northern end of the Blue-Orange Line on the eastern side of the city. It is also possible, but less likely, that gap trains might be interlined between the Red and the Blue-Orange Lines via the C&A connector track, and between the Red and Green Lines via the B&E connector.

The schedule currently calls for a gap train at the end of most lines, staffed by an operator, and ready to be placed into service on short notice. This reserve ensures that no trips are missed when a train is removed from service because of a mechanical failure or to aid in re-blocking when a line is delayed by other operational problems.

This Fleet Management Plan calls for 44 cars in FY07 to be used for daily gap train service. This level will be increased to 56 cars (7 8-car trains) by 2013.

APPENDIX C

PREVENTATIVE MAINTENANCE

The preventive maintenance program is a form of progressive inspection and servicing, the schedule for which is shown in Figure C-1 and is described in detail in the paragraphs that follow.

FIGURE C-1
Metrorail Revenue Vehicle Fleet Management Plan
RAIL CAR PREVENTIVE MAINTENANCE SCHEDULE

Inspection Type	Inspection Interval*	Average Mileage*	Elapsed Time (hrs)	Labor Hours
Daily	24 hours	166	0.5	0.5
Intermediate	30 days	5,000	4	4
A	60 days	10,000	24	30
B	Semi-Annual	30,000	24	46
C	Annual	60,000	36	60

**Inspection frequency is dictated by manufacturer's recommended mileage-based intervals. For ease of scheduling, the mileage interval is translated into a time interval based on known average daily miles operated by a WMATA rail car.*

Daily Inspection: The daily inspection consists of a safety test of the carborne automatic train control equipment, a visual inspection of the interior and exterior of the car, and a functional test of safety-critical and passenger convenience components such as lighting, the public address system, and emergency evacuation equipment. Defects are corrected prior to releasing the car for service. Graffiti removal is a top priority. No car is released for service with graffiti or vandalized equipment. Daily inspections are normally accomplished in the yard rather than inside the shop.

Intermediate Inspection: This inspection involves the examination and servicing of types of equipment that require more extensive and time-consuming action than is possible on the daily inspection. It is less extensive and complex than a Type A inspection, however. For example, group box covers components, filters are changed in the environmental and pneumatic systems, battery cells are serviced, and wheel truck assemblies are inspected.

Type A Inspection: Type A, B, and C inspections always take place with the car inside the shop. Prior to technical inspection, under-car equipment is cleaned to enhance the quality of the inspection. Blow pits with compressed air hoses are provided at each service and inspection facility to blow carbon dust out of traction motors and generators. Blow pits also have hot water wash equipment to remove grease and dirt from mechanical components such as air conditioning condenser coils, couplers and wheel trucks. Following the cleaning process, designated system components are inspected for serviceability and are functionally tested.

Type B Inspection: This includes all the requirements of the Type A inspection. Additional tasks include but are not limited to a brake caliper torque check, a detailed coupler and draft gear inspection, and other servicing and adjustments not required as frequently as in the previous inspections.

Type C Inspection: This encompasses all the requirements of the previous inspections, and adds routine overhaul of selected electrical and mechanical components. The equipment to be overhauled is removed and replace in compliance with a schedule established by the Office of Rail Maintenance Planning and Scheduling. Removed components are sent to the overhaul shop.

Scheduled Component Overhaul: The scheduled overhaul program involves the pre-failure replacement of components based on known and projected failure rates. Components are scheduled for overhaul at regular intervals based on mileage or operating hour criteria as appropriate. Overhauls are performed by the Brentwood overhaul shop or by outside vendors. Removal and replacement of the parts on the car performed by WMATA service and inspection shop personnel. This includes replacement of worn or discolored seat cushions, vinyl covers, replacement of worn carpet, and refurbishment of exterior painted surfaces.

Scheduled Car Body Refurbishment: The carpeting and painted surfaces of the rail car body require periodic scheduled maintenance or replacement to ensure that the car’s appearance is maintained. Keeping the carpet in good condition contributes to passenger safety. Carpeting is replaced every five years; requiring that 20 percent of the fleet be scheduled annually for carpet replacement. The exterior decor panels at window level also require new paint and decals on a five year cycle. The painted fiberglass front end of the rail car requires repair and painting every ten years. All of the car body maintenance programs are scheduled routinely to reduce the impact on peak service and to minimize staffing requirements.

Rail Cars Out of Service for Scheduled Maintenance:
An average of 56 rail cars are needed to conduct the scheduled maintenance program. Cars must be held out of service for the following reasons:

Reason Out of Service	Percent of Cars Out of Service
Type A, B, and C Inspection	46%
Intermediate Inspection	8%
Carpet Replacement	15%
Front-end & decor panel paint & decals	8%
Major component replacement, sub-system light overhaul, and modifications	23%
TOTAL	100%

Cleaning Program: This program consists of four levels of interior and exterior cleaning, performed during off-peak and non-revenue hours as follows:

Level One: Daily trash and newspaper removal while the train is in service. Car cleaning personnel are assigned to terminal stations to accomplish this task. They also provide emergency spot cleaning, and alert the Terminal Supervisor to more extensive cleaning requirements that may warrant removing the train from service temporarily. Cars with serious graffiti or other vandalism are removed from service immediately.

Exterior washing is accomplished daily by train operators taking their trains through the automatic car wash as they return to the yard following passenger service.

Level Two: Performed daily in train storage yards. This task includes trash removal; spot cleaning of walls, windows, and seats; carpet vacuuming; and removal of minor graffiti. The Authority has experienced only a few incidents of major graffiti on rail cars, and its removal requires a major effort that is outside the scope of this routine cleaning program.

Level Three: This task is performed at 60 day intervals in conjunction with the Type A inspection. The interior of the car is thoroughly cleaned. The walls, ceiling, windows, light fixtures, and seats are hand washed with detergent, and the carpet is shampooed.

Level Four: This cleaning is performed bi-annually by an outside contractor. The unpainted aluminum body of WMATA's Metrorail cars requires professional cleaning to remove iron oxides and stains tht cannot be removed by normal car washing techniques.

Preventive Maintenance Program Monitoring and Support

WMATA's Rail Car maintenance personnel are responsible for the development and revisions to the scheduled maintenance programs. All programs are reviewed annually for adequacy, applicability and necessity. Manufacturer's recommendations, historical data on rail car system performance and direct contact with car maintenance employees performing the work provide the foundation for evaluating maintenance program effectiveness.

The Quality Assurance Branch monitors fleet performance to ensure that vehicle maintenance practices and procedures are effectively supporting the goal to provide the best in safe, reliable, cost effective and attractive rail transit services. Daily audits are performed within the various maintenance shops and on revenue lines to measure the quality of maintenance performed. The results of the audits are reported to the respective maintenance managers and the Chief Operating Officer for the Department of Rail. Considerable time is spent auditing preventive maintenance in progress and immediately after completion. Procedural problems and failure trends are reported to the Vehicle Engineering Branch for further evaluation and corrective action.

The current scheduled maintenance program is the result of over 30 years of maintenance and operating experience. Rail car system and component maintenance requirements change with age and usage.

Continuous monitoring of performance and physical evaluation of equipment condition is required to determine the maintenance requirements necessary to meet service and budgetary goals.

UNSCHEDULED CORRECTIVE MAINTENANCE

Equipment maintenance will be accomplished essentially at a fixed rate. It is not a question of whether a component will have to be serviced, overhauled, or replaced, but when. When preventive maintenance is accomplished on a scheduled basis, plans can be made to compensate for the absence of the equipment. When maintenance is accomplished as a result of an in-service failure, on the other hand, it is difficult (and more expensive) to compensate for its loss, and service quality suffers. Nonetheless, no matter how a maintenance organization tries to minimize in-service failure rates, the fact remains that unexpected failures will occur, even on new systems and components. The objective of a preventive maintenance program is to minimize the corrective maintenance requirement, and avoid the accompanying service quality degradation.

Failure Rate and Cars Out of Service: One hundred and fifty (150) component failures are reported to Metrorail car maintenance on an average weekday. Reported failures range from minor faults such as burned out light bulbs to major conditions such as shorted traction motors. A failure may occur while a car is in passenger service, or it may be discovered during a daily inspection by a mechanic. Of the 150 average daily component failures, 66 (44%) are repaired without having to hold the car out of service.*

**For the purpose of this discussion we assume one failure per car, although that is not always the case.*

The remaining cars must be held out of service for the following reasons:

Reason Out of Service	Percent of Cars Out of Service
System failure	93%
Engineering evaluation (repeat failure or unusual occurrence)	7%
Total	100%

Performance data are reviewed daily, weekly, and monthly for trends. When an unfavorable performance trend is detected, cars may be held out of service for engineering evaluation. Sometimes systems can be re-engineered to improve reliability.

Mean Time to Restore: The Mean Time to Restore (MTTR) varies greatly as a result of the logistics involved in getting cars distributed among the shops. The average labor time to complete a repair is three hours. However, the elapsed time to return a car to revenue service is six hours or more for major equipment problems. The following represents WMATA's average daily turn-around time:

Time Out of Service	Percent of Cars Out of Service
Less than one day	52%
Two Days	24%
More than two days	24%
Total	100%

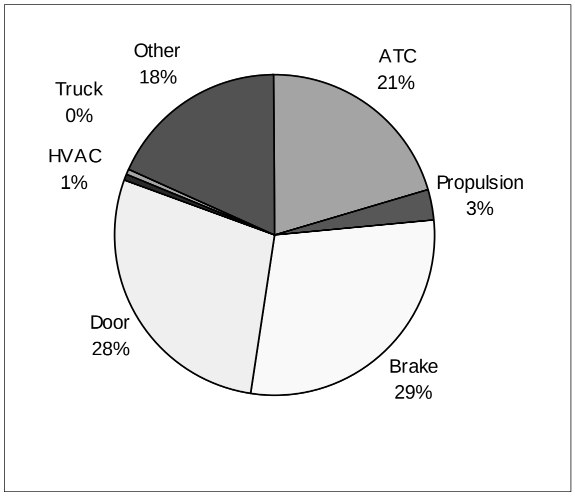
Sub-System Delays: Figure C-2 shows the delays of the major individual carborne sub-systems per million miles during the period October 2001 to September 2006.

FIGURE C-2

SUB-SYSTEM DELAYS (Greater than 3 minutes)

	ATC	Propulsion	BRAKE	DOOR	HVAC	TRUCK	OTHER
Oct-05	4.9	0.2	5.8	6.2	0.0	0.2	3.5
Nov-05	3.7	0.2	6.2	5.2	0.4	0.0	2.6
Dec-05	4.8	0.7	5.5	5.5	0.0	0.4	2.7
Jan-06	4.2	0.2	3.6	4.6	0.0	0.2	3.9
Feb-06	3.2	1.0	5.5	4.3	0.2	0.0	4.5
Mar-06	2.3	0.7	4.4	3.5	0.0	0.0	3.2
Apr-06	3.5	0.9	4.5	3.1	0.0	0.0	1.6
May-06	3.4	0.9	5.7	4.4	0.0	0.0	2.6
Jun-06	2.9	0.2	5.6	5.6	0.2	0.2	2.7
Jul-06	4.1	0.4	6.6	6.1	0.0	0.0	4.2
Jul-06	3.7	0.4	4.4	7.2	0.4	0.0	5.3
Aug-06	4.1	0.6	4.8	6.1	0.0	0.0	3.3
Sep-06	3.7	0.5	5.2	5.2	0.1	0.1	3.3
Average %	**20.6%**	**2.9%**	**28.7%**	**28.4%**	**0.6%**	**0.5%**	**18.4%**

Delays per million miles (DPMM) by Sub-System:
(Delays= All revenue service incidents that have >3 minutes train delay charged to CMNT)



The "OTHER" category, in Figure C-2 includes failures of the following types of carborne equipment:

- Destination signs
- Car body components
- Operator's seat and other cab equipment
- Windows and interior glass
- Primary and auxiliary power (not propulsion)
- Communications equipment
- Lighting
- Couplers

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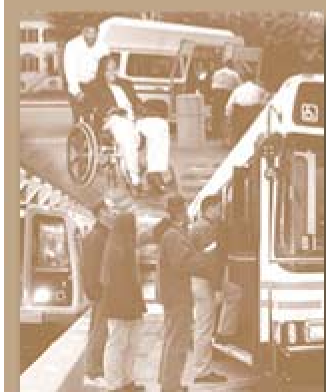
Metrorail Fleet Management Plan

Presented to the Board of Directors:

Customer Service, Operations and Safety Committee

November 9, 2006



Rail Fleet Management Plan

- 2004 Plan Update
- Planning tool documenting projected Metrorail system growth
- Does not obligate the Authority to projected requirements
- Plan update is required by FTA to support the Dulles Extension Project and future rail car purchases

	Fleet Size Rail Cars	Rail Car Storage Capacity	Maintenance Bays Requirement	Maintenance Bays Available
Current	948	1,316	142	146
6000 Series Procurement	184	0	28	28
Total by 2009	**1,132**	**1,316**	**170**	**174**
Impact of Dulles				
Phase I	64	42	10	8
Phase II	64	184	10	10
SubTotal Dulles	128	226	20	18
System Total with Dulles	**1,260**	**1,542**	**190**	**192**
System Growth thru 2015	130	0	20	0
System Total thru 2015	**1,390**	**1,542**	**210**	**192**