TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Synthesis 11

System-Specific Spare Bus Ratios

A Synthesis of Transit Practice

Transportation Research Board
National Research Council

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Synthesis of Transit Practice 11

System-Specific Spare Bus Ratios

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TRANSPORTATION RESEARCH BOARD
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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it

The need for TCRP was originally identified in *TRB Special Report 213--Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000,* also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of vice configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB), and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at anytime. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end-users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the Transit Development Corporation, the National Research Council, or the Federal Transit Administration of the U S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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PREFACE

A vast storehouse of information exists on many subjects of concern to the transit industry. This information has resulted from research and from the successful application of solutions to problems by individuals or organizations. There is a continuing need to provide a systematic means for compiling this information and making it available to the entire transit community in a usable format. The Transit Cooperative Research Program includes a synthesis series designed to search for and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in subject areas of concern to the transit industry.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to transit agency general managers; operations, planning, maintenance, and finance personnel; as well as to regional, state, and federal funding agencies, and others concerned with the provision of safe and efficient public transit service. This synthesis documents critical site-specific variables that influence transit agencies' spare bus ratio policies. It profiles a select group of transit agencies of varying sizes and geographic locations and describes their operating environments in order to relate how these affect the number of spare buses each agency needs to meet its service requirements.

Administrators, practitioners, and researchers are continually faced with issues or problems on which there is much information, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered or not readily available in the literature, and, as a consequence, in seeking solutions, full information on what has been learned about an issue or problem is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to the available methods of solving or alleviating the issue or problem. In an effort to correct this situation, the Transit Cooperative Research Program (TCRP) Synthesis Project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common transit issues and problems and synthesizing available information. The synthesis reports from this endeavor constitute a TCRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to a specific or closely related issue or problem.

This report of the Transportation Research Board provides information to familiarize transit agency staff with the unique and different operational, environmental, and political factors that affect optimal fleet size at various transit agencies. It describes the efforts of agencies striving to achieve and maintain lower spare ratios while continuously challenged with ridership fluctuations, aging fleets, as well as operating environments, maintenance programs, fleet mixes, roadcalls, training programs, and management and finance considerations.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, available information was assembled from numerous sources, including a number of public transportation agencies. A topic panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of Chuck Berkshire, Deputy General Manager, Maint., New Jersey Transit Corporation, Department of Bus Service; Antonio P. Chavira, Jr., Director of Operations, Los Angeles County Metropolitan Transportation Authority; Paul C. Gillum, Jr., Deputy Assistant General Manager, Department of Bus Service, Washington Metropolitan Area Transit Authority; Clarence I. Giuliani, Principal, Giuliani and Associates, Inc.; Philip R. Hale, Senior-Manager Bus Fleet, Dallas Area Rapid Transit; George I. Izumi, Senior Engineer, Federal Transit Administration; Frank Kobliski, Vice President, Operation & Maintenance, Central New York Regional Transportation Authority; Brian H. O'Leary, Vehicle Maintenance Manager, Municipality of Metropolitan Seattle; and Peter L Shaw, Public Transportation Specialist, Transportation Research Board

The Principal Investigators responsible for the conduct of the synthesis were Sally D. Liff, Manager, Synthesis Studies, and Donna L. Vlasak, Senior Program Officer. This synthesis was edited by Linda S. Mason, assisted by Rebecca B. Heaton.

Valuable assistance to the Topic Panel and the synthesis staff was provided by Gwen Chisholm Smith, Senior Program Officer, Transit Cooperative Research Program, Transportation Research Board

Information on current practice was provided by many transit agencies. Their cooperation and assistance were most helpful.

SYSTEM-SPECIFIC SPARE BUS RATIOS

SUMMARY

The job of fleet managers is to provide customers with vehicles that meet their requirements. Fleet managers must optimize available resources and deliver safe, clean, and reliable equipment on time. When the demand for vehicles is associated with a scheduled service, the challenge is particularly exacting. Assuring the availability of needed buses every day, every peak hour, is one of the toughest jobs in the transportation service industry. Especially in the cost-conscious environment of public transit, fleet managers cannot be burdened with excess buses that require additional resources and can adversely affect the overall efficiency of the fleet. Managing fleet size in relation to service levels is smart management and is also fiscally responsible. Transit managers use the spare ratio factor as a key performance indicator to measure how they are doing. Moreover, federal and state agencies, notably the Federal Transit Administration (FTA), review spare ratios to evaluate the effectiveness of fleet management and whether the agency needs financial assistance to acquire new buses for fleet additions and replacements.

The purpose of this study was to document and examine the critical site-specific variables that affect the number of spare vehicles that bus systems need to maintain maximum service requirements. The project involved transit managers at a cross section of bus transit agencies of varying size and geographic location in the United States and Canada who responded to a detailed survey questionnaire. Many also participated in follow-up interviews.

Although transit managers generally acknowledged that right sizing the fleet actually improves operations and lowers cost, many reported difficulties in achieving and consistently maintaining a 20 percent spare ratio as recommended by FTA. The general consensus was that more flexibility was required in determining the actual number of vehicles needed to accommodate the different operating environments and service requirements unique to each property. The variables most commonly mentioned by survey respondents, which are listed below, affect all agencies to some degree, although any given factor may predominate at a specific agency.

Maintenance Programs
Operating Environment
Annual Bus Mileage
Bus Operating Speeds
Ridership Fluctuations
Service/Route Adjustments
Age of Fleet
Peak-to-Base Ratio
Fleet Mix of Makes and Models
Roadcalls
Vehicles per Mechanic
ADA and Alternative-Fuel Buses
Management and Finance
Bus Purchase/Retirement Schedule
Inventory Management
Maintenance Training
Bus Back-up for Rail Service Disruptions

The respondents to the survey advocated that more emphasis be placed on developing improved and innovative bus maintenance techniques, which would assist them in minimizing down time and improving vehicle availability, ultimately leading to reduced spare vehicles and labor and material costs.

Many agencies have been successful in limiting reliance on excess spare vehicles. Those transit officials agree that several factors and initiatives have led to their success and are critical to the success of any program:

- A corporate philosophy that encourages managing with a lean fleet
- Strong preventive maintenance programs, including frequent, regular, and timely inspections with the immediate repair of found defects; midlife major bus rehabilitation; avoiding deferred maintenance; resolving repeater road calls, and instituting innovative maintenance practices
- Regular procurements of new buses to avoid maintenance of old buses that can increase costs if the buses have not been maintained properly
- Effective use of advance technology to manage critical maintenance functions, including the orderly and timely replacement of parts
- Managing human resources to create a cooperative labor environment.

The transit managers interviewed also strongly recommended greater interagency communication and cooperation in sharing information on successful programs, with a particular emphasis on technological innovations to improve fleet management.

Respondents also discussed the need for further research on innovative fleet management technologies; alternative methodologies to more accurately determine appropriate spare requirements for each agency, including the possibility of establishing a percentage range for various agencies; and creative maintenance programs to increase bus availability. Moreover, given the operating problems associated with managing a multi-make and multi-model fleet, many transit managers also recommended further research on the bus procurement process, i.e., how to improve competitive solicitation to encourage fleet standardization or how to better integrate multi-make and multi-model buses into their fleets.

Finally, the absence of comparative data was a major concern to many managers. Different methods are used throughout the industry to calculate the spare ratio and other key performance indicators, such as mean distance between failures. Further research to explore the kinds of standard methodologies that could be used to determine these key factors, and standards for preventive maintenance programs, such as inspection cycles and other maintenance projects, would be useful.

CHAPTER ONE

INTRODUCTION

BACKGROUND

The job of the transit bus fleet manager is one of the toughest in the transportation service industry. Whether assumed by the general manager, the maintenance manager, or others, assuring the availability of needed buses every day, every peak hour, is a daunting task. Especially in the cost-conscious environment of public transit, the fleet manager cannot be burdened with a fleet that includes vehicles that are not carrying their full share of the demand, or buses whose unit costs bring down the overall productivity of the fleet. Managing fleet size in relation to service levels is smart management and is also fiscally responsible. Transit managers use the performance measurement known as spare ratio as one indicator of their status in this important area. Funding agencies, notably the Federal Transit Administration (FTA), also use spare ratios to judge the effectiveness of fleet management and as one indicator of the need for financial assistance to acquire new buses for fleet additions and replacements.

Maintaining the proper spare ratio factor is a complex dynamic problem, making it difficult to compare properties because of site-specific variables that frequently impact peak vehicle requirements. Service levels fluctuate depending on ridership demands, political and community pressure to operate certain routes, and the fiscal realities of the nation's transit systems. Thus, at any point in time, the spare ratio factor may change depending on these factors alone. In addition, there are other key variables such as age and condition of fleet, physical operating environment, and vehicle heavy maintenance and overhaul programs that also may critically influence the quantity of vehicles required to maintain daily service levels. Table 1 identifies the variables that transit officials consider most influential in determining their agencies' ability to operate within limited spare bus ratios. Nevertheless, FTA and some state funding agencies, transit governing boards, and general managers regard spare ratio calculations as useful indices of performance and appropriate management objectives. In its Circular C 9030 1A, issued in 1987, FTA provides guidelines for the administration of its Section 9 formula assistance program. In that Circular FTA recommends a 20 percent spare ratio for all FTA grantees owning 50 or more revenue vehicles. Specifically, section D of the Circular states that "Spare ratios will be taken into account in the review of projects proposed to replace, rebuild or add vehicles. The basis for determining a reasonable spare bus ratio should take into consideration specific local service factors. The number of spare buses in the active fleet ... should normally not exceed 20 percent of the vehicles operated in maximum service." The complete text of appropriate sections of Circular C 9030 1A can be found in Appendix A of this report.

While these guidelines *recommend* a 20 percent spare ratio and provide some flexibility for exceptions, many transit agencies have adopted the 20 percent guideline as a mandate and continually strive to meet it. However, bus transit officials continue to debate whether the suggested spare ratio is reasonable and whether its impact on the industry is beneficial.

TABLE 1
KEY VARIABLES AFFECTING BUS SPARE RATIOS

Maintenance Programs
Operating Environment
Annual Bus Mileage
Bus Operating Speeds
Ridership Fluctuations
Service/Route Adjustments
Age of Fleet
Peak-to-Base Ratio
Fleet Mix of Bus Makes and Models
Roadcalls
Vehicles per Mechanic
ADA and Alternative-Fuel Buses
Management and Finance
Bus Purchase/Retirement Schedule
Inventory Management
Maintenance Training
Bus Back-up for Rail Service Disruptions

OBJECTIVES AND METHODOLOGY

The objective of this synthesis project is to inform the industry debate over the proper and effective calculation and application of spare ratios. The synthesis identifies and discusses the critical site-specific variables that affect the number of spare buses each agency needs to meet its service requirements.

A survey was conducted of bus transit agencies of varying sizes and geographic locations in the United States and Canada. The survey questionnaire is included as Appendix B. The survey responses document the state of the practice in the industry concerning spare vehicles and highlight specific innovative practices that have helped transit officials reach and maintain relatively low spare bus ratios. Further, the report examines the maintenance impact of the required fleet changes resulting from implementation of the Americans with Disabilities Act (ADA) and the use of alternative-fuel buses to meet the requirements of Clean Air Act Amendments of 1990 (CAAA).

Of the 50 agencies that received the questionnaire, 36 responded, including two Canadian agencies--BC Transit and Toronto Transit Commission. Follow-up interviews were completed with key transit managers at several of the responding agencies and selected site visits were made. Table 2 lists the agencies responding to the survey and identifies the total active fleet and other critical operating statistics by agency. It is important to note that the bus agency respondents did not always use the same methodologies, definitions, or criteria in

TABLE 2
CLASSIFICATION BY TOTAL ACTIVE FLEET

No.	Agency	Total Active Fleet	Spare Bus Ratio	MPH	Annual Average Miles/Bus	Average Fleet Age (years)
SMALL						
1.	Alexandria Transit Co (DASH) Alexandria, VA	33	32	13.5	36,570	70
2	Springfield Mass Transit District (MTD) Springfield, IL	46	19	11.9	26,155	85
3.	Berks Area Reading Transportation Authority (BARTA) Reading, PA	58	17	12.7	33,734	5.0
4.	Birmingham-Jefferson County	105	13	7.0	37,984	10.0
5.	Peninsula Transportation District Commission Hampton, VA	116	15	13.8	33,740	7 8
6.	Charlotte Transit System (CT) Charlotte, NC	159	19	15 1	36,224	11 0
7	Pierce County Public Transportation Benefit Area Authority Corporation	160	20	13.3	42,493	6.6
	(Pierce Transit) Tacoma, WA	199	15	12.2	25,168	5.6
8.	Central New York Regional Transportation Authority (CENTRO) Syracuse, NY					
	AVERAGE		**19**	**12.4**	**34,031**	**7.7**
MEDIUM						
9.	Memphis Area Transit Authority (MATA) Memphis, TN	225	20	13.5	38,159	9 8
10	Kansas City Area Transportation Authority Kansas City, Mo	234	20	13.0	34,083	7.8
11.	Miami Valley Regional Transit Authority (MVRTA) Dayton, OH	247	22	12 8	33,421	7.4
12.	Central Ohio Transit Authority	310	23	12 6	29,476	6.6
13.	Metropolitan Transportation Authority-Long Island Bus Garden City, NY	318	20	N/A	N/A	8 2
14.	San Diego Transit Corporation San Diego, CA	353	32	11.9	47,537	6.7
15	Santa Clara County Transit District Santa Clara, CA	464	22	14.0	48,666	75
16.	Regional Transit Authority New Orleans, LA	472	20	12.0	29,206	10.8
	AVERAGE		**22**	**12.8**	**37,221**	**8.1**
LARGE						
17.	Milwaukee County Transit System (MCTS) Milwaukee, WI	537	20	12.0	39,540	9.0
18.	Tri-County Metropolitan Transportation District (Tri-Met) Portland, OR	579	20	13.0	40,665	7.5
19.	Regional Transportation District (RTD) Denver, CO	597	19	14.4	46,285	8.3
20.	Metro-Dade Transit Agency (MDTA) Miami, FL	612	22	12.8	47,813	8.0
21.	Greater Cleveland Regional Transit Authority Cleveland, OH	643	20	13 0	42,471	7.6
22	Metropolitan Atlanta Rapid Transit Authority (MARTA) Atlanta, GA	669	20	12.7	45,052	7.0
23	Alameda-Contra Costa Transit District (AC Transit) Oakland, CA	720	21	12 6	32,584	7.0
24	Mass Transit Administration of Maryland (MTA) Baltimore, MD	819	25	12.0	34,218	74
25.	Dallas Area Rapid Transit (DART) Dallas, TX		21.6	N/A	44,117	9 0
26	Port Authority of Allegheny County (PA Transit) Pittsburgh, PA	895	28	13.9	38,125	7.0
27.	BC Transit Vancouver, BC	926	14	12.3	45.676	11.6

TABLE 2 (CONTINUED)

No	Agency	Total Active Fleet	Spare Bus Ratio	MPH	Annual Average Miles/Bus	Average Fleet Age (years)
28	Metropolitan Council Transit Operations Minneapolis, MN	963	13	14.8	28,311	6.6
	AVERAGE		**21**	**13.0**	**40,405**	**8.0**
VERY LARGE						
29.	Massachusetts Bay Transportation Authority (MBTA) Boston, MA	1009	20	10.6	32,669	11.3
30.	Metropolitan Transit Authority of Harris County (Houston METRO) Houston, TX	1090	16	14.5	38,353	7.0
31.	King County Department of Metropolitan Services (Seattle METRO) Seattle, WA	1212	22	14.0	40,174	10.0
32	Washington Metropolitan Area Transit Authority (WMATA) Washington, DC	1497	12	10.0	35,076	10 4
33	Toronto Transit Commission (TTC) Toronto, CN	1704	10	12.2	44,427	9.0
34.	New Jersey Transit Corporation (NJT) Newark, NJ	1856	17	14.9	49,286	10.0
35	Los Angeles County Metropolitan Transportation Authority (LACMTA)	2294	20	12.2	42.127	8 1
36.	Los Angeles, CA Metropolitan Transportation Authority-New York City Transit Brooklyn, NY	3644	15	7.3	29,922	8.0
	AVERAGE		**17**	**12.0**	**39,004**	**9.3**
SYSTEMS AVERAGE			20	12.6	37,991	8.3

calculating and presenting basic information. Although this has not detracted from the value of the major findings and recommendations, it has highlighted the major study conclusion--there is a critical need for uniformity in methodologies and definitions.

The spare bus ratios reported by the agencies are not always calculated on the basis of the formula prescribed by FTA for reporting under the Section 15 financial and operating information system. In the Section 15 formula for spare ratio, the total active fleet less the peak vehicle requirement becomes the numerator of a fraction in which the peak vehicle requirement is the denominator:

$$\text{Spare Ratio} = \frac{\text{Total active fleet - Peak vehicle requirement}}{\text{Peak vehicle requirement}}$$

Nor is the definition of the number of peak buses in service always uniform. For example, buses used in training or used as on-street reserve for breakdowns or overcrowding may be included in peak total vehicle numbers.

In this synthesis, the bus spare ratios *as reported by the respondents* were consistantly used. When possible, the specific methodologies used in each case are presented. Each system's spare ratio is presented as reported to provide a context in which the respondents discussed the particular issues that ultimately affected their ability to provide quality service.

Elsewhere in the report certain procedures, formulas, and assumptions were used to evaluate the data submitted. These methodologies were used to achieve consistency among the various bus systems reporting data from the questionnaire:

1. All information is presented for the 1993 reporting period, unless specifically indicated otherwise.
2. To calculate average mileage per bus, the annual scheduled revenue miles were divided by the peak vehicle requirements:

$$\text{Average mileage per bus} = \frac{\text{Annual scheduled revenue miles}}{\text{Peak vehicle requirements}}$$

3. To calculate average bus speed, the annual scheduled revenue miles were divided by the annual scheduled revenue hours:

$$\text{Average bus speed} = \frac{\text{Annual scheduled revenue miles}}{\text{Annual scheduled revenue hours}}$$

4. To calculate roadcalls per bus, a two-step procedure was used. This information is less precise because the "roadcall" definitions used by the respondents vary significantly (see Table 3).

TABLE 3
METHODOLOGY FOR CALCULATING MDBF (1993)

Agency	Location	Definition of Road Call for Calculating MDBF (1993)
Alexandria Transit Co. (DASH)	Alexandria, VA	Any failure that requires a maintenance response to continue revenue service; also failures related to farebox and tries.
Springfield Mass Transit District (MTD)	Springfield, IL	Buses that are disabled and have to be towed to the garage
Berks Area Reading Transportation Authority (BARTA)	Reading, PA	135,000-150,000 miles, defined as "drive train failure"--any failure of the engine, transmission or rear end that would necessitate the overhaul of that component
Birmingham-Jefferson County Transit Authority (MAX)	Birmingham, AL	Any interruption that needs a mechanic's assistance
Peninsula Transportation District Commission	Hampton, VA	(Did not respond to this question)
Charlotte Transit System (CT)	Charlotte, NC	FTA Section 15, Form 402 standards
Pierce County Public Transportation Benefit Area Authority Corporation (Pierce Transit)	Tacoma, WA	FTA Section 15, Form 402 standards
Central New York Regional Transportation Authority (CENTRO)	Syracuse, NY	Buses that are disabled and have to be towed to the garage
Memphis Area Transit Authority (MATA)	Memphis, TN	Every failure except flat tires
Kansas City Area Transportation Authority	Kansas City, MO	FTA Section 15, Form 402 standards
Miami Valley Regional Transit Authority (MVRTA)	Dayton, OH	Roadcall data is based on weighted average of electric trolleys and buses; data included anytime a bus is removed from service for mechanical failures but does not include pullouts for trolley system failures such as substation failures, wires down, etc.
Central Ohio Transit Authority	Columbus, OH	FTA Section 15, Form 402 standards
Metropolitan Transportation Authority-Long Island Bus	Garden City, NY	All breakdowns from mechanical failures (as defined by FTA)
San Diego Transit Corporation	San Diego, CA	Counts all incidents where a bus has to be taken out of service for any reason
Santa Clara County Transportation District	Santa Clara, CA	Mechanical failure occurs when buses are met, assisted or returned to the yard for body, brake, cooling, electrical systems failures, as well as for engine, window, exhaust system, fuel system, suspension, wheels, steering, transmission, engine oil, or start-up problems
Regional Transit Authority	New Orleans, LA	Mechanical failure occurs when buses are met, assisted or returned to the yard for body, brake, cooling, electrical systems failures, as well as for engine, window, exhaust system, fuel system, Suspension, wheels, steering, transmission, engine oil, or start-up problems
Milwaukee County Transit System (MCTS)	Milwaukee, WI	Any interruption that is mechanically related
Tri-County Metropolitan Transportation District (Tri-Met)	Portland, OR	Any mechanical failure except accidents, chains, tires, etc
Regional Transportation District (RTD)	Denver, CO	Any maintenance related problem that results in a service delay while the bus is in revenue service
Metro-Dade Transit Agency (MDTA)	Miami, FL	FTA Section 15, Form 402 standards
Greater Cleveland Regional Transit Authority	Cleveland, OH	Whenever a coach is removed from the road while in regular Service, see Section 15, Form 402 definition
Metropolitan Atlanta Rapid Transit Authority (MARTA)	Atlanta, GA	Anytime a repair truck is sent to a bus
Alameda-Contra Costa Transit District (AC Transit)	Oakland, CA	Incident in which there is a 6-minute or more interruption of service
Mass Transit Administration of Maryland (MTA)	Baltimore, MD	Incidents that involve the following failures: farebox, engine, electrical, body, suspension, brakes, a/c, steering, transmission, pneumatics, wheelchair, and fuel systems
Dallas Area Rapid Transit (DART)	Dallas, TX	FTA Section 15 guidelines
Port Authority of Allegheny County (PA Transit)	Pittsburgh, PA	All service calls reported to traffic dispatchers
BC Transit	Vancouver, BC	Any maintenance related interruption in service that requires a roadcall to fix or exchange a bus before it has finished its service requirements
Metropolitan Council Transit Operations	Minneapolis, MN	Any chargeable mechanical failure
Massachusetts Bay Transportation Authority (MBTA)	Boston, MA	Problems that could have been prevented by good maintenance practices (does not include flat tires, loose mirrors, accidents, etc.)
Metropolitan Transit Authority of Harris County (Houston METRO)	Houston, TX	Section 15, Form 402 standards plus air conditioning, which is considered essential in Houston
King County Department of Metropolitan Services (Seattle METRO)	Seattle, WA	Section 15 plus tire failure, farebox failure, wheelchair lift failure, air Conditioning, out of fuel-coolant-lubricant, and other causes not listed as Mechanical failures

TABLE 3 (CONTINUED)

Agency	Location	Definition of Road Call for Calculating MDBF (1993)
Washington Metropolitan Area Transit Authority (WMATA)	Washington, DC	Any maintenance related interruption in service that requires a roadcall to fix or exchange a bus before it has finished its service requirements
Toronto Transit Commission (TTC)	Toronto, CN	Chargeable failure or change-off; two situations are defined for chargeable failure: a component or system failure resulting in removal of vehicle from revenue service, or repair or replacement of component while in revenue service
New Jersey Transit Corporation (NJT)	Newark, NJ	Any maintenance related problem that results in a service delay while the bus is in revenue service
Los Angeles County Metropolitan Transportation Authority (LACMTA)	Los Angeles, CA	Vehicle-caused service interruption greater than 10 minutes
Metropolitan Transportation Authority-New York City Transit	Brooklyn, NY	Any service interruption

The annual scheduled revenue miles were divided by the miles in "mean distance between failures" (MDBF):

$$\text{Number of roadcalls} = \frac{\text{Annual scheduled revenue miles}}{\text{Mean distance between failures}}$$

then the number of roadcalls were divided by the total active fleet:

$$\text{Roadcalls per bus} = \frac{\text{Number of roadcalls}}{\text{Total active fleet}}$$

Transit officials are concerned that managing with restricted fleet sizes will compromise their primary objective: to provide uninterrupted quality transit service for their customers. The site-specific variables that transit officials indicated most critical are central to the proper calculation and application of spare ratio indicators. Depending on local experience and practices, these factors and how they are treated in the spare ratio can lead to local benefits or can lead to inefficiencies and a decline in service quality. Chapter 2 discusses these factors in more detail.

Chapter 3 provides in-depth case studies of three transit agencies that have achieved spare ratios close to 20 percent while maintaining a high degree of service reliablity by implementing innovative approaches. Shorter profiles of each responding system and the ways identified spare ratio factors impact the agency's ability to meet its spare ratio goal are presented in Chapter 4. Many of these factors may not be under management's control, but nonetheless, they affect maintenance and service requirements.

Chapter 5 discusses conclusions drawn from reported practices and identifies areas in which further research is recommended.

CHAPTER TWO

SURVEY RESULTS

CHARACTERISTICS OF SPARE BUS RATIO FACTORS

The results of this project and the survey of transit agencies did not identify any single criterion that determines what spare bus ratio is appropriate or useful at any particular locality or nationwide. There are wide variations among properties in the proportion of spare vehicles when the ratio is measured against such variables as operating environment, age of fleet, peak-to-base ratio, urban versus rural or suburban service, and the proportion of vehicles out of service daily. However, there are groups of characteristics which, when measured together, predict where a given system may fall within the spectrum of reported spare bus ratios. Some of these are listed in Table 4. Spare ratios reported in this study range from as low as 12 percent of the total active fleet to a high of 32 percent.

The variables affecting the need for spare buses are multiple, complex, and interrelated. If a bus transit system has been able to purchase buses regularly, has had relatively few makes and models in its inventory, has been able to maintain or increase ridership, has had strong preventive maintenance programs, including midlife overhaul of buses, and has provided specialized and continual training to its maintenance staff, the chances are high that it will need fewer spare buses than those allowed by the FTA 20 percent guideline and fewer spare buses than the average or median industry index. The study found that opposite values for these factors, plus characteristics such as low speeds and/or high mileage, poor road conditions, and difficult labor/management relations tended to increase spare bus requirements and ratios.

Large urban bus systems, for example, reported that they must contend with stop and go traffic conditions at slow speeds, which increases the accident rate and maintenance needs for various component systems as well as a high incidence of vandalism. Small city and suburban operating managers complained that high mileage stresses a fleet and may require more maintenance. Many systems complained that extreme weather conditions play a significant role by adding to the wear and tear on air conditioning and heating systems as well as other major components.

In another example, bus transit systems in the northeastern United States encountered significant delays and unplanned maintenance during the winter of 1994 as a result of unanticipated snow and ice storms. Similarly, those systems running electric trolley buses were required to substitute bus service in bad weather, further increasing the need for extra buses. Road conditions are under the control of local municipalities on which transit systems are dependent to ensure that the roadways are clear and safe. Faced with similar restraints on budgets and personnel availability, some cities were not able to respond adequately and the failure to keep up with the storms adversely affected many agencies already overburdened with maintenance work. For those transit systems operating in hot and/or cold climates, maintenance of critical component systems, such as heating and air-conditioning systems, can have a major impact on the agency's ability to maintain service, especially if there is a corporate policy to pull buses from service with nonfunctioning heating and air-conditioning systems. Most transit managers responding to the survey indicated that they have had and continue to have budget and funding problems, particularly local share funding, that directly impact funds available for maintenance. Some have not replaced buses on a regular basis while others have deferred maintenance and delayed badly needed overhaul programs. In addition, many transit agencies are still operating 1980 and older vintage buses which are now approaching 15 years of age and require additional buses to support them.

Two basic characteristics of the factors affecting spare ratios are their transiency and their relativity. These characteristics should be emphasized before the techniques and approaches to lowering the spare bus ratio are considered: first, the spare ratio is heavily influenced by the temporary status of bus purchases and disposal, and therefore is subject to wide fluctuations over a short time period; second, that individualized factors affecting only one transit agency can override all of the other positive or negative features.

Because of the potential for the short-term effects of individual variables to powerfully impact on spare bus needs, it would be preferable to base conclusions from trend evaluations of the systems rather than the snapshot analyses possible from this study. Nevertheless, a few variables emerge as more pertinent than others, and when combined in a positive or negative pattern, give definitive information on the particular bus system's ability to balance efficient and high quality service while limiting the size of its spare fleet. Table 1 lists these variables. The following short descriptions summarize the general comments made by the officials in discussions about spare ratio.

Maintenance Programs

If there is one set of criteria that supports a low spare ratio and high reliability, it is implementing a timely preventive maintenance program in which inspections are regularly conducted at frequent cycles and parts are replaced if defective; an ongoing and timely overhaul program; and an active and continuous training program for the maintenance staff. Moreover, replacing major component systems based on the failure experience of the particular component rather than at actual breakdown or in accord with an arbitrary time schedule, dramatically increases reliability, thus reducing unanticipated downtime, and the need for spare vehicles. Managers noted that midlife varied from one component to another, i.e., a bus may need two engines, four transmissions, and body paint every three years. Midlife also varies by vehicle and location.

TABLE 4
MAINTENANCE CHARACTERISTICS (1993)

Transit Agency	Age of Fleet	No. Makes/Models	% Running Repairs	% Out of Service	Mechanics: Bus Ratio	Alternative-Fuel Buses
Alexandria Transit Co. (DASH) Alexandria, VA	7	4	6	15	1:5	No
Springfield Mass Transit District (MTD) Springfield, IL	9	4	11	13	1:4	No
Berks Area Reading Transportation Authority (BARTA) Reading, PA	5	4/10	10	38	1:4	No
Birmingham-Jefferson County Transit (MAX) Birmingham, AL	10	4/4	9	11	1:3	No
Peninsula Transportation District Commission Hampton, VA	8	3/5	9	11	1:9	No
Charlotte Transit (CT) Charlotte, NC	11	6	13	14	1:4	1 20% soy fuel; 4 electric buses
Pierce County Public Transportation Benefit Area Authority Corporation (Pierce Transit) Tacoma, WA	7	4/8	6	8	1:4	49 CNG buses
Central New York Regional Transportation Authority (CENTRO) Syracuse, NY	6	7/15	6	7	1:5	8 CNG buses
Memphis Area Transit Authority (MATA) Memphis, TN	10	6/10	NA	NA	1:5	10 Trolley buses
Kansas City Area Transportation Authority Kansas City, MO	8	6	NA	NA	1:4	No
Miami Valley Regional Transit Authority (MVRTA) Dayton, OH	7	5/19	11	15	1:4	36 Trolley buses
Central Ohio Transit Authority Columbus, OH	7	2/9	13	16	1:5	No
Metropolitan Transportation Authority (MTA-Long Island Bus) Garden City, NY	8	5/11	5	8	1:4	10 CNG buses
San Diego Transit Corporation San Diego, CA	7	7	10	14	1:2	No
Santa Clara County Transportation District Santa Clara, CA	8	2/8	7	18	1:2	No
Regional Transit Authority New Orleans, LA	11	8/9	11	17	1:2	No
Milwaukee County Transit System (MCTS) Milwaukee, WI	9	7/10	13	20	NA	No
Tri-County Metropolitan Transportation District (Tri-Met) Portland, OR	8	4/13	5	12	1:4	10 LNG buses
Regional Transportation District (RTD) Denver, CO	8	8/16	6	7	1:2 6	No
Metro-Date Transit Agency (MDTA) Miami, FL	8	3/9	9	18	1:3.2	5 Methanol, 5 CNG buses
Greater Cleveland Regional Transit Authority Cleveland, OH	8	3/15	10	15	1:2.7	No
Metropolitan Atlanta Rapid Transit Authority (MARTA) Atlanta, GA	7	4	9	15	1:2.2	No
Alameda-Contra Costa Transit District (AC Transit) Oakland, CA	7	4/17	7	14	1:3 0	No
Mass Transit Administration of Maryland (MTA) Baltimore, MD	7	2/13	5	20	1:3.1	4 CNG buses
Dallas Area Rapid Transit (DART) Dallas, TX	9	3/5	8	NA	1:2.1	No

TABLE 4 (CONTINUED)

Transit Agency	Age of Fleet	No. Makes/Models	% Running Repairs	% Out of Service	Mechanics: Bus Ratio	Alternative-Fuel Buses
Port Authority of Allegheny County (PA Transit) Pittsburgh, PA	7	11/17	1	NA	1:1 4	5 CNG buses
BC Transit Vancouver, BC	11.6	7/8	8	15	1:3 4	244 trolley buses (diesel buses only)
Metropolitan Transit Commission (MTC) Minneapolis, MN	7	9/24	3	9	1:2.8	10 ethanol buses
Massachusetts Bay Transportation Authority (MBTA) Boston, MA	11	4/23	9	24	1:3.0	No (including Everett backshop)
Metropolitan Transit Authority of Harris County (Houston METRO) Houston, TX	8	10/18	8	14	1:3.8	NA
King County Department of Metropolitan Services (Seattle METRO) Seattle, WA	10	5/10	13	10	1:4.0	100 trolleys: 232 dual power buses (diesel and electric)
Washington Metropolitan Area Transit Authority (WMATA) Washington, DC	10	7/35	4	9	1:2 4	No
Toronto Transit Commission (TTC) Toronto, CN	9	4/22	7	9	1:2.9	25 CNG buses
New Jersey Transit Corporation (NJT) Newark, NJ	10	7/44	NA	NA	1:3	5 CNG buses
Los Angeles County Metropolitan Transportation Authority (LACMTA) Los Angeles, CA	8	4/15	11	13	1:2.3	10 CNG buses; 412 methanol buses
MTA-New York City Transit Authority (NYCTA) Brooklyn, NY	8	3/NA	4	15	1:3.0	NA

Preventive maintenance programs at each of the reporting transit agencies are summarized in Table 5.

Operating Environment

Those systems operating entirely in an urban environment appeared to experience the most difficulty in maintaining a 20 percent spare bus ratio. The high levels of pollution, congestion, accidents and vandalism, and travel at lower speeds required more bus maintenance than systems where buses traveled in rural and suburban areas.

Annual Bus Mileage

While high mileage often occurred in a nonurban and even intercity operating environment, which generally required more inspections and therefore more scheduled downtime for the fleet, low mileage, when coupled with low speed, generated significant maintenance problems because of the wear and tear on major component systems such as brakes and transmissions.

Bus Operating Speeds

Most maintenance officials at agencies with low speeds indicated more defects and downtime because increased wear and tear on brakes and transmissions required more maintenance.

Ridership Fluctuations

Fluctuating ridership levels continue to affect the number of spare vehicles needed. Over the last few years, some properties have lowered peak vehicle requirements, either because of ridership decline or because budget cuts have forced them to operate fewer vehicles. Although many properties are actively engaged in programs to recapture the lost ridership, significant increases have not yet occurred and transit management believes that they must hold onto their fleets in anticipation of an upturn.

For those agencies experiencing reduced ridership levels, the spare ratio was likely to be artificially high because of the decrease in the peak vehicle requirement. Many agencies wanted to hold onto their buses either in anticipation of an upturn in ridership or to satisfy specialized service needs during the year. In addition, some managers were reluctant to dispose of buses because they were not purchasing buses on a regular schedule and needed more spare buses to support the higher downtime of older fleets.

Service/Route Adjustments

Changes in population density or employment patterns can have a dramatic effect on peak service requirements. As employment location shifts from center city to dispersed outlying locations, radial bus routes become less used. Unless route

TABLE 5
PREVENTIVE MAINTENANCE PROGRAMS REPORTED BY TRANSIT AGENCIES SURVEYED

Transit Agency	Preventive Maintenance Cycle	Major Overhaul	Passenger Amenities Policies
Alexandria Transit Co. (DASH) Alexandria, Va	Bi-monthly and annual except brakes, which are done weekly	No	Hold buses cleanliness, no a/c and heat
Springfield Mass Transit District (MTD) Springfield, IL	Every 6,000 miles	No	Hold buses for no a/c and no heat
Berks Area Reading Transportation Authority (BARTA) Reading, PA	Every 6,000 miles and at 6-month state inspection	No	Hold buses for no a/c and no heat, and excessively torn seats
Birmingham-Jefferson County Transit (MAX) Birmingham, AL	3,000; 6,000; 24,000; and 48,000 miles	No	Hold buses with no a/c, cut seats, body damage, transmission/engine failure, electrical failure
Peninsula Transportation District Commission Hampton, VA	6,000 miles and at 6 weeks, 3 months, and 10 months	No	Hold buses with no a/c, heat, vandalism, dirt, interior lights, destination sign, and wheelchair lifts
Charlotte Transit (CT) Charlotte, NC	6,000 and 12,000 miles	No	Cleanliness, air conditioning, heat
Pierce County Public Transportation Benefit Area Authority Corporation (Pierce Transit) Tacoma, WA	A-inspection 2 weeks, tune-up annually, and inspection at 6,000 miles	No	Do not hold buses out, but if bus is unsanitary, will hold in for cleaning
Central New York Regional Transportation Authority (CENTRO) Syracuse, NY	Inspection every 6,000 miles with oil/filter change at 18,000; 30,000 dyno, change transmission fluid and filters every 24,000 and midlife every 8 years	Yes	Hold buses for cleanliness, interior lighting, farebox, radio, etc.
Memphis Area Transit Authority (MATA) Memphis, TN	Every 4-6 weeks, 6,000 mile inspection	Yes, every 200,000 to 350,000 miles	Hold buses for no a/c
Kansas City Area Transportation Authority Kansas City, MO	Mechanical and body every 8,000 miles	No	No
Miami Valley Regional Transit Authority (MVRTA) Dayton, OH	Every 6,000 miles	No	Hold buses out of service for cleanliness, no a/c or heat, or if seats are excessively torn
Central Ohio Transit Authority Columbus, OH	Every 6,000 miles	No	Will hold buses out of service for cleanliness, torn seats, no a/c or heat
Metropolitan Transportation Authority-Long Island Bus Garden City, NY	Pre-1988 buses every 4,000 miles, post 1988 buses inspected every 6,000 miles, wheelchair and a/c monthly and other Special items as appropriate	No, due to fiscal crisis	Only for no a/c or heat at this time due to problems with old fleet
San Diego Transit Corporation San Diego, CA	Lube and safety at 3,000 miles, engine oil/filter at 6,000 miles, transmission at 24,000, differential every 64,000, brakes every 500 miles	Complete engine overhaul at 300,000	Graffiti, cleanliness, air conditioning as much as possible
Santa Clara County Transportation Agency Santa Clara, CA	1,000 miles and then every 6,000 miles	No	Did not respond
Regional Transit Authority New Orleans, LA	Every 6,000 miles	No	Will hold buses bout of service for cleanliness, damaged seats, and no air conditioning/heat
Milwaukee County Transit System (MCTS) Milwaukee, WI	Every 6,000 miles	Midlife at 8 years	Will hold buses only for damaged seats and cleanliness
Tri-County Metropolitan Transportation District (Tri-Met) Portland, OR	1,500 mile followed by another 3,000 mile inspection with wheelchair lift at 12,000 mile and oil changes done every 6,000 and 12,000; transmission inspected at 48,000 and tune-ups at 50,000	No, but components are thoroughly checked at inspection intervals. Depending on the mileage and history, components will be removed and overhauled.	will hold buses only for no heat, torn seats and and only in limited circumstances when the buses are dirty.
Regional Transportation District (RTD) Denver, CO	3,000 miles with inspection done at 6,000 with oil change and analysis. Transmission fluid analysis and change And engine oil done at 24,000	No	Will hold buses for dirty interiors, torn seats, and nonoperational a/c systems only in the summer months and heat in the winter
Metro-Dade Transit Agency (MDTA) Miami, FL	6,000; 18,000; and 54,000	Not at this time	Will hold buses out of service in extreme heat if a/c is not working
Greater Cleveland Regional Transit Authority Cleveland, OH	Preventive maintenance at 2,000-4,000 miles with follow-up at 6,000. Air conditioning, wheelchair lifts are Inspected at 6,000 miles.	Vehicle overhaul pro-ram requires vehicles between 5 and 7 years to undergo complete body, frame, and powertrain rehabilitation	No policy in place

TABLE 5 (CONTINUED)

Transit Agency	Preventive Maintenance Cycle	Major Overhaul	Passenger Amenities Policies
Metropolitan Atlanta Rapid Transit Authority (MARTA) Atlanta, GA	Every 7,000 miles regular inspection for all systems are performed	5-7 year overhaul cycle. At midlife will paint and perform body repairs as Needed. Engine and Transmissions are Overhauled at failure, Although the plan is to Overhaul the engines at 250,000 miles	Will hold buses for no a/c or heat, wheelchair lifts, drivers' radios, and cleanliness
Alameda-Contra Costa Transit District (AC Transit) Oakland, CA	Major inspections every 10,000 miles with 5,000 mile inspections for vehicles still in warranty and 1,200 mile safety Inspections for all vehicles	Buses not old enough	Will hold buses only in extreme cases of wet or damaged seats
Mass Transit Authority of Maryland (MTA) Baltimore, MD	Brakes every 2,000 miles, major inspections every 6,000 miles, and transmission, differential every 24,000. Inspect a/c and wheelchair every 90 days And drivers check exterior of the bus Every morning	Not at this time	Will hold buses out of service for a/c or heat, broken farebox, and nonfunctioning Radio
Dallas Area Rapid Transit (DART) Dallas, TX	Every 6,000 miles	Yes, for Neoplans every 7 years	Passenger amenities policy requires that buses be held in for cleanliness, torn seats. No a/c and heat
Port Authority of Allegheny County (PA Transit) Pittsburgh, PA	Relies on manufacturer's recommendations for particular coach type	Every 4 years	Nonfunctional heat and a/c and heavily soiled seats will require that a bus be pulled from service
BC Transit Vancouver, BC	Check over at 1500 kms, minor at 6,000 kms, major at 2,500 kgs and 7,500 kgs	All buses are repainted at 7 years, receive a Complete body structural At 10-12 years, engine Overhaul at 4-5 years, Transmission at 2 years And differential at 6-7 Years	Will hold buses in for cleanliness, torn seats, heat; buses are not a/c equipped
Metropolitan Council Transit Operations Minneapolis, MN	Brakes are inspected every 3,000 miles, oil change and general inspection are Performed every 6,000 miles, semi-Annual inspections are done every 18,000 Miles	Overhaul is completed at 6 years or 200,000 miles. On overhaul buses are painted and body repairs are done Including interiors. Engine, transmission, And a/c are performed on The mechanical	Buses that are damaged from vandalism, are not clean, and have no functional heat will be held from service
Masschusetts Bay Transportation Authority (MBTA) Boston, MA	Every 3,000 miles	Overhauls are performed every 6 years with major Exterior and interior Work performed. In Addition, engine, Transmission, paint, air Dryer and brake system Are rebuilt or replaced	Buses will be held from service for no heat and a/c in appropriate weather Other minor problems will be handled if buses are available
Metropolitan Transit Authority of Harris County (Houston METRO) Houston, TX	Major pm performed every 4,000 miles, a/c, wheelchair lifts are also inspected at that time. LNG buses are inspected every 4,000 miles. There is also a major yearly inspection.	6-8 years, Engines overhaulted every 180,000; transmission 140,000; and floors are Replaced every 6 years. All buses are painted Every 6 years.	Agency policy is to hold buses from service for non functioning radios, signs, a/c systems, cleanliness, and nonworking lifts.
King County Department of Metropolitan Services (Seattle METRO) Seattle, WA	Depending on the particular bus, inspection performed every 2,000 to 3,000 miles	Overhaul program started in 1991 so most of the fleet is late with Midlife overhaul. In the Future, the plan is to Overhaul all coaches at Midlife.	Agency will hold buses out of service for cleanliness and significant or excessive levels of seat damage or graffiti.
Washington Metropolitan Area Transit Authority (WMATA) Washington, DC	Multilevel inspection program with basic 5,000 mile inspection. Agency has seasonal inspection program, a/c Inspection program every 90 days, and Wheelchair are done weekly and monthly	Goal is to perform overhauls every 5 years.	Agency reports that during periods of Extreme heat or cold, they hold buses out for the respective system. Under certain circumstances, the agency will hold buses out for torn seats, graffiti, or cleanliness

TABLE 5 (CONTINUED)

Transit Agency	Preventive Maintenance Cycle	Major Overhaul	Passenger Amenities Policies
Toronto Transit Commission (TTC) Toronto, CN	Safety inspection performed every 2,000 miles with a minor at 8,000 miles and a major at 32,000 miles	All overhauls are performed every 8-10 years	Agency will hold buses out for cleanliness, electronic destination signs, and torn seats
New Jersey Transit Corporation (NJT) Newark, NJ	Inspections are performed every 3,000 miles	Current overhaul program is reactive to vehicle failures. Transit type vehicles will be overhauled every 250,000 surburban 275,00 and cruiser 425,000 miles	Agency will hold buses out of service for a/c malfunctions and any other nonsafety Item that has surpassed scheduled repair Dates identified in NJT's quality control Program
Los Angeles County Metropolitan Transportation Authority (LACMTA) Los Angeles, CA	Brakes are inspected every 1,000 miles and ordinary inspections are performed every 6,000 miles	The agency has a 7-year goal, but reports that it is late on its overhauls	Agency will hold buses in for nonsafety Related passenger amenity items when Spare vehicles are available
MTA-New York City Transit Brooklyn, NY	Buses are inspected every 3,000 Miles	A mini-overhaul program is provided every 3 years and a general overhaul every 6 years	Agency will hold buses out of service for Nonfunctioning a/c, and heat systems, and Interior cleanliness

changes can continue to serve the work trips, fewer people ride the buses. Also, new residential development in suburban areas requires bus route changes to capture potential ridership. Most of the demographics and employment shifts in recent years have reduced rather than helped bus system coverage.

Age of Fleet

With few exceptions, agencies are keeping buses in service longer. Almost every manager agreed that the older the bus, the more likely it is to require frequent maintenance and to be out of service. Retired buses should be segregated as quickly as possible to avoid reliance on the old fleet during the break-in period for new buses and to avoid an artificial increase in the spare factor. Moreover, problems with older fleets have been complicated because many systems have delayed their midlife overhaul programs for budgetary and scheduling reasons. Because many transit agencies bought large quantities of buses in the same time period, many maintenance managers complained that they were unable to complete overhauls on time because they did not have sufficient maintenance personnel, or even funds to handle the large number of buses.

Peak-to-Base Ratio

While this indicator can have an impact on maintenance service schedules, the results of the study showed that many bus systems are already performing maintenance on the day shifts, even if they do not have a large number of buses in the house. There were wide variations in the peak-to-base ratio as compared with the spare ratio. However, it appeared to give an agency some edge if preventive maintenance could be performed in the first shift without impacting service requirements.

Fleet Mix of Bus Makes and Models

Many maintenance officials complained about the problems associated with the multiple makes and models of buses with which they had to contend in their fleet inventories.

Those agencies with many different bus makes had to closely monitor parts inventory to limit the number of buses out of service because no parts were available. Some managers said that purchasing untried buses because of a low bid sometimes resulted in buying poor quality vehicles that had high maintenance requirements. Varied fleets also affected maintenance because it required more mechanics with specialized skills to work on different technology buses at a time when many agencies were cutting training budgets and staff. However, competitive solicitation requirements and public procurement regulations are applicable to the transit industry. These requirements can place an agency in a position of accepting buses with varied technology and different maintenance and material requirements thus increasing the need for more spare vehicles and more training to ensure that all maintenance personnel have the skill to make repairs on the buses.

Roadcalls

Roadcalls reflect many different criteria, for example, an aging fleet, poor maintenance practices, and the general operating environment will affect the number of roadcalls. The standards used for roadcalls vary so much among survey respondents that it is impossible to draw meaningful comparative conclusions from the data (See Table 3). The mean distance between failures (MDBF) statistics supplied by the respondents are calculated in different ways: some systems used mileage divided by total roadcalls without regard to whether there was a service interruption, while others used service interruptions of some measure of time to define roadcall incidents. Other properties counted a roadcall only when they had to dispatch a maintenance worker to the bus, while still others included those incidents when drivers take the bus out of service into the garage for repair. However, because roadcalls may require substitute service by spare vehicles, the greater the number of roadcalls, the larger the need for spare buses.

Vehicles per Mechanic

This indicator was difficult to assess since most transit systems operate backshops along with operating garages, with different functions that varied at each agency. Some agencies included their backshop personnel in the equation while others included only those in the operating depots. Some of the mechanics in the garages did heavy repairs, while others were limited to light maintenance work. Additionally, union work rules strongly affected the number of hours, type of work, and training requirements of mechanics, thus affecting the ratio of mechanics to buses.

The lines between heavy repair and light maintenance have been blurred as the fiscal climate has changed in recent years. In smaller transit systems, mechanics perform different kinds of work. Also, new sophisticated specialized training requires more mechanics to service a bus. However, most properties agreed that a low number of vehicles per mechanic indicated an inefficient use of personnel and funding and many were evaluating this indicator to improve maintenance operations and save money.

ADA and Alternative Fuels

Many transit agencies indicated that maintenance of the more complex equipment associated with ADA-qualified buses, especially with the increase in roadcalls, at a time when they have fewer maintenance employees to handle the work, heavily influences spare fleet requirements.

Regarding alternative fuels, there is insufficient experience to draw conclusions. For those systems that have alternative-fuel buses, maintenance managers report both ease of maintenance and operation with CNG buses and difficulties in service, more downtime due to lower fuel capacity, and difficulties in maintenance work. At least one manager expressed a strong preference for LNG buses over CNG buses. Another agency is trying a soy-based fuel as an alternative fuel pilot. Methanol appears to be the most difficult of the new fuels, in terms of reduced capacity and effect on bus engines. At this juncture, alternative-fuel buses probably require more substitute service than new diesel buses, but no hard conclusions can be drawn. A few transit agencies reported that they were allowed to adjust their spare ratio with FTA approval to compensate for alternative-fuel buses. Careful evaluation is required before the purchase of alternative-fuel buses; agencies should be guided by the experience of other systems that have operated pilot projects to determine if they can easily accommodate the demands of the new technology in developing effective major overhaul programs.

Management and Finance

Many transit systems espouse a corporate philosophy mandating an operation with minimal spares and the survey results show that this philosophy was a key factor in helping some managers go the extra mile to manage with few excess buses. Budgetary reductions caused by decreased revenues from the farebox and declining operating and capital subsidies have had a dramatic impact on many transit systems in recent years. There have been personnel reductions, elimination of training programs, and in some cases delays in obtaining matching local funds to purchase new equipment. These factors have increased the reliance on spare buses as properties face aging fleets, which they cannot overhaul in a timely manner, and cannot keep repaired because of far fewer maintenance employees with proper training. Most agencies are searching for innovative ways to do more with less.

Bus Purchase/Retirement Schedule

When new buses are delivered, there is always a break-in period during which fleetwide defects can surface. Agency personnel often have difficulty in working on unfamiliar buses, mechanics must be trained to service the new vehicles, and the spare parts inventory must be available. To accommodate these difficulties most agencies will not dispose of their old vehicles for an extended period, to provide spares to cover new vehicle downtime.

Inventory Management

A factor associated with the growing specialization of bus components and the increased number of makes and models that bus systems are purchasing is availability of an adequate spare parts inventory and space to store it. Managers warn that in the near future, excessive downtime could result because spare parts are not readily accessible. On the other hand, inventory is an asset and in these fiscally constrained times, carrying excess inventory will adversely affect the bottom line. Balance is required.

New standardized system technology would ensure maximum availability of material and parts to avoid unnecessary bus downtime. With the introduction of many bus makes and models, inventory management is a critical factor. Many managers during the course of the survey expressed a great deal of concern about this issue. Failure to have available parts and other components when they are needed will adversely affect any maintenance program. As long as managers are cognizant of the issues and vigilant about what tools are available to them the probability of buses "out for no stock" will greatly diminish.

Maintenance Training

As a result of budget reductions, there have been some cutbacks in maintenance staffing levels, but the real impact of constrained dollars has occurred in the limitations on maintenance training programs. Faced with restricted training budgets and diminished maintenance personnel levels, the training for some agencies has been limited to on the job training which can have a significant impact for those agencies with multi-make and model buses that require more skilled technicians.

Despite the budget issues that have reduced funding for training programs, the national trend is to provide broad-based training so that mechanics are qualified to work on all buses--even alternative-fuel buses and the new electronic technology that are predominate among the recently acquired buses.

Bus Back-up for Rail Service Disruptions

With the increasing numbers of multi-modal fleets involving fixed guideway rail and electric trolley buses, bus transit fleet managers are frequently called for substitute diesel buses to provide service in emergencies such as power disruptions, right-of-way construction and repairs, and other interruptions such as fires, accidents, or weather related events. This requires the availability of contingency fleets of spare vehicles, taking buses away from the normal maintenance and repair schedules. Deferment or postponement of maintenance can cause expensive and complex future emergency repairs. The survey reveals that this substitution requirement is quite frequent and intrusive to balanced fleet operations.

CHAPTER THREE

IN-DEPTH CASE STUDIES

Notwithstanding the difficulties experienced throughout the industry, many transit agencies have achieved spare ratios close to 20 percent while maintaining a high degree of service reliability by implementing innovative approaches. These transit systmes have a strong corporate philosophy supporting a cost-efficient management approach. Interested managers might want to explore some of the strategies presented here. Several of the agencies may have a slightly higher spare ratio for a variety of reasons, but are nonetheless highlighted in this section because of the interesting programs in use at the specific property that might be helpful to other systems seeking new ideas.

Metropolitan Transit Authority Of Harris County (Houston Metro) Houston, TX

Fleet Characteristics, Operations, and Service Environment

Houston Metro, a large mixed inter- and intracity and suburban bus operation, reports a total active fleet of 1,090 buses available for revenue service, with a 1993 maximum peak service requirement of 907 buses, that originate from five operating garages. Not counted in the total available fleet are 218 inactive buses that are either pending sale or are used in non-revenue service. The peak-to-base ratio is 2.5 with less than 40 percent of the buses in the garages at noon. Unlike other properties, Houston has not experienced a decrease in service levels and reports an increasing annual budget and service levels over the last 2 years. The number of buses and the vehicle maintenance expenses, including labor costs, have increased as well.

Houston Metro has increased its fleet size with the purchase of new buses and the acquisition of additional buses when it assumed operations for a private bus operator in 1993. Houston's fleet consists of relatively new buses. It regularly replaces older buses. Although the average age of the fleet is now reported at 8.0 years, 40 percent are 8 or fewer years of age and only eight buses are older than 12 years. Given the imminent arrival of 175 LNG buses, the average fleet age will decrease significantly in 1995. Although the fleet consists of 11 makes and models, including 30-ft, 40-ft, and 45-ft transit buses, suburban and articulated vehicles, and a variety of minibuses, which could be a major problem, the fact that they do not have to manage a fleet of older buses helps contribute to a better maintained fleet. The management reports that they make every effort to maintain an adequate inventory of parts for these different makes and models so that buses out of service for no stock are kept to an absolute minimum.

In addition, management believes that the type of service Houston provides also helps them operate with a limited spare ratio. The buses average a relatively high 14.5 mph, which limits some of the maintenance problems faced by other properties with fleets that operate at slow speeds. In large measure, the speed is a result of the substantial park-and-ride and express service Houston operates into the downtown area However, management states that its city service, which typically operates at lower speeds, requires a more generous spare ratio. Houston's management reports a 16 percent spare ratio and says that its goal is to operate with a 10 percent spare factor (which they did recently when the agency assumed the service for a private transit company that ceased operations.) The spare ratio fluctuates because Metro changes their scheduled service during September of every year.

Maintenance

Houston Metro has adopted a strong preventive maintenance program that includes 4,000-mile inspections, oil sampling on a regular basis, pre-inspection steam cleaning of major component systems, aggressive adherence to the state mandated opacity program, and a program designed to identify and eliminate repeater roadcalls.

The major preventive maintenance inspection is conducted every 4,000 miles with inspections of other systems such as air conditioning, wheelchair lifts, radios, and destination signs completed at various intervals along with the mechanical inspections. Although the state mandated opacity program is voluntary, Houston Metro has adopted it in an effort to reduce the number of smoking buses on the road, thereby increasing the life of its engines. Under this program, Houston residents can report by telephone any smoking bus observed in service The program started in 1992 with more than 151 telephone reports of smoking buses. Management reports that they have received zero complaints in 1994. To accomplish this significant reduction, they purchased an Opacity Meter, an electronic instrument, to review the entire fleet to determine the presence of defects that cause the engine to smoke. Engine defects when identified are corrected before the problem occurs on the road. Not only has this approach reduced the number of complaints, but it has had the added benefit of extending the life of the engines, and saving the agency money.

Management also aggressively pursues repeater roadcalls, they do not accept reports of "no trouble found" and then put the bus back on the street before identifying and repairing the problem. They have found that many problems occur in the engines and the electrical components of the bus, an area where there is generally limited expertise in the workforce. As a result, they make a special effort to locate and train workers with a special aptitude for this kind of work. Technical support is provided to identify persistent problems.

Management reports that the major overhaul program has been delayed for specific buses because the maintenance shop is geared to handle 800 buses and there are now almost 1,200 on the property (with the arrival of new buses in 1994). Thus, instead of completing the overhauls every 6 years as projected, they evaluate each bus to determine if the overhaul is required. As a result, some bus overhauls are completed every 8 years.

Houston Metro also has implemented a management program to ensure that all of its employees are involved in the effort to improve the quality of the fleet. Management advocates work schedules that require preventive maintenance be performed on the day shift rather than at night to ensure that they can recruit the best people and to maintain control of the work performed. Requiring employees to work on the night shift as many properties do because the buses are in the house at that time, Houston management believes, decreases the ability to provide the proper management controls and professional technical expertise to support the maintenance staff when required.

Houston Metro reports that it trains service personnel to look out for problems between inspections to catch defects before they result in roadcalls. Similarly, bus operators are expected to critically inspect the buses for defects. Cosmetic defects are repaired if possible before the bus goes into service the next day. The drivers are required to cycle lifts before they go into service. Buses with nonperforming wheelchair lifts are not put in service, further reducing the number of roadcalls. In this way, Houston Metro has been able to keep roadcalls for inoperative wheelchair lifts to a minimum. In addition, they have installed scuff plates on the right corner of the buses to protect the front door lifts from hitting the curb.

Houston Metro has a strong training program that focuses on the electronics of the bus. In addition, it has introduced an innovative maintenance apprenticeship program through which many of its employees are trained. On completion of the course, after 18 months of training, these workers are designated journeyman mechanics.

Conclusion

Houston Metro reports a first-rate maintenance program, which supports their belief that a 20 percent spare ratio is adequate. Maintenance managers strongly believe that the best way to manage the fleet is to limit the number of spare buses on the property. As a consequence, the fleet size is geared to allow for only a minimal number of vehicles above that required for service. Providing that they can continue to replace buses on a regular basis, it is certain that with the current operating conditions, Houston Metro will achieve its goal of a 10 percent spare factor.

Washington Metropolitan Area Transit Authority (WMATA) Washington, D.C.

Fleet Characteristics, Operations, and Service Environment

In addition to and fully integrated with its excellent subway system, WMATA manages a fleet of 1,497 buses. The buses serve as feeders to the rapid transit system as well as providing service within and outside of Washington. The bus routes cover the entire metropolitan area, concentrating on heavily used urban thoroughfares and mixed city/suburban roads. The agency also manages and provides maintenance for about 24 privately contracted buses during the peak visitor season (February to June).

WMATA is able to operate with an extremely low spare bus ratio of 13 percent, even though the agency's operation is typically urban, exhibiting many factors related to wear on vehicles including a widely variable climate that requires air conditioning in the summer and protection from snow and ice storms during the winter months.

Average annual mileage per bus is 35,076 and average speed is only 10.0 mph. Additionally, the fleet contains a large variety of bus makes and models, and the average fleet age is 10.2 years, including 144 buses that are at least 30 years old. Since 1990 the number of buses in the active fleet has gone down by about 9 percent and the peak vehicle requirement by just over 8 percent, giving WMATA the opportunity to dispose of some of its oldest vehicles. According to shop management officials, the key to this 13 percent spare bus ratio is new bus purchases combined with programs and policies for preventive maintenance and midlife overhauls.

Within the peak vehicle requirement, with FTA approval, WMATA counts 15 strategic buses, which are used similarly to the gap trains in its rail system. These buses stay with drivers in bus loops and other designated locations close to areas of frequent accidents or breakdowns. They are called into service for emergencies, which WMATA managers note, occur approximately four times daily.

WMATA says that the FTA has approved their method of calculating the spare bus ratio, which includes these strategic buses in the peak vehicle requirement. WMATA calculates the spare factor based on the average number of buses out for scheduled and unscheduled maintenance, with consideration for staffing limitations. If the spare bus ratio is calculated according to the FTA methodology, the ratio comes to 13.6 percent, still exceedingly low compared with most other transit properties.

Fewer than half of the buses are lift-equipped and only 8 percent of the fleet is in full conformance with ADA requirements but that will be remedied in the next few years as almost all of the new purchases will be ADA compliant. The current fleet does not include vehicles that are alternatively fueled, although officials believe that they will start acquiring such buses in the near future.

Maintenance

The replacement/overhaul program is relatively new and should become even more effective when its experience can be used to predict and anticipate component failures. Buses are taken out of service at midlife (6 years) and rebuilt before problems occur. According to shop management, 100 buses are being rebuilt this year. In addition, there is a very detailed ongoing inspections program, in which components are replaced before failure occurs regardless of the age of the component. The inspectors are developing a data-track system to give a systemwide picture of when individual parts are likely to fail. These programs are not without their critics; some of the older maintenance staff feel that the early replacement policy is wasteful and expensive and that it is better to wait until failure to ensure that the best use is made of the existing equipment.

Running repairs take about 63 vehicles a day out of service, about 4 percent, and preventive maintenance, overhaul and other causes remove an additional 77 buses, keeping 9 percent of the fleet out of service, a reasonable number given fleet age and operating conditions. Miles between roadcalls has steadily increased since 1990, from about 2,300 to 3,600. In 1993, there were about 8.6 roadcalls per bus, with roadcalls defined as any breakdown while in revenue service that requires the bus to be removed from service or responded to by a service truck, with a deviation in schedule.

The ratio of mechanics to buses is high. Each worker has just over two buses to maintain, compared with most agencies which require each of their mechanics to service about four buses. Maintenance personnel are assigned according to the annual fleet using a mileage formula, rather than by the number of buses. This allows a steady number of workers when there is short-term fluctuation in the number of buses due to new purchases or disposal. It prevents workers from exerting less effort when there is less to do and similarly, keeps a base of trained workers when there is a sudden rise in the number of vehicles. The shop resource managers point out, however, that there is a fine line between an efficient operation and having maintenance personnel overwhelmed by being assigned too many buses for an extended period.

Conclusion

WMATA officials believe that for their agency, the 20 percent spare factor is excessive from both operating and budget perspectives. They report that they were able to reduce their spare factor to 12.4 percent by taking fewer buses out of service for maintenance at a time when budget mandates limited the number of mechanics in the agency.

Toronto Transit Commission (TTC)
Toronto, Ontario, Canada

Fleet Characteristics, Operations, and Service Environment

The TTC's 1704 bus fleet operates in a large urban environment with severe winter conditions. The bus fleet is part of a well-integrated transportation system that also includes subway, light rail, street cars and 30-ft van service (Wheel-Transit). Almost all (97 percent) of the bus routes feed the other modes. Buses substitute for rail service 40 to 60 times per year. Included in the peak vehicle requirements are a small number of contingency buses, that is, buses with drivers stationed during rush hour at various high-use stops and subway stations. There are 10 contingency buses in the morning and 23 in the afternoon peak period.

The average bus speed is 12.2 mph, a moderate rate reflecting both in-city congestion and lower traffic levels on the suburban portions of the routes. However, the average annual mileage per bus of 44,427 is high, indicating heavy use of the vehicles. The peak vehicle requirement, 1390 buses, is heavily oriented toward work trips with a peak-to-base ratio of 2.25:1. TTC uses a different methodology in calculating its spare bus ratio at 10 percent, based on scheduled service and maintenance requirements; however, application of the FTA formula yields a spare bus ratio of 22 percent.

During the last 2 years, TTC's ridership has declined, due primarily to poor economic conditions during which industrial layoffs were common. In addition, corporations moved northward to the suburbs or out of Ontario entirely.

TTC's fleet plan takes ridership shifts into account, it has cut back on planned purchases, preferring to chance the higher maintenance costs associated with older vehicles over the costs of new buses. Current fleet age averages 9 years. Buses are retired at 18 years, with comprehensive overhauls undertaken when the buses are 8 to 10 years old to extend the life of the bus.

Currently TTC is holding, though not as part of the active fleet, vehicles that have been in accidents or are more than 18 years old. These are scheduled to be sold, but some of them could be pressed into service under emergency conditions. Nevertheless, some new buses are on order. Among the buses to be delivered are additions to the current fleet of 25 CNG buses. TTC has been very satisfied with its alternative-fuel buses and has customized both the garage where they are housed and the vehicles themselves to promote greater efficiency. The service area has been ventilated and an extra cylinder has been added to each bus to address the frequent need for refueling, which currently takes place off site. A new onsite fueling station is being completed that will service 125 CNG buses.

TTC'S high peak-to-base ratio makes it possible to perform running repairs--of which there are 130 daily--at off-peak hours, thus minimizing the time that buses are out of service. On an average day, 153 buses are out of service for all causes, representing about 9 percent of the total active fleet.

Maintenance

TTC's operation is one of the most responsive and efficient of the systems studied; not only has TTC been able to adjust fleet size in accordance with ridership demand, but it is continuously evaluating and updating its maintenance procedures. Inspections are done at 8,000 mile intervals on the day shift and all buses are overhauled between 8 and 10 years of age. TTC'S capital budget planning takes into account future needs for repair and inspection facilities. Right now, they are evaluating whether to reconfigure these areas to accommodate low-floor buses and a large fleet of CNG buses.

Training is an ongoing issue as TTC moves toward preventive maintenance and operation on a 24-hour basis. It is tailoring training to real-time work, seeing that the mechanics are less specialized and able to perform a variety of tasks including work on the newer more sophisticated vehicles. Technical assistance is moving into the operating areas, with facilitators on the floor for all shifts, manufacturers' manuals at hand, and updating bulletins available to maintenance personnel. There is one mechanic for approximately 3.6 buses.

Although TTC has no ADA requirements, about 20 percent of its vehicles are either lift-equipped or have a kneeling feature and future purchases will take the disabled community's interest into consideration.

Conclusion

Although TTC's spare bus ratio is slightly over 20 percent, their high standards of customer service within an integrated transportation environment and their forward-looking policies warrant close observation by agencies seeking to improve their operations.

CHAPTER FOUR

AGENCY PROFILES

In this section, profiles of the respondent bus systems are presented, with emphasis on the particular blend of characteristics that appear to govern each property's spare bus ratio. Each profile is organized so that general information on the transit system is followed by a short synopsis relating the property to its operating environment with highlights of the key factors that govern those conditions.

SMALL AGENCIES (FEWER THAN 200 BUSES)

Alexandria Transit Company (DASH)
Alexandria, VA

Springfield Transit Company (MTD)
Springfield, IL

Berks Area Reading Transportation Authority (BARTA)
Reading, PA

Fleet Characteristics, Operations, and Service Environment

Three small bus transit agencies have been included in the study. Small agencies such as DASH, MTD, and BARTA are an important part of the nation's public transit service, and are encouraged to conform with the FTA guidelines for spare ratios even though these guidelines apply specifically to agencies with 50 or more revenue vehicles.

Of particular importance for these and other small properties is the fact that all statistical proportions change dramatically with addition or deletion of a few buses and should not be regarded with the concern that would greet similar proportions at larger operations.

With 33 buses in its active fleet, DASH operates predominantly as a feeder and sometimes as a replacement for portions of the Washington METRO rail system. In addition, its buses are used to supplement METRO on charters and other tourist oriented activities. It maintains a spare bus ratio of 32 percent, to accommodate this charter work.

MTD is in the state capitol of Illinois; its system operates 46 buses in a medium-sized city environment, varying little in peak service requirement between winter and summer. Its spare ratio is reported at 17 percent, based on the dedication of lift-equipped vehicles to advertised scheduled routes.

BARTA's active fleet of 58 vehicles includes five held for dire emergencies. It operates in a mixed suburban/city environment, in the relatively severe climate and terrain of south central Pennsylvania. Its spare bus ratio is reported at 17 percent.

All three systems are oriented toward the commuter work trip, carrying about twice as many patrons at peak hour as midday. The DASH fleet travels farther and goes faster than the other two systems--36,750 annual miles per bus traveling 13.9 miles per hour, compared with 33,734 miles at average speeds of 12.7 miles per hour for BARTA and 26,155 miles at average speeds of 11.9 miles per hour for MTD.

Given the FTA standard of bus retirement at 12 years, it appears that all three systems operate young fleets: BARTA's buses (excluding the five old ones reserved for emergencies) average 5 years, DASH's 7, and MTD's 8.5 years. All fleets are partially lift-equipped (ranging from 42 to 62 percent), with plans to bring the entire fleets into ADA compliance.

Maintenance

Both BARTA and DASH operate with a substantial number of buses out of service for running repairs, inspections and other causes. Because there is such a low number of buses in their systems, the fact that 15 to 20 percent of the fleet is unavailable each day makes it imperative that these small systems carry enough spare buses to meet service. MTD reports only 13 percent out of service on a given day. All three systems have adequate inspection programs, and none have midlife overhaul programs (although BARTA managers report that PennDOT has a vehicle overhaul program). Their ratio of maintenance staff per vehicle is low compared with larger properties: one person per four to five buses.

Conclusion

In summary, the experience of very small properties may not be directly translatable to that of larger systems. Sometimes they serve special purposes, such as DASH's feeder operation; more frequently these small systems are the only means of transportation for those without their own car in isolated environments. Systems with fewer than 100 buses should probably be treated on a case-by-case basis, with less emphasis on statistics and more on the quality and continuity of service they provide.

Birmingham-Jefferson County Transit Authority
Metro Area Express (MAX)
Birmingham, AL

Fleet Characteristics, Operations, and Service Environment

Birmingham's small fleet operates in a medium-sized city environment with a moderate climate (although air conditioning is necessary during the summer months). The spare bus ratio of 12 percent (only 12 spare buses) is one of the lowest of the agencies participating in the survey. As mentioned earlier however, minor changes in small fleet characteristics can have dramatic impacts on the factors being analyzed. In 1993, the newest buses in the fleet were 4 years old, whereas 58 buses, more than half of the active fleet, are 13 or more years old. Average age is 10 years. Currently there are no lift-equipped buses in the fleet nor are there any alternative-fuel buses.

The fleet is stable, having neither grown nor changed its peak service requirements materially since 1990. Buses with more than 15 minutes between peak runs are doubled back for additional service, thus ensuring full use of the fleet and decreasing the need for spare buses. Although the number of buses has not increased, other factors indicating efficiency and care for the fleet are rising slightly: the capital budget grew from $15.3 million to $15.7 million in 1993 and the number of maintenance workers rose from 54 to 64 during the same period. Bus speeds were relatively fast in 1993--14.2 miles per hour with a moderate average annual mileage per bus of 37,984, suggesting that although there are few spare buses, the fleet is not overtaxed by constant use.

Maintenance

The miles between roadcalls (Birmingham includes any interruption requiring a mechanic's assistance) translates into nine calls per year per bus, a relatively high number given the few spares available for replacement. There is one mechanic per three buses. Like most small properties, Birmingham has no vehicle overhaul program.

Conclusion

Birmingham officials recognize the problems associated with an aging fleet and respond to the question of whether a 20 percent spare rate is realistic with the comment that the older the buses are, the more spares required. The key to Birmingham's continuing to maintain its current performance will be its ability to replace its aging fleet.

Peninsula Transportation District Commission
Hampton, VA

Fleet Characteristics, Operations, and Service Environment

Peninsula Transportation District operates in a medium-sized urban environment, with a fleet of 116 vehicles. Even with its moderate climate and few extremes of heat or cold; both heating and air conditioning systems on the buses are needed. The agency attributes it low spare bus ratio of 18 percent to its inspection and maintenance practices, relatively young fleet age (7.8 years) and lack of operating constraints. Peninsula's buses are able to travel 13.8 miles per hour, suggesting that a number of its routes are outside the congested part of the area, even though the average annual mileage per bus is a moderate 33,740 miles. Trips are heavily work oriented, with a 2.94 peak-to-base ratio. Of note is a much higher morning peak, when 77 percent of the fleet is in service compared with the afternoon peak when only 57 percent of the fleet is being used.

Unlike many properties that carry a large variety of makes and models of buses, Peninsula has only five different models and the bulk of the fleet (72 out of 116 vehicles) are FLX vehicles. Although there have been no purchases for 2 years, the average age of the fleet is 7.8 years, and only a quarter of the fleet is more than 8 years old. There are no alternative-fuel buses. One-third of the fleet is lift-equipped.

Maintenance

Running repairs, inspections, overhauls, and similar events pull about 10 percent (13 buses) of the fleet out of service daily, which suggests that there are few vehicles sitting idle. There are only 18 spares. Buses are taken out of service not only for mechanical failure but for damage from vandalism, electronic problems such as destination signs, lighting, and nonworking lifts. It is estimated that each bus has about six roadcalls annually (the information given does not specify whether roadcalls are limited to the FTA-defined mechanical calls or cover other types of repair problems). Peninsula reports only one mechanic for every seven buses (most agencies operate with one mechanic per two to four buses).

Conclusion

Peninsula officials indicate that the 20 percent spare bus ratio is realistic for them.

Charlotte Transit System (Charlotte Transit)
Charlotte, NC

Fleet Characteristics, Operations, and Service Environment

In 1993 Charlotte Transit's fleet consisted of 159 buses. Even though both heat and air conditioning systems are necessary, the temperate climate reduces to some extent the weather related wear on the fleet. The agency's average bus speed was 15.1 miles per hour and the annual average mileage was 36,224 indicating a relatively congestion-free environment. Charlotte's spare bus ratio is reported at 19 percent, reflecting the factors listed above as well as a carefully managed fleet.

The average age of the fleet is 11 years, and the agency's last purchases were in 1990. The primary reason for lack of new buses is money; Charlotte's City Council is reluctant to spend capital on new bus equipment. The agency is in the process of purchasing 21 new vehicles; however, the request to the City had been for 51 new buses--30 were rejected. As a result, the agency is overhauling its older buses, rebuilding engines, and hoping that the newer more efficient engines will meet air quality standards without forcing it to buy alternatively fueled vehicles. Currently, Charlotte Transit has one demonstration bus that runs partly on soy diesel. So far the agency has had no problems with this vehicle which uses 80 percent diesel and 20 percent soy fuel. The managers will evaluate its cost, efficiency, and pollution reduction ability before purchasing any more. Additionally, there are four electric buses, leased by Duke Power, circulating in the downtown as an experiment. These, too, will be evaluated. Charlotte

Transit is following closely the experience in Nashville, which has nine of these electric buses in operation. Because Charlotte's air quality is poor, city officials have concerns about meeting EPA standards.

One-third of the fleet is lift-equipped, FLX buses with front-door lifts; all future purchases will be in compliance with ADA requirements. The bid currently out includes some low-floor buses.

Maintenance

Charlotte Transit places emphasis on ensuring that all mechanics are able to work on all of the buses, from the oldest to the 50 newest vehicles with sophisticated electronic gear. Specialized courses are offered; as an example, the agency has received EPA certification for training in its air conditioning maintenance.

Conclusion

Charlotte's management believes that a 20 percent spare ratio is realistic. The high priority given to maintenance, inspection, and rebuilding older vehicles is the key to reducing the spare fleet.

Pierce Transit (Pierce)
Tacoma, WA

Fleet Characteristics, Operations, and Service Environment

Pierce Transit provides both intra-and intercity transportation service for Tacoma, Washington, located just south of Seattle. In addition to its regular fleet operation, this agency also oversees van service, and contracts out 22 additional buses (no maintenance is performed on these contract buses). None of the services feed each other; they all operate independently. The buses operate in a variety of environments, ranging from rural to center city. The long distances traveled and changing traffic and road conditions add wear and tear on the vehicles, subjecting them to additional maintenance needs.

Pierce Transit's officials report a spare bus ratio of 20 percent. Older vehicles awaiting disposal are kept until newer models are working well. Pierce Transit uses three transit bus makes and two CNG makes. One-third of the fleet is CNG buses. Even though the average fleet age is only 6.6 years, no buses have been purchased for the past 3 years, and there are 14 buses that are 20 years old.

Maintenance

If the old buses are disposed of shortly, the spare bus ratio should decline, even if some of them are replaced with CNG buses, which perform well in the Tacoma environment as has been the case in other northern climates including Toronto. The buses travel at a moderately high speed of 13.3 miles per hour, and each bus covers approximately 42,500 miles annually, reflecting the intercity part of the service and probable lack of major congestion on most routes. The daily peak-to-base ratio is a low 1.51, suggesting that the buses are used for nonwork as well as work trips.

Conclusion

The variety of bus makes and models adds to maintenance time and cost, as workers must be thoroughly trained in a variety of techniques and must understand the strengths and limitations of each different model. The variety in the fleet also adds to inventory management issues, i.e., keeping adequate spare parts inventories at the shops where the different models are stored. In spite of this, Pierce officials report only five buses in the active fleet out of service daily for running repairs, five for body shop, and the remaining three for other causes.

Central New York Regional
Transportation Authority
Syracuse, NY

Fleet Characteristics, Operations, and Service Environment

CENTRO's small fleet of 199 buses operates both intra- and intercity, in Syracuse's medium-sized urban environment and vicinity. The climate is temperate in the summer and exceedingly severe in the winter, with a large amount of snow. Recent downturns in efficiency have been caused by the fact that two local bus companies failed and CENTRO had to take over their equipment and routes. Overall, the bus system operates at average speeds of 12.2 miles per hour with annual average mileage of 25,168 miles per bus. Fleet age averages 5.6 years with replacement scheduled at 12 to 13 years. However, 54 vehicles are 10 or more years old. The key to CENTRO's reported low spare bus ratio of 14.5 percent, according to its operation's manager, is the emphasis placed on preventive maintenance and on careful study of new products and processes before purchase. In addition, staff are sent to other properties to evaluate how items such as lift repairs and CNG bus fueling are handled. Then, equipment is customized to meet CENTRO's needs and schedules are adapted to take care of anticipated problems. Another reason given for the low spare ratio was the fact that CENTRO took on 22 pieces of peak work by adding only 22 coaches, with no additional spares, thus decreasing the overall fleet ratio.

CENTRO calculated its spare bus ratio at 14.5 percent by using the number of buses in the garage after maximum deployment divided by the number in the total fleet on the theory that the only nonactive buses in the property are nonserviceable and not yet sold for scrap. But even the number calculated according to FTA methodology (17 percent) is well below 20 percent, and reflects the care and efficiency of the Syracuse operation.

Maintenance

Approximately two-thirds of the fleet is lift-equipped at this time. These buses do not present any unusual maintenance problems because the lifts were specially designed for

Syracuse's climate. However, they take up more space than other vehicles, posing garage storage problems. The eight CNG buses present no maintenance problem, but because they must be fueled off-site, they are out-of service more than the rest of the fleet. CENTRO is getting a federal grant to build an on-site fueling station.

There is insufficient space in the garages to perform preventive maintenance work during the night when the buses are being stored; also, the greater amount of body work required as the fleet gets older affects the number of spare buses needed to maintain service. About 12 buses are out for running repairs daily. Preventive maintenance cuts down substantially on the number of buses that require unplanned service; only one mechanic per 4.7 vehicles is needed to take care of CENTRO's maintenance needs.

Spare parts generally do not present a problem because CENTRO's management information system keeps inventories updated. In a few cases, difficulties arise with bus parts requiring delivery from overseas (for example, wheel studs from Germany).

Conclusion

In summary, CENTRO's operation is carefully controlled, with particular attention paid to its unique climate and operational requirements, and a constant goal of operating with minimum additional equipment or personnel. It reports that a 20 percent spare factor is generous and CENTRO could operate successfully with fewer spare buses.

MEDIUM-SIZED TRANSIT AGENCIES (FEWER THAN 500 BUSES)

Memphis Area Transit Authority (MATA)
Memphis, TN

Fleet Characteristics, Operations, and Service Environment

The Memphis Area Transit Authority operates a fleet of 182 buses and 10 electric trolleys, plus 22 paratransit vehicles in a mixed suburban/city environment. The climate is moderate. Excluding the paratransit vehicles and trolleys, in 1993 the average system speed was 13.5 miles per hour and each bus averaged 38,159 miles per year. Approximately 85 percent of the buses feed the trolley system. Although only 5 percent of the fleet is lift-equipped, ADA standards are otherwise met and when these buses were purchased, lifts were not required. Currently the paratransit vehicles are serving the needs of the disabled, though of course, new buses will all be lift-equipped to bring the fleet into compliance with current requirements.

A number of unique factors affect MATA's operation, of which the most prominent are a trolley line that opened in April 1993 and has been a great success for center city travel. The FTA has approved a contingency fleet of 32 vehicles used primarily as shuttles to the Pyramid, a 3-year-old arena used for sports events, concerts, and the like; or to accommodate the community when floods and tornadoes have required emergency transportation needs. When the Pyramid opened, with events scheduled about once weekly during the winter months, MATA used shuttle service to bring people back and forth from outlying areas to alleviate what they feared would be a mammoth crush. MATA was able to secure FTA approval for 32 extra buses. The feared traffic congestion never happened and as Pyramid customers grew accustomed to the routine of attending events, they found ways to bring and park their cars more conveniently. Shuttle ridership has declined and fewer buses are needed at Pyramid events. The older contingency fleet composed of the oldest buses, requires high levels of maintenance and spare parts are hard to obtain. The vehicles take up space, add to overall operating costs, and are seldom in use. Keeping and maintaining this under-used fleet has become a burden; transit officials are now considering a reduction or elimination of the contingency fleet. Overall ridership has declined somewhat also, so that disposal of these older vehicles without replacement will probably take place in coming months, thereby reducing the agency's spare ratio below 20 percent.

Maintenance

Maintenance will continue to be a problem for MATA, however, as almost 40 percent of its fleet (82 buses) was purchased in a single year (1985). These buses require extensive maintenance and/or overhaul. The agency has not bought new diesel buses since 1988 because they could not meet the FTA criteria of 12 years/500,000 miles. A purchase order is in process. When the new vehicles arrive and the contingency fleet is reduced or eliminated, the average fleet age will drop sharply, as will the need for maintenance. Memphis does have a comprehensive inspection program as well as overhaul criteria based on evidence of engine wear, so the existing fleet is in good condition. There is one mechanic per 3.5 buses.

Conclusion

In summary, Memphis' bus and trolley operation is becoming more efficient and more able to control costs without reducing service to the community. The electric trolleys represent the agency's method of reducing pollution and improving air quality; no other alternative-fuel vehicles are being considered at this time.

Kansas City Area Transportation Authority
Kansas City, MO

Fleet Characteristics, Operations, and Service Environment

The Kansas City fleet operates in a mixed city/suburban environment under relatively severe climatic conditions, both winter and summer. Currently there are 234 buses in the fleet, and the peak vehicle requirement is 206 buses. All except 24 of the buses are diesel powered 40-ft buses. The average fleet age is 7.8 years, reflecting recent purchases--170 of the buses are 5 years old or less, although there seems to have been a 9-year gap during which no buses were acquired; 65 of the buses are more than 14 years old. Until recently, the agency had little problem conforming with elderly and handicapped regulation because 62 percent of the fleet is lift-equipped, but the most recently purchased vehicles have lifts that require constant attention. Service is heavily peaked, with 2.4 times as many vehicles operating during the afternoon peak period as at noon. In the last few years both the bus operating budget and the number of maintenance employees have declined modestly. Kansas City reports its current spare bus ratio at 20 percent. Because there are so few spare buses, the agency has had difficulty putting enough vehicles in service to meet peak daily requirements.

This agency reports that it calculates its spare ratio as follows: afternoon peak vehicle requirement divided by total buses. Using the FTA suggested methodology, the spare would be 13.5 percent--exceptionally lean. However, Kansas City planned to purchase new buses in 1994, bringing the total active fleet from 234 to 260 vehicles, and raising the spare bus ratio to 26 percent.

Maintenance

The fleet has only six different models, another factor that contributes to fleet efficiency. Similar vehicles require a less complicated spare parts inventory and training can be provided more easily for a few rather than a large assortment of vehicles. Because purchases have been made in bulk, it is likely that a sizable number of vehicles will require extensive rehabilitation at the same time, draining the maintenance resources for ongoing repair, prevention, or inspection purposes; the vehicle to mechanic ratio is 1:4. Nonetheless, the agency reports that its mean distance between failures for 1993 was 9,000 miles, using the Section 15 definition. As the fleet ages, this agency may well require more than the 8 percent spare vehicles they now have on the property.

Conclusion

Kansas City's new bus purchases should remedy the problems experienced recently when there were not enough buses in the total fleet to provide optimum service and carry out necessary maintenance. It is anticipated that the new buses will allow the agency once again to provide quality service and still maintain a relatively low spare bus ratio.

Miami Valley Regional Transit Authority (MVRTA)
Dayton, OH

Fleet Characteristics, Operations, and Service Environment

In 1993, the MVRTA fleet consisted of 36 trolley buses (average age 17) and 211 diesel buses, with an average age of 7.4 years. The buses travel at 12.8 mph over an annual average of 33,421 vehicle miles. Dayton's climate provides extremes of both heat and cold, requiring that heating and air conditioning systems be in top operating condition.

MVRTA reports a spare bus ratio of 22 percent, attributable to a declining number of buses needed for peak service, an aging trolley fleet, 15 percent of vehicles temporarily out of service, and inadequate space in the facilities to inspect and repair buses. In addition, congestion and detours on city streets at the time the survey was done caused by a major road reconstruction program, led to the low bus speed which added to high wear and tear on the fleet.

MVRTA officials have chosen to keep older diesel buses in their fleet in spite of their heavier repair requirements and less efficient operation. The older buses substitute for trolley buses, which have no off-wire capability, and back up the electric trolley fleet which is being refurbished and replaced, until the bugs have been worked out on the new vehicles. In 1993, spare diesel buses were needed about three times weekly as emergency substitutes for the trolley buses. When the street construction program is completed and the new trolley buses are in acceptable working condition, the older vehicles, both trolley buses and diesel buses, will be retired. The fleet will then be smaller and the spare bus ratio should be reduced significantly. By 1997, MVRTA plans to purchase 31 additional trolley buses and reduce its diesel fleet by a like amount.

Conclusion

Looking to the future, MVRTA officials feel that it may be difficult to achieve a 20 percent spare bus ratio due to the lack of off-wire capability of the trolley buses and the commitment to have spare diesels ready for emergency replacement. However, the trolley buses remain an essential part of the agency's long-term fleet planning, as they are the means of compliance with air quality requirements. Dayton does not expect to purchase any alternative-fuel vehicles, relying instead on the anti-pollution effect of the electric trolleys.

Central Ohio Transit Authority
Columbus, OH

Fleet Characteristics, Operations, and Service Environment

The Central Ohio Transit Authority manages a fleet of 310, in a mixed city/suburban environment. Buses travel at an average speed of 12.6 miles per hour and average annual mileage per bus of 29,476 miles. Columbus' climate is moderate to severe, requiring both heat and air conditioning in the buses, and frequent periods during the winter when driving can be hazardous.

With peak service requirements of 253 buses, the spare bus ratio is 22 percent. Wide swings in the ratio since 1990 (between 18 percent and 29 percent) indicate that purchase and disposal patterns have strongly influenced the number of spare vehicles owned by the agency. Management confirms this, noting that they are now about to right-size their fleet and should be able to reduce the spare ratio to 20 percent in the very near future.

Maintenance

Whereas the average fleet age is only 6.6 years, more than one-third of the buses are at least 10 years old and there were no purchases between 1987 and 1992. Just over one-third of the fleet is lift-equipped, and about one-fifth of the fleet meets total ADA guidelines. The agency reports that meeting the ADA guidelines is one of the factors that have kept the spare ratio above 20 percent, suggesting problems with the lift equipment as well as the electronics of the new buses. Other reasons cited are inoperative air conditioners (their goal is to have 95 percent of the fleet with working systems) and old fareboxes. All of these should be less burdensome as new equipment replaces the older fleet and the maintenance staff becomes more experienced with the complexity of the new technology of the ADA equipment.

The fact that so many buses are at least 10 years old helps explain why a large proportion of the buses require substantial maintenance. This is confirmed by the fact that 13 percent of the fleet is out of service for running repairs--a somewhat higher proportion than is true for other fleets. Columbus does not have an overhaul program. Nonetheless, this system has an advantage in that the high peak-to-base ratio (2.45:1) permits many of the repairs to be made during the base period.

Conclusion

If Columbus can continue to control its purchases and disposal, and is able to implement a midlife overhaul program for buses approaching 6 years old, it anticipates no problem in achieving and maintaining a 20 percent spare bus ratio.

Metropolitan Transportation Authority
Long Island Bus (MTA LIB)
Garden City, NY

Fleet Characteristics, Operations, and Service Environment

MTA LIB, the smallest of the Metropolitan Transportation Authority's sister agencies, is a medium-sized mixed suburban and city bus company with a total active fleet of 318 buses with an average age of 8.2 years. MTA LIB operates 265 buses in peak weekday service at an average 14.9 mph and has an additional 53 buses available as spares. The manager reports that MTA LIB currently operates with a 20 percent spare factor, approximately 5 percent more than the 15 percent mandated by New York State Department of Transportation. The authorized increase to 20 percent is premised on the acquisition and operation of 10 CNG buses MTA LIB acquired to test as a part of an alternative fuel project. Only 40 percent of the fleet is lift-equipped, and as a result, MTA LIB reports that it must reassign the 1989 Orion buses to assure a proper allocation of handicap accessible buses on certain routes to meet ADA requirements.

Maintenance

MTA LIB officials report that a key issue for the agency is the multi-make and -model fleet, consisting of four different makes purchased in different years as follows:

Year	*Model*	*Number*	*Average Age (years)*
1978	*FLX-40'*	*12*	*16*
1981	*FLX-870-40’*	*109*	*13*
1984	*FLX Metro-40'*	*34*	*10*
1985	*Neoplan-25'*	*3*	*9*
1986	*Neoplan-25'*	*2*	*8*
1988	*Gillig-40'*	*61*	*6*
1990	*Orion*	*21*	*4*
1990	*Orion 11-25'*	*1*	*4*
1991	*Orion-40'*	*57*	*3*
1992	*Orion CNG-40'*	*10*	*2*

In addition, MTA LIB managers state that the age of the fleet coupled with the lack of funds for an overhaul program make it extremely difficult to operate with a 20 percent spare factor. Well over 100 buses are in need of an overhaul, which has been delayed for up to 2 years. The maintenance staff also cites the lack of new engines as another problem that complicates the maintenance program because they must rebuild existing engines to accommodate the needs of the older fleet. To ease the pressure on the spare fleet and in anticipation of an overhaul program, MTA LIB recently purchased old GMC buses (rehabilitated by the Blitz Corporation in 1985-86) from the (New York City Transit). Unfortunately, the funds for the overhaul program have not been forthcoming. To further relieve the pressure on the fleet, the managers report that they use the newer buses on the longest routes. Nonetheless, escalating road calls and demands for heavier maintenance for the older buses have increased the need for spare vehicles to minimize service disruptions. Although service has not been significantly affected by the increase in roadcalls, which average 7.6 per bus, MTA LIB managers indicate that they are managing the fleet with increasing difficulty. The Gillig fleet is a particular problem because of the need for an overhaul and the increased incidence of maintenance problems.

On average, more than 24 buses, almost half of the spare buses, are out of service during peak period for a variety of reasons. To ensure that there are few service disruptions, the agency will replace buses that experience in-service failures with spares if available, further increasing the need for vehicles. Because of the increase in roadcalls and the resulting decrease in available spare buses, MTA LIB management claims that it will not hold buses out of service except for lack of heat or air conditioning if the weather is severe. Although the managers recognize the importance of a clean, near perfect fleet, they simply cannot afford the luxury of such a resource, expensive program. Thus, there is no quality control program mandating that buses be held in for minor passenger amenities, such as dirty windows, scratches, and minor body damage.

Although MTA LIB has a stable maintenance workforce, training on the multi-model fleet has been problematic. Because of funding restraints, most training is limited to on-the-job training. In addition, in recent years, MTA LIB has had to reduce maintenance staff, which has increased the work that each mechanic performs. Its managers indicate that, unlike other transit properties in the area, their mechanics are responsible for almost 4 buses. With the complexity associated with the maintenance of so many different bus models and the demands of an aging fleet, untrained personnel increase out of service time and create even greater demand for more spare vehicles.

Conclusion

MTA LIB managers indicated that although they are presently operating within the recommended guideline, a 20 percent spare factor may not be realistic because it does not provide sufficient flexibility for emergencies, accommodate the needs of an aging fleet, or permit the implementation of an enhanced passenger amenities program.

San Diego Transit Corporation
San Diego, CA

Fleet Characteristics, Operations, and Service Environment

San Diego's fleet of 353 vehicles operates in a large urban multi-model environment with a light rail system and paratransit vans. The agency also serves a large transit population. Approximately 34 percent of the buses feed the other modes. About 17 buses are reserved for stadium service and another 20 to 25 for contingencies. Average speed of the buses is 11.9 miles per hour, and the high annual mileage per bus--47,537-- reflects long hours of operating service which can add substantially to wear and tear on the fleet. Today the average fleet age is only 6.7 years. However. until 2 years ago, the agency operated one of the oldest fleets in the country. Most of the state and federal transportation capital funding available to the area went to the light rail line, limiting the purchases of new buses. Now, the agency has chosen to keep many of the older buses for its contingency needs. Recent purchases affecting half the fleet have had the effect of sharply reducing the average age. The fleet is 96 percent lift-equipped. The newer buses have particulate traps and other requirements mandated by California's air quality standards.

Southern California's mild climate eliminates many problems common to agencies that operate either in severe cold or tropical heat, however, California's attempts to reduce air pollution by imposing strict controls on vehicle emissions have caused cost and operational problems for the transit agency.

The agency's high 1993 spare bus ratio of 32.2 percent is caused primarily by increased maintenance associated with California's anti-pollution regulations, and by the timing sequences of new bus purchases versus disposal of older vehicles. Although the ratio will fluctuate according to the status of buses purchased and disposed of, officials do not believe they will be able to reduce the spare bus ratio below 20 percent as long as they have to comply with California's emission reduction standards.

Particulate trap failures have posed a problem for the agency; recently, permission has been secured from California officials to disconnect these traps so long as the catalytic machinery remains in place. Recent analyses have shown that the pollution benefits in the traps are minuscule and not worth the trouble or expense to install. Four CNG buses were scheduled to arrive in 1994 and another 26 were to be added to the fleet in 1995. Officials are concerned about the impact that these vehicles will have on the overall fleet performance. Moreover, CNG fuel costs about $1.28 per mile (compared with refined diesel at $.85 per mile), requires reconfiguration of shop and storage spaces and is harder on bus engines than is diesel. Some transit properties, including San Diego, are opting for the new cleaner diesel fuel as their major pollution reduction program, because with the same amount of funding, they can still achieve auto emissions reduction while providing additional public transportation service.

Maintenance

Maintenance is a major issue in San Diego. Management stated that the newer buses are full of electronic components. The engines, transmissions, head signs, and radios, for example, are run by computer. In spite of their seniority and familiarity with the mechanics of operations, mechanics trained many years ago are poorly equipped to handle the new buses. Today's needs are for electrical engineers and computer experts, management claimed. Sometimes work has to be farmed out to mechanics more familiar with a specific bus type. This is done only when absolutely necessary because experience has shown that in-house repairs are done with more "pride of ownership" and are therefore handled more quickly and with more assurance.

Although extensive programs are underway in-house to train existing staff in the new maintenance techniques, the agency is not convinced that training additional mechanics will have a beneficial effect on the service availability of the fleet, and would prefer to operate with fewer vehicles and a leaner staff. They believe that having a large number of spares around lessens the pressure on the maintenance staff and indeed causes more people to be hired, thus further bloating the costs of operation. Reducing overall fleet size could have a mushrooming impact on reducing costs and maintenance needs, and will be especially beneficial if old vehicles are disposed of and not replaced. In the near future, as San Diego's fleet is modernized and reduced, it is probable that the spare bus ratio can be reduced. Mechanical roadcalls are not measured in isolation; however, the total number of roadcalls has decreased on an annual basis. On average in 1993, there were nine calls per bus. Ten percent of the buses are out each day for running repair.

ADA requirements do not materially affect the San Diego operation as the agency has had lift-equipped vehicles for many years, it was the first agency in the country to provide lifts in line-haul service. The mechanics have now had long years of experience with the lifts and report that there are no special problems in using or maintaining the lifts.

Conclusion

San Diego is another good example of why there should not be a single spare ratio imposed on all agencies. The combined effects of California's strong air pollution regulations, specialized maintenance and service demands, and the skewed distribution of buses by age and type impact the operating environment in such a way as to drive the spare ratio upward. San Diego needs a larger proportion of spare buses than most properties surveyed.

Santa Clara County Transit District
Santa Clara, CA

Fleet Characteristics, Operations, and Service Environment

Santa Clara's fleet of 464 buses operates on mixed suburban/city routes; the agency also manages a light rail system with which 39 of the 72 buses connect. The mild California climate eliminates much of the wear and tear experienced by other systems. Buses travel fast and far; in 1993, average bus speed was 14 miles per hour and the annual mileage per bus, based on peak daily service, amounts to 48,666 miles. Its spare bus ratio is 22 percent.

Santa Clara's peak service requirement declined from 416 vehicles in 1990 to 380 in 1993; its fleet size has been reduced from 499 to 464, and its spare bus ratio has also fallen from a high of 34 percent in 1991. Given the large number of old buses still remaining in the fleet, its likely that the agency could further reduce its spare bus ratio without adversely impacting overall performance and service, particularly since the major problem facing the agency is the presence of old equipment. The recent purchases (180 buses, almost 40 percent of the active fleet, are 3 years old or less) combined with disposal of older vehicles has reduced the average bus age in the fleet to 7.5 years. Nevertheless, there are still 108 buses in the fleet that are 14 years old.

Maintenance

The adage that the older the bus, the more maintenance it requires is very true for this property. Santa Clara officials report that over 17 percent of the fleet is out of service daily, with running repairs accounting for the bulk of the out-of-service vehicles. Other reasons given are preventive maintenance and overhaul, vendor or contract work, out of stock parts and accidents requiring body work. The number of mechanical road calls annually, using a slightly broader standard than that suggested by FTA, is 2010 miles between calls, 9200 calls annually, or about 20 per bus. (These data are affected by the high overall mileage experience by the system's buses.) The agency reports a ratio of one mechanic to two buses. As is true for other California agencies, the fleet is almost entirely lift-equipped, with no problems noted in maintaining the lifts and other equipment designed to make the buses more accessible to the physically challenged community.

Conclusion

The agency credits its spare bus ratio reduction over the past few years to new buses and to better training for its mechanical staff; the mechanics are able to take on the electronic and other requirements of the newer models. The officials believe that the 20 percent spare ratio is realistic and achievable so long as the current fleet configuration and replacement schedule remain intact and the legislature continues to provide funds for new purchases.

Regional Transit Authority (RTA)
New Orleans, LA

Fleet Characteristics, Operations, and Service Environment

The RTA operates a medium-sized transit fleet of 472 buses of multiple makes and models, with an average age of 10.8 years, in a hot, humid climate. The buses travel at an average speed of 12 mph and each accumulates 29,206 miles annually. The only other transit operation is the light rail which operates downtown, and it serves both commuters and tourists, particularly in the downtown area. Air conditioning is critical to this fleet and every effort is made to ensure that all buses in service have a functioning A/C system.

Maintenance

The RTA operates a well-maintained fleet but the managers report some difficulties because of the mixed nature of the fleet. In 1993, RTA had 177 Rapid Transit System buses of 1980 vintage, 55 Flexible (average age 12.6 years), 165 MAN Nutzfahrzeuge Aktiengesellschaft buses (average age 8.8) and a number of small buses and vans, significantly newer Almost 50 percent of the fleet is older than 10 years, which significantly affects maintenance costs. Although the agency reports a 20 percent spare ratio, the managers indicate they still have difficulty managing with such a low number of vehicles. Maintenance at their facilities is difficult because the facilities cannot accommodate the size of the fleet. The new East New Orleans Transit facility, for example, completed in March, 1992, was designed for 240 buses and now houses 316 buses. Another facility, built in the early 1900's, currently houses 156 buses and must complete all maintenance activities with three permanent lifts and one portable lift and limited parking space. The lack of adequate work space and equipment continues to impact the need for spare vehicles and requires close monitoring to ensure that repairs are made.

Conclusion

RTA is proud of its modest spare ratio and believes that with the acquisition of new buses, it will be able to reduce the spare ratio even further. RTA officials have responded that at this time a 20 percent spare ratio is not realistic given the average age of the fleet.

LARGE TRANSIT SYSTEMS (BETWEEN 500 AND 1,000 BUSES)
Milwaukee County Transit System (MCTS)
Milwaukee, WI

Fleet Characteristics, Operations, and Service Environment

Milwaukee has a large mixed suburban and city bus transportation system, operating 537 buses countywide, and is operated by a private company hired by the County of Milwaukee. Although the County owns the buses, the three garages, the main fleet maintenance facility, and the land on which the facilities are situated, none of the personnel are County employees.

The agency reports a peak vehicle requirement of 431 buses. Weather is a major factor for this system. In the winter, the number of accidents increases significantly. Average fleet age is 9 years, the buses travel at 12.0 mph, and every bus accumulates 39,450 miles annually. In recent years, the agency has been affected by declining ridership levels. In both 1992 and 1993 Milwaukee experienced a 4 percent ridership decline, and another decrease in 1994, which has decreased the buses required for peak service. Another factor that influences the number of vehicles available for service is the very low peak-to-base ratio; 65 percent of the fleet is on the road at noon. As a result, most of the inspections and maintenance are performed on the second shift.

Management reports a spare ratio of 20 percent, noting that maintaining this level is difficult because of the climate, the nature of the service they operate, current fiscal constraints, and an aging fleet.

Maintenance

Milwaukee's decreased operating budget has reduced manpower, which has resulted in a deferral of the agency's midlife overhaul program as well as an increase in the time between ordinary inspections from 3,000 to 6,000 miles. Managers report an average of 2.8 buses per mechanic as the current staffing level, which they state is too tight to increase the number of overhauls and inspections performed. Management expressed concern that these changes may create problems in the future due to deferred maintenance.

In 1994, they were completing the major overhaul of the 1986 Neoplan fleet, which is 2 years behind schedule and will not be completed until 1995--40 buses were planned for 1994 and the final 32 in 1995. In addition, management reports that the transit system operates 40 1985 Crown articulated buses, which are overdue for an overhaul, but they can only complete 10 buses per year for the next 4 years. They state that components for the system are difficult to obtain and they are limited by the number of lifts they can use for these oversize buses at the fleet maintenance facility. The delay in the overhaul for these buses creates problems for the agency because these buses require a great deal of maintenance. To limit the maintenance liability of these buses, management has restricted the use of Crown to Freeway Flyer express service, which transports passengers from outlying parking areas in the suburbs to the downtown area, special events, and major high school runs. The 57 1987 Neoplans will not be overhauled until mid 1995.

To accommodate the increase in the inspection cycle time, the management reports that maintenance staff takes oil samples on a regular basis to identify any problems, and will address those defects as necessary. Notwithstanding these maintenance issues, this agency averages 12.6 percent of the total active fleet out of service daily for running repairs and roadcalls average 12.3 per vehicle. Because so many buses are in service at noon, most inspections are performed on the second shift.

Cold weather is another factor that affects Milwaukee's ability to maintain a 20 percent spare ratio, causing component defects, particularly in transmissions, defroster motors, and diversion pumps. In response to the question as to whether they could provide better service if they had more spare buses, the management said that the available resources do not permit them to increase the fleet size and staff levels, and they are willing to sacrifice the quality of the service in the winter to maintain financial viability.

Similarly, the limited resources and the number of spare buses precludes a major passenger amenities program, especially in winter. Although drivers have the discretion to hold a bus in if it is not clean, management believes that they have lowered their expectations regarding the cosmetic appearance of buses in recent years because of the cost associated with making these repairs. They do not take buses out of service for nonfunctioning air conditioning. If it is very hot, a transportation supervisor will meet the bus on the line and unlock the windows. However, no heat in the harsh Wisconsin winters mandates that buses be taken out of service. Milwaukee buses run through the inner city and management notes that there has been a significant increase in vandalism incidents on the buses and other related transit facilities. However, graffiti and torn or broken seats will not necessarily generate a roadcall unless it is a safety issue.

Notwithstanding the problems discussed above, the maintenance staff believes that it performs well, citing the quality of the staff which is highly motivated to make service, "no matter what it takes." In addition, management invests in individual mechanic training and maintains an on-site training staff of three, which is augmented by specially selected and skilled mechanics to whom they pay an added premium of $.75 per hour to assist with the training. The training staff develops the curriculum and handles the class work and the mechanics do all the hands-on training. Management updates the training for each mechanic annually.

Milwaukee also indicated that it has an excellent vehicle maintenance computer system to track component rebuilds and repeater roadcalls. The computer system captures all maintenance history because all mechanics must enter the work they have performed on the vehicles into the system. This enables the agency to identify problems early on and make adjustments in the program to resolve problems with buses or components.

Finally, the facilities are new or rehabilitated within the last 5 years with sufficient workspace and state-of-the-art equipment. The fleet maintenance facility is just 6 years old and handles most of the heavy maintenance.

Conclusion

Milwaukee's operation parallels the financial and operating conditions in existence at most transit systems. Although they would like to have more buses available to improve maintenance, they cannot afford the luxury. The lack of funds and the limited number of vehicles does impact the quality, if not the quantity, of service. At this time, the major impact is limited to the appearance of the bus system; however, it remains to be seen how soon the inevitable result of deferred maintenance of major components will manifest itself.

Regional Transportation District (RTD)
Denver, CO

Fleet Characteristics, Operations, and Service Environment

Denver's Regional Transit District operates its fleet within a large urban environment, providing intercity service to the surrounding region in climatic conditions that can be severe during the winter months. RTD contracts 183 buses to private carriers, for which it assumes no maintenance responsibility, but recommends a spare ratio of 20 percent. No feeder service is provided to other transportation modes, although RTD does offer van service in addition to its scheduled operation. The RTD reports its spare bus ratio at 19 percent and has been decreasing since 1991 when it was above 20 percent.

Fleet size and peak vehicle requirements also have declined since 1991--from a total active fleet of 612 buses and peak vehicle requirement of 509 buses to the current 597/503 bus level. Reflecting both the efficient center city mall service in the downtown and the intercity service, RTD's average speed and annual average miles are above those for most systems surveyed: 14.4 miles per hour and 46,285 average miles per bus. The average fleet age is 8.3 years, with only 13 percent of the buses purchased within the last 4 years; the bulk of the vehicles (79 percent) were acquired between 1981 and 1989. This suggests that a large number will become obsolete in the next few years. In 1993, 89 percent of the buses were lift-equipped.

Maintenance

Each mechanic is responsible for about 2.6 buses. RTD's thorough inspection program (every 3,000 miles, with oil change and analysis at 6,000 mile intervals and a comprehensive inspection every 24,000 miles is reflected in the agency's low number of vehicles out of service daily and the low average annual number of roadcalls per vehicle. All inspections are performed on the first shift, which requires somewhat more spares because of the medium spare to bus ratio. On a daily basis only 35 vehicles (5 percent of TAF) require running repairs and there is an average of fewer than five annual roadcalls per vehicle. RTD defines roadcall as "any maintenance related problem that results in a service delay while the bus is in revenue service." In 1993, the RTD reported 8,456 miles between lost service roadcalls; an improvement from 1990 when the agency reported 3,298.

Conclusion

RTD officials report that a 20 percent spare ratio is realistic for their agency even though it has a significant number of old buses.

Metro-Dade Transit Agency (MDTA)
Miami, Fl

Fleet Characteristics, Operations, and Service Environment

MDTA operates 612 buses, with an average age of 8 years, along with a heavy rail system and metro mover in Miami, a large urban environment that serves both residents and tourists. In addition, MDTA reports that it contracts out 21 buses on weekdays, but does not perform any in-house maintenance on these buses and does not recommend or mandate any specific spare ratio for the contractor. Fifty-two percent of their routes connect with their metro rail system and another 25 percent connect with the metro mover. The buses operate at an average speed of 12.7 mph and each bus accumulates approximately 47,813 miles annually.

MDTA reported in 1993 that it operated with a 22.1 percent spare ratio that was adjusted to 20.8 percent with FTA approval to accommodate the acquisition and operation of 15 1992 alternative-fuel buses. More than 58 percent of MDTA'S vehicles are in service at noon. Unlike many other transit systems, MDTA bus operations increased its budget by one percent from 1992 to 1993 as well as its total active fleet by 38 buses, but decreased its peak vehicle requirement by four buses in the same time period.

Maintenance

MDTA reported that 112 buses are held out of service during peak period for a variety of reasons of which 55 buses (8 percent of the TAF) can be attributed to running repairs. For maintenance inspections, all buses are cycled at 6,000, 18,000, and 54,000 miles but the agency does not report any major rehabilitation program. In 1993, MDTA reported that the mean distance between roadcalls averaged 3,015 miles with an average of 12.9 roadcalls per bus. This is a decrease from the 6,543 average miles between roadcalls reported in 1991. In 1991, there were only 5.9 roadcalls per bus, even though there has been a major acquisition of new buses, almost 30 percent of the fleet, and improved maintenance standards. However, the recent purchase of 15 alternative-fuel buses has caused significant vehicle downtime.

MDTA also reports that its bus-to-mechanic ratio is 3.2 buses for every mechanic, which is lean considering the size and complexity of the fleet. Moreover, management stated that although it holds or removes buses from service for nonfunctioning air conditioning systems and wheelchair lifts, as well as for cleaning, they have no written policy guidelines. Nonetheless, the maintenance manager reported that they add 20 spare buses to support this policy.

Conclusion

MDTA officials report that they do not believe a 20 percent spare ratio is realistic for their system. Because their buses run more miles than the average transit system, they believe that spare ratios should be based on miles run and on the average speed per bus, since all maintenance is based on miles.

Greater Cleveland Regional Transit Authority
Cleveland, OH

Fleet Characteristics, Operations, and Service Environment

Cleveland's 643 bus system operates in a mixed city/ suburban environment in climatic conditions noted for extremes of both heat and cold. In addition to its owned fleet, the agency contracts 59 buses, and assumes responsibility for major repairs on these contract vehicles. The Authority also operates van, rapid transit, and light rail services with which 95 percent of the bus routes connect (20 percent are primarily feeder routes). Buses provide emergency substitute service for rail service failures 10 to 20 times a year. The spare bus ratio is 20 percent, with 107 spare vehicles and a peak daily requirement of 536 buses. Both the total active fleet and the peak vehicle requirement have been decreasing; in 1990, there were 695 buses in the fleet and 588 were needed to meet daily service. Reflecting the partially suburban component of service, the buses travel at above average speed--12.9 mph and each bus covers almost 42,471 miles annually.

The average fleet age is 7.6 years, with 81 vehicles over 12 years old; officials say that one of their issues is whether buses beyond their useful lives should be sold or held in reserve for unusual events. There were insufficient spare buses to handle the crowds at the opening of Cleveland's new ballpark. As a result, buses were chartered at a high cost. The managers question whether it would have been more efficient to have kept older vehicles in storage as a contingency for such circumstances, even though retaining these vehicles would raise the spare bus ratio, increase maintenance requirements and possibly impede the purchase of additional new vehicles. The bus transportation administrator comments that although a spare ratio of 20 percent is sufficient for maintenance purposes, it does not make sense to sell off vehicles in excess of 20 percent or peak requirement whenever service requirements drop; if service requirements again increase, the additional needs cannot be met without the purchase of new vehicles.

Although there were no alternative-fuel buses in the fleet, the agency reports that it is buying 20 CNG buses, with engines specially designed for the Cleveland climate. They expect to have few problems with the buses and have one garage ready to serve them. At the time of the survey, 44 percent of the vehicles were lift-equipped with no reported problems. The only problem the agency anticipates is the more limited range of CNG buses and the consequent increase in time for refueling than is required for the diesel fleet.

Maintenance

The overhaul program has these specifications: vehicles undergo complete body, frame, and powertrain rehabilitation after 5 to 7 years. Approximately 95 buses are out of service each day--about 66 for running repairs, 20 for overhaul, and the remainder for miscellaneous reasons. There is one mechanic for about 2.7 buses. In 1993, there were 6,366 mechanical roadcalls, defined as whenever a coach is removed from the road while in regular service according to the definition in 402 from Section 15, which results in 9.9 calls annually per vehicle in the active fleet, which is significantly less than this transit system's experience in 1990 with 8,516 roadcalls with 12.2 calls per bus.

Conclusion

The key to Cleveland's low spare bus ratio is in its excellent inspection, overhaul, and maintenance program as well as its practice of disposing of older buses. As noted by the Authority's bus transportation administrator, however, they may be willing to trade the efficiency associated with a lean fleet for the security of being able to serve changing ridership levels and specialized demands for service.

Metropolitan Atlanta Rapid Transit Authority (MARTA)
Atlanta, GA

Fleet Characteristics, Operations, and
Service Environment

MARTA's active fleet in 1993 was 669 buses with reported average age of 7 years, a peak vehicle requirement of *557* buses, and a reported spare ratio of 20 percent. The fleet operates 23 hours per day and travels at an average speed of 12.7 mph. Almost 60 percent of the fleet is lift-equipped. Ninety-five percent of the buses feed the rail service but substitutes service only three times per year.

Recent discussions with MARTA officials reveal that this system is currently taking delivery of 51 new buses, replacing all of the articulated fleet which has been maintenance intensive due to high roadcalls. With the completion of this purchase, the entire fleet will be less than 7 years old, which should ensure continued ability to maintain a 20 percent spare factor. MARTA has no alternative-fuel buses. but reports that the agency anticipates a purchase of 61 CNG buses in the summer of 1995 and an additional 100 CNG buses in 1996 and will build a new 200 vehicle-capacity CNG bus garage.

MARTA states that all buses reported in the total active fleet are available for service, although management reports 15 buses are held in contingency for emergencies.

Reflecting a reduction in ridership, there has been a decrease in the peak vehicle requirement with a concomitant reduction in the total active fleet since 1992. However, the bus operating budget remained virtually the same over the same time period.

Maintenance

MARTA has an aggressive overhaul program with almost 60 buses processed through the program at one time. The midlife overhaul program provides paint, bodywork, and repairs as needed. Engine overhauls are scheduled at 250,000 miles. Regular inspections are performed every 7,000 miles.

The reported 2,879 mile mean distance between failures statistic (4.3 roadcalls per bus) for 1993 reflects only those incidents in which a repair truck is sent to the bus. Problems with air conditioning, heating, wheelchair lifts, drivers' radios, and cleanliness will result in removal of the bus from service.

In addition to the high number of roadcalls for the articulated fleet, maintenance managers reported that the lift-equipped buses require a great deal of maintenance. Air conditioning defects are also cited as a major problem in the summer months. The manager interviewed commented that the increased need for spare vehicles because of the southern states' hot summer weather should be considered in determining an appropriate spare factor for their systems. In MARTA's case, the manager reported that two garages had space limitations that frequently required personnel to work outside or to increase the manpower per bus to complete the job quickly. However, the manager indicated that a 20 percent spare ratio was realistic.

Conclusion

Overall, it is apparent that MARTA is a well-managed property with few problems. The acquisition of alternative-fuel buses, however, may affect the need for spare vehicles.

Alameda-Contra Costa Transit District (AC Transit)
Oakland, CA

Fleet Characteristics, Operations, and Service Environment

AC Transit operates in a large urban environment with a temperate climate. Officials state that there are 815 buses in the fleet, of which only 720 are available for service. Eighty percent of the fleet feeds other modes of transportation. On occasion they provide emergency substitute bus service for BART. The majority of the 95 remaining buses are being held pending sale and are not available for scheduled route service. Ten of the 95 are assigned to the contingency fleet and another seven are designated as training vehicles. Thus, management reports that they operate with a 20 percent spare ratio. The average fleet age is 7.0 years and AC Transit purchases roughly 60 buses a year. The agency is 100 percent lift-equipped.

There are no alternative-fuel buses at this time, but the agency anticipates purchasing five LNG buses in the near future. In preparation, they are redesigning the maintenance shops and facilities to accommodate the new equipment.

Although the fleet accumulates high mileage (32,584), it travels at a relatively high speed (12.6 mph), and thus does not undergo the wear and tear that some systems experience with slow speeds and high mileage. The weather is mild and none of the fleet is equipped with air conditioning, eliminating required repairs for this critical component system.

Maintenance

Major inspections are conducted every 10,000 miles and components are replaced as required. The number of buses out of service for daily running repairs is limited to less than 10 percent of the fleet. However, AC Transit sites that it defines roadcall as "any bus failure in which time lost exceeds 6 minutes." With a mean distance between failures of 3,845 in 1993, each bus accumulated approximately 5.3 roadcalls per bus.

The only major problem experienced with lifts is that drivers are overly cautious, believing that they will be held liable if a wheelchair bound passenger is injured, and are therefore reluctant to use the lift. But management sees this as a training problem they are now attempting to solve with more education and discussion with employees. The major problem AC Transit faces is the timely sale of old buses as they are restrained from purchasing new buses until the old ones are sold. Over the year AC Transit reduced its spare ratio by the timely sale of old vehicles.

Conclusion

AC Transit's operation demonstrates how well a system can work when all the factors affecting spare ratio are in an agency's favor. The fleet is young and the agency replaces buses on a regular cycle, selling buses older than 12 years as soon as possible. The management advises that they cannot hold onto buses because they would be restricted in new purchases. In the past, the agency had a problem with excess buses, but now makes sure that it obtains permission to sell the buses quickly, further ensuring that it is operating well within a 20 percent guideline. Although management believes that a 20 percent spare ratio is reasonable for their property, they strongly believe that there should be no single standard applicable to all properties because of the different factors affecting service.

Mass Transit Administration Of Maryland (MTA)
Baltimore, MD

Fleet Characteristics, Operations, and Service Environment

The Maryland Department of Transportation's Mass Transit Administration operates the bus and rail systems in the Baltimore metropolitan area, a large urban environment. Currently the bus fleet is downsizing: in 1993, the agency reported a total active fleet of 819 buses and 19 Mobility vans and a peak service requirement of 630 buses; in September 1994, the fleet consisted of 777 vehicles, and in 1995 they expect to further reduce fleet size by 35 vehicles. MTA contracts 71 buses, primarily for radial and circumferential work related service, recommending to the contractor that it maintain one spare bus per line for substitute service. Approximately 57 percent of MTA's routes feed other modes (van service, subway, light rail, and commuter rail). Bus service is needed for rail emergencies or construction about once every 10 days.

Maryland's climate can be considered severe with a mean wintertime temperature of around 32° and with ice and snow conditions common; in the summer months, temperatures can exceed 90° for weeks at a time. In 1993, the average age of the fleet was a relatively young 7.4 years, resulting from the purchase of new buses and the disposal of the oldest vehicles. Approximately 42 percent of the fleet is lift-equipped. Meeting ADA requirements has not been a problem since screw-drive lifts were replaced by chain-drive lifts. Alternative-fuel vehicles have not yet presented a problem as there are only four CNG demonstration buses. Fueling is done on-site at the one garage that has been fitted to fuel the buses; however, building additional garages will be very expensive.

Typical urban congestion is evidenced by the relatively slow average bus speed of 11.9 mph and the low average annual miles per bus--34,218. Baltimore's spare bus ratio, reported at 25 percent is attributable to a number of factors: declining ridership (although this has stabilized in recent months) resulting from a recession that caused closings and exodus of industrial and commercial firms; the opening of a light rail line that drew passengers from bus to trolley; state law mandating that 50 percent of operating costs come from the farebox; and, reduced capital available from local and federal governments to purchase new buses.

In addition, there are major demographic changes occurring in the metropolitan area; overall ridership is steady, but the demand for routes is changing from radial to circumferential as industry moves to the suburbs. Studies are ongoing to ascertain demand in the newer residential industrial and commercial areas; it is likely that a whole new pattern of origins and destinations will emerge.

The fleet plan has been almost impossible to carry out because of past falling ridership and the state's inability to pay the local share of new buses. MTA would like to be able to purchase a minimum number of buses each year to prevent accumulating too many buses with the same repair/rebuild cycles. However, no new buses were bought in 1991, and MTA had to compensate in 1992 by purchasing a larger number. The purchase delay, combined with lack of need for new vehicles quickly drives the age of fleet upward. However, continued downsizing may permit MTA to dispose of its oldest buses and thereby decrease average fleet age. The total active fleet comprises all vehicles except those designated for sale. Vehicles that have been in accidents are kept unless the repair would cost more than the payback to the federal government, in which case the buses are disposed of. MTA does not maintain an at-ready contingency fleet, relying instead on its spare pool. During the severe winter of 1993-94, when ice on the catenary wires brought the light rail system almost to a standstill, buses were used continuously. Spares are also used for special events, such as shuttling patrons from park-and-ride lots to baseball games at Camden Yards and for the annual Chesapeake Bay Bridge walk. At these times, a different fare structure is employed.

Maintenance

Inspection, maintenance, and running repairs are carried out efficiently on a 24-hour schedule, as there is a very high peak-to-base ratio of 2.89, suggesting that prime use of the transit system is for work related trips. In 1993, there were almost 6,700 mechanical roadcalls (according to the FTA definition) or about 8 roadcalls annually per bus. The maintenance staff, though lowered through attrition as part of the overall system downsizing, is able to do a good job because of ongoing and specialized training programs, particularly on newer electronic and alternative-fuel components of the fleet. Although the MTA does major engine and body work, management indicates that they do not currently have a bus rehabilitation program in place.

Meeting all of the ADA and EPA requirements is a growing concern to MTA management, as they add significant time to the inspection and repair routines. The inspection procedures are much more sophisticated and intensive, and the electronic components require much more time to remove and replace. Buses are out of service for longer periods and the system needs more spares to cover these out-of-service buses

Conclusion

In summary, MTA officials believe that although a 20 percent spare bus ratio can be achieved, it is not reasonable for their system. Management would be more comfortable with a slightly higher ratio because buses would be available not only for emergency substitutions and special event service, but to cover for buses out of service for inspections, regular maintenance, and running repairs. Although they agree that too many buses would add unnecessarily to storage and maintenance costs and reduce maintenance staff incentive to quickly put buses back into service, they believe that an additional two to three percentage points in the spare bus ratio would be beneficial at least for the Baltimore bus system.

Dallas Area Rapid Transit (DART)
Dallas, TX

Fleet Characteristics, Operations, and Service Environment

DART's large metropolitan operation benefits from a moderate winter climate, although both heat and air conditioning are required for the buses. The fleet is relatively old, with approximately two-thirds of the vehicles more than 10 years old. The number of routes covered has increased in recent years, in keeping with the growth patterns of this large urban area; for 1993 average annual bus mileage is estimated at 44,117 miles. DART's peak vehicle requirement is 680 buses. The 1993 spare ratio is reported at 21 percent, down slightly from prior years.

Maintenance

Not only is the DART fleet relatively old compared with other fleets in the survey, but over half of the buses are the same make and model: the 461 10-year-old Neoplan buses all are likely to require maintenance, rehabilitation, and replacement at approximately the same time, creating a sizable financial burden. DART does have an overhaul program, providing midlife major rehabilitation (at 7 years) for these vehicles Nevertheless, the fact that DART has only three vehicle types and five models cuts down on the variety of its spare parts inventory and necessity for separate training techniques.

To ensure that there are sufficient vehicles to meet peak requirements, DART provides an extensive inspection and maintenance program: each day 22 buses (almost 3 percent of the active fleet are taken out of service for mandated inspections (every 6,000 miles). In 1993, 68 vehicles daily (about 8 percent of the fleet) required running repairs, down from more than 100 daily in 1992 and more than 200 daily in 1990 The maintenance director attributes the reduction to improved training for the DART mechanics.

Conclusion

DART officials believe that a 20 percent spare ratio is achievable for their system, and should be able to reach it with timely new bus purchases, thus reducing the need for extensive maintenance and overhaul.

Port Authority Of Allegheny County (PA Transit)
Pittsburgh, PA

Fleet Characteristics, Operations, and Service Environment

PA Transit, a mixed suburban/city bus operation, had a total active fleet of 895 buses, of which 702 were required for service. The average speed is 13.9 mph with each vehicle accumulating 38,125 miles. There is a corporate policy to manage within the FTA's guidelines of a 20 percent spare ratio. The current reported spare ratio of 21.6 percent reflects the acquisition of new buses purchased in 1993 and the failure to retire older buses at the same pace. The average age of the fleet is reported at 7 years, although 67 buses far exceed 12 years, the reported retirement age. PA Transit management indicates that it will retire more buses when the new buses arrive in 1994 and 1995. Moreover, the peak requirement will increase to 737 buses, which will have a positive affect on the agency's spare ratio.

Maintenance

Although PA Transit has old buses and sometimes severe winter weather, it successfully manages its fleet. At the time of the survey, PA Transit held only 8 buses daily for running repairs. The agency reported that it had 2,879 miles between roadcalls for 1993, with an average of 10.3 roadcalls per bus. PA Transit officials report that although the current inspection cycle is tied to the specific coach manufacturers recommendations. the inspection program is under review and they anticipate instituting an inspection program at 6,000 mile intervals in early 1995. PA Transit has an overhaul program that cycles all buses through every 4 years. The maintenance process is complicated by the eight different bus makes on the property, but PA Transit has nonetheless managed to reduce the need for excess spare vehicles.

Conclusions

The agency cites three factors that impact its spare ratio: age and condition of fleet, poor streets, which increases maintenance, and ineffective maintenance practices. PA Transit's management also reports that its collective bargaining agreement prohibits major working condition changes in maintenance, for example, requiring labor to work outside specifically designated job classifications. This inability to move maintenance personnel to other jobs to accommodate work needs impacts their ability to maximize efficiency.

Despite these problems, PA Transit officials are determined, with the acquisition of new buses and improved maintenance procedures, to achieve a 20 percent spare ratio.

BC Transit
Vancouver, British Columbia

Fleet Characteristics, Operations, and Service Environment

Other than the Toronto Transit Commission, BC Transit is the largest bus/trolley operating system in Canada and provides intercity, suburban, and rural service with 682 buses and 244 trolleys. Although the Canadian properties are not covered under the FTA regulations, it is useful to review how this system handles the spare ratio issue. BC Transit officials report a spare ratio of 13.8 percent, which has remained virtually the same over the last 5 years. The spare ratio is calculated as follows:

$$\text{Total Active Fleet} = \frac{\text{Peak Vehicle Requirement}}{\text{Total Active Fleet}}$$

BC Transit reports a total active fleet of 926 buses of which 798 are required for peak service. The fleet average age is 11 06 years. Both the total active fleet and peak vehicle requirements increased slightly from 1992 to 1993, 911 to 926 and 789 to 798 respectively. Ninety percent of the bus routes feed Skytrain and the agency reports that it supplies substitute bus service for Skytrain 10 to 15 times per year. Average speed is 19.8 mph, which is largely attributable to the suburban and rural service it provides. Intracity speeds are lower. Each bus accumulates 73,509 miles, which also results from the intracity and rural service for which BC Transit uses suburban coaches.

Maintenance

BC Transit operates a mixed fleet with 25-ft, 35-ft, and 40-ft buses, trolley coaches, and suburban buses This system also operates 21 articulated buses of recent vintage On average, this system reports that it has 70 buses out of service daily for running repairs, which constitutes 8 percent of the total fleet. While officials at this system report that they have experienced difficulties in managing with such a lean spare ratio, BC officials attribute their success to their comprehensive preventive maintenance and overhaul program. The inspection cycle is vigorous, as is indicated by the sample inspection cycle listed below:

Type of Inspection	*Time*	*Mileage*
Check over	*1 hr*	*1500 kms (932.55 mi)*
Minor	*2-3 hr*	*6000 kms (3,728 22 mi)*
Major 1	*6-9 hr*	*2500 kms (1,500 mi)*
Major 3	*8-10 hr*	*7500 kms (4,660 mi)*

The trolleys are inspected every 35 days at the Oakridge facility, a more generous inspection cycle in which the minor inspection is performed every 12 000 kms (7,456.44 mi.) The overhaul program for all buses (GM, MCI, and NEW FLYER) has different requirements as follows: repaints are done every 7 years; complete body structural is performed every 10 to 12 years; and the engine is overhauled every 4 to 5 years, the transmission every 2 years, and the differential every 6 to 7 years. BC Transit indicates that it maintains 22 contingency buses to cover buses out of service for overhauls These spares are not included in the total active fleet.

This system defines a roadcall as "any failure in-service that requires a roadcall truck to fix or exchange a bus before it has finished its service requirements." BC Transit does not have air conditioned buses because of the mild temperatures, which substantially reduces the number of roadcalls, but it will remove buses from service for cleanliness, torn seats, and heat defects.

Notwithstanding its good record, BC Transit reports that it requires more spare buses. At this time, the agency is unable to provide additional service in those areas that require it, which means lost revenue and ridership. Another problem officials cite is the impact on the maintenance program. The lack of spares and the physical restraints in their depots have decreased BC Transit's ability to repair buses in a timely and efficient manner. The officials report crowded work areas, poor facility design, and space constraints that require the constant rescheduling of work. Buses have to be shifted on and off hoists to make room for other work and there is limited floor space in the shops for trouble shooting and repairs. Having more buses would facilitate faster and more efficient repairs.

Conclusion

Clearly this system has accommodated the limitations associated with having minimal available spare buses, although additional buses would ease the pressure on the staff and the budget. But the managers' ability to provide service consistently with the existing spares supports the view that systems can and will operate without the cushion of extra buses. In this case, necessity has bred innovation.

Metropolitan Transit Commission (MTC)
St. Paul/Minneapolis, MN

Fleet Characteristics, Operations, and Service Environment

The MTC in St. Paul, Minnesota, operates a fleet of 963 buses in a large urban environment. Winter conditions are severe. Although the buses travel much faster--14.7 mph--than is true for most large city systems, the 28,311 average annual miles per bus is below that of most suburban and many of the urban systems studied. The fleet is young, with an average age of 6.6 years. The MTC has been able to purchase new buses on a regular cycle, thus preventing large numbers of buses from requiring repair or overhaul at the same time.

The very low spare bus ratio of 13 percent is explained partly by an increase in ridership and thus a corresponding increase in peak service requirements. The spare bus ratio is lowered also by inclusion of two to three vehicles in the peak service requirement that really are being held for rush hour contingency use. Other reasons that minimize out-of-service buses are the low average age of the fleet, the excellent inspection/overhaul program, good and continuing training programs, and the fact that only 14 percent of the fleet is lift-equipped, which reduces service and inspection downtime. Also the fact that there is a very high peak-to-base ratio (3.33:1) makes it possible to complete running repairs during nonpeak hours, thus eliminating the need for additional spare buses.

Maintenance

MTC's bus fleet is varied; there are 24 different models, including in late 1994, 37 demonstration ethanol or particulate trap buses. Fueling takes place off-site now, although there are plans to refurbish an old inadequate garage to handle alternative fuels and the lift equipment that is now being installed. The spare parts inventory is difficult to maintain, especially the foreign items; moreover, delivery of new equipment is erratic. Nonetheless, buses out of service for no stock are kept to an absolute minimum. To combat the inspection and maintenance problem, MTC has recently augmented its technical services staff. The large fleet of MAN Nutzfahrzeuge Aktiengesellschaft buses requires specially trained technicians and the rise from 356 to 419 maintenance workers between 1992 and 1993 is mainly to handle the MAN Nutzfahrzeuge Aktiengesellschaft buses. Nevertheless, less than 3 percent of the fleet is out each day for running repairs, and only about 9 percent of the fleet is out of service daily for all causes--a much lower percentage than other properties. The excellent condition of the fleet is evidenced also by the increasing miles between mechanical roadcalls (from an average of 4,200 miles to 4,600 miles over the 1990 to 1993 period). St. Paul's system averages just over 5,200 roadcalls annually, about six per bus.

Currently, MTC is reviewing its inspection schedules and may revise them in keeping with the technical requirements of the new buses. In addition to the comprehensive inspection program, which inspects buses every 3,000 miles and is now being reviewed, there is an overhaul program that covers both mechanical and cosmetic work at either 6 years or 200,000 miles. The engine, transmission, and air conditioning systems are the major components overhauled in this program. They report that in some cases garages are inadequate to handle the amount of repair work needed. This is overcome by assigning fewer buses to those garages and operating with a lower spare factor.

Conclusion

MTC's ability to maintain and operate its fleet in an efficient manner is reflected in the low spare bus ratio. MTC officials suggest that, for their property at least, a 20 percent spare ratio might be high; given the increasing ridership. They believe they can operate with a 15 percent ratio which will allow them to decrease fuel usage, parking space needs, and assist in control of all maintenance expenditures.

VERY LARGE TRANSIT SYSTEMS (OVER 1,000 BUSES)

Massachusetts Bay Transit Authority (MBTA)
Boston, MA

Fleet Characteristics, Operations, and Service Environment

The MBTA is a large urban multi-modal operating authority, with a total current fleet of 1,009 buses of an average age of 11.9 years. Sixty percent of the bus fleet is older than 10 years and 10 percent are older than 20 years. Management reports that 97 percent of its bus routes feed rapid transit, commuter rail, light rail, or electric trolley buses. Due to major reconstruction on the rail system, buses were substituted for rail service on the Red line every weekend from March through November in both 1994 and 1995 and everyday on the Blue line from June, 1994 through June, 1995. Because of congestion in the Boston area, buses travel at 10.6 mph and each accumulates 32,669 miles annually. Management reports its spare ratio at 20 percent and cite the key factors affecting the number of spare buses as fleet age, rail substitutions, a delayed overhaul program that has increased maintenance requirements, and the severe winter weather.

Management indicated that of the 1,009 bus total fleet, approximately 97 buses were assigned to the contingency fleet, which was not to be used except in emergencies. However, for a period of time, the agency failed to segregate the contingency fleet and, as a result, the buses remained in regular service.

With the integration of these contingency buses into the regular bus fleet, the spare ratio increased to 33 percent. The agency is now committed to a plan that segregates the contingency fleet in separate on-site storage areas to ensure that these buses will not be used except in the agreed on circumstances and it now believes that the spare ratio is 20 percent.

The MBTA has received permission to use some of the contingency fleet to augment the shuttle service they must operate to substitute for rail service due to construction on the Blue line. In addition, they will also use this fleet to provide a float for the overhaul program.

Maintenance

Discussions with MBTA management in the fall of 1994 indicate that the agency has begun to take delivery of 250 new buses to replace approximately the same number in the current fleet. Fifty percent of the fleet is older than 10 years and 100 buses in the fleet were more than 20 years old at the time the respondents answered the survey.

While the new bus purchase will help relieve the pressure, problems associated with the overhaul program that was delayed for 200 buses by 2 years because of budgetary restraints still remain. This delay in major bus rehabilitation has contributed to increased maintenance for the fleet and greater reliance on spare vehicles. The MBTA also has a 3,000-mile inspection cycle for all buses. Due to the age of the fleet, MBTA holds 24 percent of the TAF out daily for running repairs. Another factor that has increased the need for spares is that lift-equipped buses (47 percent of the fleet) must be assigned to certain routes to accommodate the disabled community. The 250 new buses will meet all ADA requirements, but also will increase maintenance because of the lack of experience with this new equipment.

Weather conditions in the Boston area can adversely affect the need for spare vehicles, as it did in the winter of 1994 with severe ice and snow storms that significantly increased defects due to accidents, frozen air, and "no heat" roadcalls, which the MBTA considers a safety issue requiring the removal of the bus from service.

Conclusion

MBTA management stated that although they believe a 20 percent spare factor is adequate for their property, given the demands for heavy service in the Boston area, it is not always easy to manage the operation with so few spare buses.

MBTA reports that it is corporate policy to operate with a 20 percent spare factor because it believes that operating with a minimum number of vehicles creates an environment in which strong maintenance practices can flourish.

King County Department Of Metropolitan Services (Metro)
Seattle, WA

Fleet Characteristics, Operations, and Service Environment

Metro's 1,212 vehicle fleet operates in a temperate climate, serving both intra-and intercity needs, traversing the large urban environment from center city to mixed suburban, and among the many residential, industrial, and commercial enclaves that makeup the greater Seattle area. Average bus speed is fast--14.2 mph, and annual miles per bus are high--40,174--reflecting the suburban distances traveled on the routes. Metro contracts out 32 buses and also operates van service and light rail. The 22 percent spare bus ratio reflects both the diversity of service and the challenges posed by attempts to meet high environmental standards and at the same time provide a well-maintained and up-to-date bus system.

A major operational complication is the dual-powered bus fleet: 232 vehicles with complete diesel and electric power trains, purchased in 1990 and 1991 because the Metropolitan Council and citizenry wanted to eliminate diesel exhaust fumes within the center city bus tunnel. These Breda buses are technically more complicated both to operate and to repair. On the freeway approaches to the city, they operate as diesel buses, and on entering the tunnel they switch to electric power. Rail has been put into the tunnel: however, no rail vehicles are on order, and the vote on continuing as is or focusing on a rail mode in the tunnel will take place in 1995. Spare buses must be available for the times when the dual-powered vehicles are out of service.

An additional issue is presented by Seattle's 138 trolley buses, which are more expensive to operate than diesel, but are much cleaner. At this time, Metro has more trolleys than it needs, because the 46 MAN Nutzfahrzeuge Aktiengesellschaft units purchased in 1987 were for a transit project that was canceled. However, a new project will start in 1995 that will use trolleys. The others were purchased in 1979 The spare bus ratio is affected by the trolleys because these vehicles need diesel bus substitution whenever road construction forces rerouting to streets where there are no overhead wires, as well as when the overhead wires malfunction. Last year, all of the overhead wiring was repaired to reduce system failures.

Average fleet age is relatively old-10 years-reflecting both the service years of the trolley buses, which are not retired until they are 18 years old, and the fact that no new buses have been purchased since the dual-powered vehicles in 1991. No buses were acquired while the political leadership debated the pros and cons of purchasing alternative-fuel buses.

Only recently, following a change in government, has a decision been made regarding the manner in which Seattle will achieve its air quality goals. The new County Executive has determined that the area will be better served, and pollution reduced more significantly by adding buses that burn the new cleaner diesel fuel. The decision was based partly on findings that CNG vehicles are more expensive to purchase and operate and reduce pollution very little below buses using the new diesel fuel. By providing additional service and modern buses, Seattle will encourage motorists to leave their cars and use public transportation. They hope that this will result in a greater drop in air pollution than would have been available from the CNG buses for the same amount of funding.

Eighty-seven percent of the fleet is lift-equipped. Spares were increased when the lift-equipped vehicles were initially purchased, but this equipment does not present special problems.

Maintenance

In addition to the dual-powered bus problems, there are other factors that impact spare vehicle requirements. The maintenance staff of one mechanic per approximately four buses is low, particularly when the demand for repair, inspection, and overhaul are taken into consideration. These operations also require a sizable spare fleet. Metro reports that on a daily basis, 13 percent of the fleet is out for running repairs. In addition, a comprehensive inspection schedule and a midlife overhaul program for all vehicles was implemented in 1991.

Seattle's bus system has been affected by changing environmental goals and approaches as well as changes in the political leadership. The area is growing and puts high priority on high-quality bus service.

Conclusion

Metro officials comment that their spare bus ratio exceeds 20 percent because of factors related to the age of the fleet, the technical complexity of dual-powered buses, the decision to delete a portion of service, and the delays in new bus purchases pending a decision on which clean air technology to deploy. However, they note that the spare bus ratio has been reduced by 4 percent through technical improvements to the dual-powered bus and by "surplussing" excess (older) coaches. They conclude, however, that a 20 percent ratio is not realistic for Seattle, citing both delays in the clean air technology decisions and complications associated with dual-powered buses that have increased dependence on the older fleet with increased down time for repairs. Furthermore, they state that the latest decisions have included reprogramming funds that will cause them to hold onto the older buses longer than had been expected, thus driving up the need for repair and maintenance and consequent substitution with spare vehicles.

New Jersey Transit Corporation (NJ Transit)
Newark, NJ

Fleet Characteristics, Operations and
Service Environment

NJ Transit's 1,856-bus fleet operates intra- as well as intercity, along congested urban routes and high-speed commuter highways, and through suburban, midsize urban, and rural areas. Its 1993 average high speed--14.9 mph and high annual average mileage per bus--49,286--attest to the predominantly nonurban character of the system. However, downtown lines average 6.6 mph. Mid-Atlantic weather conditions add to the wear on the buses, requiring air conditioning during the summer months as well as repairs due to the winter snow and ice. About one-quarter of the bus routes feed into the commuter rail and light rail systems also serving the Newark-New York-New Jersey area. In addition, NJ Transit contracts out 1,012 buses for which it has no maintenance responsibility. The agency does recommend, however, that the private operators adopt a 15 percent spare factor for their fleet. The large fleet includes a variety of vehicle types and the average age of the buses is 10 years. Thirty percent of the fleet--548 vehicles--were 13 or more years old in 1993; however, new purchases in 1994 of 318 buses should reduce the average age to 8.5 years.

In 1993, the agency calculated its spare ratio at 17 percent, using a methodology involving maximum peak vehicle needs plus spare percentage. The agency increases service in the summer months to support increased commutes to the shore area of the state.

Maintenance

Although NJ Transit manages its operation within the 20 percent guidelines, management reports it does so with some difficulty. In addition to the high average age of the fleet, the agency is experiencing high maintenance of lift equipment, problems with its alternative-fuel vehicles and inadequate work space in some depots, which requires juggling the fleet to accomplish repairs. In 1993, NJ Transit accumulated 24,600 roadcalls (13 roadcalls per bus) and in FY 1994, the roadcalls seem to have risen slightly, a result of the extreme winter.

In stating why NJ Transit has been able to reduce its spare bus factor since 1990, managers noted that the maintenance programs were enhanced, especially for older buses Improved inspection procedures permit efficient use of the maintenance staff. The inspection program consists of a multi-level inspection performed every 3,000 miles, then every 24,000 miles and finally there is a major inspection at 96,000 miles. The 1993 overhaul program, which reacts to vehicle failure, is being revised to schedule major component exchanges based on unit life cycles.

Conclusion

NJ Transit reported its spare bus ratio at 17 percent in 1993. NJ Transit officials believe that the 20 percent level is achievable, particularly in light of the new bus purchases, which permit them to dispose of the higher maintenance older vehicles. NJ Transit buys and replaces large numbers of vehicles most years, creating short-term wide fluctuations in the spare bus ratio. They also have expanded service, which has reduced spares. Another factor in reducing the spare ratio is the increased use of the existing fleet, which leaves fewer buses in the depots. NJ Transit is firmly committed to reducing its spares, believing that the more spare buses, the less attention is paid to keeping the entire fleet in good operating condition. The managers desire a minimum spare ratio for NJ Transit and expect to keep theirs low because they believe an increased spare ratio will decrease garage focus on maintenance of the fleet and increase the agency's capital costs.

Los Angeles County Metropolitan Transportation
Authority (LACMTA)
Los Angeles, CA

Fleet Characteristics, Operations, and
Service Environment

LACMTA operates a multi-model fleet of 2,294 buses of an average age of 8.1 years. The management states that an additional 114 buses, with fare boxes and radios removed, are maintained in a contingency fleet for emergencies, increasing the fleet size to 2,375 buses.

LACMTA is a heavily used bus system, serving a largely transit-dependent ridership population, and frequently carrying crush loads of up to 160 percent of seating capacity. The agency reports that it currently operates with a 20 percent spare ratio, a reduction from 1990 when it operated with a 40 percent spare factor Management attributes this reduction largely to the sale of old buses and improved maintenance practices that now allow the agency to operate with fewer spares. Over the last 4 years, the peak vehicle requirements have fluctuated from a high of 1,968 buses in 1990 to 1,912 in 1993 and are still declining because of major budgetary reductions. Spare buses, used on an "as needed" basis, are heavily relied on to fill gaps in service. Current rail services for the agency are limited to an 18 mile light rail line and a 4.5 mile heavy rail subway system. Thus, only 44 percent of the bus routes serve the rail system. Bus substitution for rail service emergencies and construction occur very infrequently.

Maintenance

A number of factors impact the need for spare buses at this property. Of primary importance is the large number of vehicles that are out of service each day. On average, the agency reports that approximately 11 percent of its fleet is out of service during daily peak periods for maintenance repairs. The agency reported 16,358 roadcalls, approximately 7.1 roadcalls per bus. A key variable that affects LACMTA's spare ratio is the lack of a strong on-going major overhaul program that has increased maintenance for the fleet. Because of a lack of funds in recent years, management reports that it delayed the overhaul program for the 1982, 1984, and 1987 buses. They are currently overhauling the 1982 fleet, and will commence the 1985's next year. One of the issues LACMTA faced in managing the overhaul program is that 800 buses were due for an overhaul at roughly the same time. In 1980, LACMTA purchased 782 RTS-II buses and 35 more in 1982. In order to process such a large number of buses through an overhaul program, a large maintenance staff and reliable older buses would have been required. Faced with budgetary problems, the agency did not have the labor or material resources to manage an extensive overhaul program. Currently, management is exploring different programmatic options for later year models that should be scheduled for a midlife overhaul now. Management indicates that they would replace/rebuild certain components across specific fleets at a given time and mileage level. Given the high mileage of this fleet, LACMTA believes that this procedure will reduce the number of repair incidents but may not necessarily extend the life of the vehicle.

LACMTA maintenance staff also cite the erratic bus purchases in recent years as another factor that has contributed to the maintenance problems. The managers report that deferred maintenance had been a problem in the past because of the heavy service demands, high mileage from long runs, and limited operating funds. With its low peak-to-base ratio, management reported that it was difficult to bring the buses in for maintenance and inspection in a timely manner. LACMTA officials admitted that in the past they have delayed ordinary inspections as well as the overhauls in order to meet service demands. With the recent service reductions, they have limited the deferred maintenance to an exception basis, but management said it is still difficult to catch up from the delayed overhaul programs.

Because of what the management calls their "antipasto" fleet, there have also been problems in getting and maintaining all the spare parts required for the fleet, particularly the foreign buses. However, LACMTA is managing spare parts availability better now and only 5 buses were out of service because no replacement parts were available in 1993. Previously buses out of service awaiting replacement parts had been a major problem, increasing the need for more spare buses In addition, managers report that the high level of street accidents and the problems with sinking streets further increase the need for spare buses. Failure to repair minor accident damage in order to make the buses available for service has sometimes contributed to an unattractive fleet.

Further, LACMTA operates 412 methanol buses, 10 CNG buses, and is awaiting delivery of 196 CNG buses. Management reports major problems with the methanol buses, which resulted in engine replacement every 25,000 miles. Although some of the problems with the technology have been mastered, these buses are still problematic and the agency does not expect to reorder any more in the future.

Conclusion

While management endorses a 20 percent spare ratio, with the numerous problems this property has experienced in recent years, it is apparent that LACMTA will continue to have great difficulty in providing consistent service while keeping up with the maintenance required for the fleet. However, continued service reductions may help. The delayed overhaul program will continue to impact maintenance requirements until new buses replace the old and thus increase the need for spare buses as the property scrambles to catch up with this program. In addition, with the acquisition of new CNG buses LACMTA may have difficulty in meeting its 20 percent goal. New initiatives to limit deferred maintenance and out of stock downtime, and to accelerate the overhaul program, although late, will no doubt have a positive impact on the performance and appearance of the buses.

MTA New York City Transit (MTA NYCT)
Brooklyn, NY

Fleet Characteristics, Operations, and Service Environment

MTA NYCT Surface Transit Division, the largest bus operation in the country, operates 24 hours a day over varying geographical and operating terrain. According to the January 1994 bus assignment report, MTA NYCT Surface Division has a total active fleet of 3,644 buses, with an average age of 8 years and a peak vehicle requirement of 3,082 buses. At the time the questionnaire was submitted, management reported that it operated with a 15 percent spare factor with an additional 3 percent (125 buses) designated as shop reserve but not reported in the total available fleet to support its aggressive mini- and general overhaul programs. MTA NYCT Surface has been successful in reducing the number of excess buses over the years. The agency is decentralized into five operating divisions each headed by a General Manager, one for each borough of the city, with a specific number of depots assigned to it. The General Manager has full responsibility for all administrative, transportation, and maintenance functions at the depots contained within the division. Each division has an assigned fleet of relatively the same average age with consistent spare ratios for each depot and a specific number of shop reserve buses to support heavy maintenance requirements. Each of the divisions has unique operating characteristics that impact maintenance and operating requirements.

The specific divisions in the reported January 1, 1994 bus assignments and spare ratios are as follows:

Division	*Operating Depots*	*TAF/PVR*	*Shop Reserve*
Manhattan	*5*	*793/689*	*27*
Brooklyn	*5*	*1063/924*	*38*
Bronx	*4*	*756/658*	*27*
Queens	*3*	*606/439*	*18*
Staten Island	*2*	*427/372*	*15*

Maintenance

MTA NYCT Surface management believes that a 15 percent spare ratio should be adequate to run their service given the age of the fleet and the quality of the maintenance programs in practice at the agency. Nonetheless, while the MTA NYCT does make every effort to run with a lean fleet, because of specific issues discussed below, it has encountered problems in meeting service requirements with the current number of buses available. The agency has experienced some fleetwide maintenance problems and labor unrest in some divisions that have contributed to an excessive number of buses out of service, sometimes affecting the ability to meet service. MTA NYCT believes, however, that a 15 percent spare factor is appropriate for its agency and continues to work toward that number.

The number of roadcalls for each division varies considerably and as a result may have a substantial impact on how well the division performs with the limited spare buses available for routine maintenance. The Manhattan and Bronx divisions traditionally have had more roadcalls than other divisions covering the outer boroughs and consequently lower mean distance between failures statistics. For example, Manhattan, which must traverse midtown at extremely slow speeds, experiences a lower mean distance between failures than the outer boroughs. Slow speeds of approximately 4 to 6 mph create engine and transmission problems increasing maintenance requirements and time out of service. Because of the traffic conditions in Manhattan, this division must also contend with out of service buses due to accidents. In addition, with a high peak-to-base ratio, Manhattan does not always have the luxury of working on buses during the day, which can create a problem in completing repairs found on cyclical inspections or repairing buses damaged in accidents. Both Queens and Staten Island, which have significantly higher operating speeds, also have a low peak-to-base ratio, which allows these divisions to perform maintenance between peak periods of the day.

Even with the replacement of several old depots in recent years, the lack of adequate work space in some Manhattan depots remains a problem that also affects the number of spare vehicles required to ensure on-time service performance. Many of the older depots were simply not built for the demands of today's large fleets. For example, depots located in the heart of the inner city are especially crowded at night when the buses are available for maintenance. In addition, these depots also have the oldest lift equipment, which often requires repairs, further complicating the maintenance performance.

Sometimes, unanticipated fleetwide problems can undermine the agency's best efforts to run a lean fleet. MTA NYCT experienced just such a problem in 1993, when it encountered major problems with the engine bulkheads and radius rods on 1981, 1982, 1983 RTS buses, which required heavy maintenance work. The current spare ratio was insufficient to support this maintenance effort while meeting service requirements in all divisions at all times.

Conclusion

The impact of the ongoing labor/management tension in some divisions of the MTA NYCT deserves comment as it applies to spare ratio. MTA NYCT has had a long-standing issue with maintenance productivity at some of its depots that has resulted in excessive roadcalls and buses out of service for extended periods of time. Not withstanding the implementation of solid maintenance practices and procedures as well as the efforts of maintenance management and labor, some of these depots continue to manifest major problems; the number of buses out of service remains high and service quality is not what it should be. Over the years, the spare ratio at these depots has varied from very high to the current lean standards of 15 percent without success. Management at the agency believes that maintaining a low (15 percent) spare factor makes better fiscal sense and will eventually encourage the highest productivity possible.

CHAPTER FIVE

CONCLUSIONS

THE FLEET MANAGEMENT CHALLENGE

The calculation and monitoring of spare ratios continues to be an important management tool in the transit industry. The results of the survey conducted in this study demonstrate that transit managers are cognizant of their responsibility to manage their fleets within reasonable spare ratio constraints. The survey responses further indicate that efforts are being made throughout the industry to find ways to reduce reliance on spare vehicles. Many maintenance managers not only endorse the FTA guideline of a 20 percent spare ratio as a reasonable goal, but have adopted a "leaner is better" philosophy in managing their fleets. But respondents indicate that they do not support using the application of a single standard spare ratio goal for all transit agencies. They generally agree that greater flexibility in the application of federal spare ratio guidelines would be appropriate because of the unique and different operational, environmental, and political factors that affect optimal fleet size at each transit agency.

FTA officials state that the 20 percent spare ratio it has established as a guideline is only that, a recommended guideline and that adjustments for unique circumstances are often made. Indeed, several survey respondents indicated that they have received authorization from FTA to exceed the 20 percent guideline for various reasons, such as the decreased vehicle availability associated with new technology alternative-fuel buses. Nevertheless, many of the transit agencies included in the study interpret the FTA's 20 percent spare ratio as a mandated ceiling and not as a guideline. Efforts by FTA to emphasize and to clarify this flexibility would assist local transit officials and FTA regional officials in discussions concerning circumstances that they, the local transit managers, believe require a spare ratio higher than 20 percent in order to manage the fleet in a cost-effective manner.

While a majority of the respondents stated that a 20 percent spare ratio was realistic, others strongly advocated that each agency should have its own spare ratio goal in accord with the unique factors that affect its operation. Other respondents recommended using a spare ratio range that takes into account the variances in operating conditions and would provide a fairer and more objective standard.

Regardless of particular spare ratios, all of the agencies surveyed indicated that they were constantly challenged to achieve and consistently maintain lower spare ratios. Although the impact of a single factor on a particular agency may vary considerably, a set of common factors that affect optimal fleet size were identified in the study. Of the 17 factors identified for analysis in Chapter 1, survey respondents and interviewees alike identified eight that had, in their views, a significantly larger impact on spare ratio management than the others. They were:

- Ridership Fluctuations,
- Age of Fleet,
- Operating Environment--including traffic and street conditions, severe weather, bus speed and bus mileage accumulation,
- Maintenance Programs--including preventive maintenance programs with frequent inspection cycles and a major overhaul program,
- Fleet Mix of Bus Makes and Models,
- Roadcalls,
- Training Programs--quality and training of the maintenance staff, and
- Management and Finance--including a strong corporate philosophy mandating managers to manage with a lean fleet, sufficient capital, and operating funds that allow new bus purchases, key maintenance programs, and vehicle maintenance personnel; and union work rules that provide flexibility to the maintenance manager.

SUCCESSFUL APPROACHES

Responding to the challenges of fleet management, many of the agencies in the survey have introduced new practices that have lowered cost, increased efficiency, and allowed them to manage well within spare ratio guidelines. For example, Houston Metro has introduced strategies that improve bus reliability and reduce downtime, such as the state's Opacity Program. This program, which used exhaust smoke as a sign that maintenance is needed, has helped reduce the number of roadcalls and engine defects. Another example is Houston's Repeater Roadcall Program, which has helped to identify and repair those buses with troublesome performance histories Houston Metro also developed a scuff plate which, when installed under the front door of a bus, prevents damage to a wheelchair lift when the bus strikes the curb. These are just a few of the elements of Houston's strong preventive maintenance program.

Other agencies, including CENTRO in Syracuse, New York, are actively searching for new techniques and processes for improved fleet management by sending its staff to other transit agencies where new strategies are in place; where appropriate, CENTRO adapts these innovations to fit its own local requirements. Portland's Tri-Met transit system relies heavily on a maintenance information system that provides bus history by make, model, and individual vehicle This information allows for the early resolution across the entire fleet of problems discovered in individual vehicles. Tri-Met also has a computerized parts inventory that generates a "never out" list of critical parts. This system limits the frequency of instances when buses are out of service due to lack of parts critical to bus operation. Similarly, WMATA schedules parts replacement and overhauls of its vehicles on the basis of its experience with the make and model of the bus rather than scheduling it when a component failure occurs.

Survey respondents report that a good training program for maintenance staff is crucial to a well-managed fleet. Charlotte's transit system is engaged in a cross-training effort that will help its staff service new buses. Houston has one of the better apprentice programs. It prepares maintenance staff to become journeyman mechanics over an 18-month period; graduates of the program can resolve effectively any maintenance problem encountered in the fleet.

NEED FOR ADDITIONAL RESEARCH

Analysis of survey responses and discussion with transit officials in connection with this synthesis have led to useful insights into the role of spare ratios in transit fleet management. Similarly, circumstances that facilitate low spare ratios and those that lead in the opposite direction to larger spare fleets are identified. That the impacts of these circumstances vary among transit agencies depending on local circumstances is clear from the study results. Exactly how much they vary, and the quantitative extent of their impacts is harder to determine. The reason is that methods for calculating many of the relevant variables are nonuniform. Much of the data collected cannot be used for comparative purposes because of the different methodologies and definitions employed by the transit agencies in responding to the questionnaire. It was found that measuring technologies, accuracy, and frequency vary, that definitions vary, and that the methodology and calculations used to develop the data and other information used to discuss and compare spare ratios vary substantially from transit agency to transit agency. Thus, additional research to better understand these relationships could be useful in providing common definitions and comparable statistics.

This synthesis project revealed that the lack of common definitions and comparable statistics hinders interagency communications within the transit industry on this important subject, limiting the ability of transit managers to learn from the mistakes and successes of others. Many of the respondents indicated that further research on innovative maintenance practices, including inspection cycles and the content of the inspection, preventive maintenance, and rehabilitation protocols, would be valuable in helping them meet the challenge of managing with leaner fleets. The nature of these practices dramatically affects the long-term performance of the vehicle, its availability, downtime, overtime cost, essential workforce, and ultimately the need for spare vehicles. Roadcall data, which is another key performance indicator and which forms the basis for the mean distance between failures statistic and determines inspection cycles and many other maintenance programs, should also be based on a uniform methodology. Without a common vocabulary and comparable quantitative data, agencies will be hindered in their efforts to help each other operate with a minimum of spare vehicles.

Additional research could be used to identify acknowledged and accepted concepts, definitions, and methodologies that accompany any quantitative indexes, norms, averages, medians and other measurements used by transit agencies to develop system-specific spare ratios. For example, the availability of a contingency fleet is critical for some systems, but there is currently no consensus regarding the best methodology for establishing the need for contingency or the circumstances under which such a fleet may be used. Other important definitions could be clarified, such as total active fleet and peak vehicle requirement. Commonly accepted methodologies are necessary to establish effective spare bus ratio targets that account for the several critical factors identified in this synthesis.

GLOSSARY

Alternative - Fuels-fuels such as methanol, ethanol, CNG, LPG, LNG, and soy bean/diesel fuel

Americans with Disabilities Act (ADA) - defines the responsibilities of and requirements for transportation providers to make transportation accessible to individuals with disabilities

Clean Air Act Amendments (CAAA) of 1990 - require significant reduction of pollutants from various sources, including transit service agencies, and alternative fuels offer one means of achieving these reductions

Contingency - Fleet-revenue vehicles placed in an inactive status for energy or other local emergencies after the revenue vehicles have reached the end of their normal minimum useful life. The vehicle must be properly stored and maintained, and the contingency plan must be approved by FTA

Downtime - generally described as that time when revenue vehicles are out of service for maintenance, in service failure, etc.

Inspection Cycles - preventive maintenance inspection cycle; scheduled inspections of various components and systems that may require repair or replacment to prevent breakdown

Life Cycle - 12 years or 500,000 miles for buses

Making Service - providing sufficient revenue vehicles to meet peak service requirements

Mean Distance Between Failures - average number of miles in revenue service before a mechanical failure causes service interruption

Midlife Overhaul - rebuilding of bus systems to original specification' of the manufacturer; may include some new components but has less emphasis on structural restoration, focusing instead on mechanical systems and vehicle interiors

Peak Service - the times of the day when additional services and vehicles are provided to handle highest passenger volumes

Peak-to-Base Ratio - the ratio between the number of revenue vehicles operating in passenger service during the peak period and the number of revenue vehicles operating in service during the base period

Preventive Maintenance Program - regular inspection and repair cycles, include midlife overhaul

Running Repairs - ordinary maintenance required to maintain fleet

Spare Bus Ratio (FTA guidelines) - the number of spare vehicles divided by the vehicles required for annual maximum service

Strategic Buses - buses placed along heavily used routes, ready to enter service to provide bus availability when other revenue vehicles are removed from service

Total Active Fleet - vehicles in total, this includes all revenue vehicles held at the end of the fiscal year, including those in storage, emergency contingency, awaiting sale, etc.

APPENDIX A

FEDERAL TRANSIT ADMINISTRATION

Circular C 9030 1A
1987

Spare Ratio. Spare ratios will be taken into account in the review of projects proposed to replace, rebuild or add vehicles. The basis for determining a reasonable spare bus ratio should take into consideration specific local service factors. The number of spare buses in the active fleet for grantees owning fifty or more revenue vehicles should normally not exceed 20 percent of the vehicles operated in maximum service. For purposes of the spare ratio calculation, "vehicles operated in maximum service" should be in accordance with the definition of this term under the Section 15 reporting requirements (49 C.F.R Part 630).

For purposes of Section 9 bus grants, applicants must certify that both their current spare ratio and the spare ratio anticipated at the time the new buses are introduced into service, are in conformance with these guidelines. While these spare ratio guidelines are specifically addressed to applicants owning fifty or more revenue vehicles, applicants owning fewer vehicles are encouraged to conform to them. In addition, it is UMTA's intention to review this spare ratio guideline periodically to determine if a reduction is warranted. All grantees will have their spare ratio history examined during triennial reviews,

Contingency Fleet. Buses may be placed in an inactive contingency fleet for energy or other local emergencies. No bus is to be stockpiled before that vehicle has reached the end of its normal minimum useful life. Buses held in a contingency fleet must be properly stored and maintained, and grantees must be prepared to furnish a contingency plan, updated as necessary, at the time of the TIP/AE and triennial reviews, to support the continuation of such a contingency fleet. Any rolling stock not supported by a contingency plan will be considered as part of the active fleet.

APPENDIX B
Survey Questionnaire

TRANSIT COOPERATIVE RESEARCH PROGRAM (TCRP)
SYNTHESIS TOPIC SA-2
SYSTEMS SPECIFIC SPARE RATIOS--BUS

1994 QUESTIONNAIRE

THANK YOU for taking the time to respond to this questionnaire. For this synthesis study, we are surveying fifty bus agencies around the United States and several in Canada to look at how transit agencies establish and maintain the spare ratio for their bus fleets. From the information provided by the respondents, this study will explore all of the operating and non-operating variables that may affect the number of buses a given agency requires to provide daily service.

As you know, the Federal Transit Administration (FTA) currently recommends a 20% spare ratio as the optimum spare factor. However, depending on the particular circumstances of the transit agency more or fewer buses may be required. It is vitally important that we as transit professionals begin to look at this issue in depth. By analyzing this issue in the context of different operating environments, and from the maintenance perspective, we hope to provide transit managers with practical information which will assist them in managing their fleets better. Therefore, it is critical that you provide accurate and detailed information; it will assist us in presenting the information in a report that could perhaps help others solve a challenging problem with which they have been grappling for some time.

The survey will also explore the methodology each agency uses to determine its spare ratio and investigate the operating problems that might require a different factor than that recommended by the FTA. We also want to know how much it is costing you to maintain your current fleet and whether you have implemented programs to downsize your fleet to achieve certain economies. If you have reduced your fleet over the last couple of years, we would like to know how you did it, including the resolution of any problems you encountered. If you are operating with less than a 20% spare factor, we'd like to know how you have accomplished this as well.

The questionnaire is very detailed with additional space for narrative comment if you require it. We encourage you to tell us about those issues that have affected your operations. Finally, we want to know whether you believe that a standard spare ratio factor makes sense considering the operating and financial difficulties the transit industry faces today.

Judith Pierce will be calling you after you have returned the questionnaire for clarification and further information.

Please return the completed questionnaire by March 18, 1994, to:

Judith T. Pierce
P.O. Box 58159
Philadelphia, PA 19102-8159

Direct any inquires to Judith T. Pierce at 215-527-5122, Sally D. Liff or Donna L. Vlasak at 800-424-9818 or 202-334-3242.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION.

TRANSIT COOPERATIVE RESEARCH PROGRAM (TCRP)
SYNTHESIS TOPIC SA-2
SYSTEM-SPECIFIC SPARE RATIOS--BUS

1994 QUESTIONNAIRE

Organization:____
Address: ____
____

Part One

This questionnaire is divided into two parts. Part One is designed to elicit information about your agency and the kind of bus service it provides to complete the profile of your agency. Therefore, it may be appropriate for the Operations Planning or Finance Department staff to answer the questions. Part Two is directed at the maintenance manager and is designed to obtain information about your fleet and explore the maintenance practices used in your operation. Do not provide information on contract bus service unless you actually perform in-house maintenance on the buses as if you were providing the service yourself. All references to the year should be the fiscal year.

The purpose of this questionnaire is to gather information about your fleet size in relation to the number of vehicles you require for your peak requirement. The synthesis study will explore how diverse properties have established their spare ratio, the various factors that affect the spare ratio, and maintenance practices which have affected the size of the fleet.

Individual Filling Out Questionnaire:

Name:_____ ____________________________________
Title: ____
Department: ____________________________________
Telephone: _____________________________________

APPENDIX B (Continued)

1. Please describe the type of bus service you provide?*

--Intra-City
  large urban environment
  small/medium size city environment
  mixed suburban/city
--Inter-City
--Suburban Only
--Rural

*(This questionnaire does not cover paratransit services. Do not include vehicles used for paratransit services unless they are a part of your daily services.)

2. Does your property contract out bus service? ___________________

A: If yes, how many buses do you contract out? ___________________

B: Do you perform in house maintenance on these buses? _____________

C: If you contract out bus service, what spare ratio do you recommend or mandate the contractor to maintain,
if any? ____
____
____
____

3. Does your property provide other modes of transportation?

None
Van Service
Rapid Transit
Commuter Rail
Light Rail
Electric Trolley Buses

4. What percentage of your bus routes feed these other modes of transportation?
____

4a. On average, how frequently do you provide substitute bus service for rail service in emergencies or due to construction.
____

5. Please describe bus operations at your agency for the time periods indicated below.

Year	Total Dally Hours of Operation	Annual Scheduled Revenue Miles	Annual Scheduled Revenue Hours
1993	____________	____________	____________
1992	____________	____________	____________
1991	____________	____________	____________
1990	____________	____________	____________

6. What is your peak operating period?

Morning — Summer
Afternoon — Winter

7. What is your maximum seasonal peak vehicle requirement?

Summer (July 1) ___________________________________
Fall (October 1) ___________________________________
Winter(December) ___________________________________

8. What is your peak to base ratio? For the base calculation, use your lowest bus requirement during the day.
____
____

9. What percentage of your total active fleet is in-service at the following times:

8:00 A.M. _________________
12:00 Noon _________________
5:00 P.M. _________________
Midnight ___________________

10. Please indicate your Agency's Vehicle Maintenance Expenses (mV) for the following time period. Vehicle maintenance expenses are defined as total operating expenses associated with the inspection, maintenance, and repair of vehicles, such as mechanic wages and fringe benefits, maintenance supplies, repair parts, and outside and/or contract maintenance and repair work. On the labor side include the salaries and fringe benefits of all employees except management, stockroom personnel, farebox maintenance workers and administrative and support personnel.

Year	Annual VME	Total # Maintenance Employees*
1993	__________	_________________________
1992	__________	_________________________
1991	__________	_________________________
1990	__________	_________________________

(Include foreman, mechanics (all classes and levels), general helpers, stock room workers, cleaners, fullers, etc.. Do not include support employees such as clerical staff.)

11. Please specify your Agency's annual operating budget for the years indicated below. If your agency operates rail service or other modes of transportation indicate what percentage of the operating budget is dedicated to bus operations.

TOTAL OPERATING BUDGET — BUS OPERATIONS BUDGET

1993___________________________________
1992___________________________________

APPENDIX B (Continued)

PART TWO

Individual Filling Out The Questionnaire:

Name: ____
Title: ____
Telephone: ____

This section is designed to elicit information on the size and type of fleet that you have had to work with over the last four years and the type of maintenance practices you use in providing the service. In answering the questions, the following definitions apply.

Total Active Fleet (TAF) is defined as all revenue vehicles, held at the end of the fiscal year, that are available for revenue service. Include those buses that are held out of service for long term maintenance including vehicle overhauls, emergency contingency, spares, or vehicles that are otherwise out of service. Do not include vehicles that are scrapped or are awaiting sale.

Spare buses are defined as revenue vehicles available to accommodate routine and heavy maintenance requirements, as well as unexpected vehicle breakdowns or accidents, while preserving scheduled service operations.

12.

Year	TAF	Peak Vehicle Requirement For Scheduled Service*
1993	________________	______________________
1992	________________	______________________
1991	________________	______________________
1990	________________	______________________

* This number represents the highest peak vehicle requirement for scheduled service for the year.

13. How do you calculate your peak service requirements? _______________
____
____
____
____

14. State the bus spare ration (%) for your property for the years indicated below?

1993____
1992____
1991____
1990____

15. How did you arrive at this ratio? Explain methodology used.
____
____
____
____

____
____
____

16. Please fill in the following information describing your present fleet. Please attach an inventory of your fleet that indicates type and age if available. Each year of a specific vehicle type constitutes a vehicle type. For example, if your agency has multiple years of GMC buses, provide the number for each year.

Vehicle Type*	Number	Average Age
___________	______	___________
___________	______	___________
___________	______	___________
___________	______	___________
___________	______	___________
___________	______	___________

- (40' or 30' foot bus, articulated, suburban coach, three axle, double Decker, electric trolley bus etc. Use only those buses which are in your total active fleet. If your property has a particular bus model of different age, each year equals a different vehicle type.)

17. What is the average age of your total active fleet? ____________________

18. At what age does your agency retire buses? ________________________

19. What percentage of your fleet is life equipped? ____________________

20. What percentage of your buses meet ADA requirements? ______________

21. If your fleet is not 100% life equipped, do you plan to purchase more buses in the future?

Yes
No

22. If no, how do you intend to comply with the ADA requirements? Explain ____
____
____
____

23. Do you set aside extra buses outside of the intended spare pool to substitute for in-service failures?
Yes
No

If yes, what percentage of your peak vehicle requirement are substitute buses?
____

24. State the average number of buses in the total active fleet held out of service during peak service for

APPENDIX B (Continued)

vendor/contract work ___________________________
running repairs _______________________________
out of stock parts _____________________________
vehicle overhaul ______________________________
emergency contingency _________________________
Other ____

23. How frequently must you perform inspections?

Type of Inspection	Time	Mileage
____________________	_______	_____________
____________________	_______	_____________
____________________	_______	_____________
____________________	_______	_____________
____________________	_______	_____________
____________________	_______	_____________

24. What time of day do you perform your inspections?___________________

25. Are there physical restraints in your depots, such as inadequate space or lifts, that requires a higher spare factor? If yes, please explain what the restraints are and how you handle them. ____
____
____
____
____
____

26. Do you have a vehicle overhaul program? Please provide a copy of your agency's specifications detailing type of overhaul work performed.

Yes
No

27. If yes, what is the overhaul cycle for your buses by model?

Vehicle Model	Overhaul Cycle
_________________	_____________
_________________	_____________
_________________	_____________
_________________	_____________
_________________ _________________	

28. What has been your average yearly mean distance between mechanical failure?

1993____

28. What has been your average yearly mean distance between mechanical failure?

1993____
1992____
1991____
1990____

29. In calculating your mean distance between failure, what constitutes a failure?
____
(Please attach a copy of your specifications.)

30. Is it the policy of your agency to hold buses out of service for non-safety related passenger amenities, such as cleanliness, torn seats, air conditioning/heat etc.)
If yes, please indicate those items for which you will hold buses out of service.
____
____
____
(If you answered yes, please attach a copy of your program guidelines.)

31. If yes, does this affect the number of spare vehicles that you have available? ______
How many additional buses do you allow for this? ___________________

32. What is the ratio of mechanics* to vehicles? ____________________
(*mechanics who actually work on the vehicle including those who do body work, painting and those who work on vehicle components. Do not include fuelers and personnel who change tires only.)

33. What is the ratio of buses to mechanics? ________________________

34. If your spare ratio factor exceeds 20% of your system maximum operating requirements, what three factors do believe contribute to your spare ratio? (examples, age of fleet, poor streets, outdated and inadequate depot equipment, etc.)
____
____
____
____

35. If you reduced your spare ratio factor over the last four years, please state how much and how you were able to accomplished this.(Examples include new bus purchase, more mechanics, better training etc.)
____
____
____

36. Do you believe that a 20% spare ratio factor is realistic for your agency?
If no, please explain why. ____
____
____
____

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