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The New York City Double Deck Bus Demonstration Project: An Evaluation

Final Report
May 1978

Service and Methods Demonstration Program

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Urban Mass Transportation Administration
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16. Abstract

From July 1974 through June 1977, the Double Deck Bus (DDB) Demonstration Project was conducted in New York City and in Los Angeles. The primary objective at the two sites was to assess potential increase in vehicle productivity in a feeder/park-and-ride/express busway service (L.A.) and in local service (NYC). Double deck buses carry from 68 to 85 passengers as contrasted with conventional buses which carry from 45 to 47 passengers. Both buses call for only a single transit employee, the driver. This report provides a comparative evaluation between the eight British Leyland double deck buses and four conventional GM buses in New York. Volume I contains an executive summary of both projects, while Volume III provides a detailed analysis of the double deck bus demonstration in Los Angeles.

Bus routes in New York were characterized by congested traffic, heavy passenger loads, frequent stops, and frequent passenger turnover. A full-range of socio-economic classes was served and the routes traversed lower- to upper middle-class residential districts, major shopping centers and commercial and business areas. Only seven months of revenue service data are analyzed in this report, due to delays in manufacturing and in satisfying United States safety and environmental requirements.

The evaluation considers passenger (including transit dependent) acceptance and perceptions of the DDB when compared with the conventional bus. Drivers, mechanics, and dispatchers were interviewed to identify their reactions to the new bus. Statistics are presented on schedule adherence, dwell times, passenger throughput, vehicle reliability, on-board safety, fuel and oil consumption rates, operating costs, and financial and scheduling implications. Problems encountered in introducing a non production-line vehicle into revenue service in an existing fleet are discussed.

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PREFACE

This final report on the New York Double Deck Bus Demonstration Project is being submitted to the Transportation Systems Center (TSC) in Cambridge, Massachusetts by CACI, Inc. - Federal under Contract DOT-TSC-1082.

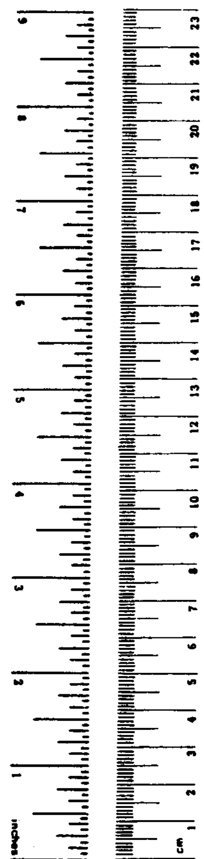
Personnel of the Manhattan and Bronx Surface Transit Operating Authority (MaBSTOA) were extremely cooperative in providing necessary data. Mr. Anthony Caranno, Assistant General Superintendent of MaBSTOA, and Henry Hesse provided a close liaison between CACI staff and MaBSTOA personnel and data sources. Without the excellent cooperation of the MaBSTOA staff in the overall data collection program, as well as the April 1977 passenger survey and on-board data collection efforts by MaBSTOA drivers, it would have been difficult for this report to be put together.

Appreciation is extended to A. Jeffrey Skorneck and Mary I. Olson of CACI and to Ms. Stephanie Raia of Columbia University for their organizational and data collection efforts. Dr. William Farrell, currently of the University of Pittsburgh, provided weekly liaison with the New York project and performed all the data processing for the two on-board data collection activities. Finally, Larry Bruno of UMTA provided valuable suggestions throughout the project and during the preparation of this report.

METRIC CONVERSION FACTORS

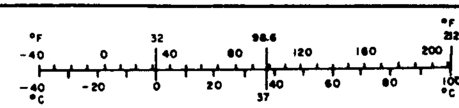
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. INTRODUCTION

This document is one of two volumes which constitute the evaluation of the Double Deck Bus (DDB) Demonstration Project conducted under the Service and Methods Demonstration (SMD) Program of the Urban Mass Transportation Administration (UMTA). The Transportation Systems Center (TSC) is responsible for evaluation of all SMD projects. CACI, Inc. - Federal is the Evaluation Contractor for this particular demonstration project.

The demonstration project was conducted in two cities, Los Angeles and New York, and covered a three-year period from July 1974 through June 1977. The New York Double Deck Bus Demonstration Project involved the utilization of eight British Leyland Motors (BLM) double deck vehicles. The Leyland double deck buses have a seating capacity of 68 per vehicle and were operated on two bus routes characterized by congested traffic, heavy passenger loads, frequent stops, and frequent passenger turnover. These two routes ran from the northern end of Manhattan to the southern end, and served a full range of activity mixes and diverse socio-economic classes.

In contrast, the Los Angeles Double Deck Bus Project utilized two German Neoplan vehicles with a seating capacity of 84 per vehicle. Two types of service were provided: during morning and evening peak periods a "park-and-ride" express run traveling on approximately 12 miles of an exclusive express busway (later expanded to permit car pools with three or more passengers), and an all-day revenue service run between the Los Angeles central business district (CBD) and the suburban community of Pomona (approximately 30 miles east of the CBD). This latter route also utilized the exclusive express busway, as well as the San Bernardino Freeway for much of its non-CBD run.

Participating in this project under two separate grants from UMTA were the New York Metropolitan Transportation Authority (MTA), with operations of the service being handled by the New York City Transit Authority (NYCTA) and its subsidiary, the Manhattan and Bronx Surface Transit Operating Authority (MaBSTOA), and the Southern California Rapid Transit District (SCRTD).

Due to differences in the planned service types at the demonstration sites, evaluation activities and results are reported in individual volumes. This volume focuses on the New York Double Deck Bus Demonstration Project. Volume I contains an executive summary of both projects, while Volume III provides a detailed analysis of the double deck bus demonstration in Los Angeles. Evaluation activities were based upon an evaluation plan developed in the fall of 1975.[1]

1.1 DEMONSTRATION OBJECTIVES AND ISSUES

This section sets forth the objectives (both SMD and local), as well passenger-, transit operator-, and vehicle-related issues.

1.1.1 SMD Program Objectives

The double deck bus demonstration project primarily addresses the SMD objective of increased vehicle productivity. Double deck buses have considerably greater passenger seating

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[1] "Evaluation Plan for the Double Deck Bus Demonstration Project," CACI, Inc. - Federal, November, 1975.

capacity than conventional buses: 68-84 versus 45-47. An increase in vehicle productivity would result from higher passenger loads, combined with a less than proportional increase in vehicle operating costs and no schedule changes.

In addition, the SMD Program objective to "improve service for the transit dependent" is indirectly addressed due to two specific design characteristics of these particular vehicles that are not necessarily features generic to double deck buses. These features are wider doorways and lower steps.

1.1.2 Local Objectives

In its application for the UMTA grant, the MTA stated that "the purpose of the project is to investigate, in daily revenue service, operating aspects which are unique to the DDB." More specifically, the grant application mentioned the following:

1) Public acceptance of the DDB.

2) Safety aspects with respect to the stairs and the upper deck.

3) Passenger flow.

4) Route constraints caused by vehicle height.

5) Economic and service benefits due to the DDB design.

Each of these objectives has an impact on transit vehicle productivity, the main SMD Program objective.

1.1.3 Issues

Several issues of potential interest to transit authorities considering the addition of DDBs to their fleets have been considered. These issues have been grouped into three categories:

1) Passenger-related - passenger perception and acceptance of the double deck vehicle in comparison to the conventional bus:

- The acceptance of the double deck vehicle by the general public (including the elderly and handicapped). Interest centers on overall preference for bus types and reasons why the DDB and conventional buses were selected.

- Passenger trip characteristics of those who utilize the second level. The seating capacity of the upper level is almost twice that of the lower level, so it is of interest to determine whether passengers will go upstairs regardless of the trip length. For example, will a passenger making a short trip be as likely to utilize the upper level as a passenger making a longer trip?

- Passengers' perceptions of the stairs to the second level and the unattended second level. Since the stairwell could be a possible source for accidents, passenger attitudes on its ease of use are important.

- Passengers' perceptions of the double deck bus accommodations and conveniences. Considered are such factors as ease of boarding; movement through the bus; comfort of the ride, the seats, and environment; and level of noise. These factors could have an impact on modifications to bus design.

- Ease with which the handicapped and elderly can utilize the vehicles. Since it is not the intent to introduce a vehicle which would exclude its use by the elderly and handicapped, it is important to get their reactions to features of the bus which might possibly deter their using it.

2) <u>Transit operator-related</u> - bus operation and productivity compared with conventional buses on the same routes.

- Initial mechanical problems at demonstration start-up. Any transit authority considering introduction of a new vehicle type into an existing fleet must be aware of potential problems which could cause initial delays. Such delays could be costly and have a negative impact on public acceptance.

- Reliability factors such as downtime, dwell times, schedule adherence, and overall vehicle performance. The DDB's greater capacity is wasted if the vehicle does not provide reliable service. The bus must be able to maintain the schedule achieved by its conventional counterpart if it is to serve on the same routes.

- Vehicle productivities that include the peak-to-base ratio.[1] If DDB vehicle productivities exceed those of the conventional bus, and if operating costs are comparable, then the DDB can improve the peak-to-base ratio by enabling fewer vehicles to provide the same type of service with only modest changes in headways.

- Route assignments with consideration for the type of service to be provided and actual physical constraints on routes to accommodate the double deck bus. For example: are modifications necessary to routes because of the height of the bus? Is the DDB a potential replacement on a one-to-one basis for the conventional bus on any route, or are there DDB characteristics which make the DDB a more appropriate vehicle on some routes than on others?

- Potential union problems within the transit operation. Since labor costs constitute the largest single operating cost, it is important to determine whether there are premium wages required for DDB drivers or whether labor-related costs are about the same for the DDB and the conventional buses.

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[1] The ratio of number of buses used during peak hours to number of buses used during off-peak hours.

- On-board safety and vandalism. This issue focuses on the stairs to the second level and the number and seriousness of any stair-related accidents that occur. In addition, vandalism could become a problem on the unattended upper level.

- Possible additional insurance fees. Any increased fees would have an impact on the ability to maintain comparable operating costs.

- Ease with which DDBs are integrated into existing fleet by the dispatchers. In New York, the dispatchers have the ability to modify runs based upon vehicle performance. If the schedule adherence of the DDBs is poor relative to the conventional buses, the dispatchers will find themselves having to modify run segments for the DDBs more than for conventional buses.

3) Double deck bus vehicle-related issues:

- Mechanic and driver impressions of the vehicle. Any new bus requires a mechanical break-in period. In addition, the way in which drivers and mechanics view the bus can have an impact on the vehicle's operational reliability. A positive attitude can be a beneficial factor in the introduction of a new bus.

- Vehicle delivery, certification, and retrofit requirements, as well as modifications necessary to meet national and local laws and specifications. Considerable time, and consequently costs, may be devoted to resolving some of these problems before revenue service can begin. The impact of such problems is important from planning and cost viewpoints.

- Availability of spare parts for foreign-designed and -built vehicles. Ordinarily, when a new vehicle is introduced into the fleet, adequate spares are purchased along with these new vehicles. In the case of the demonstration vehicles, it is conceivable that an inadequate number of spares, coupled with the fact that suppliers for most spares are in Europe, might have an impact on vehicle availability.

- Contractual responsibility of the manufacturer and the local liaison. For instance, are there difficulties encountered in dealing with a foreign supplier which create unnecessary delays in initiation of revenue service and which extend repair times?

- Ease with which modifications to vehicles can be accomplished. Because of the mechanics' lack of familiarity with the vehicle and its use of metric tools, it is possible that longer than usual times might be required for modifications. This can also have an impact on vehicle availability.

In considering the vehicle-related issues, it is important to identify situations which may be unique to the given vehicle design and possibly the demonstration (e.g., inadequate spares), as compared with the generic double deck bus design.

1.2 DOUBLE DECK BUS HISTORY AND INNOVATIONS IN NEW YORK

Double deck buses are not new to New York City. In fact, in the 1930s there were 160 such buses in service. The new Leyland buses, unlike those operating during the first half of this century, are completely enclosed, require air conditioning, and utilize only one MaBSTOA person, the driver. Seating capacity is approximately the same as the 1930s DDBs. The two routes on which the demonstration DDBs and their conventional counterparts operated were approximately the same as two routes on which the DDBs operated before service was discontinued in the 1950s.

As early as 1901, single deck and double deck battery-powered buses of various configurations operated in New York City. The battery-powered buses were withdrawn from service and replaced by bigger horse-drawn buses in 1902. After much operational experimentation, the horse-drawn buses were replaced in 1906 by 34-passenger single deck gasoline-powered buses.

In 1912, 25 Brill double deck bodies, with 25 seats on the top open deck and 23 seats inside, were ordered. An additional 25 double deck buses were purchased the following year. It was difficult to maintain adequate spares for these buses due to the European sources for the buses and the impact of World War I. Numerous local modifications were necessary to allow for improved operations and easier local maintenance and repair.

Between 1917 and 1921, an additional 240 double deck buses were added to the fleet. In 1922, an extension over the driver's compartment on the top deck increased seating capacity to 51.

In 1925 single deck buses replaced the double deck buses on certain new routes because of clearance problems with the higher buses.

The last fleet of front-engine double deck buses was put into service in early 1930. Introduction of these buses, plus a decline in ridership, resulted in the eventual withdrawal of all of an earlier DDB type from service.

In 1933 two experimental double deck buses were constructed and tested. One preserved the traditional front-engine design and was 30 feet long; the other had a motor in the rear, a new engineering concept. The latter, with its larger seating capacity, 71 versus 56, was more desirable. By late 1938 there were 160 of the rear-engine double deck buses in service.

In 1942, in common with most other bus companies, the Fifth Avenue Coach Company (operator of the DDBs) was ordered by the Office of Defense Transportation to reduce tire mileage and fuel consumption, as a wartime measure. This led to a reduction in service. Even without the subsequent ridership declines, the double deck buses, requiring two transit personnel, became too costly to operate after the war. Other factors influencing the demise of the DDBs in New York were the slow loading and acceleration of the DDBs, as contrasted with the experimental 54-passenger single decker. (The current double deck bus requires only one operator and has an acceleration capability equivalent to that of the conventional bus. The analysis in Section 5.3 indicates that loading and unloading times per passenger are essentially equal for the two bus types.) The last open-top DDBs were retired on December 29, 1946. Following the purchase of 300 new GM diesels between 1946 and 1952, the last double deck bus was retired from service on April 27, 1953, ending the DDB era that lasted for more than 50 years in New York City.[1]

1.3 EVALUATION OVERVIEW

This section describes the approach taken in performing the evaluation of the Double Deck Bus Demonstration Project and discusses the roles and interrelationships of the various organizations involved.

1.3.1 Project Evaluation Activities

The framework within which the evaluation activities were to be conducted is set forth in the Evaluation Plan. This Plan was established to be consistent with the planned sequence of events in the demonstration. Scheduled versus actual demonstration events are depicted in Figure 1.

Since the evaluation efforts centered on making comparisons between the DDBs and the conventional counterparts on the same routes, there were three basic sources for data: (1) service and maintenance records; (2) on-board surveys, passenger counts, and dwell times; and (3) driver, maintenance, and dispatcher interviews. The first were obtained on a monthly basis from September 1976 through May 1977, either from original documents or from summary computer printouts. The latter two were obtained twice during the revenue service portion of the demonstration, in October 1976 and May 1977.

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[1] "Motor Coach Age," Vol. XXIII, No. 7-8, July - August 1971.

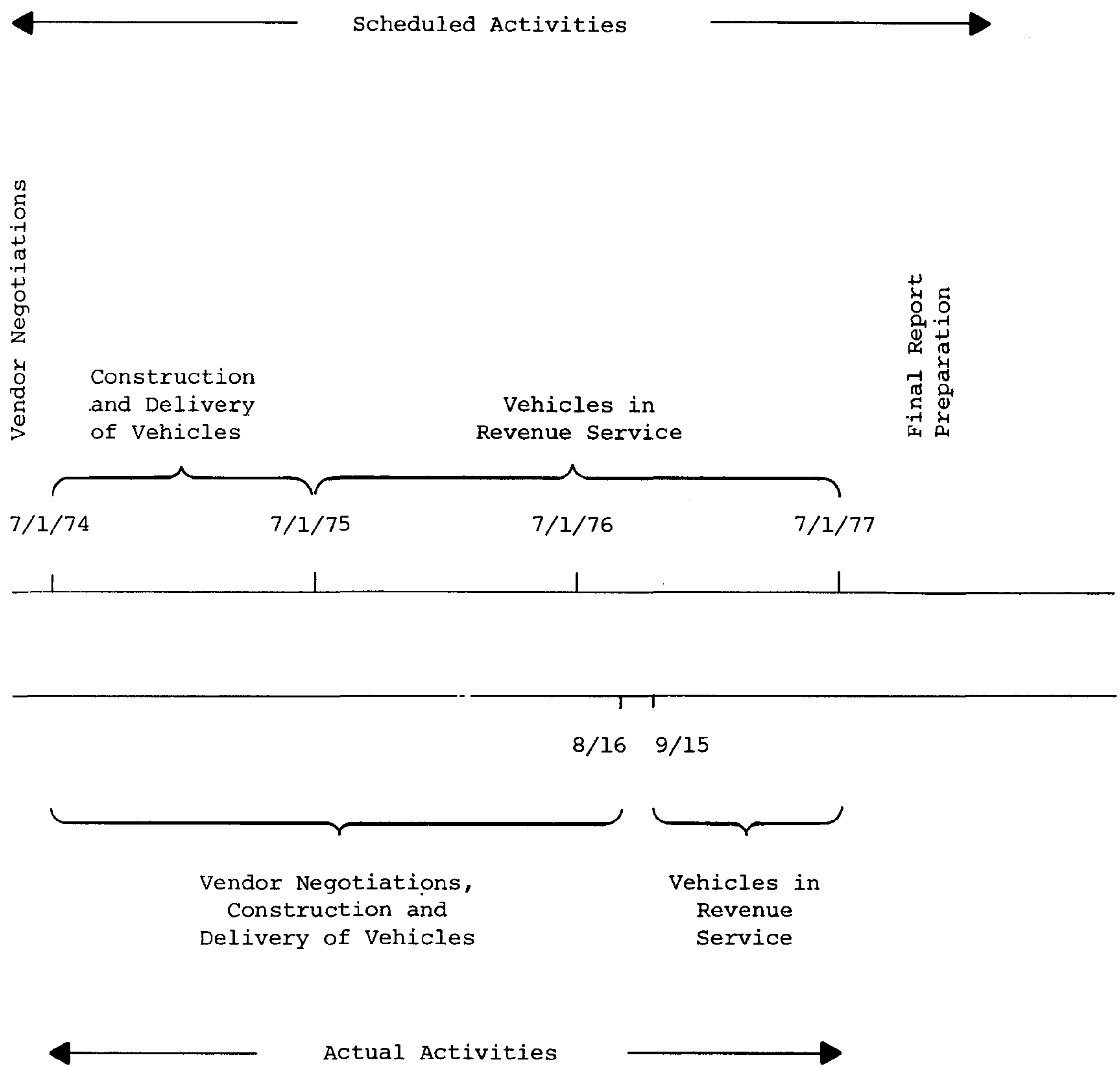

FIGURE 1. SCHEDULED VERSUS ACTUAL DEMONSTRATION ACTIVITIES

The original intent in the Evaluation Plan was to compare the double deck buses to new conventional Flxibles and to make the comparisons after both bus types had gone through their burn-in period. However, due to the long delay in the start of revenue service, the double deck bus remained in its burn-in phase during the entire data collection period. Also, since MaBSTOA was having major problems with their new Flxible fleet, the decision was made to use the older GM buses operating on the same routes as the comparison vehicles.

The evaluation efforts covered two major phases:

1) Pre-revenue service: Originally scheduled for completion in February of 1976, these activities continued until September of 1976 when revenue service first began in New York. During this phase, continuing contact was maintained by the contractor with the demonstration site through phone communications and visits, as required. Information was obtained regarding problems associated with procurement, certification, transportation, and introduction of the DDBs into regular revenue service. This phase resulted in much of the information contained in Section 3.1, Pre-Revenue Service Activities.

2) Revenue service: This phase, initiated in September 1976, involved the collection of both monthly and spot-monitored data. Data were obtained primarily from MaBSTOA records and were collected once a month through May 1977. Some data are missing during this time frame, primarily due to computer breakdown and weather conditions which forced the DDBs into

storage during exceptionally cold periods (lower deck ambient temperature less than 32°F).

In addition to the continuously (monthly) collected data, spot-monitored data were collected twice, in October 1976 and in May 1977. These data consist of the following information: attitudes, perceptions, travel characteristics, and demographics associated with passengers on both bus types; dwell times; passenger loadings; and trip times.

During the evaluation data collection efforts, several problems were encountered:

1) Computer storage and retrieval systems did not function all the time, creating voids in some data elements.

2) Actual times required for specific repair and maintenance activities were either not recorded or were inconsistently recorded. Routine maintenance and repair efforts were given specific times as a result of meetings with British Leyland representatives. This approach is consistent with times assigned for similar functions on the conventional fleet.

3) Cost information for both bus types was not always available in sufficient disaggregation to be useful in making comparisons between bus types.

1.3.2 Evaluation Report Structure

The remaining chapters of this report describe the demonstration site, demonstration events, and the evaluation findings. More specifically:

1) Chapter 2 includes information on site geographics, demographics, and available transportation at the time of project initiation. The double deck bus routes and factors external to the project which might have an impact on transferability of findings are identified.

2) Chapter 3 describes the events that led to revenue service initiation, including vehicle selection, route identification, and facilities requirements. Revenue service and major demonstration events are covered.

3) Chapter 4 discusses various vehicle-related issues such as problems associated with the vehicle's foreign manufacture and prototypical design.

4) Chapter 5 addresses transit operator-related issues, e.g., mechanical reliability and maintainability, operating costs, passenger throughput and dwell times, schedule adherence, safety and accidents, vandalism and crime, vehicle size constraints, union demands and insurance costs.

5) Chapter 6 provides an analysis of passenger acceptance, with emphasis on information obtained from the passenger data collection efforts. Passenger preference for bus type, acceptance of accommodations, demographics, and travel characteristics as they relate to bus choice are presented.

6) Chapter 7 summarizes the demonstration project and highlights conclusions drawn, with emphasis on the potential transferability to other locales.

1.3.3 Organizational Involvement

Associated closely with the Double Deck Bus Demonstration Project were four organizations:

1) The Office of Transportation Management and Demonstrations, the Urban Mass Transportation Administration (UMTA) - Responsible for the Service and Methods Demonstration Program and mandated by law to identify sites to develop, demonstrate, and evaluate new applications of current transit equipment and management techniques in providing improved quality and quantity of public transportation. Assigns Project Manager to monitor demonstration activities and provide a focal point for coordination of all demonstration-related efforts.

2) The Transportation Systems Center (TSC) Cambridge, Massachusetts - Responsibility for all aspects of evaluation associated with the SMD Program. Assigns an Evaluation Manager for each demonstration, who develops the initial objectives and issues, measures, data sources, and scope of the demonstration.

3) The Metropolitan Transportation Authority (MTA) - The New York grantee, who acquired the buses and operated them on lines of the New York Transit Authority and the Manhattan

and Bronx Surface Transit Operating Authority. Responsible directly to UMTA for complying with the grant conditions and for providing necessary data and information to assess the demonstration.

4) The Evaluation Contractor - Selected by TSC to perform the evaluation activities. Contractor works closely with the grantee during pre-implementation and implementation, primarily concerning data and information collection. Contractor is responsible for the synthesis of information collected during the demonstration and for the preparation of the final evaluation report.

2. SERVICE AREA CHARACTERISTICS

This chapter describes the routes served by the DDBs and relates them to the area transportation system. Geographic and demographic characteristics for the New York service area are presented as an aid to interpreting the results of the demonstration and making statements about transferability to other locations. Exogenous factors which might have an impact on transferability of findings to other locales are identified.

2.1 DOUBLE DECK BUS DEMONSTRATION ROUTES

The two routes served during the demonstration project are illustrated in Figure 2. The routes encounter heavily congested traffic and traverse fairly flat terrain, except for some slightly hilly portions and some portions with poorly maintained road surfaces. Figure 3 identifies characteristics of the routes. On weekdays, service on the two routes commences at approximately 5:30 AM and continues until about 11:00 PM, with headways ranging from two to ten minutes, depending upon the time of day. On weekends, service commences about a half-hour later in the morning but does continue until about 11:30 PM, with headways of from six to 15 minutes. For more details, see Tables 1 and 2. Approximately 1.3 million persons (residing in an area of approximately 20 square miles) live within a five-block walk of the two bus routes.

Route M4, in its southbound leg, originates at the Cloisters in northern Manhattan and proceeds down Fort Washington Avenue to Broadway and West 159th Street. The run then goes down Broadway to 135th Street, where it heads west to Riverside Drive. At Cathedral Parkway, the route turns

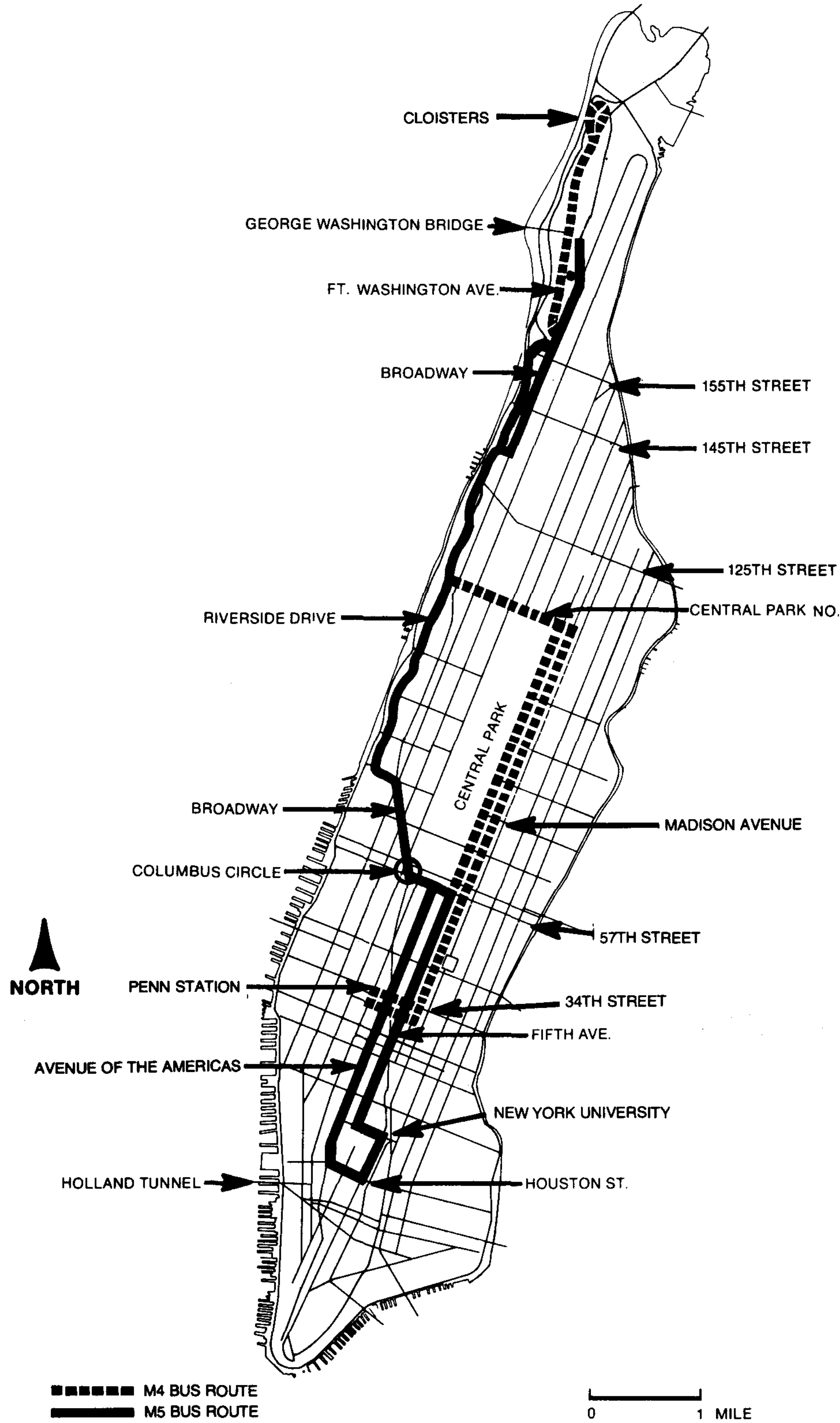

FIGURE 2. MANHATTAN DOUBLE DECK BUS ROUTES

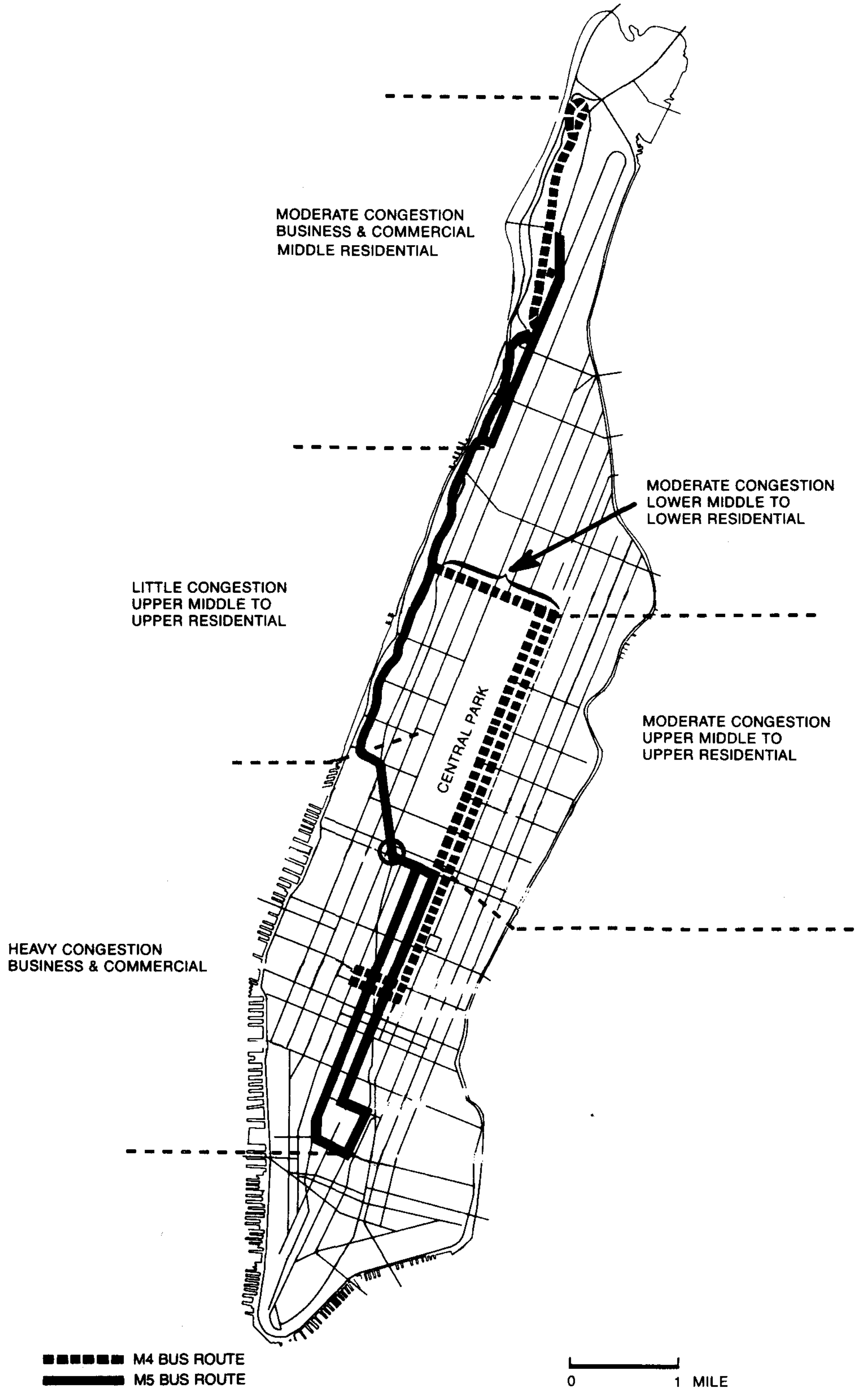

FIGURE 3. CHARACTERISTICS OF THE DEMONSTRATION ROUTES

TABLE 1. HOURS OF SERVICE FOR ROUTES M4 AND M5[1]

ROUTE	SOUTHERN TERMINAL	NORTHERN TERMINAL	LEAVING NORTHBOUND (WEEKDAYS)	LEAVING SOUTHBOUND (WEEKDAYS)	LEAVING NORTHBOUND (SATURDAY)
	Pennsylvania Sta	Ft. Washington Av-193 St	6:55 AM-8:34 AM	5:43 AM-10:00 AM	7:05 AM-9:35 AM
M4	Pennsylvania Sta	Ft. Washington Av-Cloisters	8:36 AM-3:48 PM	10:02 AM- 5:25 PM	9:45 AM-3:55 PM
	Pennsylvania Sta	Ft. Washington Av-193 St	3:53 PM-11:25 PM	5:33 PM-10:05 PM	4:01 PM-11:20 PM
			Service between 135 St & Ft Tryon Pk operates from 5:19 AM-7:40 AM		Service between 135 St & Ft Tryon Pk operates from 6:26 AM-8:17 AM
M5	Houston St-W Bway	157 St Bway via Riverside	4:34 PM-5:30 PM	7:22 AM-8:16 AM	---
	Houston St-W Bway	178 St Bway	7:20 AM-12:15 AM	6:00 AM-10:45 PM	7:10 AM-12:19 AM

ROUTE	SOUTHERN TERMINAL	NORTHERN TERMINAL	LEAVING SOUTHBOUND (SATURDAY)	LEAVING NORTHBOUND (SUNDAY)	LEAVING SOUTHBOUND (SUNDAY)
	Pennsylvania Sta	Ft. Washington Av-193 St	6:00 AM-11:00 AM	7:45 AM-10:46 AM	6:45 AM-12:12 PM
M4	Pennsylvania Sta	Ft. Washington Av-Cloisters	11:06 AM-5:34 PM	11:04 AM-5:08 PM	12:18 PM-6:30 PM
	Pennsylvania Sta	Ft. Washington Av-193 St	5:44 PM-10:10 PM	5:14 PM-11:20 PM	6:40 PM-10:12 PM
				Service between 135 St & Ft Tryon Pk operates from 6:26 AM-8:17 AM	
M5	Houston St-W Bway	157 St Bway via Riverside	---	---	---
	Houston St-W Bway	178 St Bway	6:00 AM-10:42 PM	8:03 AM-11:50 PM	7:00 AM-10:40 PM

[1] Manhattan Bus Guide, New York City Transit Authority.

TABLE 2. APPROXIMATE FREQUENCY OF SERVICE, IN MINUTES, FOR ROUTES M4 AND M5[1]

WEEKDAYS				
Route	8:00 AM	Noon	5:30 PM	9:00 PM
M4	3	5	4	10
M5	2	5	4	10

SATURDAY				
Route	8:00 AM	Noon	5:30 PM	9:00 PM
M4	10	6	8	12
M5	8	6	8	15

SUNDAY				
Route	8:00 AM	Noon	5:30 PM	9:00 PM
M4	10	8	8	12
M5	10	8	8	15

[1]Manhattan Bus Guide, New York City Transit Authority.

east and heads across town on Central Park North until it reaches Fifth Avenue, where the run turns south again. At 34th Street this run heads west to its terminal point opposite Penn Station.

On its northbound leg, the bus heads east on 32nd Street to Madison Avenue, where it proceeds north until turning west on Central Park North. The southbound routing is followed until the bus reaches Broadway and 158th Street, at which point it continues northbound on Broadway. At 168th Street the bus turns west to Fort Washington Avenue and its eventual northern terminus at the Cloisters.

The routing passes through residential, business, and shopping areas, all of which tend to be highly congested with vehicular traffic, particularly during the peak periods. With minor exceptions, the residential districts are located north of Central Park and along Fifth and Madison Avenues to about 57th Street. Those along Fifth Avenue tend to be middle- to upper middle-class, while those north of Central Park tend to be more middle- to lower middle-class. South of Central Park, the route runs through heavily congested commercial and shopping areas.

Summary statistics on this route and Route M5 appear in Table 3.

Route M5 has its northern terminus adjacent to the entrance to the George Washington Bridge. The route proceeds down Broadway to 157th Street, where it heads west to Riverside Drive or proceeds to 135th and then heads west. It follows Riverside Drive down to 72nd Street, where it turns east to Broadway. The Riverside Drive portion of this route traverses one of the more affluent residential areas in Manhattan and, with the exception of peak periods, has

TABLE 3. SUMMARY STATISTICS, ROUTES M4 AND M5

	ROUTE	
	M4	M5
Route Length (one-way)	10.5 miles	10.3 miles
Annual Passengers	9.8 million	7.4 million
Annual Vehicle-Miles	1.4 million	1.3 million
Peak Headway	3 minutes	2 minutes
Number of Buses Serving Routes (weekday mornings)	50	47

fairly light traffic, as contrasted with the balance of the route. The route angles down Broadway to 57th Street, where it again heads east to join the southbound portion of Route M4 on Fifth Avenue. Proceeding down Fifth Avenue, the bus turns east on West 9th to Broadway, where it once again heads south to its terminus on West Houston Street.

The northbound leg proceeds from Houston Street to the Avenue of the Americas. Here the route heads north to 59th Street, where it jogs west to Columbus Circle. At Columbus Circle, Route M5 picks up Broadway north to West 72nd Street, once again heading west to Riverside Drive. From this point to its terminus at the George Washington Bridge, the balance of Route M5 retraces the southbound portion of the run.

As in the case of Route M4, the buses pass through residential, business, and shopping areas. The southern portion of the route extends into the New York University campus area, approximately one and one-half miles south of

Penn Station. The northern terminus of this route is approximately one mile south of the Cloisters.

2.2 SERVICE AREA TRANSPORTATION

The service area for this demonstration is totally within the borough of Manhattan, which is served by bus and subway. There are currently 18 major north/south routes and 24 crosstown or east/west routes. Some of these routes have variations in origins, destinations, and service periods based upon time of day and day of week. Prior to the demonstration, only conventional buses were in use on the Manhattan routes. Headways range from two to five minutes during peak periods on most routes, and from two to ten minutes during off-peak periods.

Fares within Manhattan are 50 cents, with reduced fares available for students (purchased through their schools), the elderly (65 and older), and the handicapped (those for whom boarding, alighting, and movement through the buses is difficult).

In addition to the frequent surface public transit, there are three inter-connected subway systems serving Manhattan, with fares of $0.50. These subways generally follow a north/south direction, with an average of six to eight blocks between stops, as compared to the buses which provide more frequent stops and cross-town coverage. The subway routes provide excellent coverage through the Manhattan corridor over which the DDBs operated.

Commuter trains bring approximately 300,000 persons to Grand Central and Pennsylvania Railroad Stations from suburban New York, New Jersey, Connecticut, and Pennsylvania.

Approximately 75 percent of these commuters transfer directly to bus or subway for the balance of their work-related trip.

2.3 GEOGRAPHIC AND DEMOGRAPHIC CHARACTERISTICS

While for the United States as a whole and SMSAs greater than 250,000 population there has been an increase in population from 1970 to 1976, the New York DDB service area has experienced a significant decline of approximately 1.7% per year. Both average household size and family size within the service area are smaller than for the U.S. and for SMSAs over 250,000. Median family income in the service area ($9,130) is less than for the United States ($9,579) and SMSAs greater than 250,000 ($10,761). The service area population is significantly older (median age of 35.8 years, as contrasted with 28.3 for the United States as a whole) and more dependent upon public transportation (79% own no automobile as compared with 18% for the United States as a whole). More detailed statistics are given in Tables 4 and 5.

Winter weather conditions range from fairly mild (little or no snow) to extremely cold periods with heavy snow (as was true during the December 1976 to February 1977 evaluation period). Terrain traversed by buses on the two routes is, in general, fairly flat, with hilly sections primarily at the northern two miles of the runs.

2.4 EXOGENOUS FACTORS

There were several factors which must be considered in assessing the transferability of this demonstration project's findings. The first was the unusually harsh winter, which generated requirements for more heat than the units on the DDBs were designed to produce. This resulted in the buses' being out of service for six weeks. This severe winter weather was followed by a summer period which called for air conditioning which the buses were not properly equipped to deliver. Again, the buses were out of service, this time for several months while the air conditioning was being fixed. New York's poorly maintained roads caused unexpected breakdowns, and the buses' spring suspension gave passengers on the upper level a bumpy ride. The heavily congested traffic conditions on the majority of the routes may not be typical of other potential operating locales. As a consequence of a high crime rate, buses in New York have to be garaged indoors, and potential sites were constrained by vehicle height. This same crime rate tends to restrict the routes on which the buses can be used, primarily because of the unattended upper level.

TABLE 4. SELECTED 1970 CENSUS DEMOGRAPHIC DATA FOR THE NEW YORK CITY, MANHATTAN SERVICE AREA, SMSAs GREATER THAN 250,000, AND UNITED STATES

DEMOGRAPHICS	MANHATTAN	SMSAs> 250,000	United States
Population			
1970	1,479,000	121,262,988	203,286,253
1976[1]	1,334,000	125,853,415	214,321,947
Annual growth 70-76	-1.7%	0.6%	0.9%
Sex			
Male (%)	46.4	48.4	48.7
Female (%)	53.6	51.6	51.3
Race			
White (%)	71.3	86.0	87.6
Black (%)	25.2	12.5	11.0
Other (%)	3.4	1.5	1.3
Number of Families	343,500	30,386,048	51,014,262
Average Family Size	3.0	3.6	3.6
Number of Households	667,500	38,319,240	63,464,604
Average Household Size	2.2	3.1	3.1
Family Income			
Under $5,000 (%)	24.1	15.8	20.3
$5,000 - 9,999 (%)	30.9	29.7	32.5
$10,000 - 25,000 (%)	32.2	48.4	42.6
Over $25,000 (%)	12.9	5.9	4.7
Average	$14,412	$12,208	$10,999
Median	$ 9,130	$10,761	$ 9,597
Age			
0-20 (%)	25.6	39.1	39.6
21-39 (%)	30.3	24.8	24.0
40-64 (%)	30.1	26.8	26.5
65+ (%)	14.0	9.3	9.9
Median	35.8	28.4	28.3
Educational Level of Adults over 25 Yrs.			
1-8 years (%)	29.3	25.0	28.3
9-11 years (%)	15.6	19.5	19.4
12 years (%)	23.2	31.9	31.1
13-15 years (%)	10.7	11.4	10.6
16+ years (%)	21.1	12.2	10.7

[1] CACI, Inc. proprietary SITE Program; population forecasts based on methodology developed by National Planning Data Corporation, Ithaca, NY.

TABLE 5. AUTO OWNERSHIP AND MODE OF TRAVEL TO WORK, 1970 CENSUS

WORK TRANSPORTATION INFORMATION	MANHATTAN SERVICE AREA	SMSAs> 250,000	UNITED STATES
Auto Ownership			
None (%)	78.7	19.3	18.0
One (%)	19.7	45.4	54.0
Two or more (%)	1.7	35.3	28.0
Mode of Travel to Work			
Automobile driver (%)	7.9	65.7	66.0
Automobile passenger (%)	2.2	10.9	11.7
Bus or streetcar (%)	21.1	8.1	5.5
Subway, elevated or railway (%)	43.7	3.7	2.3
Walk (%)	16.9	6.3	7.4
Other (%)	4.2	3.1	3.6
Work at home (%)	4.0	2.1	3.5

3. DEMONSTRATION PROJECT DEVELOPMENT, IMPLEMENTATION, AND OPERATIONS

This chapter considers pre-revenue service events including the selection, purchase, and delivery of the Leyland vehicles, major events occurring from revenue service start-up to May 31, 1977, and an indication of media reaction to the DDBs.

3.1 PRE-REVENUE SERVICE ACTIVITIES

In March of 1974, an application was submitted to the Department of Transportation, Urban Mass Transportation Administration, for a grant to purchase and operate four British Leyland double deck buses on regular routes as replacements for conventional buses. American manufacturers were unwilling to produce DDBs for this demonstration, so British Leyland was selected as having a production-line bus which, with what were initially thought to be minor modifications, could be put into revenue service. Four additional DDBs were purchased by New York State for the demonstration.

The application was approved in June of 1974 with the following estimated costs:

Purchase of four buses at $78,000 each	$312,000
Insurance and freight at $2,400 each	9,600
Duty at $3,100 each	12,400
One lot of spare parts	32,000
Engineering support	9,669
Travel and subsistence	2,500
Sub-Total	$378,168
Contingency at 10%	37,816
Total	$415,984

The $32,000 in spares was for the four UMTA-funded vehicles. The spare parts coverage was based upon British Leyland's recommendations from the experience of London Transport Ltd., the providers of public transportation in London, England.

Although initially estimated at $78,000 each, the DDBs, as they were finally put into revenue service, cost an estimated $99,000 each. These increased costs were borne by the MTA. Figures 4 and 5 show the Leyland in New York City.

The demonstration funds included any modifications to vehicle specifications needed to satisfy United States safety and certification requirements. Operating and maintenance costs incurred after the warranty period were to be borne by the MTA from its operating revenues.

Selected specifications for the Leyland DDBs and the counterpart conventional GM buses (used for comparative purposes) are given in Table 6. Initially, the more modern Flxible buses were to be used as conventional counterparts for the demonstration. It was determined, however, that these buses were experiencing break-in problems which might make a comparison between the two bus types meaningless. Therefore, four older GM buses (Bus No's 8614 - 8617) with approximately 200,000 miles each were identified. It was felt that the tracking of any additional vehicles would have been too costly for the data collection efforts. Costs for the GM conventional buses at about the same time as the Leylands were purchased were $80,000 per bus.

The double deck buses ordered from British Leyland were basically standard production-line vehicles, but they did require some modifications to conform to U.S. standards and in order to add the air conditioning systems. These modifications and subsequent vehicle problems are discussed in more detail in Chapter 4, Vehicle-Related Issues.

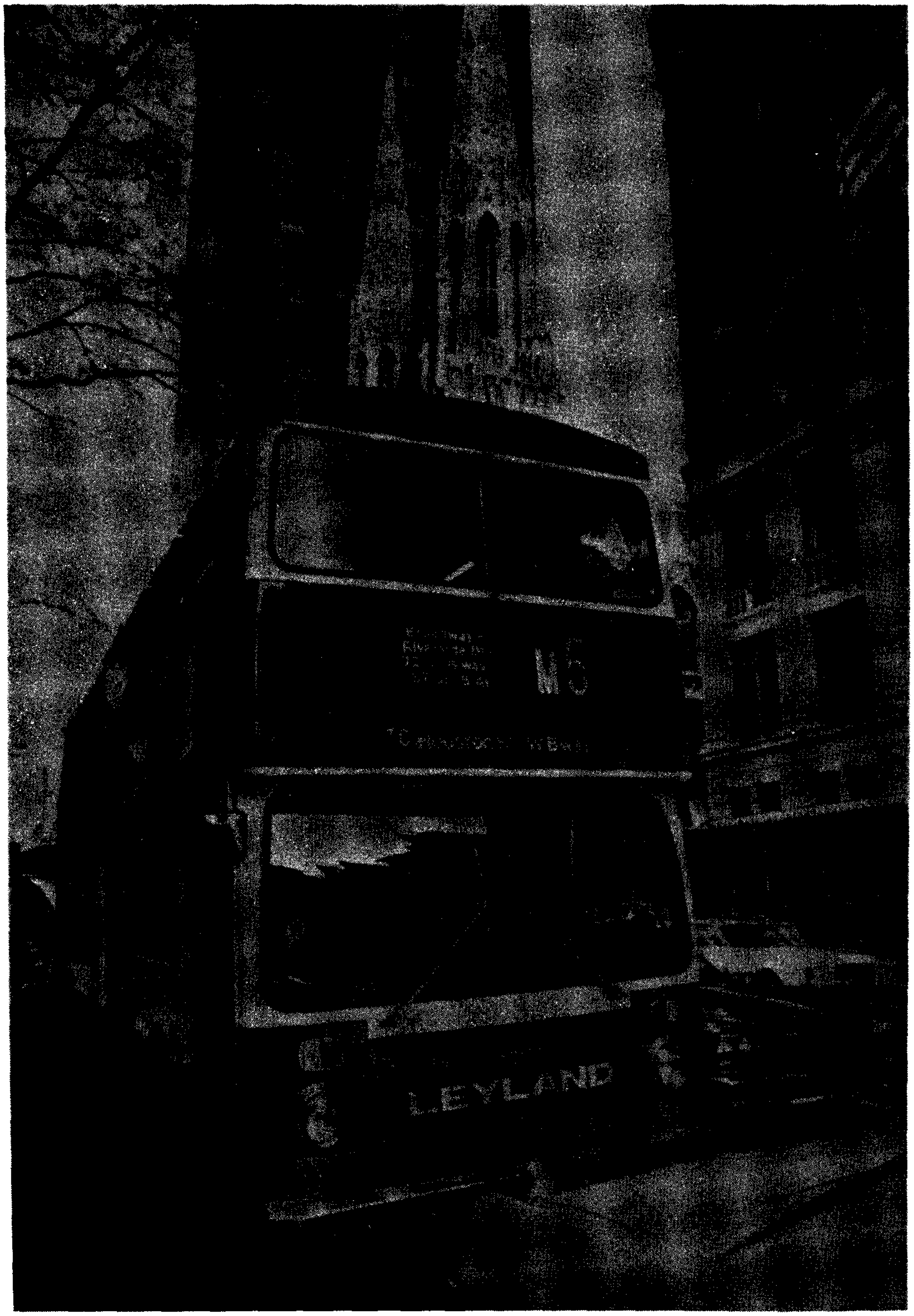

FIGURE 4. THE BRITISH LEYLAND ON FIFTH AVENUE

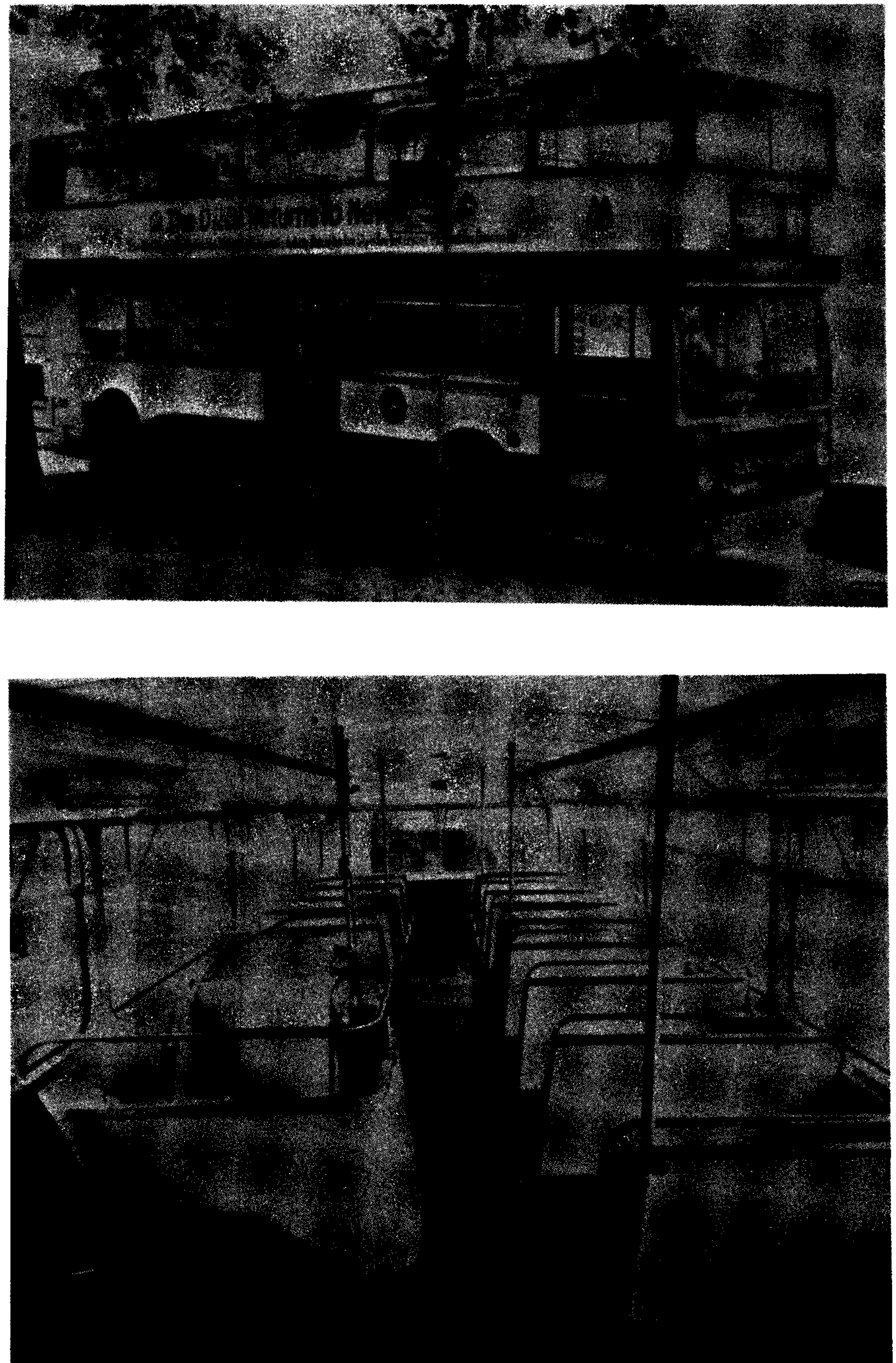

FIGURE 5. THE BRITISH LEYLAND ON DISPLAY IN NEW YORK

TABLE 6. SELECTED DOUBLE DECK AND GM VEHICLE SPECIFICATIONS[1]

Specifications	British Leyland	GM
Passenger Capacity:	81	68
Seated - upper level	43	-
Seated - lower level	25	45
Seated - total	68	45
Standing, lower level[2]	13	23
Length (feet)	33.3	40
Width (feet)	8.3	8.5
Height (feet)	14.5[3]	10.4
Wheelbase (feet)	18.5	23.8
Final cost per vehicle	$99,000	$80,000

[1] Service and Methods Demonstration Program Annual Report U.S. Department of Transportation, November, 1975, p. 187.

[2] Estimated at 50% of lower-level seated capacity.

[3] Clearances must be two inches or more above this figure due to bus bounce.

The eight British Leyland vehicles, originally scheduled to be delivered in December 1975, did not arrive in port until August 17, 1976. On August 18, the buses were unloaded and traveled in caravan style from the port of entry in Newark, New Jersey, across the George Washington Bridge to the MaBSTOA 146th Street garage facilities. Prior to arrival of the DDBs, routes to Manhattan had to be selected carefully due to the bus height. Arrangements were made with local authorities along the route to Manhattan for police support to minimize disturbance to the local traffic.

Pre-service vehicle inspection was handled in the same manner as for conventional buses, and included safety checks, lubrication and oil changes. Following the driver and mechanic training period, the eight DDBs were displayed in New York, with opening-day ceremonies being held on September 14, 1976. The buses entered revenue service the next day.

Several modifications had to be made to the routes, to the facilities which would house the DDBs, and to the equipment which would be used to service the DDBs. In preparing the New York streets for the operation of the double deck buses, necessary route modifications had to be identified. Preparatory activities included modifying routes where necessary to allow for the 14.5-foot bus height plus an additional two inches for suspension rebound. Necessary route modifications included trimming trees (performed by the Department of Parks) and modifying street lights and traffic lights (accomplished by the Broadway Maintenance Department). Work was performed at no cost to MaBSTOA. (Due to the height of the double deck vehicles, a special permit was required to operate the vehicles on the city streets.)

Routes were selected primarily because of potential passenger loadings, height constraints, and proximity to eligible garaging and maintenance facilities. The depot was selected to be near the specific demonstration routes and to have adequate vertical clearance for entry to the depot and internally. Several other Manhattan routes could be utilized in future revenue service.

Tires on the DDBs required an unusually high amount of pressure for proper performance: 120 psi. This exceeded the capabilities at the 146th Street depot, so arrangements had to be made for installation of a reserve air tank.

The transit workers union raised some issues stemming from the introduction of the double deck buses. One issue was the increased wages of $0.10 an hour for the double deck bus drivers. The justification for this request was that the vehicles required additional skill and attention in operation compared to the conventional bus. This request was waived by the union for the duration of the demonstration, only to be revived later. A premium pay of $0.25 per hour was enacted as a result of arbitration for the spring driver "pic"[1] (route selection) only. Another issue was to modify the union contract due to the necessity of shuttling drivers from the 132nd Street depot, where they were dispatched, to the 146th Street depot, where the double deck buses were kept (again, due to vehicle height). This issue was resolved by building travel time (extra pay) into the schedule.

Mechanic training of 18 persons was for 20 hours and involved lectures, slides, and on-the-job experience. A total of 250 personnel received two-hour pay for break-in driver training on the DDB.

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[1]Driver seniority entitles drivers to their choice ("the pic") of routes several times each year.

3.2 SERVICE IMPLEMENTATION AND MAJOR EVENTS

Operational problems were encountered from the start of revenue service. Those problems associated with the vehicle are discussed in Chapter 4.

One bus driver, not following a modification to Route M-4 that had been made due to the height of the DDB, collided with an overpass on an approach to the George Washington Bridge. The bus was sufficiently damaged that it had to be withdrawn from service for repair. The bus was returned to service six weeks later.

On-board data collection activities were conducted on the DDBs and conventional buses during October 1976 to obtain passenger-related information.[1] Dwell time and passenger load studies were also conducted. In addition, interviews were held with drivers, mechanics, and dispatchers to assess reactions to the DDBs as compared with conventional buses.

The buses were being integrated into the fleet when severe cold weather resulted in the heating system's being unable to maintain acceptable ambient temperatures on the lower deck. All eight buses were withdrawn from service in late December 1976 and did not re-enter regular revenue service until mid-February 1977. From mid-February until the end of May, revenue service continued with an average of four to five buses in daily service.

Contrary to pre-demonstration indications, the drivers' union petitioned for a premium pay of $0.25 per hour. This request was submitted to arbitration and was ruled in favor of

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[1]Results of this effort and the May 1977 data collection effort are discussed in Chapter 6.

ɜ union. This temporary premium increment went into effect early May 1977 and was to expire in the fall of 1977. At e time of publication of this report, the premium pay was ill in effect.

A second series of data collection activities occurred ı May 1977 when an on-board data collection effort was ɔnducted by MaBSTOA personnel concerning passenger informa- ion and attitudes. In addition, dwell times and passenger oad statistics were collected. Interviews were also held ith drivers, mechanics, and dispatchers.

.3 MEDIA RESPONSE

During the demonstration period, considerable press was iven to the vehicles. Initially, as the anticipation grew, he press was quite favorable. As problems developed with he buses' reliability, less-favorable articles appeared more requently in New York and nearby papers.

This trend can be seen in the following selected chrono- ical sequence of headlines:

August 19, 1976, Reporter Dispatch: "Doubledecks return to New York Streets"

August 19, 1976, The New York Times: "Double-Decker Bus Returning to New York"

August 19, 1976, Staten Island Advance: "Piggyback buses, by Jove! Queen Marys back on Fifth"

ugust 20, 1976, Daily News: "Hey, Look What's Back"

ıgust 22, 1976, The Sunday Record: "Riding high again. The doubledeckers are back"

August 30, 1976, Newsday: "The big city rides high once again"

September 9, 1976, Reporter Dispatch: "Double-deckers too tall for city"

September 9, 1976, The New York Times: "Double-Decker Buses Force Some Changes"

September 15, 1976, Daily News: "Give a Big Cheer, the Tall Buses are Here!"

September 15, 1976, The New York Times: "Double-Deck Buses Make Debut and Stop Traffic (Pedestrian)"

September 15, 1976, New York Post: "Double Decker, Double Trouble"

September 16, 1976, Daily News: "Deckers' Double Trouble"

September 18, 1976, The New York Times: "Breakdowns Plague New Double-Deckers"

September 18, 1976, Daily News: "Blimey, Lemons! Buses are 2-Tiered Trouble"

September 23, 1976, Daily News: "Double-Decker in a Crunch"

November 6, 1976, New York Post: "Doubledeck Buses rising to Occasion"

January 27, 1977, Daily News: "Cold Ruins 8 Lemons -- the TA's"

4. VEHICLE-RELATED ISSUES

One major intent of the DDB Demonstration Project was to assess the capability of the DDBs to provide reliable increased passenger capacity without a proportionate increase in costs or schedule changes. From both the operating data and personnel (drivers, mechanics, and dispatchers) comments, it was apparent that two major vehicle-related problems complicated the assessment:

1) <u>Foreign manufacture</u>. This resulted in poor communication, design unfamiliar to the drivers and mechanics, lack of spare parts and appropriate (metric) tools, and long delays in obtaining spares. If the buses had been purchased as a regular part of the bus fleet, and not as part of a demonstration, it is likely that adequate numbers of tools and spares would have been available.

   While most mechanics seemed to feel that the conventional bus provided better day-to-day service (dependability), there was a general feeling that the double deck bus still was not properly broken in and, therefore, because of inadequate information, tool availability and experience, the servicing of the double deck bus was still more difficult. Some of the problems were in getting used to the double deck bus, not having appropriate tools with which to work on the double deck bus, learning the standards and metric system related to the double deck bus, and recognizing different features about the double deck bus (such as the transmission, undercarriage and suspension).

2) Prototypical nature of the DDBs. While the buses were basically production-line vehicles, modifications were made that affected the reliability of the vehicles at least initially in the demonstration.

Major problems encountered with the double deck bus related primarily to the electrical, cooling, and heating systems, each of which was specially designed for the NY Leyland bus. Loads experienced on all three sub-systems were well in excess of design capabilities, and considerable initial expense was incurred in redesign and integrating these three sub-systems into the overall Leyland system.

Overall, the mechanics, drivers, and dispatchers seemed to feel that the double deck bus could serve a useful purpose in the system once it had completed its "debugging period" and had arrived at a point where it was requiring only routine maintenance and repair.

4.1 VEHICLE MODIFICATIONS AND DELAYS

Because of various regulations and because of inadequate initial design, a number of modifications were necessary. The double deck buses ordered from British Leyland were basically standard production-line vehicles. Modifications included left-hand drives, pollution-control devices, and U.S. safety standard windows (glass). Obtaining emissions certification and performing the vehicle modifications consistent with U.S. safety and operational standards were influential factors in the delivery delay of approximately one year. In addition, a dock strike in England and problems associated with fitting the packaged air conditioning units produced by the American firm, Trane, contributed to the delay.

British Leyland Motors (BLM) petitioned the National Highway Traffic Safety Administration for exemption from four safety standards. (These are set forth in Appendix F.) Waivers were denied, and vehicle modifications were made to assure compliance with these four safety standards. BLM determined that costs to certify that the bus engines complied with Environmental Protection Agency (EPA) regulations would be excessive, and an exemption was requested. Waivers were obtained from the EPA emission testing requirements.

Originally scheduled to be delivered in December 1975, the eight British Leyland vehicles did not arrive in port until August 17, 1976. Due to the height of the double deck vehicles, a special permit was required to operate the vehicles on the city streets.

Operational problems were encountered from the start of revenue service--September 15, 1976. The major problem area was associated with the air conditioning system and arose from the apparent impact that the addition of the air conditioning had on other sub-systems on the bus. These were the first Leyland buses to be air conditioned, and the alternator system could not provide enough power to operate the air conditioning system in addition to fulfilling its other requirements. Another recurring problem was related to the door-brake interlocks. Due to mechanical problems during October 1976, an average of four buses were in service at any time (the historical percentage of on-road hours for MaBSTOA vehicles has been in excess of 85 percent).

When the DDBs first arrived, they had large glass windows with vent openings at the top. In October 1976 these windows were replaced with solid windows made of a glass/plastic combination, with no vent openings. This modification was done to minimize problems associated with vandals pushing out the side windows, and potential breakage. In May 1977, these windows were again modified so that they resembled the original British design except they were of a glass/plastic combination. This final modification was necessary to allow for ventilation should the air conditioning fail. These new windows were to be opened only in case of an emergency, but the unreliability of the air conditioning system resulted in over-heated passengers' continually pushing them open.

4.2 REVENUE SERVICE PERFORMANCE

A vast majority of dispatchers felt that the double deck bus fell behind schedule more often than the conventional bus (generally, five to 15 minutes), particularly during peak periods and in the more congested downtown areas. They attributed this to higher passenger patronage and consequent longer dwell times at stops. Statistics on schedule adherence given in Chapter 5 do not indicate that the DDB is necessarily less dependable than the conventional bus. Recent performance of the DDB on Route 5 suggests that an improvement may have occurred from October 1976 to May 1977, with the DDB actually achieving a slightly better performance than the conventional buses.

Drivers indicated that the conventional bus was the easier of the two in controlling on-board activity, that it was more reliable and dependable, and that it was more likely to maintain schedule adherence.

The dispatchers, about two to one, indicated that they felt the double deck buses appeared to be carrying more passengers per run.

The buses were being integrated into the fleet when severe cold weather resulted in the heating system's being unable to maintain acceptable ambient temperatures on the lower deck. All eight buses were withdrawn from service in late December 1976 and did not re-enter regular revenue service until mid-February 1977. From mid-February until the end of May, revenue service continued with an average of four to five buses in daily service.

During March and April 1977, the DDBs were averaging about 70 percent on-road hours, primarily because problems were still being encountered with the air conditioning. In May this figure deteriorated even further, as DDBs were out of service for modifications to the windows.

During the summer months, DDBs were put into the shop for heating retro-fits and air conditioning conversions. One bus remained in the shop for four weeks waiting for necessary parts from BLM. During this period, the Leyland's percentage of on-road hours (actual in-service hours compared to projected total on-road hours) ranged on a weekly basis from 0% to 47%. Alternator problems again developed, and six buses were down during one four-week period.

4.3 TRANSIT PERSONNEL COMMENTS

In interviewing the dispatchers, mechanics, and drivers of the double deck buses in New York City, overall reactions did not change from the initial interviews in October 1976 when revenue service was initiated, to the comments made in April 1977. Reactions generally favored the conventional bus. In the opinion of the evaluation team, much of the preference appears to be due to the fact that the double deck buses in New York were still being broken-in and had not yet achieved a predictable and acceptable service performance. It is felt that the comments which follow should be tempered by this fact.

When asked about servicing and maintenance functions, the mechanics indicated that both vehicles were essentially the same. It appeared to be easier to change oil and the oil filter on the double deck bus; while it was easier to check the transmission fluid level, to wash the vehicle exterior, and to clean the vehicle interior on the conventional bus. In most other cases, such as servicing the transmission, engine tuneups, and rotating tires, the mechanics felt that they had inadequate experience with the double deck bus to really make fair comparisons.

Drivers tended to react more favorably to the ease of operation of the double deck bus and felt that it outranked the conventional bus in the areas of steering efforts, steering precision (tracking), cornering stability, maneuverability, and noise level. Most of the drivers felt that the vertical size of the bus did require care in avoiding obstructions. They also exhibited a concern about monitoring passenger movements to prevent on-board accidents and behavioral problems, as well as communication with passengers. The drivers felt that it was easier to monitor passenger movement on the conventional bus than on the double deck bus. Because of the difference in the levels, the drivers felt strongly that activities upstairs were different from those downstairs, primarily due to school-age children during the daytime and the inability to control behavior on the upper level.

Most of the drivers did not feel that they had any serious problems in acquainting themselves with the buses. Those that did, said that any new bus requires a certain amount of learning. The drivers indicated that the operation of the rear door by the driver rather than by the passenger was a detriment and difficult to control.

The drivers felt, almost unanimously, that the conventional bus far outranked the double deck bus with respect to service dependability. Again a majority of the drivers felt that the double deck bus still was not a proven vehicle and needed more time before fair judgment could be made.

In spite of problems with the double deck bus, both dispatchers and drivers felt that the passengers seemed to prefer the double deck bus over the conventional bus (an observation which is consistent with the on-board passenger survey reported in Chapter 6) and that the upper level was preferred over the lower level, with the exception of the elderly and handicapped, who seemed to prefer the lower level.

5. TRANSIT OPERATOR-RELATED ISSUES

This chapter focuses on transit operator-related issues, with particular emphasis on vehicle operational characteristics during revenue service and consequent effects on vehicle efficiency. The following topics are discussed in this chapter with respect to their impact on the assessment:

1) Mechanical reliability and maintainability.

2) Operating costs.

3) Passenger throughput and dwell times.

4) Schedule adherence.

5) Safety and accidents.

6) Vandalism and crime.

7) Vehicle size as it affects garaging and route availability.

Also discussed are considerations of such things as union demands and unusual insurance costs. Figure 6 illustrates the relationship among these factors as they influence vehicle efficiency.

5.1 MECHANICAL RELIABILITY AND MAINTAINABILITY

Before making comparisons between the two bus types in terms of in-service reliability, certain points should be noted:

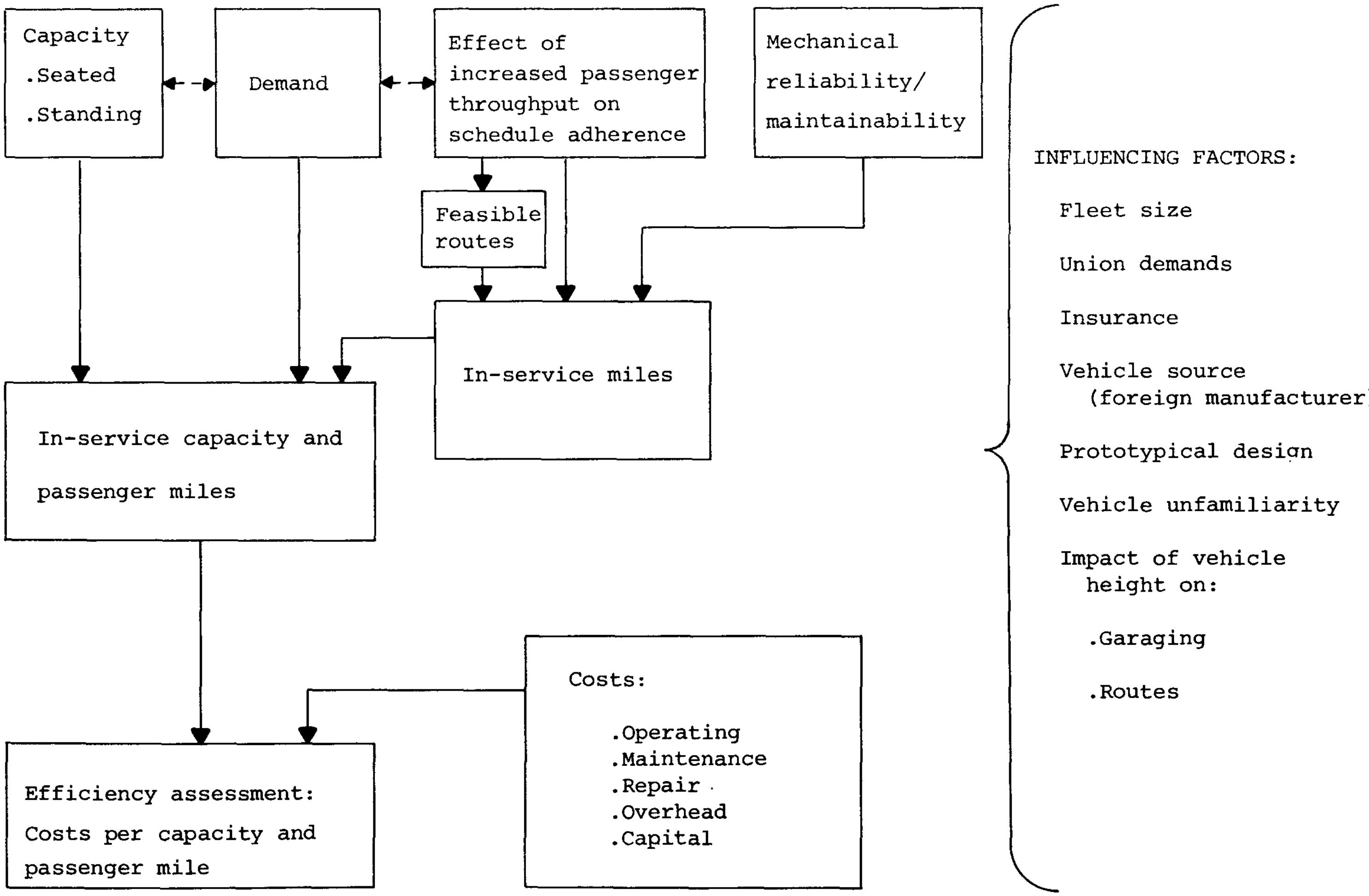

FIGURE 6. VEHICLE OPERATIONAL CHARACTERISTICS AND CONSEQUENT EFFICIENCY

1) Double deck vehicles have preventative maintenance schedules similar to the conventional buses, namely at 3,000, 6,000, and 24,000 miles. At the time of cessation of the data collection program for this evaluation, none of the double deck buses had accumulated more than 15,000 miles; hence, none of the buses experienced the 24,000-mile heavy service overhaul.

2) The four conventional buses had all accumulated more than 200,000 miles before completion of the data collection and were burning considerably more oil than the double deck buses. In addition, all of the conventional buses had been through many 24,000-mile preventative maintenance actions. The failures experienced by the conventional buses were considered normal for buses of their ages in the wear-out phase of their existence.

A summary of service orders (maintenance actions) by bus by month appears in Table 7.

During the first few months of operation, the double deck fleet was averaging almost 900 in-service miles less per bus per month than the conventional buses. This figure dropped to approximately 250 less in-service miles per bus per month during the March to May 1977 time frame. If this trend had continued, the double deck fleet might have approached the same performance figure as the conventional bus.

However, during May, the double deck buses were taken out of service to install heaters and refit window panes; and during the summer months after the demonstration period, the DDB fleet saw little service due to modifications to the

TABLE 7. MONTH AND TYPE OF SERVICE ORDERS PERFORMED ON DEMONSTRATION VEHICLES[1]

Vehicle No.	1976 Sept.	Oct.	Nov.	Dec.	1977 Jan.	Feb.	Mar.	Apr.	May
Conv:									
8614	6,000	24,000	3,000	--	6,000	3,000	--	6,000	--
8615	3,000	6,000	--	3,000	6,000	--	3,000	--	6,000
8616	24,000	3,000	6,000	--	--	Heavy	6,000	--	3,000
8617	--	6,000	3,000	--	6,000	3,000	--	~~6,000~~ 24,000	--
DDB									
D-1	Pre-insp.	--	6,000	--	--	3,000	--	6,000	3,000
D-2	Pre-insp.	--	--	--	--	--	3,000	6,000	--
D-3	Pre-insp.	--	--	--	3,000	--	6,000	--	3,000
D-4	Pre-insp.	--	6,000	--	--	--	3,000	--	3,000
D-5	Pre-insp.	--	6,000	--	--	--	6,000	--	3,000
D-6	Pre-insp.	--	6,000	--	--	--	6,000	--	3,000
D-7	Pre-insp.	--	--	--	3,000	--	6,000	--	--
D-8	Pre-insp.	--	--	--	--	--	6,000	--	3,000

1 - Standard maintenance actions are performed at 3,000, 6,000, and 24,000 mile intervals. No double deck bus reached the 24,000-mile level.

heating system (required as a consequence of the severe winter weather) and failure of the air conditioning system and consequent conversion.

During the demonstration operating period, the conventional buses averaged 4.6 in-service repair calls (or road calls) per bus per month, while the double deck buses averaged almost twice as many per bus at 8.2. The number of in-service repair calls interrupting service are indicated in Table 8, with no trends apparent for either vehicle type. The conventional buses averaged 400 in-service miles per bus between road calls, as contrasted with only 190 for the double deck buses, a ratio of more than two to one. When taking into consideration bus capacity (the DDB at 81 and the conventional at 68), the conventional bus averaged 27,200 capacity-miles between service interruption, while the DDB averaged 15,390 (a ratio of 1.77 to 1).

MaBSTOA's experience has been that a given bus will be down 5% of the time for scheduled maintenance and another 5% to 10% for unscheduled repairs and in-service repair calls which interrupt service. Hence, a minimum conventional fleet standard is 85% of scheduled hours actually on the road. As can be seen in Figure 7, the double deck fleet was approaching this standard, with the exception of the winter months during which the heating system could not compensate for the low internal ambient temperature caused by extreme cold. However, as was noted above, during the summer months after the demonstration period, DDB reliability deteriorated.

In May 1977, MaBSTOA issued a report summarizing problems associated with the Leyland coaches. This document is reproduced in Appendix G and is indicative of difficulties encountered during the "burn-in" phase.

TABLE 8. IN-SERVICE REPAIR CALLS (ROAD CALLS) INTERRUPTING SERVICE, AND IN-SERVICE MILES BETWEEN ROAD CALLS

Month	Total Road Calls[1]		Total In-Service Miles		Miles Between Road Calls Per Bus		Capacity-Miles Between Road Calls[2] Per Bus	
	CVB	DDB	CVB	DDB	CVB	DDB	CVB	DDB
1976								
Oct.	16	38	9,032	8,258	560	240	38,080	19,440
Nov.	19	52	9,072	6,861	480	130	32,640	10,530
Dec.	14	93	-[3]	-	-	-	-	-
1977								
Jan.	11	*[4]	-	-	-	-	-	-
Feb.	21	*[4]	8,863	-	420	-	28,560	-
Mar.	24	48	6,914	12,027	290	250	19,720	20,250
Apr.	17	71	8,022	14,859	470	210	31,960	17,010
May	24	59	6,628	10,084	280	170	19,040	13,770
TOTALS	146	361	48,531	52,089	400[5]	190[5]	27,200	15,390

[1] Four conventional buses operating every month. Six double deck buses in October and November and eight for remaining months.

[2] Double deck bus capacity taken as 81 and GM bus as 68.

[3] A "-" means data unavailable, due to computer failure.

[4] A "*" means buses were not operating.

[5] Based upon 121 road calls for conventional buses (Dec. and Jan. not included) and 268 road calls for double deck buses (Dec., Jan., and Feb. not included).

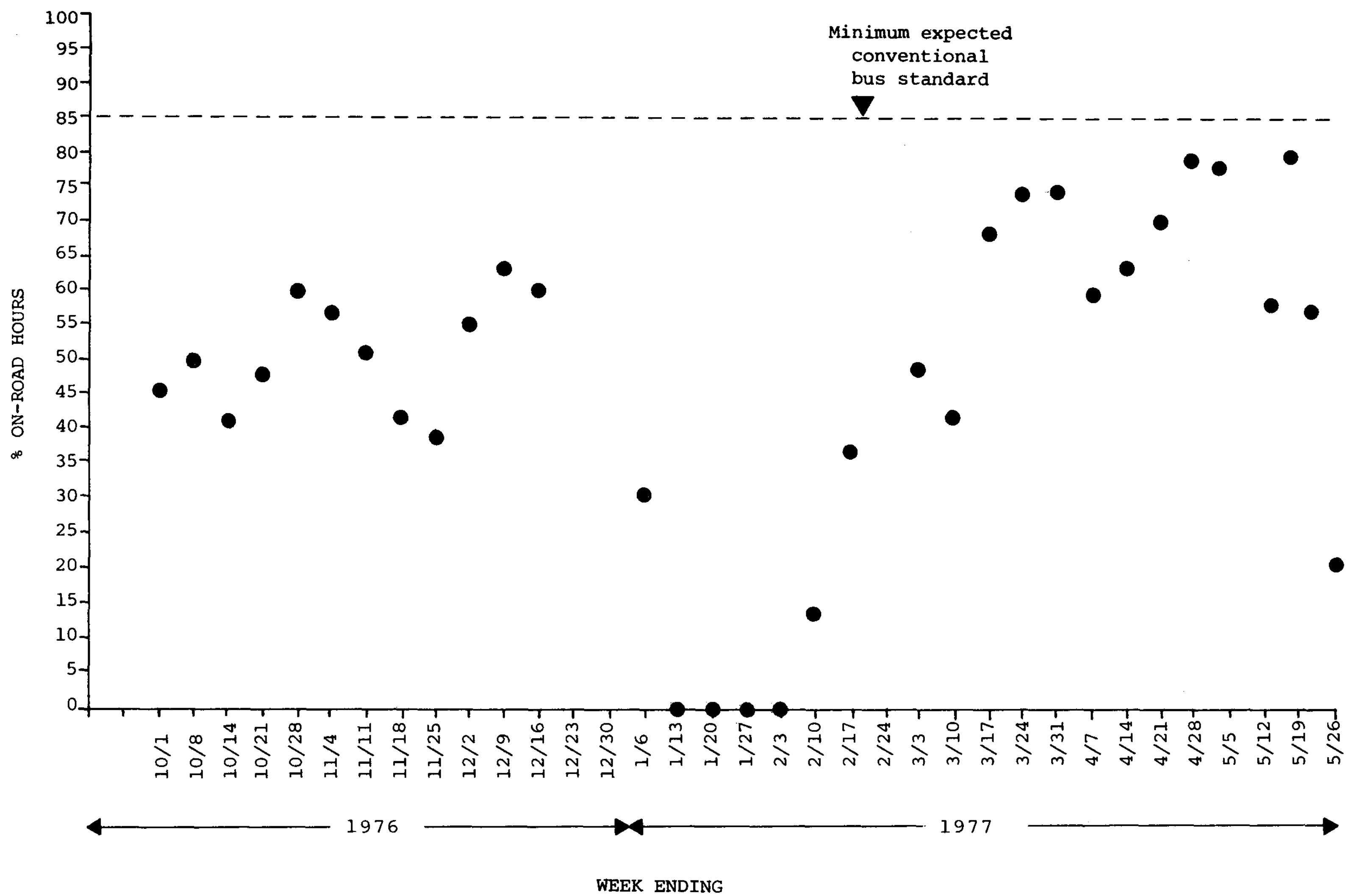

FIGURE 7. PERCENT OF SCHEDULED HOURS ACTUALLY ON-ROAD FOR DDB FLEET

The top five defects interrupting service are indicated in Table 9, ranked first by frequency of occurrence on the double deck bus and then by frequency of occurrence on the conventional bus. The primary category for both bus types was associated with electrical failures, although electrical failures occur almost twice as frequently with the double deck bus.

It is maintained by both MaBSTOA and British Leyland that installation of the air conditioning (a first for the Leyland) resulted in the alternator's electrical supply being inadequate, precipitating other electrical problems (see Appendix G) which were not associated with the inherent Leyland design. According to MaBSTOA, once the heating, air conditioning, and associated electrical problems on the DDBs have been rectified, the major causes of failures should have been eliminated. When this occurs, the double deckers should approach the conventional counterparts in terms of average monthly in-service mileage.

Adequate numbers of metric tools and spare parts are essential to vehicle availability. MaBSTOA experienced numerous instances in which vehicles were idle because adequate spare kits had not been ordered at the start of the demonstration and the required spare parts were not available locally.

A realistic comparison cannot be made between the conventional and DDB repair and maintenance costs per vehicle-mile since the reported DDB costs did not include items covered by warranty and would, in all probability, be higher once the warranty period expires. MaBSTOA management feels that the

TABLE 9. COMPARISON OF MAJOR IN-SERVICE REPAIR CALLS FOR DEFECTS INTERRUPTING SERVICE

RANKED BY DOUBLE DECK				
Type of Defect	Double Deck		Conventional	
	No.	%	No.	%
Electrical	138	36.7	29	19.9
Heating	66	17.6	16	11.0
Body	34	9.0	16	11.0
Miscellaneous Mechanical	24	6.4	3	2.1
Air Conditioning	23	6.1	1	0.7
Other	91	24.2	81	55.5
TOTALS	376	--	146	--

RANKED BY CONVENTIONAL BUS				
Type of Defect	Conventional		Double Deck	
	No.	%	No.	%
Electrical	29	19.9	138	36.7
Brakes	18	12.3	13	3.5
Engine	17	11.6	11	2.9
Heating	16	11.0	66	17.6
Body	16	11.0	34	9.0
Other	50	34.2	114	30.3
TOTALS	146	--	376	--

DDB reliability and maintainability costs would average about the same as conventional buses once the warranty period expires.

5.2 OPERATING COSTS

Costs associated with fuel, oil, and drivers' salaries make up the major portion of the operating costs. Monthly data on in-service mileage, fuel and oil consumption, and days in service are given in Appendix H for each of the eight double deck and four conventional buses. Cumulative demonstration mileage and average monthly mileage (miles per gallon of fuel and miles per quart of oil) by bus type appear in Tables 10 and 11.

During the in-service evaluation period (once the double deck buses re-entered regular revenue service following the severe cold weather in January and February), the fleet fuel consumption in miles per gallon remained consistently better than that for the four conventional counterparts. At the same time, the newer double deck buses required considerably less oil to be added between regular oil changes, achieving an average of 3,260 miles per quart versus 96 miles per quart for the conventional fleet. The newness of the buses makes any comparison on oil consumption meaningless.

Driver salaries in New York, at the time of preparation of this report, were $7.11 per hour, with a premium pay of $0.25 per hour for the double deck bus drivers. This premium pay was to have been discontinued in the fall of 1977, but was still in effect at the time of publication of this report.

At the time of preparation of this report, diesel fuel for the buses cost $0.3755 per gallon, and oil cost $0.96 per quart. It was initially intended to develop an overall cost

TABLE 10. VEHICLE OPERATION MILEAGES DURING PERIOD SEPTEMBER 1976 - MAY 1977

Bus	Cumulative Demonstration Mileage	Months in Operation	May 31, 1977 Total Life Mileage
Conventional			
8614	12,469	6	228,831
8615	12,573	6	219,811
8616	14,640	6	223,267
8617	8,849	6	233,884
Average Per Bus Per Month	2,022	N/A	N/A
Double Deck			
D-1	7,278	5	13,180
D-2	3,031	5	8,884
D-3	4,875	3	12,041
D-4	7,943	5	12,357
D-5	8,034	5	13,657
D-6	8,813	5	14,108
D-7	6,586	5	10,220
D-8	5,529	3	12,057
Average Per Bus Per Month	1,476	N/A	N/A

TABLE 11. IN-SERVICE MILEAGE, FUEL AND OIL CONSUMPTION FOR DOUBLE DECK (DDB) AND CONVENTIONAL (CVB) BUSES

Month	Average in-service miles per bus		Average miles/gallon		Average miles/quart	
	DDB	CVB	DDB	CVB	DDB	CVB
1976						
Oct.	1,376	2,258	3.1	3.1	2,060	65.4
Nov.	1,144	2,268	3.1	3.4	--[1]	69.3
Dec.[2]	--	--	--	--	--	--
1977						
Jan.[2]	--[3]	--	--[3]	--	--[3]	--
Feb.[3]	--[3]	2,216	--[3]	3.2	--[3]	113.6
Mar.	1,503	1,729[4]	3.5	3.2	2,000	108.0
Apr.	1,857	2,006	3.6	3.2	7,430	114.6
May	1,261	1,657[4]	3.3	3.0	2,520	265.1
Monthly Averages	1,447	2,022	3.4	3.2	3,260	95.9

1 - No oil added.

2 - Computer failure; no data available.

3 - Double deck buses only sporadically in service due to low temperatures.

4 - Bus No. 8617 running into excessive road calls and removal.

estimate for operating both bus types (to include driver salaries and fringes, gas and oil costs, and repair and maintenance costs). The short time during which the buses were in revenue service (effectively a "burn-in" period), coupled with the lack of sufficient hard numbers on repair and maintenance costs, make extrapolations somewhat dangerous. It does appear, however, that, with driver salaries the same and once the "burn-in" period has ended, the DDB may not be more expensive to operate and will definitely put more capacity on the road.

Extra costs may be associated with the fact that there is a second level and more time is therefore required for internal inspection and cleaning.

5.3 PASSENGER THROUGHPUT AND DWELL TIMES

The relationship between dwell time and passenger throughput (throughput is defined as the number of passengers getting on and off the vehicle), and its consequent effect on total run time, are explored in this section. A discussion of the impact of this on schedule adherence follows in the next section.

A total of twelve double deck and twelve conventional bus runs were sampled in October 1976 and May 1977 using the form indicated in Appendix C, Figure C-1. At each stop, a count was recorded of the number of passengers boarding and alighting the bus, as well as the time in seconds it took to handle these passengers. The following derivative measures were calculated for each run:

1) Total number of throughput passengers.

2) Average dwell time in seconds per throughput passenger.

Dwell time and passenger throughput data are summarized in Appendix I.

In an effort to isolate possible differences between the DDBs and the conventional buses with respect to dwell times and passenger throughput, a number of statistical procedures were employed. In some instances the rigorous assumptions were probably not satisfied, but it was felt that approximations were all that were necessary to identify possible areas of difference. Details of these statistical procedures appear in Appendix D.

An initial analysis was made between total run dwell times and total run passenger throughput (see Figure 8). Least-square regression equations were calculated for conventional buses and for double deck buses, with the equations being forced to fit through the origin. The two regression equations, where Y is total dwell time in seconds and X is total run throughput in passengers, are:

For the conventional buses:

$$Y = 3.508\ X$$

For the double deck buses:

$$Y = 3.531$$

Both regression equations are significant (at better than the .01 level of significance) and are also not significantly different from each other. Hence, a single pooled regression equation was computed:

$$Y = 3.521\ X$$

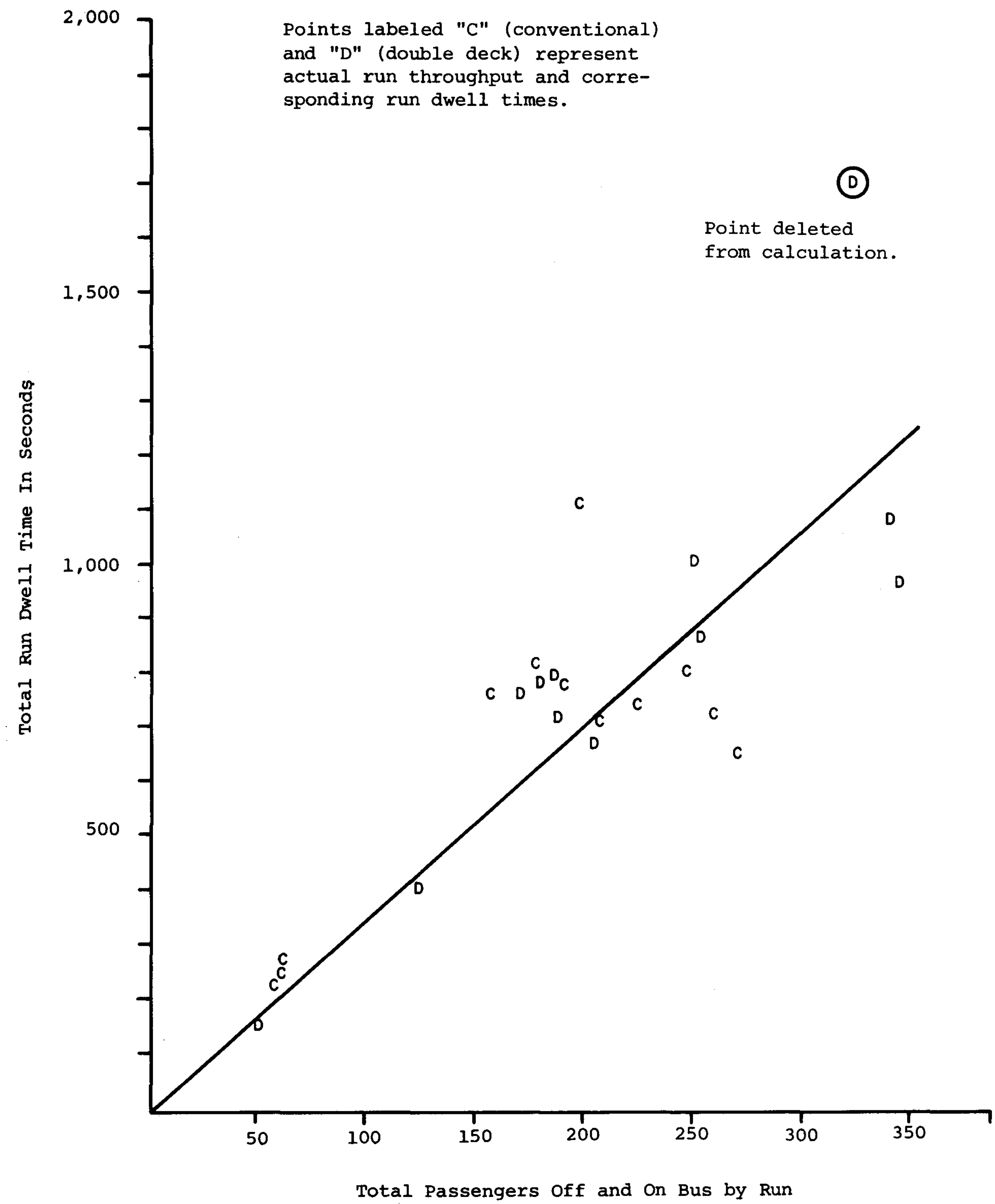

FIGURE 8. COMPARISON, BY RUN, OF TOTAL DWELL TIME AND TOTAL NUMBER OF PASSENGERS ON AND OFF BUS

The extreme double deck bus point (300 throughput passengers and 1,718 seconds total dwell time) was eliminated from the calculations as an obvious outlier.

The implication of this common regression equation is that the Leyland buses appear to be processing passengers at the same rate as the conventional buses (approximately 3-1/2 seconds per boarding and alighting passengers). The conclusion is that use of the internal stairwell does not appear to impede passenger circulation.

Average dwell time per throughput passenger was classified by vehicle type and time of day (peak and midday). Summary mean values appear in Table 12. Analyses of mean differences yield no significance at the .05 level. These results are consistent with the findings of the regression analysis.

TABLE 12. AVERAGE DWELL TIMES PER THROUGHPUT PASSENGER FOR DOUBLE DECK AND CONVENTIONAL BUSES DURING PEAK AND MIDDAY PERIODS

Bus Type	Service Period		Bus Averages
	Peak	Midday	
Double Deck	3.92	3.92	3.92
Conventional	3.22	4.15	3.92
Service-Period Averages	3.57	4.04	3.92

The findings on dwell time per throughput passenger have implications with respect to scheduling of the double deck buses. For the sample data, dwell time ranged from 14.0% to 23.4% of actual run times. If the double deckers tended to carry more passengers than the conventional buses used on the same route, then one schedule for both vehicle types could not be maintained.

Although it was not the purpose of the demonstration to collect statistics on passenger loadings (i.e., demand), passenger counts were necessary for the dwell time, throughput, and schedule adherence analyses. For the 24 similar sample cases (twelve of each bus type), the DDBs averaged a total load of 214 passengers per run, as contrasted with 177 for the conventional buses, a ratio slightly better than the bus capacities.

Results on schedule adherence are discussed in the next section. Viable scheduling options using the Leylands are explored in the final chapter of this report.

5.4 SCHEDULE ADHERENCE

For purposes of reporting data in this section of this report, data have been classified by Route (4 or 5), northbound (NB) or southbound (SB), bus number (D-1 through D-8 for the DDBs and 8614 through 8617 for the conventional GMs), time of day, and run type. With respect to time of day and run type, the following criteria have been used:

1) Time of day. The schedule has been divided into the following four time periods:

   a) Morning peak period, 6:30 AM to 9:00 AM (A)

b) Evening peak period, 4:30 PM to 6:30 PM (P)

c) Midday, 9:00 AM to 4:30 PM (M)

d) Evening off-peak period, 6:30 PM to 11:00 PM (E).

2) On Route 4, the run is classified into the above time periods under the following conditions:

a) On the southbound run, the scheduled time to pass 110th Street and Broadway.

b) On the northbound run, the scheduled departure time from either Pennsylvania Station or 42nd Street and 5th Avenue.

3) On Route 5, the run is classified into the above time periods under the following conditions:

a) Southbound, based upon the scheduled time at 72nd Street and Broadway.

b) Northbound, based upon the scheduled departure time from Houston Street or any dispatch point from Houston north to 25th Street and Broadway.

4) Run types are classified as a full run, with scheduled time greater than 40 minutes (F); a partial run with congestion (PC); and a partial run under less-congested conditions (PLC). For the two routes, the following criteria were utilized:

a) For Route 4, a full runis taken as 135th Street to 42nd Street southbound, and from Pennsylvania Station or 42nd Street to 135th Street, northbound.

b) For Route 5, a full runis taken from Houston Street or any dispatch point up to 25th and Broadway to 135th Street, northbound, and from between 178th and 135th Streets and Broadway to any dispatch station south of 56th and 5th Avenue, southbound.

5) Any other run segments have been treated as partial runs, with those north of 110th Street on Route 4 and north of 72nd and Broadway on Route 5 being considered as less-congested portions (PLC).

Schedule adherence information was collected Tuesday and Wednesday, October 26 and 27, 1976, and again on Tuesday and Wednesday, April 26 and 27, 1977. These days were selected as probably not being influenced by possibly abnormal traffic conditions and for non-severe weather conditions such as one might have encountered during the extremely cold winter and very hot late spring and eary summer months.

Considerably more data were reviewed than have been recorded for the following analyses. More than twice as much demonstration data were available but had to be discarded due to identified inconsistences and unclear recordings.

The procedure utilized in the data search was to track double deck and conventional buses from one dispatch point to another. The dispatch Tally Slip shown in Appendix B was the basic source document. Where data were available for at least two dispatch points, the run was recorded for purposes of analyzing schedule adherence. Each run is classified as to time of day, run type, and scheduled versus actual trip time, as contained in dispatch records. Where several dispatch points were available for a given run, times were utilized for full run and partial run segments. The runs analyzed in Tables 13 - 17 averaged 42.5 scheduled minutes for both the double deck and the conventional buses.

Deviations of actual trip time from scheduled trip time were recorded, and these were converted to percentage of scheduled trip time. For example, if the scheduled trip time is 49 minutes and the actual trip time is 53 minutes, the numerical departure is four minutes behind schedule (-4) or 8.2% late. Detailed data on all run segments are contained in Appendix E.

Based upon the dispatch records, scheduled run times vary by time of day and even within peak or off-peak periods. Summary data on schedule adherence, independent of time of day, run type or direction, are given for Routes 4 and 5 in Tables 13 and 14 respectively. Bus run segments were classified as being behind schedule, on schedule (arrival time and scheduled arrival time recorded exactly the same by dispatch), or ahead of schedule. Data from Route 4 have been combined into a single table as a consequence of determining that there was no significant difference between the fall and spring schedule adherence data. Recorded run times indicated that the double deck bus tended to fall behind schedule more frequently than the conventional bus.

During October the double deck buses on Route 5 tended to fall behind schedule more than the conventional ones (see Table 14). However, the schedule adherence for the Route 5

TABLE 13. SCHEDULE ADHERENCE, ROUTE 4, FALL AND SPRING COMBINED[1]

Bus Type	Behind Schedule No.	% →	On Schedule[2] No.	% →	Ahead of Schedule No.	% →	Totals
Double Deck	21	55.3	13	34.2	4	10.5	38
Conventional	15	37.5	18	45.0	7	17.5	40
TOTALS	36	46.2	31	39.7	11	14.1	78

[1] Arrow indicates direction to read percents.

[2] Dispatch actual arrival time same as scheduled arrival time.

TABLE 14. SCHEDULE ADHERENCE, ROUTE 5, FALL AND SPRING SEPARATELY

Bus Type	Behind Schedule No.	% →	On Schedule No.	% →	Ahead of Schedule No.	% →	Totals
October 1976							
Double Deck	17	42.5	12	30.0	11	27.5	40
Conventional	20	35.1	18	31.6	19	33.3	57
TOTALS	37	38.1	30	30.9	30	30.9	97
April 1977							
Double Deck	11	23.9	18	39.1	17	37.0	46
Conventional	9	30.0	8	26.7	13	43.3	30
TOTALS	20	26.3	26	34.2	30	39.5	76

double deck buses improved dramatically in April and surpassed that of the conventional buses: 23.9% of the DDB run segments were behind schedule, compared to 30.0% of the conventional bus segments.

Results are given in Table 15 for schedule adherence data for full runs (40 minutes or more scheduled) separated into peak and off-peak periods. Once again the data indicate that the double deck bus was more likely than the conventional bus to fall behind schedule.

From the run segment data in Appendix E, summary average percentage departures from schedule by bus type have been calculated by time of day and run type. These data appear in Table 16. For partial runs through congested and through not congested zones, the two bus types averaged about the same percentage departures from schedule. It is over the longer runs (40 to 73 minutes) that the double deck fell behind schedule by a larger average percentage, 5.84%. The conventional bus seems, on the average, to have been about on schedule. If the percentage deviations from schedule are analyzed over all conditions for the two bus types, the DDBs averaged 4.16% behind schedule, as compared with 2.21% behind schedule for the conventional buses.

If actual deviations from schedule in minutes, rather than percentage deviations, are utilized, the results in Table 17 indicate that, except for full runs, the DDB and conventional buses seem to be late by about the same time. For the full runs, the DDBs average 3.0 minutes late, while the conventional buses averaged .3 minutes early. Overall, the DDBs averaged 2.2 minutes behind schedule, while the conventional buses averaged .3 minutes late. These results are consistent with the findings using percentage departures

TABLE 15. SCHEDULE ADHERENCE, FULL RUNS, PEAK VS. OFF-PEAK PERIODS

Bus Type	Behind Schedule		On Schedule		Ahead of Schedule		Totals
	No.	% →	No.	% →	No.	% →	
Double Deck							
Peak	12	41.3	8	27.6	9	31.0	29
Off-Peak	16	42.1	15	39.5	7	18.4	38
TOTALS	28	41.8	23	34.3	16	23.9	67
Conventional							
Peak	9	30.0	14	46.7	7	23.3	30
Off-Peak	14	35.9	9	23.1	16	41.0	39
TOTALS	23	33.3	23	33.3	23	33.3	69
BOTH VEHICLES	51	37.5	46	33.8	39	28.7	136

TABLE 16. AVERAGE PERCENTAGE DEPARTURES FROM SCHEDULE BY BUS TYPE, TIME OF DAY, AND RUN TYPE

Bus Type	Run Type	Time of Day		Average (%)
		Peak (%)	Off-Peak (%)	
Double Deck	Full Run (40-73 min.)	- 3.39	- 7.77	- 5.84
	Congested, Partial Run (12-40 min.)	- 9.38	-17.96	-13.28
	Not Congested, Partial Run (13-40 min.)	- 3.47	- .30	.53
Conventional	Full Run (40-73 min.)	- .25	.55	.20
	Congested, Partial Run (12-40 min.)	-12.84	-14.98	-13.73
	Not Congested, Partial Run (13-40 min.)	-11.40	- .44	- 2.82
Averages		- 3.60	- 2.91	- 3.17

TABLE 17. AVERAGE DEPARTURES FROM SCHEDULE IN MINUTES BY BUS TYPE, TIME OF DAY, AND RUN TYPE

Bus Type	Run Type	Time of Day		Average
		Peak (Min.)	Off-Peak (Min.)	(Min.)
Double Deck	Full Run (40-73 min.)	- 1.9	- 3.9	- 3.0
	Congested, Partial Run (12-40 min.)	- 1.7	- 3.7	- 2.5
	Not Congested, Partial Run (13-40 min.)	- 1.4	- .9	- 1.0
Conventional	Full Run (40-73 min.)	.0	.5	.3
	Congested, Partial Run (12-40 min.)	- 1.3	- 3.2	- 2.1
	Not Congested, Partial Run (13-40 min.)	- 1.9	- .4	- .8
Averages		- 2.9	- 1.3	- 1.3

from schedule. While the data did indeed indicate that the double deck buses fell behind schedule more often than the conventional buses, the differences in schedule adherence were found not to be statistically significant at the .05 level. However, this lack of significance was probably due to the large amount of variability in the sample data and the relatively small sample sizes. It was felt by the evaluators that a difference did, in fact, exist. This was further substantiated by observations made by drivers, dispatchers, and other operating personnel, although these individuals seemed to have overstated the actual delays.

5.5 SAFETY AND ACCIDENTS

During the brief revenue-service period, there were too few driver-related accidents (accidents in which a driver was injured) to pinpoint differences between the two bus types (see Table 18). With respect to vehicle-related accidents (accidents in which the bus was damaged), in only one instance can the accident be associated with the bus type. In this situation, the driver did not follow a route modification that was required due to bus height and, as a consequence, the double deck bus struck the bottom of an overpass. There were no injuries to passengers as a consequence of this accident. In all other cases, the accidents were similar for the two types of buses (struck an auto, struck another bus in the shop, unknown cause, etc.). Since accidents on eight double deck buses are being compared with those on four conventional buses, and since the miles traveled by each vehicle type differed significantly, accident rates in Table 8 are given per 100,000 vehicle-miles.

TABLE 18. ACCIDENT REPORTS, SEPTEMBER 1976 - MAY 1977[1]

Type of Damage or Injury	Conventional Buses		Double Deck Buses		Total Number
	Number	Per 1000,000 Vehicle Miles	Number	Per 100,000 Vehicle Miles	
Damage or injury caused to:					
Vehicle	3	6.2	10	19.2	13
Driver	2	4.1	1	1.9	3
Passenger	1	2.1	9	17.3	10

In the case of passenger-related accidents, however, there was a marked difference between the two bus types. Four of the nine double deck bus accidents were associated with use of the stairwell to the upper level. In two cases, passengers fell down the stairwell; and in two cases passengers reported an injured leg as a consequence of climbing the stairs. There were no claims filed against MaBSTOA. Some passengers claimed that the stairwell was too narrow, too steep, or difficult to use when the bus is in motion. However, 75% of those surveyed thought that the internal stairs were easy to use.

The balance of the passenger-related accidents on both bus types were associated with movement within the bus and problems associated with the doors in boarding or alighting. Based upon past MaBSTOA management experience, the number of accidents was not judged to be unusual for either bus type during this time period.

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[1]Source: MaBSTOA Accident Damage Reports.

5.6 VANDALISM AND CRIME

Although it was initially felt that the unattended upper level of the DDB might be more susceptible to vandalism, such was not the case. There were three reported instances of vandalism for the double deck buses and two for the conventional buses. All five cases involved an object's (egg, rock, snowball, steel bolt, and one unknown object) being thrown at the bus from the outside. No personal injuries resulted, but some property damage resulted; e.g., broken windows, soiled interior and soiled driver uniform.

As in the case of vandalism, it was anticipated that the unattended upper level might be conducive to more crime, but reports did not indicate any increase in crime on these two routes. Periscopes had been installed on the buses so that the driver could monitor activity on the upper level. These may have functioned as crime deterrents, but most passengers were probably not aware of their existence. There was only one instance of crime reported on each bus type. In both cases passengers were abusive and threatening and were later removed by the police. The specific routes involved in the demonstration traversed relatively safe residential, business, and commercial neighborhoods.

5.7 VEHICLE SIZE AS IT AFFECTS GARAGING AND ROUTE AVAILABILITY

As discussed in Chapter 4, vehicle configuration is an important factor when considering the introduction of the double deck bus. Vehicle dimensions are a determinant of accessibility to storage and maintenance facilities. Vertical clearance is perhaps the most important consideration, although the ability to get at vehicle parts for cleaning and repair is also important. In Manhattan, only two such facilities could handle the buses because of their height. The one on 146th Street was selected due to its proximity to the demonstration routes.

Routes were carefully checked for vertical clearances; trees were trimmed and lights were elevated as required. MaBSTOA personnel found that they had to check the routes periodically, since vegetation began to grow back. In at least one instance, damage occurred to a bus because of foliage.

5.8 RELATED CONSIDERATIONS

Two final considerations with which the transit operator was faced were possible additional insurance costs and union demands. Since the MaBSTOA fleet was self-insured, no increase in insurance costs occurred.

Due to garaging and maintenance considerations discussed above, drivers who were based at the 132nd Street depot had to be shuttled to the 146th Street depot to pick up their buses. The union, building travel time as extra pay into the work schedules, agreed not to make any demands during the demonstration. During arbitration, however, the DDB drivers were awarded an additional $0.25 per hour for the spring schedule because they claimed the double deck bus required extra effort to drive. It was felt by MaBSTOA management that this premium pay would not continue when the next route selection by the drivers occurs. No other unusual demands were put forth by the unions.

6. PASSENGER-RELATED ISSUES

This chapter focuses on passenger-related issues. Overall preference for and choice of bus type were analyzed with respect to passenger demographics and trip characteristics (frequency, length, and purpose), and ratings of double deck and conventional bus accommodations were compared. Responses by elderly and handicapped passengers were analyzed separately to see how these riders rated the accommodations of each bus type and to assess their overall preferences. The material in this chapter is based upon an on-board survey (see Appendix A) conducted during the month of October in 1976, shortly after the double deck buses were introduced into full revenue service, and a second survey that was conducted in May of 1977.

Initially, in determining the sample size for the on-board data collection effort in October 1976, it was felt that approximately 100 elderly and handicapped riding on each bus type would be necessary for a valid assessment of attitudes towards accommodations as well as trip characteristics, demographics, and bus type preferences. (This figure is based upon a sample size necessary at the 95% confidence level to assure an estimate of a true population percentage within plus or minus 10% in absolute terms.) With this sample of 100 for each bus type as a baseline, it was estimated that approximately 10% of the passengers would fall into this category. Hence, a sample of 1,000 was sought for each bus type during the fall survey.

As it turned out, 945 double deck and 936 conventional bus passenger responses were considered usable. One hundred and nineteen forms were discarded because of inconsistencies or obvious errors in reading the survey instrument. One hundred and seventy-seven passengers reported they were 65 or older, and 73 reported that they were disabled. When combining these two groups into a transit-dependent category, there were a total of 231 (134 riding the conventional bus and 97 aboard the double deck bus).

Sample sizes were reduced for the May 1977 survey, since further comparisons for transit dependents were not contemplated. For this second survey 996 forms were acceptable for analysis, with only 25 being rejected during a quality audit. Of the 996 survey responses, 499 were from passengers on the double deck bus and 497 from passengers on the conventional bus.

The analysis described in this report consists primarily of setting up contingency tables and using the chi-square (χ^2) statistic[1] to compare responses. Results were considered as statistically significant if the sample chi-square statistic exceeded the tabular value at the .05 level. In addition to objective measurements, passenger comments were solicited during both surveys for several of the questions. A summary of the comments is presented at appropriate points in the discussion of passenger responses.

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[1]For an in-depth explanation of the chi-square statistic, the reader is referred to three sources: Statistical Package for the Social Sciences, 2nd Edition, N.H. Nie, C.H. Hull et al, McGraw-Hill Book Company, New York, NY, 1975; Statistical Methods in Educational and Psychological Research, Wert, J.E., Neidt, C.O., and Ahmann, J.S., Appleton-Century-Crofts, Inc., New York, NY, 1954; and Information Theory and Statistics, Kullback, S., John Wiley and Sons, New York, NY, 1959.

6.1 PREFERENCE FOR BUS TYPE

The double deckers were judged a success by their riders. Table 19 summarizes the response of New York double deck bus riders to the question, "Which type of bus do you like best?" For all categories double deck bus passengers preferred the double deckers. More transit dependent passengers on the double deckers preferred this vehicle than not. A considerably higher proportion of passengers on the upper level preferred the double deck bus, as compared with those riding on the lower level. All of these results were statistically significant at the .05 level. These results are substantiated by both dispatchers and drivers who felt that the passengers preferred the double deck bus over the conventional one.

The following discussion relates to bus preferences <u>for double deck bus riders only</u> (both surveys) when classified according to whether special plans were made for the trip, level of the bus on which riding, location on the bus, ease of using the stairs, and reasons for selecting a particular level. In all cases of DDB passengers, there is a significantly stronger preference for the double deck bus over the conventional bus.

TABLE 19. DOUBLE DECK BUS PASSENGER RESPONSES TO: "WHICH TYPE OF BUS DO YOU LIKE BEST?"

Preference	All Passengers	Transit Dependent	Regular Riders	Made Special Plans	Double Deck Bus	
					Lower Level	Upper Level
Conventional	13.8%	20.9%	15.0%	6.8%	21.3%	5.7%
Double Deck	57.6	43.5	57.7	80.5	42.9	72.8
Don't Know	6.4	7.6	5.7	3.2	7.3	5.4
No Preference	22.3	27.9	21.6	9.6	28.5	16.1

Two hundred and fifty-one out of 1307 persons (19.2%) said they made special plans to ride the DDB. Of those who made special plans to ride the double deck bus, 80.5% said they preferred the double deck over the conventional (6.8%); while 52.2% of those who said they made no special plans preferred the double deck over the conventional (15.4%).

Did you make special plans to ride on a double deck bus for this trip?						
	Special Plans				TOTALS	
	YES		NO			
Preference	No.	%↓	No.	%↓	No.	%↓
Conventional	17	6.8	163	15.4	180	13.8
Double Deck	202	80.5	551	52.2	753	57.6
Don't Know	8	3.2	75	7.1	83	6.4
No Preference	24	9.6	267	25.3	291	22.3
TOTALS	251	19.2→	1056	80.8→	1307	-

For those riding on the lower level of the double deck bus, 42.9% preferred the double deck to 21.3% preferring the conventional bus. On the upper level, a logical increase in preference for the double deck bus to 72.8% versus 5.7% for the conventional bus was noted.

On which level are you now riding?						
Preference	LEVEL				TOTALS	
	Lower		Upper			
	No.	%↓	No.	%↓	No.	%↓
Conventional	135	21.3	38	5.7	173	13.3
Double Deck	272	42.9	488	72.8	760	58.3
Don't Know	46	7.3	36	5.4	82	6.3
No Preference	181	28.5	108	16.1	289	22.2
TOTALS	634	48.6→	670	51.4→	1304	-

Seventy-five percent of those surveyed thought that the internal stairs were easy to use. Of those who felt it was easy to use, 74% favored the double deck as compared to 6.0% favoring the conventional bus. For those who felt the stairs were not easy to use, 48% still favored the double deck, as contrasted with 28% preferring the conventional bus. Regardless of the difficulties in maneuvering through the stairwell, it appears that double deck bus riders still prefer the double deck bus.

Were the stairs easy to use?						
Preference	YES		NO		TOTALS	
	No.	%↓	No.	%↓	No.	%↓
Conventional	36	5.8	59	28.1	95	11.4
Double Deck	464	74.2	100	47.6	564	67.5
Don't Know	27	4.3	12	5.7	39	4.7
No Preference	98	15.7	39	18.6	137	16.4
TOTALS	625	74.8	210	25.2	835	-

For those on the upper level, when asked whether the stairs were easy to use, 136 passengers and seven transit dependents made comments on the survey forms. Sixty of the regular passengers and five of the transit dependents felt that bus motion was a problem. Thirty-four of the regular passengers who indicated the stairs were not easy to use, felt the steps were too narrow or too steep.

It was felt that, by the spring 1977 survey, MaBSTOA riderships would have had an opportunity to ride the DDBs and, hence, to develop opinions regarding the DDBs. Therefore, the bus preference question was included in the 1977 survey of conventional bus riders as well as double deck bus riders. The four tables which follow enable comparisons to be made between conventional and double deck bus ridership with respect to preference when classified by trip frequency, trip purpose, age, and disability. In the case of double deck bus riders overall, approximately 58% prefer the double deck bus, to 14% preferring the conventional bus. Conventional riders, on the other hand, tend to prefer the conventional bus (47%) to the double deck bus (25%). However, it is not known whether these conventional riders had ever been on a double deck bus.

With respect to trip frequency, there is no significant difference between the distribution of preferences for both conventional bus riders and double deck bus riders. The distribution of preferences for double deck riders and for conventional riders, when examined separately, is not statistically related to trip purpose.

COMPARISON OF TRIP FREQUENCY AND BUS PREFERENCE

Preference	More than two days per week		One to two days per week		Less than one day per week		TOTALS	
	No.	% ↓	No.	% ↓	No.	% ↓	No.	% ↓
Double Deck Riders								
Conventional	142	15.0	22	12.2	14	7.3	178	13.5
Double Deck	548	57.7	109	60.5	108	55.9	765	57.9
Don't Know	54	5.7	14	7.8	16	8.3	84	6.4
No Preference	205	21.6	35	19.4	55	28.5	295	22.3
TOTALS	949	--	180	--	193	--	1,322	100.0
Conventional Riders								
Conventional	180	48.9	27	47.4	14	33.3	221	47.3
Double Deck	93	25.3	12	21.1	12	28.6	117	25.1
Don't Know	22	6.0	6	10.5	3	7.1	31	6.6
No Preference	73	19.8	12	21.1	13	31.0	98	21.0
TOTALS	368	--	57	--	42	--	467	100.0

COMPARISON OF TRIP PURPOSE AND BUS PREFERENCE

Preference	Work or School		Other		Both[1]		TOTALS	
	No.	% ↓	No.	% ↓	No.	% ↓	No.	% ↓
Double Deck Riders								
Conventional	128	15.2	42	10.8	11	13.8	181	13.8
Double Deck	493	58.6	218	56.3	44	55.0	755	57.7
Don't Know/ No Preference	220	26.2	127	32.8	25	31.3	372	28.4
TOTALS	841	--	387	--	80	--	1,308	--
Conventional Riders								
Conventional	142	48.6	67	46.5	8	47.1	217	47.9
Double Deck	73	25.0	34	23.6	3	17.6	110	24.3
Don't Know/ No Preference	77	26.4	43	29.9	6	35.3	126	27.8
TOTALS	292	--	144	--	17	--	453	--

[1]Either work and/or school plus at least one other choice (e.g., shopping).

With respect to age distribution, the double deck riders under 65 exhibit a significantly stronger preference for the double deck bus (59.5%) than do those 65 and older (40.4%). In the case of the conventional bus ridership, those 65 and over exhibit a stronger preference (78.3%) for the conventional bus than do those under 65 (41.9%).

Double Deck Riders						
Preference	AGE				TOTALS	
	Under 65		65 and Over			
	No.	%↓	No.	%↓	No.	%↓
Conventional	154	12.7	28	24.6	182	13.7
Double Deck	721	59.5	46	40.4	767	57.9
Don't Know	75	6.2	8	7.0	83	6.3
No Preference	261	21.6	32	28.1	293	22.1
TOTALS	1211		114		1325	
Conventional Riders						
Conventional	168	41.9	54	78.3	222	47.2
Double Deck	114	28.4	4	5.8	118	25.1
Don't Know	26	6.5	4	5.8	30	6.4
No Preference	93	23.2	7	10.1	100	21.3
TOTALS	401		69		470	

For each bus type, there is no significant difference with respect to preferences by those who do and those who do not possess a physical disability.

Double Deck Riders						
Preference	DISABILITY				TOTALS	
	YES		NO			
	No.	%↓	No.	%↓	No.	%↓
Conventional	11	21.2	166	13.2	177	13.5
Double Deck	25	48.1	735	58.3	760	57.9
Don't Know	3	5.8	81	6.4	84	6.4
No Preference	13	25.0	279	22.1	292	22.2
TOTALS	52		1261		1313	
Conventional Riders						
Conventional	17	60.7	198	45.6	215	46.5
Double Deck	6	21.4	112	25.8	118	25.5
Don't Know	1	3.6	30	6.9	31	6.7
No Preference	4	14.3	94	21.7	98	21.2
TOTALS	28		434		462	

6.2 TRIP CHARACTERISTICS

This section discusses the effect of trip length, frequency, and purpose on bus choice. In order to ascertain potential differences in the distribution of trip length by bus type, the routes in New York City were divided into zones of ten north/south blocks, of about a half mile each. These zones are, for example, the 40s, the 50s, the 60s, etc., and two cross-town zones of about the same distance at 110th Street and Central Park North. Passenger boarding and departure zones were coded on the survey form. Trip length is defined as the number of zones through which a passenger traveled. Without being specific as to the number of miles traveled, an assessment was made as to whether the distribution of trip lengths was significantly different for double deck and conventional bus riders. No significant difference was found between double deck and conventional bus riders in terms of the distribution of trip lengths.

It had been hypothesized that persons making short trips would not choose to spend the extra time to go upstairs on the double deckers. However, the distribution of trip lengths was again not significantly different between those riding on the upper level and those riding on the lower level.

With respect to frequency of riding the bus, there was a significant difference between double deck and conventional bus passengers. The percentage of frequent riders was higher for the conventional bus (77.2% versus 71.2% on the double deck bus stated they rode more than two days per week), perhaps indicating the sightseeing aspects of the double deckers.

How often do you ride a bus?							
BUS TYPE	More than two days per week		One or two days per week		Less than one day per week		TOTALS
	No.	%→	No.	%→	No.	%→	No.
Double Deck	980	71.2	194	14.1	203	14.7	1377
Conventional	1085	77.2	171	12.2	150	10.7	1406
TOTALS	2065	74.2	365	13.1	353	12.7	2783

There was no significant difference between the distribution of trip purposes for double deck and conventional bus passengers, with approximately 63% making a work- or school-related trip.

What is the main purpose of this trip?							
BUS TYPE	Work or School		Single Other Purpose		Two Other Purposes		TOTALS
	No.	%→	No.	%→	No.	%→	No.
Double Deck	870	63.9	405	29.8	86	6.3	1361
Conventional	855	62.0	446	32.3	79	5.7	1380
TOTALS	1725	62.9	851	31.0	165	6.0	2741

6.3 PASSENGER REACTIONS TO ACCOMMODATIONS

Passenger responses to the vehicle accommodations questions (questions one through nine) have been analyzed in terms of whether the respondent was on the double deck bus or the conventional bus. In virtually all instances, the double deck bus responses indicated a more positive reaction to bus accommodations than did conventional bus responses. In some cases, however, the differences were not statistically significant; these will be noted in the discussion which follows.

For some of the accommodation questions, a difference in the response patterns was observed from the first survey to the second survey. In those cases the data are reported and analyzed separately. In instances where the response patterns for the two surveys were not statistically significant, survey results have been combined into a single table.

With respect to ease in boarding the bus, passengers on both bus types responded with a strong positive reaction, although the double deck bus passengers, with 94% positive responses, were (statistically) significantly different from the conventional bus passengers with 90% responses. The double deckers have wider doors and lower steps than the conventional buses.

Was the bus easy to board?					
BUS TYPE	YES		NO		TOTALS
	No.	%→	No.	%→	No.
Double Deck	1323	94.0	94	6.0	1407
Conventional	1263	89.6	147	10.4	1410
TOTALS	2586	91.8	231	8.2	2817

There were 112 comments to this question, 57 "yes" responses and 55 "no" responses. For the conventional bus, 21 of the "no's" indicated the steps were too high and nine that the bus was too crowded. For the double deck bus, 30 of the "yes's" said that the door width was good; four of the "no's" said the bus was too crowded. There were 41 comments from transit dependents, 21 responding "yes" and 14 "no." On the conventional bus, 13 respondees commented that the steps were too high; while, on the double deck bus, 14 of the "yes" responses commented on a favorable door width and that the steps were lower at boarding.

With respect to problems in walking through the bus, there was a difference between the first and second survey. In the first survey there was a highly significant difference, with 77% of the double deck bus passengers indicating no difficulty and 63% of conventional bus passengers indicating no difficulty. On the second survey there was no significant difference in the response between double deck and conventional bus passengers, although the fraction of people having no difficulty in walking through the bus was larger for both conventional and double deck bus passengers. There was only one formal complaint to MaBSTOA management associated with movement through the double deck bus; namely, that there were an excessive number of standees. The downstairs aisle on the double decker is wider than on the conventional buses. However, the upstairs aisle is narrower and head room is restricted.

Did you have any problems walking through the bus?					
BUS TYPE	YES		NO		TOTALS
October 1976	No.	%→	No.	%→	No.
Double Deck	205	22.6	701	77.4	906
Conventional	337	36.9	576	63.1	913
TOTALS	542	29.8	1277	70.2	1819
May 1977					
Double Deck	103	21.8	369	78.2	472
Conventional	86	18.3	385	81.7	471
TOTALS	189	20.0	754	80.0	943

There were 481 comments, 442 associated with "yes" responses and 39 with "no." On the conventional bus, 158 of the "yes's" complained of the horizontal bar and the center pole, as did six of the transit dependents. Fifty-seven of the respondees on the conventional bus said the bus was too crowded, while 22 complained of bumpiness or shakiness. On the double deck bus, 44 of the "yes" comments noted that the ceiling on the upper level was too low, 43 that the bus was too crowded, 43 that the bus shakes and the ride is choppy and bumpy (the double deckers have spring suspension while the conventionals have air suspension), and 34 that the aisles upstairs were too narrow. Similar reactions were set forth by the transit dependents, from whom 30 comments were received, seven responding "yes" and 23 responding "no."

A significantly greater percentage of double deck passengers responded favorably to the question "Are the seats comfortable?" Eighty-eight percent of the double deck bus passengers said they were, while only 73% of the conventional passengers responded favorably. The seats on the Leyland were padded, while those on the conventionals were not.

Are the seats comfortable?							
BUS TYPE	YES		NO		DON'T KNOW		TOTALS
	No.	%→	No.	%→	No.	%→	No.
Double Deck	1204	88.1	112	8.2	50	3.7	1366
Conventional	996	72.9	249	18.2	122	8.9	1367
TOTALS	2200	80.5	361	13.2	172	6.3	2733

When questioned regarding the ease of use of the grab rails, both the double deck and conventional bus passengers indicated very positively (86% and 80%) that they were easy to use, but the difference between the responses of double deck and conventional passengers was significant. Results were consistent between the two surveys.

Are the grab rails easy to use?					
BUS TYPE	YES		NO		TOTALS
	No.	%→	No.	%→	No.
Double Deck	949	86.2	152	13.8	1101
Conventional	946	80.2	233	19.8	1179
TOTALS	1895	83.1	385	16.9	2280

Passengers on both bus types commented on the use of the grab rails. Thirty-eight passengers on the conventional bus indicated that the rails were in the way and awkward, while 12 DDB passengers made the same comment. Eleven of the conventional bus passengers indicated that the rails were too high. Four DDB passengers felt that there were not enough rails. Due to the lower ceiling height, the grab rails were lower on the Leyland and, therefore, easier to reach.

When queried about the internal environment of the buses, 82% of the double deck bus riders felt that it was comfortable. This contrasted with a positive response by the conventional bus passengers of only 64%. Eight percent of the double deck bus passengers felt that the bus was stuffy, while 18% of the conventional passengers felt the same way. During both surveys, weather conditions were mild so that the inadequate heating and air conditioning did not have an impact on responses to this question. Five formal complaints on poor air conditioning and heating on the DDBs were received by MaBSTOA management.

Is the bus . . .?						
BUS TYPE	Comfortable		Too Cold		Too Hot	
	No.	%→	No.	%→	No.	%→
Double Deck	1088	81.9	13	1.0	53	4.0
Conventional	853	63.5	22	1.6	99	7.4
TOTALS	1941	72.6	35	1.3	152	5.7

Is the bus . . .?							
BUS TYPE	Drafty		Stuffy		Other		Totals
	No.	%→	No.	%→	No.	%→	No.
Double Deck	28	2.1	101	7.6	46	3.5	1329
Conventional	59	4.4	242	18.0	68	5.1	1343
TOTALS	87	3.3	343	12.8	114	4.3	2672

Although there was a significant difference between double deck and conventional passenger responses to the question "How does the noise level compare with most buses?", there was also a shift in responses from the first to the second survey. In both cases, however, the double deck bus passengers have a significantly stronger feeling that the bus is quieter, with 62% positive (as compared to 37% favoring the conventional) in the first survey and 48% (as compared to 12%) in the second survey. Reasons for the shift are not obvious.

How does the noise level compare with most buses?							
BUS TYPE	Noisier		About the same		Quieter		Totals
	No.	%→	No.	%→	No.	%→	No.
Oct 1976							
Double Deck	56	6.4	275	31.5	541	62.0	872
Conventional	29	3.2	537	60.1	328	36.7	894
TOTALS	85	4.8	812	46.0	869	49.2	1766
May 1977							
Double Deck	44	9.9	188	42.2	214	48.0	446
Conventional	53	11.8	345	76.5	53	11.8	451
TOTALS	97	10.8	533	59.4	267	29.8	897

Since the upper level of the DDB is considerably quieter than the lower level, for the double deck bus passengers only, passenger reactions to noise were compared by level on which they were riding as well as the location on the bus within the given level. It is fairly clear that the passengers riding on the upper level had a stronger feeling that the bus was quieter than did those riding on the lower level (71.8% to 41.9%). However, for passengers on the upper level, the reaction to noise was significantly different based upon location. Those riding in the front felt the bus was significantly quieter (78.3%) than most buses than did those in the middle and rear (not significantly different from each other at 68.0%). In addition, for the passengers located on the lower level, there was a dramatic shift from the first to the second survey. On the first survey the passengers in the front felt, almost two to one, that the bus was quieter than did those in the rear (61.7% to 33.6%). In the second survey, there was no significant difference in response with respect to the location of the passenger on the lower deck.

Where are you located? (Upper-level passengers only)								
NOISE LEVEL	Front		Middle		Rear		Totals	
	No.	%↓	No.	%↓	No.	%↓	No.	%↓
Noisier	3	1.3	7	2.9	7	4.5	17	2.7
About the same	47	20.4	76	31.4	37	23.9	160	25.5
Quieter	180	78.3	159	65.7	111	71.6	450	71.8
TOTALS	230		242		155		627	

Where are you located? (Lower-level passengers only)								
NOISE LEVEL	Front		Middle		Rear		Totals	
Oct 1976	No.	%↓	No.	%↓	No.	%↓	No.	%↓
Noisier	5	3.9	10	11.9	24	17.9	39	11.3
About the same	44	34.4	34	40.5	65	48.5	143	41.3
Quieter	79	61.7	40	47.6	45	33.6	164	47.4
TOTALS	128		84		134		346	
May 1977								
Noisier	12	13.3	8	14.5	11	15.3	31	14.3
About the same	46	51.1	27	49.1	41	56.9	114	52.6
Quieter	32	35.6	20	36.4	20	27.8	72	33.2
TOTALS	90		55		72		217	

When asked about the comfort of the ride, there was no significant difference between responses for double deck and conventional riders on the first survey, with about 79% responding favorably. On the second survey, however, there was a significant downward shift in terms of assessed comfort for both the double deck and the conventional, to 71.9% and 65.1% respectively, with the double deck bus passengers now indicating a significantly more favorable reaction to bus riding comfort. These results run counter to the physical situation, since the DDBs have only a spring suspension as contrasted with the air cushions on the conventional buses. The newness of the DDBs may have influenced passenger perceptions. It is also possible that the roughness of the roads (pot holes and infrequent repair) may far outweigh the effect of differences in type of suspension.

Does the bus ride comfortably?					
BUS TYPE	YES		NO		TOTALS
Oct 1976	No.	%→	No.	%→	No.
Double Deck	614	79.5	158	20.5	772
Conventional	613	78.5	168	21.5	781
TOTALS	1227	79.0	326	21.0	1553
May 1977					
Double Deck	299	71.9	117	28.1	416
Conventional	272	65.1	146	34.9	418
TOTALS	571	68.5	263	31.5	834

With respect to comfort of the bus ride, 436 passengers commented, 144 responding "yes" and 292 responding "no." There were a total of 48 comments made by transit dependents. For riders of both bus types, for both transit dependent and other passengers, a large majority felt that the ride was bumpy, rocky, choppy, and shaky; and a number of them (36) indicated that they felt this was due to poor road conditions.

On the first survey, a vast majority of the riders on both bus types (90.9%) felt that the interior bus lighting was "about right." On the second survey, however, the double deck bus passengers indicated a stronger acceptance, 95.1%, with respect to interior lighting. On the second survey there was a significant difference between the double deck and the conventional passengers, although the responses from conventional bus passengers still remained at approximately the 90% level.

Is the bus lighting . . .?							
BUS TYPE	About Right		Too Bright		Too Dim		TOTALS
Oct 1976	No.	%→	No.	%→	No.	%→	No.
Double Deck	803	91.3	29	3.3	48	5.5	880
Conventional	822	90.6	30	3.3	55	6.1	907
TOTALS	1625	90.9	59	3.3	103	5.8	1787
May 1977							
Double Deck	431	95.1	7	1.5	15	3.3	453
Conventional	407	89.8	3	0.7	43	9.5	453
TOTALS	838	92.5	10	1.1	58	6.4	906

The final accommodations question asked was "Is the visibility from the bus windows good?" Of the double deck passengers, 97.3% said "yes," while only 87.5% of the conventional passengers said "yes," a highly significant difference. If these data are examined, considering the level on which the passenger was riding on the DDB, the significance exists among all three groups of riders (upper level, lower level, and conventional bus). A significantly greater percentage of riders on the upper level of the DDB compared to those on the lower level said that visibility from the windows was good. It should be noted that the windows on the double deck buses are larger than the windows on the conventional ones.

Is the visibility from the bus windows good?					
BUS TYPE	YES		NO		TOTALS
	No.	%→	No.	%→	No.
Double Deck:					
Upper level	658	99.2	5	.8	663
Lower level	589	95.3	29	4.7	618
Conventional	1166	87.5	167	12.5	1333
TOTALS	2413	92.3	201	7.7	2614

The final item in this section relates to reasons for selecting the level on the bus, when classified by the specific level on which the passenger was riding. Of those who were riding on the lower level, 58% indicated that they had no reason for selecting the level, and 23% felt that the other level was crowded or hard to reach. Conversely, of those riding on the upper level, 65% preferred that level. Dispatchers, by about four to one, indicated that passengers preferred the upper level over the lower level.

Comparison of Double Deck Passenger Level, With Reason for Selecting That Level

Reason for selecting level	LEVEL				TOTALS	
	Lower		Upper			
	No.	%↓	No.	%↓	No.	%↓
No reason	314	58.0	119	21.1	433	39.2
Prefer this level	101	18.7	364	64.7	465	42.1
Other level crowded or hard to reach	126	23.3	80	14.2	206	18.7
TOTALS	541		563		1104	

Three hundred seventy comments by passengers on the upper level and 134 comments by passengers on the lower level were given to the question concerning reasons for selecting the level. In the transit-dependent group, the analogous figures were 13 and 15 respectively. A vast majority of both groups, 206 regular passengers and 13 transit dependents on the upper level, felt that the view and sightseeing capabilities were most significant. Other similar comments for those on the upper level included 60 indicating the novelty, 58 saying it was just "fun" and 17 commenting on the roominess and comfort. On the lower level it was felt by 29 of the regular passengers and ten of the transit dependents that bus motion, narrow stairs, and the low ceiling upstairs were a detriment. It is interesting to note that 21 persons commented that the lower level was less crowded and roomier, and indicated that they were making short trips.

6.4 THE TRANSIT DEPENDENT

In an effort to examine transit-dependent passenger reactions to vehicle accommodations, as well as demographics and trip characteristics, separate analyses were run for the transit dependent. For these analyses, transit dependents are defined as those 65 years of age or older (Question 12), or handicapped (Question 13), or both. Transit-dependent passengers were separately analyzed for the October 1976 onboard data collection only, since the size of that sample was selected to allow for such analyses. There were a total of 231 transit-dependent passengers, 97 on the conventional bus and 134 on the double deck bus. Because of the small sample size, not all analyses performed on the total passenger set were accomplished for the transit dependents.

There was a significantly smaller percentage of those 65 and over riding the double deck bus (8.7%) than the conventional (12.4%). There was no significant difference between the percentage of physically handicapped riding the two bus types. (These figures include results from both surveys.)

To which age group do you belong?					
BUS TYPE	Under 65		65 and Over		TOTALS
	No.	%→	No.	%→	No.
Double Deck	1253	91.3	120	8.7	1373
Conventional	1233	87.6	176	12.4	1409
TOTALS	2486	89.4	296	10.6	2782

Do you have any physical handicaps that make most buses difficult to use?					
BUS TYPE	YES		NO		TOTALS
	No.	%→	No.	%→	No.
Double Deck	57	4.2	1308	95.8	1365
Conventional	72	5.2	1313	94.8	1385
TOTALS	129	4.7	2621	95.3	2750

6.4.1 Preference for Bus Type

While 44% of transit dependents riding the double deck bus indicated a preference for the double deck bus, only 17% indicated a preference for the conventional bus. Thirty-nine percent either didn't know which they preferred or had no preference.

No significant difference in bus preference was noted when considering trip frequency, level on which riding, or trip length. When considering trip purpose, a significantly greater percentage of those making work or school trips preferred the double deck bus to the conventional bus, 55% to 9%.

Question 10: How often do you ride a bus?								
Preference	More Than Two Days Per Week		One to Two Days Per Week		Less Than One Day Per Week		Totals	
	No.	%↓	No.	%↓	No.	%↓	No.	%↓
Conventional	12	19.4	2	11.1	1	11.1	15	16.9
Double Deck	27	43.5	9	50.0	3	33.3	39	43.8
Don't Know	4	6.5	3	16.7	1	11.1	8	9.0
No Preference	19	30.6	4	22.2	4	44.4	27	30.3
Totals	62		18		9		89	

Preference	Level on Bus					
	Lower		Upper		Totals	
	No.	%↓	No.	%↓	No.	%↓
Conventional	12	20.0	3	12.0	15	17.6
Double Deck	22	36.7	14	56.0	36	42.4
Don't Know	7	11.7	1	4.0	8	9.4
No Preference	19	31.7	7	28.0	26	30.6
Totals	60	70.6→	25	29.4→	85	

Preference	Trip Purpose							
	Work or School		Single Other Response		Two Responses		Totals	
	No.	%↓	No.	%↓	No.	%↓	No.	%↓
Conventional	3	9.1	8	19.0	5	55.6	16	19.0
Double Deck	18	54.5	17	40.5	3	33.3	38	45.2
Don't Know/No Preference	12	36.4	17	40.5	1	11.1	30	35.7
Totals	33	39.3→	42	50.0→	9	10.7→	84	

6.4.2 Trip Characteristics

As with passengers in general, the distribution of trip lengths, as measured by number of zones traversed, was not significantly different between transit-dependent double deck and conventional bus riders. In addition, for those riding the double deck bus, the distribution of trip lengths was, again, not significantly different between those riding on the upper and those riding on the lower level. With respect to frequency of riding a bus, there was no significant difference between those riding the conventional and the double deck bus, nor was there any significant difference noted in response to the question concerning trip purpose.

Question 10: How often do you ride a bus?							
Bus Type	More Than Two Days Per Week		One or Two Days Per Week		Less Than One Day Per Week		Totals
	No.	%→	No.	%→	No.	%→	
Double Deck	66	69.5	19	20.0	10	10.5	95
Conventional	94	71.2	18	13.6	20	15.2	132
Totals	160	70.5	37	16.3	30	13.2	227

Question 11: What is the main purpose of this trip?							
Bus Type	Work or School		Single Other Response		Two Responses		Totals
	No.	%→	No.	%→	No.	%→	
Double Deck	35	38.5	46	50.5	10	11.0	91
Conventional	40	31.0	79	61.2	10	7.8	129
Totals	75	34.1	125	56.8	20	9.1	220

6.4.3 Accommodations

For all nine questions concerning accommodations, transit dependents on the double deck bus gave a more positive rating than did those on the conventional bus.

With respect to ease of boarding the bus, problems in walking through the bus, comfort in terms of atmospheric characteristics, and noise levels, the double deck bus was considered significantly better than the conventional bus. Specific responses follow:

Question 1: Was the bus easy to board?

Bus Type	Yes		No		Totals
	No.	%→	No.	%→	
Double Deck	94	96.9	3	3.1	97
Conventional	105	80.8	25	19.2	130
Totals	199	87.7	28	12.3	227

Question 2: Did you have any problems walking through the bus?

Bus Type	Yes		No		Totals
	No.	%→	No.	%→	
Double Deck	15	16.0	79	84.0	94
Conventional	39	31.7	84	68.3	123
Totals	54	24.9	163	75.1	217

Question 5: Is the bus . . .[1]					
Bus Type	Comfortable		Not Comfortable		Totals
	No.	%→	No.	%→	
Double Deck	76	89.4	9	10.6	85
Conventional	94	75.8	30	24.2	124
Totals	170	81.3	39	18.7	209

[1] The choices other than "comfortable" have been combined because of the small number responding to each choice such as "too cold," "too hot."

Question 6: How does the noise level compare with most buses?							
Bus Type	Noisier		About the Same		Quieter		Totals
	No.	%→	No.	%→	No.	%→	
Double Deck	10	11.9	29	34.5	45	53.6	84
Conventional	6	5.1	72	61.5	39	33.3	117
Totals	16	8.0	101	50.2	84	41.8	201

When considering the <u>level</u> of the double deck bus on which the transit-dependent passenger was riding, the opinion regarding noise level is even more significant. Of the upper-level transit dependents, 81% stated it was quieter, and only 40% on the lower level said it was quieter. On the lower level, 47% did feel, however, that the noise level, when compared with most buses, was about the same.

How does the noise level compare with most buses?						
Noise Level	Level on Bus				Totals	
	Lower		Upper			
	No.	%↓	No.	%↓	No.	%↓
Noisier	7	12.7	3	11.5	10	12.3
About the Same	26	47.3	2	7.7	28	34.6
Quieter	22	40.0	21	80.8	43	53.1
Totals	55		26		81	

These preferences for the double deck bus are consistent with that found with passengers in general.

With respect to comfort of seats, ease of use of grab rails, comfort of ride, bus lighting and visibility from the bus windows, the transit dependent discerned no significant difference between the two bus types, even though passengers in general seemed to favor the double deck bus with respect to comfort of seats, ease of use of the grab rails, and visibility from the bus windows. Specific responses follow:

Question 3: Are the seats comfortable?

Bus Type	Yes		No		Don't Know		Totals
	No.	%→	No.	%→	No.	%→	
Double Deck	76	81.7	12	12.9	5	5.4	93
Conventional	100	80.6	19	15.3	5	4.0	124
Totals	176	81.1	31	14.3	10	4.6	217

Question 4: Are the grab rails easy to use?

Bus Type	Yes		No.		Totals
	No.	%→	No.	%→	
Double Deck	59	81.9	13	18.1	72
Conventional	82	80.4	20	19.6	102
Totals	141	81.0	33	19.0	174

Question 7: Does the bus ride comfortably?

Bus Type	Yes		No		Totals
	No.	%→	No.	%→	No.
Double Deck	60	84.5	11	11.5	71
Conventional	86	78.9	23	21.1	109
Totals	146	81.1	34	18.9	180

Question 8: Is the bus lighting . . .

Bus Type	About Right		Too Bright		Too Dim		Totals
	No.	%→	No.	%→	No.	%→	No.
Double Deck	74	90.2	4	4.9	4	4.9	82
Conventional	109	90.1	4	3.3	8	6.6	121
Totals	183	90.1	8	3.9	12	5.9	203

Question 9: Is the visibility from the bus windows satisfactory?

Bus Type	Yes		No		Totals
	No.	%→	No.	%→	No.
Double Deck	85	96.6	3	3.4	88
Conventional	102	90.3	11	9.7	113
Totals	187	93.0	14	7.0	201

7. SUMMARY EVALUATION FINDINGS AND IMPLICATIONS

This chapter summarizes results of the evaluation and considers implications which have an impact on transferability of demonstration results to other locales. In brief, the results argue for the incorporation of the double deck bus into American bus fleets from both an economic and level-of-service point of view. Experience with the demonstration vehicles has aided manufacturers and transit operators in the development of vehicle specifications appropriate for the American market.

The chapter is organized according to vehicle-related, transit operator-related, and passenger-related findings and implications. Because the in-service data collection time was so short, certain constraints on the interpretation of the findings must be borne in mind:

1) The double deck buses had not completed a normal "shake-down" period, experienced by all new buses. The four demonstration counterpart GM conventional buses were older buses (averaging more than 200,000 accumulated miles). Consequently, in an engineering sense,[1] equipment comparisons are being made between those in the burn-in phase (the Leylands) and those in the wear-out phase (the GMs).

2) Major problems encountered with the double deck bus related primarily to the cooling and heating systems, each of which was specially designed for the New York Leyland buses.

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[1] _Methods for Statistical Analysis of Reliability and Life Data_, Mann, N.R., Schafer, R.E., and Singpurwalla, N.D., John Wiley & Sons, New York, 1974.

3) Extreme cold hit the East in late December 1976 and on through mid-February 1977, keeping the Leylands out of service for approximately six weeks due to inadequate heating capability.

7.1 VEHICLE-RELATED ISSUES

7.1.1 Findings

A major intent of the demonstration was to assess the capability of the double deck bus to make available a greater capacity at a cost per capacity-mile less than or equal to that of its conventional counterpart. Several major vehicle-related problems complicated this assessment:

1) The foreign origin of the vehicles introduced schedule delays. There was an inadequate number of spare parts, and these were not easily accessible.

2) Although the bus was to have been a production-line vehicle with only minor modifications, the changes that were made created a problem both with respect to unfamiliarity with the mechanical design and with an unsatisfactory level of operational performance. The result was poor reliability and too-frequent maintenance requirements.

Schedule delays were caused by a number of factors:

1) It was necessary to make modifications to satisfy federal and state safety and environmental requirements. Major modifications

included pollution control devices, safety windows, left-hand drives, and air conditioning. (No Leyland had been air conditioned before.) Federal safety standards were not waived, but testing to demonstrate compliance with emission standards was.

2) A dock strike in England delayed the shipment of the vehicles.

3) The installation of the air conditioning unit by Trane, an American manufacturing firm, took longer than had been expected; and, once installed, these units did not perform satisfactorily. Problems existed with both the size of the unit (requiring structural modifications to the bus) and its impact on the electrical system (requiring the fitting of a second alternator to the bus engines).

As a result, the Leylands entered revenue service only nine months before termination of the demonstration.

While Leyland provided a local representative who dealt directly with MaBSTOA, the significant and frequent problems with the buses resulted in less-than-timely reactions. Other than the design problems which resulted in the unexpected failures, MaBSTOA management felt that the interactions with Leyland were consistent with what a transit authority might expect from a firm introducing a new bus type.

The DDBs were idle for periods of time because of inadequate spares, a situation which would probably not have existed if there had been a larger number of vehicles in the fleet. Problems associated with the lack of an adequate number of spare parts were augmented by increased shipping time and difficulties in communication.

Although the air conditioning was the major design-change problem, during the excessively cold winter months the heating system was unable to maintain adequate temperatures on the lower level, and the buses had to be withdrawn from revenue service. It was felt that the Leyland's four-cycle engine, which is cool-running, did not throw off enough waste heat to handle the heating load. Therefore, a supplemental heating unit had to be added. Besides the problems due to heating and air conditioning, and the resulting adverse effects on the electrical system, MaBSTOA management did not feel that the problems encountered during the introduction of the DDBs into the fleet were different from what one would anticipate during the break-in of any new bus type.

MaBSTOA required two hours for driver training and 20 hours for mechanic training, neither being considered excessive. Mechanic and driver attitudes towards the DDBs were generally positive. The mechanics felt that, once they had become better acquainted with the DDBs, they would be no more difficult to service than the conventional buses. They also felt that lack of experience, proper tools, and adequate spares made timely servicing of the DDBs difficult.

Drivers felt that learning how to operate the DDBs was not difficult and that the DDBs were easier to operate, particularly in steering and cornering stability. These factors, coupled with the fact that the DDB is seven feet shorter than the conventional bus, resulted in greater maneuverability, even in heavy traffic.

The vertical size of the bus appeared to be of little consequence once appropriate routes had been selected. The primary concern voiced by the drivers was with operation of the rear door. In their judgment, control should have been in the hands of the passenger rather than the driver, who is not always free or able to monitor use of the rear door.

7.1.2 Implications

As a result of the New York experience, the following points should be considered by any transit authority contemplating the introduction of new vehicles such as the DDBs into an existing fleet:

1) Prior to ordering any new bus, a total system design review should be conducted involving the manufacturer, the transit management, mechanics, drivers, and dispatchers. The vehicle design specifications should receive input from all involved personnel. Such a multidisciplinary design review can have a major impact on identifying potential problems in the pre-production phase (e.g., the impact of the air conditioning on the electrical system could probably have been foreseen with a thorough design review).

2) The time frame for the introduction of any foreign vehicle must consider the time necessary for certification of the vehicle to meet safety and environmental standards.

3) When a new vehicle (essentially a prototype) is to be introduced into an existing fleet, adequate time must be allowed for break-in,

particularly if the vehicle has not undergone usual manufacturer testing. (Both Leyland and MaBSTOA personnel indicated that there was pressure to get the buses into service, despite the lack of adequate and standard pre-testing.)

4) Personnel planning for drivers and mechanics must consider generic bus type characteristics which might alter such training programs (e.g., mechanical design and maneuvering characteristics).

7.2 TRANSIT OPERATOR-RELATED ISSUES

Findings and implications dealing with the operator issues are summarized in this section. Due to the vehicle-related problems discussed above, only six months of revenue-service data were available for this portion of the analysis.

7.2.1 Findings

Mechanical Reliability and Maintainability. Problems encountered with the Leylands during the eight months of revenue service do not appear to be generic to double deck buses but, rather, are associated with the design modifications discussed in the previous section.

The conventional buses averaged 4.6 in-service repair calls per bus per month, while the double deck buses averaged almost twice as many per bus at 8.2. Even considering the greater capacity of the DDBs, the DDBs averaged 17,000 capacity-miles between in-service repair calls for the last three months of the demonstration, as contrasted with 23,600 for the conventional buses.

Major reliability problems with the Leylands centered around the American-installed air conditioning system. No Leyland had been air-conditioned before; as a result, the alternator's electrical supply was found to be inadequate. This situation precipitated other electrical problems. Fifty-four percent of the failures necessitating in-service repair calls for the double deck buses were associated with the electrical system (36.7%) and the heating system (17.6%). The electrical system was also the number one failure type for the conventional bus at 19.9%, with brake problems running second at 12.3%. During the summer months following the evaluation period, modifications to the heating and air conditioning system resulted in the DDBs' being down most of the time.

Vehicle-related problems identified in the previous section contributed to unacceptable mechanical reliability and unnecessarily long maintenance times. MaBSTOA management, however, feels that, once the design flaws have been rectified, the DDBs should approach the same level of reliability and maintainability as the conventional buses.

Since maintenance cost data for the Leylands did not include items covered under warranty, no comparisons can be made between the reliability and maintainability costs of the two vehicle types. MaBSTOA management, however, feels that these costs should be quite comparable once the design deficiencies have been corrected and the DDBs are no longer covered by warranty.

Operating Costs. Fuel, oil, drivers' salaries and associated fringe benefits are the primary operating costs associated with the vehicles. The DDBs averaged a slightly better fuel consumption rate of 3.4 miles per gallon as compared with the 3.2 miles per gallon for the conventional buses. The comparative ages of the two buses (brand new DDBs and considerably older GMs) make any comparison on oil consumption meaningless. (Fuel and oil costs in New York at the time of preparation of this report were $0.3755 per gallon of diesel fuel and $0.96 per gallon of oil, including taxes.)

Drivers' salaries in New York were $7.11 per hour, with a premium pay of $0.25 per hour for the DDB still in effect at the time of publication of this report.

<u>Passenger Throughput and Dwell Times</u>. Any inhibiting factor to movement on the DDB introduced by the internal stairwell appeared to have been balanced by the lower entry and exit steps and the wider doors. As a result, boarding and alighting of passengers required, on the average, 3.5 seconds per passenger for both bus types. In addition, an analysis of dwell time per throughput passenger showed no significant difference between bus type and between peak and off-peak service. The DDBs, therefore, might be expected to fall behind schedule if their extra capacity is utilized.

Results from the passenger surveys indicated that the double deck buses were indeed easier to board than the conventional buses and that 25% of the riders on the second level found the stairwell somewhat difficult to use. During periods when passenger flow was heavy, many passengers stood on the lower level rather than go upstairs to look for a seat.

Bus drivers pointed out that egress from the bus was not as effective as with the conventional bus because the rear door was driver-controlled rather than passenger-controlled (a DDB characteristic which MaBSTOA management would change on any new order).

Schedule Adherence. Vehicle mechanical reliability and passenger movement on, off, and through the buses had an impact on schedule adherence. In New York, dispatchers are utilized at selected points along each route to track scheduled versus actual times at each point and to provide decisions with respect to modifying runs, sending buses to repair facilities, and returning them to service.

Data were sampled in the fall and again in the spring to determine whether any shifts had occurred in the ability of the buses to maintain their schedules. The percent of double deck bus runs that were behind schedule decreased from 42.5% in October 1976 to 23.9% in April 1977. The corresponding figures for the conventional buses were 31.2% and 27.3%.

When considering route, direction, peak and off-peak periods, and run type (length and congestion), no indication existed in examining approximately 250 run segments that any of the above factors had an impact on schedule adherence. If the percentage deviations from schedule are analyzed over all conditions for the two bus types, the DDBs averaged 4.16% behind schedule, as compared with 2.21% behind schedule for the conventional buses.

Although the observed differences in schedule adherence were found not to be statistically significant, this lack of significance was probably due to the large amount of variability in the data and the small sample sizes. It was the evaluators' feeling that a difference did, in fact, exist. Recorded run times indicated that the double deck bus tended to fall behind schedule more frequently than the conventional bus. Dispatchers and drivers also felt that the DDBs tended to fall behind schedule more than the conventional buses, particularly during peak periods and in congested areas.

However, they indicated that the DDB performance should improve once the break-in period had been completed.

Safety and Accidents. There were nine reported passenger-related accidents on the double deck buses, as compared with only one on the conventional counterparts. Of the nine, four were associated with use of the stairwell. In two cases passengers fell down the stairwell, and in two cases passengers reported injured knees as a consequence of climbing to the upper level. All accidents were minor, and no claims were filed against MaBSTOA. There were only three driver-related accidents, two on the conventional and one on a double deck bus.

Of the ten vehicle-related accidents on the double deck bus, only one accident could be associated with the generic characteristics of the DDB. A driver did not follow a route modification necessitated by the bus height; as a result, the bus struck the bottom of an overpass. The bus was out of service for six weeks, and no passengers were injured.

Vandalism and Crime. Contrary to expectations concerning the unattended second level, incidents of vandalism and crime were not different from those encountered on the conventional buses. While the NY DDBs are equipped with a periscope for viewing the upper level, the drivers on the specific routes did not notice any activities which created a continuing concern. It should be noted, however, that the routes over which the DDBs traveled did not run directly through any of the problem neighborhoods of New York, a factor which probably influenced the lack of vandalism and crime on the upper, unattended deck.

Garaging and Route Availability. During the planning phase, it is essential that adequate attention be given to the need for and the costs associated with modification of storage and repair facilities and rights-of-way. Dynamic bus heights necessitated removing tree limbs (a recurring problem) and raising street lights and traffic lights. One of the routes had to be diverted around a low overpass, and only two Manhattan garages had doors high enough to accommodate the vehicles.

Related Considerations. The drivers' union demanded and received a temporary $0.25 per hour pay increase. Management has argued that the size of the Leyland buses (shorter and narrower than conventional ones) and their power steering make them an easy vehicle to operate (a fact substantiated by the drivers). Since MaBSTOA is self-insured, no additional insurance costs were incurred.

7.2.2 Implications

The foregoing vehicle operational characteristics and consequent impacts on vehicle efficiency lead to several significant implications for transit operators in other locales. These relate to route selection and garaging, vehicle scheduling, financial considerations, and training.

Route Selection and Garaging. Because of the increased height of double deck buses, routes and maintenance facilities must be chosen carefully. Lights and signs must be checked and raised where necessary. In addition, a system for checking and trimming and then re-checking and re-trimming trees must be established. Where overpasses or other structures are not high enough to accommodate the DDBs, the route must be altered.

Costs of these route modifications must be considered, as must costs associated with modifications to facilities that will store or maintain the vehicles. Facility modifications must be accomplished before initial receipt of the vehicles. The route over which the vehicle will travel from manufacturer to the transit operator must be identified and modified, as necessary, to accommodate the vehicle. Costs and time must be allowed for these activities.

Scheduling. Since double deck buses process passengers at the same rate as conventional buses, they tend to fall behind schedule as their passenger loads increase. The MaBSTOA management has not been satisfied with the mode of operation employed during the demonstration. They do not feel that a one-for-one substitution of the DDB for a conventional bus on the routes used in New York makes sense because the full capacity of the vehicle is not properly utilized. Rather, they foresee the Leyland DDB serving a useful and productive role as a limited-stop vehicle, running express between major points. This is similar to the way the double deckers were used in the fifties. Under such an arrangement, the DDBs should realize travel times equivalent to or less than the conventional buses providing local service, even though the DDBs may be carrying more passengers. However, if the double deck bus headways are high and passengers traveling between points served by the DDBs take the first bus that comes along, even though it is a conventional bus making all intermediate stops, the level of service on the conventional bus could be expected to deteriorate.

Two other scheduling options could be considered: using only DDBs on a route or using the DDBs only on express routes with limited stops at either end. The first option is suitable on routes where the patronage is sufficient to justify the increased capacity and where headways are small enough so that the substitution of fewer vehicles (at a rate less than one-for-one) does not have a noticeable effect on wait time. The Leyland, with its wide first-level aisle, is an ideal vehicle for this purpose.

For express routes, the schedule-adherence problem is minimized, since most passengers would get on or off during the brief collection or distribution segment of the route. The Leyland DDB is not being considered on express runs by MaBSTOA, however, because passengers on such runs are highly sensitive to amenities which are not provided by the current Leyland design.

Financial Considerations. The preceeding findings relative to transit operator-related issues have failed to uncover any significant differences in vehicle efficiency between the two bus types, provided the design problems which degraded mechanical reliability and maintainability are solved. In the previous section on scheduling implications, it was pointed out that the DDBs could be substituted for conventional buses on a less than one-for-one basis. The financial implications of such substitutions are addressed here.

Since drivers' salaries and associated fringe benefits make up the major portion of vehicle operating costs, the present value of potential savings in drivers' salaries has been compared to the current capital cost differential resulting from the substitution of DDBs for conventional buses. Certain assumptions have been made:

1) Current purchase prices for the conventional and Leyland buses are respectively $100,000 and $125,000.

2) Salaries plus fringe benefits for drivers range between $23,000 and $30,000. This is assuming that more than one driver is required per bus due to vacations, sick leave, holidays, and the fact that the vehicles are utilized 12 to 14 hours per day.

3) Salaries plus fringe benefits are increasing at an annual rate of 8%.

4) The discount rate for money is 9%.

5) The lifetime of a bus is between 12 and 15 years.

The DDBs have been substituted for the conventional buses at rates less than one-for-one. Two load factors have been considered:

1) Seated capacity only (Leyland 68, GM 45).

2) Comfortable standing capacity (standing only on lower level of DDB) at 50% of available lower deck seats (Leyland 81, GM 68).

Under these conditions, the substitution rates were:

1) Seated capacity - two Leylands for three conventionals.

2) Comfortable standing capacity - five Leylands for six conventionals.

The results are presented in Table 20 and for all cases indicate that the transit operator would realize a substantial savings per bus by substituting DDBs for conventional buses. The DDBs appear most favorable when the substitution

TABLE 20. PRESENT VALUE OF SAVINGS FOR DOUBLE DECK BUS SUBSTITUTION[1]

Driver Salary Plus Benefits	Bus Life	Substitution Rates	Present Value of Savings Per DDB
$23,000	12 years	2 for 3	$151,000
		5 for 6	45,000
	15 years	2 for 3	$180,000
		5 for 6	57,000
$30,000	12 years	2 for 3	$189,000
		5 for 6	61,000
	15 years	2 for 3	$226,000
		5 for 6	76,000

[1]Costs include driver salary plus benefits and purchase price of the vehicles. The conventional bus was assumed to cost $100,000 and the Leyland $125,000.

rate is based upon seated capacity only, as it should be for long hauls. The analysis understates the savings, since fuel, repair and maintenance costs have not been included.

Table 21 gives the number of years the DDBs would have to remain in revenue service to justify their initial capital costs, for each substitution rate. For the Leylands, the payback period is relatively short, ranging from immediately to only two years.

Training. In assessing the apparently poorer reliability record of the DDBs (measured in terms of miles between service calls), it should be kept in mind that what looks like a reliability problem may be, in part, a training problem. While the negative influence of inadequate mechanic training and experience cannot be measured quantitatively, both the mechanics and the MaBSTOA management indicated that a lack of familiarity with the electrical and mechanical systems of the DDBs extended repair times and probably contributed to the occurrence and repetition of system failures. They indicated that such would probably not have been the case with a vehicle more familiar to the mechanics.

It is essential that adequate time be allowed and numbers of personnel be trained to assure that person-related factors have a minimum impact on vehicle performance and consequent productivity.

7.3 PASSENGER-RELATED ISSUES

Passenger perceptions and acceptance of the DDB and the conventional bus where assessed and contrasted. Overall preference for bus type was analyzed with respect to passenger demographics and trip characteristics, and ratings of DDB and conventional bus accommodations were compared. Elderly and handicapped passengers (classified as transit dependent

TABLE 21. PAYBACK PERIOD[1]

Driver Salary Plus Benefits	Substitution Rates	Payback Period (Years)
$23,000	2 for 3	0
	5 for 6	2
$30,000	2 for 3	0
	5 for 6	1

[1] Costs include driver salary plus benefits and purchase price of the vehicles. The conventional bus was assumed to cost $100,000 and the Leyland $125,000.

in this report) were analyzed separately from all passengers for preference, trip characteristics, and reactions to accommodations. Summary findings below are based upon two passenger surveys conducted in New York, the first in October 1976 (approximately 1,000 on each bus type) and the second in May 1977 (approximately 500 on each bus type).

7.3.1 Preference

Double deck bus passenger preference for the double deck bus over the conventional bus ranged from better than twelve to one for double deck bus riders on the upper level, to approximately two to one for transit-dependent riders. Although 44% of the transit dependents riding double deck buses preferred the DDB over the conventional bus, 39% either didn't know or had no preference.

Both dispatchers and drivers in New York felt that the passengers preferred the double deck over the conventional bus and that, with the exception of the elderly and handicapped, the upper level was preferred over the lower level. This is substantiated by the fact that 71% of the elderly and handicapped surveyed in October rode on the lower level, as against 49% of all passengers.

7.3.2 Trip Characteristics

The distribution of trip lengths was not significantly different between passengers on DDB and conventional buses. An unexpected finding was that trip lengths of passengers on the upper level were not significantly different from those of passengers remaining on the lower level; thus, passengers making short trips found it worth their while to locate on the upper level.

With respect to the frequency of riding the buses, conventional bus passengers tended to take the bus slightly more frequently than DDB passengers. Of those riding the DDBs, 20 percent had made special plans to make the trip. For double deck and conventional bus passengers, there was no significant difference in trip purpose, with approximately 63 percent making work or school trips.

7.3.3 Accommodations

Double deck bus passengers exhibited a more favorable reaction than did conventional bus passengers to all of the questions related to vehicle accommodations. The following areas elicited a statistically significant difference (in favor of the DDB) between the passengers on the two bus types:

1) Ease of boarding (the Leyland had lower steps and wider doors than the conventional bus).

2) Comfort of seats (the Leyland seats were padded).

3) Use of grab rails (the Leyland had lower ceilings).

4) Internal environment (surveys were conducted on days with moderate temperatures, so impact of air conditioning and heating problems were not reflected in responses).

5) Noise level (much of this can be attributed to passengers on the second level of the DDB, of whom 71.8 percent felt it was quieter, as contrasted with 47.4% on the lower level and 33.2% on the conventional bus).

6) Visibility from the windows (99.2% on the upper level and 95.3% on the lower level, as contrasted with 87.5% for the conventional bus).

Although not significantly different, DDB passenger reactions to the following accommodations were more favorable than the conventional bus passengers' reactions: walking through the bus, comfort of the ride (even though the Leyland's spring suspension gave a more bumpy ride on New York's poorly repaired streets than the air suspension of the conventionals), and interior lighting.

Seventy-five percent of the DDB passengers felt the stairs were easy to use, and only 23% of the riders on the lower level indicated they were there because the upper level was crowded or hard to reach. By contrast, 65% of those passengers on the upper level were there because they preferred it.

Passenger comments regarding the DDB accommodations indicated the narrow and steep stairwell and narrowness of the aisles and lower ceilings as liabilities. On the positive side, most passengers who commented felt that the wider and lower doorway was an asset on the double deck bus.

7.3.4 Elderly and Handicapped

A sample of transit-dependent passengers riding on both bus types during the October 1976 survey was analyzed separately. Among the transit dependents riding the DDBs, 44% preferred the double deck bus, while 39% either didn't know or had no preference.

Among double deck bus riders, no significant difference in bus preference was noted when considering trip frequency, level on which riding, or trip length. For the trip characteristics of frequency, length, and purpose, there were no significant differences between double deck and conventional bus transit dependents.

With respect to ease of boarding the bus, problems in walking through the bus, comfort in terms of the internal environment, and noise levels, the double deck bus was considered significantly better than the conventional bus. Those riding on the upper level of the DDB, when comparing it to conventional buses, felt the DDB was significantly quieter than did those on the lower level.

Considering comfort of seats, ease of use of the grab rail, comfort of ride, bus lighting, and visibility from the bus window, no significant difference between transit-dependent riders on the two buses was detected.

Transit dependents found the DDB essentially as acceptable as the conventional bus, with three exceptions: the steepness and narrowness of the stairwell, the narrow upstairs aisle, and the low ceilings. The wider entry doors and lower level of the entryway step were considered an asset.

APPENDIX A. PASSENGER-RELATED ON-BOARD DATA COLLECTION INSTRUMENTS

October 1976, English

DO NOT MARK IN THIS COLUMN (1-4) BC: (5-7) DLC: DC: (8-10)

PREGUNTAS EN ESPANOL EN EL OTRO LADO

The purpose of this survey is to determine passenger response to bus comfort and convenience. Your reactions to the bus you are now riding on will be compared with reactions to buses of another type. Your frank responses will help to improve service. **Completed form will be collected by person wearing a white hat.**

1. Was this bus easy to board? ☐ YES (1) ☐ NO (2) — (11)
   comments ______
2. Did you have problems walking through the bus? ☐ YES (1) ☐ NO (2) — (12)
   If yes, why? ______
3. Are the seats comfortable? ☐ YES (1) ☐ NO (2) ☐ DON'T KNOW (3) — (13)
4. Are the grab rails easy to use? ☐ YES (1) ☐ NO (2) — (14)
   comments ______
5. Is the bus . . . — (15) (16)
   ☐ comfortable (1) ☐ too cold (2) ☐ too hot (3) ☐ drafty (4) ☐ stuffy (5)
6. How does the noise level in this bus compare with the noise level in most buses? — (17)
   ☐ noisier (1) ☐ about the same (2) ☐ quieter (3)
7. Does this bus ride comfortably? ☐ YES (1) ☐ NO (2) — (18)
   comments ______
8. Is the bus lighting . . . — (19)
   ☐ about right (1) ☐ too bright (2) ☐ too dim (3)
9. Is visibility from the bus windows satisfactory? ☐ YES (1) ☐ NO (2) — (20)
10. How often do you ride a bus? — (21)
    ☐ more than 2 days per week (1) ☐ 1 - 2 days per week (2) ☐ less than once a week (3)
11. What is the main purpose of this bus trip? to or from . . . — (22) (23)
    ☐ work (1) ☐ school (2) ☐ social/recreational (3)
    ☐ shopping (4) ☐ personal business (5) ☐ other (6)
12. To which age group do you belong? — (24)
    ☐ under 20 (1) ☐ 20-44 (2) ☐ 45-64 (3) ☐ over 65 (4)
13. Do you have any physical disabilities that make most buses difficult to use? ☐ YES (1) ☐ NO (2) — (25)
    If yes, please describe ______ — * (26)
14. Did you make special plans to ride on a double deck bus for this trip? ☐ YES (1) ☐ NO (2) — (27)
15. a) On which level are you now riding? ☐ lower (1) ☐ upper (2) — (28)
    b) Where are you located? ☐ front (1) ☐ middle (2) ☐ rear (3) — (29)
    c) If on upper level, were stairs easy to use? ☐ YES (1) ☐ NO (2) — (30)
    comments ______
16. Why did you select this level rather than the other level? — (31)
    ☐ no particular reason (1)
    ☐ I prefer this level; comments ______ (2)
    ☐ the other level was too crowded (3)
    ☐ difficult to get to other level (4)
17. Which type of bus do you like best? — (32)
    ☐ single deck bus (1) ☐ double deck bus (2) ☐ don't know (3) ☐ no preference (4)

* (33)

*Comments:

QUESTIONS IN ENGLISH ON OTHER SIDE

NO MARQUE EN ESTA COLUMNA

1730 (1-4)

SC: (5-7)

DLC: DC: (8-10)

El proposito de esta investigacion es para determinar las respuestas a la comodidad y convenencia del omnibus. Sus reacciones a el omnibus que usted aborda ahora seran comparadas con las reacciones a omnibuses de otro tipo. Su respuesta franca ayudara a mejorar el servicio. **Las formas terminadas seran colectadas por la persona usando un sombrerito blanco.**

1. Fue este omnibus facil de abordar? ☐ SI (1) ☐ NO (2) — (11)
   comentario ______

2. Tuvo usted problemas al caminar atraves del omnibus? ☐ SI (1) ☐ NO (2) — (12)
   Si su respuesta es si, porque? ______

3. Son los asientos comodos? ☐ SI (1) ☐ NO (2) ☐ NO SE (3) — (13)

4. Son las barandas facil de usar? ☐ SI (1) ☐ NO (2) — (14)
   comentario ______

5. Es el omnibus . . . — (15) (16)
   ☐ comodo (1) ☐ muy frio (2) ☐ muy caliente (3) ☐ airoso (4) ☐ sin aire (5)

6. Como se compara el nivel de ruido en este omnibus al nivel de los demas omnibuses? — (17)
   ☐ mas ruido (1) ☐ mas o menas igual (2) ☐ mas quieto (3)

7. Viaja comodo en este omnibus? ☐ SI (1) ☐ NO (2) — (18)
   comentario ______

8. Es la luz del omnibus . . . — (19)
   ☐ mas o menos bien (1) ☐ muy alumbrante (2) ☐ muy baja (3)

9. Es la visibilidad de las ventanas del omnibus satisfactoria? ☐ SI (1) ☐ NO (2) — (20)

10. Que tan seguido aborda usted el omnibus? — (21)
    ☐ mas de 2 dias por semana (1) ☐ 1 - 2 dias por semana (2) ☐ menos de una vez por semana (3)

11. Cual es el proposito principal de este viaje en omnibus? a o de . . . — (22) (23)
    ☐ trabajo (1) ☐ escuela (2) ☐ social/diversion (3)
    ☐ compras (4) ☐ negocios personales (5) ☐ otra (6)

12. A cual grupo de edad pertenece usted? — (24)
    ☐ menos de 20 (1) ☐ 20-44 (2) ☐ 45-64 (3) ☐ mas de 65 (4)

13. Tiene usted algun defecto fisico que le cause dificultad al usar el omnibus? — (25)
    ☐ SI (1) ☐ NO (2)
    Si su respuesta es si, por favor describa ______ — * (26)

14. Hizo usted planes especiales para viajar en un omnibus de plataforma doble? ☐ SI (1) ☐ NO (2) — (27)

15. a) En cual nivel esta usted viajando ahora? ☐ abajo (1) ☐ arriba (2) — (28)
    b) Donde esta usted situado? ☐ enfrente (1) ☐ mitad (2) ☐ atras (3) — (29)
    c) Si esta en el nivel de arriba, fueron las escaleras facil de usar ? ☐ SI (1) ☐ NO (2) — (30)
    comentario ______

16. Porque selecciono usted este nivel en lugar de otro nivel? — (31)
    ☐ ninguna razon en particular (1)
    ☐ Yo prefiero este nivel; comentario ______ (2)
    ☐ el otro nivel estava muy lleno (3)
    ☐ dificultad para llegar al otro nivel (4)

17. Cual tipo de omnibus le gusta a usted mas? — (32)
    ☐ omnibus de una plataforma (1) ☐ omnibus de plataforma doble (2)
    ☐ No se (3) ☐ no tengo preferencia (4) — * (33)

*Comments:

May 1977, English

DO NOT MARK IN THIS COLUMN (1-3) BC: (4-7) DLC: DC: (8-10)

The purpose of this form is to determine passenger response to bus comfort and convenience. Your reactions to the bus you are now riding on will be compared with reactions to buses of another type. Your frank responses will help to improve service. **Completed form will be collected by an employee of MaBSTOA.**

1. Was this bus easy to board? ☐YES (1) ☐NO (2) — (11)

   comments ______ — (12)

2. Did you have problems walking through the bus? ☐YES (1) ☐NO (2) — (13)

   If yes, why? ______ — (14)

3. Are the seats comfortable? ☐YES (1) ☐NO (2) ☐NO OPINION (3) — (15)

4. Are the grab rails easy to use? ☐YES (1) ☐NO (2) — (16)

   comments ______ — (17)

5. Is the bus . . .

   ☐ comfortable (1) ☐ too cold (2) ☐ too hot (3) ☐ drafty (4) ☐ stuffy (5) — (18) (19)

6. How does the noise level in this bus compare with the noise level in most buses?

   ☐ noisier (1) ☐ about the same (2) ☐ quieter (3) — (20)

7. Does this bus ride comfortably? ☐YES (1) ☐NO (2) — (21)

   comments ______ — (22)

8. Is the bus lighting . . .

   ☐ about right (1) ☐ too bright (2) ☐ too dim (3) — (23)

9. Is visibility from the bus windows satisfactory? ☐YES (1) ☐NO (2) — (24)

10. How often do you ride a bus?

    ☐ more than 2 days per week (1) ☐ 1 - 2 days per week (2) ☐ less than once a week (3) — (25)

11. What is the main purpose of this bus trip? to or from . . .

    ☐ work (1) ☐ school (2) ☐ social/recreational (3) — (26)

    ☐ shopping (4) ☐ personal business (5) ☐ other (6) — (27)

12. To which age group do you belong?

    ☐ under 20 (1) ☐ 20-44 (2) ☐ 45-64 (3) ☐ 65 or over (4) — (28)

13. Do you have any physical disabilities that make most buses difficult to use? ☐YES (1) ☐NO (2) — (29)

    If yes, please describe ______ — (30)

14. Which type of bus do you like best?

    ☐ single deck bus (1) ☐ double deck bus (2) ☐ no opinion (3) ☐ no preference (4) — (31)

15. Did you make special plans to ride on a double deck bus for this trip? ☐YES (1) ☐NO (2) — (32)

16. a) On which level are you now riding? ☐ lower (1) ☐ upper (2) — (33)

    b) Where are you located? ☐ front (1) ☐ middle (2) ☐ rear (3) — (34)

    c) Are stairs to upper level easy to use? ☐ YES (1) ☐ NO (2) ☐ NO OPINION (3) — (35)

    comments ______ — (36)

17. Why did you select this level rather than the other level?

    ☐ no particular reason (1) — (37)

    ☐ I prefer this level (2)

    ☐ the other level was too crowded (3)

    ☐ difficult to get to other level (4)

    comments ______ — (38)

APPENDIX B
BASIC NEW YORK MANHATTAN AND BRONX SURFACE TRANSIT OPERATING AUTHORITY DATA RECORDING FORMS

This appendix includes the following forms:

1) Tally Slip, used by dispatchers to record scheduled and actual arrival times at selected points on routes. Bus disposition information is also recorded when buses are diverted due to departure from schedule or repair requirements.

2) Supervisor's Daily Report, used by dispatchers to summarize information on the Tally Slip.

3) Extra Headways, also used by dispatchers to summarize daily operational information.

4) Status of Equipment, identifies defects, repair and maintenance service by bus.

5) Bus Maintenance Record, identifies in greater detail repair and maintenance work done on specific vehicles.

MANHATTAN & BRONX SURFACE
TRANSIT OPERATING AUTHORITY

M & B 134-14
REV. 1

TALLY SLIP

__________BOUND SLIP NO.__________

____

__________DAY __________19____

WEATHER__________PAVEMENT__________

TALLIED AT____________________

RUN NO.	BUS NO.	TIME M	PASS.	PASS.	PASS.	HEADWAY	SIGN

NAME____________________ P.R. No.__________

ADDRESS____________________

FIGURE B-1. TALLY SLIP

FIGURE B-2. SUPERVISOR'S DAILY REPORT

MANHATTAN & BRONX SURFACE TRANSIT
OPERATING AUTHORITY
SUPERVISORS DAILY REPORT

LINE ______________________
Report of: ______________________ P.R. No. ______
Address ______________________
Date ____________ Total Time ____________

POST OF DUTY

From	To	Location

	RIDING	SERVICE	ON OR BEHIND TIME	WEATHER CONDITIONS
1 to 2 AM				
2 " 3 "				
3 " 6 "				
6 " 7 "				
7 " 8 "				
8 " 9 "				
9 " 10 "				
10 " 11 "				
11 " 12 Noon				
12 " 1 PM				
1 " 2 "				
2 " 3"				
3 " 4 "				
4 " 5 "				
5 " 6 "				
6 " 7 "				
7 " 8 "				
8 " 9 "				
9 " 10 "				
10 " 11 "				
11 " 12 Mid.				

Remarks: ______________________

M&B 134-23 Rev. 1

DELAYS RELATING TO DISABLED COACHES AND ACCIDENTS: Give time Control Centre Clerk was notified and, if delay was caused by a vehicle, give owner's name, address and license number. State if you were present during delay.

RUN	BUS	TIME	DIR.	DELAY	LOCATION	CAUSE	REMARKS

Report exact location of defective or dangerous roadway, sidewalk, bridges projecting over curb line, overhanging tree branches, low wires, projecting canopies, excavations, heavy traffic areas, and time lost.

____

ALWAYS BE CAREFUL
ALWAYS BE COURTEOUS

EXTRA HEADWAYS: Report all headways of 3 minutes or more in excess of schedule, if schedule interval is 2 minutes or greater.

RUN	BUS	TIME	DIR.	HEADWAY		LOCATION	CAUSE	HOW COVERED
				TOTAL	EXTRA			

DETOURS AND TURNBACKS

RUN	BUS	TIME	DIR.	DESTINATION	NO. OF PASSENGERS	LOCATION	CAUSE

SHORT SIGNS

Location Chief

FIGURE B-3. EXTRA HEADWAYS

MANHATTAN AND BRONX SURFACE TRANSIT OPERATING AUTHORITY

M&B 135-29

STATUS OF EQUIPMENT

SYMBOL
1. Date and Type of S.O. Performed
2. Operator's Reported Defect
3. Road Replacement
4. Repairs Required (Known Defect)
5. Campaigns
6. At Base Shop

BUS ____________

CAMPAIGNS

SYM.	WORK REQUIRED	DATE	DISPOSITION	DATE	MECH. NO.	FOREMAN

FIGURE B-4. STATUS OF EQUIPMENT

DATE IN	TIME IN AM PM	TIME OUT AM PM	NEW YORK CITY TRANSIT AUTHORITY MANHATTAN AND BRONX SURFACE TRANSIT OPERATING AUTHORITY **BUS MAINTENANCE RECORD**	REPL.

DATE OUT	BUS. NO.	OPERATOR'S REPORT OR WORK TO BE DONE

REPL. BY ____________

LOC. ____________

TIME REPL. ____________

TIME ARR. ____________

TIME RET. ____________

NO	ITEM NO.	GROUP TITLE
1		ENGINE
2		FUEL
3		EXHAUST
4		COOLING
5		ELECT.
6		AIR
7		AIR COND.
8		CONV.
9		PR. SHAFT & H.BRAKE
10		WHEELS & RIMS
11		STEERING
12		BRAKES
13		R. AXLE
14		F. AXLE
15		SPRINGS & MOUNTS
16		BODY
17		FARE BOX
18		ACCID.
19		FLAT TIRES
20		NO FUEL
21		MISC. MECH.
22		NO DEFECT
23		DIRTY BUS
24		RADIO
25		VANDALISM

OPERATOR ____________ SIGNATURE ____________ NO.

FOREMAN OR INSPECTOR ____________ SIGNATURE ____________ NO.

WORK DONE & EXACT REASON FOR FAILURE

OILS ADDED

CHECK ALL LIGHTS ____________ **LUBE** ________ **QTS.**

COMPARTMENT DOORS ____________ **CONV.** ________ **QTS.**

SHOP REPAIR	UNIT NO. REMOVED	UNIT NO. INSTALLED	ITEM NO.	MECH'S NO. & INITIALS	MECH'S NO. & INITIALS	TIME START	TIME FINISH
YARD REPAIR							
MAT'L. FAILURE							
SPEC. ATT.							
INSP.							

	DECEL. READING @ 20 M.P.H.			LAST INSP.
OVER-HAUL	SERVICE	1ST FT.	2ND FT.	DATE
NO. STOCK	HAND	FT.	FT.	MILEAGE

BUS YARD

FOREMAN ____________ SIGNATURE

58-61-0070—400M—JUNE '76

FIGURE B-5. BUS MAINTENANCE RECORD

APPENDIX C. PROJECT FORMS FOR ON-BOARD DWELL TIME AND PASSENGER COUNT DATA AND TRANSIT PERSONNEL INTERVIEW FORMS

This appendix includes the following forms:

1) Trip- and Dwell-Time Sampling Form, used by on-board samplers to determine number of passengers on and off at each stop, as well as dwell times.

2) On-Board Data Collection Administration Form, used by on-board samplers to record zones in which survey forms were distributed.

3) Driver Data Collection Instrument, used for interviews of double deck bus drivers in New York City and Los Angeles.

4) Mechanic Data Collection Instrument, used for interviews of double deck bus mechanics in New York City and Los Angeles.

5) Dispatcher Data Collection Instrument, used for interviews of dispatchers in New York City (no analogous position in Los Angeles).

A brief discussion of how the first two forms were used, and results from their use, are found in Appendix I, Dwell Time and Passenger Throughput.

The last three forms were used in October 1976 and again in April 1977, when interviews were conducted with dispatchers, mechanics, and drivers of the DDBs to obtain their general impressions and reactions. The interviews were conducted by a member of the CACI evaluation team, on an informal basis, with no more than two transit personnel being involved at any point in time. Overall reactions of the interviewees were similar for both interviews.

TRIP- AND DWELL-TIME SAMPLING FORM

	date
	bus number
	route number
	counter name
	door monitored fr. rr.

departure time	total # pass. on initial leg of run

scheduled stop (street intersection)	#pass. off	#pass. on	time dr. opened	standees ∅	few	many	special circumstances (if any)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

arrival time	# pass. off through door at termination of run

FIGURE C-1. TRIP- AND DWELL-TIME SAMPLING FORM

ON-BOARD DATA COLLECTION ADMINISTRATION FORM - Front Door

<u>Instructions</u>: Hand-out data collection forms and pencils to boarding passengers, requesting their assistance. Note the boarding location on this form as you distribute the passenger form. Note only the number of the last data collection form distributed within each zone.	Name: Date: Departure Time: Bus No.: Type: DDB CVB Route No.: 5 Direction: SB NB

Form Number of First Form to be Distributed:

Departure Location Code	Description of Zone	Form # of Last Form Distributed
5170	170 and above	
5160	160 to 169	
5150	150 to 159	
5140	140 to 149	
5130	130 to 139	
5120	120 to 129	
5110	110 to 119	
5100	100 to 109	
5090	90 to 99	
5080	80 to 89	
5070	70 to 79	
5060	60 to 69	
5050	50 to 59 (some XT on 57th)	
5040	40 to 49	
5030	30 to 39	
5020	20 to 29	
5010	10 to 19	
5000	9 and below	

FIGURE C-2. ON-BOARD DATA COLLECTION ADMINISTRATION FORM

Date ______________

Time ______________

Who Conducted __________

DOUBLE DECK BUS PROJECT DRIVER DATA COLLECTION INSTRUMENT

(conducted verbally)

This interview's purpose is to determine your opinion of operational differences between conventional and double deck buses. Passenger preferences are important, but it is the driver who must live with the bus several hours a day. Your frank responses are appreciated.

For each of the following areas of bus operation, please rank your preference.

1. Ease of operation:	CVB	DDB
a. visibility	___	___
b. steering efforts	___	___
c. steering precision (tracking)	___	___
d. acceleration	___	___
e. braking	___	___
f. cornering stability	___	___
g. emergency handling	___	___

FIGURE C-3. DRIVER DATA COLLECTION INSTRUMENT

h. maneuverability ___ ___

i. riding comfort ___ ___

j. noise level ___ ___

k. interior climate (ventilation, temperature control, etc.) ___ ___

l. overall ease of operation ___ ___

2. Does the size of the double deck bus require extra attention in avoiding obstruction such as low branches, overpasses, etc.?

YES	NO	N/D
o	o	o

DR1

3. Control of on-board activities	CVB	DDB	N/D
a. monitoring passenger movements;	o	o	o
b. prevention of on-board accidents (falling, etc.);	o	o	o
c. monitoring passenger behavior (mischief, vandalism, etc.);	o	o	o
d. communication with passengers (announcement of stops);	o	o	o

e. In the double deck bus, does there seem to be a difference between activities taking place on the lower level and those taking place on the upper level?

YES	NO	N/D
o	o	o

If "yes," please describe: ____________________

____

____

4. Reliability/schedule adherence

	CVB	DDB	N/D
a. overall reliability (fewer repairs necessary);	o	o	o
b. day-to-day service dependability (fewer interruptions in normal route service);	o	o	o

Reasons (check as many as are appropriate):

o repairs less serious;

o repairs on the other type of bus can only be performed at times when normal service must be interrupted;

o not as much attention given repairs as with other bus;

o other ______________________________

____

	CVB	DDB	N/D
c. Ease in maintaining schedule (running on time):	o	o	o

Reasons (check as many as are appropriate):

o better performance;

o fewer passengers/fewer stops required;

o boarding/discharging of passengers faster;

o on-board circulation easier;

o ticket collection (if any) faster;

o other ______________________________

DR2

5. <u>Passenger response</u>

	CVB	DDB	N/D
a. overall passenger preference;	o	o	o

	UP	LOW	N/D
b. Which level, if any, do passengers seem to prefer?	o	o	o

c. Noteworthy passenger comments?____________

____

____

____

	YES	NO
6. Were there problems in acquainting yourself with operation of the double deck bus that would probably not be encountered with any new bus model?	o	o

Comments:______________________________________

____

____

____

DR3

Date____________________

Time____________________

Who Conducted__________

DOUBLE DECK BUS PROJECT MECHANIC DATA COLLECTION INSTRUMENT

(conducted verbally)

The purpose of this interview is to determine the service differences between conventional and double deck buses. While drivers operate these vehicles several hours a day, mechanics must understand and manipulate the technical aspects of their operation in order for them to run. Your frank responses are appreciated.

For the following maintenance functions, which bus is easier to service? Also, please indicate the approximate time to perform this function for each vehicle, to the nearest 15 minutes.

Maintenance Function	CVB Easier	DDB Easier	Time CVB	Time DDB
Check oil level	o	o	____	____
Change oil	o	o	____	____
Change oil filter.	o	o	____	____
Check transmission fluid level	o	o	____	____
Service transmission	o	o	____	____
Tune engine (minor)	o	o	____	____
Tune engine (major)	o	o	____	____
Rotate tires	o	o	____	____
	o	o	____	____

FIGURE C-4. MECHANIC DATA COLLECTION INSTRUMENT

Wash vehicle exterior

Clean vehicle interior o o ___ ___

Are there any maintenance services that are especially difficult on the double deck bus?

YES	NO
o	o

If any, what? ____________________________________

____

Which type of bus appears to require fewer repairs?

CVB	DDB	N/D
o	o	o

MC1

Which bus appears to deliver better day-to-day service dependability (fewer interruptions in normal service)?

CVB	DDB	N/D
o	o	o

Reasons (check as many as are appropriate):

- o repairs less serious;
- o repairs on the other type of bus can only be performed at times when normal service must be interrupted;
- o not as much attention given repairs as with other bus;
- o other: ____________________________________

____

____

Were there problems in acquainting yourself with servicing or repairing the double deck bus that would probably not be encountered with any new bus model?

YES	NO
o	o

Description: ____________________________________

Additional comments: ____________________

MC2

Date____________________

Time____________________

Who Conducted____________

NEW YORK DISPATCHER DATA COLLECTION INSTRUMENT (conducted verbally)

---

1. Which type of bus tends to fall behind schedule more frequently?

    o double deck bus

    o conventional bus

    o about the same

    Reasons?____

2. Which type of bus appears to be carrying a greater number of passengers per run?

    o double deck bus

    o conventional bus

    o about the same

    o relationship fluctuates throughout the day

    Comments:____

3. As passenger loads on each bus are assessed, does there appear to be a passenger preference for either of the two double deck bus levels?

    o no; about equal

    o yes; passengers seem to prefer the upper level

    o yes; passengers seem to prefer the lower level

FIGURE C-5. DISPATCHER DATA COLLECTION INSTRUMENT

- o yes; but the preference seems to vary with the time and/or location

Comments: ______________________________

4. Do waiting passengers seem to prefer one bus to the other?
   - o no; seem to indicate no preference for either type of bus
   - o yes; seem to prefer double deck bus
   - o yes; seem to prefer conventional bus
   - o do not know

   Additional comments: ______________________________

APPENDIX D. STATISTICAL PROCEDURES

In the analysis of data collected in Los Angeles during the Double Deck Bus Demonstration Project, where appropriate, certain inferential statistical procedures were employed. Each of these techniques[1] is briefly described as it relates to a specific analysis. Data were processed on the PDP-10 computer, using the SPSS package.[2]

REGRESSION

In comparing total passenger throughput (indicated by X) per run with total dwell time (indicated by Y) per run, a least-square regression equation was fit through the origin. Results are reported for conventional and double deck buses separately. In addition, the significance of the individual regression coefficients was tested. Statistics employed for these analyses were:

$$Y = b\,X$$

---

[1] For correlation and regression, analysis of mean differences, and analysis of variances, an excellent reference is Experimental Statistics, Mary G. Natrella, National Bureau of Standards Handbook 91, October 1966. For analysis of survey responses and schedule-adherence data, a technique similar to chi-square was used. See Information Theory and Statistics, Solomon Kullback, John Wiley and Sons, Inc., New York, N.Y. 1959.

[2] Statistical Package for the Social Sciences, Second Edition, N. H. Nie et al, McGraw-Hill Book Company, 1975.

where $b = \sum XY / \sum X^2$

$X =$ individual run total passenger throughput

$Y =$ individual run total dwell time

The appropriate analysis to test the significance of the regression coefficient is:

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Sum of Squares
Due to regression	$M_1 = b\sum XY$	1	$S_1 = M_1/1$
Residual	$M_2 = \sum Y^2 - b\sum XY$	n-1	$S_2 = M_2/n-1$
Total	$\sum Y^2$	n	-

$$F = S_1 \div S_2$$

where F has 1 and (n-1) degrees of freedom.

To test whether the two regression equations are significantly different, the following statistic was employed:

$$t = (b_1 - b_2) \div S_{(b_1 - b_2)}$$

where t is Students "t" distribution with $n_1 + n_2 - 2$ degrees of freedom

b_1, b_2 are the two regression coefficients

$S_{(b_1-b_2)}$	is the standard error of the difference between the two regression coefficients
n_1, n_2	are the two sample sizes

MEAN AND VARIANCE DIFFERENCES

In comparing average dwell time per throughput passenger (indicated by Z) for the double deck and the conventional buses, standard analysis of mean and variance procedures were employed.

$$F = S_1^2 \ / \ S_2^2$$

where

where	F	is the value of the F distribution with $(n_1 -1)$ and $(n_2 -1)$ degrees of freedom
	S_1^2, S_2^2	are the respective variances for the double deck and conventional bus Z values
	n_1, n_2	are the number of data points for the double deck and conventional buses respectively

Standard one-way and two-way analysis of variance tables were utilized to compare differences between bus types and times of day.

FREQUENCY CROSS COMPARISONS FOR SURVEYS

In comparing differences in responses for double deck and conventional bus passengers, as an example, information statistics presented in the second referenced text were employed. These statistics are distributed as chi-square and tend to be more accurate for small sample sizes.

To test for the significance of difference in responses, for example, by double deck bus and conventional bus passengers to the question "Is the visibility from the bus windows good?", the following procedure was utilized:

Bus Type	Yes	No	Totals
Double Deck	1290	40	1330
Conventional	1166	167	1333
Totals	2456	207	2663

$$\begin{aligned} \text{Chi Square} &= 2\,(2{,}663 \ln 2{,}663 + 1{,}290 \ln 1{,}290 + 40 \ln 40 + \\ &\quad 1{,}166 \ln 1{,}166 + 167 \ln 167 - 1{,}330 \ln 1{,}330 \\ &\quad - 1{,}333 \ln 1{,}333 - 2{,}456 \ln 2{,}456 - 207 \ln 207) \\ &= 2 \times 45.0 = 90.0 \end{aligned}$$

which is significant for one degree of freedom at better than the .001 level.

The degrees of freedom for more extensive tables are given by the number of rows less one multiplied by the number of columns less one; i.e., $(r - 1)(c - 1)$.

APPENDIX E. DETAILED SCHEDULE ADHERENCE DATA, NEW YORK CITY

For four days (October 26 and 27, 1976 and April 26 and 27, 1977) data were extracted from dispatcher records relative to complete runs for the eight double deck buses (E-1 through E-8), the four conventional GM counterparts (8614 through 8617), and other conventional buses. Conventional buses, other than the counterpart demonstration buses, were included to bring the sample sizes, where necessary, up to those for the DDBs. These data, which permit comparison of actual with scheduled trip time, have been classified in the following manner:

1) Route Number and Direction (southbound and northbound).

2) Time Period (morning peak, 6:30 - 9:00 AM.; midday, 9:00 AM - 4:30 PM; evening peak, 4:30 - 6:30 PM; and, evening, 6:30 - 11:00 PM).

3) Run Type ("almost a full run" and a minimum of 40 minutes scheduled trip time; less than a full run of no more than 40 minutes scheduled trip time and through congested areas; and, less than a full run of no more than 40 minutes scheduled trip time but through less-congested areas).

From the basic dispatch data, segments of runs were identified for the buses, provided there were at least two data points indicating scheduled and actual departure times. From these basic data, departures from schedule were calculated as well as percentage departure from schedule. The data in this appendix are analyzed in Chapter 4.

Date and Route		Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
					Scheduled	Actual		
10/26/76								
#4	NB	D4	A	F	49	53	- 4	- 8.2
		D8	A	F	53	56	- 3	- 5.7
		D4	M	F	67	67	0	--
		D8	M	F	67	67	0	--
		D8	M	F	67	99	-32	-47.8
		D4	P	F	70	77	- 7	-10.0
		8617	P	F	58	58	0	--
		7785	A	F	47	46	+ 1	2.1
		8662	A	F	47	47	0	--
		8636	A	F	47	47	0	--
		6813	A	F	47	52	- 5	-10.6
		8664	M	F	53	52	+ 1	1.9
		6823	M	F	53	53	0	--
		8633	M	F	67	67	0	--
		7805	M	F	67	70	- 3	- 4.5
		8682	M	F	67	67	0	--
		5216	P	F	55	53	+ 2	3.6
		8636	P	F	55	57	- 2	- 3.6
		8639	P	F	70	70	0	--
		8667	E	F	53	55	- 2	- 3.8
		5220	E	F	47	52	- 5	-10.6
	SB	D1	A	PLC	21	21	0	--
		D4	M	PLC	24	24	0	--
		D8	M	PLC	24	16	+ 8	33.3
		8617	E	PLC	21	21	0	--
		D8	M	F	46	61	-15	-32.6

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes: Scheduled	Trip Times in Minutes: Actual	Departure from Schedule[3]	% Departure from Schedule[3]
10/26/76							
#4 SB	D1	M	F	47	62	-15	-31.9
	D4	M	F	46	58	-12	-26.1
	8617	P	F	46	46	0	--
	7792	M	F	46	47	- 1	- 2.2
	8695	M	F	46	46	0	--
	7799	M	PLC	24	22	+ 2	8.3
	7792	M	PLC	24	24	0	--
	8636	M	PLC	24	24	0	--
10/27/76							
#4 NB	D1	P	F	70	70	0	--
	D5	P	F	70	78	- 8	-11.4
	8615	P	F	70	72	- 2	- 2.9
	D3	P	F	71	72	- 1	- 1.4
	8614	P	F	61	67	- 6	- 9.8
	D1	E	F	50	52	- 2	- 4.0
	D5	E	F	47	57	-10	-21.3
4/26/77							
#4 NB	8616	P	F	55	55	0	--
	D2	P	F	70	70	0	--
	8614	P	F	80	81	- 1	- 1.3
	D4	P	F	70	91	-21	-30.0
	D4	P	PC	16	14	+ 2	12.5
	D2	E	F	50	50	0	--
	8614	E	F	49	55	- 6	-12.2

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
4/26/77							
#4 NB	D5	E	F	47	47	0	--
	6807	P	PC	16	10	+ 6	37.5
SB	D7	A	PLC	21	21	0	--
	8614	A	PLC	24	30	- 6	-25.0
	8616	A	PLC	24	29	- 5	-20.8
	D4	M	PLC	24	35	-11	-31.4
	D5	M	PLC	24	39	-13	-54.2
	8616	M	F	70	86	-16	-22.9
	8616	M	PLC	24	32	- 8	-33.3
	D2	M	PLC	24	37	-13	-54.2
	8616	M	PLC	24	24	0	--
	D5	P	PLC	24	31	- 7	-29.2
	8616	P	PLC	21	21	0	--
	D2	E	PLC	21	21	0	--
	8614	E	PLC	21	21	0	--
	D5	E	PLC	21	21	0	--
	8614	E	PLC	21	21	0	--
4/27/77							
#4 NB	D8	A	F	49	56	- 7	-14.3
	D1	A	F	53	55	- 2	- 3.8
	D4	A	F	53	53	0	--
	8614	A	F	53	53	0	--
	D1	M	F	67	66	+ 1	1.5
	D4	M	F	67	67	0	--
	8614	M	F	67	71	- 4	- 6.0

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
4/27/76							
#4 NB	D8	M	F	67	87	-20	-29.9
	D1	M	F	67	85	-18	-26.7
	8614	M	F	70	69	+ 1	1.4
	D8	P	F	54	53	+ 1	1.9
	D1	P	F	54	56	- 2	- 3.7
	8614	E	F	42	29	+13	31.0
10/26/76							
#5 NB	D3	M	F	85	85	0	--
	D3	M	F	54	54	0	--
	D3	M	PLC	19	18	+ 1	5.3
	D5	M	F	77	78	- 1	- 1.3
	D5	M	F	58	58	0	--
	8614	M	F	77	69	+ 8	10.4
	8614	M	F	58	51	+ 7	12.1
	D3	M	F	77	68	+ 9	11.7
	D3	M	F	58	58	0	--
	D1	E	F	62	78	-16	-25.8
	D1	E	F	43	57	-14	-32.6
	8616	E	F	58	57	+ 1	1.7
	D1	E	F	41	43	- 2	- 4.9
	8616	E	PC	35	35	0	--
	8616	P	PC	36	34	+ 2	5.6
	8614	P	PC	25	25	0	--
	8614	P	PC	19	18	+ 1	5.3
	D3	P	PC	25	30	- 5	-20.0

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
10/26/76							
#5 NB	D3	P	F	44	52	- 8	-18.2
	D5	M	PLC	29	29	0	--
	D5	M	PLC	17	15	+ 2	11.8
	8616	M	PLC	30	30	0	--
	8616	M	PLC	18	18	0	--
	D3	M	PLC	30	30	0	--
	D3	M	PLC	18	15	+ 3	16.7
	8614	M	PLC	28	26	+ 2	7.1
	8614	M	PLC	19	16	+ 3	15.8
	8617	M	PLC	31	31	0	--
	8617	M	PLC	19	19	0	--
	8617	M	PLC	31	31	0	--
	8617	M	PLC	19	18	+ 1	5.3
	8616	M	PLC	19	18	+ 1	5.3
	D5	E	PLC	17	20	- 3	-17.6
	7783	M	F	73	74	- 1	- 1.4
	6814	M	F	73	73	0	--
	6815	M	PLC	18	17	+ 1	5.6
	6811	P	F	53	58	- 5	- 9.4
	8660	E	F	60	53	+ 7	11.7
	7792	E	F	61	60	+ 1	1.6
	6814	E	F	60	59	+ 1	1.7
SB	8616	M	PLC	37	54	-17	-45.9
	8616	M	PLC	21	29	- 8	-38.1
	D5	P	F	52	72	-20	-38.5
	D5	P	PLC	18	20	- 2	-11.1

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM
2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.
3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
10/26/76							
#5 SB	8614	P	F	52	53	- 1	- 1.9
	8614	P	PLC	34	35	- 1	- 2.9
	D3	P	F	52	49	+ 3	5.8
	D3	P	PLC	37	35	+ 2	5.4
	8614	E	F	48	50	- 2	- 4.2
	8614	E	PLC	35	31	+ 4	11.4
	8614	E	PLC	16	16	0	--
	D3	E	F	48	40	+ 8	16.7
	D3	E	PLC	35	30	+ 5	14.3
	8616	E	F	46	42	+ 4	8.7
	8616	E	PLC	15	11	+ 4	26.7
	D5	M	PLC	31	30	+ 1	3.2
	D3	M	PLC	30	30	0	--
	D5	M	PLC	32	32	0	--
	8614	M	F	47	55	- 8	-17.0
	8614	M	PLC	32	29	- 3	- 9.4
	D3	M	PLC	32	34	+ 2	6.3
	D5	A	F	54	54	0	--
	8616	A	F	54	54	0	--
	D3	A	F	54	54	0	--
	8614	A	F	73	73	0	--
	8617	A	F	63	68	- 5	- 7.9
	D1	P	PC	31	41	-10	-32.2
	D1	E	PC	31	31	0	--
	8617	M	PC	15	19	- 4	-26.7
	8683	A	F	61	57	+ 4	6.6
	8670	A	F	56	56	0	--

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route		Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
					Scheduled	Actual		
10/26/76								
#5	SB	5209	A	F	58	58	0	--
		7784	A	F	60	60	0	--
		8678	M	F	47	47	0	--
		8634	M	F	45	45	0	--
		8673	M	PLC	18	20	- 2	- 11.1
		5210	M	PLC	18	19	- 1	- 5.6
		6829	M	PLC	18	21	- 3	- 16.7
		7786	M	PLC	18	18	0	--
		8694	P	PLC	14	18	- 4	- 28.6
		8678	P	PLC	19	21	- 2	- 10.5
		7806	P	PLC	19	22	- 3	- 15.8
		8626	P	PLC	19	19	0	--
		8693	P	PLC	19	21	- 2	- 10.5
		6811	E	PLC	18	15	+ 3	16.7
		8658	E	PLC	18	20	- 2	- 11.1
		7786	E	PLC	18	17	+ 1	5.6
10/27/76								
#5	NB	D4	M	PLC	19	45	-26	-136.8
		D6	M	PLC	19	23	- 4	- 21.1
	SB	D6	P	PLC	13	21	- 8	- 61.5
		D4	E	PLC	18	9	+ 9	50.0
		D6	E	PLC	18	18	0	--
		8615	A	PC	12	23	-11	- 91.7
		D4	M	F	45	52	- 7	- 15.6
		D6	M	F	44	53	- 9	- 20.5

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route		Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
					Scheduled	Actual		
10/27/76								
#5	SB	D6	M	PC	15	25	-10	- 66.7
		D4	A	PC	11	15	- 4	- 36.4
4/26/77								
#5	NB	8615	M	F	77	72	+ 5	6.5
		8615	M	F	80	76	+ 4	5.0
		D8	M	F	79	73	+ 6	7.6
		D7	M	F	77	73	+ 4	5.2
		D6	P	F	77	75	+ 2	2.6
		D7	E	F	41	37	+ 4	9.8
		D6	E	PC	36	38	- 2	- 5.6
		D1	P	PC	35	28	+ 7	20.0
		D8	M	PLC	18	18	0	--
		D1	M	PLC	18	18	0	--
		D6	M	PLC	19	13	+ 6	31.6
		D6	M	PLC	19	21	- 2	- 10.5
		D7	E	PLC	19	17	+ 2	10.5
		D6	E	PLC	19	21	- 2	- 10.5
	SB	D8	A	F	52	52	0	--
		D1	A	F	54	52	+ 2	3.7
		D6	A	F	60	62	- 2	- 3.3
		8615	M	F	61	63	- 2	- 3.3
		D8	M	F	63	63	0	--
		D6	M	F	63	63	0	--
		8615	M	PLC	19	19	0	--
		D8	M	PLC	19	19	0	--

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
4/26/77							
#5 SB	D7	M	PLC	19	19	0	--
	D6	M	PLC	19	19	0	--
	8615	M	PLC	19	19	0	--
	D1	M	PLC	19	20	- 1	- 5.3
	D8	P	PLC	19	19	0	--
	D7	P	PLC	19	20	- 1	- 5.3
	D6	E	PLC	18	16	+ 2	11.1
	D8	E	PLC	18	18	0	--
	D7	E	PLC	18	17	+ 1	5.6
	D6	E	PLC	18	19	- 1	- 5.6
4/27/77							
#5 NB	D2	A	F	70	62	+ 8	11.4
	D7	A	F	66	62	+ 4	6.1
	D6	M	F	72	64	+ 8	11.1
	8615	M	F	78	71	+ 7	9.0
	8616	M	F	87	73	+14	16.1
	D2	M	F	67	67	0	--
	8615	M	F	73	73	0	--
	8616	M	F	74	74	0	--
	D6	P	F	58	58	0	--
	8615	P	F	77	74	+ 3	3.9
	8616	P	F	60	60	0	--
	D6	E	F	62	62	0	--
	8616	E	F	58	59	- 1	- 1.7
	8615	E	F	60	61	- 1	- 1.7

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
4/27/77							
#5 NB	D4	E	F	58	58	0	--
	D6	E	PC	36	37	- 1	- 2.8
	8616	E	PC	36	45	- 9	- 25.0
	D2	M	F	77	77	0	--
	8662	A	F	72	62	+10	13.9
	8664	A	F	73	63	+10	13.7
	8662	E	PLC	19	16	+ 3	15.8
	8679	E	PLC	19	15	+ 4	21.1
	8664	E	PLC	19	17	+ 2	10.5
SB	8616	P	F	49	52	- 3	- 6.1
	8615	E	F	48	57	- 9	- 18.8
	D4	P	PLC	35	32	+ 3	8.6
	D6	P	F	46	41	+ 5	10.9
	8616	P	F	46	45	+ 1	2.2
	8615	P	PLC	15	15	0	--
	D2	A	F	52	50	+ 2	3.8
	D7	A	F	54	52	+ 2	3.7
	D6	A	F	60	60	0	--
	8615	A	F	62	62	0	--
	8616	M	F	62	58	+ 4	6.5
	D2	M	F	63	66	- 3	- 4.8
	D6	M	F	44	55	-11	- 25.0
	8615	M	F	63	61	+ 2	3.2
	D2	M	PLC	19	19	0	--
	D6	M	PC	34	39	- 5	- 14.7
	8615	M	PC	34	34	0	--
	D6	P	PC	31	31	0	--

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM

2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.

3 - A minus sign indicates bus was behind schedule.

Date and Route	Bus Number	Time Period[1]	Run Type[2]	Trip Times in Minutes		Departure from Schedule[3]	% Departure from Schedule[3]
				Scheduled	Actual		
4/27/77							
#5 SB	7799	P	PC	15	20	- 5	- 33.3
	8693	P	PC	15	17	- 2	- 13.3
	8680	E	PC	13	16	- 3	- 23.1

1 - A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM; E: 6:30-11:00 PM
2 - F: 40 minutes or more scheduled; PC: congested area, less than 40 minutes; PLC: less congested, less than 40 minutes.
3 - A minus sign indicates bus was behind schedule.

APPENDIX F. FEDERAL MOTOR VEHICLE SAFETY STANDARD EXEMPTIONS

On August 27, 1975, British Leyland submitted a petition to the National Highway Traffic Safety Administration (NHTSA) requesting a waiver from certain Federal Motor Vehicle Safety Standards for the eight demonstration DDBs.

1) Standard No. 102, Transmission Shift Sequence, Starter Interlock and Transmission Braking Effect. A portion of this standard requires a supplemental braking effect when bus speed is below 25 MPH. British Leyland argued that usual operating speeds would not require the full braking effect.

2) Standard No. 108, Lamps, Reflective Devices, and Associated Equipment. British Leyland argued that, given the urban conditions under which the demonstration vehicles were to operate, the full photometric performance required by this standard would not be needed.

3) Standard No. 121, Air Brake Systems. British Leyland argued that, although the vehicle failed to meet requirements for brake actuation and release time, and reservoirs, it nevertheless provided equivalent performance.

4) Standard No. 217, Bus Window Retention and Release. British Leyland claimed that the vehicle has a total area of emergency egress of 8,702 square inches, almost double the emergency exit area required by the standard and thus provides an equivalent overall level of safety.

Both the Urban Mass Transportation Administration and the Metropolitan Transit Authority of New York City supported the petition by British Leyland. The opinion of the California Highway Patrol (CHP) was opposed, expressing concern about the possible deterioration of an exempted brake system in use. In addition, the CHP stated that they felt conforming lighting equipment should not be difficult to supply.

In its April 20, 1976 decision, NHTSA stated that "...British Leyland has failed to sustain the burden of proving that its buses will provide an overall level of safety equivalent to or exceeding that of a fully conforming vehicle... There is no inherent reason why double-decker buses cannot meet all Federal bus safety standards, and NHTSA understands that UMTA is also funding a project under which conforming double-decker buses of German Manufacture will be used in Los Angeles... [Therefore,] the petition by British Leyland U.K., Ltd. is hereby denied."

APPENDIX G

SUMMARY OF LEYLAND COACH PROBLEMS

The following is a summary of repetitive problems incurring since starting in-service operation in September 1976:

1. ALTERNATOR AND FAN DRIVE COUPLING

   From the very start in October '76 we experienced difficulty with alternator drive couplings deteriorating and the resulting alternator failures. By October 6th every coupling had been tentatively repaired. By October 27th at least one alternator on every bus had been replaced. In most cases this was the #1 alternator.

   The Leyland Company came up with two modification couplings. As of December 23rd, all buses had been fitted with the new coupling. These new couplings have not shown any apparent deterioration, possibly because the air conditioning has not been operational since the retrofit and therefore no fluctuating loads are being placed on the alternator.

   We were recently informed that Leyland has a new coupling modification which may yet have to be installed on all coaches.

2. AIR CONDITIONING

   Problems were encountered with air conditioning restart due to the auxiliary engine not being able to overcome the high head pressure of the compressor after shut down. Problem was identified at a test made September 21, '76. This problem was solved by fitting a hot gas by-pass valve so as to equalize the pressures. To date, all coaches have been modified with this valve. Additional problems were encountered with the A/C electrical wiring and controls. This problem is under investigation by Leyland Engineering and the solution should be forthcoming soon.

3. TIMING CASE LEAKAGE

To date we have had three failures in this area. A minor modification for timing case fastenings was provided by Leyland and will be carried out as required. It was reported by a Leyland representative that this problem is possibly related to the #2 alternator drive. Failures of a similar design have occurred in the U.K.

4. ALTERNATOR AND REGULATOR FAILURES

Since early in October 1976 we experienced alternator failures. It was determined that these failures were probably caused by one of three reasons:

A. Overall vehicle consumption too high causing over voltage cut out.

B. Badly discharged batteries, due to age, causing sulfation of cell plates. All buses have been fitted with new batteries.

C. Flexible coupling set up torsional vibrations which in turn may have caused possible electrical spike inputs. Since the fitting of new batteries and modified couplings, we have had no further related failures of alternators.

A number of voltage regulators also failed. Two units had failures of the field current circuits and this was probably a result of the shorts in the alternator rotor windings. A third had a failed driver transistor.

5. BATTERY FAILURES

A built-in design problem may cause short battery life under normal service operation. Battery housing, with its limited accessibility, allowed road shock vibrational motion to break and end-connection-cell, by flexing the post against an almost rigid cable.

The relatively inefficient electrical supply system causes deep cycling and will lead to rapid sulphation.

A/C batteries, due to lack of A/C drive engine operation, lose their charge and in freezing weather will develop cracks. Since the radios operate from the A/C batteries the discharge problem allows for no radio operation for long periods of time. (Mainly in winter.)

6. A/C DRIVE ENGINE DILUTION

To date every A/C drive engine has shown substantial oil dilution. Investigation seems to indicate that the dilution is caused by accidental turning over of the engine with no start of the engine itself.

Bus operators may be hitting the start switch on the operators console. This is only an assumed cause for the dilution and will only be proven when the drivers panel is rewired in connection with the Webasto Heater installation and the A/C controls rewiring to be performed by Leyland.

7. TRANSMISSION FAILURE

Seized top gear clutches were found on one transmission. Information from Leyland seems to indicate that there has been a batch fault of top gear clutches and that this gear box was manufactured at that particular time.

8. DOOR INTERLOCK

This problem was due to air pressure being trapped in rear brake supply line after door interlock pilot air valve was deenergized. On investigation it was discovered that by repiping the pilot air valve it gave an immediate air release. All buses have now been modified.

A number of door interlock relays were also found defective and were replaced.

9. SUSPENSION

Three buses have sheared the rivets that hold the spring clips in position. On inspections, no further deterioration has shown, but spring breakage must be anticipated.

10. ELECTRICAL WIRING

Every coach was individually hand wired without color coding being used. Since every coach is wired differently, this has caused many maintenance problems.

11. WATER IN AIR SYSTEM

Following four to five weeks of the buses going into operation, they were being brought out of service with the low air warning buzzer and warning light activated. On investigation, it was found that this was due to water ingress in the air switches. It was decided to add two D.V.2 valves on a test basis. All coaches have now been modified.

12. SALOON HEATING

Heating problems became apparent during the first week of cold temperatures. Many tests were carried out and ultimately it was decided that a supplemental heater would be added.

Leyland supplied and installed one "Webasto" heater on a test basis. The balance of the buses are now being retrofitted.

13. THROTTLE DIP CYLINDERS

Seven failures of this item have occurred. On investigation, no apparent reason could be found other than the inadequacy of the cylinder to meet working capacity requirements.

14. SELNEC INTEGRITY TEST CIRCUIT

This appears much too sensitive and the fault light comes on due to high humidity levels causing minor earth leaks.

15. RADALARM PLUG AND ENGINE COOLING SYSTEM

The radalarm plug vibrates loose and brings on low coolant warning, plug clip and unit appear inadequate. Most coaches have now been wired directly, by-passing this plug.

Large top mounted heater cores and the expansion of hot water causes pressure to increase beyond the limits of the pressure relief valve.

The lack of a surge tank to take up this expansion allows for the loss of coolant resulting in a low water situation. Leyland is presently working on this problem.

16. MASTER START SWITCH

The operation of this switch allows for a no charge situation when the engine is running and the switch is in the off position. Though this seems to be a driver training problem, Leyland agreed to investigate the possibility of rewiring this switch.

17. WATER VALVE INLET PIPE

Problem with this pipe was due to the heater water feed pipe vibrating on the main control box support angle. This pipe will be replaced and modofied by Leyland during the "Webasto" retrofit.

18. FUEL LINES

A number of fuel lines have broken. This problem seems to be the result of excessive vibration on rigid steel fuel lines of small diameter. Leyland was advised.

19. REAR SIGNAL BULBS

Many signal bulbs have been replaced. This again seems to be caused by excessive vibration and inadequately designed sockets and spring contacts.

20. LOW MILEAGE

Due to the above problems and the resulting out-of-service time, the coaches have accumulated very little mileage. This might result in further problems showing up at a later date.

APPENDIX H. DETAILED MONTHLY OPERATIONAL MILEAGE, FUEL, AND OIL CONSUMPTION FOR THE NEW YORK DOUBLE DECK BUS DEMONSTRATION VEHICLES

Month	Vehicle No.	Operational Miles	Fuel Consumption		Oil Consumption[1]		Days In Service
			Month	MPG	Month	MPQ	
October 1976	8614	1,995	667	3.0	38	53	26
	8615	2,026	615	3.3	41	49	24
	8616	2,443	785	3.1	37	66	26
	8617	2,568	802	3.2	22	117	30
	D-1	1,692	510	3.3	2	846	24
	D-2	130	35	3.7	2	65	2
	D-3	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
	D-4	1,375	391	3.5	0	--[3]	16
	D-5	2,023	709	2.9	0	--[3]	28
	D-6	2,087	685	3.0	0	--[3]	29
	D-7	951	314	3.0	0	--[3]	17
	D-8	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
November	8614	2,473	693	3.6	31	80	27
	8615	2,233	669	3.3	19	118	24
	8616	2,288	753	3.0	56	41	26
	8617	2,078	574	3.6	25	83	24
	D-1	1,138	358	3.2	0	--[3]	22
	D-2	424	158	2.7	0	--[3]	8
	D-3	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
	D-4	1,291	410	3.1	0	--[3]	20
	D-5	981	313	3.1	0	--[3]	22
	D-6	1,577	516	3.1	0	--[3]	24
	D-7	1,450	468	3.1	0	--[3]	21
	D-8	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
December[4]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
January 1977[4]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]
February	8614	1,873	497	3.8	10	187	21
	8615	1,945	671	2.9	12	162	24
	8616	2,576	826	3.1	25	103[5]	25
	8617	2,469	743	3.3	31	80	26
	D-1 to D-8[4]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]

1 - Exclusive of scheduled oil changes.
2 - Computer failed to pick up data for these vehicles.
3 - No oil added this period.
4 - Computer breakdown during these months, therefore, no data.
5 - Heavy service order (extensive maintenance) performed 2/16/77.

Month	Vehicle No.	Operational Miles	Fuel Consumption		Oil Consumption[1]		Days In Service
			Month	MPG	Month	MPQ	
March	8614	1,863	675	2.8	23	81	25
	8615	2,011	560	3.6	26	77	25
	8616	2,712	838	3.2	11	247	29
	8617	328	81	4.0	4	82	4
	D-1	517	114	4.5	0	--[2]	8
	D-2	856	271	3.2	0	--[2]	16
	D-3	1,707	430	4.0	0	--[2]	23
	D-4	1,699	471	3.6	0	--[2]	23
	D-5	1,598	481	3.3	0	--[2]	22
	D-6	2,018	563	3.6	6	336	27
	D-7	1,840	557	3.3	0	--[2]	23
	D-8	1,792	530	3.4	0	--[2]	22
April	8614	2,367	738	3.2	37	64	27
	8615	2,009	616	3.3	13	155	22
	8616	2,329	772	3.0	4	582	26
	8617	1,317	387	3.4	16	82	17
	D-1	1,995	619	3.2	0	--[2]	26
	D-2	1,046	213	4.9	0	--[2]	17
	D-3	1,814	426	4.3	2	907	27
	D-4	1,535	410	3.7	0	--[2]	20
	D-5	2,140	638	3.4	0	--[2]	27
	D-6	1,886	558	3.4	0	--[2]	25
	D-7	2,127	629	3.4	0	--[2]	27
	D-8	2,316	612	3.8	0	--[2]	27
May	8614	1,898	699	2.7	6	316	24
	8615	2,349	801	2.9	7	336	27
	8616	2,292	708	2.9	11	208	28
	8617	89	31	2.9	1	89	1
	D-1	1,936	645	3.0	0	--[2]	27
	D-2	575	211	2.7	0	--[2]	8
	D-3	1,354	410	3.3	0	--[2]	18
	D-4	2,043	545	3.7	0	--[2]	26
	D-5	1,292	368	3.5	4	323	17
	D-6	1,245	385	3.2	0	--[2]	17
	D-7	218	65	3.4	0	--[2]	2
	D-8	1,421	429	3.3	0	--[2]	19

1 - Exclusive of scheduled oil changes.

2 - No oil added this period.

APPENDIX I. DWELL TIME AND PASSENGER THROUGHPUT

In two surveys, conducted October 1976 and May 1977, twelve double deck and twelve conventional runs were sampled to obtain information on dwell time and passenger throughput.

Two persons rode each bus, one stationed at the front door and the other at the rear door. Counts were made of the number of passengers boarding the bus and exiting the bus at each stop. In addition, total dwell time (as measured from time the door opened until it was closed) was recorded using stop watches. The exception to this procedure was in instances where the doors remained opened due to a traffic light but no passengers boarded or alighted. In those cases, the dwell time measurement ceased when the last passenger activity occurred.

Results of these two surveys are summarized on the following two pages.

Route	Bus Type	Time of Day[1]	Total Throughput[2]	Total Dwell Time (Seconds)	No. of Stops	Average Dwell Time[3]	Average Throughput[3]	Dwell Time As % of Actual Run Time	Average Dwell Time/Throughput[5]
Route 4									
SB	CV	P	63	279	31	9.00	2.03	-[4]	4.43
	DD	M	169	857	36	23.81	4.69	23.4	5.07
	CV	A	249	701	48	14.60	5.18	-[4]	2.82
	CV	M	58	257	19	13.53	3.05	-[4]	4.43
	CV	M	198	1,106	53	20.87	3.74	-[4]	5.59
	DD	M	341	1,085	60	18.08	5.68	10.4	3.18
NB	DD	M	252	871	45	19.35	5.60	20.4	3.46
	CV	A	271	657	61	10.77	4.44	-[4]	2.42
	DD	M	342	965	42	22.98	8.14	-[4]	2.82
	CV	M	206	708	40	17.70	5.15	-[4]	3.44
Route 5									
SB	CV	M	159	766	53	14.45	3.00	-[4]	4.82
	DD	M	207	671	49	13.69	4.22	-[4]	3.24
	DD	A	178	782	51	15.33	3.49	20.7	4.39
	CV	M	190	792	48	16.50	3.95	17.8	4.17
	CV	M	222	755	63	11.98	3.52	14.0	3.40
	DD	M	300	1,718	61	28.16	4.92	-[4]	5.73

[1] A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM

[2] Total number of passengers getting on and off the bus during each run.

[3] Based on corresponding totals divided by number of stops.

[4] Start and/or ending run times not recorded.

[5] Total run dwell time divided by total number of run throughput passengers.

Route	Bus Type	Time of Day[1]	Total Throughput[2]	Total Dwell Time (Seconds)	No. of Stops	Average Dwell Time[3]	Average Throughput[3]	Dwell Time As % of Actual Run Time	Average Dwell Time/Throughput[5]
<u>Route 5</u>									
NB	DD	M	250	1,002	60	16.70	4.17	23.2	4.01
	DD	P	119	409	30	13.63	3.97	-[4]	3.44
	DD	A	186	733	41	17.87	4.53	17.0	3.04
	CV	M	186	821	38	21.61	4.89	-[4]	4.41
	CV	M	56	240	16	15.00	3.50	20.0	4.29
	CV	M	261	731	49	14.92	5.32	15.8	2.80
	DD	M	49	167	17	9.82	2.88	-[4]	3.41
	DD	M	181	791	41	19.29	4.41	-[4]	4.37

[1]A: 6:30-9:00 AM; M: 9:00 AM-4:30 PM; P: 4:30-6:30 PM

[2]Total number of passengers getting on and off the bus during each run.

[3]Based on corresponding totals divided by number of stops.

[4]Start and/or ending run times not recorded.

[5]Total run dwell time divided by total number of run throughput passengers.

APPENDIX J. REPORT OF INVENTIONS

A diligent review of the work performed under this contract has revealed no significant innovations, discoveries, or improvements of inventions at this time. In addition, all methodologies employed are available in the open literature.

The findings in this document will be useful in evaluating the utility of the British Leyland type double deck bus in providing regular transit service.

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McCall, Chester H.

The New York City double deck bus demonstration

~~2-9-81~~	~~Sechez~~		

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