Report No. DOT-UT-90039-81-1

BASELINE CONDITIONS REPORT

for a

SOCIO-ECONOMIC IMPACT ASSESSMENT

of the

LOS ANGELES AUTOMATIC VEHICLE MONITORING DEMONSTRATION

U. S. DEPARTMENT OF TRANSPORTATION
Urban Mass Transportation Administration
Washington, D. C. 20590

May 1981

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Prepared by

Juarez and Associates, Inc.
Los Angeles, California

and

SYSTAN, Inc.
Los Altos, California

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
Urban Mass Transportation Administration
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16. Abstract

Automatic Vehicle Monitoring (AVM) is an electronic system of monitoring the location and status of transit vehicles operating on city streets. AVM is expected to result in better service to passengers and reduce operating costs. Buses will adhere more closely to schedules and headways; this may result in fewer buses being required to maintain a given level of service. Data needed for management purposes also can be collected automatically. AVM promotes greater passenger and operator security because a driver can instantly notify the control center of an emergency so the police can be alerted and given the exact location of the vehicle.

Urban Mass Transportation Administration (UMTA) is sponsoring the demonstration of a fully functional AVM system in Los Angeles, California. The demonstration, involving 200 buses and 12 random route service vehicles operated by the Southern California Rapid Transit District, consists of three stages. During Stage 1 (April to September 1980), baseline data has been collected, forming the basis of this report. Stage 2 (September 1980 to February 1981), "start-up" dispatchers become active users of the AVM system for both monitoring AVM routes and real-time control of AVM routes. Stage 3 (March to June 1981) is an operational test period.

The evaluation of the Los Angeles AVM includes a before and after assessment of the socio-economic impacts of the demonstration focusing on the changes that affect or are perceived by the public and transit operator. Issues under investigation are the AVM implementation process, level of service impacts, the demand response, and the economic and efficiency impacts of the system. The intent of this evaluation is to develop findings relevant (transferable) to other transit properties considering AVM.

This interim report documents baseline conditions of the demonstration site. The baseline data reported here will be compared with data collected during Stage 3 of the demonstration to complete the before and after assessment of social and economic impacts of AVM.

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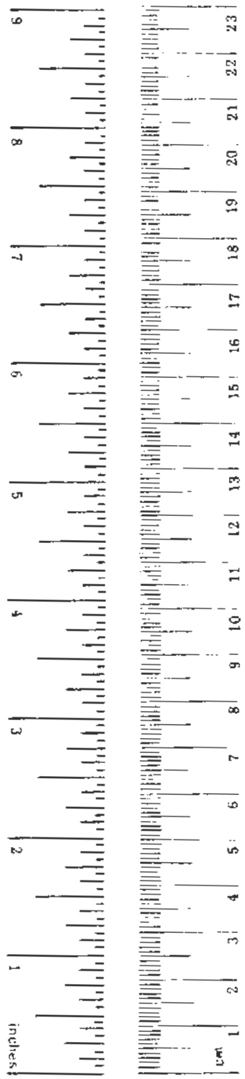
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

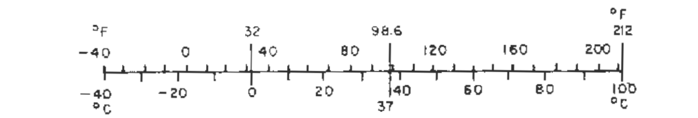
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



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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PREFACE

This report was prepared pursuant to a contract conducted under the capable direction of John Durham of the Urban Mass Transportation Administration and Michael Wolfe of Transportation Systems Center. The contractors also wish to acknowledge the data-collection assistance of Kenneth Bray, TSC's representative at SCRTD headquarters, and Allan Styffe, SCRTD's AVM liaison. Representatives of the assessment contractor responsible for project management and reports preparation were Douglas Daetz and Marlies Bebendorf of SYSTAN and Elizabeth Juárez of Juárez and Associates.

A revised impact assessment (evaluation) plan for the AVM demonstration is currently being prepared by SYSTAN for the Transportation Systems Center. That document, together with this baseline report, should provide an updated description of the socioeconomic impact assessment.

1. SUMMARY

1.1 Introduction

This report is a quantitative and qualitative presentation of baseline conditions for the Urban Mass Transportation Administration's (UMTA's) demonstration of Automatic Vehicle Monitoring (AVM) in Los Angeles, California. The report is an element of UMTA's assessment of that demonstration. It is descriptive in nature and does not contain conclusions, as it is intended to serve as an interim document. The final report of the socioeconomic impact assessment of the Los Angeles AVM demonstration is scheduled for completion in November 1981.

1.2 Purpose of an AVM System

The primary function of an AVM system is to monitor the location of all vehicles operating within the area served by the system. Real-time location information is useful for both fixed-route bus systems and flexible-route (or "random-route") vehicle systems such as police, taxi, dial-a-ride, and other demand-responsive services. Another important function of AVM systems is the automatic collection of time-and-place-specific data on bus operations (and, in applications involving passenger counters, passenger activity). This data is stored for later analysis.

For the fixed-route bus system, which is the main focus of the Los Angeles demonstration, an important use of AVM is to improve schedule adherence through real-time control of buses on route. The AVM system will automatically detect bus deviations from schedule. This information can either trigger the automatic transmission of messages to appropriate bus drivers or be used by the dispatcher to formulate corrective actions that are then radioed to the drivers.

Improved adherence to schedules benefits both the transit user and the transit operator through improved reliability, shorter passenger wait times, more uniform passenger loading, and reduced operating costs. Other potential benefits of AVM for a fixed-route bus system include enhanced driver and passenger security and improved planning and scheduling as a consequence of more complete and up-to-date management information.*

During the past 20 years approximately 35 variations of automatic vehicle monitoring systems have been or are being implemented in public transportation properties, principally in Europe. As of this date, about 20 of these systems are either active or in the process of being developed.** There is worldwide interest by the transit community in AVM and its potential uses, impacts, and benefits.

1.3 The Los Angeles AVM Demonstration

The Los Angeles Automatic Vehicle Monitoring Demonstration, which began in 1977, is the second phase of a program sponsored by the U.S. Department of Transportation. In Phase I, nonservice operational tests of four AVM location technologies were conducted in Philadelphia during the winter of 1976-77. In the Los Angeles Phase II demonstration, 200 buses operated by the Southern California Rapid Transit District (SCRTD)

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* A few prior studies of actual and hypothetical AVM systems have estimated that the benefits to a transit operator of an AVM system outweigh its costs. However, many of the conjectured benefits of AVM are qualitative or subjective in nature and therefore difficult to enter into a cost-benefit calculus.

** See U.S. Department of Transportation, Urban Mass Transportation Administration, Automatic Vehicle Monitoring Program Digest, April 1981, Report No. DOT-TSC-UMTA-81-11. See also Exhibit 2.6 for an international summary of AVM experiments in public transportation.

have been outfitted with AVM equipment, including passenger counters.*
Four of the approximately 220 SCRTD routes were selected for testing of the AVM system; these four routes, which include the busiest route in SCRTD's system (Route 83, Wilshire Boulevard), require the assignment of approximately 150 of the AVM-equipped buses each day. Signpost transmitters, which continuously emit a unique identification signal, were placed along the four routes at intervals of approximately 1,000 feet. In addition, 12 random-route service and supervisory vehicles were equipped for AVM. Their locations can be accurately monitored when they are within the 54-square-mile primary AVM service area, an area in central Los Angeles that is completely "signposted."** Only five supervisory vehicles are expected to be within the primary area at any one time. Originally, 25 patrol cars of the Los Angeles Police Department (LAPD) were to be monitored within the primary AVM service area. However, LAPD did not receive the grant needed to fund its participation, so no police cars were included in the demonstration.

The major goals of the AVM demonstration in Los Angeles are to

- observe how a large transit property reacts and adjusts to AVM,
- determine how well the deployed AVM system performs under actual field conditions,

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* The AVM equipment was installed on 150 standard GMC buses, 33 lift-equipped AM General buses, and 17 MAN articulated buses.

** Signposts are located at a distance of about 2,000 feet from each other, except along the AVM routes where the separation is only about 1,000 feet. A total of about 915 signpost transmitters have been deployed for the demonstration.

* estimate the extent to which the expected benefits* of AVM were realized and are realizable by the host transit property, and
* gain insights into the general and site-specific factors that affect the relationship between the benefits and costs of AVM.

The operational phase of the demonstration consists of three stages, as shown in Exhibit 1.1. During Stage 1, baseline data was collected for comparison with data from subsequent stages. In Stage 2, "start-up," dispatchers became active users of the AVM system for both monitoring AVM routes and real-time control of AVM routes. This second stage was a learning period for all concerned: the dispatchers at the AVM console, the division dispatchers who assigned buses to routes, the technicians who maintained the AVM equipment, the contractor's system engineers, and so on. Stage 3 is the operative test period. The functioning of AVM hardware and software and the daily assignment of AVM buses to AVM routes should be relatively stable, and the AVM dispatchers will have had time to get used to the AVM system. In-vehicle display units (IVDs), which indicate to drivers the correct system time and the degree of adherence to schedule (early, on time, or late), will be deployed on at least one route in Stage 3. Deployment of four bus stop display units, which indicate to prospective passengers the expected waiting time for the next bus and the interval between buses, may also occur during Stage 3.

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* Potential transit property benefits are (a) improved on-time service; (b) better adherence to scheduled headways (reduced "bus bunching"); (c) shorter waiting time for passengers; (d) more even loadings of passengers on vehicles; (e) increased passenger and driver safety due to silent alarm feature used with AVM; (f) reduced layover time due to reduced variability of total travel time (which may permit fewer vehicles and drivers to maintain a given level of service on AVM-controlled routes); and (g) cost savings through a more efficient or cost-effective use of personnel and rolling stock. See Chapter 3 for a discussion of these issues.

EXHIBIT 1.1

STAGES (CONFIGURATIONS) OF THE AVM DEMONSTRATION

STAGE	CHARACTERISTICS	PURPOSE
1 BASELINE ("Before") (April 14, 1980 to Sept. 14, 1980)	No dispatcher monitoring No use of controls No in-vehicle display	Baseline data collection
2 START UP ("Interim") (Sept. 15, 1980 to Feb. 28, 1981)	Dispatcher training Dispatcher monitoring of AVM routes Control by voice No in-vehicle display	Full shakedown of system, with dispatchers active Test of dispatcher control
3 TEST ("After") (March 1, 1981 to June 30, 1981)	Dispatcher monitoring of AVM routes Control by voice Control by digital message In-vehicle display Bus stop display unit (may not be deployed)	Test of dispatcher control Test of IVD value Observe user response to bus stop display unit (may not be done)

Since the purpose of this report is to present a picture of "baseline" conditions against which the effects of active use of AVM can be judged, most information in the report pertains to Stage 1. However, a small amount of the data discussed in this report was collected during Stage 2.

1.4 Demonstration Participants

The Los Angeles AVM Demonstration is sponsored by the Office of Bus and Paratransit Technology of the Urban Mass Transportation Administration of the U.S. Department of Transportation. The host transit property is the Southern California Rapid Transit District. UMTA has delegated responsibility for system design, implementation, and technical evaluation to the Transportation Systems Center (TSC), a research organization within the Department of Transportation. TSC has contracted with Gould Information Identification, Inc., to design and install the AVM system at SCRTD, to develop operational procedures for its use, and to collect data to be used in the assessment of the AVM system. Wilson-Hill Associates has been retained by the system manager to support the AVM training of SCRTD dispatchers and to evaluate the human factor impacts of AVM on dispatchers and drivers. In addition, MITRE Corporation was retained to provide technical support in the area of management information systems (MIS). The organizational relationships are shown in Exhibit 2.2.

UMTA's Office of Socio-Economic and Special Projects manages an Impact Assessment Program, which evaluates important new technology demonstrations. In 1978, SYSTAN, Inc., was retained to plan a socioeconomic evaluation of the AVM demonstration.* The evaluation plan specified the manual collection of schedule-adherence and passenger-load data on control routes selected to match as closely as possible the experimental AVM routes. In 1979, UMTA contracted with Juárez and Associates, Inc., and SYSTAN both to carry out the data collection, data assembly, and data analysis tasks necessary for an adequate baseline description for the Los Angeles application of AVM and then to prepare a "baseline conditions" report. Subsequently, TSC, which supports the Impact Assessment Program, contracted with SYSTAN and Juárez and Associates to perform a socioeconomic impact assessment of the demonstration. In this report, SYSTAN and Juárez and Associates are collectively referred to as the "assessment contractor."

1.5 The Baseline Description

The present description of baseline conditions for the AVM demonstration is based on data that was collected by or made available to the assessment contractor prior to February 15, 1981. Any additional or modified data pertaining to the baseline period which becomes available after February 15 will be incorporated into the final report.

The specific types of data used to depict the baseline situation consist primarily of

- automatically recorded AVM data (schedule adherence, passenger counts),
- data collected manually on four control routes (schedule adherence, passenger counts),

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* SYSTAN, Inc., A Plan to Conduct a Socioeconomic Evaluation of the Los Angeles Automatic Vehicle Monitoring (AVM) Demonstration, Los Altos, California, July 1978.

- interviews with SCRTD management,
- questionnaires returned by a sample of drivers and dispatchers,
- traffic counts along AVM and control routes, and
- passenger wait times at selected stops on AVM routes.

Problems with ghost (non-AVM) buses or "bad order" AVM buses (i.e., those whose AVM equipment is not functioning) assigned to AVM routes prevented the calculation of headway deviations for the AVM routes. Consequently, the calculation of headway deviations was not done for the control routes. In addition, problems with passenger-counting systems installed on the AVM buses have resulted in the passenger-load data being less reliable and less complete than had been anticipated.* Data collection is discussed in Chapter 4, and the baseline data description appears in Chapter 5.

This report does not contain any conclusions concerning the impact of AVM in Los Angeles. These conclusions will be made after the data from AVM's test period (Stage 3: March to June, 1981) is compared with the baseline data. Nonetheless, the following comments concerning the assessment situation revealed by the baseline study are offered:

1. Sufficient data will be available to measure the impact of real-time control on the schedule adherence of buses on AVM routes during the demonstration. However, there will not be time before the demonstration ends to fully test the relative impacts of a wide range of real-time control strategies.
2. The baseline schedule adherence data for the AVM and control routes show a pattern of sufficient similarity to confirm that

* Currently only about 100 of the 200 AVM buses have properly functioning passenger counters.

- the AVM routes are not unlike other SCRTD routes in terms of schedule reliability,
- the control routes are reasonably well matched to the AVM routes, and
- the method used to calculate schedule deviations for AVM routes gives reasonable results.

Thus an adequate basis for detecting exogenous changes in bus performance and ridership is expected.

3. The data may be too scant, too rudimentary, or too much influenced by exogenous factors to determine the impact of AVM during the demonstration in the areas of (a) security of drivers and passengers* and (b) general transit planning and bus scheduling. Hence, the assessment of security and management information impacts may have to remain couched in terms of potential or promising impacts.

* No AVM routes run extensively through high-crime areas.

2. INTRODUCTION

2.1 Purpose of the Report

This report is a quantitative and qualitative presentation of baseline conditions for the Urban Mass Transportation Administration's demonstration of Automatic Vehicle Monitoring (AVM) in Los Angeles, California. The report is an element of UMTA's assessment of that demonstration. It is descriptive in nature and does not contain conclusions, as it is intended to serve as an interim document. The final report of the socioeconomic impact assessment of the Los Angeles AVM demonstration is scheduled for completion in November 1981. The purpose of this interim report is to provide a baseline description of the bus transit situation in Los Angeles into which the AVM demonstration was introduced.

This chapter presents background information on AVM systems, the history of the current AVM project, the Los Angeles setting for the demonstration, and demonstration events to date. Chapter 3 identifies the objectives of the Los Angeles AVM demonstration and the issues to be investigated during its implementation. Then, since the principal concern of the present effort was the collection and assembly of data to describe the pre-implementation or baseline conditions against which to compare conditions after AVM went into operation, the data collection requirements for a socioeconomic impact assessment of AVM are specified in Chapter 4.

Chapter 5 of this report summarizes the baseline data for the AVM demonstration. This data will be compared in a subsequent study with data to be collected during the test phase (Stage 3) of the demonstration in order to determine the extent to which the expected or hypothesized socioeconomic impacts of AVM were realized in the Los Angeles application. Tabular and graphical presentations of data too detailed for inclusion in the body of the report have been placed in an appendix.

2.2 Background Concerning the Los Angeles AVM Demonstration

The major goals of the AVM demonstration in Los Angeles are to

- observe how a large transit property reacts and adjusts to AVM,
- determine how well the deployed AVM system performs under actual field conditions,
- estimate the extent to which the expected benefits* of AVM were realized and are realizable by the host transit property, and
- gain insights into the general and site-specific factors that affect the relationship between the benefits and costs of AVM.

The operational phase of the demonstration consists of three stages, as shown in Exhibit 2.1. During Stage 1, baseline data was collected for comparison with data from subsequent stages. In Stage 2, "start up," dispatchers became active users of the AVM system for both monitoring AVM routes and real-time control of AVM routes. This second stage was a learning period for all concerned: the dispatchers at the AVM console, the division dispatchers who assigned buses to routes, the technicians who maintained the AVM equipment, the contractor's system engineers, and so on. Stage 3 is the operative test period. The functioning of AVM hardware and software and the daily assignment of AVM buses to AVM

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STAGES (CONFIGURATIONS) OF THE AVM DEMONSTRATION

STAGE	CHARACTERISTICS	PURPOSE
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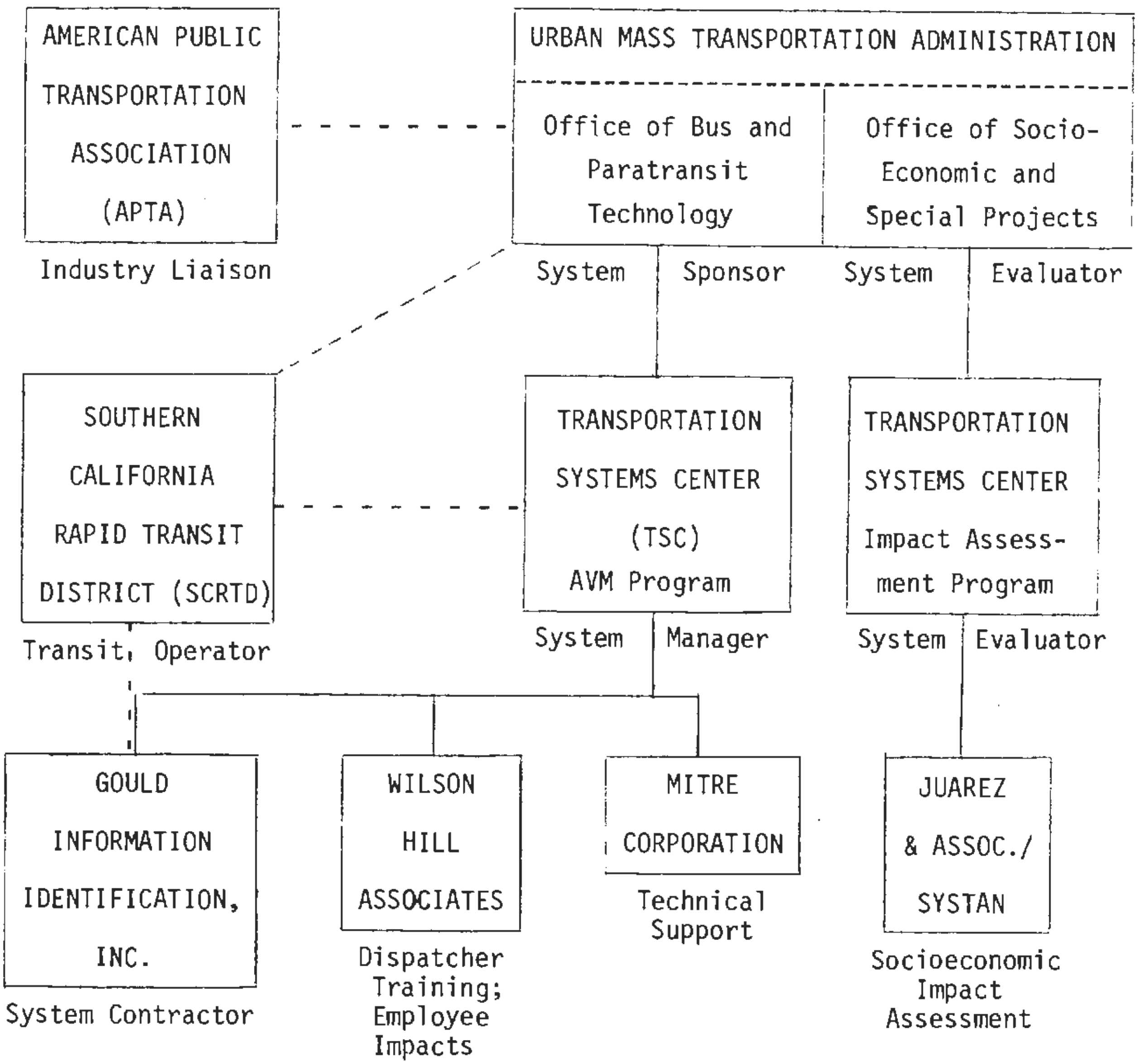
routes should be relatively stable, and the AVM dispatchers will have had time to get used to the AVM system. In-vehicle display units (IVDs), which indicate to drivers the correct system time and the degree of adherence to schedule (early, on time, or late), will be deployed on at least one route in Stage 3. Deployment of four bus stop display units, which indicate to prospective passengers the expected waiting time for the next two buses, may also occur during Stage 3. Most information in the report pertains to Stage 1, although a small amount of data was collected during Stage 2.

The Los Angeles AVM Demonstration is sponsored by the Office of Bus and Paratransit Technology of the Urban Mass Transportation Administration of the U.S. Department of Transportation. The host transit property is the Southern California Rapid Transit District (SCRTD). UMTA has delegated responsibility for system design, implementation, and technical evaluation to the Transportation Systems Center (TSC), a research organization within the Department of Transportation. TSC has contracted with Gould Information Identification, Inc. (hereinafter referred to simply as Gould) to design and install the AVM system at SCRTD, to develop operational procedures for its use, and to collect data to be used in the assessment of the AVM system. Wilson-Hill Associates has been retained by the system manager to support the AVM training of SCRTD dispatchers and to evaluate the human factor impacts of AVM on dispatchers and drivers. In addition, MITRE Corporation was retained to provide technical support in the area of management information systems (MIS). The organizational relationships are shown in Exhibit 2.2.

EXHIBIT 2.2

ORGANIZATIONS INVOLVED IN THE LOS ANGELES AVM DEMONSTRATION



UMTA's Office of Socio-Economic and Special Projects manages an Impact Assessment Program, which evaluates important new technology demonstrations. In 1978, SYSTAN, Inc., was retained to plan a socio-economic evaluation of the AVM demonstration. The evaluation plan specified the manual collection of schedule-adherence and passenger-load data on control routes selected to match as closely as possible the experimental AVM routes. In 1979, UMTA contracted with Juárez and Associates and SYSTAN both to carry out the data collection, data assembly, and data analysis tasks necessary for an adequate baseline description for the Los Angeles application of AVM and then to prepare a "baseline conditions" report. Subsequently, TSC, which supports the Impact Assessment Program, contracted with SYSTAN and Juárez and Associates to perform a socioeconomic impact assessment of the demonstration. In this report, SYSTAN and Juárez and Associates are collectively referred to as the "assessment contractor."

2.3 AVM Functions

The primary function of an AVM system is to determine the current or real-time spatial locations of active vehicles within the system. This information can be used by vehicle fleet controllers and dispatchers to more effectively manage the fleet's operation. The locational information can also be used with other technical innovations to derive additional benefits, and can be compiled for later use. In the Los Angeles demonstration, for example, the vehicle location information is being coordinated with automatic passenger-counting equipment to provide detailed transit ridership data and may be used to inform passengers of the expected arrival time of the next bus. The AVM system also records and summarizes operational data for planning and scheduling. Additional uses of AVM are likely to be discovered through experimentation with its capabilities in actual operation. An overview of the outputs from the AVM system and their uses is shown in Exhibit 2.3.

2.3.1 Real-Time Vehicle Location Information

Fixed Route Bus Systems

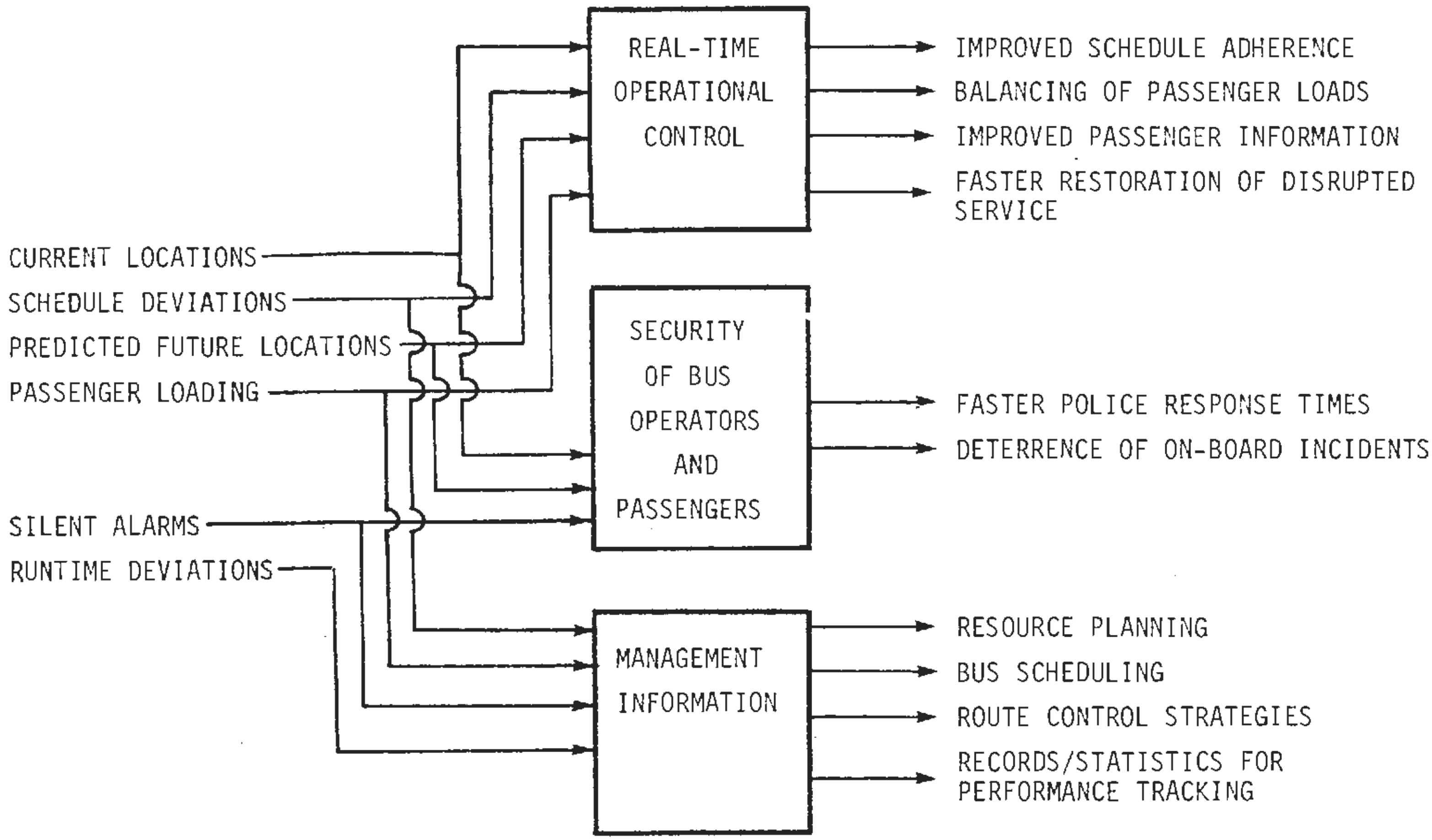
In a fixed-route bus system, real-time vehicle location information is used to inform the dispatcher if any buses are deviating from their schedules. By radio the dispatcher can direct the deviating buses or other buses to take specific actions to correct the deviations. If there is an overall improvement in schedule adherence, a variety of benefits to both the transit passenger and operator will result. For example, improved schedule adherence will provide more reliable passenger service and fewer cases of extreme bus crowding caused by headway imbalances. The transit operator may also be able to reduce the layover time normally incorporated into a route's schedule to compensate for operating delays, thereby improving vehicle productivity. These and other fixed-route benefits associated with AVM are discussed in Chapter 3.

Flexible-Route Systems

Real-time vehicle location information can also generate operational improvements in demand-responsive systems where vehicles respond to individual service requests. Such systems include the police, taxis, dial-a-bus, package pickup and delivery service, and service vehicles such as tow trucks or transit supervisory vehicles. Vehicles in these systems typically receive direction via radio communications from a central control room. Real-time vehicle location information enhances the operation of these systems because the controller can dispatch the

EXHIBIT 2.3

AVM DATA AND ITS USES



vehicles more efficiently. In the simplest case, such as a taxi or police system, the dispatcher in an Automatic Vehicle Dispatching system could instantly select the vehicle closest to a service request rather than using the conventional process, which may be more time consuming or which may not result in the assignment of the closest vehicle.

2.3.2 Bus Arrival Time Displays

The current locations of buses on a fixed-route system can be used to calculate the approximate times that these buses will arrive at specific points along their routes, using pre-estimated travel speed assumptions for various route segments. These estimated arrival times can be shown on electronic visual display units installed along the route. Upon arriving at a bus stop at which a bus stop display unit was functioning, passengers could read the approximate arrival times of the next or next few buses. Given this information, a passenger might leave and return to meet the bus rather than wait for a bus whose arrival time is uncertain.

2.3.3 Passenger Counting

AVM can also be used effectively with passenger-counting devices that record the number of passengers boarding and exiting the bus. The AVM system would note the time and location of the bus when passengers boarded or exited. The data set collected would comprise a full description of when, where, and how many passengers used the transit system. Such a comprehensive demand data set would aid the transit system's planners in their continuing efforts to select the routes and schedules that best meet their users' needs. On a real-time basis, dispatchers could use this information to maintain more balanced bus loadings.

2.3.4 Management Information

Even without a passenger-counting system, AVM can provide useful information for transit planners, schedulers, and managers. In addition to generating a complete record of schedule reliability at each timepoint, AVM can be used to calculate actual run times for either an entire route or segments of the route. This information will allow the scheduling department to construct schedules that more accurately reflect the actual run time experience. Also, by knowing the degree of variation in route running time, the schedulers can minimize the required layover time at the ends of routes. In addition to providing more comprehensive data than is normally collected on transit properties, AVM can record the data automatically, thereby eliminating costly manual schedule checking as well as the costs of transferring the manually collected data to a machine-readable form.

2.4 Characteristics of AVM Systems

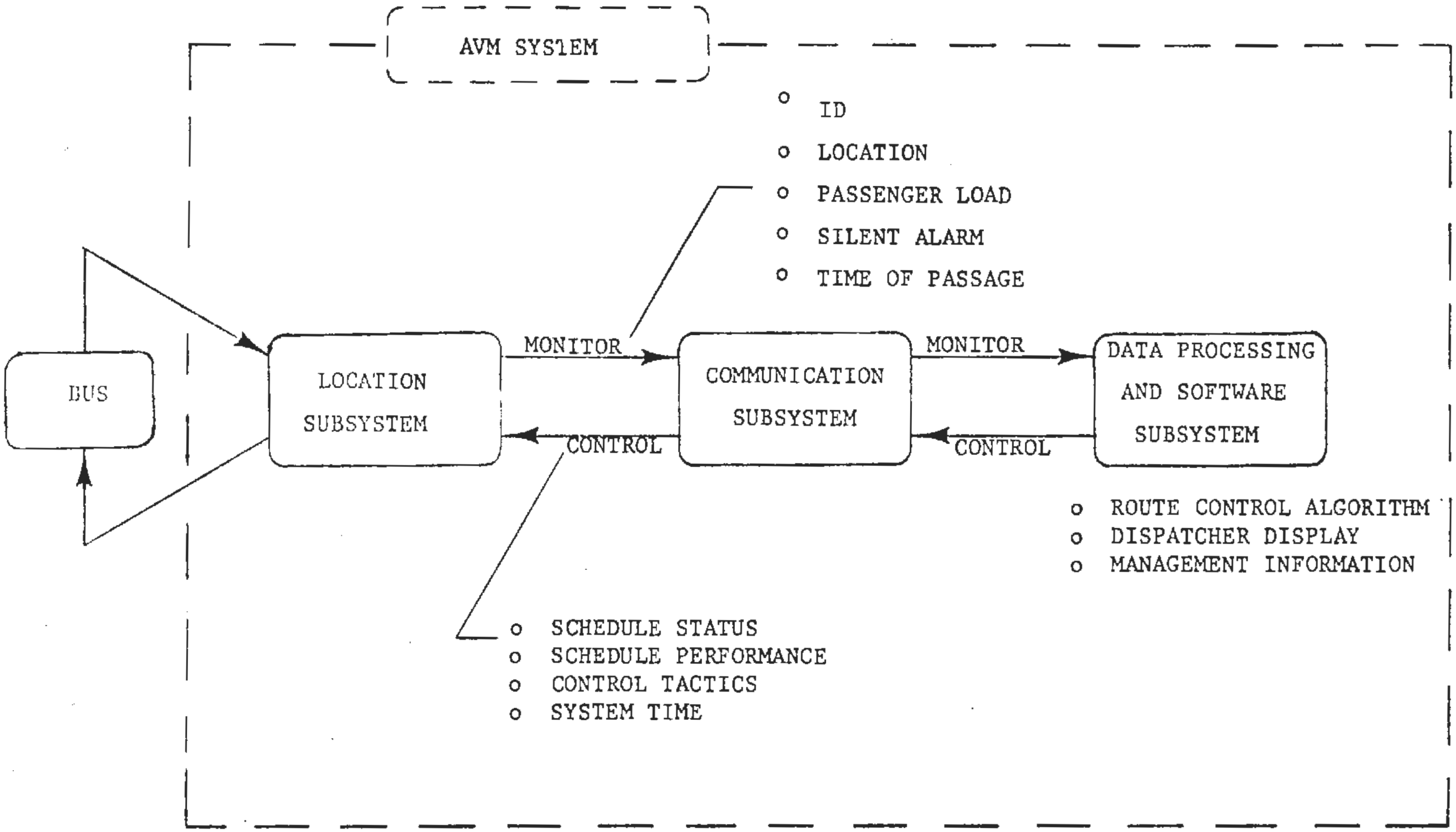
2.4.1 Subsystems

An AVM system consists of three subsystems: location, communication, and data processing and software (Exhibit 2.4). The location subsystem generates the signal or transmission that is processed and converted to locational information. The communication subsystem transmits this raw data from the location subsystem in the field to a central facility where it is processed. The data-processing and software subsystem computes and processes the information for immediate and later use, and displays the information to dispatchers, drivers, users, and so forth.

Of the three subsystems, the location subsystem is the primary innovation that makes AVM an experimental system featuring a new technology. The other subsystems are already widely used in a variety of applications.

EXHIBIT 2.4

AVM DESIGN STRUCTURE



2.4.2 Types of Location Subsystems

Four types of location subsystems were tested in Phase I of DOT's AVM program: sharp signpost, broad signpost, radio frequency multilateration, and dead-reckoning subsystems. The Los Angeles AVM demonstration utilizes the broad signpost system.

Sharp Signpost

With a sharp signpost system, a vehicle passes a signpost that can detect coded information on the vehicle and thereby pinpoint the vehicle's location to within a few feet. When the vehicle passes another signpost, the vehicle's location is updated. Examples of sharp signposts are microwave and optical scanner beams emanating from a signpost and magnetic detectors embedded in the street. Since a system relying solely on sharp signposts would be able to locate vehicles only at signpost locations, the system would require sufficient signposts so that the longest distance that could be traveled between two signposts would not exceed the locational accuracy requirements of the system. Therefore, to reduce the necessity for large numbers of signposts, sharp signpost systems are almost always used in conjunction with odometers.

Broad Signposts

In a broad signpost system, the signpost detects a vehicle when it comes within a certain range of the signpost. In the simplest system, the broad signpost system locates the vehicle in the center of the detection area of each signpost, this being the location having the smallest average error for all possible locations in the detection area. In more sophisticated systems, such as the one used in the Los Angeles demonstration, detection fields overlap so that vehicles can be located at approximate locations between signposts. This improves locational accuracy and reduces the number of signposts required.

Radio Frequency Multilateration

In a radio frequency multilateration system, radio signals are transmitted between vehicles and fixed locations. The time required for these signals to travel is measured and used to calculate vehicle locations. Several existing navigation techniques use radio frequency multilateration to determine location, but it is more difficult to use these techniques in urban environments because of transmission distortions caused by buildings and electromagnetic interference.

Dead-Reckoning

A dead-reckoning system uses an on-board compass and odometer to continuously measure the direction and distance that a vehicle is traveling, which is used to compute the vehicle's location. The measurement errors in a dead-reckoning system compound over time; therefore, it is necessary to initialize the computation before the accumulated errors become significant. One technique for initialization is to compare all locational information generated to a map of all streets in the area. Vehicle locations would then always be assigned to an actual street location, which would minimize the possibility of error.

2.5 Project History

2.5.1 The UMTA/TSC Automatic Vehicle Monitoring Project

UMTA's initial AVM project began in 1968 when it awarded a grant to the Chicago Transit Authority for the installation of an AVM system on its fixed-route buses. A signpost system was developed by the Motorola Corporation, but reliability problems with the digital communications system prevented an effective evaluation of the system.*

* Miller, H.G., W.M. Basham, Evaluation of the Monitor - CTA Automatic Vehicle Monitoring System, Final Report, U.S. DOT, Transportation Systems Center, March 1974 (PB-231-533).

In 1971, UMTA selected four competing location subsystems for testing in Philadelphia. One signpost and three radio frequency systems were tested that year. The results were favorably evaluated, and the MITRE Corporation was subsequently contracted to select a site to demonstrate an AVM system. After reviewing 19 large radio-equipped transit operations, Los Angeles was selected. However, AVM technology developed rapidly during the next few years and subsequent work was delayed until 1974. At that time, UMTA and TSC developed a plan to undertake a new set of AVM subsystem tests and the subsequent demonstration of the most effective system in Los Angeles.

The UMTA/TSC plan called for a two-phase effort. In Phase I, new contractors were selected to have their systems tested in Philadelphia and TSC conducted a comprehensive cost-benefit study of AVM. Phase II is the Los Angeles demonstration, which was contingent upon favorable results of both Phase I efforts.

In February 1975, $1.2 million was allocated for Phase I of the project. Four systems were subsequently tested in Philadelphia during the winter of 1976-77, including the Gould broad signpost system, another signpost system, and two radio frequency systems. The performance specifications described in Section 2.6.2 were used to evaluate the results. The systems demonstrated the capability of achieving these standards. The TSC cost-benefit study,* which was completed in February 1977, concluded that AVM systems were cost effective for fixed-route bus and police systems. In August 1977, UMTA consequently approved $7.4 million for the implementation of Phase II of the AVM

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* Reed, H. David, Mary Roos, Michael Wolfe, and Ron DiGregorio, A Study of the Costs and Benefits Associated With AVM, U.S. DOT, Transportation Systems Center, Cambridge, Mass., Feburary 1977 (UMTA-MA-06-0041-77-1).

program, the Los Angeles demonstration. Gould was selected as the system contractor at that time.

The Los Angeles AVM demonstration involves 200 buses and 12 random-route service vehicles operated by the Southern California Rapid Transit District. These vehicles have been outfitted with broad signpost vehicle locating equipment; additionally, the buses have been equipped with automatic passenger counters. Four of about 220 SCRTD routes were selected for testing of the AVM system (see Exhibit 2.5). These four bus routes, which include the busiest route in SCRTD's system (Route 83, Wilshire Boulevard), require the assignment of approximately 150 of the AVM-equipped buses each day. Signpost transmitters, which continuously emit a unique identification signal, were placed along the routes at intervals of 1,000 feet; they were also placed at larger intervals within a primary 54-square mile AVM service area in central Los Angeles. The combination of wayside transmitters, in-vehicle AVM digital receivers/transmitters (radios), and a base station command/control unit allows the AVM-equipped vehicles to be accurately located.

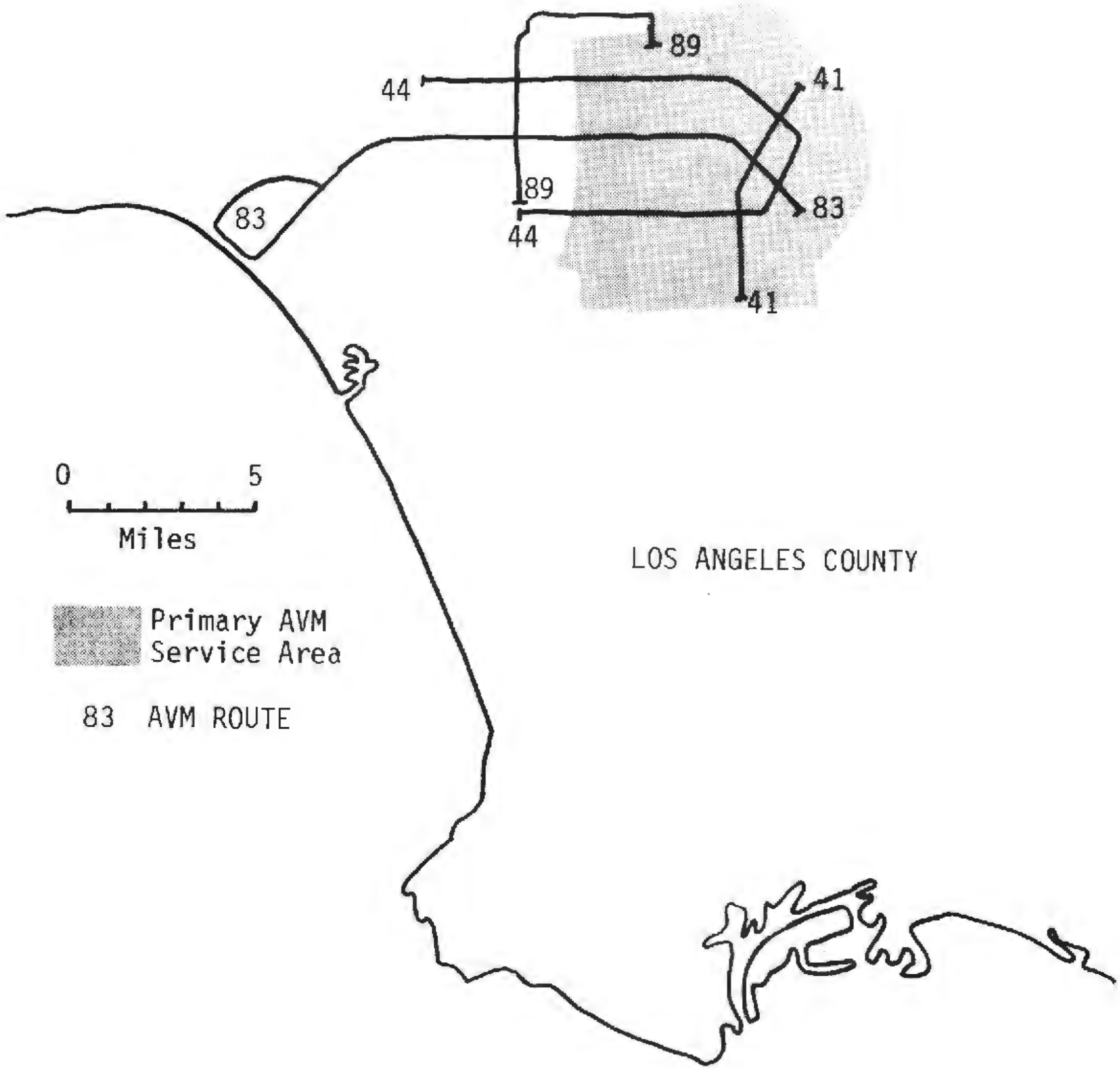
2.5.2 Other AVM Experience

AVM is in its development phase and there have been relatively few implementation experiences in the United States to date. Other than the UMTA-funded AVM system in Chicago, to date only three other AVM systems have been established in the U.S. Two of these were implemented for police department use only. The St. Louis Metropolitan Police Department has tested a dead-reckoning AVM system developed by Boeing.* In Hunting-

* The trademarked system is called FLAIR, for Fleet Location and Information Reporting. Results of the tests have been reported in papers by Gilbert C. Larson and by Richard C. Larson, Kent W. Colton, and Gilbert C. Larson. See references in the Bibliography.

EXHIBIT 2.5

AVM ROUTES AND SERVICE AREA



ton Beach, California, a signpost AVM system developed by Gould was recently implemented. In 1979, the New York City Transit Authority started testing a signpost AVM system with 202 buses operating on 12 routes out of the Queens Village Depot. Across the border, in Toronto, Canada, the Toronto Transit Commission operationally tested an AVM system with 100 buses in 1979, and it is planning to expand the system to over 200 buses. In Europe and Japan, AVM systems have been or are being used to monitor transit buses in about 30 cities, including London, Hamburg, and Zurich (Exhibit 2.6).

2.6 Demonstration Description

2.6.1 System Coverage

The Los Angeles AVM demonstration deals primarily with the monitoring and control of fixed-route buses along four complete routes. Due to resource and time constraints, the monitoring of the locations of flexible-route vehicles in a defined service area has remained a secondary priority. Only in responding to an emergency situation (like a silent alarm) would the AVM dispatcher be expected to seek the nearest SCRTD flexible-route vehicle using the AVM system. All of the test routes at least partially traverse the primary AVM service area, in which the location subsystem is fully integrated.

Fixed-Route Bus Coverage

The Transportation Systems Center selected four routes, with headways ranging from three to 12 minutes, to comprise the fixed-route demonstration component. The routes were selected to relatively represent the fixed-route bus system. In addition to the four AVM routes, four control routes were selected by SCRTD and the assessment contractor. These

EXHIBIT 2.6

AN INTERNATIONAL SUMMARY OF AVM EXPERIMENTS IN PUBLIC TRANSPORTATION

City/Country	Year Initiated	Original Target	No. of Vehicles	Main Supplier	Status in 1979
London, U.K.	1958	Simple AVL	240		Life expired
Hamburg, F.R.G.	1969	Limited AVM	165	Prodata	Active/expanding
Chicago, U.S.A.	1969	AVM demo	500	Motorola	Completed; EVL active
Zurich, Switzerland	1971	Limited AVM	150	Hani-Prolectron	Active/expanding to full
Paris, France	1973	AVM demo	35	Matra	Terminated (1976)
Bristol, U.K.	1973	AVM demo	100	Marconi	Withdrawn (1974)
London, U.K.	1973	AVM demo	44	Marconi	Concluded
Tokyo, Japan	1973	AVM demo	75	Tokyu	Completed
Nottingham, U.K.	1974	Limited AVD	8	Philips	Active
Dublin, Ireland	1974	AVM demo	900	Storno	Active/expanding
Toronto, Canada	1974	AVM demo	100	—	Pilot/evaluation
Nagoya, Japan	1974	AVM demo	17	Denso	Completed
Besancon, France	1974	AVM demo	60	Thomson CST	Active/completed
Toulouse, France	1975	AVM demo	16	C.G.A.	Terminated
Cincinnati, U.S.A.	1975	TIS demo	30	GM/Motorola	Active/expanding
Brescia, Italy	1976	AVM demo	90	Italtel	Demo suspended - strike (1977)
Hanover, F.R.G.	1976	AVM demo	150	Bosch	Evaluation
Berne, Switzerland	1976	AVM pilot	12	Hani-Prolectron	Expanding
Stockholm, Sweden	1977	AVM pilot	60	Datasaab	Evaluation
Friederichshafen, F.R.G.	1977	DRT + AVM	12	Dornier	Active demo
Graz, Austria	1977	Full AVM	225	Hani-Prolectron	Active
Mississauga, Canada	1977	AVL + info. system	35	—	Active/expanding
London, U.K.	1978	AVM demo	50	—	Pilot project
Wunstorf, F.R.G.	1978	DRT + AVM demo	5	MBB	Active
Strasbourg, France	1978	AVM demo	180	C.G.A.	Being developed
Gothenburg, Sweden	1979	Parallel demonstration projects for combination taxi-dispatching/AVL system. Developed by Volvo and SRA Communications with Swedish Taxi Drivers Organization.			Being developed
Malmo, Sweden	1979				
Stockholm, Sweden	1979				
Darmstadt, F.R.G.	1979	AVM pilot	80	Hani-Prolectron	Being developed
Rome, Italy	1979	AVM pilot	37	Italtel	Being developed
Regensburg, F.R.G.	1979	AVM pilot	15	Siemens	Being developed
Wiesbaden, F.R.G.	1979	AVM pilot	25	Siemens	Being developed
Ausburg, F.R.G.	1979	AVM pilot	25	Siemens	Being developed
New York City, U.S.A.	1979	Full AVM	241	Motorola	Being developed
Los Angeles, U.S.A.	1979	AVM demo	200	Gould	Being developed

Key

AVL = automatic vehicle location
AVM = automatic vehicle monitoring
AVD = automatic vehicle dispatching
DRT = demand responsive transportation
EVL = emergency vehicle location
TIS = transit information system

Adapted from 1979 EcoPlan Status Report on AVM Development and Prospects (34)

SOURCE: Automatic Vehicle Monitoring Program Digest, U.S. Department of Transportation, Urban Mass Transportation Administration, Report No. DOT-TSC-UMTA-82-22.

routes have characteristics similar to the AVM routes, and are being checked twice during the demonstration to determine if factors unrelated to AVM are influencing the demonstration's results. AVM routes are being monitored continuously during all stages of the demonstration, while control routes are being checked once during Stage 1 (baseline period) and Stage 3 (test period). Appendix Exhibit A-3 is a control route data collection form, showing that headways, schedule adherence, and passenger loading information is being collected. In addition, Gould and TSC have set aside AVM route 44 as a control route for purposes of Gould's evaluation effort; no tests of dispatcher control have been made on AVM route 44.

AVM Service Area

Besides the monitoring of buses on four routes, 12 SCRTD service vehicles are monitored within a primary AVM service area of 54 square miles (and a secondary area of about 400 square miles with much lower locational accuracy). The 12 service vehicles consist of six supervisor cars, three transit police cars, two mobile-mechanic vehicles and an electronics van.

Some of these vehicles are operating outside of the primary AVM service area almost all of the time. Supervisors operate in zones throughout the Los Angeles metropolitan area, and only five supervisory vehicles are normally assigned to the primary service area; three of these normally operate in the CBD area and the fourth and fifth operate in the remainder of the primary service area. The other AVM-monitored service vehicles operate extensively but not exclusively in the primary service area.

2.6.2 Performance Specifications

The original performance specifications for the Los Angeles AVM system's primary service area are summarized in Exhibit 2.7. TSC developed these specifications for the AVM project after examining the results of several analytic models designed to predict the potential benefits to police and bus operations of different levels of AVM accuracy.* However, the specifications concerning temporal accuracy were later waived for the Los Angeles AVM system. Mean-time-between-failure requirements for the main components of the AVM system have also been established. The technical evaluation that Gould is conducting for TSC will address the degree of success in achieving these standards.

2.6.3 Hardware and Software

The AVM system hardware has been provided by Gould Information Identification, Inc., and its subcontractors. An overview of this system is shown in Exhibit 2.8. The principal Gould location subsystem is a broad signpost system in which signposts transmit unique digital location codes that are detected by on-board receivers. The radiation fields of signposts overlap so that vehicle location is determined by the relative intensities of the transmissions detected by the vehicles' receivers. To monitor buses along the fixed routes, signposts have been placed about five to the mile along each route. To monitor flexible route vehicles in the primary service area, signposts have been placed at approximately 2,000 feet.

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* Bernard Blood and Bernd Kliem, Experiments on Four Different Techniques for Automatically Locating Land Vehicles, Transportation Systems Center, November 1977.

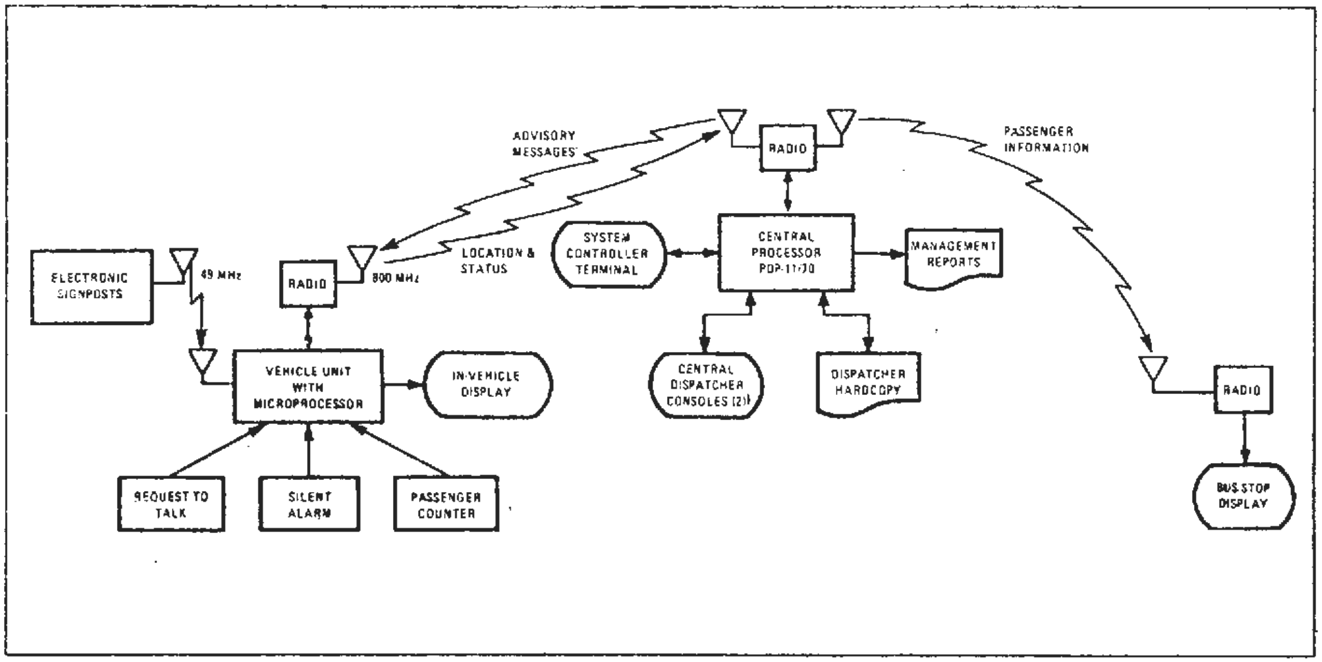
Exhibit 2.7

AVM PERFORMANCE STANDARDS

Data Item	Accuracy Required	Percent of Measurements Required to Meet Standard
Fixed-Route Bus Location	Within 300 feet of actual location	95%
"	Within 450 feet of actual location	99.5%
Time Fixed-Route Bus Passes a Timepoint	Within 15 seconds of actual time	95%
"	Within 60 seconds of actual time	99.5%

EXHIBIT 2.8

CONFIGURATION OF AVM SYSTEM COMPONENTS



SOURCE: <u>Program Fact Sheet</u>, UMTA Technology Sharing, U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Technology Development and Deployment, July 1980.

Passenger counters were developed by a subcontractor and were tested on Fort Worth buses prior to their use in Los Angeles. The system finally adopted uses treadle-type mats on two steps of the bus entrance to measure the sequence and count the number of boarding and alighting passengers.

The AVM system can use the locational data to provide current operational data and/or instructions to dispatchers, drivers, and transit users. Summary operating reports will be generated for transit managers, planners, and schedulers as appropriate. In the control room, dispatchers can determine the location of any AVM bus on any AVM route. They are notified by the system if any buses are operating significantly off schedule. When a silent alarm signal is received, AVM displays the bus number and location.

In Stage 3 of the demonstration, drivers of AVM buses on Line 41 will have in-vehicle display (IVD) units in addition to their radio units.* The layout of this unit is shown in Exhibit 2.9. These display units have a digital clock, a schedule meter, and a message status panel. The clock will show the driver the official time, and the needle on the schedule meter will automatically and continuously indicate to the driver whether he or she is early, on time, late, or very late. The system can also automatically activate message lights on the message status panel. However, except for the "start" message to a driver at layover or the "wait" message to a driver more than two minutes early, the preestablished digital messages would be sent by dispatchers only after communication with the driver.

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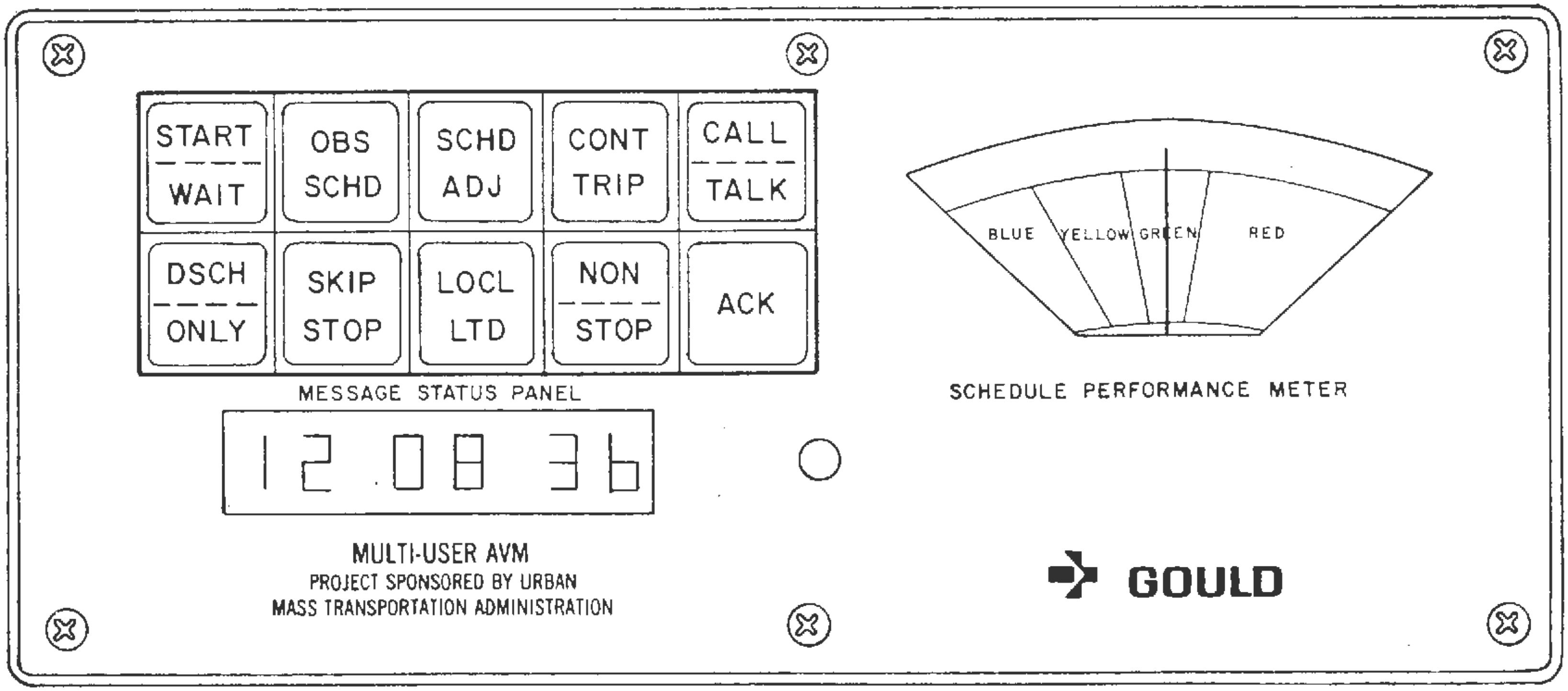
* Twenty buses have been equipped with the IVDs for the test on Line 41.

EXHIBIT 2.9

IN-VEHICLE DISPLAY



The Los Angeles AVM demonstration may also include the deployment of four bus arrival time display units at major bus stops where a great number of passengers board. A photograph of one of these units is shown in Exhibit 2.10. One unit is installed in the control room of SCRTD for pretesting and is operating experimentally. If installed for public use, units will display the expected arrival time of the next bus in two directions on each of two routes (83 and 89).*

Finally, the AVM system will permit the periodic generation of summary operating reports for each AVM route for SCRTD managers, planners, and schedulers. These reports include summary statistics for schedule adherence, trip time, and passenger loads for each scheduled trip over the day. Detailed passenger boarding and exiting data may also be tabulated for use by the planning department.

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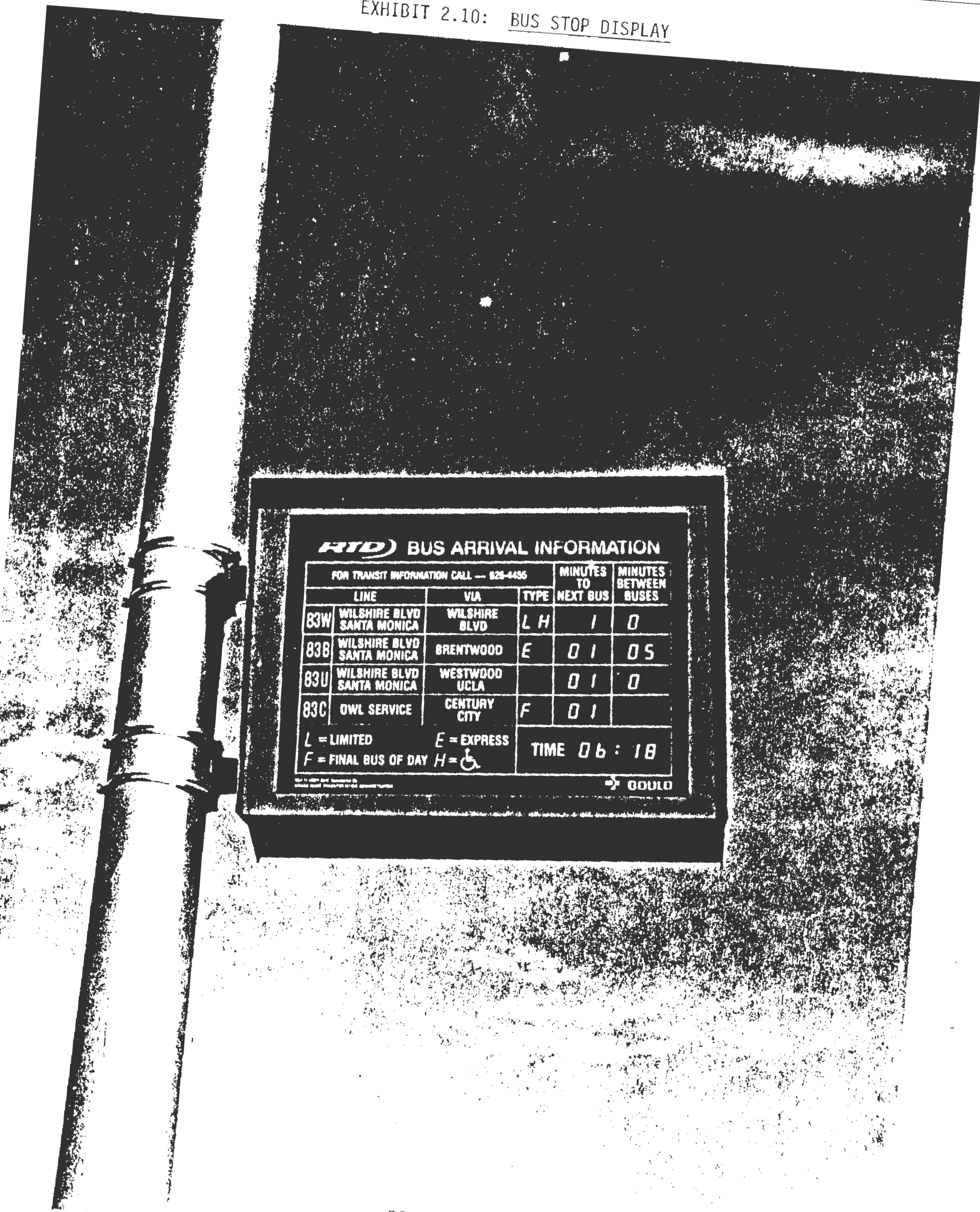
* The location that has tentatively been selected is Wilshire Boulevard and Fairfax Avenue, where AVM lines 83 and 89 intersect. The current plan, should SCRTD choose to proceed with installation of the display units, calls for placing the units in display windows of department stores and other business establishments at the bus stops. See Section 4.2.4 (Accuracy of the Bus Stop Display Units) for a discussion of the issues which must be resolved before the units can be installed.

EXHIBIT 2.10: BUS STOP DISPLAY



3. IMPACT ASSESSMENT ISSUES

3.1 Overview

The current assessment of the AVM demonstration is limited to an examination of the socioeconomic impacts of the demonstration. Therefore, the assessment focuses on the changes that affect or are perceived by the public and the transit operator. Evaluation of the actual technical performance of AVM is not directly considered here because Gould will perform the technical evaluation. However, data generated by the AVM system will be used in the assessment, and the accuracy of AVM information is consequently of importance. The assessment contractor has frequently communicated with Gould (normally through TSC) in order to assure the receipt of data of a kind and in a form compatible with assessment needs.

The impact assessment of AVM in Los Angeles will consider a variety of interrelated issues, including issues not addressed by the TSC cost-benefit study. Specifically, the cost-benefit study addressed only measurable economic impacts including the capital and operating costs of AVM, the transit and police system operating savings accruing from fewer buses and police cars required to provide equivalent levels of service, and transit data collection savings resulting from AVM's automatic tabulation of ridership and schedule adherence data. However, AVM may also generate impacts where costs and benefits cannot be readily converted into financial terms, although they may often be quantified for statistical comparison. For example, if AVM permits a police unit to respond to a silent alarm from an off-schedule or off-route bus in time to apprehend a criminal or to prevent a serious injury, then future incidents may be deterred or prevented, lawsuits may be avoided or, most importantly, a life may be saved.

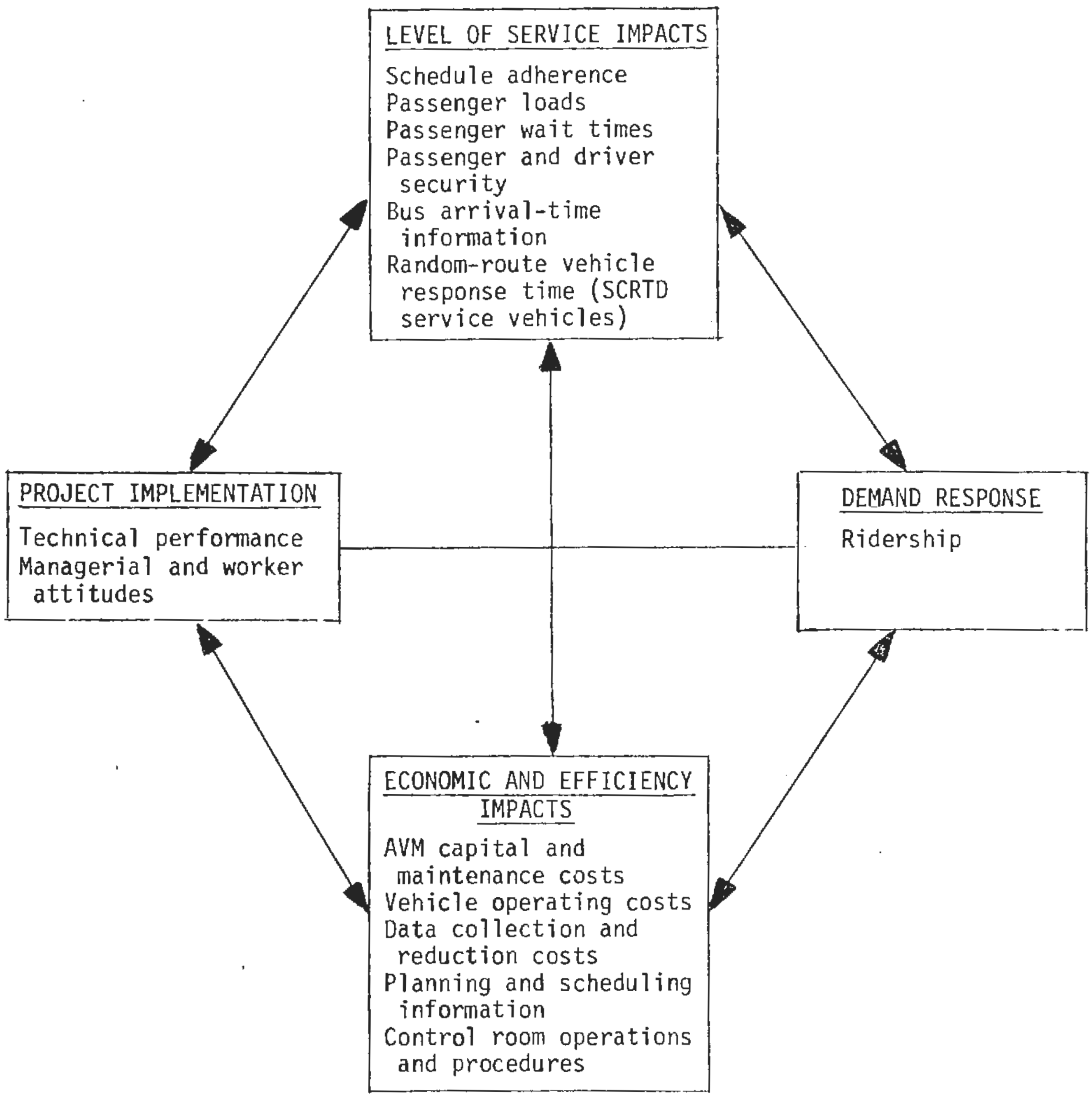
In some cases, the financial and nonfinancial issues cannot be separated, and a trade-off exists between them. For example, if AVM improves schedule adherence and thereby makes feasible the shortening of layover times, then the transit operator is afforded the choice of reducing the number of buses on a line to lower operating costs or reducing the line's headway to improve the level of service provided. The assessment of the AVM demonstration must consequently address all of these issues within an integrated framework.

The issues being investigated can be divided into four interrelated categories: the AVM implementation process, the level-of-service impacts, the demand response, and the economic and efficiency impacts of the system. That these classes of impact are interrelated can be appreciated through the following example. The implementation of AVM in Los Angeles is changing some of the transit district's operational procedures, is offering the opportunity for real-time control of buses on route, and is generating improved data for managerial use. Thus, the implementation of the AVM system may result in an improved level of service to transit users, which in turn may lead to a higher level of demand for transit. A further consequence of such a chain of effects might be an improvement in the productivity and revenue-to-cost ratio of the transit district. Exhibit 3.1 suggests the various possibilities for causal relationships among the impact categories.

The specific indicators for each category of impact are also shown in Exhibit 3.1. The indicators define the areas in which AVM impacts are being sought. Data pertinent to each indicator is being collected in order to determine the amount of change, if any,

EXHIBIT 3.1

IMPACT ASSESSMENT CATEGORIES AND INDICATORS



OVERALL IMPACT ASSESSMENT

that occurs over the course of the AVM demonstration. The present impact assessment approach is predicated on the premise that, viewed against a backdrop of "control route" and "setting" information, the pattern of changes in indicator variables should permit the deduction of valid conclusions concerning the impact of AVM in the Los Angeles demonstration and the potential impact of AVM in other circumstances.

3.2 Project Implementation

3.2.1 Technical Performance

The primary implementation issue is the technical performance of the AVM system. Clearly, the successful assessment of AVM's socio-economic impacts requires that the system perform accurately and reliably. To assure that this condition would be met, UMTA and TSC specified required levels of locational accuracy and reliability (see Section 2.6.2), and provided for a shakedown period prior to formal system testing. Nevertheless, the technical performance of the AVM system must be considered as potentially influencing the magnitudes of other impacts. Schedule-adherence, run-time, and passenger-load data generated by the AVM system are being used for the impact assessment, and the results of the assessment will depend on the accuracy of the data.

3.2.2. Managerial and Worker Attitudes

A second implementation issue is the attitudes of the managers and workers who are affected by AVM. For AVM to be most effective, the managers, planners, schedulers, dispatchers, and drivers working with AVM must feel that it is a worthwhile and effective innovation. The uses of AVM were partly specified by Gould and TSC, but the control room staff is expected to find new uses for the equipment during the demonstration. Likewise, it will be up to the planners and schedulers receiving the data generated by AVM to make the most effective use of it. The acceptance of AVM by these employees will largely determine its value.

The attitudes of bus drivers warrant special consideration. Drivers may view AVM primarily as a surveillance tool that will be used to evaluate their performance. On the other hand, AVM may be used to make their work easier. For example, there may be less overcrowding on buses as a result of AVM.

3.3 Level-of-Service Impacts

Except for the few bus stop display units that may be installed, the functioning of the AVM system will not be visible to the public. However, several major objectives of AVM pertain to an improvement in the level of service offered to transit users and the general public.

3.3.1 Schedule Adherence

One of the most important objectives of using AVM in fixed-route transit systems is to improve schedule adherence, because adherence to schedule is a primary and very visible indicator of the level of service provided by any public transit agency. A dispatcher at an AVM console can immediately see by color-coded symbols on a cathode ray tube (CRT) display which buses on a route are deviating significantly from the schedule. The dispatcher can then direct buses on the route to take actions to correct the deviation before the condition worsens. Some commands may also be automatically sent to drivers, such as "wait" if they are operating ahead of schedule.

Schedule adherence itself is a principal measure of service reliability. However, a level-of-service benefit resulting from improved reliability lies in the potential to reduce headways. If schedule adherence improves significantly, the transit operator can revise the bus schedule so that there is less layover time at the two terminals of a route; shorter layovers would be possible because less recovery time would have to be provided to allow late buses to catch up with the schedule.* If layovers are shorter, a reduction in headways can be achieved with the same number of buses. Shorter headways would reduce passenger wait times. Alternatively, an operator can use the savings in layover time to reduce the number of buses operating on a line, while maintaining the same headways (see Section 3.5).

3.3.2 Passenger Loads

Better schedule adherence should also result in more uniform passenger loads. This would decrease the likelihood that passengers would have to stand and would reduce the general discomfort caused by bus overcrowding.

3.3.3 Passenger Wait Times

Persons who coordinate their arrival times at a bus stop with the bus schedule (planned-access users) can be expected to have shorter wait times if AVM improves schedule adherence, since bus arrival times will be more predictable. These planned-access users will be able to arrive at a bus stop closer to scheduled arrival times because buses

* In the case of SCRTD, the employment contract with the drivers' union specifies that drivers should average at least 10 percent layover time. Thus, there is a minimum amount of layover time below which SCRTD cannot fall even if perfect schedule adherence meant that no recovery time had to be allowed for in schedules.

will be less likely to leave early; they will in general also have shorter waits for late buses. Random-access users (those users arriving at a bus stop without regard to the schedule) will also realize shorter average wait times. Over a large sample of random arrivals, the average wait time is modeled by the following formula, where W = average wait time, H = nominal headway, and S = standard deviation of the headway:

$$W = \frac{H}{2} = \frac{S^2}{2H}$$

Thus, decreasing the headway variance (S squared) results in shorter average wait times for random-arrival users.

When short headways exist, most users are likely to be random-access passengers; with longer headways, passengers are more likely to plan their arrivals at the bus stop. Since AVM is being implemented on routes with both short (3-minute) and medium (12-minute) headways, the effects of AVM on the wait times of both user types are being investigated.

3.3.4 Passenger and Driver Security

An important AVM level-of-service issue pertains to the physical security of bus drivers and passengers. SCRTD buses are presently equipped with radios with a silent alarm feature. A driver can flip a special switch to silently signal the control room that police assistance is needed; at the same time the bus's outside emergency flasher lights are activated and the radio is shut off until the driver reactivates it. When the control room receives a silent alarm signal, the bus, route, and run numbers are displayed. Without AVM, the dispatcher must estimate the location of the bus from memory or by consulting the appropriate run schedule. With AVM, the dispatcher can immediately determine the location of the bus to within a few hundred feet. Once the dispatcher has a bus location to report, he or she then notifies the appropriate law enforcement agency.*

Dispatchers reportedly require only a few seconds to estimate a bus's location without AVM. Unless the bus is either far off schedule or off route in the part of central Los Angeles that is fully signposted, the time saved by the elimination of this estimation process is not expected to significantly reduce total response time. Although there may be little change in the time required to notify the police, AVM will provide a more accurate estimate of a bus's location than when the location is estimated by the dispatcher. More accurate bus location information is expected to result in faster police response time to the bus. This, in turn, may result in more frequent apprehension of suspects. Thus, over the long run, AVM may act as a deterrent against on-board crimes or may at least divert potential crimes to other locations. However, the short life and small scale of the demonstration prevents any meaningful testing of this latter hypothesis. Police response times are being measured, but the small number of incidents that are occurring during the demonstration may not provide a sufficient base upon which to draw conclusions regarding changes in police response time.

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* Since most SCRTD operations are in the City of Los Angeles, the Los Angeles Police Department (LAPD) is most often the appropriate agency. However, some SCRTD routes pass through unincorporated areas of Los Angeles County or through many smaller communities having their own police forces or contracting with the County Sheriff's Department. The multiplicity of jurisdictions presents a problem for dispatchers, who must first determine the jurisdiction of a location.

3.3.5 Bus Arrival Time Information

Four electronic bus stop display units may be installed at bus stops that generate high passenger volumes during Stage 3 of the demonstration. These units will receive signals from the AVM central computer conveying estimates of the arrival times of the next bus or next few buses for display to waiting patrons. These persons might then decide to use the time until the bus arrives for some other purpose.

The primary assessment issues are to determine user response to the displays and the level of accuracy of the arrival time estimates. As a bus approaches a stop where a display unit is located, the arrival prediction displayed can be expected to become more accurate. Therefore, the level of accuracy will be determined for different time intervals prior to the actual arrival time of the bus.

If the AVM system is successful in achieving its objective of maintaining bus schedule adherence, the bus stop display units may not be much more useful to waiting passengers than a simple posting of a schedule. The major benefit of these units would occur when there is an unusual delay caused by a breakdown, traffic congestion, or a missed run. The assessment will compare the predictive accuracy of the display units with that of a regular schedule. Passengers waiting at the display unit locations will also be surveyed in order to determine if users perceive this innovation to be beneficial.

3.3.6 Random-Route Vehicle Response Time

Another objective of AVM is to reduce the time required for random-route vehicles dispatched by a central control room to respond to a service request. A reduction in response time is hypothesized because an AVM dispatcher can quickly display each vehicle's location and direct the vehicle closest to the site of the service request to respond to that request.

Demand-responsive services, such as police, taxi, dial-a-bus, and pick-up and delivery services, could benefit from an AVM system. The more efficient dispatching is expected to result in faster service to persons requesting service. The improvement could also be used to reduce the number of vehicles in the fleet while maintaining the same service levels.

Since the Los Angeles Police Department (LAPD) is not participating in the demonstration, impact assessment effort in this area has been curtailed. Only 12 SCRTD service vehicles are being monitored by AVM, half of which are supervisors' vehicles.

3.4 Demand Response

Several of the level-of-service impacts discussed are likely to result in higher transit patronage levels. Specifically, improved schedule reliability, shorter wait times, shorter headways, decreased bus crowding, and the installation of bus stop display units are expected to increase patronage. This expectation assumes that there are persons not currently using transit who are willing to use transit if service conditions improve. The issue of ridership change due to AVM will not be addressed in the Los Angeles demonstration's assessment owing to difficulties encountered with the passenger counters and to the fact that the Stage 3 testing period is so brief.

3.5 Economic and Efficiency Impacts

The implementation of AVM may result in several economic benefits to the transit operator, including the benefits cited by TSC in its AVM cost-benefit study. These benefits, as well as the nonfinancial benefits cited above, are being considered in the overall assessment of AVM. However, given the short test period for the AVM system during the demonstration, no attempt to estimate AVM-induced changes in farebox revenues will be made. In any event, it was assumed from the outset that any increase in farebox revenues caused by AVM would probably represent only a small portion of total AVM costs.

3.5.1 The Cost of AVM

The first economic issue is to determine the cost of implementing AVM for different size systems. In its 1977 cost-benefit study, TSC estimated the capital and operating costs of AVM systems based on four manufacturer proposals for implementing AVM in the Los Angeles demonstration. The actual experience of implementing the system in Los Angeles will provide more recent and more refined cost estimates.

3.5.2 Reduced Vehicle Operating Costs

As initially discussed in Sections 3.3.1 and 3.3.6, the service-level improvements generated by AVM may be converted into lower operating costs while maintaining the original service levels. In its cost-benefit study, TSC suggested that improved schedule adherence will allow the bus operator to lengthen headways compared with before AVM and maintain the same average wait for users (see Section 3.3.3 of this report for a discussion of how headways and schedule adherence affect wait times). It is likely, however, that most operators and users will perceive lengthened headways as a reduction in service quality that is independent of the improvement in schedule reliability.

3.5.3 Reduced Data Collection and Reduction Costs

A potential economic benefit of AVM is that it can greatly reduce the transit operator's cost of collecting data concerning operations and ridership. Almost all transit systems employ persons whose jobs are to measure bus run times or count passengers. Run-time data enables the schedulers to create schedules with realistic run times, while the ridership data indicates the productivity of each route. The data is used for deciding how to expand, contract, or modify a system. Checkers may also be used to note schedule adherence in order to monitor system reliability.

With AVM, schedule adherence and run times are automatically measured and calculated. Also, as in the Los Angeles demonstration, relatively inexpensive on-board passenger counters can be linked to the AVM system so that the numbers of passengers boarding and exiting at all locations may be measured. Furthermore, this data is automatically measured and compiled in a computer, eliminating the task of coding and keypunching the data recorded by the checkers.

The data-collection savings that a transit operator may realize is a function of the level of checker effort maintained prior to and after AVM implementation. The TSC cost-benefit study suggested that this could be the most significant cost savings generated by AVM. In Los Angeles there may not be any measurable savings, since the four AVM routes comprise a very small proportion of the SCRTD total route mileage. Rather than eliminating checkers, SCRTD will probably just increase the measurements made on a few other routes. The main assessment issue is whether the data generated by AVM is accurate and usable, so that in a larger systemwide implementation of AVM, actual cutbacks in manual checking could be made.

3.5.4 Improved Data for Planning and Scheduling

In the previous section, the question considered was whether the data generated by AVM could substitute for that collected manually. An objective of AVM goes beyond this concern, however. That is, AVM is hypothesized to provide a much more comprehensive data base than can reasonably be collected manually, and this is expected to greatly aid the transit planning and scheduling functions.

One data collection improvement is the increased sample size associated with AVM. Since manual data collection is costly, transit operators generally make very few measurements on each route. Having fewer than a half a dozen recent run-time and ridership measurements for each run on a route is rather common in transit systems, and schedule adherence data is often nonexistent. With AVM, schedule adherence, run times, and ridership data can be collected for every bus trip made. The assessment goal here was to focus on how SCRTD made use of this expanded data set and to determine whether the existence of AVM data changes SCRTD's planning and scheduling procedures. Unfortunately, SCRTD planners and schedulers will not have an opportunity to fully utilize AVM-generated data before the demonstration ends in June 1981. Hence, the assessment of improved planning data will be limited to describing its expected or potential use.

3.5.5 Control Room Operations and Procedures

The introduction of AVM is expected to alter the way dispatchers perceive and perform their jobs and may lead to changes in some of the internal operations of the SCRTD control room. Some of these changes have already been mentioned, such as enabling AVM dispatchers to issue a corrective-action command to the driver of a bus that is deviating from schedule. Another possible change is the procedure used to monitor and dispatch the supervisors, transit police, and mechanics located in the primary AVM service area.

It is also possible that the control room dispatchers will develop unforeseen uses of AVM, since 1980 saw the first U.S. applications -- in Los Angeles and New York City -- of AVM to control transit vehicles. During the demonstration, another contractor is observing control room operations and will interview SCRTD dispatchers and their supervisors. The results of these observations and interviews will be incorporated into the assessment.

4. DATA COLLECTION

4.1 Introduction

Data collection is a crucial element of the demonstration, since a successful impact assessment depends upon sufficiently complete and accurate data being available for analysis. The data requirements for the impact assessment of the AVM demonstration exceed those that the Southern California Rapid Transit District would have for its own uses, in terms of the number and variety of measurements and the sample sizes required with each measurement. Consequently, Gould and the assessment contractor rather than SCRTD have collected and processed much of the data for the assessment.

Data collection efforts represent a significant cost in any demonstration process. The data collection plan developed for the assessment* was designed to eliminate redundancy and promote efficiency in data collection by providing a single source which can be consulted regarding a project's data requirements.

Monitoring of the progress of the Los Angeles AVM Demonstration has been ongoing since the initiation of work by the assessment contractor in April 1979. The monitoring has involved

- frequent contact with SCRTD, including meetings, interviews, telephone calls, and correspondence, in order to keep abreast of all deliberations and activities having an impact on project implementation and evaluation;
- collecting media reports;

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* SYSTAN, Inc., A Plan to Conduct a Socioeconomic Evaluation of the Los Angeles Automatic Vehicle Monitoring (AVM) Demonstration, Los Altos, California, July 1978.

- communicating with various government agencies and private organizations in the AVM demonstration, including the Urban Mass Transportation Administration, Transportation Systems Center, Gould Information Identification, Los Angeles Transportation Department, and American Public Transit Association;
- data collection planning;
- overseeing data collection activities and assisting SCRTD in the collection of data where appropriate; and
- updating the evaluation plan as necessary and distributing copies of any changes to interested parties.

Site data was collected primarily from the Bureau of the Census; SCRTD brochures, materials, and reports; interviews; and local media. Unfortunately, there was very little baseline information available from SCRTD about the AVM and control routes themselves. The assessment contractor had primarily been interested in collecting data on ridership, demographics (e.g., median age and income of riders and other user characteristics), attitudes, transit preferences, fare revenues, and the types of areas the buses run through. Although there were a few statistics available on lines 89 and 91 as a result of an August 1979 on-board transit survey conducted by SCRTD, these have not been included in the report since there was nothing comparable for any of the other routes.

4.2 Measurement Instruments and Techniques

The approach adopted for the assessment of impacts in the Los Angeles AVM Demonstration relies primarily on a "before" and "after" comparison: data for a baseline period when AVM was only passively collecting data will be compared with data to be collected during a test period when AVM is in active use for real-time control. A comprehensive discussion of the entire methodology and impact assessment will be included in the final assessment report.

This report describes only the data that has been collected and processed as part of the baseline data collection phase. Baseline data was collected in 1980 and early 1981; thus some of the baseline data was not collected in its true "before" period. For example, interviews with SCRTD managers and surveys of drivers and dispatchers were delayed by SCRTD until after the AVM system had been officially announced and had entered an active start-up phase.*

The various types of demonstration data have been organized into four categories corresponding to the impact areas of the AVM demonstration: implementation, level of service, demand, and economic/efficiency impacts. Baseline data and data collection plans for the test phase are outlined for each of the impact areas in Sections 4.2.1 through 4.2.4.

4.2.1 Implementation Data

SCRTD Manager Attitudes

During the start-up phase, a sample of SCRTD managers was interviewed by the assessment contractor to determine their individual expectations of the AVM system. The respondents were chosen to represent departments affected by the demonstration, including Planning and Scheduling, Operations, Maintenance and Equipment, Management Information Systems, Telecommunications, the Dispatching Center, Instruction, and the Transit Police.

Topics addressed in these interviews included perceptions of AVM's potential cost effectiveness regarding their own and other departments,

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* The AVM system was announced in the September 1980 issue of RTD Headway, SCRTD's internal newsletter, and a few dispatchers (one on duty at any given time) began using the AVM console for bus monitoring and real-time control on September 15, 1980. Interviews with SCRTD management were not conducted until October and November of 1980; the surveys of drivers and dispatchers were not distributed by SCRTD until December 1980, and January/February 1981, respectively.

AVM's acceptance by other SCRTD employees, problems expected during the demonstration, and the benefits of the system in a wider application. These were unstructured, open-ended discussions, since each manager was primarily interested in a specific aspect or outcome of the system (e.g., security, schedule adherence, regulation of passenger loading, maintenance, or management information). The same persons will be reinterviewed toward the end of the test phase of the demonstration. Baseline results are presented in Section 5.2.1.

SCRTD Employee Attitudes

To complement the viewpoints and expectations of SCRTD's managers, SCRTD employees who were involved with the AVM system on a daily basis were surveyed. During the start-up phase, some AVM dispatchers as well as a sample of AVM-route bus drivers responded to a survey addressing the perceived benefits and drawbacks of AVM. Drivers and dispatchers are the people who must make the system work, and their acceptance of AVM's usefulness is clearly critical. A particularly sensitive issue is whether the drivers perceive AVM as a tool to evaluate their performance. Baseline results are presented in Section 5.2.2.

Changes to SCRTD Data Collection, Planning, Scheduling, and Control Functions

AVM is expected to reduce the personnel required to collect operations data and increase the amount of data provided for in planning and scheduling functions. In addition, the dispatchers who monitor AVM have an additional tool available to them. One of the human factors and man-machine interaction aspects of AVM that will be studied by Wilson-Hill Associates is the impact of AVM on the dispatchers. Some new control room procedures may be recommended by TSC and Gould. However, the control room staff may make other procedural modifications as they gradually learn the capabilities of the AVM system and invent applications. Likewise, the SCRTD planning and scheduling departments can be expected to use the expanded data sets available to them in novel ways.

4.2.2 Level-of-Service Data

Bus Schedule Deviations and Headways

The impact of the AVM system on bus schedule adherence (service reliability) is perhaps the single most important assessment issue of the demonstration. Consequently, a large and relatively costly sample of schedule adherence measurements was specified.

Baseline data for the four AVM routes was collected by Gould before bus drivers were apprised of AVM's presence. For six months, starting in mid-March 1980, the AVM system was operated in a passive, data-recording mode; i.e., there was no monitoring of AVM buses by an AVM dispatcher or use of any control tactics or communications that might have alerted drivers to the AVM data collection. Five months' worth of data, that collected between April 14 and September 14, 1980, has been taken as baseline data. Thus, a very comprehensive set of data was obtained automatically at significantly lower cost than with manual data collection. Timepoint measurements were taken along the entire length of all AVM routes, on weekdays, over a 20-hour period between 4:00 A.M. and 12:00 P.M. Each bus-stop record consists of the specific data characterizing a bus (route, run number, bus number), the time it left a bus stop, and the numbers of passengers boarding and alighting.

Baseline data for the four control routes had to be collected manually. Since having an observer on board runs the risk of influencing a driver's behavior, observation by checkers stationed at bus stops was chosen as the means to gather schedule-adherence and passenger-load information. Checkers positioned at three timepoints along each route recorded bus departure times and approximate passenger loads for buses running in both directions on weekdays over an 11-hour period between 7:00 A.M. and 6:00 P.M.

Bus departure times collected during the baseline phase can, in principle, also be used to calculate actual headways, headway deviations from scheduled intervals, and run-time variations. Hence, this data contributes to a comprehensive baseline description of the level of service, as it shows actual versus scheduled travel times as well as the effect of "bus bunching," which AVM is expected to reduce.

During the test phase of AVM operation, bus departure times will be recorded in exactly the same ways: automatically for the AVM routes, manually along control routes. The latter will be monitored in late April and early May 1981 during the last three months of the AVM demonstration. These observations of control routes one year after the baseline observations should provide a check on trends in service reliability and ridership against which to judge AVM's impact. Baseline results are presented in Section 5.5.2.

Passenger Loads

For both the baseline and test data collection, passenger loads are measured together with bus departure times. Passenger boardings and alightings are counted automatically by the AVM system, and thus load counts at a specific point can be calculated. For the control routes, on-site observers record the estimated number of passengers on board the bus when it leaves the bus stop. Baseline results are presented in Section 5.5.5.

Passenger Wait Times

Passenger wait times for the AVM routes were measured manually in late January and early February 1981 at one or two timepoints per route for a period of one to three weekdays. A sample form for recording this data is presented in the Appendix in Exhibit A-5. Near the end of the test period, in June 1981, passenger wait times for the AVM routes will again be collected manually in order to see if any significant change occurred.

Plans for the recording of passenger wait times for the control routes were deleted when it first appeared that wait-time data was not going to be collected for the AVM routes; these plans have not been reactivated for schedule and resource reasons. However, passenger wait time data for control routes is not considered necessary because control route data on bus departure times and passenger loads should provide sufficient information to determine if changes in transit parameters unrelated to the AVM demonstration had occurred. Also, the wait-time data obtained for route 44 -- the "uncontrolled" AVM route -- can be interpreted as control route data. Baseline results are presented in Section 5.5.6.

Accuracy of the Bus Stop Display Units

If SCRTD, Gould, and TSC agree that the bus stop displays will be sufficiently accurate to expose to the public, they will be installed at the sites previously mentioned during the test phase of the demonstration. The issues which need to be resolved before they can be deployed are:

- Ghost buses. These are buses not equipped with AVM hardware that are assigned to AVM routes. The arrival of ghost buses will not be predicted on the display units, so a potential bus patron looking at a display will think that the wait for the next bus is longer than it really is when one of these buses is on route.
- Missing buses. When an AVM-equipped bus is assigned to an AVM route but the assignment is not entered into the information system by the division dispatcher, this creates an apparent gap in the service. This situation will also cause the bus stop display to indicate a longer delay than is really the case.
- Short headways. Both routes 83 and 89 are characterized by short headways, and thus the value of the display units is not as great as it would be in situations where passengers had to wait a long time (e.g., more than 15 minutes) for the next bus. Originally, the units were to have been installed at the Los Angeles International Airport on an airport express route. This route, which has since been cancelled, provided longer-headway, nonstop service between LAX and several terminals in the Los Angeles central business district. It would have been an ideal testing situation for the display units.

If these issues are satisfactorily resolved and the display units are installed, each unit will be observed for three to eight days (7:00 A.M. to 6:00 P.M.) following installation; repeat measurements may be required in case major changes are made in the algorithms developed for predicting arrival times in order to detect the impact of these changes.

The observers monitoring the bus display units will note the scheduled arrival times of buses and record the predicted arrival time shown on the display unit every two minutes beginning as soon as the last bus leaves. The observer will also record the actual bus arrival time, from which prediction deviations can be calculated. A sample form to be completed for each bus observed is shown in Exhibit A-4 in the Appendix.

The data collected will be used to see how the accuracy of the predicted arrival times varies as a function of the amount of time before actual and scheduled arrival. Here the basic objective is to determine if the bus stop display units provide better, equal, or worse predictions of bus arrival time than the actual bus schedule.

Survey of User Attitudes Toward Bus Display Units

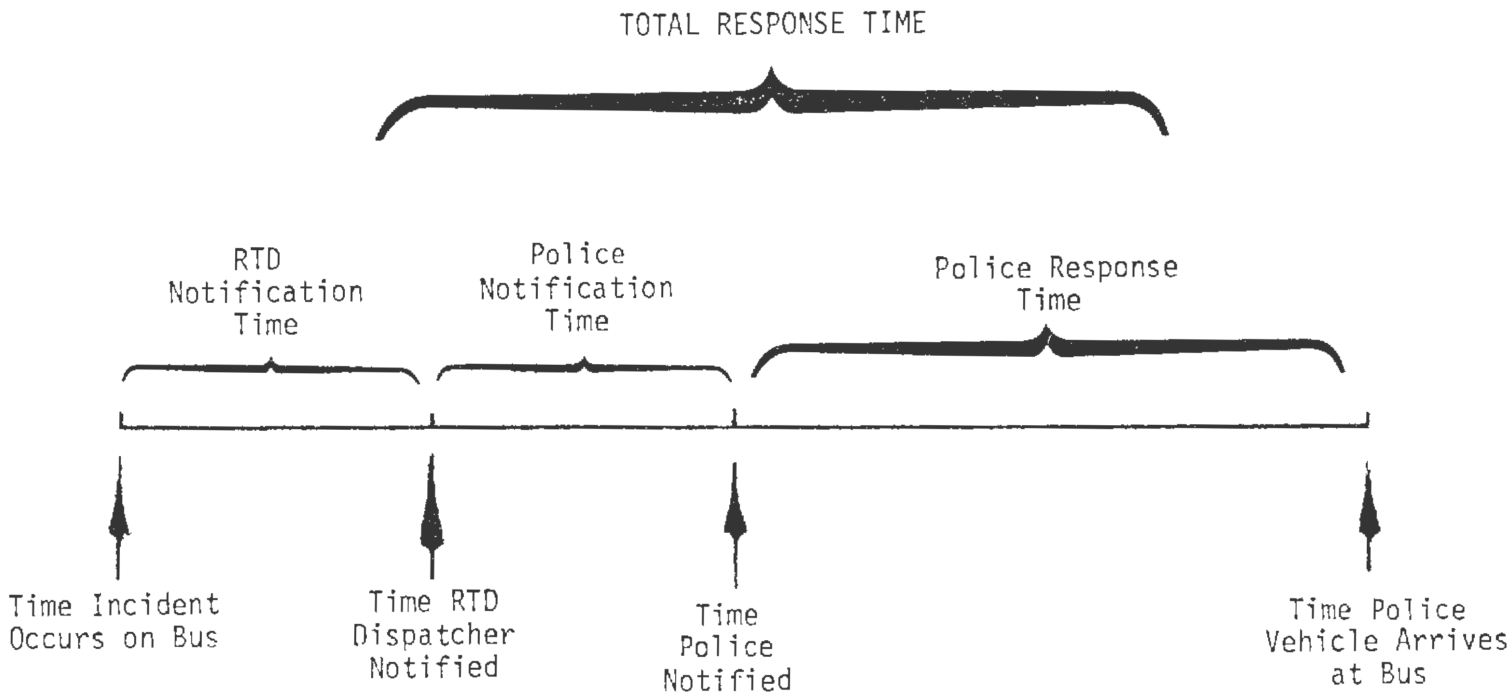
Checkers from SCRTD will conduct a transit user survey of persons waiting at the four bus stops where bus arrival display units have been installed. At each display unit, the observers will distribute a short survey form to waiting passengers designed to elicit the passengers' attitudes toward the arrival display units. A few demographic and travel characteristic questions will also be included in order to discover if there is any systematic variability in attitudes. The observers will collect completed forms on site, but will also provide postage-free mail-back envelopes for those not finishing before their bus arrives. Between route 83, which has 3-minute headways, and intersecting route 89, which has 6- to 8-minute headways, some 600 buses will arrive each day at the bus stops located at Wilshire Boulevard and Fairfax Avenue. Consequently, the distribution of surveys over a full day (7:00 A.M. to 6:00 P.M.) can be expected to generate a sufficiently large sample size (over 1,000).

Response Time to Buses Calling for Assistance

When a crime or disturbance takes place on board a bus, several events occur between the time of the incident and the time police arrive at the vehicle. The breakdown of this total response time is shown in Exhibit 4.1.

EXHIBIT 4.1

COMPONENTS OF TOTAL RESPONSE TIME TO BUSES REQUESTING POLICE ASSISTANCE



The SCRTD notification time reflects the time it takes for a driver to notify the SCRTD dispatcher that assistance is needed. The installation of the silent alarm can reduce SCRTD notification time if the driver is afraid to radio for help but is able to discreetly set the silent alarm. AVM by itself would not affect this parameter.

AVM does have the potential for decreasing the time required to notify the police, since the location of the vehicle calling for help will be immediately available to the SCRTD dispatcher and its location will not have to be calculated. Without AVM, but with the present Automatic Vehicle Identification (AVI) system, when a silent alarm signal from a bus is received, the bus number, route number, and scheduled run number are immediately displayed on the dispatcher's CRT screen. The dispatcher, who is familiar with the run numbers and routes, usually requires only a few moments to estimate the bus's probable location. These few seconds are generally insignificant relative to police response time, the final component of response time, unless the bus is early, late, or off route. Police or special agents must search for buses that are early, late, or off route when drivers trigger a silent alarm, and the time elapsed in finding them may be considerable.

AVM will have the greatest impact on police response time in this latter situation, since the police vehicle will be directed to the actual bus location rather than to the dispatcher's best estimated location.* The estimate is usually most unreliable when a silent alarm is received from a bus that is supposed to have completed its run.

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* This advantage would occur only when the silent alarm is used for notification in areas that are signposted; if the driver can radio the request, the precise location of the vehicle is specified by the driver.

Under existing SCRTD procedures, in these cases the division yard must first be checked to ascertain if the bus has returned or left again, or if the alarm was activated accidentally by someone cleaning or servicing the bus.* The impact assessment task is to identify the change in police response time.

For the baseline phase, police response time for three different months are available for AVM and control routes. Only about 20 legitimate silent alarms requiring a police response occur per month on all eight routes together. Each incident of crime or disturbance is documented on a "CS-10 Trouble Report Form" in the SCRTD control room. The control room radio system automatically records the time of all driver radio transmissions (including the silent alarm); also, all drivers of AVM and control routes are instructed to inform the control room when the police arrive. In many cases, however, a delay occurs between police arrival and the driver's notification to the dispatcher. Consequently, the response time data generated can only be interpreted as indicative for the baseline situation.

The test-period analysis will also rely on the information provided by CS-10 forms. A sample CS-10 is contained in the Appendix in Exhibit A-6. Considering the difficulties encountered in recording accurate police arrival times, the sample size would have to be very large to draw conclusions about AVM's impact at a reliable level of significance. However, there are few legitimate silent alarms on per month on the AVM routes. This analysis will also be limited by exogenous influences.

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* The false silent alarm rate during 1980 was 51 percent. Most false alarms are accidental activations or cases in which the driver acted on suspicion of a crime.

For example, the increasing occurrence of crime in Los Angeles has led SCRTD to hire more transit police to ride buses and has also spread police resources thinly. Baseline results of police response time are presented in Section 5.5.7.

Bus On-Board Crimes and Disturbances

The assessment contractor pursued data availability for this task with the Los Angeles Police Department, other local police departments, several judicial offices, and SCRTD. The various police departments and judicial agencies contacted do not keep separate records for on-board bus crimes and disturbances, and thus data collection efforts are limited to SCRTD's own records, the CS-10 Trouble Report Forms. Given the small number of legitimate silent alarms and on-board crime reports for the AVM routes, the sample size will be too small to obtain statistically significant results about the impact of AVM on on-board crime. Furthermore, it is implausible that, during the demonstration, potential criminals will perceive that reponse times have changed on the four routes and consequently not commit a crime. If there is any such rational response, it would probably result from an SCRTD public announcement that certain routes now have AVM control, and the crimes would be diverted to other routes or to nonbus locations. It is not feasible to detect this diversion because of its small magnitude relative to total crime.

Arrests Resulting from On-Board Crimes

If police response time to silent alarm signals is shortened by AVM, one would expect a greater proportion of these incidents to result in the arrest of suspects. The SCRTD Security Department does collect data on apprehension of suspects for all routes, along with police response times and on-board crimes and disturbances; unfortunately, AVM-related arrest data is subject to the same limitations regarding sample size.

4.2.3 Demand Data: Ridership

Separate collection of ridership data on AVM routes is not required, as passenger loads are already recorded together with schedule deviation data. It is doubtful, however, if a comparison of ridership in the baseline and test stages will reveal a significant increase due to AVM, because it usually takes three to six months for a demand effect to stabilize.

4.2.4 Economic and Efficiency Data

A meaningful before/after comparison of vehicle productivity, scheduling efficiency, and operating costs would require information about scheduling and/or vehicle supply changes in response to better schedule adherence achieved by the AVM system. However, SCRTD is unlikely to take this initiative during the demonstration period. Therefore, as far as data are available, the final evaluation will focus on potential reductions in bus supply due to AVM.

4.3 Data Collection Summary

Exhibit 4.2 summarizes the data collection plan for the impact assessment, specifying how, when, and where all data elements are to be collected.

EXHIBIT 4.2: DATA COLLECTION SUMMARY

Data to be Collected	By Whom?	Where?	How?	When?	How Many? (Sample Size)	Evaluation Criteria Addressed
Implementation Data:						
SCRTD Management Attitudes	SYSTAN/ Juárez	SCRTD Offices	Interviews with SCRTD managers	Start-up phase: Oct/Nov. 1980 Test phase: May-June 1981	All persons directly involved with AVM	Preimplementation needs and expectations
SCRTD Employee Attitudes	SYSTAN/ Juárez (Wilson-Hill)	SCRTD Offices + Divisions	Interviews with SCRTD drivers and dispatchers	Start-up phase: Dec. 1980/ Jan. 1981 Test phase: May-June 1981	All AVM dispatchers and a sample of drivers assigned to AVM routes	Employee attitudes, control room operations
Changes in Data Collection, Planning, Scheduling, and Control Room Functions	SYSTAN/ Juárez	SCRTD Offices	Interviews with RTD planners and schedulers	Continuous project monitoring	As required	Data collection effectiveness, planning & scheduling effectiveness, control room operations
Level of Service Data:						
Schedule Deviations, Run-time Deviations, Passenger Loads (AVM Routes)	Gould	Entire length of all AVM routes	Tabulated automatically by AVM system	Weekdays during baseline, start-up and test phases	As close to 100% as AVM bus assignments and AVM system permit	Schedule reliability, bus ridership, bus crowding, vehicle productivity
Schedule Deviations and Passenger Loads (Control Routes)	Juárez/ SYSTAN	Three time-points on each of four control routes	On-site measurements of bus departure time & number of passengers on board	Two weeks in baseline period, two weeks during test period	3-4 days per route, all buses in both directions between 7 AM and 6 PM	Schedule reliability, bus ridership, bus crowding, vehicle productivity

(Exhibit 4.2, Continued)

Data to be Collected	By Whom?	Where?	How?	When?	How Many? (Sample Size)	Evaluation Criteria Addressed
Passenger Wait Times (AVM Routes)	SCRTD	Two time-points on each of four AVM routes	On-site measurements of the time passengers and buses arrive at the bus stop	Start-up phase: Jan. 1981 Test phase: June 1981	2 days per route, all passengers and buses in both directions between 7 AM and 6 PM	Wait times
Bus Arrival Display Unit Accuracy	Juárez/ SYSTAN	All locations of display units	On-site recording of predicted and actual bus arrival times	Test phase: Following installation in April-June 1981	3-8 days of measurement of all buses between 7 AM and 6 PM	Bus arrival information
User Attitudes Toward Bus Arrival Display Units	SCRTD	All locations of display units	On-site distribution of surveys to waiting passengers	Test phase: Following installation in April-June 1981	All passengers during one day between 7 AM and 6 PM (over 1,000)	Bus arrival information
Police Response Time to Buses Calling for Assistance	SCRTD	SCRTD control room (CS-10 Forms)	Recordings of silent alarm activation time and police arrival time at vehicle	Baseline: June/July 1979 August/Sept 1980 Start-up: Nov/Dec 1980 February 1981 Test: May 1981	100% on all AVM and control routes	Police response time
Bus On-Board Crime and Disturbances	SCRTD	All SCRTD buses (CS-10 Forms)	Reported by drivers and dispatchers as they occur	Baseline: June/July 1979 August/Sept 1980	100% on all AVM and control routes	Crimes and disturbances

(Exhibit 4.2, Continued)

Data to be Collected	By Whom?	Where?	How?	When?	How Many? (Sample Size)	Evaluation Criteria Addressed
Arrests Resulting from Bus On-board Crimes	SYSTAN/ Juárez	SCRTD CS-10 forms	Review dispositions of all reported crimes on SCRTD buses	Baseline: June/July 1979 August/Sept 1980	100% on all AVM and control routes	Crimes and disturbances
Demand Data:						
Ridership - See above "Passenger Loads"						
Passenger Boardings Around Bus Arrival Display Units	Gould	AVM route bus stops within 1/4 mile of display units	Tabulated automatically by AVM system	Entire test period	Continuous during test period	Display unit usage
Economic and Efficiency Data:						
Vehicle Productivity	SCRTD	SCRTD offices	Computations of vehicle hours and vehicle miles	Weekday averages computed monthly	Continuous, all routes	Vehicle productivity
Scheduling Efficiency	SCRTD	SCRTD offices	Computations of layover and operating times	Weekday averages computed monthly	Continuous, all routes	Scheduling efficiency
Operating Costs	SCRTD	SCRTD offices	Computations of vehicle hours	Weekday averages computed monthly	Continuous, all routes	Bus operating costs

(Exhibit 4.2, Continued)

Data to be Collected	By Whom?	Where?	How?	When?	How Many? (Sample Size)	Evaluation Criteria Addressed
AVM Costs	TSC	SCRTD, UMTA, TSC	SCRTD, UMTA, TSC records of equipment and operating costs	Continuous as they are generated	Continuous, all routes	AVM costs
Transit Data Collection	SCRTD/ SYSTAN & Juarez	SCRTD offices	SCRTD records & reports; media	Continuous during test period	Continuous, all AVM and control routes	Data collection
Control Room Operations	SCRTD/ SYSTAN & Juarez	SCRTD control room	Investigations with supervisors and dispatchers	End of test period	All AVM dispatchers and supervisors	Control room effectiveness
Planning & Scheduling Costs	SCRTD/ SYSTAN & Juarez	SCRTD offices	SCRTD records & reports; investigations with planning & scheduling depts.	Continuous during test period	Planners, schedulers and supervisors	Planning & scheduling Cost-effectiveness
<u>Demonstration Site Data:</u>						
Traffic Volumes	City of Los Angeles	Selected locations on AVM and control routes	Tabulated automatically by traffic counters	Baseline: Jan. 1980 Test: April 1981	24-hour counts for 3 days at each location	

5. BASELINE DESCRIPTION

5.1 Demonstration Setting

5.1.1 The Los Angeles Metropolitan Area

The Los Angeles metropolitan area, the second largest in the country, is highly decentralized and has a transportation system heavily dominated by the automobile. Although demographic data indicate that some other metropolitan areas are characterized by even greater decentralization and auto dependence, none of these other areas approach Los Angeles in size.

Los Angeles County, which comprises the Los Angeles Standard Metropolitan Statistical Area (SMSA), contains 7,411,302 people according to the 1980 census. Just under 3 million of these people live in the City of Los Angeles. The population of Los Angeles and Orange counties combined is over 9 million. In 1973, there were over 3.7 million automobiles in Los Angeles County, or one car for every 1.84 persons. Nationally, there was one car for every 2.06 persons in 1973, or 10 percent fewer cars per capita. Put another way, there were 1.33 cars per household in Los Angeles County (SMSA) in 1970, compared with 1.23 cars per household in all SMSAs. In the Los Angeles SMSA, only 3.7 percent of workers used public transit to travel to work in 1970, compared with about 12 percent in all SMSAs and 17 percent in the 33 SMSAs with populations of over one million.

The primary reason for the heavy reliance upon automobile travel in Los Angeles is the decentralization of population and activity centers in the metropolitan area. For example, only 4.5 percent of workers in Los Angeles County in 1970 were employed in the Los Angeles central business district (CBD); this percentage was the second lowest among the 18 largest SMSAs (St. Louis was 3.9 percent). Among all 33 SMSAs, an average of 9.4 percent of all workers were employed in the CBD.

5.1.2 The Southern California Rapid Transit District Services

The Southern California Rapid Transit District was created in 1964 from the old Los Angeles Metropolitan Transit Authority (MTA). The California legislature had established MTA in 1951 as a planning agency and in 1957 as an operating agency in order to consolidate the many independent transit companies in Los Angeles. Over the years, 38 systems have been consolidated. The District is governed by an 11-member Board of Directors appointed by local elected officials. Five members are appointed by the Los Angeles County Board of Supervisors, two members are appointed by the Mayor of Los Angeles City, and four members are appointed by a selection committee representing the other 77 cities in the District.

SCRTD provides public transit services in a 2,280 square-mile area in the Greater Los Angeles area. Approximately 2,800 buses are used to provide service on about 220 routes. In 1980, 390 million passenger trips were made on the system, 16 percent more than 1979. In 1980, total operating costs were approximately $300 million, of which about two-fifths was covered by fares. The almost $200 million shortfall in farebox revenue was funded by a combination of local, state (mostly sales tax), and federal subsidies. Key SCRTD operating statistics are summarized in Exhibit 5.1.

EXHIBIT 5.1

SCRTD OPERATING STATISTICS*

Annual passenger boardings	352,600,000**
Annual vehicle miles operated	99,025,000
Vehicle productivity (passengers/vehicle mile)	3.56
Fiscal year 1980-81 operating budget	$336,712,000
Fiscal year 1980-81 estimates:	
Operating cost per vehicle mile	$3.40
Operating cost per passenger	$0.95
Passenger revénues	$143,200,000
Average revenue per passenger	$0.41
Operating ratio (revenues/costs)	42.5%

* From SCRTD, "Facts at a Glance," September 1, 1980

** SCRTD has estimated more recently that total passenger boardings for all of 1980 were 390,000,000.

Bus Routes and Ridership

Many of SCRTD's 220 routes are convoluted and inefficient, but changes are not easily made because alterations in one route may require adjustments in as many as 10 others. The problem routes were inherited from the 1950s and earlier when transit in Los Angeles was contracted to private companies which competed with each other for business. There are still 11 bus companies which operate 149 bus lines within SCRTD's operating radius,* and in some cases passengers can transfer from one to another. Nevertheless, SCRTD provides approximately 90 percent of all public transit services to 185 cities and communities in Los Angeles County and portions of Orange, Riverside, San Bernardino, and Ventura counties.

SCRTD is the nation's third largest urban mass transit system, but the nation's largest all-bus transit system. On a typical weekday, there are as many as 1.4 million passenger boardings, or between 500,000 and 600,000 daily riders. Lines are as short as one mile and as long as 76 miles.

Although the District's buses are used primarily by commuters going to and from work, SCRTD carries only about 5 percent of all work trips

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* Other bus lines are Orange County Transit District which operates 442 buses on 75 lines; Santa Monica Municipal Bus Lines which operates 114 buses on 12 lines; Culver City Municipal Bus Lines which operates 23 buses on 3 lines; Norwalk Transit System which operates 26 buses on 3 lines; Long Beach Public Transportation Company which operates 143 buses on 15 lines; Torrance Transit System which operates 33 buses on 19 lines; Gardena Municipal Bus Lines which operates 32 buses on 4 lines; Montebello Municipal Bus Lines which operates 32 buses on 10 lines; Laguna Beach Municipal Transit Line which operates 6 small buses, 2 trams, and a trolley car on 3 lines; City of Commerce which operates 10 buses on 4 lines; and Hermosa Beach which operates a free bus on a single line.

in Greater Los Angeles. According to one study conducted in 1978,* 31 percent of all bus riders are poor, elderly, or handicapped; 37 percent are under 29 years of age; 23 percent are 62 years old or older; 93 percent make less than $10,000 per year; and 38 percent are unemployed. Almost 100,000 Los Angeles Unified School District students ride SCRTD buses each school day.

Most buses run over a 16-hour day,** and less than one-half of all passengers travel during the peak rush hour periods (6:00 A.M. to 8:00 A.M. and 3:30 P.M. to 5:30 P.M.). SCRTD takes in about $45,000 in cash fares every day (it no longer accepts dollar bills) and sells approximately 161,000 passes every month.

There are local bus lines which serve passengers on city streets and make frequent stops on assigned routes; limited bus lines which stop only at major intersections along assigned routes; and express bus lines which travel on the freeways and which may make only a few stops at the beginning and the end of assigned routes.

AVM Evaluation Routes

The four AVM test routes (4, 44, 83, and 89) were selected to represent a cross-section of the types of routes SCRTD and other transit properties in the United States operate. Control routes (84, 4, 91, and 94) were selected to match the AVM routes as closely as possible. All the AVM and control routes are located in the central city and the western sector (see Exhibit 5.2). All are local routes except

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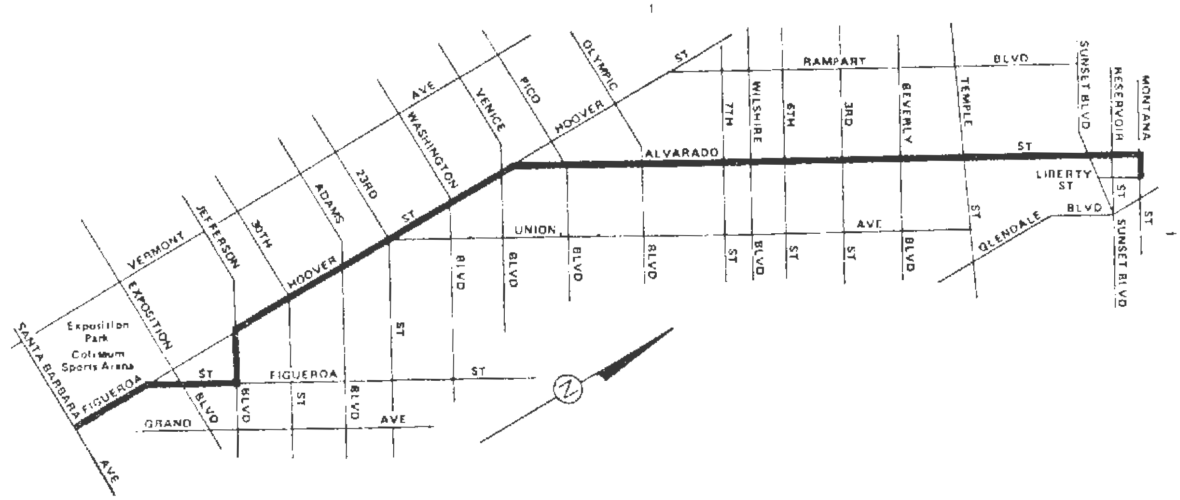
* 1978, SCRTD Service Awareness Study, conducted by Human Factors Research, Inc., Van Nuys, CA. June 1978.

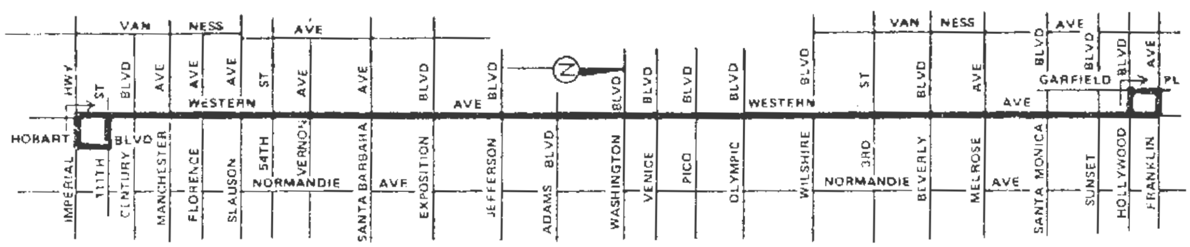
** There are some special "owl" runs, which provide service throughout the night.

EXHIBIT 5.2

AVM AND CONTROL ROUTES

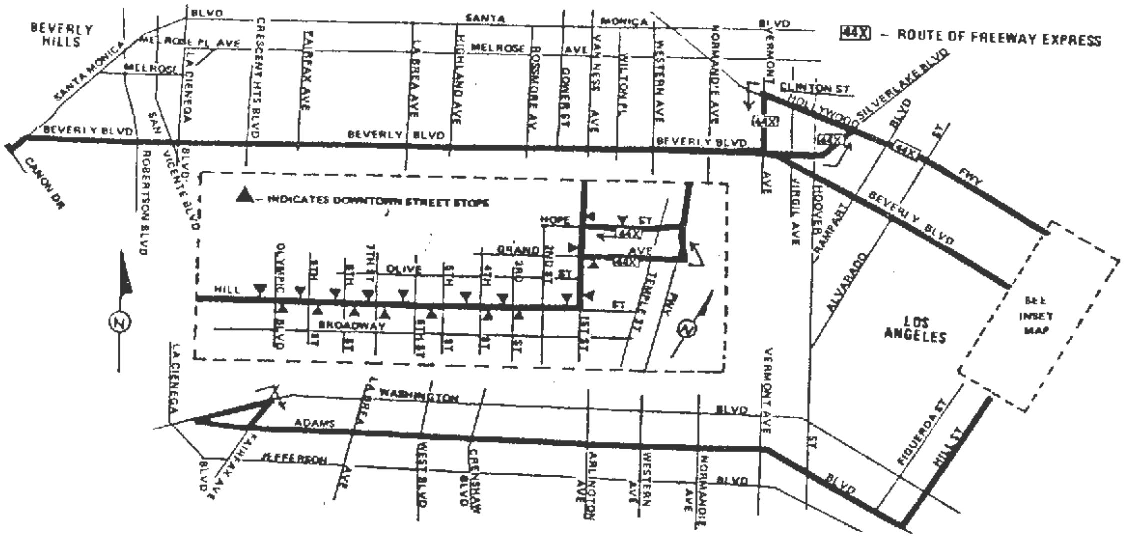


AVM Route 41

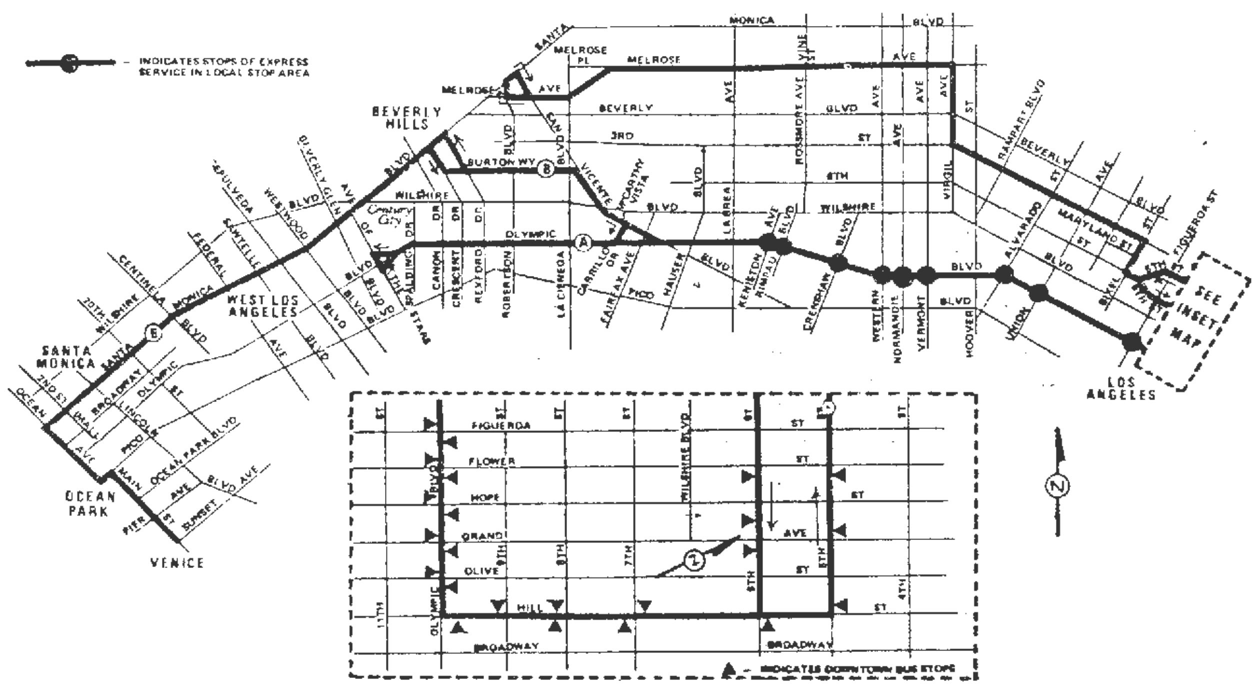


Control Route 84

EXHIBIT 5.2 (Continued)

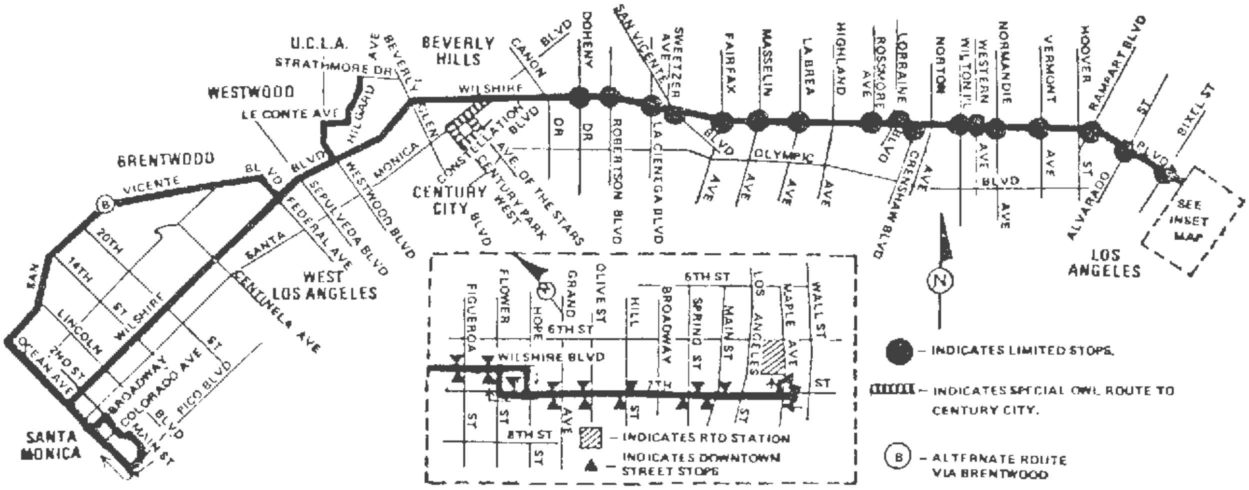


AVM Route 44

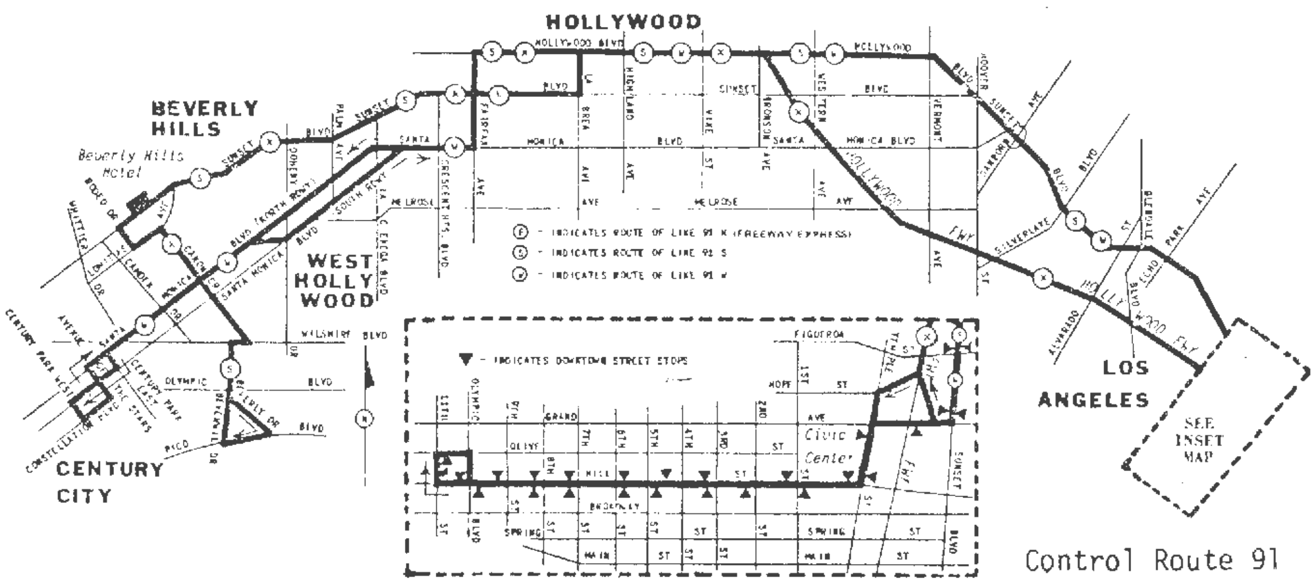


Control Route 4

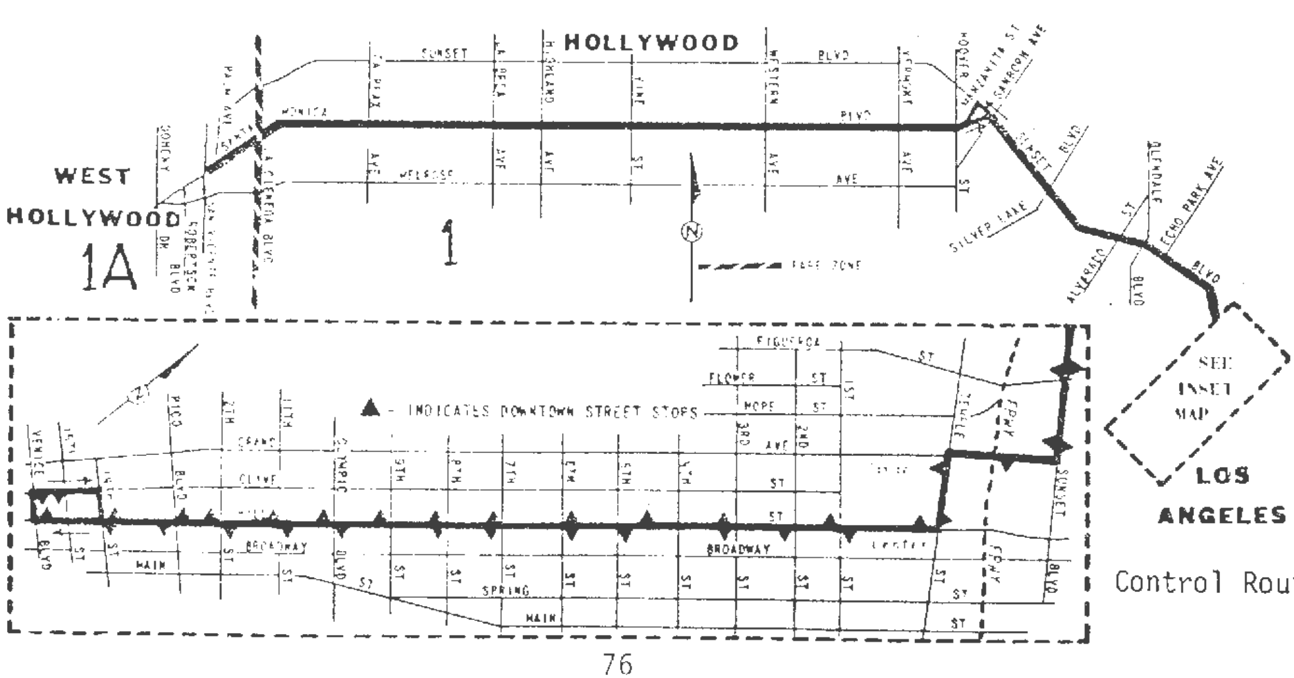
EXHIBIT 5.2 (Continued)



AVM Route 83

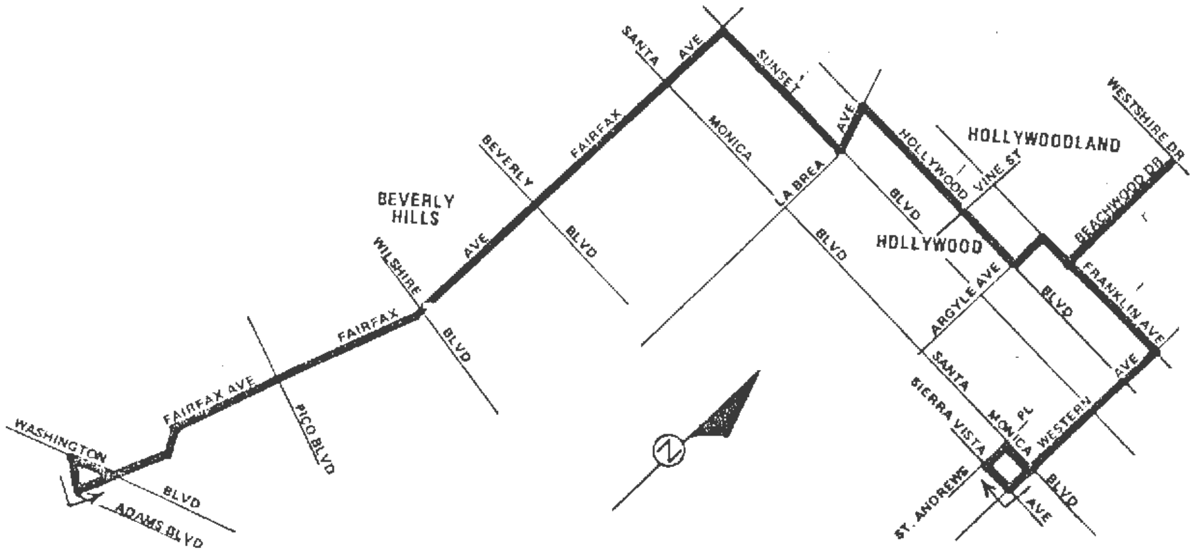


Control Route 91

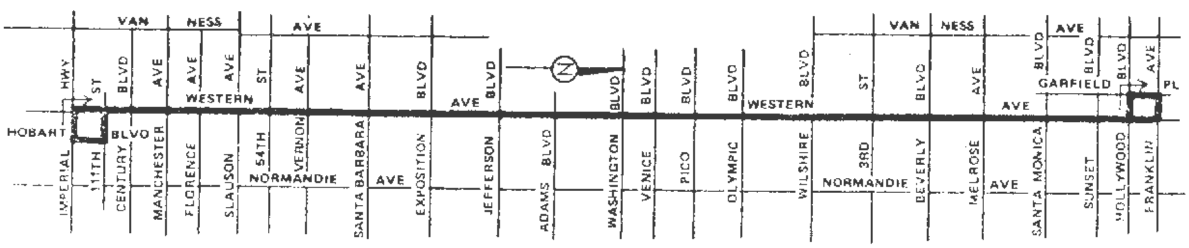


Control Route 94

EXHIBIT 5.2 (Continued)



AVM Route 89



Control Route 84

Line 83, which provides local and limited bus service along the Wilshire corridor, and lines 44X and 91X which make short jogs on the Hollywood Freeway. (Express buses were not included in the evaluation.) The Wilshire corridor is by far the most heavily traveled line in the SCRTD system, carrying 62,000 passengers per day. Line 83 was the last line to stop paying for itself as SCRTD's costs escalated.

The AVM and control routes operate in some of the more affluent parts of town, such as Westwood Village, Brentwood, and Beverly Hills. However, they also pass through some low-income and/or high-crime areas, including South Central Los Angeles, parts of downtown Los Angeles, and Hollywood.

Buses

SCRTD has about 2,800 buses in its fleet, many of which are quite old. The average age of SCRTD's buses in late 1980 was just under 13 years,* with some buses as old as 20 to 25 years. The number of road calls for breakdowns and other problems runs about 1,500 per week. During peak hours, SCRTD has about 2,000 buses in operation.

The standard bus is the most widely used. It is 40 feet long and has about 50 seats. Intermediate buses are smaller, 30 to 35 feet long, and carry fewer passengers. These are often assigned to suburban neighborhood areas. The 30 articulated buses in SCRTD's fleet can bend in the middle. They are 60 feet long, carry about 65 seated passengers, and are assigned to high patronage areas. Double-deck buses are 40 feet long, carry 84 passengers, and are used for high-demand commuter cruiser

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* As of September 1, 1981, the average age of the active fleet is expected to be 4.3 years.

service. Minibuses are 20 feet long, have 20 seats, and operate in the central business district and Westwood Village. They maneuver easily in and out of traffic. Interurban buses are similar to standard buses, except that they contain luggage compartments. They are used for long hauls and for airport express lines.

SCRTD has recently purchased 230 new Grumman Flxible buses, which are standard size and seat 46 passengers. These buses were to have been replacements for older buses, but cracks in the chassis have been found and all have been taken out of service for repair until Spring 1981 at the earliest. In addition to the Grumman Flxible buses, 940 new GM RTS-2s have been ordered. These are equipped with wheelchair lifts. At present 21 lines have 200 buses that wheelchair users can ride. The AVM hardware is installed on 200 SCRTD buses* and 12 service vehicles (six supervisors' vehicles, three transit police, two mobile mechanics, and one electronics van) which operate in the 54-square mile random-route area west from the central business district.

Operations Control: Radio Dispatchers

Of particular importance to the AVM demonstration is SCRTD's bus and communication system. A dispatching center, or control room, is located in the SCRTD's downtown headquarters. All buses have two-way radios with a priority call feature and a silent alarm system. SCRTD operates over 15 radio channels, 10 of which are used for buses, four for supervisory vehicles, and one for security vehicles. During most of the day, 10 dispatchers are on duty, each dispatcher monitoring one

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* One hundred fifty standard or conventional GMC buses, 17 articulated MAN buses (all of which are on Line 83), and 33 lift-equipped AM General buses. A few buses have been lost to AVM service due to accidents and other breakdowns.

radio channel. Each bus route is assigned to one of the 10 channels so that the workload is evenly divided among the dispatchers.

Each dispatcher works with a radio transmitter and receiver and a cathode-ray video screen. When a non-AVM equipped driver radios the control room, his or her bus number, route number, and scheduled run number are displayed on the screen. All District buses are equipped with Automatic Vehicle Identification (AVI) electronics, which enables the control center to identify which bus is assigned to what route and what run on any given day, but which does not enable the control center to determine where on its assigned route the bus is at any given time.

When a silent alarm signal is received, the non-AVM dispatcher consults the run schedule in order to estimate the bus's location, calls SCRTD's supervisors or special agents, and then calls the appropriate police department if the situation demands. Bus drivers are supposed to signal back when the situation is cleared. Since so many silent alarms are accidentally triggered,* many when the buses are in the division yard or garage, a problem arises if a silent alarm is received when a bus is supposed to have completed its run and been retired. Under existing non-AVM procedures, the division yard must first be checked to see if the bus has left or returned and if the alarm was set off accidentally by someone cleaning it or servicing it. Because radio communication is cut off when the alarm is triggered, it has been extremely difficult for the dispatcher to ascertain whether the alarm is legitimate.

* The rate of false silent alarms is high due in part to the poor location of the trigger and to malfunctioning switches. The system is in the process of being redesigned and all buses will be retrofitted.

A continuous log of all radio communications is automatically maintained by a printer in the control room. The time the communication starts (to the nearest second), the bus, route, and run numbers and the radio channel are recorded. Silent alarm signals have a special designation. Beginning in January 1981, all radio and telephone communications between drivers and dispatchers are also tape recorded.

Dispatchers, like drivers, bid their assignments, those with the highest seniority having the first choice of assignments. Dispatchers normally bid three times per year. In June 1980, all potentially eligible dispatchers were introduced to the AVM console before the first bidding took place. The four dispatchers who first bid AVM had varied reasons for doing so, including the attractiveness of the available shifts. For the four AVM shifts, one high-seniority dispatcher, two middle-seniority dispatchers, and one low-seniority dispatcher bid. Two high-seniority "extra" dispatchers were assigned as back-ups, since "extra" dispatchers cannot bid. During the first few months of AVM implementation, the dispatchers had responsibility for a number of non-AVM buses because there was not an extra radio channel available for the exclusive use of the AVM buses. This was essentially corrected in time for the December 1980 shake-up, when dispatchers again bid their assignments. Two new dispatchers bid on to AVM at that time, and the number of non-AVM bus lines assigned to channel 5 was substantially reduced so that more time could be devoted specifically to AVM route control functions.

Ghost buses, that is, non-AVM-equipped buses assigned to AVM routes,*

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* A similar problem is "bad-order" buses, that is, AVM-equipped buses assigned to the wrong runs on AVM routes. This is discussed in Michael Wolfe's (TSC) memo dated February 6, 1981.

have been a recurring problem for dispatchers, although action has been taken to improve this situation. The problem has been partly a result of the difficulty that division dispatchers have had in locating buses equipped with functioning AVM hardware and assigning them to AVM routes. Division garages which serve AVM routes also serve non-AVM routes. Parking space at the garages is critical and in the past the buses have been driven out of the yard in the reverse order of their being driven into the yard, which has resulted in the missing or AVM and non-AVM ghost buses. A related problem has been created because division dispatchers sometimes have neglected to enter their bus assignments into the AVI computer system.

Bus Drivers

As of November 1980, there were 4,235 full-time bus drivers and 327 part-time drivers (e.g., students) working for the District. The total number of drivers varies from 4,500 to 4,800. Each operator is assigned to one of 11 division locations which range in size from approximately 250 to 600 operators. Seniority decides which division drivers are in and what routes they get. Operators bid their division locations annually and their bus runs three times per year, although some operators work the "extra board" and may be called upon to drive any of the routes assigned to their respective divisions. Operators are supervised by division managers and assisted and monitored by field supervisors. In addition, they receive assignments from division dispatchers and training from division instructors. SCRTD has 16 undercover spotters randomly riding buses and reporting drivers for rule violations. One out of every eight drivers is a woman. Because they are low in seniority, women tend not to draw the best runs.

Based on seniority, a driver with the highest seniority may be promoted to driver supervisor and then he or she may apply for and take an examination to become a dispatcher, a management position which receives higher pay.

Most drivers who bid for AVM routes in June 1980 did not know about the demonstration beforehand. The official announcement was made in September 1980 when the real-time control phase of the demonstration became operational, although the 200 AVM buses had been fitted with the equipment prior to April 1980. On October 20, 1980, an announcement from the general superintendent of transportation urged all drivers to cooperate during the remainder of the AVM demonstration by adhering to schedules as closely as possible within the guidelines of the District's operating rules.

5.2 Implementation Data

5.2.1 SCRTD Management Attitudes

In October and November 1980, 13 SCRTD managers in various departments were interviewed by two representatives of the assessment contractor. The attitudes of those interviewed toward major issues related to the AVM demonstration are summarized in Exhibit 5.3. The last column of the second page of the exhibit indicates the overall attitudes of the respondents.

Security and schedule adherence and planning turned out to be the key concerns. Significant improvements in these areas were expected by most respondents. Overall agreement could be found among the responses to many of the other issues, too: the survey showed a general

EXHIBIT 5.3: MANAGEMENT ATTITUDES ABOUT AVM

AVM CONNECTED ISSUES / RTD DEPARTMENTS	Respondent's Main Concern in AVM	Economic Aspects	Equipment and Maintenance	In-vehicle Display (IVD); Bus-Stop Display (BSD)	Schedule Planning	Attitudes of Bus Operators
TRANSIT POLICE	Security	Benefits expected to equal costs in the long run	Problem: Accidental activation of silent alarm	No Statement	No Statement	Resentment based on increased control expected but appreciation of more security
MANAGEMENT INFORMATION SYSTEMS	Data Generation for Scheduling	Benefits expected to equal costs in the long run	Electronic equipment considered to be "exotic", breakdown problems expected	• IVD: Reduced use of radio communication • BSD: Expensive, but very useful	Improvement effective only as long-term response. Political scheduling influences	Resentment possible
PLANNING DEPARTMENT	Data Generation for Scheduling	Cost effectiveness expected; location of over- and under-serviced areas possible	AVM Technology considered to be "long overdue"	No Statement	Improvement expected based on ridership data	Resentment possible, but AVM not intended as "police-system"
INSTRUCTION DEPARTMENT	Schedule Adherence, Security	Cost-effectiveness expected; increase of productivity possible	Savings in non-AVM equipment and manpower expected	• IVD: Useful for schedule adherence of early buses • BSD: Useful at selected stops only	No Statement	Good response expected; no additional training time required
MAINTENANCE & EQUIPMENT	Security	Cost/Benefit relation hard to measure in a transit system	Problem: Limited interchangeability of buses during partial AVM-implementation	• IVD: Useless considering traffic flow and driver competence • BSD: Helpful	Improvement expected	No Statement
DISPATCHING CENTER	Random-Route Vehicle Location	Cost-effectiveness expected; location of over- and under-serviced areas possible	Problem: Tremendous overall maintenance costs	• IVD: Useful to adjust early buses, otherwise, abused as excuse for accidents • BSD: Useful, if announcement includes type of service	Improvement expected based on ridership data	Resentment possible; but AVM not intended as "driver-policing" tool
OPERATIONS (RESPONDENT 1)	Schedule Adherence, Security	Cost-effectiveness expected; higher paperwork efficiency possible	Positive: Shorter response time to road-service calls	No Statement	Marked improvement expected based on data availability and accuracy	Resentment possible; good response from conscientious drivers expected
ADMINISTRATION MANAGEMENT	Security	No Statement	No Statement	No Statement	No Statement	95% cooperation in misdemeanor incidents expected
OPERATIONS (RESPONDENT 2)	Passenger Loading	Benefits expected to exceed costs in the long run; more efficient use of manpower	AVM equipment considered to be "exotic"; breakdowns expected; but: necessary	• IVD: No Statement • BSD: Not expected to become operational	No Statement	Resentment expected; but appreciation of more security
SCHEDULING DEPARTMENT (RESPONDENT 1)	Data Generated for Scheduling	Cost-effectiveness and increased productivity expected in the long run	No Statement	• IVD: Not very useful • BSD: Totally useless, too expensive considering the effect	Marked improvement expected based on ridership data	"Revolt" expected in case of extreme exertion or control
SCHEDULING DEPARTMENT (RESPONDENT 2)	Real-Time Control	No Statement	No Statement	• IVD: Use by operators doubtful • BSD: Not very useful, superior to posted signs	Fine-tune system possible based on up-dated information	Acceptance expected in case of moderate use of AVM control
TELECOMMUNICATIONS	Real-Time Control, Security	Cost-effectiveness expected in case of high ridership	AVM equipment considered to be "latest word" in real-time control; but high maintenance costs	• IVD: Reduced use of radio communication • BSD: Useful, superior to posted schedules	Improvement expected	Acceptance expected in case of moderate use of AVM control
ISSUE SUMMARY		Cost-effectiveness expected in the long run	Acceptance of AVM-technology, but maintenance problems expected	Regarded useful with reservations	Improvement expected based on data availability	Partial resentment of behavior control possible

EXHIBIT 5.3 (CONTINUED)

AVM CONNECTED ISSUES / RTD DEPARTMENTS	Impact on Dispatchers	Security	Level of Service	Passenger Demand	Expansion of the AVM	Respondent's Overall Attitude
TRANSIT POLICE	No Statement	Improvement expected (shorter response time)	Improvements: Greater reliability of service, fast adjustments	Increased ridership expected	Useful: To all transit police vehicles	Very favorable ●
MANAGEMENT INFORMATION SYSTEMS	Personnel assignment problem: ambition to exercise real-time control necessary	Improvement expected; but AVM considered a rather expensive way	No Statement	Increased ridership expected	Useful: To heavily used lines	Positive ◐
PLANNING DEPARTMENT	Positive: Preventive rather than reactive operations expected	No Statement	Improvements: Greater reliability, better-spaced headways, increased service	Increased ridership expected	Not Useful: To express buses using freeways	Very favorable ●
INSTRUCTION DEPARTMENT	No Statement	Improvement expected	Improvements: Less over-loading, fast adjustments	Increased ridership expected	No Statement	Positive ◐
MAINTENANCE & EQUIPMENT	No Statement	Improvement expected	Necessary: Multilingual transit information	Increased ridership	Necessary: System-wide for full functioning	Indefinite ○
DISPATCHING CENTER	Positive: Increased control; but longer training and special counseling expected	Improvement expected (shorter response times)	Improvement: Greater reliability based on control of driver behavior	No Statement	Useful: To all random-route vehicles, heavily used lines, high frequency lines	Positive ◐
OPERATIONS (RESPONDENT 1)	Personnel assignment problem: competitive attitude for better performance necessary	Improvement expected	Marked improvements. consistently spaced headways	No Statement	Useful: To lines with headways up to 15 min. to core routes, crime area routes, hinterland routes	Very favorable ●
ADMINISTRATION MANAGEMENT	No Statement	Response-time decrease by 2/3 expected	No Statement	Positive reaction to on-board arrests	Useful: To crime area routes; principally system-wide	Very favorable ●
OPERATIONS (RESPONDENT 2)	Personnel assignment and training problem: more stress expected	Improvement expected	Improvement: Better distribution of passenger loads	Increased ridership expected	Not Useful: To small communities	Indefinite ○
SCHEDULING DEPARTMENT (RESPONDENT 1)	More dispatchers needed for intense operations	No Statement	Improvements: Passenger loading, dynamic schedule change prevention of headway variances	Increased ridership	Useful: To about 20 lines with bunching effects	Very favorable ●
SCHEDULING DEPARTMENT (RESPONDENT 2)	More dispatchers needed for intense operations	Improvement expected	Improvements: Passenger loading greater reliability better-spaced headways	Increased ridership	Useful: To heavily used lines	Positive ◐
TELECOMMU-NICATIONS	Positive: Preventive rather than reactive operations expected	Improvement expected (shorter response-times)	Improvements: Passenger loading, increased service	Increased ridership expected	Useful: To some lines, according to costs and benefits	Positive ◐
ISSUE SUMMARY	Improved preventive operations possible; but: personnel problems	Improved level of security expected	Improved schedule adherence and increased service expected	Increased ridership	Conditional expansion desirable	—

expectation of cost effectiveness of the AVM system, ridership increases, and the usefulness of an expansion of the system. Some disagreement existed about the AVM hardware: although the technology was accepted as a necessary innovation for a transit system, many breakdowns and maintenance problems were also anticipated. The in-vehicle and bus-stop displays were subject to the highest degree of controversy. The Management Information Systems and Telecommunication departments assigned the highest value to these devices; others considered them to have only limited or no use at all. Most respondents expressed concern about personnel assignment and training problems regarding bus drivers and dispatchers. Drivers might view AVM as a potential means to evaluate and control their behavior; dispatchers must be trained to exercise real-time control, making full use of the instruments and information provided by the AVM system.

Overall, management expectations of AVM performance were positive, and all respondents expressed the interest of their departments in participating and cooperating in the demonstration.

5.2.2 Driver and Dispatcher Attitudes

Two-page questionnaires (see Exhibits A-1 and A-2 in the Appendix) were developed by the assessment contractor for distribution to drivers and dispatchers. In December 1980, the driver survey was distributed by SCRTD to 10 preselected drivers* in each of the three divisions out of which AVM-equipped buses are dispatched; in January 1981, SCRTD gave the dispatcher survey to five AVM dispatchers (and in February to three more). Responses were received from 26 drivers and three dispatchers (later seven

* Drivers who had a "line instructor" status.

dispatchers). A summary of their answers is presented in Exhibits 5.4 and 5.5. Multiple answers were permitted for each question.

The drivers who responded show a very positive assessment of AVM, inasmuch as 77 percent of them expected AVM to make their work easier. However, only 54 percent thought it would win acceptance from drivers in general. A majority expected (or hoped) AVM would be effective in the areas of schedule adherence (73 percent), communication between drivers and dispatchers (62 percent), and driver security (62 percent). More than half (54 percent) used the space provided for special comments to express their concern that AVM should have an impact on drivers who run buses considerably earlier than scheduled time (i.e., "hot" or "sharp") to gain longer breaks or smaller passenger loads. Less agreement could be found among the responses regarding the impact on ridership and the system's cost effectiveness. Some of the other comments indicated expectations of a better distribution of passenger loads, better connections for passengers, and a more regular observation and control of the entire system.

The overall assessment by dispatchers is similar, with all respondents agreeing that AVM will make their jobs easier and with most focusing on the positive impacts. As there are only seven responses available, however, the observations prepared by TSC's resident (on-site) manager for the AVM project* regarding AVM dispatcher attitudes are presented below to supplement the analysis.

Interviews after seven weeks of AVM use in the start-up period revealed substantial differences in dispatcher attitudes and reactions

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* Memorandum dated November 3, 1980, from Ken Bray to Peter Segota (both of TSC).

EXHIBIT 5.4

SURVEY OF SELECTED AVM DRIVERS, DECEMBER 1980 *

Surveys distributed: 30
Surveys returned: 26
Usable surveys: 25 (1 form returned with one comment only)

SURVEY QUESTIONS	RESPONSES (IN %)
1. How will AVM affect your job? (Multiple answers permitted)	
Make it easier	80
Make it more difficult	0
Won't affect it	12
Other	8
2. How will AVM affect bus operations? (Multiple answers permitted)	
Maintenance of on-time service	76
Better driver/dispatcher communication	64
Fewer buses required on AVM lines	0
Improved driver security	64
Improved passenger security	56
Won't affect bus operations	40
Other	0
3. How will AVM affect ridership?	
Increase on AVM lines	36
Decrease on AVM lines	4
Won't affect ridership	44
Don't know	8
Other	8
4. Will AVM win acceptance and cooperation from drivers?	
Yes	56
No	28
Maybe	8
Don't know	8
Other	0
5. Will the AVM system pay for itself?	
Yes	24
No	40
Maybe	16
Don't know	20
Other	0

* See Appendix Exhibit A-1 for a copy of the questionnaire.

EXHIBIT 5.5

SURVEY OF AVM DISPATCHERS, JANUARY/FEBRUARY 1981 *

Surveys distributed: 8
Surveys returned: 7

SURVEY QUESTIONS (Multiple answers permitted)	Responses (in %) January (n=3)	Jan/Feb (n=7)
1. How will AVM affect your job?		
Make it easier	100	100
Make it more difficult	33	57
Won't affect it	0	0
Other	33	29
2. How will AVM affect bus operations?		
Maintenance of on-time service	33	57
Better driver/dispatcher communication	100	71
Fewer buses required on AVM lines	0	14
Improved driver security	100	86
Improved passenger security	100	86
Won't affect bus operations	0	0
Other	0	0
3. How will AVM affect ridership?		
Increase on AVM lines	33	43
Decrease on AVM lines	0	0
Won't affect ridership	67	43
Don't know	0	14
Other	0	14
4. Will AVM win acceptance and cooperation from drivers?		
Yes	100	86
No	0	0
Maybe	0	14
Don't know	0	0
Other	0	0
5. Will AVM win acceptance and cooperation from dispatchers?		
Yes	100	57
No	0	14
Maybe	0	14
Don't know	0	0
Other	0	29
6. Will the AVM system pay for itself?		
Yes	33	43
No	67	57
Maybe	0	0
Don't know	0	0
Other	0	0

* See Appendix Exhibit A-2 for a copy of the questionnaire.

toward the system. According to the various perceptions of the dispatchers, there are several factors limiting AVM's effectiveness:

- AVM hardware/software problems;
- SCRTD operational problems (e.g., assignment of non-AVM buses to AVM routes);
- dispatcher work loads (i.e., time that has to be devoted to non-AVM buses; this issue was corrected at the December 1980 shake-up); and
- insufficient training in tactical situations (with the reluctance to take corrective tactical actions also due to the large number of situations being displayed, the lack of consensus regarding which situations actually require corrections, the uncertainty with respect to the effectiveness of potential corrective actions, and the relative difficulty of assessing the effect of any corrections tried).

5.3 AVM and Control Route Data

As mentioned earlier, from all SCRTD bus routes, routes 41, 44, 83, and 89 were chosen for the demonstration application of AVM. In addition, four routes similar in location, configuration, length of route, and headways (routes 4, 84, 91, and 94) were selected to serve as controls for monitoring system or environmental changes independent of AVM. Exhibits 5.6 and 5.7 compare the bus frequencies, configurations, headways, lengths, and peak passenger loadings for the AVM and control routes.

Although the control routes were selected carefully to resemble the AVM routes with regard to major characteristics, their comparison is subject to some limitations:

- Some imprecision in matching routes is inevitable.

EXHIBIT 5.6

COMPARISON OF BUS FREQUENCIES AND CONFIGURATIONS FOR AVM AND CONTROL ROUTES

Route	Approximate Number of Buses in One Direction (NB or EB)* Weekdays Only						
Route	7-9AM	9AM-3:30PM	3:30PM-5:30PM	5:30PM-7AM	Daily Total	Division Numbers	Route Configuration
41 (AVM)	12	32	13	27	84	2	Straight crosstown (N-S)
84 (Control)	18	32	14	33	97	5	Straight crosstown (N-S)
89 (AVM)	17	50	17	30	114	7	L-shape (NE-WS)
84 (Control)	18	32	14	33	97	5	Straight crosstown (N-S)
44 (AVM)	23	43	19	40	135	2,7	U-shape in CBD (ESW-ENW)
4 (Control)	28	54	31	42	155	6,7	U-shape in CBD (ESW-ENW)
83 Loc. (AVM)	25	121	25	64	235	2,6,7	Straight crosstown (E-W)
Ltd. (AVM)	16	0	25	6	47		
91 (Control)	20	43	22	56	141		Straight crosstown (E-W)
94 (Control)	14	39	13	29	95	2,7	Straight crosstown (E-W)

* NB = Northbound
EB = Eastbound

EXHIBIT 5.7

COMPARISON OF HEADWAYS, LENGTHS, AND PEAK PASSENGER LOADINGS FOR AVM AND CONTROL ROUTES

Route	Representative Headways (minutes) Weekdays			Peak Number of Buses	Miles on Route	Ratio of Passengers to Seats *
	AM Peak 7-8AM	Midday 10AM-2PM	PM Peak 4-5PM			
41 (AVM)	9	12	9	10	5.5	1.28
84 (Control)	4-5	15	7	27	12.2	1.18
89 (AVM)	6	8	7	18	9.6	1.36
84 (Control)	4-5	15	7	27	12.2	1.18
44 (AVM)	4	10	5-6	50	19.2	1.37
4 (Control)	3	8	3-4	65	28.3	1.52
83 Loc. (AVM)	3	3-4	3	103	18.8	1.44
83 Ltd. (AVM)	5		5			
91 (Control)	5	10	5	45	16.2	1.44
94 (Control)	9	10	8	18	12.7	1.40

* Peak hour passenger loading

- There is a difference of measurement error. On the AVM routes, each bus is polled every 40 seconds, and the signposts do not always coincide with bus stops; consequently interpolation techniques must be applied to estimate each bus's current position as well as its time of departure from any given bus stop. The measurement error generated by this procedure is estimated to be between -1 and +1 minute around actual departure time. On the control routes, the measurement error is a result of the deficiencies of manual time checking with watches showing no seconds or watches that are inaccurately set, and is estimated to be within 30 seconds on the average.

Nevertheless, the monitoring of control routes has the following advantages:

- It provides a check for the representativeness (nonidiosyncratic nature) of the AVM routes.
- It provides complementary data for four additional routes in a transit system of more than 200 routes.
- It provides a check on trends in ridership.
- It provides a check on trends in driver performance.
- It provided data earlier than the AVM routes did; thus, the processing, analysis, and interpretation of control route data gave important insights into the subtleties of schedule adherence data, prior to receipt of AVM data.

5.4 Traffic Volumes

In January 1980, traffic volumes were measured by the Los Angeles City Transportation Department at 14 locations along AVM and control routes. The measured traffic volumes are presented for peak and off-peak periods in Exhibits 5.8 and 5.9.

EXHIBIT 5.8: TRAFFIC VOLUMES ALONG AVM ROUTES

(Average Numbers of Vehicles)

RT.	TRAFFIC COUNTER LOCATION	DIRECTION	7-9 A.M. TOTAL	7-9 A.M. PER HOUR	9 A.M.-3 P.M. TOTAL	9 A.M.-3 P.M. PER HOUR	3-6 P.M. TOTAL	3-6 P.M. PER HOUR	COMPARISON ROUTE*
41	ALVARADO ST. S/O BEVERLY BLVD.	NORTH	1260	630	4470	750	3830	1280	Route 84
		SOUTH	1470	735	2590	430	1120	370	
41	HOOVER ST. N/O 20th ST.	NORTH	2000	1000	4350	730	3300	1100	
		SOUTH	1920	960	4900	820	3760	1250	
44	ADAMS BLVD, E/O WESTERN AVE.	EAST	1440	720	2900	480	1980	660	Route 4
		WEST	1000	500	2900	480	2760	920	
44	BEVERLY BLVD, E/O WESTERN AVE.	EAST	1330	665	4400	730	2930	980	
		WEST	2140	1070	6660	1110	4010	1340	
83	WILSHIRE BLVD. E/O WESTERN AVE.	EAST	2100	1050	6080	1010	3070	1020	Routes 91 and 94
		WEST	1340	670	5900	980	4110	1370	
83	WILSHIRE BLVD. W/O VETERAN AVE.	EAST	7357	3680	19107	3180	7433	2480	
		WEST	2406	1200	14257	2380	9908	3300	
89	FAIRFAX AVE. S/O BEVERLY BLVD.	NORTH	1400	700	5640	940	4440	1480	Route 84
		SOUTH	1760	880	5660	940	2670	890	
	MEAN AVM ROUTES			1030		1070		1320	
	MEAN: AVM ROUTES (83 EXCLUDED)			790		740		1030	

SOURCE: City of Los Angeles, Dept. of Transportation, January 1980

* See Exhibit 5.9.

EXHIBIT 5.9: TRAFFIC VOLUMES ALONG CONTROL ROUTES

(Average Numbers of Vehicles)

RT.	TRAFFIC COUNTER LOCATION	DIRECTION	7-9 A.M. TOTAL	7-9 A.M. PER HOUR	9 A.M.-3 P.M. TOTAL	9 A.M.-3 P.M. PER HOUR	3-6 P.M. TOTAL	3-6 P.M. PER HOUR	COMPARISON ROUTE*
4	MELROSE AVE. E/O WESTERN AVE.	EAST	1540	770	4670	780	2910	970	Route 44
		WEST	1660	830	4960	830	2750	920	
4	OLYMPIC BLVD. E/O WESTERN AVE.	EAST	3680	1840	6570	1100	3830	1280	
		WEST	2050	1025	5800	970	5930	1980	
84	WESTERN AVE. S/O SLAUSON AVE.	NORTH	1710	855	3660	610	2360	790	Route 41 and Route 89
		SOUTH	1080	540	3490	580	2630	880	
84	WESTERN AVE. S/O BEVERLY BLVD.	NORTH	1500	750	5350	890	3530	1180	
		SOUTH	2310	1155	5450	910	2780	930	
91/94	SUNSET BLVD. AT SANBORN AVE.	EAST	1490	745	3680	610	2510	840	Route 83
		WEST	1240	620	4630	770	3210	1070	
91/94	SUNSET BLVD. AT ECHO PARK AVE.	EAST	990	495	2190	370	1410	470	
		WEST	1190	595	3670	610	3230	1080	
91/94	HILL ST. N/O 5th ST. (CBD)	NORTH	1270	635	4960	830	3930	1310	
		SOUTH	2900	1450	5370	900	2790	930	
	MEAN CONTROL RTS.			880		770		1130	

SOURCE: City of Los Angeles, Dept. of Transportation, January 1980

* See Exhibit 5.8.

With the exception of Route 83 (Wilshire Boulevard), AVM and control routes seem to be subject to similar traffic conditions. A repetition of these measurements during Stage 3 of the demonstration in April 1981 will provide information regarding the general development of traffic conditions that will be considered in the comparison of "after" and "before" (baseline) data.

5.5 Level of Service Data

5.5.1 Introduction to AVM Data Collection and Processing

Starting on March 17, 1980, Gould began collecting AVM data. Each day a magnetic tape is made of all information transfers between AVM buses and the central computer. This tape, called the "AVM log tape," contains the raw data for processing into "Level 1" output* for each route in each direction. Level 1 output consists of "bus stop records" at from four to six timepoints along each route. Each bus stop record gives the time, route, run number, trip number, stop number, timepoint number, passengers on board, passengers boarding, passengers alighting, total boardings and total alightings to the given point on the route, run-time variation, schedule deviation, scheduled time, and signpost number. Some interpolation is necessary to arrive at the time given in the bus stop record, since signposts are not always collocated with bus stops and each bus is polled for information only every 40 seconds.** Location information can be off by one bus stop, and passenger-count information can be off by two stops.

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* Gould has defined three levels of processing software and information output.

** The interpolation assumes that buses travel at constant speed between timepoints.

Level 2 information, which is built up from Level 1 bus stop records, provides daily results summarized as averages, standard deviations, and frequency distributions for three variables: schedule deviation, run-time variation, and passengers on board.* There is one page of Level 2 output for each route for each variable; the presentation on each page shows the summary statistics for each of four non-overlapping time blocks.

To provide a higher level of aggregation than daily summaries, Gould defined two-week "test periods,"** starting with March 17, 1980. Thus, data for "test period 3" covers the weekdays between April 14 to 25, 1980, which is the period that best corresponds with the data collected for the control routes. Test periods 3 through 13 correspond to the total baseline period. Gould developed "Level 3" software to allow the aggregation of daily level 2 data into data for an entire test period or for other desired combinations, e.g., all Mondays in test periods 3 through 13. Examples of Level 3 output, which have the same format as Level 2 data, are shown in Exhibits A-8 through A-12 in the Appendix.

5.5.2 Bus Schedule Deviations

The data presented was collected between April 15 and May 2, 1980, for the control routes, and from April 14 to April 25, 1980 (equivalent to test period 3), for the AVM routes; sample sizes and a copy of the manual data collection forms are contained in the Appendix in Exhibits

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* In the near future, Level 2 output will include the variables "total boardings," "cumulative run time," and "bus-to-bus variation in passenger loads."

** Test period is abbreviated "TP" in some later references.

A-3, A-8 to A-12, and A-17 to A-20. The time blocks used in the reporting of results were defined as follows: A.M. block, 6:00-8:30 A.M.; midday block, 8:30 A.M.-3:30 P.M.; P.M. block, 3:30-6:00 P.M. However, control route data for the A.M. block was collected starting 7:00 A.M.

The allocation of each data point to a specific time block was based on the point of time the respective bus started its run for the AVM routes; for comparability the control route data was processed according to the same criterion. Two of the effects of this principle are the rather low number of observations in the P.M. time block, and consequently an increased mean lateness in the midday block caused by the inclusion of rush-hour buses. These effects have a stronger influence on routes with a long average run length (e.g., routes 44, 83, 4, 84, 91, and 94 with run times between 60 and 130 minutes). A special convention had to be found for route 83 limited. It only operates during the A.M. and P.M. peak hours, providing extended service for route 83 local. No more than an insignificantly small number of its runs are scheduled at the very beginning or end of the midday block. Therefore, Gould considered it preferable to include these few buses in the A.M. and P.M. time blocks, respectively.

Both AVM and control route data were checked for "bad" data points; for the AVM route, schedule deviations of more than +9 or -29 minutes were generally eliminated. The control route data was edited manually. In addition to correcting coding and keypunching errors, several cases of checking imprecisions were eliminated. Exhibit 5.10, the Bus Stop Correspondence Table, associates reference numbers used in the succeeding graphs and tables with bus stops. For example, in graphs of baseline

EXHIBIT 5.10

BUS STOP CORRESPONDENCE TABLE

Bus Stop I.D. No. (Graphs)			Bus Stop I.D. No. (Tables)			Bus Stop I.D. No. (Graphs)
			A V M R O U T E S			
			ROUTE 41			
1	Santa Barbara Ave. & Figueroa Street		1		Alvarado St. & 6th St.	3
2	Alvarado St. & Pico Blvd.	Northbound	2	Southbound	Alvarado St. & Pico Blvd.	2
3	Alvarado St. & 6th St.		3		Santa Barbara Ave. & Figueroa Street	1
			ROUTE 44			
4	Beverly Blvd. & La Cienega Blvd.		1		La Brea Ave. & Adams Blvd.	6
5	Beverly Blvd. & Western Ave.	Northbound	2	Southbound	Beverly Blvd. & Western Ave.	5
6	La Brea Ave. & Adams Blvd.		3		Beverly Blvd. & La Cienega Blvd.	4
			ROUTE 83			
7	Wilshire Blvd. & Westwood Ave.		1		Wilshire Blvd. & Western Ave.	9
8	Wilshire Blvd. & Fairfax Ave.	Eastbound	2	Westbound	Wilshire Blvd. & Fairfax Ave.	8
9	Wilshire Blvd. & Western Ave.		3		Wilshire Blvd. & Westwood Ave.	7
			ROUTE 89			
10	Fairfax & Wilshire Blvd.		1		Hollywood Blvd. & Vine St.	12
11	Fairfax Ave. & Santa Monica Blvd.	Northbound	2	Southbound	Fairfax Ave. & Santa Monica Blvd.	11
12	Hollywood Blvd. & Vine St.		3		Fairfax Ave. & Wilshire Blvd.	10
			C O N T R O L R O U T E S			
			ROUTE 4			
1	Olympic Blvd. & Rimpeau Blvd.		1		Melrose Ave. & Western Ave.	3
2	Olympic Blvd. & Figueroa St.	Northbound	2	Southbound	Olympic Blvd. & Figueroa St.	2
3	Melrose Ave. & Western Ave.		3		Olympic Blvd. & Rimpeau Blvd.	1
			ROUTE 84			
4	Western Ave. & Machester Ave.		1		Western Ave. & Melrose Ave.	6
5	Western Ave. & Adams Blvd.	Northbound	2	Southbound	Western Ave. & Adams Blvd.	5
6	Western Ave. & Melrose Ave.		3		Western Ave. & Manchester Ave.	4
			ROUTES 91 AND 94			
9	Sunset Blvd. & Sanborn Ave.		1		Sunset Blvd. & Grand Ave.	7
8	Sunset Blvd. & Echo Park Ave.	Eastbound	2	Westbound	Sunset Blvd. & Echo Park Ave.	8
7	Sunset Blvd. & Grand Ave.		3		Sunset Blvd. & Sanborn Ave.	9

data, bus stop 1 on AVM route 41 is at Santa Barbara Avenue and Figueroa Street; in tables of baseline data, Santa Barbara Avenue and Figueroa Street is bus stop 1 for northbound travel but bus stop 3 for southbound travel.

The results of schedule adherence measurements are presented in Exhibits 5.11 to 5.19. Exhibit 5.11 shows mean schedule deviations for AVM and control routes, allowing comparisons of the different degrees of lateness according to time block and direction for each route and providing a basis for comparisons among routes. (Corresponding graphs are contained in the Appendix in Exhibits A-13 and A-21.) A late bus is indicated by a negative value of schedule deviation, and an early bus by a positive value. Overall, buses were running about 1.3 minutes late along both AVM and control routes, which supports the hypothesis that the AVM routes are indeed representative of the SCRTD system. Lateness tended to be concentrated in special sections or directions of some routes; for example, westbound runs of route 83 had significantly higher schedule deviations than eastbound runs. On some routes (e.g., 41 northbound and 83 limited eastbound and westbound), the average lateness increased from morning to evening, while for other routes (e.g., 44 northbound and 4 northbound), the average lateness decreased from morning to evening. The control routes appear to be characterized by patterns of mean schedule deviations reasonably similar to those of AVM routes.

EXHIBIT 5.11

MEAN SCHEDULE DEVIATIONS[1] FOR AVM AND CONTROL ROUTES

ROUTES DIRECTIONS	TIMEBLOCK								
	AM			MIDDAY			PM		
	BUS STOP [2]								
	1	2	3	1	2	3	1	2	3
AVM ROUTES									
41 NORTHBOUND	-1.2	-0.2	-1.8	-1.3	-1.4	-2.3	-1.1	-1.4	-2.7
SOUTHBOUND	-3.1	-2.9	-1.4	-2.3	-1.7	1.0	-2.6	-2.4	0.4
44 NORTHBOUND	-0.6	-0.7	-1.6	0.0	-1.3	-1.4	-0.5	-1.1	0.0
SOUTHBOUND	-1.0	-0.1	-1.3	-1.7	0.6	-1.5	-1.2	-1.2	1.4
89 NORTHBOUND	-0.3	-0.5	-0.4	0.1	-0.8	-1.5	-0.5	-0.8	-1.1
SOUTHBOUND	-1.0	-0.6	-1.7	-0.7	-0.3	-2.6	-1.3	-0.2	-0.3
83 EASTBOUND	-0.3	-0.9	-1.0	-0.2	-1.7	-1.7	1.4	-1.5	-2.6
Loc. WESTBOUND	-3.1	-3.8	-6.9	-2.9	-3.3	-4.5	-4.1	-3.5	-3.2
83 EASTBOUND	-0.6	0.0	-1.6	Rush-hour runs only			-3.2	-2.5	-3.5
Ltd. WESTBOUND	-2.8	-3.0	-6.1				-4.9	-5.4	-6.6
CONTROL ROUTES									
4 NORTHBOUND	-1.35	0.34	-1.20	-0.74	-1.50	-1.17	-1.48	-2.00	-0.37
SOUTHBOUND	-0.03	1.15	-0.86	-0.64	-1.51	-1.24	-1.12	-2.86	-2.92
84 NORTHBOUND	-0.29	-1.26	-3.19	-0.16	-0.38	-1.72	-0.57	-0.91	-1.46
SOUTHBOUND	-0.74	-1.07	2.06	-0.78	-0.59	-0.46	-1.12	-2.87	-0.79
91 EASTBOUND	-0.29	-1.21	-0.85	-1.80	-2.79	-1.98	-4.31	-3.61	-3.00
WESTBOUND	-1.33	-1.42	-0.98	-1.16	-1.56	-2.02	-2.06	-2.69	-4.23
94 EASTBOUND	-1.54	-2.01	-1.75	-0.80	-1.73	-0.85	-1.56	-2.74	-1.67
WESTBOUND	-1.17	-0.94	-0.10	-0.79	-1.21	-1.46	-1.11	-1.58	-3.37

[1] In minutes; sample sizes are presented in the Appendix.

[2] Successive stops in each direction; see Bus Stop Correspondence Table (Exhibit 5.10).

Differences in schedule deviations caused by weather type did not appear to be significant. Also, sample sizes for observations on rainy days were rather small. Therefore, means and standard deviations for rainy days are only contained in the Appendix in Exhibits A-25 to A-31.

Exhibit 5.12 presents the standard deviations of schedule adherence measurements. (Corresponding graphs are contained in the Appendix in Exhibits A-14 and A-22.) They usually ranged from 2 to 4 minutes, showing no appreciable differences among AVM and control routes. Exhibit 5.13 documents schedule deviation data for AVM routes for the entire baseline period (i.e., aggregated over test period 3 through test period 13) to give an overall view of that demonstration stage.

The frequency distributions of Exhibits 5.14 to 5.17 permit a more detailed analysis of the degree of schedule deviations passengers had to expect at different times during the day. In general, in the A.M. block a considerable percentage of buses ran within 3 minutes of the scheduled time, but in the course of the day the distributions tended to spread out (i.e., schedule adherence tended to deteriorate). Remarkable in this context is the increased fraction of buses running early in the late afternoon on some routes (e.g., for eastbound runs, up to 24 percent on route 91, 20 percent on route 94, and 71 percent on route 83 local), which becomes evident in Exhibits 5.18 and 5.19. (Corresponding graphs are contained in the Appendix in Exhibits A-15, A-16, A-23, A-24.)

As was the case with the means and standard deviations of schedule deviations, the percentages for early, late, and on-time buses shown in Exhibits 5.18 and 5.19 reveal an overall comparability of AVM and control routes. Both the AVM and control routes had an average of 40 percent of

EXHIBIT 5.12

STANDARD DEVIATIONS[1] FOR SCHEDULE DEVIATIONS

FOR AVM AND CONTROL ROUTES

ROUTES DIRECTIONS	TIMEBLOCK								
	AM			MIDDAY			PM		
	BUS STOP[2]								
	1	2	3	1	2	3	1	2	3
AVM ROUTES									
41 NORTHBOUND	2.6	2.6	3.1	1.5	2.1	2.6	1.7	2.4	3.5
SOUTHBOUND	2.9	3.4	4.3	1.8	2.1	2.8	2.1	2.6	3.4
44 NORTHBOUND	1.7	3.2	3.7	1.5	3.7	4.7	2.3	3.5	4.7
SOUTHBOUND	1.9	1.6	3.8	2.7	1.7	5.0	2.4	2.8	4.1
89 NORTHBOUND	1.6	1.5	1.6	1.7	2.1	2.5	1.9	2.4	2.4
SOUTHBOUND	1.4	2.0	2.3	1.5	2.2	3.1	2.4	2.0	2.3
83 EASTBOUND	3.0	2.8	2.6	3.1	3.3	3.6	2.5	3.6	4.1
Loc.WESTBOUND	3.1	3.8	4.5	3.5	3.9	4.9	4.3	4.8	5.4
83 EASTBOUND	2.6	2.5	2.9	Rush-hour runs only			3.8	3.4	3.7
Ltd.WESTBOUND	3.2	3.6	4.7				4.4	4.6	5.4
CONTROL ROUTES									
4 NORTHBOUND	2.54	3.98	3.83	2.92	3.38	4.68	3.38	2.91	3.83
SOUTHBOUND	1.76	3.53	2.75	2.28	2.88	3.32	2.36	5.33	5.59
84 NORTHBOUND	2.70	1.89	2.42	1.87	1.50	2.64	2.34	2.41	3.11
SOUTHBOUND	1.50	2.25	2.55	1.86	2.45	4.23	2.95	2.97	3.68
91 EASTBOUND	2.61	2.03	2.19	3.73	4.07	4.23	5.66	5.17	5.39
WESTBOUND	2.03	2.34	3.08	2.77	3.15	3.67	3.06	3.23	4.51
94 EASTBOUND	2.51	2.89	2.58	2.63	3.06	3.21	2.93	2.69	3.13
WESTBOUND	2.41	1.96	2.22	2.10	2.42	2.98	2.51	2.59	6.47

[1] In minutes, sample sizes are presented in the Appendix.

[2] Successive stops in each direction; see Bus Stop Correspondence Table (Exhibit 5.10).

EXHIBIT 5.13

SCHEDULE DEVIATION DATA FOR AVM ROUTES FOR APRIL 14, 1980 TO SEPTEMBER 14, 1980 (TP3-TP13)

ROUTES TIMEBLOCKS, DIRECTIONS[1]			MEANS (in min.)			STANDARD DEVIATIONS (in min.)			SAMPLE SIZES		
			BUS STOP[2]								
			1	2	3	1	2	3	1	2	3
41	AM										
		NB	-1.2	0.0	-1.3	2.1	2.3	2.7	626	629	629
		SB	-2.6	-2.2	-0.3	2.4	2.6	3.5	591	592	585
	MID										
		NB	-1.1	-1.5	-2.8	1.7	2.3	2.9	1465	1437	1435
		SB	-2.3	-1.8	0.9	1.9	2.4	3.0	1449	1445	1420
	PM										
		NB	-0.8	-1.0	-2.6	1.9	2.6	3.0	422	417	409
		SB	-2.6	-2.4	0.9	2.2	2.7	3.3	425	423	406
44	AM										
		NB	-0.2	-0.1	-0.6	1.7	2.6	3.2	1105	1108	841
		SB	-1.1	0.2	-0.1	2.1	1.6	3.5	757	1193	923
	MID										
		NB	0.0	-1.6	-1.7	1.6	3.7	4.6	1717	1620	1566
		SB	-1.5	0.6	-1.5	2.3	1.9	4.8	1610	1607	1506
	PM										
		NB	-0.5	-1.2	0.4	2.1	3.9	4.4	539	527	373
		SB	-1.6	-1.0	1.4	2.4	2.7	4.2	470	4B4	458
89	AM										
		NB	0.2	-0.1	-0.1	1.7	1.8	1.9	939	1039	1015
		SB	-0.8	0.1	-0.8	1.5	1.9	2.1	1004	1025	1032
	MIO										
		NB	0.4	-0.6	-1.4	1.8	2.4	2.9	2225	2201	2108
		SB	-0.7	-0.2	-2.2	1.8	2.4	3.3	2260	2250	2211
	PM										
		NB	0.0	-0.5	-1.2	2.0	2.6	3.0	708	699	660
		SB	-0.8	0.1	-0.8	1.5	1.9	2.1	1004	1025	1032
83	AM										
Loc.		EB	0.1	-0.3	-0.2	2.6	2.3	2.2	877	967	1081
		WB	-2.1	-2.2	-4.5	2.9	3.3	4.4	1013	946	945
	MID										
		EB	-0.4	-1.7	-1.8	3.4	3.4	3.7	3634	3443	3481
		WB	-3.4	-3.5	-5.2	3.9	4.2	5.2	3500	3459	3514
	PM										
		EB	0.5	-1.7	-2.3	3.8	3.6	4.0	518	504	498
		WB	-5.1	-3.9	-4.1	4.7	5.0	5.7	422	418	296
83	AM										
Ltd.		EB	0.0	0.3	-1.1	2.5	2.4	2.8	776	789	872
		WB	-2.3	-2.3	-5.1	2.9	3.5	4.5	1144	1064	1082
	PM										
		EB	-3.6	-2.7	-3.5	3.8	3.9	4.4	472	470	475
		WB	-4.5	-4.5	-5.8	4.5	4.9	5.6	620	612	590

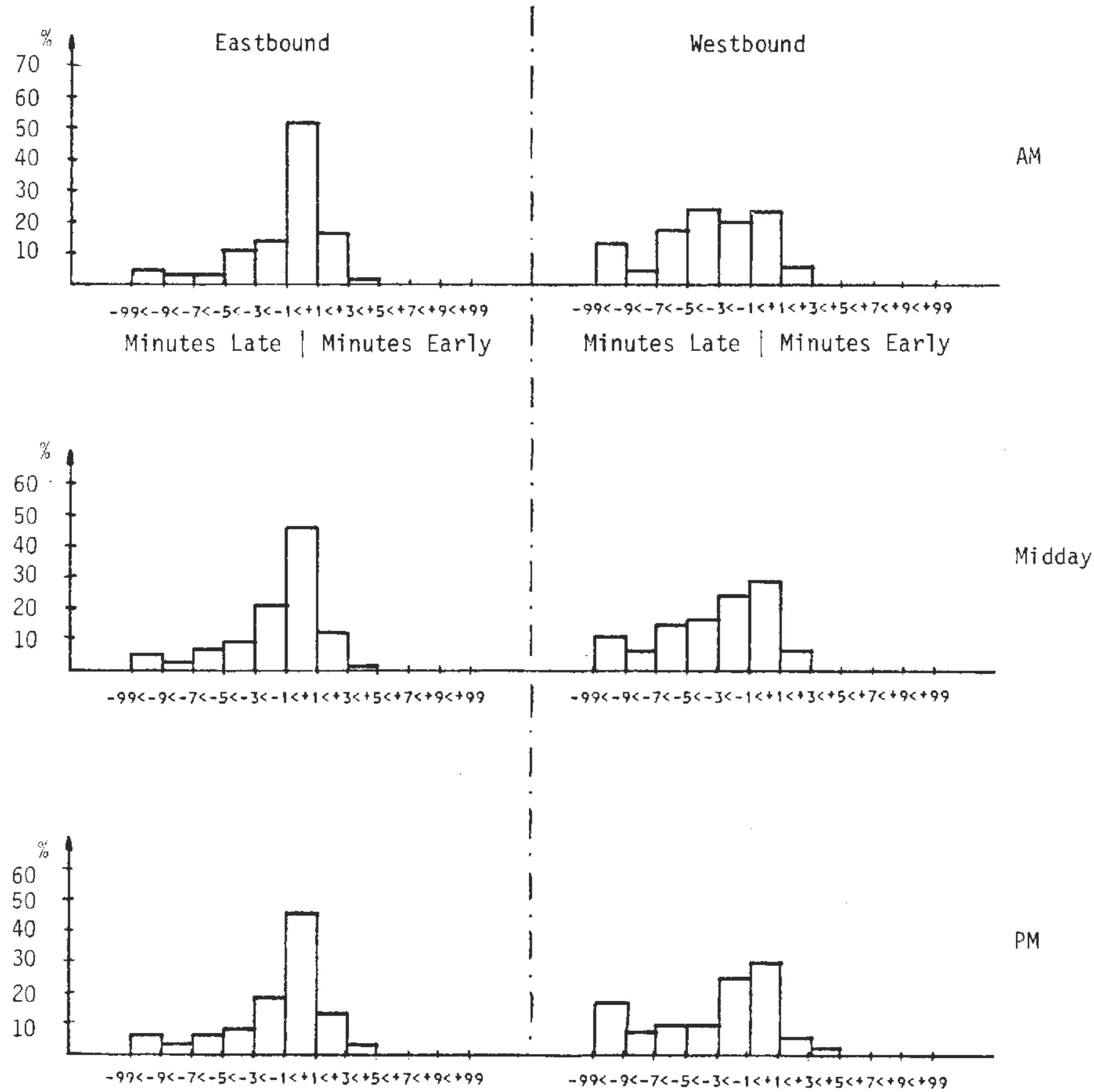
[1] Northbound (NB), Southbound (SB), Eastbound (EB), Westbound (WB).

[2] Successive stops in each direction, compare Bus Stop Correspondence Table (Exhibit 5.10).

EXHIBIT 5.14

AVM ROUTE 83 LOCAL: FREQUENCY DISTRIBUTION OF SCHEDULE DEVIATION AT WILSHIRE BLVD. & FAIRFAX AVE.[1]

(Weekdays, April 14-25, 1980)

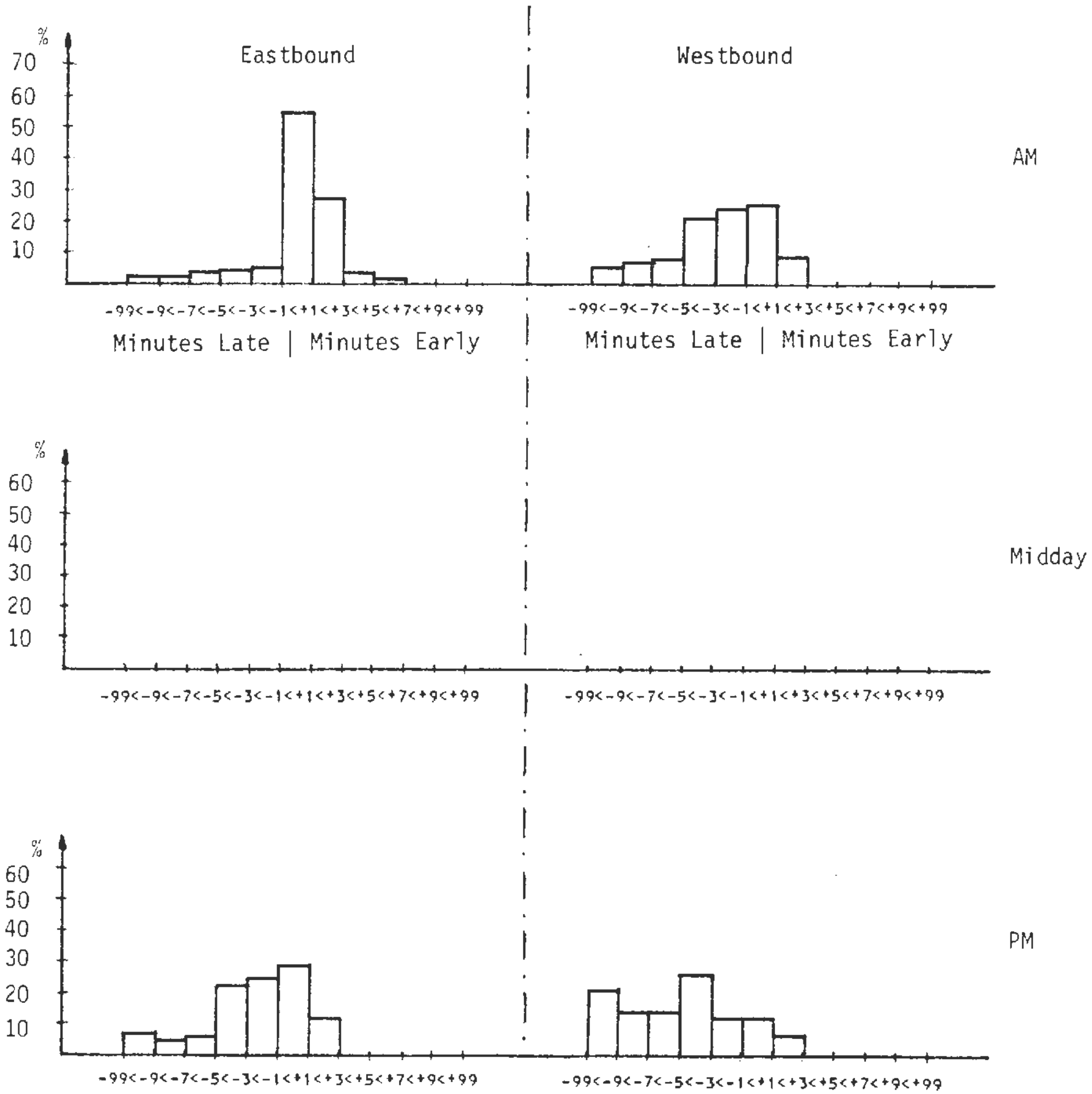


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-11.

EXHIBIT 5.15

AVM ROUTE 83 LIMITED: FREQUENCY DISTRIBUTION OF SCHEDULE DEVIATION AT WILSHIRE BLVD. & FAIRFAX AVE.[1]

(Weekdays, April 14-25, 1980)



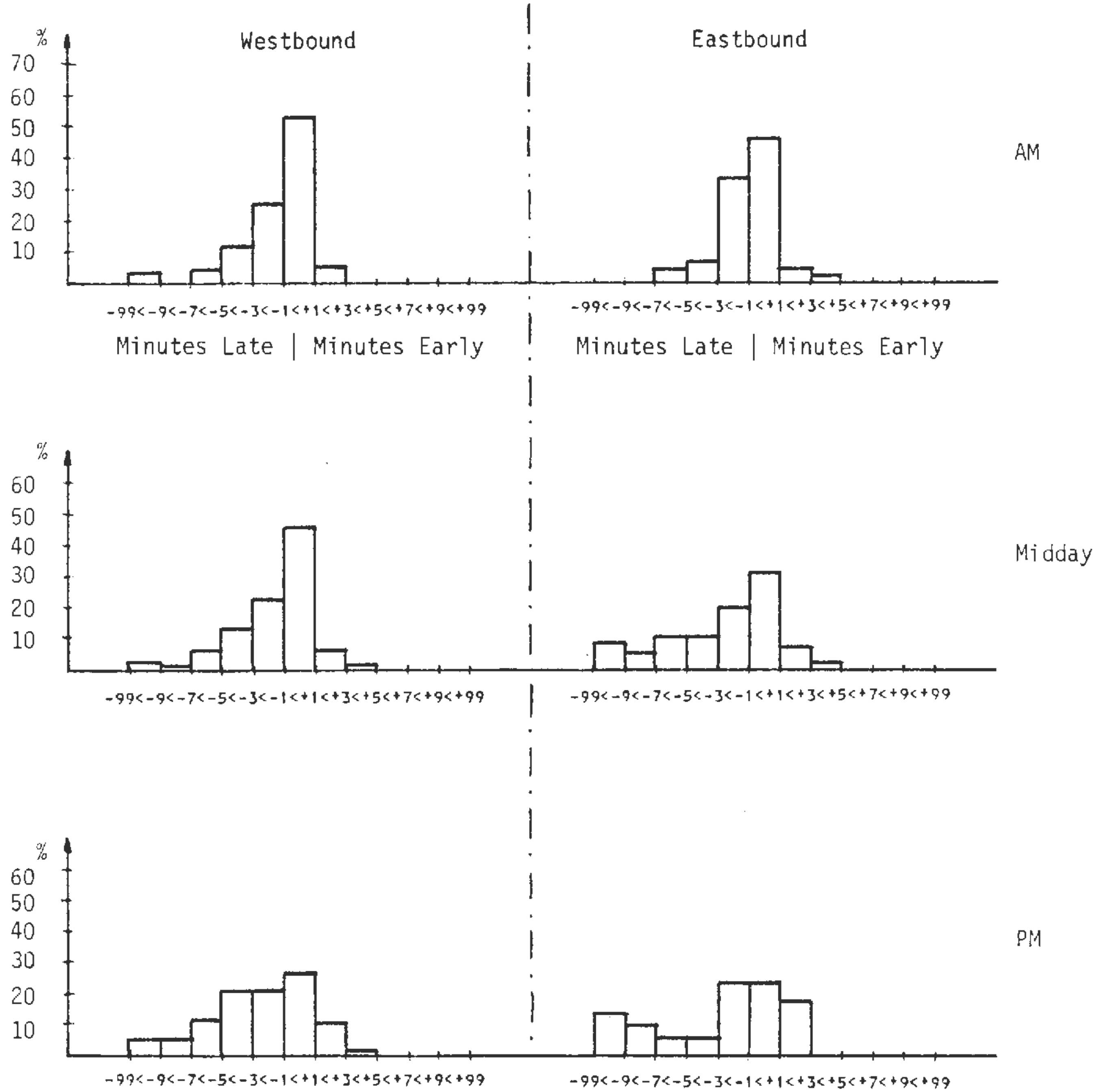
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-12.

EXHIBIT 5.16

CONTROL ROUTE 91: FREQUENCY DISTRIBUTION OF SCHEDULE

DEVIATION AT SUNSET BLVD. & ECHO PARK AVE.[1]

(April 29 - May 2, 1980)

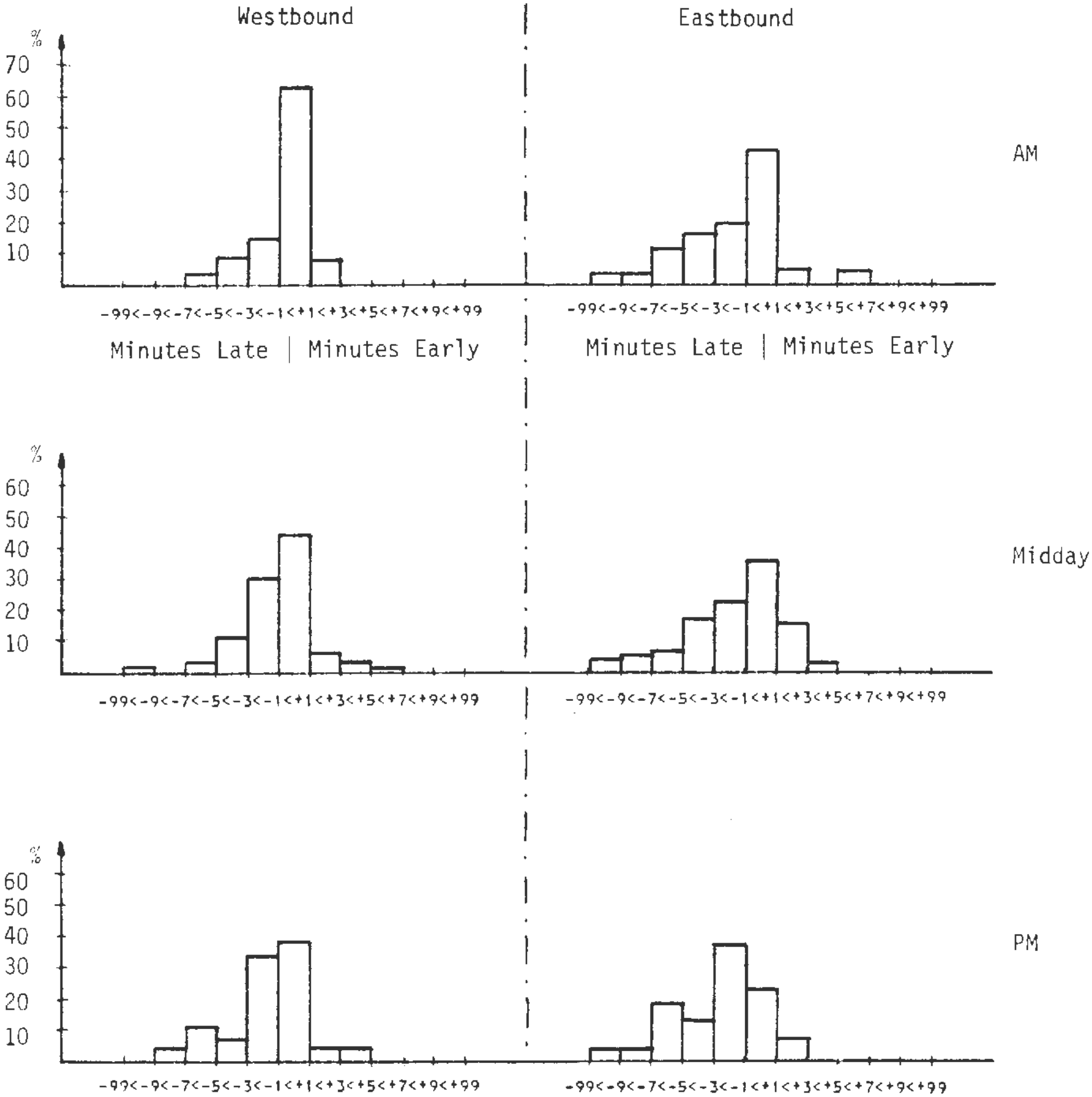


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-19.

EXHIBIT 5.17

CONTROL ROUTE 94: FREQUENCY DISTRIBUTION OF SCHEDULE DEVIATION AT SUNSET BLVD. & ECHO PARK AVE.[1]

(April 29 - May 2, 1980)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-20.

EXHIBIT 5.18

SCHEDULE DEVIATIONS [1]

(AVM Routes)

ROUTES TIME BLOCKS DIRECTIONS [2]		MORE THAN 1 MIN. EARLY			± ON TIME 1 MIN.			MORE THAN 3 MIN. LATE		
		1[3]	2	3	1	2	3	1	2	3
41	AM									
	NB	11	25	9	39	45	36	21	14	29
	SB	2	7	32	20	21	15	42	43	36
	MIDDAY									
	NB	2	7	5	48	39	32	12	22	33
	SB	0	6	52	21	33	24	29	24	9
	PM									
	NB	3	3	8	54	47	27	11	19	42
	SB	2	3	40	15	25	29	37	36	15
44	AM									
	NB	15	30	23	51	33	29	10	20	32
	SB	11	24	28	42	53	24	7	6	29
	MIDDAY									
	NB	16	29	28	62	33	26	5	25	27
	SB	7	39	36	40	51	17	19	4	32
	PM									
	NB	22	28	45	42	29	21	9	24	23
	SB	8	16	58	52	51	9	12	21	13
89	AM									
	NB	19	13	16	57	57	53	7	8	8
	SB	2	21	7	62	42	39	9	11	26
	MIDDAY									
	NB	29	20	10	52	46	38	5	14	23
	SB	9	31	11	63	42	24	6	10	41
	PM									
	NB	16	21	13	48	44	43	9	18	20
	SB	13	22	21	39	47	43	15	8	12
83	AM									
	EB	39	17	14	37	51	51	11	18	18
LOC	WB	2	6	0	31	27	9	45	55	77
	MIDDAY									
	EB	42	12	19	27	45	39	14	23	24
	WB	6	6	10	36	34	26	45	45	57
	PM									
	EB	71	15	10	21	45	36	3	21	37
	WB	4	7	34	26	36	42	47	40	41
83	AM									
	EB	28	30	15	46	55	27	15	11	21
LTD	WB	3	9	3	27	25	9	42	42	69
	PM									
	EB	4	11	7	29	29	19	39	37	50
	WB	4	6	6	15	11	11	62	73	72

1 Cumulative frequencies in %

2 Northbound, Southbound, Eastbound, Westbound

3 Successive bus stops in each direction (Compare Exhibit 5.10). Corresponding sample sizes are presented in the Appendix in Exhibits A-8 to A-12.

EXHIBIT 5.19

SCHEDULE DEVIATIONS [1]

(Control Routes)

ROUTES TIME BLOCKS DIRECTIONS [2]		MORE THAN 1 MIN. EARLY			ON TIME ± 1 MIN			MORE THAN 3 MIN. LATE		
		1[3]	2	3	1	2	3	1	2	3
4	AM									
	NB	10	44	22	53	24	34	19	16	27
	SB	14	51	18	73	29	49	3	9	16
	MIDDAY									
	NB	14	11	30	53	44	25	12	22	28
	SB	15	11	18	50	42	42	8	21	21
	PM									
	NB	14	16	33	38	25	5	23	34	21
	SB	15	20	25	50	21	17	21	37	28
84	AM									
	NB	29	2	1	36	56	18	13	17	46
	SB	13	13	62	45	52	28	5	15	3
	MIDDAY									
	NB	19	11	11	60	63	34	6	3	25
	SB	11	2	41	54	52	24	11	19	22
	PM									
	NB	20	13	16	45	46	29	9	9	19
	SB	19	3	35	39	33	22	20	37	23
91	AM									
	WB	16	5	11	26	52	55	19	18	13
	EB	15	7	20	51	47	37	11	12	14
	MIDDAY									
	WB	14	8	8	47	46	44	18	24	32
	EB	10	11	22	43	31	30	26	38	33
	PM									
	WB	16	11	6	22	26	25	31	42	57
	EB	11	17	24	29	22	24	55	39	42
94	AM									
	WB	27	8	27	18	63	51	23	14	12
	EB	8	5	10	45	43	39	28	33	32
	MIDDAY									
	WB	13	9	18	48	45	32	11	16	23
	EB	18	17	30	45	32	29	17	30	26
	PM									
	WB	10	8	12	48	37	35	14	22	40
	EB	11	6	20	37	22	34	24	37	26

1 Cumulative frequencies in %
2 Northbound, Southbound, Westbound, Eastbound
3 Successive bus stops in each direction (Compare Exhibit 5.10.)
Corresponding sample sizes are presented in the Appendix in Exhibits A-17 to A-20.

all buses running within 1 minute of their scheduled departure time, about 20 percent running more than 3 minutes late, and 20 percent running more than 1 minute early. The early buses are the special concern of bus drivers themselves, as the survey above indicated. However, the 40 percent of buses that are either more than 1 minute early or more than 3 minutes late account for most of the schedule deviations that AVM aims to correct.

5.5.3 Headway Deviations

Headway deviations are derived from the difference between scheduled and actual departure times of successive buses. The basic data to calculate headway deviations is available (although with certain problems) for both AVM and control routes. However, to date, processing complications stemming from the presence of "ghost" (non-AVM-equipped) buses or nonresponding AVM equipment on AVM buses have prevented any calculations of headways or headway deviations for the AVM routes. Given the nonavailability of headway data for AVM routes, calculation of headway data for the control routes was suspended until such time as AVM headway data may become available.

5.5.4 Run-Time Variation

Data on the variations in run times has been processed for the AVM routes; for the control routes, run-time data exists only for parts of the respective routes and has not yet been analyzed. The additional information provided by run-time variation does not appear to be crucial as far as the baseline comparison of AVM and control routes is concerned, as schedule deviations and passenger loads are sufficient for this basic purpose. Run-time variation data for the AVM routes (TP3) is tabulated in Exhibits A-47 to A-51 in the Appendix.

5.5.5 Passenger Loads

The data discussed in the following paragraphs was collected together with the schedule adherence measurements in April and May 1980 for AVM and control routes; the corresponding sample sizes are provided in the Appendix in Exhibits A-32 to A-40.

For comparability reasons, again, the allocation of AVM and control route data points to time blocks was determined by the convention that has been used for schedule deviation data, i.e., the time when the individual bus started its run.

For the AVM routes, a rather small number of data points became available -- a consequence of the high percentage of "bad" cases. In the beginning of the demonstration, many malfunctions of the passenger-counting device used on AVM-equipped buses were registered.* In order to derive at least partially reliable mean passenger counts, all "zero" data points were not considered for the analysis for AVM route data -- a principle which was also adopted for the control routes to establish comparability. In addition, a new data-editing method was developed to identify "valid" load counts. Still, a considerable degree of undercounting prevailed. Therefore, a comparison of passenger loads for AVM and control routes can only provide a very rough check on changes in passenger loads from the baseline to the test period.

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* For example, treadle-type passenger-counting mats installed on the first steps of the buses accumulated moisture, causing the electric circuits to fail. They had to be redesigned and replaced.

Exhibits 5.20 to 5.25 summarize the results of passenger load tabulations. In Exhibits 5.20 and 5.21, the routes characterized by the largest mean schedule deviations (83, 91, and 94 -- see above) show the highest average passenger volumes as well, reaching peak values of 60 passengers per run. Commonly, passenger loads for both AVM and control routes ranged between 30 and 45 passengers, with no apparent systematic differences between AVM and control routes. Most of the data for both AVM and control routes was collected on clear days. By chance, however, data was collected on one wet (rainy or drizzly) day for each control route. Exhibits A-41 to A-46 in the Appendix present passenger-load data for the drizzly/rainy days on each control route. Passenger loads tended to be lower in some cases by up to 50 percent, but as the data is only for a single day and sample sizes are generally small, this data should only be considered as suggestive of the effect of wet weather on ridership. Passenger counts for rainy days alone for the AVM routes -- based on the new data-editing method -- were not available for inclusion in this report.

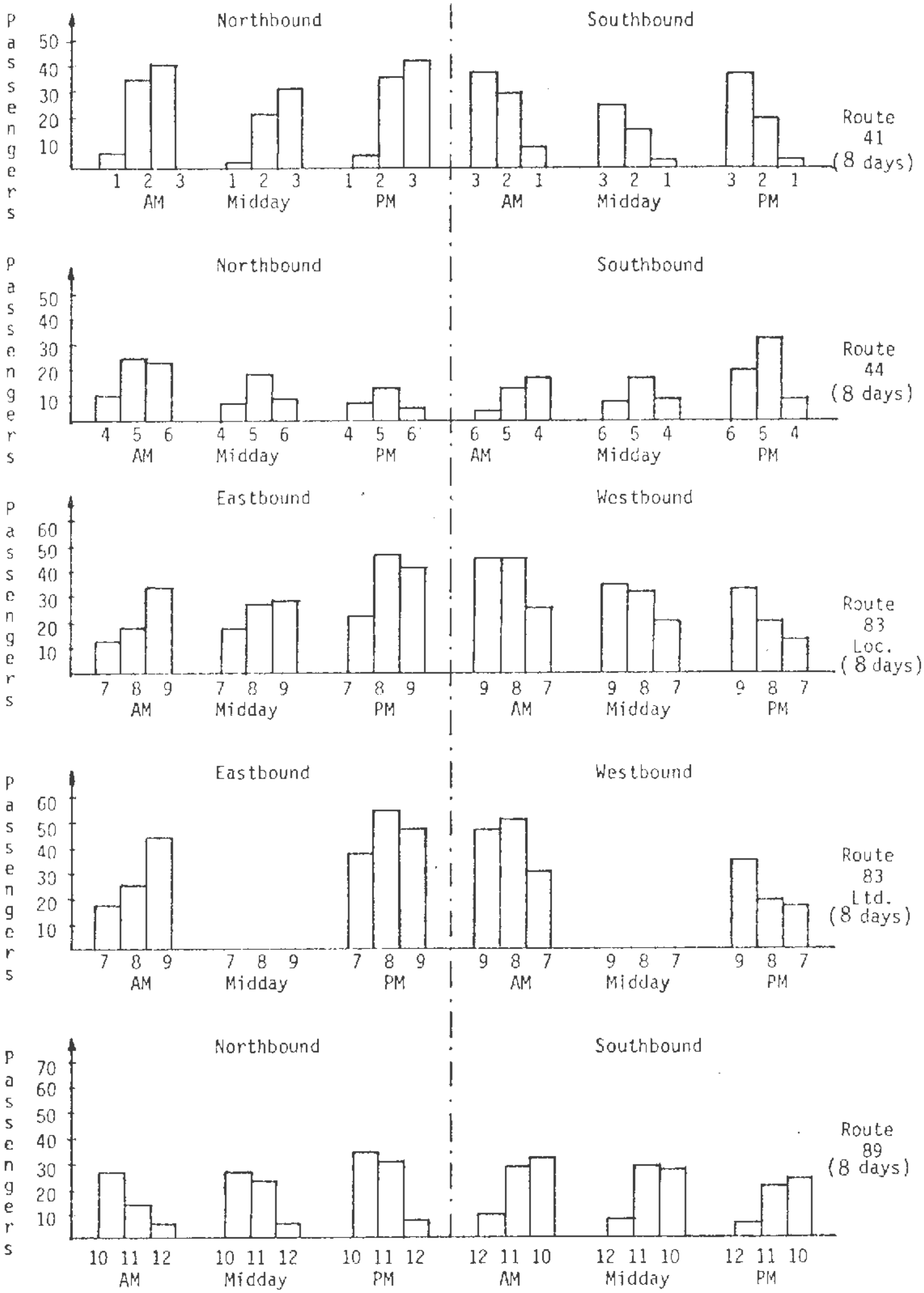
The standard deviations of passenger loads are graphed in Exhibits 5.22 and 5.23. They were highest for route 83, usually ranging between 10 and 20 passengers.

The last tables (Exhibits 5.24 and 5.25) document the distribution of passenger loads, permitting comparisons among routes, directions, and time blocks. Cumulative frequencies were calculated for buses running almost empty (fewer than 10 passengers) and for overcrowded buses (more than 50 passengers). In some cases, almost equal percentages of buses with very small and very large numbers of passengers could be

EXHIBIT 5.20

AVM ROUTES: MEAN PASSENGER LOADS[1]

(By Bus Stop[2] and Time Block)



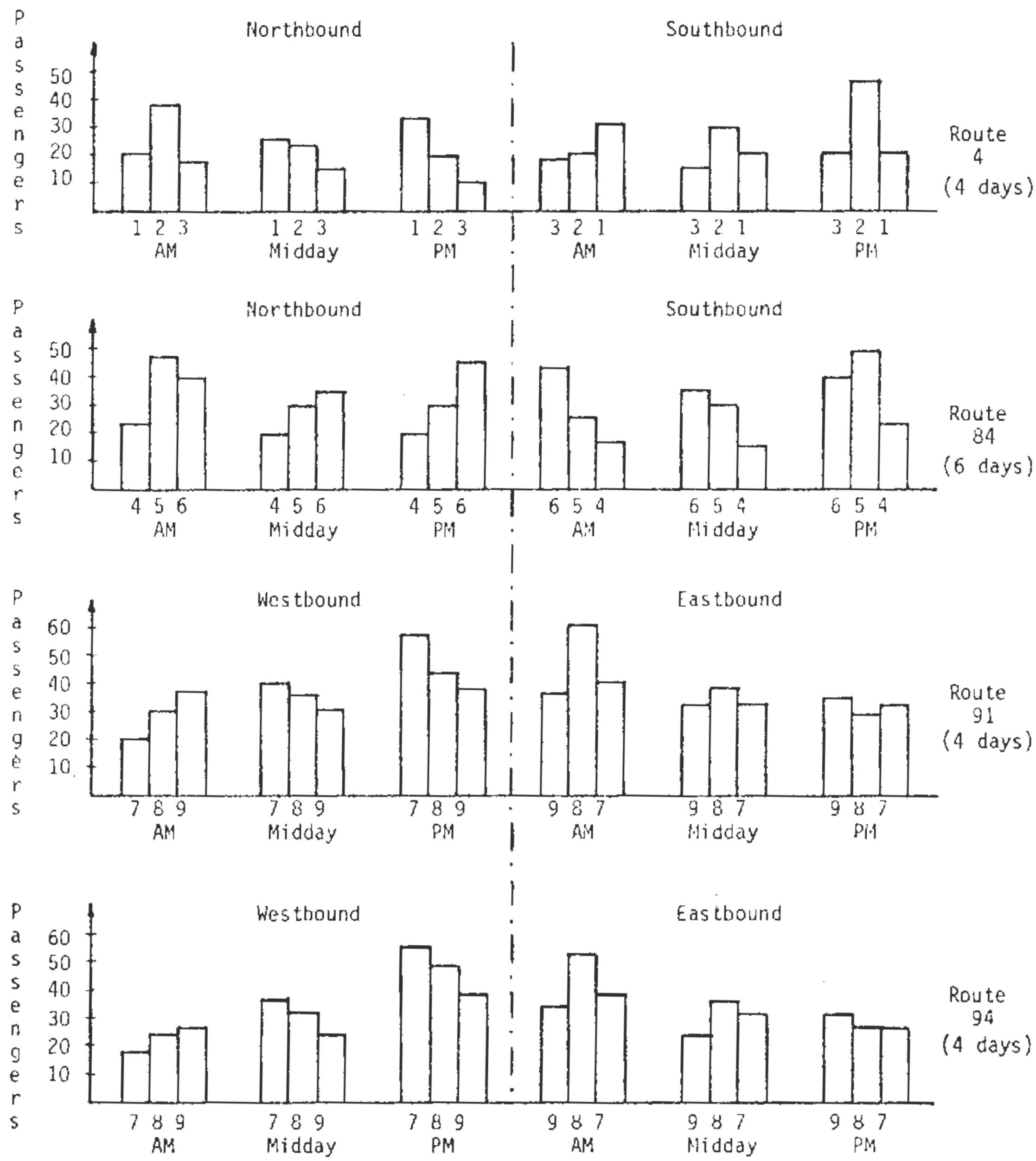
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-32 to A-36.

2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT 5.21

CONTROL ROUTES: MEAN PASSENGER LOADS[1]

(By Bus Stop[2] and Time Block)



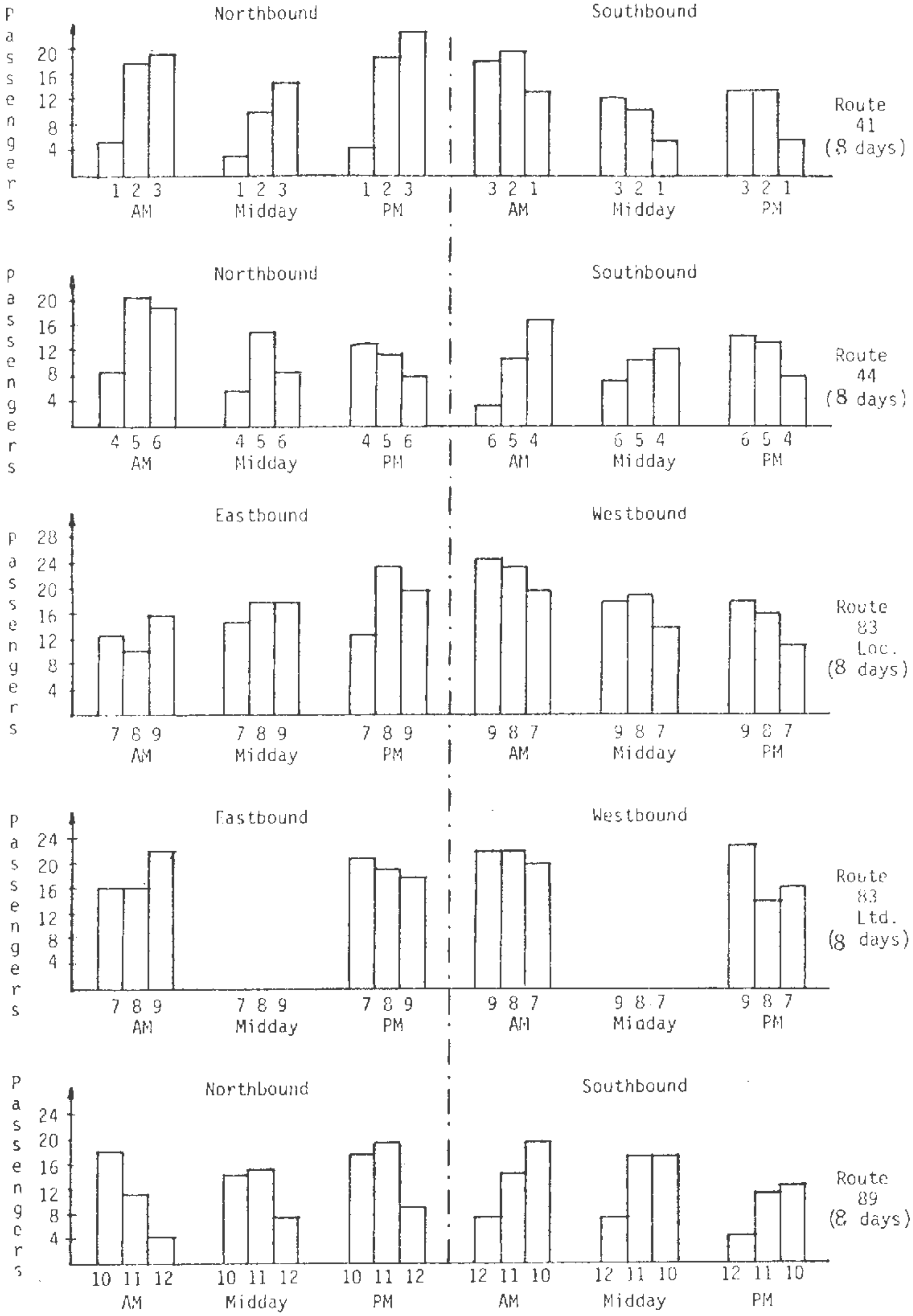
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-37 to A-40.

2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT 5.22

AVM ROUTES: STANDARD DEVIATION OF PASSENGER LOADS[1]

(By Bus Stop[2] and Time Block)



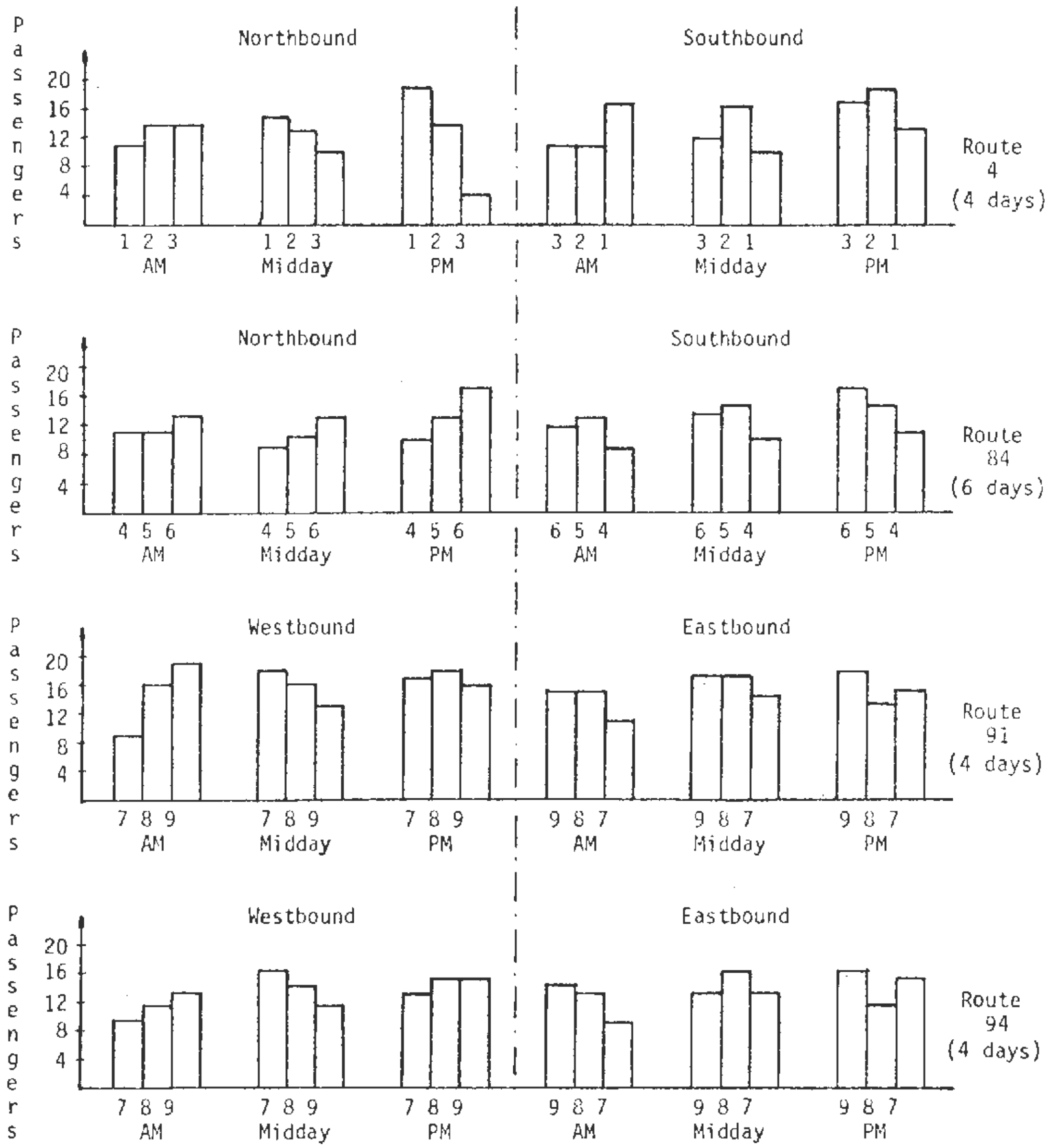
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-32 to A-36.

2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT 5.23

CONTROL ROUTES: STANDARD DEVIATION OF PASSENGER LOADS[1]

(By Bus Stop[2] and Time Block)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-37 to A-40.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT 5.24

PASSENGER LOADS (AVM ROUTES)

ROUTES TIMEBLOCKS DIRECTIONS[1]	MEAN # OF PASSENGERS (ALL STOPS)	BUSES WITH FEWER THAN 10 PASS. (%)			BUSES WITH MORE THAN 50 PASS. (%)		
		1[2]	2	3	1	2	3
41 AM							
NB	27.30	82	4	2	0	18	38
SB	23.69	8	16	77	22	14	2
MIDDAY							
NB	18.31	97	7	4	0	1	11
SB	13.37	11	38	92	5	0	0
PM							
NB	15.30	88	10	10	0	26	62
SB	18.59	5	31	88	15	0	0
44 AM							
NB	18.21	58	32	32	0	11	8
SB	11.27	95	38	51	0	0	7
MIDDAY							
NB	11.05	75	27	66	0	3	0
SB	11.12	67	27	63	0	1	3
PM							
NB	8.88	73	47	88	2	0	0
SB	20.20	29	7	67	5	10	0
83 AM							
LOC. EB	20.80	53	18	6	3	1	13
WB	37.73	14	12	22	48	43	14
MIDDAY							
EB	23.92	33	17	17	3	15	11
WB	27.89	11	15	29	21	18	3
PM							
EB	34.57	19	11	14	0	47	24
WB	22.79	14	29	56	11	7	0
83 AM							
Ltd. EB	28.74	33	13	11	2	6	50
WB	41.38	8	9	16	45	59	15
PM							
EB	45.93	6	6	6	24	66	51
WB	22.11	20	29	38	26	2	6
89 AM							
NB	13.59	17	50	96	12	0	0
SB	22.10	68	9	15	0	9	18
MIDDAY							
NB	18.42	11	16	77	6	6	0
SB	20.74	69	16	20	0	10	11
PM							
NB	23.00	7	19	72	16	18	0
SB	14.99	90	24	19	0	4	4

1 Northbound (NB), Southbound (SB), Eastbound (EB), Westbound (WB)
2 Successive bus stops in each direction (compare Exhibit 5.10).

Corresponding sample sizes are presented in the Appendix in Exhibits A-32 to A-36.

EXHIBIT 5.25

PASSENGER LOADS
(Control Routes)

ROUTES TIMEBLOCKS DIRECTIONS[1]	MEAN # OF PASSENGERS (ALL STOPS)	BUSES WITH FEWER THAN 10 PASS. (%)			BUSES WITH MORE THAN 50 PASS. (%)		
		1[2]	2	3	1	2	3
4 AM							
NB	25.5	20	2	29	1	29	6
SB	24.0	17	14	16	2	1	12
MIDDAY							
NB	23.5	5	8	29	10	7	1
SB	22.5	47	4	9	2	17	0
PM							
NB	25.4	12	24	42	25	8	0
SB	31.2	38	0	23	11	56	3
84 AM							
NB	38.6	7	0	1	3	43	23
SB	28.4	1	7	9	37	8	1
MIDDAY							
NB	28.3	7	1	1	0	2	20
SB	27.7	0	3	23	18	13	1
PM							
NB	30.8	10	5	1	1	6	55
SB	36.9	1	1	20	36	52	1
91 AM							
WB	31.6	11	4	2	3	13	27
EB	46.4	1	0	0	28	77	29
MIDDAY							
WB	35.7	1	2	1	31	24	14
EB	34.5	5	5	6	21	29	15
PM							
WB	46.6	0	4	2	71	42	34
EB	32.1	2	5	0	33	8	18
94 AM							
WB	23.3	14	4	6	0	2	8
EB	42.2	0	0	0	15	77	10
MIDDAY							
WB	30.7	1	2	2	28	13	5
EB	26.4	5	4	3	10	25	13
PM							
WB	46.9	0	0	0	82	50	35
EB	31.1	7	11	12	16	0	4

1 Northbound, Southbound, Westbound, Eastbound

2 Successive bus stops in each direction (compare Exhibit 5.10).

Corresponding sample sizes are presented in the Appendix in Exhibits A-37 to A-40.

observed for the same time and direction, reflecting two possible consequences of schedule deviations: (1) buses running early cause larger passenger loads for their successors running on schedule (which are then prone to falling behind schedule), and/or (2) with irregular and appreciable schedule deviations, scheduled headways are not maintained, resulting in "bus bunching" and unevenly distributed passenger loads.

Data for the entire baseline period (TP3 - TP13) is not presented here because passenger counts for this time period based on the new data-editing method have not yet been made available.

5.5.6 Passenger Wait Times

Passenger wait-time data for the AVM routes was collected from January 19 to February 2, 1981. The schedule for the observations is given below:

Route	Location	Direction	Time	No. of Weekdays
83	Wilshire & Glendon	EB	8:24 A.M. - 3:30 P.M.	3
89	Fairfax & Willoughby	SB	8:00 A.M. - 12:00 Noon	3
	Fairfax & Pico	NB	1:30 P.M. - 6:00 P.M.	3
44	Beverly & Western	EB	8:00 A.M. - 5:00 P.M.	1
	Adams & Figueroa	EB	8:00 A.M. - 5:00 P.M.	1
	Adams & Figueroa	WB	8:00 A.M. - 5:00 P.M.	1
41	Alvarado & 7th	NB	9:00 A.M. - 5:00 P.M.	2
	Alvarado & 7th	SB	8:00 A.M. - 5:00 P.M.	2

Checkers tabulated passenger arrival times at a bus stop and bus arrival and departure times for 15-second intervals. Exhibits 5.26 through 5.31 present the results of these observations. Exhibit 5.26 gives an overview of mean wait times, standard deviations, and sample

EXHIBIT 5.26

PASSENGER WAIT TIME

WAIT TIME DATA / HEADWAYS (in min.)	TIME BLOCK		
	AM	MIDDAY	PM
3	ROUTE 83: $\bar{x}$ = 2.01 σ = 1.80 n = 165	ROUTE 83: $\bar{x}$ = 2.40 σ = 2.06 n = 1396	ROUTE 83: $\bar{x}$ = 3.44 σ = 3.35 n = 188
5			ROUTE 44: $\bar{x}$ = 3.09 σ = 2.62 n = 92
6	ROUTE 44: $\bar{x}$ = 2.10 σ = 2.65 n = 10		ROUTE 44: $\bar{x}$ = 5.06 σ = 3.76 n = 58
7	ROUTE 44: $\bar{x}$ = 3.08 σ = 2.10 n = 36		ROUTE 89: $\bar{x}$ = 3.40 σ = 2.50 n = 296
8	ROUTE 44: $\bar{x}$ = 2.08 σ = 2.12 n = 13	ROUTE 44: $\bar{x}$ = 3.90 σ = 2.64 n = 41	ROUTE 44: $\bar{x}$ = 9.15* σ = 7.53 n = 40
8	ROUTE 89: $\bar{x}$ = 3.64 σ = 2.34 n = 108	ROUTE 89: $\bar{x}$ = 3.78 σ = 2.92 n = 455	ROUTE 89: $\bar{x}$ = 3.68 σ = 2.99 n = 157
9			ROUTE 41: $\bar{X}$ = 5.43 σ = 3.55 n = 82
10	ROUTE 41: $\bar{x}$ = 4.28 σ = 2.76 n = 29		ROUTE 41: $\bar{x}$ = 4.37 σ = 3.14 n = 62
10	ROUTE 44: $\bar{x}$ = 4.50 σ = 2.25 n = 21	ROUTE 44: $\bar{x}$ = 4.61 σ = 3.34 n = 374	
12		ROUTE 41: $\bar{x}$ = 5.94 σ = 4.07 n = 910	ROUTE 41: $\bar{x}$ = 5.66 σ = 3.89 n = 356

*High mean caused by three successive buses passing the bus stop.

sizes for each bus route, grouped for peak and off-peak hours and by length of headway. In the majority of cases, the average wait time does not exceed one-half of the scheduled headway length; only routes 44 and 83 show considerably higher values in the P.M. peak. In those cases with sample sizes of more than 100 passengers, 95 percent confidence intervals cover 6 to 30 seconds around the mean wait time, so that a comparison with "test" period data might show significant changes. The percentage of passengers who waited longer than one headway are presented in Exhibit 5.27. Route 83 stands out with 40 percent of passengers waiting more than one headway (3 minutes) during the P.M. peak. These high values are caused by irregular headways, i.e., "bus bunching." Another observation in this regard is that some buses with full loads, especially on route 44 during the P.M. peak, passed bus stops without stopping to pick up waiting passengers, thus increasing their wait times considerably.

Exhibits 5.28 to 5.31 show the frequency distributions of wait times for selected lengths of headway for each route. Corresponding tables are contained in the Appendix in Exhibits A-52 to A-55. Usually they show a major percentage of passengers waiting up to 3 minutes only, but for the longer headways some uniformity of passenger arrivals is indicated by more or less even percentages of passengers waiting up to one nominal headway length.

EXHIBIT 5.27

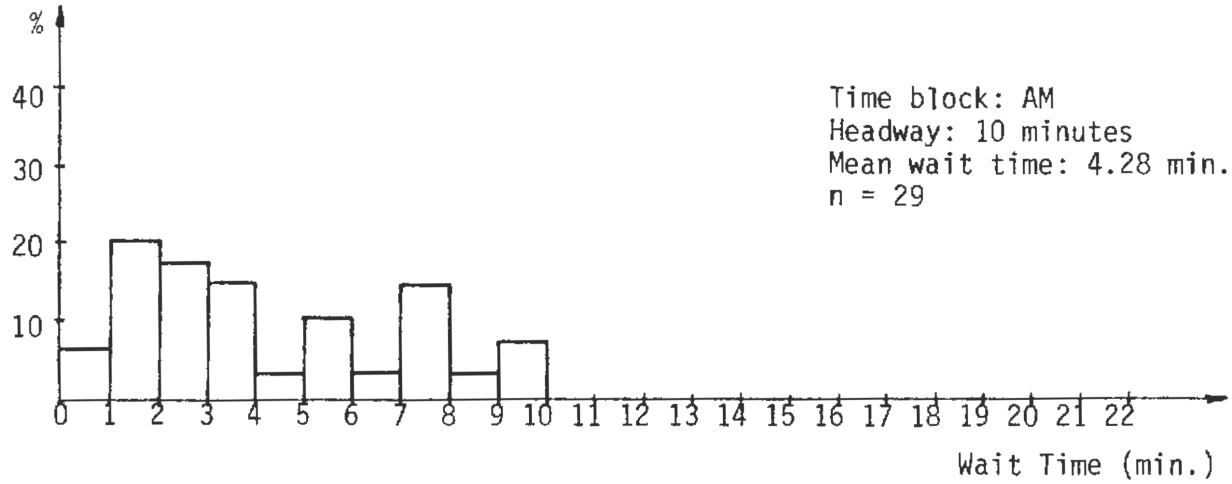
PASSENGER WAIT TIME

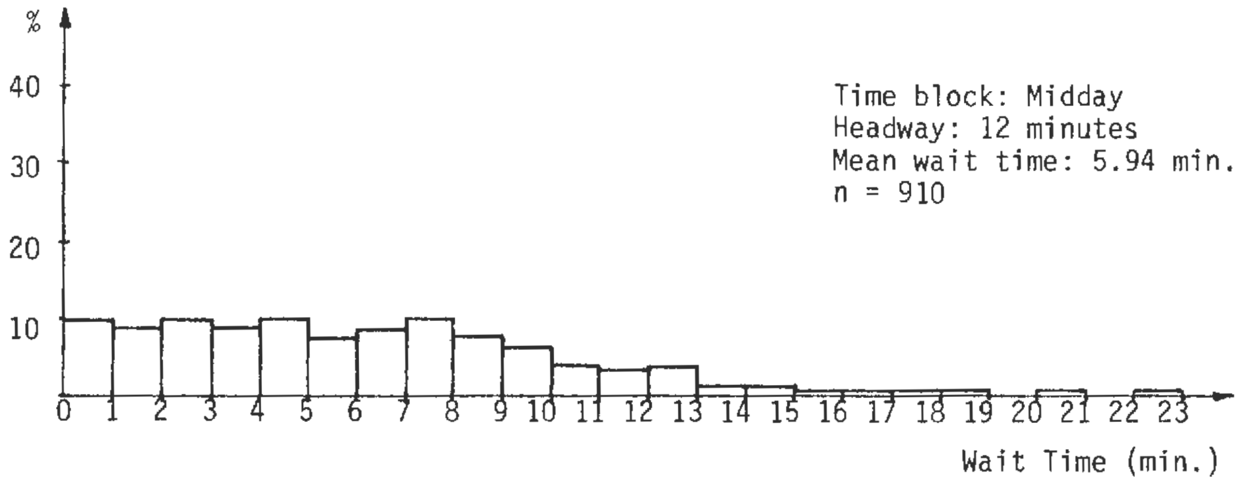
PERCENTAGES OF PASSENGERS WAITING LONGER THAN ONE FULL HEADWAY

ROUTES HEADWAYS \ PASSENGERS (%)	TIME BLOCK		
	AM	MIDDAY	PM
ROUTE 41:			
9 Minutes			14.7 (n = 82)
10 Minutes	0.0 (n = 29)		1.6 (n = 62)
12 Minutes		7.3 (n = 910)	4.7 (n = 356)
ROUTE 44:			
5 Minutes			18.5 (n = 92)
6 Minutes	10.0 (n = 10)		36.1 (n = 58)
7 Minutes	2.8 (n = 36)		
8 Minutes	0.0 (n = 13)	7.3 (n = 41)	50.0 (n = 40)
10 Minutes	0.0 (n = 21)	3.9 (n = 374)	
Route 83:			
3 Minutes	24.8 (n = 165)		40.3 (n = 188)
3/4 Minutes		23.4 (n = 1396)	
(Alternating)			
ROUTE 89:			
7 Minutes			10.5 (n = 296)
8 Minutes	2.8 (n = 108)	6.4 (n = 455)	7.7 (n = 157)
TOTAL	12.0 (n = 382)	14.0 (n = 3176)	16.0 (n = 1331)

EXHIBIT 5.28

PASSENGER WAIT TIMES, ROUTE 41





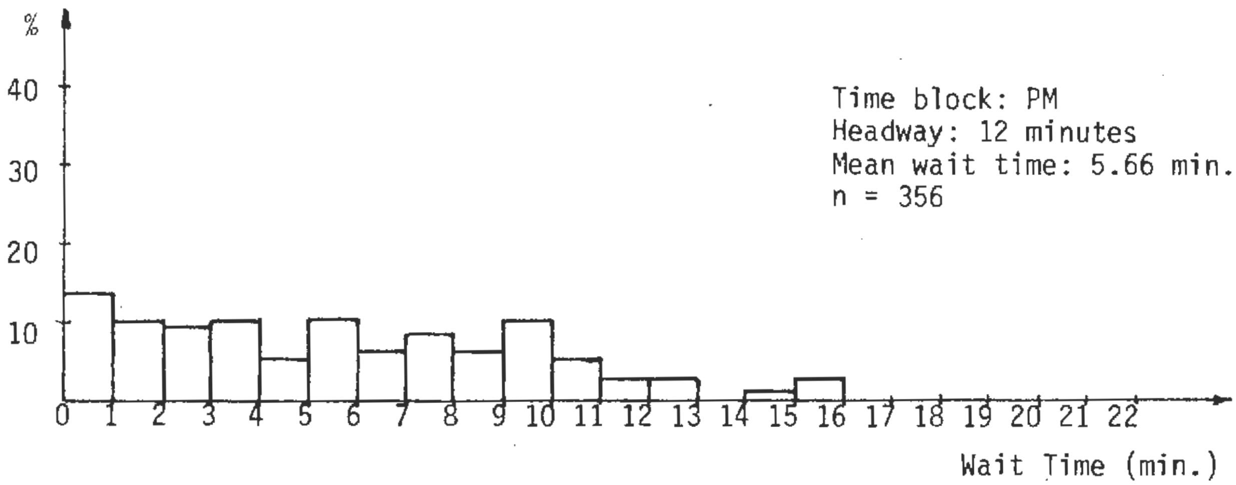
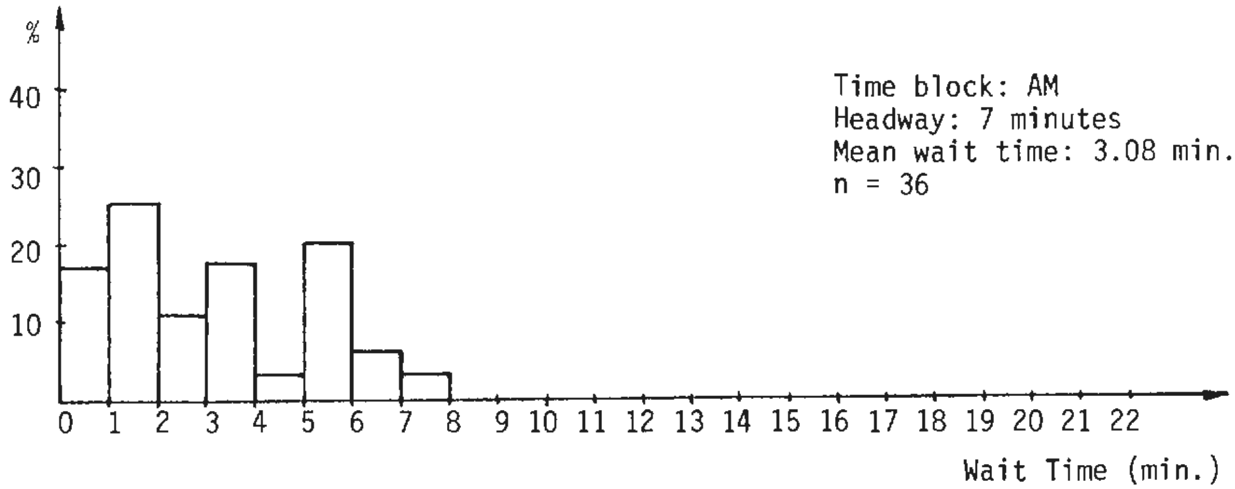
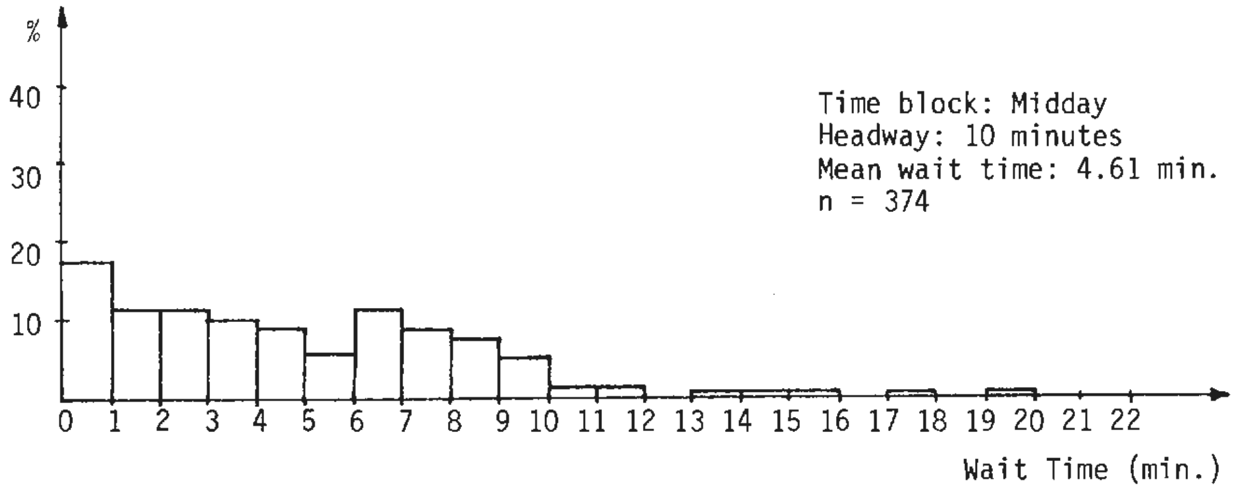


EXHIBIT 5.29

PASSENGER WAIT TIMES, ROUTE 44





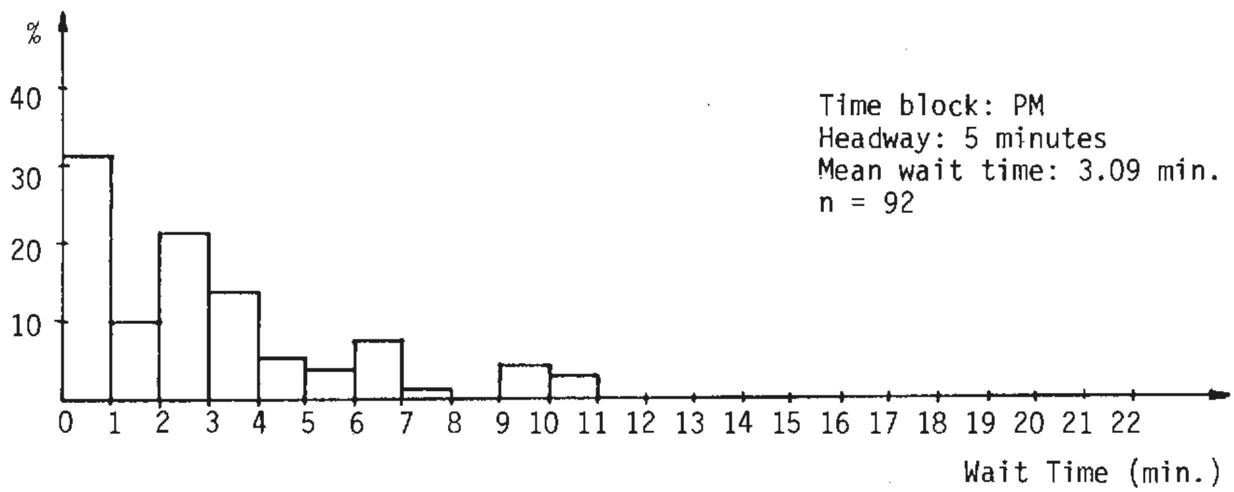
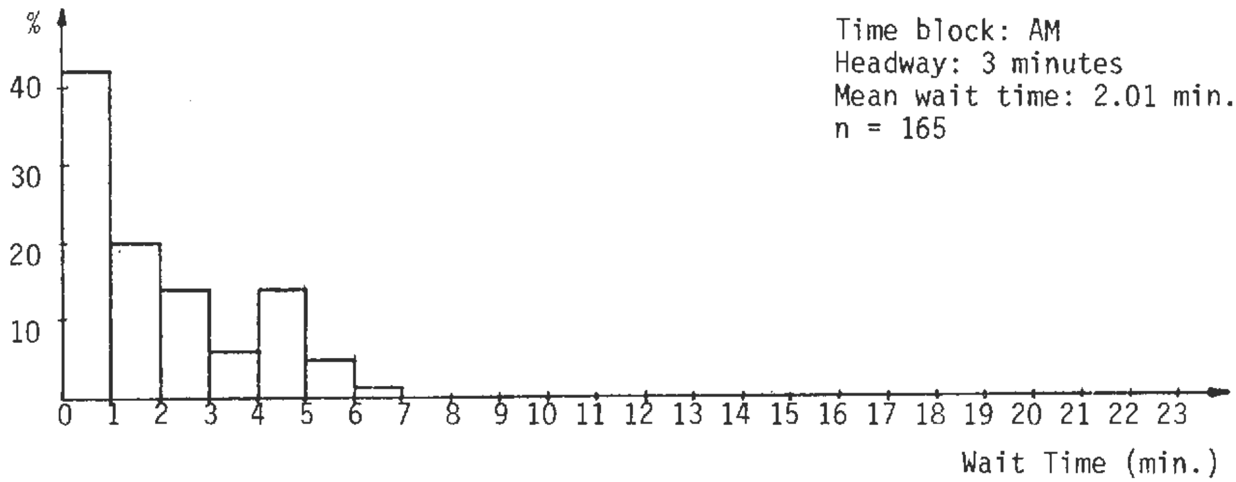
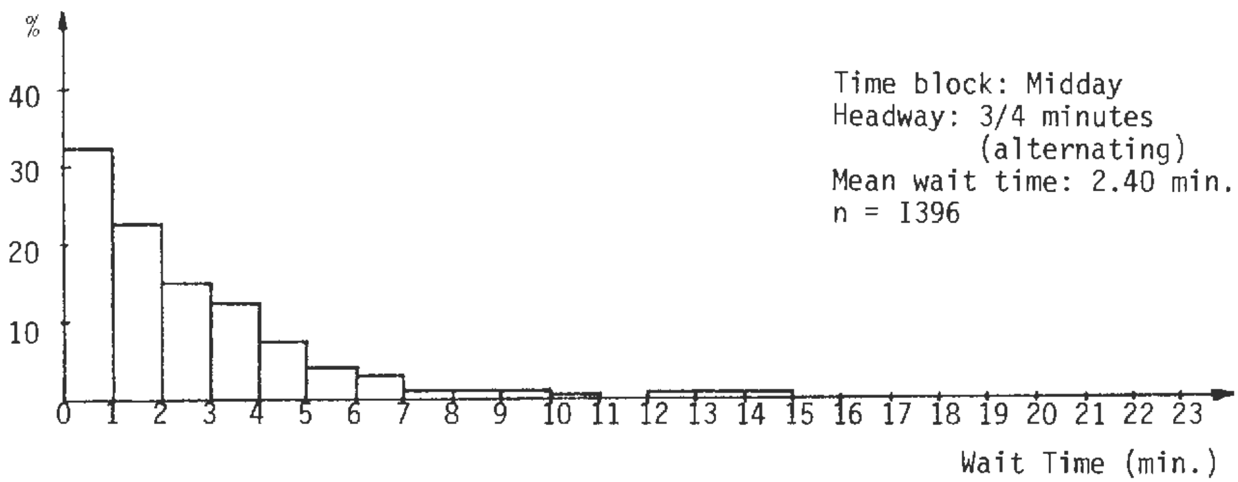


EXHIBIT 5.30

PASSENGER WAIT TIMES, ROUTE 83





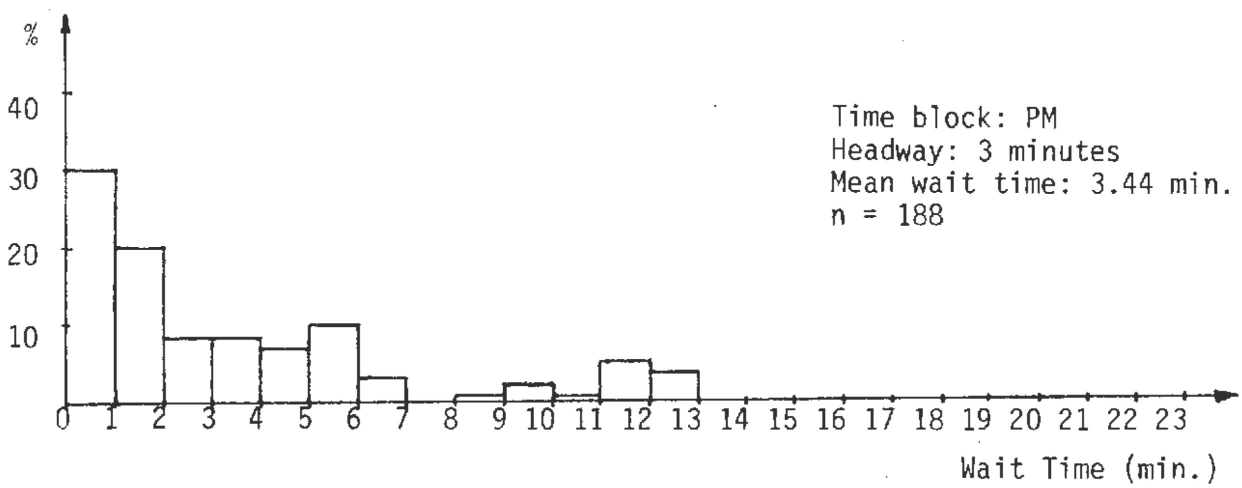
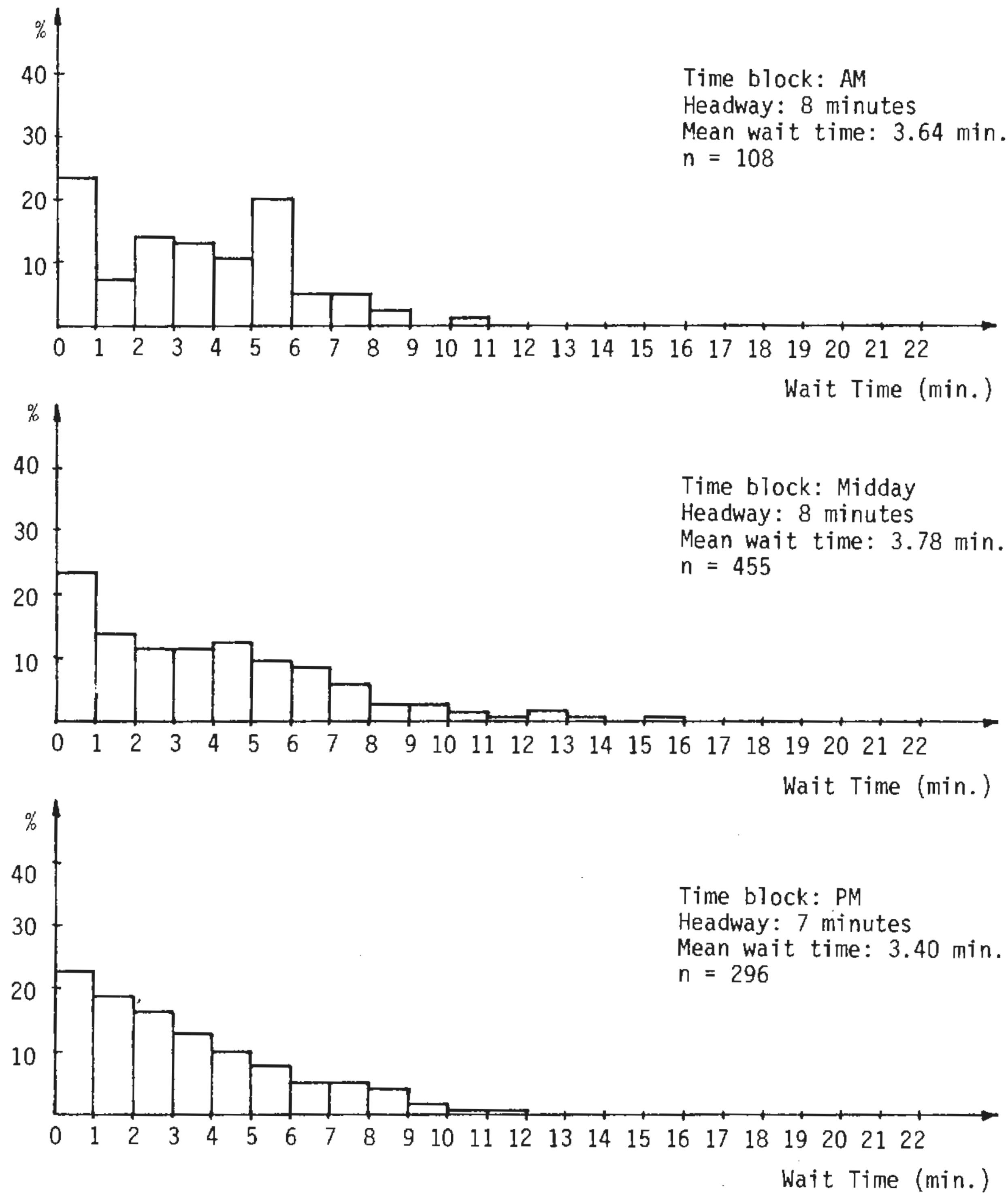


EXHIBIT 5.31

PASSENGER WAIT TIMES, ROUTE 89



5.5.7 Response Times to Buses Calling for Assistance

For the baseline presentation, CS-10 Trouble Report Forms were made available by SCRTD for the following time periods:

June 18 to July 14, 1979
August 14 to September 14, 1980
November 15 to December 15, 1980

These records are the only basis for the present analysis of response times to silent alarm calls, and their inherent limitations make precise statistical results impossible. Some of these limitations are:

- The sample size was small. There were 42 silent alarms on AVM and control routes in June/July 1979, 20 in August/September 1980, and 17 in November/December 1980. Of these, only about one-half (i.e., 18, 11, and 6, respectively) could be considered "legitimate" cases for analysis, providing the point of time a justified silent alarm was activated, as well as the time the bus was contacted by an SCRTD supervisor, transit police, or a unit of the LAPD or other law enforcement agency.
- It was difficult to determine the true response time. Even in those few cases eligible for analysis, the determination of response intervals was obscured by several factors, among them the fact that time-clock stamps on the CS-10 forms mark full minutes only, some inconsistencies in the procedure of marking timepoints on CS-10 forms during the driver/dispatcher communication process, and the difficulty of obtaining the exact arrival time of assistance at the bus. The error generated by these factors is estimated to lie generally between a minimum of 1 minute and a maximum of 4 to 5 minutes.

The upper part of Exhibit 5.32, "Response Times to Silent Alarms," documents the number and nature of all crimes and disturbances registered for AVM and control routes during the three periods for which data was

EXHIBIT 5.32

RESPONSE TIMES TO SILENT ALARMS

Routes, # of Cases / Crimes, Disturbances	June/July 1979								Aug./Sept. 1980								Nov./Dec. 1980							
	AVM				Control				AVM				Control				AVM				Control			
	41	44	83	89	4	84	91	94	41	44	83	89	4	84	91	94	41	44	83	89	4	84	91	94
Fare Dispute											1					1								
Disturbance		2	1	1	2	1	3	1			6				1			3	1		1	2		1
Intoxicated Pass.																							2	
Thefts			1		1		1								2							1		
Damage to Bus											1										1	1	1	
Fight															1			1			1			
Assault			2				1																	
Use of Weapon			1						1	1	1			1							1			

	June/July 1979 AVM	June/July 1979 Control	Aug./Sept. 1980 AVM	Aug./Sept. 1980 Control	Nov./Dec. 1980 AVM	Nov./Dec. 1980 Control
Mean Response Time (in min.)	7.0 (n=8)	10.8 (n=10)	12.8 (n=6)	11.8 (n=5)	13.5 (n=2)	11.5 (n=4)
	9.1 (n=18)		12.4 (n=11)		12.2 (n=6)	
Standard Deviation (in min.)	4.9	7.7	5.2	6.1	2.5	5.9
	6.7		5.7		5.1	
95 % Confidence Intervals for the Mean Response Time (in min.)	3.6 to 10.4	6.0 to 15.6	8.6 to 17.0	6.4 to 17.2	10.0 to 17.0	5.8 to 17.2
	6.0 to 12.2		9.0 to 15.8		8.2 to 16.2	

examined. The category "disturbance" includes incidents like smoking and drinking, profanities, and verbal threatening; "thefts" ranged from passengers stealing bus transfer tickets to professional pick-pocketing; "damages to the bus" were mainly broken windows and mirrors; and a knife was the "weapon" most frequently displayed.

The lower part of Exhibit 5.32 gives mean response times, standard deviations, and 95 percent confidence intervals for the means, based on all cases available for June/July 1979, and the number of "legitimate" and "interpretable" cases observed during the other two periods. These results suggest that response time may have increased slightly between 1979 and 1980, whereas the August/September and November/December values appear to be essentially the same. On the average, a response time of 12 to 13 minutes with a standard deviation of 5 to 6 minutes seems to be characteristic for the routes associated with the AVM demonstration. The widths of the respective confidence intervals for the mean values of response time (covering between 6 and 11 minutes) emphasize the difficulties that will be encountered in future comparisons of this data with "test" response times: in order to infer that the AVM system causes a statistically significant reduction in response times, their mean values would have to be considerably lower than present means. Another complication arises because an anticrime campaign was introduced by SCRTD in late October 1980. It consisted of

- allowing bus drivers to carry and use mace, and
- increasing and publicizing the presence of undercover agents on buses, especially on "problem routes" (see Appendix Exhibit A-7).

This initiative may have been a significant factor in the marked decrease of incidents on route 83 in November/December 1980, compared with the earlier June/July 1979 and August/September 1980 data (one case compared with five and nine cases, respectively). Effects of the campaign may also influence the frequency of silent-alarm incidents during the "test" period.

5.6 Demand Data

As explained above, passenger-load data will provide the basis of determining if a significant change in transit demand has occurred.

5.7 Exogenous Factors Affecting the Demonstration

A series of three exogenous events have had an impact on the demonstration. The first was the gasoline shortage that began in April 1979 and became acute enough in May to cause the imposition of an odd-even rationing system for the purchase of gasoline and to trigger a steady rise in gasoline prices. SCRTD ridership increased by 200,000 daily boardings, reaching a record of 1.47 million bus boardings on May 14, compared with 1.1 million in May 1978. During this time the AVM hardware was being installed on the buses, a tricky situation since the installers were attempting not to interfere with bus operations at a time when all available buses were being pressed into service.

The second exogenous event intervened on August 26, 1979, when a strike by transit employees halted bus operations until September 18, 1979. Drivers, mechanics, and maintenance workers, all belonging to different unions, went out on strike for higher pay. The strikes also came at a difficult time since the unions had to be informed of the AVM demonstration and their acceptance of it was critical to successful implementation. If the drivers' union were to consider AVM an additional burden to drivers, or a type of performance evaluation, the union could have effectively stymied further progress. On December 4, an AVM briefing was given to union leaders at a regular SCRTD Transportation Department meeting, and no serious problems arose. By late December, ridership was back up to 1.2 million passengers a day, 15 percent above what it had been in December 1978.

The third exogenous event was a fare increase* implemented on July 14, 1980, after considerable public opposition. This came during the first stage of the demonstration when baseline data were being collected on all four AVM routes. Apparently, the fare increase did not affect ridership very much, since 1980 was a record year for District ridership; 390 million passenger boardings were made, an increase of 16 percent over 1979.

5.8 Demonstration Schedule

Exhibit 5.33 presents a chronology of the Los Angeles AVM demonstration through Stage 2, the start-up portion. During the test period (Stage 3), which begins March 1, 1981, data will be collected for comparison with the baseline data in the actual assessment of the socio-economic impacts of AVM.

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* Basic fare increased from 55 cents to 65 cents, while the basic transfer increased from 5 cents to 20 cents, with only two transfers permitted per ride. New freeway express fares ranged from 95 cents to $2.15, up from 55 cents to $1.55. Regular monthly passes went from $20 to $26, while senior citizens' monthly passes went from $4 to $6, high school student passes from $14 to $16, and college student passes from $14 to $20.

EXHIBIT 5.33

CHRONOLOGY OF THE LOS ANGELES AVM DEMONSTRATION

DATE	DEMONSTRATION EVENTS	EXOGENOUS EVENTS	NON-AVM SYSTEM MEASUREMENTS
Sept. 1977	UMTA selected Gould to design, develop and implement an AVM system for field testing by SCRTD.		
1977-1979	Hardware development by Gould.		
March 28, 1978	Preliminary presentation of AVM system, Gould, Ft. Worth, Texas.		
Feb. 28, 1979	First meeting of APTA sub-committee on AVM, TSC, Cambridge, MA.		
Apr. 27, 1979	Impact assessment contract signed by Juárez & Associates, and SYSTAN.		
April-May 1979		Gasoline shortage crisis (record ridership on SCRTD)	
May 24-25, 1979	Second APTA AVM subcommittee meeting, Gould, Ft. Worth, TX.		
June 1979	Final selection of AVM test routes.		
July 3, 1979	Final selection of control routes for the impact assessment.		
Aug. 1979	Installation of AVM computer equipment at SCRTD, complete with capability to monitor up to 12 vehicles on line 41.		
Aug. 26-Sept. 17, 1979		RTD operations stopped by strikes	
Dec. 4, 1979	AVM briefing given to union leaders at regular Transportation Department meeting.		
Dec. 13-14, 1979	Third APTA AVM subcommittee meeting, SCRTD, Los Angeles, CA.		

EXHIBIT 5.33

(continued)

DATE	DEMONSTRATION EVENTS	EXOGENOUS EVENTS	NON-AVM SYSTEM MEASUREMENTS
Jan. 1980	AVM bus hardware installation complete. Software to track 200 vehicles complete.		
Jan. 15-30, 1979			Traffic volume counts by Los Angeles Traffic Department.
Mar. 17-April 13, 1980	Shake-down period for automatic data collection.		
April 1980	Installation of signpost transmitters complete.		
	STAGE I: BASELINE		
April 14, 1980	Automatic collection of evaluation data began for all four AVM routes.		
April 15-May 2, 1980			Manual baseline data collection on all four control routes.
May 27, 1980	Software installed with capability of showing schedule deviations on dispatcher displays.		
July 14, 1980		SCRTD fare increase.	
Aug. 11-28, 1980	Two-week training sessions for the first six AVM dispatchers (familiarization continued through Sept. 14, 1980).		
Sept. 3, 1980	Article announcing AVM in SCRTD's "Headway."		

EXHIBIT 5.33

(continued)

DATE	DEMONSTRATION EVENTS	EXOGENOUS EVENTS	NON-AVM SYSTEM MEASUREMENTS
	STAGE II: START-UP		
Sept. 15, 1980	Dispatchers began real-time control activities on AVM test routes 41, 83, and 89.		
Oct. 1, 1980	SCRTD technicians began on-the-job training in maintenance and trouble-shooting on AVM equipment.		
Oct. 14-15, 1980	Fourth APTA AVM subcommittee meeting, SCRTD, Los Angeles, CA.		
Oct. 20, 1980	RTD open letter to bus drivers concerning AVM demonstration.		
Oct. 24-Nov. 26, 1980			Interviews with SCRTD management.
Nov. 9, 1980		Schedule change for AVM Route 83	
Dec. 1980			Survey of selected AVM drivers.
Dec. 10-21, 1980	Training of two new dispatchers.		
Dec. 21, 1980	Dispatchers' shift shake-up.		
Dec. 21, 1980	Group of non-AVM bus lines removed from AVM voice radio Channel 5.		
Jan. 1981			Survey of AVM dispatchers
Jan. 4, 1981		Schedule change for AVM Route 83	
Jan. 19-Feb. 2, 1981			Manual collection of passenger wait time data for all AVM test routes.

APPENDIX SECTION I

DATA COLLECTION AND SURVEY FORMS

Exhibit No.

A-1: Drivers' Survey Form

A-2: Dispatchers' Survey Form

A-3: Control Route Data Collection Form

A-4: Bus Stop Display Unit Accuracy Data Collection Form

A-5: Wait Time Data Collection Form

A-6: CS-10 Trouble Report Form

A-7: Bus Crime Impact Area

EXHIBIT A-1

DRIVERS' SURVEY FORM

As part of the evaluation of the AVM Demonstration, SCRTD would like to know how drivers feel about the AVM system before it is fully operating. Therefore, please answer this questionnaire as best as you can. Signing your name is totally optional. Your answers will be kept strictly confidential. Thank you very much for your cooperation.

1. How do you think this new Automatic Vehicle Monitoring System will affect your job?

    _____ Make it easier. (In what way?) ______________________________

    ____

    _____ Make it more difficult. (In what way?) ______________________

    ____

    _____ Won't affect it. (What aspects of your job will not be affected?)

    ____

    _____ Other (specify) ____

2. How do you think the AVM will affect bus operations? (Please check all responses that apply)

    _____ Will help bus drivers maintain on-time service
    _____ Will improve communication between drivers and dispatchers
    _____ Will require fewer buses on AVM lines
    _____ Will improve the security of bus drivers
    _____ Will improve the security of bus passengers
    _____ Won't affect bus operations
    _____ Other (specify) ____

    Please add any comments you have about any of these subjects __________

    ____

    ____

    ____

3. How do you think the AVM will affect ridership?

_____ Increase ridership on AVM lines

_____ Decrease ridership on AVM lines

_____ Won't affect ridership

_____ Don't know

_____ Other (specify) ______________________________

4. Do you think the AVM system will win acceptance and cooperation from the drivers after it has been tested?

_____ Yes

_____ No

_____ Maybe

_____ Don't know

_____ Other (specify) ______________________________

5. Do you think that using the AVM system will allow RTD to reduce its costs for providing bus service enough to make up for the additional costs of the AVM system?

_____ Yes

_____ No

_____ Maybe

_____ Don't know

_____ Other (specify) ______________________________

We would appreciate any comments you may have on any of the above subjects or anything else related to the AVM Demonstration.

____

____

____

____

Name ______________________ (optional)   Badge ______________________ (optional)

EXHIBIT A-2

DISPATCHERS' SURVEY FORM

As part of the evaluation of the AVM Demonstration, SCRTD would like to know how dispatchers feel about the AVM system before it is fully operational. Therefore, please answer this questionnaire as best as you can, put it in the envelope, and post it in any mail box. Your answers will be kept strictly confidential. Thank you very much for your cooperation.

1. How do you think this new Automatic Vehicle Monitoring System will affect your job?

   _____ Make it easier. (In what way?) ______________________

   ____

   _____ Make it more difficult. (In what way?) ______________________

   ____

   _____ Won't affect it. (What aspects of your job will not be affected?)

   ____

   _____ Other (specify) ______________________________________

2. How do you think the AVM will affect bus operations? (Please check all responses that apply)

   _____ Will help bus drivers maintain on-time service

   _____ Will improve communication between bus drivers and dispatchers

   _____ Will require fewer buses on AVM lines

   _____ Will improve the security of bus drivers

   _____ Will improve the security of bus passengers

   _____ Won't affect bus operations

   _____ Other (specify) ______________________________________

   Please add any comments you have about any of these subjects _________

   ____

   ____

   ____

   ____

3. How do you think the AVM will affect ridership?

_____ Increase ridership on AVM lines

_____ Decrease ridership on AVM lines

_____ Won't affect ridership

_____ Don't know

_____ Other (specify) ________________________________

4. Do you think the AVM system will win acceptance and cooperation from the drivers after it has been tested?

_____ Yes

_____ No

_____ Maybe

_____ Don't know

_____ Other (specify) ________________________________

5. Do you think the AVM system will win acceptance and cooperation from the dispatchers after it has been tested?

_____ Yes

_____ No

_____ Maybe

_____ Don't know

_____ Other (specify) ________________________________

6. Do you think that using the AVM system will allow RTD to reduce its costs for providing bus service enough to make up for the additional cost of the AVM system?

_____ Yes

_____ No

_____ Maybe

_____ Don't know

_____ Other (specify) ________________________________

We would appreciate any comments you may have on any of the above subjects or anything else related to the AVM Demonstration.

____

____

____

____

EXHIBIT A-3

CONTROL ROUTE DATA COLLECTION FORM

Location:______________________________ (01-10) Name of Checker:______________________________(15-16)

Date:______________________________ (11-14)

North Bound or West Bound (17)						South Bound or East Bound (17)					
Route Number	Bus Number	Run Number	Time Leaving Stop (Hr/Min/Sec)	Scheduled Time (Office Use Only)	Estimated Number of Passengers	Route Number	Bus Number	Run Number	Time Leaving Stop (Hr/Min/Sec)	Scheduled Time (Office Use Only)	Estimated Number of Passengers
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)
(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)	(18-19)	(20-23)	(24-25)	(26-31)	(32-35)	(36-37)

EXHIBIT A-4

BUS STOP DISPLAY UNIT ACCURACY

DATA COLLECTION FORM

Route: ____________ Direction: __N __S __E __W

Display Unit Location: ______________________________

Scheduled Bus Arrival Time: _________________________

Time (two-minute intervals) Predicted Arrival Time

Actual Bus Arrival Time: _______________

Bus Number: ___________________________

EXHIBIT A-5

WAIT TIME

DATA COLLECTION FORM

LINE:________ DATE: ________________

LOCATION:________________ DIR:________

WEATHER:__________ CHECKER:________

______ AM/PM

HOUR

SECONDS										
	00	06	12	18	24	30	36	42	48	54
0-14										
15-29										
30-44										
45-59										
	01	07	13	19	25	31	37	43	49	55
0-14										
15-29										
30-44										II
45-59										
	02	08	14	20	26	32	38	44	50	56
0-14										
15-29										
30-44										
45-59										
	03	09	15	21	27	33	39	45	51	57
0-14										
15-29										
30-44										
45-59										
	04	10	16	22	28	34	40	46	52	58
0-14										
15-29										
30-44										
45-59										
	05	11	17	23	29	35	41	47	53	59
0-14										
15-29										
30-44										
45-59										

EXHIBIT A-6

RTD 32-17
REV. 3/79

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

TROUBLE REPORT FORM CS-10

DISP. NO

VEH._____ LINE_____ BR. NO. _____ OPER NO._____ CH. NO. _____ SAS___ PHONE_____ DIV NO. _____

CALL LOC. _____ DIR. TIME _____

TROUBLE LOC._____ DIR. _____ TIME _____ CLEARED_____

ACC.____ WIT. ____ SICK ____ REF. AID ____ PHOTOS ____ BUS DAMAGE_____

NO.INJ. _____ TREATED AT-SCENE _____ NO. TO HOSP. _____ WHERE? _____ AMB? _____

AIR CONDITIONER		DIRECTIONAL SIGNALS		LATE (10–41)		RADIO – USE	
AIR LEAK		DIRTY BUS		LIGHTS – HEAD/TAIL		ROBBERY	
AIR PRESSURE		DISTURBANCE		LIGHTS – INSIDE		SICK OPERATOR	
ALARM		DOOR – ENTRY		LIGHTS – MARKER		SICK PASSENGER	
ALTERCATION		DOOR – EXIT		LOST ARTICLE		THEFT	
ASSAULT – OPERATOR		ENGINE – HOT		LOST PASSENGER		TIRE	
ASSAULT – PASSENGER		ENGINE – NO POWER		MIRROR		TRANSFERS	
BATTERY		ENGINE – STALLED		MISSILES		TRANSMISSION - CLUTCH	
BELLOWS		FAREBOX		OIL LEAK		TRANSMISSION – LEAK	
BLOCKADE		FARE DISPUTE		OIL PRESSURE		TRANSMISSION – SHIFT	
BRAKES – GRABBING		HAZARD		OUT LATE		TRANSMISSION – SLIPS	
BRAKES – HOT		HEADSIGN		OVERLOAD		VANDALISM	
BRAKES – SLACK		HEATER		PADDLEBOARD		WATCH	
CANCELLATION		HOLD–UP		PUNCH		WATER LEAK	
COMPLAINT		HORN		RADIO – BEEPING		WIPERS	
DEFROSTERS		INFORMATION		RADIO – NO RX		ZONE CHECKS	
DETOUR		INTOX. PASSENGER		RADIO – NO TX		OTHER:	

MOVING: ☐ STANDING: ☐

SUMMARY:

REPORTED	BY	TO	TIME

VEH. NO._____ REPLACE ___ TURNBACK____ OHB ____ RELAY____ TIME____

LOC. _____ DIR. _____

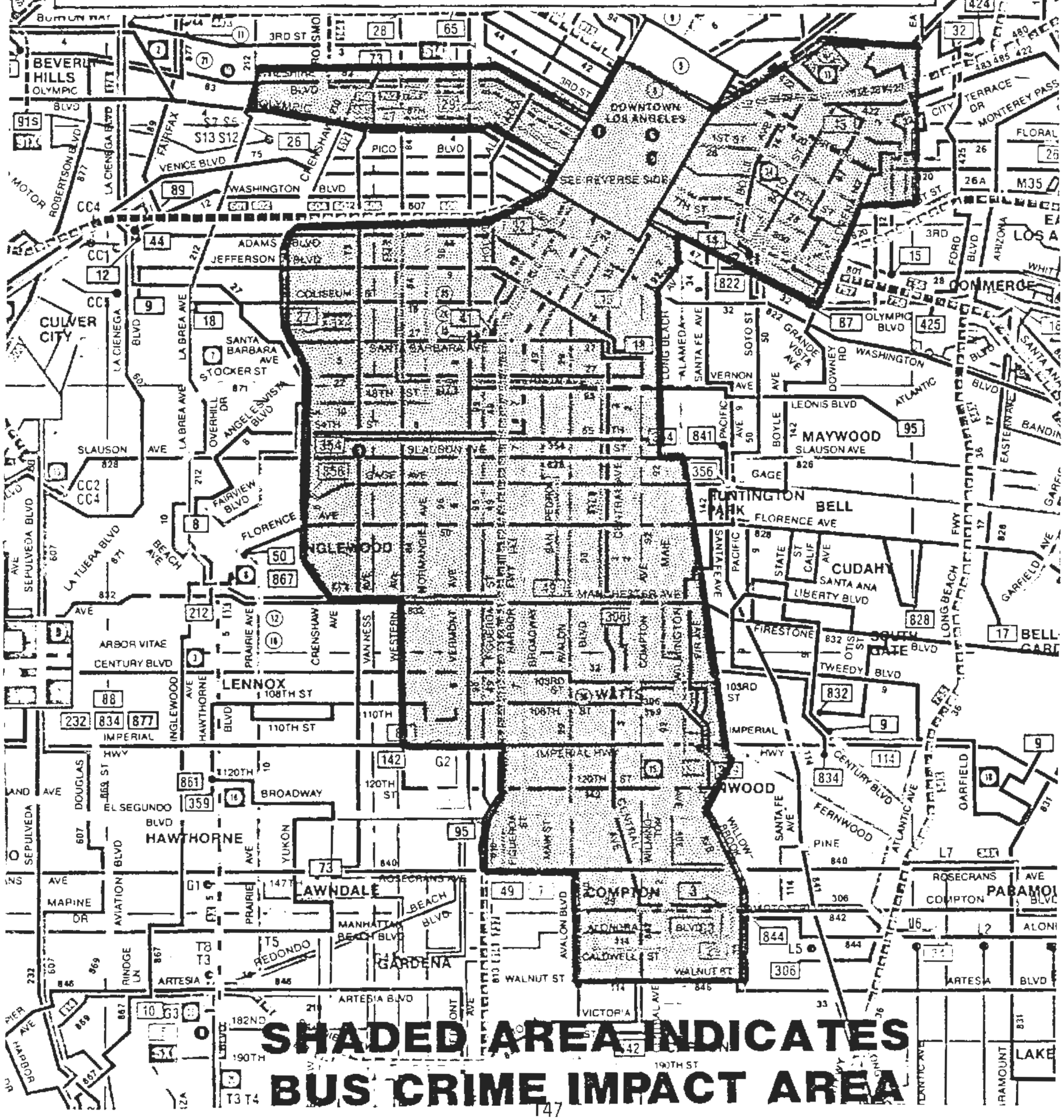
COPIES												SER. DELAY

HOURS OF COVERAGE - 3:00pm-Midnight

SQUARE MILES ______________________ 66

RTD

EXHIBIT A-7



SHADED AREA INDICATES BUS CRIME IMPACT AREA

APPENDIX SECTION II

SUPPLEMENTARY DATA AND FIGURES FOR SCHEDULE DEVIATIONS

Exhibit No.

EXHIBIT A-8

AVM ROUTES: SCHEDULE DEVIATIONS

(8-Day Averages for Route 41)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

SCHEDULE DEVIATION (MINS)

LINE 41 AM

NORTHBOUND																SOUTHBOUND													
NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD	LOCATION	NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD
80	-1.2	2.6	0	0	8	13	31	39	4	3	3	1	0	0	SBARB/FGROA	81	-1.4	4.3	4	5	11	16	17	14	16	10	6	1	0	2
80	-0.2	2.6	0	0	6	8	18	45	18	3	0	4	0	2	ALVRD/PICO	80	-2.9	3.4	9	3	5	26	29	21	6	1	0	0	0	1
80	-1.8	3.1	3	5	8	13	28	36	5	1	3	0	0	4	ALVRD/SIXTH	80	-3.1	2.9	5	6	6	25	35	20	1	1	0	0	0	0
78	-1.0	3.4	1	5	9	12	17	29	21	4	1	1	0	4	MONT /LBRTY	81	-1.9	2.6	1	1	7	14	35	36	5	1	0	0	0	0

LINE 41 MID

NORTHBOUND																SOUTHBOUND													
NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD	LOCATION	NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD
183	-1.3	1.5	0	1	1	10	38	49	2	0	0	0	0	0	SBARB/FGROA	179	1.0	2.8	0	1	2	4	16	23	29	18	5	1	0	1
180	-1.4	2.1	1	1	3	17	33	39	6	1	0	0	0	0	ALVRD/PICO	180	-1.7	2.1	1	1	5	17	38	33	5	1	0	0	0	0
180	-2.3	2.6	3	2	8	20	29	32	4	1	0	0	0	0	ALVRD/SIXTH	179	-2.3	1.8	1	1	5	22	50	21	0	0	0	0	0	0
180	-1.1	3.2	3	2	7	13	21	28	21	5	1	0	0	0	MONT /LBRTY	182	-0.9	1.5	0	1	2	5	24	65	3	0	0	0	0	0

LINE 41 PM

NORTHBOUND																SOUTHBOUND													
NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD	LOCATION	NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD
63	-1.2	1.7	0	0	3	8	32	54	3	0	0	0	0	0	SBARB/FGROA	62	0.4	3.4	3	0	2	10	16	29	16	19	5	0	0	1
62	-1.4	2.4	3	0	3	13	31	47	3	0	0	0	0	0	ALVRD/PICO	63	-2.4	2.6	3	3	6	24	35	25	3	0	0	0	0	0
63	-2.7	3.5	5	3	10	24	24	27	6	2	0	0	0	0	ALVRD/SIXTH	62	-2.6	2.1	3	2	3	29	47	15	2	0	0	0	0	0
62	-1.0	4.2	5	2	5	11	19	26	19	8	3	2	0	0	MONT /LBRTY	65	-0.9	1.2	0	0	2	3	38	55	2	0	0	0	0	0

LINE 41 NITE

NORTHBOUND																SOUTHBOUND													
NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD	LOCATION	NOBS	MEAN	STDV	<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9											BAD
102	-1.9	1.8	1	1	2	19	43	34	0	0	0	0	0	0	SBARB/FGROA	91	1.0	2.3	0	0	0	2	18	27	32	18	3	0	0	0
101	-1.4	1.9	2	0	3	6	42	45	3	0	0	0	0	0	ALVRD/PICO	93	-0.7	1.4	0	0	0	6	35	48	10	0	0	0	0	0
100	-1.7	2.4	2	1	4	15	33	36	9	0	0	0	0	0	ALVRD/SIXTH	94	-1.6	1.3	0	0	2	9	55	32	2	0	0	0	0	0
98	-0.3	3.0	2	1	1	13	19	32	21	8	2	0	0	1	MONT /LBRTY	94	-1.2	1.5	0	0	2	4	53	35	2	3	0	0	0	0

EXHIBIT A-9

AVM ROUTES: SCHEDULE DEVIATIONS

(8-Day Averages for Route 44)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

SCHEDULE DEVIATION (MINS)

LINE 44 AM — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
147	-0.6	1.7	0	1	1	7	24	52	13	1	0	0	0	0	ADAMS/LBREA	134	-1.3	3.7	4	6	9	10	19	24	20	7	1	0	0	1
148	-0.8	2.3	1	0	2	11	21	51	14	0	0	0	0	0	ADAMS/VRMNT	137	-2.1	3.2	2	7	8	16	24	34	7	1	0	1	0	0
148	-0.8	2.4	1	0	4	9	22	45	18	1	0	0	0	0	OLYMP/HILL	170	-1.4	3.0	2	2	6	14	29	31	12	4	1	0	0	1
147	-0.7	3.2	2	1	5	12	14	35	24	5	1	0	0	0	BVRLY/WSTRN	172	-0.1	1.6	0	1	1	4	19	52	23	0	1	0	0	1
113	-1.6	3.8	4	8	8	12	15	29	15	6	3	0	0	0	BVRLY/LCNGA	115	-1.0	1.8	1	2	0	4	40	42	10	1	0	0	0	0
75	-3.7	4.7	16	7	12	16	16	20	8	3	1	1	0	0	SMNCA/CANON	103	-1.4	2.5	3	1	3	11	38	31	12	2	0	0	0	0

LINE 44 MID — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
215	-0.2	1.5	0	0	0	4	22	58	15	0	0	0	0	1	ADAMS/LBREA	191	-1.5	5.0	9	6	6	10	16	17	19	13	4	1	0	0
214	-0.3	1.6	0	0	3	6	16	57	18	0	0	0	0	1	ADAMS/VRMNT	199	-2.5	3.9	8	7	8	14	20	31	12	2	0	0	0	0
212	-1.5	2.3	0	3	6	13	24	46	8	0	0	0	0	1	OLYMP/HILL	204	-1.6	3.6	4	4	4	15	24	27	17	3	1	0	0	0
208	-1.3	3.8	6	3	7	9	13	33	25	4	1	0	0	2	BVRLY/WSTRN	201	0.6	1.7	0	0	2	2	6	51	35	3	1	0	0	2
201	-1.4	4.7	9	5	8	5	17	26	15	8	4	1	0	1	BVRLY/LCNGA	204	-1.6	2.2	1	1	4	12	34	41	6	0	0	0	0	0
99	-3.8	5.2	17	6	15	12	14	18	10	5	2	0	0	1	SMNCA/CANON	103	-1.5	2.6	1	1	8	13	25	46	6	1	0	0	0	0

LINE 44 PM — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
78	-0.8	2.2	1	1	1	6	32	35	23	0	0	0	0	0	ADAMS/LBREA	70	1.4	4.1	1	3	3	6	20	9	17	21	14	6	0	1
78	-1.0	2.2	0	0	6	10	23	44	17	0	0	0	0	0	ADAMS/VRMNT	73	-1.5	3.6	7	3	5	11	14	34	23	1	1	0	0	0
90	-0.4	2.8	2	1	1	10	21	29	28	7	1	0	0	1	OLYMP/HILL	75	-2.0	4.5	9	4	3	13	19	31	17	4	0	0	0	1
83	-1.1	3.5	4	2	6	12	19	29	20	4	4	0	0	0	BVRLY/WSTRN	74	-1.2	2.8	3	3	7	8	12	51	16	0	0	0	0	0
62	0.0	4.7	2	3	13	5	11	21	21	13	6	5	0	0	BVRLY/LCNGA	73	-1.3	2.4	1	3	4	5	27	52	5	0	1	0	0	0
44	0.0	3.9	0	2	14	9	7	25	23	11	7	2	0	2	SMNCA/CANON	42	-0.6	1.6	0	0	2	2	29	62	2	0	2	0	0	0

LINE 44 NITE — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
115	-0.8	1.8	0	1	2	8	31	43	16	0	0	0	0	0	ADAMS/LBREA	104	-1.9	3.1	3	3	12	15	22	33	11	1	0	1	0	0
115	-1.3	2.2	1	0	3	16	27	42	11	0	0	0	0	0	ADAMS/VRMNT	106	-2.1	2.6	2	5	6	19	30	36	2	0	1	0	0	0
121	-2.0	2.5	1	2	8	20	27	34	7	0	0	0	0	0	OLYMP/HILL	107	-0.9	2.2	0	2	4	8	32	33	20	2	0	0	0	1
122	-1.7	3.5	4	7	6	6	20	42	15	1	1	0	0	0	BVRLY/WSTRN	102	0.0	1.7	0	0	1	4	18	50	25	3	0	0	0	0
117	-1.2	4.3	9	3	3	3	12	41	21	6	0	1	0	0	BVRLY/LCNGA	94	-2.4	2.3	0	4	13	17	35	28	3	0	0	0	0	1
114	-0.8	4.5	9	4	4	6	8	30	28	11	2	0	0	2	SMNCA/CANON	79	-2.2	2.3	0	6	6	13	41	29	5	0	0	0	0	1

EXHIBIT A-10

AVM ROUTES: SCHEDULE DEVIATIONS

(8-Day Averages for Route 89)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

SCHEDULE DEVIATION (MINS)

LINE 89 AM

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
120	-0.5	1.3	0	0	0	6	17	73	5	0	0	0	0	0	ADAMS/WASH	143	-1.6	2.6	2	2	6	15	22	42	10	0	0	0	0	0
129	-0.3	1.5	0	0	2	5	18	59	17	0	0	0	0	0	FRFAX/WILSH	145	-1.7	2.3	1	3	6	16	28	39	7	0	0	0	0	0
140	-0.5	1.6	0	0	1	8	21	56	14	0	0	0	0	0	FRFAX/SMNCA	146	-0.7	2.0	1	1	2	7	27	43	19	1	0	0	0	0
135	-0.4	1.6	0	0	1	7	22	53	16	1	0	0	0	0	HWOOD/VINE	145	-1.0	1.4	0	0	1	8	27	62	2	0	0	0	0	0

LINE 89 MID

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
264	-0.1	1.0	0	0	0	2	11	76	10	0	0	0	0	0	ADAMS/WASH	267	-1.6	3.6	4	4	8	16	21	21	21	4	1	0	0	0
263	0.1	1.7	0	0	1	4	14	52	27	2	0	0	0	0	FRFAX/WILSH	266	-2.6	3.1	5	5	10	21	24	24	11	0	0	0	0	0
261	-0.8	2.1	0	1	5	8	20	46	20	0	0	0	0	0	FRFAX/SMNCA	268	-0.3	2.2	0	1	3	6	16	42	29	2	0	0	0	0
249	-1.5	2.4	1	4	6	12	29	38	9	1	0	0	0	0	HWOOD/VINE	266	-0.7	1.5	0	1	2	3	22	64	8	0	0	0	0	0

LINE 89 PM

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
104	-1.0	2.1	1	0	3	8	19	63	6	0	0	0	0	0	ADAMS/WASH	94	0.9	2.7	0	1	2	5	14	28	32	13	4	1	0	0
102	-0.5	1.9	0	0	4	5	27	48	15	1	0	0	0	0	FRFAX/WILSH	93	-0.3	2.3	0	1	3	8	24	41	17	5	1	0	0	0
103	-0.8	2.4	0	1	6	11	17	44	17	4	0	0	0	0	FRFAX/SMNCA	95	-0.2	2.1	0	1	1	7	21	47	18	3	1	0	0	0
100	-1.1	2.4	0	3	4	13	24	42	11	3	0	0	0	0	HWOOD/VINE	94	-1.2	2.1	0	1	5	7	33	40	12	1	0	0	0	1

LINE 89 NITE

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
100	-2.7	2.7	2	4	14	22	26	29	3	0	0	0	0	0	ADAMS/WASH	107	2.4	2.9	1	0	0	1	7	13	33	36	7	1	0	1
96	-1.3	2.4	1	1	7	13	25	44	7	2	0	0	0	0	FRFAX/WILSH	106	-0.3	2.0	0	0	3	7	17	49	22	3	0	0	0	2
95	-1.4	2.2	0	0	9	12	28	43	6	1	0	0	0	0	FRFAX/SMNCA	111	-0.9	2.4	0	0	8	9	26	45	8	3	1	0	0	1
83	-1.0	2.3	0	0	5	13	30	35	12	4	1	0	0	0	HWOOD/VINE	113	-2.0	2.9	2	4	3	19	27	41	4	1	0	0	0	0

EXHIBIT A-11

AVM ROUTES: SCHEDULE DEVIATIONS

(8-Day Averages for Route 83 Local)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

SCHEDULE DEVIATION (MINS)

LINE 83 : LOCAL AM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
52	-0.9	2.4	2	2	6	4	23	52	12	0	0	0	0	0	OCEAN/PICO	15	-4.7	3.2	13	7	20	40	0	13	7	0	0	0	0	1
118	-0.3	2.9	3	0	3	5	14	36	36	2	0	0	0	0	WILSH/WSTWD	115	-6.9	4.5	29	19	15	14	15	9	0	0	0	0	0	2
127	-0.7	2.9	3	2	2	8	14	49	21	1	0	0	0	0	WILSH/SMNCA	120	-5.7	4.4	20	12	22	15	18	13	1	0	0	0	0	1
126	-0.9	2.8	3	2	2	11	14	52	16	1	0	0	0	0	WILSH/FRFAX	121	-3.8	3.8	12	5	16	22	18	21	6	0	0	0	0	0
130	-1.0	2.6	2	2	5	8	18	52	12	2	0	0	0	0	WILSH/WSTRN	122	-3.1	3.1	4	7	11	23	23	29	2	0	0	0	0	0
128	0.4	3.6	0	3	8	5	17	18	23	16	8	2	0	1	7TH /MAPLE	125	-1.9	2.0	1	1	5	12	42	40	0	0	0	0	0	0

LINE 83 : LOCAL MID EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
175	-0.1	2.2	2	1	1	2	16	52	25	1	0	0	0	0	OCEAN/PICO	167	-5.0	6.0	25	12	10	12	10	14	13	4	1	1	0	4
379	-0.2	3.1	2	2	4	6	17	27	33	9	0	0	0	0	WILSH/WSTWD	377	-4.5	4.9	19	7	15	15	18	16	7	3	0	0	0	5
359	-0.5	3.0	3	2	4	5	16	38	32	1	0	0	0	1	WILSH/SMNCA	367	-4.4	4.6	16	10	12	17	19	17	8	1	0	0	0	4
369	-1.7	3.3	5	3	6	9	20	45	12	1	0	0	0	0	WILSH/FRFAX	374	-3.3	3.9	10	6	14	15	22	28	6	0	0	0	0	2
367	-1.7	3.6	6	4	6	8	18	39	17	1	0	0	0	1	WILSH/WSTRN	370	-2.9	3.5	6	9	9	21	19	30	6	0	0	0	0	0
357	-1.0	5.1	8	4	8	11	15	14	17	12	9	2	0	3	7TH /MAPLE	379	-1.8	1.8	1	1	3	11	47	37	1	0	0	0	0	3

LINE 83 : LOCAL PM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
8	0.1	1.7	0	0	0	13	13	38	38	0	0	0	0	0	OCEAN/PICO	4	-4.3	4.0	0	50	0	25	0	25	0	0	0	0	0	0
72	1.4	2.5	1	1	0	1	4	21	49	22	0	0	0	0	WILSH/WSTWD	39	-3.2	5.4	18	10	5	8	18	8	31	3	0	0	0	2
74	0.0	2.5	1	3	0	4	14	43	32	3	0	0	0	0	WILSH/SMNCA	53	-3.7	5.4	19	8	8	6	19	26	11	4	0	0	0	1
74	-1.5	3.6	5	3	5	8	18	46	12	3	0	0	0	0	WILSH/FRFAX	56	-3.6	4.7	14	7	9	11	23	29	5	2	0	0	0	0
72	-2.6	4.1	8	7	7	15	17	36	10	0	0	0	0	0	WILSH/WSTRN	55	-4.1	4.3	11	13	5	18	29	20	4	0	0	0	0	0
71	-2.1	6.8	17	1	15	6	15	7	10	11	11	6	0	1	7TH /MAPLE	59	-2.2	2.0	0	3	8	12	47	27	2	0	0	0	0	3

LINE 83 : LOCAL NITE EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
120	-1.6	2.8	2	7	3	5	27	48	8	1	0	0	0	0	OCEAN/PICO	93	-3.9	4.7	13	9	13	17	24	11	8	3	3	0	0	0
161	-0.9	3.0	1	2	6	9	20	39	17	4	1	1	0	1	WILSH/WSTWD	135	-2.1	3.5	6	4	10	13	19	33	13	3	0	0	0	0
150	-0.9	2.6	2	0	7	9	19	44	19	1	0	1	0	1	WILSH/SMNCA	108	-2.2	3.5	6	4	11	14	22	28	15	1	0	0	0	0
153	-0.8	2.5	1	1	5	8	16	53	14	2	1	0	0	1	WILSH/FRFAX	114	-2.2	2.8	4	2	14	12	25	39	5	0	0	0	0	1
153	0.2	2.5	1	2	2	2	11	53	23	4	1	1	0	0	WILSH/WSTRN	114	-3.2	3.0	5	8	10	25	27	18	7	0	0	0	0	0
146	0.6	3.6	1	1	6	9	15	21	23	15	6	3	0	5	7TH /MAPLE	118	-3.3	2.7	4	9	8	22	39	14	3	0	1	0	0	0

EXHIBIT A-12

AVM ROUTES: SCHEDULE DEVIATIONS

(8-Day Averages for Route 83 Limited)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

SCHEDULE DEVIATION (MINS)

LINE 83 : LIMITED AM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
113	0.0	2.0	1	0	3	3	7	58	28	0	0	0	0	1	OCEAN/PICO	131	-9.0	5.2	52	9	14	8	12	4	1	1	0	0	0	6
114	-0.6	2.6	2	1	5	7	10	47	26	2	0	0	0	0	WILSH/WSTWD	143	-6.1	4.7	26	13	12	18	19	9	3	0	0	0	0	2
113	-0.1	2.5	3	1	3	6	4	50	32	1	0	0	0	0	WILSH/SMNCA	142	-4.2	3.9	12	9	20	15	22	16	6	0	0	0	0	2
115	0.0	2.5	2	2	3	4	5	56	26	2	1	0	0	0	WILSH/FRFAX	145	-3.0	3.6	6	7	8	21	23	26	9	0	0	0	0	0
115	-1.6	2.9	3	3	3	13	35	27	12	3	0	0	0	0	WILSH/WSTRN	143	-2.8	3.2	4	3	10	25	27	27	3	0	0	0	0	1
113	0.7	3.5	3	1	2	8	11	27	23	19	5	2	0	1	7TH /MAPLE	140	-1.8	2.4	3	1	1	8	45	41	1	0	0	0	0	2

LINE 83 : LIMITED MID EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

LINE 83 : LIMITED PM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
57	-0.7	3.1	4	2	4	7	12	42	30	0	0	0	0	1	OCEAN/PICO	80	-5.4	6.0	23	14	19	10	10	10	6	4	3	3	0	1
57	-3.2	3.8	7	2	18	23	18	28	5	0	0	0	0	0	WILSH/WSTWD	84	-6.6	5.4	32	14	12	13	12	11	4	2	0	0	0	1
57	-2.9	3.7	7	5	9	23	23	21	12	0	0	0	0	1	WILSH/SMNCA	84	-6.0	5.2	26	15	8	18	14	12	4	1	1	0	0	1
58	-[illegible].4	3.4	7	3	5	21	24	28	12	0	0	0	0	1	WILSH/FRFAX	82	-5.3	4.6	20	13	13	24	11	12	6	0	0	0	0	1
59	-3.4	3.7	12	3	8	24	25	20	5	2	0	0	0	0	WILSH/WSTRN	83	-4.8	4.3	12	16	18	16	20	14	4	0	0	0	0	2
57	-3.9	4.6	14	7	11	23	23	9	5	9	0	0	0	2	7TH /MAPLE	88	-3.3	3.7	8	5	6	14	48	19	1	0	0	0	0	0

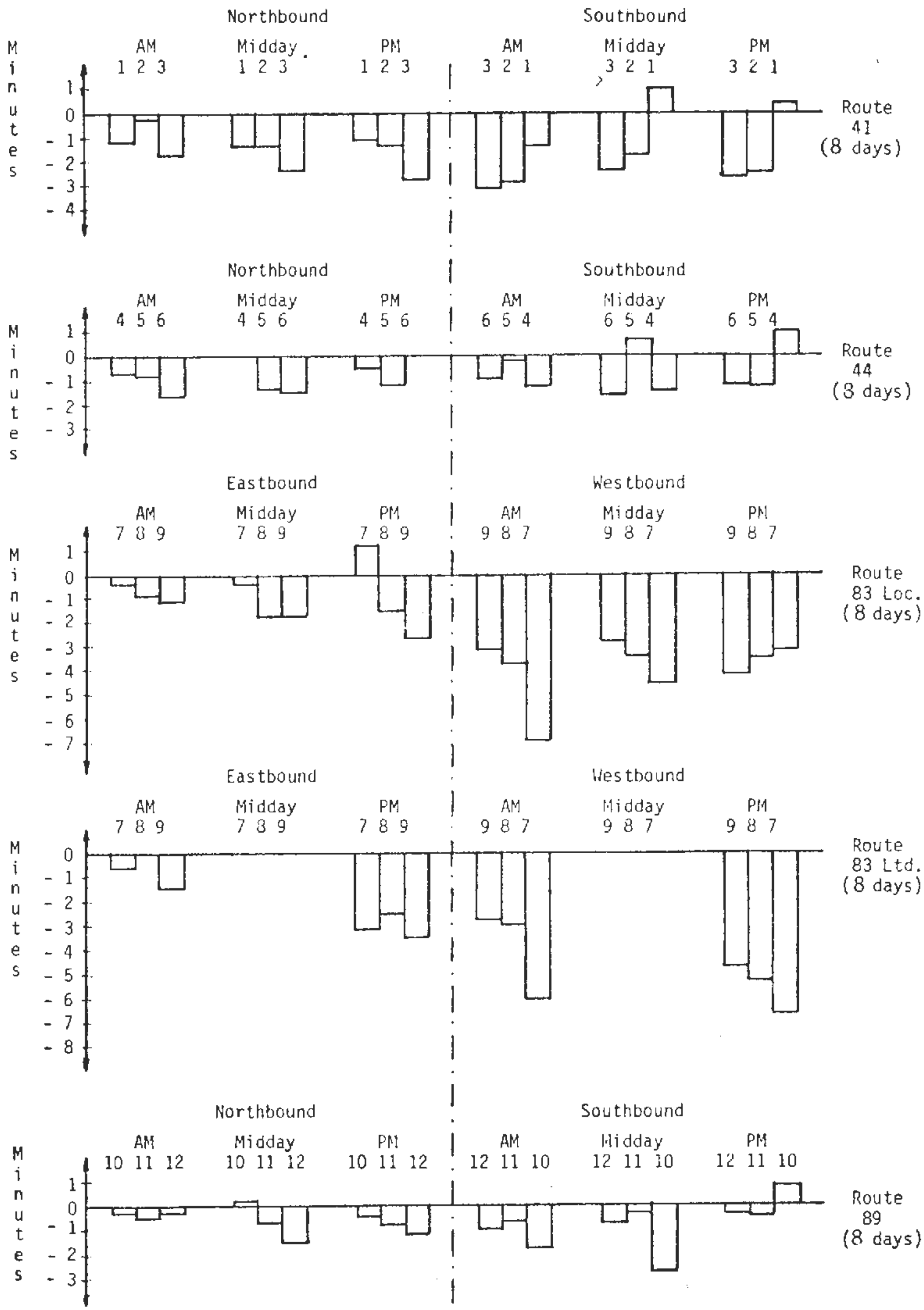
LINE 83 : LIMITED NITE EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

EXHIBIT A-13

AVM ROUTES: MEAN SCHEDULE DEVIATIONS[1]

(By Bus Stop[2] and Time Block)

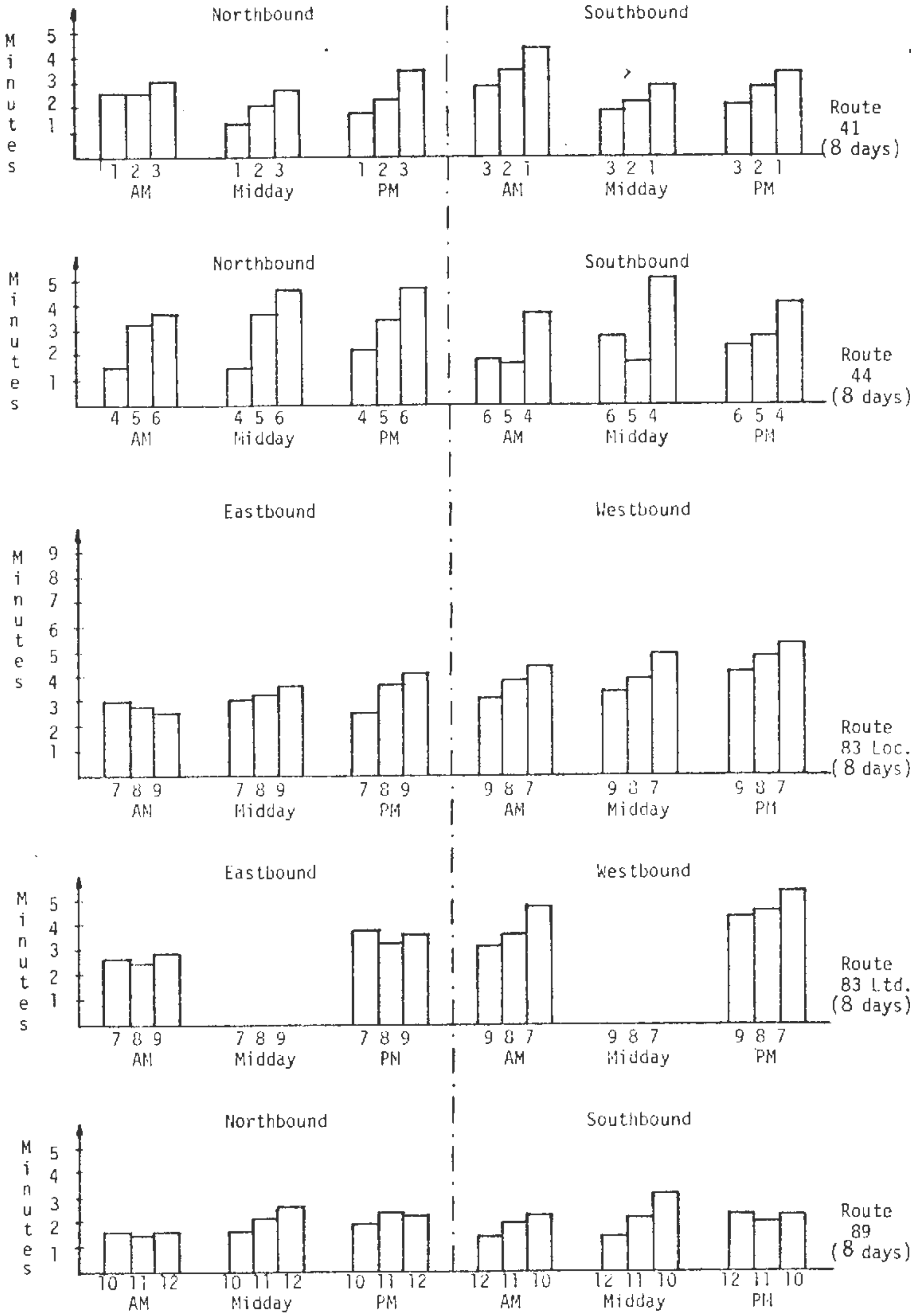


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-8 to A-12.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-14

AVM ROUTES: STANDARD DEVIATION OF SCHEDULE DEVIATIONS[1]

(By Bus Stop[2] and Time Block)

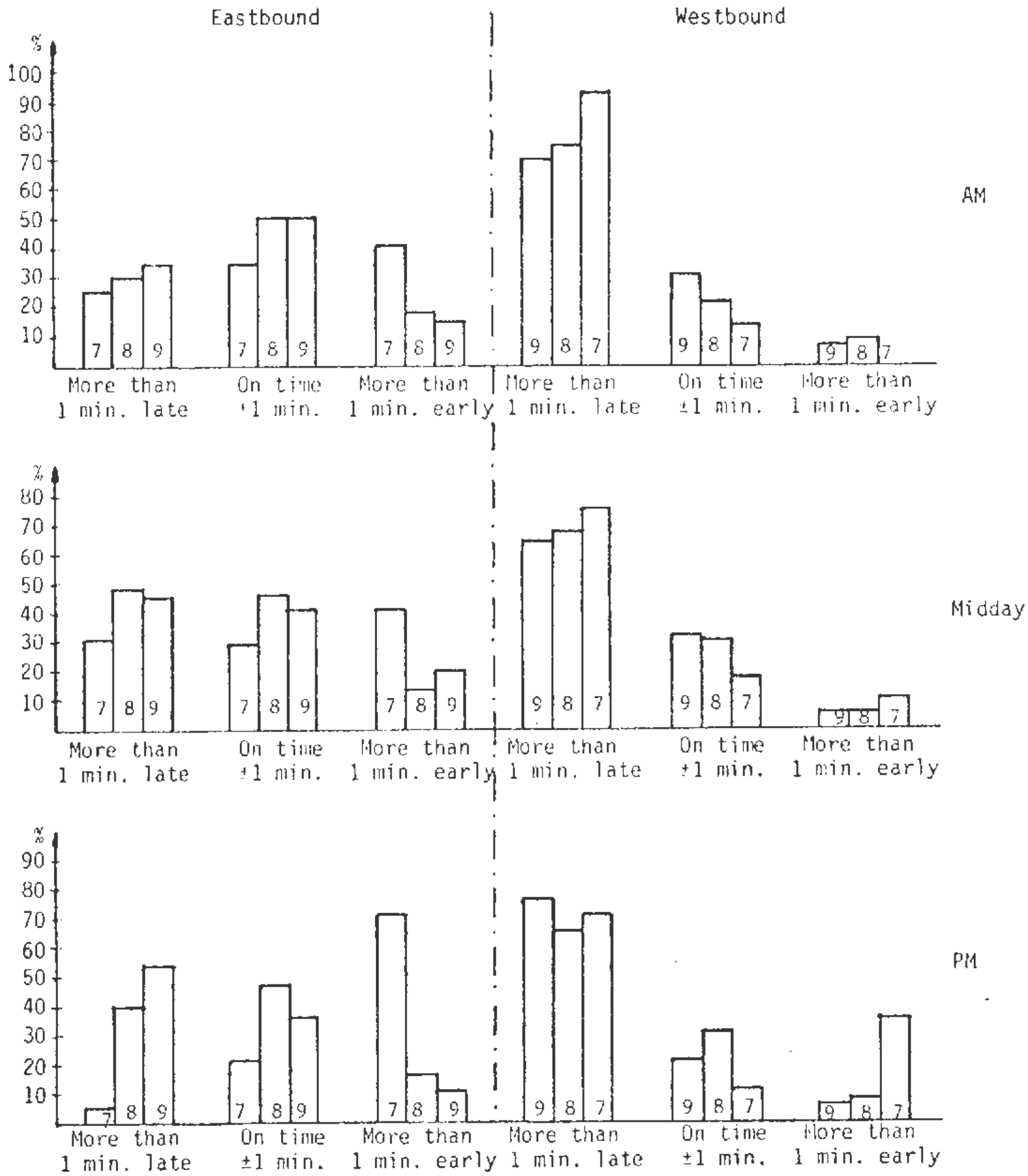


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-8 to A-12.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-15

AVM ROUTE 83 LOCAL: PERCENT OF BUSES EARLY, ON TIME, AND LATE[1]

(By Bus Stop[2])



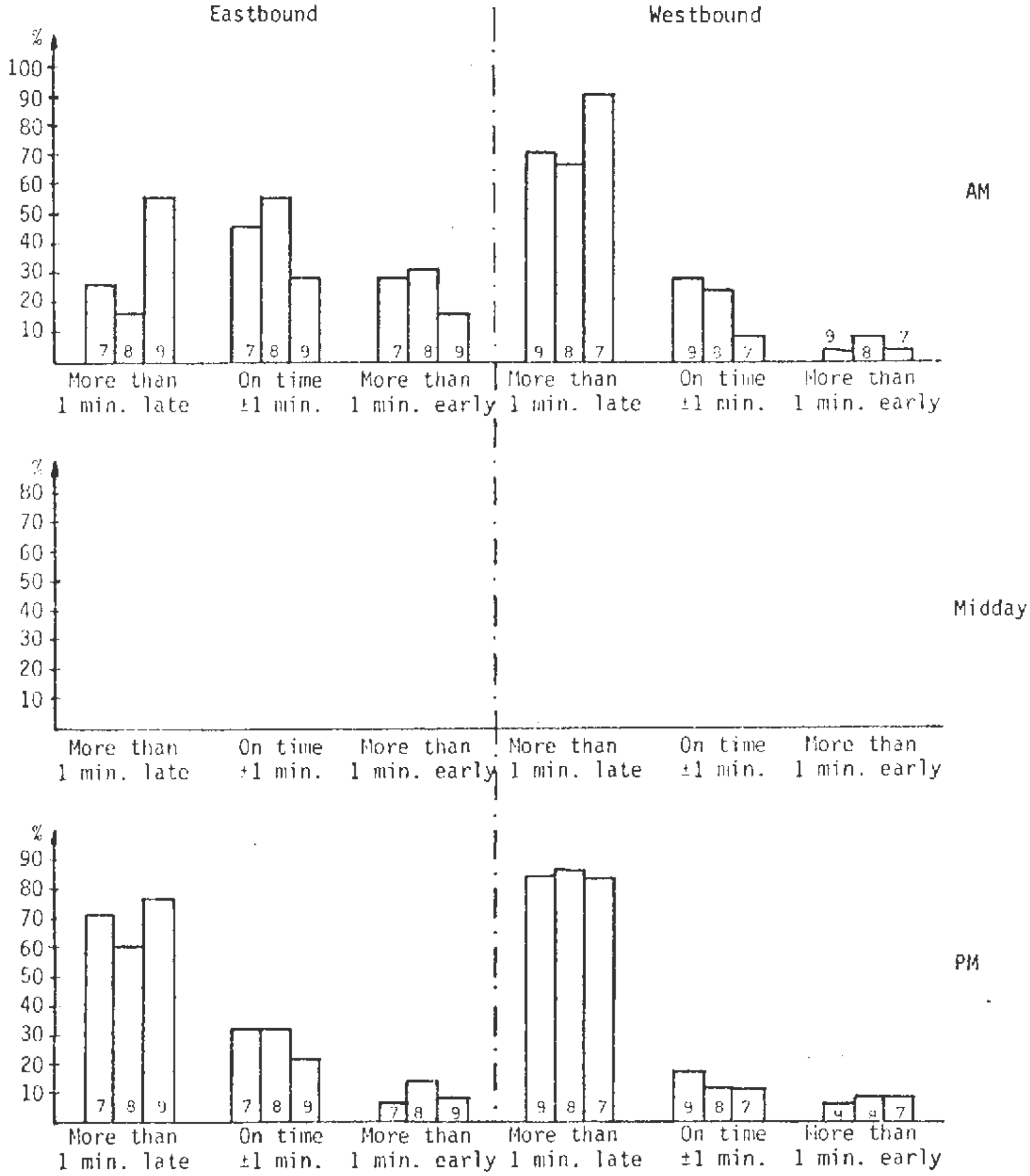
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-11.

2 See bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-16

AVM ROUTE 83 LIMITED: PERCENT OF BUSES EARLY, ON TIME, AND LATE[1]

(By Bus Stop[2])



1 Corresponding numerical values and sample sizes are presented in the Appendix in the Exhibit A-12.

2 See bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-17

CONTROL ROUTES: SCHEDULE DEVIATIONS (4-Day Averages for Route 4)

ROUTE 4

SCHEDULE DEVIATIONS (PERCENTS BY MINUTES) LATE | EARLY

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9<+99										
.	1=NORTHBOUND	5=OLYPIC&RIMPAU	0	.	.	.	.	25	0	0	0	0	0	0	0	0	0	0	0
		6=OLYPIC&FIGURA	0	.	.	.	.	32	0	0	0	0	0	0	0	0	0	0	0
		4=MELROSE&WSTRN	0	.	.	.	.	26	0	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	0	.	.	.	.	9	0	0	0	0	0	0	0	0	0	0	0
		6=OLYPIC&FIGURA	0	.	.	.	.	42	0	0	0	0	0	0	0	0	0	0	0
		5=OLYPIC&RIMPAU	0	.	.	.	.	21	0	0	0	0	0	0	0	0	0	0	0

TIME: 1=AM	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9<+99										
	1=NORTHBOUND	5=OLYPIC&RIMPAU	138	-1.35	2.54	-11.5	3.2	0	1	2	5	11	18	53	9	1	0	0	0
		6=OLYPIC&FIGURA	122	0.34	3.98	-11.3	10.0	0	2	3	4	7	16	24	15	20	7	1	1
		4=MELROSE&WSTRN	130	-1.20	3.83	-11.6	8.9	0	5	5	3	14	18	34	12	4	4	2	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	83	-0.03	1.76	-10.0	3.3	0	1	0	1	1	8	73	13	1	0	0	0
		6=OLYPIC&FIGURA	130	1.15	3.53	-15.0	6.0	0	2	2	2	3	12	29	16	28	7	0	0
		5=OLYPIC&RIMPAU	209	-0.86	2.75	-9.9	7.5	0	1	5	1	9	16	49	17	1	0	0	0

TIME: 2=MIDDAY	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9<+99										
	1=NORTHBOUND	5=OLYPIC&RIMPAU	287	-0.74	2.92	-13.6	13.9	2	2	2	3	5	20	53	10	3	0	0	0
		6=OLYPIC&FIGURA	291	-1.50	3.33	-19.3	8.8	1	4	2	6	10	22	44	9	1	1	0	0
		4=MELROSE&WSTRN	199	-1.17	4.68	-15.0	8.8	0	7	4	9	8	19	25	13	10	5	2	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	204	-0.64	2.23	-15.0	5.3	0	2	0	1	5	26	50	13	2	0	0	0
		6=OLYPIC&FIGURA	247	-1.51	2.23	-15.3	6.0	0	2	4	2	13	26	42	9	1	1	0	0
		5=OLYPIC&RIMPAU	253	-1.24	3.32	-12.9	6.7	0	4	3	5	9	18	42	15	2	1	0	0

TIME: 3=PM	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9<-7<-5<-3<-1<+1<+3<+5<+7<+9<+99										
	1=NORTHBOUND	5=OLYPIC&RIMPAU	73	-1.46	3.38	-18.1	5.8	1	3	3	3	14	25	38	12	1	1	0	0
		6=OLYPIC&FIGURA	57	-2.09	2.91	-9.0	4.0	3	0	7	11	16	26	25	14	2	0	0	0
		4=MELROSE&WSTRN	19	-0.37	3.83	-7.1	6.4	0	0	5	0	16	42	5	11	11	11	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	40	-1.12	2.36	-7.6	2.0	0	0	3	8	10	15	50	15	0	0	0	0
		6=OLYPIC&FIGURA	64	-2.06	5.33	-24.0	6.5	0	13	2	2	20	20	21	14	4	2	0	0
		5=OLYPIC&RIMPAU	75	-2.92	5.59	-20.6	5.2	0	12	4	4	8	29	17	20	4	1	0	0

EXHIBIT A-18

CONTROL ROUTES: SCHEDULE DEVIATIONS (6-Day Averages for Route 84)

ROUTE 84

SCHEDULE DEVIATIONS (PERCENTS BY MINUTES) — LATE | EARLY

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9	<+99
.	1=NORTHBOUND	3=NSTRNCMANCHSTR	0	.	.	.	.	19	0	0	0	0	0	0	0	0	0	0	0
		2=NSTRNCADAMS	0	.	.	.	.	9	0	0	0	0	0	0	0	0	0	0	0
		1=NSTRNCMELROSE	0	.	.	.	.	15	0	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	1=NSTRNCMELROSE	0	.	.	.	.	27	0	0	0	0	0	0	0	0	0	0	0
		2=NSTRNCADAMS	0	.	.	.	.	13	0	0	0	0	0	0	0	0	0	0	0
		3=NSTRNCMANCHSTR	0	.	.	.	.	32	0	0	0	0	0	0	0	0	0	0	0
1=AM	1=NORTHBOUND	3=NSTRNCMANCHSTR	103	-0.29	2.70	-6.5	5.0	0	0	3	1	9	22	36	22	7	0	0	0
		2=NSTRNCADAMS	143	-1.26	1.89	-7.3	3.0	0	0	1	3	13	25	56	2	0	0	0	0
		1=NSTRNCMELROSE	162	-3.19	2.42	-10.0	1.5	0	1	7	13	25	36	18	1	0	0	0	0
	3=SOUTHBOUND	1=NSTRNCMELROSE	91	-0.74	1.50	-4.8	2.8	2	0	0	0	5	36	45	13	0	0	0	0
		2=NSTRNCADAMS	86	-1.07	2.25	-7.0	5.0	18	0	0	6	9	20	52	12	1	0	0	0
		3=NSTRNCMANCHSTR	119	2.06	2.55	-4.8	9.0	0	0	0	0	3	8	28	29	24	7	2	0
2=MIDDAY	1=NORTHBOUND	3=NSTRNCMANCHSTR	265	-0.16	1.87	-8.7	5.9	0	0	0	2	4	15	60	16	3	0	0	0
		2=NSTRNCADAMS	262	-0.30	1.50	-7.6	6.0	0	0	0	0	3	23	63	10	0	1	0	0
		1=NSTRNCMELROSE	259	-1.72	2.64	-16.2	5.0	0	2	2	6	15	31	34	9	2	0	0	0
	3=SOUTHBOUND	1=NSTRNCMELROSE	281	-0.78	1.86	-8.8	4.2	0	0	1	3	7	24	54	11	0	0	0	0
		2=NSTRNCADAMS	295	-1.59	2.45	-11.3	5.2	2	2	2	5	10	26	52	2	0	0	0	0
		3=NSTRNCMANCHSTR	294	-0.46	4.23	-31.3	6.7	2	3	3	6	10	13	24	28	10	2	1	0
3=PM	1=NORTHBOUND	3=NSTRNCMANCHSTR	100	-0.57	2.34	-8.9	6.2	0	0	2	3	4	26	45	16	2	2	0	0
		2=NSTRNCADAMS	95	-0.91	2.41	-14.5	6.8	0	1	0	5	3	32	46	11	1	1	0	0
		1=NSTRNCMELROSE	78	-1.46	3.11	-11.0	5.5	0	3	4	4	12	33	29	10	3	3	0	0
	3=SOUTHBOUND	1=NSTRNCMELROSE	117	-1.12	2.95	-10.5	5.0	0	2	4	7	7	22	39	16	3	0	0	0
		2=NSTRNCADAMS	106	-2.87	2.97	-12.7	1.7	0	5	6	10	14	27	33	3	0	0	0	0
		3=NSTRNCMANCHSTR	82	-0.79	3.68	-10.8	7.0	0	2	2	13	6	20	22	20	10	4	1	0

EXHIBIT A-19

CONTROL ROUTES: SCHEDULE DEVIATIONS (4-Day Averages for Route 91)

ROUTE 91

SCHEDULE DEVIATIONS (PERCENTS BY MINUTES) LATE] EARLY

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	-9<-7	-7<-5	-5<-3	-3<-1	-1<+1	+1<+3	+3<+5	+5<+7	+7<+9	+9<+99
.	2=WESTBOUND	9=SUNSET&GRAND	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	21	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	15	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	20	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	20	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	-9<-7	-7<-5	-5<-3	-3<-1	-1<+1	+1<+3	+3<+5	+5<+7	+7<+9	+9<+99
1=AM	2=WESTBOUND	9=SUNSET&GRAND	38	-1.33	2.03	-5.8	2.8	0	0	0	3	16	39	26	16	0	0	0	0
		8=SUNSET&ECHPARK	98	-1.42	2.34	-12.0	2.3	0	2	0	4	12	24	52	5	0	0	0	0
		7=SUNSET&SANBORN	95	-0.93	3.08	-14.3	5.3	0	3	2	2	6	20	55	6	4	1	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	75	-0.29	2.61	-6.5	7.8	0	0	0	3	8	24	51	7	1	4	3	0
		8=SUNSET&ECHPARK	96	-1.21	2.03	-7.0	4.5	0	0	0	5	7	33	47	5	2	0	0	0
		9=SUNSET&GRAND	49	-0.85	2.19	-5.7	5.0	0	0	0	2	12	29	37	18	2	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	-9<-7	-7<-5	-5<-3	-3<-1	-1<+1	+1<+3	+3<+5	+5<+7	+7<+9	+9<+99
2=MIDDAY	2=WESTBOUND	9=SUNSET&GRAND	174	-1.16	2.77	-18.5	3.2	0	1	1	5	11	21	47	13	1	0	0	0
		8=SUNSET&ECHPARK	177	-1.56	3.15	-18.3	9.2	1	2	1	7	14	23	46	6	1	0	0	1
		7=SUNSET&SANBORN	176	-2.02	3.67	-21.9	8.2	1	3	3	11	15	16	44	5	1	1	1	0
	4=EASTBOUND	7=SUNSET&SANBORN	216	-1.80	3.73	-13.5	9.1	0	6	3	7	10	19	43	6	3	1	0	0
		8=SUNSET&ECHPARK	209	-2.79	4.07	-17.0	5.7	2	9	6	11	12	20	31	8	3	0	0	0
		9=SUNSET&GRAND	217	-1.98	4.23	-16.2	6.7	0	9	5	8	11	15	30	13	7	2	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	-9<-7	-7<-5	-5<-3	-3<-1	-1<+1	+1<+3	+3<+5	+5<+7	+7<+9	+9<+99
3=PM	2=WESTBOUND	9=SUNSET&GRAND	122	-2.06	3.06	-10.0	4.6	1	1	6	14	10	32	22	14	2	0	0	0
		8=SUNSET&ECHPARK	103	-2.69	3.23	-11.2	3.8	1	5	5	11	21	21	26	10	1	0	0	0
		7=SUNSET&SANBORN	91	-4.23	4.51	-17.0	4.8	0	14	10	12	21	11	25	5	1	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	45	-4.31	5.66	-17.6	4.8	0	22	9	4	20	4	29	9	2	0	0	0
		8=SUNSET&ECHPARK	41	-3.61	5.17	-20.2	2.2	1	15	10	7	7	22	22	17	0	0	0	0
		9=SUNSET&GRAND	51	-3.00	5.39	-17.0	5.7	0	16	8	12	6	12	24	16	4	4	0	0

EXHIBIT A-20

CONTROL ROUTES: SCHEDULE DEVIATIONS (4-Day Averages for Route 94)

ROUTE 94

SCHEDULE DEVIATIONS (PERCENTS BY MINUTES)

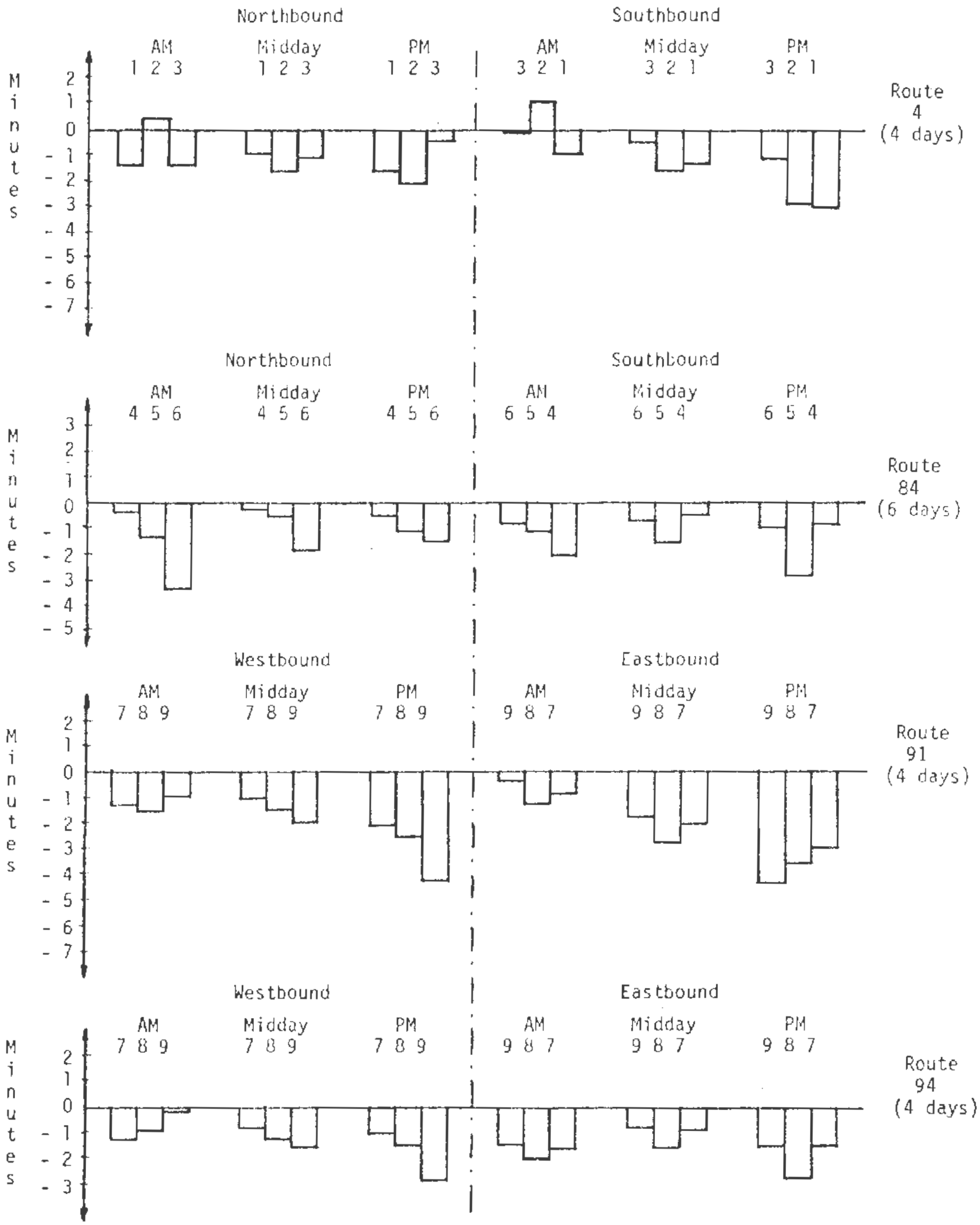
LATE | EARLY

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	-99<-9	-9<-7	-7<-5	-5<-3	-3<-1	-1<+1	+1<+3	+3<+5	+5<+7	+7<+9	+9<+99
.	2=WESTBOUND	9=SUNSET&GRAND	0	.	.	.	.	2	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	5	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	12	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	15	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0
1=AM	2=WESTBOUND	9=SUNSET&GRAND	22	-1.17	2.41	-6.3	3.0	0	0	0	5	18	32	18	27	0	0	0	0
		8=SUNSET&ECHPARK	52	-0.94	1.96	-7.0	2.3	2	0	0	4	10	15	63	8	0	0	0	0
		7=SUNSET&SANBORN	51	-0.10	2.22	-6.7	5.0	0	0	0	6	6	10	51	25	0	2	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	47	-1.54	2.51	-7.5	3.5	0	0	2	9	17	19	45	6	2	0	0	0
		8=SUNSET&ECHPARK	60	-2.01	2.89	-10.3	6.5	0	2	2	12	17	20	43	3	0	2	0	0
		9=SUNSET&GRAND	31	-1.75	2.55	-6.8	2.3	0	0	0	13	19	19	39	10	0	0	0	0
2=MIDDAY	2=WESTBOUND	9=SUNSET&GRAND	160	-0.79	2.10	-12.1	3.3	1	1	1	1	8	29	48	12	1	0	0	0
		8=SUNSET&ECHPARK	159	-1.21	2.42	-13.8	5.3	2	1	0	4	11	30	45	6	2	1	0	0
		7=SUNSET&SANBORN	162	-1.46	2.90	-14.0	7.5	0	2	3	5	13	27	32	14	2	1	1	0
	4=EASTBOUND	7=SUNSET&SANBORN	166	-0.80	2.63	-10.0	9.9	0	2	1	3	11	21	45	15	1	1	0	1
		8=SUNSET&ECHPARK	162	-1.73	3.06	-15.6	4.3	2	2	5	6	17	22	32	15	2	0	0	0
		9=SUNSET&GRAND	168	-0.85	3.21	-14.2	5.6	0	1	5	6	14	15	29	24	5	1	0	0
3=PM	2=WESTBOUND	9=SUNSET&GRAND	67	-1.11	2.51	-9.3	4.1	0	1	3	6	4	27	48	7	3	0	0	0
		8=SUNSET&ECHPARK	54	-1.58	2.59	-8.2	3.7	1	0	4	11	7	33	37	4	4	0	0	0
		7=SUNSET&SANBORN	51	-3.37	6.47	-34.5	6.3	1	8	10	8	14	14	35	8	2	2	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	43	-1.56	2.93	-9.8	3.3	0	5	2	5	12	28	37	9	2	0	0	0
		8=SUNSET&ECHPARK	36	-2.74	2.69	-9.1	2.8	0	3	3	17	14	36	22	6	0	0	0	0
		9=SUNSET&GRAND	41	-1.67	3.13	-9.0	2.9	0	2	7	10	7	20	34	20	0	0	0	0

EXHIBIT A-21

CONTROL ROUTES: MEAN SCHEDULE DEVIATIONS[1]

(By Bus Stop[2] and Time Block)



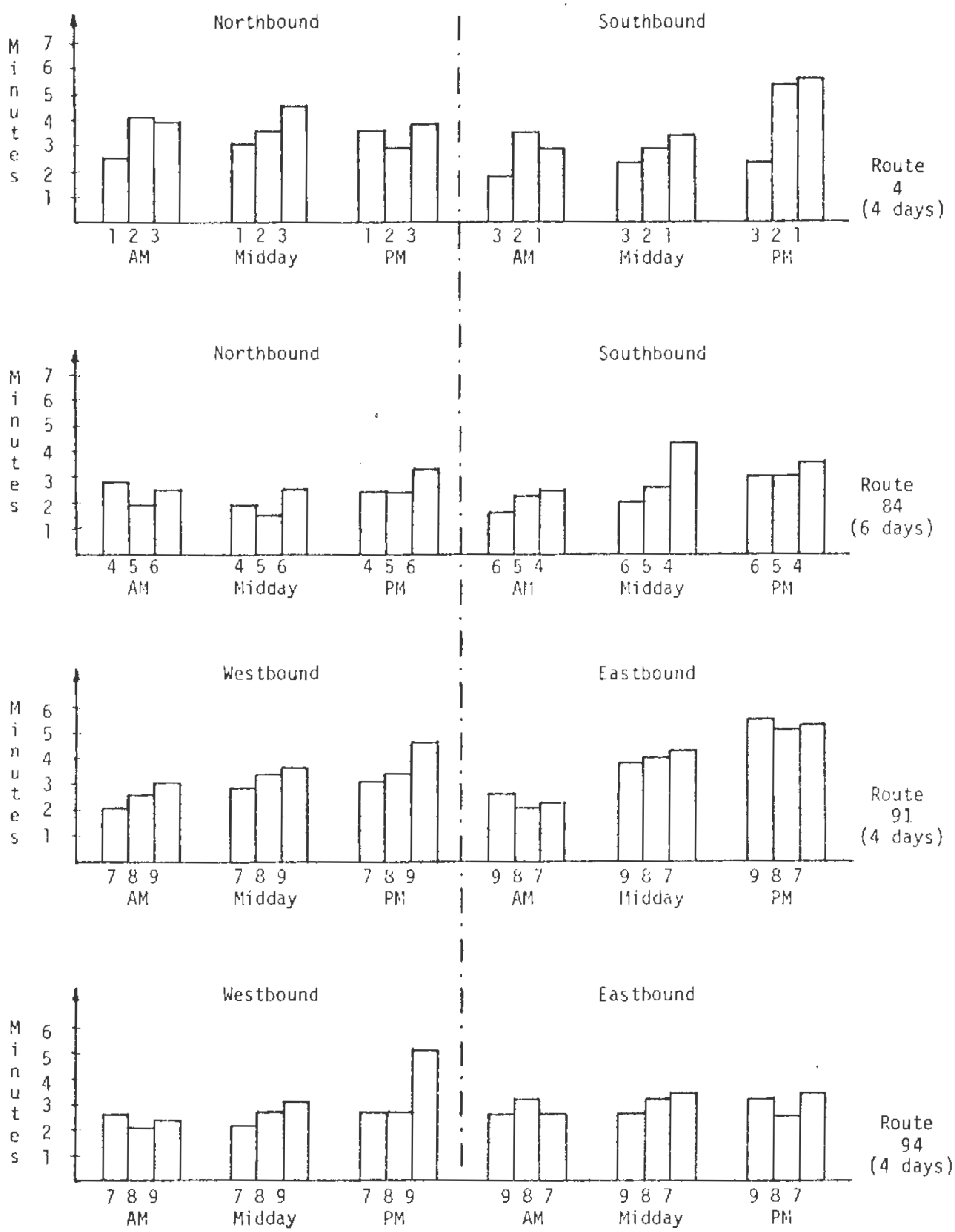
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-17 to A-20.

2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-22

CONTROL ROUTES: STANDARD DEVIATION OF SCHEDULE DEVIATIONS[1]

(By Bus Stop[2] and Time Block)



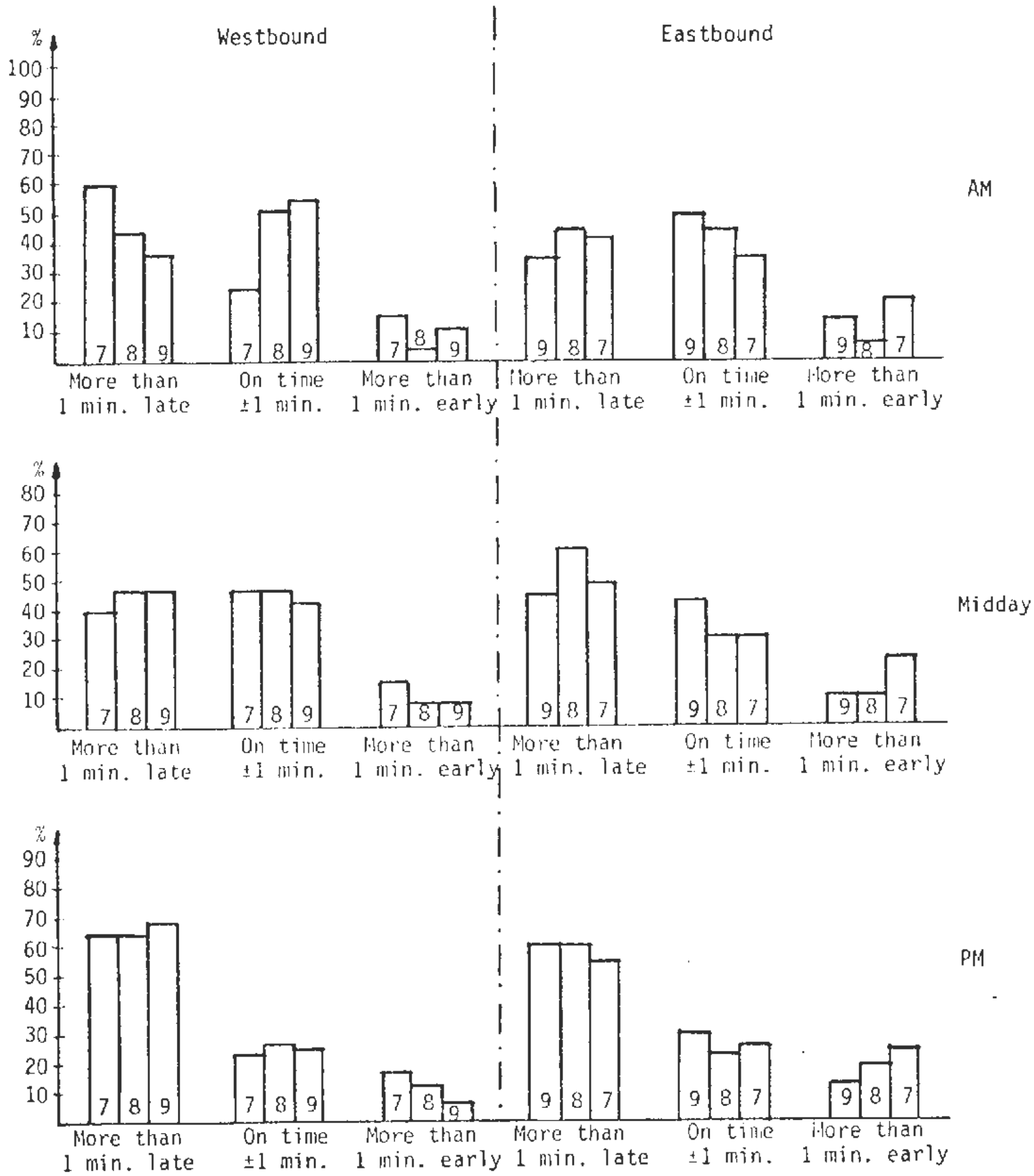
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-17 to A-20.

2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-23

CONTROL ROUTE 91: PERCENT OF BUSES EARLY, ON TIME, AND LATE[1]

(By Bus Stop[2])



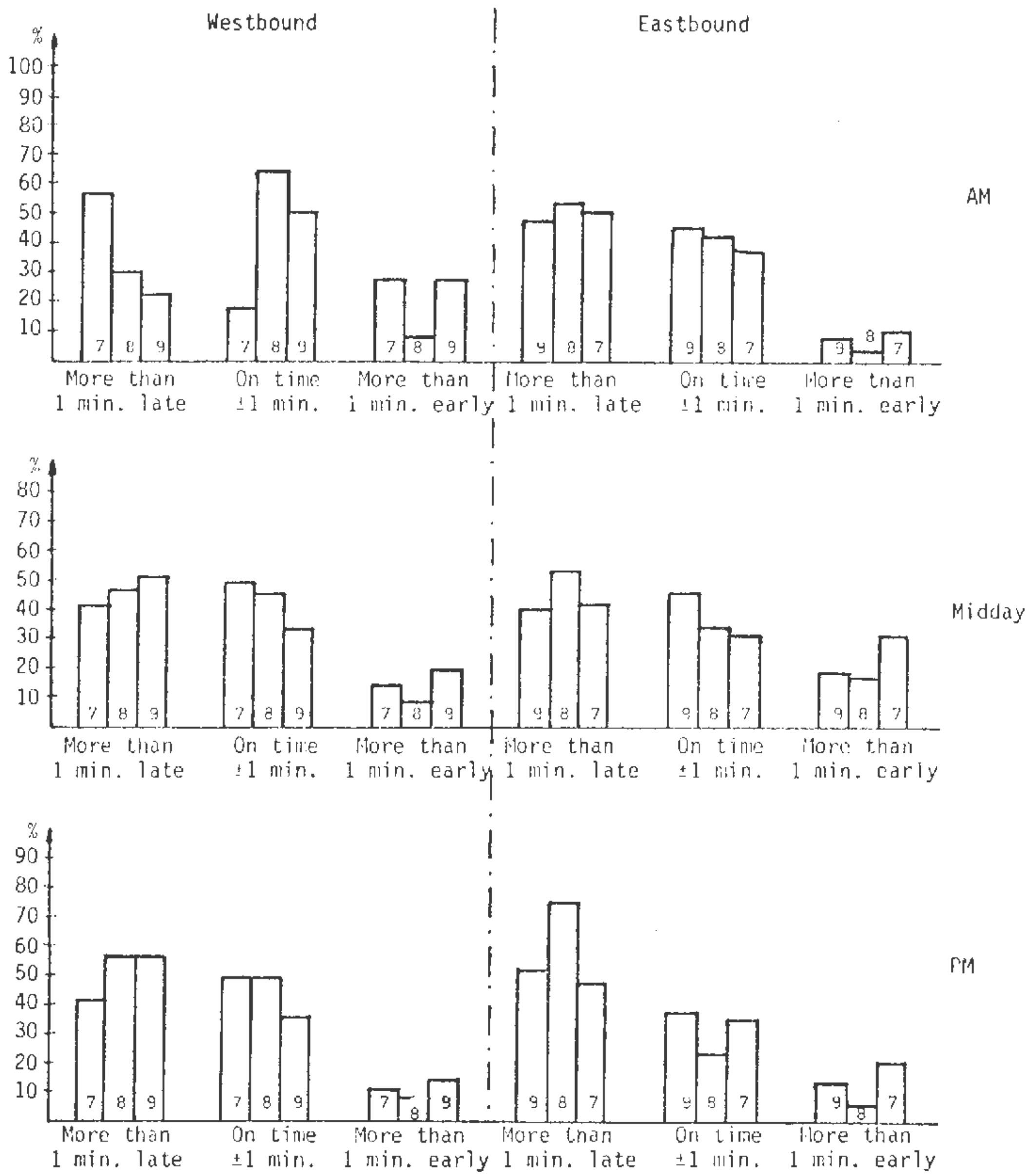
1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-19.

2 See bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-24

CONTROL ROUTE 94: PERCENT OF BUSES EARLY, ON TIME, AND LATE[1]

(By Bus Stop[2])



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibit A-20.

2 See bus stop correspondence table, Exhibit 5.10.

EXHIBIT A-25

MEAN SCHEDULE DEVIATIONS ON RAINY DAYS[1]

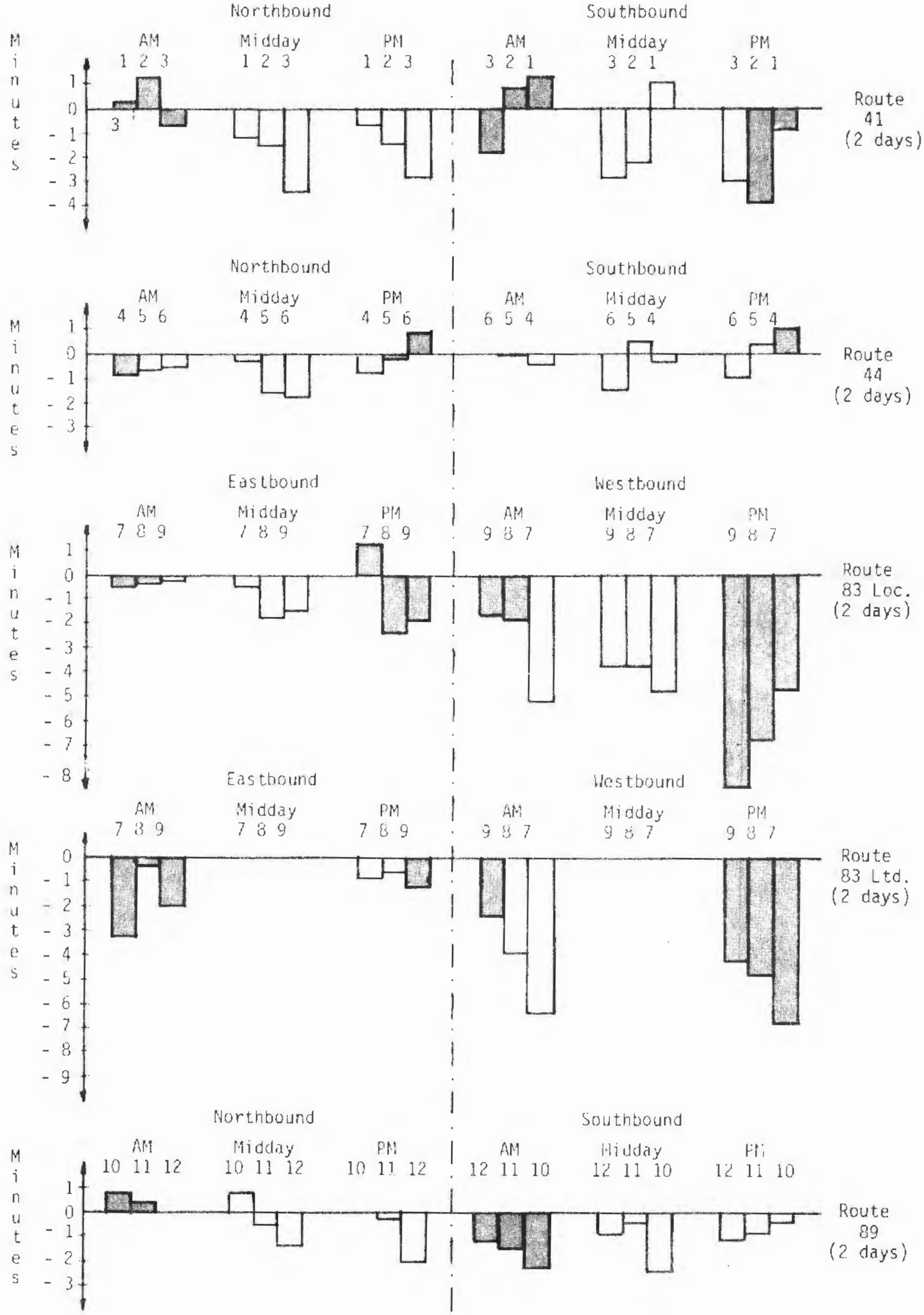
ROUTES	AM			MIDDAY			PM		
DIRECTIONS	1[2]	2	3	1	2	3	1	2	3
41									
Northbound	0.4	1.3	-0.7	-1.2	-1.5	-3.3	-0.6	-1.4	-2.9
Southbound	-1.9	0.7	2.4	-2.8	-2.1	1.0	-3.0	-3.9	-0.8
44									
Northbound	-0.9	-0.8	-0.5	-0.2	-1.6	-1.7	-0.8	-0.1	2.5
Southbound	0.0	-0.1	-0.5	-1.5	0.4	-0.4	-1.1	0.2	2.3
89									
Northbound	0.7	0.3	0.0	0.6	-0.5	-1.4	-0.0	-0.1	-2.0
Southbound	-1.1	-1.5	-2.2	-0.9	-0.5	-2.4	-1.1	-0.8	-0.2
83 LOC.									
Eastbound	-0.5	-0.4	-0.2	-0.4	-1.7	-1.5	1.4	-2.3	-1.9
Westbound	-1.6	-1.8	-5.1	-3.8	-3.8	-4.7	-8.8	-6.9	-4.8
83 LTD.									
Eastbound	-3.3	-0.5	-2.0	Rush-hour runs only			-0.8	-0.7	-1.2
Westbound	-2.5	-4.0	-6.4				-4.3	-4.6	-6.8
4									
Northbound	-0.70	-1.65	-1.78	-0.90	-1.79	-1.51	-1.55	-2.06	
Southbound	-1.01		-0.54	-0.77	-2.02	-1.55		-8.93	-8.75
84									
Northbound	-1.71	-1.56	-3.08	-0.72	-0.80	-1.05	-1.22	-1.01	-0.53
Southbound	-1.21	0.19	3.15	-0.59	-2.04	-0.34	0.37	-2.07	0.58
91									
Westbound	-1.80	-1.28	-1.43	-0.58	-1.52	-1.36	-1.28	-2.98	-7.74
Eastbound	-0.86	-1.25	-0.69	-1.23	-1.56	-0.26	-4.93	-1.96	-0.51
94									
Westbound	-2.09	-1.06	-0.18	-0.26	-0.82	-1.10	-0.18	-1.66	-7.02
Eastbound	-2.31	-2.82	-3.17	-0.45	-0.83	0.21	-1.73	-1.86	0.33

1 In minutes; two days of data collection for AVM routes, one day for control routes.
2 Successive bus stops in each direction (compare Exhibit 5.10).

EXHIBIT A-26

AVM ROUTES: MEAN SCHEDULE DEVIATIONS FOR RAINY DAYS[1]

(By Bus Stop[2] and Time Block)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-25 and A-31.

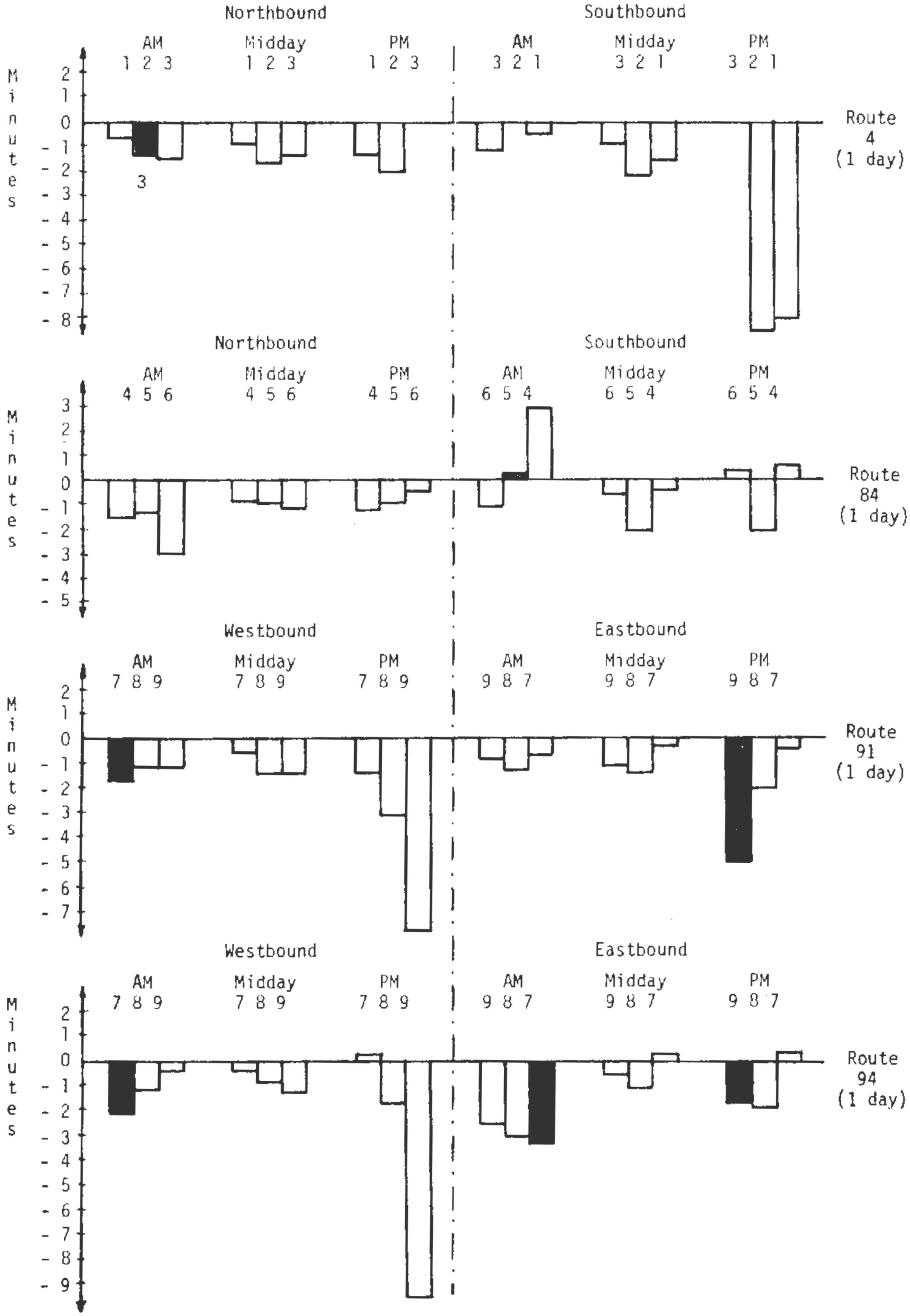
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.

3 Sample sizes of less than 10 are identified by shading.

EXHIBIT A-27

CONTROL ROUTES: MEAN SCHEDULE DEVIATIONS FOR RAINY DAY[1]

(By Bus Stop[2] and Time Block)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-25 and A-31.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.
3 Sample sizes of less than 10 are identified by shading.

EXHIBIT A-28

STANDARD DEVIATIONS FOR SCHEDULE DEVIATION DATA ON RAINY DAYS[1]

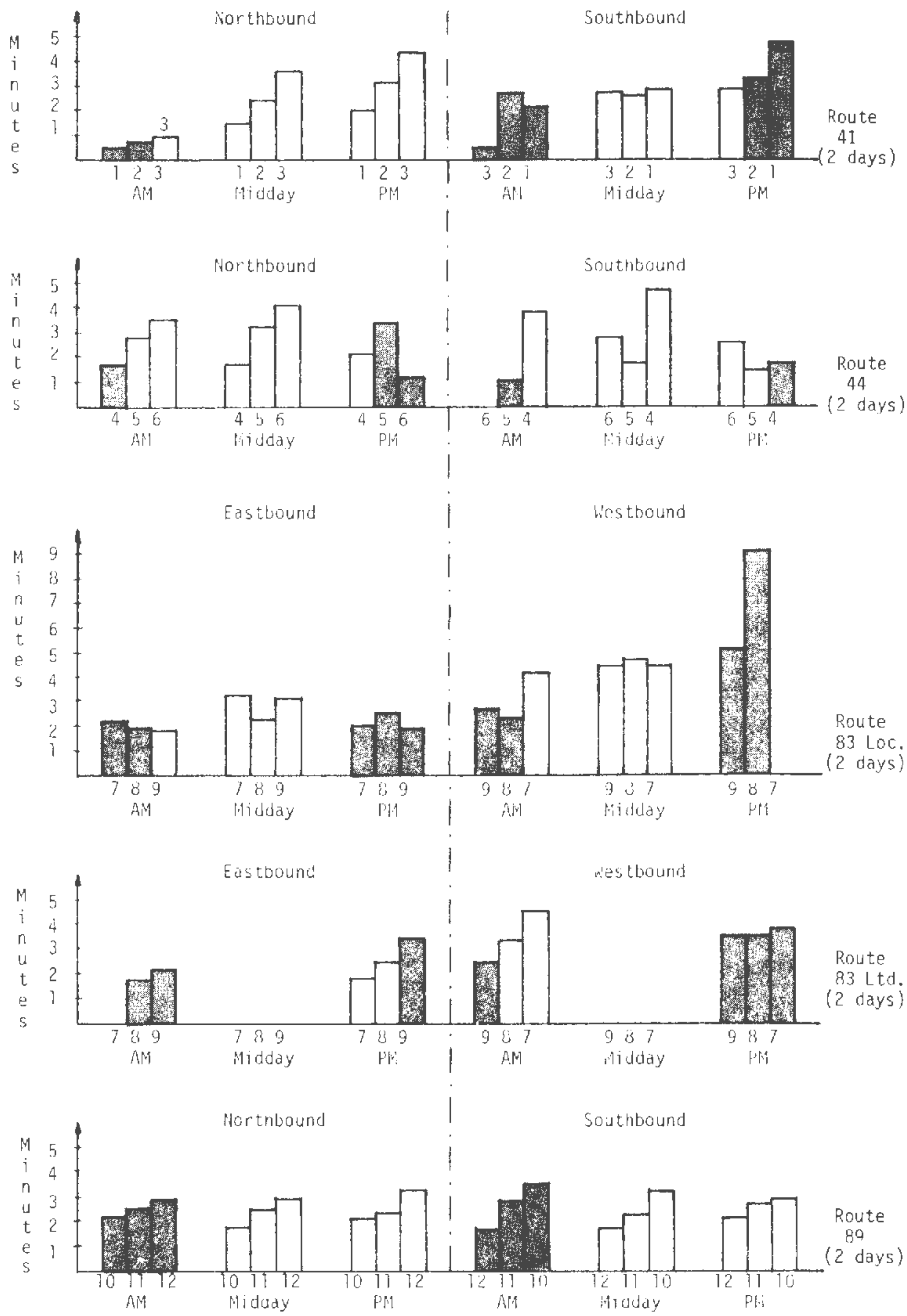
ROUTES	AM			MIDDAY			PM		
DIRECTIONS	1[2]	2	3	1	2	3	1	2	3
41									
Northbound	0.5	0.9	1.0	1.5	2.5	3.6	2.0	3.1	4.3
Southbound	0.5	2.6	2.1	2.7	2.6	2.9	2.8	3.4	4.8
44									
Northbound	1.6	2.9	3.5	1.6	3.3	4.1	2.1	3.4	1.2
Southbound	0.0	1.1	3.9	2.8	1.8	4.7	2.5	1.3	1.7
89									
Northbound	2.1	2.5	2.9	1.8	2.5	3.0	2.1	2.3	3.3
Southbound	1.8	2.9	3.5	1.6	2.1	3.2	2.1	2.6	2.9
83 LOC.									
Eastbound	2.1	1.8	1.9	3.2	2.2	3.1	2.0	2.5	1.8
Westbound	2.6	2.3	4.1	4.5	4.7	4.5	5.2	9.1	0.0[3]
83 LTD.				Rush-hour runs only					
Eastbound	0.0	1.7	2.1				1.9	2.5	3.5
Westbound	2.5	3.3	4.5				3.5	3.5	3.7
4									
Northbound	2.51	3.84	3.64	2.99	3.88	4.48	2.89	3.03	
Southbound	2.85		3.21	1.60	2.62	3.66		6.68	7.73
84									
Northbound	2.37	1.74	2.56	1.85	1.36	2.41	2.34	1.02	2.89
Southbound	1.70	1.24	1.99	1.58	2.45	3.47	1.36	2.82	2.72
91									
Westbound	1.46	2.98	3.05	2.06	3.06	3.09	3.09	3.58	4.44
Eastbound	1.79	1.65	1.61	3.32	3.53	3.59	7.37	3.62	4.09
94									
Westbound	1.67	2.00	2.34	1.75	3.24	2.30	1.31	1.83	6.44
Eastbound	2.14	2.56	2.66	2.07	2.57	2.64	2.85	2.38	2.10

1. In minutes; two days of data collection for AVM routes, one day for control routes.
2. Successive bus stops in each direction (Compare Exhibit 5.10).
3. Zero values caused by sample sizes of n=1.

EXHIBIT A-29

AVM ROUTES: STANDARD DEVIATION OF SCHEDULE DEVIATIONS FOR RAINY DAYS[1]

(By Bus Stop[2] and Time Block)

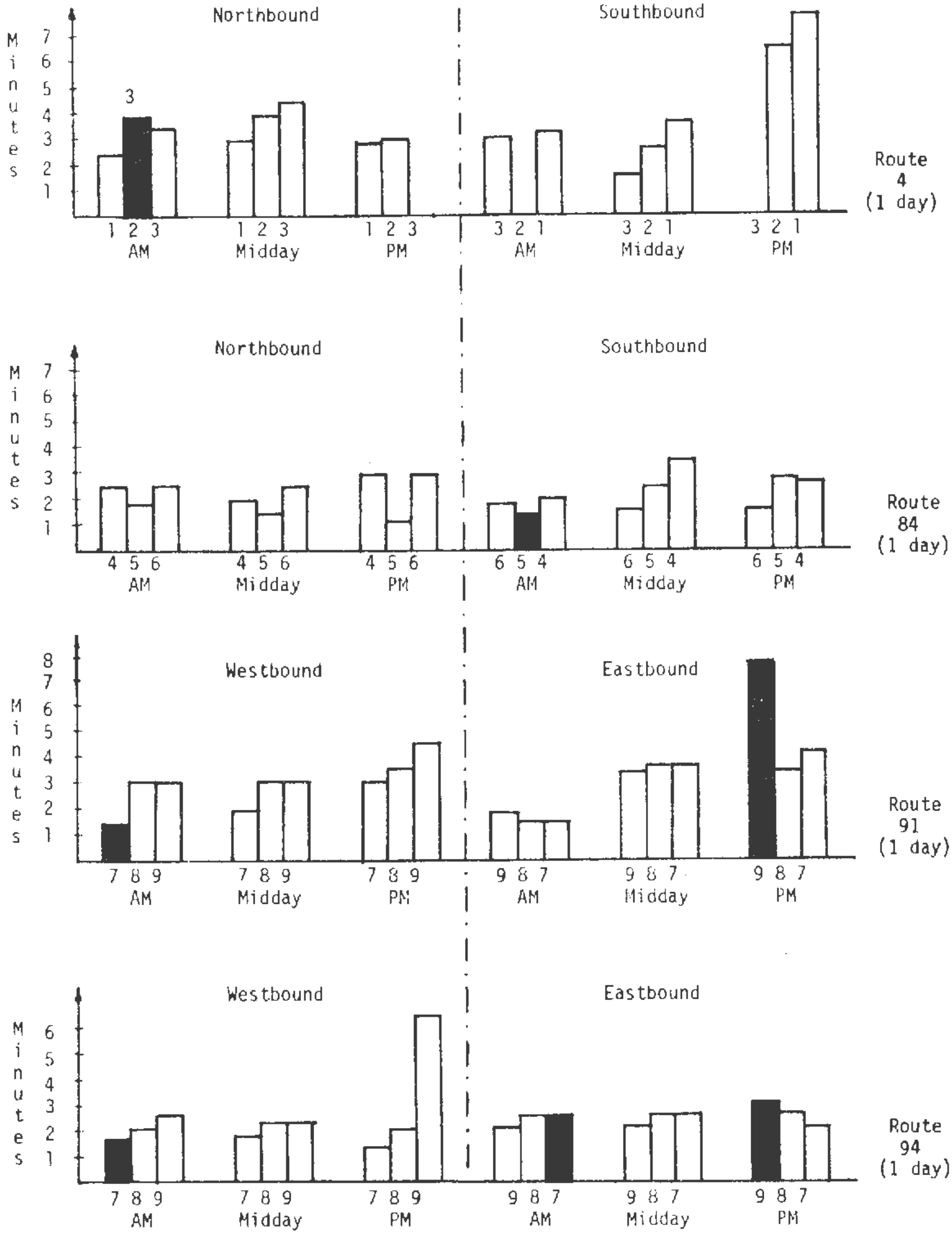


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-28 and A-31.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.
3 Sample sizes of less than 10 are identified by shading.

EXHIBIT A-30

CONTROL ROUTES: STANDARD DEVIATION OF SCHEDULE DEVIATIONS FOR RAINY DAY[1]

(By Bus Stop[2] and Time Block)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-28 to A-31.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.
3 Sample sizes of less than 10 are identified by shading.

EXHIBIT A-31

SAMPLE SIZES FOR SCHEDULE DEVIATION DATA ON RAINY DAYS[1]

ROUTES DIRECTIONS	AM 1[2]	AM 2	AM 3	MIDDAY 1	MIDDAY 2	MIDDAY 3	PM 1	PM 2	PM 3
41									
Northbound	2	2	2	42	40	41	10	10	10
Southbound	2	2	2	39	39	42	12	9	8
44									
Northbound	3	16	15	51	46	47	16	5	2
Southbound	0	5	12	52	52	48	11	12	5
89									
Northbound	4	6	9	51	53	53	14	12	10
Southbound	5	7	8	57	56	58	13	11	10
83 LOC.									
Eastbound	7	9	11	104	98	98	8	4	4
Westbound	5	8	12	100	102	101	3	2	1
83 LTD.									
Eastbound	1	4	7	Rush-hour runs only			14	12	9
Westbound	7	11	16				6	5	3
4									
Northbound	34	4	35	71	65	33	19	14	
Southbound	21		52	47	64	63		20	18
84									
Northbound	18	24	28	45	44	43	16	16	13
Southbound	13	7	19	47	50	47	20	19	13
91									
Westbound	8	24	26	45	44	44	32	27	17
Eastbound	20	24	12	53	54	56	5	12	14
94									
Westbound	5	13	14	42	40	41	16	13	10
Eastbound	13	15	7	42	40	43	9	10	10

1 Corresponding to Exhibits A-25 to A-30.
2 Successive bus stops in each direction (Compare Exhibit 5.10).

AVM Routes: Two days of data collection for each route
Control Routes: One day of data collection for each route

APPENDIX SECTION III

SUPPLEMENTARY DATA AND FIGURES FOR PASSENGER LOADS

Exhibit No.

EXHIBIT A-32

AVM ROUTES: PASSENGER LOADS

(8-Day Averages for Route 41)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

LOAD FACTOR (# OF PASSENGERS)

LINE 41 AM

NORTHBOUND															SOUTHBOUND													
NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100	BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100	BAD
50	4.9	4.8	82	18	0	0	0	0	0	0	0	0	0	30	SBARB/FGROA	53	6.3	12.5	77	15	6	0	0	0	0	2	0	0	0	30
52	35.0	16.7	4	12	27	27	13	2	12	4	0	0	0	30	ALVRD/PICO	51	26.7	19.1	16	18	22	14	18	6	8	0	0	0	0	30
50	41.7	17.7	2	10	14	16	20	24	12	0	2	0	0	34	ALVRD/SIXTH	50	37.0	17.7	8	4	26	12	28	14	6	2	0	0	0	30
51	7.8	11.6	73	20	0	2	4	2	0	0	0	0	0	31	MONT /LBRTY	51	7.6	10.3	69	20	10	0	0	2	0	0	0	0	0	30

LINE 41 MID

NORTHBOUND															SOUTHBOUND															
NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
118	2.1	2.5	97	3	0	0	0	0	0	0	0	0	0	65	SBARB/FGROA	116	2.1	5.3	92	5	2	1	0	0	0	0	0	0	0	64
116	22.0	9.8	7	34	38	18	3	0	1	0	0	0	0	64	ALVRD/PICO	116	13.7	10.2	38	37	18	4	3	0	0	0	0	0	0	64
116	31.1	14.5	4	16	31	23	15	7	4	0	0	0	0	64	ALVRD/SIXTH	115	24.4	12.3	11	23	33	24	3	4	1	0	0	0	0	64
115	5.9	6.8	76	20	3	1	0	0	0	0	0	0	0	65	MONT /LBRTY	117	2.5	5.6	95	3	1	0	1	0	0	0	0	0	0	65

LINE 41 PM

NORTHBOUND															SOUTHBOUND															
NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
41	3.5	4.4	88	12	0	0	0	0	0	0	0	0	0	22	SBARB/FGROA	41	2.1	4.5	88	12	0	0	0	0	0	0	0	0	0	22
40	35.4	18.4	10	13	20	8	25	18	8	0	0	0	0	22	ALVRD/PICO	42	17.7	12.8	31	24	26	14	5	0	0	0	0	0	0	21
40	42.1	21.6	10	8	10	13	10	33	8	8	3	0	0	23	ALVRD/SIXTH	41	36.0	13.2	5	0	22	34	24	15	0	0	0	0	0	21
39	6.3	7.2	67	28	5	0	0	0	0	0	0	0	0	23	MONT /LBRTY	43	3.8	4.9	77	23	0	0	0	0	0	0	0	0	0	22

LINE 41 NITE

NORTHBOUND															SOUTHBOUND															
NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
66	2.0	2.5	98	2	0	0	0	0	0	0	0	0	0	36	SBARB/FGROA	56	1.7	3.5	95	5	0	0	0	0	0	0	0	0	0	35
65	16.0	11.1	28	40	18	11	3	0	0	0	0	0	0	36	ALVRD/PICO	58	13.2	9.5	41	36	17	3	2	0	0	0	0	0	0	35
64	21.9	13.3	20	22	31	16	9	2	0	0	0	0	0	36	ALVRD/SIXTH	59	19.6	11.7	24	27	31	12	5	2	0	0	0	0	0	35
64	5.1	8.4	88	8	3	0	0	2	0	0	0	0	0	35	MONT /LBRTY	59	1.7	2.9	97	3	0	0	0	0	0	0	0	0	0	35

EXHIBIT A-33

AVM ROUTES: PASSENGER LOADS

(8-Day Averages for Route 44)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

LOAD FACTOR (# OF PASSENGERS)

LINE 44 AM

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
			NORTHBOUND													SOUTHBOUND														
85	9.4	8.3	58	32	9	0	1	0	0	0	0	0	0	62	ADAMS/LBREA	72	15.2	17.3	51	21	11	6	4	6	0	0	1	0	0	63
86	40.7	17.0	5	3	15	28	16	21	8	3	0	0	0	62	ADAMS/VRMNT	72	12.8	11.6	40	40	11	6	1	0	1	0	0	0	0	65
85	30.1	14.4	11	6	29	33	13	7	1	0	0	0	0	63	OLYMP/HILL	99	20.8	19.7	39	13	16	12	10	4	3	1	1	0	0	72
84	23.6	20.1	32	15	21	7	12	7	2	1	1	0	0	63	BVRLY/WSTRN	100	13.5	10.6	38	36	17	7	2	0	0	0	0	0	0	73
62	23.0	18.5	32	13	18	16	13	5	3	0	0	0	0	51	BVRLY/LCNGA	65	3.5	3.3	95	5	0	0	0	0	0	0	0	0	0	50
44	17.8	14.1	30	30	20	14	5	0	2	0	0	0	0	31	SMNCA/CANON	56	1.0	1.6	100	0	0	0	0	0	0	0	0	0	0	47

LINE 44 MID

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
			NORTHBOUND													SOUTHBOUND														
125	5.7	5.9	75	22	2	0	0	0	0	0	0	0	0	91	ADAMS/LBREA	110	9.4	12.6	63	22	9	3	1	2	0	1	0	0	0	81
121	23.1	12.4	12	26	35	15	11	2	0	0	0	0	0	94	ADAMS/VRMNT	109	21.0	17.5	29	26	16	12	12	2	2	1	1	0	0	90
120	29.4	14.7	9	9	34	27	12	6	3	1	0	0	0	93	OLYMP/HILL	112	21.1	14.8	28	22	25	8	14	2	1	0	0	0	0	92
118	19.2	14.5	27	27	23	12	8	3	0	0	0	0	0	92	BVRLY/WSTRN	113	16.6	10.8	27	42	21	6	4	0	1	0	0	0	0	90
111	8.4	9.2	66	21	10	4	0	0	0	0	0	0	0	91	BVRLY/LCNGA	113	7.3	7.1	67	25	6	2	0	0	0	0	0	0	0	91
49	6.1	8.6	76	14	6	4	0	0	0	0	0	0	0	51	SMNCA/CANON	51	2.0	3.9	96	2	2	0	0	0	0	0	0	0	0	52

LINE 44 PM

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
			NORTHBOUND													SOUTHBOUND														
44	7.7	13.0	73	18	2	0	5	0	2	0	0	0	0	34	ADAMS/LBREA	42	7.5	7.9	67	26	5	2	0	0	0	0	0	0	0	29
44	14.5	13.6	39	34	18	5	2	0	0	2	0	0	0	34	ADAMS/VRMNT	42	29.7	16.7	10	12	33	21	12	7	2	0	2	0	0	31
48	23.4	17.8	27	23	8	19	17	4	2	0	0	0	0	43	OLYMP/HILL	43	30.3	18.3	12	14	30	12	19	9	0	5	0	0	0	33
47	13.0	12.3	47	26	15	9	4	0	0	0	0	0	0	36	BVRLY/WSTRN	43	32.3	14.2	7	7	23	40	14	5	5	0	0	0	0	31
34	4.7	7.7	88	9	0	0	3	0	0	0	0	0	0	28	BVRLY/LCNGA	42	20.5	14.5	29	29	17	14	7	5	0	0	0	0	0	31
24	4.3	7.5	92	4	0	4	0	0	0	0	0	0	0	22	SMNCA/CANON	21	7.1	9.0	67	24	5	5	0	0	0	0	0	0	0	21

LINE 44 NITE

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
			NORTHBOUND													SOUTHBOUND														
57	5.8	4.9	86	12	2	0	0	0	0	0	0	0	0	58	ADAMS/LBREA	56	15.0	13.2	46	23	13	11	7	0	0	0	0	0	0	48
57	17.7	16.7	39	28	16	4	9	2	2	2	0	0	0	58	ADAMS/VRMNT	57	15.8	9.7	30	37	25	7	2	0	0	0	0	0	0	49
60	14.9	15.0	45	27	12	7	5	5	0	0	0	0	0	61	OLYMP/HILL	57	19.2	13.9	21	42	18	9	5	5	0	0	0	0	0	51
61	16.3	19.8	49	26	7	3	0	8	5	2	0	0	0	61	BVRLY/WSTRN	53	13.1	11.1	45	38	9	4	2	0	2	0	0	0	0	49
59	11.3	15.1	61	15	12	2	7	3	0	0	0	0	0	58	BVRLY/LCNGA	48	8.1	8.8	73	17	8	0	2	0	0	0	0	0	0	47
60	4.5	7.1	85	7	8	0	0	0	0	0	0	0	0	56	SMNCA/CANON	38	3.5	7.0	87	8	3	3	0	0	0	0	0	0	0	42

EXHIBIT A-34

AVM ROUTES: PASSENGER LOADS

(8-Day Averages for Route 89)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

LOAD FACTOR (# OF PASSENGERS)

LINE 89 AM — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
77	4.8	6.5	84	12	3	1	0	0	0	0	0	0	0	43	ADAMS/WASH	93	6.0	8.9	81	14	2	2	0	0	1	0	0	0	0	50
81	26.9	17.6	17	22	21	14	14	7	5	0	0	0	0	48	FRFAX/WILSH	93	31.1	18.6	15	13	23	15	16	11	5	1	1	0	0	52
92	12.2	11.1	50	27	14	7	2	0	0	0	0	0	0	48	FRFAX/SMNCA	93	27.2	14.3	9	24	26	23	11	8	1	0	0	0	0	53
89	2.9	4.1	96	3	1	0	0	0	0	0	0	0	0	46	HWOOD/VINE	93	8.0	8.8	68	17	12	3	0	0	0	0	0	0	0	52

LINE 89 MID — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
164	1.6	3.2	97	2	1	0	0	0	0	0	0	0	0	100	ADAMS/WASH	169	5.6	9.8	82	9	4	1	2	1	0	0	0	0	0	98
163	25.3	14.1	11	26	26	23	7	4	2	0	0	0	0	100	FRFAX/WILSH	169	26.8	17.1	20	12	24	20	14	7	4	0	0	0	0	97
160	24.4	14.6	16	19	29	18	11	5	1	0	0	0	0	101	FRFAX/SMNCA	171	28.0	17.1	16	16	23	23	12	5	3	2	0	0	0	97
156	5.1	6.6	77	19	4	0	0	0	0	0	0	0	0	93	HWOOD/VINE	170	7.4	6.5	69	28	3	1	0	0	0	0	0	0	0	96

LINE 89 PM — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
70	1.6	2.1	100	0	0	0	0	0	0	0	0	0	0	34	ADAMS/WASH	57	6.9	8.0	74	23	2	0	2	0	0	0	0	0	0	37
67	32.0	17.3	7	18	21	21	16	6	9	1	0	0	0	35	FRFAX/WILSH	57	22.2	12.2	19	21	30	26	2	2	0	0	0	0	0	36
68	30.1	19.4	19	13	13	15	22	15	3	0	0	0	0	35	FRFAX/SMNCA	58	18.8	11.4	24	28	31	14	2	2	0	0	0	0	0	37
65	6.3	8.8	72	15	12	0	0	0	0	0	0	0	0	35	HWOOD/VINE	58	4.1	4.1	90	10	0	0	0	0	0	0	0	0	0	37

LINE 89 NITE — NORTHBOUND / SOUTHBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
74	0.4	0.9	100	0	0	0	0	0	0	0	0	0	0	26	ADAMS/WASH	80	3.1	3.8	93	8	0	0	0	0	0	0	0	0	0	28
70	14.3	11.9	40	34	14	6	3	3	0	0	0	0	0	26	FRFAX/WILSH	81	10.6	6.7	52	38	7	2	0	0	0	0	0	0	0	27
69	18.4	11.4	25	30	25	14	6	0	0	0	0	0	0	26	FRFAX/SMNCA	83	10.3	6.0	49	42	8	0	0	0	0	0	0	0	0	29
62	6.9	5.9	65	32	3	0	0	0	0	0	0	0	0	21	HWOOD/VINE	84	2.9	3.9	93	6	1	0	0	0	0	0	0	0	0	29

EXHIBIT A-35

AVM ROUTES: PASSENGER LOADS

(8-Day Averages for Route 83 Local)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

LOAD FACTOR (# OF PASSENGERS)

LINE 83 : LOCAL AM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
28	1.6	1.7	100	0	0	0	0	0	0	0	0	0	0	24	OCEAN/PICO	8	0.8	1.7	100	0	0	0	0	0	0	0	0	0	0	8
65	11.0	12.0	58	31	2	2	5	3	0	0	0	0	0	53	WILSH/WSTWD	59	25.2	19.2	22	25	10	17	12	7	7	0	0	0	0	58
67	17.0	13.0	31	37	16	4	7	3	0	0	0	0	0	60	WILSH/SMNCA	61	30.4	21.1	15	23	13	15	13	10	5	5	2	0	0	60
67	17.4	10.1	18	48	24	7	1	0	1	0	0	0	0	59	WILSH/FRFAX	60	43.7	23.8	12	3	12	17	13	12	18	8	5	0	0	61
67	33.7	15.5	6	13	19	30	18	6	4	3	0	0	0	63	WILSH/WSTRN	59	44.2	24.9	14	2	15	14	8	14	14	15	5	0	0	63
67	11.2	9.8	49	39	6	4	1	0	0	0	0	0	0	62	7TH /MAPLE	61	10.3	10.8	59	21	15	2	3	0	0	0	0	0	0	64

LINE 83 : LOCAL MID EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
102	1.1	1.8	99	1	0	0	0	0	0	0	0	0	0	73	OCEAN/PICO	100	2.0	4.1	97	1	2	0	0	0	0	0	0	0	0	71
205	17.3	14.6	33	30	22	7	3	2	1	0	0	0	0	174	WILSH/WSTWD	209	18.6	14.2	29	30	21	12	4	2	1	0	0	0	0	173
193	21.9	15.4	21	27	27	12	6	5	1	1	0	0	0	167	WILSH/SMNCA	202	21.7	14.4	20	28	24	18	6	3	1	0	0	0	0	169
197	26.7	17.8	17	18	26	15	10	9	5	1	0	0	0	172	WILSH/FRFAX	202	31.9	18.7	15	10	18	19	19	12	5	1	0	0	0	174
198	28.0	17.9	17	13	23	21	16	5	4	1	1	0	0	170	WILSH/WSTRN	198	33.6	18.2	11	13	17	21	18	13	6	2	0	0	0	172
195	8.5	9.4	63	27	6	3	1	1	0	0	0	0	0	165	7TH /MAPLE	205	7.4	8.1	68	24	7	0	0	0	0	0	0	0	0	177

LINE 83 : LOCAL PM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
6	0.5	0.8	100	0	0	0	0	0	0	0	0	0	0	2	OCEAN/PICO	1	3.0	0.0	100	0	0	0	0	0	0	0	0	0	0	3
43	21.7	13.3	19	28	23	21	9	0	0	0	0	0	0	29	WILSH/WSTWD	18	11.7	11.4	56	22	17	6	0	0	0	0	0	0	0	23
45	29.3	18.3	16	13	22	18	18	9	4	0	0	0	0	29	WILSH/SMNCA	27	9.8	11.8	67	15	11	4	4	0	0	0	0	0	0	27
45	46.0	23.8	11	4	9	11	18	16	13	11	7	0	0	29	WILSH/FRFAX	28	19.5	15.9	29	29	18	14	4	7	0	0	0	0	0	28
42	35.5	19.9	14	7	12	14	29	14	5	5	0	0	0	30	WILSH/WSTRN	28	33.2	17.8	14	4	11	32	29	4	7	0	0	0	0	27
44	8.5	12.2	64	23	9	0	2	2	0	0	0	0	0	28	7TH /MAPLE	32	13.2	14.2	47	28	16	3	0	6	0	0	0	0	0	30

LINE 83 : LOCAL NITE EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
73	1.2	1.9	99	1	0	0	0	0	0	0	0	0	0	47	OCEAN/PICO	58	1.1	2.1	100	0	0	0	0	0	0	0	0	0	0	35
86	8.4	8.4	64	26	8	1	1	0	0	0	0	0	0	76	WILSH/WSTWD	73	11.4	13.5	59	19	14	3	3	3	0	0	0	0	0	62
76	13.8	11.4	37	33	20	8	3	0	0	0	0	0	0	75	WILSH/SMNCA	53	17.3	14.8	30	38	15	8	6	0	4	0	0	0	0	55
75	18.1	13.7	29	31	20	12	7	1	0	0	0	0	0	79	WILSH/FRFAX	58	20.7	20.4	31	29	19	9	3	0	3	2	3	0	0	57
75	24.6	14.7	16	25	13	29	15	0	1	0	0	0	0	78	WILSH/WSTRN	58	25.3	20.4	22	22	21	12	14	0	2	5	2	0	0	56
74	14.3	13.7	50	16	15	14	4	1	0	0	0	0	0	77	7TH /MAPLE	60	5.6	7.5	82	13	2	3	0	0	0	0	0	0	0	58

EXHIBIT A-36

AVM ROUTES: PASSENGER LOADS

(8-Day Averages for Route 83 Limited)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

LOAD FACTOR (# OF PASSENGERS)

LINE 83 : LIMITED AM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
52	0.9	1.2	100	0	0	0	0	0	0	0	0	0	0	62	OCEAN/PICO	65	1.6	4.0	94	5	2	0	0	0	0	0	0	0	0	72
52	17.3	14.5	33	37	12	10	8	0	2	0	0	0	0	62	WILSH/WSTWD	67	30.0	19.8	16	13	21	16	16	9	4	1	1	0	0	78
52	21.1	15.7	21	44	8	10	12	4	2	0	0	0	0	61	WILSH/SMNCA	67	36.0	20.0	12	12	15	15	24	10	9	1	1	0	0	77
53	24.5	15.4	13	30	26	13	11	4	2	0	0	0	0	62	WILSH/FRFAX	66	49.7	22.4	9	3	5	11	14	18	24	15	2	0	0	79
53	44.2	22.3	11	4	11	11	13	21	19	6	4	0	0	62	WILSH/WSTRN	65	46.5	21.5	8	3	6	20	17	12	18	12	3	0	0	79
52	8.5	7.5	62	29	10	0	0	0	0	0	0	0	0	62	7TH /MAPLE	64	12.4	12.3	47	28	17	5	2	0	2	0	0	0	0	78

LINE 83 : LIMITED MID EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

LINE 83 : LIMITED PM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
34	2.6	3.5	97	3	0	0	0	0	0	0	0	0	0	24	OCEAN/PICO	48	2.9	5.1	92	6	2	0	0	0	0	0	0	0	0	33
33	37.5	20.8	6	18	9	21	21	9	3	9	3	0	0	24	WILSH/WSTWD	48	15.3	15.6	38	35	10	10	0	4	2	0	0	0	0	37
33	44.3	20.4	6	6	9	15	21	18	12	12	0	0	0	25	WILSH/SMNCA	48	15.7	15.9	40	29	15	8	0	6	2	0	0	0	0	37
33	52.9	18.8	6	0	3	12	12	21	27	15	3	0	0	26	WILSH/FRFAX	48	17.7	13.7	29	23	29	13	4	2	0	0	0	0	0	35
33	47.4	17.5	6	0	9	12	21	24	21	6	0	0	0	26	WILSH/WSTRN	49	33.1	22.5	20	8	12	16	16	16	6	0	4	0	0	36
33	14.2	13.6	48	21	9	21	0	0	0	0	0	0	0	26	7TH /MAPLE	49	8.1	8.0	61	31	6	2	0	0	0	0	0	0	0	39

LINE 83 : LIMITED NITE EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD	LOCATION	NOBS	MEAN	STDV	<10	<20	<30	<40	<50	<60	<70	<80	<90	<100		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

EXHIBIT A-37

CONTROL ROUTES: PASSENGER LOADS (4-Day Averages for Route 4)

ROUTE 4

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	PERCENTS 0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
-	1=NORTHBOUND	5=OLYPIC&RIMPAU	0	.	.	.	.	25	0	0	0	0	0	0	0	0	0	0	0
		6=OLYPIC&FIGURA	0	.	.	.	.	32	0	0	0	0	0	0	0	0	0	0	0
		4=MELROSE&WSTRN	0	.	.	.	.	26	0	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	0	.	.	.	.	9	0	0	0	0	0	0	0	0	0	0	0
		6=OLYPIC&FIGURA	0	.	.	.	.	42	0	0	0	0	0	0	0	0	0	0	0
		5=OLYPIC&RIMPAU	0	.	.	.	.	21	0	0	0	0	0	0	0	0	0	0	0
1=AM	1=NORTHBOUND	5=OLYPIC&RIMPAU	134	19.97	11.32	1	50	4	2	20	27	28	19	4	1	0	0	0	0
		6=OLYPIC&FIGURA	122	38.10	14.74	5	73	0	0	2	5	20	22	22	18	9	2	0	0
		4=MELROSE&WSTRN	116	18.56	14.22	1	64	14	13	29	27	30	7	1	0	6	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	83	17.08	10.71	2	60	0	0	17	43	28	7	2	1	1	0	0	0
		6=OLYPIC&FIGURA	120	20.29	10.83	1	50	10	6	14	30	28	22	5	1	0	0	0	0
		5=OLYPIC&RIMPAU	196	29.01	16.90	1	65	13	6	16	17	12	21	23	6	6	0	0	0
2=MIDDAY	1=NORTHBOUND	5=OLYPIC&RIMPAU	285	26.73	14.80	4	78	3	0	5	30	33	14	7	7	2	1	0	0
		6=OLYPIC&FIGURA	290	24.49	13.34	1	70	2	1	8	34	25	20	6	5	2	0	0	0
		4=MELROSE&WSTRN	156	15.65	9.61	1	55	43	43	29	40	20	8	3	1	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	192	13.76	11.60	1	58	6	6	47	18	26	6	1	2	0	0	0	0
		6=OLYPIC&FIGURA	245	30.76	16.49	3	73	2	1	4	22	28	22	8	7	8	2	0	0
		5=OLYPIC&RIMPAU	252	21.23	9.63	2	52	1	1	9	38	30	18	5	0	0	0	0	0
3=PM	1=NORTHBOUND	5=OLYPIC&RIMPAU	73	33.53	18.95	2	69	1	0	12	12	22	12	16	14	11	0	0	0
		6=OLYPIC&FIGURA	54	19.93	13.79	4	70	6	0	24	33	28	6	2	4	2	2	0	0
		4=MELROSE&WSTRN	19	10.05	3.58	4	16	0	0	42	58	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	40	19.70	16.22	1	64	0	0	38	20	25	0	8	8	3	0	0	0
		6=OLYPIC&FIGURA	82	47.43	19.47	10	78	2	0	0	11	11	13	9	22	18	16	0	0
		5=OLYPIC&RIMPAU	74	19.39	12.69	3	63	1	1	23	35	23	12	4	0	3	0	0	0

EXHIBIT A-38

CONTROL ROUTES: PASSENGER LOADS (6-Day Averages for Route 84)

ROUTE 84

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	PERCENTS 0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
.	1=NORTHBOUND	3=WSTRNSMANCHSTR	0	.	.	.	.	19	0	0	0	0	0	0	0	0	0	0	0
		2=WSTRNSADAMS	0	.	.	.	.	9	0	0	0	0	0	0	0	0	0	0	0
		1=WSTRNSMELROSE	0	.	.	.	.	15	1	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	1=WSTRNSMELROSE	0	.	.	.	.	27	13	0	0	0	0	0	0	0	0	0	0
		2=WSTRNSADAMS	0	.	.	.	.	13	0	0	0	0	0	0	0	0	0	0	0
		3=WSTRNSMANCHSTR	0	.	.	.	.	32	0	0	0	0	0	0	0	0	0	0	0
1-AM	1=NORTHBOUND	3=WSTRNSMANCHSTR	101	23.68	11.32	3	55	2	2	7	27	34	20	10	3	0	0	0	0
		2=WSTRNSADAMS	142	47.44	11.36	17	70	1	0	0	1	6	16	35	22	20	1	0	0
		1=WSTRNSMELROSE	153	40.09	13.19	8	75	4	0	1	5	13	25	34	17	2	4	0	0
	3=SOUTHBOUND	1=WSTRNSMELROSE	93	44.74	11.85	2	75	0	0	1	2	4	17	39	28	8	1	0	0
		2=WSTRNSADAMS	104	24.59	13.35	6	60	0	0	7	34	28	15	9	7	1	0	0	0
		3=WSTRNSMANCHSTR	117	10.73	9.18	1	50	2	0	9	46	30	9	5	1	0	0	0	0
2=MIDDAY	1=NORTHBOUND	3=WSTRNSMANCHSTR	263	19.46	8.80	5	65	2	0	7	48	33	8	3	0	0	0	0	0
		2=WSTRNSADAMS	262	30.13	9.67	7	70	0	0	1	11	40	31	15	2	0	0	0	0
		1=WSTRNSMELROSE	257	35.49	13.34	2	70	2	0	1	7	29	23	19	15	5	0	0	0
	3=SOUTHBOUND	1=WSTRNSMELROSE	279	35.93	14.26	8	75	2	0	0	10	24	25	22	8	7	3	0	0
		2=WSTRNSADAMS	295	30.49	14.72	2	73	2	0	3	19	33	21	11	8	4	1	0	0
		3=WSTRNSMANCHSTR	290	16.89	9.90	2	58	6	2	23	46	21	6	3	1	0	0	0	0
3=PM	1=NORTHBOUND	3=WSTRNSMANCHSTR	99	21.38	9.80	1	55	1	0	10	35	37	12	4	1	0	0	0	0
		2=WSTRNSADAMS	95	28.02	12.71	2	63	0	0	5	22	31	26	9	4	2	0	0	0
		1=WSTRNSMELROSE	78	46.22	17.12	7	75	0	0	1	9	10	12	13	29	17	9	0	0
	3=SOUTHBOUND	1=WSTRNSMELROSE	115	39.93	17.41	7	75	2	0	1	13	19	18	13	16	17	3	0	0
		2=WSTRNSADAMS	103	48.13	14.90	8	72	3	0	1	2	10	17	17	26	20	6	0	0
		3=WSTRNSMANCHSTR	82	18.43	10.61	3	52	0	0	20	46	20	10	4	1	0	0	0	0

EXHIBIT A-39

CONTROL ROUTES: PASSENGER LOADS (4-Day Averages for Route 91)

ROUTE 91

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

PERCENTS

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<	10<	20<	30<	40<	50<	60<	70<	80<	90<100
.	2=WESTBOUND	9=SUNSET&GRAND	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	21	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	15	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	20	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	20	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<	10<	20<	30<	40<	50<	60<	70<	80<	90<100
1=AM	2=WESTBOUND	9=SUNSET&GRAND	38	19.79	9.48	5	50	0	0	11	42	29	16	0	3	0	0	0	0
		8=SUNSET&ECHPARK	96	30.97	15.83	2	90	2	2	4	14	29	27	13	6	4	2	0	1
		7=SUNSET&SANBORN	94	37.12	19.15	4	85	1	1	2	11	30	18	13	10	9	4	4	0
	4=EASTBOUND	7=SUNSET&SANBORN	74	36.41	14.74	8	75	1	0	1	12	24	12	22	23	4	1	0	0
		8=SUNSET&ECHPARK	93	58.69	14.63	10	90	3	2	0	2	0	3	18	19	37	9	10	2
		9=SUNSET&GRAND	49	38.29	11.46	15	56	0	0	0	6	16	24	24	29	0	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<	10<	20<	30<	40<	50<	60<	70<	80<	90<100
2=MIDDAY	2=WESTBOUND	9=SUNSET&GRAND	174	38.41	18.45	5	90	0	0	1	12	29	13	14	17	7	5	1	1
		8=SUNSET&ECHPARK	176	36.02	15.75	1	90	2	0	2	11	16	28	18	15	6	2	0	1
		7=SUNSET&SANBORN	177	31.95	13.37	4	80	0	0	1	16	29	25	15	7	6	0	1	0
	4=EASTBOUND	7=SUNSET&SANBORN	215	30.15	17.29	4	80	1	0	5	18	26	20	9	13	4	4	1	0
		8=SUNSET&ECHPARK	210	37.80	16.65	3	70	1	0	5	12	12	20	20	16	12	1	0	0
		9=SUNSET&GRAND	215	33.76	15.29	1	82	2	0	6	8	27	21	23	10	3	2	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<	10<	20<	30<	40<	50<	60<	70<	80<	90<100
3=PM	2=WESTBOUND	9=SUNSET&GRAND	121	56.00	16.83	13	92	2	0	0	2	6	7	15	26	25	11	7	2
		8=SUNSET&ECHPARK	104	42.90	18.41	4	82	0	0	4	9	13	20	13	22	12	6	2	0
		7=SUNSET&SANBORN	90	30.24	16.07	2	84	1	0	2	9	17	22	16	22	9	2	1	0
	4=EASTBOUND	7=SUNSET&SANBORN	45	34.69	17.75	5	70	0	0	2	18	29	11	7	22	4	7	0	0
		8=SUNSET&ECHPARK	40	28.27	13.75	5	58	2	1	5	28	23	23	15	8	0	0	0	0
		9=SUNSET&GRAND	50	32.94	14.88	10	70	1	0	0	22	24	14	22	16	0	2	0	0

EXHIBIT A-40

CONTROL ROUTES: PASSENGER LOADS (4-Day Averages for Route 94)

ROUTE 94

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

PERCENTS

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
.	2=WESTBOUND	9=SUNSET&GRAND	0	.	.	.	.	2	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	11	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	5	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	12	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	15	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0

TIME: 1=AM	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
	2=WESTBOUND	9=SUNSET&GRAND	22	17.77	9.37	4	40	0	0	14	45	27	9	5	0	0	0	0	0
		8=SUNSET&ECHPARK	53	23.89	11.40	2	50	1	1	4	30	30	23	11	2	0	0	0	0
		7=SUNSET&SANBORN	51	25.04	13.39	3	60	0	0	6	33	29	14	10	6	2	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	47	33.70	13.02	10	61	0	0	0	15	26	23	21	6	9	0	0	0
		8=SUNSET&ECHPARK	59	51.93	12.55	15	75	1	0	0	5	2	5	10	47	27	3	0	0
		9=SUNSET&GRAND	30	36.27	8.55	20	54	1	1	0	0	10	57	23	10	0	0	0	0

TIME: 2=MIDDAY	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
	2=WESTBOUND	9=SUNSET&GRAND	160	36.70	15.70	5	73	1	1	1	12	24	23	13	20	6	2	0	0
		8=SUNSET&ECHPARK	159	32.28	13.60	7	68	2	1	2	18	19	28	19	9	4	0	0	0
		7=SUNSET&SANBORN	161	23.04	10.55	6	70	1	0	2	37	37	17	2	3	1	1	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	164	23.21	12.52	2	70	2	0	5	41	26	13	5	9	0	1	0	0
		8=SUNSET&ECHPARK	162	34.80	15.59	3	70	2	1	4	10	26	17	18	20	4	1	0	0
		9=SUNSET&GRAND	168	30.73	13.22	4	59	0	0	3	18	30	22	14	13	0	0	0	0

TIME: 3=PM	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
	2=WESTBOUND	9=SUNSET&GRAND	65	54.45	13.34	18	73	2	0	0	2	9	3	5	43	31	8	0	0
		8=SUNSET&ECHPARK	54	47.00	15.29	14	74	1	0	0	4	15	15	17	26	22	2	0	0
		7=SUNSET&SANBORN	52	37.44	15.35	10	70	0	0	0	8	35	10	13	25	8	2	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	42	28.45	15.96	7	70	1	0	7	29	21	10	17	14	0	2	0	0
		8=SUNSET&ECHPARK	36	24.58	12.12	3	46	0	0	11	23	22	22	17	0	0	0	0	0
		9=SUNSET&GRAND	41	24.59	15.41	4	76	0	0	12	37	20	12	15	2	0	2	0	0

EXHIBIT A-41

CONTROL ROUTES: PASSENGER LOADS FOR RAINY DAYS (Route 4)

ROUTE 4 WEATHER3=RAIN

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

TIME	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	PERCENTS 0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
.	1=NORTHBOUND	5=OLYPIC&RIMPAU	0	.	.	.	.	10	0	0	0	0	0	0	0	0	0	0	0
		6=OLYPIC&FIGURA	0	.	.	.	.	12	0	0	0	0	0	0	0	0	0	0	0
		4=MELROSE&WSTRN	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	6=OLYPIC&FIGURA	0	.	.	.	.	5	0	0	0	0	0	0	0	0	0	0	0
		5=OLYPIC&RIMPAU	0	.	.	.	.	5	0	0	0	0	0	0	0	0	0	0	0
1-AM	1=NORTHBOUND	5=OLYPIC&RIMPAU	34	19.71	10.77	2	40	0	0	21	26	26	21	6	0	0	0	0	0
		6=OLYPIC&FIGURA	4	40.25	26.29	8	65	0	0	25	0	0	25	0	25	25	0	0	0
		4=MELROSE&WSTRN	35	15.66	9.12	3	30	0	0	34	29	23	14	0	0	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	21	19.29	14.04	2	60	0	0	19	43	14	14	5	0	5	0	0	0
		5=OLYPIC&RIMPAU	47	31.70	17.21	1	65	5	2	11	15	11	28	23	2	11	0	0	0
2=MIDDAY	1=NORTHBOUND	5=OLYPIC&RIMPAU	71	25.66	14.32	4	78	0	0	6	25	39	17	4	4	3	1	0	0
		6=OLYPIC&FIGURA	65	29.52	17.11	10	65	0	0	0	34	23	11	8	17	8	0	0	0
		4=MELROSE&WSTRN	33	13.58	8.74	2	40	0	0	39	39	15	3	3	0	0	0	0	0
	3=SOUTHBOUND	4=MELROSE&WSTRN	45	16.02	11.83	1	45	2	2	40	16	29	13	2	0	0	0	0	0
		6=OLYPIC&FIGURA	64	33.25	18.65	5	70	0	0	5	17	31	16	3	9	14	5	0	0
		5=OLYPIC&RIMPAU	62	21.47	8.48	2	37	1	1	8	32	34	26	0	0	0	0	0	0
3=PM	1=NORTHBOUND	5=OLYPIC&RIMPAU	19	32.00	14.67	7	59	0	0	11	5	32	21	16	16	0	0	0	0
		6=OLYPIC&FIGURA	13	27.77	22.24	5	70	1	0	23	15	31	0	0	15	8	8	0	0
	3=SOUTHBOUND	6=OLYPIC&FIGURA	20	46.50	25.50	10	70	0	0	0	20	20	0	0	10	5	45	0	0
		5=OLYPIC&RIMPAU	17	18.88	11.66	3	38	1	1	24	29	24	24	0	0	0	0	0	0

EXHIBIT A-42

CONTROL ROUTES: PASSENGER LOADS FOR RAINY DAYS (Route 84)

ROUTE 84 WEATHER3=RAIN

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
										PERCENTS									
.	1=NORTHBOUND	3=WSTRNCMANCHSTR	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0
		2=WSTRNCADAMS	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0
		1=WSTRNCMELROSE	0	.	.	.	.	2	0	0	0	0	0	0	0	0	0	0	0
	3=SOUTHBOUND	1=WSTRNCMELROSE	0	.	.	.	.	7	5	0	0	0	0	0	0	0	0	0	0
		2=WSTRNCADAMS	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0
		3=WSTRNCMANCHSTR	0	.	.	.	.	7	0	0	0	0	0	0	0	0	0	0	0
1=AM	1=NORTHBOUND	3=WSTRNCMANCHSTR	18	26.94	8.25	15	45	0	0	0	11	44	33	11	0	0	0	0	0
		2=WSTRNCADAMS	24	46.96	13.08	26	70	0	0	0	0	8	25	25	21	13	8	0	0
		1=WSTRNCMELROSE	28	41.36	12.09	8	69	0	0	4	4	0	25	46	18	4	0	0	0
	3=SOUTHBOUND	1=WSTRNCMELROSE	15	50.20	7.78	39	68	0	0	0	0	0	7	47	33	13	0	0	0
		2=WSTRNCADAMS	17	23.02	12.75	8	55	0	0	6	41	12	29	6	6	0	0	0	0
		3=WSTRNCMANCHSTR	18	20.56	6.62	10	35	1	0	0	33	56	11	0	0	0	0	0	0
2=MIDDAY	1=NORTHBOUND	3=WSTRNCMANCHSTR	45	20.02	8.66	6	40	0	0	16	29	42	11	2	0	0	0	0	0
		2=WSTRNCADAMS	44	27.16	9.79	12	56	0	0	0	20	50	18	7	5	0	0	0	0
		1=WSTRNCMELROSE	43	31.72	13.71	9	62	0	0	2	16	30	23	12	14	2	0	0	0
	3=SOUTHBOUND	1=WSTRNCMELROSE	47	32.00	12.44	10	64	0	0	0	13	32	30	15	6	4	0	0	0
		2=WSTRNCADAMS	50	29.86	14.63	2	66	0	0	4	18	32	26	8	4	8	0	0	0
		3=WSTRNCMANCHSTR	47	16.51	9.06	2	52	1	0	21	53	19	4	0	2	0	0	0	0
3=PM	1=NORTHBOUND	3=WSTRNCMANCHSTR	16	17.13	6.58	5	32	0	0	13	56	25	6	0	0	0	0	0	0
		2=WSTRNCADAMS	16	27.88	13.54	6	50	0	0	6	31	19	25	13	6	0	0	0	0
		1=WSTRNCMELROSE	13	37.00	17.04	11	67	0	0	0	15	23	31	8	8	15	0	0	0
	3=SOUTHBOUND	1=WSTRNCMELROSE	20	32.00	9.85	15	59	0	0	0	15	25	45	10	5	0	0	0	0
		2=WSTRNCADAMS	19	43.63	14.64	13	65	0	0	0	5	5	32	21	21	16	0	0	0
		3=WSTRNCMANCHSTR	13	13.62	7.67	3	24	0	0	31	46	23	0	0	0	0	0	0	0

EXHIBIT A-43

CONTROL ROUTES: PASSENGER LOADS FOR RAINY DAYS (Route 91)

ROUTE 91 WEATHER4=DRIZZLE

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

PERCENTS

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	10<20	20<30	30<40	40<50	50<60	60<70	70<80	80<90	90<100
.	2=WESTBOUND	9=SUNSET&GRAND	0	.	.	.	.	2	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&EECHPARK	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	3	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	7	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&EECHPARK	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0
1=AM	2=WESTBOUND	9=SUNSET&GRAND	8	20.38	15.28	5	50	0	0	13	50	0	25	0	13	0	0	0	0
		8=SUNSET&EECHPARK	24	29.92	13.65	5	60	0	0	8	4	33	29	4	13	4	0	0	0
		7=SUNSET&SANBORN	25	38.68	18.51	4	75	1	1	8	0	20	32	16	4	16	4	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	19	35.47	15.32	8	58	1	0	5	11	21	11	26	26	0	0	0	0
		8=SUNSET&EECHPARK	24	56.04	10.73	35	80	0	0	0	0	0	4	21	25	33	13	4	0
		9=SUNSET&GRAND	12	34.17	12.40	15	51	0	0	0	17	8	33	17	25	0	0	0	0
2=MIDDAY	2=WESTBOUND	9=SUNSET&GRAND	45	34.07	17.54	10	83	0	0	0	20	36	13	7	16	4	2	2	0
		8=SUNSET&EECHPARK	43	34.33	16.44	10	90	1	0	0	19	16	37	14	5	7	0	0	2
		7=SUNSET&SANBORN	44	35.82	13.72	10	80	0	0	0	9	25	30	16	11	7	0	2	0
	4=EASTBOUND	7=SUNSET&SANBORN	52	45.62	19.97	10	80	1	0	0	8	15	15	8	25	8	15	6	0
		8=SUNSET&EECHPARK	54	33.61	15.16	11	65	0	0	0	13	15	22	19	20	11	0	0	0
		9=SUNSET&GRAND	56	31.57	15.15	3	70	0	0	7	13	27	20	21	11	0	2	0	0
3=PM	2=WESTBOUND	9=SUNSET&GRAND	32	55.19	14.15	22	84	0	0	0	0	3	9	19	31	22	9	6	0
		8=SUNSET&EECHPARK	27	37.59	19.14	4	82	0	0	7	7	22	33	0	15	11	0	4	0
		7=SUNSET&SANBORN	17	41.47	14.55	5	60	0	0	6	0	6	24	18	35	12	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	5	49.00	15.97	25	70	0	0	0	0	20	0	0	60	0	20	0	0
		8=SUNSET&EECHPARK	12	29.67	14.11	5	53	0	0	8	17	25	25	17	8	0	0	0	0
		9=SUNSET&GRAND	13	34.77	15.49	10	58	1	0	0	23	15	15	23	23	0	0	0	0

EXHIBIT A-44

CONTROL ROUTES: PASSENGER LOADS FOR RAINY DAYS (Route 94)

ROUTE 94 WEATHER4=DRIZZLE

ESTIMATED BUS PASSENGERS - EMPTY BUSES EXCLUDED

PERCENTS

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
.	2=WESTBOUND	8=SUNSET&ECHPARK	0	.	.	.	.	3	0	0	0	0	0	0	0	0	0	0	0
		7=SUNSET&SANBORN	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	0	.	.	.	.	3	0	0	0	0	0	0	0	0	0	0	0
		8=SUNSET&ECHPARK	0	.	.	.	.	4	0	0	0	0	0	0	0	0	0	0	0
		9=SUNSET&GRAND	0	.	.	.	.	1	0	0	0	0	0	0	0	0	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
1=AM	2=WESTBOUND	9=SUNSET&GRAND	5	21.60	8.62	10	32	0	0	0	40	40	20	0	0	0	0	0	0
		8=SUNSET&ECHPARK	13	24.62	9.00	10	40	0	0	0	23	33	31	8	0	0	0	0	0
		7=SUNSET&SANBORN	14	25.93	12.38	10	54	0	0	0	36	36	21	0	7	0	0	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	13	34.23	11.76	18	60	0	0	0	8	31	23	31	0	8	0	0	0
		8=SUNSET&ECHPARK	14	51.21	11.79	15	65	1	0	0	7	0	0	14	57	21	0	0	0
		9=SUNSET&GRAND	7	28.86	4.71	20	33	0	0	0	0	29	71	0	0	0	0	0	0

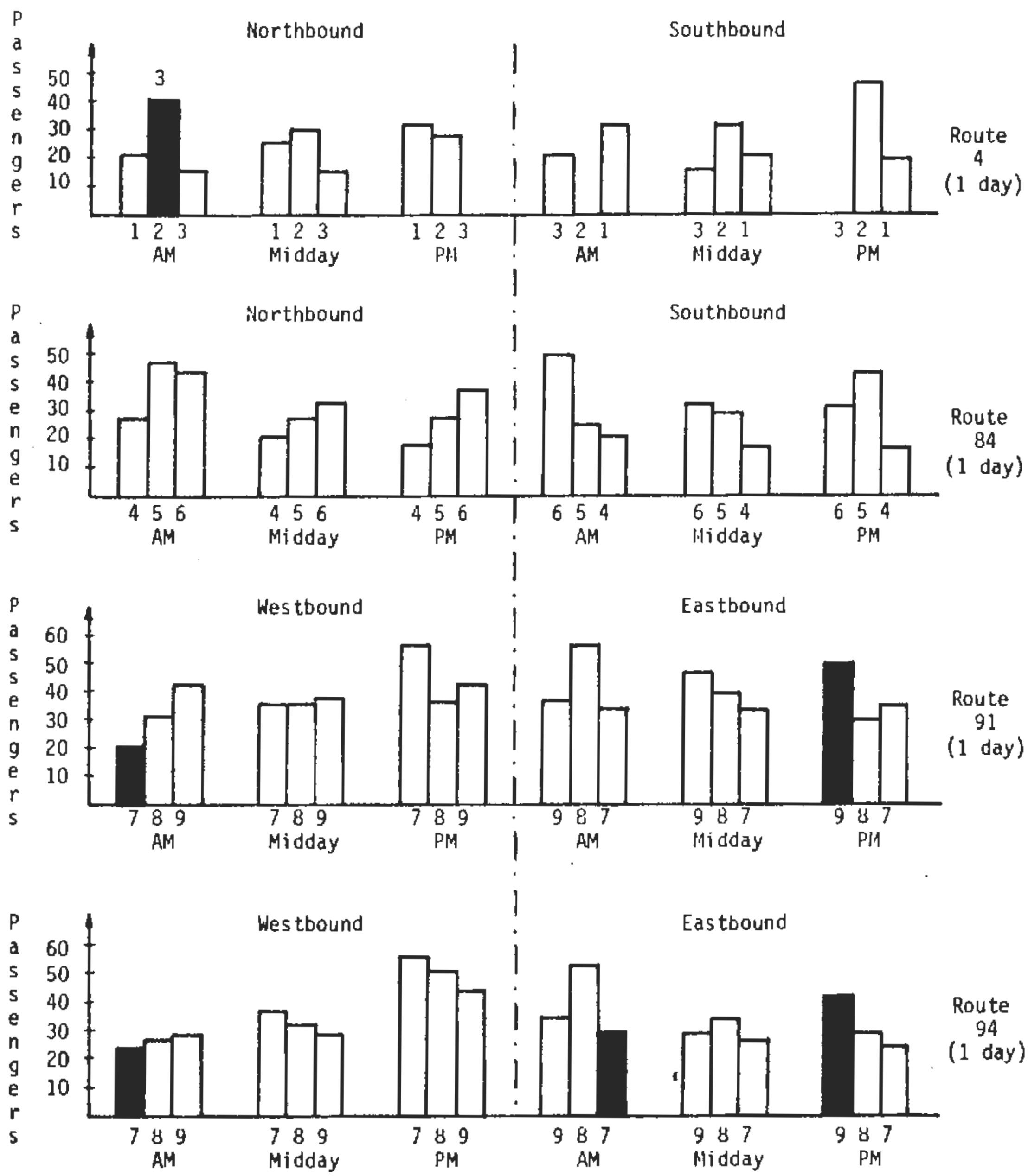
TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
2=MIDDAY	2=WESTBOUND	9=SUNSET&GRAND	42	34.60	13.53	11	60	0	0	0	7	33	31	7	19	2	0	0	0
		8=SUNSET&ECHPARK	40	30.55	10.92	15	60	1	0	0	15	30	33	15	5	3	0	0	0
		7=SUNSET&SANBORN	40	25.85	13.85	6	70	1	0	3	30	35	20	3	5	3	3	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	40	27.97	15.21	7	70	2	0	5	25	28	15	10	15	0	3	0	0
		8=SUNSET&ECHPARK	39	32.87	12.60	14	58	1	0	0	13	33	21	15	18	0	0	0	0
		9=SUNSET&GRAND	43	25.79	10.46	6	50	0	0	5	23	40	19	12	2	0	0	0	0

TIME:	DIRECTION	LOCATION	NOBS	MEAN	STDV	MIN	MAX	BAD	NZERO	0<10	<20	<30	<40	<50	<60	<70	<80	<90	<100
3=PM	2=WESTBOUND	9=SUNSET&GRAND	16	54.00	13.53	27	70	0	0	0	0	6	13	6	31	38	6	0	0
		8=SUNSET&ECHPARK	13	49.77	13.18	28	68	0	0	0	0	15	8	23	31	23	0	0	0
		7=SUNSET&SANBORN	10	41.50	16.67	20	70	0	0	0	0	40	0	10	40	0	10	0	0
	4=EASTBOUND	7=SUNSET&SANBORN	8	40.63	17.82	20	70	1	0	0	0	38	0	13	38	0	13	0	0
		8=SUNSET&ECHPARK	10	28.70	10.91	12	46	0	0	0	20	30	20	30	0	0	0	0	0
		9=SUNSET&GRAND	10	24.10	15.57	6	52	0	0	20	30	20	10	10	10	0	0	0	0

EXHIBIT A-45

CONTROL ROUTES: MEAN PASSENGER LOADS FOR RAINY DAY[1]

(By Bus Stop[2] and Time Block)

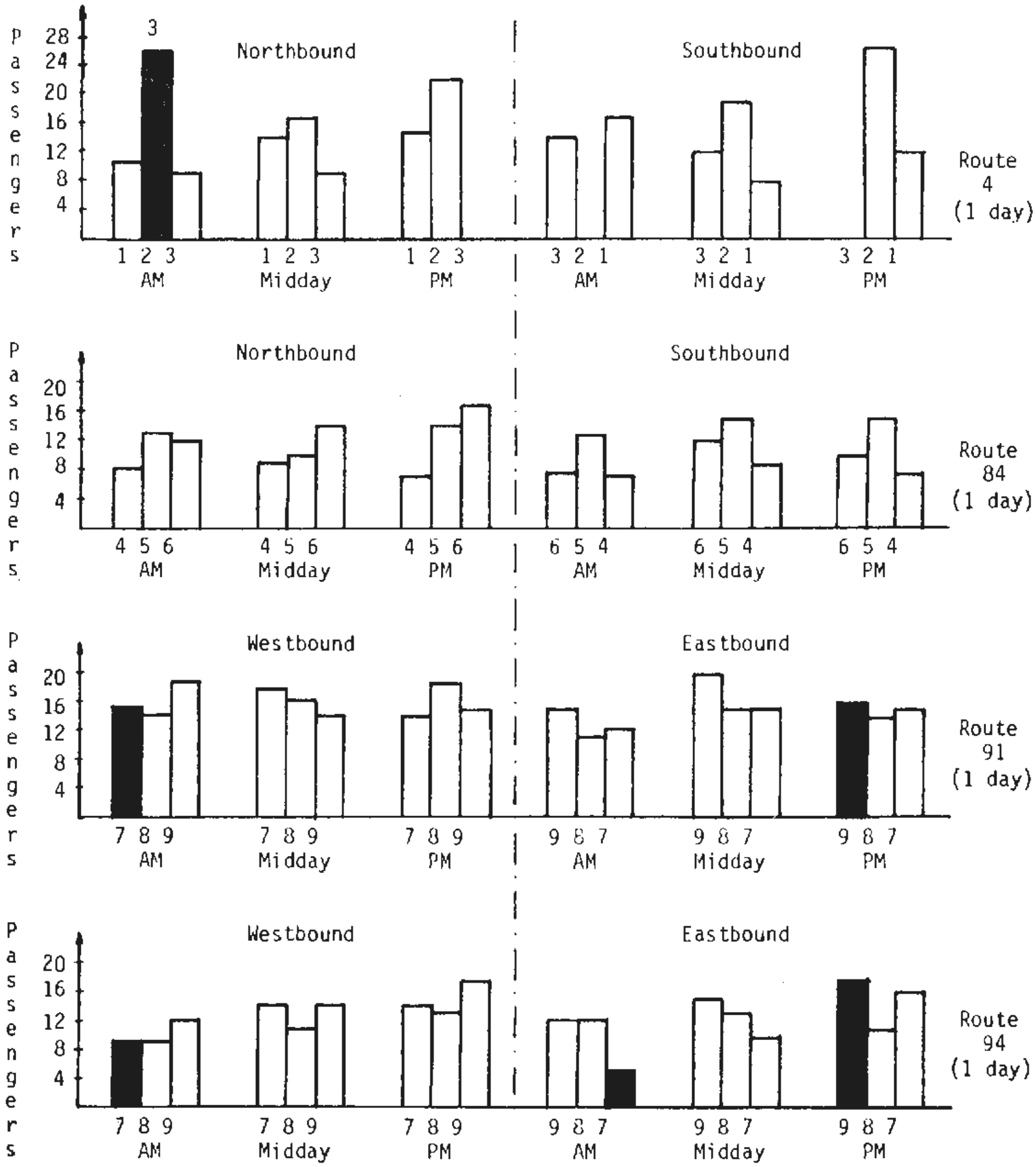


1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-41 to A-44.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.
3 Sample sizes of less than 10 are identified by shading.

EXHIBIT A-46

CONTROL ROUTES: STANDARD DEVIATION OF PASSENGER LOADS FOR RAINY DAYS[1]

(By Bus Stop[2] and Time Block)



1 Corresponding numerical values and sample sizes are presented in the Appendix in Exhibits A-41 to A-44.
2 Numbers refer to the bus stop correspondence table, Exhibit 5.10.
3 Sample sizes of less than 10 are identified by shading.

APPENDIX SECTION IV

RUN-TIME VARIATION DATA

EXHIBIT A-47

AVM ROUTES: RUN-TIME VARIATION

(8-Day Averages for Route 41)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

RUNTIME VARIATION (MINS)

LINE 41 AM

NORTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SOUTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
80	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	SBARB/FGROA	81	-0.5	3.5	0	2	10	14	16	21	26	5	6	0	0	2
80	-1.0	1.4	0	0	0	10	39	44	8	0	0	0	0	2	ALVRD/PICO	80	1.0	2.2	0	0	0	0	20	31	33	11	4	1	0	1
80	0.6	2.2	0	0	0	5	16	43	19	16	0	1	0	4	ALVRD/SIXTH	80	1.2	1.5	0	0	0	0	4	44	44	8	1	0	0	0
78	-0.4	2.5	0	0	1	18	26	26	18	12	0	0	0	4	MONT /LBRTY	81	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 41 MID

NORTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SOUTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
183	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	SBARB/FGROA	179	-1.9	2.4	0	1	9	22	30	29	8	2	0	0	0	1
180	0.1	1.7	0	0	1	3	17	54	21	3	1	1	0	0	ALVRD/PICO	180	0.8	1.5	0	0	0	0	11	49	32	8	0	0	0	0
180	1.0	2.3	0	0	0	4	11	39	29	13	2	1	1	0	ALVRD/SIXTH	179	1.4	1.0	0	0	0	0	1	34	59	6	1	0	0	0
180	-0.2	2.8	0	0	3	11	30	28	13	11	3	2	0	0	MONT /LBRTY	182	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 41 PM

NORTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SOUTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
63	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	SBARB/FGROA	62	-1.4	2.9	0	3	3	26	24	23	15	5	0	0	2	1
62	0.3	1.6	0	0	0	2	23	44	24	8	0	0	0	0	ALVRD/PICO	63	1.4	2.0	0	0	0	0	8	29	43	16	3	0	2	0
63	1.6	2.6	0	0	0	2	11	32	32	13	8	2	2	0	ALVRD/SIXTH	62	1.6	1.5	0	0	0	0	0	40	42	16	0	2	0	0
62	-0.2	3.3	0	2	2	15	26	29	13	8	3	2	2	0	MONT /LBRTY	65	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 41 NITE

NORTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SOUTHBOUND NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
102	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	SBARB/FGROA	91	-2.4	2.1	0	1	5	35	37	15	5	0	0	0	0	0
101	-0.5	1.2	0	0	0	3	21	64	12	0	0	0	0	0	ALVRD/PICO	93	-0.7	1.3	0	0	0	3	40	46	11	0	0	0	0	0
100	-0.2	2.0	0	0	0	9	22	46	21	1	0	0	1	0	ALVRD/SIXTH	94	0.2	0.9	0	0	0	0	12	68	19	1	0	0	0	0
98	-1.5	2.7	0	1	6	16	37	28	10	1	0	0	1	1	MONT /LBRTY	94	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

EXHIBIT A-48

AVM ROUTES: RUN-TIME VARIATION

(8-Day Averages for Route 44)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

RUNTIME VARIATION (MINS)

LINE 44 AM

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
147	-0.4	0.7	0	0	0	0	19	78	3	0	0	0	0	0	ADAMS/LBREA	134	0.1	4.4	1	1	4	16	27	14	11	13	4	5	2	1
148	-0.3	1.7	0	0	0	5	24	50	15	5	0	0	0	0	ADAMS/VRMNT	137	0.9	3.9	0	1	1	7	28	20	18	16	4	4	3	0
148	-0.2	1.9	0	1	1	5	26	48	15	3	1	0	0	0	OLYMP/HILL	170	0.2	3.3	0	0	5	10	25	26	18	10	4	1	1	1
147	-0.3	2.8	0	1	3	9	25	39	12	7	2	2	1	0	BVRLY/WSTRN	172	-1.2	1.8	0	1	2	18	25	48	6	0	0	0	0	1
113	0.7	3.4	0	1	3	8	21	25	20	11	4	5	2	0	BVRLY/LCNGA	115	-0.4	1.3	0	0	0	0	32	59	6	3	0	0	0	0
75	2.6	4.4	0	1	3	5	13	16	17	19	11	8	7	0	SMNCA/CANON	103	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 44 MID

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
215	0.1	0.5	0	0	0	0	1	94	5	0	0	0	0	1	ADAMS/LBREA	191	0.0	4.9	1	4	9	16	20	14	12	8	7	5	4	0
214	0.2	1.2	0	0	0	0	17	62	20	1	0	0	0	1	ADAMS/VRMNT	199	1.0	3.6	0	0	2	9	23	25	18	12	7	3	3	0
212	1.3	2.0	0	0	0	0	8	42	32	11	5	0	0	1	OLYMP/HILL	204	0.1	3.4	0	1	2	11	23	27	19	9	3	1	2	0
208	1.0	3.5	0	0	1	4	19	38	17	8	6	2	5	2	BVRLY/WSTRN	201	-2.1	1.9	0	0	4	24	44	24	1	1	0	0	0	2
201	1.1	4.5	0	1	3	10	17	22	22	7	4	4	8	1	BVRLY/LCNGA	204	0.0	0.6	0	0	0	0	6	87	7	0	0	0	0	0
99	3.4	5.2	0	1	2	4	9	19	20	14	10	5	15	1	SMNCA/CANON	103	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 44 PM

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
78	0.0	0.5	0	0	0	0	6	88	5	0	0	0	0	0	ADAMS/LBREA	70	-2.5	4.1	1	9	24	13	21	10	14	3	0	4	0	1
78	0.3	1.7	0	0	0	1	17	59	19	3	0	1	0	0	ADAMS/VRMNT	73	0.5	3.8	0	1	4	5	29	29	11	10	4	4	3	0
90	-0.2	3.1	0	0	1	12	32	29	19	2	1	1	2	1	OLYMP/HILL	75	0.9	4.6	0	0	5	9	23	25	12	12	4	4	5	1
83	0.6	4.6	0	2	7	5	25	24	13	11	2	6	4	0	BVRLY/WSTRN	74	0.1	2.6	0	0	0	9	24	42	11	7	5	1	0	0
62	-0.5	5.2	3	5	10	13	19	18	11	6	8	2	5	0	BVRLY/LCNGA	73	0.1	0.6	0	0	0	0	3	89	8	0	0	0	0	0
44	-0.6	5.5	2	9	11	7	20	18	7	11	5	5	5	2	SMNCA/CANON	42	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 44 NITE

NB NOBS	NB MEAN	NB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	SB NOBS	SB MEAN	SB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
115	-0.1	0.8	0	0	0	0	8	86	5	0	1	0	0	0	ADAMS/LBREA	104	0.1	3.7	1	2	5	10	13	35	17	5	9	3	1	0
115	0.4	1.8	0	0	0	3	12	52	28	3	0	0	1	0	ADAMS/VRMNT	106	0.2	3.4	0	3	6	8	16	33	20	7	7	1	1	0
121	1.0	2.3	0	0	0	3	10	41	31	9	2	2	1	0	OLYMP/HILL	107	-1.0	2.9	1	3	7	8	29	31	12	8	0	1	0	1
122	0.7	3.6	0	0	2	7	22	36	14	7	5	5	2	0	BVRLY/WSTRN	102	-2.1	2.0	0	1	9	17	38	31	4	0	0	0	0	0
117	0.2	4.5	1	1	3	13	26	31	6	4	5	3	6	0	BVRLY/LCNGA	94	0.3	1.4	0	0	0	0	12	73	11	2	1	1	0	1
114	-0.2	4.6	0	2	6	15	35	16	6	6	4	4	6	2	SMNCA/CANON	79	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	1

EXHIBIT A-49

AVM ROUTES: RUN-TIME VARIATION

(8-Day Averages for Route 89)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

RUNTIME VARIATION (MINS)

LINE 89 AM			NORTHBOUND													SOUTHBOUND														
NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
120	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	ADAMS/WASH	143	1.1	2.3	0	0	0	1	14	45	24	11	2	2	1	0
129	-0.1	0.9	0	0	0	0	17	71	12	0	0	0	0	0	FRFAX/WILSH	145	1.2	2.0	0	0	0	0	10	44	32	10	3	1	1	0
140	0.1	1.1	0	0	0	0	14	65	21	1	0	0	0	0	FRFAX/SMNCA	146	0.1	1.7	0	0	0	0	23	56	18	2	0	1	1	0
135	0.0	1.5	0	0	0	4	19	51	23	3	0	0	0	0	HWOOD/VINE	145	0.4	0.8	0	0	0	0	1	84	12	2	1	0	0	0

LINE 89 MID			NORTHBOUND													SOUTHBOUND														
NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
264	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	ADAMS/WASH	267	1.3	3.3	0	0	1	5	20	24	17	16	10	2	3	0
263	-0.2	1.5	0	0	0	2	25	57	12	3	0	0	0	0	FRFAX/WILSH	266	2.3	2.9	0	0	0	2	10	23	30	18	11	5	2	0
261	0.7	2.0	0	0	0	0	18	51	18	9	4	1	0	0	FRFAX/SMNCA	268	0.1	1.9	0	0	0	3	22	46	19	8	0	0	0	0
249	1.4	2.5	0	0	0	2	11	37	28	14	5	2	1	0	HWOOD/VINE	266	0.5	0.9	0	0	0	0	3	73	23	2	0	0	0	0

LINE 89 PM			NORTHBOUND													SOUTHBOUND														
NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
104	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	ADAMS/WASH	94	-1.9	2.8	1	4	6	21	31	26	6	4	0	0	0	0
102	-0.3	1.5	0	0	0	3	25	58	14	1	0	0	0	0	FRFAX/WILSH	93	-0.8	2.3	0	0	9	5	29	37	15	5	0	0	0	0
103	-0.1	2.1	0	0	0	8	28	38	17	9	1	0	0	0	FRFAX/SMNCA	95	-0.8	1.9	0	0	1	11	36	36	13	4	0	0	0	0
100	0.0	2.4	1	1	0	6	18	43	22	8	0	1	0	0	HWOOD/VINE	94	0.2	1.1	0	0	0	1	6	71	18	3	0	0	0	1

LINE 89 NITE			NORTHBOUND													SOUTHBOUND														
NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
100	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	ADAMS/WASH	107	-4.8	2.6	5	15	20	37	18	4	2	0	0	0	0	1
96	-1.4	1.4	0	0	1	14	41	41	3	1	0	0	0	0	FRFAX/WILSH	106	-1.9	2.3	0	1	14	13	36	29	5	2	0	0	0	2
95	-1.3	1.9	0	0	4	14	33	41	7	1	0	0	0	0	FRFAX/SMNCA	111	-1.2	2.2	0	1	4	14	35	31	13	2	1	0	0	1
83	-1.6	2.6	1	0	13	12	25	35	11	2	0	0	0	0	HWOOD/VINE	113	-0.4	1.2	0	0	0	3	23	64	10	1	0	0	0	0

EXHIBIT A-50

AVM ROUTES: RUN-TIME VARIATION

(8-Day Averages for Route 83 Local)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

RUNTIME VARIATION (MINS)

LINE 83 : LOCAL AM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
52	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	OCEAN/PICO	15	2.5	3.5	0	0	0	7	7	13	27	33	7	0	7	1
118	-0.1	1.7	0	0	0	0	31	48	15	5	0	1	0	0	WILSH/WSTWD	115	4.9	4.2	0	0	1	0	3	16	12	23	14	12	18	2
127	0.4	1.9	0	0	0	2	17	54	19	7	2	0	0	0	WILSH/SMNCA	120	3.7	4.2	0	0	1	2	8	16	22	18	14	7	13	1
126	0.6	2.1	0	0	2	2	13	46	26	9	2	1	1	0	WILSH/FRFAX	121	1.9	3.5	0	0	0	3	15	29	20	17	6	6	4	0
130	0.7	2.5	0	0	2	3	14	39	25	12	3	0	1	0	WILSH/WSTRN	122	1.2	2.6	0	0	0	1	22	32	20	17	6	2	1	0
128	-0.8	3.8	1	5	9	12	23	20	17	6	5	2	0	1	7TH /MAPLE	125	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 83 : LOCAL MID EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
175	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	OCEAN/PICO	166	3.5	5.6	0	1	2	6	16	14	13	12	7	10	19	5
379	0.3	2.0	0	0	0	1	25	47	18	6	2	1	0	0	WILSH/WSTWD	376	2.6	4.5	0	0	4	4	12	21	16	16	11	7	9	6
359	0.6	2.1	0	0	0	1	18	47	23	6	3	1	1	1	WILSH/SMNCA	367	2.3	4.3	1	0	1	4	16	21	20	14	9	8	7	4
369	1.7	2.6	0	0	1	1	5	37	33	14	6	2	1	0	WILSH/FRFAX	374	1.4	3.5	1	0	1	3	17	31	21	12	7	3	3	2
367	1.6	3.2	0	0	0	3	10	35	26	14	5	3	3	1	WILSH/WSTRN	370	1.1	2.9	1	0	0	2	21	32	21	13	6	3	1	0
356	0.9	4.7	1	2	5	12	17	17	16	14	8	3	5	4	7TH /MAPLE	379	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	3

LINE 83 : LOCAL PM EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
8	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	OCEAN/PICO	4	2.2	1.7	0	0	0	0	0	50	0	50	0	0	0	0
72	-0.8	1.3	0	0	0	3	42	46	10	0	0	0	0	0	WILSH/WSTWD	39	1.3	4.7	0	3	3	18	15	13	15	8	13	5	8	2
74	0.7	1.5	0	0	0	0	12	55	26	5	1	0	0	0	WILSH/SMNCA	53	1.3	4.1	0	4	0	4	28	17	15	11	11	6	4	1
74	2.2	2.8	0	0	0	1	7	27	32	19	9	3	1	0	WILSH/FRFAX	56	1.3	3.0	0	0	0	5	18	29	23	13	7	5	0	0
72	3.2	3.3	0	0	0	0	4	25	24	26	11	4	6	0	WILSH/WSTRN	55	1.9	2.6	0	0	0	2	5	35	31	11	11	4	2	0
71	2.6	6.3	0	1	7	13	13	6	23	8	8	8	13	1	7TH /MAPLE	59	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	3

LINE 83 : LOCAL NITE EASTBOUND / WESTBOUND

NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	NOBS	MEAN	STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
120	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0	OCEAN/PICO	93	1.1	5.0	1	3	6	9	13	14	25	11	10	2	6	0
161	-0.4	1.7	0	0	1	7	23	52	16	1	1	0	0	1	WILSH/WSTWD	135	-0.9	3.9	2	4	7	15	16	30	11	7	2	4	1	0
150	-0.2	1.8	0	0	1	4	21	53	17	1	2	0	0	1	WILSH/SMNCA	108	-1.1	3.9	1	4	11	18	19	18	19	5	4	3	1	0
153	-0.4	2.3	0	1	3	6	27	41	16	3	3	0	0	1	WILSH/FRFAX	114	-1.1	2.8	0	0	6	16	36	19	15	5	1	2	0	1
153	-1.2	2.6	1	3	5	10	28	39	10	3	1	0	0	0	WILSH/WSTRN	114	-0.1	2.4	0	0	0	8	32	28	20	7	4	0	0	0
146	-1.8	4.0	5	5	8	16	23	19	12	8	3	1	0	5	7TH /MAPLE	118	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

EXHIBIT A-51

AVM ROUTES: RUN-TIME VARIATION

(8-Day Averages for Route 83 Limited)

LEVEL3 OUTPUT. REFER TO ATTACHED DIRECTORY FOR INCLUSIVE FILES.

RUNTIME VARIATION (MINS)

LINE 83 : LIMITED AM EASTBOUND / WESTBOUND

EB NOBS	EB MEAN	EB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	WB NOBS	WB MEAN	WB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
113	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	1	OCEAN/PICO	131	7.5	4.8	0	0	0	2	1	5	13	16	9	11	43	6
114	0.6	1.8	0	0	0	1	15	53	22	7	3	0	0	0	WILSH/WSTWD	143	4.5	4.1	0	0	0	0	5	15	21	19	15	13	13	2
113	0.1	1.8	0	0	1	1	21	57	14	3	4	0	0	0	WILSH/SMNCA	142	2.6	3.4	0	0	0	3	11	18	29	18	13	4	5	2
115	0.0	2.0	0	0	0	7	18	50	19	2	3	0	0	0	WILSH/FRFAX	145	1.3	2.7	0	0	1	2	14	32	26	16	6	3	1	0
115	1.6	2.6	0	0	0	3	12	27	25	23	6	3	0	0	WILSH/WSTRN	143	1.1	2.1	0	0	0	1	15	35	33	11	4	1	0	1
113	-0.7	3.0	0	3	4	17	22	27	16	7	3	1	0	1	7TH /MAPLE	140	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	2

LINE 83 : LIMITED MID EASTBOUND / WESTBOUND

EB NOBS	EB MEAN	EB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	WB NOBS	WB MEAN	WB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

LINE 83 : LIMITED PM EASTBOUND / WESTBOUND

EB NOBS	EB MEAN	EB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	WB NOBS	WB MEAN	WB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
57	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	1	OCEAN/PICO	80	1.6	5.0	3	0	8	6	13	14	16	20	13	3	6	1
57	2.5	2.2	0	0	0	0	5	23	32	28	11	2	0	0	WILSH/WSTWD	84	3.0	4.2	0	1	0	5	10	15	21	20	13	5	10	1
57	2.1	2.2	0	0	0	0	7	32	25	28	5	4	0	1	WILSH/SMNCA	84	2.6	4.2	0	1	1	2	15	12	27	19	8	7	6	1
58	1.5	2.6	0	0	2	2	10	31	24	22	5	3	0	1	WILSH/FRFAX	82	2.0	3.3	0	0	1	4	12	18	32	16	10	5	2	1
59	2.8	3.2	0	0	0	2	10	19	22	22	12	10	3	0	WILSH/WSTRN	83	1.5	2.8	0	0	0	2	12	34	31	11	6	1	2	2
57	3.4	4.7	0	0	0	7	11	14	18	14	21	5	11	2	7TH /MAPLE	88	0.0	0.0	0	0	0	0	0	100	0	0	0	0	0	0

LINE 83 : LIMITED NITE EASTBOUND / WESTBOUND

EB NOBS	EB MEAN	EB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD	LOCATION	WB NOBS	WB MEAN	WB STDV	<-9	<-7	<-5	<-3	<-1	<+1	<+3	<+5	<+7	<+9		BAD
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	OCEAN/PICO	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTWD	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/SMNCA	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/FRFAX	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	WILSH/WSTRN	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	7TH /MAPLE	0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX SECTION V

SUPPLEMENTARY PASSENGER WAIT TIME DATA

Exhibit No.

A-52: Passenger Wait Time, Route 41

A-53: Passenger Wait Time, Route 44

A-54: Passenger Wait Time, Route 83

A-55: Passenger Wait Time, Route 89

EXHIBIT A-52

PASSENGER WAIT TIME, ROUTE 41

PASSENGERS / WAIT TIME (in min.)	TIME BLOCK									
	AM		MIDDAY		PM		PM		PM	
	LENGTH OF HEADWAY (in min.)									
	10		12		9		10		12	
	No.	%	No.	%	No.	%	No.	%	No.	%
1	2	6.9	94	10.3	13	15.9	13	21.0	47	13.2
2	6	20.7	74	8.1	5	6.1	11	17.7	37	10.4
3	5	17.2	99	10.9	8	9.8	3	4.8	31	8.7
4	4	13.8	72	7.9	6	7.3	4	6.5	35	9.8
5	1	3.4	97	10.7	12	14.6	5	8.1	19	5.3
6	3	10.3	68	7.5	5	6.1	1	1.6	36	10.1
7	1	3.4	74	8.1	5	6.1	8	12.9	21	5.9
8	4	13.8	86	9.5	12	14.6	8	12.9	30	8.4
9	1	3.4	69	7.6	4	4.9	5	8.1	23	6.5
10	2	6.9	58	6.4	4	4.9	3	4.8	35	9.8
11			30	3.3	3	3.7	1	1.6	17	4.8
12			22	2.4	0	0.0			8	2.2
13			26	2.9	2	2.4			8	2.2
14			8	0.9	3	3.7			0	0.0
15			8	0.9					3	0.8
16			5	0.5					6	1.7
17			3	0.3						
18			6	0.7						
19			4	0.4						
20			0	0.0						
21			5	0.5						
22			0	0.0						
23			2	0.2						
TOTAL	29	100.0	910	100.0	82	100.0	62	100.0	356	100.0
MEAN WAIT TIME	$\bar{x}$=4.28 min.		$\bar{x}$=5.94 min.		$\bar{x}$=5.43 min.		$\bar{x}$=4.37 min.		$\bar{x}$=5.66 min.	

EXHIBIT A-53

PASSENGER WAIT TIME, ROUTE 44

WAIT TIME (in min.) \ PASSENGERS	TIME BLOCK																	
	AM		AM		AM		AM		MID		MID		PM		PM		PM	
	LENGTH OF HEADWAY (in min.)																	
	6		7		8		10		8		10		5		6		8	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	5	50.0	6	16.7	7	53.8	2	9.5	7	17.1	66	17.6	29	31.5	11	19.0	3	7.5
2	2	20.0	9	25.0	1	7.7	3	14.3	4	9.8	42	11.2	9	9.8	4	6.9	7	17.5
3	1	10.0	4	11.1	1	7.7	0	0.0	5	12.2	43	11.5	20	21.7	10	17.2	1	2.5
4	0	0.0	6	16.7	1	7.7	2	9.5	12	29.3	39	10.4	12	13.0	2	3.4	3	7.5
5	0	0.0	1	2.8	1	7.7	7	33.3	2	4.9	32	8.6	5	5.4	6	10.3	1	2.5
6	1	10.0	7	19.4	2	15.4	1	4.8	3	7.3	22	5.9	3	3.3	4	6.9	0	0.0
7	0	0.0	2	5.6			3	14.3	4	9.8	42	11.2	7	7.6	5	8.6	2	5.0
8	0	0.0	1	2.8			2	9.5	1	2.4	29	7.8	1	1.1	0	0.0	3	7.5
9	1	10.0					1	4.8	0	0.0	25	6.7	0	0.0	7	12.1	2	5.0
10									1	2.4	20	5.3	4	4.3	4	6.9	4	10.0
11									2	4.9	4	1.1	2	2.2	1	1.7	2	5.0
12											5	1.3			1	1.7	0	0.0
13											0	0.0			0	0.0	0	0.0
14											1	0.3			1	1.7	2	5.0
15											1	0.3			2	3.4	0	0.0
16											1	0.3					1	2.5
17											0	0.0					0	0.0
18											1	0.3					0	0.0
19											0	0.0					0	0.0
20											1	0.3					3	7.5
21																	0	0.0
22																	3	7.5
23																	1	2.5
24																	2	5.0
TOTAL	10	100	36	100	13	100	21	100	41	100	374	100	92	100	58	100	40	100
MEAN WAIT TIME	$\bar{X}$ = 2.10 min		$\bar{X}$ = 3.08 min		$\bar{X}$ = 2.08 min		$\bar{X}$ = 4.50 min		$\bar{X}$ = 3.90 min		$\bar{X}$ = 4.51 min		$\bar{X}$ = 3.09 min		$\bar{X}$ = 5.06 min		$\bar{X}$ = 9.15 min	

EXHIBIT A-54

PASSENGER WAIT TIME, ROUTE 83

PASSEN-GERS / WAIT TIME (in min.)	TIME BLOCK					
	AM		MIDDAY		PM	
	LENGTH OF HEADWAY (in min.)					
	3		3/4*		3	
	No.	%	No.	%	No.	%
1	69	41.8	459	32.9	57	30.3
2	34	20.6	313	22.4	39	20.7
3	21	12.7	212	15.2	16	8.5
4	10	6.1	170	12.2	17	9.0
5	21	12.7	102	7.3	13	6.9
6	8	4.8	59	4.2	19	10.1
7	2	1.2	45	3.2	6	3.2
8			8	0.6	0	0.0
9			10	0.7	1	0.5
10			11	0.8	4	2.1
11			2	0.1	1	0.5
12			0	0.0	9	4.8
13			3	0.2	6	3.2
14			1	0.1		
15			1	0.1		
TOTAL	165	100.0	1396	100.0	188	100.0
MEAN WAIT TIME	$\bar{x}$ = 2.01 min.		$\bar{x}$ = 2.40 min.		$\bar{x}$ = 3.44 min.	

* Alternating

EXHIBIT A-55

PASSENGER WAIT TIME, ROUTE 89

PASSENGERS / WAIT TIME (in min.)	TIME BLOCK							
	AM		MIDDAY		PM		PM	
	LENGTH OF HEADWAY (in min.)							
	8		8		7		8	
	No.	%	No.	%	No.	%	No.	%
1	25	23.1	106	23.3	65	22.0	46	29.3
2	8	7.4	60	13.2	53	17.9	17	10.8
3	15	13.9	50	11.0	46	15.5	14	8.9
4	14	13.0	51	11.2	35	11.8	23	14.6
5	12	11.1	56	12.3	28	9.5	16	10.2
6	21	19.4	39	8.6	22	7.4	14	8.9
7	5	4.6	37	8.1	16	5.4	8	5.1
8	5	4.6	26	5.7	13	4.4	7	4.5
9	2	1.9	7	1.5	11	3.7	2	1.3
10	0	0.0	7	1.5	4	1.4	3	1.9
11	1	0.9	5	1.1	1	0.3	2	1.3
12			1	0.2	2	0.7	3	1.9
13			7	1.5			2	1.3
14			1	0.2				
15			0	0.0				
16			2	0.4				
TOTAL	108	100.0	455	100.0	296	100.0	157	100.0
MEAN WAIT TIME	$\bar{x}$ = 3.64 min.		$\bar{x}$ = 3.78 min.		$\bar{x}$ = 3.40 min.		$\bar{x}$ = 3.68 min.	

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