SCRTD METRO RAIL PROJECT

SPECIAL STUDY OF THE INTEGRATION OF BUS AND RAIL OPERATIONS CONTROL CENTERS

INTERIM REPORT ON TASK 1:

REVIEW OF SCRTD BUS DISPATCH OPERATIONS

May 1984

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INTRODUCTION

The Southern California Rapid Transit District (SCRTD) is considering the possibility of expanding its planned Metro Rail Central Control Facility into a multi-modal facility handling not only Metro Rail operations, but also light rail and bus operations. Consequently, the SCRTD has requested Booz, Allen & Hamilton Inc. to assess the advantages and disadvantages of such an integration. The possible integration of Metro Rail and light rail control facilities has been evaluated in a study published in interim form in March 1984.[1] The assessment of combined bus/rail control functions is being undertaken in a six-task study, as follows:

Task 1: Review the present SCRTD Bus Central Control Facility's space, staffing, equipment and functions, and evaluate future requirements.

Task 2: Review the facility space, staffing, equipment and functions planned for the Metro Rail Central Control Facility.

Task 3: Evaluate the Central Control Facility space, staffing, equipment and functions at other selected North American transit systems.

Task 4: Evaluate the space, staffing, and equipment required for an SCRTD combined bus/rail Central Control Facility.

Task 5: Evaluate existing plans for both bus and rail Central Control Facilities on the basis of data gathered at other transit properties.

Task 6: Evaluate the Central Control Facility options -- separate bus and rail facilities, and a joint bus/rail facility -- and make recommendations.

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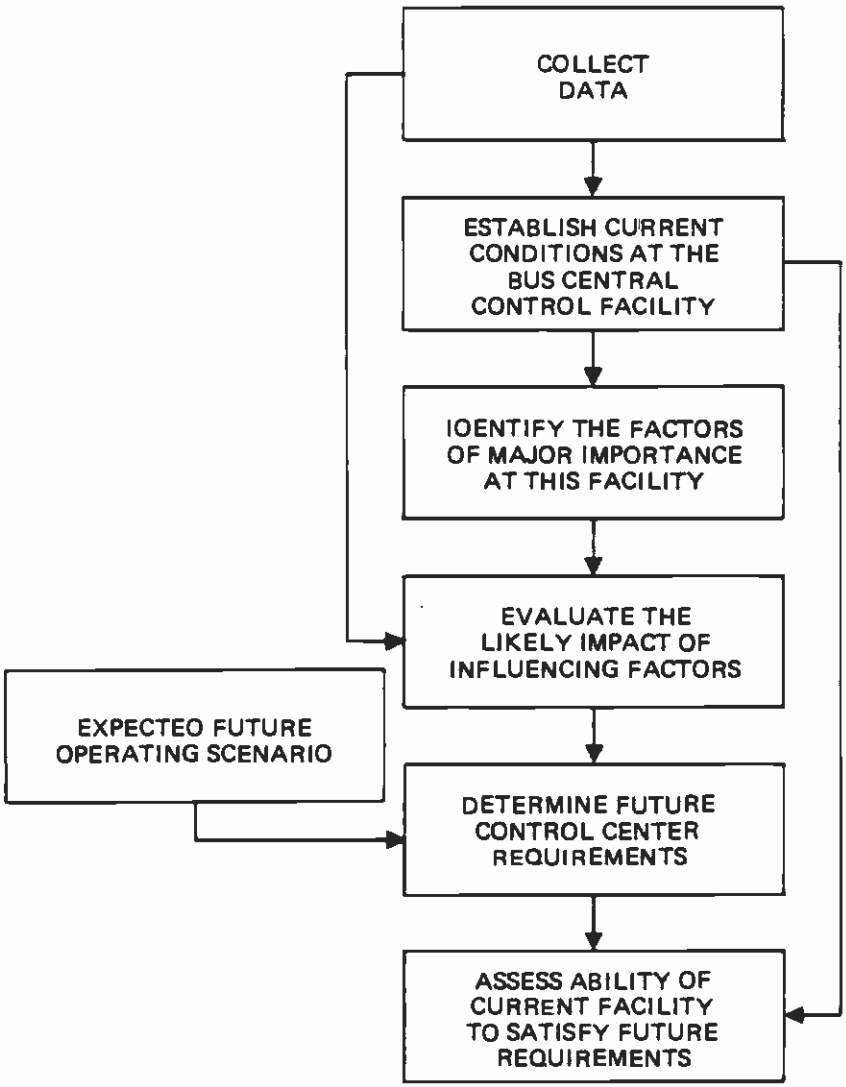
1. Booz, Allen & Hamilton Inc., Special Study of Metro Rail/Light Rail Central Control Facility Integration, SCRTD Metro Rail Project Interim Report, March 1984.

This current report presents the findings of the first task, documenting the current operations of SCRTD's Bus Central Control Facility, identifying the demands that will likely be imposed on it in the future, and assessing the ability of the present facility to satisfy these future requirements. Our approach to this task is depicted in Exhibit 1. Because the focal point of the facility is bus dispatching and monitoring, the majority of the analysis is concentrated on the transactions performed by bus dispatchers and the technology employed for this function.

EXHIBIT 1
TASK 1: APPROACH



1. THE PHYSICAL PLANT, FUNCTIONS AND ORGANIZATION OF THE CURRENT BUS CENTRAL CONTROL FACILITY

Described in this chapter is the present status of the SCRTD Bus Central Control Facility, which is responsible for providing vehicle dispatching, schedule control, security dispatching, and liaison between vehicle operators, division maintenance, road supervisors, and transit security for SCRTD's bus fleet of approximately 2,000 peak vehicles. This description, which serves as a baseline from which to begin the estimation of the potential future requirements of the facility, encompasses the facility's space, staffing, costs, functions and technology.

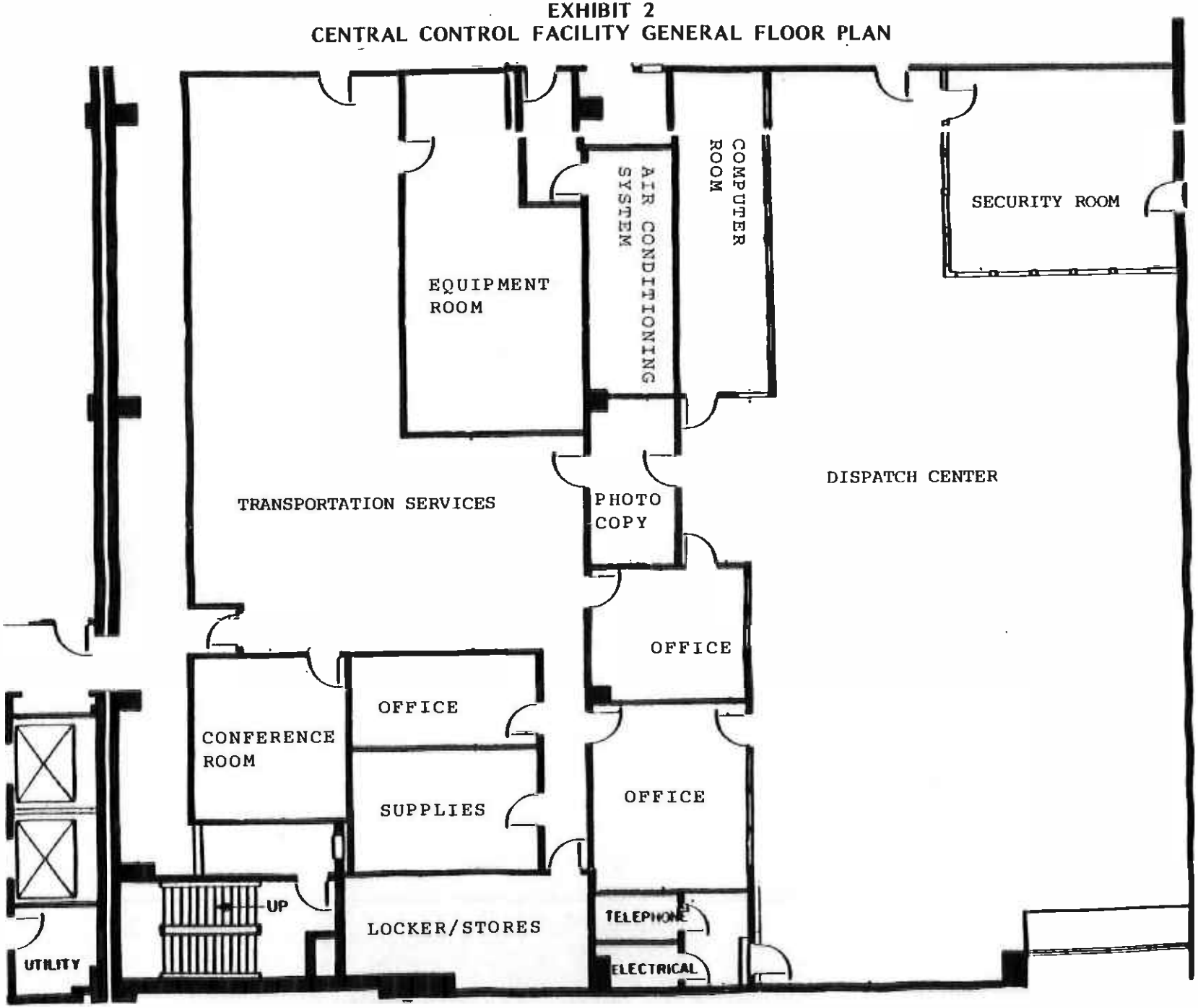
1.1 FACILITY SPACE, STAFFING, AND COST

The Bus Central Control Facility is located on the fourth floor of the SCRTD offices at 425 South Main Street. The total floor space of the facility is 6,800 square feet, distributed as follows:

	Area (sq.ft.)	No. of Staff/ Peak Shift
Bus Dispatch Center	2,700	11
Security (Transit Police) Room	360	2
Computer Room	232	-
Mechanical/Electrical Room	112	-
Administration/Support Area	3,396	11
TOTAL	6,800	24

A general floor plan of the facility is given in Exhibit 2. The facility is located in close proximity to the offices of the SCRTD Transit Police to ensure a prompt and complete response to all emergencies.

EXHIBIT 2
CENTRAL CONTROL FACILITY GENERAL FLOOR PLAN



Within the Bus Central Control Facility, the Bus Dispatch Center occupies a total of 2,700 square feet and is staffed during peak shift operations by 10 dispatchers and 1 supervisor. The Bus Dispatch Center currently contains 12 dispatcher work stations and 1 supervisory work station (see Exhibit 3). However, only 10 radio frequencies are dedicated to direct bus communication, and since peak dispatchers are each assigned to one channel, only ten dispatcher work stations are currently active.

Each dispatcher work station consists of two major components: dispatching hardware (CRTs, keyboards, telephone banks) and scheduling support (hard copy) documentation. In addition, two of the work stations are presently equipped with automatic vehicle monitoring (AVM) equipment, as described subsequently.

The estimated space allocations for each of these work stations are:

	Area (Sq. Ft.)
Dispatcher work station	84
- with AVM/AVL equipment	96
Supervisory work station	84
- with two support tables	138

Each of these estimates includes a 3-foot maintenance clearance in front of the work station and a 2-foot aisle clearance behind (see Exhibit 4).

The Security Room occupies 360 square feet and is located within the Bus Dispatch Center to facilitate liaison between dispatchers and the Transit Police officer manning the Security Room. This room contains dispatching equipment including a large console with CRT, a keyboard, and telephone banks. Criminal investigating equipment is also contained here and room access is, therefore, restricted. The room is usually staffed by one Transit Police officer; however, a second officer during the pm peak handles all telephone calls.

The Administrative/Support Area occupies almost 3,400 square feet of space and includes offices and cubicles, a photocopy room, a supply room, a locker and storage area, an equipment room, and a conference room. During peak shift operations, this large area is staffed by a maximum of eleven employees:

EXHIBIT 3
Central Control Facility Layout
Current Dispatcher Work Station Distribution

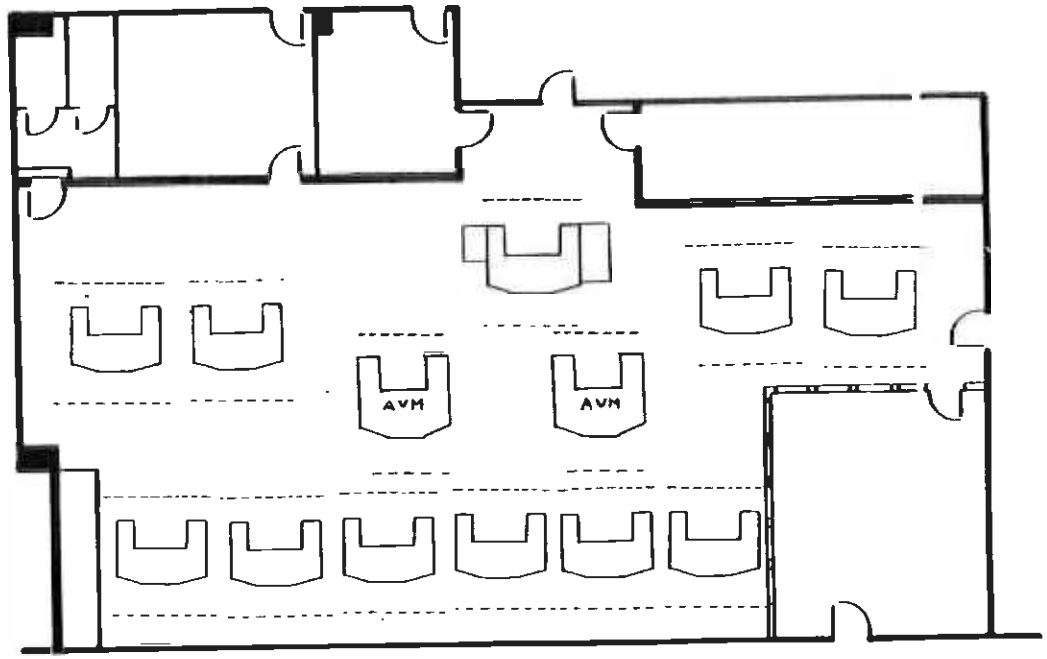
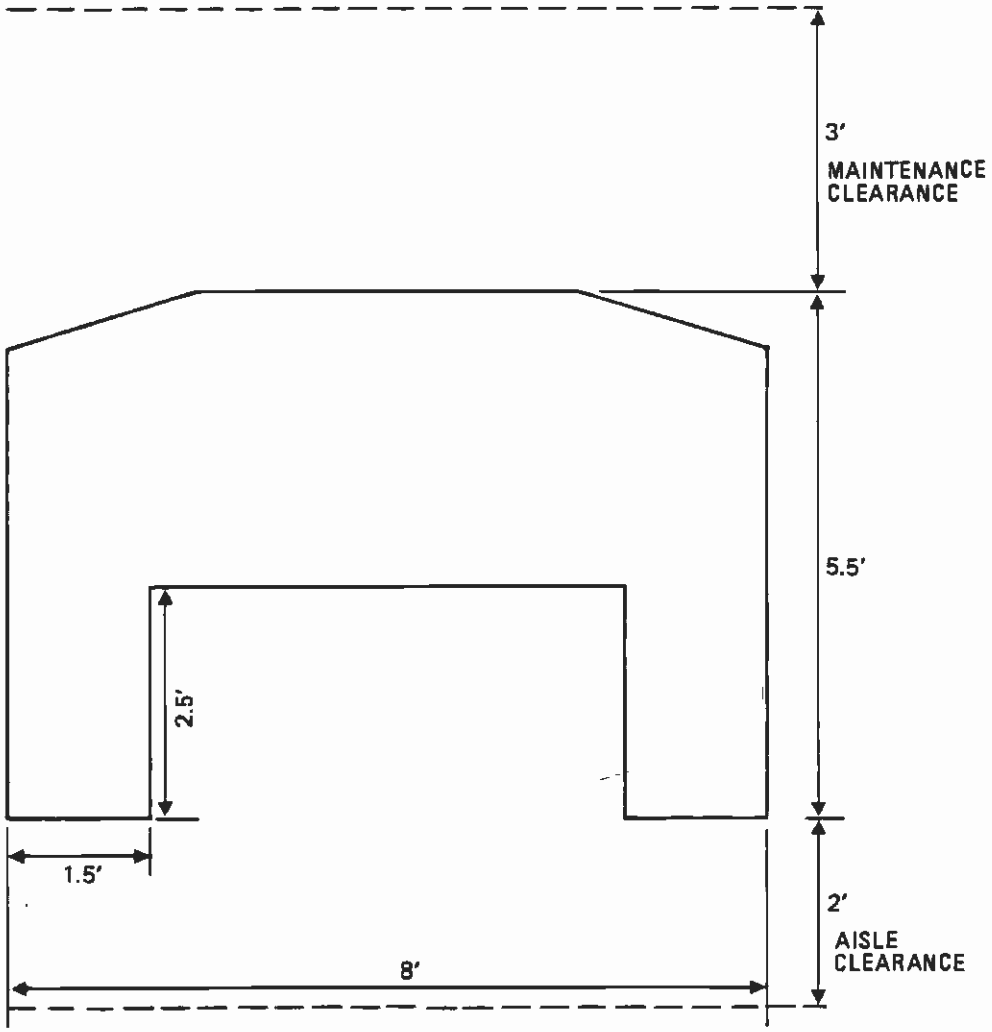


EXHIBIT 4
DISPATCHER WORK STATION SPACE REQUIREMENTS

BEST ESTIMATE OF SPACE REQUIREMENT FOR
CURRENT (NON-AVM) WORK STATION: 5'3" X 7'8"
MEASURING ERROR ADJUSTMENT: 5'6" X 8'
ALLOW 2' FOR AISLE ACCESS IN REAR OF WORK STATION:
ALLOW 3' FOR MAINTENANCE ACCESS IN FRONT OF WORK STATION:
SPACE REQUIREMENT PER WORK STATION:
10'6" X 8' = 84 SQUARE FEET



SCALE: 1/2" = 1 FOOT

- Operations Control and Services Superintendent
- Vehicle Operations Manager
- Assistant Vehicle Operations Managers (3)
- Radio Dispatch Manager
- Special Events Dispatcher
- Supervisor of Passenger and Lease Services
- Staff Assistant
- Stenographer
- Typist/Clerk.

According to SCRTD personnel, the latter three employees are not dedicated to the Bus Central Control Facility, but are shared between sections of the transportations services group.

Exhibits 5 through 9 indicate the organizational structure of the SCRTD divisions which support the functions of the Bus Central Control Facility -- the Transportation Division, Telecommunications Division, and Transit Police.

The rental cost of the current Bus Central Control Facility at 425 South Main Street less improvements, is estimated at $5 per square foot.

1.2 FUNCTIONS AND TECHNOLOGY

The Bus Central Control Facility has two principal functions:

- To monitor SCRTD bus operations and respond to unscheduled conditions (malfunctions, accidents, traffic conditions, etc.) to maintain a satisfactory level of service

- To monitor bus security and to quickly respond to security incidents where and when they occur.

These principal functions are carried out by the Bus Dispatch Center and, in the latter case, by the Bus Dispatch Center in conjunction with the Transit Police officer manning the Security Room. The transactions, equipment, and workload involved in fulfilling these functions are described below.

EXHIBIT 5
Organization Chart -- SCRTD Operations

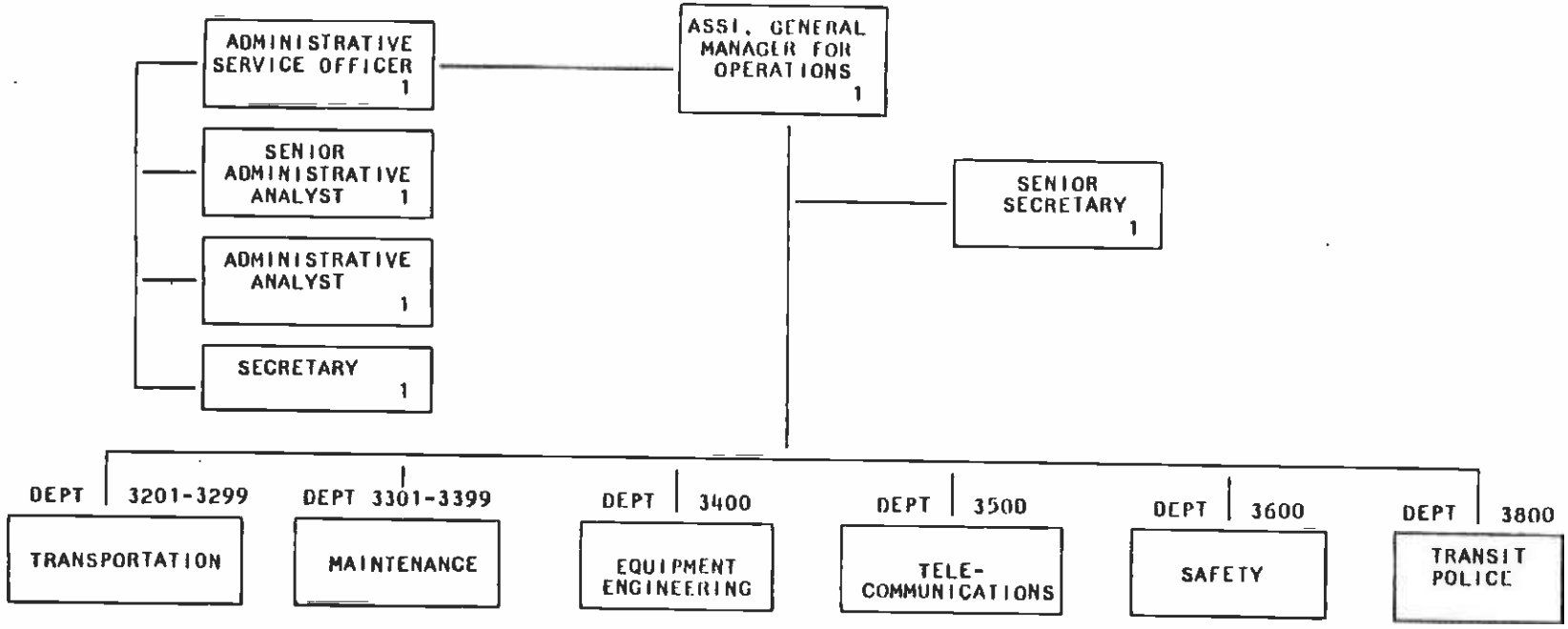


EXHIBIT 6
Organization Chart -- Transportation Division

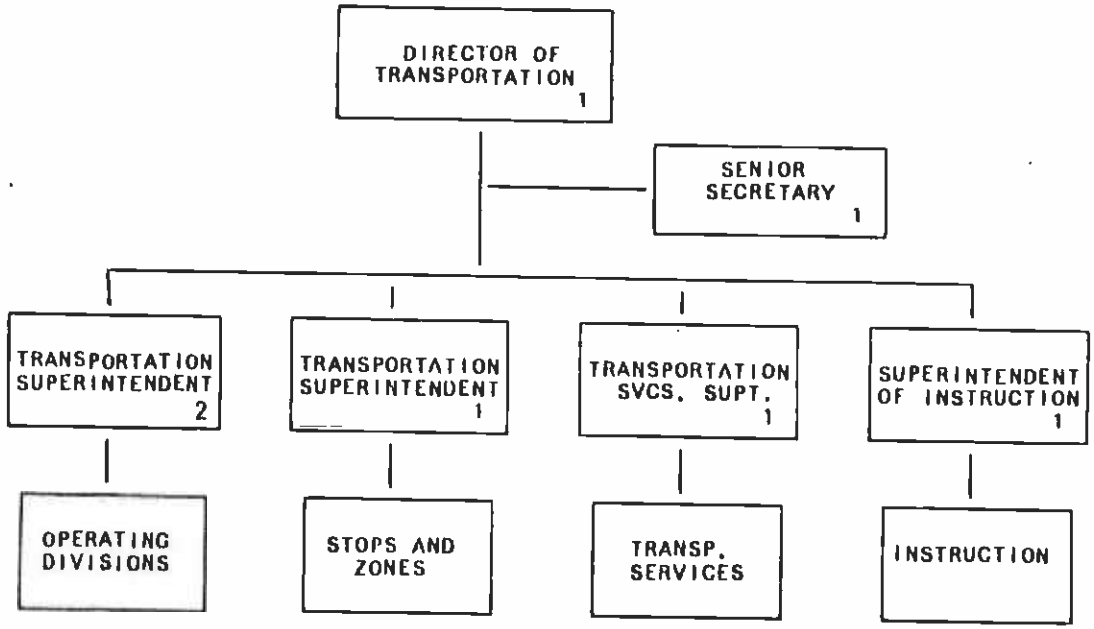


EXHIBIT 7
Organization Chart -- Transportation Services

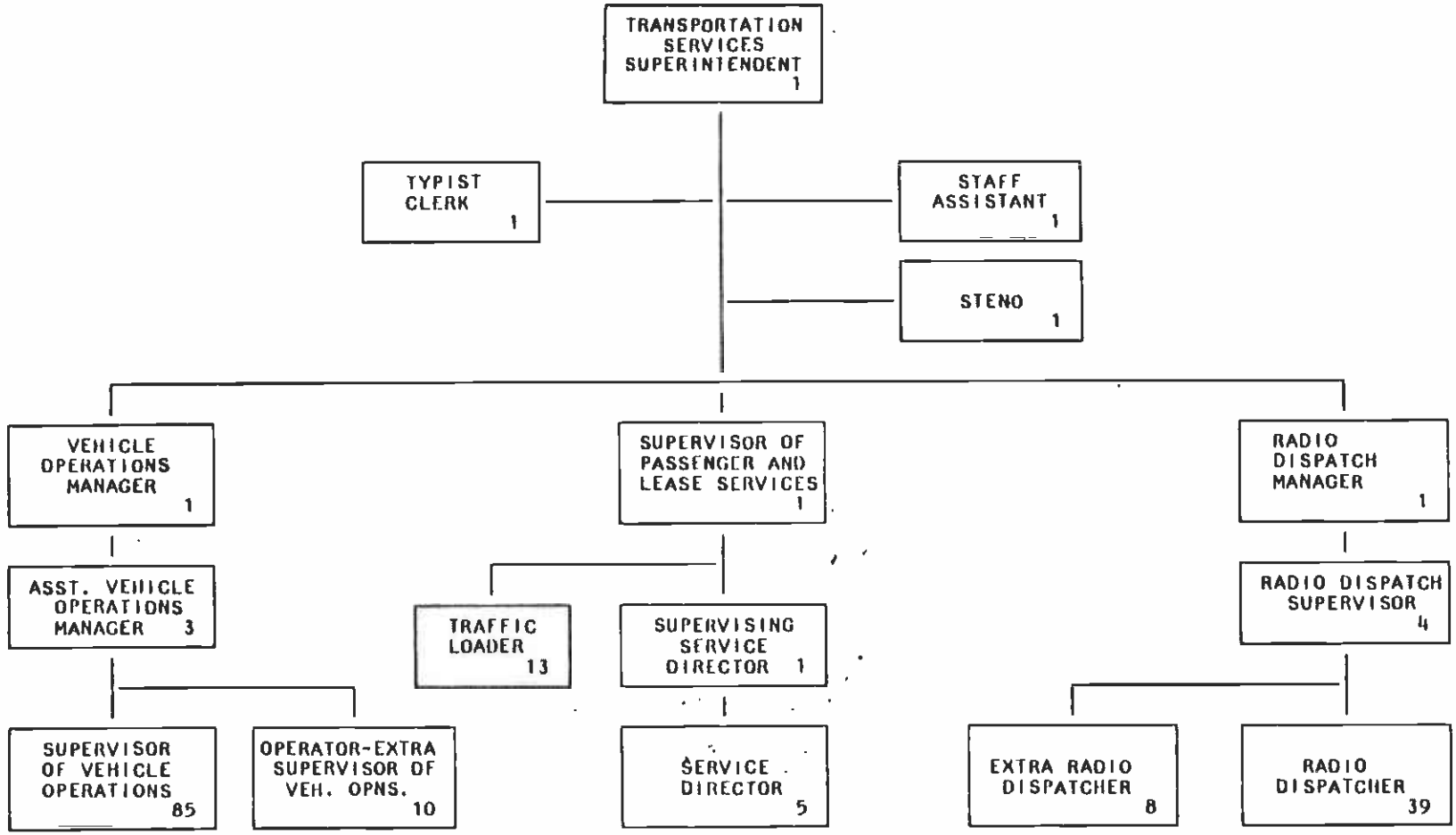


EXHIBIT 8
Organization Chart -- Telecommunications Division

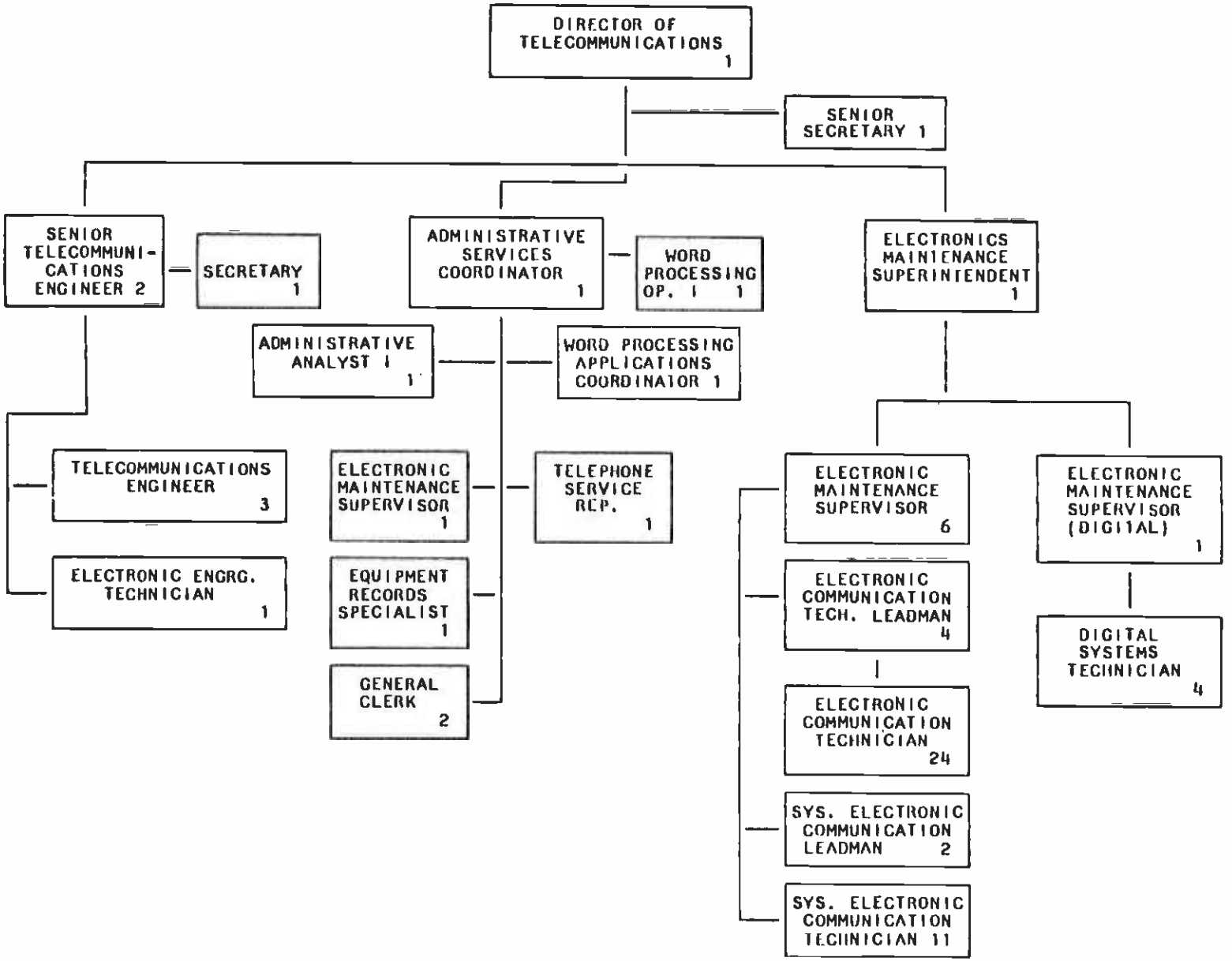
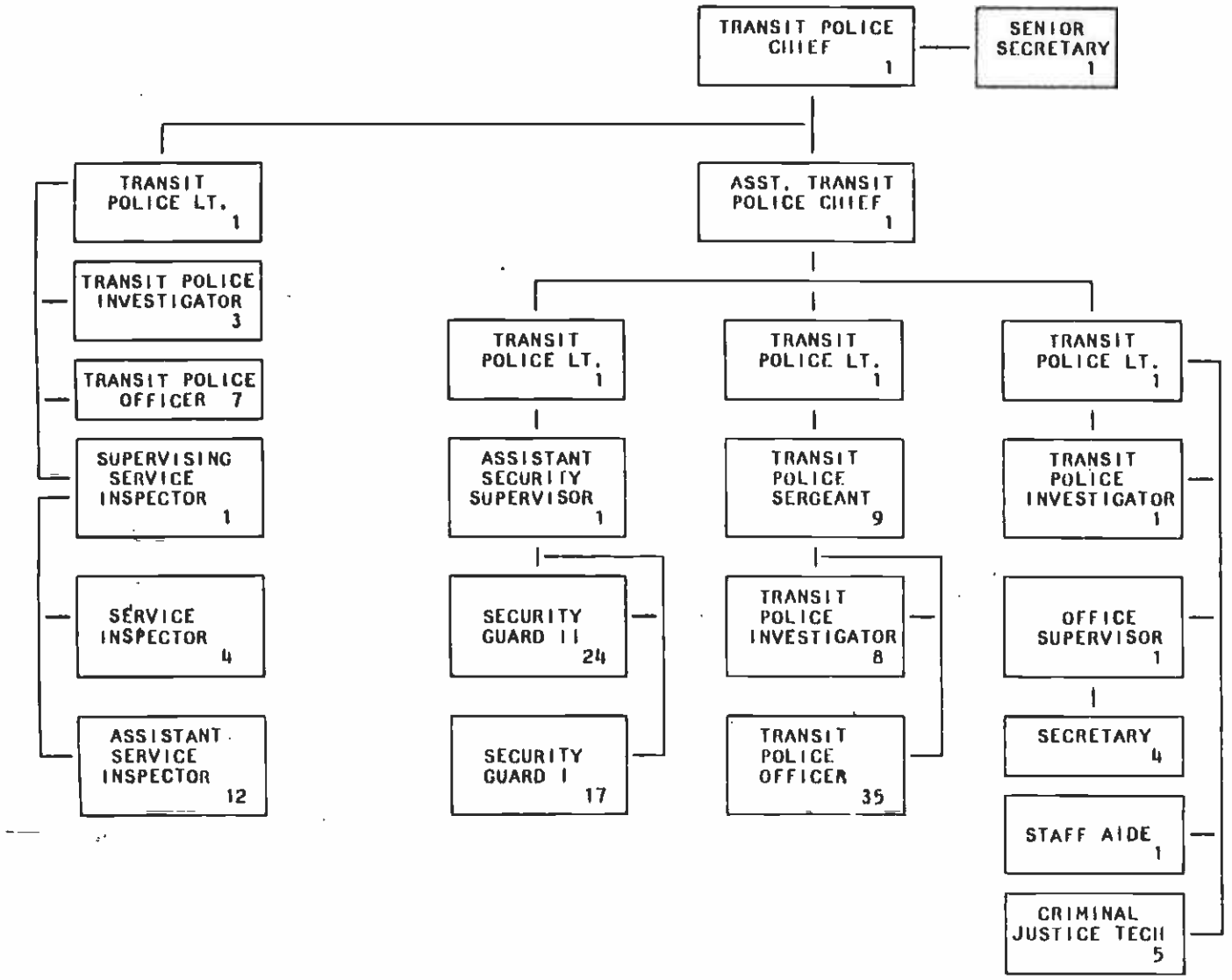


EXHIBIT 9
Organization Chart -- Transit Police



Transactions

Monitoring of SCRTD bus operations and security and responding to unscheduled conditions, requires bus dispatchers to coordinate bus maintenance, field supervisors, Transit Police, and other relevant personnel. The primary means of this coordination is by telephone or radio communication.

A total of 10 radio frequencies currently are available for communications between bus operators and the Dispatch Center. Present procedures assign buses by routes to the radio channels, distributing the buses to the channels as equitably as possible within the limits imposed by remote-transmitter locations. This process yields an average load per dispatcher of approximately 200 buses, but with a range of 139 to 239 buses.

As noted previously, each dispatcher has an extensive work station equipped with CRTs, keyboards, a telephone bank, and a file of hard-copy schedule information. The CRTs display bus channel and route information and a Street Supervisor Status System (a function of VMS). In addition to this equipment, automatic vehicle monitoring equipment has been installed at two work stations and is being tested on a few high-density bus routes. This equipment does not negate the need for audio communication between dispatchers and bus operators; rather, it enables dispatchers to monitor bus locations.

Dispatchers often handle schedule adherence/vehicle delay situations by directly communicating with bus operators, but can defer the incident to a road supervisor through radio contact. Road calls require the dispatcher to manually record the incident and to relay necessary information to a maintenance division via telephone. Lag time occurs for the dispatcher as he must wait for the call to be answered or returned, the status of vehicles or mechanics to be determined, and a response to be given. At this time, dispatchers are also keying the maintenance information into the Vehicle Maintenance System (VMS), which is being tested and is scheduled to enter systemwide operation within the next several weeks. The VMS is designed to automate the interface between dispatchers and the maintenance divisions and to eliminate the need for dispatchers to report verbally by telephone to the maintenance divisions.

Non-emergency security calls are taken by dispatchers and are then manually diverted to the Transit Police officer manning the Security Room -- that is, dispatchers hand-carry the information over to the Security Room. Emergency situations are identified by silent alarms and are automatically transmitted to the Security Room.

All transactions are manually recorded on incident reports (CS 10 reports). These forms are then photocopied and distributed to relevant SCRTD personnel. (For a major incident, upwards of 20 copies may be made and distributed.) While the form is concise and easy to use, it requires time to fill out and some retrieval time when callbacks occur. Currently, over a quarter of a million CS 10 reports are prepared annually. The distribution of CS 10 reports among incident types -- road calls, delays, security calls, operator assistance calls, etc. -- is not known. However, a broad estimate of annual security calls, including emergency and non-emergency incidents, places the number of such calls at approximately 22,000, representing about 9 percent of total dispatcher transactions.

Workload

The workload of the Dispatch Center, as measured by CS 10 reports, has increased by over 60 percent since 1977, rising from approximately 154,221 incidents in that year to about 256,000 in 1983 (see Exhibit 10). This is a startling rise in workload and warrants an investigation into its cause. The magnitude of the workload is illustrated by the fact that on one day (April 13, 1984), 1,047 CS 10 reports were filled out and a total of 1,600 photocopies of these reports were distributed. In addition to the impact of such a workload on dispatchers, it seems apparent that the volume of CS 10 reports filed would require substantial support time for photocopying, distributing, and filing the reports. No information on such support requirements has, however, been obtained.

Given that there are currently 10 dispatchers, the workload per dispatcher is now approximately 25,600 incidents per year. In 1978, annual incidents per radio channel totaled 23,500. The following year, two additional channels were added, decreasing the per channel load to 20,900 (see Exhibit 11). At the current annual level of 25,600, dispatchers are

EXHIBIT 10
Annual Production of CS 10 Reports

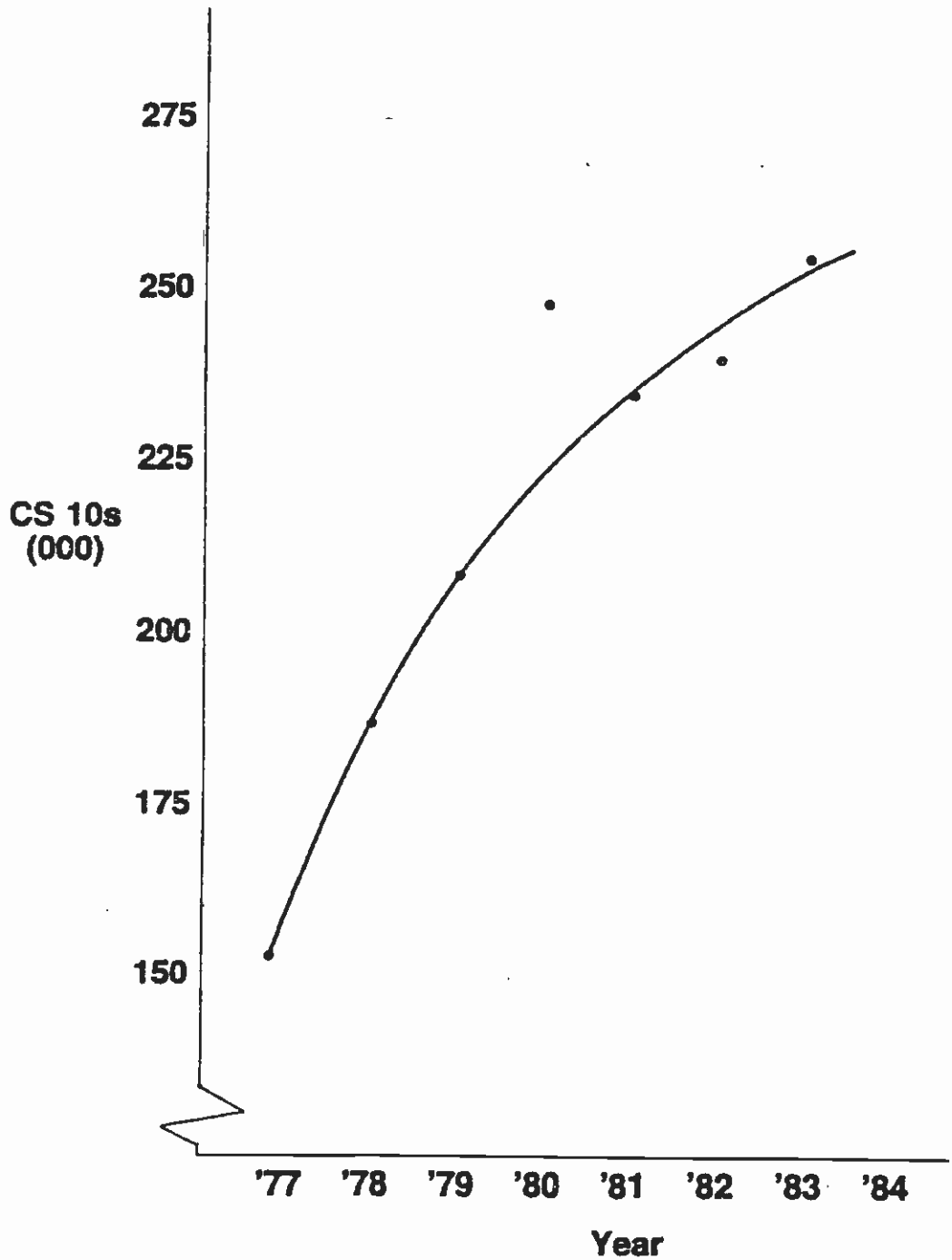
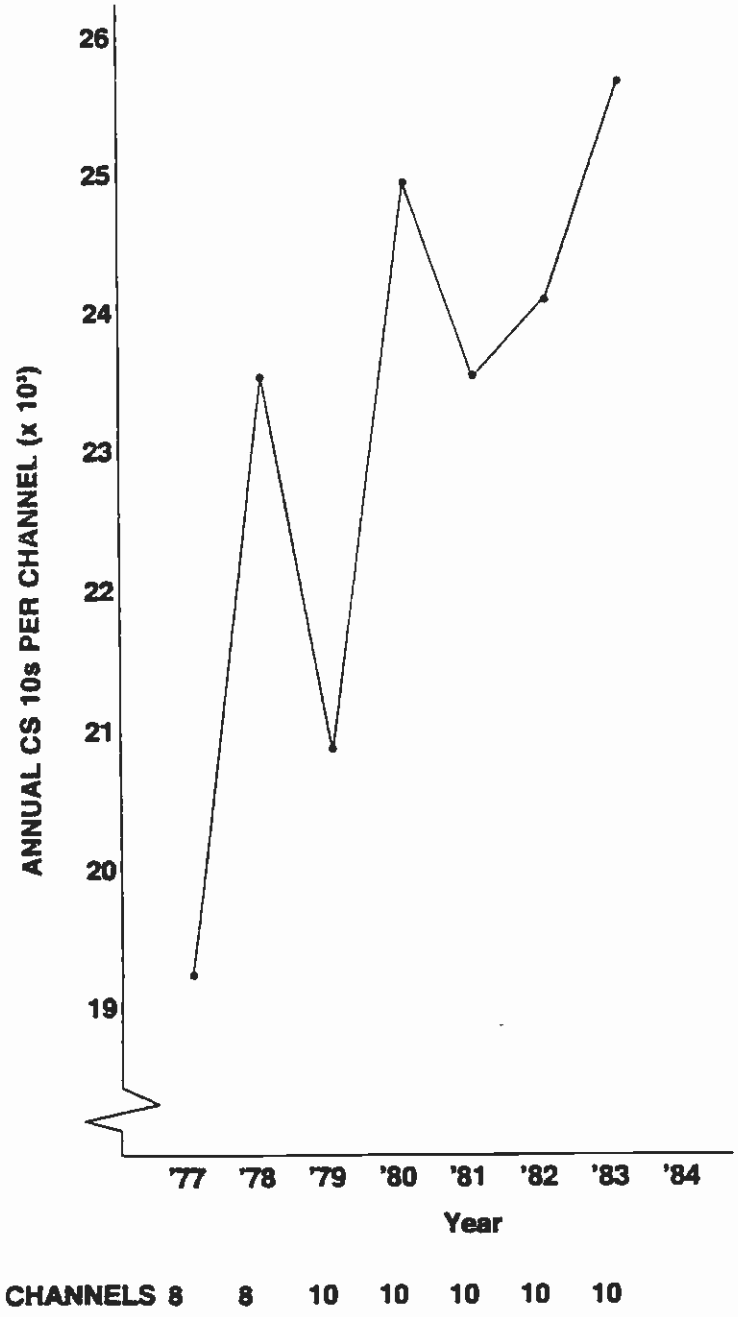


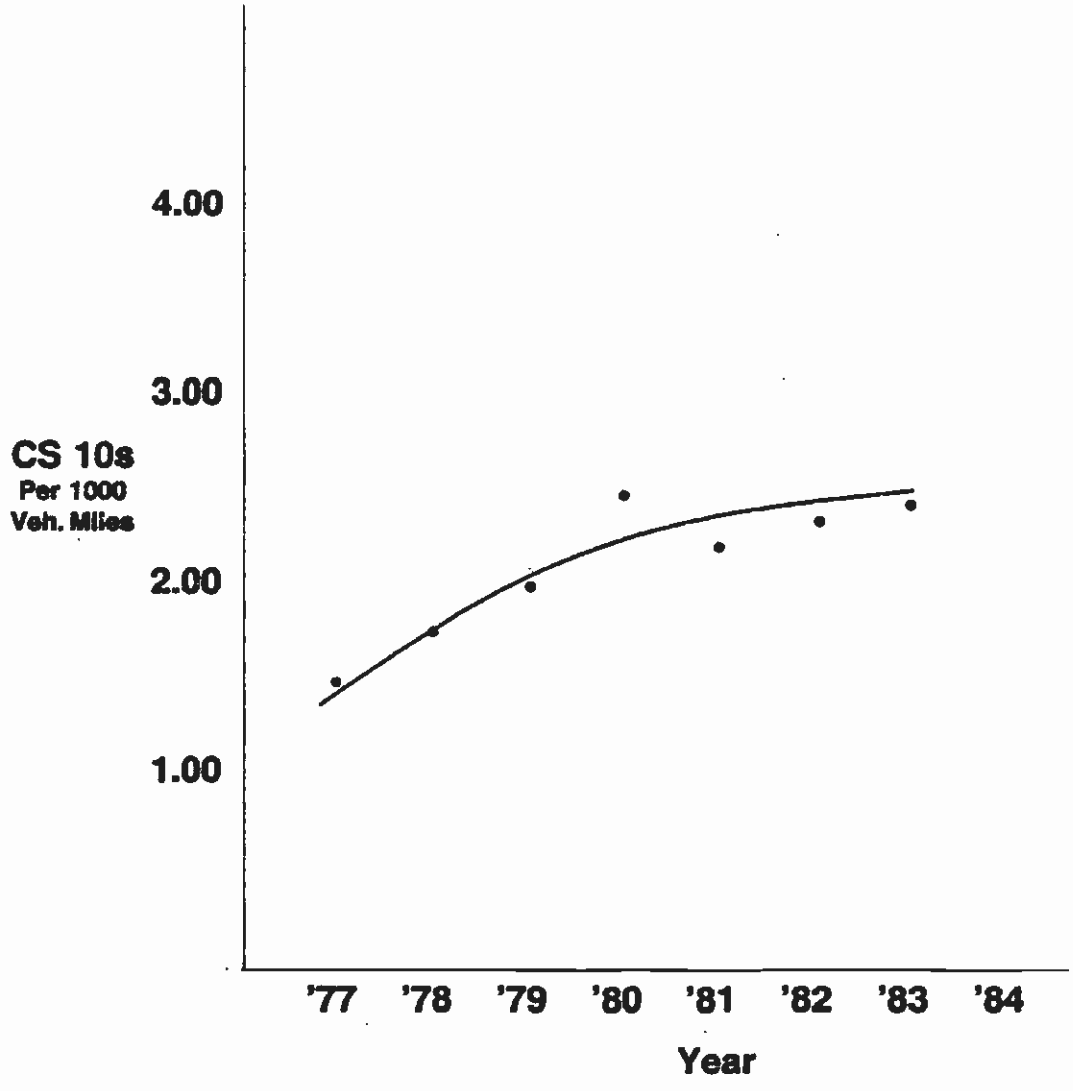
EXHIBIT 11
Average Load Per Channel



viewed as overburdened, although no documentation of maximum work station processing capacity has been found.

One possible explanation of the rising trend in incident reports is the increased percentage of fleet vehicles equipped with radios, for approximately 3,000 radios have been purchased and installed since 1977. A second factor is clearly the poor performance experienced by new vehicles. A decrease in mean miles between roadcalls from 3,500 to 2,800 miles has occurred. This situation is apparently stabilizing, as indicated in Exhibit 12, and improvement is expected. Additional factors which could influence the workload on the center, now and in the future, are discussed in the following chapter.

EXHIBIT 12
CS 10s Per 1000 Bus Miles



2. FACTORS INFLUENCING FUTURE REQUIREMENTS

During the review of the present SCRTD Bus Control Facility, various factors were identified that may influence its future requirements. These factors fall within two major categories -- those that may affect the center's workload, and those that may affect dispatcher productivity. Both combine to influence the number of dispatchers needed to staff the facility, and thus the space required within the facility.

2.1 FACTORS INFLUENCING DISPATCHER WORKLOAD

The number of transactions needing to be handled by dispatchers is a function of the size of the fleet being supported, the age of the fleet, the passenger load per vehicle, the level of passenger service provided by the fleet, and other factors. Each is discussed below.

Size of the Fleet

The size of the fleet being supported by the Bus Central Control Facility has remained relatively constant in recent years, rising from 2,001 peak vehicles in 1980 to an estimated 2,072 peak vehicles in 1984. It is projected that the bus fleet will comprise 2,119 peak vehicles in 1985, but will decrease again to 2,072 vehicles in 1989 (see Exhibit 13).

Projections for the year 2000 contained in the SCRTD Metro Rail Milestone 9 Final Report, Supporting Services Plan (May 1983), show 2,209 peak vehicles required in the year 2000 in the absence of Metro Rail service, and 1,969 peak vehicles in that year given an integrated Metro Rail/bus system. The size of the fleet is thus projected to remain near its present level, and consequently no significant change in workload is foreseen as a direct effect of fleet size.

EXHIBIT 13
Number of Peak Vehicles -- SCRTD Bus Operations

Year	No. of Peak Vehicles
1978	1,825
1979	1,982
1980	2,001
1981	2,036
1982	2,007
1983	2,013
1984	2,072
1985	2,119
1986	2,046
1987	2,090
1988	2,099
1989	2,072

Source: 1978-84, SCRTD Annual Reports; 1985-89, SCRTD Five-Year Operating Plan.

Passenger Load Per Vehicle

Although the size of the fleet has remained relatively constant and is projected to continue to do so through the year 2000, the number of passengers riding SCRTD buses has been steadily increasing. Annual ridership increased from 282 million in 1977 to 415 million in 1983, and is estimated to reach 465.4 million in 1984 and 482.3 million in 1989 (see Exhibits 14 and 15).

Given the relatively constant fleet size, this rise in ridership has meant a significant rise in the annual passenger load per peak vehicle. Whereas the annual ridership per peak vehicle in 1978 was approximately 172,600, this number had risen to 206,600 in 1983. It is estimated at approximately 224,600 in 1984, and is projected to reach slightly over 232,700 in 1989 (see Exhibits 14 and 16). This represents a 20 percent rise in annual passenger load per peak vehicle in the years 1978 through 1983, and a 35 percent increase in the entire period 1978 through 1989.

This trend is forecast to continue, for the Milestone 9 Final Report predicts daily bus passenger boardings in the year 2000 will be almost 57 percent greater than the 1982 level without Metro Rail service and approximately 50 percent above the 1982 level with integrated Metro Rail/bus service.

It is likely that these increased passenger loads are causing an increase in the number of road calls presently being received at the SCRTD Bus Dispatch Center, and will continue to do so in both the short- and long-term future. An assessment of the relationship between passenger loading and number of road calls is not possible at this time because CS 10s are not disaggregated into road-call and other incident categories.

Age of Fleet

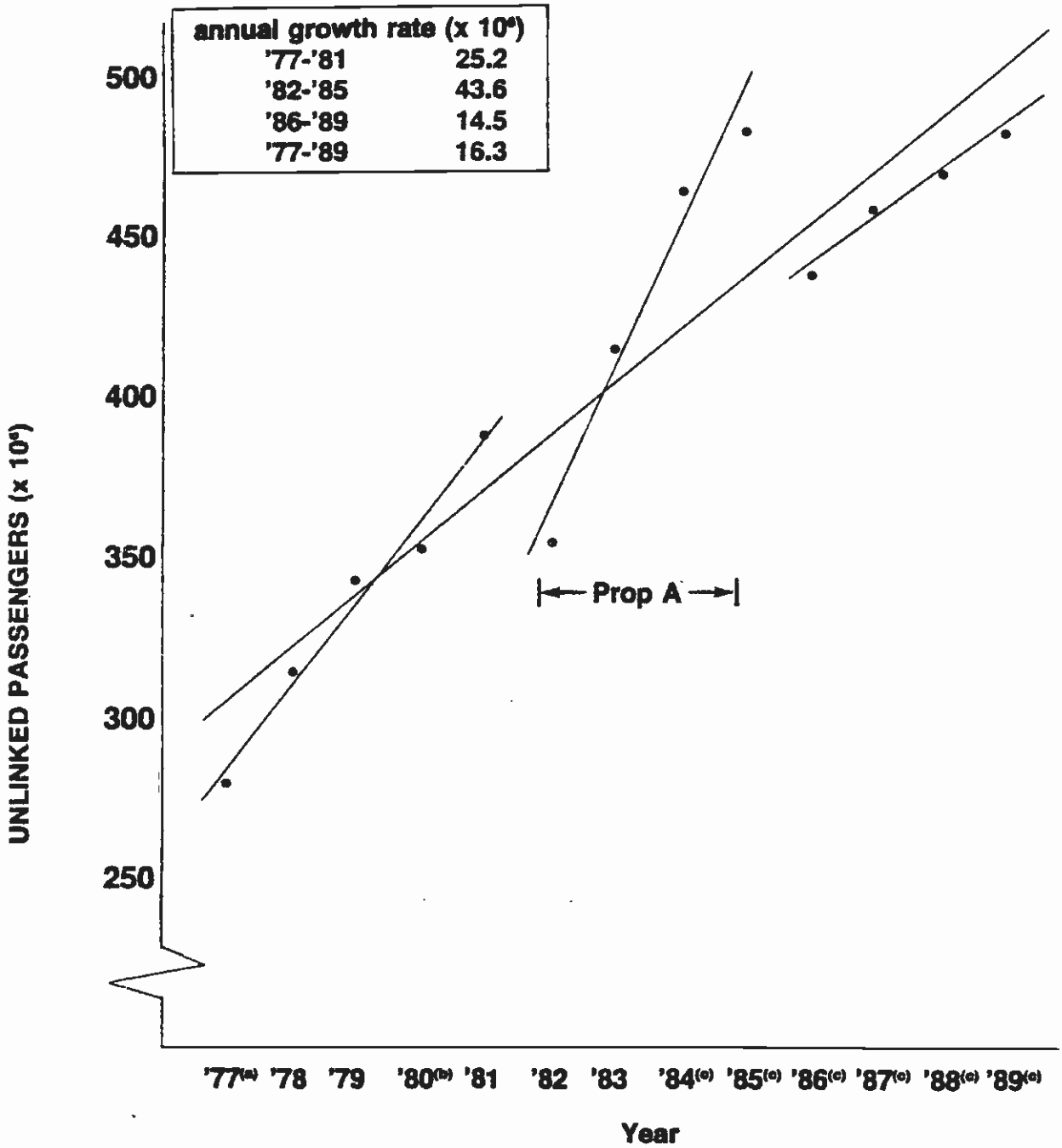
In general, the number of road calls experienced by a transit system will increase as the average vehicle age increases. At SCRTD, however, average fleet age has decreased from 12.0 years in 1977 to 9.4 years in 1984, but road calls have increased. As previously mentioned, poor performance of recent fleet procurements explains this inversion. This situation is stabilizing, however, and significant decreases in the annual number of road calls can be expected in the short term.

EXHIBIT 14
Growth in SCRTD Bus Ridership

Year	Annual Unlinked Ridership	Annual Ridership/ Peak Vehicle
1977	282,000,000	-
1978	315,000,000	172,602
1979	344,200,000	173,915
1980	352,600,000	176,212
1981	397,000,000	194,990
1982	352,700,000	175,735
1983	415,000,000	206,607
1984	465,400,000	224,614
1985	484,000,000	228,410
1986	438,000,000	206,701
1987	456,900,000	218,612
1988	470,400,000	224,107
1989	482,300,000	232,770

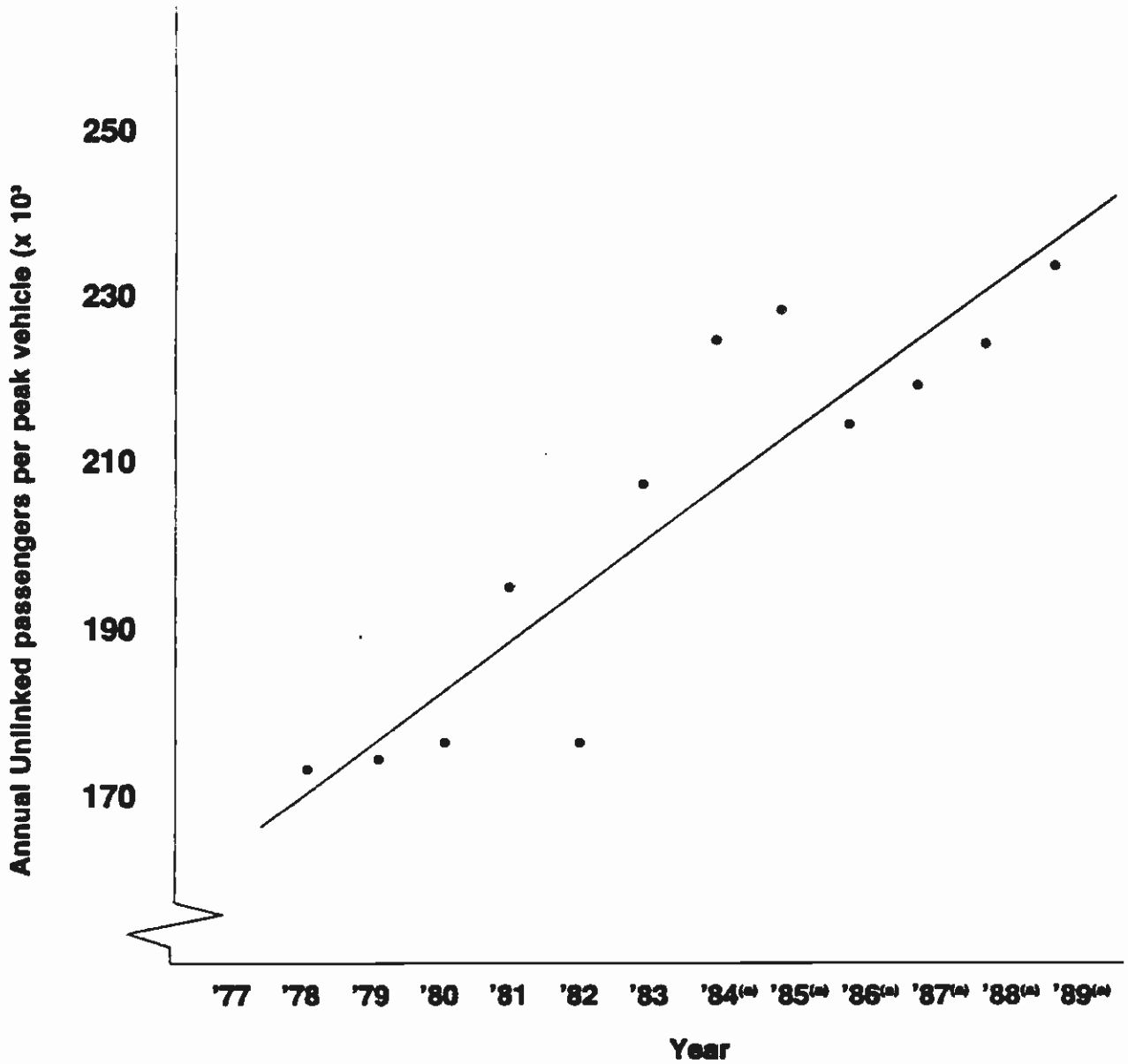
Source: 1977-84, SCRTD Annual Reports; 1985-89, SCRTD Five-Year Operating Plan.

EXHIBIT 15
Ridership Growth



Note:
(a) 36 day work stoppage
(b) 23 day work stoppage
(c) Source: 5-year operating plan

EXHIBIT 16
Annual Passenger Load Per Peak Vehicle



(a) Source: five year operating plan

In the long term, however, road calls will begin to gradually increase again as the SCRTD fleet ages. Exhibit 17 illustrates the relationship of number of road calls to fleet age. As indicated, the number of road calls is also a function of vehicle miles, discussed in the following section.

Level of Passenger Service

The level of passenger service provided by a transit system, as measured by vehicle miles and vehicle hours, has a direct effect on annual road calls and thus on the workload of the Central Control Facility. At SCRTD, service levels through 1989 are projected to rise only slightly, from an estimated 110 million annual vehicle miles in 1984 to a projected 113.9 million annual miles in 1989, or less than 3 percent (see Exhibit 18).

Projections contained in the Milestone 9 Final Report indicate that service levels will not change markedly in the long term. The Milestone 9 Report places daily SCRTD bus miles in 1982 at about 315,000 and projects these will rise in the year 2000 to approximately 391,000 in the absence of Metro Rail service, and to about 323,000 given an integrated Metro Rail/bus system. In both cases, the projected rise is less than 3 percent. Vehicle hours have been estimated in the Milestone 9 Final Report at a daily average of about 23,000 in 1982 and are projected to rise in the year 2000 to about 28,500 without Metro Rail service and to about 25,000 with integrated Metro Rail/bus service.

The influence of level of service on annual road calls, and thus workload, is assumed to be negligible in both the short and long run.

Automatic Data Collection System

The SCRTD is currently developing specifications for a new mini-computer communications system, which is discussed in more detail later in this chapter. A major feature of this system will be an Automatic Data Collection System (ADCS) which will automatically transmit and record passenger load and schedule adherence data. This system is expected to enhance significantly SCRTD's service planning, and should therefore act to reduce schedule adherence and vehicle delay incidents. The projected scheduling benefits of ADCS are described in a report prepared by SCRTD. However, the absence of any historic data precludes an estimation of the likely effect on annual workload which such a system might produce.

EXHIBIT 17
Sample Graph of Impact of Fleet Age and Usage
on Repair Frequency

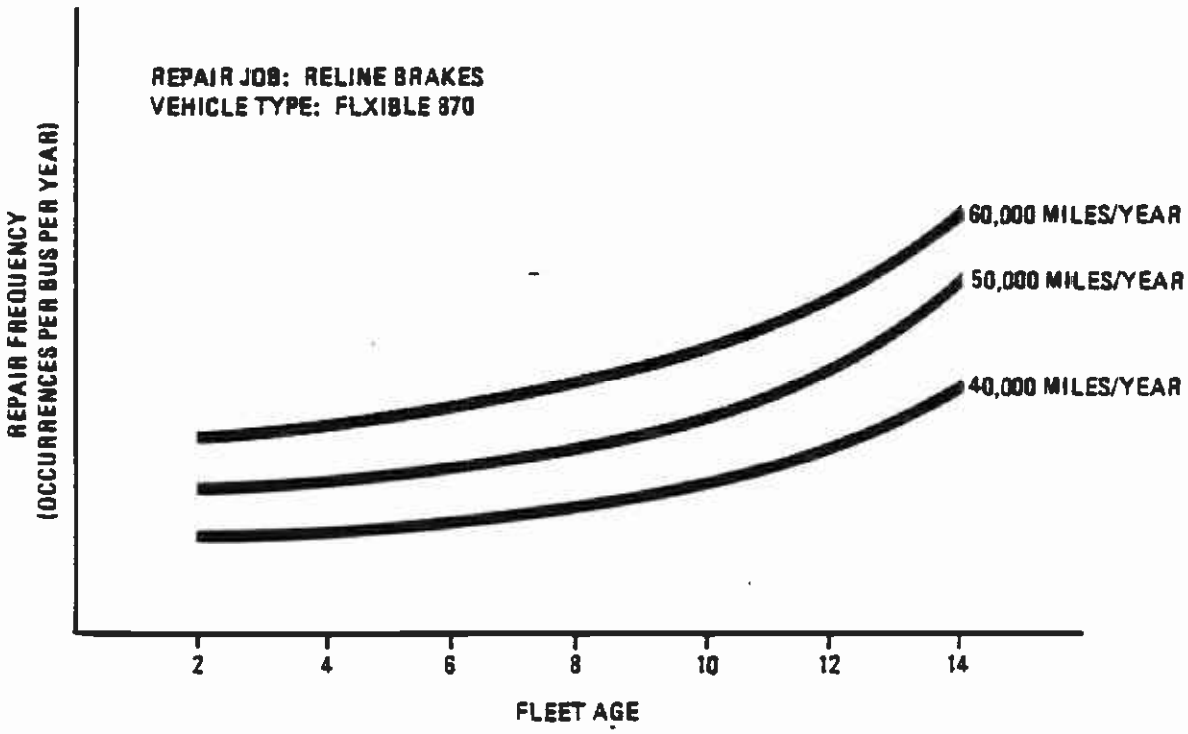


EXHIBIT 18
Annual Vehicle Miles, SCRTD Bus Operations

Year	Annual Vehicle Miles (000)
1977	102,900
1978	104,000
1979	102,000
1980	99,000
1981	105,500
1982	101,460
1983	103,654
1984	110,069
1985	112,270
1986	108,100
1987	110,600
1988	113,400
1989	113,900

Source: 1977-84, SCRTD Annual Reports; 1985-89, SCRTD Five-Year Operating Plan.

Automatic Mechanical Failure Monitoring

The specifications for the new mini-computer communications system include vehicle radio equipment with the capability to monitor and automatically transmit vital data on a limited number of vehicle systems. By providing early warning of mechanical problems, vehicle damage is expected to be reduced. In a few cases this feature could reduce road calls, however, the influence of this on dispatcher work load will be very slight and assumed negligible.

Security Calls

As noted in Chapter 1, annual security calls, including emergency and non-emergency incidents, are broadly estimated at 22,000 per year, accounting for about 9 percent of total dispatcher transactions. Historic data on security calls have not yet been found and an accurate prediction of future trends is therefore precluded. No major fluctuations are anticipated, however, and annual security calls are assumed in this analysis to remain constant.

Other Factors

Other factors that influence the workload placed on dispatchers primarily concern transactions other than schedule adherence/delay, road calls, or security calls. These comprise bus operator assistance calls (unscheduled facility maintenance calls, personnel complaints, supervisory information, and so on), and arise from the fact that the Dispatch Center is the primary contact for bus operators.

2.2 FACTORS INFLUENCING PRODUCTIVITY

The future requirements of the Bus Central Control Facility are a function not only of the factors that will affect the facility's workload, as identified above, but also of factors that will influence the productivity of each dispatcher. These factors include the reliability of the equipment used by dispatchers, the method used to report incidents, and new technology being planned by SCRTD for the facility's operations, including the Vehicle Maintenance System (VMS), automatic vehicle monitoring/automatic vehicle locating (AVM/AVL) function, Automatic Call Distributing function, and a Road Mechanic Status System (function of VMS). The latter three are features of the mini-computer communications system currently being designed for the facility.

Console Equipment Reliability

The frequency of breakdowns and average downtime of console equipment obviously will affect work station productivity. A review of available data, supported by interviews with SCRTD personnel, indicates that console equipment reliability at the Bus Dispatch Center is extremely high. The effect of equipment performance on work station productivity is therefore assumed to be negligible in this analysis. However, this assumption should be reevaluated as operating policy and equipment decisions are made.

Incident Reporting

The current method of processing transactions -- manual preparation of a CS 10 report by the dispatcher and relaying of information to relevant personnel -- is a time-consuming process and is cited by dispatchers as a deterrent to efficiency. Any enhancement to this process could therefore improve productivity.

Vehicle Maintenance System (VMS)

The Vehicle Maintenance System (VMS), currently being tested by SCRTD and scheduled for full-time systemwide use within the next several weeks, is designed to automate the dispatcher/maintenance interface. It should therefore have a positive influence on dispatcher productivity, although SCRTD judges that this influence will be small.

It should be noted, however, that in the current test of VMS, dispatchers are required not only to enter the information into VMS, but also to manually fill out CS 10 reports and telephone maintenance divisions. This redundant reporting is currently acting to decrease dispatcher productivity, and will continue to do so during the transition phase from the former manual process to full use of VMS. In the longer run, VMS may improve productivity to some degree, but only if it is implemented fully; if it is not, the detrimental effects of redundant reporting requirements will continue to be felt.

Automatic Vehicle Monitoring/Automatic Vehicle Locating Equipment

The automatic vehicle monitoring/automatic vehicle locating equipment (AVM/AVL) system enables a dispatcher to conduct real-time monitoring of vehicles through the route network, or alternatively to pinpoint vehicle

locations in an emergency or in unusual situations. The AVM/AVL feature is included in the specifications being developed for the mini-computer communications system.

The AVM system is currently being tested on four routes. It allows a dispatcher to visually monitor all vehicles along the route. This enables him to clearly identify clustered, delayed, or disabled buses and to modify vehicle assignment -- stop to discharge only, reroute, etc. Although in concept such a system has apparent advantages, its operational practicality is suspect:

- Extreme automobile traffic conditions during peak periods restrict dispatcher flexibility and virtually negate the usefulness of AVM.
- Dispatcher and vehicle operators are hesitant only to discharge passengers and not allow boarding, as altercations can develop between operators and patrons waiting to board.
- Dispatchers view the present AVM system as "unmanageable" during peak periods and ignore the monitoring equipment during these times.

When used for automatic vehicle locating (AVL), the system does not present the same difficulties. It affords dispatchers the opportunity to identify vehicle positions for security and overall schedule management purposes. The responsibility for "real-time" schedule management, however, remains with the bus driver.

According to SCRTD estimates, the use of the AVM/AVL system, in conjunction with the Automatic Data Collection System (ADCS) described above, will provide significant service benefits, enabling analysis of data to identify problem routes and monitoring to determine problem causes and resolutions. The effect on dispatcher productivity of monitoring activities will be negative, however. The additional operational information automatically channelled to the control center through ADC will prompt more service "flags". The AVL system and other support features will provide dispatchers with additional tools for control, but will, therefore, increase the processing time requirement per incident. These systems, while expected to result in more effective control of bus operations, will decrease dispatcher productivity. SCRTD estimates an immediate and significant requirement for a 40 percent addition to its dispatcher staff once the AVM/AVL and ADCS

systems are in full operation, even given productivity improvements from the other factors discussed in this chapter.

Automatic Call Distributing

The Automatic Call Distributing System, a feature of the planned mini-computer communications system, will distribute calls evenly across radio channels, thereby minimizing peak requirements. This feature has the potential to significantly increase dispatcher productivity, given that channel load is at present uneven.

Automation of call distribution will not simply redistribute the vehicles per channel but will distribute all transactions evenly. Based on present performance standards and on a 5-day data sample, it is estimated that this feature will improve productivity by about 30 percent (see Exhibit 19). No consideration has been given nor has documentation been found on the acceptability of delays/queues of incoming calls.

One expressed concern of automatic call distributing is the increased requirements on the dispatchers, as they must be familiar with the entire systemwide route network. Increased training is expected to overcome this difficulty.

Road Mechanic Status System

An additional link in the dispatching communication network which is automated through VMS is road mechanic contacting. Lag time occurs in transaction processing while maintenance personnel identify and dispatch available road mechanics in response to a mechanical failure of vehicles. VMS automates this function, storing the status of road mechanics in an active (up-to-date) file, allowing the dispatcher to quickly identify available mechanics. This feature is expected to marginally increase dispatcher productivity, reducing telephone communications and expediting road call processing. A quantified estimate of the impact of this would be completely subjective and has not been made.

2.3 SUMMARY

The factors identified above are summarized in Exhibit 20, which also notes the likely influence these factors will have on the future requirements of the SCRTD Bus Dispatch Center. It should be noted that the

EXHIBIT 19
Load Per Channel Reduction Potential

Date	Day	Radio Channels 1	2	3	4	5	6	7	8	9	10	Average	Peak Reduction
03-07-84	Wednesday	106	161	105	98	176*	115	133	81	151	148	127.4	27.6%
03-08-84	Thursday	162	164	140	107	158	124	108	56	191*	165	137.5	28.0%
03-09-84	Friday	148	173	129	106	174	130	96	68	196*	159	137.9	29.6%
03-11-84	Sunday	72	112	55	48	78	52	71	16	117*	110	73.1	37.5%
03-12/84	Monday	120	203*	126	88	176	125	143	67	179	156	138.3	31.9%

* Peak Load.

Peak Reduction Formula:

$$PR = \frac{\text{Peak Load - Average Load x 100}}{\text{Peak Load}}$$

EXHIBIT 20
Future Work Station Impact Summary

DISPATCHER TRANSACTIONS

Influencing Factor	Expected Future Impact	Comments
ADCS*	(Potentially) significant reductions in scheduling vehicle delay problems	• Difficult to quantify or estimate impact • Expect "significant service planning benefits"
Level of Service	No change	• Constant level of service planned
Fleet Size	No change	• Constant number of peak vehicles planned
Load per Vehicle	Slight increase in road calls	• Load per vehicle is steadily increasing • Impact on road calls not quantified
Fleet Age	Initial vast reduction, then gradual increase in road calls	• Significant road call reduction expected as new fleet performance stabilizes • Gradual increase in road calls as fleet ages • Impacts and time frames unknown
Automatic Mechanical Failure Monitoring	Insignificant effect	• Potential for a very slight decrease in road calls, but only in isolated cases (e.g., specific vehicle systems) • Primary advantage in reducing the extent of damage, not the frequency of failure.
Non Emergency and Silent Alarm Incidents	No change	• Less than 10% of all transactions • Constant level of security incidents anticipated; but with no data support

* Features of the mini-computer system currently being designed.

EXHIBIT 20
(Continued)

PRODUCTIVITY

Influencing Factor	Expected Future Impact	Comments
CS 10 Reporting	Unknown	• Over 0.25 million reports filed annually • Number of annual reports is increasing • Time-consuming manual process and wide distribution of reports
Telephone Transactions	No effect	• Maintenance interface automated through VMS
VMS	Slight productivity increase with full system implementation	• Automates inefficient functions • Impact is estimated (unquantified)
Console Equipment Reliability	No change	• Expect continued high performance
AVM/AVL* (in conjunction with ADC)	Decrease in productivity	• Expect primarily emergency vehicle location - no real time monitoring • ADC driven utilization of AVM/AVL and supporting features expected to decrease productivity
Road Mechanic Status System	Slightly increased productivity	• Automates communication link not handled through VMS • Magnitude of impact not estimated
Automatic Call Distributing*	30% productivity increase	• Reduces peak load per channel to a minimum • Impact determined from five-day sample

* Features of the mini-computer system currently being designed.

implementation of the mini-computer communications system will not only influence the staffing level of the Bus Dispatch Center, but will also impose requirements for data processors and electronics maintenance personnel.

3. FUTURE FACILITY REQUIREMENTS

This chapter describes our findings, based on information gained in our analysis and from SCRTD, with regard to the short- and long-term future staffing and space requirements for the Bus Central Control Facility.

3.1 STAFFING REQUIREMENTS

This section discusses the future staffing requirements of each of the areas of the Bus Central Control Facility -- the Bus Dispatch Center, the Security Room, and the Administrative/Support Area.

Bus Dispatch Center

The number of dispatchers needed in the Bus Dispatch Center is a function of the workload of the center and the productivity of dispatchers, as discussed in detail in the previous chapter. The workload on the center has risen dramatically during recent years, and no significant decreases in this workload level are seen as a result of the factors identified in Chapter 2. (The extremely high, and rising, number of CS 10 reports being handled per year by the center, however, warrants a review of data to determine whether the current workload is being driven by vehicle performance, control practices and policies, or other problems.)

With regard to dispatcher productivity, significant improvements (estimated at 30 percent) are expected to result from the implementation of the Automatic Call Distributing System. Automation of the dispatcher/maintenance interface through VMS, and improvement to the dispatcher/roving mechanic interface through the Road Mechanic Status System (also a feature of VMS), are also expected to act to improve productivity.

The productivity improvements possible from these factors are, however, negated by SCRTD's judgment concerning the effect of the use of the AVM/AVL System, in conjunction with the ADC system. In SCRTD's determination, the use of these features will impose a requirement for a 40 percent increase in the number of peak dispatchers, even given productivity increases from Automatic Call Distributing, the Road Mechanic Status System, and other sources.

Given this determination, the number of bus dispatchers needed to staff the center in the short term will be 14. Adding a contingency factor for the longer term of 15 percent, the number of positions rises to 16.

Security Room

SCRTD has determined the need to dedicate one bus dispatcher to process security incidents. Implementation of this will coincide with the mini-computer system.

Administrative/Support Area

The implementation of the mini-computer system will require the addition to SCRTD staff of data processors, and of on-site electronics maintenance personnel if the Bus Central Control Facility is moved from 425 South Main Street to a new location. It is unclear that the data processors will administratively be part of the Bus Central Control Facility or that they will physically be located within the facility.

3.2 SPACE REQUIREMENTS

The space requirements for the Bus Central Control Facility are a function of the factors summarized in Exhibit 21, which also indicates that the critical determinant of future space requirements is the Bus Dispatch Center.

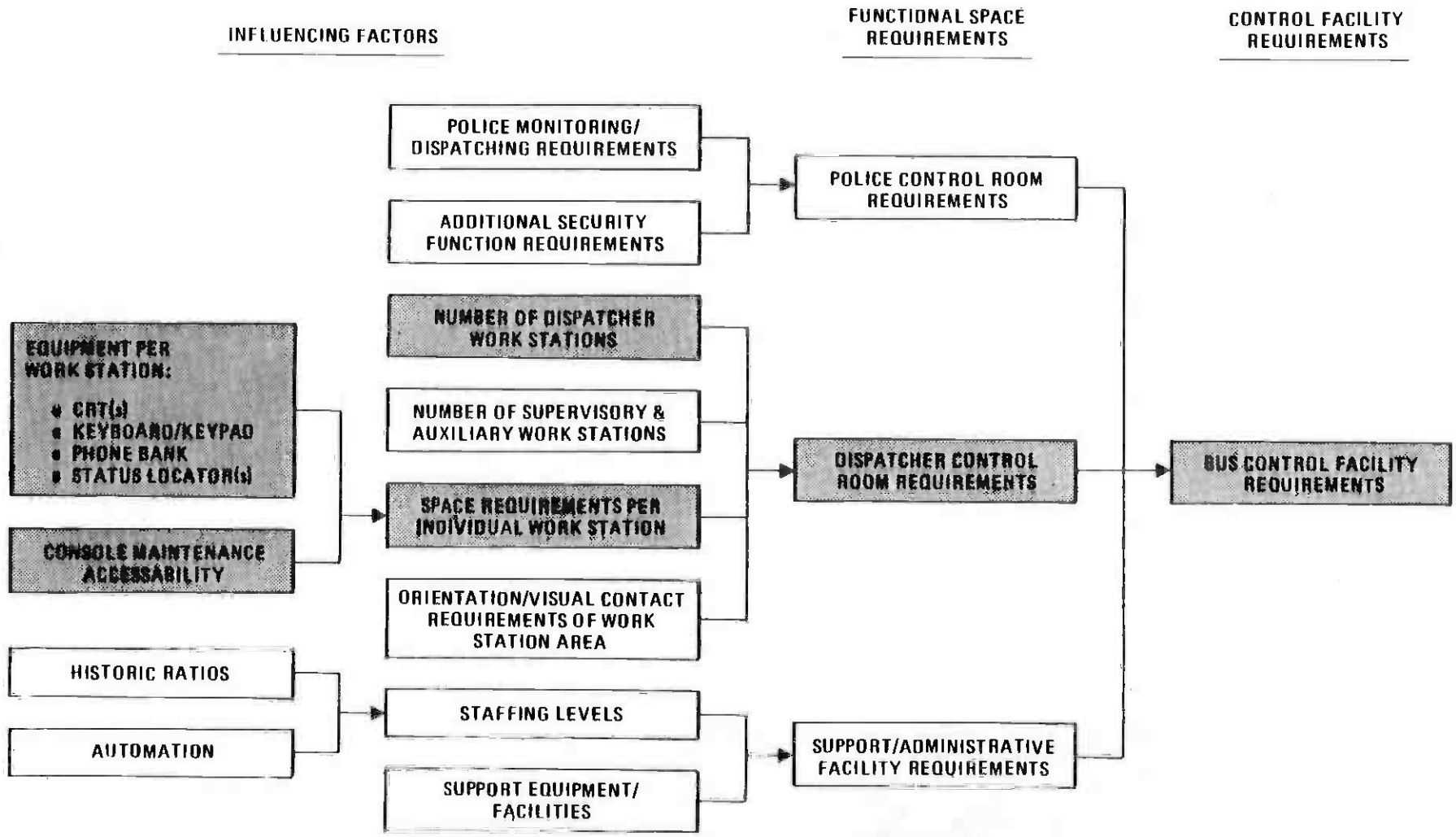
Bus Dispatch Center

The space requirments of the Bus Dispatch Center are a function of:

- Orientation/visual requirements
- Number of supervisory/auxiliary work stations
- Number of dispatcher work stations
- Space per work station.

With regard to orientation/visual requirements, interviews with dispatchers and dispatching administrators indicate that there are no restrictions as to the layout of the dispatcher and supervisory work stations. Acoustic concerns may become constraining as work stations are added, although low-cost partitions can overcome these problems.

EXHIBIT 21
Bus Central Control Facility Requirements



Currently there is one supervisory work station. This requirement will not increase even given increases in the number of dispatcher work stations. Auxiliary stations are not expected to be necessary following completion of the present test of the AVM system.

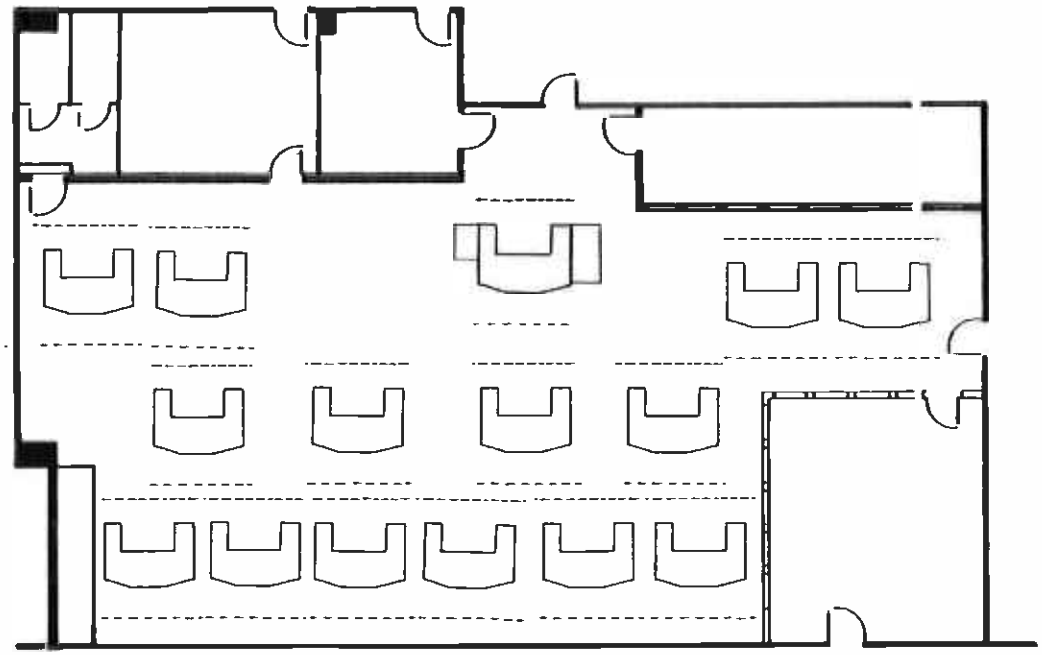
The number of dispatcher work stations, as noted above, will be 14 in the short term based on SCRTD's judgment of the effect of the implementation of the mini-computer communications system, and 16 given a long-run contingency factor.

The current space per work station has been generously estimated at 84 square feet for dispatcher work stations and 138 square feet for the supervisory work station with two support tables. These measurements include a 3-foot maintenance clearance in front of the work station, a 2-foot aisle clearance behind, and a slight adjustment (3-6 inches) to compensate for possible measurement inaccuracy. (Side clearance is not mandatory, although acoustic concerns should be considered.)

This 84-square-foot estimate of space for dispatcher work stations could actually decrease following installation of the planned mini-computer communications system, as conceptually designed. The equipment required for this system will comprise only two CRTs (with 12- to 15-inch screens) and two keyboards per work station. The need for hard-copy scheduling documentation will be eliminated as this information will be on-line, and consequently the wings on each dispatcher station could be removed, prompting space savings. However, the physical make-up of the current work stations is not conducive to removal of the wings. Furthermore, cost savings occur from using the current shells, and, therefore, the work station space requirement will probably remain the same.

For the purposes of this analysis, then, the 84-square-foot figure is used to determine if the present Bus Dispatch Center is able to accommodate increased numbers of work stations. As Exhibit 22 illustrates, the center can easily accommodate 14 dispatcher work stations plus one supervisory station. The center also has sufficient space to accommodate 16 dispatcher stations; these could be accommodated by adding two positions to the middle bank of stations.

EXHIBIT 22
Central Control Facility Layout
Expanded Dispatcher Work Station Distribution



Security Room

The present Security Room, with 360 square feet, has sufficient space to easily accommodate an additional staff member per shift.

Administrative/Support Area

The Administrative/Support Area, with 3,396 square feet of floor space, is the largest area within the Bus Central Control Facility. Its staff is not projected to increase in the short term, and any long-term growth is not projected to be substantial. The facility is thus judged to be of sufficient size to accommodate both short- and long-term requirements.

4. CONCLUSIONS

The information presented in the previous chapters of this report on the present status of SCRTD's Bus Central Control Facility and its future requirements indicates that the present facility at 425 South Main Street can accommodate projected levels of growth. The requirements of the Bus Dispatch Center are the critical determinants of the adequacy of the current facility, and the assessment contained in Chapter 3 has determined that the center is capable of accepting staff of 14 peak dispatchers in the short term and 16 in the longer run. This number of work positions can be accommodated within the center even if work station space allocations remain at 84 square feet, a generous estimate of required space. Therefore, no facility expansion is warranted.

Although the assessment has led us to conclude that the present facility is capable of accepting the projected level of growth, questions exist regarding the assumptions on which this projection is based. The first, and most important, concerns the current workload of the facility. The number of CS 10s -- a quarter of a million in 1983 -- is inordinately high and is exhibiting annual increases. This figure is high both in absolute terms and, as a subsequent report will confirm, in comparison with the number of incidents being recorded at comparable North American transit systems. Before any realistic assessment can be made of likely future workload at SCRTD's Bus Central Control Facility, a detailed analysis is necessary to identify the cause for the high number of CS 10 reports and whether opportunities are available for significant reductions in this workload.

In addition, it is unclear that the implementation of the mini-computer communications system, particularly the ADC, AVL and supporting features of the system, will override the potential improvements in productivity that may be generated by other factors. The combined effects of the implementation of VMS and the mini-computer system are unknown, and much will depend on the way in which the systems are implemented and utilized.

In our judgment, therefore, no deterministic assessment can be made on the basis of this report regarding future space requirements for a new Bus Central Control Facility, either as a separate facility or as a combined Bus/Metro Rail Central Control Facility. The present facility is capable of accommodating any short-term growth that may be necessary. Any decisions on future facility sizing should be based on a more detailed understanding of the driving factors of the current workload, as well as on actual experience with the new technology being planned for the Dispatch Center. In the absence of such information, a contingency factor will need to be developed and applied to account for possible growth in facility staff and space requirements.