SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

METRO RAIL PROJECT

SYSTEM OPERATING PLAN

FOR MOS-1

DRAFT

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1.0 INTRODUCTION

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The Southern California Rapid Transit District (SCRTD) is developing an 18-mile rail rapid transit system. This system, called Metro Rail, will be the core element of a regional rail rapid transit network which will include both the heavy and light rail modes. The scarcity of federal funds means that the Metro Rail system will be built in stages. Initially a 4-mile segment with five stations, identified as MOS-1, will be constructed.

This operating plan for the initial 4-mile segment has been developed in concert with the system design. The plan documents the service characteristics, control and communications equipment, key staff requirements, and operating practices which will enable the Metro Rail system to run safely and efficiently. The plan does not provide detailed procedures for operating the system nor for responding to emergency situations. Rather, it provides a general overview of operations from which rules and procedures can be prepared.

The plan contains nine other chapters:

- Chapter 2 provides a description of the MOS-1 Metro Rail system
- Chapter 3 presents passenger service characteristics and related data
- Chapter 4 describes the equipment to be used for controlling system operations
- Chapter 5 outlines the staff organization and responsibilities for operations
- Chapter 6 describes the normal operating routine
- Chapter 7 discusses operational problems that may occur and presents mitigation measures
- Chapter 8 outlines fare collection operations equipment and practices
- Chapter 9 discusses the collection and processing of revenue from the Metro Rail system

- Chapter 10 outlines the interaction between the Metro Rail operating and maintenance functions.

2.0 SYSTEM DESCRIPTION

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The Southern California Rapid Transit District (SCRTD) has planned an 18.6-mile Metro Rail system from downtown Los Angeles to the Wilshire District, Fairfax, Hollywood, and the San Fernando Valley areas. It is anticipated that this will be the start of a regional rail rapid transit system.

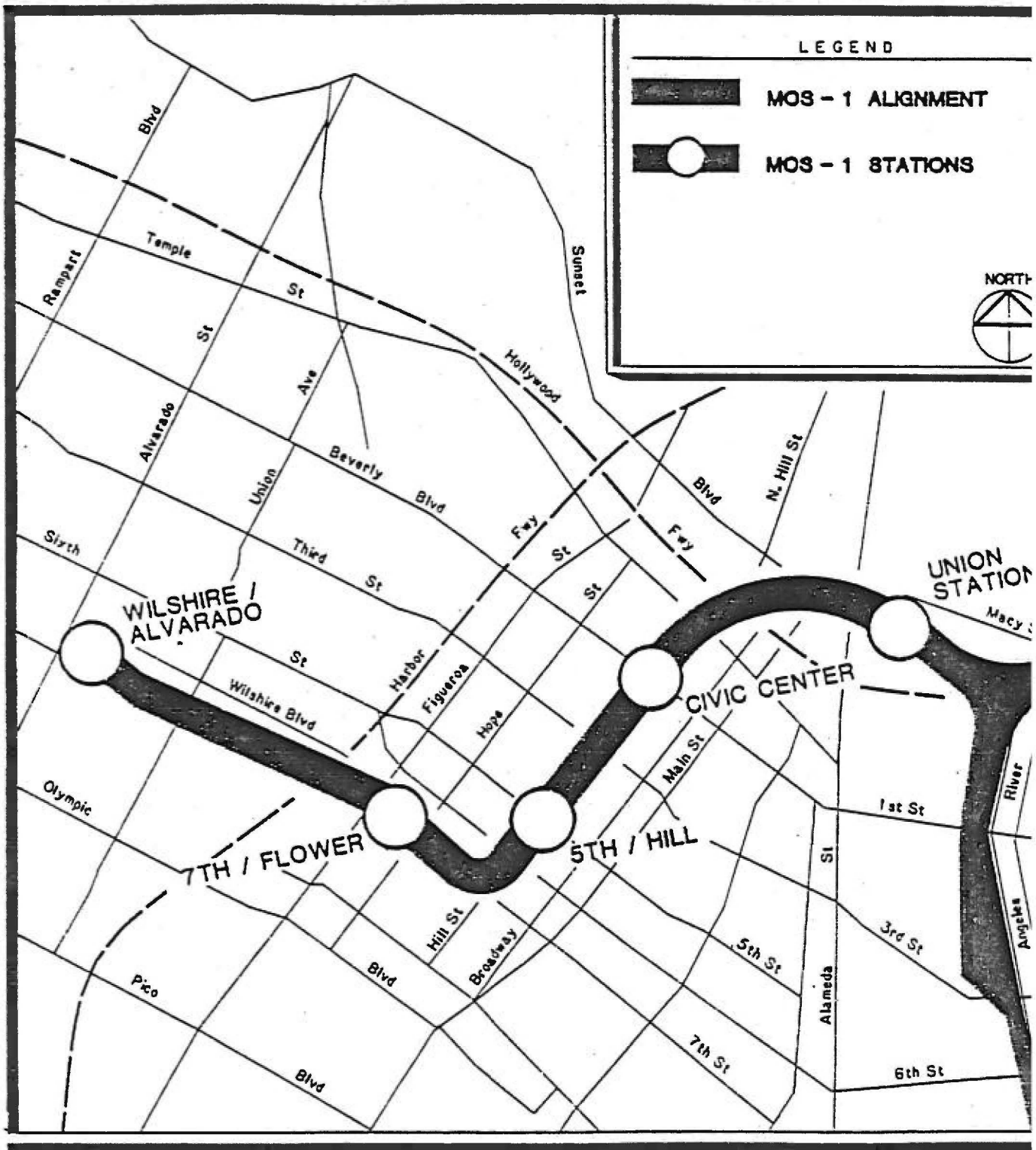
The Urban Mass Transportation Administration (UMTA) is unable to commit to the full Metro Rail system because of budget constraints and authorization legislation that prohibits committing federal funds past fiscal year 1986. Therefore the SCRTD has proposed to UMTA a four-mile, five-station rail line extending from the yard and shop facility to the Wilshire/Alvarado Station as an initial segment for funding purposes.

The initial segment (MOS-1) will contain five stations, as shown in Exhibit 2-1. The 3.1 mile mainline route begins at Union Station, where it turns northwest and runs through the central business district along Hill Street. Turning on Seventh Street, the route heads toward the west side of downtown, past the Harbor Freeway, and continues to the Wilshire/Alvarado Station. The rail line is entirely subway with virtually all line segments constructed by tunnel boring machines and stations and crossovers built by cut and cover construction techniques. Three crossovers are included in the mainline portion of MOS-1. Two crossovers are located at either side of the Union Station and one is located at the east end of the Wilshire/Alvarado Station.

The vehicles for the system will be stainless steel, standard gauge, 75 foot long rail cars, which will be configured in dependent pairs. They will be capable of operating at speeds up to 70 miles per hour. They will operate on 750 VDC power and will be capable of regenerative braking. Metro Rail trains will consist of two, four, or six transit vehicles. The capacity of each single vehicle is 59 seated passengers, up to about 110 standing passengers at normal loads, and over 200 standing passengers at crush loads. One wheelchair space is provided in each car.

MOS-1 trains will be provided with Automatic Train Protection (ATP) and Automatic Train Operation (ATO) equipment to ensure safe speed and separation of trains, and provide automatic speed regulation and precise station stops.

EXHIBIT 2-1
Alignment of Initial Segment of Metro Rail System



Alignment of Initial Segment of Metro Rail System

Figure 1

Stations will be cut-and-cover construction, with either one or two mezzanines. Each fare collection area will have one or two arrays of entry/exit faregate barriers; however, the quantity of fare gates and other fare equipment will be reduced compared to requirements of the 18 mile system. The fare structure will be based on a single zone. Escalators, stairs, and elevators will provide normal vertical circulation between surface, mezzanine, and platform levels, with one elevator provided per station. Additional exits will be provided for use in emergencies. Stations will be equipped for both attended and unattended operation. For planning purposes, following the initial start-up period, all MOS-1 stations will be unattended. Some stations will have adjacent parking facilities, pick-up/drop-off areas and/or bus pull-in areas to accommodate patrons arriving by automobile or by bus.

Ridership on the initial segment by the year 2000 is projected to be approximately 54,000 per day.[1] About two-thirds of these passengers will be connecting to RTD bus routes serving the five Metro Rail stations. Ridership patterns on the initial system segment will differ from the full system. During peak hours, the maximum loading will be from Union Station in the morning and to Union Station in the evening. The 24-hour loading pattern, however, has relatively constant loadings on each of the links with the heaviest travel between Wilshire/Alvarado and 7th/Flower stations.

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1 Source: SCRTD Memorandum, October 3, 1984, Keith L. Kellough, Re: Station-to-Station Trip Volumes--MOS-1 Option.

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3.0 METRO RAIL SERVICE CHARACTERISTICS

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This chapter presents the service characteristics for the MOS-1 system, including ridership forecasts, service requirements, travel times, operating statistics, and fleet requirements. The train schedule has been developed to satisfy projected passenger demand and the service standards established on the basis of the experience of other rail properties and the cost of providing the service. The train schedule incorporates travel time estimates that are based on both the route and vehicle characteristics.

3.1 RIDERSHIP FORECASTS

Total weekday patronage for MOS-1 is projected to reach 54,218 by the year 2000. These estimates are shown in Exhibits 3-1, 3-2, and 3-3. Station activity and link loads are shown for daily, a.m. peak, and p.m. peak periods.

The maximum daily load point is between the 7th/Flower and Wilshire/Alvarado stations. 31,556 daily trips pass through this link. The most heavily used peak-hour link is between Civic Center and Union Station with 3,108 outbound trips in the a.m. peak and 2,924 inbound trips in the p.m. peak. The most heavily used station is Wilshire/Alvarado where approximately 15,800 persons (31,600 trips) are expected daily.

3.2 SERVICE STANDARDS

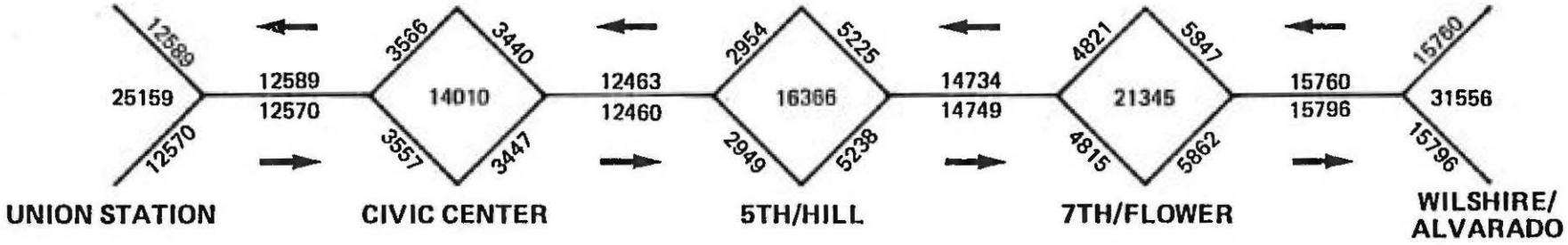
Service standards establish minimum comfort and convenience levels for passenger service. The maximum vehicle loads, hours of service, and minimum frequency of service defined in this operating plan determine the maximum level of crowding and waiting time that a passenger can expect.

3.2.1 Vehicle Load Standards

Three vehicle load standards (off-peak, peak, and crush) have been established for Metro Rail operations. The first two vehicle load standards are used for scheduling purposes; the third is for analysis of failure management strategies.

Off-Peak Load Standard. An off-peak load standard of 90 passengers per vehicle has been established. This standard is based on a capacity of 59 seated passengers, 1 wheelchair passenger, and 30 standing passengers.

EXHIBIT 3-1
Initial System Segment
Boarding, Alighting & Link Volumes by Direction
(2000) Average Daily Volumes



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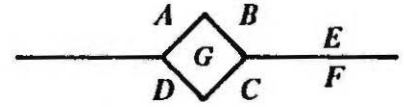
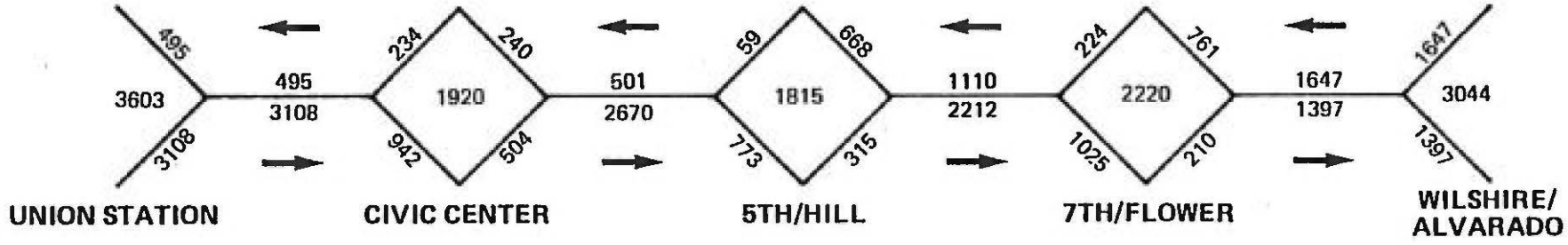


A: BOARD INBOUND
B: ALIGHT INBOUND
C: BOARD OUTBOUND
D: ALIGHT OUTBOUND
E: LINK INBOUND
F: LINK OUTBOUND
G: TOTAL STATION VOLUME

EXHIBIT 3-2
Initial System Segment
Boarding, Alighting & Link Volumes by Direction
(2000) A.M. Peak Hour Volumes



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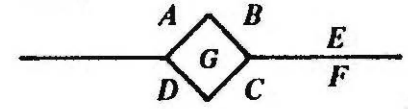
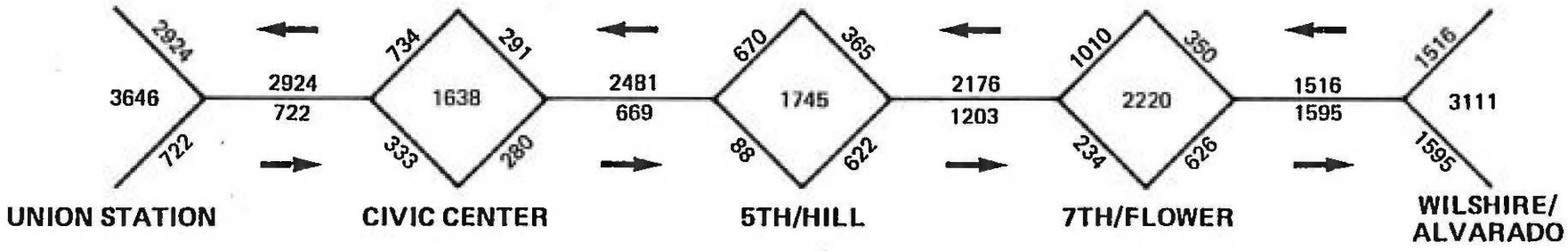


A: BOARD INBOUND
B: ALIGHT INBOUND
C: BOARD OUTBOUND
D: ALIGHT OUTBOUND
E: LINK INBOUND
F: LINK OUTBOUND
G: TOTAL STATION VOLUME

EXHIBIT 3-3
Initial System Segment
Boarding, Alighting & Link Volumes by Direction
(2000) P.M. Peak Hour Volumes



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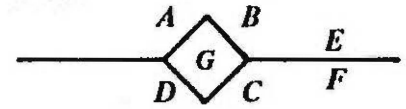

A: BOARD INBOUND
B: ALIGHT INBOUND
C: BOARD OUTBOUND
D: ALIGHT OUTBOUND
E: LINK INBOUND
F: LINK OUTBOUND
G: TOTAL STATION VOLUME

Peak Load Standard. A peak load standard of 169 passengers per vehicle has been established to provide adequate room for circulation among standees and thus to aid in minimizing station dwell times. This standard comprises seating capacity for 59 passengers, one wheelchair location, and space for 109 standees. It is based on a standing density of 3.3 square feet per passenger. A standing density of 3.0 square feet per passenger is considered the minimum required for adequate circulation. A 10 percent contingency, resulting in 3.3 square feet per standee, was added to allow for imbalances in vehicle loading that may occur in peak periods.

Crush Load Standard. A crush load standard of 220 passengers per car has been defined for emergency egress planning purposes (not for structural design purposes). The standard is based on a capacity of 59 seated positions, one wheelchair location, and 2.25 square feet per standee. This standing density is an average for a six-car train, in which densities throughout the train may range between 2.0 and 3.0 square feet.

3.2.2 Hours of Service

Metro Rail is being designed to permit flexibility in establishing the hours of service. Given the minimal demand anticipated for rail service between 1:30 a.m. and 5:30 a.m. and the availability of local bus service in the corridor during that period, a 20-hour service period has been defined. Hours of service at the maximum load point will be approximately 5:30 a.m. to 1:30 a.m. daily, including Saturdays, Sundays, and holidays. Departure of the first train from the yard and arrival of the last train at the yard will occur slightly beyond these hours.

The period between 1:30 a.m. and 5:30 a.m. will be used for efficient, uninterrupted right-of-way maintenance. Nothing in the design of the Metro Rail system, however, will preclude 24-hour operation if such service becomes appropriate.

3.2.3 Policy Headways

Policy headways define the maximum amount of time that passengers will spend awaiting Metro Rail trains during various periods of the day. Headways shorter than policy are provided as required to satisfy vehicle loading standards or to relay equipment to points where it is needed.

The policy headways adopted for Metro Rail are given in Exhibit 3-4. They have been defined on the basis of projected demand levels along the Metro Rail corridor and an assessment of service levels provided by other systems. (Service frequencies on other systems range from 2 to 10 minutes between peak-period trains and from 5 to 10 minutes between midday trains.) Metro Rail service hours and off-peak train frequencies may be adjusted following the initiation of service as actual ridership characteristics become apparent.

3.3 TRAVEL TIMES

The times required for trains to make one-way and round trips have been estimated to permit an analysis of fleet requirements and the service schedule. Exhibit 3-5 shows the station-to-station run times and station dwell times for the morning peak period. The outbound and inbound trips are expected to take approximately 6 1/2 minutes.

The estimated travel times have been based on the route alignment for the 4-mile Metro Rail system as of January 1985, and the following Metro Rail performance characteristics: an initial acceleration rate of 2.7 mphps; a signal brake rate of 2.2 mphps; a maximum speed of 70 mph; a performance level of 85 percent; and speed codes of 0, 8, 9, 25, 40, 45, 55, and 70 mph.

3.4 SERVICE REQUIREMENTS

The Metro Rail operating plan is based on the following operating philosophy:

- All trains will stop at each station
- Train service will be provided at the policy headway unless vehicle loading or vehicle relaying (positioning) requires additional service.

3.4.1 Peak-Hour Service

During peak periods (6:30 a.m.-8:30 a.m. and 3:30 p.m.- 5:30 p.m.) four-car consists will be operated with a peak load standard of 169 passengers per car, providing total capacity of 676 passengers per train. The greatest demand for Metro Rail service will occur in the morning peak hour (7 a.m.-8 a.m.). The estimated 3,100 outbound passengers in the a.m. peak hour can be accommodated by service at the five-minute policy headway, with 12 outbound trains per hour. Trains at five minute headways provide enough

EXHIBIT 3-4
Recommended Policy Headways

Period		Maximum Schedule Headway (Minutes)	Number Vehicle Per Train
Weekdays:			
Early morning	5:30 a.m. - 6:30 a.m.	10	4
Peak periods	6:30 a.m. - 8:30 a.m.	5	4
	3:30 p.m. - 5:30 p.m.	5	4
Midday	8:30 a.m. - 3:30 p.m.	10	4
Evening	5:30 p.m. - 8:00 p.m.	10	4
Night	8:00 p.m. - 1:30 a.m.	10	4
Weekends/Holidays:			
All day	5:30 a.m. - 1:30 a.m.	20	4

EXHIBIT 3-5
Metro Rail Travel Times
A.M. Peak Periods

Station	Trip Times (Seconds) Outbound	Inbound
Union Station		94
Civic Center	102	58
5th And Hill	59	68
7th And Flower	68	116
Wilshire/Alvarado	111	
Total	340	336
Dwell Times*	60	60
One-Way Trip Time	400	396
	6 min. 40 sec.	6 min. 36 sec.

* 20 seconds at each station.

capacity to carry the projected patrons traveling outbound during the peak 15 minute period.

During the p.m. peak (4 p.m.-5 p.m.) in the inbound direction, with 2,924 passengers traveling through the maximum load point, the policy headway of five minutes is also adequate.

The operating schedule for the morning service is shown in Exhibit 3-6. Four, four-car trains are required to satisfy the passenger demand. All trains will be stored overnight at the main yard and all trains will be dispatched from Union Station.

3.4.2 OFF-PEAK SERVICE

During the off-peak period, the policy headway will govern frequency of service. An average of about 1,000 hourly midday passengers are expected to travel through the maximum load point in each direction between 8:30 a.m. and 3:30 p.m. Two four-car trains operating at 10-minute headways will be sufficient to serve this volume. Two four-car trains operating on ten-minute headways will provide evening and night service 5:30 p.m. until 1:00 a.m.

On weekends and holidays one four-car train will be operated at 20-minute intervals.

Consist changing will not be employed, as the savings in energy and maintenance costs cannot offset the added staff costs and potential for delay due to electrical and mechanical problems associated with coupling and uncoupling vehicles.

3.5 OPERATING STATISTICS

Exhibit 3-7 summarizes the service to be provided during the 20-hour operating period on weekdays. In each direction, 148 train trips will be operated per day. Operating statistics are summarized in Exhibit 3-8. On an annual basis, the system will log 44,560 train trips, 14,853 train hours, 59,413 car hours, and 1,097,958 car miles.

These statistics do not include yard or test or other non-revenue movements. All train trips will be operated as revenue service. No deadheading will occur under normal conditions.

3.6 FLEET REQUIREMENTS

A total fleet size of 30 cars will be required for year 2000 service.

EXHIBIT 3-6
Proposed Weekday Morning Schedule

Train Number	Depart Union Station	Arrive Wilshire/ Alvarado	Depart Wilshire/ Alvarado	Arrive Union Station
1	5:30:00*	5:36:40	5:40:00	5:46:36
2	5:40:00*	5:46:40	5:50:00	5:56:36
1	5:50:00	5:56:40	6:00:00	6:06:36
2	6:00:00	6:06:40	6:10:00	6:16:36
1	6:10:00	6:16:40	6:20:00	6:26:36
2	6:20:00	6:26:40	6:30:00	6:36:36
3	6:25:00*	6:31:40	6:35:00	6:41:36
1	6:30:00	6:36:40	6:40:00	6:46:36
4	6:35:00*	6:41:40	6:45:00	6:51:36
2	6:40:00	6:46:40	6:50:00	6:56:36
3	6:45:00	6:51:40	6:55:00	7:01:36
1	6:50:00	6:56:40	7:00:00	7:06:36
4	6:55:00	7:01:40	7:05:00	7:11:36
2	7:00:00	7:06:40	7:10:00	7:16:36
3	7:05:00	7:11:40	7:15:00	7:21:36
1	7:10:00	7:16:40	7:20:00	7:26:36
4	7:15:00	7:21:40	7:25:00	7:31:36
2	7:20:00	7:26:40	7:30:00	7:36:36
3	7:25:00	7:31:40	7:35:00	7:41:36
1	7:30:00	7:36:40	7:40:00	7:46:36
4	7:35:00	7:41:40	7:45:00	7:51:36
2	7:40:00	7:46:40	7:50:00	7:56:36
3	7:45:00	7:51:40	7:55:00	6:36:03
1	7:50:00	7:56:40	8:00:00	8:06:36
4	7:55:00	8:01:40	8:05:00	8:11:36
2	8:00:00	8:06:40	8:10:00	8:16:36
3	8:05:00	8:11:40	8:15:00	8:21:36
1	8:10:00	8:16:40	8:20:00	8:26:36
4	8:15:00	8:21:40	8:25:00	8:31:36@
2	8:20:00	8:26:40	8:30:00	8:36:36
3	8:25:00	8:31:40	8:35:00	8:41:36@
1	8:30:00	8:36:40	8:40:00	8:46:36
2	8:40:00	8:46:40	8:50:00	8:56:36
1	8:50:00	8:56:40	9:00:00	9:06:36
2	9:00:00	9:06:40	9:10:00	9:16:36
1	9:10:00	9:16:40	9:20:00	9:26:36
2	9:20:00	9:26:40	9:30:00	9:36:36

* Departs Yard
@ Enters Yard

EXHIBIT 3-7
Summary of Weekday Service

Period	Headways	Train Trips		Car Trips		Cars/Train
		Inbound	Outbound	Inbound	Outbound	
4:50 a.m.-6:30 a.m.	10	9	12	36	48	4
6:30 a.m.-8:30 a.m.	5	24	24	96	96	4
8:30 a.m.-9:00 a.m.	10	4	3	16	12	4
9:00 a.m.-3:00 p.m.	10	36	36	144	144	4
3:00 p.m.-3:30 p.m.	10	3	4	12	16	4
3:30 p.m.-5:30 p.m.	5	24	24	96	96	4
5:30 p.m.-1:20 a.m.	10	48	45	192	180	4
		148	148	592	592	

EXHIBIT 3-8
Summary of Operating Statistics

Period	Days/Year	Train Trips	Car Trips	Train Hours	Car Hours	Car Miles
Weekdays	255	148	592	46.9	187.5	3,552
Saturdays/ Sundays/ Holidays	110	62	248	19.6	78.5	1,488
Annual	365	44,560	178,240	14,116	56,448	1,069,440

This provides:

- Sixteen cars for revenue service
- Four cars for terminal spare (gap trains) to replace in-service failures or to fill gaps resulting from significant service delays
- Ten cars for maintenance spares, which assumes a 66 percent availability.

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4.0 EQUIPMENT FOR SYSTEM OPERATIONS

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The Metro Rail system will require equipment to provide train protection, to control train movements, to supervise train schedules, and to ensure a timely exchange of information among all elements of the system. This equipment will be installed in many locations: on vehicles, in tunnels, in stations, in the Rail Control Center (RCC), and in the main yard. This chapter briefly describes the train control and communications equipment that will be used to control Metro Rail operations.

4.1 TRAIN CONTROL EQUIPMENT

Metro Rail trains will normally operate on the mainline, in the terminal zones, and between the transfer point and the mainline under the control of Automatic Train Control (ATC) equipment. This section summarizes the functions of ATC equipment, and then describes the train control equipment that will be installed at various locations of the Metro Rail system.

4.1.1 ATC Equipment Functions

ATC equipment will perform the functions of Automatic Train Protection (ATP), Automatic Train Operation (ATO), and Automatic Train Supervision (ATS). These functions will enforce train safety, control train motion, and permit supervision of train operations on the mainline. The ATP function will ensure safe train operation and the ATO and ATS functions will be entirely subordinate to the ATP function. Each is discussed below.

ATP equipment will enforce train safety. The equipment will:

- Enforce speed limits, through the use of speed codes along the track, causing the service brakes to be applied whenever a train exceeds the safe speed limit
- Provide brake assurance by commanding the emergency brakes to be applied whenever deceleration is commanded but not confirmed
- Generate track occupancy data to ensure the establishment of speed profiles for following trains

- Prevent conflicting train routings or movements
- Ensure safe separation of trains
- Detect broken rails
- Prevent a Train Operator from opening doors unless a train is stopped, and prevent a train from moving when vehicle doors are open.

ATO equipment will control train movements through the following functions:

- Automatically regulate speed by controlling the propulsion and brake equipment when the train is operating in the ATO mode.
- Perform the programmed station stopping functions during operation in ATO mode.

ATS equipment will support the monitoring and direction of train operations. The equipment will:

- Communicate train identity, destination and status information via the train to wayside radio.
- Communicate dwell-expired signals via the train-to-wayside radio.
- Store and transmit route requests consistent with interlocking availability.
- Enable local control of interlockings and other remotely commanded equipment, when commands from the RCC are unavailable.
- Adjust station dwell time by transmitting changes from the RCC to the vehicle.
- Provide routing through interlockings, including alternate routing at turnback zones.

The ATS equipment design also has the provision for automatic modification of train performance levels to respond to schedule delays. This feature will not be used in initial system operations, and

handling.

Under normal operating conditions, all trains will stop at each Metro Rail station. In the ATO mode, the train will automatically decelerate to a smooth stop at the station platform. In the manual mode, the Train Operator will brake the train to a stop within the limits of the station platform. Forward position adjustments may be required to ensure that trains are properly berthed. These adjustments will be made in the MTO mode.

A "Train Berthed" indicator will light when the train is stopped entirely within the limits of the platform and is receiving a Door Open command from the station ATC equipment. The Train Operator will open the cab window in preparation for observing passengers boarding and exiting the train. The Train Operator will then open the doors by pressing the Door Open pushbutton on the correct side of the train.

The station dwell will be timed by the SCADA equipment and will be adjustable from the RCC. When the dwell has expired, a "Dwell Expired" indicator will light in the cab. When the Train Operator has pressed the Door Close pushbutton, the Door Close chimes will sound and the train doors will begin to close. The Train Operator must carefully watch the doors to ensure that all people are safely clear of the doors. If an object prevents a door from closing within a fixed time interval, that doorset will recycle automatically. When all the doors have closed, the train will automatically depart if it is in the ATO mode. In other modes, the Train Operator will use the manual controller to move the train.

Union Station and Wilshire/Alvarado terminals will be the line ends of the MOS-1 system. Both terminals will use crossovers as the means of train turnback. At Wilshire/Alvarado, the crossover in front of the station will be used. At Union Station, crossovers on both sides of the station can be used.

The normal method of train turnback at the terminal stations during off-peak service will be via the crossover in front of the station. Inbound trains will cross over in front of the station and will stop on the outbound side of the platform for passenger unloading and loading. The Train Operator will open the doors, shut down the cab, move to the cab at the opposite end of the train, and prepare the equipment for departure (including entering his badge number, train run number, and trip destination). At the scheduled departure time, the Dwell Expired

indicator in the cab will notify the Train Operator to close the doors. Upon departure, the train will proceed on the normal outbound route.

During peak hours, a maximum of 4 four-car trains will be required to accommodate the projected passenger demand in the year 2000.

Train Operator relief will be managed by the Line Supervisors. Short breaks may be accommodated by dropback rotation, although operator relief for illness will require the use of extra board personnel from the yard. The Line Supervisors and Crew Dispatcher will coordinate to arrange the relief of Train Operators.

6.2.2 Station Operation

Metro Rail stations will normally operate without the need for a Station Agent. The fare collection equipment will be automatic and will be monitored by CCTV. In the event that a patron has a problem, a CCTV Operator will assist in resolving it. When a Station Agent is present at a station, he will provide assistance and directions to patrons and may conduct "finger tip" maintenance on fare collection equipment. Line Supervisors may also provide patron assistance and limited troubleshooting of fare collection equipment at Metro Rail stations. Procedures for fare collection equipment operations are discussed in detail in Chapter 8.

Station Agent relief or relief for illness will be coordinated by the Communications Controller. The Station Agent will request relief by telephoning the Communications Controller who may ask the Crew Dispatcher to supply a replacement for the relief period, or for the remainder of the shift.

Patron security will be provided by CCTV and by roving Transit Police. The Transit Police will maintain high visibility in Metro Rail stations and on trains to deter crime and vandalism and to quickly respond to security incidents. A plainclothes Transit Police fare compliance team will be used to monitor fare collection operations and to apprehend fare evaders.

6.2.3 Changes In Mainline Fleet Size

To begin daily system start-up, a sufficient number of four-car trains will be dispatched from the yard in order to begin revenue service. The build-up

for peak periods will be accomplished by dispatching the proper number of trains from the yard. After the peak periods, an appropriate number of trains will be removed from service and will be placed in storage in the yard.

The SCADA subsystem will maintain the schedule of Metro Rail operations and of corresponding increases and reductions in mainline fleet size. Additions to the mainline fleet will be made using the same procedure used to start Metro Rail service.

Trains leaving mainline service according to the operating schedule will have their departure routes established by the SCADA subsystem. The trains will depart from Union Station in the ATO mode and will proceed to the signal at the transfer point. The Yard Dispatcher will establish a route within the yard to move the train to a final storage location. After receiving a proceed indication at the transfer point, the Train Operator will move the train in Restricted Manual submode to the storage location. The necessary radio coordination between the Train Dispatcher, Yard Dispatcher, and Train Operator will be maintained to ensure that trains are removed from service as scheduled, and routed to the appropriate location in the yard, for cleaning, maintenance, and/or storage.

6.3 SYSTEM SHUTDOWN

At the close of revenue operations, several activities will need to be accomplished:

- Passengers must be informed
- Stations must be closed
- Trains must be removed from service and stored
- Staff must check out
- The system must be configured for nonrevenue service activities.

Each of these activities is described below.

6.3.1 Passenger Announcements

Announcements will begin to be made at a reasonable time before system closing to alert patrons to the scheduled end of Metro Rail operations. Such

announcements will be made periodically at each station and on each train. During the service run of the last train of the day, frequent announcements will be made at each station to inform patrons of its scheduled arrival and departure times, and to notify patrons that the station will close after the train's departure. A similar announcement will be made aboard the train itself.

6.3.2 Station Closing

Following the departure of the last train of the day, each station will be inspected by the Transit Police to ensure no patrons or other unauthorized people are in the station. When the station is empty, station equipment and lights will be turned off and the public entrances will be closed by the Transit Police. Closing of all Metro Rail stations will be accomplished within a 10 minute period.

6.3.3 Train Removal

At the end of their revenue service runs, trains will normally be taken to the yard to be made ready for the next morning's service.

The Train Operator will depart from Union Station in the ATO mode and will proceed in that mode to the transfer point. After receiving a green signal at the transfer point, the Train Operator will move the train in Restricted Manual Submode along a route established by the Yard Dispatcher to a final storage location. After shutting down the train, the Train Operator will walk through the train to inspect it and to ensure that no passengers remain aboard. The Train Operator will also collect any "Defect Cards" noting train maintenance needs and, as he checks out from his shift, will deliver the cards to the Crew Dispatcher. (See Chapter 10 for details on maintenance procedures.)

6.3.4 Staff Checkout

At the end of their shifts, all Metro Rail personnel will report back to the location from which they received their shift assignment. Station Agents, the Yard Dispatcher, most Train Operators, and Line Supervisors will report back to the Crew Dispatcher at the Main Shop.Transit Police will report to the Police Command Center. RCC staff will report to the Operations Supervisor.

6.3.5 Non-Service Hours

After the last train has completed its run, Metro Rail track and wayside maintenance activities may begin. These activities may require the use of work trains and the removal of power from some sections of track. During non-service hours, the Communications Controller in the RCC will monitor and direct maintenance activities along the mainline. In addition, a CCTV Operator will monitor the status of stations.

7.0 ABNORMAL SYSTEM OPERATIONS

7.0 ABNORMAL SYSTEM OPERATIONS

This chapter discusses operations on the Metro Rail system during equipment failures and similar events that could cause schedule delays or lower service levels. The discussion is limited to operations during abnormal conditions internal to the Metro Rail system. Operations during emergency conditions, including DWP power outages, floods, fire, and seismic events, are addressed in detail in the Metro Rail Emergency Preparedness Plan and are not considered herein.

The following section of this chapter describes the general causes of abnormal operating conditions and briefly identifies the types of actions that may be taken by operating staff to minimize service disruptions. Details on operational responses to abnormal conditions are given in the second section of this chapter. The chapter concludes with a discussion of schedule recovery methods and restoration of full service. All operational responses to abnormal conditions on the Metro Rail system will be managed by RCC staff (primarily the Train Dispatcher) under the overall direction of the Operations Supervisor.

7.1 CAUSES OF ABNORMAL OPERATIONS

Four general types of events that may cause schedule delays or service disruptions on the Metro Rail system are addressed in this section:

- Wayside equipment failures
- Track failures
- Train failures
- Patron actions.

Each is discussed in turn in the following paragraphs.

7.1.1 Wayside Equipment Failures

Wayside equipment failures can be generalized into three classes:

- Loss-of-routing failures
- Local wayside signal failures
- Station stopping equipment failures.

Loss-of-routing may occur because a switch cannot be moved or is not locked, or because a signal cannot be cleared or a trip stop lowered. Routing failures at the end-of-line terminals will have the greatest impact on operations, because the terminal interlockings must be repeatedly used for crossover moves. Loss-of-routing failures at other interlockings can be temporarily resolved by blocking the affected switches, permitting reduced-speed operations.

Wayside signal failures resulting in train stoppages at a specific track location can be caused by many different wayside equipment failures, including false occupancies and loss of speed commands. The fail-safe nature of the train control system will cause the train approaching the affected zone to come to a stop. The Train Dispatcher, possibly in conjunction with maintenance personnel, must then determine the nature of the equipment failure that has occurred. Once this has been determined, the train can move through the affected zone in the Restricted Manual submode, and returning to automatic operation after clearing the affected zone. The required distance of the manual move will typically be 500 to 2,000 feet.

Extended train berthing and dwell times may be caused by a loss of the Door Open and Door Close commands, or by a failure of the appropriate station stop control signals. Loss of the Door Open signal from wayside will require the Train Operator, after receiving permission from the Train Dispatcher, to operate a bypass switch which will enable the doors to open.

When Station Stop Control Signals have been lost, train berthing times will be extended since trains will have to be berthed by Train Operators in manual, rather than automatic, mode. However, the first train to enter the station after loss of the Stop Control Signals will run through the station. The Train Operator must proceed to the next station. The Train Operator will make an announcement over the train intercom to inform passengers of the reason for the station run-through and to instruct those passengers destined for the run-through station to disembark at the next station, board a train in the opposite direction, and proceed to their original destination.

The Train Dispatcher will notify all other Train Operators that Stop Control Signals have been lost at the station and will instruct them to enter MTO mode as they approach the station and manually berth the trains.

7.1.2 Track Failures

Passage through a section of track may be blocked by a power outage, objects on the track, a derailment or a broken rail.

A derailed train may block a mainline track or both tracks if the derailment occurs at a crossover; it may foul an interlocking; it may block one or more tracks leading to the yard throat and transfer points. Loss of power or objects on the track can cause similarly extensive blockages. A broken rail will generally block a single track.

In any case, blockages of a track or tracks will result in complete disruption of scheduled service. A modified service, provided by single tracking, turnback, shuttle or substitute bus service, must be arranged.

7.1.3 Train Failures

Train failures can be grouped into six classes:

- Train cannot move at all
- Train can move only in EMO mode
- Train cannot move in ATO mode
- Train can move in ATO/MTO only in reverse direction
- Train can operate only at reduced speed
- Station dwell is extended (including undershoot or overshoot).

Few train equipment failures will result in a train's being unable to move under its own power for more than 15 minutes. To minimize having to work runarounds, trains recognized as unable to move will be pushed to the nearest station by a following train, where the failed train's passengers will be discharged (the pushing train will have discharged its passengers before pushout begins). The failed train will then be pushed off the revenue service track by the following train. If the failed train cannot be pushed or moved within 15 minutes of failure, single track operation will be conducted around the stopped train. Passengers in the stopped train will be evacuated using the method decided upon by the Operations Supervisor and under his direction, as detailed in the Metro Rail Emergency Preparedness Plan.

Failures of trainlines or the lead pair's ATC will require operation in Emergency Manual Operation (EMO) mode, in which ATP equipment is entirely cut out from operation. In this circumstance, a train is likely to be delayed for 10 minutes for problem diagnosis and determination of corrective action. After authorization is radioed from the Train Dispatcher, the Train Operator will proceed in EMO mode, under manual control and rule and non-vital 25 mph speed protection, to the next station on the line. After discharging all passengers at the station, the train will proceed directly off the revenue service track to a pocket track or to the yard.

Failures of the ATO equipment can cause a train to be operable in the MTO mode only. Such trains are likely to experience a delay of less than 5 minutes for problem diagnosis. After authorization from the Train Dispatcher, the Train Operator will switch to MTO mode and will complete his service run, after which the train will proceed to storage.

Trains that can operate in ATO/MTO only in reverse direction can, in some circumstances, leave the revenue service track without causing a significant disruption to revenue service operations. If the distance back to a terminal station or a pocket or crossover track is not too great, and if a route can be cleared from the train to the storage location, the train may be reversed and brought off the revenue service track into storage under control of the working cab. All passengers must be offloaded at the nearest station before the storage location. If such a procedure is not possible, train push-out or single-track operations must be undertaken.

Propulsion, traction power, or certain braking failures can result in a train's running at reduced speeds. Some failures will lead only to a slight reduction in speed, which will not necessitate the removal of a train from service. If the failure causes a significant reduction in speed, the train will generally discharge all passengers at the next station on the line and then leave the revenue service track at an average speed of about 25 mph or less.

Braking failures which reduce the available emergency braking capacity below the design limit require the Train Dispatcher to align a safe route and maintain an adequate extended safe braking distance between the failed train and all other trains. The failed train must discharge all passengers at the nearest station.

Extended station dwells may occur because of failures of door control equipment or station stop equipment. The duration of the failure may be short if it can be cleared by the Train Operator. However, if the passenger doors must be closed manually, then the delay may be a few minutes while the Train Operator closes and locks out the failed doors. Problems with the vehicle ATO equipment and/or with the vehicle brakes may cause a train to berth incorrectly at a station. If the train undershoots the platform, the Train Operator will need to enter MTO mode and correctly berth the train manually. If the train overshoots the platform, the Train Operator must proceed to the next station.

7.1.4 Patron Action

Patron action can extend station stops beyond planned durations. Disruptive actions may include:

- Slow entry/exit of passengers due to crowding or physical disability
- Medical emergency or death
- Emergency traction power trip.

The resulting delays may range from a few seconds to an hour or more. Major problems such as medical emergencies, suicides, etc., will require assistance from the Transit Police, Metro Rail Maintenance Department, Los Angeles Police Department, or other outside agencies. The length and nature of the delay will dictate the corrective action to be taken. Minor delays may be recovered by using modifications to station dwell and terminal layover times.

7.2 CORRECTIVE ACTIONS

The Train Dispatcher will monitor the status of the Metro Rail system using the available displays and communication networks. When a problem occurs, the Train Dispatcher can implement a variety of actions with the concurrence of the Operations Supervisor. Those actions are:

- Platform undershoot/overshoot correction
- Single track operations
- Replacement of failed train
- Equipment bypass or cutout
- Pushout
- Alternate service.

The actions may be taken singly or together. Each is described below.

7.2.1 Platform Undershoot/Overshoot Correction

Equipment failures or Train Operator errors can cause abnormal berthing at a station, which is programmed to be accurate within inches. If a train does not stop correctly in a station, the Train Operator must take corrective action.

If a train stops short without fully entering the station platform, the Train Operator will enter (or continue in) the MTO mode and move further down the track, until the train is safely and correctly positioned within the platform limits.

If a train overshoots the station so that the Train Operator cannot be completely assured that the train is fully and safely berthed at the station platform, the Train Operator will:

- Notify the Train Dispatcher of the situation
- Announce to the passengers that the train cannot be exited at this station. Passengers destined for the station must proceed to the next station and return on a train traveling in the opposite direction
- Continue to the next station in MTO mode. At the next station, the Train Operator will return to ATO mode, if required by the schedule.

The Train Operator will not move the train against the established direction after overshooting.

7.2.2 Single Track Operations

When a track is blocked by a train or otherwise impaired, the Train Dispatcher will establish single track operations. The Train Dispatcher will:

- Order trains on the blocked track to discharge their passengers at the next station
- Establish a shuttle service on the clear track
- Notify the Communications Controller to make appropriate announcements, both on board the trains and at stations.

The shuttle service will continue until the impairment is cleared.

7.2.3 Replacement of a Failed Train

A train which has experienced equipment failure may be withdrawn from service and replaced by another train. Depending on the nature of the equipment failure, the train may be removed from service either immediately, at the end of a revenue trip, or upon return to the yard.

A replacement train will need to be dispatched from the yard. The replacement dispatch procedure will be initiated by the Train Dispatcher who will inform the Yard Dispatcher to expect the failed train and to prepare a substitute train and enter it into revenue service.

7.2.4 Equipment Bypass or Cutout

If the impact of a failure can be controlled through the use of equipment cutouts and/or bypasses, the Train Dispatcher will instruct the Train Operator to take appropriate actions. As directed by the Train Dispatcher, Line Supervisors may assist in trouble- shooting the equipment failure either at the point of detection or at some other location if the train continues in service. The equipment cutout and/or bypasses may include:

- Cutting out propulsion and/or electric braking on the affected vehicle(s). Independent controls will be provided for propulsion and electric braking.

- Cutting out the friction brakes of a truck or a complete vehicle. Air pipe and train-stop cocks will enable defective components to be cut out. The Train Operator will need to leave the operating cab and crawl under part of the train to activate the cutout cock. If a Train Stop has failed, the Train Operator will need to leave the cab and use the emergency walkway to reach and lash down or release the failed stop.

- Using the Stop-and-Proceed submode to enable the train to move. The train will be limited to a maximum speed of 10 mph. In the Stop-and-Proceed submode, the Train Operator will need

to manually berth the train at stations, as in the MTO mode.

- Cutting out passenger doors which are malfunctioning.

  If the doors do not operate automatically when the Door Open pushbutton is pressed, the Train Operator must ensure the train is correctly berthed within the limits of the platform. The Train Operator will then operate the Berthing Signal Bypass or Zero Speed Bypass switch, as appropriate, to open the doors, and will restore the switch to its normal position before closing the doors.

  If the train cannot operate because a door is indicated as open, the Train Operator must ensure that all doors are actually closed. If all doors are closed and the Door Open indicator is still lit, the Train Operator will operate the Door Closed Bypass switch and will continue to the next station. All passengers will be offloaded, and the train will proceed to the yard for service.

- Using EMO in case of ATP equipment failure. If a train must operate in EMO mode, all passengers will be offloaded at the next station. The Train Operator will then proceed off the revenue track at a safe operating speed (the lower of either the 25 mph non-vital EMO speed limit or the posted speed limit). Because the train speed cannot be guaranteed by equipment, rules may require longer than normal train separations to be operated.

7.2.5 Pushout

When a train cannot be moved under its own power, it can be pushed out by another revenue train or by a maintenance vehicle. In no case will either the pushed or the pushing train carry passengers past a station while in pushout operation. If possible, the pushing train will discharge its passengers before the pushout operation begins. The failed train will be pushed to the nearest station and discharge its passengers. Pushout will then continue and the failed train will be

stored temporarily at the Wilshire/Alvarado Station until it can be repaired or train will be pushed to the main yard. If the defective train is stored at the Wilshire/Alvarado Station, normal operations will use the other side of the station platform. The Train Dispatcher will notify the Communications Controller of the need for appropriate announcements both on board the trains and at stations, to instruct train passengers to leave the train and to warn patrons at stations not to board.

During a pushout, the Train Operator of the disabled train will remain in the leading cab so as to be able to apply the emergency brakes in case of a track obstruction. If the lead cab emergency brake pushbutton is not working, the Train Operator of the pushing train must be prepared to apply his emergency brakes as notified (over radio or intercom) by the Train Operator of the failed train.

7.2.8 Alternative Service

If an abnormal operating condition is expected to create a major delay or create unsafe conditions, the Operations Supervisor may order alternative service around the point of disruption. This alternative service will generally entail the use of buses to move passengers between the appropriate stations. The Operations Supervisor will coordinate with the bus dispatch center and will initiate the necessary changes to Metro Rail operations to make the bus bridge effective.

7.3 RESTORATION OF FULL SERVICE

Since the MOS-1 line is short, there will be few opportunities to use performance level modifications or adjustments to station dwell times to restore the operating schedule. When significant delays occur, the Train Dispatchers will attempt to space the trains to institute the appropriate headway. This process may involve faster terminal turnback operation and adjustments to station dwell times. If the delay is sufficient to increase train loads, the Train Dispatcher may also add another train to the mainline operation.

8.0 FARE COLLECTION SYSTEM OPERATIONS

8.0 FARE COLLECTION SYSTEM OPERATIONS

This chapter describes operating procedures for the Metro Rail fare collection system. The chapter first briefly describes the fare media and equipment that will compose the system, and then describes the procedures for system operation under normal and abnormal conditions.

8.1 FARE MEDIA AND FARE COLLECTION EQUIPMENT

Fixed zones of travel will be established for the rail system (both Metro Rail and light rail). The stations in MOS-1 will be located in one fare zone. A base fare will be charged for travel within one rail zone, and incremental zone charges will be incurred for travel beyond the base zone (to either Metro Rail or light rail destinations). Payment of a nominal transfer charge, in addition to the base fare and any zone charges, will enable rail passengers to transfer to bus during a continuous trip. However, the transfer to bus must be made within a limited time interval after the completion of the rail journey. Discounted base fares will be provided to the elderly, handicapped, and students.

These fare elements will be incorporated into the fare structure through the following types of fare media:

- Regular-fare, single-trip tickets to any rail (Metro Rail or light rail) destination zone, which will be sold by ticket vending machines in each station. Tickets that include a transfer to bus will be encoded as such and will have an appropriate code printed on the face of the ticket; therefore, separate transfer media will not be required.

- Discount-fare, single-trip tickets to any rail destination zone, with or without a transfer to bus, which will be sold at off-site sales outlets.

- Regular-fare and discount-fare monthly passes, which will be sold at off-site sales outlets.

The Metro Rail system will have a fare collection system of the automatic barrier type, with fare gates that will read the magnetically encoded tickets and passes. In

Metro Rail stations, an array of fare gates will define the line between the free and paid areas of the mezzanines; these gates will provide the means of entrance and exit for patrons. Each fare gate array will include a special gate, wide enough to accommodate a wheelchair, for use by handicapped patrons. Each array will also include emergency exit gates, with emergency-release hardware operable from the paid area of the mezzanine, to ensure that passengers will be able to safely evacuate stations during emergencies.

In addition to the fare gate arrays, the fare collection system will also include the following equipment:

- Automated ticket vending machines (TVMs) will vend regular-fare, single-trip tickets, with or without transfers to bus. The TVMs will also be capable of upgrading the value of prepurchased fare media. TVMs will be located in the free area of Metro Rail station mezzanines.

- Bill changer machines (BCMs) will dispense coins (Susan B. Anthony dollars) in exchange for U. S. $1 and $5 bills. BCMs will be located in the free areas of station mezzanines near TVMs and in the paid areas near add-fare machines.

- Add-fare machines (AFMs) will be located in the paid areas of station mezzanines near fare gate arrays. When a patron has taken a rail trip beyond the zones of travel for which his or her ticket (or pass) is valid, the AFMs will enable the patron to increase the fare media's value to the amount required to exit the Metro Rail system.

The Metro Rail fare collection system will, as noted previously, incorporate magnetically encoded regular-fare and discount-fare single-trip tickets (with and without transfers to bus) and monthly passes. In addition, the system's fare media will include certain emergency media (transfers and exit cards), magnetically encoded exchange media for patrons entering the light rail system (which will have paper tickets) and traveling to a Metro Rail destination, and special free passes for SCRTD employees and certain other categories of patrons (police, etc.).

8.2 NORMAL FARE COLLECTION OPERATIONS

Under normal system operations, patrons will use the fare collection system with limited assistance from

operations personnel. Procedures for patron use of the fare collection equipment under normal conditions are described below.

8.2.1 Patron Use of Fare Collection System

Patrons entering Metro Rail stations without prepurchased tickets will purchase their tickets from the TVMs located in the free area of the station mezzanine. The TVMs will accept U. S. coins and will vend regular-fare, single-trip tickets to any Metro Rail or light rail station, with or without a transfer to bus. Patrons will use buttons located on the face of the TVM to select their desired destination zone, and to select transfer to bus, if desired. The TVM will display the appropriate fare and will dispense the ticket (and any change owed) upon receipt of the required amount. Patrons may use BCM's located next to TVM's in order to obtain coins in exchange for $1 or $5 bills.

The TVMs will vend only regular-fare, single-trip tickets. Discount-fare patrons, because they must provide proof of eligibility, will be able to buy their tickets only at off-station sales outlets. All monthly passes, whether discount or regular fare, will also be sold only at sales outlets.

Metro Rail tickets will be encoded with valid zones of travel and transfer information (if appropriate). The face of the ticket will be imprinted with zone and transfer information. Because tickets will be dated and timed by the fare gate arrays, and not at the time of purchase, they may be prepurchased (at TVMs for regular-fare and sales outlets for discount-fare) for later use. Monthly passes will be encoded and printed with an expiration date, as well as with other necessary information (valid zones, etc.). Fare gates will, therefore, not imprint date and time information on them.

All patrons may use TVMs to increase the value of their prepurchased passes or tickets for single trips to additional zones.* To increase the value of fare media, a patron will insert the ticket or pass

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* Discounts will be offered to eligible patrons only for base-fare amounts. Since all patrons will pay the same incremental zone charges, discount-fare as well as regular-fare patrons may use TVMs to increase the value of their fare media.

into an acceptor slot on the TVM and will select the desired new destination zone. The TVM will display the fare that is owed and, after that amount is paid, will return a reencoded ticket or pass to the patron. (Patrons increasing the value of tickets will be issued a new ticket by the TVM, encoded and printed with the appropriate zone and transfer information. Patrons increasing the value of their pass for a single trip will be reissued the same pass. The TVM will encode the appropriate single-trip information on the pass, but will not print any information on the face of the pass.)

Patrons will enter the paid area of stations via the entry fare gates. Patrons will insert their magnetically encoded fare media into slots in the fare gate consoles. Upon reading a valid ticket or pass, the fare gate will release to permit the patron to enter and will then return the ticket or pass. Entry gates will print transfer information (date, time, origin station) on tickets to light rail destinations or with a transfer to bus.

Handicapped patrons may use the handicapped gates, which will open when media encoded as elderly/ handicapped (E & H) are read. If a handicapped patron with a regular-fare ticket (purchased at a TVM) requires use of the handicapped gate, he or she must contact the Station Agent (or the RCC, via the Passenger Assistance Intercom) and request that the gate be released when the ticket is inserted.

Patrons will exit the Metro Rail system through exit fare gates, which will release upon insertion of valid fare media. (Patrons wishing to exit through handicapped gates will follow the same procedures used to enter the system.) Fare gates will capture single-trip tickets to Metro Rail destinations, but will return tickets with transfers to bus, tickets to light rail destinations, and unexpired monthly passes.

If additional payment is required to leave the system, the exit fare gate will return the fare media and display an appropriate notice. The patron must then use an AFM to increase the value of the fare media. The AFM will read the inserted media, display the fare increment owed, and reencode the media for valid exit, after the proper fare amount is deposited (returning any change owed to the patron). AFMs will only accept coins; BCMs will, therefore, be located near all AFMs.

A slightly different procedure must be followed for passengers purchasing single-trip tickets from a light rail origin station to a Metro Rail destination zone. Such passengers will need to exchange their paper tickets for magnetically encoded ones at the 7th/Flower Station, the juncture of the two rail lines. A special station agent booth will be located at that station, where passengers will turn in their paper tickets for Metro Rail exit tickets. These tickets will enable the passengers to enter the Metro Rail fare gate arrays at the 7th/Flower Station and exit the system at the Metro Rail destination noted on their paper light rail ticket. If the light rail ticket also included transfer to bus, the Metro Rail exit ticket provided to the patron will also include a transfer.

Metro Rail employees will generally use regular entry and exit fare gates. Maintenance and revenue service staff, when they require additional room to transport equipment (e.g., revenue carts), will use the emergency exit gates. Authorized use of the emergency gates will require employees to use a key to deactivate the gate alarm before opening the gate.

8.2.2 Patron Assistance

Assistance to patrons will be provided remotely by RCC personnel or in person by Station Agents or Line Supervisors.

CCTV Operators at the RCC will be responsible for responding to patron assistance calls. CCTV Operators will visually monitor the fare collection equipment and patrons using equipment. When a patron requires assistance and no Station Agent or Line Supervisor is available, the patron will contact a CCTV Operator via the "hands free" Patron Assistance Intercom at the Patron Assistance Center. As noted in Chapter 4, these centers will be located near fare gates in the free area of station mezzanines, and near AFMs in the paid area. Each Patron Assistance Center will also include a ticket reader, which will enable CCTV Operators and on-site personnel to read information encoded on fare media, and, therefore, assist patrons experiencing problems with the media.

The Communications Controller at the RCC will be responsible for remotely monitoring the status of fare collection equipment, for placing equipment in and out of service, for contacting the Maintenance Department to have field technicians dispatched as needed, and for handling calls to the RCC from Station Agents, Line Supervisors, maintenance personnel,

and other SCRTD staff. As such, the Communications Controller will be responsible for following up on equipment malfunctions that cannot be corrected immediately.

8.3 DETECTION AND RESPONSES TO INCIDENTS

This section describes the procedures to be followed to assist patrons experiencing problems with fare collection equipment, and to provide maintenance to correct the equipment failures.

- Fare media, bill, or coin jams
- Fare media rejection
- Ticket not printed
- Ticket lost by patron
- Equipment failure.

In general, Metro Rail procedures will incorporate a philosophy on patron claims that will require acceptance of a patron's statement of loss in all cases that cannot be immediately verified, unless the patron is a known and repeated fare abuser. Metro Rail personnel will ensure that patrons experiencing a loss due to equipment malfunctions are not unnecessarily detained. If appropriate, a Patron Claim Form will be completed by Station Agents, Line Supervisors, or CCTV Operators in the event that money is claimed to be owed to the patron by SRCTD. One copy of the claim form will be sent to the Claims Department, and one copy to the patron. All settlements to patrons will be handled by mail.

If a loss is claimed by a patron who is known to be a repeated fare abuser, or if it is determined that a patron is attempting to use a ticket or pass that has been illegally altered, the Station Agent, Line Supervisor, or CCTV Operator will (1) ask the patron to present identification, (2) request the patron to wait while assistance is summoned, and (3) request that Transit Police be dispatched to handle the problem.

When media are damaged or lost due to equipment malfunction and are required to complete the patron's journey, emergency media may be provided by a Station Agent or Line Supervisor. Two kinds of emergency media will be available: pre-encoded emergency exit cards, which will allow exit at any Metro Rail station and will be captured by the exit fare gate, and paper emergency transfers, which will permit a transfer to bus or travel on light rail. The emergency transfers will be accepted as valid media when the date, time, and destination (bus or a light rail destination zone) are printed and signed by a Station Agent or Line Supervisor on the face of the transfer.

8.3.1 Fare Media, Bill, or Coin Jams

In the event that fare media, bills, or coins jam in Metro Rail fare collection equipment, patrons will notify the Station Agent, if one is present, or will contact a CCTV Operator at the RCC via the Passenger Assistance Intercom.

If a Station Agent is present, he or she will open the equipment and attempt to locate and retrieve the lost fare medium or money. If the fare medium or money cannot be retrieved, or if the medium is retrieved but is damaged, the Station Agent will either (1) ask the patron to purchase a replacement ticket and complete a Patron Claim Form to reimburse the patron for the loss; or (2) open the fare gate to enable the patron to enter the system, supply an emergency exit card (and emergency transfer, if necessary) so the patron can exit the system, and, if the patron's loss exceeded the value supplied by the emergency media, complete a Patron Claim Form. If the loss occurred at the patron's exit station, the Station Agent will open the exit fare gate to allow the patron to leave the system; supply an emergency transfer, if required, and complete a Patron Claim Form if the patron is still owed money.

At the Metro Rail stations where no Station Agent is present, CCTV Operators will assist patrons in an analogous manner. Fare gates will be opened remotely by CCTV Operators to enable patrons to enter or exit the system (for patrons entering the system, fare gates will be opened upon request subsequently at the patron's destination station); patron claim information will be taken by CCTV Operators and a copy of the claim form will be mailed to the patron. If necessary, the CCTV Operator will dispatch a Station Agent or Line Supervisor to supply the patron with emergency media. The patron may choose to purchase a replacement ticket rather than wait for the emergency media, in which case a Patron Claim Form will be completed by the CCTV Operator.

8.3.2 Fare Media Rejection

If a pass or ticket is rejected by a Metro Rail fare gate, the patron will be instructed to insert the fare medium into the station ticket reader at the Passenger Assistance Center. If the fare medium appears to be correctly encoded and undamaged, the patron will be instructed to try to use the medium in another fare gate. If this fails, and a Station Agent is present, the Station Agent will release the fare gate; supply emergency media, as needed; and, if

required, complete a Patron Claim Form. If no Station Agent is present, the CCTV Operator will remotely open fare gates, will dispatch personnel with required emergency media, and complete a Patron Claim Form, if necessary. Again, if the patron chooses to purchase a replacement ticket rather than await emergency media, the CCTV Operator will simply complete a Patron Claim Form to ensure the patron is reimbursed.

8.3.3 Ticket Received Without Printed Information

If station TVMs or entry gates fail to print on a ticket the information needed for the patron to transfer to bus or to proceed to a light rail destination, the patron will be instructed to insert the ticket in the ticker reader to ensure that it is properly encoded. If the correct information is encoded, the patron will be instructed to use the ticket to enter and exit the Metro Rail system, and will be provided with an emergency transfer by the on-site Station Agent or by personnel dispatched by the CCTV Operator. Alternatively, the patron may purchase a replacement ticket, and a Patron Claim Form will be completed.

8.3.4 Ticket Loss by Patron

If a patron has lost a ticket after entering the station paid area, the Station Agent or CCTV Operator will release the fare gate to allow the patron to exit the system. If the ticket included a transfer to bus or to a light rail destination, the patron will be informed that a new ticket must be purchased. In cases of hardship, the Station Agent or CCTV Operator may provide an emergency transfer.

8.3.5 Equipment Failure

Equipment failures may be detected by the Communications Controller, by Station Agents or Line Supervisors, or by patrons. Generally, the equipment will take itself out of service and will transmit diagnostic information directly to the RCC via the Station Fare Collection Control Unit. The Communications Controller will notify the Maintenance Department of the need to dispatch field technicians. If a Station Agent or Line Supervisor detects an equipment failure, he or she will complete an equipment incident report, leave a copy of the report in the equipment unit, and inform the Communications Controller of the problem via the administrative telephone.

Once a field technician is dispatched, maintenance will be carried out through on-site repair or component change-out.

8.4 FARE COLLECTION SYSTEM SECURITY

Fare collection security will primarily be the responsibility of the Transit Police fare compliance team. These plainclothes officers will rove station areas and observe station activity. They will be responsible for responding to incidents involving fare gate jumping, fare media fraud, and fare equipment vandalism.

9.0 REVENUE PROCESSING AND MEDIA DISTRIBUTION

9.0 REVENUE PROCESSING AND MEDIA DISTRIBUTION

This chapter describes the equipment, organization, and procedures planned for Metro Rail's revenue processing (cash collection and counting) and fare media encoding and distribution activities. The chapter is divided into five sections:

- Facilities and equipment
- Organization and personnel
- Revenue collection operation
- Revenue accounting and reporting
- Media encoding and distribution.

Revenue processing and media distribution for the Metro Rail system will be accomplished by expanding the SCRTD units now responsible for processing bus revenues and distributing bus passes. Existing facilities will be used to the maximum extent possible, as described below.

9.1 FACILITIES AND EQUIPMENT

The facilities, vehicles, and equipment to be used for counting cash, coding and storing media, and transporting both are outlined in this section.

9.1.1 Central Cash Counting Facility

A central cash-counting facility located at Division 2 currently is used for processing SCRTD bus revenues. This facility includes coin-counting and bill-counting rooms and equipment; a vault room with loading bay; loading docks; revenue cart storage area; administrative rooms; and ancillary facilities for personnel. Metro Rail's cash-counting work will also be handled at this location. Ticket stock and coin supplies for use in Metro Rail's automatic fare collection equipment will also be distributed from the central cash-counting facility.

Bus revenues are presently processed at the central cash-counting facility during a single work shift. Because new bus fare collection equipment will simplify revenue processing operations, a single shift will remain adequate even if bus revenues rise. The volume of Metro Rail revenue may require a second shift, operating at the same facility.

9.1.2 Media Encoding Stockroom

A media encoding stockroom will be provided for media processing, and its functions will be integrated with SCRTD's current prepaid bus pass sales operation. All fare media will be stocked at, and distributed from, this facility, and a ticket encoding machine will be located within the facility for the printing and pre-encoding of magnetic media. The precise location of this facility has not yet been determined.

Unencoded ticket stock for issuance by Metro Rail station TVMs will be stored at this facility and transported to the central cash-counting facility as needed for daily distribution to each station. Encoding equipment will process all passes and discount ticket stock to be sold at SCRTD service centers and sales outlets. It will also process emergency exit cards. Orders for such stock will be received, processed, and filled at this facility.

9.1.3 Vault Trucks and Media Delivery Vans

Armored vault trucks will be used to transport coins, bills, and media between the central cash-counting facility and stations. Security forces will accompany revenue servicing agents in servicing fare collection equipment daily at each Metro Rail station. One truck will be used to serve the five stations in MOS-1. SCRTD's existing media delivery vans will be used to transport ticket stock from the stockroom to the central cash-counting facility, and pre-encoded media to SCRTD service centers and sales outlets.

9.1.4 Revenue Carts

Revenue carts will be used to transport empty bill containers, filled cash replenishment containers, and unencoded ticket stock from the central cash-counting facility to each station. The cart will be prepared at the facility, loaded on the vault trucks, and taken to stations. At the stations, carts will be moved via escalator or elevator to the areas where TVMs, AFMs, and bill changer machines will be serviced. The carts will then hold full bill containers, overflow cash, empty cash replenishment containers, and captured media for return to the facility.

Two sizes of carts will be used, depending on the access route to automatic fare collection equipment at a station. A larger, heavier cart may be used to service single-mezzanine stations where carts can be moved by elevator to and from all fare collection

equipment areas. At the six double-mezzanine stations, access to one mezzanine will require the use of an escalator, and a smaller, lighter cart will be used. With the planned coin recirculation system, approximately eight carts will be needed to service the five stations.

9.1.5 Equipment

SCRTD currently has three coin sorting/counting machines in use at the central cash-counting facility. These machines will be capable of handling the Metro Rail coin processing operation. The processing of currency, which is currently labor intensive, will be simplified by new bus fare collection equipment and Metro Rail's bill containers. Bills will be stacked flat by the fare collection equipment, requiring clerks only to count the currency and prepare it for bank deposit.

TVMs at Metro Rail stations will receive blank ticket stock for issuance of regular fare tickets. Necessary magnetic encoding of this stock will be done at time of passenger purchase. As noted previously, such other media as discount tickets and passes will be processed by an encoding machine located at the stockroom site.

In addition, at the 7th/Flower Station, a ticket encoding machine will be located at the special station agent booth. This encoding machine will enable the agent to prepare magnetically encoded Metro Rail exit tickets which will be exchanged for printed tickets held by light rail patrons continuing on to Metro Rail destinations. The encoding machine will imprint codes on the magnetic strip of blank stock and will also print the appropriate information on the face of the ticket.

9.2 ORGANIZATION AND PERSONNEL

Revenue processing and media distribution activities for Metro Rail will be integrated into the existing SCRTD infrastructure under two basic functions--finance and security. In addition, personnel at the media encoding stockroom will coordinate with the SCRTD marketing organization to ensure that needs for passes and discount tickets are met in a timely and efficient manner.

The personnel required for media and revenue processing include:

- Revenue collectors
- Revenue clerks and supervisors

- Media clerks and supervisors
- Security guards.

Revenue collectors will be responsible for distributing revenue and fare media to, and retrieving them from, Metro Rail station fare collection equipment and SCRTD service centers. They will also be responsible for distributing media to sales outlets (media only). Revenue collectors will be accompanied by security guards during revenue and media pick-up/delivery trips.

At the central cash-counting facility, revenue clerks will process the cash collected from Metro Rail. Their activities will be overseen by revenue supervisors. The facility will be protected by security guards.

Media clerks will sort and package fare media, and pre-encode magnetic media, for distribution to service centers and sales outlets. Media supervisors will oversee the efforts of the media clerks. A security guard will be stationed at the media encoding stockroom.

Security personnel used for these activities will be integrated with SCRTD's other security forces. Collectors and clerks will be within the finance and accounting organization and be fully integrated with existing activities and personnel.

9.3 REVENUE COLLECTION

This section describes the procedures whereby Metro Rail revenues will be collected, cash will be counted, and tickets and cash will be transported between the Central cash-counting facility and stations.

9.3.1 Revenue Collection Process

Revenue servicing will be a closed system, with coin recirculation which uses monies deposited by one patron for the subsequent issuance of change to another patron. Under a closed system, revenue and media stock are kept in secured containers during handling. A revenue crew, composed of two revenue collectors and two security guards, will be sent to each Metro Rail station during off-peak periods. One security guard will serve as the driver of the armored truck and will remain with the truck while the other guard will accompany the revenue collectors to service the station.

The armored trucks will contain revenue carts which, prior to the crew's departure from the central cash-counting facility, will have been loaded by revenue clerks with:

- Empty bill containers
- Full SBA containers
- Full cash replenishment containers (nickels, dimes, and quarters)
- Unencoded ticket stock.

At stations, the carts will be taken to, and removed from, mezzanines fare collection areas by elevator or escalator. The carts will be pushed through emergency exit gates for access between the free and paid areas of station mezzanines.

At the stations, the revenue collectors will be responsible for the following functions:

- Removing full secured bill containers from bill changer machines and replacing them with empty containers
- Emptying overflow cash containers from TVMs and AFMs into the revenue cart money vault, and returning emptied containers to the equipment
- Replenishing supplies of change in the storage areas when necessary
- Replenishing Metro Rail TVMs with blank ticket stock
- Removing captured media from Metro Rail fare equipment and emptying them into trash bags to be taken to the central cash-counting facility for disposal
- Removing Susan B. Anthony dollar containers from the TVMs and AFMs and transferring them to the bill changer machines.

After servicing of the Metro Rail stations is completed, the armored trucks will return to the central cash-counting facility, delivering the revenues to the revenue clerks.

Servicing of service centers and sales outlets will involve the same procedures as are currently followed. At the service centers, unused stock will be stored in a safe along with collected revenues. Revenue crews will collect revenues from service centers; at sales outlets, revenues will be remitted to accounting on a regular basis in the form of a check, at which time a report of sales will also be submitted.

9.3.2 Cash-Counting Process

When servicing of the stations is completed, the revenue crew will return the carts to the central cash-counting facility for the processing of the revenues received from the stations and the proper disposal of captured fare media. The coins from the overflow cash containers will be dumped into a coin sorting and counting machine for processing. Currency from the bill containers will be counted, stacked, and wrapped. Empty cash replenishment containers will be refilled and secured. A supply of coins will be retained from Metro Rail revenues for the refilling of empty cash replenishment containers. (This retaining of a coin supply and refilling of containers will be new functions at the central cashcounting facility imposed by Metro Rail requirements.) Revenue clerks will prepare the revenues received from the stations for deposit in the bank.

The central cash-counting facility will not require additional equipment or space for handling Metro Rail revenue processing requirements.

9.3.3 Vault Truck Operation

With a coin recirculation system in use, Metro Rail's 18 stations will be serviced by three daily round trips between the central cash-counting facility and station locations. These trips would be scheduled to meet such objectives as:

- Equalizing the servicing workload
- Geographically organizing stations assigned to each route to minimize total travel time
- Limiting in-station revenue servicing to off-peak or nonoperating hours.

9.4 REVENUE ACCOUNTING AND REPORTING

The fare collection equipment at stations will transmit revenue data to the fare collection central computer at the RCC for statistical accounting and auditing use.

The revenue processed for each station will be recorded at the central cash-counting facility. These records will then be compared to those of central computer to complete the balancing process.

9.5 MEDIA ENCODING AND DISTRIBUTION

Media encoding, printing, and distribution will be added to the duties of the existing prepaid sales operation. Regular fare Metro Rail tickets will be purchased from TVMs at all Metro Rail stations, and passes and discount tickets will be sold at SCRTD service centers and sales outlets.

9.5.1 Media Encoding

At Metro Rail stations, regular-fare tickets will be magnetically encoded by TVMs for one-zone or zone-to-zone travel (including tickets to light rail zones). Discount Metro Rail tickets, all passes, and emergency exit cards will be centrally pre-encoded and preprinted. All tickets and passes will have codes for fare category and zones of travel printed on the face of the medium as well as encoded on the magnetic strip. In addition, tickets that include transfer to bus will have an appropriate code printed on their face and encoded on the magnetic strip.

9.5.2 Media Distribution

The media encoding stockroom will receive all new ticket stock. This stock will consist of passes and tickets preprinted with basic standard items such as the RTD logo. Metro Rail media will have blank magnetic strips for encoding by Metro Rail equipment. The stock will also include colored stock for certain discount fare media. The stockroom will distribute stock to:

- The central cash-counting facility for use on revenue carts servicing TVMs. Special stock, such as preprinted emergency exit cards, for use by Station Agents will also be distributed through the central cash-counting facility.

- SCRTD's service centers and sales outlets, which will sell discount tickets and passes.

The latter locations currently handle bus media. Metro Rail tickets and passes will simply be an additional product line handled by the existing distribution and sales network.

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10.0 MAINTENANCE INTERFACE

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This chapter describes the interface between the maintenance and operations functions for the Metro Rail system and those activities which require interaction between the two organizations. Fundamentally, the maintenance organizations have "ownership" of the Metro Rail equipment. The organizations are responsible for the availability and readiness of the equipment and facilities so that passengers may be transported in a clean, comfortable, and safe manner.

Three main activities will require interface between the maintenance and operations functions:

- To introduce or remove vehicles from revenue service
- To report equipment failures and take corrective action
- To perform preventive maintenance on each of the elements of the Metro Rail system.

Communications on each of these activities will normally take place between the Rail Control Center and two Maintenance Control Centers. A Vehicle Maintenance Control Center will be located on the second floor of the Main Shop building to coordinate and plan vehicle maintenance activities. A wayside Equipment/Facilities Maintenance Control Center will be located in the Maintenance of Way building to coordinate and plan station, tunnel, power, train control, communications, and fare collection maintenance.

10.1 THE INTRODUCTION AND REMOVAL OF TRAINS FROM REVENUE SERVICE

At the start of each day, the Vehicle Maintenance organization will prepare trains for revenue service according to the operating schedule requirements. The organization will prepare a computer based listing of the trains to be operated and the vehicle numbers for each consist. The Yard Dispatcher will assign the initial work run number for each train, make the vehicles into trains when necessary, and position them in the yard in the priority for departure. The train listing and their yard locations will then be transmitted via the SCADA system to the Crew Dispatcher and to the Rail Control Center. The Crew Dispatcher will use the list to direct Train Operators to their assigned

trains. Personnel in the RCC may use the list to discuss problems with the trains in the event of revenue service failures.

There may be occasions when there are insufficient trains or vehicles available to satisfy the operating schedule. On those occasions, the Operations and Vehicle Maintenance organizations will cooperate to develop a contingency plan which may include using fewer vehicles in some trains or increasing headways. The contingency plan must not compromise the safety of passengers or Train Operators, but may affect either service standards or vehicle loading standards during the implementation of the plan.

Before trains are dispatched into revenue service, a Train Operator, who is assigned to yard duty, will board the rear cab of a consist and walk through the train to inspect for cleanliness, vandalism, or vagrants. This operator will place unused defect cards in each cab when necessary, and will also perform the predeparture tests prescribed in the Standard Operating Procedures. The train will then be turned over to a revenue service Train Operator who will take it on to the mainline.

If a vehicle defect is encountered while in revenue service, the Train Operator will fill out a defect ticket for the problem. If the defect may affect service or safety, the Train Operator will also alert the Train Dispatcher in the Rail Control Center. Depending on the nature of the problem, the Train Dispatcher may leave the train in service or return it to the yard and substitute another train.

At the end of each revenue service run, the Train Operator will bring the train back to the yard. Trains scheduled for washing will be taken through the Car Wash and all trains will be routed to an appropriate storage location by the Yard Dispatcher. After storing the train, the Train Operator will walk through it to pick up defect tickets from the other cabs, and to inspect for vandalism or vagrants. The Train Operator will deliver the tickets to the Crew Dispatcher and inform him of any problems on the train. The Crew Dispatcher will inform the vehicle Maintenance Control Center of these problems and provide the Center with the defect tickets.

10.2 REPORTING EQUIPMENT FAILURES AND TAKING CORRECTIVE ACTION

Equipment failures and problems requiring corrective action may be identified by operations personnel, maintenance personnel, or by Metro Rail passengers. Problems reported by maintenance personnel will not normally involve an inter-

face between the operations and maintenance functions. However, that category is included in this document for completeness.

Although the method of reporting the failures and problems varies, all corrective maintenance requirements will ultimately be recorded in the appropriate Maintenance Control Center. The reporting channels are:

- Vehicle problems identified during revenue service operations will be reported by the Train Operator to the Train Dispatcher in the Rail Control Center. The Train Dispatcher will relay the information to the Communications Controller who will enter the information on the SCADA/TRANSMIS computer and inform the Maintenance Control Center staff.

- Other rail operations personnel (e.g., Line Supervisors, Transit Police, Train Dispatchers) will report conditions requiring corrective maintenance directly to the Communications Controller, who will relay the information to the appropriate Maintenance Control Center, via the SCADA/ TRANSMIS link.

- Problems discovered by maintenance personnel during their inspection or repair activities will be reported to their foreman who will investigate and then forward the information to the appropriate Maintenance Control Center.

- Patrons may report problems to the Train Operator via the train's passenger assistance intercom (PAI); to Line Supervisors or Station Agents in person, or by the PAI in each station; or to the RCC staff via the PAI or telephone. These reports will be forwarded to the Communications Controller for recording and routing.

In many instances, equipment failures will affect revenue service operations and will require close coordination between operations and maintenance staff to correct the problem.

When a vehicle problem is identified, the Train Operator, with the assistance of the Train Dispatcher and/or a Line Supervisor, will attempt to resolve the problem. If the problem is serious and could affect the safety or performance of the train, then the Train Dispatcher and

the Operations Supervisor may take the train out of service and store it at a convenient point in the Metro Rail system. The Train Dispatcher will then enter a substitute or gap train into service. Should the failure occur when no gap train is on the mainline, the Train Dispatcher will coordinate with the Yard Dispatcher to arrange for a substitute train and Train Operator to be introduced onto the line. If the train is immobile, the Maintenance Department will dispatch a maintenance crew to the failed train to resolve the problem and ask the operator to return it to the yard, or store the train temporarily in a convenient pocket track.

There will be fare collection maintenance technicians continuously roving the Metro Rail system performing preventive and corrective maintenance. As problems occur and are recorded, technicians will be dispatched to correct the defective equipment. In addition, Station Agents will be trained to perform "fingertip" maintenance on the fare collection equipment and the Communications Controller or CCTV Operator may ask them to attempt problem resolution. If it is necessary for a technician to work in the revenue secure area of the fare collection equipment, the repair must be made in the presence of the Transit Police. In those instances, the Communications Controller will contact the Watch Commander who will arrange for the Transit Police to be present for such maintenance activities.

Failures of train control or traction power equipment may require maintenance personnel to work along the trainway, in substations, or in train control equipment rooms. The Operations Supervisor will authorize maintenance personnel to conduct work in those areas during revenue service hours. When appropriate, speed restrictions will be enforced in tunnel areas occupied by maintenance personnel and some substation equipment may be shut down while repairs are effected. Equipment repairs will be made as expeditiously as possible and the Operations Supervisor will be informed when operating restrictions are no longer needed. Maintenance work on or near the right of way during non-reveune hours will be scheduled in advance and coordinated between the Maintenance and Operations organizations to ensure that no conflicts arise.

10.3 PERFORMING PREVENTIVE MAINTENANCE ON THE METRO RAIL SYSTEM

Most preventive maintenance will be performed during non-revenue service hours, although preventive maintenance on station and fare collection equipment may be conducted during off-peak periods. The interface between operations and maintenance personnel should only occur in those instances when maintenance personnel are working in the tunnels, stations, substations, or train control rooms.

In those instances, the personnel in the Rail Control Center will be informed of the nature of the work, its location, and estimated completion time. The maintenance personnel will be in frequent radio communication with the RCC to inform them of the status of the work and any problems which have occurred.

Occasionally a train or vehicle pair may remain in revenue service beyond the time when it should have returned to the yard for scheduled servicing. In that case, the Vehicle Maintenance and Operations organizations will coordinate the removal of the train from revenue service and its replacement with either the gap train or a new consist from the yard.

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