Southern California Rapid Transit District

METRO RAIL PROJECT

SYSTEM MAINTENANCE PLAN

JANUARY 1988

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

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T A B L E O F C O N T E N T S

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1.0 INTRODUCTION

I N D E X O F E X H I B I T S

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The System Maintenance Plan for the Southern California Rapid Transit District's (SCRTD's) Metro Rail project addresses the requirements of a comprehensive program for maintaining system facilities and equipment. By defining all required maintenance elements within one document, the Plan provides guidance and coordination to the development of the maintenance program.

1.1 OBJECTIVES

The principal objectives of the System Maintenance Plan are to:

- Identify the SCRTD's objectives and policies for maintenance of the Metro Rail system
- Describe the facilities needed to maintain the Metro Rail system
- Define a functional organization for the management of the Metro Rail maintenance program
- Identify the information and processes needed to control maintenance work and manage interactions with other SCRTD functions
- Identify maintenance elements whose provision will be integrated for the bus, light rail, and Metro Rail systems
- Provide a framework for the development of comprehensive maintenance manuals and training programs.

1.2 SCOPE

In addition to this Introduction, the System Maintenance Plan consists of seven chapters:

- Chapter 2.0 states the SCRTD's maintenance objectives and policies.
- Chapter 3.0 describes the facilities that will be employed in maintaining the Metro Rail system.

- Chapter 4.0 outlines the organization and responsibilities of the maintenance functions.
- Chapter 5.0 describes maintenance management information systems.
- Chapter 6.0 describes maintenance operations.
- Chapter 7.0 describes the materials management process.
- Chapter 8.0 describes the manuals and training required to support maintenance activities.

The System Maintenance Plan is a companion document to the System Operating Plan[1] and has been developed incrementally during the design of the Metro Rail project. This edition of the System Maintenance Plan reflects the design of Metro Rail facilities and equipment, and the organizational and operating philosophies of the SCRTD, as of the end of the final design phase. The plan will be periodically updated throughout the remainder of the project as more detailed information becomes available.

Because of funding limitations, the full Metro Rail system will be constructed in stages. A 4-mile segment, termed Minimum Operable Segment-1 (MOS-1), will be the initial operating segment, and additional segments will be constructed as funding permits. Section 1.3 describes the general characteristics of both the full system and of MOS-1.

The basic maintenance philosophy reflected in this Plan will not change as a function of system size. However, some maintenance elements planned for the full system will be deferred for MOS-1. Within the following chapters, the text describes the maintenance program for the full system; footnotes to the text identify elements of the program to be deferred for MOS-1.

The scope of this Plan is limited to the heavy rail (Metro Rail) maintenance program. This scope includes a discussion of maintenance facilities and staff that will provide integrated service to the Metro Rail and light rail systems, but excludes consideration of maintenance requirements specific to the light rail line. The latter

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1 SCRTD Metro Rail Project, System Operating Plan, October 1986.

are described in the Long Beach-Los Angeles Rail Transit Project Operations and Maintenance Plan.[2]

1.3 SYSTEM DESCRIPTION

The Metro Rail system is a rail rapid transit line planned by the Southern California Rapid Transit District to run from downtown Los Angeles to the San Fernando Valley. The system was originally planned to follow a route from downtown Los Angeles via the Wilshire District, Fairfax and Hollywood to the San Fernando Valley. However, concerns about the safety of tunneling through the Fairfax area resulted in a Federal requirement that SCRTD reconfigure the alignment to avoid potential methane gas areas. Four candidate alignments were assessed, and on April 30, 1987, the SCRTD Board of Directors adopted the preferred alternative. As illustrated in Exhibit 1-1, this alignment will include both subway and aerial configurations and will be served by 16 stations. The main line will begin in subway at Union Station in downtown Los Angeles, and will continue in subway under the central business district and west under Wilshire Boulevard to Western Avenue. The alignment of the Metro Rail system west of the intersection of Wilshire and Western remains under study.

The Metro Rail alignment will proceed north from Wilshire Boulevard along Vermont Avenue, where it will transition from subway to elevated rail service between Third and First Streets. Elevated trains will operate down the center of Vermont Avenue, approximately 20 feet above the surface. Continuing in an aerial mode, the alignment will curve west from Vermont Avenue to Sunset Boulevard. The line will proceed west on Sunset in an aerial mode to a point between Argyle Avenue and Gower Street, where the alignment will transition back to subway.

A subway station is planned at Sunset and Vine. Beyond that, Metro Rail will turn northwest with a stop at Hollywood/Highland. A future station at the Hollywood Bowl will be possible with this alignment. The rail line then will proceed underground through the Santa Monica Mountains to Universal City and its terminus in North Hollywood.

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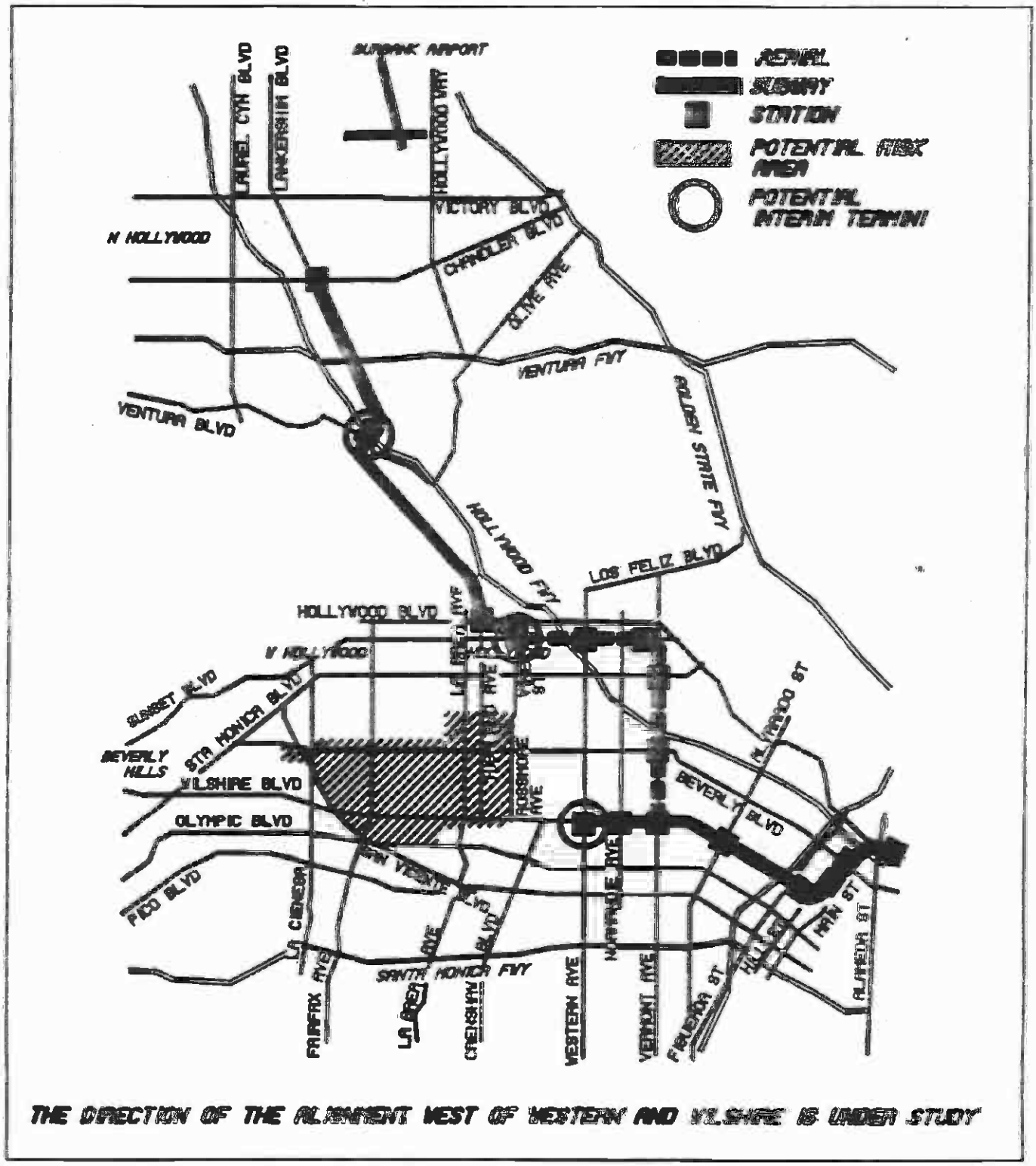
2 Los Angeles County Transportation Commission (LACTC), Long Beach-Los Angeles Rail Transit Project, Operations & Maintenance Plan, prepared by Southern California Rail Consultants, Rev. 4, June 1986.

EXHIBIT 1-1
Metro Rail System



This line is planned to be the core element of a regional rail rapid transit system. In addition to the planned 20-mile line, two future extensions of the Metro Rail system have been identified as part of the regional rail rapid transit system. These future extensions may involve surface as well as subway or aerial segments.

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 and will operate on 750 VDC power supplied via third rail. Present plans call for Metro Rail trains to consist of four or six vehicles. Each single vehicle will have a capacity of 59 seated passengers plus space for one wheelchair, up to 109 standing passengers at normal loads, and 160 standing passengers at crush loads.

Trains will have automatic train protection equipment to ensure safe speed and separation of trains. Automatic train operation equipment will also be included to regulate train speed and provide precision station stopping and train berthing verification for trains operating on the main line. System operation will be centrally controlled from the Rail Control Center, located in the yard, using communication links with facilities and trains involving telephones, radios, closed-circuit televisions, and data transmission.

The first 4 miles of the line have been identified as the initial operating segment, given that Federal funding is currently insufficient to enable construction of the full Metro Rail system. This initial segment, identified as MOS-1, will begin at Union Station, northeast of the Los Angeles Civic Center; will run through the central business district; and will terminate on the west at the Wilshire/Alvarado Station. The main line will be entirely in subway. Line segments will be constructed by tunneling machines, and stations and crossovers will be excavated by cut-and-cover construction techniques. Three crossovers will be included in the subway portion of MOS-1, one at each end of Union Station and one at the east end of the Wilshire/Alvarado Station.

Additional subway and surface track will connect the main line with the yard southeast of Union Station. MOS-1 will include all yard and shop facilities planned for the full system except for a portion of the yard tracks and some shop equipment, which will be installed as warranted by system and fleet expansion.

The MOS-1 line will have five stations. The station at 7th/Flower will be the transfer point between the Long Beach-Los Angeles light rail system and the Metro Rail system. Four of the stations will be of a double-ended design with two mezzanines; the fifth station, Wilshire/ Alvarado, will have a single center mezzanine. The stations have been designed for unattended operations; however, some stations may be attended at certain times of day. Each mezzanine free area will have automated ticket vending machines. The fare structure for MOS-1 will be based on a single zone; however, the fare collection equipment will have a multi-zone capability to enable system expansion to be accommodated. Escalators, stairs, and elevators will provide normal vertical circulation between surface, mezzanine, and platform levels. 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.

Patronage estimates have been prepared for the year 2000 for the full system. Weekday ridership is expected to be approximately 364,000 trips. Of these, approximately 55 percent will occur in peak periods (6:00-9:00 a.m. and 3:00-6:00 p.m.), with 23 percent of the weekday ridership concentrated in the peak hours (7:00-8:00 a.m. and 4:00-5:00 p.m.).

2.0 MAINTENANCE OBJECTIVES AND POLICIES

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Chapter 2.0 identifies and describes the fundamental objectives and related policies of the Metro Rail maintenance program. These objectives and policies will govern the planning and conduct of all maintenance activities on the Metro Rail system.

2.1 OBJECTIVES

There are four Metro Rail maintenance program objectives. They are to:

- Provide the maintenance activities needed to support a safe transit system
- Provide a high level of service dependability
- Provide clean vehicles and facilities
- Perform all maintenance activities in an efficient, cost-effective manner.

The SCRTD's maintenance goal for Metro Rail is to ensure that all equipment is properly maintained to maximize its performance and longevity. This goal will be accomplished by an established review process that ensures equipment is performing as required, through a non-deferred preventive maintenance program and through the expeditious performance of repairs. Maintenance requirements will be constantly monitored by engineers and maintenance management to ensure that the appropriate work is being accomplished. To support these activities, the SCRTD will thoroughly document equipment performance statistics and maintenance activities and will conduct regular analyses to identify and correct undesirable trends before they become problems.

2.2 POLICIES

The following policies govern the formation and conduct of the Metro Rail maintenance program and related activities. The Metro Rail maintenance program will consist of an optimal mix of preventive and corrective maintenance activities directed towards the periodic inspection, servicing, and repair of all Metro Rail system

elements. Policies relating to the following areas are presented:

- Preventive Maintenance
- Corrective Maintenance
- In-House Versus Contract Maintenance
- Repair Versus Component Change-Out
- Work Control
- Management Information
- Staffing
- Training
- Safety
- Program Integration.

2.2.1 Preventive Maintenance

Preventive maintenance will be performed on Metro Rail equipment and facilities at regularly scheduled intervals. The intent is to retain Metro Rail property in a condition compatible with operational safety, dependability, and appearance standards. Preventive maintenance activities include:

- Servicing and Inspection. All system elements will be subjected to a periodic servicing and inspection program. The level and frequency of servicing and inspection will be consistent with contractor and supplier recommendations, industry standards, and Metro Rail experience.

- Cleaning. All facilities, parking lots, roads, storage areas, and vehicles (revenue and non-revenue) will be periodically swept and cleaned.

- Overhaul. This is a special maintenance activity concerned with the planned rehabilitation, retrofit, or modification of a system element. The activity will generally be performed to improve equipment performance and to minimize future failures.

No maintenance program can be effective without well-designed and enforced preventive maintenance procedures. Metro Rail preventive maintenance will be accomplished in accordance with planned intervals. Preventive maintenance requirements will be developed by engineers in conjunction with maintenance management, and performance will be monitored to ensure adequacy. The requirements will be revised as needed to address a changing environment.

2.2.2 Corrective Maintenance

Corrective maintenance will be directed at repairing failed or malfunctioning parts, components, or subsystems. The intent is to restore the equipment to a satisfactory and safe condition within the shortest reasonable time. Corrective maintenance will be performed on an unscheduled and scheduled basis.

Unscheduled corrective maintenance may apply to "quick fix" actions, where the failed unit is repaired in a short period of time, requiring a minimum amount of effort. It may also apply to emergency repairs.

Corrective maintenance will be scheduled when the repair action cannot be completed in a short period of time because:

- The action is considered a heavy repair activity, requiring a significant amount of time and/or resources.
- Required materials, equipment, tools, or capable labor are not immediately available.
- The repair can be safely deferred and performed more efficiently at a later time in conjunction with some other repair action.

The SCRTD's maintenance philosophy is to be prepared to react to unscheduled maintenance as a matter of course, and to provide reasonable turnaround to keep the required equipment available.

2.2.3 In-House Versus Contract Maintenance

The design of Metro Rail equipment and facilities will enable most maintenance work to be performed in-house. Exceptions to the policy of performing work in-house include:

- Work performed by Metro Rail contractors and suppliers under warranty, training, or labor support agreements.
- Component repair or assembly work and routine servicing of certain equipment that can more economically be contracted out to local service shops or to the original equipment manufacturers.

The SCRTD, in conjunction with LACTC, has identified the following tasks as those that will be contracted out:

- Preventive and corrective maintenance of:
  - Elevators
  - Escalators.
- Component repair of:
  - Traction power equipment
  - Traction motors
  - Hydraulic pump motors
  - Condenser fan motors
  - Evaporator blower motors
  - Axles.
- Major repairs to trackwork
- Heavy (non-routine) cleaning at stations[1] and landscaping.

2.2.4 Repair Versus Component Change-Out

On-line maintenance will be performed by utilizing replaceable, pretested modules, components, or assemblies, wherever possible. The actual time to restore an element to service should consist only of the time needed to diagnose the fault and to replace the faulty part with a functioning spare unit. The objective of this policy is to minimize system downtime and to enable critical work to be performed in an optimal environment.

2.2.5 Work Control

All maintenance activities will be conducted within the framework of a comprehensive work control and management system. The system will consist of documented maintenance policies, administrative and repair procedures, automated information systems, and management reports for control and follow-up on all Metro Rail maintenance activities. The process will enable Metro Rail management to control and manage all maintenance activities and help to achieve maintenance program objectives.

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1 On the MOS-1 system, all cleaning services at stations will be performed by contract personnel.

2.2.6 Management Information

Required maintenance information will be collected and stored in the SCRTD's Transit Management Information System (TRANSMIS) and Facilities Maintenance System (FMS). These systems will provide on-line capability for documenting, retrieving, and analyzing maintenance and reliability data. The information will be used by maintenance management personnel to:

- Determine future maintenance requirements
- Direct and schedule daily maintenance activities
- Analyze maintenance problems
- Track important information, such as:
  - Work in progress and deferred
  - Parts under warranty
  - Parts availability and consumption
  - Maintenance costs, including labor and materials
  - Equipment configuration, modifications, and retrofits
  - Equipment reliability and maintainability
  - Labor productivity.

Reports will take the form of daily, weekly, and quarterly publications, along with a variety of special reports that are intended to focus on special performance parameters. Maintenance reporting will provide all levels of management with common performance criteria and keep system performance in the forefront and as the focus of daily activities.

2.2.7 Staffing

To support the maintenance program, the SCRTD will maintain a labor force with the skills and training needed to accomplish maintenance tasks. The staffing needs of each department/section will be regularly reviewed to ensure that appropriate staff levels are present to support all planned projects and required tasks.

2.2.8 Training

The SCRTD will have a comprehensive maintenance training program to ensure that skills are developed to an acceptable level. Courses will be provided by contractors for their equipment and will also be developed in-house by SCRTD staff. The training program will include certification programs for maintenance staff, as well as specific training courses to enable SCRTD personnel to advance their knowledge in areas required in the performance of their duties.

2.2.9 Safety

All maintenance program activities will reflect a high degree of concern for the personal safety of all Metro Rail employees, patrons, and other individuals who may come in contact with Metro Rail facilities and equipment. Procedures describing the safe operation of all maintenance tools, equipment, and vehicles (e.g., work train) will be developed and actively enforced. Procedures and training will also address safety on the main line and in the yard. All maintenance personnel will receive relevant classroom and on-the-job training, including testing and certification, regarding all safety requirements.

2.2.10 Program Integration

To the extent beneficial, the SCRTD will integrate the maintenance programs for all modes of transportation, i.e., light rail, heavy rail, and bus. This approach will maximize labor productivity; minimize administrative workloads; and provide economy in materials management, information system development, and component repair activities.

3.0 MAINTENANCE FACILITIES

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Chapter 3.0 describes the facilities that will be used to maintain the Metro Rail system. These include:

- Metro Rail Yard and Shops
- Central Maintenance Facility
- Maintenance Support Facilities.

3.1 YARD AND SHOPS

The Metro Rail yard and shops will be housed on a 40-acre site located to the east of the Los Angeles central business district. The site extends from the Santa Ana Freeway on the north to approximately 1,100 feet south of the 6th Street Bridge; and from the Los Angeles River on the east to Santa Fe Avenue on the west. Exhibit 3-1 provides a general plan of the yard area.

The yard area will contain 10 storage tracks capable of handling a fleet of 170 passenger vehicles,[1] a Main Shop building for vehicle maintenance, vehicle cleaning facilities, and a Maintenance-of-Way building. These facilities are described below.

3.1.1 Main Shop Building

The Main Shop building will contain the equipment and facilities necessary for servicing, inspecting, and repairing Metro Rail passenger vehicles. As shown in Exhibit 3-2, the Main Shop building will contain the following maintenance areas:

- Blowdown facility
- Service and inspection area
- Heavy repair area
- Truck shop
- Wheel shop
- Equipment maintenance shops.

The blowdown facility will be used to remove dirt from the undercarriage of passenger vehicles prior to scheduled maintenance inspections. The blowdown facility

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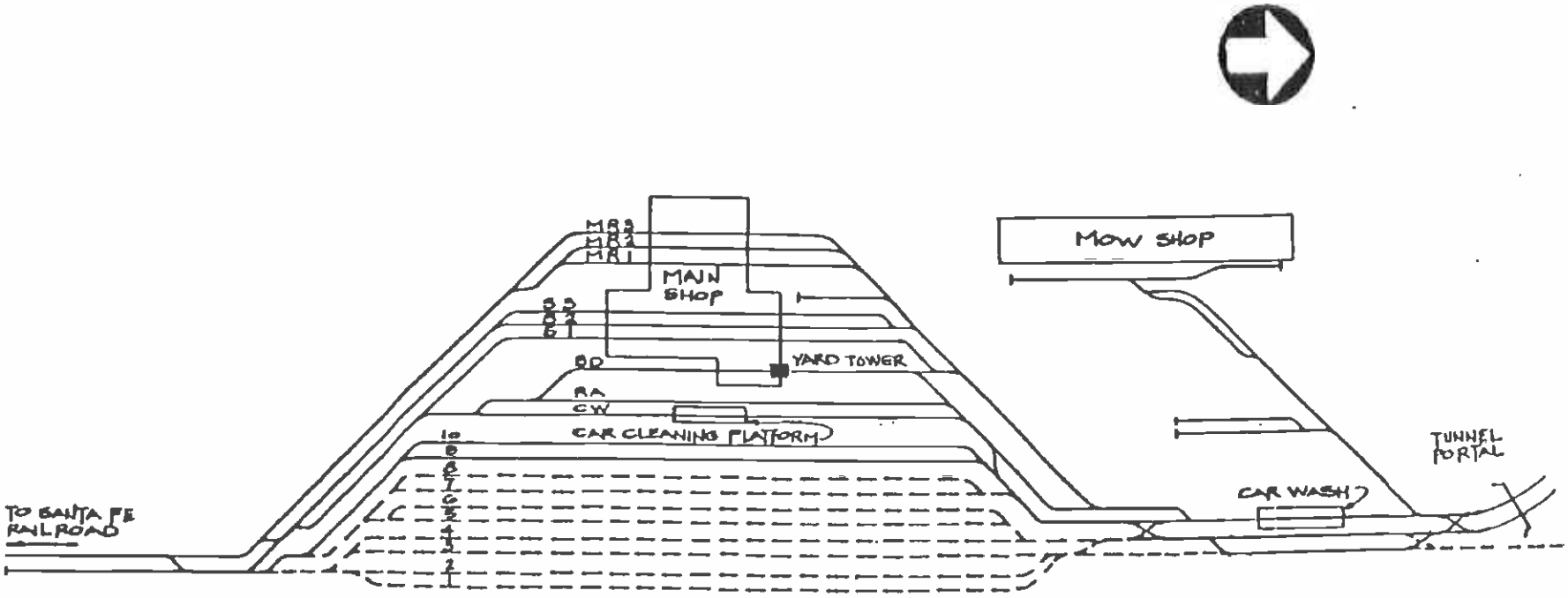
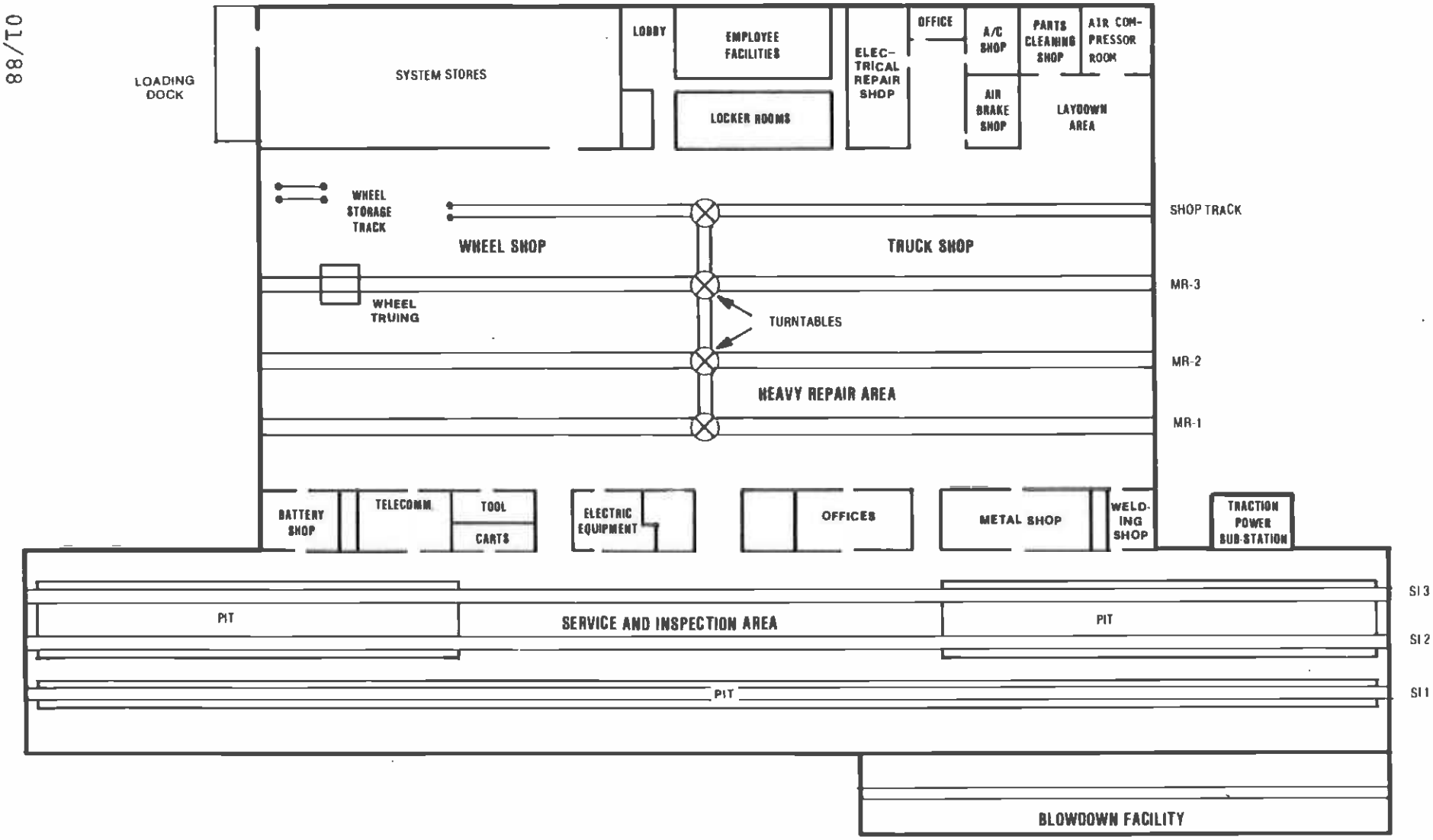
1 Two storage tracks will be constructed for the MOS-1 system, which will have a fleet of 30 passenger vehicles. Construction of the remaining eight storage tracks will be deferred until warranted by system expansion.

EXHIBIT 3-1
Yard and Shop Facilities



------ TRACK DEFERRED FOR MOS-1

EXHIBIT 3-2
Main Shop Building



NOTE: Exhibit does not depict all turntables planned for the Main Shop building.

will be long enough to accommodate one married pair of vehicles. It will contain compressed air and vacuum equipment to collect dust and debris produced during the cleaning operation.

The service and inspection area will be used for scheduled inspection and preventive maintenance, minor corrective maintenance, and exchange of minor components. The area will contain three tracks, each long enough to accommodate six vehicles. Three pits will be located in the area. One pit will run under track SI-1 for its entire length. The remaining two pits will be located at each end of tracks SI-2 and SI-3; each of these pits will be wide enough to include both tracks and will be as long as a married pair of vehicles.[2]

The heavy repair area will be used for overhauls, major repairs, and major modifications to passenger vehicles; exchange of trucks and other major pieces of equipment; and on-vehicle wheel truing. The area will contain three tracks, each having the capacity to accommodate two married pairs of vehicles. In-floor car hoists will be located along the tracks to raise the vehicles for undercar repairs and/or truck removal. Turntables, located at the mid-point of each track, will be used to move trucks from the heavy repair area to the truck shop. Bridge cranes will be installed to move components around the heavy repair area. Portable jacks and hoists will also be provided. A wheel truing machine will be located at the end of track MR-3.[3]

The truck shop and wheel shop will be located adjacent to the heavy repair area. The truck shop will be used for repair and overhaul of vehicle trucks, exchange of truck components, and removal of major components (e.g., brake units) for repair at the Main Shop building's equipment maintenance shops. The wheel shop will be used for dismounting and pressing wheels, bearings, and drive gears from and onto axles; boring wheels and machining axles for proper fit; and replacing journal bearings and drive gears.

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2 Equipment to be deferred for MOS-1 includes 6 of 12 stingers, plus various pieces of free-standing or portable equipment.

3 Equipment to be deferred for MOS-1 includes 1 of 2 bridge cranes, 4 of 8 car hoists, and 3 of 6 turntables. In addition, the wheel truing machine will initially be deferred; wheelsets will be shipped to the light rail maintenance facility in Long Beach for repair.

A shop track in the truck and wheel shops will accommodate trucks and wheelsets that are awaiting maintenance or have been repaired. The bridge cranes in the heavy repair area will extend into and be shared with the truck and wheel shops.[4]

The equipment maintenance shops will support maintenance requirements in the Main Shop building.[5] These shops will include the following:

- Air brake shop--Repair of brake units, brake cylinders and other air equipment (e.g., air compressors)
- Electrical repair shop--Repair of motors and electrical components and assemblies
- Telecommunications shop--Minor repair and storage of telecommunication items
- Battery shop--Testing, charging, servicing, and storage of batteries
- Air conditioning shop--Repair of vehicle air conditioning and heating equipment
- Metal shop--Repair, occasional modification, and fabrication of metal items
- Parts cleaning shop--Cleaning of vehicle parts
- Welding shop--Cutting, grinding, welding.

In addition, the Main Shop building will contain a laydown area, tool room, storage area, and employee facilities such as locker, lunch, and training rooms. The second floor of the Main Shop building will contain offices for vehicle maintenance personnel and a Vehicle Maintenance Control Center (MCC), which will be responsible for sched-

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4 Equipment to be deferred for MOS-1 includes a bore mill and wheel press.

5 Various shop equipment will be deferred for MOS-1. Built-in equipment to be deferred includes a bridge crane in the electrical repair shop, a brake press and rolling/bending machine in the metal shop, and a blast booth in the parts cleaning shop.

uling Metro Rail vehicle maintenance activities.[6] Also on the second floor of the Main Shop building, but separated from the maintenance offices, will be the Rail Control Center (RCC) and transportation divisional offices.

3.1.2 Vehicle Cleaning Facilities

The vehicle cleaning facilities will be used for exterior and interior cleaning of passenger vehicles. Exterior vehicle washing will be performed in a car wash facility located on one of the yard lead tracks. Trains leaving the car wash facility will be able to proceed directly to the storage yard. The car wash facility will include equipment for the control, treatment, and recirculation of waste water.

Routine interior car cleaning will be performed in the storage yard. Equipment required for interior cleaning will include a transport venicle with trash container to remove bagged debris. No other specialized equipment will be required for routine light cleaning.

Heavy interior cleaning will require a mechanical scrubber for the car floors and stain-removing equipment. The heavy cleaning platforms, which will be located adjacent to the Main Shop, will give cleaning crews easy access to the vehicles. The Main Shop building will contain facilities to store cleaning equipment and debris-transport vehicles ("golf carts").

3.1.3 Maintenance-of-Way Building

The Maintenance-of-Way (M-O-W) building will serve as a base for personnel responsible for maintaining the fixed facilities and the trackwork (the track structure and hardware) of the rail system.[7] Such work will generally be performed along the line, requiring personnel to travel to the site to perform the maintenance activities. Most

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6 For MOS-1, a single MCC will be located within the Maintenance-of-Way building and initially will serve the vehicle and facilities maintenance functions of both the Metro Rail and light rail lines. As the rail system expands, a separate Vehicle MCC will be established in the Main Shop building.

7 The M-O-W building will initially handle both Metro Rail and light rail maintenance-of-way. As the rail system expands, satellite M-O-W facilities will be established along the light rail lines.

of the tools, equipment, and material needed for this work will be stored within the M-O-W building or in outside storage; the M-O-W building will also provide facilities for the repair of items removed from the wayside and fixed facilities.[8]

Specifically, the M-O-W building will include:

- General repair area for the repair and overhaul of large wayside components
- Building equipment repair area for the repair of equipment items removed from buildings, stations, tunnels, and other structures
- Tool room for the storage of M-O-W shop tools
- General storage for storing equipment, secured materials, and supplies
- Support facilities for personnel, including men's and women's wash and locker rooms, lunch room, and training room
- Administrative offices for M-O-W activities.

The layout of the first floor of the M-O-W building is shown in Exhibit 3-3. A second floor extends over a portion of the building and will contain additional administrative offices. Within the M-O-W building, the Facilities MCC will manage the scheduling of daily maintenance activities and the dispatching of maintenance crews in response to operational requirements.[9]

Adjacent to the M-O-W building will be an outdoor material storage area that will be protected by security fencing. A paved parking area and storage tracks for auxiliary vehicles will be provided to the east of the M-O-W building.

3.2 CENTRAL MAINTENANCE FACILITY

The Central Maintenance Facility (CMF), located approximately one mile north of the yard and shops area,

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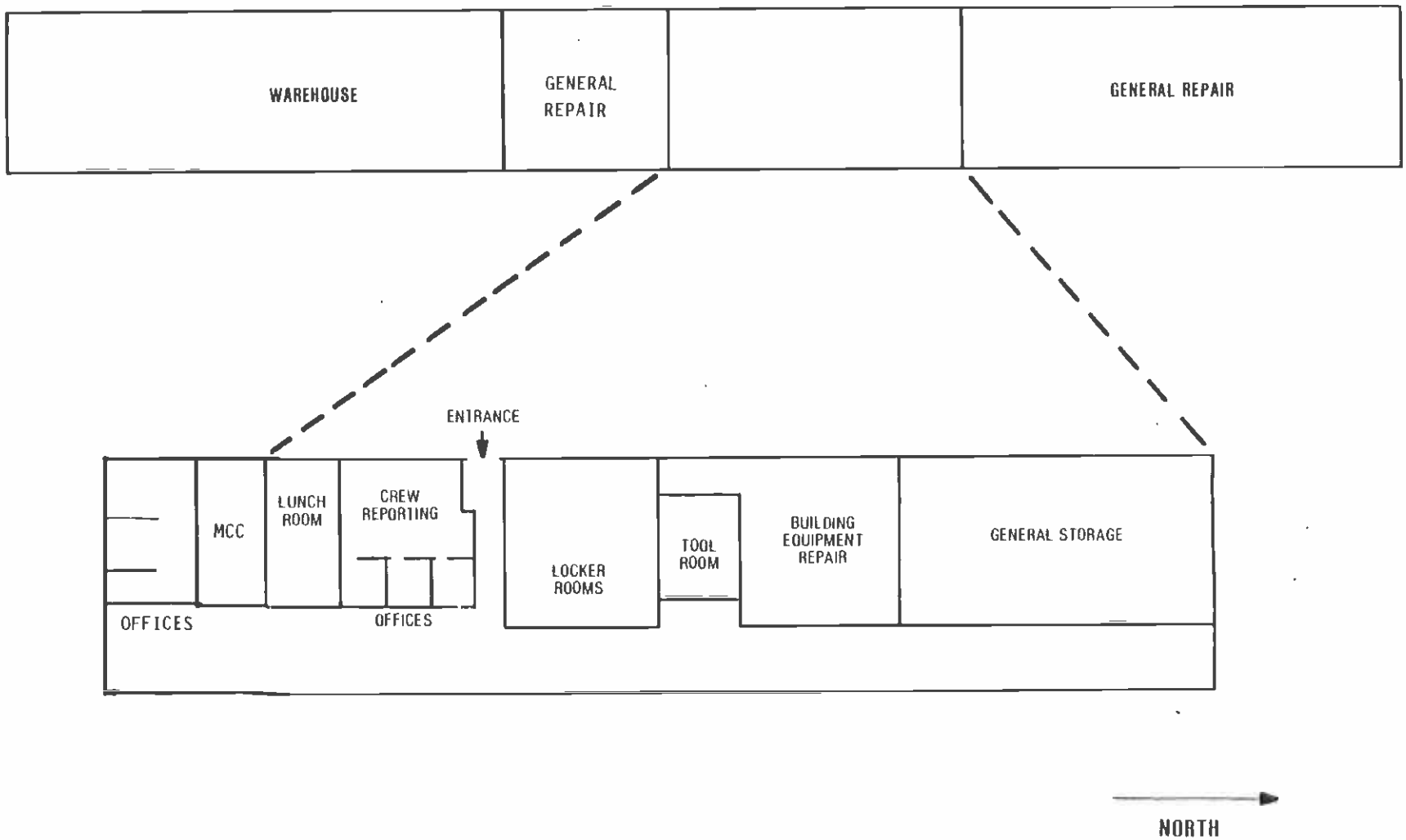
8 Equipment to be deferred for MOS-1 is limited to free-standing or portable equipment.

9 As noted previously, for MOS-1 this MCC will serve both the vehicle and facilities maintenance functions.

EXHIBIT 3-3
Maintenance-of-Way Building



will handle most electronic component repairs and repairs to equipment that is common to rail and bus operations. The CMF will include the following shops:

- Electronic Shop for the repair of electronic equipment, including:
  - Radio
  - Telephone
  - Fare collection equipment
  - Data transmission equipment
  - Closed-circuit televisions
  - Antennas
  - Destination signs.
- Component Paint Shop for the repainting of vehicle components
- Upholstery Shop for the repair or replacement of damaged or worn furnishings, such as seats and liners
- Heating, Ventilating, and Air Conditioning (HVAC) Shop for the repair and maintenance of HVAC equipment.

In addition, the CMF will contain other repair shops, including a glass repair shop and a carpentry shop; a storage area for rotable components; fuel dispensing facilities; and employee support facilities.

3.3 SUPPORT FACILITIES

The Main Shop and M-O-W building shops will be supported by other SCRTD maintenance facilities for welding, sheet-metal work, cabinet making, fencing, paving, and repair of automotive vehicles.

4.0 MAINTENANCE ORGANIZATION

4.0 MAINTENANCE ORGANIZATION

Chapter 4.0 describes the presently anticipated structure of the SCRTD maintenance organization and the responsibilities of the departments. It also identifies key management personnel within the departments and describes their roles and responsibilities.

4.1 ORGANIZATIONAL STRUCTURE

The Metro Rail system will be maintained by two departments within the SCRTD. The Equipment Maintenance Department will be responsible for maintaining all SCRTD rolling stock (Metro Rail vehicles, light rail vehicles, buses and automotive vehicles), and will have primary responsibility for mechanical component rebuilds conducted at the CMF. The Facilities Maintenance Department will be responsible for maintaining all SCRTD ways and structures, and will have primary responsibility for electronics and certain electrical repairs performed at the CMF. Exhibits 4-1 and 4-2 illustrate the planned organization of these departments for rail system maintenance (the organization for bus system maintenance will essentially remain in its current form). The organization charts reflect SCRTD plans and are subject to revision as the Metro Rail and light rail systems near the start of revenue service operations.

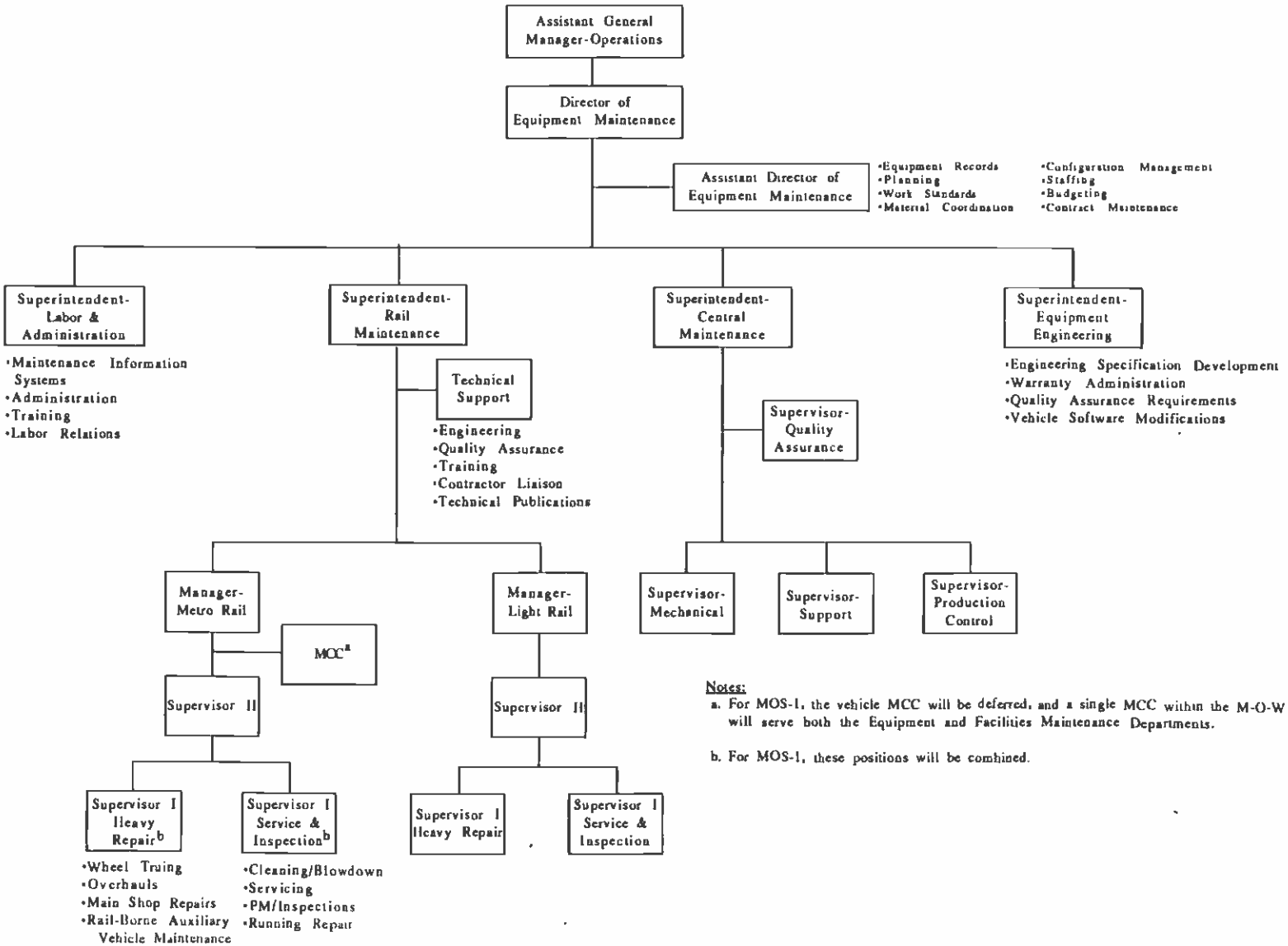
As the exhibits indicate, each of the maintenance departments will be headed by a Director. Under each Director will be several levels of personnel with management responsibilities, including Superintendents, Managers (Equipment Maintenance Department only), Supervisors II, and Supervisors I. The primary roles and responsibilities of each are described below. Following this general description of responsibilities is a more specific description of the roles of each of the maintenance departments.

4.1.1 Directors of Maintenance

The Directors of Equipment Maintenance and Facilities Maintenance will report to the Assistant General Manager for Operations, and will provide senior management direction to their respective departments. The Directors will be responsible for:

- Ensuring all department activities are directed towards supporting a safe, reliable, and efficient transit operation

EXHIBIT 4-1
Organization of Equipment Maintenance Department (Rail)

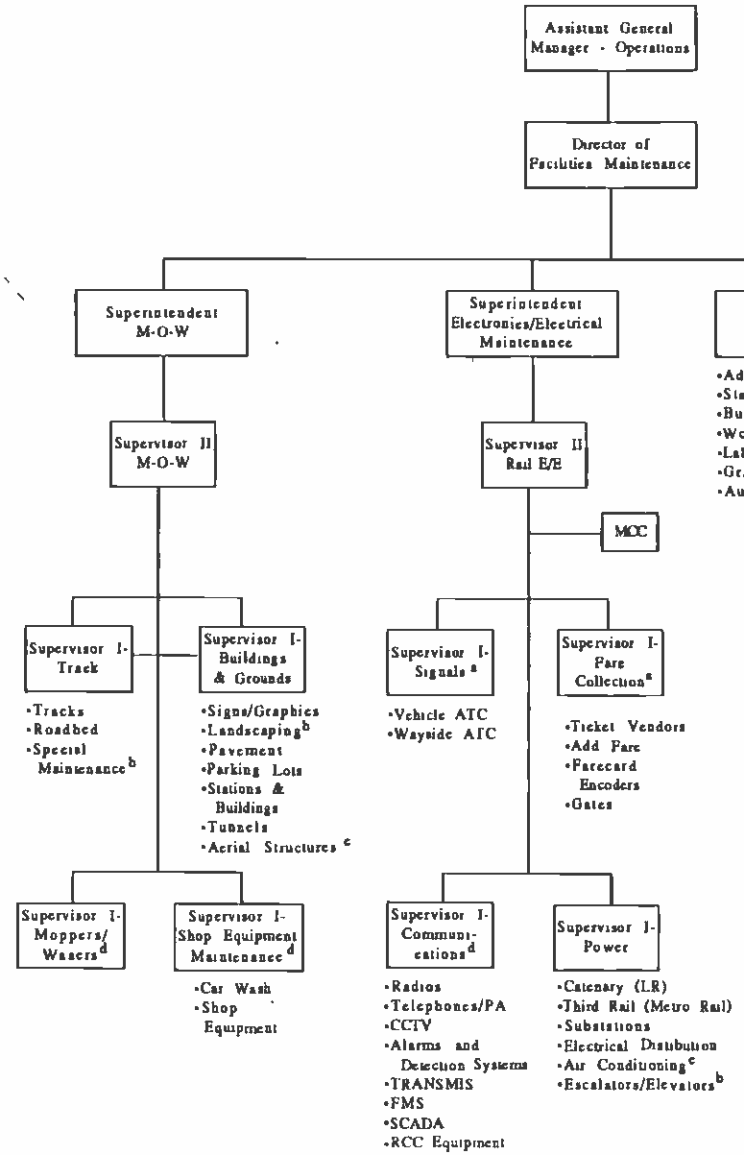


Notes:

a. For MOS-1, the vehicle MCC will be deferred, and a single MCC within the M-O-W building will serve both the Equipment and Facilities Maintenance Departments.

b. For MOS-1, these positions will be combined.

EXHIBIT 4-2
Organization of Facilities Maintenance Department (Rail)



Notes:

a. For MOS-1, these positions will be combined.
b. Maintenance to be performed under contract, supervised by indicated personnel.
c. The MOS-1 system will not include any aerial structures.
d. For MOS-1, these positions will be deferred. See text for assignment of responsibilities.
e. Initially, maintenance of air conditioning equipment will be supervised by the existing Supervisor I - Electrical at Vernon, who currently directs a crew of four HVAC maintenance personnel.

- Developing and/or approving all management and program policies of the department

- Coordinating transit maintenance activities with other SCRTD departments.

Within the Equipment Maintenance Department, the Director will be assisted by an Assistant Director of Equipment Maintenance, who will provide support in such areas as budget development, planning, configuration management, and materials management coordination. Within the Facilities Maintenance Department, Superintendents will provide similar support.

4.1.2 Superintendents

Each Director of Maintenance will be supported by several Superintendents, who will manage the activities of a major section within their respective departments. Superintendents will be responsible for planning, coordinating, and directing their section's maintenance activities, and will have ultimate responsibility for the timely and effective performance of those activities. Specific duties of the Superintendents will include:

- Ensuring that the section's activities support a safe, reliable, and efficient transit operation

- Exercising effective administrative control over the section's operations

- Directing the implementation of department policies and procedures and reviewing technical and administrative policies and procedures for improvement

- Preparing and presenting reports within areas of responsibility as may be appropriate; and attending meetings, hearings relating to employee complaints and grievances, and other activities pertinent to the execution of functional responsibilities.

4.1.3 Managers

Within the Equipment Maintenance Department, Managers will report to a Superintendent and will be responsible for planning, organizing, and directing the activities of a major maintenance division (Metro Rail or light rail) or

specialized maintenance operation. Specifically, Managers will be responsible for:

- Developing goals and establishing priorities for the maintenance division or specialized operation
- Directing the activities of subordinate staff
- Preparing technical reports
- Participating in labor negotiations.

Within the Facilities Maintenance Department, Superintendents will fulfill these responsibilities.

4.1.4 Supervisors II and I

The primary role of Supervisors will be to manage the day-to-day performance of maintenance activities. Supervisors II will oversee the activities of several work groups, while Supervisors I will provide first-line direction to a single work group. The duties of supervisors will include:

- Providing technical assistance and logistical support to maintenance personnel
- Analyzing failures in systems and equipment as necessary to identify causes, and directing implementation of appropriate corrective actions
- Ensuring that personnel receive requisite training
- Authorizing acquisition of necessary supplies, equipment, tools, and other materials, as required
- Evaluating and attempting to resolve employee complaints and grievances.

4.2 EQUIPMENT MAINTENANCE DEPARTMENT

The Equipment Maintenance Department will be responsible for maintaining the SCRTD's vehicle fleet. As shown in Exhibit 4-1, the Department will be under the overall direction of the Director of Equipment Maintenance. The Director will be supported by an Assistant Director, whose responsibilities will include:

- Development of budgets, work standards, and staffing plans

- Conduct of long-range planning
- Assessment of contract maintenance requirements
- Maintenance of equipment records, including configuration records for all vehicles
- Coordination of materials management issues with the Office of Contracts, Procurement and Materiel.

The Director will also be supported by four Superintendents, who will be responsible for:

- Rail Maintenance (light rail and Metro Rail passenger vehicles and rail-borne auxiliary vehicles)
- Central Maintenance (mechanical component rebuild)
- Labor and Administration
- Equipment Engineering.

The following sections describe the roles of the Rail Maintenance and Central Maintenance Sections in maintaining Metro Rail vehicles, and then describes the support to be provided by the Labor and Administration Section and the Equipment Engineering Section.

4.2.1 Rail Maintenance

The Rail Maintenance Section, under the overall direction of the Superintendent of Rail Maintenance, will be responsible for maintaining both Metro Rail and light rail passenger vehicles and rail-borne auxiliary vehicles. Rail vehicles will be maintained at two facilities: the Metro Rail Main Shop in downtown Los Angeles, and the light rail Main Shop in Long Beach. Eventually, some minor repair capabilities may also be provided at the North Hollywood terminal of the Metro Rail system.

The Superintendent of Rail Maintenance will be assisted by a Technical Support Group and by two divisional managers, one for Metro Rail and one for light rail vehicle maintenance. The Technical Support Group will provide expert advice and assistance on both Metro Rail and light rail vehicle maintenance. The Technical Support Group will include electrical and mechanical vehicle engineers who are familiar with the design of the equipment and who will conduct engineering analyses, including analyses of

equipment reliability. In addition, quality assurance staff will ensure that proper maintenance practices are developed and periodically audited. The Technical Support Group will also include personnel to provide vehicle maintenance training, to maintain technical publications on a current basis, and to provide liaison with on-site contractor representatives.

Reporting to the Superintendent of Rail Maintenance, the Manager for Metro Rail vehicle maintenance will have overall responsibility for all vehicle maintenance activities conducted at the Metro Rail Main Shop building. The Manager, supported by a Supervisor II, will oversee the activities of two groups--the heavy repair group and the service and inspection (S&I) group--each of which will be under the day-to-day supervision of a Supervisor I.[1]

The heavy repair group will be responsible for wheel truing, overhauls, and repairs conducted in the various shops of the Main Shop building. These shops will provide capabilities for the repair of railcar equipment, such as brakes, air conditioning, batteries, and electrical systems, as well as facilities for truck removal, repair, and rebuild. Repairpersons in the heavy repair group will work in the shops and on vehicles located on tracks MR-1, 2, and 3, and the shop tracks.

The S&I group will be responsible for cleaning, blowdown, preventive maintenance, and running repairs on the fleet. This group will also perform daily safety checks. Repairpersons and car cleaners in the S&I group will work at the car wash facility, the heavy cleaning platform, the blowdown facility, and the S&I area.

A Vehicle MCC will be responsible for coordinating vehicle maintenance activities and providing liaison between the Equipment Maintenance Department and operations personnel.[2] The Vehicle MCC will be under the direction of the Manager for Metro Rail vehicle maintenance, and will be staffed by clerks. The MCC staff will schedule maintenance activities, receive incoming failure reports, and coordinate the maintenance response.

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1 For the MOS-1 system, only one Supervisor I position will be staffed, and the Supervisor I will be responsible for directing the activities of both the heavy repair and S&I groups.

2 As noted previously, for MOS-1, a single MCC within the M-O-W building will serve both the Equipment Maintenance and Facilities Maintenance Departments.

4.2.2 Central Maintenance

The Superintendent of Central Maintenance will have overall responsibility for secondary repair of mechanical components for both the bus and rail fleets conducted at the CMF. These activities will include the rebuilding of mechanical components and modules, the repair of upholstery, and the repainting of components. The responsibilities of this section will include:

- Receiving, inspecting, and conducting routine tests on purchased components, modules, and parts
- Conducting overhaul and testing of components and modules in accordance with preventive maintenance programs
- Performing repair testing and failure analysis of failed components and modules
- Modifying components and modules.

4.2.3 Support Sections

The Equipment Maintenance Department will include two sections that will provide administrative and technical support to vehicle maintenance personnel. These sections, which will each be managed by a Superintendent, are as follows:

- The Labor and Administration Section will be responsible for all general administrative activities related to vehicle maintenance. The activities of this section will include providing office and clerical support, managing maintenance information systems, preparing and updating administrative procedures, developing training programs, and providing labor relations support.
- The Equipment Engineering Section will be responsible for developing specifications for new vehicles and equipment, developing quality assurance specifications, overseeing any software modifications to vehicle equipment, and providing bus and rail vehicle warranty administration.

4.3 FACILITIES MAINTENANCE DEPARTMENT

The Facilities Maintenance Department will be responsible for maintaining all SCRTD ways and structures, and for electrical and electronics repairs to fixed

equipment and certain vehicle-borne subsystems. The department, which will be headed by the Director of Facilities Maintenance, will consist of four major sections:

- Maintenance-of-Way
- Electronics/Electrical
- Fiscal/Planning
- Facilities Maintenance Engineering.

The following sections describe the roles of the Maintenance-of-Way and Electronics/Electrical Sections, and then describes the support to be provided by the Fiscal/Planning and Facilities Maintenance Engineering Sections.

4.3.1 Maintenance-of-Way Section

The M-O-W Section will be responsible for maintaining all SCRTD ways and structures, whether Metro Rail, light rail, or bus. The section will be under the overall direction of the Superintendent of M-O-W, and its activities will be managed from the M-O-W building in the Metro Rail yard. The Superintendent of M-O-W will be assisted in his managerial duties by a Supervisor II.

The M-O-W Section will be divided into four functional groups: track maintenance, building and grounds maintenance, shop equipment maintenance, and mopping/waxing. Each of these groups will be headed by a Supervisor I, who will report through the Supervisor II to the Superintendent of M-O-W. The roles of each are as follows:

- The Supervisor I-Track Maintenance will be responsible for the maintenance of Metro Rail and light rail tracks and roadbed. The Supervisor will supervise a group of SCRTD track maintenance personnel, who will inspect tunnels, service and inspect tracks and roadbed, and perform routine repairs to tracks and roadbed.[3] The Supervisor will also supervise contract personnel who will perform heavy track maintenance.

- The Supervisor I-Building and Grounds Maintenance will be responsible for maintaining the structural elements of all SCRTD property; repairs to

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3 Repairs to tunnels will be performed by building and grounds maintenance personnel.

mechanical systems in facilities, such as plumbing systems and fire protection systems; inspection and maintenance of bridges (light rail) and aerial structures;[4] maintenance of tunnels; maintenance of signs and graphics; gardening and landscaping services; and maintenance of fencing, pavements, and parking lots. The Supervisor will direct the activities of the SCRTD buildings and grounds maintenance group, and will also supervise the work of contract personnel providing landscaping services.

- The Supervisor I-Shop Equipment Maintenance will be responsible for maintaining the car wash facility and all SCRTD shop equipment, such as hoists/jacks, overhead cranes, and turntables.[5]

- The Supervisor I-Mopping/Waxing will be responsible for cleaning services at SCRTD stations and other facilities, including removal of trash, dusting and washing of surfaces, and waxing of floors. The Supervisor will direct the activities of SCRTD moppers and waxers, and will supervise contract personnel who will perform heavy cleaning at stations.[6]

4.3.2 Electronics/Electrical Maintenance

The Electronics/Electrical Maintenance Section will be responsible for maintenance of all SCRTD communications, train control, fare collection, and power/electrification equipment. The Superintendent of Electronics/Electrical Maintenance will have overall responsibility for managing the section's activities. He will be assisted by a Supervisor II for rail electronics/electrical maintenance.

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4 The MOS-1 system will not include any aerial structures.

5 For the MOS-1 system, this position will be deferred, and the Supervisor I-Track Maintenance will be responsible for maintenance of the car wash facility and shop equipment.

6 For the MOS-1 system, this position will be deferred, and the Supervisor I-Buildings and Grounds will be responsible for supervising the cleaning of SCRTD facilities. On the MOS-1 system, all station cleaning (routine and heavy) will be performed by contract personnel.

Reporting to the Supervisor II will be a Supervisor I for each of four functional groups: fare collection, communications, signals, and power. The roles of each are as follows:

- The Supervisor I-Fare Collection will be responsible for maintaining farecard encoders, ticket vending machines, add-fare machines, and fare gates.[7]

- The Supervisor I-Signals will be responsible for maintaining venicle and wayside train control equipment.[7]

- The Supervisor I-Communications will be responsible for maintaining radios, telephone and public address equipment, CCTV cameras and monitors, RCC equipment (status board, computers, and consoles), seismic and gas detectors, alarm systems, TRANSMIS and FMS equipment and software, and tne equipment and software of the Supervisory Control and Data Acquisition (SCADA) subsystem.[8]

- The Supervisor I-Power will be responsible for the maintenance of traction power and AC power distribution systems, substations, the third rail of the Metro Rail system, and the catenary of the light rail system; and for electrical repairs in stations and other facilities, including repairs to elevators, escalators, air conditioning equipment, and lighting. The Supervisor will direct the activities of SCRTD power technicians and will also supervise the activities of contract personnel responsible for maintaining elevators and escalators.

The Electronics/Electrical Section will be managed from the M-O-W building. An MCC will be located at the M-O-W

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7 The MOS-1 system will have a barrier-free fare collection system, and fare collection equipment will be limited to automatic ticket vending machines. For MOS-1, the positions of Supervisor I-Fare Collection and Supervisor I-Signals will be combined into one position.

8 For MOS-1, this position will be deferred, and the existing Supervisor I-Communications (Bus) will be responsible for the maintenance of communications equipment.

building, and will be supervised by the Supervisor II-Rail Electronics/Electrical Maintenance. The MCC will be staffed by clerks and will be responsible for scheduling and coordinating maintenance activities, for receiving failure reports, and for providing liaison with operations personnel.

While the Electronics/Electrical Section will be centrally managed from the M-O-W building, the section's staff will be geographically dispersed; shop technicians will be located at the M-O-W building and the CMF, and field technicians will rove the system performing corrective and preventive maintenance.

4.3.3 Support Sections

The Facilities Maintenance Department will include two sections that will support the activities of line maintenance personnel. These sections, which will each be managed by a Superintendent, are as follows:

- The Fiscal/Planning Section will be responsible for providing administrative support, preparing management reports, and coordinating with other SCRTD departments and offices, such as Personnel; Contracts, Procurement and Materiel; and Labor Relations. This staff will prepare budgets and long-term plans, develop work standards, administer contracts and grants, and conduct performance audits.

- The Facilities Maintenance Engineering Section will be responsible for maintaining technical and configuration management documentation, managing maintenance information systems, administering warranty programs, writing specifications, developing quality assurance programs, and providing liaison with on-site contractors. This section will also manage reliability and maintainability programs, help develop in-house training courses and materials, and provide expertise in software, hardware, electrical/electronics, mechanical and civil engineering.

5.0 MAINTENANCE MANAGEMENT INFORMATION SYSTEMS

5.0 MAINTENANCE MANAGEMENT INFORMATION SYSTEMS

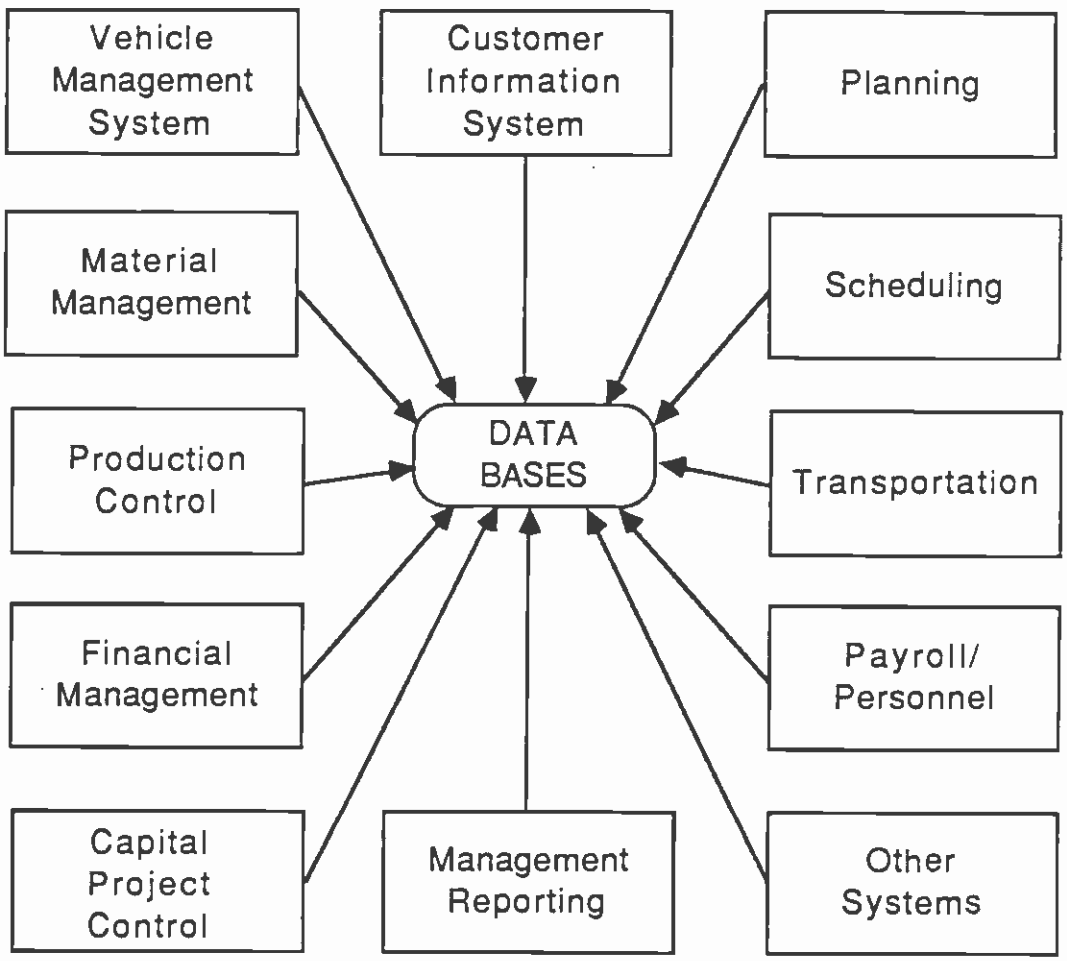
As described in preceding chapters, responsibility for maintenance of the Metro Rail system will be shared by the Equipment Maintenance and Facilities Maintenance Departments, and maintenance activities will take place in various facilities and in the field. Computer-based management information systems will be used to facilitate the planning, coordination, and management of maintenance activities. These systems will be used to store, manipulate, and retrieve maintenance data on all Metro Rail system elements, and will enable the transfer of information among maintenance personnel and locations on a real-time basis. The following sections of this chapter describe these maintenance-related information systems and their use.

5.1 MAINTENANCE-RELATED INFORMATION SYSTEMS

Two computer-based information systems will be used by maintenance managers as primary tools for tracking and scheduling maintenance activities and capturing maintenance data. These are the Vehicle Management System (VMS) and the Facilities Maintenance System (FMS). VMS will be used to process maintenance information on passenger vehicles and rail-borne auxiliary vehicles; FMS will be used to process maintenance information on all other Metro Rail system elements. The maintenance data handled by each system will include planned or preventive maintenance activities, failure reporting and corrective actions, status of work performed by repairpersons, component configuration data, and component warranty claim information.

VMS is a component of SCRTD's Transit Management Information System (TRANSMIS), a network of computer-based information systems that are linked by centralized data bases (see Exhibit 5-1). TRANSMIS has conceptually been designed for both bus and rail application, and is presently being implemented for the SCRTD bus system. While not all TRANSMIS subsystems are fully operational at present, VMS is functional and is now being used to process bus maintenance data. VMS will only require certain modifications to support rail maintenance data requirements.

EXHIBIT 5-1
Transit Management Information System
(TRANSMIS)



In addition to VMS, three other subsystems of TRANSMIS will be used for processing maintenance-related information for the Metro Rail system:

- Production Control System
- Material Management System
- Payroll/Personnel System.

The Production Control System (PCS) will be used to manage the secondary repair (shop) activities associated with overhauls and rebuilds of components of passenger vehicles and rail-borne auxiliary vehicles. Such secondary repairs will take place at the Main Shop building or the CMF. PCS will provide for the:

- Planning, scheduling, and monitoring of component repairs
- Initiation, change, and close-out of shop orders, to be used in controlling the production work process
- Documentation and analysis of work performed, including material and labor consumption, for each shop order.

The Material Management System (MMS) will be used for processing inventory-related information. MMS is the focus of the SCRTD materials management process and is primarily used by the SCRTD Office of Contracts, Procurement and Materiel (OCPM). The system provides a mechanism for receiving material, preparing purchase orders, and tracking inventory. Through its capabilities, the SCRTD will maintain inventory levels necessary to support the maintenance activities of Metro Rail.

The Payroll/Personnel System will be used to process and maintain payroll-related information for all SCRTD employees, including maintenance personnel. The system will calculate gross and net pay based upon hours worked and reported by each repairperson.

All TRANSMIS subsystems will be linked by centralized data bases, enabling data from various subsystems to be combined for analysis and ensuring that rotable components can be tracked throughout their life.

FMS is a stand-alone computer system that is currently under development by the Facilities Maintenance Department. Although FMS will not be a component of TRANSMIS, a transfer of data between FMS and various TRANSMIS components will be made possible by a link between FMS and the mainframe

computer at SCRTD headquarters. This link will enable the Material Management System and the Payroll/ Personnel System of TRANSMIS to capture relevant information entered into FMS; it will also enable a transfer of data between FMS and VMS.

5.2 VMS USE

VMS will be used to record and update maintenance information on passenger vehicles and rail-borne auxiliary vehicles, such as failure data, repair activity, labor hours, and materials usage. The stored data will be used to plan, schedule, and manage maintenance activities, and will also be used for evaluation and diagnostic purposes, including the identification of repetitive problems, assessment of equipment reliability and opportunities for improvement, and review of labor utilization.

Data will be entered into or retrieved from VMS via computer terminals located within the Main Shop building, the CMF, and the MCC. In addition, data will be entered into VMS through Data Collection Terminals, or Badge Readers, that will be located in the crew reporting areas and shop areas of the Main Shop building and the CMF. These Badge Readers will be similar in design to those now in use for collecting data on bus system maintenance (see Exhibit 5-2). SCRTD Equipment Maintenance Department personnel will use the Badge Readers to clock in and clock out each day; in addition, they and contractor personnel will use the Badge Readers to record vehicle maintenance activities.

Maintenance personnel will be issued I.D. badges which they will insert into a slot on the face of the Badge Reader to clock in or out or to enter maintenance data. The Badge Reader will contain function selection keys, numeric operating keys, and control keys that the user will depress in response to various prompts appearing on a lenticular display screen.

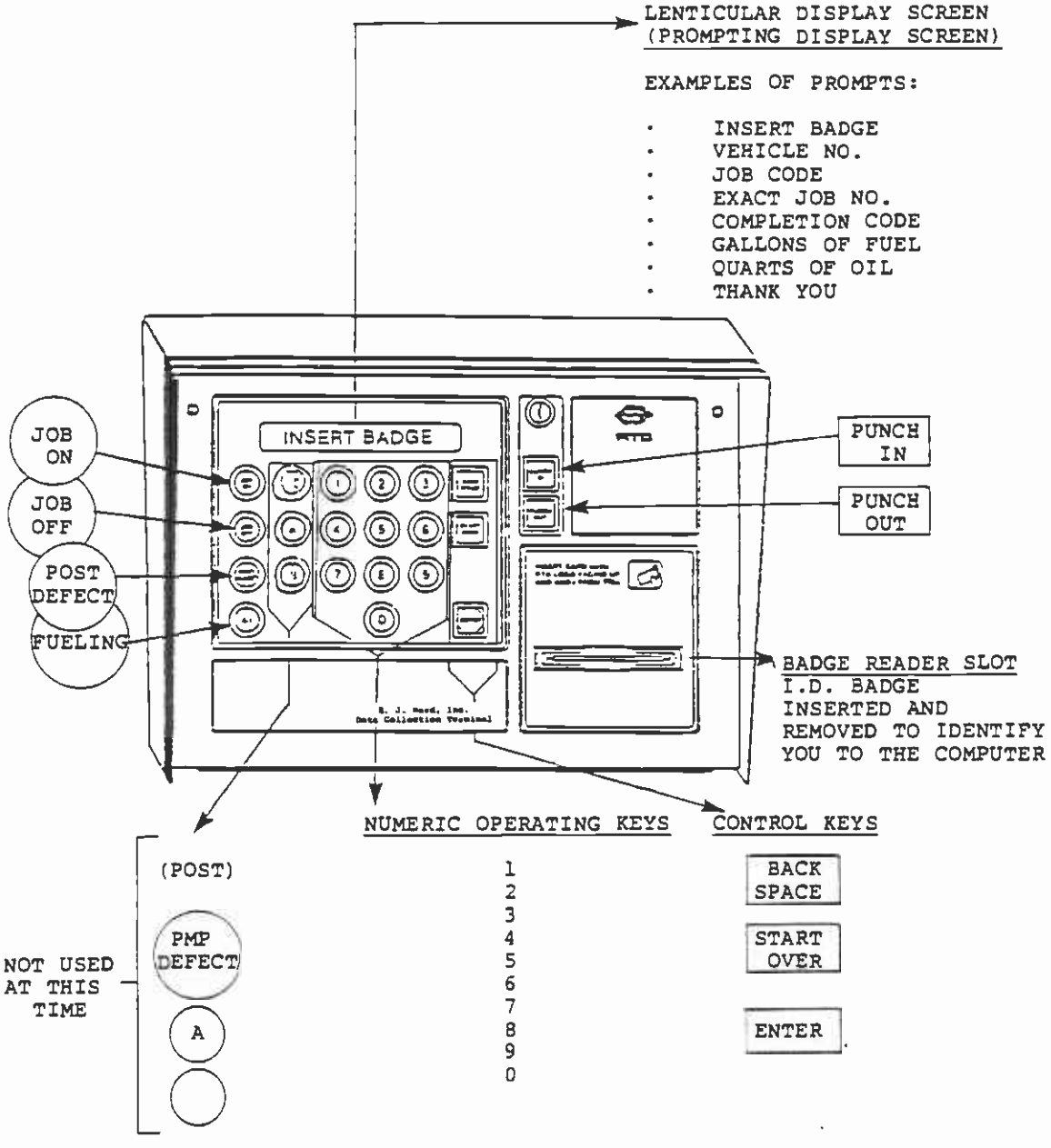
The following sections provide an overview of the use of VMS elements for:

- Timekeeping and Payroll
- Failure Documentation
- Work Scheduling
- Work Documentation.

5.2.1 Timekeeping and Payroll

Equipment Maintenance Department personnel will enter their I.D. badges into Badge Readers to clock in and out

EXHIBIT 5-2
Data Collection Terminal
(Badge Reader)



for the day. The information will be entered into VMS and will be immediately available for maintenance Supervisors to review and, if necessary revise, daily work plans based on labor availability. Through the centralized TRANSMIS link, the information will also be transferred from VMS to the Personnel/Payroll System to enable gross and net pay for employees to be calculated.

5.2.2 Failure Documentation

Vehicle failures affecting safety or service standards that occur during revenue service will be reported by the Train Operator to the Rail Control Center (RCC) by vehicle radio communication. The Train Dispatcher at the RCC will create a SCADA incident report and transmit it to the MCC. The clerk at the MCC will enter the failure data into VMS.[1] Information entered will include the I.D. badge number of the Train Operator reporting the problem, the vehicle number, a description of the problem, and such other information as the date/time, operating mode, train consist make-up, and vehicle location.

Minor defects on passenger vehicles will be reported via Defect Cards. These will be delivered by Train Operators to the Division Dispatcher at the end of the revenue service day. The Division Dispatcher will turn over the Defect Cards to a clerk at the MCC, who will enter the failure data into VMS. The information will be used to schedule corrective maintenance activities in the Main Shop building.

Failures identified by maintenance personnel during preventive or corrective maintenance activities in general will be posted via Badge Reader.

5.2.3 Work Scheduling

VMS will be used to schedule preventive maintenance (PM) activities on Metro Rail passenger vehicles and rail-borne auxiliary vehicles. Initially, recommended PM servicing and inspection schedules supplied by contractors will be loaded into VMS. As experience is gained, the

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1 A potential automated link between SCADA and VMS is under investigation. This link would automatically transfer data from SCADA to VMS, thus obviating the need to manually enter the data into VMS. The link may be implemented for the full Metro Rail system, but will not be available for MOS-1. A similar link between SCADA and FMS will also be investigated.

contractor-recommended PM schedules may be adjusted to respond to specific Metro Rail vehicle requirements. Clerks at the MCC will enter the PM data into VMS, and will generate periodic schedules (daily/weekly/monthly) to identify planned maintenance activities. The longer-term schedules will be reviewed on the basis of labor and component availability to revise and update shorter-term PM schedules. The schedules will be transmitted from the MCC to maintenance Supervisors, who will use the schedules to make daily work assignments. MCC personnel will monitor the status of task accomplishment.

VMS will similarly be used to schedule corrective maintenance activities on Metro Rail passenger vehicles and rail-borne auxiliary vehicles. Failure data entered into VMS will be used to generate schedules of corrective maintenance requirements, which will be transmitted by the MCC to maintenance Supervisors. The Supervisors will use the schedules to make daily work assignments, and MCC personnel will monitor the status of task accomplishment.

In addition to VMS, PCS will also be used as a scheduling tool by Equipment Maintenance Department supervisory personnel. PCS will be used to schedule the rebuilding or overhaul of components of passenger vehicles or rail-borne auxiliary vehicles, and will provide a means for predicting material requirements and tracking production.

5.2.4 Work Documentation

VMS will be used to document maintenance activities, both corrective (including secondary repair) activities and PM activities. Repairpersons will use Badge Readers to enter maintenance data into VMS. At the start of a maintenance task, the repairperson will "job-on" by inserting his or her I.D. badge into the Badge Reader and then entering and recording such information as the vehicle number; a work order code, if required; the nature of the repair or PM activity (job code); and failed and replacement component identification.

At periodic intervals, odometer readings will be entered into VMS. VMS as implemented for bus system maintenance accepts updates from each fuel island when buses are being serviced. Because Metro Rail passenger vehicles will not be fueled, it is anticipated that updates of the hour meters and cab odometers will be entered via computer terminal.

Upon completion of the maintenance task, the repairperson will "job off" by again inserting his or her I.D. badge into the Badge Reader and recording the work order

code, if required; job code; and a completion code. The work order code will also be used to enter a warranty number, if applicable.

For a failed part, the only other documentation that will be necessary will be a failure identification tag (either a warranty tag for a warrantable defect or a defect tag for a non-warrantable failure) to enable the failed part to be identified and segregated.

5.3 FMS USE

FMS will be used to record and update maintenance information on all non-vehicle Metro Rail system elements (e.g., fare collection equipment, automatic train control [ATC] equipment, traction power equipment). The information captured by the system will include failure data, repair activity, labor hours, and material usage. The data will be used to plan, schedule, and manage maintenance activities, and will also be used for evaluation and diagnostic purposes, including problem identification, equipment reliability assessments, and labor utilization reviews.

Data on Metro Rail equipment and facilities will be entered into FMS via computer terminals located at the M-O-W building, the CMF, and the MCC.

The following sections provide an overview of the use of FMS for:

- Timekeeping and Payroll
- Failure documentation
- Work scheduling
- Work documentation.

5.3.1 Timekeeping and Payroll

Facilities Maintenance Department personnel will use timecards to clock in and out each workday. The information on the timecards, including the employee's name, I.D. badge number, and work hours, will be entered into FMS by clerks. This information will be available to maintenance Supervisors for review of labor availability. The information will periodically be transferred by batch from FMS to the Personnel/Payroll System via the link with the SCRTD mainframe computer.

5.3.2 Failure Documentation

Failures to non-vehicle Metro Rail system elements will in general be annunciated to the Communications

Controller in the RCC.[2] The Communications Controller will generate a SCADA incident report and will transmit it to the MCC, where a clerk will enter the data into FMS.[3]

Failures identified in the field by repairpersons during corrective and preventive maintenance activities will be reported to the MCC by telephone or radio. If the failure is discovered in the shops of the M-O-W building or the CMF, the repairperson will notify his or her maintenance Supervisor, who will enter the information into FMS via computer terminal.

5.3.3 Work Scheduling

FMS will be used to schedule all preventive and certain corrective maintenance activities of the Facilities Maintenance Department.

Initially, contractor-recommended preventive maintenance schedules will be loaded into FMS; these schedules may later be revised to reflect maintenance experience with Metro Rail system elements. Clerks in the MCC will enter the data into FMS, and will generate periodic schedules of PM requirements for each system element. These schedules will be transmitted to appropriate maintenance Supervisors, who will use them to make daily work assignments.

FMS will also be used to schedule corrective actions for failures that do not require immediate response. From the failure information entered into FMS, clerks in the MCC will generate schedules of corrective maintenance requirements. These will be transmitted to maintenance Supervisors for use in making daily work assignments. MCC personnel will monitor the accomplishment of scheduled preventive and corrective maintenance tasks.

5.3.4 Work Documentation

Repairpersons within the Facilities Maintenance Department will document their maintenance activities on

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2 The position of Communications Controller will not be staffed on the MOS-1 system. For MOS-1, the Operations Supervisor will fulfill all the functions of Communications Controller.

3 See footnote 1.

daily worksheets. The information entered in the sheets will include such items as:

- Employee name
- I.D. badge number
- Work order and job order code
- Serial numbers of failed and replacement components
- Time taken to complete the maintenance task.

At the end of their shifts, repairpersons will turn in their completed worksheets to their Supervisors for review and approval. Clerks will enter the data from the worksheets into FMS.

In addition, any repairperson dispatched in response to a failure requiring immediate repair will contact the MCC upon completion of the repair. The repairperson will notify the MCC that the failure has been corrected and will provide the MCC with the same information entered on the worksheet. A clerk in the MCC will enter the data into FMS[4] and will contact the Communications Controller to confirm that the reported problem has been corrected.

The only other documentation required of repairpersons will be the tagging of failed parts with warranty tags (for warrantable failures) or defect tags (for non-warrantable failures) to enable failed parts to be identified and segregated.

5.4 REPORT REQUIREMENTS

Maintenance personnel will require a variety of reports. Many reports will be standard and will be batch-processed on a periodic basis (i.e., daily, weekly, monthly). Special reports will also be used by management and by various support staff groups (i.e., maintenance engineering). These reports reflect a one-time need and will be generated by a direct query to TRANSMIS or FMS.

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4 FMS will automatically flag duplicate reports, so that no redundant information will be captured when clerks later enter information from a repairperson's completed worksheet.

The content, format, type of information, and frequency of standard reports will be determined by management personnel. Report requirements will initially be developed by management prior to pre-revenue testing and will be finalized by revenue start-up. At a minimum, the reports will cover the following areas:

- Preventive and corrective maintenance scheduling
- Work status (i.e., open orders, work in progress, and closed orders)
- Failure histories, including the documentation and analyses of component failures for each rail car and other system elements
- Materials processing, including the status and failure history of warranted components
- Warranty processing, including the status and failure history of warranted components
- Cost accounting, including resource expenditures (e.g., labor and materials cost) associated with the maintenance of all system elements.

Because of the linkages available among TRANSMIS subsystems and between TRANSMIS and FMS, historical reports that integrate data on labor (from VMS or FMS) and material (from MMS) will be available for follow-up and analysis. Once properly initialized, VMS or FMS can track rotable components throughout their life. In addition, the link between VMS, MMS, and PCS will allow the accumulation of data on labor and material costs associated with secondary repairs to components of passenger vehicles and rail-borne auxiliary vehicles.

6.0 MAINTENANCE PROCESS

6.0 MAINTENANCE PROCESS

Chapter 6.0 describes the process whereby Metro Rail preventive and corrective maintenance activities will be managed and coordinated.

Corrective maintenance consists of those activities required to repair deficiencies caused by failures, accidents, or vandalism. The need for corrective maintenance is usually identified as a result of failures during revenue service, but may also be identified during PM. The goal of a corrective maintenance program is to have the resources ready to quickly restore inoperative equipment to a safe, properly functioning state at a reasonable cost. To assist in achieving this goal, on-line corrective maintenance will be performed by utilizing replaceable, pretested modules, components, or assemblies, wherever possible. The modular replacement technique will minimize system downtime and enable secondary repair of the failed component to take place in an optimal environment. The modular replacement approach will also enable some Metro Rail secondary repair functions to be combined with similar bus and light rail maintenance functions, including repairs to:

- Electronics equipment
- Air conditioning equipment
- Upholstery.

The Metro Rail preventive maintenance (PM) program will encompass four general types of activities:

- Inspection, which consists of a visual examination of facilities and equipment to determine if conditions exist that require a maintenance action. The frequency of inspection depends primarily on the criticality of the equipment and the probability of finding a defect. Inspections may also include simple tests to ascertain whether the equipment is performing satisfactorily.

- Servicing, which consists of regularly scheduled activities that are necessary to maintain the performance of the system and its components. These activities include lubrication and adjustment, but may also involve the replacement of

consumables such as filters. Servicing schedules are normally provided by equipment manufacturers in their maintenance manuals. Although manufacturers' recommendations will be followed during the warranty period, servicing schedules may subsequently be modified to suit the particular conditions of the Metro Rail system.

- Cleaning, which involves routine custodial and janitorial services.

- Planned Overhaul, which involves the planned rebuild, or the retrofit or modification of a system element. Planned rebuilds are performed to maintain satisfactory equipment performance. Planned retrofits and modifications are performed to improve equipment performance and/or to minimize future failures, and may be initiated by a manufacturer's service bulletin or by an SCRTD management directive based on engineering analysis of a specific problem.

The PM program is intended to identify problem areas before they require corrective maintenance. Therefore, reporting requirements must be developed for each inspection procedure to support future PM activities as well as to effectively communicate the specific need for corrective maintenance. The flow and processing of information between PM and corrective maintenance activities will be critical to the success of both programs. Records of all PM actions will be maintained in VMS or FMS.

The PM program will evolve as designs are finalized, as contractors' maintenance procedures and schedules are submitted and approved, and as maintenance records are developed during revenue service for component failure data and the cost of associated corrective maintenance needs. The objective is to achieve a balance between PM and corrective maintenance activities that minimizes the overall maintenance cost of the Metro Rail system while maintaining safety, performance, comfort, and appearance standards.

The following section provides an overview of the process whereby PM and corrective maintenance activities will be managed. A more specific description of the maintenance process is then provided for each of the major elements of the Metro Rail system:

- Passenger vehicles
- Rail-borne auxiliary vehicles
- Fare collection equipment

- Automatic train control equipment
- Communications equipment
- Power/electrification equipment
- Way and structures

6.1 OVERVIEW

Responsibility for maintaining the Metro Rail system will be shared by the SCRTD Equipment Maintenance and Facility Maintenance Departments. The Maintenance Departments will essentially have "ownership" of Metro Rail equipment and facilities, and will be responsible for ensuring the availability and readiness of the equipment and facilities to meet Metro Rail service levels and standards. The process by which the activities of these departments will be controlled and coordinated is summarized below.

6.1.1 Identifying and Assigning Maintenance Actions

Within each maintenance department, an MCC will be responsible for scheduling and coordinating the department's maintenance activities. The Vehicle MCC will be located in the Main Shop building; the Facilities MCC, in the M-O-W building.[1] Each will be staffed by clerks who will be responsible for developing maintenance schedules; receiving failure reports and dispatching personnel to provide corrective maintenance; and entering and updating maintenance information in VMS or FMS.

The MCCs will maintain information on required PM actions and intervals, and will use this information to generate weekly schedules of PM activities. These schedules, as well as checklists of designated tasks for each PM activity, will be transmitted to the appropriate maintenance Supervisor, who will use the schedules to make daily work assignments.

The MCCs will also receive all reports of in-service failures, will enter failure data into VMS or FMS, and will coordinate the corrective maintenance response. If the failure requires an immediate field response, the MCC will dispatch a maintenance crew to the site of the failure. For failures that do not require an immediate response, the failure data entered into VMS or FMS by the MCC will be used to generate schedules of corrective

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1 For MOS-1, a single MCC will be located in the M-O-W building and will support both the Equipment Maintenance and Facilities Maintenance Departments.

maintenance requirements. These schedules will be used by maintenance Supervisors in making daily work assignments, and the status of work accomplishment will be monitored by the MCCs.

The day-to-day coordination and assignment of maintenance activities must balance corrective maintenance and PM requirements within the constraints imposed by such factors as:

- The availability of resources including spare parts, consumable supplies, adequately trained personnel, machinery, tools, and shop space
- The status of work in progress
- Whether the failure is covered by warranty or a maintenance support agreement, and the notification procedures agreed upon by the SCRTD and contractor representatives
- The Metro Rail operating schedule and the availability of vehicles, equipment, and facilities to meet that schedule.

6.1.2 Conducting the Maintenance Activities

The following general steps will be followed by all maintenance personnel in completing a work assignment:

- Review the assignment and collect the tools and equipment required to do the work
- Document the repair activity in accordance with the procedures described in Chapter 5.0
- Conduct the maintenance activity in accordance with all safety requirements and all procedures specified in maintenance manuals
- Tag and properly dispose of defective parts
- Test and check-out the repair.

Whenever a maintenance crew is required to work in tunnels, on aerial structures,[2] in main-line substations, in station train control and communications (TC&C) rooms, or on certain station equipment (e.g., escalators or

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2 The MOS-1 system will not include any aerial structures.

elevators), the crew must receive authorization from the RCC before beginning work. The maintenance crew will report to the RCC by radio or telephone before entering the work area, and will report clear of the area at the conclusion of the maintenance activity.

While maintenance work is proceeding, the crew will remain in communication with the RCC as necessary to ensure crew safety; to coordinate the removal and restoration of traction power; and, during revenue service hours, to provide sufficient information on which to base decisions concerning adjustments to Metro Rail service. During revenue service hours, appropriate speed restrictions will be imposed on main-line sections occupied by maintenance personnel, and the Train Dispatcher will notify Train Operators by radio of the speed restrictions. When operating restrictions are expected to be long term due to the time required for maintenance, special bulletins will be issued to Train Operators as they report to duty at the Division Dispatcher's desk. Repairs will be made as expeditiously as possible, and the maintenance crew will inform the RCC when the crew is clear of the area.

The coordination of maintenance activity in the yard, including vehicle rerailing, wayside ATC equipment repairs, etc., will be the responsibility of the Yard Dispatcher. Maintenance crews working in the yard will report by radio to the Yard Dispatcher to receive authorization before beginning maintenance activities. While maintenance work is proceeding, the crew will remain in communication with the Yard Dispatcher regarding the removal and restoration of traction power, necessary operational restrictions in the yard, the estimated duration and extent of the problem, and so on. At the conclusion of maintenance activities, the maintenance crew will notify the Yard Dispatcher when the crew is clear of the area.

Maintenance personnel will perform their tasks in accordance with the requirements of comprehensive quality assurance programs that will be established for all system elements. Monitoring and surveillance of quality assurance program implementation will routinely be conducted, and periodic quality assurance audits will be performed. Within the Equipment Maintenance Department, quality assurance personnel within the Rail Maintenance and Central Maintenance Sections will be responsible for performing quality assurance monitoring and audits; within the Facilities Maintenance Department, maintenance Supervisors will monitor and audit the work of their personnel.

6.1.3 Close-Out and Follow-Up

Upon completing a maintenance assignment, maintenance personnel will:

- Return repaired vehicle or components. All repaired items will be returned to their proper location. For passenger vehicles, the shop Supervisor will coordinate the transfer of vehicles out of the shop into the yard with the Yard Dispatcher. Components to be repaired in the CMF or the repair shops of the Main Shop or M-O-W buildings will be processed for repair and returned to inventory. Components will be appropriately tagged for rebuild, scrap, or warranty return.

- Collect and return equipment, tools, and unused supplies. It will be the responsibility of repairpersons to return all equipment, tools, maintenance manuals, and unused parts and supplies to their proper location after conducting the assignment, unless they are needed for a subsequent task.

When it is not possible to complete all maintenance assignments, deferred tasks will be monitored and rescheduled. Generally, deferred work will remain open because the parts, technical assistance, time, or resources needed to perform the required maintenance are not available. PM activities that cannot be accomplished during an assigned shift will be rescheduled by the appropriate maintenance Supervisor. If a backlog of requirements cause PM activities to be deferred beyond the week scheduled for their accomplishment, the MCC will reschedule the deferred work. Scheduled corrective maintenance tasks that remain uncompleted at the end of a shift will be rescheduled by the appropriate maintenance Supervisor, and their status will be monitored by the MCC.

6.1.4 Engineering and Analysis

Information documenting all repair activities will be analyzed to identify improvements, develop modification programs, enhance the effectiveness of maintenance practices and procedures, and refine PM requirements. These analyses will primarily be conducted by engineering and quality assurance personnel within the Rail Maintenance Technical Support Group of the Equipment Maintenance Department, and by engineering personnel within the Facilities Maintenance Department. Within both maintenance departments, supervisory

personnel will review and assess data to identify problem trends and develop improvements.

6.2 PASSENGER VEHICLES

Personnel from the Equipment Maintenance Department will be involved in three fundamental activities:

- Vehicle plan preparation
- Preventive maintenance
- Failure reporting and corrective actions.

Practically all passenger vehicle maintenance will be performed in tne Main Shop or the storage yard. The exception will be when a train in service becomes immobile and requires that a maintenance crew travel to it to enable it to move.

6.2.1 Vehicle Plan Preparation

Prior to the start of each day, the MCC will prepare a vehicle plan that will identify the vehicles available for revenue service, and any pertinent maintenance information on the vehicles (e.g., information that would affect the placement of a vehicle within a consist); the vehicles scheduled for maintenance; and the vehicles that will remain in the yard as maintenance spares. This vehicle plan will be entered into SCADA by the MCC clerk, and will be used by the Yard Dispatcher to direct train make-up.

If there are occasions when there are insufficient trains or vehicles available to satisfy the operating schedule, the Operations Supervisor and the MCC will develop a contingency plan which may include temporarily deferring maintenance on some vehicles, using fewer vehicles in some trains, or increasing headways to reduce the total required number of trains. The contingency plan will not compromise the safety of passengers or Train Operators, but may affect either service standards or vehicle load standards.

At the end of their revenue service runs, trains will return to the yard. On the basis of the information contained in the daily vehicle plan, the Yard Dispatcher will route the trains to appropriate yard storage locations or to the Main Shop building for maintenance. Trains scheduled for washing will be routed through the car wash facility before being stored.

6.2.2 Preventive Maintenance Activities

Schedules of PM activities will be prepared by the MCC. Schedules for vehicle cleaning will be a part of the daily vehicle plan entered into SCADA. Schedules for other PM activities will be prepared on a weekly basis by the MCC and entered into VMS. The schedules will be transmitted to the Shop Supervisor, along with checklists of PM tasks. The Supervisor will use the schedules to make daily PM work assignments.

Repairpersons will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document their activities in VMS by using Badge Readers located in the Main Shop building.

Cleaning. After the trains have completed their last revenue service run of the day, they will be taken to the yard for storage and cleaning. Car cleaning crews will report to the Main Shop and use "golf carts" to proceed with their equipment and materials to the vehicles in the yard. Before entering the vehicles, the crew will place an indicating device at the end of each train to prohibit train movement. The crews will enter the cars via the side doors, with their cleaning equipment and supplies. Trash will be collected into disposable bags and placed in the adjacent roadways for pick-up and disposal. Floor coverings will be swept or vacuumed; the seats cleaned; other surfaces dusted and otherwise cleaned; insides of windows cleaned; and spots, stains, and graffiti removed. The vehicles will be inspected for broken or damaged windows, lights, seats, interior liners, etc. If the component cannot be quickly and easily repaired or replaced, the vehicle will be scheduled for corrective maintenance.

Three times each week, each train will receive an exterior washing in the automatic car wash facility. At the end of their revenue service runs, trains scheduled for exterior washing will be routed through that facility by the Yard Dispatcher. The Train Operator will enter the "wash/couple" submode, pass through the car wash facility, and then proceed to the storage location assigned by the Yard Dispatcher.

Service and Inspection. For planning purposes, the PM program for the fleet of passenger vehicles is based upon a cycle of servicing and inspection activities conducted at 5,000-mile, 10,000-mile, 30,000-mile, and 60,000-mile intervals. (Actual requirements will depend on the vehicle design and manufacturer's recommendations.) The short-interval (i.e., 5,000- and 10,000-mile) planned

activities include inspecting components for excessive wear or damage and ensuring that all fluid levels are maintained. The less frequent (i.e., 30,000- and 60,000-mile) activities are more comprehensive and require such maintenance actions as lubrication, adjustment, and verification that components operate within design specifications.

Servicing and inspection requirements per passenger vehicle are estimated as follows:

Interval (Miles)	Labor-Hours Per Inspection	Number of Inspections Per 60,000-Mile Cycle	Labor-Hours Per 60,000-Mile Cycle
5,000	10	6	60
10,000	20	4	80
30,000	30	1	30
60,000	40	1	40
		12	210

Because the servicing and inspection requirements are cumulative (that is, 10,000-mile requirements include all 5,000-mile requirements), one 60,000-mile inspection cycle will include six 5,000-mile, four 10,000-mile, one 30,000-mile, and one 60,000-mile inspection. Given annual fleet utilization in the year 2000 of 10,700,000 miles,[3] an estimated 37,400 man-hours will be expended annually on servicing and inspection of passenger vehicles. If inspections are conducted seven days per week, one six-car train must be inspected each day.[4]

Prior to each inspection the underside of each passenger vehicle will be blown down to remove dirt and grease. After each inspection, the passenger vehicle will receive a heavy interior and exterior cleaning. This activity will be accomplished by a crew of two and will take place at the heavy cleaning platforms adjacent to the Main Shop. The interior cleaning will consist of washing the floor, walls, and seats. The exterior cleaning will

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3 SCRTD Metro Rail Project, System Operating Plan, October 1986, Exhibit 3-9.

4 The MOS-1 system will have an annual fleet utilization in the year 2000 of 1,031,000 miles. At this utilization rate, an estimated 3,600 man hours per year will be required to service and inspect passenger vehicles.

include washing the front and rear ends of the vehicle and the coupling area.

Planned Overhaul. At manufacturer-specified intervals, selected components, such as gear units or traction motors, will be removed and rebuilt. The units will be removed from passenger vehicles in the Main Shop building and will be sent to the Main Shop's equipment repair shops, the CMF, or outside contractors for refurbishing. New or rebuilt units from inventory will be installed in the vehicle so it can return to service.

6.2.3 Corrective Maintenance Activities

Failure Reporting. Before a train is dispatched into revenue service, a Yard Operator will board the train and will place unused Defect Cards in the cab of each vehicle. The Yard Operator will also perform various predeparture tests of key operational components, such as brakes and doors.

If an equipment failure is identified during the predeparture tests, the Yard Operator will notify the Yard Dispatcher of the problem. If the problem will not affect safety or service levels, the Yard Dispatcher will instruct the Yard Operator to fill out a Defect Card and continue to prepare the train for departure. If the problem is more severe, the Yard Dispatcher will generate a SCADA incident report and transmit it to the MCC. The clerk will acknowledge the incident report and will enter the failure data into VMS.[5] The Yard Dispatcher will then coordinate with the Shop Supervisor to arrange for the failed vehicle(s) to be moved to the Main Shop or to a storage track to await maintenance, and will have replacement vehicles moved into place for train make-up, inspection, and positioning for departure.

Vehicle problems identified during revenue service operations will be noted by the Train Operator on a Defect Card. If the defect may affect safety or service, the Train Operator will also notify the Train Dispatcher in the RCC. The Train Dispatcher will generate a SCADA incident report and will transmit it to the MCC. The MCC clerk will acknowledge the incident report and will enter the failure data into VMS.

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5 As noted in Chapter 5.0, a potential automated link between SCADA and VMS is under investigation and may be implemented for the full Metro Rail system. A similar link between SCADA and FMS will be investigated.

The Train Operator, with the assistance of the Train Dispatcher and/or a Line Supervisor, will attempt to resolve the problem. If the problem cannot be resolved and impairs safety standards or significantly impairs service levels, the Train Dispatcher will order the train removed from revenue service.

If the train is immobile and cannot be moved from the main line, the Train Dispatcher will contact the MCC and request that a maintenance crew be dispatched to the scene. The MCC will contact the railcar shop and arrange for a crew to be dispatched to the train.

Minor vehicle equipment problems will be brought to the attention of the MCC by the Defect Cards filled out by Yard Operators and Train Operators, rather than through a SCADA incident report. After storing a train in the yard at the end of its revenue service runs, the Train Operator will walk through the train to pick up all Defect Cards. The Train Operator will deliver the Defect Cards to the Division Dispatcher and inform him of any problems on the train. The Division Dispatcher will notify the MCC of these problems and will provide the MCC with the Defect Cards. The MCC clerk will promptly enter the defect data into VMS. Defects discovered by repairpersons during preventive maintenance that require corrective action will be examined by the appropriate foreperson, the failure will be documented in VMS, and the vehicle will be scheduled for repair.

Corrective Action. In the yard, the Yard Dispatcher and Shop Supervisor will coordinate to move the failed vehicles to the Main Shop or a storage location. The Shop Supervisor will review the vehicle failure data and will prioritize maintenance activities. The daily planning and assignment of the work must balance PM and corrective maintenance activities to maximize the equipment and vehicle availability.

Repairpersons will conduct their assigned activities in accordance with all safety requirements and the procedures specified in relevant maintenance manuals. They will document all activities in VMS, using Badge Readers to "job-on" and "job-off."

After the failure has been repaired, the Shop Supervisor will coordinate the transfer of the vehicle/pair from the shop to the yard with the Yard Dispatcher. The MCC clerk will use the repair data entered in VMS to update the daily vehicle plan.

6.3 RAIL-BORNE AUXILIARY VEHICLES

6.3.1 Preventive Maintenance

The equipment within the PM program for rail-borne auxiliary vehicles includes:

- Locomotive
- Tunnel washer/vacuum[6]
- Flatcars
- Crane.

To a large degree, the frequency of PM activities on Metro Rail rail-borne auxiliary vehicles will depend on equipment usage. Heavy usage will dictate a rigorous program with lubrication, cleaning, and fluid-level checking being conducted as often as weekly. Schedules of PM activities will be prepared by the MCC and entered into VMS. These schedules will be transmitted to the Shop Supervisor, along with checklists of PM tasks. The Supervisor will use the schedules to make PM work assignments.

Repairpersons will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document their activities in VMS using Badge Readers located in the Main Shop building.

6.3.2 Corrective Maintenance

Given an effective PM program, corrective maintenance activities required for rail-borne auxiliary vehicles should be minimal. Auxiliary vehicle failures will be reported to the MCC by maintenance personnel, and the clerk in the MCC will enter the failure data into VMS. Corrective maintenance procedures for rail-borne auxiliary vehicles will be similar to those for passenger vehicles.

6.4 FARE COLLECTION EQUIPMENT

6.4.1 Preventive Maintenance

The full Metro Rail system will have an automated, barrier-type fare collection system that will include automated ticket vendors, add-fare machines, and fare gates equipped to read magnetically encoded tickets and

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6 Procurement of the tunnel washer/vacuum will be deferred for the MOS-1 system.

passes.[7] PM on fare collection equipment is vital for several reasons:

- Fare collection equipment failures can have a major impact on passenger flows and patron perception of system dependability
- The equipment is sensitive to contaminants and must be kept clean and within specific tolerances to ensure proper operation.

Weekly schedules of PM activities will be prepared by the MCC and will be transmitted to the Supervisor-Fare Collection,[8] along with checklists of PM tasks. The Supervisor will use the schedule to make daily PM work assignments to fare collection technicians.

PM on fare collection equipment will generally be conducted during off-peak revenue service hours. Fare collection technicians will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document all activities (PM and corrective maintenance actions) on their daily worksheets. Completed daily worksheets will be turned in at the end of a shift to the Supervisor for review and approval, and clerks will enter the data into FMS.

6.4.2 Corrective Maintenance

Failures of fare collection equipment will be annunciated in the RCC and the MCC through the SCADA subsystem, or they may be reported to the RCC by an employee or patron via radio, telephone, or intercom. If the problem is reported to the RCC by a patron or employee, the Communications Controller[9] will generate a SCADA incident report and will transmit it to the MCC. If the failure is annunciated via the SCADA subsystem, the MCC will directly respond to the problem. In either case, MCC personnel will use the fare

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7 The MOS-1 system will have a barrier-free fare collection system, with automated ticket vendors that dispense paper tickets.

8 On the MOS-1 system, this Supervisor will be the Supervisor-Fare Collection and Signals.

9 On the MOS-1 system, the position of Communications Controller will not be staffed, and the Operations Supervisor will fulfill all Communications Controller functions.

collection central computer to obtain diagnostic data, and will use the SCADA subsystem to remove the defective equipment from service, if necessary.[10] A clerk at the MCC will enter the failure data into FMS and will dispatch a fare collection technician to restore the equipment to a fully functional state.

Using vans, fare collection technicians will travel around the Metro Rail system during operating hours and will receive assignments via radio or telephone from the MCC. High-usage parts will be carried in the vans. The technicians will be responsive to the priorities relayed by the MCC clerk.

If it is necessary for a technician to work in the revenue-secure area of the fare-collection equipment, the repair will be made in the presence of the Transit Police. In those instances, the fare collection technician will contact the Communications Controller to notify the Watch Commander of the need to arrange for a Transit Police Officer to be present. If the repair requires that revenue-containing equipment be changed, the Transit Police Officer and technician will transport the defective unit to the central cash-counting facility in the technician's van.

After the repair has been completed, the fare collection technician will notify the MCC. The MCC clerk will contact the Communications Controller to confirm that the problem has been resolved, and will enter appropriate repair data into FMS. The MCC clerk will send the fare collection technician to his next assignment. Defective parts will be tagged and loaded on the van and will be returned to the M-O-W building for failure analysis and disposition.

6.5 AUTOMATIC TRAIN CONTROL EQUIPMENT

6.5.1 Preventive Maintenance

ATC equipment will be located along the main line, in TC&C rooms, on passenger vehicles, and in the yard. The equipment includes:

- AC and DC power supplies
- Batteries

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10 On the MOS-1 system, MCC personnel will use the fare collection microcomputer to ascertain the status of defective ticket vending machines.

- Control panels in TC&C rooms
- Track circuits
- Interlockings
- Wayside equipment, such as junction boxes, receivers, coils, signals, signs, and switch plates.

Weekly schedules of PM activities will be prepared by the MCC and will be transmitted to the Supervisor-Signals,[11] along with checklists of PM tasks. The Supervisor will use the schedule to make daily PM work assignments to signal technicians.

PM activities will usually be performed during non-revenue service hours to maximize the safety of maintenance crews and minimize service disruptions. Signal technicians will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document all activities (PM and corrective maintenance actions) on their daily worksheets. Completed worksheets will be turned in to the Supervisor for review and approval, and clerks will enter the data into FMS.

6.5.2 Corrective Maintenance

ATC equipment failure alarms will be annunciated at the RCC or the Yard Tower. The Train Dispatcher or the Yard Dispatcher will generate an incident report on SCADA and transmit it to the MCC. The MCC clerk will acknowledge the incident report; will enter the failure data into FMS; and will dispatch ATC technicians, stationed at the M-O-W building, to the scene of the problem.

ATC technicians will carry high-usage parts in their vans. Defective parts will be tagged and returned to the M-O-W building for failure analysis and disposition.

After the repair has been completed, the ATC technicians will notify the MCC. The MCC clerk will contact the Train Dispatcher or Yard Dispatcher to confirm that the problem has been resolved, and will enter appropriate repair data into FMS.

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11 On the MOS-1 system, this Supervisor will be the Supervisor-Fare Collection and Signals.

6.6 COMMUNICATIONS EQUIPMENT

6.6.1 Preventive Maintenance

Communications equipment can be segregated into ten major subsystems:

- Power
- Radio
- Telephone/EPABX
- Public Address
- Closed-Circuit Television (CCTV)
- Cable Transmission
- SCADA
- Fire and Emergency Management
- Gas Monitoring and Seismic Activity Detection
- Rail Control Center Equipment.

Weekly schedules of PM activities will be prepared by the MCC and will be transmitted to the Supervisor-Communications, along with checklists of PM tasks. The Supervisor will use the schedule to make daily PM work assignments to communications technicians.

PM on communications equipment is expected to be minimal and will be accomplished during off-peak and non-revenue service hours. Communications technicians will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document all activities (PM as well as corrective maintenance actions) on their daily worksheets. Completed worksheets will be reviewed and approved by the Supervisor, and clerks will enter the data into FMS.

6.6.2 Corrective Maintenance

Failures to most communications equipment will be annunciated in the RCC, or may be reported by Metro Rail employees to the Communications Controller via radio, telephone, or intercom. The Communications Controller will generate a SCADA incident report and transmit it to the MCC. The MCC clerk will acknowledge the incident report; will enter the failure data into FMS; and will dispatch communications technicians, stationed at the CMF, to the scene of the problem.

The communications technicians will carry high-usage parts in their vans. Defective parts will be tagged and returned by van to the CMF for failure analysis and disposition.

After the repair has been completed, the communications technicians will notify the MCC. The MCC clerk will contact the Communications Controller to confirm that the problem has been resolved, and will enter appropriate repair data into FMS.

6.7 POWER/ELECTRIFICATION EQUIPMENT

6.7.1 Preventive Maintenance

The power/electrification equipment includes traction power, auxiliary power, and emergency power, and is designed with backup and redundant elements. The power/electrification equipment includes:

- Power substations
- Transformers
- Rectifiers
- Battery and charger systems
- Uninterruptible power system
- Emergency trip stations.

Weekly schedules of PM activities will be prepared by the MCC and will be transmitted to the Supervisor-Power, along with checklists of PM tasks. The Supervisor will use the schedule to make daily PM work assignments to power technicians.

Most PM activities on power/electrification equipment will be conducted during non-revenue hours. Power technicians will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document all activities (PM and corrective maintenance actions) on their daily worksheets. Completed worksheets will be turned in to the Supervisor for review and approval, and clerks will enter the data into FMS.

6.7.2 Corrective Maintenance

Failures of traction power equipment will be annunciated in the RCC or the Yard Tower via the SCADA subsystem. The Train Dispatcher or Yard Dispatcher will generate an incident report on SCADA and will transmit it to the MCC. The MCC clerk will acknowledge the incident report; will enter the data into FMS; and will dispatch power technicians, stationed at the M-O-W building, to the scene of the problem.

The power technicians will carry high-usage parts in their vans. Large parts will be stored in the M-O-W building. Defective parts will be tagged and returned to the M-O-W building for failure analysis and disposition.

After the repair has been completed, the power technicians will notify the MCC. The MCC clerk will contact the Train Dispatcher or Yard Dispatcher to confirm that the problem has been resolved, and will enter appropriate repair data into FMS.

6.8 WAY AND STRUCTURES

6.8.1 Preventive Maintenance

Metro Rail way and structures include:

- Running and power rails
- Tunnels and tunnel equipment
- Buildings and grounds
- Shop equipment.

Weekly schedules of PM activities will be prepared by the MCC and will be transmitted to the relevant M-O-W Supervisor, along with checklists of PM tasks. The Supervisor will use the schedule to make daily PM work assignments to work crews and technicians.

Work crews and technicians will accomplish assigned PM activities in accordance with the checklists of task requirements, and will document their activities on their daily worksheets. Completed worksheets will be turned in to the appropriate Supervisor for review and approval. Clerks will enter the data into FMS.

PM activities will include a walking inspection of the trackbed, running rail, and contact rail. For safety and security reasons, the inspection will be conducted by two crews of two people during non-revenue hours. The crews will complete 6 or 8 miles of tunnel inspection each night, with the entire 40 miles of Metro Rail trackway being inspected in 7 days.[12] Included within this allotment is the time to conduct inspection and simple servicing and cleaning actions. Vans will be used to transport crews to the starting and from the end points.

Servicing and inspection of tunnel equipment, hardware and emergency systems will occur on a monthly basis. This work will include cleaning operational graphics; replacing burned-out light bulbs; and inspecting tunnel liners, standpipes, and the availability of emergency equipment.

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12 On the MOS-1 system, the walking inspection of the trackway will be accomplished in one night, and will take place once a week.

In addition, ventilating equipment, sump pumps, and fire detection and suppression systems will be periodically serviced and inspected, and tunnels will be periodically washed.[13]

Routine cleaning of stations and all cleaning at other rail facilities will be performed during daytime shifts by several crews of SCRTD moppers/waxers.[14] These crews will report in to the M-O-W building and will be taken to their assigned stations or facilities by van.

Routine cleaning at stations will be performed each day and will include sweeping of stairs, sweeping/mopping of floors, light cleaning, replenishment of washroom supplies, replacement of burned-out light bulbs, and removal of accumulated trash and debris. Periodically, stations will receive a heavy cleaning, which will be performed by contract personnel. Heavy cleaning of stations will include such tasks as removal of graffiti; polishing of stainless steel, chrome, and glass; cleaning of operational graphics; and thorough cleaning of floors and stairs.

Routine and heavy cleaning at other rail facilities will be performed by SCRTD moppers/waxers. These facilities include the RCC; MCC; and offices within the Main Shop building, M-O-W building, and CMF. Routine cleaning will be performed on a daily basis, and will include such tasks as sweeping, mopping, or vacuuming floors; dusting surfaces; cleaning washrooms; and removing accumulated trash. Periodically, the facilities will receive a more thorough cleaning, which will include such tasks as shampooing carpets and stripping and waxing floors.

On a monthly basis, escalators, elevators, doors, ventilation and emergency and facilities equipment, etc., will be inspected and serviced.[15] PM activities at stations will generally be scheduled for off-peak revenue service hours.

Maintenance of grounds and parking lots will be performed during the day by a several crews. These crews

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13 On the MOS-1 system, tunnel washing will be limited to the washing of third-rail insulators.

14 On the MOS-1 system, all station cleaning will be performed by contract personnel; SCRTD moppers/waxers will be responsible for cleaning other SCRTD facilities.

15 Inspection and servicing of escalators and elevators will be performed by contract personnel.

will report in at the M-O-W building and will be transported to their assigned locations by van. Trash will be removed from grounds and parking lots twice a week. Landscaping will be performed on an as-required basis by contract personnel.

PM on shop equipment will be performed on a monthly basis. The equipment includes turntables, hoists, cranes, and shop equipment. In addition, the car wash and blowdown facilities will be cleaned and inspected once a month.

6.8.2 Corrective Maintenance

Few failures are expected with the structural elements of stations, tunnels, and other facilities. However, many of the electrical, pneumatic, and mechanical systems within facilities will require corrective maintenance.

Failures of critical equipment, such as fans, dampers, escalators, elevators, fire detection and suppression systems, and sump pumps will be annunciated at the RCC. When a failure is annunciated, the Communications Controller will generate an incident report on SCADA and will transmit it to the MCC. The MCC clerk will acknowledge the incident report and will dispatch appropriate technicians (including contract maintenance personnel) from the M-O-W building to the scene of the problem.

Less critical failures, such as plumbing defects and minor electrical problems, will not be annunciated at the RCC. When such failures are identified by operations personnel, the failures will be reported to the Communications Controller (or, if appropriate, the Yard Dispatcher) via radio or telephone. Many of these minor problems will be uncovered by maintenance personnel during the conduct of preventive maintenance and/or periodic inspections. In such a case, the maintenance Supervisor will report the problem to the MCC, where the clerk will enter the failure data into FMS and schedule the equipment for repair.

Parts for way and structures maintenance will be stored at the M-O-W building and will be transported in vans to the station or facility needing repairs. Large or bulky items, such as replacement rails, will be transported to the system using the locomotive and flat car.

Where maintenance requires that emergency systems (fans, dampers, fire detection or suppression systems) be shut down during revenue operations, special procedures will be implemented to ensure that safety is not compromised.

Once the repair has been completed, the technicians will telephone or radio the MCC. The MCC clerk will contact the Communications Controller or the Yard Dispatcher to ensure the problem has been resolved, and will enter the appropriate data into FMS.

7.0 MATERIALS MANAGEMENT

7.0 MATERIALS MANAGEMENT

Chapter 7.0 describes the plans for managing the distribution, procurement, and storage of material which is purchased for maintaining the Metro Rail system.

The SCRTD materials management function is presently organized under the Director of the Office of Contracts, Procurement and Materiel (OCPM), who reports to the Assistant General Manager for Management. OCPM performs all functions and tasks associated with the centralized management and inventory control of SCRTD assets, material, and parts. To support the Metro Rail system, that organization will be expanded to include responsibility for the procurement, management, and storage of material for the rail system.

7.1 OBJECTIVES

Metro Rail materials management has three fundamental objectives:

- To provide effective support to maintenance functions by ensuring that parts are available when and where they are needed
- To manage the investment in inventory at a level consistent with demand and associated carrying costs
- To track inventory and minimize the loss of material from theft or other causes.

To avoid maintaining a large inventory, such factors as failure rates, inventory draw-down rates, and lease times for replenishment will be analyzed to determine spare parts requirements for the Metro Rail system. Because inventory usage depends on conditions which are unique to Metro Rail (vehicle mileage, failure rates, etc.), VMS and FMS will be used to collect and analyze failure and repair data to assist in predicting material requirements. The initial warranty period on new equipment is expected to provide sufficient data to allow this analysis and prediction process to be started.

7.2 MATERIALS MANAGEMENT PROCESS

The materials management process, shown in Exhibit 7-1, involves five activities in support of maintenance actions. The activities are:

- Material Requirements Planning
- Purchasing
- Receiving
- Inspection
- Stores.

Material Requirements Planning is the heart of the materials management process. The Material Management System (MMS) will maintain up-to-date files on all materials in Metro Rail stores. The prevailing level of inventory, procurement commitments, and lead times will systematically be analyzed against future material requirements. If shortages are probable, MMS will identify the need to purchase new material and will specify the appropriate quantities and delivery dates.

In addition, the automated link between PCS and MMS will enable OCPM personnel to track the rebuilding of passenger vehicle rotable components, and the subsequent return of the rebuilt components to inventory. This capability will assist OCPM in maintaining appropriate levels of inventory.

SCRTD management is expected to retain control over the general level of inventory through policy decisions which balance such issues as:

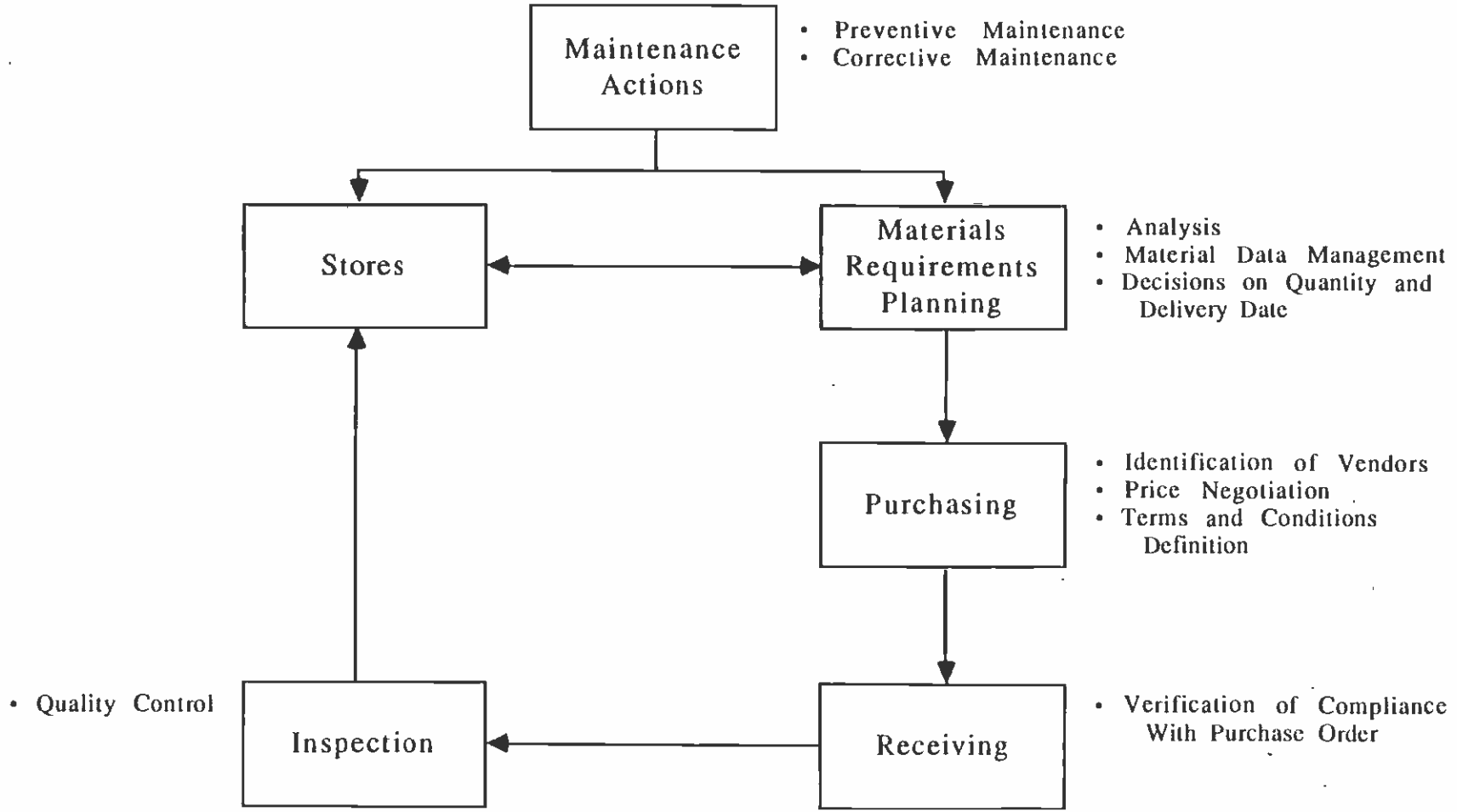
- The allowable probability for having equipment out of service because of parts shortages
- The carrying cost of the inventory.

Cognizant materials managers will be expected to monitor material consumption and deliveries to ensure that the MMS is using up-to-date information.

Purchasing personnel will receive requests to procure new material, identify potential vendors, determine or negotiate the price of the material, and prepare a purchase order which includes the appropriate terms and conditions.

Purchasing personnel will maintain a vendor file of all approved vendors for each item required by the Metro Rail system. These vendor files will contain records of previous procurements, quality or delivery problems, prices, and, where appropriate, labor agreement information.

EXHIBIT 7-1
Materials Management Process



Receiving and Inspection will be performed at the appropriate storerooms. Before being formally accepted, all shipments will be inspected for compliance with the purchase order and for defects before being placed into storage. Maintenance personnel will assist OCPM personnel in conducting these inspections.

Stores of Metro Rail parts and material will primarily be located in three facilities:

- Main Shop building
- M-O-W building
- Central Maintenance Facility.

Generally, each storeroom will be a secure area with access restricted to stores personnel. Some large material, such as rails, will be stored in a secure outside area adjacent to the M-O-W building. In addition, material which is required for cleaning stations and other facilities will be stored in those locations.

All stores will be managed by OCPM personnel, who will use the capabilities of MMS to document each withdrawal of material from inventory. When a repairperson requires a spare part from the SCRTD inventory, storeroom personnel will enter the appropriate information into the MMS. Information entered will include:

- The badge number of the repairperson requesting the part
- The quantity and part number of the material
- The date and time of withdrawal
- The equipment on which the material will be used.

Through automated MMS capabilities, OCPM will be aware that a spare part has been consumed and a replacement spare part is required. Similarly, through the automated interface with PCS, OCPM will be aware that a passenger vehicle component has been rebuilt and the rotable component has been returned to inventory.

8.0 MAINTENANCE MANUALS AND TRAINING PROGRAMS

8.0 MAINTENANCE MANUALS AND TRAINING PROGRAMS

Chapter 8.0 describes the requirements that have been established for the maintenance manuals and training programs that will support Metro Rail maintenance program activities. The manual and training requirements have been incorporated into equipment contract specifications.

8.1 MAINTENANCE MANUALS

Maintenance manuals will serve as an integral part of the Metro Rail maintenance program. They will document all information necessary for the effective and proper conduct of preventive and corrective maintenance for all system elements. Manuals will be used for three purposes:

- As training documents for new and existing personnel on the proper method of servicing and repairing a system element
- As reference documents for maintenance personnel throughout the maintenance process
- As reference documents for identifying parts and components.

To ensure consistency in the general format of manuals and thereby enhance their utility to maintenance personnel, publication requirements have been established. These specify text size and format, illustration, referencing, and binding requirements. These requirements, along with requirements on the content and types of manuals to be supplied by contractors, have been incorporated into equipment contract specifications.

8.1.1 General Content Requirements

Maintenance manuals provided by contractors for each system element will contain:

- Safety warnings and emergency procedures. All safety precautions, warnings, and emergency procedures for the equipment will be included or cross-referenced in the introduction to each manual.

- A description of the operating theory and functions for the system element. The manual will provide a general non-technical description of the system element and its components. Information covering operational characteristics and performance specifications will be provided. A detailed technical description of system element operation will be provided to identify the location of system components and how they interface. The description will be supported by diagrams and illustrations depicting the relationship of components.

- The information required to perform scheduled preventive maintenance, including inspections, lubrication, running maintenance and adjustment, and troubleshooting. Preventive maintenance procedures, intervals, and tables outlining servicing requirements will be included in the manual, along with maintenance standards including relevant limits, settings, tolerances, and the criticality of tolerances. Appropriate test evaluation procedures will also be included.

- The information required to perform fault isolation and corrective repair, including the removal, replacement, repair, overhaul, and installation of all assemblies and components. Charts and tables listing symptoms and probable causes of improper performance or failure and suggested remedies will be included in the manuals. The manuals will outline the proper method for conducting corrective repairs, including step-by-step procedures for removal and installation of subassemblies and components, as well as step-by-step procedures for removal and installation of parts in subassemblies and components. The manuals will contain detailed parts listings, including:

  - Reference to a figure number

  - A part description, including manufacturer's and vendor's part number

  - Space to allow insertion of the SCRTD's stock number.

8.1.2 Types of Required Manuals

Each manual for a given system element will consist of several volumes, including a running maintenance and

service manual, a heavy repair manual, a spare parts catalog, diagnostic and test equipment (DTE) and special tool manuals, and software documentation for microprocessor products. The manuals will be organized by subsystems (e.g., vehicle subsystems include propulsion, friction brakes, doors, car body, etc.). Maintenance requirements for each subsystem, or for selected subsystems, may be contained in a separate volume.

Running maintenance and service manuals will provide information needed for troubleshooting in-service failures and for performing running maintenance, including general servicing, lubricating, inspecting, and adjusting. The manuals will expand on information furnished in operator instruction manuals, and will include basic schematic and block diagrams to provide fault diagnosis information appropriate for in-service maintenance.

Heavy repair manuals will provide information needed for in-shop repair and trouble diagnosis. The manuals will contain detailed flow charts, exploded parts diagrams and schematic drawings, and detailed analyses related to each lowest line replaceable unit (LLRU) so that SCRTD maintenance personnel are able to effectively service, inspect, maintain, adjust, troubleshoot, repair, replace, and overhaul the LLRU.

Spare parts catalogs will be indexed by subsystem. Each subsystem assembly, LLRU, and part will be referenced by assigned part number and, where applicable, original manufacturer's part number. Equivalent parts available from other manufacturers will be identified.

DTE and special tool manuals will provide application, operation, usage, adjustment, inspection, maintenance, troubleshooting, repair, storage instructions, and spare parts information.

Software manuals for microprocessor-based products will provide a complete set of the configured documentation developed during design and modified thereafter. The design documentation will include pseudo code, system-level flow charts, data flow diagrams, and a data dictionary. In addition, the manuals will contain:

- A listing of fully configured source code and module flow diagrams
- A description of interrupt sequences and other protocols

- A listing of machine code indicating location in the microprocessor memory hardware
- Memory maps and input-output maps
- Documentation of automated design tools, including in-circuit emulators, required to modify, compile, assemble, test, and evaluate the software. Software used in developing the microprocessor software will be furnished, and details of development hardware will be provided.

History books will be provided by contractors for certain equipment (e.g., communications equipment and passenger vehicles). Each history book will include the following:

- Description of all modifications and dates of incorporation
- List of identified defects and disposition of each
- List of serially numbered apparatus
- Summary of each test performed on the equipment or its components
- List of repairs
- Provision for recording malfunctions, inspections, servicing, and major overhauls.

8.2 TRAINING PROGRAMS

Training programs for maintenance personnel will be prepared both by contractors and by SCRTD training staff. The training programs will cover the major areas of rail maintenance: facilities, electronics and communications, systems, and passenger vehicles. A wide range of courses will be provided pertaining to each area, with the courses varying in scope, length, and method of instruction. The courses are intended to provide technical training to enable maintenance personnel to perform their maintenance responsibilities in a safe and effective manner.

8.2.1 Training Courses

Training courses will consist of classroom instruction, practical training, self-programmed study, and on-the-job training. Tests will be part of each course and will range

from written examinations to demonstrations of equipment troubleshooting and correct equipment usage.

Classroom training will consist of lectures to explain theories and to review specifications, manuals, operating rules, and procedures. Audiovisual equipment will be used as necessary to augment the lectures.

Practical training will consist of hands-on experience with models, mock-ups, equipment, and tools; demonstrations; and operation of equipment under close supervision by instructors and/or supervisors. The application of classroom learning to practical training will be stressed throughout the courses.

Self-instruction will take place without the routine assistance of an instructor and will consist of study from books and manuals, reviews, quizzes, and programmed learning with personal computers. Instructors will guide students through the courses and keep track of progress by administering tests at the completion of major units.

At this point in the development of the Metro Rail system, only the concepts and general guidelines for maintenance training have been established. Exhibit 8-1 is a preliminary list of the types of courses expected to be provided to maintenance personnel.

8.2.2 Contractor-Supplied Training

Contractors will be required to train and teach SCRTD instructors and supervisory personnel in the operation and maintenance of their systems, so that SCRTD personnel in turn may train and manage operating and maintenance personnel in the safe and satisfactory operation, servicing, and maintenance of the systems. SCRTD personnel to be trained will have the basic skills pertinent to their crafts but will not necessarily be knowledgeable of their system's specific features. The contractor-supplied training program will consist of classroom, shop, and field instruction. Safety, operation, service, maintenance, and repair will be covered from the overall system level through LLRU levels.

The training program will include formal and informal instruction and the use of equipment mock-ups, models, manuals, drawings, transparencies, catalogs, and such other training aids as may be necessary. Models, mock-ups, drawings, and the like will be of durable construction and will be turned over to the SCRTD at the completion of the contract.

EXHIBIT 8-1
Training Courses - Maintenance Personnel

COURSE AND SAMPLE CONTENT

1. GENERAL SAFETY RULES

- Operations Safety
- Maintenance Safety-CAL/OSHA Requirements
- Emergency Response Procedures
- Accident/Incident Reporting

2. OPERATING RULES

- Schedules
- RCC Familiarization Tour
- Vehicle Operation Basics
- Yard Operations
- Main-Line Operations
- Signals
- Flagging

3. MAINTENANCE MANAGEMENT PROCEDURES

- SCRTD Maintenance Policies
- Maintenance Control Center Practices
- Documentation Requirements/Use of TRANSMIS, FMS
- Maintenance/QA Bulletins
- Equipment History Books
- Contractor Interface Procedures
- Configuration Control and Tagging Procedures
- Storeroom Issues
- Quality Assurance Practices
- Reference Materials/Maintenance Manuals/Library Use
- Certification and Promotion

4. MAINTENANCE COMMUNICATION PROCEDURES

- Communication System Overview
- Radio Familiarization
- Maintenance Telephone Familiarization
- Rules and Procedures
- Battery Charging

EXHIBIT 8-1 (Continued)
Training Courses - Maintenance Personnel

COURSE AND SAMPLE CONTENT

5. PASSENGER VEHICLES

- Safety Rules and Emergency Procedures
- Stinger Use
- General Vehicle Description
- Theory of Operation
- Preventive Maintenance Program
- Troubleshooting
- Carbody
- Cab Controls and Indications
- Doors
- Trucks, Wheels, Axles
- Couplers and Draft Gear
- Power Supply
- Traction Motors, Resistors
- Gear Units
- Control Circuits
- Friction Brakes
- Vehicle ATC Equipment
- Communications
- HVAC
- Test Equipment and Procedures
- Software Modification

6. AUTOMATIC TRAIN CONTROL EQUIPMENT

- Safety Rules and Emergency Procedures
- General System Overview
- Theory of Operation
- Preventive Maintenance Program
- Troubleshooting
- RCC Equipment
- ATC Room Equipment
- Track Circuits
- Interlockings
- Main-Line Wayside Equipment
- Vehicle ATC Equipment
- Yard Equipment
- Test Equipment and Procedures
- Software Modification

EXHIBIT 8-1 (Continued)
Training Courses - Maintenance Personnel

COURSE AND SAMPLE CONTENT

7. COMMUNICATIONS EQUIPMENT

- Safety Rules and Emergency Procedures
- General System Overview
- Theory of Operation
- RCC Equipment
- Preventive Maintenance Program
- Troubleshooting
- Test Equipment and Procedures
- Software Modification
- Radios
- Telephones
- Public Address System
- Closed-Circuit Television
- Cable Transmission
- SCADA
- Fire and Emergency Management
- Gas Monitors
- Seismic Detectors

8. FARE COLLECTION EQUIPMENT*

- Safety Rules and Emergency Procedures
- General System Overview
- Theory of Operation
- Preventive Maintenance Procedures
- Troubleshooting
- Ticket Vending Machines
- Gate Equipment*
- Add Fare Machines*
- Passenger Assistance Center*
- Station Fare Collection Control Unit*
- Ticket Encoding Equipment*
- Test Equipment and Procedures
- Software Modification

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* Not included in training courses for the MOS-1 system's barrier-free collection system.

EXHIBIT 8-1 (Continued)
Training Courses - Maintenance Personnel

COURSE AND SAMPLE CONTENT

9. TRACTION POWER EQUIPMENT

- Safety Rules and Emergency Procedures
- General System Overview
- Theory of Operation
- RCC and Yard Tower Equipment
- Preventive Maintenance Program
- Troubleshooting
- Substation Equipment
- Uninterruptible Power Supply
- Batteries
- Test Equipment and Procedures

10. ELECTRICAL EQUIPMENT

- Safety Rules and Emergency Procedures
- General System Overview
- HVAC and Emergency Fans
- Lighting

11. TRACKWAY MAINTENANCE

- Safety Rules and Emergency Procedures
- General System Overview
- Switches and Frogs
- Rails, Ties, and Ballast
- Third Rail and Coverboard
- Corrosion Control
- Tunnel Lining
- Standpipes
- Fire Suppression Equipment
- Pumps and Ejectors

12. CUSTODIAL CONCEPTS

- Restroom Cleanliness
- Stations
- Chemical Care
- Power Tool Use
- Parking Lots
- Graphics/Signage

EXHIBIT 8-1 (Continued)
Training Courses - Maintenance Personnel

COURSE AND SAMPLE CONTENT

13. LOCOMOTIVE AND FLAT-CAR

- Safety Rules and Emergency Procedures
- General Vehicle Description
- Work Train Operation
- Preventive Maintenance Program
- Troubleshooting
- Pre-Operational/Safety Checks
- Brake System
- Couplers
- Towing/Pushing Trains

14. SPECIAL EQUIPMENT

- Safety Rules and Emergency Procedures
- Pre-Operational/Safety Checks
- Hi-Rail Vehicle
- Tunnel Washer/Vacuum*
- Crane
- Rerailing
- Miscellaneous Tools

15. FUNDAMENTALS OF ELECTRICITY

16. ELECTROMAGNETIC INTERFERENCE

17. MICROPROCESSOR PRODUCTS

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* Not included in training courses for the MOS-1 system.

The SCRTD's instructors and supervisory staff will be exposed to the depth of detail that is necessary for the performance of preventive and corrective maintenance operations for all components.

Contractors will be required to submit training plans that include the following information:

- A narrative description of the objectives, scope, and depth of the training program
- A brief statement of the experience of the department having prime responsibility for preparation and implementation of the program, including qualifications of the assigned personnel
- A description of the training courses to be conducted, including:
  - Curriculum outline and courses
  - Lesson plan outline identifying the proposed lesson by a descriptive title and indicating the main content
  - Estimated time for presenting the material for each course
  - List of training aids indicating which aids are to be furnished by the SCRTD
  - Description of facility requirements and estimated time of use
  - If approved, description of contractor facilities, location, estimated time of use, and other logistical considerations.

The training plans will be sufficiently detailed to be used for subsequent training conducted by the SCRTD.