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SCRTD METRO RAIL PROJECT

Preliminary Engineering

PRELIMINARY MAINTENANCE PLAN

WBS 14DAG

Prepared by

Booz, Allen & Hamilton Inc.

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CHAPTER 1

INTRODUCTION

The Preliminary Maintenance Plan (PMP) for the initial Southern California Rapid Transit District (SCRTD) Metro Rail System addresses the program requirements for developing adequate capability to maintain the facilities and equipment that will form the Metro Rail System. It is the initial step in maintenance program development and provides the structure and guidelines for maintenance program development efforts to be accomplished in later stages of the Metro Rail Project.

1.1 OBJECTIVES

The objectives of the PMP are to:

- Introduce and describe the four phases of the maintenance planning process.
- Define a top level sequence of maintenance program development activities and provide a general description of such activities.
- Describe functional maintenance categories and the types of maintenance work performed.
- Provide the conceptual framework within which task level maintenance activities such as servicing, repair, modification, overhaul and inspection can be defined and developed.

1.2 SCOPE

The PMP is the first step in the development of a maintenance organization capable of supporting the entire spectrum of facilities and equipment which will form the Metro Rail System. The PMP describes general requirements for maintenance program planning activities which will begin during Preliminary Engineering and continue through revenue service operations.

1.3 ORGANIZATION

The PMP consists of six chapters. Chapters One and Two are the Introduction and System Description, respectively. Chapter Three summarizes the maintenance program development process and presents a top level maintenance planning sequence which begins with this PMP and continues through increasing levels of detail until the beginning of revenue service. Chapter Four addresses maintenance program concept development. It describes several specific planning issues which must be resolved in order to describe the conceptual maintenance program framework. Chapter Five introduces the requirement for integrated support element plans and describes maintenance organizational activities along with a brief description of the types of work performed in each activity. Chapter Six summarizes maintenance program definition and implementation activities.

2. SYSTEM DESCRIPTION

2.1 History

The California State Legislature created the Southern California Rapid Transit District (SCRTD) in 1964 with a legislative mandate to design, construct and operate a rapid transit system within the Los Angeles County area. The success of such a mandate is largely dependent upon the availability of funds. On three occasions, SCRTD attempted to obtain county-wide voter approval of rapid transit funding through increases in local sales taxes. Finally, in June 1974, Proposition 5 was passed by a solid majority, allowing the use of a portion of state gasoline taxes for rapid transit development. This measure provided a local source of funds for SCRTD to begin its rail rapid transit development program in Los Angeles.

SCRTD also received federal funding in 1974 to evaluate 16 transit corridors in the metropolitan area. A Rapid Transit Advisory Committee (RTAC), composed of representatives of local and state agencies, guided this effort. This analysis identified a rapid transit corridor which justified further evaluation.

Based on the results of the RTAC study, a Regional Transit Development Program was adopted by state and local jurisdictions. In September 1976, representatives of the City of Los Angeles, Caltrans, the Southern California Association of Governments, the County of Los Angeles, and the SCRTD applied to the Urban Mass Transportation Administration (UMTA) for assistance in financing the Regional Transportation Development Program. Designed to identify transportation problems in the Los Angeles area, this four-part program covered, among other freeway transit projects, a proposed Downtown People Mover system, and an evaluation of alternative transit solutions for the Regional Core, the approximately 55-square-mile portion of the metropolitan center of Los Angeles.

The program was subsequently endorsed by the newly established Los Angeles County Transportation Commission in 1977.

Having received UMTA and Proposition 5 funds to evaluate transit corridors in 1977, the SCRTD began an in-depth analysis of eleven alternatives -- ten rail/bus combinations and a "status quo" alternative.

Concurrently, a comprehensive environmental impact analysis was conducted to examine the efforts of each of the alternatives on the affected communities. In September 1979, the District Board of Directors selected its "preferred alternative" -- an 18-mile rail rapid transit line extending from the Central Business District through the Wilshire Boulevard area to Fairfax Avenue, and northerly through Hollywood to North Hollywood.

The results of this analytical work were published in the Final Alternatives Analysis/Environmental Impact Statement/Report and submitted to UMTA for evaluation in April 1980. Two months later, the SCRTD was allocated $12 million from UMTA and $3 million from local sources to begin the first phase of the 10-year project -- preliminary engineering. This phase includes additional environmental analysis and the basic work leading to final design and construction.

2.2 Physical Plant

The initial Metro Rail line will be a conventional two-track, steel wheel, steel rail system. It will be approximately 18 miles long consisting of underground trainway; it will serve the central business district, Wilshire Boulevard and the Hollywood and North Hollywood areas. Sixteen stations are presently planned with the distance between stations ranging from 0.5 miles in the downtown area to 2.7 miles through the Santa Monica mountains. A map of the proposed system is shown in Exhibit 2-1. A seventeenth station at the intersection of Crenshaw Boulevard and Wilshire Boulevard is under consideration.

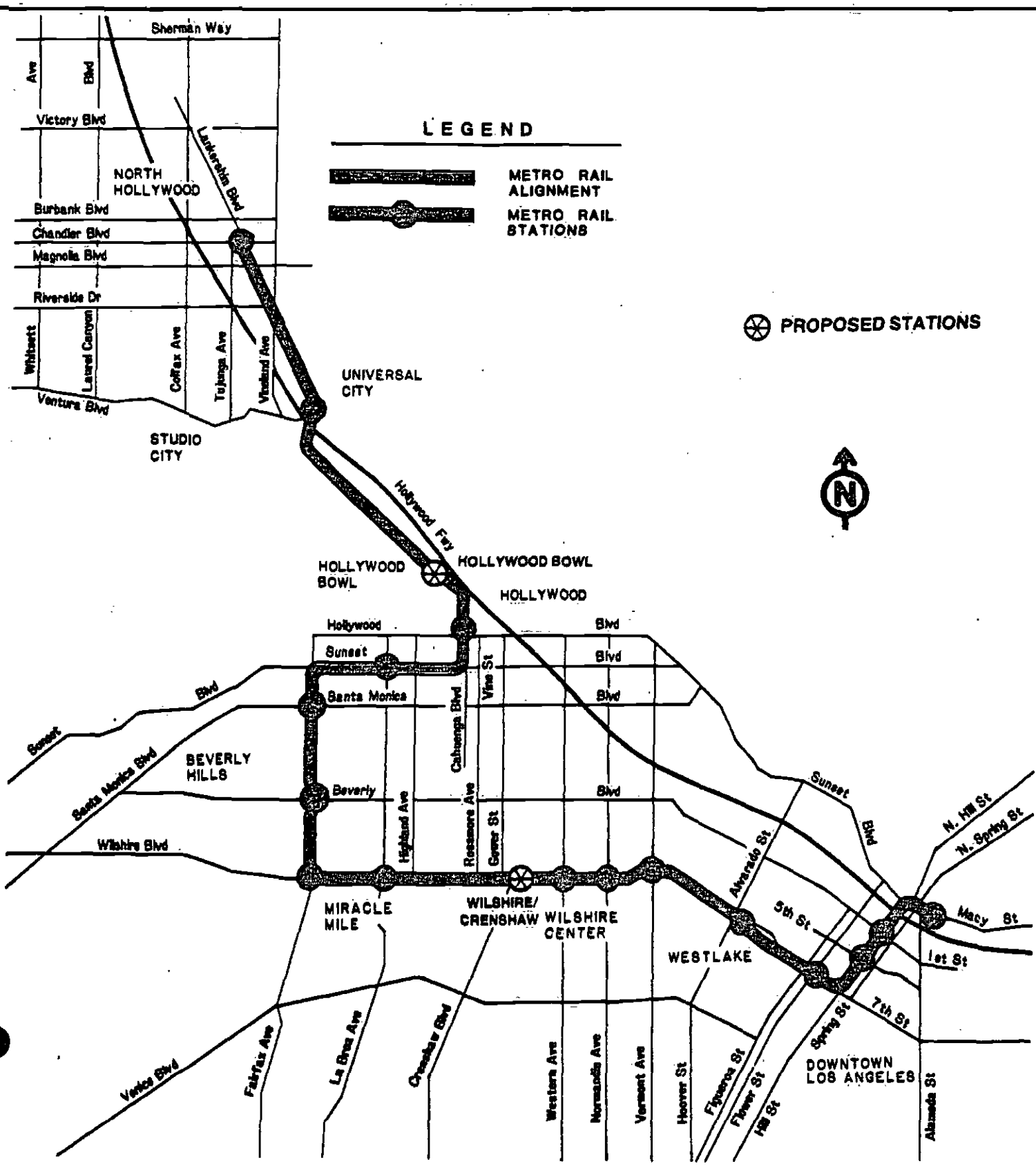
2.2.1 Stations

Stations will be subway construction with either one or two fare collection locations and with multiple entry/exit points to street level. Additional exits will be provided for use in emergencies. Escalators, stairs and elevators will provide vertical circulation between street, fare collection and platform levels, with elevator access limited to one route per station. Plans call for equipping the station for both attended and unattended operation.

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.

EXHIBIT 1

Map of the Proposed Metro Rail System



While station layout will not be identical, most station elements will be standardized for economy and ease of use, and to establish and identify for the system as a whole.

2.2.2 Vehicles

The passenger vehicle for the Metro Rail system will be a 75-ft-long, standard gauge, steel wheel vehicle capable of operating at speeds up to 70 mph. The vehicles will run on 750v DC power. They will be capable of regenerative braking.

The basic unit will be a married pair, (two cars, coupled together, which share some equipment). Vehicles will operate in trains of as many as six cars. Trains will be automatically controlled with an operator performing some functions. Each vehicle will hold about 70 seated passengers, and up to about 100 standees at normal loads and over 200 standees at crush loads.

Stainless steel will be used in constructing the vehicle body. Fire-resisting materials will be used throughout. The interior will include seating for able-bodied and handicapped patrons and include handholds and stanchions for standing patrons.

Vehicles will be equipped with lighting, heating, ventilating, and air conditioning apparatus to maintain a comfortable environment for passengers.

2.2.3 Track and Facilities

The main storage yard and the shop facility for the starter line will be located in the vicinity of the southeastern terminus. A limited number of storage tracks will be located near the North Hollywood terminal. Crossover tracks, storage tracks, and pocket tracks will be situated at suitable locations to enable trains to turn back at both ends of the corridor and at selected midline locations. These tracks will also provide temporary storage for malfunctioning trains, and permit reverse running during emergency situations.

2.3 Proposed Operations

A preliminary operating plan was developed using the results of analysis pertaining to potential ridership projections and system characteristics.

By the year 2000, it is estimated that Metro Rail will be carrying 376,000 passengers per day. The travel patterns of Metro Rail patrons are not expected to be concentrated toward the downtown business district, nor are they expected to be heavily peaked by direction of travel or time of day. Nearly two-thirds of the Metro Rail patrons (240,000) will be riding a bus to the station.

- Operating hours of 20 hours per day (5:30 A.M. to 1:30 A.M.).
- Maximum train lengths of 6 cars.
- Minimum headways of 3 1/2 minutes between trains.
- Maximum headways of 15 minutes between trains.
- Travel time of 31 minutes from North Hollywood to Union Station -- an average speed of 35 mph.

The service provided by the preliminary operating plan requires a fleet of 140 vehicles, including spares.

Nothing in system design will preclude expanding service to a 24-hour operation, if desired.

A strategy for operational management under conditions other than normal will be developed as the system design progresses. Referred to as "Failure Management", the philosophy will consider:

- Operational "Slow-Down" when required for safety or other reasons; service stoppage will be a last resort.
- Automatically or manually initiated modifications of system operating strategies and recovery operations.
- Communicating service disruptions, e.g., train delays and service information, to patrons.

CHAPTER 3

MAINTENANCE PROGRAM DEVELOPMENT SUMMARY

The maintenance program must provide sufficient plant and equipment to perform operating functions safely, efficiently and as scheduled. To accomplish this, the maintenance program will be developed to meet planned system dependability, availability, reliability and maintainability goals. These goals will be developed and finalized during the preliminary engineering and final design phases of the Metro Rail project.

This Preliminary Maintenance Plan is the first step in the maintenance planning process. It provides a general description of the activities which must be accomplished. As Metro Rail System development proceeds, maintenance planning activities will become increasingly more detailed. Exhibit 1 shows the stages of system development and the related sequence of maintenance planning phases and activities. The activities and their sequence will be defined in more detail in the System Maintenance Plan (SMP).

Development of a functioning maintenance program will be accomplished in four phases:

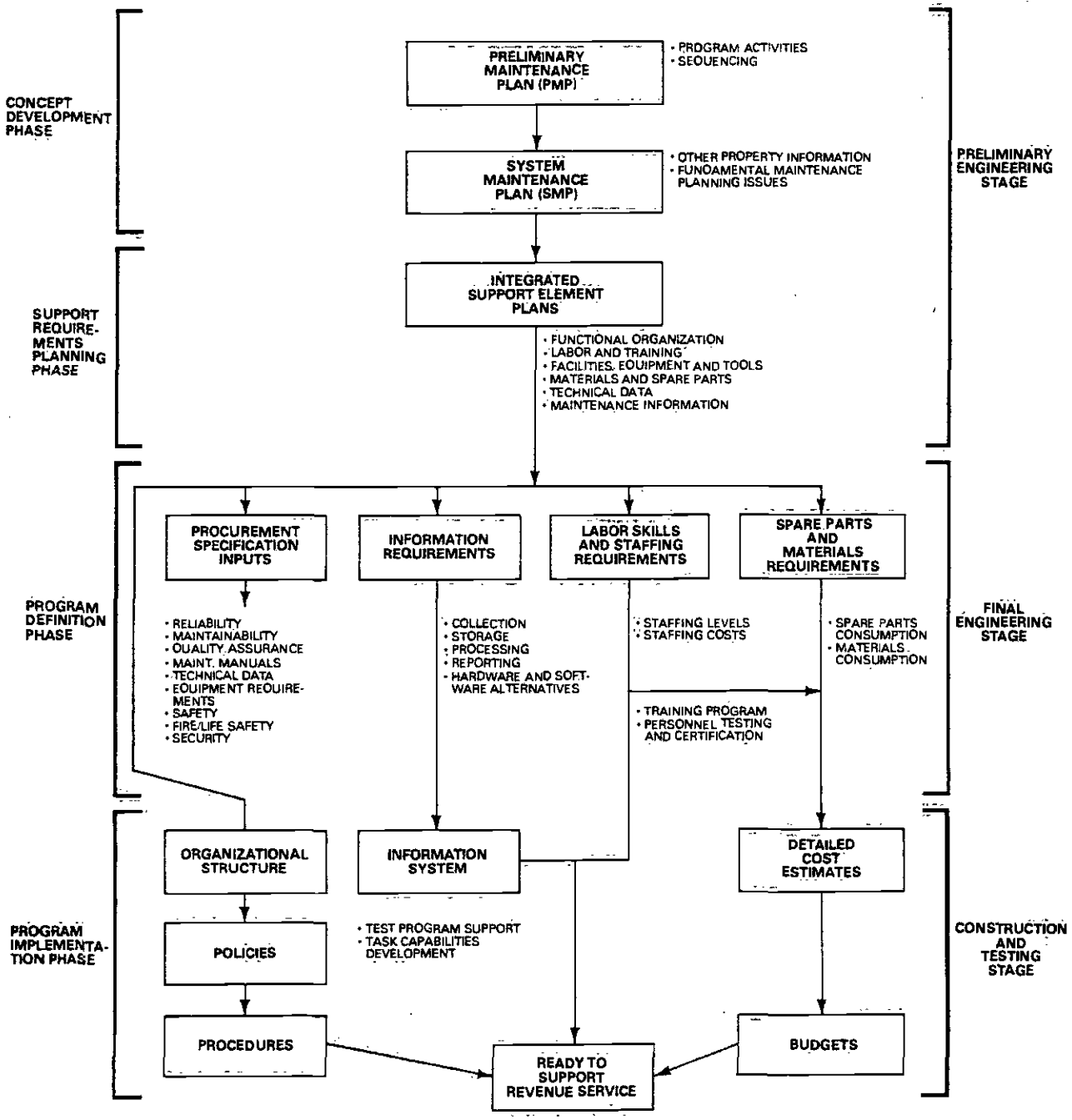
- Concept development
- Support requirements planning
- Program definition
- Program implementation.

3.1 CONCEPT DEVELOPMENT PHASE

This PMP is the first step in the Concept Development Phase. It fulfills the three objectives stated in Chapter 1. Approval by the RTD of this document marks completion of the PMP.

EXHIBIT 2

Maintenance Planning Activities and Sequence



The second major activity required during the Concept Development Phase is preparation of the System Maintenance Plan. The SMP will be more detailed than the PMP and will address many specific maintenance planning issues. The SMP has four primary objectives:

- Discussion and resolution of basic issues which are fundamental to the way the maintenance program will function (Chapter 4 of this PMP introduces a preliminary list of these issues).

- Description of the maintenance work requirement, including the types of vehicles, facilities and equipment which must be maintained, and the categories of maintenance work which must be performed (Chapter 5 of this PMP introduces these categories).

- Description of all support elements which are necessary to the maintenance program and the establishment of integrated requirements and schedules for the development of those elements.

- Initiation of a continuing process of estimating maintenance costs based on increasingly detailed information about maintenance cost factors for Metro Rail.

3.2 SUPPORT REQUIREMENTS PLANNING PHASE

The various support element plans will be developed during this phase. Requirements and schedules for this activity will have been established by the SMP. The support element plans will provide detailed guidance for developing the many interrelated elements of the maintenance program. Chapter 5 introduces the support elements, which will be described in detail by the SMP.

3.3 PROGRAM DEFINITION PHASE

The support element plans will be implemented during this phase. Detailed tasks required by each of the plans will be accomplished. A functional organization (see Exhibit 2) will be developed and the responsibilities and interrelationships of each function will be defined. These definitions will be a primary input to the final organizational structure of the maintenance department(s). The final organizational structure must be sensitive to each of the functional requirements as well as the wide differences in the nature of various system elements and facilities which will be part of Metro Rail.

Maintenance inputs will be made to the system procurement specifications. Labor and material requirements will be developed for use in the Maintenance Implementation Phase and maintenance management information requirements will be defined. Precise definition of informaton requirements is of critical importance during this phase, because the information system must be developed early in the next phase.

3.4 PROGRAM IMPLEMENTATION PHASE

During this phase, the maintenance organizational structure will be finalized; personnel will be hired and trained; vehicles, facilities and equipment will be accepted; and maintenance work will begin. The body of policies and procedures will be prepared and the information system will be developed.

It is essential that integrated policies and procedures be developed to function under the selected organizational structure. These policies and procedures must be sufficiently implemented at the beginning of system testing to facilitate maintenance during the test program. They must be fully implemented when revenue service begins.

Test operations will be accomplished and the maintenance program will be verified and adjusted, wherever necessary.

Performance of maintenance work will shift from contractor field service personnel to internal Metro Rail personnel. Finally, preliminary budget estimates will be refined to produce the first year's maintenance budget.

CHAPTER 4

MAINTENANCE CONCEPT DEVELOPMENT

A successful maintenance program is comprised of many interdependent and mutually supportive elements. To achieve an adequate degree of integration, there are a number of issues which must be addressed and resolved during the Concept Development and Support Requirements Planning Phases. These issues are fundamental to the way the maintenance program will function and will influence how the final maintenance organization is structured. The issues are comprised of many sub-tasks which will, incrementally, lead to increasing detail in the planning process. The initial list of issues is introduced below. After review and discussion by the SCRTD and appropriate consultant personnel, the issues and the means of their resolution will be fully described in the SMP. The issues include:

- Organizational structure
- Centralized versus decentralized maintenance planning and control procedures
- Preventive maintenance versus corrective maintenance
- Repair in place versus removal and replacement of modular components
- In-house versus contract maintenance
- Trouble shooting methods
- Management information systems
- Operating Concept.

4.1 ORGANIZATIONAL STRUCTURE

The organizational structure must be functionally balanced and thoroughly integrated, if maintenance performance is to be efficient and effective. The following two subsections describe functional balance and integration.

4.1.1 FUNCTIONAL BALANCE

All essential functional elements must be present and properly implemented. For example, complete data collection on the shop floor is of little use if it cannot be stored, analyzed and reported. Full manpower cannot be effective unless it is complimented by training and certification programs. Capable technicians cannot perform their jobs unless they are supplied with the right parts at the right time. In order to adequately support its operational requirements and achieve adequate performance levels, the total maintenance program must include formalized and dedicated functional activities.

Functional elements in a balanced maintenance program will include:

- Management and administration
- Work order control
- Information collection, storage, processing and reporting
- Plans and scheduling
- Quality assurance
- Training
- Maintenance engineering
- Configuration management
- Warranty cost recapture
- Inventory management
- Productivity measurement
- Management of backlogged or deferred work
- Preventive maintenance and inspection planning
- Service call management
- Technical training and proficiency certification
- Special tools management
- Technical data management including manuals; drawings, parts, catalogs and checklists.

There are a variety of organizational structures which are used in the transit industry. A theoretical structure which contains the necessary functional elements is shown in Exhibit 2. This exhibit is not intended to suggest any particular organizational structure for the SCRTD, but rather to portray functions and responsibilities that must be addressed in a properly balanced maintenance program.

4.1.2 FUNCTIONAL INTEGRATION

Functional elements must compliment and reinforce each other. All maintenance program elements are interrelated and must be mutually supportive. Deficiencies in one area will inevitably diminish the effectiveness of other elements and ultimately reduce the organization's capability to support operational requirements. The best example of functional integration is the maintenance information system and the numerous activities which it supports. Exhibit 3 illustrates many of the activities and requirements which must be supported by information from the work order document.

4.2 CENTRALIZED VERSUS DECENTRALIZED MAINTENANCE PLANNING AND CONTROL PROCEDURES

Exhibit 2 reflects a theoretical functional organization for a maintenance activity, showing various staff and line functions. With this structure, maintenance management can be highly centralized. Centralization is accomplished with each staff section dedicated to a particular functional activity and supporting all of the line functions. This arrangement has the advantage of providing dedicated labor in each staff function, while eliminating the need to duplicate staff activities under each and every line function. Therefore, staffing requirements are minimized.

Complete centralization may not be desirable, however. The types of facilities and equipment used in a rapid transit system have widely differing characteristics in terms of maintenance frequency, personnel skill and tool requirements and maintenance work locations. In some locations, it may be necessary to decentralize certain functions because of these differences. For example, a single Planning and Scheduling function would face difficulty trying to support both the vehicle maintenance activity and the facilities maintenance activities. Separate work forces are involved because technologies and scheduling requirements widely differ.

Consideration must also be given to the existing RTD maintenance organization. It may be most practical to extend the responsibilities of existing maintenance staff to cover selected portions of rail system maintenance.

EXHIBIT 3

Transit Maintenance Functional Elements and Responsibilities

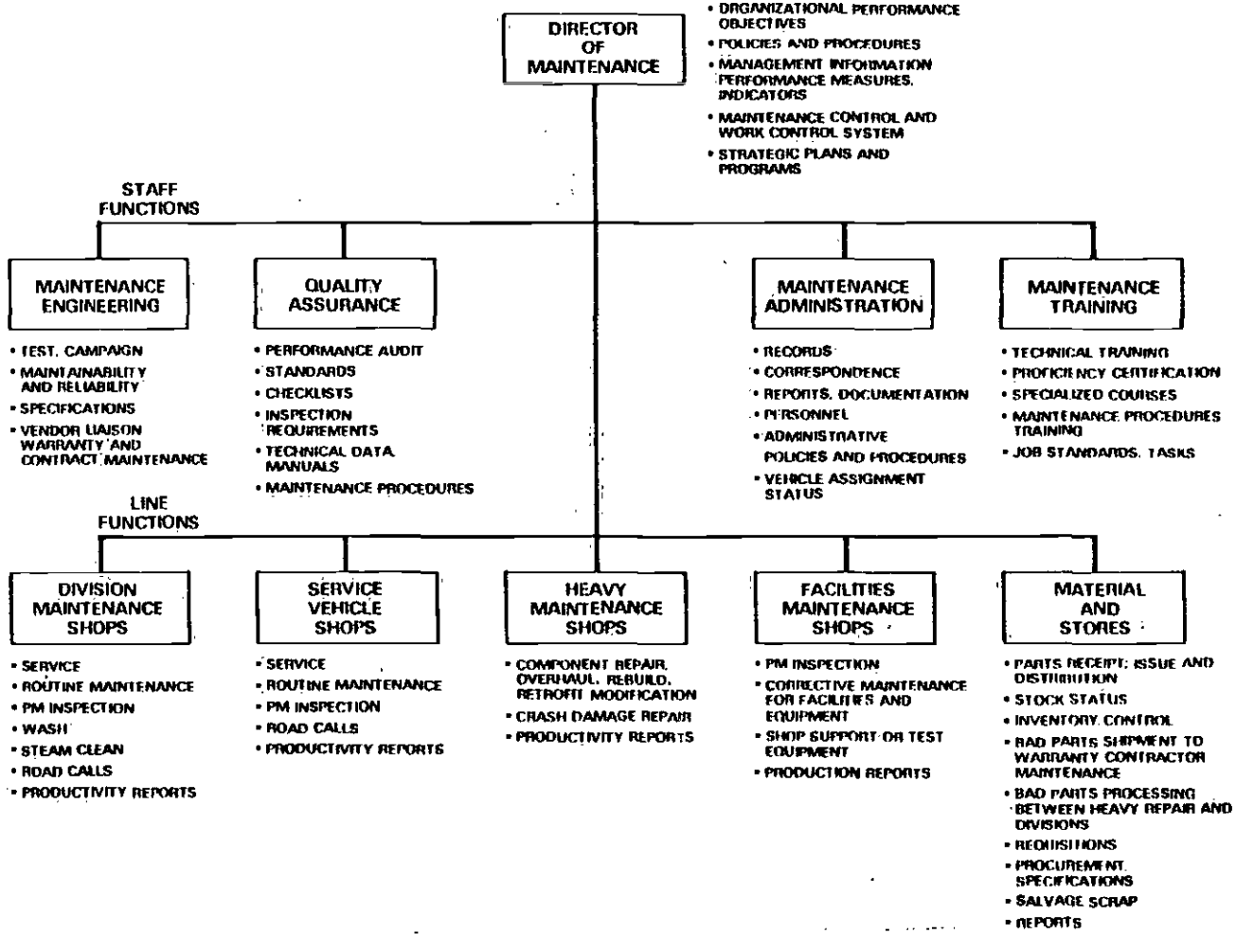
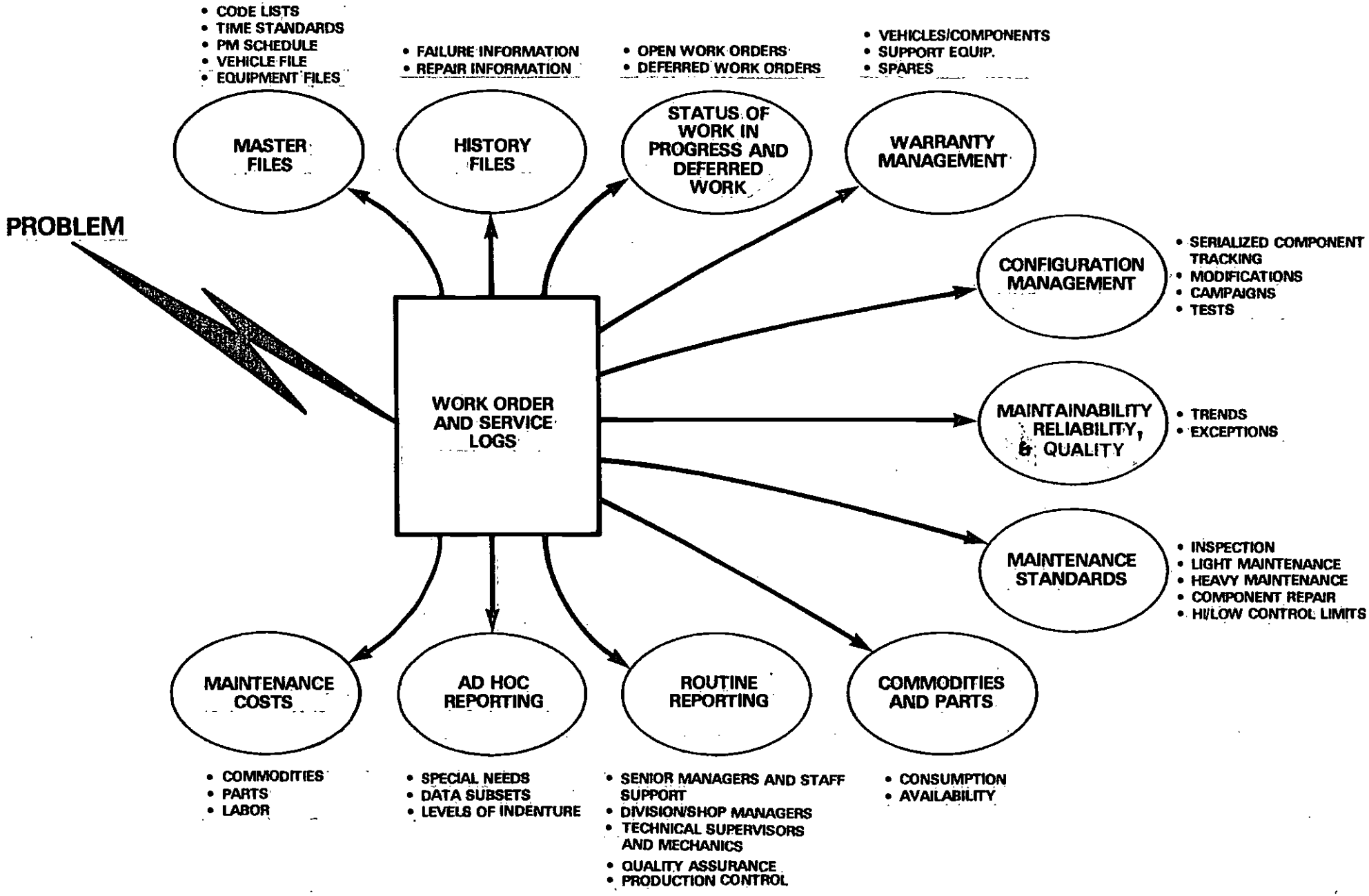


EXHIBIT 4

Maintenance Work Order Information Interfaces



Considerations such as these necessitate the division of maintenance responsibilities into a number of separate groups within the overall maintenance organization. The final degree of centralization will result from consideration of the realities of maintaining differing facilities and equipment as opposed to the efficiencies to be derived from maximum centralization.

4.3 PREVENTIVE MAINTENANCE VERSUS CORRECTIVE MAINTENANCE

Preventive maintenance is a predetermined program where properly functioning equipment is withdrawn from service to allow certain maintenance actions to be performed at specified regular intervals (hours of operation, miles of operation, etc.). Corrective maintenance involves repair work on equipment that has failed. Corrective maintenance cannot be preplanned because it is accomplished after a failure has occurred. Since preventive maintenance can be preplanned, it is usually more efficient and less costly than corrective maintenance.

Judgments concerning inclusion of an item in the preventive maintenance program must also consider the impact on service of a failure by that item. Failures of certain items, such as brakes, have high negative impact on service and must be subjected to regular preventive maintenance. Failures of other items, such as convenience lights, have little impact on service.

The preventive maintenance program should be designed to minimize in service failures of critical components and to optimize the ratio of preventive maintenance to total maintenance performed. The impact of failures on service will be minimized as will the cost of the total maintenance effort.

4.4 REPAIR-IN-PLACE VERSUS REMOVAL AND REPLACEMENT OF MODULAR COMPONENTS

The use of either repair-in-place techniques or modular replacement techniques is an important maintenance issue that effects both availability and maintainability. With the repair-in-place technique, equipment must be taken out of service for the full duration of time required to effect a repair or perform a maintenance action. The down time associated with this technique can be lengthy and can cause negative impact on system availability. With the modular replacement technique, the time to repair a vehicle or other end item consists solely of the time to diagnose the fault and replace the failed component or module with a serviceable spare unit. System down time is minimized and the actual repair time for the faulty module does not reduce system availability.

An example of repair-in-place maintenance is the wheel-truing operation. Although it would be possible to true wheels after the truck has been removed from the vehicle, many transit properties true the wheels by grinding them in place with a machine specially designed for this purpose. The time to detruck and retruck a vehicle (and the manpower required) makes this repair-in-place technique efficient and economical.

In general, modular design should be incorporated wherever possible and should remain consistent with the nature of individual systems and components. Certain items lend themselves to modularization more readily than others. Electronic equipment associated with the train control, communications or fare collection systems can be packaged in a manner that readily accommodates modular replacement. Requirements for optimum modularization should be included in all procurement specifications.

4.5 IN-HOUSE VERSUS CONTRACT MAINTENANCE

The degree to which component and assembly repair work is contracted out to local service shops, or to the original equipment manufacturers, is an important determinant of maintenance facility requirements, test equipment, maintenance personnel levels, spare parts inventory and component repair procedures. In theory, it is possible to contract out all repair and component/assembly overhaul work. However, in practice, contracting out is normally limited to special situations when:

(1) Items are of a specialty nature or of unique or complex design and manufacture which cannot be reasonably handled without extensive investment in specialized tools and the use of highly trained and skilled personnel, or

(2) Specific service shop capability can be identified in an area local to the rapid transit system, and the quality and reliability of work performed by such shops can be established.

If the second condition can be met, certain less unique or complex items should be contracted out if a cost and requirements analysis determines that it would be beneficial to do so. As a hedge against the impact of possible work stoppage, it can be beneficial to contract out selected work purely to maintain an alternate source of maintenance capability. These considerations are important, as they have major impact on facility and personnel requirements.

4.6 TROUBLE SHOOTING METHODS

Trouble shooting methods utilized to check equipment and search for the cause of fault conditions will influence the overall maintenance operations program and the design of equipment subsystems, assemblies and components. Diagnostic techniques, particularly for electrical and electronic control equipment, strongly influence, and are strongly influenced by, the extent and nature of equipment modularization. From a mean-time-to-repair viewpoint, tracking a fault condition in a cabinet full of electronic equipment may represent the majority of the on-line repair time. Once a faulty equipment module has been identified, a replacement module can be substituted for the faulty unit in a matter of minutes. Thus, specific test points and test equipment will be required for many system elements and will constitute an important part of the overall maintenance concept. Additionally, requirements for built-in test equipment and test points must be defined for incorporation into procurement specifications. These requirements should be addressed and defined during preparation of integrated support element plans (see Exhibit 1).

4.7 MANAGEMENT INFORMATION SYSTEMS

Maintenance management information lies at the core of the maintenance concept. Timely, accurate, detailed and comprehensive information is essential if centralized management and control is to function effectively.

Information collection, processing and retrieval is the nervous system of a maintenance organization. For the Metro Rail, automated information support will be a virtual necessity. Without it, the large volumes of information generated will not be able to be stored, processed or retrieved. The result will be limited access to information which would severely constrain managers' ability to identify problems and react in a meaningful way. Management information is needed by all functions at all levels, from technician to director and from engineer to planner. Whenever information is lacking, productivity and efficiency is reduced.

The first step toward developing a comprehensive maintenance information system is to describe information requirements. A major objective is to assure that information requirements at the collection point are fully defined. It is essential that complete information regarding each and every maintenance transaction be collected. This enables managers, through a combination of manual procedures and computerized processing, to access, analyze and report the information.

Reports needed by maintenance managers must also be described. Reports may include data summaries at various levels of detail and arithmetic calculations of reliability and maintainability statistics. They may involve statusing of work in process and planning of preventive maintenance schedules. Performance measures of personnel and equipment may be reported along with the costs of manhours and materials required to perform maintenance.

When information requirements have been defined, they become the primary input toward defining and developing information procedures and the computerized data processing system.

4.8 OPERATING CONCEPT

The operating concept which is ultimately developed for the Metro Rail system will influence several aspects of the maintenance program. It is essential that the interfaces between maintenance and operations be carefully defined.

In service equipment failures can have major impact on revenue operations, so maintenance forces must be able to respond quickly and accurately. This requires precise definition of operator and central control reporting requirements in addition to well planned maintenance response procedures.

The interface where vehicles are routinely transferred from operational control to maintenance, and from maintenance control to operations, is also important. Operators are the best potential source of vehicle performance information and should routinely provide accurate and complete definition of equipment problems when a vehicle returns to the yard from revenue service. Likewise, maintenance must keep operations informed as to fleet availability, and must provide sufficient vehicles when and where they are needed every day.

System operating hours are also an important determinant of maintenance program design. Trackwork, signals and train control equipment all have certain maintenance requirements which cannot be performed during revenue service operations. The maintenance program must be designed to provide services during hours when the system is not in operation or when individual system elements can be removed from service.

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These issues are important factors in the maintenance concept. The SMP will describe these issues in detail along with how they are to be approached and resolved.

CHAPTER 5

SUPPORT REQUIREMENTS PLANNING

Detailed support requirements planning will be accomplished during the second phase of maintenance program development. It will be comprised of a series of integrated support element plans which will establish specific tasks and schedules to be accomplished during the Program Definition Phase. The initial list of required support element plans includes:

- Functional organization development
- Labor and training requirements
- Facilities, equipment and tools maintenance
- Materials and spare parts requirements
- Maintenance manuals and technical data requirements
- Maintenance management information.

This list of plans will be refined and updated in the SMP with descriptions of the proposed objectives and content of each plan.

The content of the support element plans is, to some degree, generic because of the similarity of operation between transit property maintenance organizations. It is strongly influenced, however, by the property specific facilities and equipment to be maintained, by the organizational structure and maintenance capability which are developed or which presently exist, and by the operating concept and plans which are developed.

The typical activities of a rail rapid transit maintenance organization are described in the following paragraphs. The activities are grouped into 5 areas, similar to the organizational structure that exists at other rail rapid transit properties. The 5 areas are:

- Maintenance Management
- Ways, Stations and Structure Maintenance
- Railcar Maintenance
- Systems Maintenance
- Maintenance Engineering and Control.

5.1 RAIL MAINTENANCE MANAGEMENT

Rail Maintenance Management personnel are responsible for the direction and coordination of all maintenance activities required to assure system operation in a safe and reliable manner. The typical responsibilities of the organization that directs rail maintenance include:

- Establishment of maintenance policies designed to achieve system dependability and availability goals.

- Coordination and integration of the efforts of various maintenance departments.

- Liaison between the Rail Maintenance activity and other administrative and operating organizations.

5.2 WAYS, STATIONS AND STRUCTURE MAINTENANCE

This activity is subdivided into three areas responsible for maintenance, involving:

- Trackwork and structures
- Buildings and support equipment
- Custodial work in public areas.

5.2.1 TRACKWORK AND STRUCTURES

Personnel are responsible for track inspection, track repair, tamping, trash removal, leak inspections and repairs, structural inspections and repairs, welding, drain repairs, and maintaining their own equipment.

This activity includes the maintenance of storage yards and maintenance shops. Storage yards generally include yard lead tracks, transfer tracks, transportation facilities, and revenue storage tracks.

5.2.2 BUILDINGS AND SUPPORT EQUIPMENT

Personnel are responsible for the maintenance of all buildings, sidewalks, air conditioning, heating and ventilating equipment, storm pumps, sewer systems, hoist equipment, boiler and chiller plants, electrical equipment, fire protection equipment (extinguishers, alarms and valves), locks, lightbulb replacement, signs

and graphics, paving, emergency repairs and parking lot equipment. Elevator and escalator maintenance are their most critical functions, although this can sometimes be more economically handled by outside contractors.

Other facilities include electrification and control facilities, wash track, personnel offices and administrative facilities, access and interior circulation roadways, parking areas, drainage and utility systems, fencing, warehousing, electrification and control systems and the non-revenue fleet including rail, highway and rail-highway vehicles.

5.2.3 CUSTODIAL WORK

Personnel are responsible for janitorial work in all stations, shops, garages, parking lots and landscaped areas. Working activities include station cleaning and gardening, and picking up trash around the stations and in parking lots.

5.3 RAILCAR MAINTENANCE

This activity is subdivided into two areas, one responsible for service and inspection and the other for heavy maintenance and component repair.

5.3.1 SERVICE AND INSPECTION

Personnel are responsible for preventive maintenance activities, cleaning, daily inspections, testing, troubleshooting, minor corrective repairs, daily safety inspections of the vehicles and of subsystems and components. This activity usually requires around-the-clock personnel on a seven-day-a-week basis.

5.3.2 HEAVY MAINTENANCE AND COMPONENT REPAIR

Car maintenance personnel are responsible for corrective (unscheduled) maintenance, major repairs and overhauls. Component repair personnel are responsible for repairing/overhauling failed components.

5.4 SYSTEMS MAINTENANCE

This activity consists of preventive and corrective maintenance on electronic, electrical and mechanical subsystems that support rail service. Depending on the size and complexity of the transit system, the activity may be subdivided into several areas responsible for maintenance of:

- Fare Collection
- Train Control
- Communications and Computers (CCTV, radios, intercoms)
- Power Systems.

In addition to these maintenance activities, a group responsible for the testing and repair of failed components and subassemblies, and the calibration and repair of test equipment, is required. Many transit properties use outside vendors for this specialized activity.

5.4.1 FARE COLLECTION MAINTENANCE

This activity includes ticket vending machines, faregates, farecard encoders and readers, change machines and monitoring equipment. Because of the sophisticated electromagnetic, electronic, and mechanical equipment, specially trained technicians are needed to perform both scheduled and unscheduled maintenance.

5.4.2 TRAIN CONTROL MAINTENANCE

This activity includes the maintenance of vehicle, wayside and central control equipment. Train control equipment includes train protection, train operation and train supervision equipment on the vehicle, along the wayside, in the yard and in the control center.

5.4.3 COMMUNICATION SYSTEM AND COMPUTER MAINTENANCE

This activity consists of maintenance of various communication systems that include radio, PABX telephone, emergency telephone, public address, intercommunication, closed circuit television, data transmission, cable transmission, along with the various relay station, transmitters and receivers. Included is computer software and minor maintenance on computer hardware.

5.4.4 POWER SYSTEMS MAINTENANCE

This activity consists of the control, inspection, modification, overhaul, test and repair of switchgears, transformers, uninterrupted power supply systems and other sophisticated electrical equipment. This activity maintains the subsystems which deliver direct current for propulsion power for trains and alternating current for utility power throughout the system.

5.5 MAINTENANCE ENGINEERING AND WORK ORDER CONTROL

Responsibilities include the overall management, planning, scheduling, engineering, work control and management of parts and supplies required to support maintenance activities. While organizational structures vary by transit property, activities are similar. They are discussed here, segregated into three areas:

- Maintenance Management and Control
- Maintenance Engineering
- Material Management and Control.

5.5.1 MAINTENANCE MANAGEMENT AND CONTROL

This activity covers planning and scheduling, work order control, warranty program management, quality assurance, records, safety and system assurance, and training.

5.5.2 MAINTENANCE ENGINEERING

This activity consists of the specification of maintenance criteria guidelines, development and definition of technical procedures, performance of technical analyses, development of design modifications, management of retrofit programs and configuration and the review of procurement specifications.

5.5.3 MATERIAL MANAGEMENT AND CONTROL

This activity consists of maintaining a constantly available supply of required raw materials, supplies and spare parts consistent with operational demands. It must ensure proper receipt, storage, protection and issuance of materials from inventory establish appropriate controls for safeguarding those materials.

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This organizational breakdown will be refined in the SMP based on current information. The facilities and equipment to be maintained will be described in as much detail as possible, along with the types of maintenance work to be performed. This information will be an input for developing the support element plans.

CHAPTER 6

MAINTENANCE PROGRAM DEFINITION AND IMPLEMENTATION

This chapter briefly discusses the third and fourth phases of the maintenance planning process. These phases will occur during the Final Engineering and the Construction and Testing stages of the Metro Rail project. Therefore, this PMP merely summarizes certain major activities which must occur. More detailed discussion of these phases will be contained in the SMP and the support element plans.

6.1 PROGRAM DEFINITION

Having resolved the basic maintenance issues and having developed support element plans, activities during this phase accomplish detailed planning tasks. The spectrum of required tasks and schedules will be defined in the support element plans. A few of the major items of concern are described below.

6.1.1 PROCUREMENT SPECIFICATION INPUTS

The maintenance organization is responsible for maintaining procured facilities and equipment after their acceptance from the manufacturer. Therefore, maintenance planners must have a major input into the procurement specifications. Maintenance involvement in preparing specifications translates to improved confidence that the equipment will perform as expected. Specification requirements which should have maintenance input include:

- Quantitative reliability and maintainability levels including preventive maintenance requirements
- Construction/manufacturing quality assurance
- Provision of maintenance manuals and technical data
- Maintenance equipment and initial spare parts lists
- Design reviews.

6.1.2 INFORMATION REQUIREMENTS

The critical need for an information system has been described in Chapter 4. The first step in fulfilling this requirement will be a comprehensive requirements analysis conducted during Phase 3. This step will identify all requirements for information and will define alternatives for fulfilling those needs. Hardware options and software development options will be described, and a functional specification and detailed system design will be produced. This information will in turn define the amount and type of computer hardware which is needed, along with the software development requirements and schedule for system development during Phase 4.

6.1.3 LABOR SKILLS AND STAFFING

Tasks in this area will focus on developing detailed estimates of skills and staffing requirements based on the maintenance concept and the equipment and facilities to be maintained. The estimates will be used to develop refined cost estimates and as inputs to training program planning.

6.1.4 SPARE PARTS AND MATERIALS

Tasks in this area will also provide information for refining cost estimates. Inputs will be developed for initial spare parts lists to be included in procurement specifications. Additional information will be prepared to define the great variety of materials and supplies which will be required, from toilet paper and light bulbs to special trackwork and other investment items.

6.2 PROGRAM IMPLEMENTATION

This phase is the transition from planning and procurement to testing and maintenance operations. The integrated plans and schedules of the various support elements must all cluminate in a capability to perform maintenance during this phase. The organizational structure with all of its functional units and interrelationships must be finalized, as well as the body of maintenance policies and procedures. The information system must be in place prior to the beginning of system testing.

Final decisions must be made about staffing and materials requirements and a detailed operating budget prepared.