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U.S. Department
of Transportation

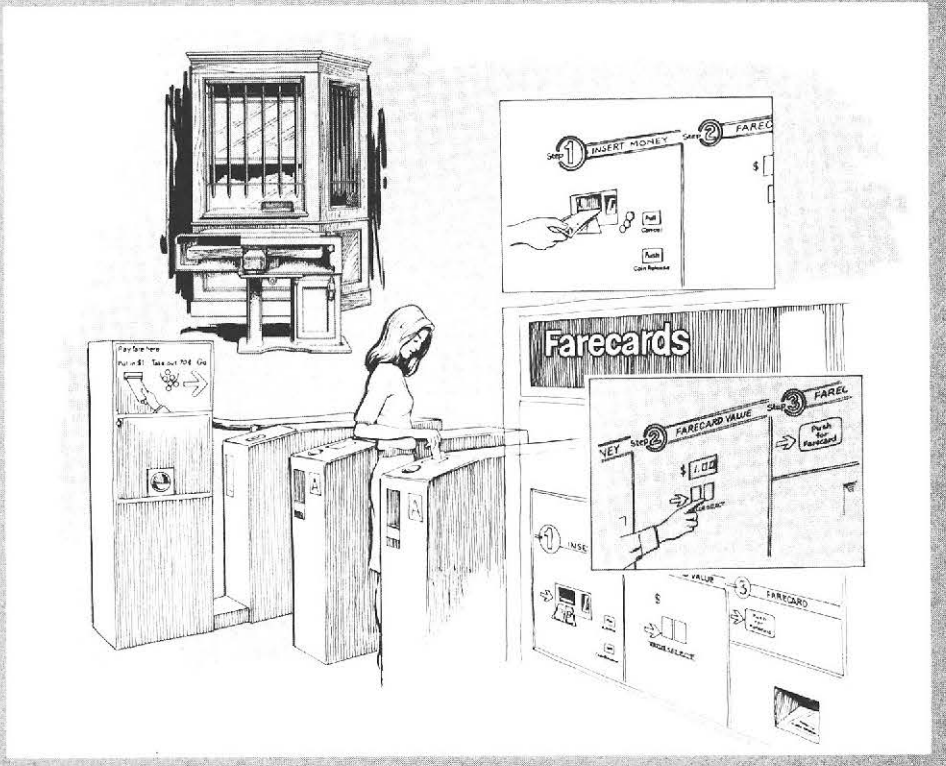
**Urban Mass
Transportation
Administration**

# Rail Transit System Maintenance Practices for Automatic Fare Collection Equipment

Transportation Systems Center
Cambridge MA 02142

May 1984








**UMTA Technical Assistance Program**

U.S. Department
of Transportation

**Urban Mass
Transportation
Administration**

# Rail Transit System Maintenance Practices for Automatic Fare Collection Equipment

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Office of Systems Assessment
Cambridge MA 02142

Office of Technical Assistance
Office of Systems Engineering
Washington DC 20590

# PREFACE

A review of rail transit system maintenance practices for automatic fare collection (AFC) equipment was performed. This study supports an UMTA sponsored program to improve the reliability of AFC equipment. The maintenance practices of the transit systems are generally similar, however, several exceptions were found which have potential for improving AFC equipment reliability if more widely adopted. Those practices worthy of consideration include: dedicated crews for performing preventive maintenance, automated scheduling and monitoring of preventive maintenance actions, incentives for additional training of maintenance technicians, and automated systems for management and analysis of information on maintenance problems and actions. Results of the study suggest that the many advantages of AFC equipment, particularly those capable of performing complex functions, are achieved at the expense of more intensive maintenance requirements. Further analyses may support development of more effective maintenance programs by determining if relationships can be established between specific maintenance practices and the reliability of AFC equipment on different transit systems.

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# 1. INTRODUCTION

This report describes the maintenance practices of rail transit systems for automatic fare collection (AFC) equipment. The report was prepared in support of an UMTA sponsored project to improve the reliability and effectiveness of AFC equipment at rail transit systems.

Automatic fare collection equipment has the potential for reducing labor costs and fraud, providing flexible and equitable fares, increasing patron mobility, documenting origin/destination patterns, and producing demand and revenue statistics. These benefits of AFC equipment are not being achieved without certain costs, however. A problem generally encountered with AFC equipment, particularly those with more complex functions, has been low reliability with resulting intensive maintenance requirements. The quality of maintenance provided by transit systems in response to this need may, in turn, influence AFC equipment reliability. By documenting their individual maintenance practices, this report will allow rail transit systems to share this information in an effort to promote improved AFC equipment reliability.

Information for this report was obtained from sources listed in the reference section and from telephone conversations and correspondence with rail transit systems using AFC equipment. A total of 14 systems are currently participating with UMTA in evaluating AFC equipment performance; however, these systems are not uniformly treated in this report. More information was obtained from some systems than others. If the information in this report proves useful to rail transit systems, it can form the basis for a more comprehensive analysis of maintenance practices.

## 2. DESCRIPTION OF AFC EQUIPMENT BY TRANSIT SYSTEM

The different types of fare collection equipment operated by the various agencies is summarized in Table 2-1. The total number of fare collection units of all types per agency range from 2846 for NYCTA to 14 for LIRR. All of the transit systems (RTA excluded) employ at least gates or turnstiles. The number of daily passengers per gate/turnstile shows considerably less variation from one system to another than the absolute number of units as shown in Table 2-2. However, the variation in this statistic still ranges from a low of 349 for ICG to a high of 2471 for CTA. This variation can partly be explained by the relative complexity of the AFC equipment used by the different agencies. Those agencies with the greatest number of passengers per gate/turnstile (CTA, SEPTA, NYCTA) have simple turnstile systems that perform only one function as shown in Table 2-3. Agencies in the next highest group (PATH, MBTA) have only turnstiles but they perform several functions. Those agencies with the fewest passengers per gate/turnstile (WMATA, MARTA, PATCO, BART and ICG) all have either multiple types of AFC equipment and or multiple functions involving magnetic fare cards performed by the gates/turnstiles. As demonstrated in Section 3.2, there is some evidence to suggest that those agencies with greater AFC equipment complexity require a larger AFC maintenance staff per passenger.

TABLE 2-1. SUMMARY OF AFC EQUIPMENT BY TRANSIT SYSTEM

| TRANSIT SYSTEMS | TYPES OF AFC EQUIPMENT | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | GATES | TURNSTILE | FARECARD VENDOR | FARECARD ADD-FARE | CHANGE MAKER | BILL CHANGER | TRANSFER/PASS DISPENSER | TOTAL AFC UNITS |
| MARTA | 164 | - | - | - | - | - | - | 164 |
| MBTA | - | 350 | - | - | - | - | - | 350 |
| CTA | - | 225[2] | - | - | - | - | - | 225 |
| ICG | 169 | - | 112 | - | - | - | - | 281 |
| RTA | - | - | - | - | - | 26 | - | 26 |
| PATH | - | 190[3] | - | - | - | - | - | 190 |
| PATCO | 85 | - | 72 | - | 42 | - | 17 | 216 |
| NYCTA | - | 2846 | - | - | - | - | - | 2846 |
| LIRR | - | 10 | 2 | - | - | - | 2 | 14 |
| SEPTA | - | 138 | - | - | - | - | - | 138 |
| BART | 320 | - | 180 | 110 | 140 | - | 80 | 830 |
| WMATA | 462 | - | 301 | 119 | - | - | - | 882 |

1 - Gates accept coins and tickets and dispense transfers.
2 - Transfer dispenser incorporated into turnstile.
3 - Bill changer tied to turnstile.

TABLE 2-2. GATE-TURNSTILE USE RATES BY TRANSIT SYSTEM

| Transit System | Route Miles | Stations | Daily Passenger (1000's) | Total Gates/ Turnstiles | Daily Passengers Per Gate/Turnstile |
|---|---|---|---|---|---|
| CTA | 89 | 142 | 556 | 225 | 2471 |
| ICG | 41 | 49 | 59 | 169 | 349 |
| MBTA | 74 | 72 | 250 | 350 | 714 |
| NYCTA | 230 | 458 | 3320 | 2846 | 1167 |
| PATH | 14 | 12 | 170 | 190 | 895 |
| PATCO | 15 | 13 | 42 | 85 | 494 |
| SEPTA | 29 | 55 | 280 | 138 | 2028 |
| BART | 71 | 34 | 143 | 320 | 447 |
| WMATA | | 43 | 290 | 462 | 627 |
| MARTA | 14 | 14 | 68 | 128 | 531 |

TABLE 2-3. GATE/TURNSTILE FUNCTIONS BY TRANSIT SYSTEM

| GATE/ TURNSTILE FUNCTION | BART | MARTA | WMATA | PATCO | PATH | MBTA | NYCTA | SEPTA | CTA | LIRR | MDCTA | MTA | ICG | RTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Graduated Fare | * | | * | | | | | | | | | | | |
| Stored Value | * | | * | | | | | | | | | | | |
| Magnetic Fare card | * | * | * | * | | | | | | * | | | * | |
| Bill Verifier | | | | * | | | | | | | | | | |
| Bill Changer | | | | * | * | | | | | | | | | |
| Transfer Dispenser | | * | | * | | | | | | | * | * | | |
| Ticket Transport | | * | | | | | | | | | | | | |
| Coin/Token Acceptor | | * | | | * | * | * | * | * | | * | * | | * |
| Pass Reader | | | | | | * | | | | | | | | |
| Change Dispenser | | | | | | | | | | | * | * | | |

# 3. MAINTENANCE PRACTICES FOR AFC EQUIPMENT

## 3.1 MAINTENANCE ORGANIZATION

Organizational charts for transit systems with organizational units responsible for maintaining AFC equipment are exhibited in Appendix A. The charts are simplified from those originally obtained from the properties to highlight those organizational elements involved in maintenance of AFC equipment. All transit systems have units fully dedicated to performing maintenance of AFC equipment in station areas. Shop repair of AFC equipment is sometimes performed by a general shop support group which has responsibility for repair of other equipment in addition to AFC equipment (PATCO, BART).

## 3.2 STAFFING AND ASSIGNMENT OF MAINTENANCE FUNCTIONS

Table 3-1 shows the number of emplyees directly associated with performing or supervising AFC equipment maintenance functions on various transit systems. All the transit systems have maintenance technicians fully dedicated to repair of AFC equipment. On some transit systems the maintenance technicians split their time between field repairs and shop repairs (ICG, MARTA, PATH). Taking into consideration the amount of time spent in shops by their line technicians, the number of AFC units (gates, fare card vendors, add fares, etc.) per line technician ranges from an approximate high of 39 to a low of 13. These numbers cannot be directly compared, since machine complexity, level of use, and equipment age have not been taken into consideration.

Normalizing these results by passenger volumes (Ref. 1) shows that the number of daily passengers per line maintenance technician (adjusted for shop time) is remarkably similar for MARTA, BART, WMATA, PATCO and ICG at 6800, 5958, 5714, 4333 and 4214, respectively. These properties each have at least 2 different

Table 3-1. STAFFING OF AFC MAINTENANCE

| Transit System | Number of Line Maintenance Technicians | Number of Shop Repair Technicians | Number of Supervisory Personnel | Other Maintenance Personnel |
|---|---|---|---|---|
| ICG | 18-Line Repairs/Shop | 4 | 5-Senior Technicians | |
| BART | 24 | 20<br>6-Assemblers | 3-Line Foreman<br>2-Shop Foreman | |
| WMATA | 8-Preventive Maint.(PM)<br>8-PM/Line Repairs<br>33-Line Repairs | 6 | 6-Shift Supervisors<br>1-Line Supervisor | 3-Dispatchers<br>2-Logistics<br>1-Locksmith<br>2-Engineers<br>4-Line runners (contract) |
| MARTA | 13-Line Repairs/Shop | Covered by line technicians. | 1-AFC Foreman | |
| PATCO | 8-Technicians<br>1-Repairman | | 1-Equip. Foreman | |
| PATH | 7-Line Repairs/Shop | 1-Full time technician. Also covered by line technicians. | | |
| CTA | | | | |

types of AFC equipment which perform a number of functions. PATH has a significantly larger number of daily passengers per line maintenance technician at 28600. The greater maintenance productivity at PATH may be attributable to the property having essentially only one type of AFC equipment (see Table 2-1) which performs relatively few functions (see Tables 2-1, 2-2, and 2-3).

All properties have provisions for supervision of maintenance technicians. In some cases, the first level of supervision is a senior technician or working foreman.

The shop staffs responsible for repair of AFC equipment on some properties are supplemented with maintenance technicians that split their time between stations and shops during off peak hours. On other properties (BART, PATCO) the shop staffs perform repair on other electronic and communication equipment in addition to AFC equipment.

The assignment of AFC maintenance personnel on properties is summarized in Table 3-2. All the properties have at least 2 maintenance shifts which span at least 12 hours of operation (most properties provide maintenance coverage from about 6 am to 10 pm). Technicians are assigned to cover a transit line or group of stations. This arrangement is permanent in BART's case. These technicians are also frequently assigned to specific high density stations during peak hours, especially if the stations are otherwise unattended, to provide quick response to maintenance needs (ICG, MARTA, PATH, CTA).

## 3.3 MAINTENANCE PROCESS

The usual processes for initiating maintenance actions on properties is summarized in Table 3-3. If a property normally has attendants on duty at their stations, the attendants are the primary means by which AFC maintenance needs are made known (BART, WMATA, CTA). If the stations are typically unattended, passengers

Table 3-2. ASSIGNMENT OF MAINTENANCE TECHNICIANS

| Transit System | Shift Size | Shift Schedule | Shift Assignment |
|---|---|---|---|
| ICG | | 1 shift: 6:00am-2:30pm<br>1 shift: 8:00am-4:30pm<br>1 shift: 10:00am-6:30pm | Technicians assigned to cover one of 4 areas. Also perform shop repairs in one of 3 satellite shops. Randolph & Van Buren Stations - peak hours. |
| BART | | 2 10-hour shifts/day (four-day work week) | Technicians permanently assigned to one of 4 lines |
| WMATA | 8 techs/shift | 2 shifts: 6:30am-3:00pm<br>2 shifts: 2:00pm-10:00pm | Each technician assigned to cover about 4 stations. |
| MARTA | 5 techs/shift (weekdays)<br>3 techs/shift (Saturday)<br>1 tech/AM shift Sunday<br>4 techs/PM shift Sunday | 2 10-hour shifts/day | High density stations - peak hours<br>Line maint (3 techs) - off peak hours<br>Shop maint (2 techs) - off peak hours |
| PATCO | | 1 shift: 6:30am-2:30pm<br>1 shift: 2:30pm-11:00pm<br>1 shift: 10:00am-6:30pm(Sun.) | Assigned to New Jersey & Philadelphia sections. |
| PATH | 7 techs/shift | | High density stations - peak hours. Split between line maint & shop repairs - off peak hours. |
| CTA | | | High density stations - peak hours. |

Table 3-3. MAINTENANCE PROCESS

| Transit System | | Process for Initiating Maintenance Actions |
|---|---|---|
| ICG | 1. | Central control monitors equipment by CCTV and remote monitoring devices and initiates maintenance requests. |
| | 2. | Passengers call in problems on PAL* phones. |
| BART | 1. | Attendant updates computer status of equipment and initiates maintenance requests. |
| WMATA | 1. | Attendant monitors equipment and submits maintenance request to central control. |
| | 2. | Central control dispatches technician and maintains records. |
| MARTA | 1. | Initiated by passengers using passenger aid phones. |
| | 2. | Stations also monitored by CCTV at 3 zone centers. Maintenance requests made from centers. |
| | 3. | Employees may initiate maintenance requests. |
| PATCO | 1. | Initiated by passengers using passenger aid phones. |
| PATH | 1. | Initiated by passengers using passenger aid phones to central control. |
| | 2. | Stations also monitored by CCTV. |
| | 3. | Attendants call in requests if present during peak hours. |
| CTA | 1. | Attendants request maintenance through their supervisors, to the CTA power supervisor, to maintenance foreman, to individual line technicians. |

*Passenger Assistance Line.

frequently initiate maintenance actions by phoning in AFC equipment problems on special passenger aid phones (PATCO). These stations are also monitored by closed circuit television (MARTA, PATH) and other status devices (ICG) which assist the property in determining if AFC maintenance actions are required. Property employees (maintenance technicians, security guards,etc) may also make note of equipment problems during the course of their normal duties and initiate maintenance actions.

## 3.4 PERFORMANCE OF MAINTENANCE TASKS

The performance of maintenance tasks by various types of employees is summarizied in Table 3-4. Minor "finger tip" maintenance requirements (soft maintenance), typically involving clearing of money/card jams, are generally performed by station attendants if the stations are staffed. PATH has a unique situation which requires both a coin box operator and a security guard to be present before AFC equipment can be opened. Because of this, attendants and maintenance technicians will initally attempt to clear jams using special probes that do not require opening the equipment. Properties which have unstaffed stations must rely on maintenance technicians to clear money jams. MARTA also permits security personnel to clear money jams.

Other maintenance actions performed on AFC equipment within the station area (hard maintenance) is universally limited to replacement of malfunctioning components/assemblies or worn parts and performing minor functions such as adjustments, lubrication and cleaning. Repair of components/assemblies and rebuilding of AFC equipment is generally performed by the properties in their shops. Most properities have shop staffs dedicated to working on AFC equipment. These staff, however, are often supplemented by line maintenance technicians (ICG, MARTA, PATH). The BART shop staff repairs all electronic equipment in addition to AFC equipment.

Table 3-4. PERFORMANCE OF MAINTENANCE TASKS

| Transit System | Who performs soft/finger tip maintenance (clearing of money/card jams)? | Do line technicians perform hard repairs consisting of lubrication, adjustments and replacement of components/ assemblies/worn parts? | Who performs shop repairs (repair of components/ assemblies). |
|---|---|---|---|
| ICG | Line technicians | Yes | Shop technicians temporarily being suplemented by line technicians. |
| BART | Attendants | Yes | Shop technicians repair all BART elecronic equipment including AFC equipment. |
| WMATA | Attendants | Yes | Shop technicians |
| MARTA | Line technicians & security personnel | Yes | Technicians split time between line & shop. |
| PATCO | | | Shop Technicians |
| PATH | Attendants & line technicians (special probes are used). Coin box operator & PATH Police required to open equipment. | Yes | 1-full time shop technician 7-technicians splitting time between line & shop |
| CTA | | Yes | |

## 3.5 PREVENTIVE MAINTENANCE PRACTICES

All properties have programs for preventive maintenance (PM) as summarized in Table 3-5. On most properties, PM is performed by line maintenance technicians as part of their normal duties. MARTA supplements its PM efforts with overtime if necessary. WMATA is the only property with a fully dedicated crew for performing PM only. Originally two shifts were established to perform PM. One of the shifts is currently supporting regular maintenance activities.

Preventive maintenance is performed at different levels and frequencies among the properties. The properties generally have daily inspections of AFC equipment to check for proper operation. Primary PM is performed on a weekly basis at ICG. The other properties have monthly programs of PM. BART and MARTA have automated scheduling of AFC equipment for PM. ICG relies on senior technicians to ensure that PM is performed on a weekly basis. A program is underway on ICG to supplement their weekly PM with complete overhauls on their AFC equipment (6 months for bill validators and coin acceptors, 12 months for gates). All properties have prescribed procedures for PM, however, they vary in specifics. Samples of prescribed preventive maintenance procedures are exhibited in Appendix B.

Manual records of PM actions performed are kept by WMATA, BART and MARTA. ICG does not keep a log of PM actions. BART and MARTA also place their PM information in a computer automated data base for providing PM status updates on all AFC equipment for management review. BART also keeps a copy of the manually completed PM trouble ticket with the AFC equipment.

## 3.6 MAINTENANCE MANUALS AND TRAINING

All properties investigated have manuals or standard procedures for maintaining AFC equipment as summarized in Table 3-6. The ICG uses an

Table 3-5. PREVENTIVE MAINTENANCE PRACTICES

| Transit System | Who performs PM? | How is PM Scheduled? | Are Prescribed Procedures used for PM? | How are PM Actions Documented? |
|---|---|---|---|---|
| ICG | Line technicians as part of normal duties. | Senior technician ensures that PM is performed weekly. Overhaul program being implemented: 6 & 12 month intervals. | Yes, developed on basis of experience. | No records of PM actions. |
| BART | Line technicians as part of normal duties. | Computer-based PM scheduling system | Yes | Trouble ticket for PM. Copy stays with equipment. Also entered into computer data base. |
| WMATA | Two shifts originally dedicated to perform only PM. | Primary PM is performed on a monthly basis. | Yes | PM card completed. Consolidated monthly reports produced. |
| MARTA | Line technicians as part of normal duties. Overtime used if necessary. | Primary monthly PM automatically scheduled. Daily & weekly inspections also performed. | Yes | Manual log and computer-based records |
| PATCO | Shop technicians and shop repairman. | No PM for ticket vendors. Gates maintained on a fixed schedule by subsystem. | | |
| PATH | Line technicians as part of normal duties. | Monthly & quarterly PM required. Daily inspections. | Yes | |
| CTA | Line technicians as part of normal duties. | PM performed at technician's discretion; turnstiles are inspected periodically depending on station traffic and technician availability. | No | |

Table 3-6. MAINTENANCE MANUALS AND TRAINING

| Transit System | Maintenance Manuals: Are they used? | Maintenance Manuals: Developed by Transit System or manufacturer? | Training Program? | Are technicians fully cross-trained on all equipment? |
|---|---|---|---|---|
| ICG | No, only a training manual | Transit System | yes | Vendor & turnstile technicians interchange roles. PAL* tech.perm.assigned. |
| BART | yes | Developed by Transit System based on manufacturer material. | Yes, for new hires. Refresher courses being considered. | yes |
| WMATA | yes | Transit System modified manufacturer manuals. New manuals from manufacturer now available. | Yes, minimum level required. Additional training optional. | yes |
| MARTA | yes | Transit System modified Manufacturer manuals. | yes | yes |
| PATCO | | | | |
| PATH | | | | |
| CTA | | | | |

*Passenger Assistance Line.

extensive training manual for this purpose. All properties have developed their own manuals usually based on documents originally provided by the AFC equipment manufacturer. WMATA is presently obtaining a revised set of maintenance manuals from the equipment manufacturer.

All properties provide maintenance training for their employees when they are hired and when new equipment is purchased. BART is currently considering refresher courses for its maintenance technicians. WMATA has a unique program of requiring a minimum level of training for all maintenance technicians and offering additional training as an employee option if higher certification is desired. Maintenance technicians are generally cross-trained on all AFC equipment. The only exception found to this is on the ICG where technicians responsible for maintaining passenger assistance phones are permanently assigned to that equipment.

## 3.7 MAINTENANCE SUPPORT ACTIVITIES

Various maintenance support activities and practices of properties are summarized in Table 3-7. Documentation of maintenance actions, excluding preventive maintenance, are at least manually performed on all properties. Samples of maintenance action reports are exhibited in Appendix C. BART and MARTA also transfer their maintenance information into a computer automated data base for generation of consolidated activity reports and maintenance statistics. Samples of computer generated maintenance statistics are exhibited in Appendix D. WMATA is planning to implement an automated system for managing its maintenance information.

Repair parts and other items required by technicians in the field are usually transported from inventory points via the rail transit line. The ICG uses highway vehicles to transport parts and equipment as well as the

TABLE 3-7. MAINTENANCE SUPPORT ACTIVITIES

| Transit System | Maintenance Documentation & Periodic Maintenance Reports | Logistics | Communication With Technicians |
|---|---|---|---|
| ICG | "Trouble Tickets" completed for maintenance actions. All records are manual. No reports. | Parts transported by rail or auto from central inventory. Technicians travel by auto. | Two-way radios. |
| BART | "Trouble Tickets" completed for maintenance actions. Central computer based records maintained ("ODDS"). Maintenance statistics reports. | Parts transported by rail from central and satellite inventories. | Telephone (supervisors have pagers) and PA system. |
| WMATA | Manual records of maintenance actions maintained. Computer-based system being implemented. | Parts transported by line runners operating under contract. | Pagers and telephone. |
| MARTA | Report completed on each maintenance action. Central computer-based records maintained. Biweekly reports. | Parts transported by rail from central storage. | Passenger aid phones and PA system. |
| PATCO | | | |
| PATH | "Coin Box Repair Report" completed for field repair actions. Monthly consolidation of reports. | | |
| CTA | | | |

Table 3-7 MAINTENANCE SUPPORT ACTIVITIES (Continued)

| Transit System | Retrofits & New Installations Performed? | Diagnostic Equipment? | Supervision? | Warranty Administration? | Engineering & Analytical staff? |
|---|---|---|---|---|---|
| ICG | Yes, when required | Ticket vendors have limited self-diagnostic aids. | 5-Senior technicians | All equipment out of warranty. | Yes |
| BART | Supervised only. | Trouble shooting guide. Special test box for IBM gates. | 4-Lead technicians 3-Foremen | Most equipment is out of warranty. | Yes |
| WMATA | Yes, just completed new mezzanine. | AFC equipment has self-diagnostic aids. | 1-Supervisor/shift roams between stations. | Yes, warranty manager. | Yes |
| MARTA | Yes, extensive retrofit currently underway. | Gates have self-diagnostic aids. Portable ticket readers & time generators. | 1-AFC foreman, 1st shift. 1-General foreman, other shifts. | No | Yes |
| PATCO | | | 1-Foreman | | |
| PATH | | Special probe used for clearing money jams. | | | |
| CTA | | | | | |

technicians between stations. WMATA uses contract employees to serve as line runners for logistical support. BART has satellite storage of parts as well as a central inventory similar to the other transit systems.

Communication with technicians in the field is accomplished by radio (ICG), telephones and pagers (BART, WMATA), PA systems (BART, MARTA) and use of passenger aid phones (MARTA).

Among their duties, maintenance technicians are frequently used by the transit systems to retrofit AFC equipment and install new equipment (ICG, WMATA, MARTA). BART performs only supervision of contractor retrofits and installations.

Special diagnostic aids and tools are generally employed by the transit systems to assist in maintaining AFC equipment. Frequently, AFC equipment has built in self diagnostic capabilities to indicate which part of the operation cycle or subsystem has malfunctioned (ICG, WMATA, MARTA). BART also has a special test box for diagnosing problems on its IBM gates. MARTA uses portable ticket readers and time generators. Since PATH personnel can't open AFC equipment without a coin box operator and security officer present, attempts are initially made to clear jams by using special metal and plastic probes.

Each transit system provides supervision of its maintenance technicians, although the means differ. Several systems (ICG, BART) have senior or lead technicians who serve as working foreman to provide direct supervision of maintenance technicians. On BART the lead technicians are supervised, in turn, by one foreman per shift. WMATA has one line supervisor per shift (6 shifts) who roams between stations to oversee work and provide technical guidance. MARTA and PATCO have one foreman responsible for overall supervision of maintenance technicians.

Most transit systems at one time had a program of warranty administration for their AFC equipment. These programs are now generally inactive since their AFC

equipment is beyond the warranty period. WMATA is the only exception found with an active warranty program and a manager of warranty administration. The warranty period is one year for new AFC equipment on WMATA.

All the transit systems have additional staff to provide engineering and analytical support to their maintenance programs. The various support activities encountered on different transit systems include the following:

- maintainability, reliability and availability engineering.
- configuration control.
- system design and specification.
- preparation of maintenance manuals and procedures.
- design of corrective actions.
- supervision of installations and retrofits.
- selection of alternative systems/subsystems.

# 4. CONCLUSIONS/RECOMMENDATIONS

AFC equipment maintenance practices of the rail transit systems investigated exhibited many general similarities. Several notable exceptions were observed, however, which might prove useful in improving equipment reliability if they were more widely implemented.

While all transit systems have programs for preventive maintenance, only one had a maintenance crew fully dedicated to this function. Such a practice could enhance the quality of preventive maintenance efforts. The scheduling of preventive maintenance by several transit systems is automatically performed by computer based systems and is also monitored by an automated updating procedure. These systems may provide better assurance that required maintenance is performed.

One transit system has requirements for additional training if maintenance technicians desire higher levels of certification. Such a program provides an incentive for technicians to improve their level of expertise.

Several transit systems have automated systems for managing records of maintenance problems and subsequent maintenance actions. These systems greatly enhance the ability of transit systems to develop information and perform analyses that will lead to more effective maintenance practices.

Analysis of the maintenance practices information suggests that more complex AFC systems permit greater operational flexibility and reduce the need for station attendants. However, these systems also require more intensive maintenance programs. In addition, the passenger processing time is generally higher for the more complex AFC systems.

It is recommended that further analyses of maintenance practices be conducted and include consideration of reliability statistics for AFC equipment on the different transit systems. If relationships between certain maintenance practices and AFC equipment reliability can be established, this information would prove useful in developing more effective maintenance programs.

# APPENDIX A

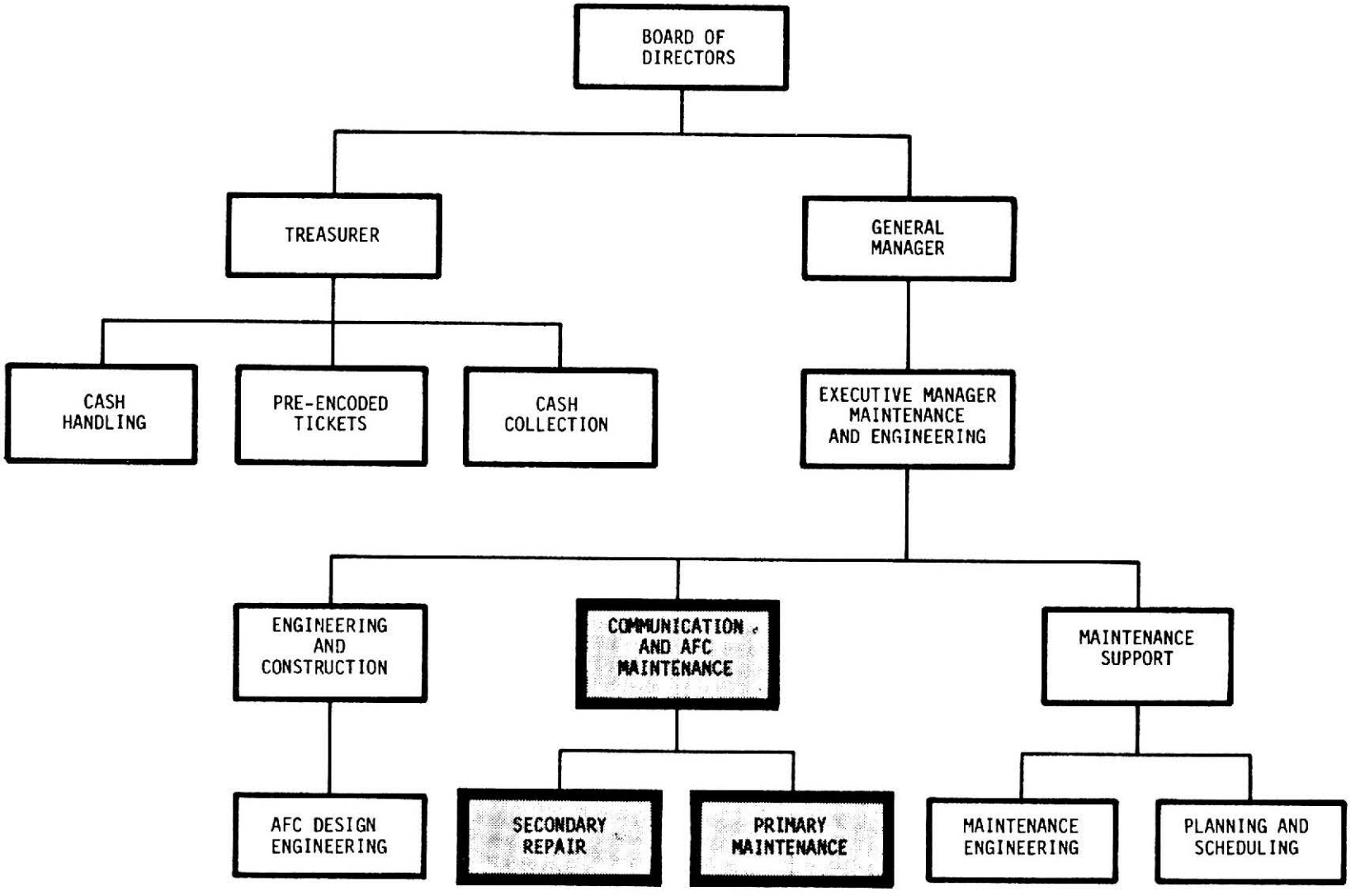
## TRANSIT AGENCY

## ORGANIZATIONAL CHARTS

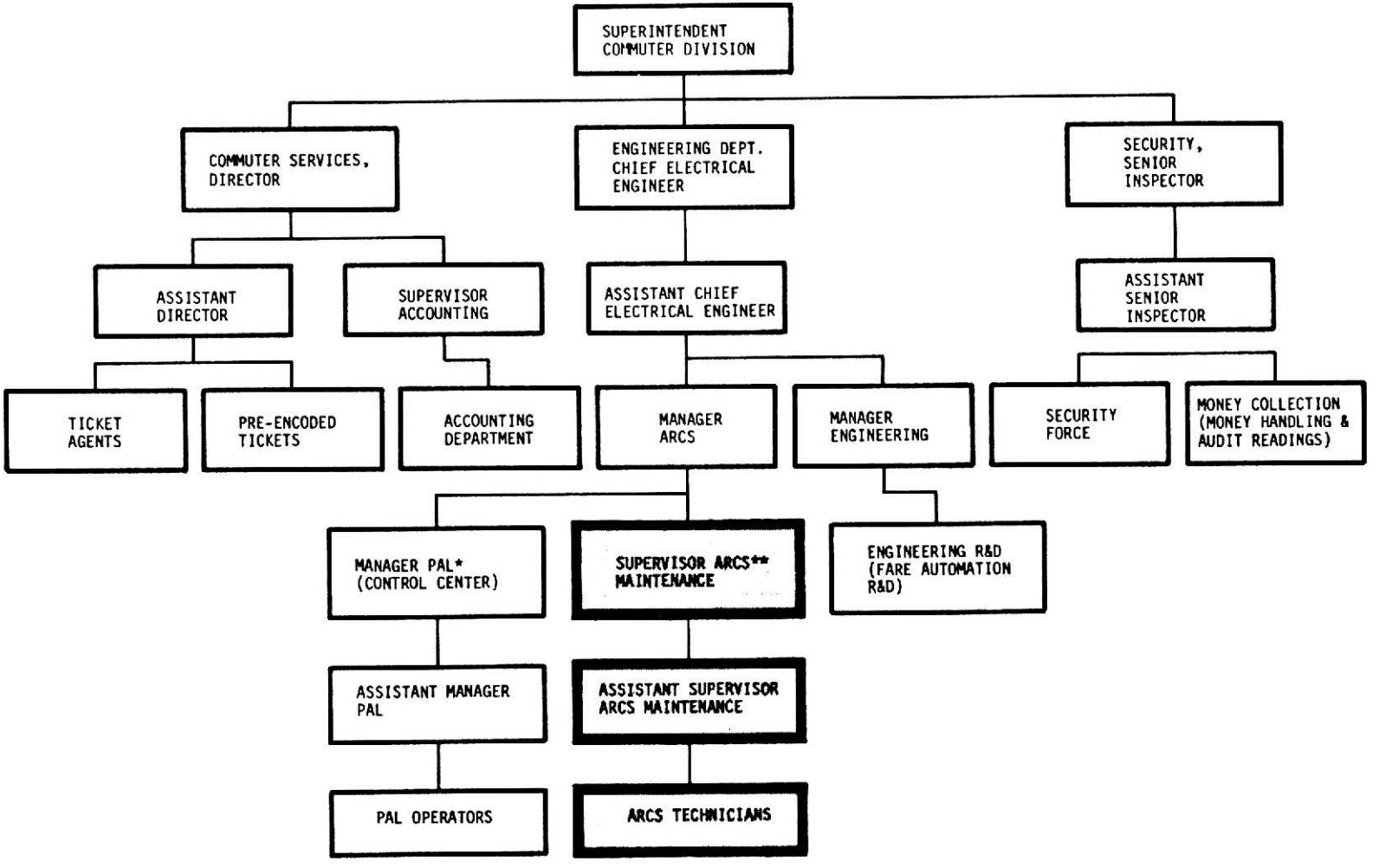
The purpose of this Appendix is to show the fare collection maintenance and revenue handling responsiblities, including staffing support and functions, within the overall organization of the rail tranist systems. Although incomplete, the organizational charts at several systems (listed below) are included with the fare collection maintenance responsibilities highlighted. Further planned maintenance study efforts by the Department of Transportation will build upon this format to make the charts as complete as possible.

BART
ICG
LIRR
MARTA
MBTA
PATCO
PATH
WMATA

BART

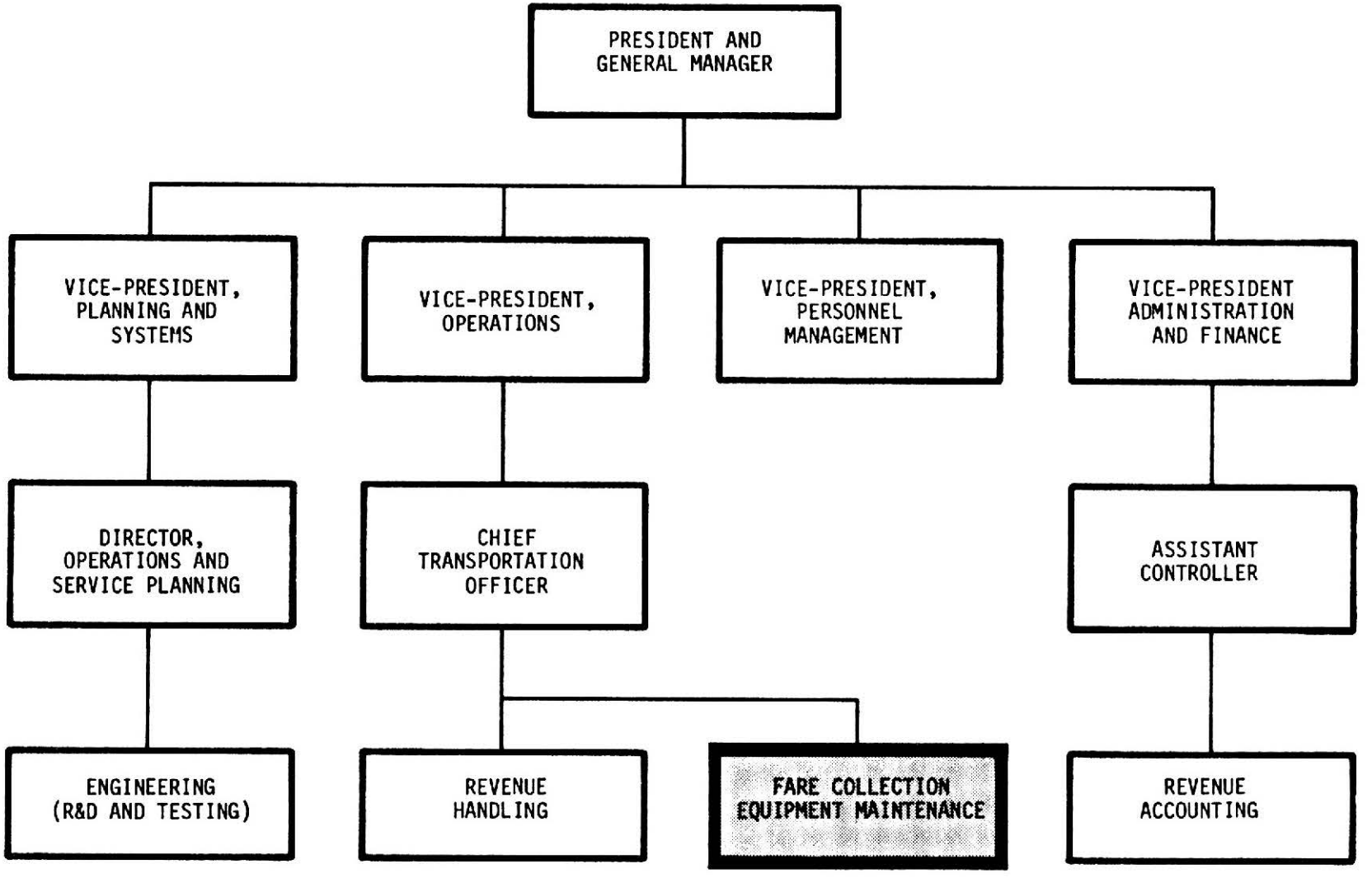

BOARD OF DIRECTORS
TREASURER
GENERAL MANAGER
CASH HANDLING
PRE-ENCODED TICKETS
CASH COLLECTION
EXECUTIVE MANAGER MAINTENANCE AND ENGINEERING
ENGINEERING AND CONSTRUCTION
COMMUNICATION AND AFC MAINTENANCE
MAINTENANCE SUPPORT
AFC DESIGN ENGINEERING
SECONDARY REPAIR
PRIMARY MAINTENANCE
MAINTENANCE ENGINEERING
PLANNING AND SCHEDULING

ICG

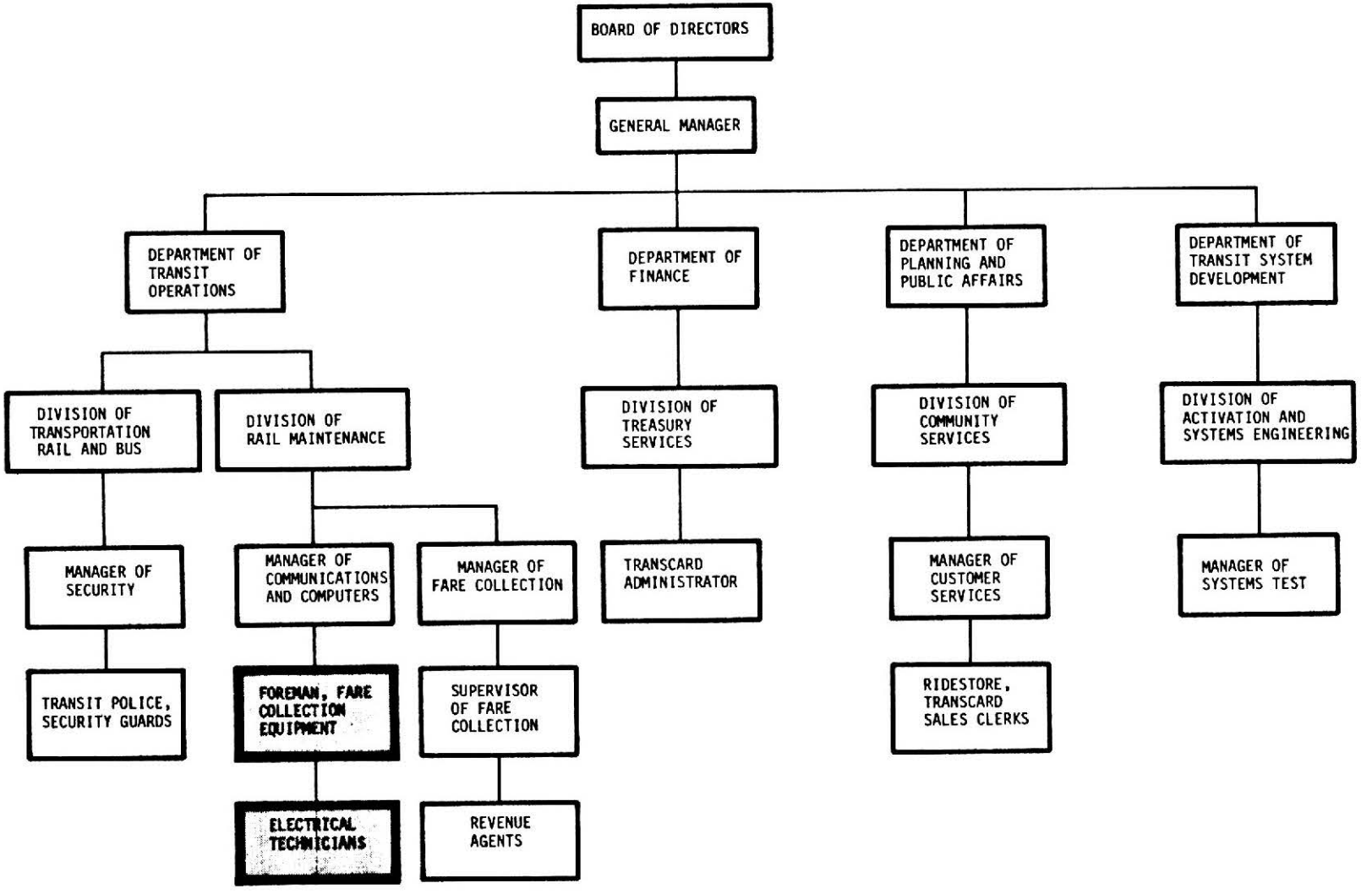



*PASSENGER ASSISTANCE LINE
**AUTOMATIC REVENUE COLLECTION SYSTEM

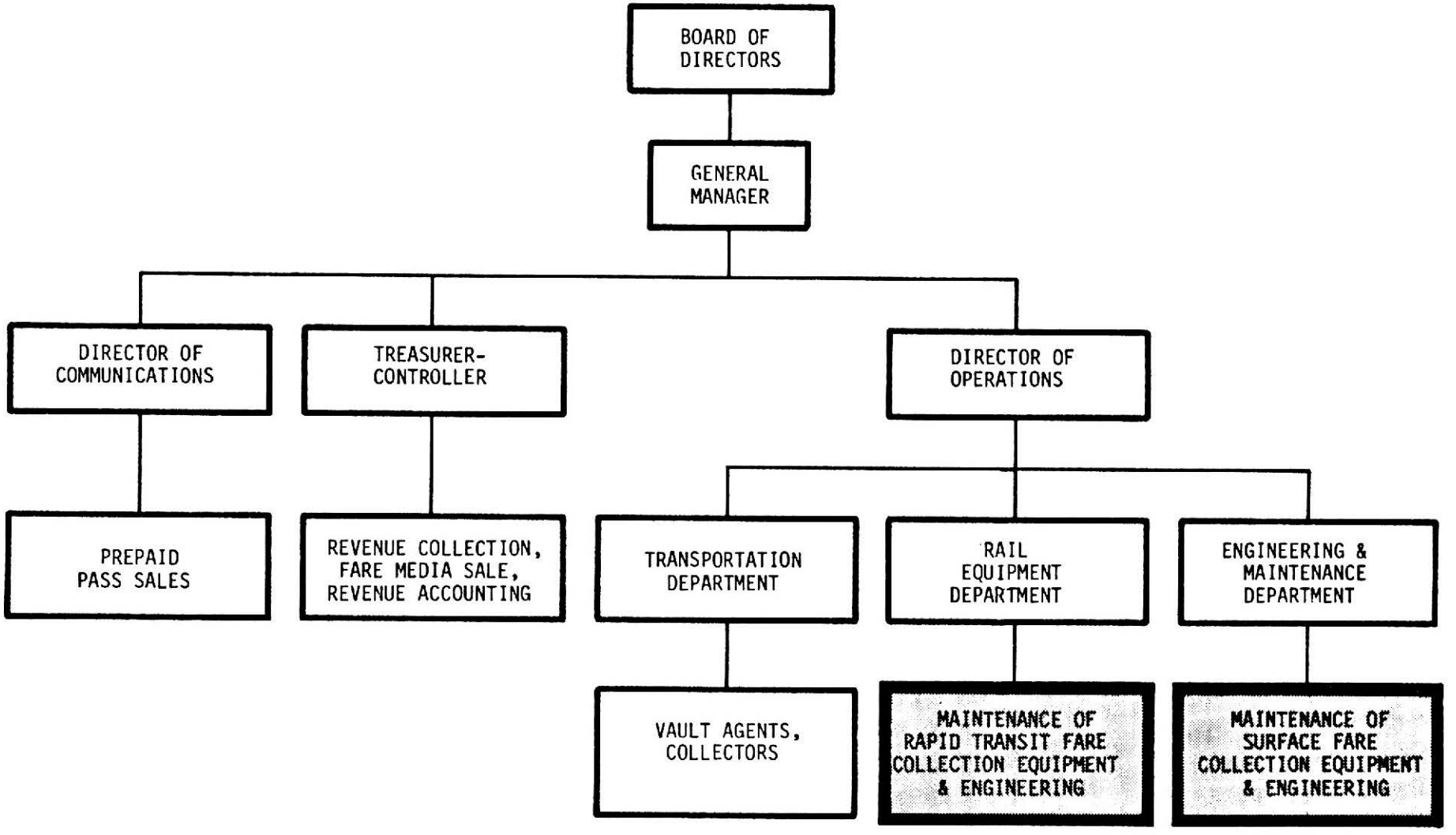
LIRR


PRESIDENT AND GENERAL MANAGER
VICE-PRESIDENT, PLANNING AND SYSTEMS
VICE-PRESIDENT, OPERATIONS
VICE-PRESIDENT, PERSONNEL MANAGEMENT
VICE-PRESIDENT ADMINISTRATION AND FINANCE
DIRECTOR, OPERATIONS AND SERVICE PLANNING
CHIEF TRANSPORTATION OFFICER
ASSISTANT CONTROLLER
ENGINEERING (R&D AND TESTING)
REVENUE HANDLING
FARE COLLECTION EQUIPMENT MAINTENANCE
REVENUE ACCOUNTING

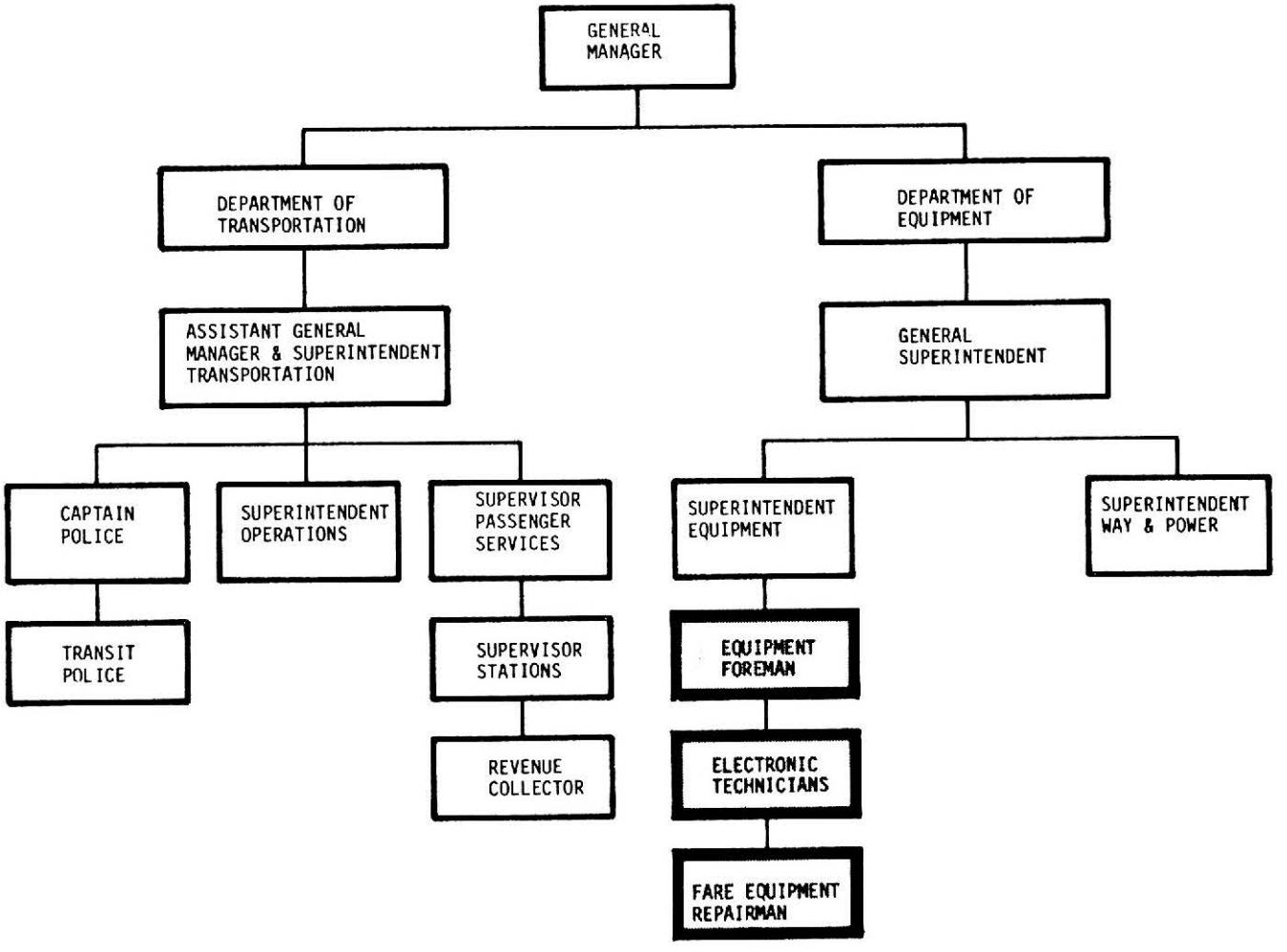
MARTA


BOARD OF DIRECTORS
GENERAL MANAGER
DEPARTMENT OF TRANSIT OPERATIONS
DEPARTMENT OF FINANCE
DEPARTMENT OF PLANNING AND PUBLIC AFFAIRS
DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT
DIVISION OF TRANSPORTATION RAIL AND BUS
DIVISION OF RAIL MAINTENANCE
DIVISION OF TREASURY SERVICES
DIVISION OF COMMUNITY SERVICES
DIVISION OF ACTIVATION AND SYSTEMS ENGINEERING
MANAGER OF SECURITY
MANAGER OF COMMUNICATIONS AND COMPUTERS
MANAGER OF FARE COLLECTION
TRANSCARD ADMINISTRATOR
MANAGER OF CUSTOMER SERVICES
MANAGER OF SYSTEMS TEST
TRANSIT POLICE, SECURITY GUARDS
FOREMAN, FARE COLLECTION EQUIPMENT
SUPERVISOR OF FARE COLLECTION
RIDESTORE, TRANSCARD SALES CLERKS
ELECTRICAL TECHNICIANS
REVENUE AGENTS

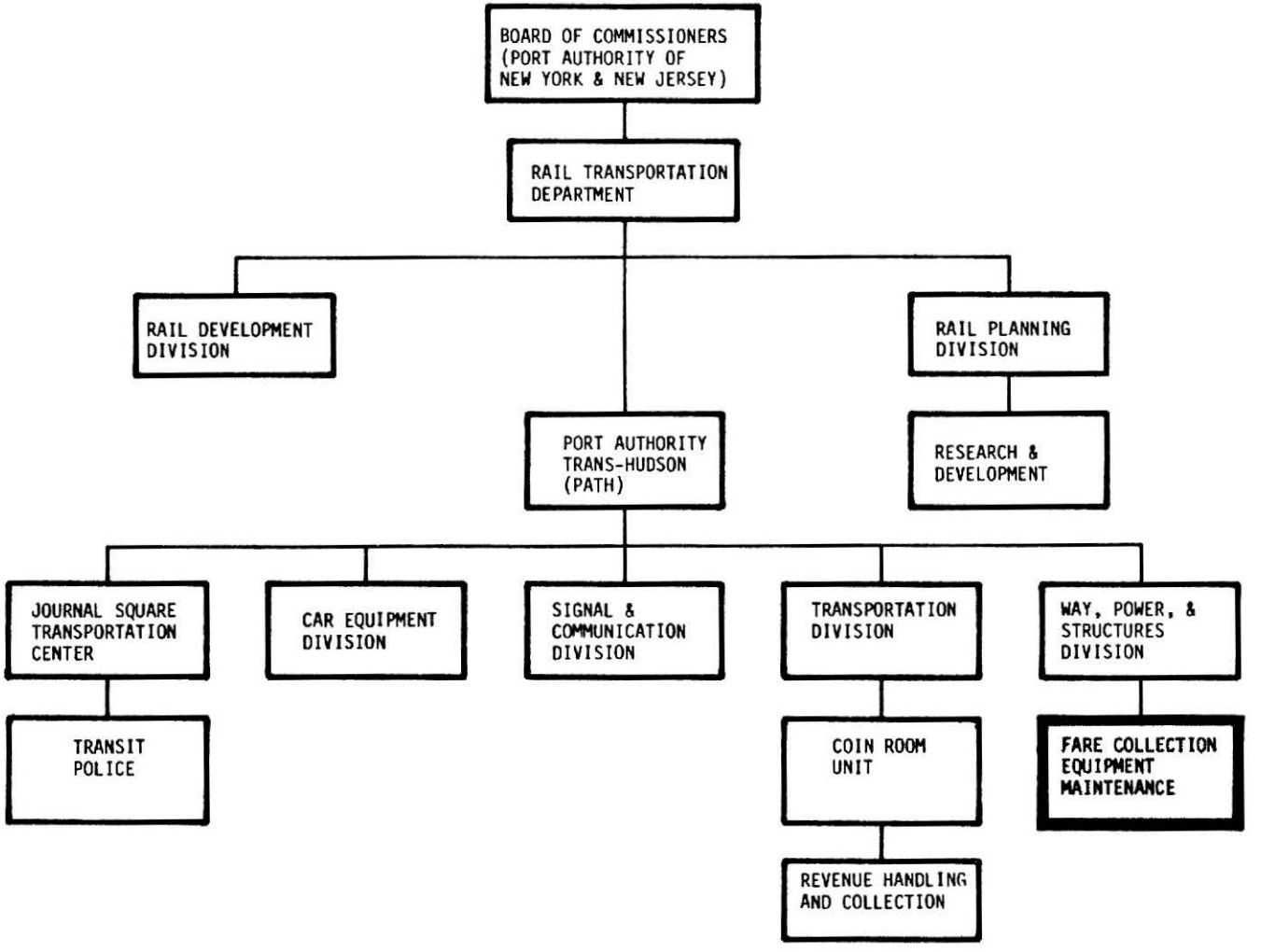
MBTA


BOARD OF DIRECTORS
GENERAL MANAGER
DIRECTOR OF COMMUNICATIONS
TREASURER-CONTROLLER
DIRECTOR OF OPERATIONS
PREPAID PASS SALES
REVENUE COLLECTION, FARE MEDIA SALE, REVENUE ACCOUNTING
TRANSPORTATION DEPARTMENT
RAIL EQUIPMENT DEPARTMENT
ENGINEERING & MAINTENANCE DEPARTMENT
VAULT AGENTS, COLLECTORS
MAINTENANCE OF RAPID TRANSIT FARE COLLECTION EQUIPMENT & ENGINEERING
MAINTENANCE OF SURFACE FARE COLLECTION EQUIPMENT & ENGINEERING

# PATCO


GENERAL MANAGER
DEPARTMENT OF TRANSPORTATION
DEPARTMENT OF EQUIPMENT
ASSISTANT GENERAL MANAGER & SUPERINTENDENT TRANSPORTATION
GENERAL SUPERINTENDENT
CAPTAIN POLICE
SUPERINTENDENT OPERATIONS
SUPERVISOR PASSENGER SERVICES
SUPERINTENDENT EQUIPMENT
SUPERINTENDENT WAY & POWER
TRANSIT POLICE
SUPERVISOR STATIONS
EQUIPMENT FOREMAN
REVENUE COLLECTOR
ELECTRONIC TECHNICIANS
FARE EQUIPMENT REPAIRMAN

# PATH


BOARD OF COMMISSIONERS (PORT AUTHORITY OF NEW YORK & NEW JERSEY)
RAIL TRANSPORTATION DEPARTMENT
RAIL DEVELOPMENT DIVISION
RAIL PLANNING DIVISION
PORT AUTHORITY TRANS-HUDSON (PATH)
RESEARCH & DEVELOPMENT
JOURNAL SQUARE TRANSPORTATION CENTER
CAR EQUIPMENT DIVISION
SIGNAL & COMMUNICATION DIVISION
TRANSPORTATION DIVISION
WAY, POWER, & STRUCTURES DIVISION
TRANSIT POLICE
COIN ROOM UNIT
FARE COLLECTION EQUIPMENT MAINTENANCE
REVENUE HANDLING AND COLLECTION

# APPENDIX B

## SAMPLE PREVENTIVE MAINTENANCE PROCEDURES

MARTA GATES - PM PROCEDURES
IGG GATE WEEKLY MAINTENANCE
ICG VENDOR WEEKLY MAINTENANCE
BART ADDFARE LUBRICATION SCHEDULE

MARTA GATES - PM PROCEDURES RECOMMENDED BY MANUFACTURER

| Location | Frequency | Item | Action |
|---|---|---|---|
| Gate array | Each shift | External appearance | Visually check for surface damage and cleanliness of each cabinet.<br><br>Ensure that all latent display covers are clean and undamaged and that when lighted, information is legible.<br><br>Verify that gates in use are properly lighted ENTER or EXIT, and gates not in use are lighted CLOSED. |
| | Each day | Coin acceptance | (1) Insert a coin and actuate PUSH FOR TRANSFER.<br><br>(2) Insert a token and actuate PUSH FOR TRANSFER.<br><br>(3) Check transfers to see that printing is centered and dark. |
| | | Turnstile | (1) Verify that the turnstile rotates in both directions and that damper functions properly. (Adjust damper only when necessary.)<br><br>(2) Verify that turnstile head bolts and arms are tight. |
| | | Displays | Verify that all LED indicators and latent displays light during lamp test. |

MARTA GATES - PM PROCEDURES RECOMMENDED BY MANUFACTURER (Continued)

| Location | Frequency | Item | Action |
|---|---|---|---|
| Gate array (cont) | Each time cabinet is opened | Access doors and panels | Check door and panel movement for binding and alignment. |
| | | Interior area of gate cabinet | Check for chafing or binding of electrical wiring. Correct any sharp edge contacts with lines. |
| | | | Check for evidence of overheating. |
| | | Cabinet locks | Check all locks to ensure proper operation and security. |
| Handicap gate | Each day | Alarm | Verify that the handicap gate alarm circuit is functioning by exiting the gate in the correct direction to check that the alarm does not sound and then by attempting to gain illegal entry to check that the alarm does sound. |
| | Every 30 days | Barrier | (1) Check barrier for proper closing and latching. |
| | | | (2) Check mounting hardware for tightness. |
| Ticket transport | Each day | Magnetic heads | Check magnetic heads for cleanliness. |
| | | Pinch rollers | Check drive and pressure rollers for signs of excessive wear. |
| | | LED lenses and phototransistors | Check for cleanliness. |

MARTA GATES - PM PROCEDURES RECOMMENDED BY MANUFACTURER (Continued)

| Location | Frequency | Item | Action |
|---|---|---|---|
| Ticket transport (cont) | Each day (cont) | Transport belts | Check transport belts for excessive wear and cleanliness. |
| Coin acceptor | Each day | Housing | Verify that the acceptor housing is correctly mounted. |
| | | Coin return | Check coin-return mechanism for correct adjustment and operation. |
| | | Coin vault | Check to see if the vault is approaching capacity. (View through coin channel.) |
| | Every 30 days | LED lenses and phototransistors | Verify that all LED and phototransistor lenses are in place. |
| | | Housing door | Verify that the door of the acceptor housing closes freely and completely triggering both microswitches. |
| Transfer dispenser | Each day | Printer | Check for acceptable print quality. |
| | | Paper roll | Check supply of stock remaining on the roll. |
| | Every 30 days | Assembly | Check all bolts for tightness. (Do not overlook allen screws on timing shaft.) |

1. Check clock and calendar.

2. Clean handler transport belt and all rollers.

3. Check all PAL functions

   A. Entry credit
   B. Exit credit
   C. Gate release
   D. Error inhibit
   E. Gate interim
   F. Out of service indication from each handler.
   G. Entry-Exit credit when gate is out of service.

4. Check for proper operation of all gates.

   A. Anti shutdown
   B. Anit pass back
   C. Run 2 paper and plastic tickets with 69 rides down in each handler.
   D. Check expiration date with tickets encoded for minimum and maximum date.
   E. Check station code with tickets encoded good in other than the zone the gates are located.
   F. Check with a zero ride ticket with a time other than the four hours which is good.
   G. Check error inhibit for station code error and 3 hour entry-exit.

5. Handler

   A. Check handlers for proper operation.
   B. Check for noisy handlers - replace and rebuild when found.
   C. Clean belts, rollers, sensors and magnetic heads.
   D. Check idler rollers for flat spots.
   E. Check to make sure that the allen screws on the belt driver roller is tight, to avoid slippage of belt and possible short tracks.
   F. Check return and capture roller set screws, make sure they are tight.
   G. Check for proper travel of ticket through handler and gate top cover.
   H. Observe and make sure there are no loose screws on handlers, especially the handler latch screws.

6. Check turnstile and adjust if necessary, for proper operation of the damper, latching and credit subtracting mechanisms.

OVERALL

1. Clean gates.
2. Remove tickets from captures.

ICG
VENDOR WEEKLY MAINTENANCE

1. Clean handler and all ticket transport rollers.

2. Check handler belts and print ribbon.

3. Check all zone push buttons, observe pay this amount display for proper fare. Select a ticket for one dollar or more and use one dime, half dollar, quarter and one nickel. Observe pay this amount display for proper subtraction. Check all zone push buttons, lights and other bulbs and replace burned out bulbs.

4. Test dispense two tickets (Check one for)
   1. Expiration date
   2. Number of rides (one-way, round-trip or weekly) and (ticket type)
   3. Length of clock track (2.6") and for skew
   4. Printer (proper date and clarity) and (handler number)
   5. Encoding should start about .4" from leading edge
   6. Return the other ticket to Supervisor's office

5. Bill Validator
   A. Accepting ones and fives (proper credit)

6. Coin Acceptor
   A. Accepting nickels, dimes, quarters and halves (proper credit)

7. Check the following items
   A. Card 13 for proper expiration date and clock setting
   B. Ticket stacker for refilling of tickets
   C. Check capture bin for captured tickets
   D. Check the last day of the month for proper setting
   E. When OSS should reject all coins and bill validator should not start
   F. Coin hoppers for change
   G. Check batt with meter should read 4.2 V.D.C., replace if necessary

8. When the logic switch is turned off and on, the trip and audit counters should be checked to make sure they don't advance. Also, check for proper expiration date and printer date.

9. Clean exterior/interior when temperature is above freezing.

### IBM ADDFARE LUBRICATION SCHEDULE

I. PURPOSE

Lubrication is applied to various moving parts to reduce friction or prevent rust.

II. MATERIALS REQUIRED

A. Lubricant IBM #12, Stock #91-50-51904
B. Lubricant IBM #23, Stock #91-50-51908
C. Lubricant, WD 40, Stock #91-50-51810
D. Texpad Texwipe, Stock #79-20-60005

III. GENERAL

A. Do not apply lubricant to any surface unless specifically called out in the procedure.
B. Clean lubricant from hands prior to working on adjustment procedure.
C. Should a lubricant be smudged onto an unwanted clean surface, remove with a texwipe alcohol pad.
D. Remove any excess lubrication.
E. Any lubricant that appears dried out or hard, should be removed prior to the addition of new lubricant.
F. Use IBM manuals for parts and assembly reference.

IV. SAFETY

A. Turn power off to prevent the starting of moving machinery while lubricant is being applied.

V. PROCEDURE

A. Transport (See Figures 1 thru 6)

1. Inject and Drive pressure roll two-leaf spring and pin contact points.
2. Inject and Drive pressure roll two-pivot points.
3. Main drive belt idler spring and pivot points.
4. Read, write, and verify casting pivot points.
5. Magnetic selected pressure roll leaf spring and pin contacts.
6. Magnetic selected pressure roll retainer spring contact with shaft end.
7. Lockout gate return extension spring.
8. THM slides.
9. Magnetic selected pressure roll detent pin and armature contact. (See Figure 7).

B. Coin Acceptor (See Figures 1 thru 6)

1. Transfer cradle pins and bushings.

C. Escrow (See Figures 1 thru 6)

1. Escrow Cup Shaft.

D. Pushbutton Assembly (See Figures 1 thru 6)

1. Shafts behind the pushbuttons where they pass through the sheet metal pushbutton housing.
2. Bent coin release assembly at all pints where metal surfaces slide or rotate against each other.

E. Door Assembly (See Figures 1 thru 6)

1. Latch cam grooves and pins..
2. Latch rod guides and clamps.
3. Latch rod strike surfaces.
4. Latch strikers - where rods engage.
5. Slot and Top of door mounted staybrace stop.
6. Spring plunger and stop pin on cabinet mounted staybrace.

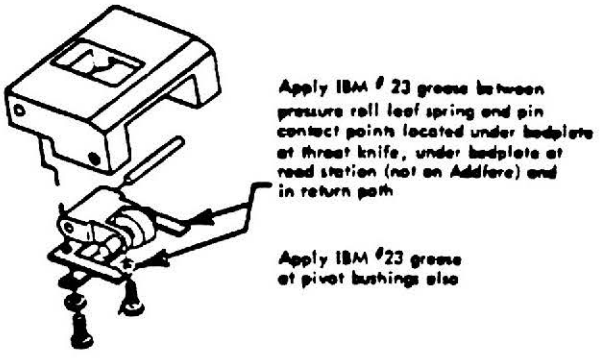



FIGURE 1 LUBRICATION-PRESSURE ROLL

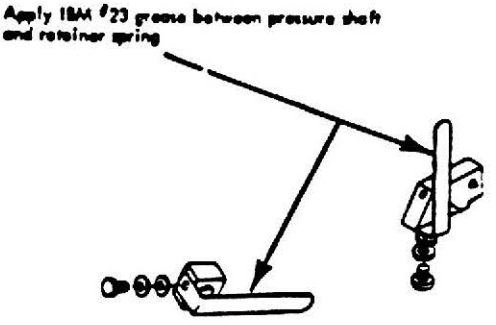



FIGURE 4 LUBRICATION-RETAINER SPRING

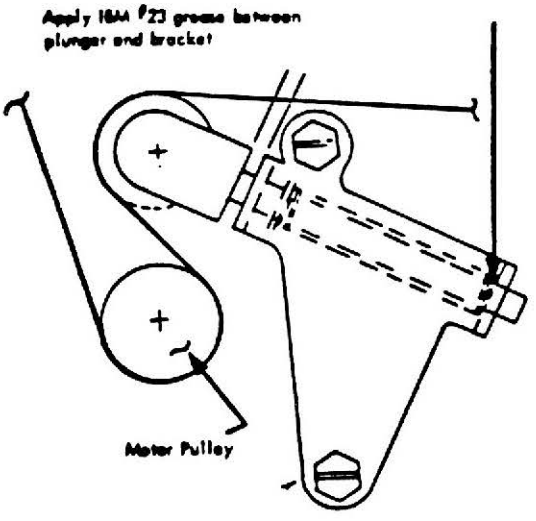



FIGURE 2 LUBRICATION IDLER ASSY.

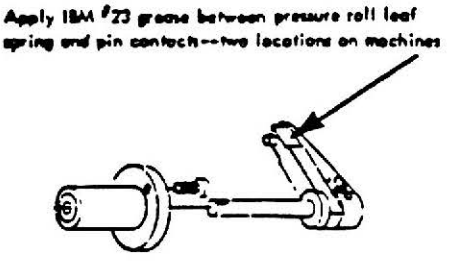



FIGURE 3 LUBRICATION-PRESSURE ROLL SPRING

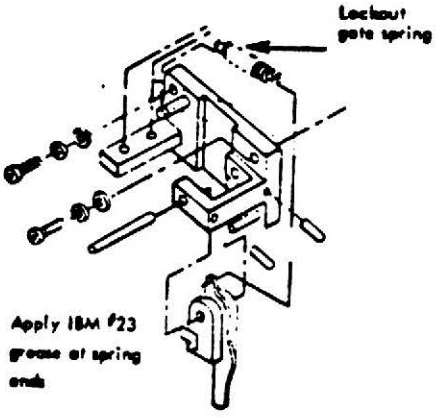
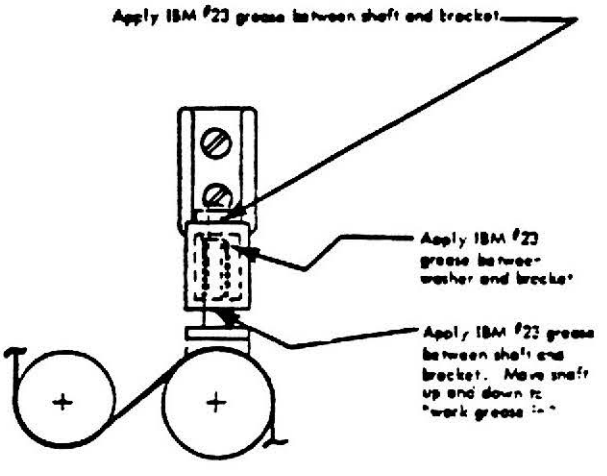



FIGURE 5 LUBRICATION-LOCKOUT GATE




(Note: These lubrication instructions apply also to the belt tighteners (2) on the Return Path Assembly)

FIGURE 6 LUBRICATION-RETURN PATH ASSY.

F. Lubricate with lubriplate: Return money, bent coin release, etc., shafts for operational ease. Adjust travel of shafts if required.

G. Lubricate with lubriplate all lock cylinders, hinges for doors, or panels, "T" handles, closing bolts and bearing surfaces. Exercise for operational smoothness.

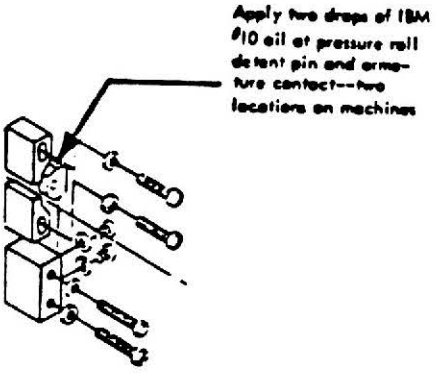



FIGURE 7 LUBRICATION-PRESSURE ROLL DETENT

# APPENDIX C

## SAMPLE MAINTENANCE ACTION REPORTS

ICG
TICKET VENDOR TROUBLE SHEET

DATE
AREA

| Tech. | Time | Station | Vendor | O.O.S. | StateA-8 | Low Tkts. | NickelJam DropSlide | NickelJam Inside Hop. | Quarter Jam DropSlide | QuarterJam Inside Hop. | Escrow Bill Jam | Validator Bill Jam | Validator Miscredit. | Validator NotAccpt. | Coin Jam Acceptor | BentCoin | Calender | Logic | Printer | Vandalism | Other | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | |

ICG
GATE TROUBLE SHEET

DATE _____

AREA _____

| Tech. | Time | Station | Gate* | Hand. * | Handler Closed | NAR | Ticket Jam | Throat Sensor | Read Sensor | Write Sensor | Return Sensor | Cap Sensor | Cap Flag | Turnstile | Logic | Heater | Vandalism | Other than Listed | OTHER REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |

MARTA

DAY MONDAY DATE 4/11/83 PAGE 1

| TIME | LOCATION | GATE | DISCREPANCY | TECH | |
|---|---|---|---|---|---|
| | ARTS | P/m's | | WD | V |
| | MIDTOWN | P/m's | | WD | 9:32 |
| | Dec | 3 | No Xfers | JJ | 959 |
| | | 4 | " " | JJ | " |
| | N Ave | P/m's | | WD | 10:10 |
| 1020 | W E | 7 | Coin Jam | WD | |
| 1022 | Dec | 4 | END > | JJ | |
| " | | 5 | " " | JJ | |
| | Ashby | H/C | Jammed | WR | |
| | W E | 8 | Turnstile too tight | WD | |
| | W E | 4 | No Xfers | WD | |
| | 5 Point | 4 | OOS | NJ | |
| | Art Center | 3 | Lock with coins | B.G. | |
| | Civic Center | North Handi | [redacted] No Xfers | JJ | |
| | Vine | 8 | Takes Xfers | JJ | |
| | ARTS | 40 | Card Jam | WD | |
| 1420 | N Ave | 20 | Won't Accept X Cards | B.G. | |
| | C C | 2 | Won't accept Xfers | B.G. | |
| | N Ave | 4 | No Xfers | B.G. | |
| | Pl Station | 8 | Jammed Card | | |
| | Ashby | 4 | Xfer Stuck in gate | JG | |
| | Dec | 5 | No Xfers | BG | |
| 1610 | CAND | 5 | No XFERS | RB | |
| 1645 | No Ave | 22 | Won't Accept Cards | BL | |
| 1645 | No Ave | 20 | Won't Reset | BG | |
| 1645 | CAND | 6 | No XFERS | RB | |

PLEASE DO NOT TEAR SIDES OFF SHEET-WE KEEP THESE PERMANENTLY IN A NOTEBOOK.

1645 RAT CIR ? Already Done BG

MARTA

DAY ____ DATE 4/11/83 PAGE 2

| TIME | LOCATION | GATE | DISCREPANCY | TECH | | |
|---|---|---|---|---|---|---|
| ~ | CC | 9 | Problem w/ Ends Panel Fwd End | BG | | |
| 1945 | WestEnd | 4 | Won't Stay ON | BG | | |
| 2115 | CHNI | 20 | Tearing Cards | WH | | |

PLEASE DO NOT TEAR SIDES OFF SHEET-WE KEEP THESE PERMANENTLY IN A NOTEBOOK.

STATION:_____CONSOLE:____SERIAL_#_____TIME:_____DATE:__/__/__
Central Control Reported:_____

| | | |
|---|---|---|
| [ ]Out of Service | [ ]Not Issuing Xfers | [ ]Not Accepting Tickets |
| [ ]Coin Jam | [ ]Wrong Date/Time Xfers | [ ]Not Accepting B/R's |
| [ ]Accepts Fare No Entry | [ ]Short Transfers | [ ]Not Accepting Weekly's |
| [ ] Rejecting Coins | [ ]Not Printing Xfers | [ ]Not Accepting Monthly's |

| | | |
|---|---|---|
| [ ]OUT OF SERVICE | [ ]XFER DISPENSER PROBS | [ ]Replaced Broken Hub |
| [ ]Ram Error | [ ]Paper Jam At Bezel | [ ]Other Turnstile Mech. |
| [ ]Rom Error | [ ]Paper Jam At Blade | [ ]Turnstile Electrical |
| [ ]Ticket/Xfer Jam Sensor | [ ]Mechanical Problem | [ ]MASTER CLOCK PROBS |
| [ ]Transfer Power Loss | [ ]Electrical Problem | [ ]Set Clock |
| [ ]Transfer Paper Low | [ ]Replaced Ribbon | [ ]Correct Elect. Prob. |
| [ ]Money Bag 2 Full/ Write Fail | [ ]Correct Ribbon Reverse | [ ]Replaced Battery |
| | [ ]Set Clock | [ ]Check/Adjusted Charger |
| [ ]Reload Variable Data | [ ]Correct Clock Mechanical | [ ]Replaced Master Clock |
| [ ]Money Bag Full | [ ]Replaced Dispenser | [ ]REPLACED LAMPS |
| [ ]Replaced I.C.'s | [ ]TICKET TRANSPORT PROBS | [ ]CABINET & LOCK PROBS |
| [ ]Money Jam | [ ]Cleared Ticket | [ ]Lock Misaligned |
| [ ]Reseated Chips | [ ]Diverter Adjusted | [ ]POWER SUPPLY PROBS |
| [ ]No Leds Lit | [ ]Correct Transport Mech. | [ ]Power Supply Replaced |
| [ ]No Jam Found | [ ]Correct Transport Elec. | [ ]LOOSE CONNECTION |
| [ ]Intrusion Indicated | [ ]Correct Blocker | [ ]Adjusted Passenger Sen. |
| [ ]Reset Logic | [ ]Replaced Transport | [ ]Corrected A15 Board |
| [ ]COIN ACCEPTOR PROBS | [ ]TURNSTILE PROBS | [ ]REPLACED OPTICAL SENSOR |
| [ ]Cleared Coin Jam | [ ]Cleaned/Adjust Solenoid | [ ]REPLACED DISPLAY PCB |
| [ ]Cleaned Coin Acceptor | | [ ]NO PROBLEM FOUND |
| [ ]Loose Plug On Acceptor | [ ]Adjusted Damper | [ ]PATRON MISUSE |
| [ ]Replaced C Acceptor | [ ]Tightened Arm/Hub | [ ]DAILY PM'S |

CORRECTIVE MAINTENANCE:_____
_____TIME:_____TECHNICIAN:_____

# APPENDIX D

## SAMPLE COMPUTER GENERATED MAINTENANCE STATISTICS REPORTS

MARTA

MAINTENANCE REPORTS PER STATION

FOR PERIOD BEGINNING 02/18/83 AND ENDING 03/03/83

| STATION | MR TTL | MR N/C |
|---|---|---|
| AVONDALE | 8 | 2 |
| DECATUR | 8 | 5 |
| EAST LAKE | 6 | 0 |
| CANDLER PARK | 1 | 0 |
| INMAN PARK | 1 | 0 |
| KING MEMORIAL | 1 | 0 |
| GEORGIA STATE | 18 | 4 |
| EAST LINE TOTAL | 43 | 11 |
| FIVE POINTS | 22 | 4 |
| OMNI | 8 | 1 |
| VINE CITY | 5 | 3 |
| ASHBY | 3 | 0 |
| WEST LAKE | 10 | 3 |
| HIGHTOWER | 7 | 1 |
| WEST LINE TOTAL | 55 | 12 |
| LAKEWOOD | 0 | 0 |
| OAKLAND | 0 | 0 |
| WEST END | 14 | 5 |
| GARNETT | 1 | 0 |
| PEACHTREE CENTER | 10 | 0 |
| CIVIC CENTER | 2 | 0 |
| NORTH AVENUE | 17 | 1 |
| MIDTOWN | 8 | 0 |
| ARTS CENTER | 8 | 0 |
| LINDBERGH | 0 | 0 |
| LENOX | 0 | 0 |
| NORTH/SOUTH LINE TOTAL | 60 | 6 |
| COMBINED TOTALS | 158 | 29 |

MARTA

MAINTENANCE REPORTS PER PROBLEM TYPE

FOR PERIOD BEGINNING 02/18/83 AND ENDING 03/03/83

| PROBLEM DESCRIPTION | EAST | WEST | N/S | TOTAL |
|---|---|---|---|---|
| TRANSFER DISPENSER PROBLEMS: | | | | |
| PAPER JAM | 5 | 3 | 3 | 11 |
| MECHANICAL | 3 | 4 | 4 | 11 |
| ELECTRICAL | 0 | 0 | 0 | 0 |
| RIBBON REPLACEMENT | 0 | 5 | 2 | 7 |
| RIBBON MECHANICAL | 0 | 0 | 0 | 0 |
| CLOCK SET | 2 | 0 | 3 | 5 |
| CLOCK MECHANICAL | 0 | 0 | 0 | 0 |
| REPLACED | 0 | 0 | 0 | 0 |
| TOTALS | 10 | 12 | 12 | 34 |
| COIN ACCEPTOR PROBLEMS: | | | | |
| COIN JAM | 1 | 2 | 5 | 8 |
| MECHANICAL | 0 | 0 | 3 | 3 |
| ELECTRICAL | 0 | 0 | 1 | 1 |
| RETURN MECHANISM | 0 | 0 | 0 | 0 |
| REPLACED | 0 | 0 | 2 | 2 |
| TOTALS | 1 | 2 | 11 | 14 |
| CARD TRANSPORT PROBLEMS: | | | | |
| TICKET JAM | 5 | 8 | 5 | 18 |
| MECHANICAL | 2 | 3 | 5 | 10 |
| ELECTRICAL | 0 | 0 | 0 | 0 |
| DIVERTER | 1 | 0 | 2 | 3 |
| BLOCKER | 0 | 0 | 0 | 0 |
| HEATER/THERMOSTAT | 0 | 0 | 0 | 0 |
| REPLACED | 0 | 0 | 0 | 0 |
| TOTALS | 8 | 11 | 12 | 31 |
| CENTRAL ELECTRONICS PCB PROBLEMS: | | | | |
| RAM/ROM | 0 | 0 | 0 | 0 |
| TICKET/XFER JAM/SENSOR FAIL | 2 | 1 | 1 | 4 |
| COIN IN RETENTION | 0 | 0 | 1 | 1 |
| MONEY BAG TWO FULL/WRITE FAIL | 0 | 6 | 1 | 7 |
| REPLACED IC | 1 | 0 | 0 | 1 |
| INTRUSION | 2 | 0 | 1 | 3 |
| NO INDICATION - RESET LOGIC | 0 | 2 | 2 | 4 |
| RESEATED CHIPS | 2 | 1 | 0 | 3 |
| RELOADED VARIABLE DATA | 4 | 6 | 7 | 17 |
| REPLACED | 0 | 0 | 0 | 0 |
| TOTALS | 11 | 16 | 13 | 40 |

MARTA

MAINTENANCE REPORTS PER PROBLEM TYPE

FOR PERIOD BEGINNING 02/18/83 AND ENDING 03/03/83

| PROBLEM DESCRIPTION | EAST | WEST | N/S | TOTAL |
|---|---|---|---|---|
| TURNSTILE PROBLEMS: | | | | |
| SOLENOID | 0 | 0 | 0 | 0 |
| ADJUST DAMPER | 0 | 2 | 0 | 2 |
| ADJUST HUB/ARM | 0 | 0 | 1 | 1 |
| BROKEN HUB | 0 | 0 | 0 | 0 |
| MECHANICAL | 1 | 2 | 1 | 4 |
| ELECTRICAL | 0 | 0 | 0 | 0 |
| TOTALS | 1 | 4 | 2 | 7 |
| MASTER CLOCK PROBLEMS: | | | | |
| SET TIME/DATE | 0 | 0 | 1 | 1 |
| ELECTRICAL | 0 | 0 | 0 | 0 |
| BATTERY | 0 | 0 | 0 | 0 |
| REPLACED | 0 | 0 | 0 | 0 |
| TOTALS | 0 | 0 | 1 | 1 |
| LAMP REPLACEMENTS: | 1 | 2 | 0 | 3 |
| CABINET AND LOCK PROBLEMS: | 0 | 0 | 4 | 4 |
| HANDICAP BARRIER PROBLEMS: | 0 | 0 | 0 | 0 |
| POWER SUPPLY PROBLEMS: | 0 | 0 | 1 | 1 |
| MISCELLANEOUS HARDWARE PROBLEMS: | | | | |
| LOOSE CONNECTION | 0 | 0 | 0 | 0 |
| PASSENGER SENSOR | 0 | 0 | 0 | 0 |
| A15 BOARD | 0 | 0 | 0 | 0 |
| OPTICAL SENSOR PCB | 1 | 1 | 0 | 2 |
| READ/WRITE PCB | 0 | 0 | 0 | 0 |
| SIGNAL CONDITION PCB | 0 | 0 | 0 | 0 |
| SOLENOID DRIVER PCB | 0 | 0 | 0 | 0 |
| JUNCTION BOX PCB | 0 | 0 | 0 | 0 |
| DISPLAY PCB | 0 | 2 | 0 | 2 |
| PUSH FOR TRANSFER SWITCH | 0 | 0 | 0 | 0 |
| CIRCUIT BREAKER REPLACED | 0 | 0 | 0 | 0 |
| VAULT/COIN BAG | 0 | 0 | 0 | 0 |
| OTHER MECHANICAL | 0 | 0 | 0 | 0 |
| OTHER ELECTRICAL | 0 | 0 | 0 | 0 |
| TOTALS | 1 | 3 | 0 | 4 |

MARTA

MAINTENANCE REPORTS PER PROBLEM TYPE

FOR PERIOD BEGINNING 02/18/83 AND ENDING 03/03/83

| PROBLEM DESCRIPTION | EAST | WEST | N/S | TOTAL |
|---|---|---|---|---|
| OPERATIONS PROBLEMS: | | | | |
| MONEY BAG FULL | 0 | 1 | 0 | 1 |
| INCORRECT BUS-RAIL TRANSFER | 0 | 0 | 0 | 0 |
| TRANSFER PAPER LOW | 0 | 0 | 0 | 0 |
| DOOR OPEN | 2 | 1 | 0 | 3 |
| REROUTED TRANSFER PAPER | 0 | 0 | 0 | 0 |
| PATRON MISUSE | 0 | 0 | 1 | 1 |
| OTHER | 4 | 1 | 0 | 5 |
| TOTALS | 6 | 3 | 1 | 10 |
| NO PROBLEM FOUND: | 4 | 2 | 3 | 9 |
| COMBINED TOTALS | 43 | 55 | 60 | 158 |

```
MRSPCD0A        MAINTENANCE AND RELIABILITY INFORMATION SYSTEM        11/16/82
FUNCTION: HISTORY EQUIPMENT                                          11.32.26
                                   WAYSIDE TRACKING
AUTOMATIC FARE COLLECTION         -INCIDENT HISTORY-
    EQUIP NO  LOC  OPEN INCD  STATUS
    1001      M16     04      SERVICEABLE

    EQUIP NO  LOC  OPEN INCD  STATUS
    1002      M90     01      SERVICEABLE

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  REPAIRED DATE/TIME  DOC NO
 N329527D   4000   M90     08/06/82 14:10      08/06/82 00:00     01
DEDUCTS FARE BUT DOES NOT PRINT VALUE ON TICKET OR OPEN BARRIERS.
REPAIRED

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  REPAIRED DATE/TIME  DOC NO
 N329535L   4000   M90     08/10/82 16:02      08/11/82 00:00     01
ACCEPTS RVTS WILL NOT OPEN GATE
REPRD LATCH ON VERFD STATN

COMMAND:
MESSAGE: USE PF8 TO PAGE FORWARD

MRSPCD0A        MAINTENANCE AND RELIABILITY INFORMATION SYSTEM        11/16/82
FUNCTION: HISTORY EQUIPMENT                                          11.32.40
                                   WAYSIDE TRACKING
AUTOMATIC FARE COLLECTION         -INCIDENT HISTORY-
    EQUIP NO  LOC  OPEN INCD  STATUS
    1002      M90     01      SERVICEABLE

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  REPAIRED DATE/TIME  DOC NO
 N338074J   4000   M90     08/25/82 17:30      08/26/82 00:00     01
BARRIER STAYS OPEN.
RESET CP-9.

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  REPAIRED DATE/TIME  DOC NO
 N338078A   4000   M90     08/27/82 19:23      08/28/82 00:00     01
VALUE DEDUCTED, BARRIERS DONT OPEN.

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  REPAIRED DATE/TIME  DOC NO
 N338115L   4000   M90     09/22/82 20:45      09/22/82 00:00     01
BARRIERS REMAIN OPEN
RESET CP-9
COMMAND:
MESSAGE: USE PF7 TO PAGE BACKWARD   OR   PF8 TO PAGE FORWARD
```

BART

```
MRSFCD0A        MAINTENANCE AND RELIABILITY INFORMATION SYSTEM        11/16/8
FUNCTION: STATUS EQUIPMENT                                           11.35.5
                                    WAYSIDE TRACKING
AUTOMATIC FARE COLLECTION          -OPEN INCIDENTS-
    EQUIP NO  LOC  OPEN INCD  STATUS
    1001      M16     04      SERVICEABLE

    EQUIP NO  LOC  OPEN INCD  STATUS
    1002      M90     01      SERVICEABLE

 INCIDENT   SYMP   ILOC  OCCURRED DATE/TIME  INCD STATUS
 N324546B   4000   M90     02/23/82 20:25    REPAIRED
TICKET JAM IN READ STATION

    EQUIP NO  LOC  OPEN INCD  STATUS
    1003      A60     01      SERVICEABLE

    EQUIP NO  LOC  OPEN INCD  STATUS
    1004      M16     03      SERVICEABLE

COMMAND:
MESSAGE: USE PF8 TO PAGE FORWARD
```

BART

```
MRSPCD0H        MAINTENANCE AND RELIABILITY INFORMATION SYSTEM        11/16/82
FUNCTION: EQUIP STATUS/STATION                                       11.51.29
                                WAYSIDE TRACKING
    LINE NO: A10
PRINT (Y/N): N                  AFC STATUS REPORT
                                   LAKE MERRIT
EX-G STA   EN-G STA   RE-G STA   CHAN STA   VEND STA   ADD  STA   READ STA TRAN STA
1020 SER   2020 SER               4408 SER   5025 SER   6011 SER   7008 SER 8021 SER
1520 SER   2520 SER               4417 SER   5038 SER   6019 SER   7018 SER 8023 SER
1602 SER   2602 OUT               4710 SER   5653 OUT   6643 SER
1702 SER   2702 SER               4719 OUT   5654 SER
                                 STATION SUMMARY
EX-GATE    EN-GATE    RE-GATE    CHANGER    VENDOR     ADDFARE    READER     TRANS
SER  04    SER  03    SER  00    SER  03    SER  03    SER  03    SER  02    SER  02
OUT  00    OUT  01    OUT  00    OUT  01    OUT  01    OUT  00    OUT  00    OUT  00


COMMAND:
MESSAGE: ENTER STATION NO/PRINT OPTION
```

```
MRSPCD0H        MAINTENANCE AND RELIABILITY INFORMATION SYSTEM        11/16/82
FUNCTION: EQUIP STATUS/STATION                                       11.53.26
                                WAYSIDE TRACKING
    LINE NO: M40
PRINT (Y/N): N                  AFC STATUS REPORT
                                   CIVIC CENTER
EX-G STA   EN-G STA   RE-G STA   CHAN STA   VEND STA   ADD  STA   READ STA TRAN STA
1058 SER   2058 SER               4016 SER   5065 SER   6039 OUT   7041 SER 8120 SER
1059 SER   2059 SER               4438 SER   5066 SER   6040 SER   7042 SER 8121 SER
1060 SER   2060 SER               4439 SER   5067 SER   6041 SER   7043 SER 8122 SER
1067 SER   2066 SER               4440 SER   5068 OUT   6057 SER              8124 SER
1556 SER   2544 SER               4702 SER   5112 SER   6608 SER              8125 SER
1557 SER   2545 SER               4739 SER   5619 SER   6613 SER
1558 SER   2546 SER               4740 SER   5623 SER
1565 SER   2565 SER
                                 STATION SUMMARY
EX-GATE    EN-GATE    RE-GATE    CHANGER    VENDOR     ADDFARE    READER     TRANS
SER  08    SER  08    SER  00    SER  07    SER  06    SER  05    SER  03    SER  05
OUT  00    OUT  00    OUT  00    OUT  00    OUT  01    OUT  01    OUT  00    OUT  00
COMMAND:
MESSAGE: ENTER STATION NO/PRINT OPTION
```

# REFERENCES


1. Rubenstein, L., J. Land, G. Deshpande. "Overview of Rail Transit Fare Collection," UMTA-CA-06-0116-80-1, August 1980.

2. Koziol, J. J.S. Vigrass. "Status Report on DOT's Rail Transit Fare Collection Project." Paper presented at American Public Tranist Association 1982 Rapid Transit Conference, June 1981.

3. Stevens, R. "Assessment of the MBTA's Automatic Fare Collection Equipment Performance." Interim Report, Transportation Systems Center, November 1980.

4. Winkler, H. "Description and Evaluation of the MBTA Magnetic Card Fare Collection System." UMTA-MA-06-0025-81-1, February 1981.

5. Stevens, R. "An Assessment of PATCO's Automatic Fare Collection Equipment." Interim Report, Transportation Systems Center, February 1981.

6. Heisler, J., R. Stevens. "Assessment of WMATA's Automatic Fare Collection Equipment Performance." UMTA-MA-06-0080-81-1, March 1981.

7. Persinger, G. "Automatic Fare Collection Reliability and Maintainability Assessment Plan for Urban Rail Transit Properties." UMTA-MA-06-0025-81-1, March 1981.

8. Morrissey, J. "An Assessment of ICG's Automatic Fare Collection Equipment." Interim Report, Transportation Systems Center, June 1981.

9. Morrissey, J. "An Assessment of CTA's Automatic Fare Collection Equipment." Interim Report, Transportation Systems Center, June 1981.

10. Morrissey, J. "An Assessment of MARTA's Rapid Rail Automatic Fare Collection Equipment." Interim Report, Transportation Systems Center, February 1982.

11. Morrissey, J. "An Assessment of PATH's Automatic Fare Collection Equipment." Interim Report, Transportation Systems Center, May 1982.

12. Deshpande, G. "Rail Transit Fare Collection: Policy and Technology Assessment." UMTA-MA-06-0025-82-4, December 1982.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