South Carolina Department of Transportation

SCDOT

Electronic Toll Collection System & Related Services

For the
Cross Island Parkway Toll Facility
Hilton Head, South Carolina
Contract P.O.# 231709

MAINTENANCE MANUAL

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LOCKHEED MARTIN

Lockheed Martin IMS

MAINTENANCE MANUAL
Rev. 0.0

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GLOSSARY OF TERMS 1

1. Electronic Toll Collection System Overview

1.1 Description

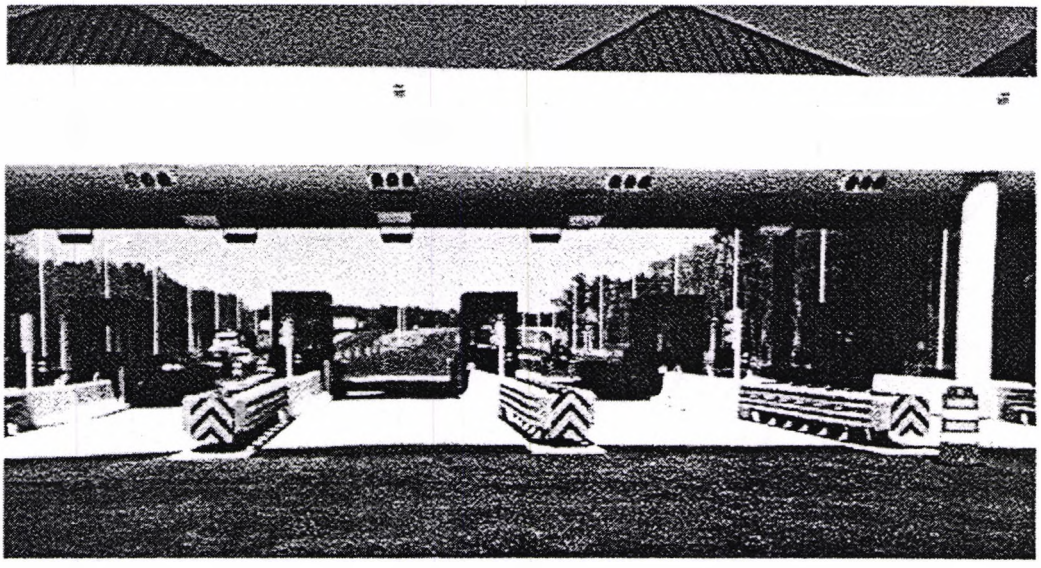
The Cross Island Parkway Toll Facilities are open to traffic and staffed by Toll Collectors twenty-four (24) hours a day, seven (7) days a week. The Cross Island Parkway Electronic Toll Collection System is designed to accommodate the rigorous demands of peak traffic hours without delays in toll collection. The system operates without loss of data in any mode of operation.

1.2 Objectives

The objectives of the Cross Island Parkway Electronic Toll Collection System are to:

- Collect tolls quickly and efficiently
- Enable rapid traffic flow through the Plaza
- Prevent loss of revenue
- Provide on-line lane audits
- Provide a user-friendly environment for operating personnel

1.3 Cross Island Parkway Plaza



The Cross Island Parkway Plaza Operations Building houses the central equipment for the Cross Island Parkway Electronic Toll Collection System. It has twelve (12) operating toll collection lanes. Three physical lanes are bi-directional as indicated in the lane configuration type description. Tolls are collected by:

- Displaying a properly mounted AVI transponder
- Paying cash to the Toll Collector

1.3.1 Lanes / Configuration Types

Lane	Lane Configuration	Type
1	Attended AVI	AVI & MLT
2	Attended AVI	AVI & MLT
3	Attended AVI	AVI & MLT
4N	Attended AVI	AVI & MLT
4S	Attended AVI	AVI & MLT
5N	Attended AVI	AVI & MLT
5S	Attended AVI	AVI & MLT
6N	Attended AVI	AVI & MLT
6S	Attended AVI	AVI & MLT
7	Attended AVI	AVI & MLT
8	Attended AVI	AVI & MLT
9	Attended AVI	AVI & MLT

1.4 Spanish Wells Road & Marshland Road

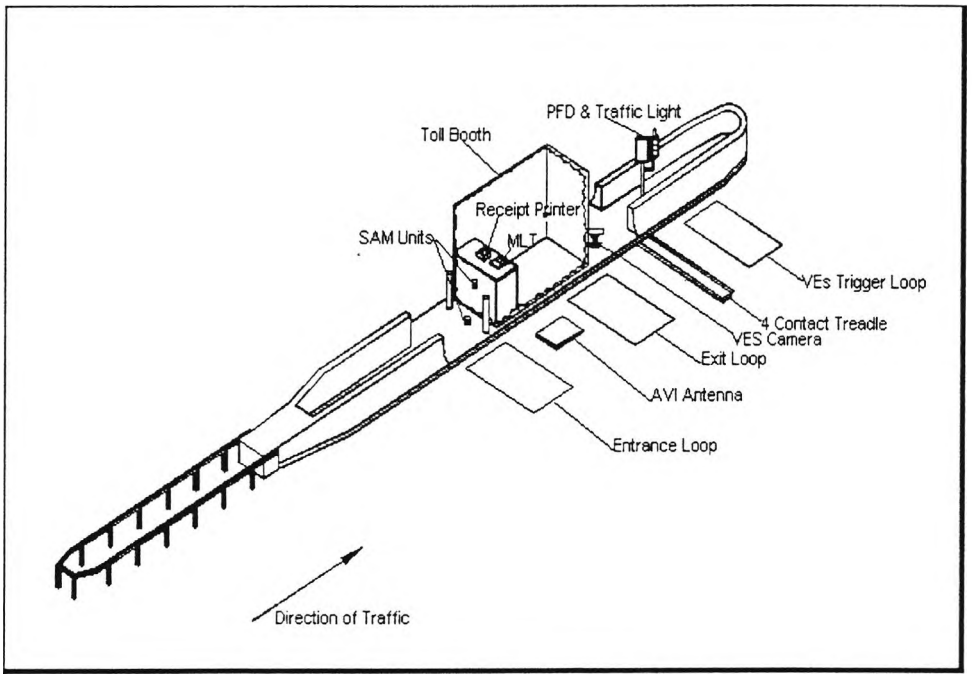
Spanish Wells Road and Marshland Road are single lane ramps. Both lanes are AVI / Automatic and unattended.

Lane	Lane Configuration	Type
10	AVI / Automatic	ACM & AVI
11	AVI / Automatic	ACM & AVI

1.5 Toll Lane Configuration

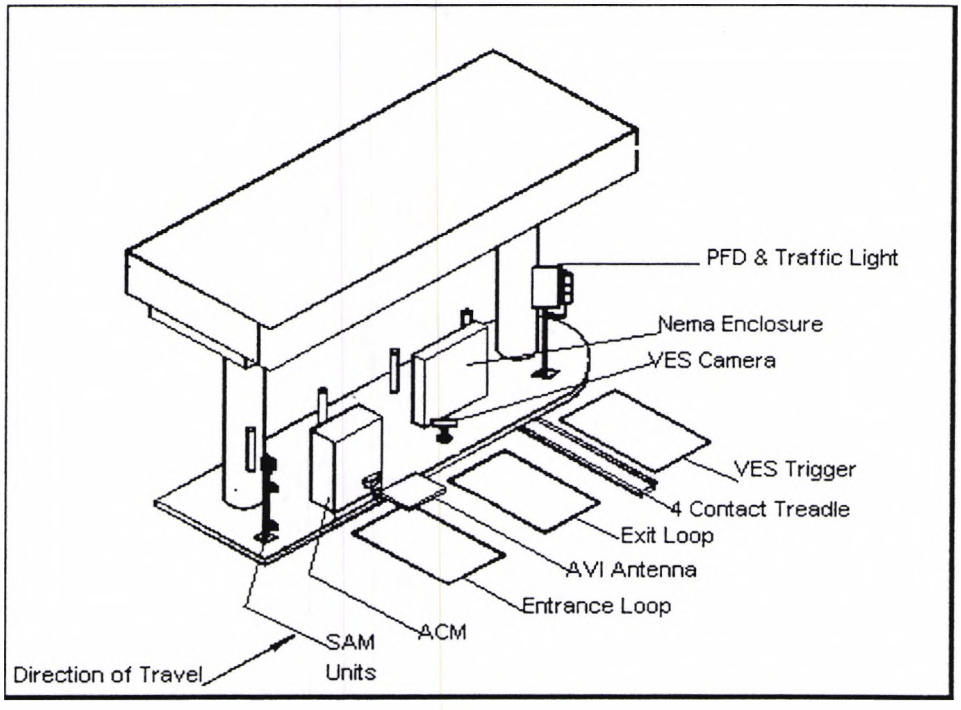
1.5.1 Cross Island Parkway Plaza

The following diagram is a plan view of a typical toll lane at the Cross Island Parkway Plaza. It is designed to show the location of the lane equipment.



1.5.2 Spanish Wells Road and Marshland Road Ramps

The following diagram is a plan view of a typical toll lane at the Spanish Wells Road and Marshland Road Ramps. It is designed to show the location of the ramp equipment.



1.6 Lane Types

The Cross Island Parkway Electronic Toll Collection System utilizes two types of lanes:

- Attended AVI
- AVI / Unattended / Automatic

1.6.1 Attended AVI / Manual

- Lanes are configured for both manual and AVI Toll Collection
- Automatic Coin Machines (ACM) can be added to these lanes at a future date

1.6.2 AVI / Unattended / Automatic

- Located at the Spanish Wells Road and Marshland Road Ramp only
- Permit the customer to use either AVI or ACM payments
- The ACM collects tolls by means of an automatic coin machine.
- The AVI / Unattended / Automatic lanes may be operated as unattended only

1.7 ETC Personnel Overview

1.7.1 Customer Service Representative

- Works at the Service Center selling the Palmetto Pass
- Updates / closes customer accounts
- Takes replenishments from customers
- Reviews violation images

1.7.2 Toll Collector

- Works in the toll booth, classifies vehicles, takes toll payments, gives receipts and directions to main landmarks
- Responsible for collecting and accounting for all toll payments received

1.7.3 Senior Toll Collector

- Works in the absence of the Plaza Shift Supervisor as required
- Works in the toll booth, classifies vehicles, takes toll payments, gives receipts and directions to main landmarks
- Responsible for collecting and accounting for all toll payments received

1.7.4 Account Clerk

- Prepares seed / device bags for Toll Collectors and Customer Service Representatives
- Counts and records deposits of toll collections from Toll Collectors and payments from Customer Service Representatives
- Prepares toll revenue for deposit
- Records all incoming and outgoing revenue transactions in the system
- Performs general office duties

1.7.5 Application System Administrator

- Establishes system security controls for all personnel
- Updates and monitors system tables
- Monitors communications between Host and PC
- Performs backup, recoveries, and system connections

1.7.6 Maintenance Personnel

- Perform preventive maintenance
- Perform maintenance on the toll collection equipment
- Coordinate and monitor activities of maintenance subcontractors

1.7.7 Toll Operations Manager

- Responsible to the SCDOT for toll operations
- Ensures that toll payments are collected and revenue is accounted for
- Responsible for the complete oversight and operation of the toll plaza

1.7.8 Office Manager

- Performs Human Resources tasks as required
- Performs supervision of Service Center operations
- Reviews AVI revenue reports for inconsistencies
- Maintains inventory of all equipment and supplies

1.7.9 Toll Superintendent

- Oversees the duties of Toll Collectors and Customer Service Representatives
- Performs non-routine activities and addresses customer inquiries
- Enters maintenance requests and follow up
- Monitors toll lane activity / Service Center activity

2. System Configuration / Equipment

2.1 Overview

The lane subsystem at the SCDOT facility serves as the primary point of vehicle detection, classification, and customer toll collection. The lane subsystem includes the IBM-PC compatible lane controller and associated in-lane devices. The SCDOT lane subsystems incorporate automatic vehicle identification (AVI), automatic coin machines (ACM), and manual toll collection. Figure 2-1 is the plan view for the Cross Island Parkway Plaza. Figure 2-2 depicts the typical barrier lane equipment layout. Equipment layout in a ramp lane is illustrated in Figure 2-3.

The lane controller is a Pentium-based PC configured with dual hard drives, image capture board, discrete digital I/O board, and two additional serial I/O communication boards. The discrete digital I/O and the two serial I/O cards are responsible for communications between the lane controller and lane devices. The network interface card (NIC) is responsible for communication between the plaza/host and lane.

2.1.1 In-Lane Devices

In-lane devices include the pre-classification devices that interface with the following:

- AVI readers
- Automatic coin machine (ACM) (ramps only)
- Treadle
- Booth, Exit, and VES loops
- SAMs
- Canopy traffic lights
- Island traffic lights
- Patron fare display (PFD)

- Magnetic card readers
- Manual lane terminal (MLT)
- Receipt printers
- Violation enforcement System (VES) components

2.1.2 Plaza Equipment List

- Workstations
- Coin Counters
- Laser Printers
- Matrix Printers

2.1.3 Host Equipment List

- Alpha Servers
- Consoles
- Magnetic Card Encoder

2.1.4 Description of Typical Transaction

The AVI antenna determines the presence of an entering vehicle if equipped with a valid transponder (toll tag) and provides the tag information automatically to the lane controller. Classification information is contained within the tag. At approximately the same time, the booth loop detects the presence of the vehicle in the lane. The collector and the SAM classifies the vehicle. As the vehicle exits the lane, the treadle counts the axles. The three classification determinations are then compared and, if not in agreement, an image of the rear license plate of the vehicle is captured by the VES and stored for review.

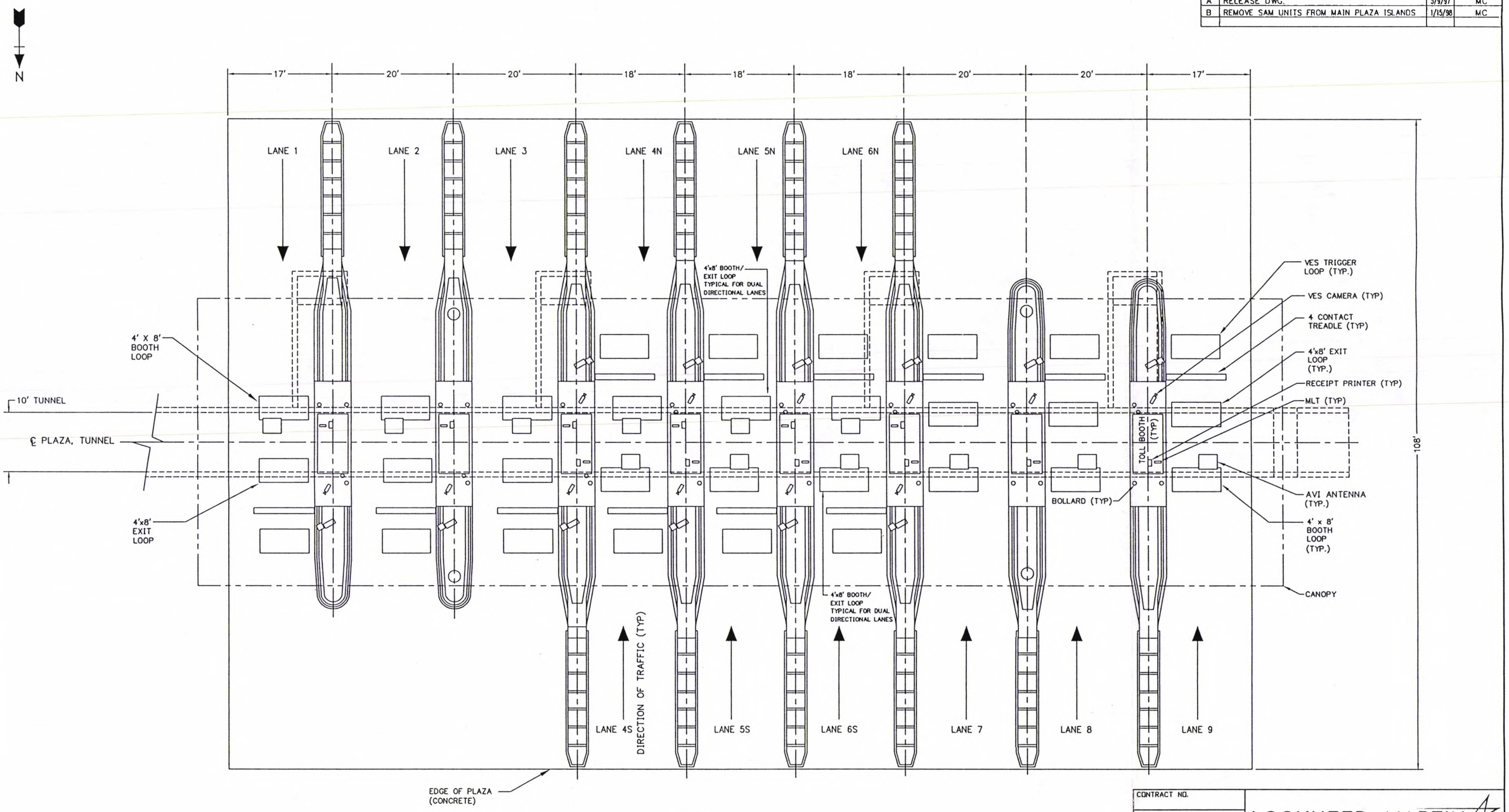
Various lane configurations at each toll plaza use some combination of the in-lane devices; however, the lane controller is identical for all lanes regardless of lane type. All lane devices are interchangeable with all other like devices.

Figure 2-4 illustrates the lane controller configuration.

2.1.5 Maintenance of All Support Equipment

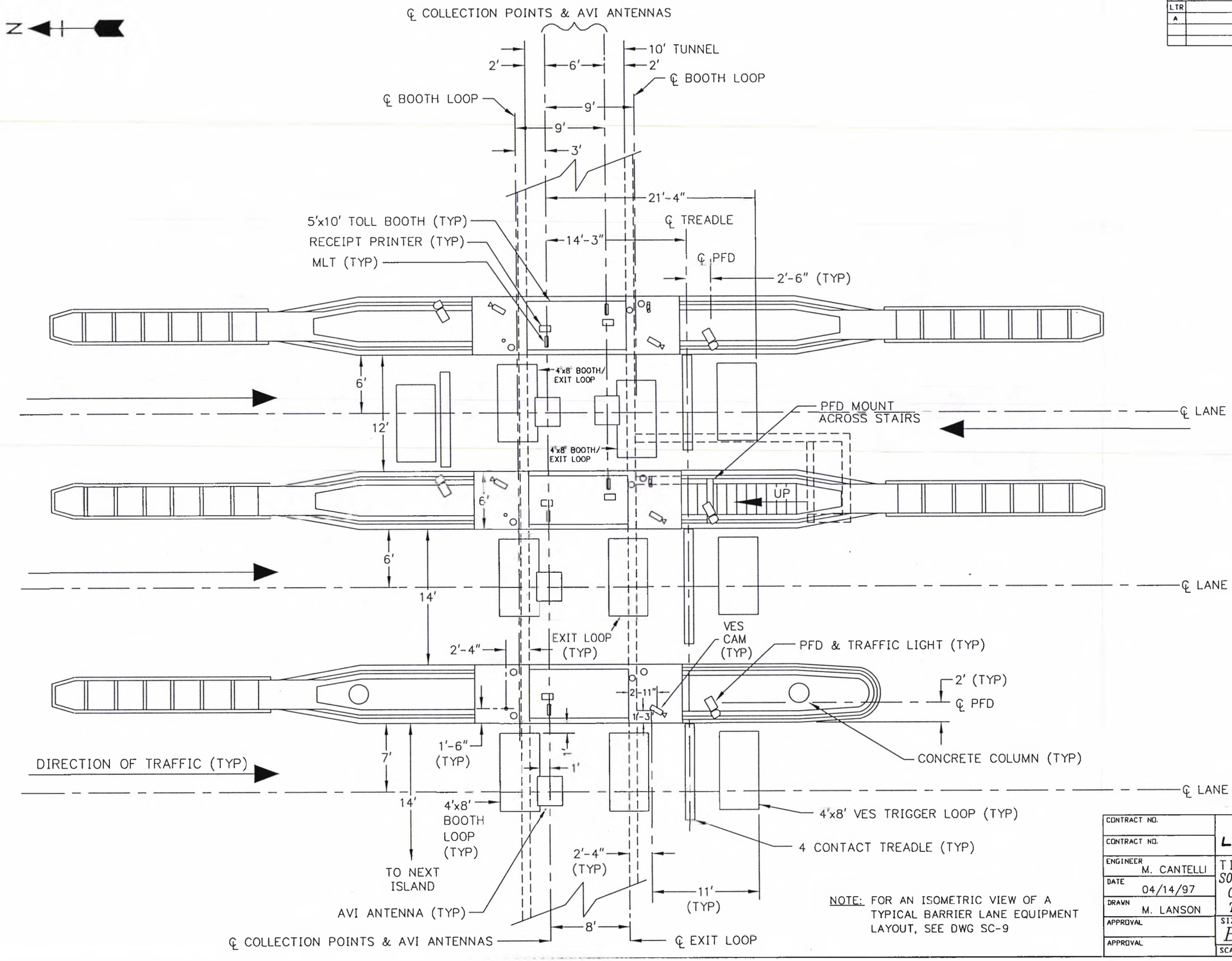
All equipment supplied under this contract will be maintained by Lockheed Martin IMS personnel.

REVISION			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASE DWG.	5/9/97	MC
B	REMOVE SAM UNITS FROM MAIN PLAZA ISLANDS	1/15/98	MC



CONTRACT NO.	LOCKHEED MARTIN METAIRIE, LA
CONTRACT NO.	
ENGINEER M. CANTELLI	TITLE
DATE 04/18/97	SOUTH CAROLINA DEPT OF TRANSPORTATION
DRAWN RJT	CROSS ISLAND PARKWAY TOLL PLAZA
APPROVAL	PLAN VIEW
APPROVAL	SIZE B — DRAWING NO. FIGURE 2-1 — REV A
	SCALE: 1/16"=1'-0" — SHEET 1 OF 1

REVISION			
LTR	DESCRIPTION	DATE	APPROVED
A	REMOVE SAN UNITS	1/23/98	MC



NOTE: FOR AN ISOMETRIC VIEW OF A TYPICAL BARRIER LANE EQUIPMENT LAYOUT, SEE DWG SC-9

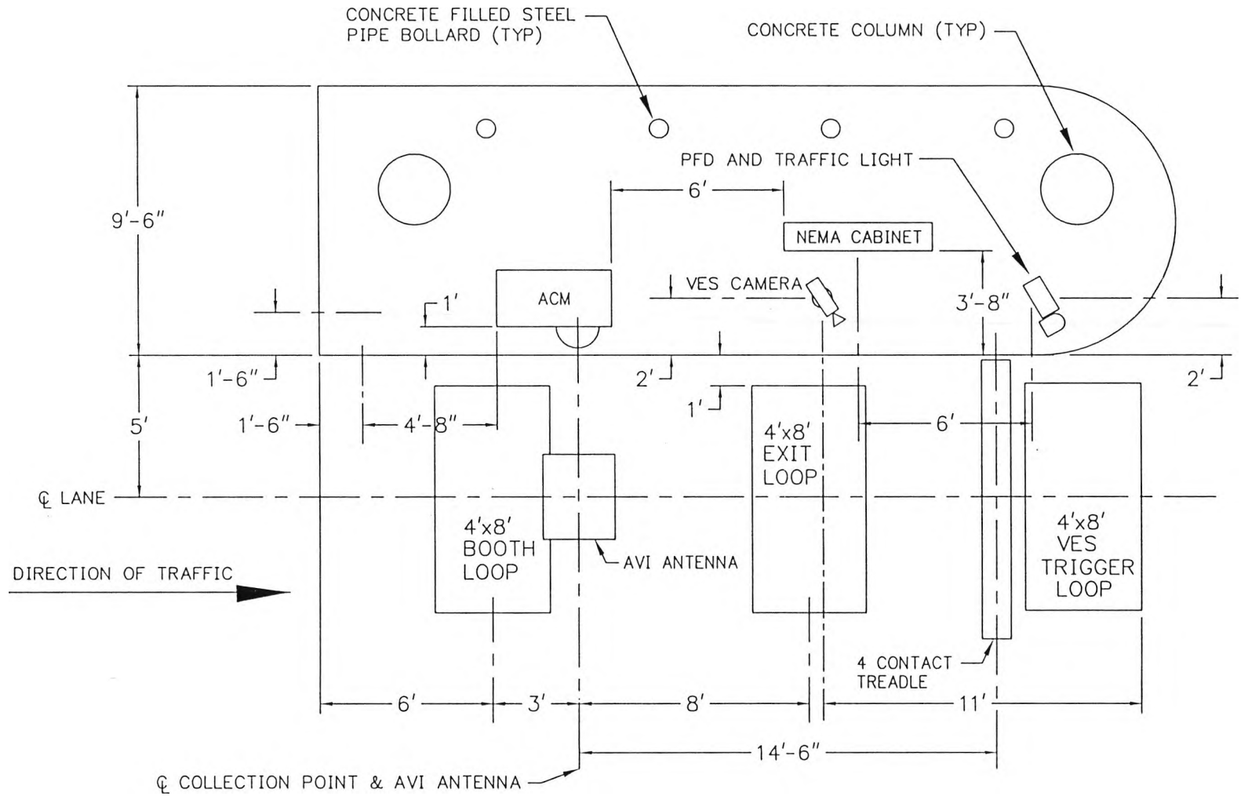
CONTRACT NO.	LOCKHEED MARTIN METAIRIE, LA
CONTRACT NO.	
ENGINEER M. CANTELLI	TITLE SOUTH CAROLINA DEPT. OF TRANSPORTATION CROSS ISLAND PARKWAY TOLL PLAZA TYP BARRIER LANES EQUIP. LAYOUT
DATE 04/14/97	
DRAWN M. LANSON	
APPROVAL	SIZE B / DRAWING NO. FIGURE 2-2 / REV A
APPROVAL	SCALE: 1"=10'-0" / SHEET 1 OF 1

4/14/97

DWG\SC\SC-2

REVISION			
LTR	DESCRIPTION	DATE	APPROVED

4/15/97



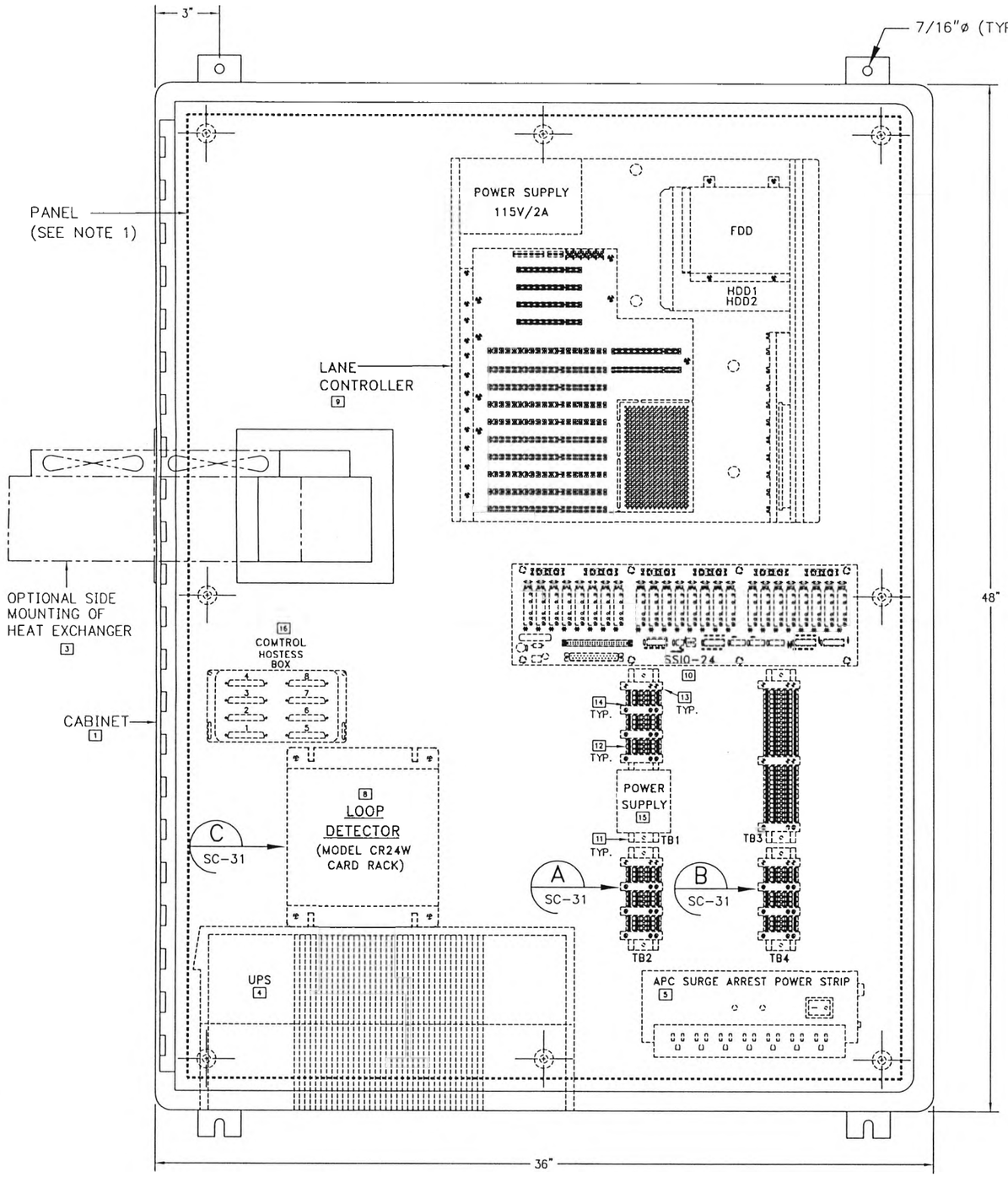
PLAN VIEW

NOTE: FOR AN ISOMETRIC VIEW OF A TYPICAL RAMP LANE EQUIPMENT LAYOUT, SEE DWG SC-9

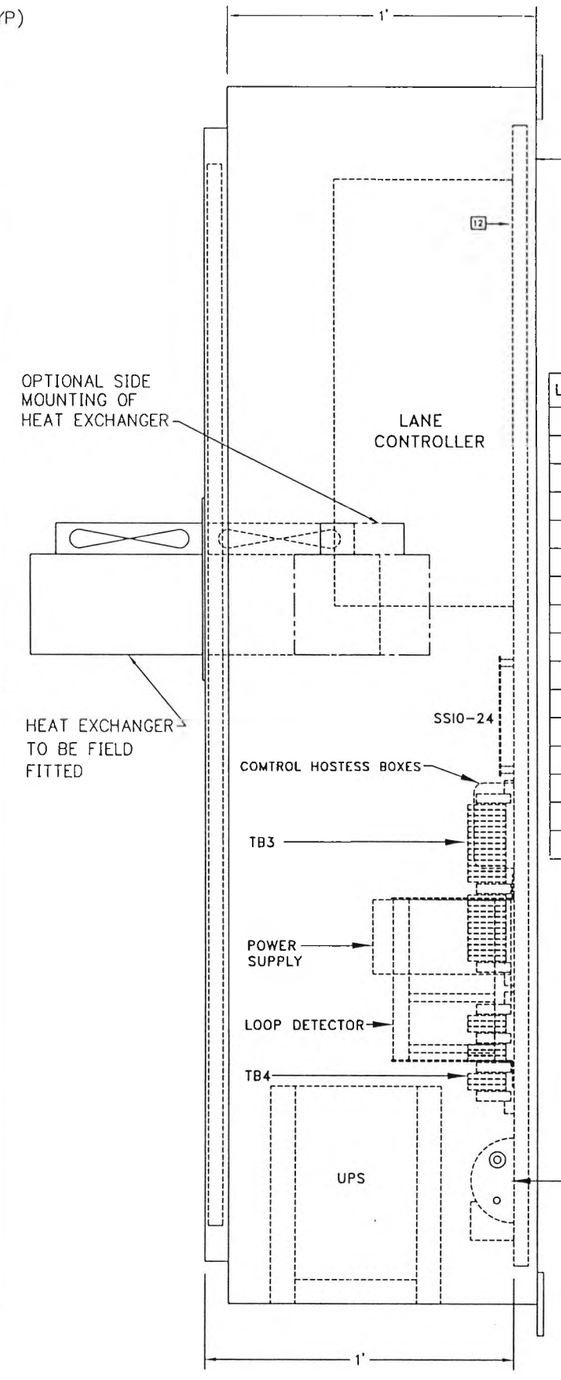
DWG\SC\SC-3

CONTRACT NO.	
CONTRACT NO.	LOCKHEED MARTIN METAIRIE, LA
ENGINEER M. CANTELLI	TITLE
DATE 04/15/97	SOUTH CAROLINA DEPT. OF TRANSPORTATION
DRAWN M. LANSON	CROSS ISLAND PARKWAY TOLL PLAZA
APPROVAL	TYP RAMP LANE EQUIPMENT LAYOUT
APPROVAL	SIZE B | DRAWING NO. FIGURE 2-3 | REV A
	SCALE: 3/16"=1'-0" | SHEET 1 OF 1

REVISION			
LTR	DESCRIPTION	DATE	APPROVED



FRONT VIEW



SIDE VIEW

NOTE: TB1 & TB2 NOT SHOWN FOR CLARITY

7/21/97

BILL OF MATERIAL

LABEL NO.	PART NUMBER	DESCRIPTION	QUANTITY
1	E48H36D, N483612	WEIGMANN LANE ENCLOSURE 48x36x12	1
2	E48-36, NP4836	WEIGMANN MOUNTING PANEL 45x33	1
3	HX400/115	HEAT EXCHANGER	1
4	SU1000XLNET	APC SMART UPS	1
5	APC PR07	APC SURGE ARREST POWER STRIP	1
6	NA	NA	–
7	NA	NA	–
8	CR24W	LOOP DETECTOR	1
9	300AM/ISA	LANE CONTROLLER	1
10	SSIO-24	SSIO-24 DIGITAL I/O BOARD	1
11	24A110	PHOENIX DIN RAIL	3
12	3003017	PHOENIX BLOCKS	44
13	120442	PHOENIX END STOPS	11
14	3003020	PHOENIX END PLATES	8
15	2943398	PHOENIX DIN RAIL MOUNT POWER SUPPLY (FUTURE)	1
16	41086008A	COMTROL HOSTESS 186 - 8 PORT	1

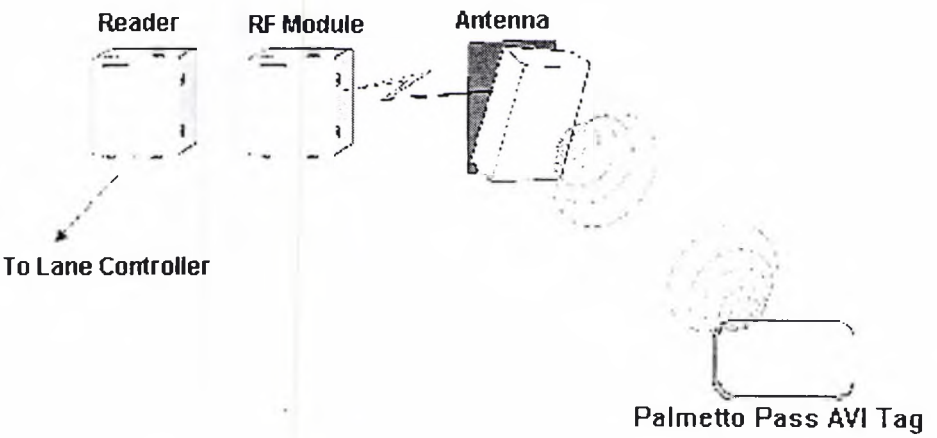
NOTE:

1. FOR TYP. PANEL ASSEMBLY, SEE DWG FSK-27.
2. FOR TYP. PANEL WIRING DETAILS, SEE DWG FSK-31.

DWG\SC\SC-17A

CONTRACT NO.	
CONTRACT NO.	LOCKHEED MARTIN METAIRIE, LA
ENGINEER M. CANTELLI	TITLE
DATE 07/21/97	SOUTH CAROLINA DEPT. OF TRANSPORTATION
DRAWN M. LANSON	CROSS ISLAND PARKWAY TOLL PLAZA
APPROVAL	TYPICAL PANEL AND CABINET
APPROVAL	SIZE B · DRAWING NO. FIGURE 2-4 · REV A
	SCALE: 1"=6" · SHEET 1 OF 1

2.2 AVI Equipment



2.2.1 Description

The AVI subsystem consists of:

- AVI transponders (Palmetto Pass)
- Programming units
- Antenna, Radio Frequency (RF) Modules
- AVI reader devices

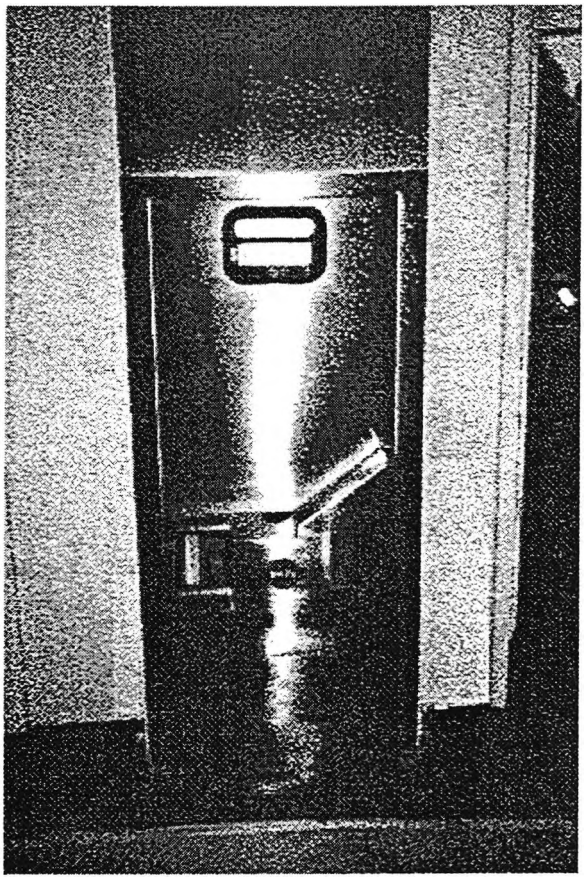
2.2.2 Location in Lane / Plaza

- The AVI transponder is affixed to the patron's vehicle windshield or the front license plate. The patron can obtain a transponder from the Cross Island Parkway Plaza Service Center.
- The Programmer unit is located at the Service Center.
- The AVI antenna is located strategically in the lane so that it can capture the signal from the transponders.
- The RF module is located in the roadside AVI reader device cabinet.
- The AVI reader device is located in the roadside AVI reader device cabinet.
- The AVI equipment is located at the Cross Island Parkway Plaza, Spanish Wells Road ramp, and Marshland Road ramp.

2.2.3 Purpose

- The transponder is the device that customers affix to either a windshield or front license plate. The device confirms a customer's account balance and decreases the account at each use by the amount of the toll.
- The programmer unit is used to enter an ID code into the transponder itself. This is done at the Service Center before issuing a transponder to the customer.
- The AVI antenna is mounted in the lane and is used to transmit and receive transponder class and account data. It interfaces with the RF module to read the signal that is sent from the transponder and sends it to the AVI reader device.
- The RF module interfaces with the AVI antenna and generates a continuous-wave signal off the antenna. When a vehicle bearing a transponder enters a lane and comes into range of the signal, the transponder detects and transmits a signal back to the antenna. The RF module accepts and transfers the return signal and sends it to the AVI reader.
- The AVI reader scans information from the transponder mounted on the vehicle and transmits it to the Lane Controller for ID verification and sufficient account balance check. Once Lane Controller account verification is complete, the Lane Controller tranmits the appropriate Patron Fare Display and Traffic Control Light (red, amber, or green).

2.3 Automatic Coin Machines (ACM)



2.3.1 Description

- The Automatic Coin Machine (ACM) can be either freestanding or mounted on the side of a tollbooth. Collected coins are stored in an internal vault.
- An ACM is equipped with:
  - ⇒ Patron "Payment Received" Fare Display screen
  - ⇒ Coin Hopper
  - ⇒ Escrow window, which can hold up to ten (10) quarters

2.3.2 Location in Lane / Plaza

- The ACM is mounted in a stand-alone cabinet.
- It is located only at the Spanish Wells Road and Marshland Road ramps.

2.3.3 Purpose

- The ACM can detect coin diameter, thickness, and metallic content.
- As coins are deposited, the Patron Fare Display decrements the initial toll due by the value of each coin deposited.
- The Patron Fare Display delivers toll messages to the patron.
- Once coins are processed, up to 10 quarters are held in the escrow window, then dropped into the internal vault in the lower section of the ACM cabinet.

2.4 Four - Contact Treadles

2.4.1 Description

Treadles are devices that are either 8' or 10' long and approximately 12" in width with either two or four contact treadles. The treadles used at the SCDOT are four-contact.

Treadles are strategically embedded in the roadway in a toll lane and resemble black rubber pads.

2.4.2 Location in Lane / Plaza

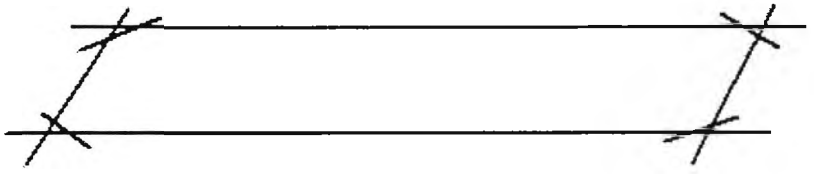
Treadles are located at the exit of each toll lane.

Treadles are located at the entrance and exit of the bi-directional lanes.

2.4.3 Purpose

- Treadles classify a vehicle by registering the number of axles.
- Each exit lane has a four-contact treadle.
- The contact treadle detects forward and backward motion of a vehicle's tires as they cross the treadle.
- If a two-axle vehicle crosses the treadle in a forward motion, two forward axles are registered, and if a two-axle vehicle crosses the treadle in reverse, two reverse axles are registered.
- This is important for auditing purposes, particularly when there is a violation or unusual occurrence.

2.5 Vehicle Detector Entry & Exit Loops



2.5.1 Description

- A Vehicle Detector Loop is a device that is embedded into the pavement that forms a closed circuit loop.
- The Vehicle Detector Loop's electronic properties change when a metallic presence is detected.
- The Vehicle Detector Loop is monitored by the vehicle loop detector and outputs a presence signal when it senses metal.

2.5.2 Location in Lane / Plaza

Vehicle Detector Loops are located:

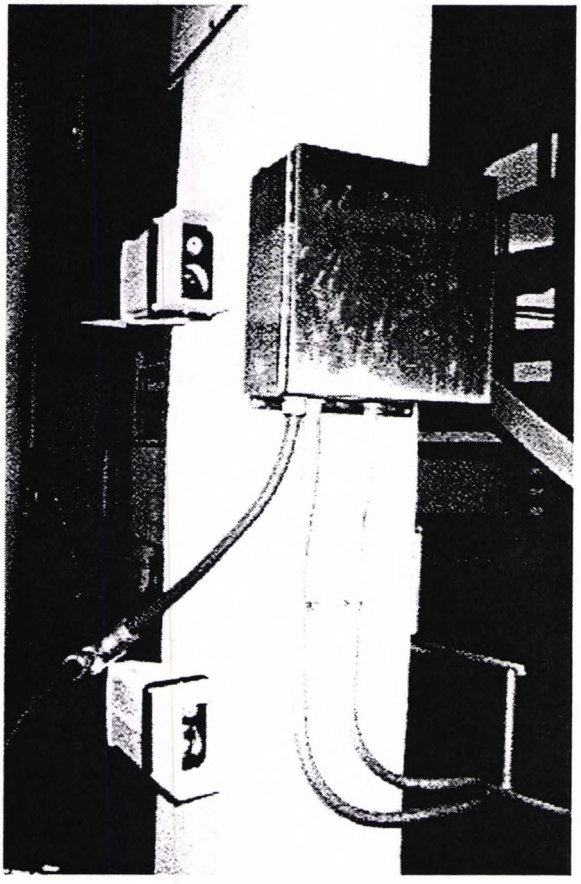
- At the entrance and exit of multi-mode lanes
- At the exit of all lanes

2.5.3 Purpose

- When a vehicle enters the lane, the entry Vehicle Detection Loop enables various lane devices:
  - ⇒ The AVI equipment
  - ⇒ The Lane Controller, advising that there is a vehicle in the lane

- When the vehicle travels over the **Exit Vehicle Detection Loop**, the following changes occur:
    - ⇒ The island traffic light changes to red
    - ⇒ The VES camera takes an image capture of the license plate
    - ⇒ Lane signs return the lane to open status, ready for the next vehicle

2.6 Vehicle Separator Device — SAM Unit



2.6.1 Description

Sensing and Activating Module (SAM) is an infrared laser device. The modulated laser light is transmitted across the toll lane and reflected back from any object that it views. The output is transmitted to the lane controller for processing.

The **SAM** is able to detect the following:

- Presence of a vehicle
- Direction of travel
- Velocity
- Height

2.6.2 Location in Lane / Plaza

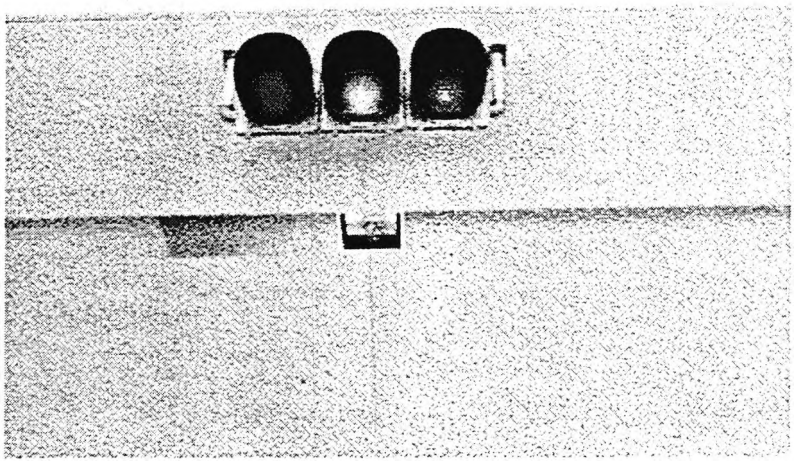
The **SAM** is located:

- In each multi-mode lane
- At the collection point of the toll lane

2.6.3 Purpose

- SAM detects the separation between vehicles.
- The data output is compared with the pre-classification information in the lane controller and ensures that the class of tag that has been read matches the classification of the vehicle.

2.7 Canopy Traffic Light (Red / Amber / Green)



2.7.1 Description

The **Canopy Traffic Lights** are visual traffic control devices that consist of a RED, AMBER, and GREEN light.

2.7.2 Location in Lane / Plaza

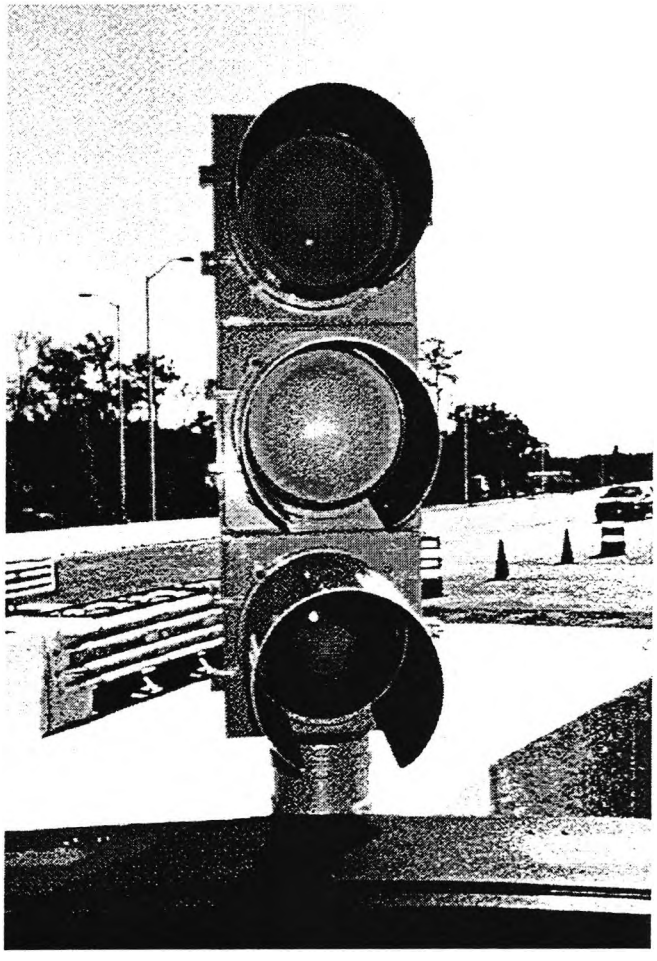
The Canopy Traffic Lights are:

- Mounted on the Plaza Canopy above the toll lane
- Mounted on both the north and south sides of the canopy in the bi-directional lanes

2.7.3 Purpose

- The Canopy Traffic Lights alert approaching drivers about the lane status
  - ⇒ RED – CLOSED
  - ⇒ Flashing AMBER – OPEN for AVI only
  - ⇒ GREEN – OPEN for manual toll collection and AVI

2.8 Island Traffic Signal



2.8.1 Description

- The Island Traffic Signal is a three-light, visual traffic control signal.
- The Island Traffic Signal consists of a RED light, an AMBER light, and a GREEN light.

2.8.2 Location in Lane / Plaza

The Island Traffic Signal is located at the exit end of the toll lane.

2.8.3 Process

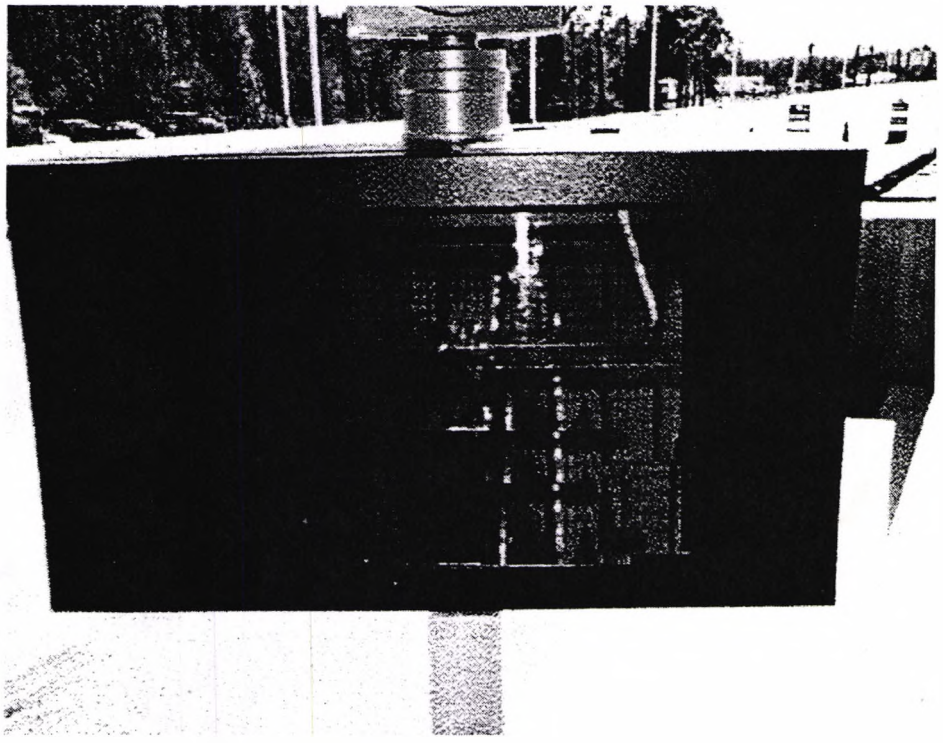
2.8.3.1 Cash Lanes

- The Island Traffic Signal is RED when a vehicle enters the lane.
- The GREEN light is triggered by a successful toll collection.
- The Island Traffic Signal turns RED again once the exit loop registers the vehicle's exit.
- The RED violation beacon and the sound alarm activate when a toll violation is registered.

2.8.3.2 AVI Dedicated Lanes

- The Island Traffic Signal is AMBER when a vehicle enters the lane.
- The GREEN light is triggered by a successful identification of the AVI Transponder.
- The Patron Fare Display notifies the user of a low balance or other problem with the AVI account.

2.9 Patron Fare Display



2.9.1 Description

- The **Patron Fare Display (PFD)** is a multi-flip, dot matrix display.
- The device uses magnetic fields and rotating magnetic disks to display messages.

2.9.2 Location in Lane / Plaza

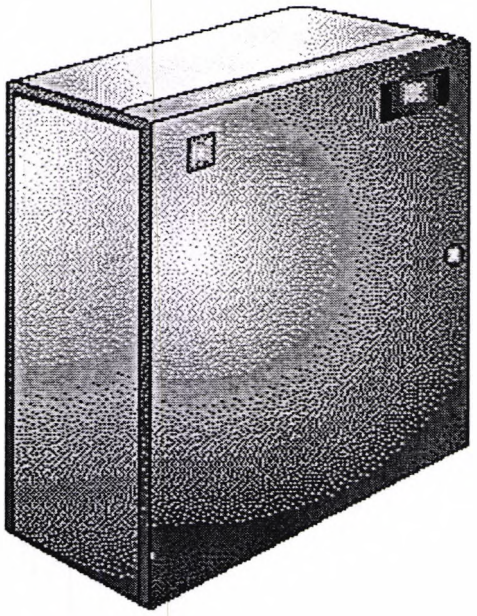
The Patron Fare Display is located on the left exit side of each toll lane.

2.9.3 Purpose

The **Patron Fare Display** indicates customer tolls in dollars and cents and exhibits certain messages:

- "**Low Balance**" in the AVI lanes
- "Thank You." The information displayed is determined by the signals sent from the lane controller.

2.10 Lane Controller



2.10.1 Description

- The **Lane Controller** consists of a Pentium 586 IBM – compatible PC and input and output devices.
- The PC is used to process all of the input data, and it generates outputs to the various lane devices such as the **Island Traffic Light**.

2.10.2 Location in Lane / Plaza

The Lane Controller is located:

- In the tunnel under the Cross Island Parkway plaza
- Within a stand-alone cabinet at the Spanish Wells Road and Marshland Road ramps

2.10.3 Purpose

- The **Lane Controller** is the foundation of ALL message processing.
- The **Lane Controller** has customized software that controls the peripheral lane equipment.
- The **Lane Controller** is the processor that interfaces between the plaza computer and lane equipment.
- The **Lane Controller** is responsible for monitoring activity in the lane and for providing the appropriate output signals to the lane equipment.

2.11 Toll booth

2.11.1 Description

- The **Toll booth** is the structure that houses the following toll collection equipment:
  - ⇒ Touchscreen
  - ⇒ Magnetic Swipe Card Reader
  - ⇒ Receipt printer
  - ⇒ Cash drawer
  - ⇒ Security alert system
  - ⇒ All other equipment necessary to manually operate these lanes
- The **Toll booth** is constructed of stainless steel.

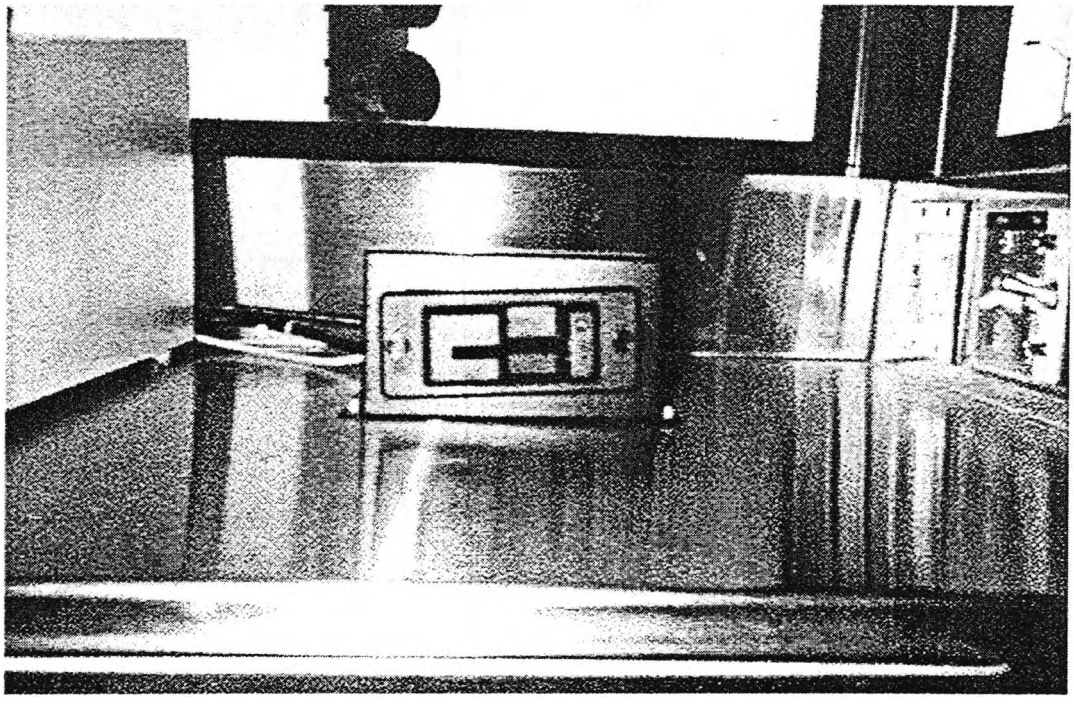
2.11.2 Location in Lane / Plaza

- The **Toll booths** are located:
  - ⇒ In manual and mixed mode lanes
  - ⇒ On the islands at the collection point
  - ⇒ At the Cross Island Parkway Plaza only

2.11.3 Purpose

- The **Toll booth** houses the Touchscreen and the Receipt Printer.
- The **Toll booth** is where the Toll Collector is stationed during the working shift.

2.12 Magnetic Swipe Card Reader



2.12.1 Description

- The **Magnetic Swipe Card Reader** comprises of a single reader mounted near the Manual Lane Terminal.
- The **Magnetic Swipe Card Reader** interfaces with the Lane Controller.

2.12.2 Location in Lane / Plaza

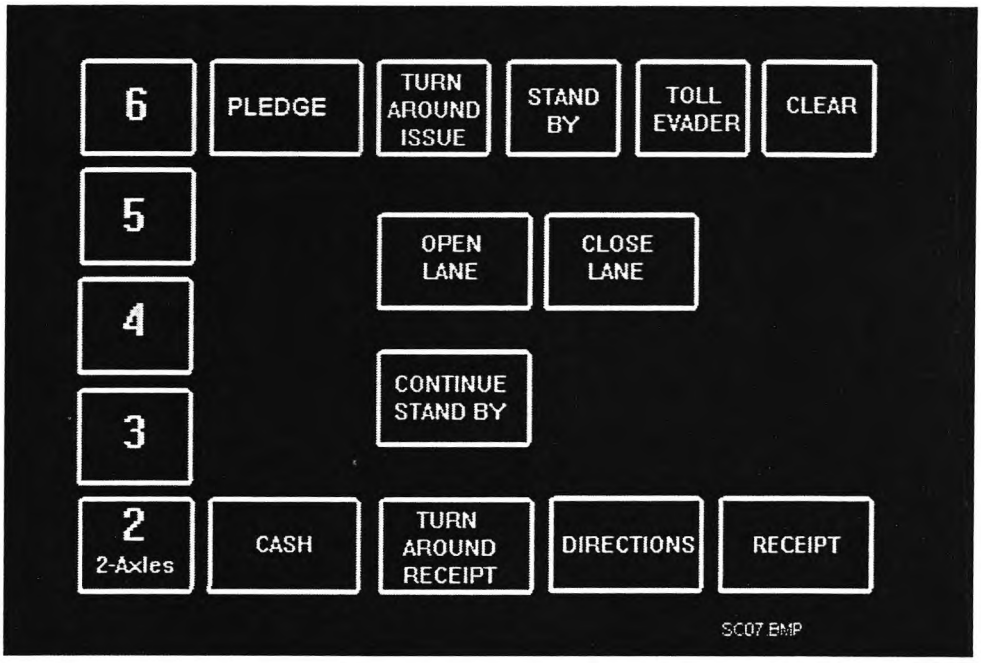
The Magnetic Swipe Card Readers are located in the toll booths of all Cross Island Parkway Plaza lanes.

2.12.3 Purpose

The Magnetic Swipe Card Reader is used by the Toll Collectors and other Cross Island Parkway Plaza personnel:

- To login into the Lane Controller
- To conduct toll transactions involving any future use of a swipe card

2.13 Manual Lane Terminal (MLT) / Toll Collector Touchscreen



2.13.1 Description

- The Touchscreen is an LCD display that uses an infrared grid to perform the touch location.
- The Touchscreen is housed in a rugged, water-tight housing, suitable for use in the toll environment.
- The Touchscreen interfaces with the Lane Controller PC.

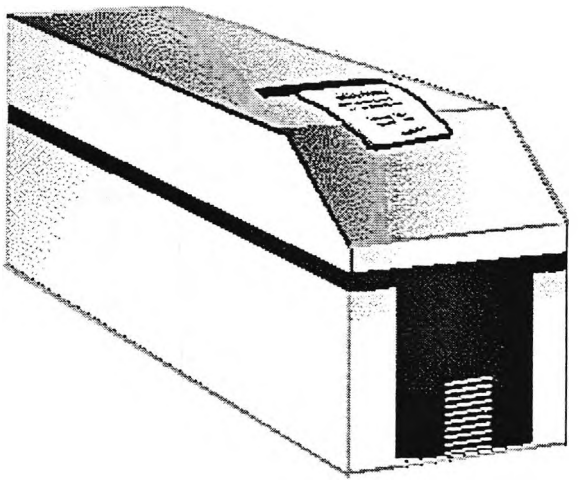
2.13.2 Location in Lane / Plaza

- The Touchscreen is located:
  - ⇒ In every manual toll collection lane
  - ⇒ At the Cross Island Parkway Plaza only

2.13.3 Purpose

- The Touchscreen features a screen display of buttons.
- By touching the appropriate button on the Touchscreen, the Toll Collector can:
    - ⇒ Classify vehicles
    - ⇒ Generate patron receipts upon request
    - ⇒ Open remote gates
    - ⇒ Perform a variety of other functions

2.14 Receipt Printer



2.14.1 Description

- The **Receipt Printer** outputs paper receipts upon request.
- The **Receipt Printer** is a dot matrix printing mechanism.

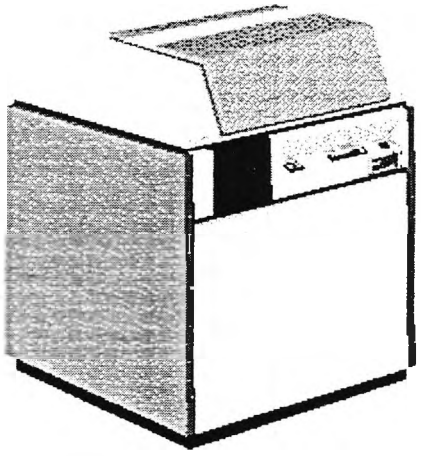
2.14.2 Location in Lane / Plaza

- The **Receipt Printer** is located:
  - ⇒ In all manual lanes
  - ⇒ On the counter beside the Toll Collector Touchscreen

2.14.3 Purpose

- The **Receipt Printer** provides a paper receipt upon request.
- Upon request, directions to specific locations can be printed out on the back of the receipts.
- The Toll Collector issues the receipt command to the **Receipt Printer** from the Touchscreen.
- When the paper supply is low, a "paper low" message displays on the Toll Collector Touchscreen.
- Only the Plaza Shift Supervisor or maintenance personnel will change the paper in the **Receipt Printer**.

2.15 Coin Counter



2.15.1 Description

- The Coin Counter is a specialized piece of equipment that counts coins.
- The Coin Counter detects the size of all coins and counts them.
- The equipment is connected to the system to record the amounts for auditing purposes.

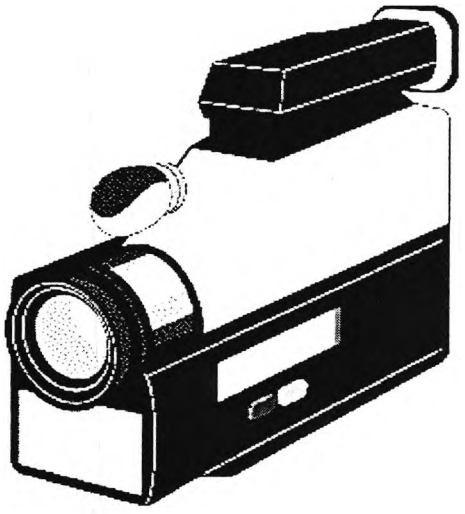
2.15.2 Location in Lane / Plaza

The **Coin Counter** is located in the Cross Island Parkway Plaza Operations building.

2.15.3 Purpose

- The **Coin Counter** is used by the Toll Collectors to count coin revenue collected in the lanes.
- The **Coin Counter** is used by the Toll Superintendent to count the coins deposited in the ACMs.
- The **Coin Counter** is used by the Account Clerk to verify the coin deposits of the Toll Collectors.
- Coins are accurately recognized by denomination and counted.
- The totals are recorded by the system.

2.16 Closed Circuit Television — "CCTV" Camera



2.16.1 Description

Closed Circuit Television (CCTV) is a system of cameras that enable the images being captured to be viewed on a television screen.

2.16.2 Location in Lane / Plaza

- The **CCTV cameras** are located:
  - ⇒ In strategic locations around the plaza and remote ramps
  - ⇒ In the counting, vault, and other rooms within the Operations Building
  - ⇒ In the Cross Island Parkway Plaza tunnel

2.16.3 Purpose

- **CCTV cameras** are strategically located to record accesses to the building, toll collection lanes, and counting room activities.
- The **CCTV** system is used primarily for security purposes.

2.17 Violation Image Capture Camera

2.17.1 Description

- The **Violation Image Capture Camera** is a specialized camera that captures digitized images when triggered by pre-specified criteria.
- The **Violation Image Capture Camera** is encapsulated in a heavy-duty housing to protect the camera from damage.

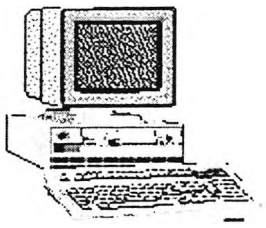
2.17.2 Location in Lane / Plaza

- **Violation Image Capture Cameras** are:
  - ⇒ Located in each lane
  - ⇒ Attached to the island, on the exit side of the Toll booth

2.17.3 Purpose

- The **Violation Image Capture Camera** captures the rear license plate of each vehicle as it leaves the lane.
- The system records vital information that is stored with each capture:
  - ⇒ date and time of day
  - ⇒ plaza and lane number

2.18 PC Workstations



2.18.1 Description

- The standard PC workstations at the Cross Island Parkway Plaza Operations Building and satellite service center locations are:
  - ⇒ 120 MHz Pentium Processors
  - ⇒ 16 MB RAM
  - ⇒ 1.2 GB Hard Drive
  - ⇒ 8X speed CD ROM

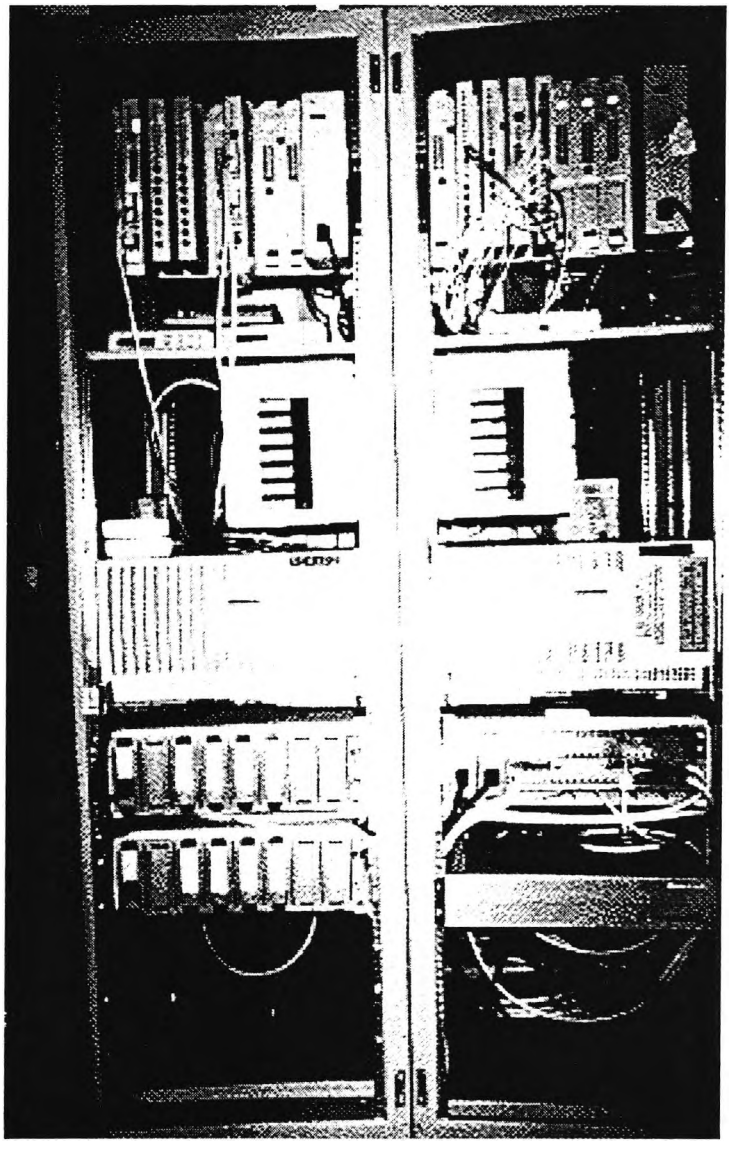
2.18.2 Location in Lane / Plaza

- The **PC workstations** are located:
  - ⇒ In the Service Center
  - ⇒ In Toll Operations Manager's office
  - ⇒ At the Toll Superintendent's office
  - ⇒ At the Maintenance Shop
  - ⇒ At the Toll Collector deposit area

2.18.3 Purpose

The **PC workstations** are connected through the network to the Alpha host system. The workstations support the application software and communicate with the host to access and transfer new data to and from the various databases.

2.19 Alpha System



2.19.1 Description

- The Alpha is the host system used by the Cross Island Parkway Plaza to support the causeway's computerized system. It consists of:
  - ⇒ Digital Alpha server 1000
  - ⇒ 256 MB RAM
  - ⇒ 20 GB Tape
  - ⇒ Disks

◊ 1 RAID-5 17.1 GB

◊ 1 STRIPE 8.6 GB

◊ 1 SHADOW 4.3 GB

2.19.2 Location in Lane / Plaza

The **Alpha System** is located in the Cross Island Parkway Plaza Operations Building.

2.19.3 Purpose

- The Alpha System is the host system that supports the Cross Island Parkway Plaza computerized Electronic Toll Collection System. The host system houses the 'brains' that receive, process, and store all of the information that is sent through the different peripherals to the host. The peripherals include:
  - ⇒ The toll collection equipment
  - ⇒ The lane controllers
  - ⇒ The service center
  - ⇒ VES and administrative workstations

The databases are configured to be able to store and retrieve data upon request. This enables the county to provide a completely audible system that tracks the funds from the point that a customer pays his / her toll to the deposit of that toll into the bank.

3. Maintenance Standards & General Procedures

3.1 Repair Standards

3.1.1 Maintain the Following Standard of Repair on All Equipment

- Results must replicate the performance specifications of the original manufacturer after repairs are complete.
- Ensure that performance parameters do not deteriorate because of deviations from the standards.
- Repairs must return the equipment to factory-like condition.
- Complete repair actions by a professional should not be discernible, except under close scrutiny, and should not add to or alter the original cabling connection scheme that was designed for the equipment.
- Use only professional repair practices to run cable, solder wiring, connect components, and replace parts.

3.1.2 Repair Requirements

- Replace worn or defective parts to correct equipment problems.
- Use materials or replacement parts that are equal to or exceed the performance specifications of the manufacturer.

3.1.3 Calibration Standards

The technician assures that all required calibration is performed when scheduled. All test equipment is calibrated at a certified calibration facility. A calibration sticker is affixed to the equipment after calibration is complete.

3.1.4 Inspection of Equipment

The technician performs inspection on all incoming equipment.

- Inspection / tests are performed on all received equipment to verify any repairs have been properly affected and to verify proper operation.
- Internal diagnostics are performed where applicable.
- Burn-in checks are done for a minimum of two hours.

3.1.5 Non-Maintenance Shop Repair Procedure

The technician performs lowest replacement unit (LRU) repairs on equipment and must arrange for repairs that are beyond the capability of the Maintenance Shop.

The technician determines the point at which assistance is needed. Before sending equipment to external repair facilities, the technician consults the Engineering Manager, who makes the final determination as to the disposition of equipment.

3.1.6 Prohibited Practices

The technician cannot perform repairs in the following manner:

- Add wiring, cabling, and other components
- Bend, twist, and distort mechanical components
- Improper soldering procedures
- Use of replacement parts that are not provided by the maintenance team
- Use of incorrect replacement parts with incorrect values or sizes – for example, large fuses or resistors

3.2 Performance Standards

A major responsibility of management is ensuring that performance levels are acheived. Several key performance objectives must be achieved or exceeded and standards must be followed. It is critical that control, feedback, and response mechanisms are in place to handle exceptions to the standards. These mechanisms include the following:

- Response time
- Maintenance Schedule
- Mean time to repair and restore (MTTR)
- Mean time between failure (MTBF)
- Customer feedback
- Evaluation
- Troubleshooting, Diagnostics, Repair, and Checkout

3.2.1 Response Time

There is a 2 hour response time required by contract.

The dispatch function is handled as follows:

- During Normal On-Site Hours Sunday through Thursday (8:00 a.m. to 5:00 p.m.)

  MOMS automatically notifies the technician of a corrective service request by paging the assigned technician. The designated operational staff may also notify the assigned technician of a corrective service request via telephone, pager, or person-to-person. If technical staff is present at the plaza, he/she will conduct an initial diagnostics and relay the appropriate information to the assigned technician.

- Other Hours and Backup

  MOMS uses call-out procedures to find the technician on-call. The technician is paged and accesses MOMS via modem, or at the plaza, to find out the plaza number, lane number, and problem code. The technician acknowledges the call by updating the service call, which can be reviewed by SCDOT or its designee. If a technician cannot meet the response requirements, the he/she must contact the Engineering Manager within 30 minutes in order for a course of action to be planned.

3.2.2 Maintenance Schedules

The maintenance team performs the maintenance efforts necessary for the complete, reliable, and uninterrupted operation of operations.

- Seven days a week
- 24 hours a day
- Under all conditions
- At least one maintenance technician is on duty during normal working hours (8:00 a.m. to 5:00 p.m., Sunday-Thursday).
- At least one technician is on call on weekends and holidays.

3.2.3 Mean-Time-To-Repair & Restore (MTTR)

MTTR is monitored through MOMS. Variations from acceptable performance or violations of standards are discussed in the monthly maintenance review by LMIMS. The monthly maintenance review is a joint meeting between SCDOT, or its designee, and the Lockheed maintenance team.

Maintenance history reports and failure trend analysis are discussed and engineering changes recommended, if required. The PM schedule is reviewed and modified, if required, by the failure trend analysis.

3.2.4 Mean Time Between Failures

MTBF is monitored by MOMS. The manufacturer supplies MTBF estimates with original equipment. Maintenance activities are scheduled, based on the estimates provided by the manufacturer.

As the contract progresses, actual MTBF data is acquired by MOMS. Each time a component fails, MOMS tracks the time since the last failure and provides new data. Maintenance schedules are modified to meet the new requirements based on the MTBF.

3.2.5 Customer Feedback

Patron / SCDOT relations provide an ongoing control mechanism designed to satisfy SCDOT, its customers, the Plaza Manager, and any and all subordinates. The maintenance team solicits feedback from SCDOT and LMIMS managers to determine whether service is meeting requirements.

3.2.6 Evaluation

Latent defect and recurring malfunction analysis must be conducted by the Field Service technician.

1. Service calls are reviewed for recurring malfunctions to determine if a trend is developing.
2. Technicians shall use the maintenance database, and other maintenance data-gathering faculties available to help identify latent defects or malfunction trends.
3. This information will be logged and tracked by MOMS.
4. When the possibility of a latent defect or trend is identified, the Engineering Manager and QA Department are to be notified of a possible latent defect or recurring malfunction.
5. The latent defect or malfunction is investigated in accordance with the LMIMS QA program.

3.2.7 Troubleshooting, Diagnostics, Repair, and Checkout

1. Personnel in the local shop are capable of troubleshooting, diagnostics, repair techniques, and checkout techniques.
2. The on-site technician sends a part out to a vendor only if the part cannot be repaired at the local shop.
3. The technician performs PM as needed on equipment and/or parts requiring repairs.
4. MOMS inventory/repair database records should be updated when repaired items are returned to ready spare status.

3.3 Problem Alerts and Technical Support

When a system or subsystem fails, a message is sent to the proper maintenance shop.

If a breakdown occurs near the end of a shift, technicians continue in an overtime mode to complete the required repairs.

Breakdowns occurring after the close of the normal day shift are dispatched to the technician via MOMS. The MOMS will detect the maintenance event and page the on-call technician.

3.3.1 Telephone Support

The first line of technical support is by telephone to the Field Technician or Engineering Manager. This ensures that at least verbal contact is made with the technician to allow for an evaluation of the problem before field support is dispatched.

3.3.2 Provide Technical Support to the Field

If a problem cannot be solved by telephone, field support is to be provided. As in telephone support, field support is requested in accordance with the response procedures.

Field support is also given during new equipment installation and evaluations.

Technical support may include:

- ECO/FCO action / reporting
- PM report and checklist

Where prior commitment or extensive repair needs could potentially cause a service call to fail in meeting contract time requirements, the technician is responsible for alerting his or her immediate supervisor. If a repair action is not complete after one hour on-site, the technician's supervisor must be notified.

3.3.3 Evaluation/Resolution

Once technical support personnel is involved, problems must be evaluated and resolved.

1. If the problem requires attention by an equipment vendor, the technician must inform and work with the equipment vendor to resolve the problem.
2. If it is determined that the problem is related to software, the LMIMS software support group is notified and a resolution is coordinated.

3.3.4 Timely Repairs / Ready Spare Bin

It is the responsibility of the Field Service Technician to ensure malfunctioning equipment is repaired in a timely manner and the ready spare bin is stocked with the proper amount of ready spares.

3.3.5 Maintenance Process

Figure 3-1 displays the Maintenance Activity Flowchart.

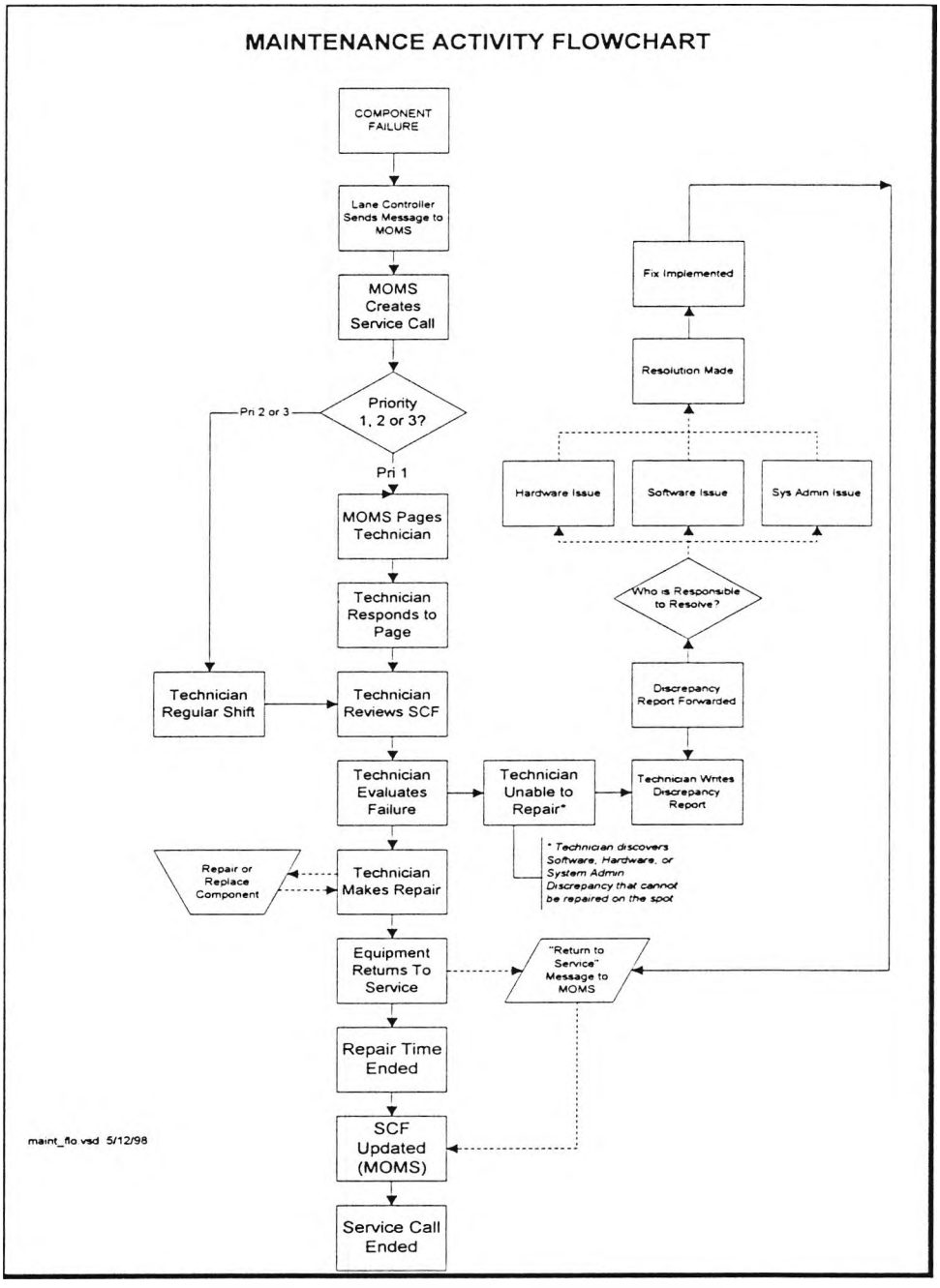


Figure 3-1 Maintenance Activity Flowchart

3.4 Safety Standards

The purpose of the implementation of safety procedures is to help make a safe work environment.

1. Safety procedures are to be enforced in the plazas, shops, and vehicles.
2. The safety procedures are to be used as a guide for all personnel assigned to the project.

3.4.1 Policy

Maintenance personnel must observe all rules set forth in this procedure for the protection of the maintenance team as well as patrons, Operations personnel, and vendor companies and their employees.

The safety of everyone involved in this project is of paramount importance. All employees are trained and made fully aware of safe practices. Training is conducted to make all assigned personnel aware of these practices.

3.4.2 Protective Equipment

Protective equipment is required for all operations, as follows:

- Highly visibile orange vests are worn by all employees operating within 15 feet of the roadway. Reflective vests are worn at night or when conditions limit visibility.
- Safety glasses are worn when drilling concrete, metal plates, or wood.
- Masks are worn when drilling or cutting results in dust in the environment.
- If noise exceeds the level set by the Occupational Safety and Health Act (OSHA), ear-protection devices are required.
- Back-support belts and shoes with steel toes are worn by installation personnel.

3.5 Safety Procedures

The following safety procedures must be adhered to by all maintenance personnel:

- All circuit breakers being worked on must be properly tagged and shut off.
- No work is performed above any open lane.
- All lanes must have signs to ensure traffic is being properly directed through the toll plaza.
- All work sites must be cleaned of all materials and tools prior to placing the lane back in service.

3.5.1 Lane Safety

The following lane safety rules are followed at all times:

- Extreme care is to be exercised when crossing lanes and crosswalks.
- Before crossing lanes, maintenance personnel must alert collectors in the booth of each lane. The collector in the booth alerts the driver and does not proceed with the toll transaction until persons have crossed the lane.
- Maintenance personnel must stop and observe traffic in both directions before stepping off the island into a lane.
- Maintenance personnel must never step off the curb before making eye contact with the driver, when walking in either direction between the toll booth.
- Maintenance personnel must never cross a lane in front of a closely approaching vehicle. He/she must wait for the vehicle to stop and be certain that the driver is aware of the intention to cross.
- Maintenance personnel must never run across the lanes, or on the grounds of the toll facility.
- Maintenance personnel must never walk between two vehicles in a toll lane, regardless of whether the driver in the following vehicle is aware of the intention to do so. The driver of the first vehicle may inadvertently place the car in reverse, resulting in injury.
- Maintenance personnel must never take control of an open lane without the express permission of the Plaza Supervisor.
- When closing a lane, maintenance personnel must use at least one traffic cone at the entry point of the lane.

- Maintenance personnel must not remove traffic cones from the lane unless all traffic signals and/or canopy lights in the lane are red to indicate lane closure.
- If additional lighting is required for maintenance at night, the lights must be properly positioned to avoid putting direct light into the eyes of oncoming drivers.

3.5.2 Lifting

Before attempting to lift anything, maintenance personnel must ascertain whether additional manpower is required to safely handle the load because of its weight and/or shape. Additional assistance is required, when using material-handling equipment to move heavy equipment. When lifting heavy items, the proper technique must be used.

3.5.3 Floor / Wall Openings and Stairwells

Equipment must not be stored or placed on any stairwell or walkway.

3.6 Security

Access booths, buildings, and computer rooms are available for authorized personnel only. Patrons and other unauthorized personnel are not allowed access to restricted areas or locked rooms.

Maintenance technicians do not discuss equipment failures with toll collection personnel. Discussions pertaining to system operational details must also be avoided.

All equipment cabinets will be locked when not being worked on. Only authorized personnel will have keys to unlock the equipment cabinets.

3.6.1 Robbery Attempts

Maintenance personnel are never to interfere with a robbery attempt. Such action jeopardizes the safety of the toll collectors and the maintenance personnel.

3.7 Lane Closure Procedure

All scheduled maintenance activity requiring closure of a lane is preceded by notification, to and approval by, LMIMS Operations. The procedures for processing traffic when a lane is closed are determined by site conditions and plaza operating procedures.

If PM requires the closure of a lane, Operations will receive written notification 24 hours in advance. The lane closures will not be performed until Operations has approved the dates and times.

The following procedure is being used for scheduled lane closures:

- Written notification of a desired scheduled lane closure is provided to Operations. This notification includes the plaza, lane, lane type, requested date, requested time, expected duration, and reason for request.
- After receiving approval from Operations, the lane closure procedure will be initiated. All scheduled activity is planned in advance to minimize the duration of the closure.
- Upon arrival at the worksite, technician(s) will notify toll collection personnel of the planned activities.
- After the toll collection personnel have authorized the closure, the actual closing and maintenance work will begin.
- All canopy lights that are in the lane being closed will be switched to red, if applicable. VMS signs will indicate the lane closure.
- The lane will be closed in accordance with Operations standards.
- The scheduled maintenance work is performed carefully and quickly.
- The lane will then be reopened to traffic in coordination with Plaza management.
- After the activity has been completed, notification of successful completion of the scheduled activity is provided to Operations. This notification will include the actual duration of the lane closure.

In the case of unscheduled closures required by failure of equipment, Operations is notified immediately.

4. Emergency / Corrective Maintenance (EM / CM)

4.1 Emergency Calls

Emergency / Corrective Maintenance will consist of calls resulting from:

- MOMS messages
- LMIMS Operations Personnel Reports (Plaza supervisor reports equipment outage.)
- Checks done by maintenance personnel during PM
- Where possible, calls placed directly by EM / CM to MOMS. Calls are handled via LRU replacement to minimize lane downtime. For an overview of the EM/CM process, see Figure 4-1.

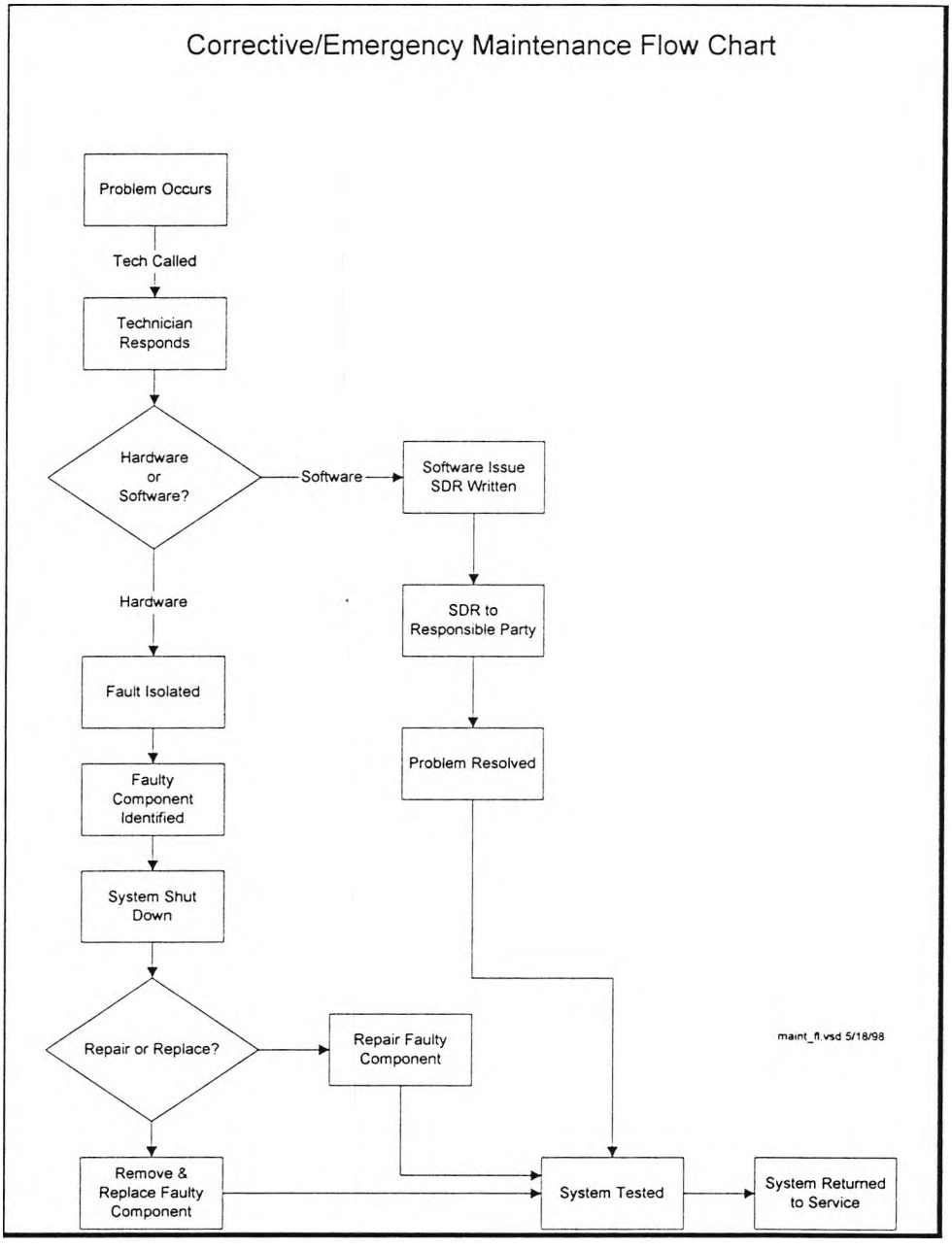


Figure 4-1 Emergency / Corrective Maintenance Flowchart

4.2 Response Procedures

Response time to a corrective or emergency condition is critical. Normal response time for EM / CM is the lapsed time between the time that the technician is notified — via radio, pager, telephone, or MOMS — and the time that the technician arrives at the work site and closes the lane. This time is not to exceed 2 hours. If these conditions cannot be met, the Engineering Manager is notified.

A technical support system provides the field work force with the technical expertise required to correct any deficiency that may occur. This support is provided through two levels:

- First level — Lead technician
- Second Level — Maintenance Team Corporate Engineering

If a problem is not resolved within 30 minutes, the technician contacts the appropriate engineering support personnel for assistance. LMIMS believes that this is sufficient time and should not be exceeded. This procedure is followed for all EM / CM actions at any time.

This support is provided 24 hours a day.

4.2.1 Technical Dispatch

Field Technicians are dispatched to respond to service calls in one of the following ways:

- MOMS contacts a technician on-call directly by paging the assigned technician in response to a Priority 1. Refer to Appendix A for Priority Levels / Failure Modes and Efforts.
- Plaza Personnel contact the Field Technician's telephone or pager during normal work hours (8:00 a.m. to 5:00 p.m.).
- Plaza personnel contact the Field Technician via pager or by telephoning technician's residence after hours.

The dispatching of a field technician occurs only as a result of the need for the corrective action because of an equipment failure or malfunction. PM and PDM calls are scheduled on a monthly basis via MOMS.

4.2.2 Acknowledgment

The technician acknowledges receipt of the call in one of the following ways:

- Via MOMS through use of modem entry, at the plaza (Maintenance Terminal), or location of equipment failure
- Via the System Monitor

4.2.3 Clearing

Calls are cleared through MOMS via the Service Call. The technician performs this action after the service call information has been entered into the system.

4.2.4 Technical Support During Normal Work Hours

If a system problem exists after one-half hour of maintenance repair effort, the local technician notifies an engineering maintenance team member.

If the maintenance team member cannot solve the problem after one-half hour of repair effort, the Engineering Manager is notified. After 1 hour of repair effort without resolution, the Engineering Manager decides whether on-site maintenance-team corporate engineering support is required.

Technical support procedures for after-hours, weekends, and holidays are the same as those used during normal work hours.

All times listed are maximums. The technician can request support sooner but must request support before the maximum times specified.

4.2.5 Delegation

The goal of delegating authority to the technician is to provide more accurate and timely reports on system status and field conditions. Authority is delegated to highly trained field technicians whose responsibility is to correct any deficiency that may occur. Field technicians use this authority to:

- Expedite decisions
- Enable quicker response to technical assistance requests

4.3 Repair Limitation / Reporting

- Failures to lane components are tracked in two major categories — field repairs and maintenance shop repairs.
- Field repairs are limited to system circuit boards or subassembly replacements and items such as fuses and switches.
- Repaired LRU or subassembly testing is performed in a bench test environment using a pseudo on-line system.
- When an LRU or subassembly is replaced, it is tagged using a Service Call Form (SCF) that is cross-referenced to MOMS by serial number.
- Maintenance shop repairs are recorded on the SCF and include the repair code, hours required, and a description of the problem. Information from MOMS and SCF is entered in MOMS.
- The MOMS database and management reporting system tracks and reports the following information:
  - ⇒ Maintenance information
  - ⇒ Failure reporting
  - ⇒ Spare- and repair-parts inventory
  - ⇒ Spare- and repair-parts purchase-order status and history
- In this manner, all failures are tracked by familiar type, LRU, assembly, or subassembly. Because all assemblies, subassemblies, and LRUs have a serial number, failure analysis for a particular item can be tracked, trends can be observed, and other objectives related to Quality Assurance (QA) can be achieved. MTTR, MTBF, Engineering Change Order (ECO) status, and other trends are all tracked via MOMS.
- Field repairs are recorded at the time of repair using the Service Call Form that is generated by MOMS. (Refer to Figure 8-2 for a sample of this form.) The Service Call Form records all the pertinent items, listed:
  - ⇒ Unit serial number
  - ⇒ Subassembly serial number
  - ⇒ Lane number
  - ⇒ Plaza number
  - ⇒ Failure description
  - ⇒ Start time
  - ⇒ Repair time
  - ⇒ Date
  - ⇒ Technician
  - ⇒ Failure code

4.4 Repair Procedures

4.4.1 Field

Repair of equipment malfunctions is performed using a diagnosis and LRU replacement methodology, as follows:

1. When a call for corrective action is received, the technician travels to the site.
2. Upon arrival, the technician begins the troubleshooting process using embedded or transportable diagnostics or other special test equipment to determine the failure of an LRU or subassembly, such as a power supply or display terminal.
3. After the defective LRU or subassembly has been identified, the technician replaces the defective LRU subassembly with an LRU or subassembly from van stock or maintenance shop spare inventory.
4. The technician performs all maintenance tests available, such as self tests and diagnostics, to ensure equipment operability prior to returning it to service.
5. The technician completes the Service Call Form and logs out of MOMS.

4.4.2 Maintenance Shop Repairs

Depot repair consists of repairing LRUs, subassemblies, and PCBs to the component level. In addition to this type of corrective action, depot repair is responsible for ECO or FCO updates to units that are in for repair.

Depot repairs are tracked by MOMS via the generation of a service call. This form, initiated by MOMS, contains the Control number assigned as a result of the field service action. All repaired LRUs, PCBs, or subassemblies are tested via the BTS before being placed in the spares inventory.

Defective parts are logged in via a service call number and serial number, and a service call is then generated. When repair and testing are complete, the technician completes the service call, enters all data in MOMS, and closes out the service call.

4.4.3 Vendor Support

Vendor support is used for the repair of LRUs, PCBs, or subassemblies if the technician determines that the repair is beyond the capability of the local shop. Vendor support is also used, if required, for system repair under the guidelines described in the preceding two subsections. All requests for vendor support are channeled through the Engineering Manager and tracked via MOMS.

5. Preventive Maintenance (PM)

5.1 Overview

PM activity is scheduled as a maintenance activity and is documented on appropriate forms that are entered into the database used for tracking.

PM activity consists of:

- Visual inspection
- Cleaning
- Adjustments to manufacturer specifications
- Lubrication
- Operational tests
- Worn-parts replacement
- Electronic calibration
- Daily walk-through

PM timing is established in conjunction with the equipment manufacturer and actual usage forecast. A schedule of PM activity has been established and will ensure the longest life of the equipment and EM / CM requirements.

Each maintenance action is done by a technician and is documented on a serialized Service Call Form. Service Call Forms are generated by PM activity and are also tracked via MOMS.

Each LRU or subassembly removed from service for repair is identified by MOMS.

The LRU mode of maintenance is vitally important to a successful maintenance operation. The Service Call Form documents are used to drive computer-generated failure-and-repair tracking from MOMS.

5.2 Notification for Lane Closure

Please see Section 3.7 for a description of the procedures and requirements for lane closure.

5.3 Scheduling

Flexibility in the creation or modification of PM schedules is necessary because the equipment comprising the Cross Island Parkway Toll Facility has never before been installed in South Carolina. Scheduling responsibility for PM activity belongs to the Engineering Manager and technicians. The PM Schedule will be determined by the technicians and submitted to the Engineering Manager for review and approval. This schedule will be determined and reviewed periodically. PM information will be available within the Service Call report. PM will be scheduled using the PM scheduling feature of the MOMS system. All PM will be performed during off-peak hours.

The initial PM schedules and procedures will be based upon the manufacturer and maintenance team recommendations. (The County will be involved in the approval.)

5.4 Changes

The technicians and the Engineering Manager are responsible for reviewing failure trends and adjusting part replacement timing. Data from other installations of specific hardware will be used in addition to results supplied by the SCDOT system.

5.5 Operational Procedures

Although the maintenance team has taken deliberate steps to provide adequate training and to anticipate environmental and operational risks to the equipment, experience has shown that periodic revision and/or re-emphasis of how equipment should be handled, stored, etc., is necessary. If failure trends related to misuse or abuse of the equipment are noted, the Engineering Manager will work closely with the SCDOT to address and eliminate each problem.

5.6 Timing

All SCDOT equipment is subject to the PM program. The PM timing for various pieces of SCDOT equipment has been established in conjunction with the equipment manufacturer. This timing information is listed in Table 5-1.

PREVENTIVE MAINTENANCE SCHEDULE		INTERVAL BETWEEN ACTIVITY IN DAYS†			FORMS FILED
SYSTEM	SUBSYSTEM	INSPECT/ TEST	CLEAN	LUBRICATE	SCF RMA
Classification Unit	Light Curtain (Ramps Only)	10/30			SCF
Classification Unit	Booth Loop	30			SCF
Classification Unit	Booth Loop Detector	30			SCFS
Classification Unit	SAM Units	30/90	30		SCF
Post Class Unit	Exit Loops	30			SCF
Post Class Unit	Exit Loop Detector	30			SCF
Post Class Unit	Treadles/Treadle Monitor	30	30		SCF
Post Class Unit	VES Loop	30			SCF
Post Class Unit	VES Loop Detector	30			SCF
Post Class Unit	Island Traffic Light	30	90		SCF
AVI	RF Module	30	30		SCF
AVI	Reader	30	30		SCF
AVI	Antennas	180			SCF
MLT	Touchscreen	90	90	30	SCF
Receipt Printer	Print Head	30	30	30	SCF
Receipt Printer	Cutter	30	30		SCF
Receipt Printer	Ribbon	30			SCF
Receipt Printer	Power Supply	90			SCF
ACM	Coin Processor	10/30/90	10	30	SCF
ACM	Coin Vaults	30	30	30	SCF
ACM	Filters	30	30		SCF
ACM	Power Supply	30			SCF
ACM	Heater	90	90		SCF
ACM	Blower	90	90		SCF
Patron Fare Display	Display Unit	90	90		SCF
Patron Fare Display	Power Supply	90	90		SCF
Lane Controller	Fan Filters	30	30		SCF
Lane Controller	Cabinet	30	30		SCF
Lane Controller	Power Supply	30	90		SCF

PREVENTIVE MAINTENANCE SCHEDULE		INTERVAL BETWEEN ACTIVITY IN DAYS†			FORMS FILED
SYSTEM	SUBSYSTEM	INSPECT/ TEST	CLEAN	LUBRICATE	SCF RMA
Lane	Uninterruptible Power Supply (UPS)	30	30		SCF
VES	Camera	30/90	90		SCF
VES	Housing	30	30		SCF
VES Light	Lamps, lenses	30	30		SCF
Plaza Power Supply	Uninterruptible Power Supply (UPS)	30	30		SCF
Plaza Computer	Filters	90			SCF
Plaza Computer	Power Supply	90			SCF
Redundant Array of Inexpensive Disks (RAID) Subsystem	Filters	90	90		SCF
Network	Cables	120			SCF
Network	Filters	120	120		SCF
Workstations	Filters	180	180		SCF
Coin Counter	Automatic Coin Machine	180			SCF
Card Encoder	Mag Head	180	180		SCF
Canopy Traffic Light		30	30		SCF

† Estimated days that PM could be performed at the time of EM / CM

Table 5-1 Preventive Maintenance Schedule / Frequency of Action

5.7 Light Curtain (Ramps Only)

Light Curtain preventive maintenance is performed at two (2) different time intervals: every 10 days and every 30 days.

5.7.1 Every 10 Days

1. Clean external surfaces of the light curtain. This is an item that may require modification over a period of time.
    - During periods of high wind, it may be necessary to increase the frequency of this activity.
2. Observe the light curtain under traffic conditions to verify Block Light Emitting Diode (LED) and Clear LED indicators are operating correctly.

5.7.2 Every 30 Days

1. Test the light curtain for proper operation with an opaque object that is 2 centimeters in size. The minimum resolution specified for the light curtain is an object that is 1 centimeter in size.
2. Cover the transmit unit and verify that the Block LED indicator reaches maximum intensity.
3. Observe the Busy LED to verify that proper data transmission to the Lane controller is occurring. (Verifying reception of data at the Lane Controller will be part of Lane Controller PM.)
4. During conditions of bright sunlight striking the receiver, adjust the range potentiometer one turn beyond the minimum level for proper operation. This will be one turn past the point where the green Clear LED illuminates.
5. Observe the light curtain under traffic conditions to verify that the Block and Clear LED indicators are operating correctly.

5.8 Booth Loops

5.8.1 Every 30 Days

1. Inspect loops for physical signs of wear or punctures.
2. Inspect splice points for water deterioration. If found, report to MOMS.
3. Inspect connections to loop harnesses.

5.9 Booth Loop Detector

5.9.1 Every 30 Days

1. Inspect all electrical connections.
2. Observe operation with traffic to verify proper operation.
3. Perform Open Loop Test as described below.

5.9.1.1 Open Loop Test

- The OPEN LOOP TEST feature enables rapid field identification of loops that have been OPEN even if the OPEN was only momentary. Cycling the three-position toggle switch to the spring-loaded OPEN LOOP TEST position (DOWN) causes all channel outputs and indicators to change to the "call state" if the loop has been open.

- The fail-safe condition of calls with an open loop is not changed by the addition of the OPEN LOOP TEST capability – that is, loops currently OPEN will cause the output and the indicator to maintain the call state condition.

- Interrogation of the OPEN LOOP TEST does not clear or reset any valid calls or OPEN LOOP TEST indications. OPEN LOOP TEST memory may be reset or cleared only by interrupting the power to the detector unit by depressing the reset switch.

5.10 SAM Units

5.10.1 Every 30 Days

1. Clean the SAM unit housing.
2. Inspect all wiring and connections.
3. Inspect the light on the power supply unit and change the fuse, if necessary.
4. Check the voltage across each unit, with and without an object present in the field.
5. Inspect the SAM unit and check the sensitivity.

5.10.2 Every 90 Days

1. Perform field checkout and test procedures.
2. Clean and vacuum all surfaces, as necessary, using a vacuum cleaner.
3. Inspect the light on the power supply unit and change the fuse, if necessary.
4. Check the voltage across each unit, with and without an object present in the field.
5. Inspect the SAM unit and check the sensitivity.

5.11 Exit Loop

5.11.1 Every 30 Days

1. Inspect loops for physical signs of wear or punctures.
2. Inspect splice points for water deterioration. If found, report to MOMS.
3. Inspect connections to loop harnesses.

5.12 Exit Loop Detector

5.12.1 Every 30 Days

1. Inspect all electrical connections.
2. Observe operation with traffic to verify proper operation.
3. Perform Open Loop Test as described below.

5.12.1.1 Open Loop Test

- The OPEN LOOP TEST feature enables rapid field identification of loops that have been OPEN even if the OPEN was only momentary. Cycling the three-position toggle switch to the spring-loaded OPEN LOOP TEST position (DOWN) causes all channel outputs and indicators to change to the "call state" if the loop has been open.

- The fail-safe condition of calls with an open loop is not changed by the addition of the OPEN LOOP TEST capability – that is, loops currently OPEN will cause the output and the indicator to maintain the call state condition.

- Interrogation of the OPEN LOOP TEST does not clear or reset any valid calls or OPEN LOOP TEST indications. OPEN LOOP TEST memory may be reset or cleared only by interrupting the power to the detector unit by depressing the reset switch.

5.13 Treadles/Treadle Monitor

5.13.1 Every 30 Days

1. Clean and inspect the treadle.
2. Inspect the treadle for visual signs of wear or cut.
3. Inspect the connections in the lane.
4. Run status response request for each treadle monitor by using a laptop computer.
5. Inspect the treadle monitor.

5.13.1.1 Status Response

When a status request message is received by the treadle monitor, it will issue several of the group messages listed below in response:

- One message for each strip from group 2
- One message for each strip from group 3
- Either the Auto On (AO) or Auto Off (AF) message
- The count forward message
- The count reverse message

5.13.1.2 Group Messages From Treadle Monitor

The following messages are sent once each time the status of the strip is detected as changed. These messages are sent regardless of the state of the automatic disable mode. This information is also contained in the status message.

- DEF K1 — Strip One OK
- DEF K2 — Strip Two OK
- DEF K3 — Strip Three OK
- DEF K4 — Strip Four OK

- S1 — Strip One Shorted
- S2 — Strip Two Shorted
- S3 — Strip Three Shorted

- S4 — Strip Four Shorted
- O1 — Strip One Open
- O2 — Strip Two Open
- O3 — Strip Three Open
- O4 — Strip Four Open

- I1 — Strip One Intermittent
- I2 — Strip Two Intermittent
- I3 — Strip Three Intermittent
- I4 — Strip Four Intermittent

5.13.1.3 Strip Disable/Enable

Each strip may be disabled or enabled in one of three ways:

1. Via dip switch on the card. If a strip is disabled using this switch, the enable message or automatic enable cannot override it. When a strip is enabled using this switch, these other modes are allowed to function.
2. Via received message. The enable/disable messages will function as long as the manual switch for that strip is enabled. Enabling a strip that has been automatically disabled will restart the automatic bad-strip-detection process. If the strip is determined to be bad, a message will be sent, and if the automatic disable mode is on, the strip will be disabled. However, if a strip is disabled with a message, it will not be automatically re-enabled.
3. Via automatic determination. If the automatic disable mode is on, strips that are determined to be bad are automatically disabled and enabled (enabled only if not disabled with switch or message). Appropriate messages are sent.

When a strip is disabled, it does not contribute to the treadle counting process. If all strips but one are disabled, the treadle monitor will report forward counts only.

The following messages are sent whenever a strip is disabled or enabled by any of the above methods. This information is also contained in the status message above:

- DEF E1 Strip One Enabled
- DEF — E2 Strip Two Enabled
- DEF — E3 Strip Three Enabled
- DEF — E4 Strip Four Enabled

- D1 — Strip One Disabled
- D2 — Strip Two Disabled
- D3 — Strip Three Disabled
- D4 — Strip Four Disabled

- DEF AF — Automatic disable mode is off.
- AO — Automatic disable mode is on.
- CF*nnnnn* — Count Forward. The treadle monitor will maintain a count of forward axles (*nnnn* represents the decimal count). For example, if the axle count was 8,954, the message would be CF08954. The maximum count is 65,535. At this point the count will roll back to zero.
- CR*nnnnn* — Count Reverse. Count of reverse treadle crossing. Same format as forward count message.

5.14 VES Loop

5.14.1 Every 30 Days

1. Inspect loops for physical signs of wear or punctures.
2. Inspect splice points for water deterioration. If found, report to MOMS.
3. Inspect connections to loop harnesses.

5.15 VES Loop Detector

5.15.1 Every 30 Days

1. Inspect all electrical connections.
2. Observe operation with traffic to verify proper operation.
3. Perform Open Loop Test as described below.

5.15.1.1 Open Loop Test

- The OPEN LOOP TEST features rapid field identification of loops which have been OPEN even if the OPEN was only momentary. Cycling the three-position toggle switch to the spring-loaded OPEN LOOP TEST position (DOWN) causes all channel outputs and indicators to change to the "call state" if the loop has been open.

- The fail-safe condition of calls with an open loop is not changed by the addition of the OPEN LOOP TEST capability. That is, loops currently OPEN will cause the output and the indicator to maintain the call state condition.

- Interrogation of the OPEN LOOP TEST does not clear or reset any valid calls or OPEN LOOP TEST indications. OPEN LOOP TEST memory may be reset or cleared only by interrupting the power to the detector unit by depressing the reset switch. < Fast Rec.

5.16 Island Traffic Light

5.16.1 Every 30 Days

1. Inspect all wiring and connections.
2. Perform test for traffic lights.
3. Perform test for alarm.

5.16.2 Every 90 Days

1. Clean all traffic signal lenses.
2. Replace traffic signal light bulbs as needed.

5.17 RF Module (AVI)

5.17.1 Every 30 Days

1. Inspect the reader cabinet for abnormal conditions.
2. Open the cabinet and inspect the connections.
3. Clean and vacuum all surfaces, as necessary, using a vacuum cleaner.
4. Verify AVI transmitter operation by connecting a laptop to the diagnostic port and check the tag read while AVI traffic is passing through the lane.
5. Observe operation of the AVI system by observing the Pal Pass and green traffic lights in the lane while AVI traffic is passing through the lane. Ensure that the traffic lights illuminate correctly.

5.18 Reader (AVI)

5.18.1 Tools Required

- Laptop computer with communication program (ProCom)

5.18.2 Every 30 Days

1. Inspect the reader cabinet for abnormal conditions.
2. Open the cabinet and inspect the connections.
3. Clean and vacuum all surfaces, as necessary, using a vacuum cleaner.
4. Verify AVI transmitter operation by connecting a laptop to the diagnostic port and check the tag read while AVI traffic is passing through the lane.
5. Observe operation of the AVI system by observing the Pal Pass and green traffic lights in the lane while AVI traffic is passing through the lane. Ensure that the traffic lights illuminate correctly.

5.18.3 Every 6 Months

- Check for fail-over operation.

5.19 Antennas (AVI)

5.19.1 Tools Required

- Digital Volt Meter (DVM)
- Bucket truck or man lift

5.19.2 Every 180 Days

1. Inspect the antenna for abnormal conditions.
2. Inspect the connections.
3. Using DVM, verify the power supply voltages.
4. Verify a 15° +/- .50 approach angle to road surface. Check the angle of antenna using an "Intelligent Level."

5.20 Touch Screen (MLT)

5.20.1 Every 30 Days

- Lubricate the mount.

5.20.2 Every 90 Days

1. Remove power from the MLT.
2. After 10 seconds, apply power and observe the self-test.
3. If the self-test fails, replace with a spare unit and repeat steps 1 and 2.
4. Clean the touch screen using a glass cleaner such as "Windex" or "Glass Plus."

5.21 Print Head (Receipt Printer)

5.21.1 Tools Required

- DVM

5.21.2 Every 30 Days

5.21.2.1 Test the Printer

1. Push-test the pushbutton to verify proper operation.
2. If the test does not run correctly, replace with spare unit and repeat step 1.
3. Inspect, clean, and lubricate print head.
4. Verify proper on-line operation with MLT and the lane controller.

5.21.2.2 Replace Ink Cartridge

1. Lift and open the cover.
2. Rotate the old cartridge-front up approximately 20 degrees.
3. Remove the cartridge by lifting up and back.
4. Place the new cartridge with ribbon over ribbon guide.
5. Press on the rear of the cartridge until it snaps into place.
6. Close the top cover.

5.22 Cutter (Receipt Printer)

5.22.1 Every 30 Days

- Make sure the printer cutter is in operational condition and is free of debris.

5.23 Ribbon (Receipt Printer)

5.23.1 Every 30 Days

1. Tighten the ribbon by rotating the manual advance counterclockwise.
2. Ensure that the ribbon does not snag.
3. Close the top cover.

5.24 Power Supply (Receipt Printer)

5.24.1 Every 90 Days

- Using DVM, measure all power supply voltages.

5.25 Coin Processor (ACM)

5.25.1 Tools Required

- Laptop computer with TSTI validator software
- Test coinage
- Metric wrenches and nut drivers
- DVM

5.25.2 Every 10 Days

1. Clean and inspect the coin processor.
2. Inspect the connectors.

5.25.3 Every 30 Days

1. Remove, clean, and inspect the coin wheel.
2. Remove, clean, and inspect the escrow wheels.
3. Clean the surfaces of the coin processor.
4. Lubricate the motor bearings.
5. Verify the validation of coins.
6. Inspect the connections.

5.25.4 Every 90 Days

5.25.4.1 Coin Processor

1. Inspect the motor brushes for excessive wear (minimum length is 0.25 inches).
2. Inspect the coin motor belt.
3. Inspect the test vault changeover unit.

5.25.4.2 Patron Toll Display

- Clean and inspect the segments.
- Inspect the connections.
- Run diagnostic maintenance mode.

5.26 Coin Vaults (ACM)

5.26.1 Every 30 Days

1. Lubricate the ACM coin vault.
2. Inspect the connections (Vault Identification Sensor).
3. Inspect and clean the coin vaults:
    - Inspect the vault lock.
    - Inspect the vault door.
    - Clean the rear of the vault encoder block.
    - Lubricate the vault rails.

5.27 Filters (ACM)

5.27.1 Every 30 Days

- Inspect and clean the filters.

5.28 Power Supply (ACM)

5.28.1 Every 30 Days

- Verify the power supply:
  - ⇒ Inspect the connections.
  - ⇒ Verify the power supply voltages (24 VAC, 24 VDC, and 5 VDC) using DVM.

5.29 Heater (ACM)

5.29.1 Every 90 Days

1. Turn the thermostat until the heater turns on.
2. Verify proper functioning.
3. Clean the heater elements and surrounding areas.

5.30 Blower (ACM)

5.30.1 Every 90 Days

1. Turn the thermostat until the blower turns on.
2. Verify the proper operation.
3. Clean the blower and surrounding area.

5.31 Patron Fare Display (PFD)

5.31.1 Every 90 days

1. Clean the face of the fare display unit.
2. The PFD is equipped with a self-test switch that may be used to check the operation of all display elements.

5.32 Power Supply (Patron Fare Display – PFD)

5.32.1 Every 90 days

1. Clean the power supply.
2. Measure the power supply voltages.

5.33 Fan Filters (Lane Controller)

5.33.1 Every 30 Days

- Clean and inspect all lane controller fan filters.

5.34 Cabinet (Lane Controller)

5.34.1 Every 30 Days

- Clean and inspect the inside and outside of the lane controller.

5.35 Power Supply (Lane Controller)

5.35.1 Tools Required

- DVM

5.35.2 Every 30 Days

- Perform a power-on self-test procedure.

5.35.3 Every 90 Days

1. Using a DVM, check the power supply voltages.
2. Clean the lane controller power supply.

5.35.4 Lane Controller Audio Error Codes

A variety of tests are executed automatically when the lane controller is powered up. Initially the "Power-On Self Test" or POST is run. It provides error or warning messages whenever a faulty component is encountered. Typically, two types of messages are issued — audio codes and display screen messages or codes.

Audio codes consist of a series of beeps that identify a faulty component. If the computer is functioning normally, there will be one short beep when the system is turned on. However, if a problem is detected, a series of beeps will occur. These audio codes define the problem and are typically the following:

Beep Code	Problem
No beep, continuous beep, or repeating short beeps	Power Supply
One long beep and one short beep	System Board
One long beep and two short beeps; or one short beep and blank	Monitor adapter card and/or monitor cable and/or wrong display
One short beep and either the red drive LED staying on or a Personal Computer Basic statement	Drive and/or drive adapter card

5.36 Lane Uninterruptible Power Supply (UPS)

5.36.1 Every 30 Days

1. Clean the fan area.
2. Check the connections.

5.37 Camera (VES)

5.37.1 Every 30 Days

1. Inspect all wiring and connections.
2. Check the VES camera power supply voltage.

5.37.2 Every 90 Days

1. Clean and inspect all wiring and connections.
2. Connect a monitor to the camera and adjust the picture quality according to the following:
   - ⇒ Focus
   - ⇒ Brightness
3. Drive a vehicle through the lane and verify that an image is taken and is of readable quality.

5.38 Housing (VES)

5.38.1 Every 30 Days

1. Clean and vacuum the inside housing.
2. Inspect for leaks or deteriorating seals; replace as needed.
3. Clean the viewing glass.
4. See the PM procedures for lenses (Section 5.37).

5.39 Lamps, Lenses (VES Light)

5.39.1 Every 30 Days

5.39.1.1 Light

1. Verify that the light turns on when the sensor is blocked and turns off when the sensor is unblocked.
2. Clean the lamp lens. Use a standard glass cleaner.

5.39.1.2 Lenses

- Clean the camera lens. Use a standard glass cleaner and lint-free towels.

  ⇒ Ensure that the position of the lens remains unchanged.

5.40 Plaza Uninterruptible Power Supply (UPS)

5.40.1 Every 30 Days

1. Observe and record the reading of the load consumption bar graph and the battery capacity bar graph.
2. Perform the UPS Self-Test described below to verify proper operation.
3. Depress the 1/Test push button to measure and record the incoming electric utility voltage.
4. Clean the UPS.

5.40.1.1 UPS Self-Test

1. Upon start-up, the UPS runs a self-test routine that determines the readiness of the unit to supply power derived from the battery to the load.
2. After an 8-second waiting period, during which the green On-line LED indicator blinks, the UPS begins the self-test by transferring the output load to the inverter.
3. While operating on-battery, as indicated by the illumination of the yellow On-Battery LED indicator, the UPS monitors the condition of the battery.
4. If the UPS detects a weak battery, the green LED at the bottom of the Battery Capacity bar graph display will blink, indicating that the UPS may not be able to provide the expected run time and the battery should be allowed to recharge.
5. If the UPS detects a battery that has become abnormally weak, the red Replace Battery LED is illuminated. The self-test routine is terminated immediately upon detection of a weak battery, and the output load is transferred to the utility.
6. A successful self-test is completed in approximately 16 seconds, at which time the output load is transferred back to the utility as indicated by illumination of the green On-line LED.
7. The battery capacity test portion of the UPS self-test may be defeated via the Battery Test Disable option switch.

5.41 Filters (Plaza Computer)

5.41.1 Every 90 Days

- Inspect and clean the filters. Replace, if necessary.

5.42 Power Supply (Plaza Computer)

5.42.1 Tools Required

- DVM

5.42.2 Every 90 Days

- Check the power supply voltages, using a DVM.

5.43 Filters (Redundant Array of Inexpensive Disks [RAID] Subsystem)

5.43.1 Every 90 Days

- Inspect and replace the filters.

5.44 Cables (Network)

5.44.1 Every 120 Days

- Check the cables and the cable connections.

5.45 Filters (Network)

5.45.1 Every 120 Days

- Inspect and clean the filters. Replace, if necessary.

5.46 Filters (Workstations)

5.46.1 Every 180 Days

- Inspect and clean the filters. Replace, if necessary.

5.47 ACM (Coin Counter)

5.47.1 Every 180 Days

Inadequate care or cleaning can result in improper operation.

Note: Never attempt to clean the sorter when it is connected to power.

Note: Never allow fingers, hair, or loose clothing to come into contact with moving parts.

The frequency of any cleaning program must be determined by the operator and will ultimately be controlled by operational environment, condition of coins, frequency of use, etc. The power cord should always be disconnected before cleaning.

5.47.1.1 General Cleaning

1. Keep the sorter clean and free of dirt and dust. A small brush is handy for cleaning hard-to-reach spots.
2. Clean the outside with a soft cloth and a mild soap. NEVER use alcohol, Ketone, or any harsh chemicals on the outside surfaces. NEVER spray any liquid directly onto the keyboard or inside the sorter.
3. Keep the sorter covered and dusted with a soft, dry cloth when not in use.

5.47.1.2 Photocell Cleaning (Location: The coin exit points along the Sorting Rail)

1. Keep the photocells, which control the counting, free of dirt buildup, coin dust, bag strings, etc.
2. CAREFULLY brush-clean the lens inside the "U" shape of each photocell with the brush provided.

5.47.1.3 Coin Rail / Coin Transfer Rail Cleaning

1. Keep the rails free of dirt buildup to enable a smooth flow of coins through the sorting gates.
2. Brush-clean the coin rails with the brush provided.

5.48 Mag Head (Card Encoder)

5.48.1 Every 180 Days

- Clean magnetic read / write head as described in the manufacturer's manual

5.49 Canopy Traffic Light

5.49.1 Every 30 Days

1. Clean all canopy traffic light lenses.
2. Inspect all wiring and connections.
3. Perform field checkout and test procedures for traffic lights.

5.49.2 Every 6 Months

- Replace traffic light bulbs once every 6 months, or at burn out.

6. Predictive Maintenance (PDM)

6.1 Equipment Failure Tracking

Unanticipated failures, while inevitable, can be dramatically reduced by analyzing MOMS failure data and data gathered during PM activity. By utilizing this data, parts can be replaced prior to failure. PDM is designed to prevent lane and other equipment outages by replacing parts prior to failure. This replacement is based on information gathered via service call analysis performed by the service technicians and Engineering Manager. The maintenance will be performed during scheduled PM.

All equipment failures will be tracked and logged via MOMS. This information is utilized to determine if a failure condition warrants the establishment of an ECO / FCO. Upon determination of the need of an ECO / FCO, the QC Engineer, along with the System Engineer assigned to the project, establish the ECO / FCO following proven engineering design procedures. In addition, the maintenance team utilizes this information proactively by practicing managed PDM. By following the failure data collected on the SCF (Service Call Form) and reported via MOMS, supervisory and senior technical personnel can determine if changes to PM timing or operational procedures are required and / or changes in sparing levels or locations are required. They will then suggest proactive LRU replacement at the next technician site visit rather than wait for a service call. This not only allows more efficient management of the work force but also dramatically improves the throughput by reducing lane downtime.

6.2 Predictive Maintenance (PDM)

6.2.1 Methodology

PDM involves frequently assessing the results of the EM/CM and PM activity. After the results have been analyzed, a failure trend often becomes apparent. This trend can be the result of a poor design or a part that is being used improperly. Based on this failure trend, an LRU will be replaced or modified before failure occurs. Once a known solution to a design problem is achieved, this solution is implemented system-wide to prevent this failure from occurring elsewhere. At each monthly meeting any trend analysis will be discussed, with the authority representative. The equipment or item being maintained becomes more reliable with the inclusion of newly designed parts in the original equipment. This occurs because problems that take a long time to appear are corrected not only where they have appeared but also in all like equipment before there is a failure.

PDM, PM, and EM/CM, with an emphasis on rapid response and repair, are the types of maintenance that will be performed. The maintenance team has determined that by the end of the first year of operation, the vast majority of maintenance activity will be preventive in nature.

7. Engineering/Field Change Order (ECO/FCO)

7.1 ECO/FCO Procedures

The Engineering Manager is responsible for determining the validity of any Engineering or Field Change Order (ECO/FCO) and for generating the ECO/FCO notification documentation. Figure 7-1 shows a sample of the ECO/FCO form. The procedures are as follows:

1. Generate an ECO/FCO form. The ECO/FCO documentation incorporates an assigned number for tracking the equipment and serial numbers affected. The documentation also includes a description of why the ECO/FCO was issued and a description of the change to be made.
2. Send a copy to SCDOT and the Program Manager for further comment and approval.
3. Upon approval of the ECO/FCO by SCDOT, an ECO/FCO package goes out to the field via the Engineering Manager for each piece of equipment affected by the ECO/FCO.

   The ECO/FCO package contains:

   - Description of how to install and check out the ECO/FCO
   - Parts needed
   - Sign-off sheet to be sent back to the Central Repair Depot (CRD) to verify that the ECO/FCO was installed.

4. Keep a log with the equipment and at the Final Design Review (FDR) indicating the ECO/FCO revision level of the equipment.
5. It is the responsibility of personnel at the site to update equipment logs upon completion of ECO/FCO installations.
6. Monitor the performance of all ECO/FCO installations to verify that no latent problem emanates from any ECO/FCO installation.

7. The status of ECO/FCO installations and the ECO/FCO revision level of the equipment are kept on the MOMS database.
8. A copy of the ECO/FCO log is given to SCDOT in order to keep all pertinent parties notified of the status of ECO/FCO.

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ENGINEERING/FIELD CHANGE ORDER FORM (ECO/FCO)

PROJECT:	*LOCATION:*
SCDOT	Cross Island Parkway
DATE ISSUED:	*ISSUED BY:*

DESCRIPTION & NEED OF PROPOSAL CHANGES:
This form summarizes modifications necessary to accommodate job conditions in order to allow construction to proceed in affected areas.

Indicate in drawing below or on attached drawings to be referenced below all structural components and proposed modifications. Include all dimensions and descriptions of materials:

Authorization and Approval:
The work described above is not to proceed until this Field Change Order Form is executed below by all authorized individuals as indicated:

LMIMS Engineer: _____	*SCDOT Authority:* _____
Signature: _____	*Signature:* _____
Date: _____	*Date:* _____

Distribution: Hardware Engineer-LMIMS
File Copy

Figure 7-1 ECO/FCO Form

7.2 Coordinate ECO/FCO Installation & Tracking

The Field Service technician is responsible for ensuring that all equipment under his / her scope of maintenance has been modified as dictated. The ECOs must have a service call generated on each piece of equipment affected. If an ECO/FCO affects all similar equipment at one site, then one service call can be used to reflect changes to all equipment at that site. The CRD lead technician provides guidance to field lead technicians effecting such ECO/FCOs.

8. MOMS – Service Requests, Repairs, and Reports

8.1 MOMS – Maintenance Management Tool

Maintenance management analyzes MOMS-generated EM / CM and PM reports to determine priorities. Timing is saved by exposing current and potential problems.

MOMS, see Figure 8-1 for an overview, is a host-resident software module that performs the following functions:

- Accepts and reports failure and warning messages from all levels of equipment
- Passes service calls to the local maintenance service shop
- Tracks and reports response and repair times on each service call
- Provides a complete inventory tracking system, including spare parts, with order levels
- Logs and maintains a database of service calls and starts paging process, if necessary
- Enables the technician to log EM / CM and PM repairs
- Reports MTBFs and MTTRs at the LRU level
- Generates Service Call Forms (see Figure 8-2)

All maintenance personnel must track maintenance activities as described within this document. Maintenance activity tracking enables the maintenance team to monitor the technician's performance. The frequency of maintenance activity reviews is described as follows:

- LMIMS reviews the service calls with the technician and determines whether a problem warrants further investigation or an ECO / FCO. At this time, a spot check is done to determine if the response time and MTTR are within the required time. The Program Manager and the Engineering Manager then determine the appropriate solution.

- Preventive maintenance schedules are reviewed weekly for accuracy and delinquency. Adjustments are made to the schedule, accordingly.
- ECO / FCOs are approved by the Engineering Manager. When the repair is complete, the Engineering Manager will check it for accuracy.

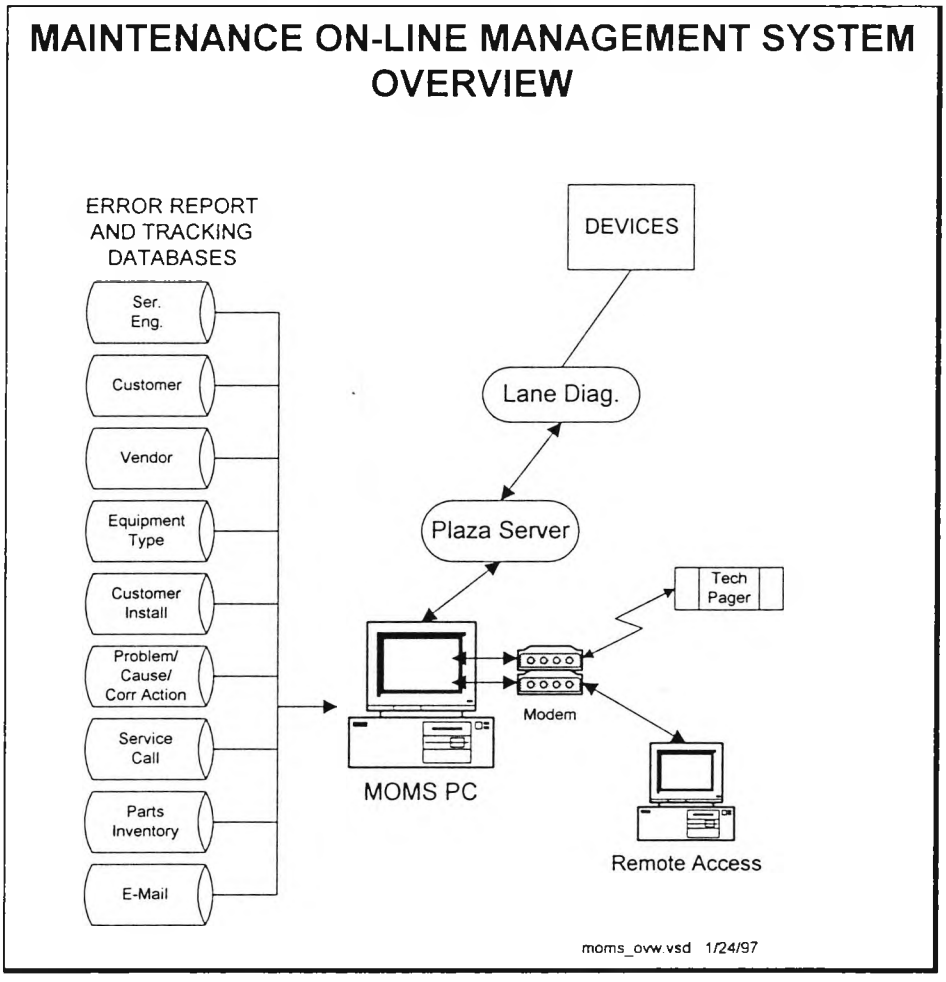


Figure 8-1 MOMS Overview

Printed: 05-15-98 15:37 Call Number: 0005480

Call Priority	Call Type	Credit Status	New Status	Oper Acct.	Purchase Order ID	Purchase Order Number	Resp Time
S R	CL		N	JAC			0002

Customer Information:			Date	Time
001002	843-342-2154	Opened:	05-15-98	1534
LANE 02		Dispatched:	05-15-98	1540
Cross Island Parkway Plaza		Closed:	05-15-98	1537
ETA:	05-15-98	1534		
MIAMI	FL 30342	Arrived:	05-15-98	1550
USA		Completion:	05-15-98	1600
PM Due:				

Contact: JOHN A. SMITH 843-342-3036

Contract Information:

Number:	Expir:	Class:
Terms:		
Equipment-Serial No.:	VIOL ENFORCEMENT CAMERA	
Warranty Expiration:		Revision Level:

Service Information:

SE Assigned:	00369	Name: JOHN A. SMITH	Mkt Seg:
Phone:		305-854-0427	Profit Center:
Special Instructions:			

Problem	Description	Cause	Action	Description

<Problem>
CAMERA MISALIGNED WHEN IMPACTED BY TRUCK MIRROR
OUT OF FOCUS

<Resolution>
REALIGN CAM AND EXAMINE VIOLATION IMAGE CAPTURE

Figure 8-2 MOMS Service Call Form

8.2 Documentation of Field Service Activity

8.2.1 EM / CM Service

Emergency Maintenance (EM) and Corrective Maintenance (CM) calls generated by failures of the equipment itself are automatically logged and numerically controlled. Service requirements can be logged-in to MOMS at the plaza. Response time tracking begins when the service technician is paged.

Upon acknowledgment of the callout by the technician, MOMS logs the technician number and the en route time.

When the technician arrives on-site, the technician can track and log the response time by putting the lane into maintenance mode via a plaza terminal entry. Data from MOMS can be assessed from the plaza terminal to help the technician in troubleshooting the equipment. Tracking and logging the response time also starts the repair time tracking. When the technician restores the lane to a mode other than maintenance, or clears the call via the plaza terminal, the repair time is closed.

The weekly archiving and daily backups are used as a safeguard to system failure, to provide additional fields of data for internal analysis, and to enable more-extensive notes and remarks. The document used is called the Maintenance On-Line Management System (MOMS). Service calls are cross-referenced to the MOMS database. When a part must be removed from the lane for repair, a service call report is cross-referenced to MOMS and attached to the part. The technician checks the service calls via MOMS. These are used for the following:

- Time tracking
- Work detail
- Parts use

The replacement-part serial number is entered in MOMS. The inventory movement tracking is carried out via MOMS.

8.3 Maintenance Shop Documentation

All information concerning repairs — such as parts use, repair time, or current revision status — is entered and tracked using the Service Call Form. The Service Call Form is generated by the technician, according to the MOMS design document at the time that a repair item, such as a Patron Fare Display (PFD), returns to the shop. The Service call Form and MOMS are used for inventory tracking use, MTTR and MTBF calculations, and total repair times.

The technician enters information for the Service Call Form into MOMS via the service call processor in MOMS.

The maintenance shop documentation is:

- **SCDOT Installation Plan** containing the procedures for configuring the Cross Island Parkway lanes and test procedures for all lane configurations
- **Maintenance Service Manuals** required for maintenance support
- **Vendor Operating, Installation, and Maintenance Manuals** required for LRU and subassembly repairs for all equipment within the system
- **Various Component Product Data Manuals for Components** such as ICs, Memory Chips, and Micro-Processors
- **Procedure Manuals for Supervisor and Toll Collector Operations** required for after-hours, weekends, and holiday help-desk functions
- **As-built site drawings**

8.3.1 Vendor / Third-Party Repair

The maintenance team performs Lowest Replacement Unit (LRU) repairs on non-proprietary, non-unique boards. Specialized and unrepairable boards are returned to the vendor for repair or replacement. These activities are reported via entry of the Service Call Form. Total repair time and other information, such as ECO updates, is entered on the Service Call Form when the part is returned from the vendor. At that time, the Service Call Form is closed via the service call process in MOMS.

8.4 Field-Level Documentation

All field-level documents will be stored in the maintenance shop. Field-level documentation will consist of manufacturer maintenance service manuals, MOMS user manuals, and various operation manuals for test equipment such as oscilloscopes, digital voltmeters (DVMs), and "as built" site drawings.

Maintenance service manuals serve as the main operating documents for field repair. These manuals will be developed using vendor-supplied operating and maintenance manuals for all equipment in the system. These manuals will include procedures for equipment testing, troubleshooting, adjusting equipment, and PM. Maintenance service manuals will contain procedures for MOMS activity for status checks and data entry for service call updates.

Also, these manuals contain a section of Standard Operating Procedures (SOPs) for obtaining technical support and after-hour call-outs.

8.5 Maintenance On-Line Management System (MOMS)

MOMS is a computer software package that operates on a dedicated MOMS PC, enabling the user to automate the facility maintenance process.

MOMS automates a facility's maintenance process by:

- Receiving 'failures' that are sent as messages from the lane equipment and automatically process the service calls
- Enabling users to manually enter service requests into the system
- Enabling maintenance personnel who do the work to record the maintenance performed into the system
- Enabling users to track the status of service requests and maintenance performed
- Enabling the preventive maintenance (PM) schedule to be entered into the system
- Tracking the scheduled PM actions

The MOMS package was chosen because it has the ability to interact with digital pagers to contact the maintenance personnel.

8.6 How MOMS Works

8.6.1 Process #34 - From Equipment to the Host

1. All lane devices are configured to send messages either directly to or through the Lane Device Handler in the Lane Controller.
2. Once an error has been detected by the Lane Device Handler, the error message is passed through the Diagnostic Process for verification.
3. Once verified, an 'error transaction' is written to the lane tranlog and to the Plaza DECMessageQ. This is called the 'Tranlogging Process.'

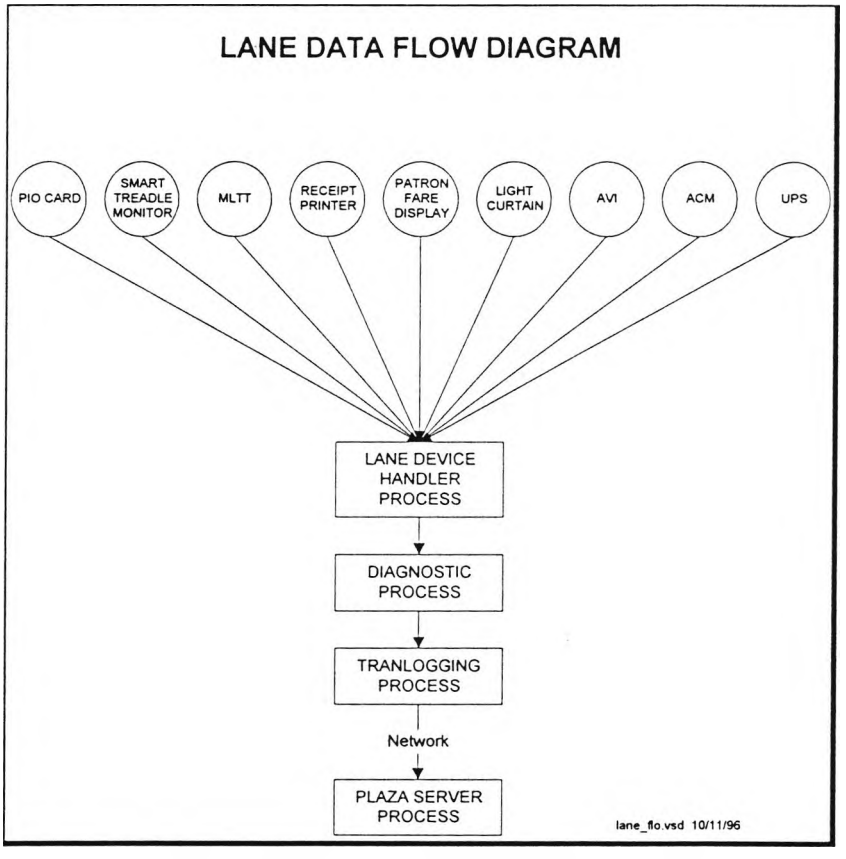


Figure 8-3 Lane Data Flow Diagram

8.6.2 Process — From the Host to the Service Call

1. The MOMS process #34 — Process MOMS Records — is continuously monitoring the MOMS.IN file for any new error messages written by the Server program.
2. When MOMS receives an error message, MOMS will write an acknowledgment to the MOMS.OUT file in response.
    - MOMS will then verify the customer code in the Customer Installed Database.
    - If the customer code is not found, MOMS will ignore the message.
    - If the error message contains a valid customer code, MOMS will check the priority of the message.
3. A priority message assigned a priority 1 will begin the paging process and will update the Service Call database.
4. The paging process will check the Service Engineer (SE) database to determine the assigned active technician.
5. Once the Service Call Database is updated, the Dispatch Grid will be updated to include the new service call.

8.6.3 Process #21 — Enter Service Call

The service technician will enter the service call by using the MOMS process #21, Enter Service Call; the enter service call process enables the technician to enter the part used along with the time spent in the service call. When the technician closes the service call on Process 21, the parts inventory database and the MTBF and MTTR database are updated automatically.

For details of the process, see section 8.11.

8.6.4 Process #22 — Update Service Call

1. The service technician will complete the service call by using the MOMS process #22, Update Service Call; the update service call process enables the technician to enter the part used along with the time spent in the service call. When the technician closes the service call on Process 22, the parts inventory database and the MTBF and MTTR database are updated automatically. For details of the process see section 8.12.
2. The dedicated MOMS PC will run process #34 at all times except during database recovery.
    - Database recovery is a utility provided by Micro Design that keeps the database in good condition.
    - This utility should be run approximately once per week.
3. In order to perform other functions in MOMS while process #34 is running, additional personal computers are linked to the server. All data entry and updating functions will be performed on the additional PCs. Figure 8-4 displays the MOMS Data Flow Diagram.

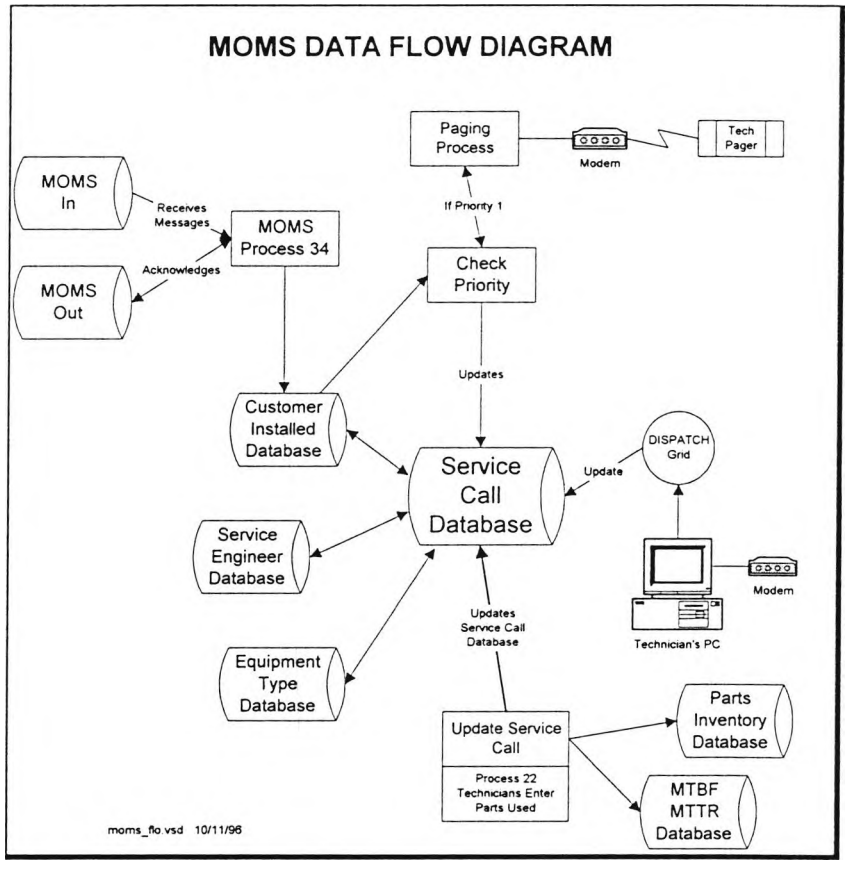


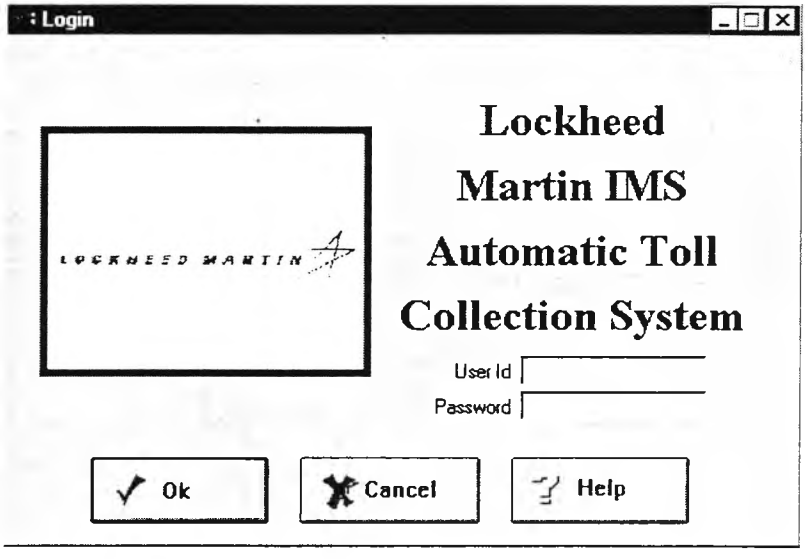
Figure 8-4 MOMS Data flow Diagram

8.7 Login to the ETC System

The login process provides security and access only to the users who are authorized to use the system.

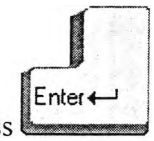
8.7.1 Process

1. Double click on the Application icon that is available on the Program Manager window. The following **Login** window is displayed:

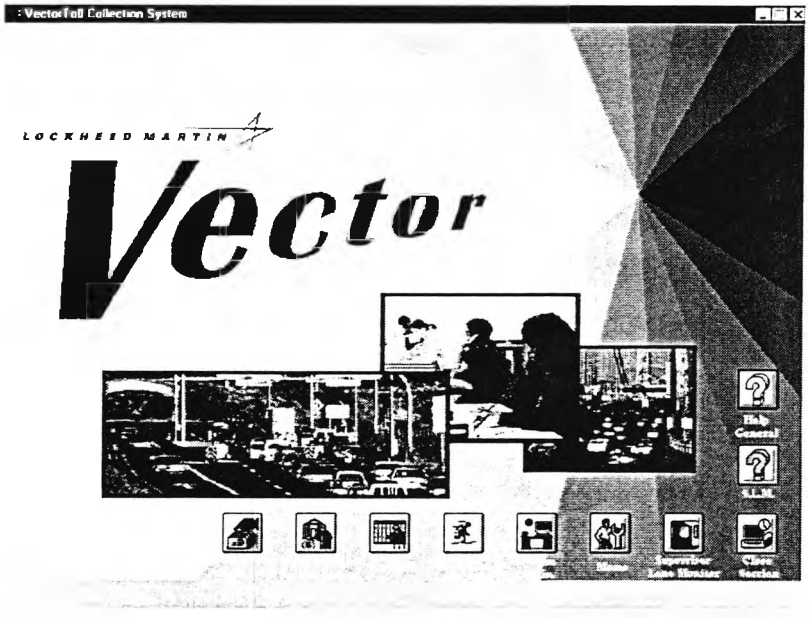


2. Enter **User ID**. Press Tab.
3. Enter **Password**.
4. Click on Ok.

Or

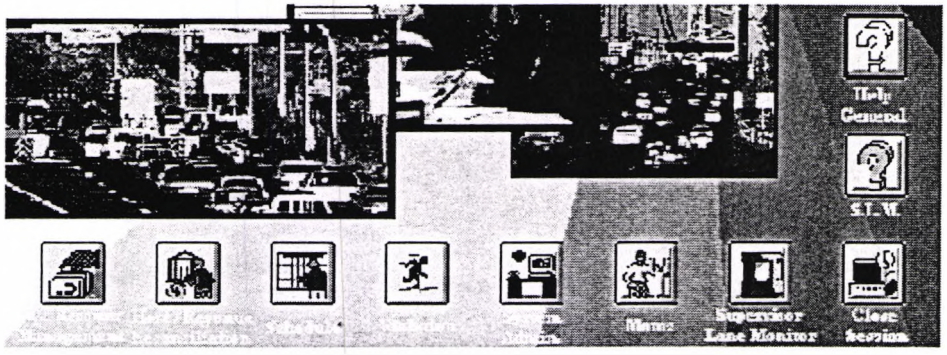


Press . The **Vector Electronic Toll Collection System** screen is displayed with various options.

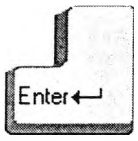


8.8 Access MOMS

In the lower right-hand corner of the Main Screen are various buttons. They allow certain users to access different applications after successfully logging into the system.

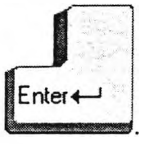


1. Click on to access the **Maintenance On-Line Management System - MOMS application**. The system requires a specific security clearance. Once the user accesses the initial MOMS screen, the user must login with an operator ID and a password. At the following initial **MOMS** screen:

2. Press 

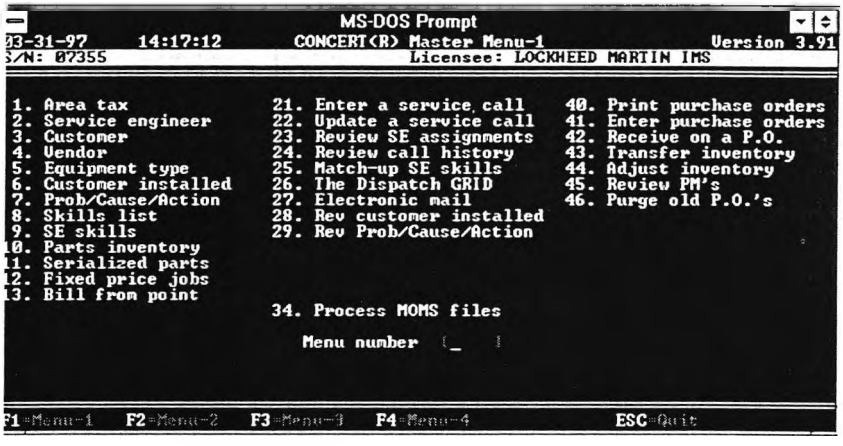
to continue. The following screen will be displayed:

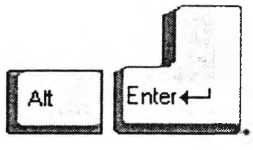
3. At **Master Password**, enter the password that has been assigned specifically for access to the MOMS system.

4. Press 

. The cursor moves to OPERATOR ID.

5. Enter correct ID number. The following screen will be displayed:



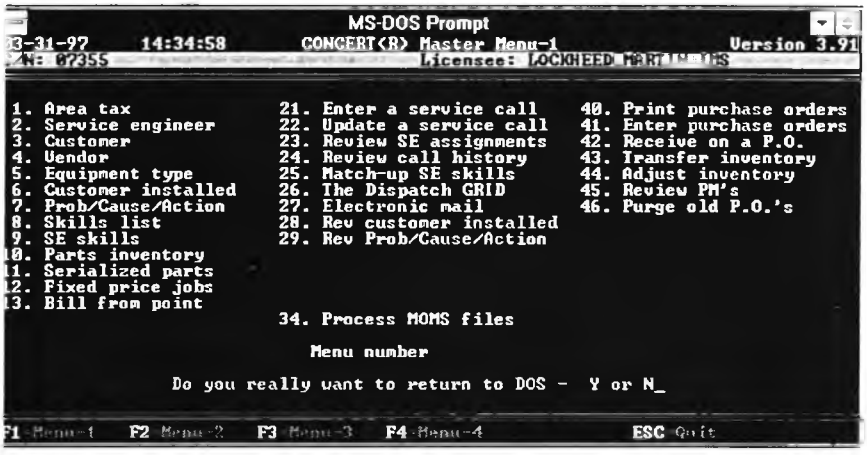
To maximize the screen, press 

.

8.9 Exit MOMS Application

8.9.1 Once a Service Entry Call Or Report has been Completed

1. Return to **Master Menu 1**.



2. Press Esc. The Message at the bottom requires a **Y**(es) or **N**(o) entry.
3. Press **Y**(es). The following screen is displayed:

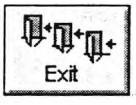
4. Press Enter. The Main Screen will be displayed.

8.10 Exit Session

8.10.1 Purpose

Each application must be closed separately. This will return the user to the Main Screen. From this screen, the "Exit" button is pressed. This will close the application altogether. In order to reenter, the user must login to the application.

8.10.2 Process

1. Click on 

The application closes and returns to the main screen.

2. Click on . The ETC application closes.

8.11 Enter a Service Request (MOMS)

The MOMS System is especially designed to automatically receive error messages from the equipment and to place the service call.

However, there will be occasions when, because of a malfunction in the system or some other situation, Maintenance Personnel and the Toll Sergeant at any of the toll facilities will be required to manually enter the 'service requests.' The Service Call Entry Screen is the option used to manually enter 'service requests.'

8.11.1 Master Menu-1

Master Menu - 1 is the first screen that is accessed when entering the Concert - MOMS system. From this screen, the other menus can be accessed. At the bottom of the screen is this legend:

= Menu 1

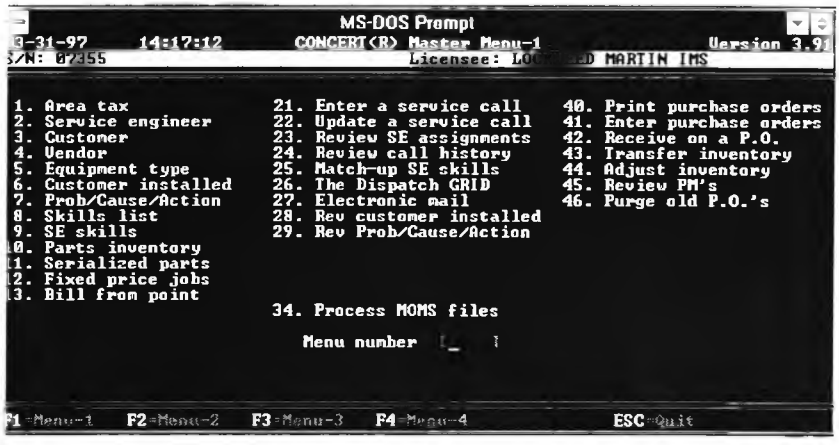
= Menu 2

= Menu 3

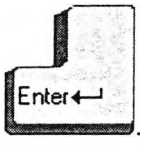
= Menu 4

= Quit application

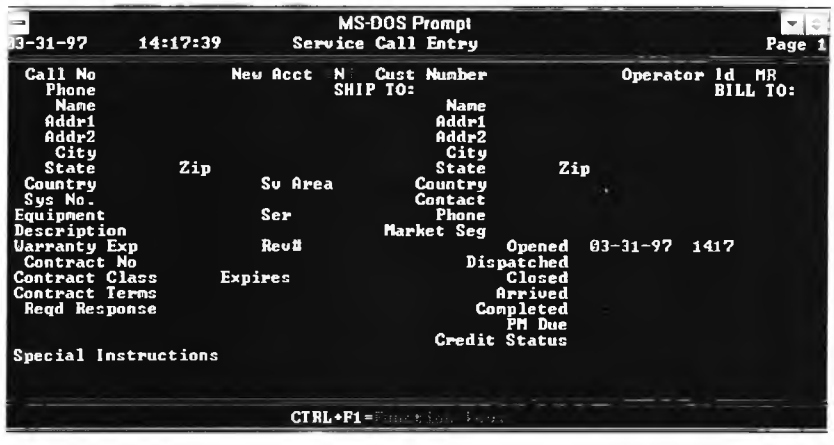
To manually enter a service call, at MASTER MENU - 1, screen # 21 is accessed.



1. Enter **21**.

2. Press 

. The following **Service Call Entry** screen will be displayed, with the cursor flashing under the green 'N.'

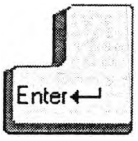


To Fill out a "General Work Order," enter:

1. Customer (Plaza and Lane)
2. Problem
3. Close Call Request

Movement from field to field can be achieved by:

Either

- Pressing 

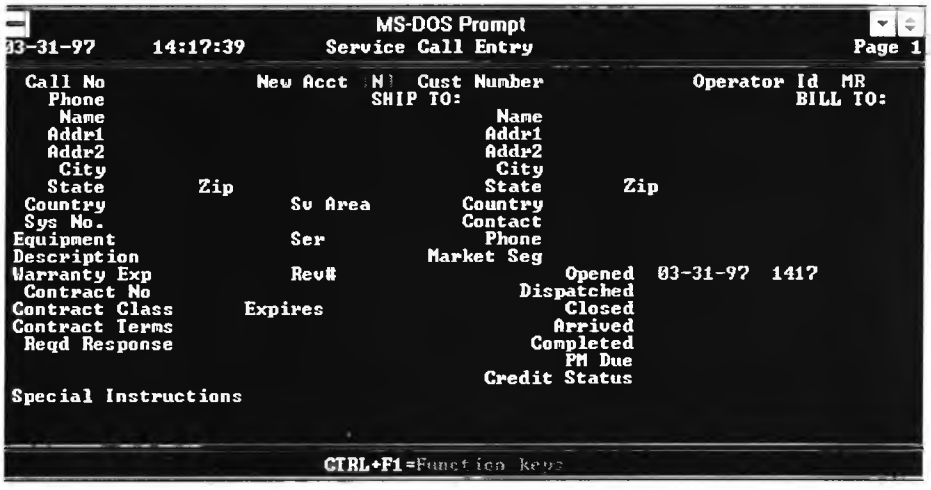
Or

- Using the or keys (to move ahead or back, respectively.)

Press either of the first two keys to move ahead to the 'Cust Number' field.

8.11.2 Service Call Entry Screen

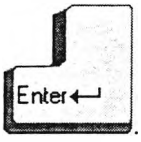
The **Service Call Entry Screen** is the option used to manually enter 'service requests.'



8.11.2.1 To View Function Keys

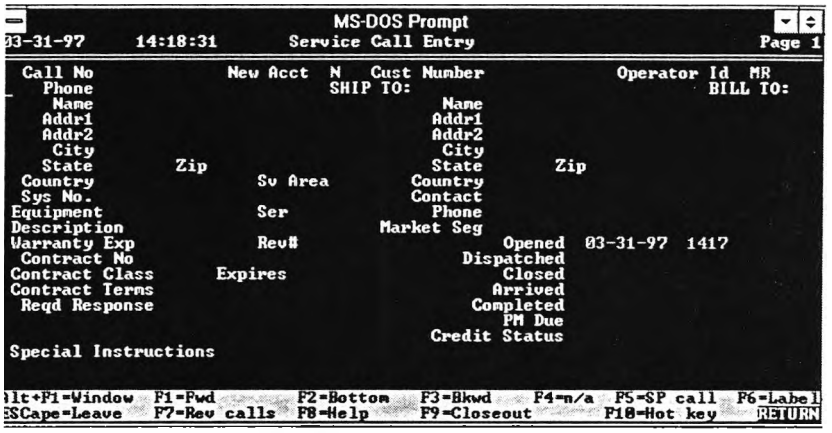
1. Press

with the cursor in any data entry field to access the Help Screen function.

The message 'Press RETURN' to continue appears at the bottom of every help screen. Other screens sometimes have **RETURN** in the lower right corner. *Some* PC keyboards, however, do not have a RETURN key. Instead, they have only 

. Enter and Return keys are usually synonymous; experimentation will tell.

2. Press Ctrl F1. The function key legend is displayed at the bottom of the screen as displayed:



3. Press Enter↵ to continue when RETURN is displayed in the lower right corner of the screen.

The display of a RED-colored "Wndw" in the lower-left corner of the screen when the cursor is on a field indicates that a pop-up window with a menu selection is available. Use this option when the field information needs to be searched for and extracted from a database.

4. To access this window, press Alt F1.

8.11.3 Service Call Entry — Function Keys

The function keys available at the Service Call Entry screen are:

= Enables the user to access an additional six pages to enter a description when the cursor is in the Problem or Resolution fields

= Enables the user to go to the last enterable field on the screen after passing Bill to Country field

= Enables the user to review the Service Engineer's workload when the cursor is positioned at the SE Assigned field on Call Entry Screen

= Enables the user to produce a spare-parts sale automatically with the cursor position on the Call Entry Screen - page 1

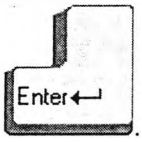
= Enables the user to produce a label using the company name, address, city, state, zip code, and contact name with the cursor on the Call Entry Screen - page 1

= Enables the user to access the Help Screen function. With the cursor in a data entry field, pressing F8 will display a five-line description of that field.

= Enables the user to go to another option's screen without returning to the Master Menu

8.11.4 Customer

The Customer field in MOMS refers to the SCDOT Toll Facilities and lane number (if applicable).

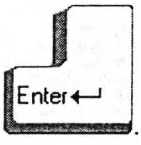
Note: The cursor will be at New Account, with N as the default. DO NOT CHANGE THIS. Press 

. This will move the cursor to **Cust Number**.

8.11.4.1 Manual Entry of Customer Number

If the Customer Number is known, it can be entered manually at the Customer Number field.

1. Press

with the cursor in the data entry field to access the **Help Screen** function.
2. Enter the **Customer Number**.
3. Press 

. The name, address, and telephone number of the Customer populates the applicable fields.

8.11.4.2 Customer Number

The Customer Number for SCDOT is a six-digit number.

The following numbers have already been entered into the Concert Database and are defined in the pop-up search lists, when accessed as outlined below.

The **first 3 digits refer to the Toll Facility**, enabling up to 999 entries. For example:

100 = Cross Island Parkway

The **last 3 digits refer to either the Plaza itself or a specific lane**, enabling up to 999 specific locations.

000 = Plaza
001 = Lane 1
002 = Lane 2
003 = Lane 3
etc.

1. Press

to bring up the 'Customer Installed Search' window.

2. Use to move the cursor to '5. Equipment type.'

3. Press

to display the 'Customer Installed Found' window.

In the two preceding steps, 'Equipment description' was selected from the 'Equipment Type *Search*' pop-up. In the resulting 'Equipment Types *Found*' pop-up, all returns for this search are presented alphanumerically in the 'Description' column. Similarly, a selection of 'Serial number' from the Customer Installed Search will result in a Customer Installed Found list sorted alphanumerically in the 'Ser #' column.

8.11.4.3 Customer Number Search

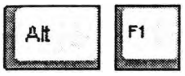
If the Customer Number is not known, a Customer Search must be made to locate the Customer information.

Note: All search returns are listed with the cursor at the first item returned — the cursor does not indicate the exact match; user must use the up and down arrows to locate the exact entry desired.

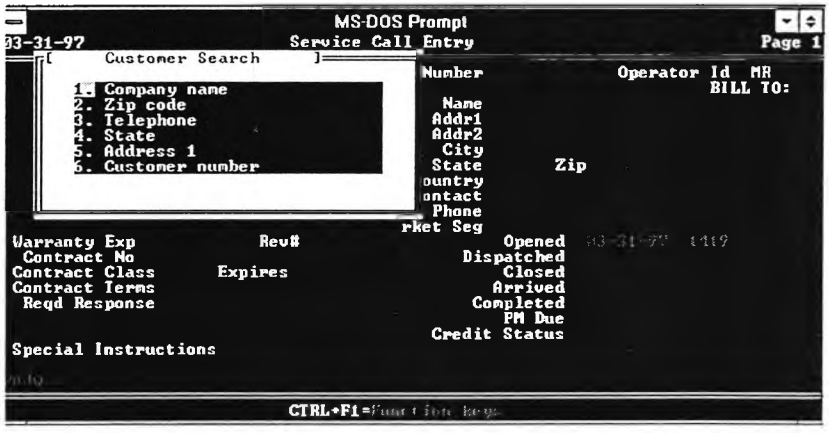
Only the 'Cust #' data field is highlighted, regardless of the field selected for searching. The highlight cannot be moved horizontally, only vertically within the 'Cust #' field.

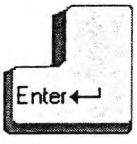
Regardless of the option selected, every 'found' window — for example, Customers Found — will display the same data columns;

'Cust #,' 'Ser #,' 'Customer Name,' 'Equip Type,' 'SE Id,' 'Mfg,' and 'System #.' Different options produce data sorted differently; the information is the same.

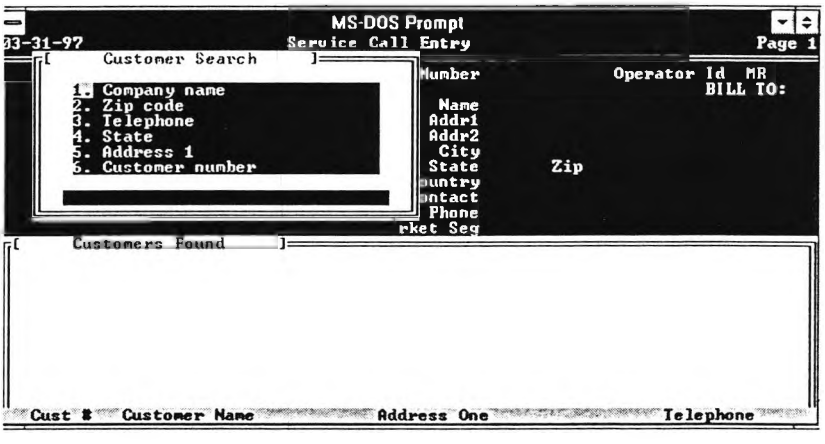
1. Press 

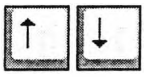
to bring up the pop-up window to conduct the search. At the top of the window is the **Customer Search** title in red.
2. Use and to navigate in the pop-up menu.
3. Select 1.

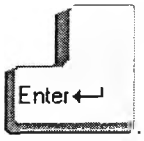


4. Press 

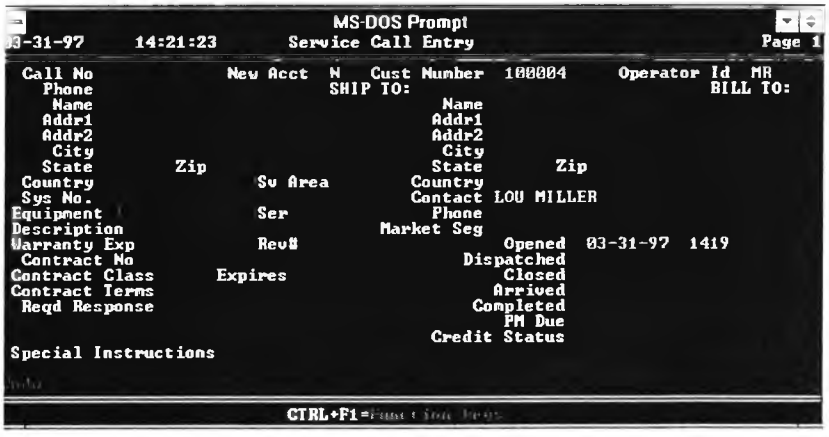
twice. The following **Customers Found** list is displayed, with entries in customer name sort.



5. Use  to navigate in the pop-up list to locate the correct "Cust #" plaza / lane combination.

6. Highlight the 'Customer' and press 

. The phone number and address information will automatically be entered into the top portion of the screen as follows:



8.11.5 Equipment

The cursor will be at Ser. Use the to move to Equipment. In this field, a number assigned to the equipment type is entered.

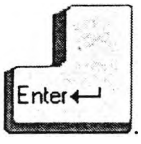
8.11.5.1 Manual Entry of Equipment Number

If the Equipment type is known, it can be entered manually at the Equipment field.

1. Press

with the cursor in the data entry field to access the **Help Screen** function.

2. Enter the **Equipment Number.**

3. Press 

. The number will populate the field.

8.11.5.2 Equipment Number

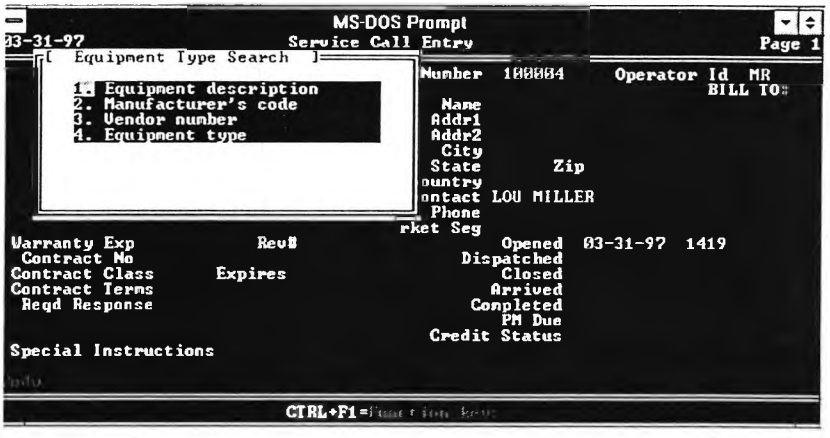
The **Equipment Numbers** for SCDOT have already been entered into the database and are defined in the pop-up search lists, when accessed as outlined.

8.11.5.3 Equipment Number Search

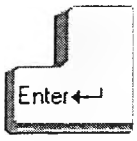
If the Equipment Number is not known, an Equipment Type Search must be made to locate the Equipment information.

The display of a RED-colored "Wndw" in the lower-left corner of the screen when the cursor is in the entry portion of a field indicates that a pop-up window with a menu selection is available. Use this option when the field information needs to be searched for and extracted from a database.

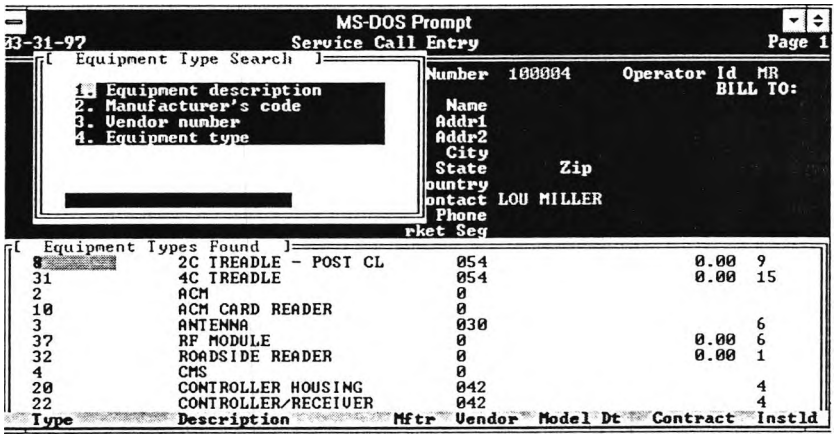
1. Press Alt F1 to access the equipment number search window.
2. Press F8 to bring up the pop-up window to conduct the search. At the top of the window is the **Equipment Type Search** title in red.

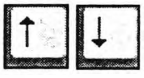
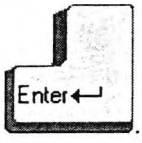


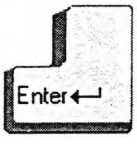
4. Use the ↑ ↓ to navigate in the pop-up menu.
5. Select **4**.

6. Press 

twice. The following **Equipment Types Found** list pops up below the menu, with entries listed in alphabetical order within the 'Description' field.



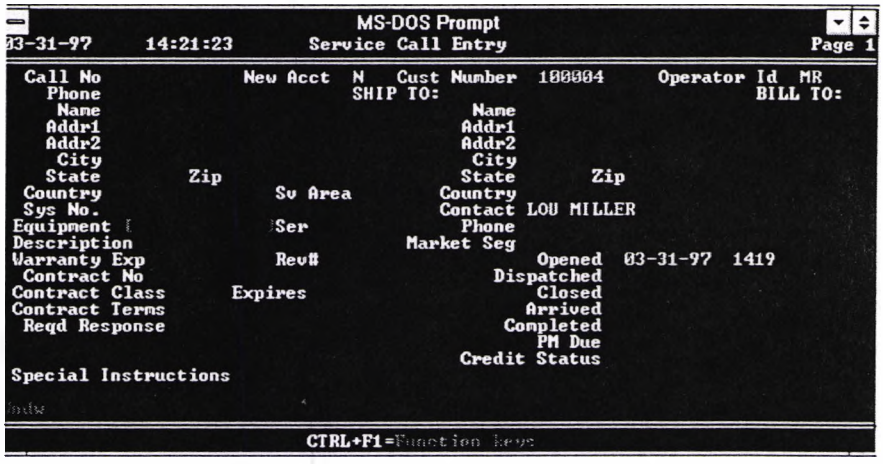
7. Use the  to navigate in the pop-up list to locate the equipment description.
8. Highlight the applicable piece of equipment that requires service.
9. Press 

. The **Equipment Type Number** will be displayed in the field.
10. Press 

to move to **Ser** (Serial Number).

8.11.6 Serial Number

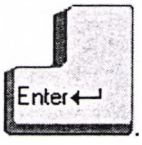
The cursor is at **Ser**. This refers to the Serial Number of the equipment type that was accessed.



8.11.6.1 Manual Entry of Serial Number

If the Serial Number is known, it can be entered manually at the Serial Number field.

1. Press

with the cursor in the data entry field to access the **Help Screen** function.
2. Enter the **Serial Number**.
3. Press 

. The number will populate the field.

8.11.6.2 Serial Number

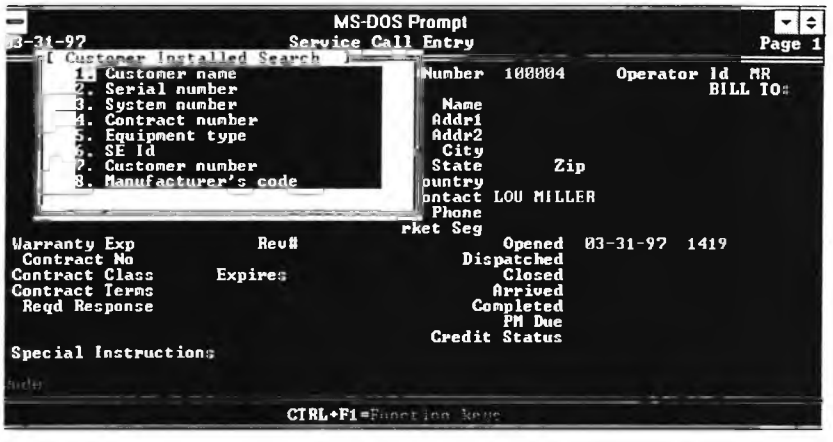
Serial Numbers for SCDOT equipment have been entered in the database and are defined in the pop-up search lists, when accessed as outlined below.

8.11.6.3 Serial Number Search

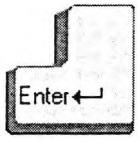
There may be times when equipment must be located by the manufacturer's serial number (for example, product safety recall, modifications that apply to product serial numbers 1234 through 2345). Because serial numbers apply to hardware items — and for our purposes, hardware items are either installed or on-the-shelf spares inventory awaiting installation — serial numbers have been accounted for in a database set up by site installation. Because a 'Customer Number,' in fact, represents the six-digit Plaza and lane combination, a **Serial Number Search** must be made as a function of the 'Customer Installed' database.

The display of a RED-colored "Wndw" in the lower-left corner of the screen when the cursor is in the entry portion of a field indicates that a pop-up window with a menu selection is available. Use this option when the field information needs to be searched for and extracted from a database.

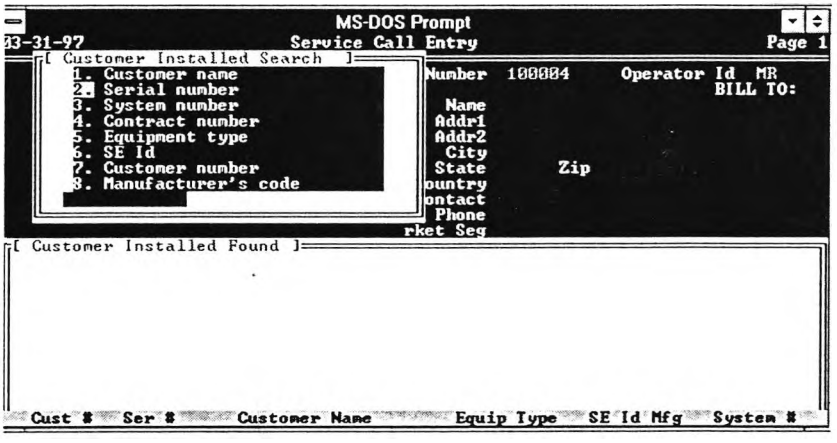
1. Press Alt F1 to access the serial number search window.
2. Press F8 with the cursor in the data entry field to access the **Help Screen** function.
3. Press Alt F1 to bring up the pop-up window to conduct the search. At the top of the window is the **Equipment Type Search** title in red color.
4. Use ↓ to navigate in the pop-up menu.

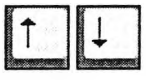
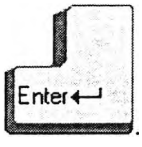


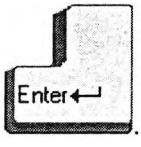
5. Select 2.

6. Press 

twice. The following **Customer Installed Found** list pops up below the menu.



7. Use the  to navigate in the pop-up list to locate the corresponding:
   - Equipment Type Number — **Equip Type**
   - Customer Number — **Cust #** (which in this case would be **100004**).
8. When a match is found, ensure that the highlighted row indicates the correct Equipment Type, Customer Name, and Customer Number.
9. Press 

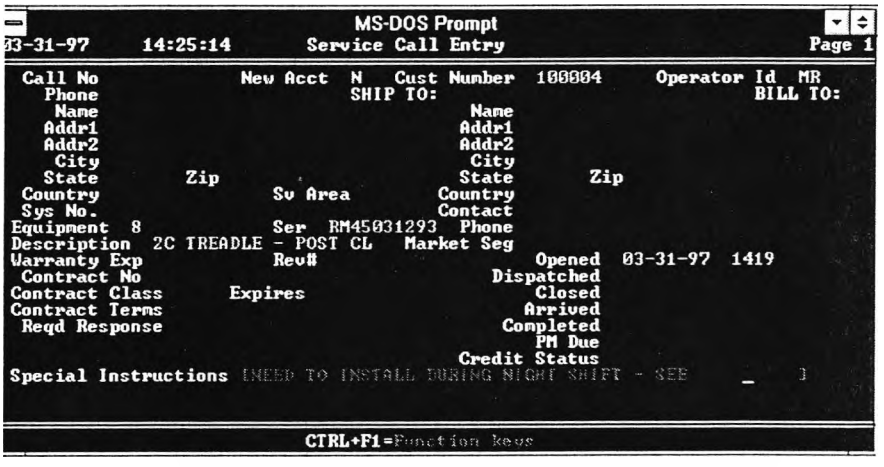
. The **Serial Number** will be displayed in the field.
10. Press 

. The cursor moves down to **Special Instructions**.

8.11.7 Special Instructions

Information is entered in this field ONLY if there is something that the maintenance personnel who are responsible for performing the maintenance need to know in order to complete their job. This field is NOT to be used for entering a description of the problem, but to qualify specific instructions, such as:

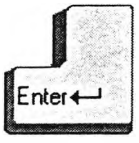
- ⇒ **Person to contact for greater details**
- ⇒ **Schedule / time restrictions**
- ⇒ **Notification of repair when complete**



8.11.7.1 Process

1. Press

with the cursor in the data entry field to access the Help Screen function.
2. Enter the request. There are no restrictions except that space is limited.

   Be clear and concise.
3. Press 

until the screen changes. The fields that are being bypassed ARE NOT to be entered by the requester but will be entered by the Maintenance personnel who complete the service on the request.

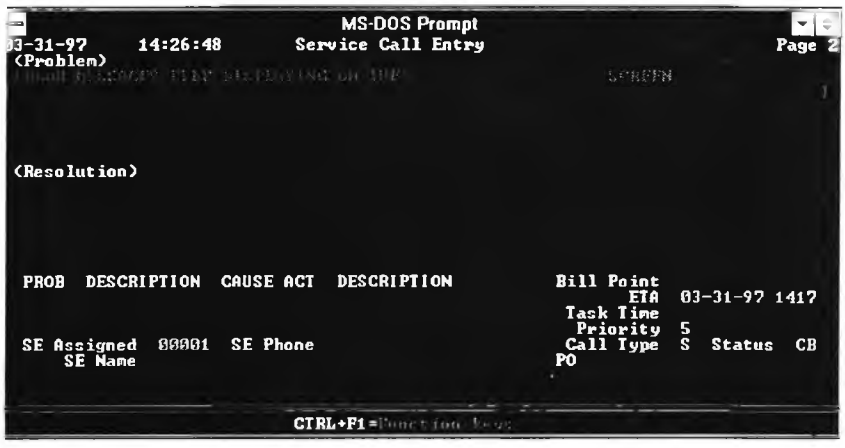
8.11.8 Problem

Page 2 of the Service Call Entry screen is displayed. The cursor is below the word "Problem." Ample space is given to enter a description of the problem. The problem description has to be entered manually.

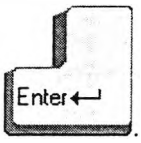
The location and equipment have already been identified. Do not attempt to reenter this information.

If additional area is needed to fully describe the problem, press F1. This will provide up to six more pages on which to enter the problem description.

It is very important to be clear and concise. Unless a complete description of the problem is provided, the maintenance personnel will not be able to provide a satisfactory resolution to the problem.



8.11.8.1 Manual Entry of the Problem

1. Enter the problem description.
2. Review what has been entered to ensure that it is clear.
3. Press 

.

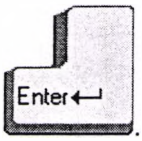
If, when the cursor is positioned in the Problem field, additional area is needed, press

. This will provide up to six more pages of space to enter the problem description.

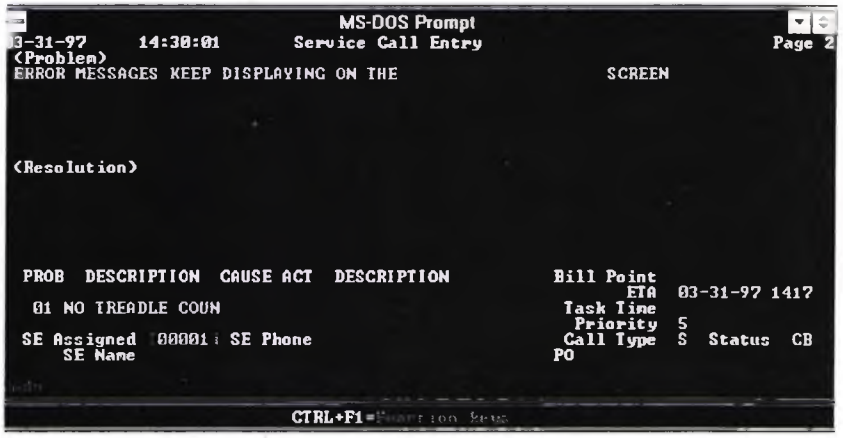
8.11.9 SE Assigned

This screen can be used to assign an SE (Service Engineer) who will be responsible for the maintenance request being made. All SE assignments are made manually.

1. Enter the **SE Assigned** ID number.



2. Press Enter. The number will be displayed in the corresponding field.



8.11.9.1 Service Engineer Search

If the available Service Engineer ID number is not known, a Service Engineer Search must be made.

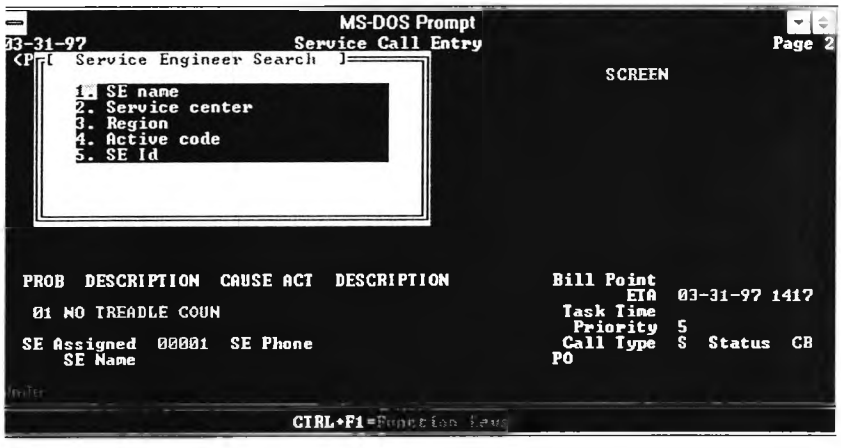
The display of a RED-colored "Wndw" in the lower-left corner of the screen when the cursor is in the entry portion of a field indicates that a pop-up window with a menu selection is available. Use this option when the field information needs to be searched for and extracted from a database.

1. To access this window, press Alt F1.

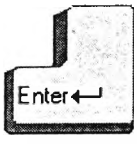
2. Press F8 with the cursor in the data entry field to access the Help Screen function.

3. Press

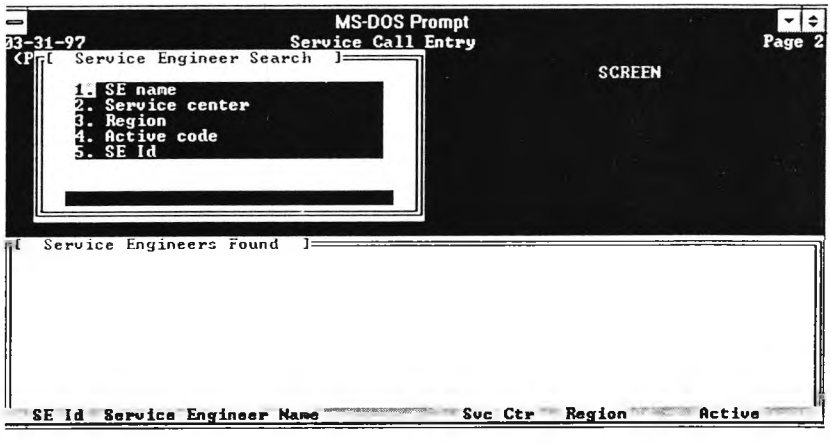
to bring up the pop-up window to conduct the search. At the top of the window is the title **Service Engineer Search** in red.

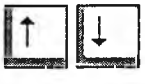


4. Select 1.

5. Press 

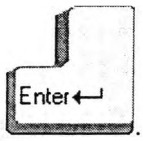
twice. The following **Service Engineer Search** list pops up below the menu, with returns presented alphabetically within 'Service Engineer Name.'



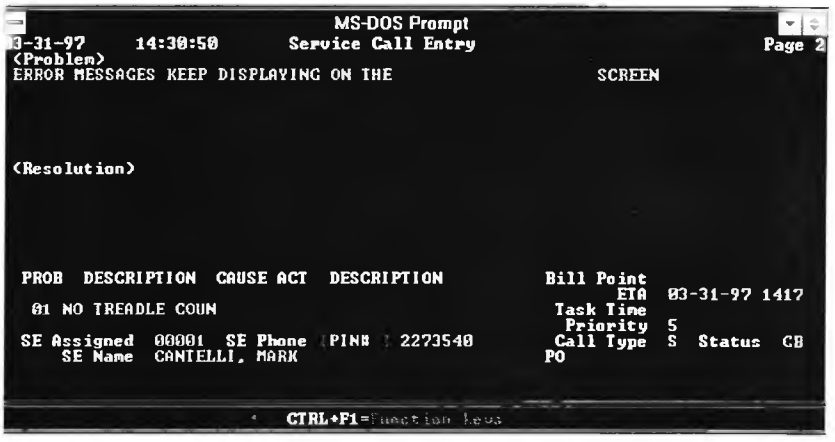
6. Use 

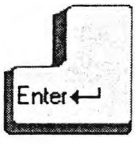
to navigate in the pop-up list to locate the corresponding **Service Engineer**.

7. Highlight the selection.

8. Press 

. The **Service Engineer** will be displayed in the field.

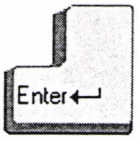


9. Press 

until the end. A question will be displayed:

Is the above information correct - please enter Y or N

8.11.10 Close Call Request — Send Page

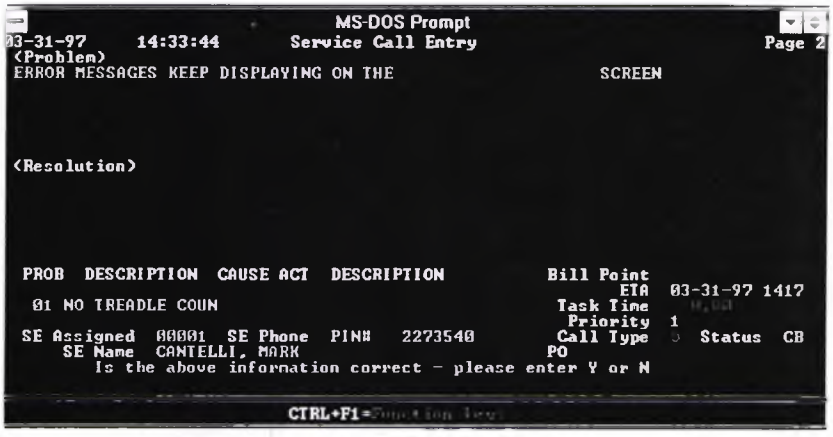


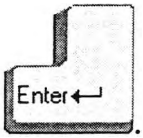
Once the Service Call Entry screen has been completed, press Enter until the end of the screen has been accessed.

8.11.10.1 Process

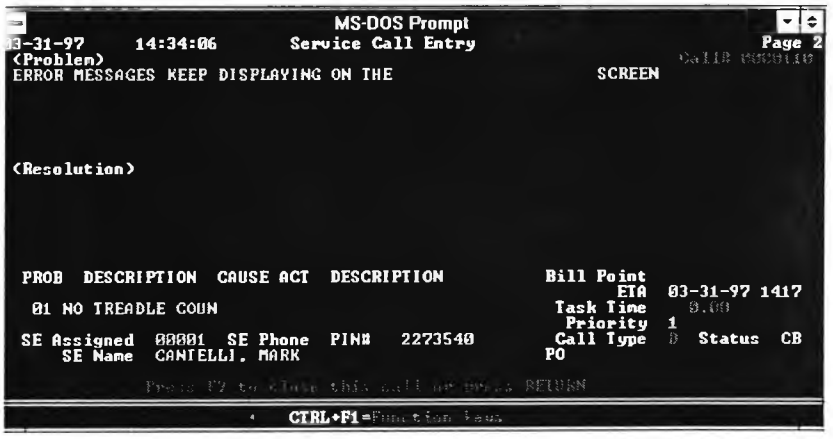
At: **Is the above information correct - please enter Y or N**

1. Enter **Y**.

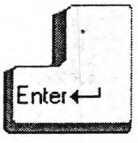


2. Press 

. The following message will be displayed:



3. Press

or 

to close the call and initiate the page.

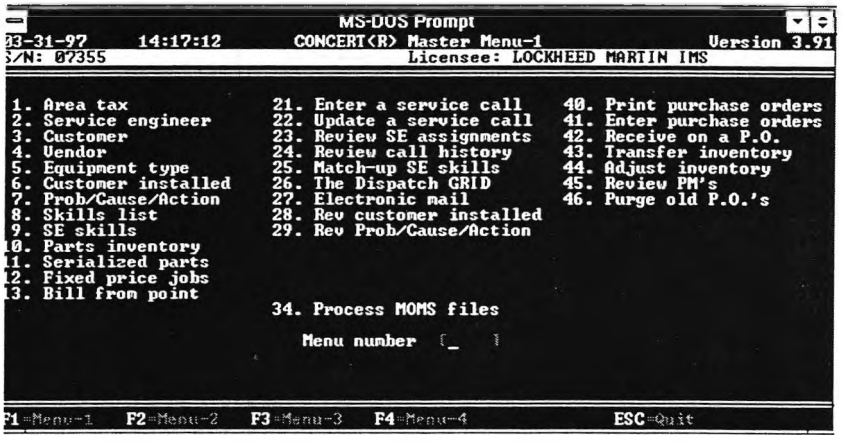
To Fill out a "General Work Order" enter:

- Customer (Plaza and Lane)
- Problem
- Close Call Request

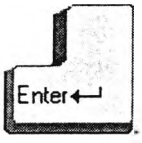
8.12 Update a Service Call

8.12.1 Access

To update a service call, at MASTER MENU - 1, screen # 22 is accessed.

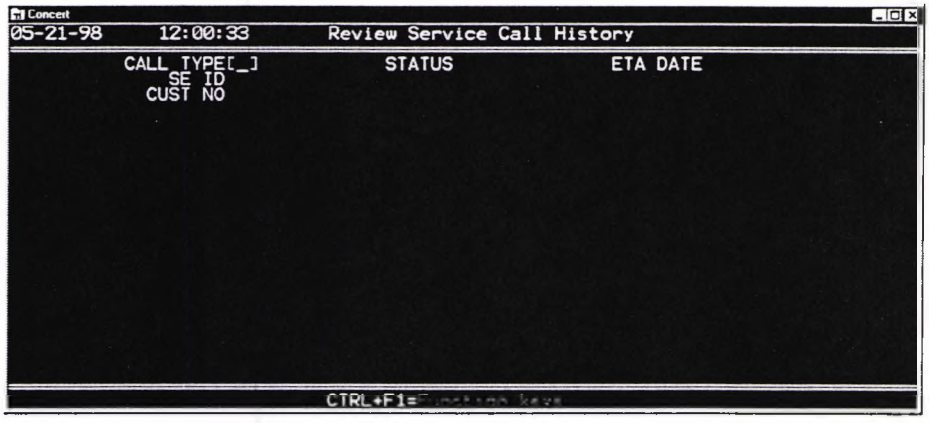


1. Enter **22**.

2. Press 

. The following **Service Call Entry** screen will be displayed.

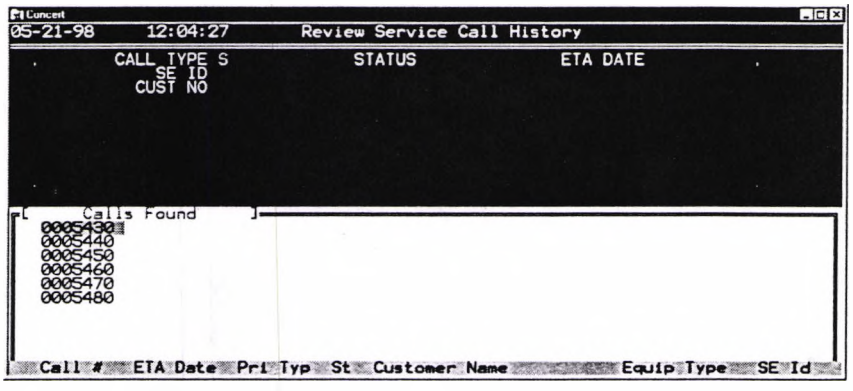
3. Press F1. The following screen will be displayed.



8.12.2 Process

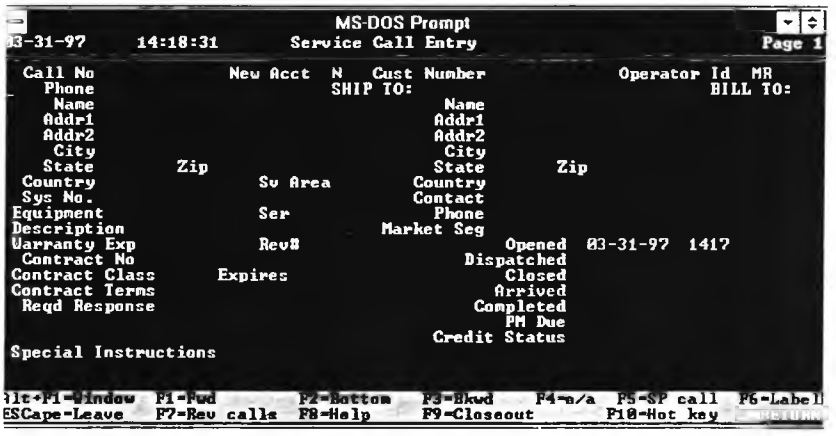
1. Type "S" in the **CALL TYPE** field.

2. Press Enter four times. The following screen will be displayed.



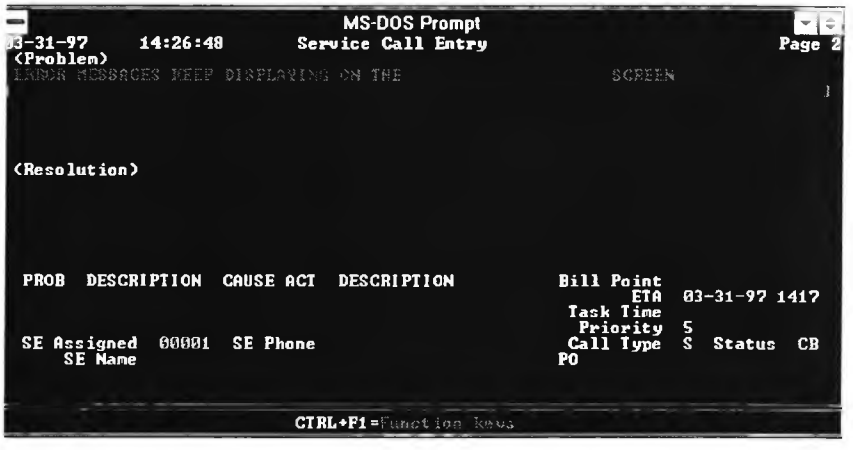
3. Highlight the call that requires a response.

4. Press Enter, then Esc. The following screen will be displayed:

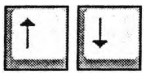


5. Press Enter. The screen appears with all of the data in the fields.

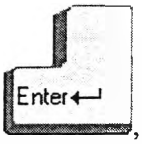
6. Press the Page down button to page 2 of the record. (Use Page up and down to maneuver through the record pages.) The following screen will be displayed.



7. Enter the **Problem**.

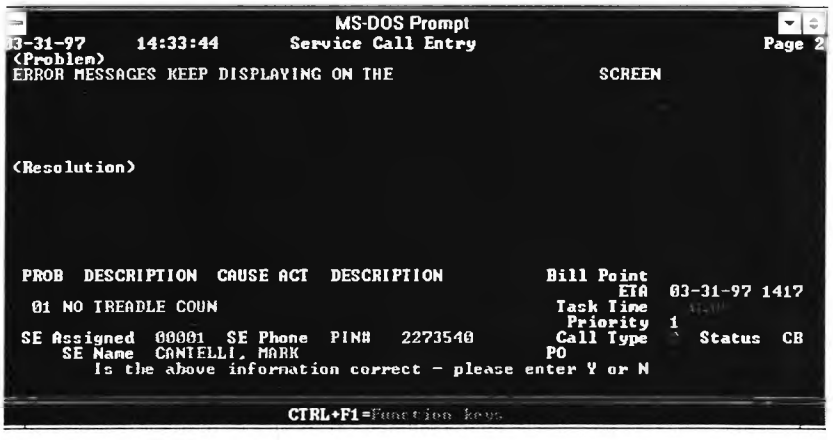
8. Use the  to navigate through the screen.

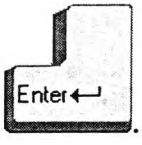
9. Enter the **Resolution**.

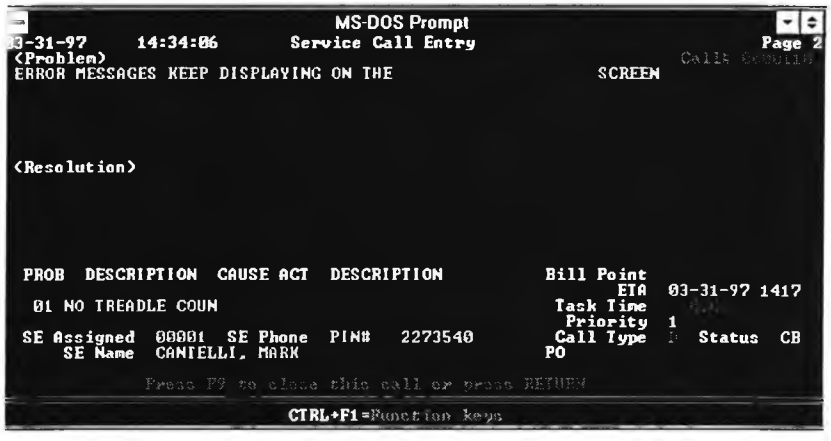
10. Press  , until the question appears at the bottom of the screen.

Is the above information correct - please enter Y or N

11. Enter **Y**.



12. Press  . The following message will be displayed:



9. Personnel, Training, and Resources

9.1 Personnel

The maintenance team consists of a project manager, engineering managers, and Lockheed Martin on-site technician. See Figure 9-1 for an organizational chart.

The primary responsibilities of the maintenance team are to:

- Enforce standards
- Comply with safety regulations
- Provide technical support to the field
- Implement the Management Plan
- Meet response and repair time requirements of the project

The trained full-time technician(s) dedicated to this contract are capable of meeting the Mean-Time-To-Respond (MTTRespond) and Mean-Time-To-Repair (MTTR) requirements necessary for effective operation of the lanes:

9.1.1 Project Manager

The Project Manager has overall responsibility for the successful implementation of the Maintenance Plan. The on-site Project Manager designated for the SCDOT project is Mr. Thomas Wright.

9.1.2 Engineering Manager

The LMIMS Engineering Manager has overall responsibility for the Cross Island Parkway maintenance program — monitoring the daily operation of the system to ensure that proper maintenance is provided. The responsibilities of the Engineering Manager include, but are not limited to, these areas:

- Technician work assignments
- Periodic inspection of work
- Submitting required reports
- Monitoring of subcontractors
- Attending technical meetings, as required
- Monitoring — and ensuring compliance for — response and repair times
- Monitoring MTBF
- Maintaining personnel records; and scheduling vacations
- Creating and implementing all SOPs
- Ensuring quality service
- Performing and managing the PM program
- Hiring, disciplining, and promoting technicians
- Interfacing with the Engineering Department, as required
- Interfacing with all vendors for support
- Responsibility for initiating, carrying out, tracking, and documenting all ECO / FCOs. This includes filing paperwork, updating schematics, and adding revision numbers to circuit boards, as required.

9.1.3 Technician

The technician and the Engineering Manager are responsible for scheduling work, evaluating equipment performance, and interfacing with subcontract support and SCDOT personnel. The technicians represent the first line of support for the toll collection system. The technician's responsibilities include, but are not limited to, these areas:

- Performing scheduled PM
- Supporting the development of the PM program by inputting maintenance action data into MOMS
- Performing required EM / CM actions
- Submitting required reports
- Providing notification about problem areas
- Providing daily liaison with plaza personnel
- Performing LRU repair on equipment and arranging for repair of equipment that is beyond the local capacity to repair
- Maintaining a spare parts database and evaluating in-stock requirement for spare parts on a quarterly basis
- Performing ECO / FCO installation / tracking
- Performing latent-defect and recurring-malfunction analysis
- Transporting repaired / malfunctioning equipment to and from the ready-spares bin
- Identifying the need for an item, helping in parts procurement, and tracking ordered parts to ensure delivery
- Determining — when an item has been identified as discontinued without replacement —the quantity that should be stockpiled for future needs or determining what items by an alternate manufacturer have the same form, fit, and function capabilities. The Engineering Manager must be consulted to support this evaluation.
- Maintaining a calibration log and coordinating all calibration activities. The calibration log is located in the site maintenance shop. It is the responsibility of the lead technician to maintain the calibration log and to notify all parties involved when test equipment calibration is required. Also, the technician is required to coordinate shipping of the equipment to the calibration lab.

LMIMS staffing analysis indicates that one technician assigned to the Hilton Head Island area will provide the needed level of maintenance for the Cross Island Parkway project.

LMIMS requires that all vendors supply telephone support for their equipment 7 days a week, 24 hours a day. All contractors of LMIMS will meet the same response times as LMIMS.

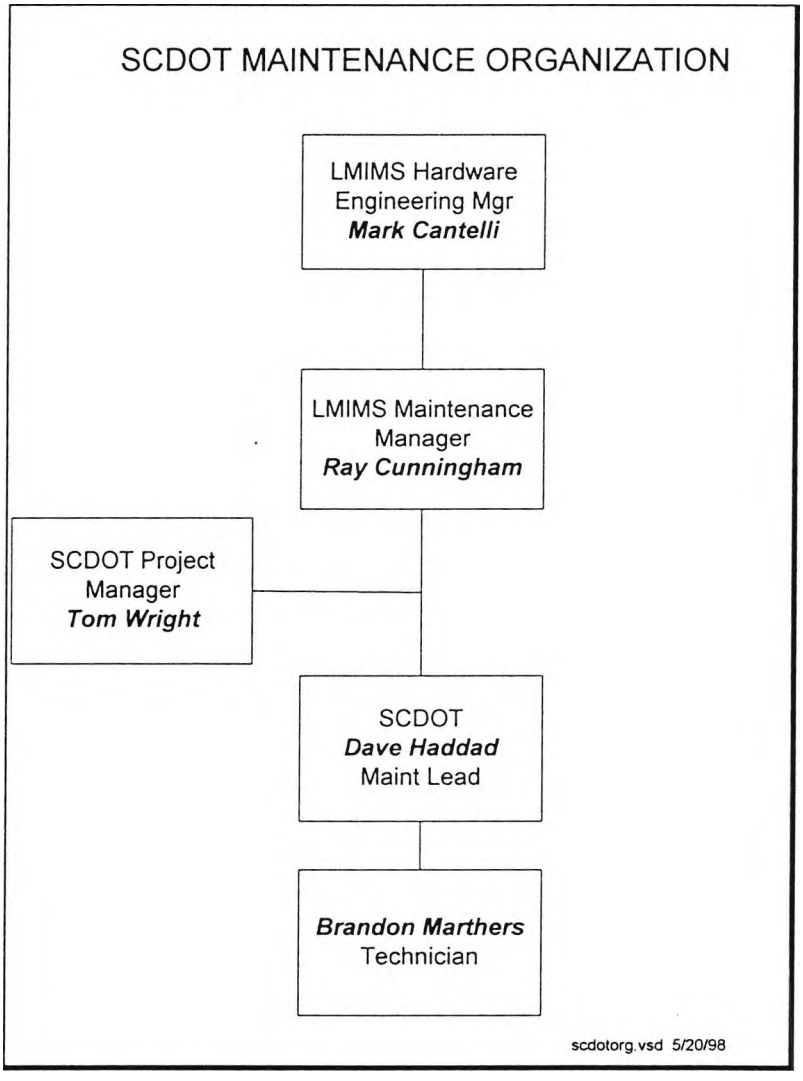


Figure 9-1 Maintenance Team Organization Chart

9.1.4 Staffing

During the contract, the work force increases as required. If possible, installation work is performed by the technicians who will be assigned dedicated maintenance responsibility. Staff technicians are added to the maintenance work force from three sources:

- Existing installation technicians
- Lockheed Martin employees
- New personnel

9.1.4.1 Existing Installation Technicians

The maintenance team firmly believes in the importance of training employees. Experience has shown that an extremely effective form of training is the work involved in doing the initial testing and installation. In addition to hands-on experience, these employees receive specific training on the equipment being installed.

9.1.4.2 Lockheed Martin Employees

As required, Lockheed Martin employees are assigned to the maintenance team to enhance the maintenance effort. There employees are selected based on their knowledge of the different components that make up the Cross Island Parkway system.

9.1.4.3 New Personnel

As a final measure, staff technicians are solicited for hire through newspaper advertisement or technical staffing agencies. An advertisement will be run in local newspapers, if it becomes necessary to hire new technicians.

9.1.4.4 Support Personnel

The maintenance team and the equipment suppliers have extensive technical support available at their respective headquarters. The Lead Technician has the responsibility to decide when to request a technical resource.

LMIMS requires all vendors to provide 7-day-a-week, 24-hour-a-day telephone support.

9.2 Duties and Responsibilities

9.2.1 Work Assignments

The Engineering Manager is responsible for specifying work assignments. Maintenance technicians report to the Engineering Manager.

Engineering has responsibility for the following functions:

- System repair through LRU level
- Equipment testing
- Second-level technical support
- System monitoring
- Technician dispatch — technical assistance

9.2.2 Field Maintenance

The division of tasks, placement of staff, and size of the workforce are designed to reduce travel time and to promptly resolve problems, while adding the least disruption to traffic.

Staffing levels are determined by response time, repair time, Mean-Time-Between-Failures (MTBF), and PM levels.

Because the motoring public tends to view the maintenance work force as SCDOT employees, the maintenance team does everything possible to ensure that the technician's work actions reflect positively on SCDOT. Emphasis is placed on being courteous but evasive to questions from toll collectors regarding the internal operations of the system. Technicians are encouraged to not socialize with toll collection personnel.

9.2.2.1 Work Sites

The field work force and repair parts are based at the Cross Island Parkway Toll Plaza. Equipment and parts will be transported to the ramp lanes, as needed, for maintenance.

9.2.2.2 Dress Code and Appearance

The maintenance team is dedicated to present itself and its employees as a highly qualified professional service organization and to present a good public image. These basic commitments — and the job requirements — help determine the following stipulations about dress and appearance:

- Wear clean, well-fitting work clothes, void of patches and tears.
- Do not wear open-toed shoes or sandals.
- Maintain basic personal hygiene practices for personal health and consideration of others.
- Keep hair, beards, and mustaches neat and well-trimmed.
- Do not use foul or abusive language —it is strictly prohibited.
- Discrimination — by comment or behavior; on the basis of gender, race, religion, or ethnicity — is punishable by dismissal.

9.3 Training

- Training is an investment — not a cost.
- Employee must take ownership of their work assignments.
- Initial OJT is provided to new employees.
- Vender training is provided when it will enhance the maintenance effort.
- All training is designed so that technicians can use diagnostics and make repairs using LRU replacement methodology.

9.3.1 Document Distribution

- Vendor manuals
- As-built drawings
- Detail System Design Document
- Maintenance Plan

Understanding of these documents is checked and reinforced.

9.3.2 On-the-Job-Training (OJT)

The following OJT is required:

- Participation in installation of equipment, when applicable
- MOMS Service Call and reporting procedures
- System training
- PM training (ride-along)
- Corrective maintenance training (ride-along)
- System knowledge testing
- First evaluation (Lead Technician and Senior Technician)
- PM assignment / on-call ride-along
- Second evaluation (Lead Technician, Senior Technician, and Field Service Manager)

9.3.3 Equipment

The maintenance team provides toll equipment training and plaza system operation and maintenance training. This includes theory of operation and the use of diagnostics including, but not limited to, the following lane equipment:

- Lane controller
- Manual Lane Terminal (MLT)
- Receipt printer
- Patron Fare Display (PFD)
- Vehicle classification subsystem
- Automatic Coin Machine (ACM)
- VES subsystem
- SAM
- AVI reader
- Loop detectors
- UPS
- Island traffic light
- Canopy traffic light

9.3.4 Plaza Subsystem

The maintenance work force receives plaza-level system operational training that includes, but is not limited to, the following:

- Lane operation (for example, opening, closing)
- Lane status monitoring
- Plaza start-up procedures
- Workstation maintenance
- Printer maintenance
- Network troubleshooting
- Host Diagnostic

9.3.4.1 MOMS

The maintenance work force receives MOMS training in these areas:

- Service Call generation
- Service Call data entry
- Priority status updates
- General data entry (for items such as part use and equipment transfer)
- System status monitoring
- Technician work assignment

The maintenance work force receives training in status monitoring and field data entry for service call completion.

9.4 Tools & Supplies

9.4.1 Communication Equipment

The maintenance team equips all field technicians with a pager. All management personnel are equipped with a pager and/or cellular phone.

9.4.2 Vehicles

Each technician assigned to maintenance is required to have reliable transportation. If transportation becomes a problem for a technician, LMIMS makes arrangements to solve the problem by using rental or replacement vehicles.

Specialized vehicles are used when necessary. A bucket truck is the only specialized vehicle currently in use.

Technicians must follow all traffic regulations. All lane closures are in accordance with procedures used at each plaza.

All field vehicles are equipped with the appropriate safety gear — for example, lights, cones, signs — that is necessary to protect the technician, other employees, patrons, and property while the lanes are blocked.

9.4.3 Test Equipment

The maintenance facility at the Cross Island Parkway plaza contains the following test equipment:

- Test Bench Simulator
- Maintenance workstation / MOMS
- Digital voltmeter
- Lap-top computer equipped with Protocol Analyzer software
- Communications breakout box
- Oscilloscope
- RF field strength meter
- CCTV monitor
- Fiber-optic power meter

9.4.4 Tools

See Appendix B.

9.4.5 Cleaning Supplies

See Appendix B.

9.4.6 Lubricants

See Appendix B.

10. Spare Parts & Inventory Control

10.1 Spare Parts Inventory Determination

Initial spare parts inventory is determined using an industry standard of ten percent of total deployed items or two units, whichever is greater, along with factory MTTR / MTBF calculations. After the system is on line, information obtained from MOMS, such as MTBFs, and semi-annual reviews, will be used to determine whether the original numbers were sufficient or if adjustments are required. The following events will be monitored and recorded for the adjustment of spare parts levels (this will be entered before start-up):

- Maintenance turnaround times
- Procurement lead times
- Availability of piece parts
- Vendor turnaround times
- Number of current lanes being maintained

10.1.1 MOMS Analysis / Spare Levels

The MOMS performs calculations, such as, Mean Time To Repair (MTTR) and Mean Time Between Failures (MTBF). Also, parts used are determined and the information is used by MOMS to trigger Inventory Order Forms. The Engineering Manager uses the MTTR / MTBF to determine spare levels, spare locations, and the workforce complement.

$$\text{Spares Needed} = \frac{\textbf{QPEI*} \times \textbf{Number of Lanes} \times \textbf{Operating Hours**}}{\textbf{LRU/MTBF}}$$

***QPEI** = (Quantity Per End Item) Number of times a particular component is used in a lane (i.e., 3 light bulbs, 2 power strips)

****Operating hours** = One year (8760 hours)

The manuals and other documentation described in the following subsections are required by field technicians to perform field-level system repair, PM, and depot repair.

10.1.2 Inventory Types

- Whole-unit components (e.g., ACM, MLT)
- Subassemblies and modules (e.g., boards, panels)
- Spare parts (e.g., coin baskets, covers)
- Repair parts (e.g., diodes, fuses, fasteners)
- Consumables

10.1.3 Inventory Levels

- In-use equipment (e.g., open lane, plaza)
- Shelf stock located in the maintenance shop
- In repair — items in the process of being repaired that are in the maintenance shop or returned to vendor via Return Material Authorization (RMA)

10.2 Physical Control

All whole units and subassemblies are identified:

1. Part number
2. Serial number

Spare parts, repair parts, and consumables have part number identification only.

Technicians are to:

1. Keep all inventory locations and vehicles locked when not attended
2. Be responsible for the accuracy of maintenance shop in-use and shelf stock inventories
3. Track all units in the repair cycle through MOMS

10.3 Inventory Documentation

The following forms are used to track inventory:

Service Call Form	The Service Call Form documents each action that a field technician takes that affects inventory and all maintenance. Whole units and subassemblies removed or installed are documented by part and serial number on the MOMS. Spare and repair parts that are used to restore service or perform a PM / PDM / ECO / FCO are listed on the MOMS.
RMA	The RMA form records all data related to the return of a part to vendor for repair or replacement. The technician is responsible for these items, refer to Figure 10-1 for a sample of this form.

LOCKHEED MARTIN

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6660 Riverside Dr. Suite 300
Metairie, LA 70003
Phone: (504) 454-7600
Facsimile: (504) 454-6542

Return Material Authorization (RMA) Form

PROJECT: SCDOT	*LOCATION:* Cross Island Parkway

MERCHANDISE:

Manufacturer:	_____	*Model:*	_____
Module Type:	_____	*Serial #:*	_____
Software Rev. #:	_____	*Rev.#:*	_____
Warranty Repair Y/N?	_____	*Return Date:*	_____

PROBLEM DESCRIPTION:

Nature of Problem:

_____

_____

_____

SHIPPING INFORMATION:

BILLING ADDRESS:	_____	*DATE SHIPPED:*	_____
	_____	*CARRIER:*	_____
	_____	*TRACKING #:*	_____
	_____	*MAF #:*	_____

SHIPPED BY SIGNATURE: _____

RECEIVING INFORMATION:

Date Promised:	_____	*Proper Operation Y/N?*	_____
Date Received:	_____	*PM Performed Y/N?*	_____

Returned to Field or Stock? _____

Returned to Technician #: _____

Received by Signature: _____

Figure 10-1 RMA Form

10.4 Inventory Tracking

The primary inventory database is MOMS. All inventory-related forms are designed for ease of data input into MOMS. Inventory tracking will be completed before start-up.

10.5 Inventory Counts

One step in the PM procedures is verification of serial numbers of active equipment. The verification serves as an ongoing "registration" of the system. Stock inventories are counted as needed. This will be completed before start-up.

10.5.1 Equipment Performance Monitoring

Equipment performance is evaluated by analyzing historical data via MOMS to ensure that acceptable MTTRs and MTBFs are being met. If they are not, the Engineering Manager determines whether it is a PM performance problem or a more serious problem (for example, a design fault).

10.5.2 Handling of Repaired Parts

Caution must be exercised when handling certain parts because of the technology used, such as Printed Circuit Boards (PCBs), which are the most sensitive to damage from poor handling. Be careful not to handle or touch PCBs and components any more than absolutely required. The use of ground straps and anti-static bags is standard practice. Integrated circuits (ICs) and other components must be kept on anti-static foam in anti-static containers.

10.5.3 Shipping of Defective or Repaired Parts

When a part is shipped, it must be packaged in its original shipping container or equivalent. All static-sensitive parts are to be wrapped or packed in anti-static material so that damage does not result from improper packaging. The proper paperwork for shipping defective or repaired parts must be complete, and all serial numbers recorded for assemblies and subassemblies that included before the part is packaged.

10.5.4 Audit of Inventory and Spares

The engineering office, via MOMS, is responsible for scheduling audits of the inventory levels in the maintenance shop. This helps in prevent inventory and logistics problems such as missing parts or invalid inventory levels. These audits must be performed at least once a year must and include audits of spare assemblies.

10.5.5 Disposition of Discarded Parts and Consumables

Engineering is responsible for collecting and analyzing discarded parts and consumables. The analysis helps identify equipment / parts deficiencies. Engineering is responsible for sending the discarded parts to the vendor, if required.

10.5.6 Maintaining Shipping / Receiving Log

The shipping / receiving log is located in the maintenance shop log book. The Field Service technician is responsible for maintaining the shipping / receiving log and obtaining periodic status reports from companies in the process of repairing or transporting equipment. The log is used in conjunction with the MOMS subsystem.

10.5.7 Maintaining Spare Parts Database

The field service technician is responsible for entering all received parts into the MOMS database. Also, the technician is responsible for maintaining a weekly updated version of the maintenance and stock databases.

10.5.8 Maintaining Ready Spare Bin

The field service technician is responsible for ensuring that malfunctioning equipment is repaired in a timely manner and that the ready-spare bin is stocked with the proper amount of ready spares.

Appendix A - Priority Levels / Failure Modes & Effects

A1. Priority Levels

- Priority 1
  Errors resulting in failure of component affecting continued operation of toll lane or plaza or continued collection of toll data. This priority level initiates a paging call to a Service Representative through the MOMS.
- Priority 2
  Errors resulting in failure of component that does not immediately affect continued operation of toll lane or plaza or continued collection of toll data.
- Priority 3
  Errors indicating potential problem with component but no immediate threat to continued operation of toll lane or plaza or continued collection of toll data.

A2. Failure Modes & Effects Analysis

A2.1. Lane Controller

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
Lane Controller					
Hard Disk Drive	manual	MOMS/Supervisor	2	Replace	The lane controller has two hard drives. If one fails the lane continues to function, but a maintenance event is recorded. The faulty drive will be replaced. The plaza supervisor is notified.
Floppy Disk Drive	manual	MOMS/Supervisor	2	Replace	The lane functions normally.
CPU Board	auto	MOMS/Supervisor	1	Replace	The lane controller shuts down. The lane will close automatically and plaza supervisor is notified.
VGA Board	auto	MOMS/Supervisor	2	Replace	The lane functions normally.
Comtrol Board	auto	MOMS/Supervisor	1	Replace	The lane controller determines that multiple devices are not communicating. The plaza supervisor is notified and the lane is closed.
PIO-INT Board	auto	MOMS/Supervisor	1	Replace	The lane controller determines that multiple devices are not communicating. The plaza supervisor is notified and the lane is closed.
Frame Grabber Board	manual	MOMS/Supervisor	1	Replace	Violation images will not be taken. Daily samples will assist in determining failure.
Ethernet Board	auto	MOMS/Supervisor	1	Replace	The ECH does not receive any heart beats from the lane controller. The lane functions in an offline until the network is functional.
Lane Controller power supply	auto/manual	MOMS	1	Repair	Lane Controller shuts down and lane is closed.
UPS	auto/manual	MOMS/Supervisor	1	Repair/ Replace	A failure is determined automatically when lane communication is lost. It will take manual intervention to determine if there is an internal failure.

A2.2. AVC

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
AVC					
Treadles	auto	MOMS/Supervisor	1	Replace	A priority 1 will be generated for control failure.
Exit Loops	auto	MOMS/Supervisor	1	Repair or Replace	If the exit loops fail, the lane functions in a degraded state. The Booth and VES loops will separate vehicles.
VES Loops	auto	MOMS/Supervisor	1	Repair or Replace	If the VES loops fail, the lane functions in a degraded state, allowing the exit loop to separate vehicles. The violation devices.
Booth Loops	auto	MOMS/Supervisor	2	Repair or Replace	If the booth loops fail, the lane functions in a degraded state.The exit loop will separate vehicles.

A2.3. Booth Equipment

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
BOOTH EQUIPMENT					
MLT	auto	MOMS/Supervisor	1	Replace	The lane will not function normally without MLT. It won't let the toll collector to open the lane or classify the vehicles.
Card Reader	Auto	MOMS/Supervisor	2	Replace	The toll collector cannot log in or out of the lane from the toll booth card reader.
Receipt Printer	auto	MOMS/Supervisor	2	Replace	The lane will function normally without receipt printer. But it won't let the toll collector to print receipts.

A2.4. AVI

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
AVI					
Roadside Reader	auto	MOMS/Supervisor	1	Replace	The lane controller continuously monitors the health of the RSR. If the health is reported "Not OK" then there will be an automatic switch over in the event that one of the readers fails. The lanes will function normally
RF Modules	auto	MOMS	1	Replace	In any event of a failure, only one lane, the lane being used, will be affected. There will be no tag reads
Antenna	Manual	MOMS	1	Replace	In any event of a failure, only one lane, the lane being used, will be affected. . There will be no tag reads

A2.5. VES

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
VES					
VES Camera	manual	MOMS/Supervisor	1	Replace	If "capture image" results in a lack of image, a failure will be reported. Reported by the Service Center.
VES Light	manual	MOMS/Supervisor	2	Replace	Must be sufficient to provide night images.

A2.6. Signs

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
Signs					
PFD	auto	MOMS/Supervisor	2	Repair	The lane will function normally without the PFD.
Canopy Light	manual	MOMS/Supervisor	1	Repair	Operation of this light is a matter of public safety.
Traffic Light	manual	MOMS	2	Repair	The lane will function normally without the Traffic Light.

A2.7. Host Equipment

FAILURE MODES AND EFFECTS ANALYSIS					
Component Failure	**Detection Method***	**Where Reported**	**Priority**	**Action Required**	**System Effects**
Host Equipment					
Alpha Server 4100 5/466 128MB RAM 2.1 GB Disk	semi-auto	MOMS	1	Failover/ Repair	In the event of a system failure on the primary Alpha 4100 system, the failover system is pre-configured and ready to assume all ETC activities. The failover system provides FULL FUNCTIONALITY and performs equal to the primary system while repairs are being made.
Additional 128MB Memory Card for Primary and Failover	manual	MOMS	1	Failover/ Repair	The Alpha 4100's memory configuration consists of (2) 128MB memory modules. If one should fail, the system could continue to function depending on the severity of the damage to the module. However, it is recommended that failover procedures be activated to ensure optimum performance levels.
15" Color Console Monitor	manual	MOMS	3	Failover/ Repair	Since the system console is mainly used at boot-up time and is not critical to the normal operation of either system, the backup system's console could be transferred to the primary system until repairs are made to the primary console.
4.3GB Capacity Disk Drive (Wide)	auto	MOMS	1	Spare/ Repair	Two "HOT SPARE" RZ29 devices are provided in the event of a disk failure. By configuring the disk farm using Digital's RAID level 5 solution, we are able to "HOT SWAP" failed disk devices without interruption of operational services or loses of data. An error message will be sent to the administrator by RAID controller. This message will be captured and sent to MMS. Upon installation, the new disk will be rebuilt automatically by the RAID system.
Front Mounting Disk Cabinet for Rack Mount	manual	MOMS	1	Repair	These devices are common to both systems and are internal to the systems cabinet. This requires an experienced field service technician to repair or replacedue to any warranty and/or maintenance contract issues. Each shelf is equipped with redundant power supplies which is the most common failure point.
StorageWorks Array Controller	auto	MOMS	1	Repair	This device has an automatic failover feature that allows uninterrupted disk service by the second or failover HSZ 50 device. A service request can be initiated and performed at a convenient time as time as to not affect the operations of the ETC system.

FAILURE MODES AND EFFECTS ANALYSIS

Component Failure	Detection Method*	Where Reported	Priority	Action Required	System Effects
HSZ 40 Disk I/O Controller	manual	MOMS	1	Replace	Since there are 2 controllers, the failover is automatic to the secondary controller which provides a fault tolerant Disk SUB System.
Plaza UPS System	Auto	MOMS	2	Repair	The UPS system is not critical to the operations of the ETC system and service will be provided on a per-call basis by Digital Equipment. There is a two hour response requirement defined within the service agreement for all hardware service calls. The UPS will be monitored and failures automatically reported to MMS.
Work Stations	Manual	MOMS	2	Repair	The lanes will function normally without the work stations.
Additional 8MB Memory Board	Manual	MOMS	3	Spare/Repair	Each PC is configured with 16 MB of Random Access Memory (RAM) Spare 8MB memory modules are available at the ETC Host site and can be delivered to the failed site. The second should be used until the memory modules can be replaced from the spared inventory.
Additional 64MB Memory Board	Manual	MOMS	3	Spare/Repair	Each PC is configured with 64 MB of Random Access Memory (RAM) Spare 8MB memory modules are available at the ETC Host site and can be delivered to the failed site
PCI Ethernet Card	Manual	MOMS	1	Spare/Repair	Spare Network Interface Cards (NIC) are available at the ETC Central Host site and can be delivered to the failed site.
DEC Laser 3500 Network Printer	manual	MOMS	2	Repair	The printers should be repaired or serviced by a Digital field service person. The failure of this equipment would be inconvenient and should be repaired as soon as possible, but it would not affect the ETC operation in the short term.
DEChub Multistack	manual	MOMS	1	Spare/Repair	Spares are kept at the ETC Central Host site and can be delivered to problem locations immediately. Failed equipment will be repaired and rotated into the spare stock.
DEC 90T and 90FL Routers	manual	MOMS	1	Spare/Repair	Spares are kept at the ETC Central Host site and can be delivered to problem locations immediately. Failed equipment will be repaired and rotated into the spare stock.
Supervisor Workstation	manual	MOMS	1	Repair	The lane will function normally without the supervisor workstation.
Modems	manual	Maint/Supv	1	Replace	MOMS paging modem.-Service engineers cannot be paged.
System Clock	manual	Maint	2	Replace	There's a difference in sync time over extended period of time.
Verifone	manual	Supv/Service Center Clerk	1	Replace	Cannot verify credit card.
Note:	1. Auto = Failure Detection and Reporting is accomplished without human intervention. Man = Failure Detection and Reporting requires human input or intervention.				

A3. Software Maintainability

SOFTWARE MAINTAINABILITY			
Category	**Description**	**Priority**	**Procedure**
Critical Fixes	Serious system malfunctions or "bugs" are further sub-divided by system impact.	Time critical. Need rapid turnaround.	When bugs are detected, the LMIMS system team will immediately identify the appropriate fix or workaround.
Product Updates	Regular scheduled releases of application software for minor bug fixes not critical to operations, system software upgrades, or third party software upgrades.	Planned well in advance and regular change control procedures will be invoked.	First implemented on the development and test facility prior to roll out into production. Application software updates subject to scripted and functional testing by onsite QA.
Product Enhancements	Changes to the system outside the scope of work identified in the initial implementation usually to add a feature or improve performance of the system	Out of scope enhancements are scheduled and planned and will appear in work schedules submitted to the project personnel.	Enhancement requests will go through the change control board as well as contract management prior to scheduling. Approved enhancements implemented on the development and test facility prior to roll out into production. Application software updates are subject to scripted and functional testing by onsite QA.
System Upgrades	System hardware enhancements necessitated by size or capacity changes	Out of scope changes are planned and scheduled well in advance since they typically affect the regular operation of the system	Scheduled with input from the LMIMS change control board, contract personnel, operations and system personnel. Procedures for system enhancements will be followed.

Figure A-1 Software Maintainability

Note: Configuration control provides oversight of our procedures for quality assurance of software changes. Lockheed Martin IMS has established a prioritization of change importance on the different kinds of changes to the system during the maintenance phase of the contract. This priority scheme is based on the varying importance and time criticality of such changes.

A4. Critical Fixes

Critical software bugs such as the lane controllers not running at all, lane transactions not created or created improperly, the host not posting lane transactions at all,(or improperly), require immediate fixes or workarounds. Critical bugs are prioritized in order of urgency of resolution. Typically, the lane controller software has the highest priority since it is the source of all toll transactions. Software downtime will be calculated based upon any priority one (1) critical error. All priority one (1) errors can affect the revenue stream of the toll facility. LMIMS will use the amount of time the particular software unit is priority one (1) non-operational as a factor in overall software availability measurement over the 90-Day Acceptance period.

Priority Two (2) errors are not as critical, but need prompt attention and correction in order to minimize operational efficiency. They do not represent a potential impact to the revenue stream and any resulting data can be corrected and re-processed upon correction of the software problem.

All other software errors will be handled under the Update category as they are minor in nature and can be scheduled under normal maintenance procedures.

These problems will be communicated to the project manager, QA department, and change control board at the Metairie Development Center. Approvals for these fixes will be needed quickly. Verbal approval, followed- up with supporting documentation, will be the normal process prior to system checkout and rollout.

CRITICAL FIXES

Critical Area	Priority	Appropriate Agency Action	Appropriate LMIMS Action
Lane software won't execute at all	1	Maintenance Manager handles call or pages LMIMS project manager immediately	Designated support programming personnel contacted immediately and corrective action is initiated as highest priority until solution is found
Lane controller not generating toll revenue transactions at all or improperly	1 Represents a potential revenue loss	Toll supervisor closes lane immediately and notifies the Maintenance Manager	Designated support programming personnel contacted immediately and corrective action is initiated as highest priority until solution is found
Host transaction services posting lane transactions improperly	1 Represents a potential revenue loss	Designated agency personnel verifies transaction discrepancies and notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated

CRITICAL FIXES			
Plaza Lane Monitoring software not operating at all	2	Toll supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
Plaza Lane Monitor not reporting lane transactions properly	2	Toll supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
Lane not responding to Plaza Lane Monitor Controls such as lane closings	2	Toll supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
Collector/Clerk deposits not executing at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
Bank deposits not executing at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
ETC Account Management software not operating at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
Violations Image Review not operating at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated

CRITICAL FIXES			
ETC Payments not functioning	12	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
ETC-Open Account not functioning at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
ETC-Account Maintenance not functioning at all	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated
ETC-Payments posting wrong financial transactions	2	Plaza Supervisor notifies Maintenance Manager.	Designated support programming personnel contacted during normal operating hours and corrective action is initiated

Figure A-2 Critical Fixes

A5. Failure Recovery & Switchover Mechanisms

FAILURE RECOVERY AND SWITCHOVER MECHANISMS			
System/Subsystem		Recovery	Switchover
Lane Controller	• Power Supply	Manual	Manual
	• Hard Drive	Automatic/Manual	Automatic/Manual
	• Floppy Drive	Manual	Manual
	• CPU Board	Manual	Manual
	• VGA Board	Manual	Manual
	• Comtrol	Manual	Manual
	• PIO Board	Manual	Manual
	• Frame Grabber	Manual	Manual
	• Ethernet Controller	Manual	Manual
	• UPS	Manual	Manual
AVI	• Power Supply	Automatic	Automatic
	• CPU	Automatic	Automatic
	• RF Control	Automatic	Automatic
	• Comms Board	Automatic	Automatic
	•		
AVC	• Treadles	Automatic/Manual	Automatic/Manual
	• Loops and Loop Detector	Manual	Manual
VES	• Cameras	Manual	Manual
	• Camera Lighting	Manual	Manual
Booth Equipment	• MLT	Manual	Manual
	• Receipt Printer	Manual	Manual
	• Card Reader	Manual	Manual
Signs	• Traffic Light	Manual	Manual
	• Canopy	Canopy	Manual
HOST SERVER	• Back-up Unit	Automatic	Automatic
	• Hard Drive Controller	Automatic	Automatic
	• Hard Drives	Automatic	Automatic
Network	• DEC Repeaters 90T/90FL	Manual	Manual
	• DEC brouter	Automatic	Automatic
	• DEC Multistack	Manual	Manual

* Semi-Automatic fail over is achieved through the use of backup devices, e.g., Loops as a backup device to the Overhead Profiler.

** Automatic/Manual occurs when subsystems are assembled with redundant components. On the first failure the recovery and switchover is "Automatic." After that, the recovery and switchover is "Manual."

Figure A-3 Failure Recovery and Switchover Mechanisms

A6. Components & Priority Listing by Shift

COMPONENTS AND PRIORITY LISTING BY SHIFT						
COMPONENTS	**PRIORITY (MON-FRI)**			**PRIORITY (SAT-SUN)**		
	SHIFT 1	**SHIFT 2**	**SHIFT 3**	**SHIFT 1**	**SHIFT 2**	**SHIFT 3**
Hard Disk Drive	2	2	2	2	2	2
Floppy Disk Drive	2	2	2	2	2	3
CPU Board	1	1	1	1	1	1
VGA Board	2	2	2	2	2	3
COMTROL Board	1	1	1	1	1	1
PIO-INT Board	1	1	1	1	1	1
Frame Grabber Board	1	1	1	1	1	1
Ethernet Board	1	1	1	1	1	1
Lane Controller Power Supply	1	1	2	1	1	2
Lane UPS System	1	1	1	1	1	1
Post – Class Treadles	1	1	1	1	1	1
Exit Loops	1	1	1	1	1	1
VES Loops	1	1	1	1	1	1
Booth Loops	2	2	2	2	2	2
Modems	1	1	2	1	1	2
System Clock	2	2	3	2	2	3
Verifone	1	1	3	1	1	3
MLT	1	1	1	1	1	1
Receipt Printer	2	2	2	2	2	3
Card Reader	2	2	2	2	2	3
Road Side Reader	1	1	1	1	1	1
AVI RF Reader	1	1	1	1	1	1
AVI Antenna	1	1	1	1	1	1
VES Camera	1	1	2	1	1	2
VES Light	2	2	2	2	2	2
PFD	2	2	2	2	2	3
Canopy Light	1	1	1	1	1	1
Traffic Light	1	2	2	1	2	2

Proprietary Data

COMPONENTS AND PRIORITY LISTING BY SHIFT						
COMPONENTS	PRIORITY (MON-FRI)			PRIORITY (SAT-SUN)		
	SHIFT 1	SHIFT 2	SHIFT 3	SHIFT 1	SHIFT 2	SHIFT 3
Alpha Server 4100 5/466128MB RAM 2.1 Disk	1	1	1	1	1	1
Additional 128MB Memory Card for Primary and Fail over	1	1	1	1	1	1
15" Color Console Monitor	3	3	3	3	3	3
4.3 GB Capacity Disk Drive (Wide)	1	1	1	1	1	1
Front Mounting Disk Cabinet for Rack Mount	1	1	1	1	1	1
Storage Works Array Controller	1	1	1	1	1	1
HSZ 50 Disk I/O Controller	1	1	1	1	1	1
Plaza UPS System	2	2	3	2	2	3
Work Stations	2	2	3	2	2	3
Additional 8M Memory Board	3	3	3	3	3	3
Additional 64MB Memory Board	3	3	3	3	3	3
Ethernet PCI Card	1	1	1	1	1	1
DEC Laser Printer	2	2	3	2	2	3
Network HUB	1	1	1	1	1	1
DECbrouter	1	1	1	1	1	1
Supervisor Workstation	1	1	2	1	1	2

Figure A-4 Components and Priority Listing by Shift

Note: Response to a shift 3 call out will depend on the availability of the lanes. If other lanes are available then a call out may not be necessary. If a call out does not occur, all priority 1 call out items must be corrected by 7:00 a.m., and all other priority items must be repaired within 2 hours of the normal workday starting time.

A7. Shift Definition

- Shift 1: 7:00 a.m. - 3:00 p.m.
- Shift 2: 3:00 p.m. - 11:00 p.m.
- Shift 3: 11:00 p.m. - 7:00 a.m.

A8. System Discrepancy Report Form

LOCKHEED MARTIN	System Discrepancy Report

LOCKHEED MARTIN IMS
6660 Riverside Drive
Metairie, LA 70003

Tracking No: _____

This form is to be used for Hardware and Software Discrepancies. See reverse for instructions.

SYSTEM DESCRIPTION:	*TEST NO:(if applicable)*	*DATE:*
DESCRIPTION OF DISCREPANCY:		*ORIGINATOR:*
		PROJECT MGR OR LEAD:
		DATE FOR RESOLUTION:
		CLIENT WITNESS: (if applicable)

RESOLUTION DESCRIPTION:			
DATE:	*SUCCESS*	*FAILURE DISCREPANCY REPORT NO.*	*TESTER NAME*
NOTE: IF SUCCESSFUL, RECORD IN "RETESTING" PORTION OF ACCEPTANCE TEST RESULTS SUMMARY FORM :(if applicable).			

Signatures (Success Only): (if client-witnessed RETESTING is necessary)

LOCKHEED TEST SUPERVISOR	*CLIENT WITNESS*

This form is initiated and tracked by the Hardware Engineering Group. Return the completed form to HEG when action is resolved.

Figure A-5 System Discrepancy Report Form

Appendix B - Test Equipment / Tools & Supplies

B1. Test Equipment

Quantity	Test Equipment
1	1. Oscilloscope 1 Model: Fluke Handheld Features:15OMz, Digital, Storage, 2 Channel
1	2. Power Supply Model: 1660 Features: Triple Output Source: Newark, Part 46F8597
1	3. Benchtop Digital Multimeter Model: Fluke 45 Source: Newark, Part # 89F1304
2	4. Protocol Analyzer Model: Breakout II
1	5. Spectrum Analyzer Model: HP8590L Source: Hewlett Packard
1	6. Test Leads Source: Newark, Part # 5OF6949

Quantity	Test Equipment
1	7. Digital Volt Meter 70 Series Source: Fluke 070054
1	8. Fiber Optic Power Meter Sekor 163323 Source: Anixter
1	RS-232 Test Kit 9702402
1	Socket Serial Card 971200312
8	9-volt batteries
12	D-Cell batteries
1	Meter Fluke 79 III
1	RS232 Tester Datacom 650

B2. Tools

Quantity	Tools
2	1. Soldering/Desoldering Station Features: ESD Safe, SMD & Multilayer Boards Model: MBT-250 Pace Source: Jensen Tools, Part # 176B250
1	2. Computer Pentium 1xx, 32 MB RAM, 120M HD, SVGA Card & Monitor, 3.5 Floppy, Keyboard
1	3. Laser Printer Model: HP 5M
1	4. Heat Gun Source: Newark, Part # 37F1437
4	5. Bench Light/Magnifier Source: Newark, Part # 89F5027
2	6. Static Control Station Source: Newark, Part # 46F7454
2	7. Jumper Test Clip Kit Source: Newark, Part # 9OF2173
1	8. Test Monitor Source: Sony 9" monitor
2	9. TEKK Radio
2	10. Null Modem
1	11. Tech Case
2	12. Laptop PC

Proprietary Data

Quantity	Tools
1	Floppy Drive, 3.5in (laptop)
1	CD ROM drive (laptop)
1	Modem, 33Kbps w/ cord
1	Technician Tool Kit-9705515
	10-pc Wrench Set
	Small Hammer
	Soldering Iron
	Diagonal Pliers, 4"
	Needle Nose Pliers, 3"
	Needle Nose Pliers, 4"
	Wire Strippers
	Mini Screwdriver Set, 7-pc
	Mirror
	Screw Starter
	Razor Knife
	Long Screwdriver
	Small vice Grips
	De-pinning Tool
	Allen Wrench Set
	Soldering Wire
	Small Phillips Screwdriver
	Small Standard Screwdriver
	Scissors
	Hemostats
	Tweezers
	Multi-bit Screwdriver
	90° Screwdriver
	Wire Cutters
	Crescent Wrench, 8"
	Voltmeter-DM2
1	Work Bench
1	RG-59/RG-8 Crimpers
	RG-59/RG-8 Strippers

B3. Cleaning Materials & Supplies

Cleaning Materials & Supplies	Quantity
Towels, Teri Knit Teri Towels	
Towels, Paper	
Glass Cleaner Windex	
Degreaser	
Spray Bottles	
Compressed Air, canned	
Rain-X Rain-X	
AA-cell batteries	48

B4. Lubricants

Lubricants		Quantity
Lubricant	Tri-Flow	

Glossary of Terms

ACM

Automatic Coin Machine - A device that accepts and counts coins for payment of tolls, without manual action or intervention.

AVC

Automatic Vehicle Classification - A system installed in a toll lane. It is used to determine and / or verify the classification of a motor vehicle passing through a lane.

AVI

Automatic Vehicle Identification - A system that consists of readers and antennas installed in the lane and transponders located on a vehicle for automatic identification of the vehicle as it passes through a toll lane.

BTS

Bench Test Simulator

CCTV

Closed Circuit Television

CM

Corrective Maintenance

CMOS

Complementary Metal Oxide Semiconductor

DEC

Digital Equipment Corporation

Display

A device that displays the patron's toll fee. It is located in the ACM.

DMA

Direct Memory Access

DOS

Disk Operating System

DSD

Detailed System Design

DVM

Digital Volt Meter

ECO

Engineering Change Order

EM / CM

Emergency Maintenance / Corrective Maintenance - Maintenance required as a result of equipment failure and therefore not previously planned or scheduled.

FCO

Field Change Order

FCOT

Field Checkout Test

HTP

Host Transaction Processor

I / O

Input / Output

IC

Integrated Circuit

ID

Identification

IMS

Lockheed Martin IMS

KB

Kilobyte

LED

Light Emitting Diode

LRM

Line Refresh Memory

LRU

Lowest Replacement Unit; Line Replaceable Unit

MAF

Maintenance Activity Form

MHZ

Megahertz

MLT

Manual Lane Toll terminal - A device used by toll operators to classify vehicles and account for toll transactions.

MOMS

Maintenance On-line Management System - A data retrieval and reporting to management system used for toll maintenance purposes. This system may also be used for diagnostics with toll system control applications.

MTBF

Mean-Time-Between-Failures

MTTR

Mean-Time-To-Repair

MTTRestore

Mean-Time-To-Restore

OEM

Original Equipment Manufacturer

OJT

On-the-Job-Training

OSHA

Occupational Safety and Health Act

PCB

Printed Circuit Board

PDM

Predictive Maintenance

PFD

Patron Fare Display - A device that displays the patron's traffic toll fee. It is located on the toll booth past the toll attendant.

Plaza Supervisor

A person who is responsible for a complete shift at a mainline plaza. Responsibilities may also include associated ramp plazas adjacent to the mainline plaza.

PM

Preventive Maintenance

Post-classification

The exit portion of the Automatic Vehicle Classification System.

QA

Quality Assurance

QC

Quality Control

QPEI

Quantity Per End Item

RAID

Redundant Array of Inexpensive Disks

RAM

Reliability, Availability and Maintainability

RCC

Reader Computer Card

Receipt Printer

A module that issues cash receipts.

RFP

Request for Proposal

RMA

Return Merchandise Authorization

RX

Receive

SCF

Service Call Form

Signals

The red and green traffic signals, with alarm lights and audible alarm, mounted on the toll island for controlling traffic. The island traffic signal is changed from red to green to indicate the ACM has counted the proper toll, the operator has processed the vehicle, or the AVI tag has been read as valid, and the vehicle may exit the lane. This item should not be confused with plaza canopy traffic signals.

SOP

Standard Operating Procedure

TCP / IP

Transmission Control Protocol / Internet Protocol

Treadle Codes

AF = Auto Off

AO = Auto On

CFnnnn= Count Forward plus 5 digit number

CRnnnn= Count Reverse plus 5 digit number

D=Disabled

DEF= Default

I=Intemittent

K=OK

O=Open

S=Shorted

TTL

Transistor-Transistor Logic

TX

Transmit

UPS

Uninterruptible Power Supply - A uninterruptible power source that develops a constant output voltage regardless of input voltage losses and variations.

VES

Violation Enforcement System - A video or photographic system designed to capture an image of the rear license plate of vehicles that violate the toll system. Additional data relative to the transaction that is generated by the toll equipment is also added to the captured image.

VOM

Volt Ohm Meter

VPS

Violation Processing System