

**NO. 4 ELECTRONIC SWITCHING SYSTEM  
MAINTENANCE OPERATIONS CENTER (MOC)  
FUNCTION AND FACILITIES**

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3. INPUT/OUTPUT FACILITIES . . . . .	4	1.01 The quantity and complexity of equipment in a No. 4 Electronic Switching System (ESS) office requires a planned approach to principal work functions involved with control and maintenance responsibilities. The organization and function of work centers unique to No. 4 ESS depend on such variables as office size, equipment ownership, and administrative policies and procedures. Control and maintenance operations are performed by the following basic work centers in a fully equipped office:	
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work closely with them in day-to-day operation of the system.

**1.02** Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

**1.03** The MOC work center concept was developed to provide management and maintenance personnel a centralized location to administer control and repair of the 1A Processor, time division network, and terminal equipment controlled by the 1A Processor. (Repair of the terminal equipment controlled by the 1A Processor may be assigned to the TEC in a large office if the equipment is located remotely from the MOC.) Actual equipment in each of these groups is listed in 2.04. Provision for storing needed documentation is provided in the MOC. This section includes the following parts:

- Description of functions
- Input/output facilities
- System performance display
- Interrelationships with other work centers.

**1.04** The MOC personnel are responsible for maintenance control operations of the No. 4 ESS which includes the 1A Processor, time division network, and terminal equipment controlled by the 1A Processor. For most troubles, the system is capable of automatic recovery under program control. However, manual backup is provided for processor configuration. *Manual control* of the system is provided by control switches on the master control console and messages that may be input on various input/output (I/O) devices. These controls are provided to remove faulty equipment from service, control the unit for diagnostic testing (repair), and restore equipment to service after completion of repair. Indications of the system status include lamps, audible alarms, and printouts. The response to these indicators may include inputting messages on an I/O device or operating control switches on the master control console.

**1.05** The MOC has the following functions:

- Control of system (No. 4 ESS) for testing, repair, and real time control of equipment configuration for system recovery

- Monitoring of system status
- Repair responsibilities
- Analysis of system printouts
- Growth coordination
- Routine maintenance.

## 2. DESCRIPTION OF FUNCTIONS

### CONTROL OF SYSTEM FOR TESTING, REPAIR, OR SYSTEM RECOVERY

**2.01** The MOC, one of several work centers in a No. 4 ESS office, is responsible for overall control of the No. 4 ESS. This responsibility is to insure the system is maintained in its highest redundant working configuration. At times, it may require operating manual controls to obtain a working configuration. The master control console (Fig. 1) and the master test and control (MTC) and secondary record 1 (SREC1) channels are primary tools used by MOC personnel for maintenance activities.

**2.02** The master control console is the primary means of observing overall status of the entire switching system and manually invoking overrides to the automatic recovery features. A secondary means of manual control is provided at the processor and peripheral frames via local frame control panels and via TTY input messages. The master control console includes status lamps and control switches. Lamps indicate trouble conditions and the current equipment configuration. Control switches provide a means of manual control over the system configuration. A more detailed description of the master control console is provided in BSP 234-110-000.

### MONITORING OF SYSTEM STATUS

**2.03** Monitoring of the system status provides the information needed to maintain a working configuration and keep the system processing calls at the engineered capacity. Lamps, audible alarms, and printouts are provided to aid in monitoring the system status. Lamps include those on the master control console and those associated with the office alarm system.



**Fig. 1—Master Control Console (MCC)—Front View**

#### **REPAIR RESPONSIBILITIES**

**2.04** Equipment for which the MOC has repair responsibilities will usually be located adjacent to the MOC area and will include the 1A Processor and other major peripheral equipment which includes the time division network. Basic 1A Processor equipment includes the following frames:

- Program store (PS)
- Call store (CS)
- File store (FS) and auxiliary data system (ADS)
- Master control console (MCC)
- Processor peripheral interface (PPI)
- Input/output (I/O)
- Tape frame (TF)
- Power conversion and distributing (PCD)
- Data set circuit (DS)

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- Central control (CC) (and associated buses)
  - (a) Program store bus (PSB)
  - (b) Call store bus (CSB)
  - (c) Auxiliary unit bus (AUB)
  - (d) Peripheral unit bus (PUB)

Major peripheral equipment frames which include the time division network are:

- Time multiplexed switching (TMS)
- Time-slot interchange (TSI)
- Peripheral unit bus branching (PUBB)
- Signal processor (SP)
- Voiceband interface (VIF)
- Common channel interoffice signaling (CCIS)
- Network clock (NC) including system clock (SC)
- Digroup terminal (DT)

Other MOC repair responsibilities are described in 2.07.

In a large office where terminal equipment controlled by the 1A Processor is located remotely from the MOC, the TEC may be assigned repair responsibilities of the terminal equipment. This responsibility is primarily identifying faulty circuit packs (from trouble locating numbers produced on printouts generated by the 1A Processor) and replacing the faulty pack.

### ANALYSIS OF SYSTEM PRINTOUTS

**2.05** Most analysis will be performed by the system software, keeping manual analysis at a minimum. However, for some troubles it is necessary to analyze certain system printouts. For intermittent troubles, it may be necessary to analyze printouts covering several days or weeks to establish a pattern to locate the trouble source. The trouble source may be software (incorrect data) or hardware (circuit pack).

### GROWTH COORDINATION

**2.06** As use of the toll network increases, system growth is necessary to increase the capability of the system to process more calls per hour. The MOC is responsible for insuring that:

- Growth procedures do not disrupt call processing
- Testing of growth equipment is coordinated with other work centers or groups as necessary.

### ROUTINE MAINTENANCE

**2.07** The nature and frequency of routine tests are described in equipment test lists (ETLs). Basically, routine maintenance is performed on equipment that requires periodic adjustments, cleaning, and testing of controls and lamps. Some of the equipment frames requiring routine maintenance are:

- MCC—Requires operational checks
- File stores—Requires filter replacement, clock tract checks, belt replacements, speed adjustments, etc
- Tape units—Requires cleaning, filter replacement, speed and alignment adjustments, etc
- Local frame controls—Requires operational checks, alarm test, etc
- Recorded announcement frame—Requires check of announcement channels, etc.

## 3. INPUT/OUTPUT FACILITIES

### DEVICES

**3.01** In addition to the MCC discussed in 2.02, the MOC has the following devices covered in 3.02 and 3.03.

**3.02 *Model 40 Data Terminal:*** The Model 40 data terminal may consist of a keyboard (K), display device (D), and printer (P). The terminal arrangement may be provided in one of several configurations. The Model 40 data terminal, or equivalent, is assigned to the various I/O channels

in the MOC. Selected channels are also assigned a magnetic tape terminal. The Model 40 is a 120-character-per-second device.

**3.03 Model 35 KSR TTY:** The Model 35 KSR TTY or equivalent, is assigned to the beltline channels for system access from equipment frame locations. The Model 35 KSR TTY is a 10-character-per-second device.

## CHANNELS

**3.04** There are several communication channels provided for interfacing the I/O devices with the rest of the system. Figure 2 is a block diagram of the channels assigned to the MOC. Input messages may be used to request information from and input information into the system. Some of the input messages are critical since they may cause actions that affect the system's ability to process calls. Therefore, it is necessary to restrict the use of some messages, and this is accomplished by input message screening. This screening is done on a message class basis.

### **3.05 Master Test and Control Channel (MTC):**

The MTC is the primary I/O for maintenance personnel to communicate with the system. The I/O device for the MTC is a Model 40 KDP, or equivalent. This channel receives output responses to MCC operations that require a response on an I/O device. In addition to MCC operation responses, it receives control messages (configuration, interrupts, audits). This is the principal I/O channel for inputting manual control messages for system control and receiving reports of errors that occur in the software programs and periodic status reports of trouble conditions. The MTC has a backup channel assigned to receive messages when the MTC is out of service for any reason. The backup channel for the MTC is the secondary record channel (SREC1) and, in turn, MTC serves as backup channel for the SREC1 and SREC2.

**3.06** The system software is designed to switch to the backup channel automatically for any channel that fails. Messages may be manually routed to the backup channel or any other channel with the proper input message.

**3.07 Secondary Record Channel 1 and 2 (SREC1 and SREC2):** There are two secondary record channels (SREC1 and SREC2). The SREC1 is a required channel used to supplement the MTC

in control, testing, and repair operations in the MOC and normally receives all repair messages. The SREC1 has signal and power cables terminated at both its usual work location and at the MCC. If the MTC has to be removed from service for any reason, SREC1 may be relocated to the MCC to function in lieu of the MTC. During conditions that cause excessive output to the MTC, the SREC1 may be designated to receive certain classes of messages normally outputted on the MTC. The method of changing to the backup channel is described in 3.06. The I/O device for the SREC1 is the Model 40 KDP, or equivalent, and a magnetic tape terminal. The SREC2 is an optional channel to be supplied when required to expand the maintenance capabilities. It is equipped (when required) with a Model 40 KP device and may be optionally equipped with a display device and magnetic tape terminal. The backup channel is the MTC.

A remote terminal port (RMT1) is provided to allow maintenance personnel to transmit output data to a digital maintenance support center. The distant maintenance support center must be equipped with a compatible terminal device. The No. 4 ESS office may dial the telephone number associated with the distant terminal and connect the telephone line to the remote terminal port. Output messages are simultaneously outputted in the office and over the DDD network to the distant maintenance support center.

### **3.08 Recent Change Monitor Channel (RCMOC):**

The RCMOC is one of three recent change message channels. It is a receive only (RO) channel located in the MOC. The other two channels are I/O channels located in the MAC. The RCMOC produces a printout of recent change messages put into the buffered mode or test mode. In addition to the printout, it records on magnetic tape all messages put into the test mode. The tape may be used later to reinsert messages that may be deleted by system recovery actions. The backup channel is SREC1. It is equipped with the Model 40 RO data terminal and magnetic tape terminal.

### **3.09 System Administration Channel (SYSAD):**

The SYSAD channel receives office summary reports such as plant measurements, machine service reports, and machine performance reports. These reports are printed on a periodic basis (hourly, daily, etc) on this receive only channel. The

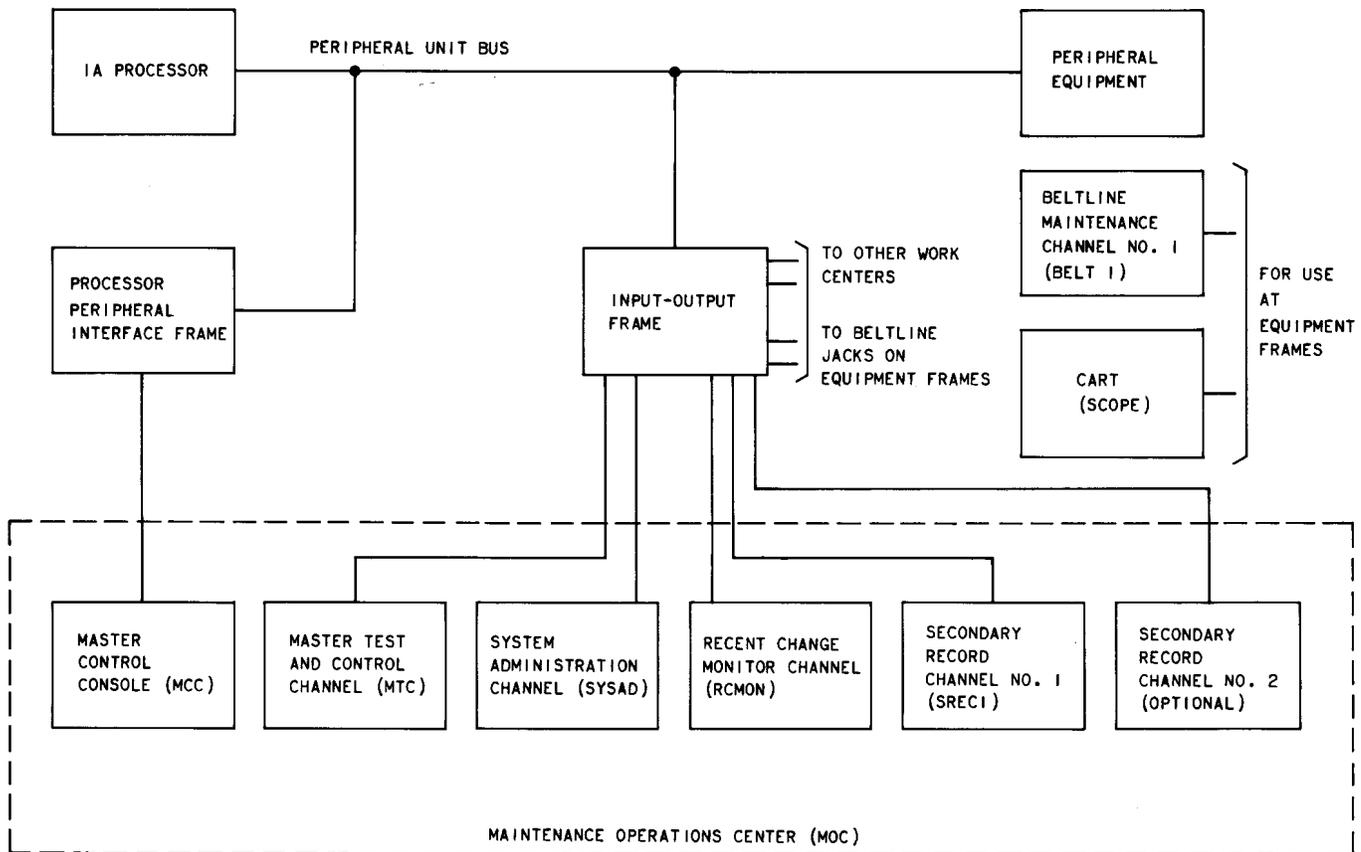


Fig. 2—Maintenance Operations Center (MOC)—Input/Output Interface

SYSAD is equipped with a Model 40 RO device. The backup channel is the SRECI1.

### 3.10 *Beltline Channels (BELT1 and BELT2):*

Two beltline channels are assigned which allow maintenance personnel to communicate with the system from frame locations. Jack access is provided to the BELT1 or BELT2 channel in the processor area and at each peripheral frame. The backup channel is the MTC. If the backup channel is needed, the system software will automatically switch to it. The beltline channels may be used by the MOC or another work center such as the TEC. In addition to jack access for the BELT1 and BELT2 channels, jack access is provided for voice communications between work centers and between equipment frames.

### INDICATIONS, ALARMS, AND PRINTOUTS

3.11 *Indications, Alarms:* There are seven basic alarms and indications on the MCC. With

each alarm condition detected, an associated TTY message is sent to a printer in the maintenance center responsible for the alarm grid in which the trouble occurred. On the switchroom floor a loud chime signal is used to sound CRITICAL and MAJOR alarms. It is sounded at a fast rate for CRITICAL and a slow rate for MAJOR alarms. The SIA ringer is used to sound MINOR alarms. In the MOC an alarm grid display panel is provided to display and sound the alarms for all the alarm grids responsible to the MOC repair center. The alarm grid display panel in the MOC may be duplicated in the other work centers (TOC, TEC) as well. Grid 1 (containing the 1A Processor and network frames) of the alarm system is always assigned to the MOC. Other grids may be assigned if necessary. This panel provides a status of the office alarm system. Since it is planned for the MOC to be located in a quiet atmosphere, a quiet alarm device (S2A ringer) is mounted in the alarm grid display panel and is sounded in synchronism with the switchroom floor alarms.

**3.12 *Printouts:*** Printouts are sent to the various I/O channels. The system determines which channel receives each message on the basis of message classes. Each message class contains predefined I/O channel(s) to which each printout is sent. Message classes are grouped into three categories (functional, unit type, maintenance center).

**3.13** For printouts concerning frame troubles, the system automatically sends the message to the maintenance center (maintenance center message class) assigned the repair responsibility for that particular frame.

**3.14** A particular printout may use various combinations of the message classes according to the type of message being printed.

**3.15** A TTY *input* is available for the maintenance personnel to change the destination of output messages *except for the maintenance center classes*.

For detailed information on printouts refer to the Output Message Manual.

**4. SYSTEM PERFORMANCE DISPLAY**

**INTRODUCTION**

**4.01** There will be a 10-by-15 array of light emitting diodes on the MCC. The array is organized into 15 columns of 10 diodes. Each column will be referred to as a display position. Each display position can be addressed and when addressed, will accept a value from 0 to 10, lighting the corresponding number of diodes in that column. The intended use of this diode array is to display system performance information in a bar chart format to the craft force.

In addition to the ten diodes per column, there is a threshold exceeded diode at the top of each column and a lamp and pushbutton at the bottom of each column. There is a 12-second visitation timer which will extinguish all the displays if the visitation indicator in the MCC is not set before its time-out time is reached.

**DISPLAY DATA**

**4.02** The data specified in Table A will be displayed at the MCC. Each numbered entry in the table corresponds to one display position starting

at the left of the display. Each display position will be dedicated to a particular datum.

**4.03 *Base-Level Cycle Time:*** The average BLC for a period of 10 seconds will be displayed as a percentage of 100 ms. This number will be derived from a count of the number of BLCs (NBLC) incremented by the overload control program for traffic measurements. The calculation of the percentage is:

$$\text{BLC time} = \frac{10 \text{ sec} \times 100\%}{\text{NBLC} \times 100 \text{ ms}} = \frac{100 \times 100\%}{\text{NBLC}}$$

**4.04 *Traffic In:*** The number of call attempts recognized by the office in a 60-second interval will be calculated. Let this number be T. Traffic will be presented as a percentage of the expected average busy hour attempts (E) provided by the office data assembler. Then,

$$\text{Traffic in} = \frac{T}{E} \times 100\%$$

T is obtained by summing the changes in the MF incoming seizure peg count, the DP delay dial incoming seizure peg, the DP immediate start incoming seizure peg, the CCIS CR seizure peg, CCIS origination CR queue abandon peg, and the CCIS origination CR queue overflow peg counters.

**4.05 *Switching Ineffectiveness:*** Switching ineffectiveness will be defined as the ratio of nonswitched calls (NSC) to the number of call attempts (T). This ratio will be calculated and displayed as a percentage every 60 seconds. Thus,

$$\text{Switching ineffectiveness} = \frac{\text{NSC}}{T} \times 100\%$$

The NSC is a count provided by trunk maintenance and is the sum of the nonequipment and equipment related ineffective attempts excluding CAMA automatic office and automatic identification failures.

**4.06 *Ineffective Machine Attempts:*** The number of ineffective attempts which are due to equipment-related difficulties (EIA) as opposed to traffic-related reasons will be displayed as a percentage of total NSCs. Thus,

TABLE A  
DATA

1. Base-level cycle time (BLC)
2. Traffic in
3. Call register (CR) occupancy
4. Calls which queued for service
5. Test call seizure time
6. Disk requests which queued
7. Switching ineffectiveness
8. Ineffective machine attempts
9. Network occupancy

The order, except for the first position, is the order of possible events in a call and also the normal order of increase due to traffic load. The first position is a general indicator of system performance and is closely related to traffic. The last position is more related to the number of calls in the talking state than to current traffic load.

The corresponding name on the MCC for each display position is:

1. BASE CYCLE TIME
2. TRAFFIC INCOMING
3. CALL REGISTER OCCUPANCY
4. CALLS QUEUED FOR SRV.
5. TEST CALL SEIZURE TIME
6. DISK REQUESTS QUEUED
7. SWITCHING INEFF. ATTEMPTS
8. EQUIPMENT INEFF. ATTEMPTS
9. NETWORK OCCUPANCY

The names are space limited to three lines of nine characters each (including blanks).

$$\text{Ineffective machine attempts} = \frac{\text{EIA}}{\text{NSC}} \times 100\%$$

$$\text{Test call seizure delays} = \frac{\text{avg delays}}{4 \text{ sec}} \times 100\%$$

This measurement will be made every 60 seconds.

**4.07 Test Call Seizure Times:** Every 60 seconds the average seizure delay of the last 16 test calls will be displayed as a percentage of 4 seconds. The test call history table will be used to determine the average seizure delay. Thus,

**4.08 Calls Queuing for Service:** Let the number of calls which enter or overflow the DP CR queue, the MF origination queue, or the CCIS origination CR queue be Q. (The CCIS origination CR queue will not exist in the Phase 1 generic issue.) Then, every 60 seconds, Q will be displayed as a percentage of call attempts. Thus,

$$\text{Calls queuing for service} = \frac{Q}{T} \times 100\%$$

**4.09 CR Occupancy:** The CR occupancy will be calculated as a percentage of total CRs. Thus,

$$\text{CR occupancy} = \frac{\text{Number CRs active} \times 100\%}{\text{Total number CRs}}$$

This measurement will be made every 60 seconds.

**4.10 Disk Requests Which Queued:** Every 60 seconds the ratio of the number of disk requests which attempted to queue (ie, queue seizure and queue overflow) to the total number of requests will be calculated and displayed as a percentage of the total number of disk requests.

**4.11 Network Occupancy:** Every 180 seconds traffic measurement calculates a measure of network occupancy, N from the service circuit and traffic separations class occupancy counts. The N is actually a count of active connections with each connection requiring two busy terminations. This measurement will be displayed as a percentage of network capacity (network capacity is defined as the network occupancy at which the matching loss becomes unacceptable). From simulations involving the 840 trunk per TSI network configuration and the No. 4 ESS path hunt program, a .9 erlang per trunk traffic load is known to be the saturation point. Expressing network capacity and use in terms of busy terminations:

$$\text{Network occupancy} = \frac{2N \times 100\%}{840 \times .9 \text{ NTSI}} = \frac{100N}{378 \text{ NTSI}} \%$$

In order to avoid requiring synchronization with the traffic measurements collection program, the display will be updated every 60 seconds.

**DISPLAY MECHANISM**

**4.12** Normally the data will be presented at the display position in a range of 0 to 100 percent in 10-percent increments. If the calculated data (B) matches or exceeds some threshold (eg, 110 percent), then the threshold exceeded diode will be lighted. If the data represents a small percentage (ie, less than 11 percent), then an automatic scale change will be made by the program. The new scale will be 0 to 10 percent in 1-percent increments,

and will be signaled by turning on the lamp beneath the display position.

Thus, the following crossover points exist:

B > 1 threshold off, low scale on, no diodes lighted

10 ≤ B < 11 threshold off, low scale on, 10 diodes lighted

11 ≤ B < 20 threshold off, low scale off, 1 diode lighted

110 ≤ B < 110 threshold off, low scale off, 10 diodes lighted

B ≤ 110 threshold on, low scale off, 10 diodes lighted.

**PROGRAM INTERFACES**

**4.13 Traffic Measurements:** The display program relies upon traffic measurement counts for many pieces of data used. Since, in general, the display program accesses these counts at a faster rate than the traffic measurement program, a last-look approach will be used by the display program. When the traffic program clears these counts it will also adjust the display program's last-look values.

One last look counter will be kept for each grouping of counters needed. The groups are:

COUNTER	SECTION USING
Base-level cycle peg	4.03
MF incoming seizure peg	4.04
DP delay dial incoming seizure peg	
DP immediate start incoming seizure peg	
CCIS CR seizure peg	
CCIS origination CR queue abandon peg	
CCIS origination CR queue overflow peg	4.08
DP CR queue peg	
MF origination queue peg	
CCIS origination CR queue peg	
DP CR queue overflow peg	
CCIS CR queue overflow peg	4.10
Disk requests accepted peg	
Disk requests rejected peg	

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Disk high-priority queue peg 4.10  
Disk high-priority queue overflow peg  
Disk low-priority queue peg  
Disk low-priority queue overflow peg

Network occupancy 4.11

Other groups of counts provided by traffic measurements, but not requiring last-look information are:

COUNTER	SECTION USING
DP CP seizure peg MF CR seizure peg CCIS origination CR seizure peg	4.09
CR release peg	4.09

(Sections 4.03, 4.04, 4.08, 4.09, 4.10 and 4.11)

**4.14 Trunk Maintenance:** The trunk maintenance administration program will supply counts of total nonswitched calls and calls not switched due to equipment problems. These are provided for the MCC display only, and therefore will be reset by the MCC display program.

(Sections 4.05 and 4.06)

**4.15 Office Data Assembler:** The office data assembler will supply the expected average busy hour attempts expressed in attempts per minute, and the total number of CRs.

(Sections 4.04 and 4.09)

**4.16 Translation:** The generic unit type and member number translation routine will be used to determine the number of time-slot interchanges in the office.

(Section 4.11)

**4.17 Test Call:** The test call program will maintain a history table of the test calls generated. The table will contain the seizure time for each of the last 16 test calls at least.

(Section 4.07)

**4.18 MCC Alarm Scan:** The MCC alarm scan program will detect the display time-out conditions and produce the system alarm.

**4.19 Phase Recovery:** Phase recovery must reset the display time-out indication before the MCC alarm scan can detect it and provide time for the normal display program to begin cycling by setting the visitation indicator in the MCC.

**4.20 Interrupt Restart:** Interrupt restart must provide more time for the normal display program to be entered before the display times out. This will be accomplished by setting the visitation indicator in the MCC.

## 5. INTERRELATIONSHIPS WITH OTHER WORK CENTERS

**5.01 Variations of Installations:** Where equipment arrangements and frequency of troubles allow, the MOC and TEC work centers may be functionally combined into one work center (MOC).

**5.02** All of the work centers (MOC, TEC, TOC) have activities that can affect the system operation. For this reason it is important that the MAC and NMC maintain proper communications with these work centers and be aware of activity or lack of activity that may affect service.

**5.03** At certain times, such as nights or weekends, the MOC may assume the repair responsibilities of the TEC. When this is done, the alarms from the TEC may be transferred to the MOC.

TABLE B

ABBREVIATIONS AND ACRONYMS

ABBREVIATION	TITLE
BELT	Beltline
BLC	Base Level Cycle
CAMA	Centralized Automatic Message Accounting
CCIS	Common Channel Interoffice Signaling
CR	Call Register
DP	Dial Pulse
EIA	Equipment-Related Difficulties
ESS	Electronic Switching System
ETL	Equipment Test List
I/O	Input/Output
MAC	Machine Administration Center
MCC	Master Control Console
MF	Multifrequency
MOC	Maintenance Operation Center
MTC	Master Test and Control
N	Service Circuit and Traffic Separation Class Occupancy Counts
NBLC	Number of Base Level Cycles
NMC	Network Management Center
NSC	Nonswitched Calls
NTSI	Number of Time Slot Interchanges
Q	The number of calls that enter or overflow the DR CR Queue MF Origination Queue CCIS Origination CR Queue
RCMOC	Recent Change Monitor Channel
RMTI	Remote Terminal Port
RO	Receive Only
SREC	Secondary Record Channel
SYSAD	System Administration
T	Number of Call Attempts in a 60-Second Interval
TEC	Terminal Equipment Center
TOC	Trunk Operation Center
TTY	Teletypewriter