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Los Angeles Police Department
Emergency Command Control Communications System
Program Management Office
Los Angeles, California

LOS ANGELES POLICE DEPARTMENT EMERGENCY COMMAND CONTROL COMMUNICATION SYSTEM (PHASE I, TASK III) VOLUME I: DIGITAL IMPLEMENTATION DESIGN REPORT

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SECTION I

INTRODUCTION

This report is provided as documentation of a design for the Los Angeles Police Department, Emergency Command Control Communications System Project, Phase One, Digital Implementation, Task III.

The basic design is presented in three sections as follows:

(1) Overall Digital System
(2) Mobile Digital Terminal
(3) Base Station Processor

Each section consists of a block diagram showing the major functions to be accomplished and a brief descriptive narrative of each functional block. The design is not limited to current equipment capabilities, but, rather, attempts to provide capabilities and functions which fit the needs of the Los Angeles Police Department.

In addition to the design description, the system requirements, estimated costs, and a brief discussion of the compatibility of the phase one design with the total ECCCS system are presented.

SECTION II

PHASE I DIGITAL SYSTEM REQUIREMENTS

The ECCCS Phase I Mobile Digital System is designed to satisfy, as a minimum, the following requirements.

A. LAPD Requirements

(1) Provide for direct field unit access, via a Mobile Digital Terminal (MDT), to the following data bases:

(a) AWWS - Automated Want/Warrent System.
(b) SVS - Stolen Vehicle System.
(c) DMV - Department of Motor Vehicles.
(d) APS - Automated Property File. (Bicycles only)
(e) NCIC - National Crime Information Center. (Accessed via vehicle license number, vehicle identification number, and/or vehicle engine numbers only)
(f) AWPS - Automated Wanted Person System.

(2) Provide for future capability for direct field unit access, via MDT, to the following data bases:

(a) APS - Automated Property File. (Full access).
(b) AFS - Automated Firearms File.
(c) PATRIC - Pattern Recognition and Information Correlation System.

(3) Complete, via the Mobile Digital System (including radio communication links), internal operations necessary for data base inquiry/response handling within 5 seconds, for 95 percent of all inquiry/response traffic. The 5-second period specified shall not include response time associated with interfacing systems.

(4) Provide for field unit display of warrant abstract data.

(5) Provide for recording, in the field units, of selected data.

(6) Provide for field unit verification that data base responses received are compatible with the inquiry transmitted.

(7) Provide digital communications between field units equipped with MDTs.

(8) Provide digital communications between MDT equipped field units and the Central Dispatch center.

(9) Provide for field unit transmission of the following status information by activation of a single key:

(a) Code 4 - No further assistance needed.

(b) Code 6 - Out for investigation.

(c) Officer needs help.

(d) Officer requests back up.

(e) At scene - Arrival at scene.

(f) Clear - Available for next call.

(10) Provide the following special function keys for field unit operations:

(a) Transmit key.

(b) Acknowledge key.

(c) AWWS/SVS/DMV key.

(d) DMV key.

(e) Print/Record key.

(f) Spare blank key.

(11) Provide for indication to the field unit operator, when the MDT is in a standby mode, that a message for his unit is waiting.

(12) Provide for automatic shut off of the MDT one (1) hour after the ignition is turned off. The MDT shall be automatically placed in a standby mode upon ignition turn-off.

(13) Provide Uniformed Field Supervisors and watch commander units with all capabilities of the standard field units plus the following:

(a) Capability to simultaneously receive digital transmissions of a Code Charles and other selected messages involving field units under his supervision.

(b) Capability to receive a hard copy of digital transmissions to and from field units assigned to his supervision consisting of:

(i) All messages uplink except inquiries to data bases.

(ii) All messages downlink.

(iii) All messages car to car.

(14) Provide the Central Dispatch Center with the capability to exchange digital messages with users of the Mobile Digital System.

(15) Provide the Central Dispatch Center with the capability to receive Code Charles notifications resulting from field unit data base inquiries such that appropriate action may be taken without delay.

(16) Provide the Central Dispatch Center with the capability to receive printouts of selected data base "hits" resulting from field unit inquiries.

(17) Provide for alerting Central Dispatch Center operators of emergency trigger messages.

(18) Provide the Mobile Digital System with the capability of automatically gathering data on data-base inquiries.

(19) Provide for recording, with the feature of timely recall, of all digital transactions at the Central Dispatch Center.

(20) Provide the Area Command Center with the capability to monitor emergency trigger and selected data base "Hit" response messages for field units under area control.

(21) Design the Mobile Digital System to satisfy the CLETS and NCIC requirements for operator identification and control.

(22) Include in the Mobile Digital System a consideration of existing and pending local, state, and federal legislation as it relates to data security and computer system configuration.

(23) Ensure the Digital System equipment shall conform to all applicable FCC regulations governing digital data transmission.

(24) Ensure that the Mobile Digital Terminals shall comply with the following Human and Engineering Factors:

(a) The MDT must be configured to conveniently fit into an already limited space in the radio car.

(b) MDT location must not interfere with an officer who must take evasive action. He must be able to exit from either side of the vehicle.

(c) MDT design and installation shall take into consideration federal and state regulations on placement of air bags, restraint devices, etc.

(d) Mobile equipment must be padded to prevent injury to officers.

(e) MDT equipment must be mounted so as to minimize the risk of it being stolen.

(f) The MDT must be ruggedized and essentially impervious to the introduction of foreign materials, e.g., coffee, dust, etc.

(g) MDT equipment must be easily removed for replacement or repairs.

(h) The officer away from his vehicle must be informed that he has an incoming message. The MDT must have an alerting method (audio and/or visual) with an appropriate volume and/or intensity control knob.

(i) Size and location of keys, switches, lights, etc., on the MDT must not prevent or inhibit the convenient operation of the equipment.

(j) Each MDT equipped vehicle must be able to communicate on all LAPD digital radio frequencies.

(k) The keyboard must include the following:

  (i) Design similarity to the standard typewriter keyboard layout.

  (ii) Full alphanumeric capability.

  (iii) Status keys, provided to meet system requirements.

(l) Officers shall be provided with an easy method of editing outgoing messages.

(m) Each MDT shall be able to interface with teleprinters.

(n) MDTs equipped with teleprinters shall be provided with an easy means of paper replacement.

(o) Teleprinters shall provide for easy readability of the last line printed, exclusive of operator action.

(p) Teleprinters shall be provided with a full-range adjustable intensity light for illumination of data printouts.

B. Requirement Modifications

(1) Paragraphs II. A. 1 and II. A. 2 are not separated in the LAPD requirements of 11-8-74; however, discussions with PMO personnel have indicated that the requirement for data base access in Phase I is as given in the above referenced paragraphs.

(2) Paragraph II. A. 3 is taken to mean electronic cycle time of the Mobile Digital System and does not include human editing requirements (if necessary).

(3) Paragraph II. A. 5 has been modified from the LAPD requirements of 11-8-74 which states: "Receive a hardcopy printout of certain hits and other selected messages." This requirement presupposes a printer in each field unit; however, this is in direct conflict with another statement in the same document which states that printers are not a part of Phase I.

(4) Paragraphs II. A. 9 and II. A. 10 are not separated in the LAPD requirements of 11-8-74; however, for the sake of clarity the status functions have been separated from the control keys in this report.

(5) Paragraphs II. A. 16 through II. A. 20 are not specified as Phase I requirements in the 11-8-74 document; however, it has been assumed that these functions are required for Phase I.

SECTION III

PHASE I OVERALL DIGITAL SYSTEM

A block diagram of the Phase I Digital System is shown in Fig. 1. The system is composed of the following major subsystems:

(1) Mobile Digital Terminals (MDT)
(2) Receiver/Transmitter Stations
(3) Base Station Processor
(4) Dispatch Center Display and Control
(5) Area Headquarters Display.

A. MDTs

For Phase I up to 180 Mobile Digital Terminals, with full alphanumeric capability, are to be installed in LAPD Central Bureau vehicles. The MDTs will be capable of direct digital inquiry of both local and remote data bases. In addition, each MDT will be equipped to transmit fixed format messages by activation of a single pushbutton (key) corresponding to the message to be sent. Each terminal shall be capable of communicating with any other terminal via relay through the base station. Supervisory vehicles will be equipped with hard copy printers in addition to a digital terminal. Patrol units will be equipped with cassette recorders for message retention. The MDTs will be operated in conjunction with digital, dedicated, half-duplex radio links.

The units shall be operated in a contention mode on a single UHF channel. In addition, all units will have the capability of operating in a polling mode upon command from the Base Station. Each unit will be uniquely identified by a preassigned code entered at operator shift sign-on. Messages will be displayed only by command of the unit operator. An indicator on the MDT will be used to notify the operator of a waiting message.

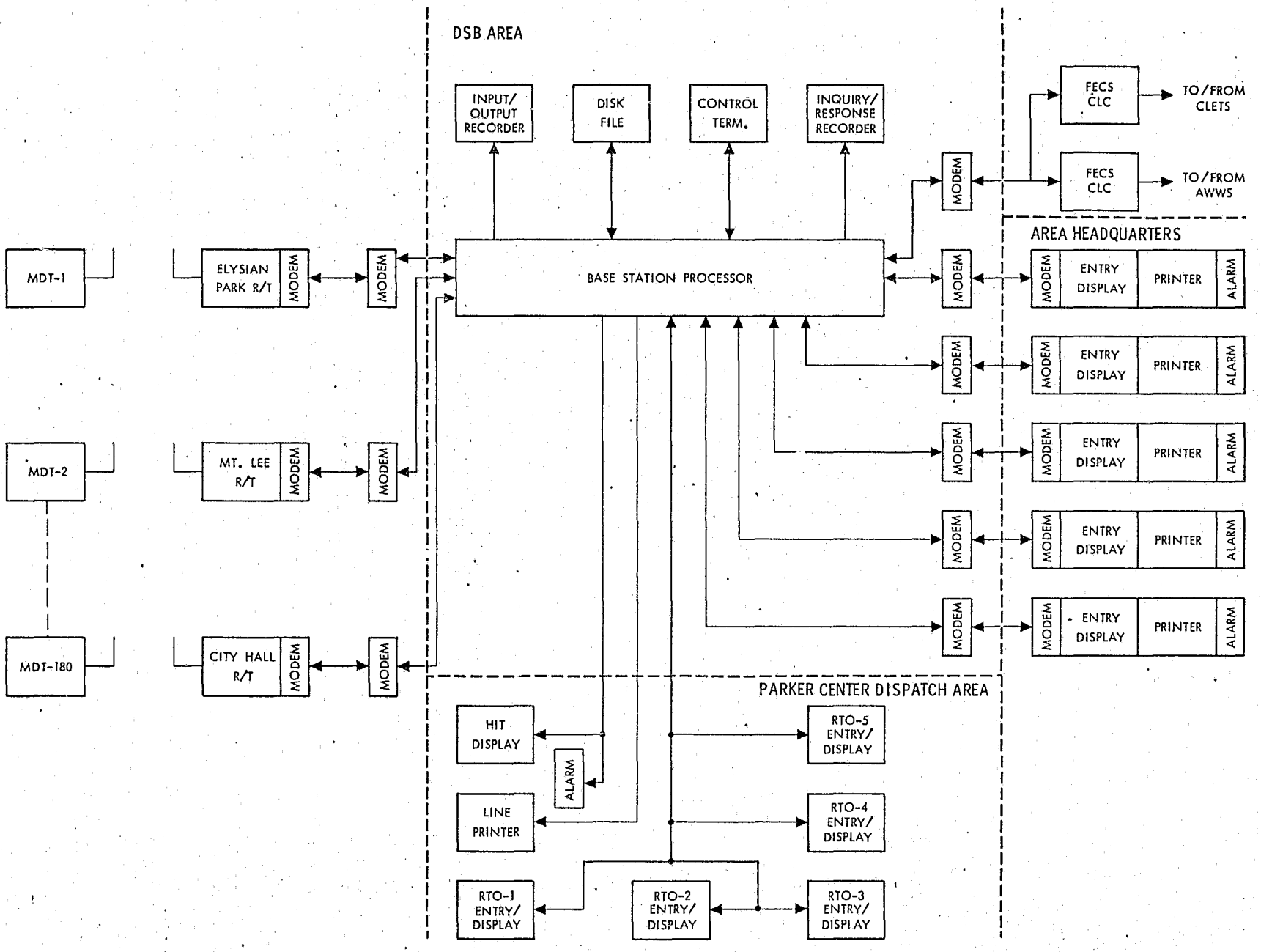

Fig. 1. Phase I Digital System Block Diagram

Data bases to be accessed by the MDTs (Phase I) are:

(1) Automated Want/Warrant System (AWWS)
(2) Stolen Vehicle System (SVS)
(3) Department of Motor Vehicles (DMV)
(4) Automated Property File (APS) Bicycles only
(5) Automated Wanted Persons System (AWPS)
(6) National Crime Information Center (NCIC).

B. Receiver/Transmitter Sites

Transmissions to the MDTs will be accomplished through three transmitter sites (Mt. Lee, Elysian Park, and City Hall) - see Fig. 2. The transmission will be controlled by the Base Station Processor, based upon the most likely location of the unit(s) to which the communication is directed. Data from the three receiver sites will be brought to individual input buffers where it will be parity-checked for errors. Error messages will be corrected to the extent possible by the base station processor.

C. Terminal Control Unit

The Terminal Control Unit (TCU) is the heart of the digital system. This unit provides for control, data routing, data processing, and storage. Data base interfacing, formating, error control, and editing are performed by this unit. Dispatch area displays, alarms, and printers are driven directly from the TCU.

D. Parker Center Dispatch Area Display and Control

Displays and data entry terminals will be provided at each Central Bureau RTO position (Central, Newton, Rampart, Northeast, and Hollenbeck). A Code C Hit Display and alarm (audio and visual) will be positioned for the dispatcher.

The Line Printer will provide a hard-copy capability for hits and, upon demand, file data. The printer should be positioned for dispatcher access which may require a modification of the closed end of the current horseshoe.

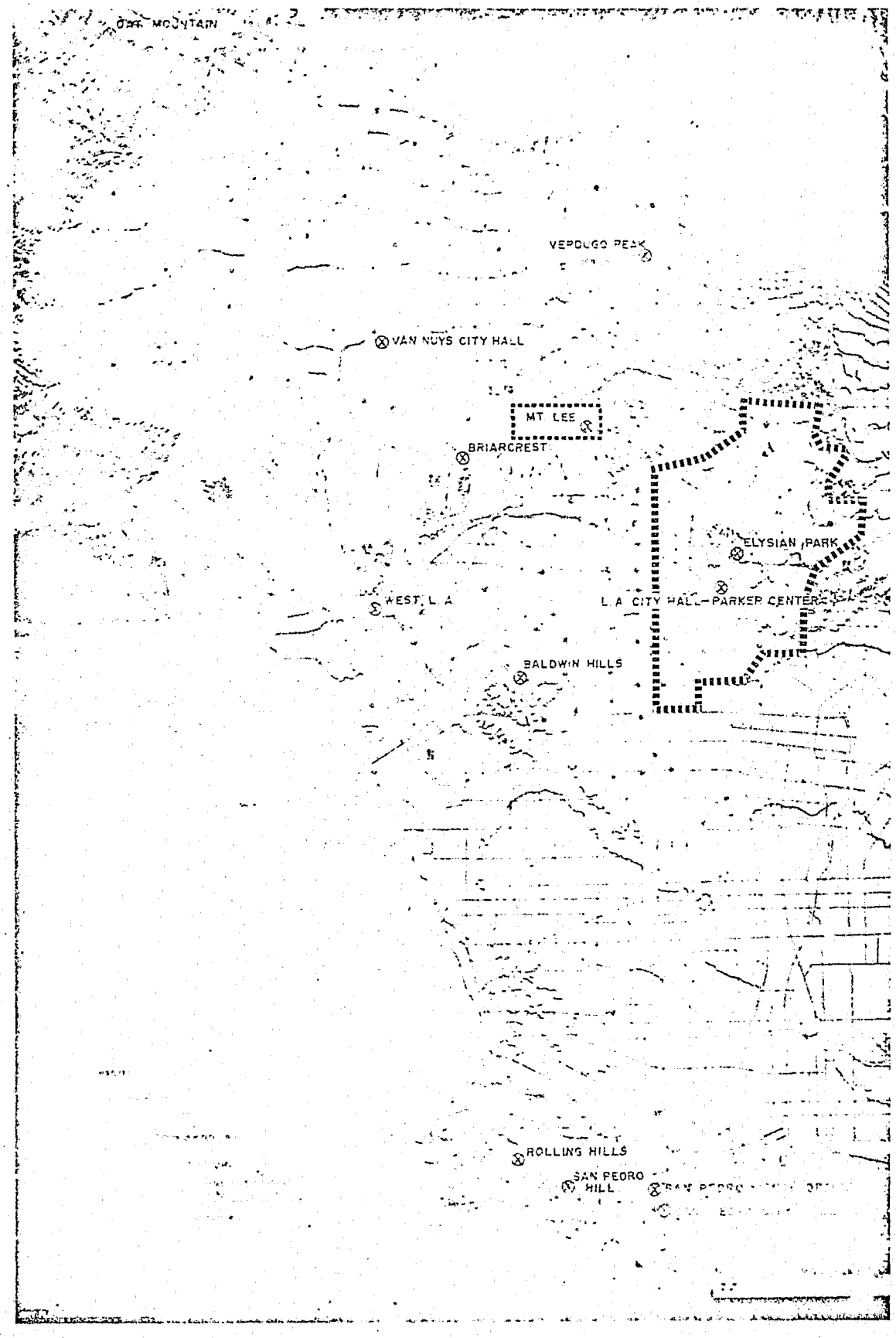

Fig. 2. Transmitter Sites in Los Angeles

E. Base Station Processor

The base station processor will provide all required data storage, routing, logging, formatting and correlation. In addition, the processor will drive all Parker Center and Area Headquarters display and alarm devices. A disk memory cartridge will be utilized in conjunction with the processor for long-term data storage.

The Base Station Processor, data recorders, and a control terminal should be located in the Data Services Bureau Area of City Hall East.

F. Area Headquarters Display

Each Area Headquarters within the Central Bureau will be provided with a data entry and display terminal plus a printer for hard copy. Code C "hit data" will be displayed and printed automatically at the Area Headquarters concerned.

SECTION IV

MOBILE DIGITAL TERMINAL (MDT)

A. Address Detector

The address detector provides control over the data transmissions which the individual MDT (Fig. 3) will recognize. Each unit should accept transmissions coded to its unique address, the Team, the Area, and the Bureau of which it is a member. Address codes must be field adjustable to provide for temporary reassignments between Bureaus, Areas, and Teams. At shift "sign-on", the MDT is initialized and the operator enters a pre-assigned unique address code for transmission to the base computer. This code is then utilized by the base processor for addressing the unit. Minimum MDT address coding capability should be flexible enough to allow for uniquely addressing:

(1) 7-field units per team
(2) 7 teams per area
(3) 15 areas per bureau
(4) 7 bureaus
(5) 7 multiple-address combinations per bureau.

B. Error Detector/Corrector

This unit checks all incoming data for errors and corrects errors within its capability. Detected, but uncorrected, errors are replaced in the data stream by a standard recognizable error character. The error character may be any symbol other than an asterisk, a numeral, or an alpha character. Messages containing uncorrected errors of greater than 5% total message characters are rejected. All other messages are forwarded for processing.

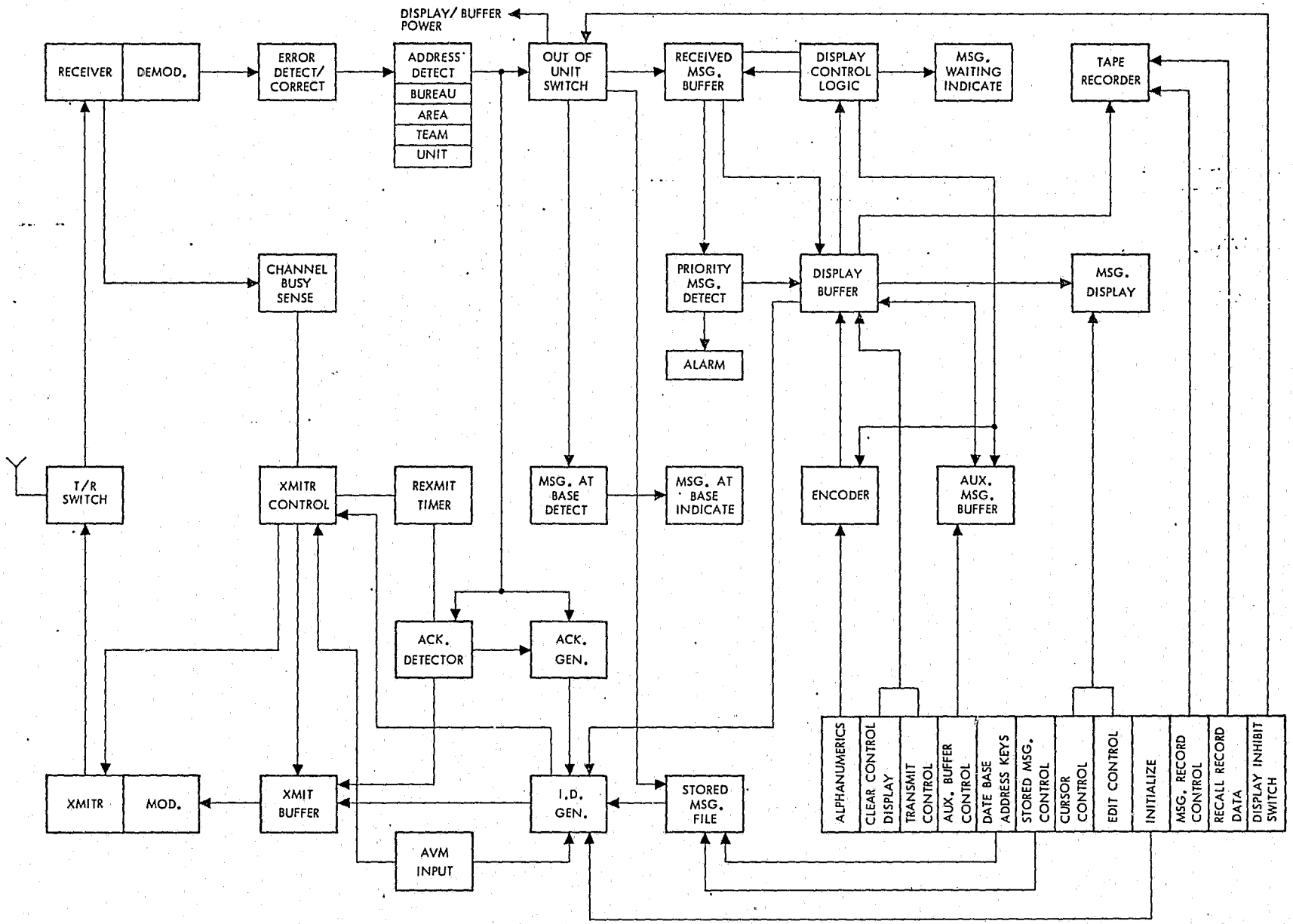

Fig. 3. ECCCS Phase I MDT Functional Block Diagram

C. "ACK" Generator

Data accepted through error and address checks initiate a signal to the message received "acknowledge" generator. The "acknowledge" unit outputs a signal to the unit identification generator and a control signal to the transmitter control unit. No "acknowledge" signal is to be transmitted for multiple-addressed messages above the team level. Messages transmitted to a given field unit with "information only" addressing to other units will be acknowledged by only the primary unit.

D. "ACK" Detector

If the received message is a base station acknowledgement to a previous mobile unit transmission, the "acknowledge" detector provides an inhibit signal to the "ACK" generator and the retransmit timer. In addition, a clear signal is sent to the transmit buffer.

E. Out-of-Unit Control

To prevent display of messages when the officer(s) are out-of-unit, or in a situation which makes it desirable to inhibit the observation of data by others, the MDT shall have a "DISPLAY INHIBIT" switch. The "DISPLAY INHIBIT" control automatically transmits a message to the base to inhibit transmission of all messages except for a "message at base" signal. When the "message at base signal" is received by the MDT, the data is by-passed to a special instruction unit which controls a visual and/or audio indicator which tells the officer that a message is waiting at the base. When the officer is ready to receive messages, he will deactivate the "DISPLAY INHIBIT" switch which will automatically notify the base station to forward pending messages. The "DISPLAY INHIBIT" shall disengage only the display functions.

F. Message at Base Detector

This unit is activated whenever the officer(s) activate the "DISPLAY INHIBIT" switch. Its purpose is to detect a special instruction from the base that a message is being held at the base and to control a visual and/or audio indicator.

G. Receive Message Buffer

All messages addressed to the unit, except when under the out-of-car constraint, are applied to the received message buffer. This buffer provides storage for incoming data when the display buffer is in use (either displaying previously received data or composed data). Upon receipt of a display buffer empty signal from the display control logic, the received message buffer forwards the data to the display buffer. This unit shall have the capability to accept a minimum of 400 characters.

H. Priority Detector

Data in the received message buffer is examined by the priority detector for preselected classification code bits. If predetermined priority bits are present, the priority detector instructs the display buffer to "clear" to the auxiliary buffer. The priority message is then displayed and recorded. The detector will energize an audible and visual alarm upon receipt of a priority message.

I. Display Control Logic

This unit senses the condition of the display buffer and, based upon its status (empty or in-use), provides control signals to the received message buffer and the message waiting indicator. If the display buffer is "in-use", the received message buffer is instructed to hold the incoming data and the message waiting indicator is activated.

J. Message Waiting Indicator

Provide officer with indication that incoming data is in storage and waiting to be displayed. It is desirable that this indicator be a small lamp which is flickered when activated.

K. Display Buffer

This unit contains the data actually being displayed at any given moment. The displayed data may be information to be transmitted or received messages from an external source. The unit shall have the capacity to handle a minimum

of 400 characters. Capability shall also exist to page the stored data either forward or reverse, to the display unit in 128-character blocks. A priority message signal from the received message priority detector causes the display buffer to shift its current data into the auxiliary message buffer. At the operator's option, the contents of the display buffer can be forwarded to the recorder for permanent retention or cleared from memory. For composition, the display buffer must be cleared prior to entering a message.

L. Auxiliary Message Buffer

This unit provides auxiliary temporary storage capacity so that "working" data (either composition or a previously received message) can be removed from the display buffer. Data in the auxiliary message buffer can be recalled at will by the operator provided the display buffer is clear. A 400-character storage capacity is required.

M. Message Print or Record Control

This unit provides a print/record command to the display buffer to dump its contents to the printer or recorder, it is activated by the operator or message instruction bits from the base. Operator control is from the MDT keyboard.

N. Clear Display Control

This unit provides a command to the display buffer to clear all current data; it is activated by the operator from the MDT keyboard.

O. Tape Recorder

A tape recorder (cassette, with playback capability) should be provided for permanent record keeping of message transactions. Both transmitted and received data may be logged. The tape would be played into a printer (at high speed) at end-of-shift for a permanent hard copy record to assist officer report generation. Supervisor units should be equipped with hard copy printout devices. This will allow the supervisor an immediate permanent record of transactions affecting units under his control.

P. Encoder

This unit translates the alphanumeric keys into the proper information bits and forwards the data to the display buffer for presentation. The encoder output is controlled by the display control logic to prevent inadvertent "write-overs" of previously displayed information.

Q. Alphanumerics

This unit provides the operator entry and control interface to the MDT; it contains all alphanumeric (26 letter plus 10 numeric), status, edit, and control function keys. Keys should be non-reflective, spaced for ease of operation, and grouped logically for use. The keyboard should be provided with non-glare illumination for night use. The illumination level shall be field adjustable. The keyboard should contain, as a minimum, the following control capability:

(1) CLEAR DISPLAY CONTROL - Provides the capability to clear the display and display buffer of currently held data. Once cleared, this data is lost.

(2) AUXILIARY BUFFER CONTROL - Provides the capability to exchange all data in the display buffer with the auxiliary buffer.

(3) RECORD CONTROL - Provides the capability to record all data in the display buffer. This control shall not clear the display buffer.

(4) RECALL RECORD CONTROL - Provides the capability to play back recorded data to the display buffer.

(5) PAGE CONTROL - Provides the capability to page 128-character blocks to the display. Should operate in either forward or reverse paging.

(6) CURSOR AND EDIT CONTROLS - Provides the capability to edit messages prior to transmission. The cursor should provide the operator with positive indication of the entry working position.

(7) DISPLAY INHIBIT SWITCH - Provides for message display control. When activated this control prevents message display on the MDT

screen and automatically notifies the base processor of the existing condition. Upon deactivation, the control notifies the base station that the MDT is ready to accept data.

(8) INITIALIZE CONTROL - Provides the capability to initialize the MDT address circuitry in preparation for entering the next working address.

(9) CANNED MESSAGE CONTROLS - Provides for transmission of standard commonly used messages by activation of a single key corresponding to the desired message. Engagement of any key causes automatic transmission of the associated message. Canned Message Controls are:

(a) CODE 4

(b) CODE 6

(c) CODE 7

(d) CLEAR

(e) AT SCENE

(f) ACKNOWLEDGE - This is a manual acknowledge that the base message is on display and is in addition to any automatic electronic acknowledge.

(g) CLEAR RESPONSE - This is required to notify the base processor that the field unit has sufficient response data and that the processor may clear its file. This control automatically transmits the response file number.

(h) FORWARD NEXT BLOCK - This key transmits a signal to the base processor, including the response file number, that the field unit is ready for the next 400-character block of a long response message.

(i) OFFICER NEEDS BACK UP

(j) OFFICER NEEDS HELP - This key should be oversized and distinctively colored for easy identification. The key should be protected against accidental activation; however this protection shall not impede intended operation.

Transmission of stored messages shall not cause any interference to the contents of the display buffer. Keys 9a through 9e and keys 9i and 9j shall be illuminated when active. Keys 9a through 9e shall be interlocked so that no two can be engaged simultaneously. Key 9f shall be utilized in conjunction with the received message buffer in that it will pull data from the received message buffer and automatically transmit a "message displayed" acknowledge to the base station as positive indication that the officer has received the information.

(10) TRANSMIT CONTROL - This control initiates the transmission sequence for all transmissions other than those controlled by the CANNED MESSAGE KEYS.

(11) ADDRESS KEYS - A set of two keys which when activated automatically address the composed data to the most commonly queried data bases. In addition, each key will cause the proper format to be displayed for data entry:

(a) DMV Inquiry

(b) AWWS/SVS/DMV Inquiry

R. Display

This unit is a visual alphanumeric display device (non-CRT) which provides officer read-out of the ditigal transactions. The unit should be capable of simultaneous display of 128 characters. The unit should minimize "wash-out" effects of direct sunlight. The unit should, also, minimize the effect of reflected light during night operation (including the keyboard illuminator).

S. Stored Message Memory

This unit provides standard, commonly used message storage. When signaled from any one of the canned message control keys, the unit selects and forwards from memory the corresponding message.

T. I. D. Generator

This unit provides for automatic unit (terminal and P. U. #) identification for every message transmitted by the MDT. The contents of this unit will be included with each MDT transmission. The specific I. D. will be entered each time the unit becomes active. See Address detector.

U. Transmit Buffer

Upon activation of a transmit function, the data to be transmitted is forwarded to the transmit buffer. The primary function of this unit is to provide transmit cycle storage independent of the display buffer. This capability releases the display buffer for incoming data or additional composition during the transmit cycle. The transmit buffer is cleared upon detection of an acknowledge message or by activation of a terminal transmit clear key. If the normal retransmit cycle has been completed without acknowledgement, a signal will be generated informing the officer of this condition. This unit shall have the capability of storing a minimum of 128 characters.

V. Retransmit Timer

This function provides for an automatic retransmission of messages. Upon first transmission of a message, the retransmit timer is initiated. At the end of a pre-determined count period, the timer re-initiates the original transmission. The number of retransmissions is pre-set. Five (5) repeats appears to be a reasonable number. Receipt of an acknowledge signal from the base inhibits further transmissions.

W. Channel Sense

To prohibit simultaneous MDT transmissions, each unit contains a channel busy detector, which senses the presence of a busy signal on the downlink carrier. This busy signal is transmitted by the base whenever it is receiving an MDT transmission. Presence of the channel busy signal inhibits the MDT transmitter control, if it is sensed prior to transmit initiation.

X. Transmitter Control

This unit provides for transmitter warm up prior to the application of modulation. The period of delay should be continuously variable from 0 to 500 milliseconds with capability for field adjustment. The presence of a channel busy signal shall inhibit the transmitter ON signal for its duration. In addition, this unit shall limit the duration of continuous transmitter ON time to one (1) minute. If a channel busy signal has occurred, the control unit shall upon loss of the busy indication initiate a random time out prior to application of the transmitter power to the antenna port. If a second busy signal is detected prior to completion of the random count sequence, the count will be held for the busy duration and then be resumed from its pre-busy count point.

Y. AVM Receiver

This unit provides for acceptance of an AVM bit stream to be relayed through the MDT. As data is received from the AVM system, it is clocked into the MDT message format and transmitted to the base. The unit shall be capable of accepting a 64-bit word from the AVM receiver. Upon request for AVM information from the base station processor, the MDT will automatically recognize the message and initiate a transmission of available AVM data.

SECTION V

BASE STATION TERMINAL CONTROL UNIT

A. Received Message Buffer

Received message buffers (one for each satellite receiver) provide for best message selection capability (replaces receiver voting). As messages are received at the satellite receivers (Fig. 4), the data is demodulated and sent to the received message buffers where it is held for examination. The buffer performs end-of-message detection and provides for parity checking of messages. Upon receiving a message the buffer transmits "data ready" and "parity check" signals to the base station processor. Storage capacity of the buffer should be compatible with two (2) 128-character messages as transmitted from the Mobile Digital Terminals of the field units. Note: The capacity must be sufficient to account for address, i.d., instruction status, and AVM characters which may be present in each message.

B. Input Message File

A "data ready" signal from the received message buffers causes the base station processor to transfer the incoming data, either on a cycle stealing or an interrupt basis, to the Input Message File (Processor core). This area will have the same minimum capacity as the received message buffer. The "parity check" signal from the Received Message Buffer will instruct the base processor as to which input subroutine the data is to be subjected to. Data in the Received Message Buffers will be transferred into file on priority based upon parity validation (i.e., should invalid parity be indicated from any Received message buffer(s), that data will be given low priority relative to valid parity data in one of the other buffers). When the base processor has accepted a valid message from one of the Received Message Buffers (i.e., either valid parity or a correctable message), that message will be cleared from all units. All data input to the Input Message File will be time tagged to the nearest minute.

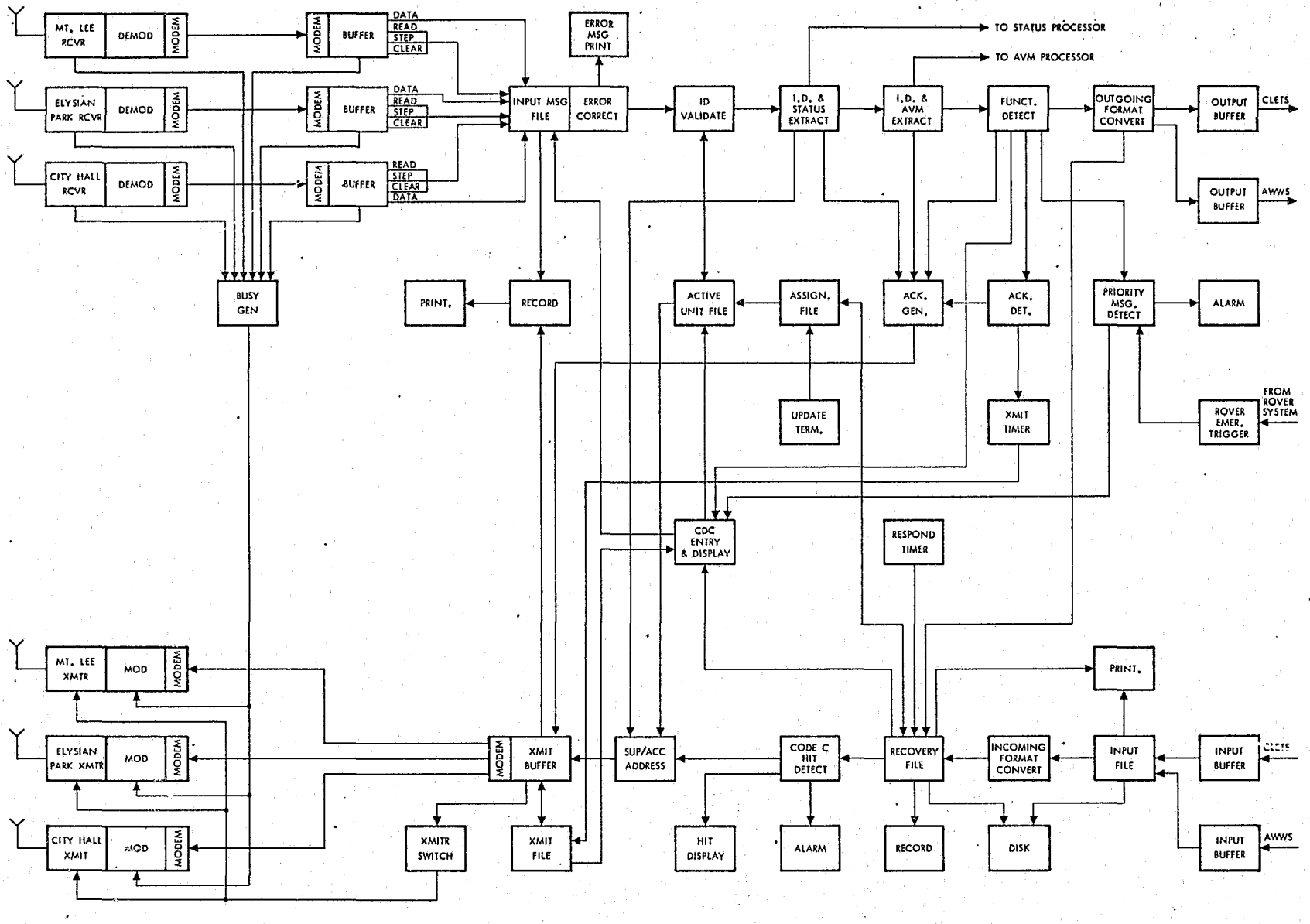

Fig. 4. Base Station Terminal Control Unit Block Diagram

C. Error Correct

If the input data is error free, it is forwarded for processing; if not, it is subjected to an error correcting routine (details of which will depend on the system implemented). A correctable message is corrected and handled as any error free message. An uncorrectable message will not be forwarded but will be dumped to a printe. for manual processing.

D. Recorder Input/Output

This unit provides the capability of storage of all received and transmitted MDT data for playback and historic purposes. Playback would be to a printer. This unit shall have the capacity to record all received/transmitted digital data for a minimum period of 24 hours. The recorder shall be configured such that data may be played back without loss of incoming information. Minimum storage capacity will be 115 Megabits. Maximum input data rate will be 2400 bps.

E. I.D. Validate

Messages accepted by the Error Detect/Correct unit are passed to the I.D. Validate processor where the message source identification is checked against the Active Unit File. If the source identification is not verified, the message is acknowledged; however, the message is not processed other than as an information message to an RTO position.

F. Assignment File

This function provides the processor with the data required for I.D. Validation, Patrol Unit Number, Unit Addressing, Supervisor and Area Headquarters correlation, and Mobile-to-Mobile communication routing. All units on Active duty at any given time are maintained in this file. Sign-on transmissions are verified against this file. In addition, the active units are correlated within the file to their respective field supervisors and area headquarters. The file is to be updated from area headquarters information at the start of each shift. The file may be updated at any time units become active by RTO notification.

G. Active Unit File

The function of this file is to minimize the base processor search time required for message validation. The Active Unit File is derived from the Assignment File upon field unit sign-on. As a field unit signs-on for its duty shift, its initial transmission is checked against the Assignment File and, if verified, a code bit, correlated to the unit identification number, is set in the active unit file. All subsequent transmissions from the field unit are verified against the code bit.

H. "ACK" Generator

Once the message source has been validated, the data is "officially" accepted into the system. At this point, a signal is sent to the ACK Generator to initiate an acknowledgement message to the sending source. Acknowledge messages are transmitted automatically.

I. "ACK" Detector

If the incoming message is an electronic acknowledgement from a mobile unit to a previously transmitted base message, it is detected in this unit. Upon detection of an acknowledgement, inhibit signals are sent to the "ACK" Generator and the transmit timer.

J. Priority Message Detector

Emergency "canned" messages from the field units will be detected and immediately activate emergency alarms within the dispatch area (visual and audible). In addition, the appropriate RTO status display will be alarmed. Supervisor and ACC of the unit originating the Emergency message will be automatically notified by the base station controller of the existing condition.

K. Rover Emergency Trigger

A digitized signal will be accepted through the base processor from the ROVER system. This signal will be error checked, decoded, and displayed in the same manner as the mobile unit emergency signal.

L. I.D. and Status Extract

All incoming messages from the mobile units will contain the latest mobile status. The mobile unit identification and status will be extracted and forwarded to the unit field supervisor and an output port which will, in future implementation phases, interface to a separate status processor.

M. I.D. and AVM Extract

All incoming messages from the mobile units may contain the latest mobile unit location information (assuming that automatic vehicle location is implemented in a future phase of ECCCS). The base processor should be capable of stripping this data and routing the information to an interface port.

N. Function Detect

The next function to be performed is determination of the routing and handling of each incoming message. The basic Phase I message types are:

(1) Sign ON/OFF messages
(2) Data Base Inquiry
(3) Emergency Trigger
(4) Test Pattern
(5) Free Form to RTO
(6) Car-to-car
(7) Time Request
(8) Manual Acknowledge
(9) MDT Electronic acknowledge
(10) Data base response paging
(11) Data base response File Clear.

ECCCS Future

(1) Status messages
(2) CAD messages (response to)
(3) AVM messages.

Each message is routed to a subroutine in the base processor. Sign ON/OFF messages are verified against an assignment file entered into the

base processor at the start of each shift. Data Base Inquiries are routed to individual subroutines for data base addressing and format conversion. The subroutine selected will be dependent upon the type of inquiry and the data base to be queried. Emergency Trigger messages (Officer needs help) are routed a priority message routine and the RTO display. Test pattern requests are routed to a test routine which transmits a known message to the MDT for verification of terminal operation. Free form messages are forwarded directly to the RTO display. Car-to-car messages are verified against the daily assignment file to verify that the unit addressed is on-net and retransmitted. The Time request routine generates an automatic time check to the requesting unit. Manual acknowledge messages are routed to the RTO from the input file.

When the field unit has examined the first 350-character block of data and determined that additional information is desirable, it initiates a "FORWARD NEXT BLOCK" message to the base processor. Upon receipt of this message, the processor extracts from a disk and processes the next 350-character block. When the field unit has sufficient data, it initiates a "CLEAR RESPONSE" signal which causes the disk to dump the remaining data. A time-out feature would be associated with response data placed in disk to preclude data accumulation beyond 15 minutes. Upon time out, a notice will be given to the appropriate RTO that data is holding. The RTO may initiate another 15 minute hold period or clear the data as desired by the field unit.

O. Outgoing Format Convert

This unit provides the format conversion required between the Phase One data processor and the addressed data base. It will have the capability to convert inquiry messages to the formats required by the following data bases:

(1) Automated Want/Warrant System (AWWS)
(2) Stolen Vehicle System (SVS)
(3) Automated Property File (APS) (Bicycles only.)
(4) Department of Motor Vehicles (DMV)
(5) Automated Firearms File (AFS)
(6) Automated Wanted Persons System (AWPS)
(7) National Crime Information Center (NCIC)
(8) Patern Recognition and Information Correlation System (PATRIC).

Access of data bases 5, 7, and 8 are not required for Phase I; however, hardware and software of the Phase I system must be compatible with future access requirements for these files. Minimum input information required for data base access shall be as follows:

	Input Information	Possible Data Bases Accessed
(1)	License Plate	SVS; DMV-VR; NCIC; AWWS
(2)	Vehicle I. D. Number	SVS; DMV-VR; NCIC
(3)	Engine Number	SVS; DMV-VR; NCIC
(4)	Name (Veh.)	DMV-DL; DMV-VR; DMV-ANI
(5)	Drivers License	DMV-DL
(6)	Bicycle Serial Number	APS
(7)	Name (Suspect)	WPS; NCIC; AWWS

The format conversion subroutines shall verify that the minimum input information required for a given data base inquiry is present in the field unit request prior to the format conversion step. If the required information is not present, an error message will be generated and transmitted to the originating mobile unit.

P. Output Buffer

This unit provides temporary data-base inquiry storage until the data-base computer is ready to accept the message. The output buffer must have the capacity to store a minimum of 256 characters. A buffer is required for each data base output line.

Q. Input Buffer

This unit provides temporary data base response storage until the base processor can input the data. The buffer performs serial-to-parallel data conversion, parity error checking, and provides a message-ready signal to the base processor. Buffer capacity shall be a minimum of 1500 characters. A buffer is required for each data base input line.

R. Input File

A 'data ready' signal from the Input Buffer causes the base processor to transfer the incoming data, on a cycle stealing basis, to the response input file. This file should have a capacity of 4500 16-bit words. The "message type" field of the incoming message is examined to determine processing requirements. Only responses to data base inquiries will be processed; administrative and error type messages will be routed to a printer.

Once it has been determined that a message is to be processed, the first 350 characters of the message are taken from file for conversion. The balance of the message is transferred to disk memory for temporary storage. 'Data Base Response Paging' and 'Data Base Response File Clear' are special purpose messages between the MDT and the base processor required for handling long (>400 characters) data-base response messages. The paging signal indicates that the field unit is ready for the next 400-character block to be sent, while the clear signal indicates sufficient information has been received and the balance of the response should be dumped.

S. Incoming Format Convert

This unit performs the necessary data conversion to translate the data-base format to the base station processor format. The unit examines the data base identification field, selects the appropriate conversion subroutine, and translates the response message on a character-by-character basis. Converted data is forwarded to the recovery file.

T. Recovery File

The Recovery File is utilized for temporary storage of inquiries while awaiting data base responses. The original inquiry, containing the field unit identification number and patrol unit number, plus an inquiry message number are routed to this file from the outgoing format conversion subroutines. In addition, when an inquiry is entered into file a counter is set indicating the number of data bases expected to respond and a response timer is initiated. The response timer is set for three (3) minutes.

As responses are received from the incoming format converter, their message numbers (turned around by the data base) are compared against the contents of the message recovery file for match. If a match is found, the response counter is decremented and processing continues. If no match is available, the message is discarded as a late response. Matched messages are next checked for message length to determine if the response is a hit. If the response is determined to be a 'Hit', the originating field unit identification number, patrol unit number, and inquiry keywords are moved to a scratchpad for integration with the response text. The message is composed and forwarded for transmission. 'No Hit' responses are checked for data base code. If the negative response was from SVS, a 'No Hit' message is immediately composed and transmitted (includes all 'no hit' data in file in addition to the SVS data). If the 'No Hit' response was other than SVS, the expected response counter is checked. Should the count equal zero, all 'No Hit' messages in file are transmitted and the inquiry plus its associated responses are transferred to the 3-hour disk file. If the response counter does not equal zero, the 'No-Hit' message is held in file pending further expected responses or file time expiration. Recovery File time out causes all response data in file to be transmitted and initiates a message (including the original inquiry) to the RTO indicating the missing response(s).

U. Data Base Response Timer

Inquiry messages arriving at the Recovery File initiates a pre-set time out sequence. If an inquiry response is not detected during the timing period, a "flag" is raised on the appropriate RTO monitor so that other action may be taken. If a response arrives after the time out period has expired but the message file has not been cleared, the message is processed in a normal manner. If the RTO has cleared the inquiry from the message file and/or reinitiated the message (new message number), the late arriving response is discarded. The time-out period will be set at three (3) minutes maximum.

V. Code 'C' Hit Detector

The function of the Code 'C' Hit Detector is to examine the response message for indicators that the information from the data base represents a potential dangerous 'Hit'. The first field after the message header of AWWS, SVS, WPS, and NCIC responses will contain a caution indicator which will be detected by this unit. When a caution indicator is detected, the response will be recorded on tape and printed out on hard copy for the dispatcher. In addition, and audible/visual alarm will be activated. Detection of a 'Code C Hit' will cause a priority bit to be inserted in the message for the field unit.

W. Hit Display

All Code 'C' messages will be routed to a hard copy printer located in the Central Dispatch area. This unit will be positioned for easy dispatcher access.

X. Supervisor/ACC Address

Code C 'Hit' messages are multi-addressed to the field unit supervisor and the proper Area Headquarters in this unit. This is accomplished by examining the originating unit identification number and inserting the appropriate bits into the address field.

Y. Transmit Buffer and Transmit File

The Transmit Buffer provides temporary storage for outgoing messages and transmitter control signals. As messages are clocked into this unit, signals are generated which control the Transmit switcher, appropriate transmitter, and the Transmit Timer. Messages are transmitted on a first-in, first-out basis with the exception of Code 'C' Hit data and officer NEEDS HELP data, both of which are given priority over all other transmissions. Upon completion of the first transmission, messages are transferred to the Transmitted File pending receipt of the electronic acknowledge signal from the addressed unit. If the addressed unit has not acknowledged the transmission within 5 seconds, the message is retransmitted. The transmit cycle will be repeated 5 times (the time between transmissions and the number of transmit cycles are dependent on the actual system procured) unless an acknowledge signal is received from

the mobile unit. Messages not acknowledged after completion of the 5th transmission cycle are transferred to the RTO display for appropriate action. Multi-addressed messages above the Team level (i.e., Bureau, Area) will be broadcast three (3) times automatically and will not require and acknowledge signal. Messages addressed to a specific unit or units with 'information-only' to other units will require acknowledge messages from the specific units addressed.

Z. Transmitter Switch

When a message is to be transmitted, the transmit switch will examine the address field to determine the units 'most likely transmitter' and close a contact to the appropriate transmitter.

AA. Transmit Timer

The Transmit Timer is initiated whenever a message is clocked into the Transmitted Buffer. The unit counts down a pre-set time period. If an acknowledge signal has not been received at the end of the predetermined time period, the Transmit Buffer is signaled to retransmit. The number of automatic retransmissions is pre-set. Receipt of an acknowledge signal from the unit addressed inhibits the timer and causes the Transmit Buffer to clear the message involved.

BB. Busy Generator

The Busy Generator is required to indicate to the field units that the channel is busy. The generator will sense the presence of carrier in any or all of the base receivers. In addition, the status of the input buffers will be sensed. If the buffers are full and/or a carrier has been detected in the receivers, a busy signal will be generated and transmitted to all field units to inhibit (automatically) the start of any transmission until the busy condition has cleared. The busy signal may be either a tone (inserted at the high end of the channel bandwidth) or a digital word transmitted during the busy uplink period. If the busy signal is a digital word, it will be appropriately inserted in all downlink transmissions which occur during uplink message transmissions.

CC. CDC Entry and Display

This unit is a full alphanumeric keyboard and CRT display device located at each Central Bureau RTO position. This unit shall have full capability to perform the following:

(1) Enter inquiry messages.
(2) Enter base-to-mobile messages.
(3) Enter the active unit file for updating.
(4) Enter Disk time-out extensions.
(5) Display mobile-to-base messages.
(6) Display Code 'C' Hit responses.
(7) Display time-out data from the recovery file.
(8) Display unacknowledged message transmissions.
(9) Display RTO initiated inquiry response messages.

DD. Disk Storage

A disk storage unit will be required for temporary data storage. Primary data to be s tored will be data base responses of greater than 350 characters in length and the most recent three (3) hours of data base inquiry/response transactions. Long message data base response messages will be stored for a period of 15 minutes to allow for field unit paging. At the end of the 15 minute period, the RTO will be notified that data has not been cleared. The RTO will then have a two-minute period prior to automatic data discard, to determine if the data should be retained. If the data is to be retained, the RTO will update the file timer to allow an additional 10 minutes. The 3-hour file will be a fixed memory block sized to the average expected traffic level. When the file is full, most recent data will 'write-over' the oldest data.

SECTION VI

PHASE I DIGITAL SYSTEM COMPATIBILITY WITH FINAL ECCCS DESIGN

The Phase I Digital System design is basically compatible with the final ECCCS design. The hardware for Phase I appears to be applicable in two areas of the ECCCS design irrespective of whether the overall system is a centralized or distributed data processing configuration.

The equipment may be used as either a MDT controller at Mt. Lee or as a Mobile Command Center processor. As a controller at Mt. Lee, the software package will require complete modification. As a Mobile Command Center processor, the hardware and software can be used essentially intact.

Some additional software capability will be needed to handle status keeping and AVM (if implemented) requirements. Also, the final ECCCS processing system will require an interface compatible with MCC inquiry/response capability of the Phase I equipment.

APPENDICES

APPENDIX A

POLLING VS CONTENTION

To determine whether the LAPD mobile digital system should operate in a polling or contention mode, an analysis was performed at JPL.* The purpose of the analysis was to investigate the relative officer access delays to the communication network in the two modes of operation. Figures A-1, A-2, and A-3 are plots of the resultant equations for various sets of parameters. The graphs show the relative delays to be expected in either a contention or a polling system under given conditions. The parameters utilized are:

(1) $\overline{M}$ = Average digital message length.
(2) $\overline{T}$ = Average time between message originations per unit.
(3) Δ = Roundtrip polling time (Polling system only).
(4) $\overline{\Delta}_c$ = Average MDT random delay period (Contention system only).
(5) R = Data transmission rate (transmission characters per second).
(6) N = Number of field units assigned to a given channel.
(7) $\overline{D}$ = Average unit access delay to the communication channel.
(8) $U = N\,\overline{M}/\overline{T}$ = Communication channel utilization level.

Curve comparison is in numerical pairs...i.e., curve (2) is the contention case of curve (1); curve (4) is the contention case of curve (3); etc.

The data indicates that for utilization levels of up to 0.35 (desirable LAPD average network utilization design goal) the contention system provides an advantage in field unit access delay over the aperiodic polling method. In fact, at the lower data transmission rates (50 and 150 characters per second) the access delays associated with the polling system appear to be incompatible with the 5-second requirement of Section II.A.3.

In addition to the analytical study, a computer simulation program was developed, under a separate JPL task, to obtain a comparison between the Polling/Contention systems. A portion of the simulation utilized typical LAPD parameters. The results of the simulation compare extremely well with

*Ref,: Attachment 1 of the "Preliminary Phase I Design Report" transmitted to LAPD, 11-11-74.

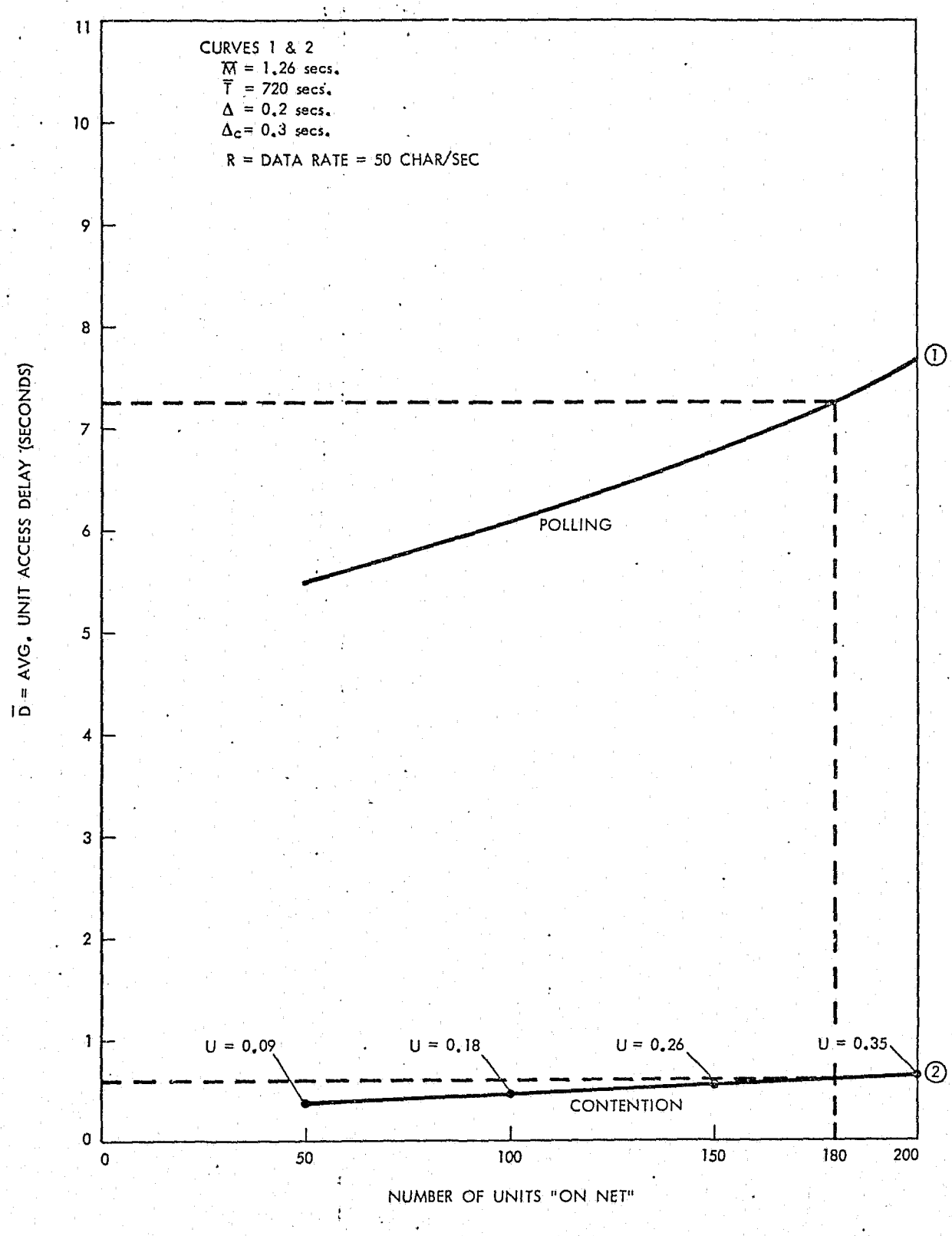

Fig. A-1. Relative Delays to be Expected in Either a Contention or a Polling System, Showing Curves 1 and 2

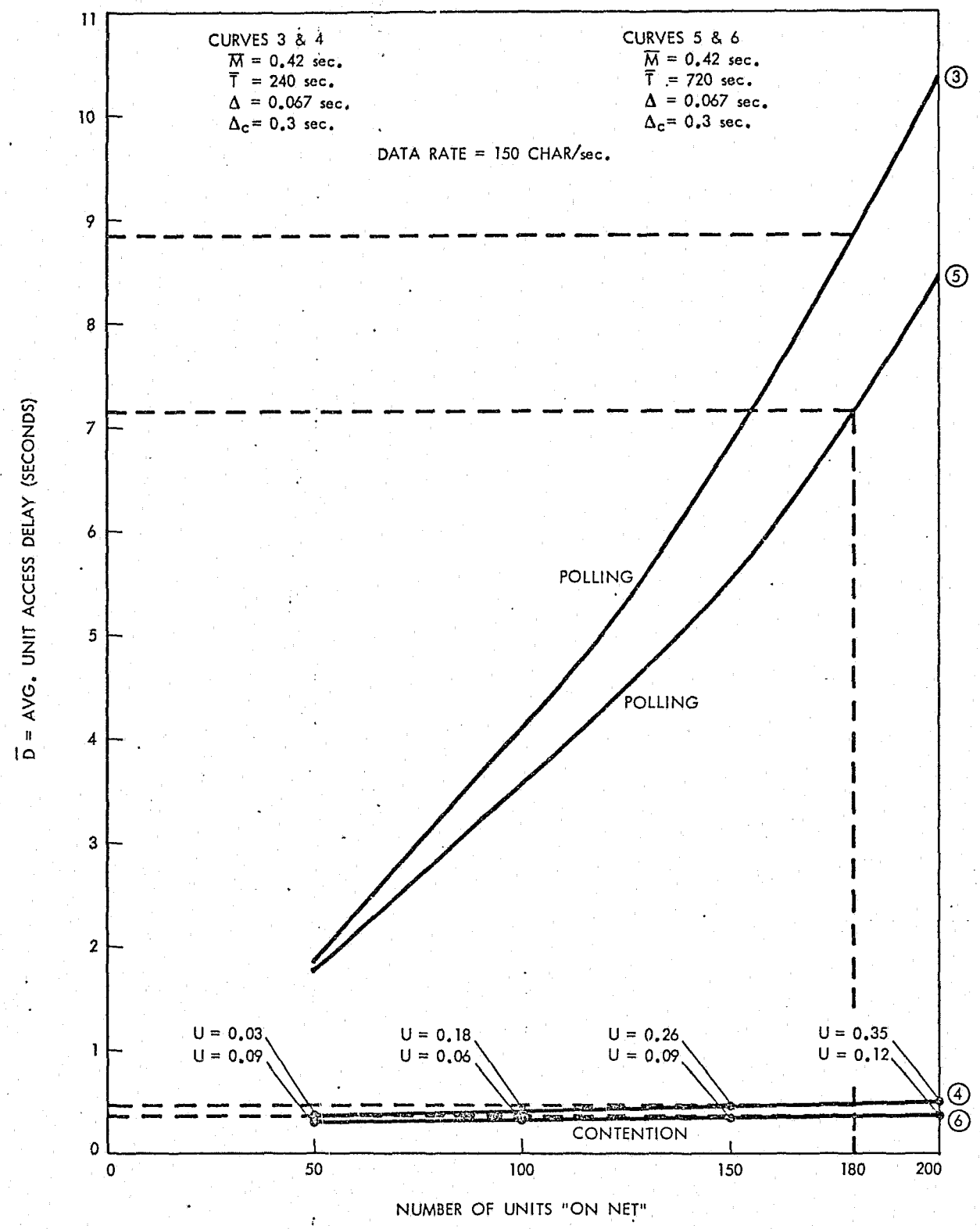

Fig. A-2. Relative Delays to be Expected in Either a Contention or a Polling System, Showing Curves 3, 4, 5, and 6

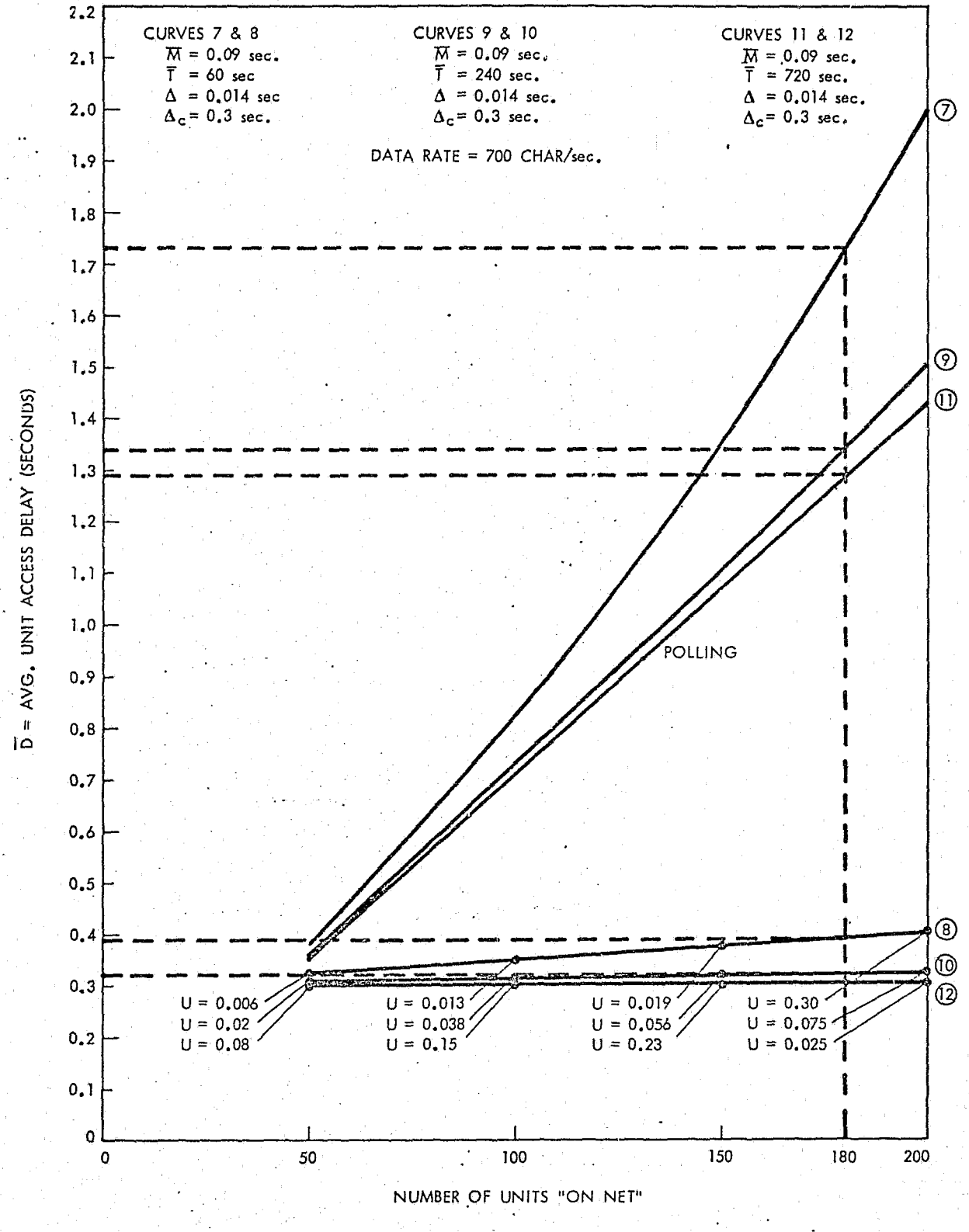

Fig. A-3. Relative Delays to be Expected in Either a Contention or a Polling System, Showing Curves 7, 8, 9, 10, 11, and 12

Figs. A-1 through A-3, with the exception that the contention access delay is approximately two times as great as shown in the attached curves. This is believed to be caused by the use of actual message distributions in the simulation model; whereas, the plotted data utilizes an average message length without regard for distribution. In either case, the contention system has a clear advantage over the aperiodic polling system in field unit access delay time for low-channel utilization levels.

Block polling (i.e., a group of field units are polled and allowed to contend for "air time" within their poll period) simulations indicate that some advantage is to be gained over both the pure contention and aperiodic polling systems at higher channel utilization levels. At low utilizations (≤ 0.40 to 0.50), the advantage reverts to the contention system.

The delays shown in the plotted data are relative and indicate only the effects directly attributable to the access system itself. The field unit access delays to be expected will be somewhat longer due to transmission link characteristics (i.e., transmitter turn on time; propagation time; receiver acquisition time; etc.). These transmissions delays will add directly to both types of channel access systems.

In conclusion, it appears that the LAPD digital communications system should utilize the contention access as its primary mode of operation. There may occur some tactical situations where it is operationally desirable to force access for given units or groups of units. Therefore, it is further recommended that equipment for the digital communication system be capable of polled operation dictated from the base station. To minimize delays in either type of access system, considerable attention must be given to keeping radio equipment response times as small as possible.

APPENDIX B

PHASE I DESIGN REQUIREMENTS NOT COMMERCIALLY AVAILABLE

The LAPD, Emergency Command Control Communications System, Phase I Digital Design, has several features that are not, at present, available in commercial Mobile Digital Terminals. To implement the proposed system, design efforts will have to be accomplished in the following areas:

(1) Four (4) line screen (32 characters per line, full alphanumeric ASCII, solid state). Present units currently utilize either one (1) or eight (8) line screens developed by Burrough Corporation. The 4 line screen will have to be located among other sources or developed. In either case, modification of present terminal designs will be required.

(2) 400-character buffer capacity. Available Mobile Digital Terminals provide for a maximum buffer size of 256 characters. This capacity appears to be slightly smaller than desirable. A significant number of data base responses are of the order of 250 characters in length. Without the larger buffer capacity, these messages will require dual transmissions to the field units. The expanded buffer capacity is not a technological problem; however, the expansion will require some redesign of the terminal itself.

(3) Four (4) buffer Capability (Receive, Display, Auxillary, Transmit). Basically, two buffers are provided in commercial units. The four (4) buffer capability will provide more flexibility for the field unit operator in message handling (display, composition, recall). The four (4) buffers present no technical problems other than the modification of the terminal design.

(4) Mobile Unit Tape Recorder. Some of the available Mobile Digital Terminals have provision for interfacing to print out devices. No units have the capability to interface with a small cassette tape recorder. The mobile terminals will require modification for tape deck control. In addition, a tape deck will have to be developed that is compatible with the mobile environment.

(5) AVM port and automatic AVM transmit function. Automatic insertion of AVM data into the message transmissions of current digital

terminals is not available, nor is the capability to sense a base station request for an AVM update and automatically cause the latest data to be transmitted. Technical feasibility is no problem; however, a small amount of added circuitry and terminal modification will be necessary.

(6) Variable Identification capability. One of the mobile terminals on the market utilized a variable terminal identification scheme. All other units utilize a fixed identification approach. Moderate design effort would be required to modify the fixed address units.

(7) Priority Message Detector. No available unit has the capability to detect and give precedence to priority messages to the field units. This capability will require some design of circuitry and the probable addition of one buffer.

(8) Function Control and Canned Message Keys. The Phase I design utilizes 19 function and canned message keys. This appears to be more than is available on any current unit. Modification to allow for the added keys will involve both circuit and packaging design changes.

APPENDIX C

COMMUNICATIONS ROOM INSTALLATION

Phase I implementation of a digital communications system will require that equipment be installed in the Parker Center Communications Room. It is expected that this equipment will include the following:

(1) Five (5) RTO Keyboard Displays
(2) One (1) High Speed Line Printer
(3) One (1) Alarm Box

All other equipment (Processor, Control Terminal, Recorders (2), Input/Output Buffers) should be installed in the Data Services Bureau area of City Hall-East.

It is important that the equipment installation in Parker Center be accomplished in a manner that will minimize interference with ongoing operations. The current RTO positions are quite crowded with equipment (Sanders Keyboard Display, time stamp machine, status board, miscellaneous files, etc.). Therefore, it does not appear to be reasonable to plan for installation of the Phase I Keyboard Display during the system check-out period when the RTO's must still depend upon their current equipment for data base inquiries.

A phased installation process could be accomplished as follows:

(1) During the initial check-out and operation of the Phase I equipment, a temporary monitor position should be established in the open area between the current RTO positions and the Communications Equipment Room. The position would contain a keyboard display and the High-Speed Line Printer. This position would function as the dispatch center interface to the digital system during initial system operation.
(2) A separate display and alarm circuit would be mounted on the Link Operators Console top shelf. This unit would automatically alert and display for the dispatcher all Code C hits and Officer-Needs-Help messages so that appropriate support action can be initiated.
(3) When confidence in the system operation has been established, the current RTO Keyboard Displays will be replaced one at a time by the Phase I equipment. Once the RTO positions are operational,

the monitor position will be deactivated and the line printer moved to the inside of the horseshoe next to the current telephone operator positions.

Checkout of the RTO keyboard displays could be accomplished at the monitor position, such that a high confidence level exists prior to actual installation in the RTO positions.

To prevent the possibility of overloading the monitor position during initial system operation, it may be necessary to arbitrarily limit the number and type of free form digital messages addressed to the monitor.

APPENDIX D

PHASE I DATA HANDLING REQUIREMENTS

This appendix contains the basic calculations utilized in sizing the Phase I Digital System. The calculations address three basic areas: (1) the mobile-processor link; (2) the processor-data base link; and (3) the internal processor requirements.

I. ECCS DIGITAL TRAFFIC REQUIREMENTS

ECCCS Processor to Mobiles.* (Central Bureau)

Current overall message rate:

$$\lambda o = \frac{\rho_o}{s_o} = \frac{0.65}{3.5} = 0.1857 \text{ messages/sec.}$$

Current response to inquiry ratio = 2.24 responses/inquiry.

1990 Data Base Response traffic:

$$\lambda n_{(DBR)} = \lambda o \, a_{DBR} \, C_{DBR} \, A \, B \, 3600 \times 2.24$$

$$= 0.1857 \times 0.13 \times 0.8 \times 2 \times 5 \times 3600 \times 2.24$$

$$= 1557.38 \text{ messages/hr.}$$

*JPL R-75-00Z, "Statistical Analysis of Radio Communications Requirements for the City of Los Angeles Emergency Command and Control Communications System" prepared for JPL by Telcom, Inc, dated 24 January 1975.

1990 Computer Aided Dispatch traffic:

$$\lambda n_{(CAD)} = \lambda o\, a_{CAD}\, c_{CAD}\, A\, 3600$$

$$= 0.1857 \times 0.13 \times 0.8 \times 2 \times 3600$$

$$= 139.05 \text{ messages/hr.}$$

1990 Fixed Text traffic:

$$\lambda n_{ft} = 3600\, \lambda o\, A \left[(a_{ft} - a_{DBI})\, c + a_{DBI}\, 5\right]$$

$$= 3600 \times \frac{0.65}{3.5} \times 2 \left[(0.59 - 0.13)\, 0.56 + 0.13 \times 5\right]$$

$$= 1213.59 \text{ messages/hr}$$

Data rate, due to Black and White digital traffic, assuming that 15% of DBI messages result in "hit" responses:

$$\lambda n' = (\lambda n_{(DBR)}\, 0.15\, L_1) + (\lambda n_{(DBR)}\, 0.85\, L_2)$$

$$+ (\lambda n_{(CAD)}\, L_3) + (\lambda n_{(ft)}\, L_4)$$

$$= (1557.38 \times 0.15 \times 75) + (1557.38 \times 0.85 \times 25)$$

$$+ (139.05 \times 75) + (1213.59 \times 5)$$

$$= 17520.53 + 33094.33 + 10428.75 + 6067.95$$

$$= 67111.56 \text{ characters/hr}$$

$$\lambda n'' = \frac{67111.56}{3600} = 18.64 \text{ character/sec.}$$

Addition of 10% to account for Motorcycle and Detective units gives:

$$\lambda''_n = 18.64 + 1.86 = 20.50 \text{ characters/sec.}$$

Addition of 10% to account for digital car-to-car traffic:

$$\lambda''_n = 20.50 + 1.86 = 22.36 \text{ characters/sec.}$$

Addition of five percent to account for retransmission of status messages to supervisors:

$$\lambda''_n = 22.36 + 0.93 = 23.29 \text{ characters/sec.}$$

Addition of 20% to account for retransmissions caused by errors and/or loss of signal:

$$\lambda''_n = 23.29 + 3.73 = 27.02 \text{ characters/sec.}$$

To maintain a desirable average utilization level of 0.35, the minimum character thruput capability of the Base Station to Mobile links should be:

$$R = \frac{27.02}{0.35} = 77.2 \text{ characters/sec}$$

The above calculations are based upon downlink traffic estimates; however, sizing the field unit to base links on this basis appears conservative in that the downlink loading is much heavier than that of the uplink. (Including AVM, as assumed.)

AVM

Assuming that each unit transmits a digital message of some type at an average of one message every four minutes and that a three (3) character AVM message is included in every transmission, the additional load represented by AVM is:

$$\frac{200 \times 3}{60 \times 4} = 2.5 \text{ char./sec.}$$

For dispatch location data required for CAD operations (it is assumed that the CAD function queries the most likely units for location data), the following data rate for Central Bureau is required: From Task II Statistical Analysis, CAD is required 139.05 times/hour,

or

$$= \frac{139.06}{3600} = 0.039 \text{ location messages/sec.}$$

Assume there are five (5) most likely units per dispatch. This requires $5 \times 0.039 = 0.195$ location messages be transmitted per second. If a location message contains 9 characters (24 location + 19 address + 24 instruction bits per message), then CAD location requires $0.195 \times 9 = 1.76$ characters/sec.

Total AVM data rate = 2.5 + 1.76 = 4.26 characters/sec.

Total Data Rate = 27.02 + 4.26 = 31.28

System thruput for 0.35 utilization = $\frac{31.28}{0.35}$ = 89.37 char/sec.

II. COMPUTER TO COMPUTER DIGITAL TRAFFIC

From Table 2-3 of the Telecom, Inc. document cited earlier in this Appendix, the following is presented:

(1) 11.44 data base inquiries per division per hour.

(2) 17 divisions

(3) Therefore, 17 x 11.44 = 194.48 inquiries per hour (current rate)

(4) Distribution of data base inquiries per Task I:

(a)	AWWS vehicle	76% of vehicle checks
(b)	AWWS suspect	100% of suspect checks
(c)	CLETS vehicle (SVS)	91% of vehicle checks
(d)	CLETS vehicle (DMV)	61% of vehicle checks
(e)	CLETS suspect	41% of suspect checks
(f)	NCIC vehicle	9% of CLETS SVS checks
(g)	NCIC suspect	100% of CLETS suspect checks

(5) Ratio of vehicle to suspect inquiries per Task I = 75/25

(6) Therefore, suspect checks = 0.25 x 194.48 = 48.62/hr
vehicle checks = 0.75 x 194.48 = 145.86/hr

(7) Responses to be expected from item (4):

(a) AWWS vehicle = 0.76 x 145.86 = 110.85 msg/hr
(b) CLETS vehicle (SVS) = 0.91 x 145.86 = 132.73 msg/hr
(c) CLETS vehicle (DMV) = 0.61 x 145.86 = 88.97 msg/hr
(d) NCIC vehicle = 0.09 x 0.91 x 145.86 = 11.95 msg/hr
(e) AWWS suspect = 1.00 x 48.62 = 48.62 msg/hr
(f) CLETS suspect = 0.41 x 48.62 = 19.93 msg/hr
(g) NCIC suspect = 0.41 x 48.62 = 19.93 msg/hr

(8) In the Phase I digital system, AWWS, SYS, and DMV will be addressed on all vehicle checks. It is further assumed that all suspect checks will be routed to AWWS, WPS, and NCIC. Therefore, the responses in 1974 figures should be:

(a) AWWS vehicle = 145.86 msg/hr
(b) CLETS vehicle (SVS) = 145.86 msg/hr

(c) CLETS vehicle (DMV) = 145.86 msg/hr

(d) NCIC vehicle = 0.09 x 145.86 = 13.1 msg/hr

(e) AWWS suspect = 48.62 msg/hr

(f) CLETS suspect = 48.62 msg/hr

(g) NCIC suspect = 48.62 msg/hr

(9) Average message lengths from Task I are:

Inquiry		Characters
(a) Vehicle Check	=	20
(b) Suspect Check	=	60
(c) Warrant Summary Request	=	20
(d) Warrant Routing Request	=	20
Response		
(a) Vehicle Check No Hit	=	45
(b) Vehicle Check Hit	=	110
(c) Vehicle Check DMV Record	=	110
(d) Vehicle (Hit) Abstract	=	200
(e) Suspect Check No Hit	=	45
(f) Suspect Check Hit	=	110
(g) Suspect (Hit) Abstract	=	600

(10) Calculation assumes the following additional factors:

(a) 100% of DBR Hits result in a warrant summary request.

(b) 50% of warrant summary requests result in an abstract transmission request.

(c) 15% of DBI result in Hits.

(d) DBI growth factor (Projection to 1990) is 2.

(e) MDT effect on DBI traffic is 5.

(f) 11 bits required per character.

(11) Traffic calculations: (1990)

Category	Char/sec	Bps
(a) ECCCS to AWWS Inquiry		
(i) Vehicle = $\frac{145.86 \times 20 \times 2 \times 5}{3600}$ =	8.10	89.14
(ii) Request for summary - vehicle = $\frac{145.86 \times 0.15 \times 0.5 \times 20 \times 2 \times 5}{3600}$ =	0.61	6.69
(iii) Request for warrant - vehicle = $\frac{145.86 \times 0.15 \times 0.5 \times 0.5 \times 20 \times 2 \times 5}{3600}$ =	0.31	3.36
(iv) Suspect check = $\frac{48.62 \times 60 \times 2 \times 5}{3600}$ =	8.10	89.14
(v) Request for summary - suspect = $\frac{48.62 \times 0.15 \times 0.9 \times 20 \times 2 \times 5}{3600}$ =	0.36	3.96
(vi) Request for warrant - suspect = $\frac{48.62 \times 0.15 \times 0.9 \times 0.5 \times 20 \times 2 \times 5}{3600}$ =	0.18	1.98
Total	17.66	194.26

		Char/sec	Bps
(b)	ECCCS to CLETS Inquiry		
	(i) Vehicle check (SVS) = $\frac{145.86 \times 20 \times 2 \times 5}{3600}$ =	8.10	89.14
	(ii) Vehicle check (DMV) = $\frac{145.86 \times 20 \times 2 \times 5}{3600}$ =	8.10	89.14
	(iii) Suspect (WPS) = $\frac{48.62 \times 60 \times 2 \times 5}{3600}$ =	8.10	89.14
	Total	24.3	267.3
(c)	CLETS to ECCCS Response		
	(i) SVS No Hit - vehicle		
	$= \frac{145.86 \times 0.85 \times 45 \times 2 \times 5}{3600}$ =	15.50	170.47
	(ii) SVS Hit - vehicle		
	$= \frac{145.86 \times 0.15 \times 200 \times 2 \times 5}{3600}$ =	12.16	133.71
	(iii) NCIC No Hit - vehicle		
	$= \frac{13.1 \times 0.85 \times 45 \times 2 \times 5}{3600}$ =	1.39	15.3
	(iv) NCIC Hit - vehicle		
	$= \frac{13.1 \times 0.15 \times 200 \times 2 \times 5}{3600}$ =	1.09	12.00
	(v) DMV Response - vehicle		
	$= \frac{145.86 \times 110 \times 2 \times 5}{3600}$ =	44.57	490.25
	(vi) CLETS No Hit - Suspect		
	$= \frac{48.62 \times 0.85 \times 45 \times 2 \times 5}{3600}$ =	5.17	56.82
	(vii) CLETS Hit - Suspect		
	$= \frac{48.62 \times 0.15 \times 110 \times 2 \times 5}{3600}$ =	2.23	24.51
	(viii) NCIC No Hit - Suspect		
	$= \frac{48.62 \times 0.85 \times 45 \times 2 \times 5}{3600}$ =	5.17	56.82

		Char/sec	Bps
(ix) NCIC Hit - Suspect			
$= \frac{48.62 \times 0.15 \times 110 \times 2 \times 5}{3600} =$		2.23	24.51
	Total	89.51	984.61
(d) AWWS to ECCCS Response			
(i) Vehicle No Hit			
$= \frac{145.86 \times 0.85 \times 45 \times 2 \times 5}{3600} =$		15.50	170.5
(ii) Vehicle Hit			
$= \frac{145.86 \times 0.15 \times 200 \times 2 \times 5}{3600} =$		12.15	133.71
(iii) Suspect No Hit			
$= \frac{48.62 \times 0.85 \times 45 \times 2 \times 5}{3600} =$		5.17	56.87
(iv) Suspect Hit			
$= \frac{48.62 \times 0.15 \times 110 \times 2 \times 5}{3600} =$		2.23	24.53
(v) Suspect Summary			
$= \frac{48.62 \times 0.15 \times 1.0 \times 600 \times 2 \times 5}{3600} =$		12.16	133.71
	Total	47.22	519.42
(12) Total Traffic From ECCCS Processor:			
(a) To AWWS		17.66	194.26
(b) To CLETS		24.30	267.30
		41.96	461.56
(13) Total Traffic To ECCCS Processor:			
(a) From AWWS		47.22	512.42
(b) From CLETS		89.51	984.61
		136.73	1497.03

(14) Data Base traffic originating from the CBO positions is not included in the above calculations; however, this represents only 5.1% of the Data Base traffic. Allowing for this traffic results in the following:

(a) Total traffic from ECCCS Processor (avg.)			
(i) To AWWS		18.56	204.17
(ii) To CLETS		25.53	280.93
	Total	44.09	484.99
(b) Total traffic to ECCCS Processor			
(i) From AWWS		49.63	545.93
(ii) From CLETS		94.08	1034.88
	Total	143.71	1580.81

(15) Allowing for peak traffic loads results in: (Avg. x3)

(a) Total traffic from ECCCS Processor (peak)			
(i) To AWWS		55.68	612.51
(ii) To CLETS		76.59	842.79
	Total	132.27	1455.30
(b) Total Traffic To ECCCS Processor (peak)			
(i) From AWWS		148.89	1637.79
(ii) From CLETS		282.24	3104.64
	Total	431.13	4742.43

(16) Assumming that the ratio of traffic between bureaus remains constant, the Central Bureau traffic will be:

To AWWS = 4.58 Char/sec (13.75) From AWWS = 12.26 Char/sec (36.78)

To CLETS = 6.31 Char/sec (18.92) From CLETS = 23.24 Char/sec (69.71)

III. INTERNAL PROCESSOR CAPABILITY

Three sets of parameters are of primary interest within the base station processor itself. These are:

(1) Maximum message processing time.

(2) Minimum File capacity requirements.

(3) Size of software program

To determine the processing requirements, a flow diagram was generated and an estimate of the instructions required for the various subroutines was made. The estimated software instructions are shown below:

	FUNCTION	ESTIMATED INSTRUCTION SET (WORDS)
1.	VENDOR RESERVE	2000
2.	EXECUTIVE PROGRAM	1000
3.	FIELD UNIT MESSAGE ROUTINES (EXCLUSIVE OF INQUIRY)	808
4.	FIELD UNIT INQUIRY ROUTINES	1132
5.	DATA BASE RESPONSE	240
6.	MISC. ROUTINES AND PERIPHERAL DEVICE CONTROL	3380
	TOTAL	8560

The various files required and their sizes are as follows:

	FILE	WORD CAPACITY
1.	ACTIVE UNITS (by I.D.)	64
2.	ASSIGNMENT FILE (by I.D., P.U., Name, Expected ON/OFF Time, ON Flag)	3400
3.	RECOVERY FILE (base upon a 3 minute maximum data base response time)	6457
4.	MDT INPUT FILE	150
5.	DATA BASE INPUT FILE (based upon simultaneous receipt of 3 1500 character messages)	4500
6.	TRANSMIT FILE	8500
	TOTAL	23071

Total core requirement:

INSTRUCTION SET	8560
FILES	23071
	31631

FOR MARGIN - DOUBLE CORE SIZE 2 x 31631 = 63262 WORDS

To determine processing speed requirements, an assumption was made that data was ready for processing simultaneously at four input ports (1 field unit message of 115 characters plus data base response messages). It is further assumed that only the first 400 characters of the response messages are processed immediately (balance held for field unit paging).

From the instruction estimates, the longest inquiry message will require approximately 585 instruction cycles. A response message will require approximately 1038 instruction cycles. At a 2.3 μ second instruction cycle time, the required process time is:

Inquiry Message - $2.3 \times 585 = 1345.5$ μsec.

Response Message - $2.3 \times 1038 = 2387.4$ μsec.

The processor time required for 1 field unit and three response messages is:

$$1345.5 + 3(2387.4) = 8507.7 \text{ μsec.}$$

The minimum time required between two incoming field unit messages (assuming a minimum message length of 5 characters and a 4800 bps data rate with a minimum 30 msec transmitter turn-on time) is:

$$\left(\frac{1}{4800} \times 5 \times 8\right) + 30000 = 38332 \text{ μsec.}$$

The minimum time required between two incoming data base messages (10 character minimum and 4800 bps data rate) is:

$$\left(\frac{1}{4800} \times 10 \times 8\right) = 16664 \text{ μsec.}$$

Processing time margin is:

$$16664 - 8507.7 = 8156.3 \ \mu\text{sec.}$$

APPENDIX E

DATA BASE RESPONSE EDITING

The design of the Phase I Emergency Command Control Communications System does not attempt to accomplish automatic electronic editing of data-base response messages. The prime reasons for this are (1) loss of trained operator judgment capability, and (2) significant added complexity of the Phase I digital system.

As currently envisioned, all hit messages will be transmitted directly to the field unit where the officer involved can weigh the response information with his own knowledge, experience, and understanding of the existing field conditions. An alternative (easily implemented) would be to transmit a short "canned" hit message to the field officer while routing the actual response message to a trained operator in the dispatch area for evaluation. The trained operator would then forward pertinent information to the field unit.

Electronic editing would strip data from response messages in accordance with a fixed program structure. Information, even though of possible value to the inquiring unit and not conforming to the pre-set edit routines, would be discarded (even "smart" machines are "dumb"). Editing data base response messages electronically is complex in that common formats are not used by the data bases; therefore, multiple editing routines must be available for the editing functions. Data weighting structures must be available within the routines for evaluation of parameters. Some data bases use truncated fields, therefore, a field-identifier lookup table is required for identification of fields.

In addition, key suspect descriptors and pertinent information regarding "caution" flags may occur in the miscellaneous fields from some data files. Identification of these key words will also require a lookup table. In short, electronics editing requires considerable software complexity and memory capability. In addition, data processing response times could easily double.

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END