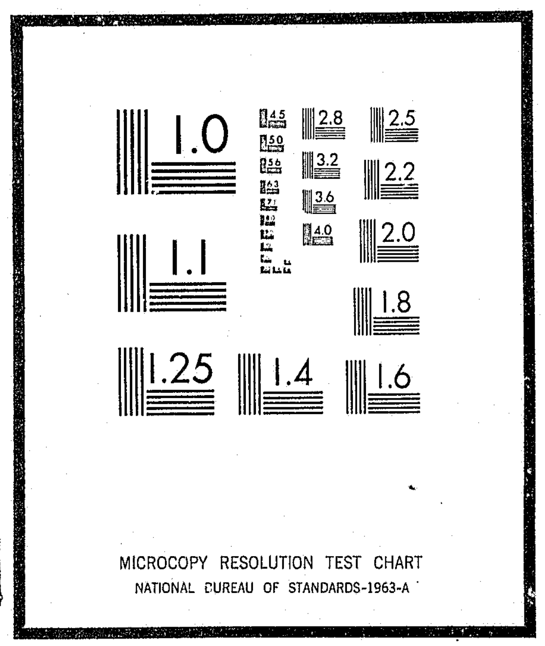
NCJRS



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1. INTRODUCTION

2. TECHNOLOGY SURVEY

3. MODELING

REPORT NO: LEADER II

COPY NO: ____________

DALLAS POLICE DEPARTMENT

COMMAND & CONTROL STUDY
SYSTEM MODELING REPORT

1 NOVEMBER 1972

THIS REPORT WAS PREPARED TO PRESENT THE RESULTS OF THE ANALYSIS DONE ON THE SELECTED ORGANIZATIONAL ELEMENTS OF THE DALLAS POLICE DEPARTMENT WHICH REPRESENT MAJOR CANDIDATES FOR AUTOMATION. THE ANALYSIS WAS DONE THROUGH USE OF MODELING TECHNIQUES BASED ON THE LEADER I REPORT AND SPECIFIC STATISTICAL DATA COLLECTED DURING PHASE II.

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1.0 INTRODUCTION

The City of Dallas entered into a contract with E-SYSTEMS INC., on January 27, 1972, for the purpose of providing support to the Dallas Police Department in the analysis of the information system now in use, and in recommending changes which would improve the effectiveness of the Department's operations.

The study was divided into three phases: During the Phase I period the baseline (i.e., current) information system was defined. In the Phase II portion of the study, parts of the baseline system were analyzed and modeled, and trade-off studies were conducted. The finalized system definition will be taken up in Phase III. This report contains a discussion of the Phase II effort.

1.1 SCOPE OF TASK

The Dallas Police Department information system was divided into 49 subsystems utilizing information obtained during the Phase I effort. A subsystem has been defined as a set of organizational units which: (1) handle similar types of information, and/or (2) perform similar designated functions on that information. All administrative units whose responsibility is primarily one of handling administrative tasks (time cards, emergency call list, monthly strength report, etc.) were considered as one subsystem. Regardless of the location of an administrative section or unit within the organizational structure, the same basic functions are performed on similar types of information. All management units at and above the Division level were grouped into a single management subsystem.

Table 1.1.A lists the subsystems. The organizational units are represented by alphabetic code instead of the unit title. Refer to the organizational chart in Figure 1.1.-1 for the unit titles.

2. TECHNOLOGY SURVEY

3. MODELING

TABLE 1. 1. A. LIST OF SUBSYSTEMS (CONT'D)

SUBSYSTEM NUMBER	ORGANIZATIONAL UNIT OR UNITS
26	DAA
27	DAB, DABA, DABB, DABC
28	DAC, DACA, DACB
29	DACC
30	DAD, DADA, DADB, DADC
31	DAE, DAEA
32	DAEF, DAEC
33	DBA, DBAA
34	DBAB
35	DBB, DBBB, DBBC
36	DBC, DBD
37	DCA
38	DCB, DCD
39	DCC
40	DDA, DDAA,DDAB
41	DDB
42	DDC
43	DDD
44	DEA, DEB, DEC, DED
45	DFA, DFB, DFC
46	EAA, EAB
47	EBB, EBC, EBD, EBE
48	CAA, CBA, CCA, CFA, EBA
49	A, AB, AC, B, BA, BB, BC, BD, BE, C, CA, CB, CC, CE, CF, D, DA, DB, DC, DD, DE, DF, E, EA, EB

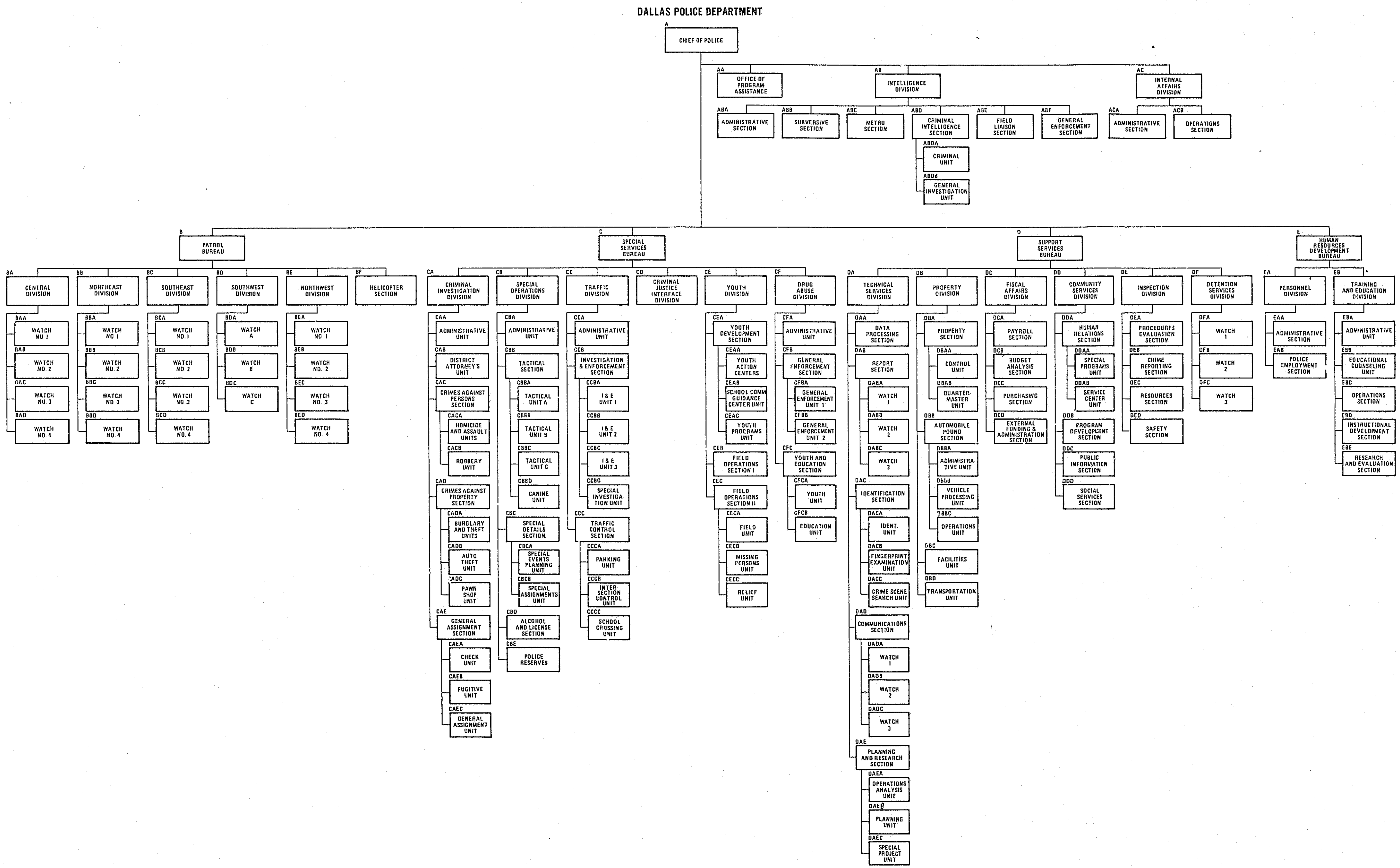

FIGURE 1.1–1. DALLAS POLICE DEPARTMENT ORGANIZATIONAL CHART

TABLE 1.1.B CANDIDATES FOR AUTOMATION

SUBSYSTEM NUMBER	UNIT TITLE OR TITLES
2	Administrative Section (Intelligence Division)
4	Metro Section (Intelligence Division)
6	Field Liaison Section (Intelligence Division)
7	General Enforcement Section (Intelligence Division)
8	Administrative Section, and Operations Section (Internal Affairs Division)
9	Patrol Bureau, all watches
12	Crimes Against Persons Section
13	Crimes Against Property Section
14	General Assignments Section
15	Tactical Section
18	Alcohol & License Section
20	Investigation and Enforcement Section
23	Youth Development Section
24	Field Operations Section I and II
25	Drug Abuse Division
27	Report Section
28	Identification Section
29	Identification Section (Crime Scene Search)
30	Communications Section
31	Planning & Research (Operations Analysis Unit)
33	Property Section (Control Unit)
34	Property Section (Quartermaster Unit)
35	Auto Pound Section (Vehicle Processing Unit and Operations Unit)
37	Fiscal Affairs (Payroll Section)

TABLE 1.1.B CANDIDATES FOR AUTOMATION (CONT'D)

SUBSYSTEM NUMBER	UNIT TITLE OR TITLES
38	Fiscal Affairs (Budget Analysis and External Funding Section)
39	Fiscal Affairs (Purchasing Section)
46	Personnel Division
47	Training and Education Division

1.2 SUMMARY OF PHASE II STUDY RESULTS

1.2.1 RELATIONSHIP BETWEEN PHASE I AND PHASE II

During Phase I of the study, the Operation LEADER group studied the operations of the Dallas Police Department. This effort included studies of organization, manning, cost, operational requirements of all facets of the police operation, and current operational procedures and standards. The study was primarily concerned with information flow; the needs of specific sections of the department for information and methods used to provide this information in a rapid and usable form. The data and knowledge gained in Phase I was documented and compiled into a four volume report which was submitted to the Dallas Police Department August 1, 1972.

Analysis of the information obtained in Phase I of the study revealed to the study group which sections of the department's operation appear to present a "bottleneck" in the information chain.

The task of Phase II involved further study of these areas. The Phase I report and the understanding of the operations obtained by the study group during Phase I was used as a basis for further study. More data and information was collected in these problem areas as needed during Phase II.

1.2.2 OUTLINE OF PHASE II RESULTS

The Phase II study effort was directed toward the modeling of 22 distinct functions. These functions are performed in: (1) the Communications Section, (2) the Patrol Section, (3) the Reports Section, and (4) the Identification Section. Table 1.2.2-1 lists these 22 functions by the organizational areas in which the are performed. The initiation, flow, processing, storage and retrieval of information is modeled for each

TABLE 1.2.2-1 FUNCTIONS MODELED

Communications Section

1. Public Initialed Telephone Calls
2. Telephone Clerks (Receiving In-coming Calls)
3. Expediter Clerk
4. Radio Dispatcher (Patrol Channels (1-5))
5. Radio Dispatcher (Inquiries, Channel 7)
6. Computer Interfaces

Patrol Section

1. Patrol Functions Involved in Answering a Call
2. Flow of Reports Initiated by Patrol Elements

Reports Section

1. Staff Review Unit
2. NCIC Clerk
3. Update Clerks
4. Reproduction Unit

Identification Section

1. Front Desk
2. Microfilm Unit
3. Clearance Request
4. Fingerprint Unit
5. Interfaces with Other Bureaus
6. Interface with Detention Services
7. Interface with Court Systems
8. Interface with Reports Section
9. Interface with DPD Personnel

of the 22 functions. These areas constitute the majority of input data to the information system and the storage of this data.

Section 3.0 and the Appendices of this report give the detailed results obtained from the modeling effort. The statistics related to the various models can be found in the Appendices along with the computer program printout of the IBM GPSS/360 program used to simulate these areas of concern.

1.3 SURVEY OF MODELING AND ANALYSIS TECHNIQUES

1.3.1 MODELING CONCEPTS

Initially in this discussion, a general definition of modeling is essential in order to understand its usage the previously mentioned candidates for modeling. A model is the related information about a system gathered for the purpose of studying the system. The construction of a model involves actually two distinct functions; to establish the model structure, and to supply the data for the model. Models referred to in this study will be treated as discrete, mathematical, and dynamic.

Due to the nature of modeling itself, it is not possible to declare a set of rules by which models are built, but some principles do exist. These principles describe different viewpoints from which to judge the information to be included in a specific model:

(a) Block-building: The system should be organized in a series of blocks. These blocks aid in simplifying the specification of the interactions within the system. This system can be represented graphically by a simple block diagram.

(b) Relevance: The model should only include those aspects of the system that are relevant to the study objectives. Any irrelevant information in the model can only increase its complexity.

(c) Accuracy: One of the most important facets involved in defining a model is the accuracy of the information gathered for the model.

(d) Aggregation: A factor to consider in the model is the extent to which the number of individual entities can be grouped into larger entities. This principle appears in the use of probability functions for sets instead of individual events.

1.3.2 PROGRAMMING METHODS

The programming methods used in system simulation depend on several factors. These factors are all contigent upon the desired end results and the nature of the model. In some areas of system simulation, the FORTRAN programming language can be utilized with excellent results, whereas, in other areas, this programming language would prove to be inefficient in both usage and results obtained. For the purpose of this study a programming language which lends itself to a mathematical, discrete, and dynamic environment was needed. The language that was selected was the IBM General Purpose Simulation System/360 (GPSS/360).

Simulation allows evaluation of existing systems, testing of those systems, and manipulation and evaluation of those systems without interfering with them.

Some of the tools required to simulate an information system are as follows: A realistic model of the system, a thorough investigation of the information flow in the system, a programming language with which to express the nature of the mathematical system, and a computer system on which to execute the simulation. The method of programming the information systems in this study using GPSS/360 will be dependent upon the nature of the desired results.

2.0 TECHNOLOGY SURVEY

Section 2.1 contains a discussion of some contemporary police automated information systems. In the Section 2.2, some possible applications of modern systems engineering methods to police operations are outlined; it is felt that the use of such techniques could enhance information flow in the police information system.

Section 2.3 deals with some automation technology applicable to police information management.

2.1 SURVEY OF LAW ENFORCEMENT INFORMATION SYSTEMS

2.1.1 CURRENT INFORMATION SYSTEMS UNDER STUDY OR NEAR IMPLEMENTATION

During the last decade, local and state police agencies have become increasingly interested in improving their data processing operation or introducing data processing into the department as a management aid and operational tool. The need for accurate up-to-date information of all types has been brought about by the rapid growth in the activities of law enforcement agencies. Criminal offenses occur, warrants are issued, vehicles and property are stolen or recovered, associated criminal activities and known or suspected offenders must be traced. Thus a mass of data must be collected, verified, stored and disseminated to the users in a timely and reliable manner. Recent and continuing major technological advances in data processing equipment and systems applications have proven themselves in savings of time, money, and manpower. The pressures for change and reform in police operations have called for progressive departments to apply various modern crime fighting techniques.

The value of quick access to accurate information for a police officer is emphasized by the President's Commission on Law Enforcement and Administration of Justice. They stated: "The importance of having complete and timely information about crimes and offenders available at the right place and the right time has been demonstrated throughout the Commission's work. Modern computer and communications technology permits many users, each sitting in his own office, to have immediate remote access to large computer-based central data banks. Each user can add information to a central file to be shared by the others. Access can be restricted so that only specified users can get certain information.... Criminal justice can benefit dramatically from computer - based information systems."

The information requirement for Law Enforcement has been considered by the various national, state and local agencies as a communication problem. Solutions in the past have been a series of inter-connected teletype systems that transferred wanted notices, requests for data, and message transfers, etc., between and within agencies. But as society has become larger and more complicated and as cities and suburbs have grown, the more responsible agencies have had to enhance their information transfer and storage capabilities. Each has found that the only way to handle the increasing demands for service is to computerize the various functions within a total systems concept.

According to a well established pattern, Law Enforcement agencies' systems requirements have been defined to establish the order and priority of needs, feasibility, and implementation. Inherent in these configurations are inquiry subsystems and computer-to-computer interfaces. Various types of terminals (video and printer) and communication channels and circuits are supported in a variety of combinations and volumes. The systems must all operate on a 24-hour 7 day a week basis and the majority

require some type of systems back-up, such as duplexed central processing units and switchable peripherals. Fail-safe features are provided to minimize the disruption of operations and enable an orderly changeover to a back-up mode. The re-start procedures are highly automated and require a minimum of assistance from computer operations. Various types of re-start procedures are available. These systems provide for keyboard terminal devices equipped with cathode-ray tube (CRT) devices in addition to printing devices. This allows messages to be composed and viewed on the CRT as well as being printed out in hard copy forms.

To sustain the police communications support facilities on a real-time basis, control functions must include an integrated system of routines to control all real-time message switching/data devices. These routines are adaptable to various particular hardware environments and provide at least the following:

(1) Line Control - Communications line control, including sending/receiving bits or characters from/to line control equipment.

(2) Message Assembly - Assembly of messages from all terminals including buffer allocation and queuing of completed input and output messages.

(3) Message Queues - Messages retrievable from queues by processing routines via simple logical I/O commands.

(4) Polling - Automatic polling of terminals with the ability to easily modify the polling list and/or the polling sequence.

(5) Terminal Addressing - Addressing of individual terminals on shared transmission lines.

(6) Traffic Queuing - Traffic queuing for inoperative or closed terminals and lines.

(7) Header Analysis - Message header analysis routines for determining destination and output display.

(8) Message Formatting - Formatting of messages and replies based upon file access results and other system responses.

(9) Message Logging - Logging of all messages for on-line retrieval within twenty-four (24) hours of transmission.

(10) Error Checking/Recovery - Transmission error checking and recovery routines.

(11) Date/Time Stamping - Date and Time stamping of all messages flowing through the system.

(12) Status Reporting - Line, network, terminal and system status reporting.

(13) Message Intercept - The ability to intercept any message, in a collective manner, which passes through the system.

(14) Acknowledgment - All messages received by the system are acknowledged. The acknowledgement format will include the system's and originator's identification numbers and time of receipt.

(15) Processing Schedules - Schedule message processing based upon message type, FIFO queue discipline.

(16) Interrupt Capability - Full interrupt accommodation to analyze cause of interrupt by supervisory program and giving control to a specific routine.

(17) Message Security - Ensuring that queued messages are not overwritten incorrectly by testing programs or by errors in operational programs and that

messages will not be lost due to various types of machine failure.

(18) System Testing Aids - Routines to aid in real-time program debugging and test of the communications system.

(19) Switch Over - Organizing switchover of the combined Information Retrieval and Communication support function to another processor in the event of hardware malfunction.

Rapid access, security, control, and efficiency are incorporated in information retrieval applications through File Control which provides the mechanism required for system file recovery. Within the file structure any number of data bases can exist simultaneously, each identified by a unique file name. The files consist of a series of records, each of which consists of a set of items. The items are further subdivided into elements, the smallest unit of information in the structure. Each set of Data Elements is then arranged in a format to produce a record type. These in turn can be "blocked" according to a common characteristic and linked together when necessary to contain an entire sub-group of the file. To provide rapid access to specific records within the file, multiple cross-indexes to individual files may be defined and maintained. Then a cross-index can be based on some unique identifier of the subject vehicle, person, property, or social security number, etc. Organization of the files consists of using one or more data elements (variables) within the record to partition the file into groups for easy access. The most common variables selected for defining on-line file groups are:

Vehicle File - License Plate Numbers & State of Registration

Master Name File - Phonetic Name Codes

Want/Warrant File - Corresponds to Master Name File

Property File - Property Category & Serial Number

Case File - Complaint or Departmental Record - Offenses, Incidents, and Follow Up.

Accident File - Traffic Accident Reports

Arrest File - Booking, Arrest Data, and Court Dispositions

Special Purpose Files - Gun Registration, Narcotics Registrants, Field Interviews, etc.

Various task forces and surveys have reported on automated police information systems and the number and types of local police departments that either have or anticipate using an automated information system. Figure 2.1-1 shows a graph representing respondents of 251 municipal police agencies, 110 or 44% of which are using Electronic Data Processing equipment to service cities of population over 25,000. These figures represent the tremendous growth in Electronic Data Processing over the years in serving those progressive police departments that have taken a forward approach in implementing or adding to their data processing equipment and systems configuration.

According to published figures, Tables 2.1-1 and 2.1-2 show the numerical ranking of current and projected Electronic Data Processing applications, the number of departments reporting, and the corresponding percent of departments represented.

As Table 2.1-2 shows, the future trend is definitely towards increased automation and within the next 3 years a significant majority of the police agencies will upgrade their information systems with more sophisticated equipment. Some 50% of the departments reported that they operate their own equipment and the sentiment in law enforcement is absolutely in favor of police control of their own systems/17/.

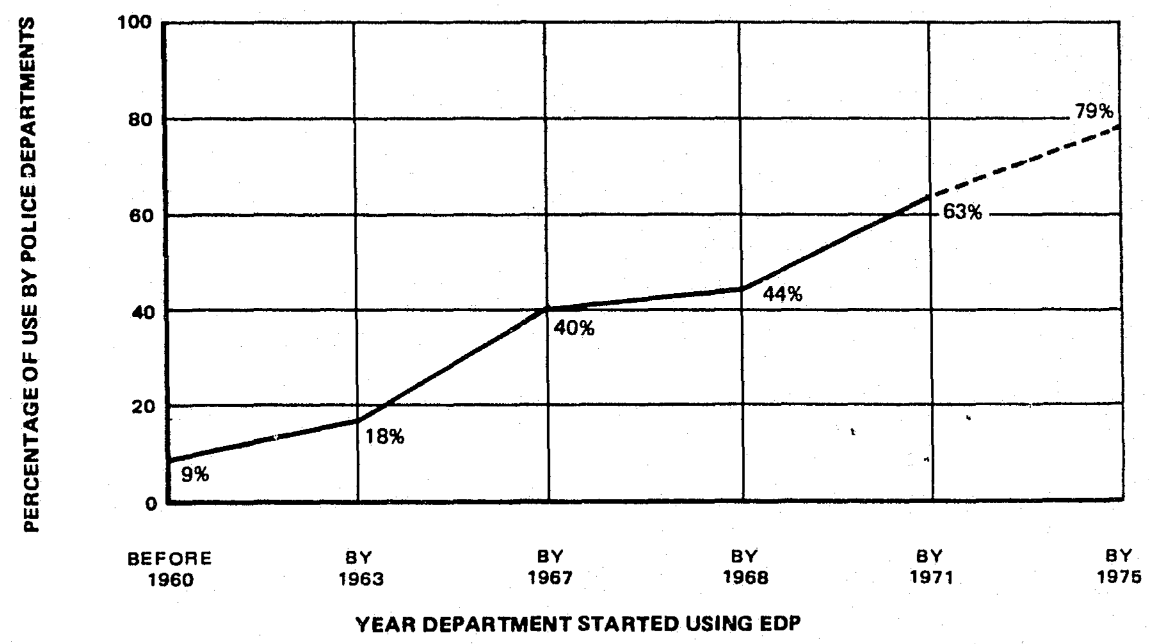

FIGURE 2.1–1 MUNICIPAL POLICE AGENCIES USING ELECTRONIC DATA PROCESSING EQUIPMENT

TABLE 2.1-1 CURRENT ELECTRONIC DATA PROCESSING APPLICATIONS BY POLICE DEPARTMENTS

IMPORTANCE RANKING	CURRENT EDP APPLICATIONS	NUMBER OF DEPARTMENTS	PERCENT OF DEPARTMENTS
1	Traffic Accidents	56	51
2	Parking Citations	55	50
3	Traffic Citations	54	49
4	Arrested Persons	45	41
5	Criminal Offenses	44	40
6	Personnel Records	43	39
7	Financial-Budget	40	37
8	Police Activities	39	36
9	Patrol Distribution	33	30
10	Juvenile Activity	33	30
11	Stolen Property	31	28
12	On-Line Inquiries	30	27
13	Vehicle Registration	29	26
14	Vehicle Maintenance and Costs	29	26
15	Warrant File	28	25
16	Offense Location	25	23
17	Inventory Control	21	19
18	Message Switching	4	4

TABLE 2.1-2 PROJECTED ELECTRONIC DATA PROCESSING APPLICATIONS BY POLICE DEPARTMENTS

IMPORTANCE RANKING	PROJECTED EDP APPLICATIONS	NUMBER OF DEPARTMENTS	PERCENT OF DEPARTMENTS
1	Arrested Persons	106	96
2	Traffic Accidents	103	94
3	Criminal Offenses	102	93
4	Personnel Records	100	91
5	Traffic Citations	99	90
6	Warrant File	96	88
7	Police Activities	95	86
8	Stolen Property	93	85
9	Parking Citations	92	84
10	Patrol Distribution	88	80
11	Financial-Budget	88	80
12	Juvenile Activity	86	78
13	On-Line Inquiries	80	77
14	Offense Location	77	70
15	Vehicle Maintenance and Costs	75	68
16	Inventory Control	74	67
17	Vehicle Registration	64	58
18	Message Switching	42	38

The areas where Electronic Data Processing has been applied most extensively include:

Crime-Related Applications

- Criminal offenses
- Arrested persons
- Juvenile activity
- Warrent file
- Stolen property
- On-Line inquiries

Police Operations Applications

- Police activity

- Patrol distribution
- Message switching
- Offense location
- Vehicle registration

Traffic Related Applications

- Traffic accidents
- Traffic citations
- Parking citations

Police Administration

- Personnel records
- Inventory control
- Vehicle maintenance and costs
- Financial budget

Despite the resistance to change and the difficulty in implementing and working the bugs out of new systems, police administrators and Criminal Justice leaders throughout the nation have been orienting their thinking and planning toward adapting the latest technological advances in the computer field to police works. The following is a brief discussion of a few, but not all, real-time systems that have been implemented nationally, on the state level, and on the regional and local levels. Table 2.1-3 is an example of a typical systems interface /21/.

Federal Level Information Systems

The current National Crime Information Center (NCIC), located in Washington, D. C. under the management of the Federal Bureau of Investigation, makes available to each state and major urban agency data on wanted persons, stolen vehicles, and stolen articles. Each of the real-time law enforcement systems are interfaced with this central FBI computer system, giving all of the terminals in each system direct access to the NCIC files.

TABLE 2.1-3 TYPICAL SYSTEMS INTERFACE

GOVERNMENT LEVEL	SYSTEM
Federal	NCIC (National Crime Information Center)
	SEARCH (System for the Electronic Analysis and Retrieval of Criminal Histories)
State	Auto-Statis (California Highway Patrol)
	DMV-AMIS (Department of Motor Vehicles - Automated Management Information System)
	CJIS (California Criminal Justice Information System)
Regional	RJIS (Los Angeles Regional Justice Information System)
	AWWS (Los Angeles Automated Want/Warrant System)

A nationwide criminal history system called Project SEARCH, an acronym for System for Electronic Analysis and Retrieval of Criminal History was begun in July 1969, with 10 states participating. The main goals are to evaluate the technical feasibility and operational utility of a cooperative interstate transference of criminal history data, and demonstrate the capability to automate state-collected criminal statistics for retrieval by selected state and federal agencies. The concept is based on the maintenance of individual state-held files and the existence of a central index, directly accessible by users in each state

and containing summary data on each state-held file. The central index will respond to an inquiring terminal by providing personal descriptors and identifying numbers, an abbreviated criminal profile and the name of the state or agency holding the full criminal history record (Agency of Record). The requesting state may then directly access the desired file from the Agency of Record.

State Level Information Systems

The following is a partial list of state computerized systems:

- NYSIIS - New York State Identification & Intelligence System
- LEANS - Law Enforcement Automated Network System - Michigan State Police
- MINCIS - Minnesota Criminal Information System
- CJIS - California Criminal Justice Information System
- MULES - Missouri Uniform Law Enforcement System
- CLETS - California Law Enforcement Telecommunications System
- CLEIS - Colorado Law Enforcement Information System
- SFIS - Statewide Federated Information System

Regional Level Information Systems

The following is a partial list of regional computerized systems:

- WALES - Washington Area Law Enforcement System
- ORACLE- Optimum Record Automation for Court and Law Enforcement (Los Angeles,County)
- CLEAR - County Law Enforcement Applied Regionally

RJIS - Los Angeles Regional Justice Information System
NCTCIC - North Central Texas Crime Information Center
PIN - Police Information Network (Alameda County California)
SAFARI - System for Automated Filing and Retrieval of Information (County of Riverside, California)

Local Level Information Systems

The New York City Police Department SPRINT (Special Police Radio Inquiry Network) system is directed toward development of a computer-assisted emergency communications system to provide rapid response of emergency vehicles and police personnel to scenes of critical incidents. With this system the New York City Police Department hopes to effectively increase the summary arrest rate, prevent completion of crimes in progress, and speed personnel and life-saving equipment to non-criminal incidents which involve danger to human life. Ultimately they plan to include the implementation of a computerized Police Tele-Communication Network which will provide all levels of command within the department access to the virtually unlimited scope of the centralized computer data base. Command levels from the top administrative officer down to the patrol force will be afforded information regarding criminal activity and history, command and control information, arrest and warrant information, stolen and lost property and crime analysis data.

The Kansas City Missouri Police Department has developed the ALERT (Automated Law Enforcement Response Team) system. The KCMPD is installing various electronic data processing equipment as a technological means of improving the efficiency of its law enforcement operation. One of the primary requirements of this computer system

is that it must answer the informational requests of officers in the field within 10 seconds after the request is made. Utilizing the "Computerized Law Enforcement Resource Allocation System," the Department is improving the effectiveness of current police resources by concentrating the available force of some 1300 men throughout the 316 square miles of Kansas City. This system shows the peak periods for responding to "Calls for Service," and predicts with 95% accuracy the predicted calls to actual events. The Kansas City Missouri Police Department feels that the computer is being utilized effectively in the support of criminal justice operations, having developed some 18 sub-systems which consist of about 200 programs in operational status, covering a broad spectrum in law enforcement.

In San Francisco, the CABLE (Computer Assisted Bay Area Law Enforcement) system is under development for police use. Phase I (Field Support Module) is designed to support the rapid response to field checks regarding people, vehicles, articles, and provide the minimal level of response necessary to establish reasonable cause for action by the officer on a rolling check, a stop, or an interrogation. The module also provides the capability to accomplish updates to all internal files and handle interfaces with the external Regional, State and National Systems. Phase II deals with "Crime Control" and will center on an improved Incident/Case Reporting System, a Patrol/Investigative Resource Allocation System, and a Management Information System. This Phase, in addition to providing further capabilities to the Field Support Module, will support Crime Control, Repression, and Prevention techniques, together with management and evaluative assist capabilities. In Phase III, development of a Records Management and Microfilm capability will begin which will utilize a multi-media approach consisting of computer and microfilm techniques to present, at remote locations, images of actual documents, i.e., mug shots, "rap" sheets, incident reports, diagrams, etc. The almost instantaneous presentation of documents, together with the information available through normal field checks procedures, will give the investigator an unprecedented degree of data access in a time element that should increase his individual potential in investigating and clearing case assignments. Thus the CABLE System shown in Figure 2.1-2 will represent a total systems approach to a completely integrated Information/Communications System which is accessed via centralized computer indexes.

As part of the Oakland Police Department LOCATE (Location of Oakland Cars via Telecommunications) project the Oakland Police have had in operation for the past year a mobile digital communications system where the information is encoded and transmitted in "short bursts" in a format that is compatible for use by a central computer. The combination of speed of transmission and digital format permits automatic handling, display, and recording of message data and permits a higher density of communication. The system is comprised of Sylvania's Digicom-300 unit and the Digimap-100, a pressure-sensitive map mounted on a grid-matrix board (See Figure 2.1-3). Pressure applied to any point on the map causes the vehicle's location to be electronically sensed and transmitted to the base station display board. Resolution of the reported location is usually within 500 feet. Maps can be easily changed and Digimap is designed to hold sixteen maps. These maps are electronically coded so the base station knows which map is being used. Each Digicom unit has four status and seven pre-set message buttons. Alphanumeric text can also be sent and received by the mobile units via a typewriter-like keyboard and small video tube. The system also features a computer which records dispatch, response, and consumed times for management analysis. The units in the cars link the field units directly

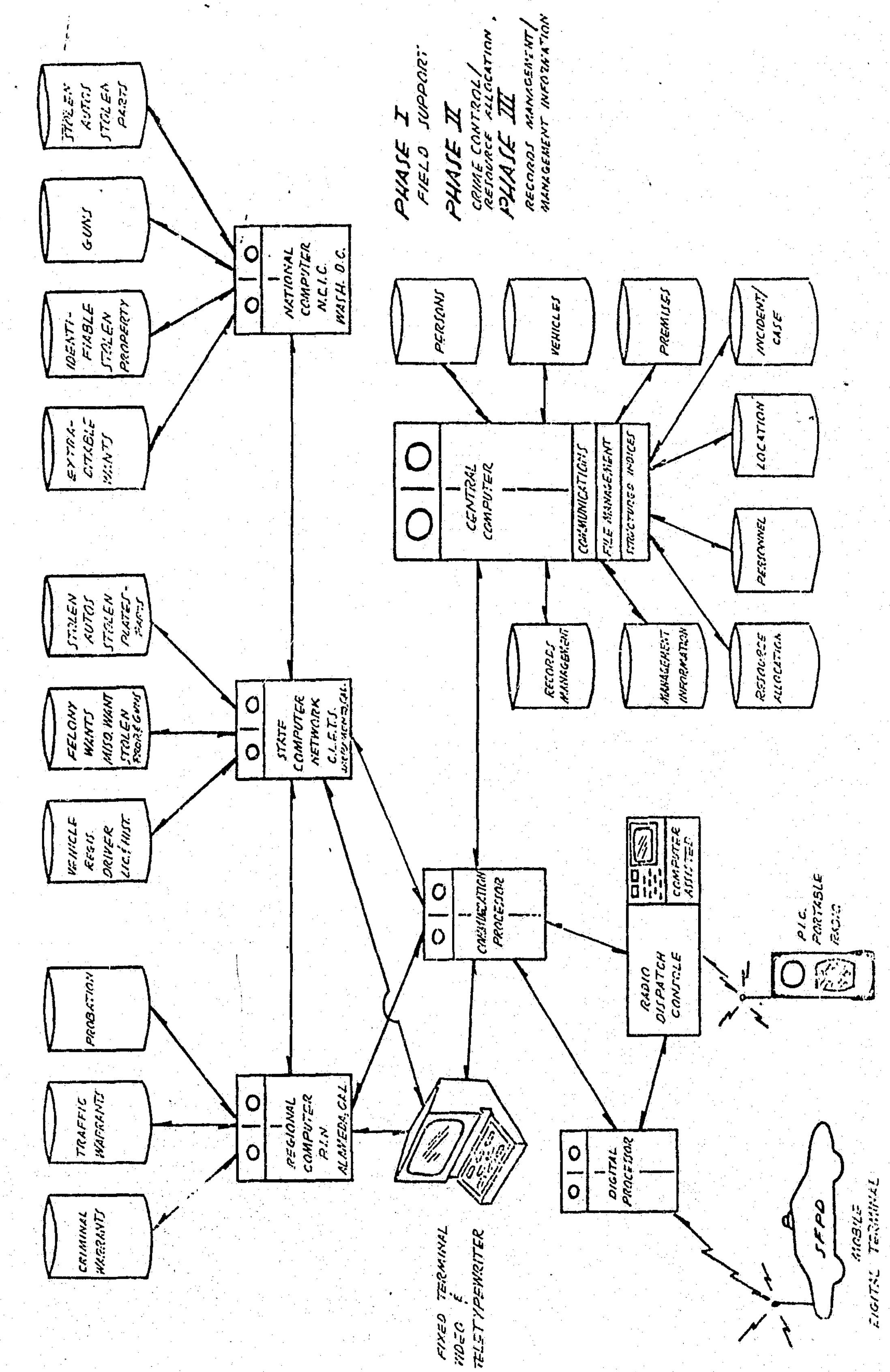

FIGURE 2.1-2. CABLE – COMPUTER ASSISTED BAY AREA LAW ENFORCEMENT SAN FRANCISCO INFORMATION/COMMUNICATIONS SYSTEM

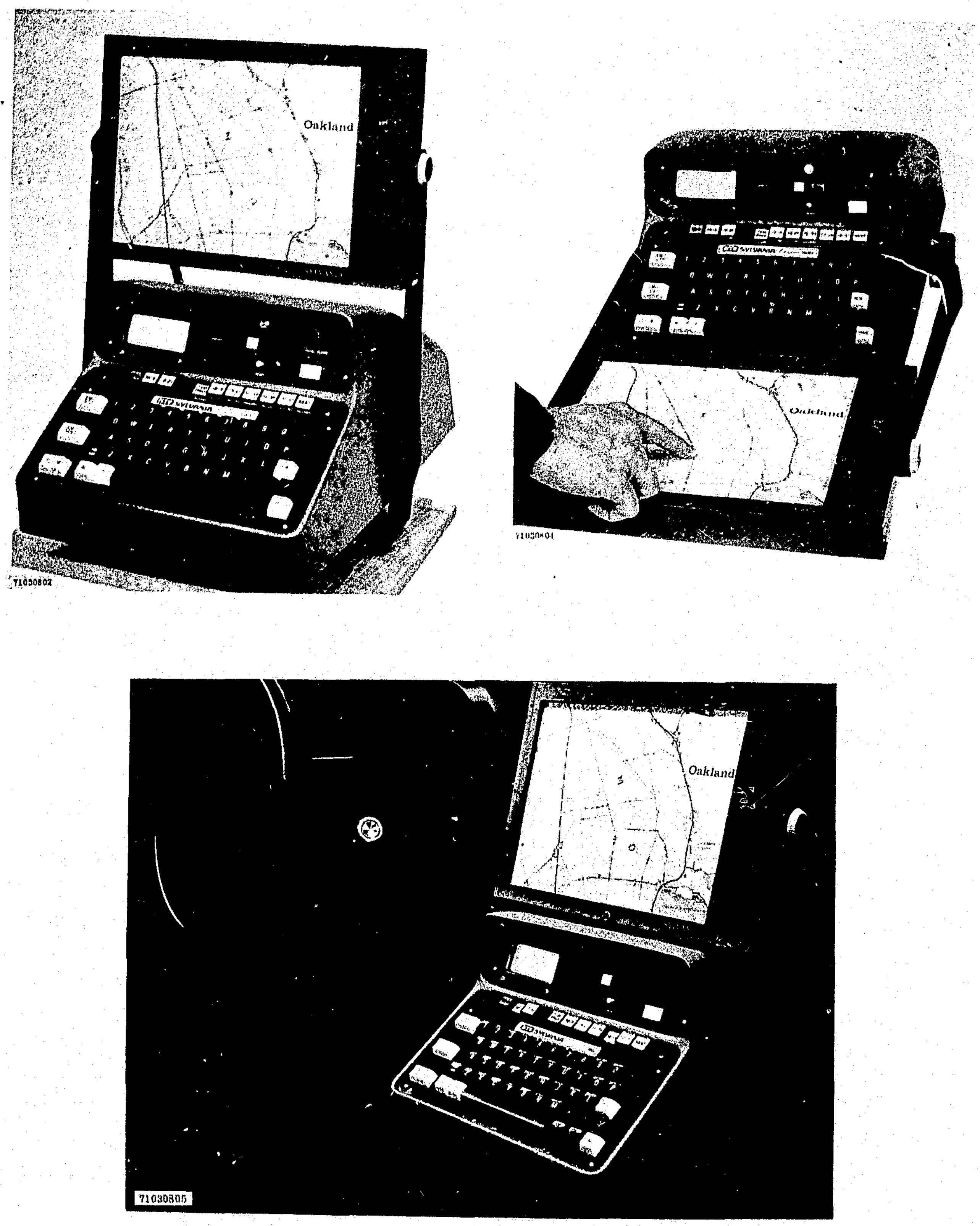

FIGURE 2.1–3. SYLVANIA/DIGIMAP WITH SYLVANIA/DIGICOM 300

to the computerized police information files which permits vehicle and name checks without utilizing voice communications. These instruments, being a first of their kind, are coming under close scrutiny from various law enforcement agencies and it is still too early to evaluate fully the project period. Certain difficulties with resolution and system downtime have been experienced and specific statistics have not been made available. But from all indications, dispatch efficiency has been greatly improved and field response time significantly lowered.

The goals of the Los Angeles Police Department PATRIC (Pattern Recognition and Information Correlation) system project are to provide efficient and effective use of crime modus operandi, suspect, vehicle, and stolen/pawned property information files for tactical and investigative purposes, provide users with filtered and distilled data in as timely a manner as possible, and maintain a dynamic system capable of being readily modified as tactical considerations change to reflect contemporary conditions. The PATRIC project has been planned in a three-step approach. Step I provides for the structuring of data bases, definition of data elements, and implementation of a limited test-bed operation involving six selected Los Angeles Police Department divisions. Operational information is supplied to the users while research is conducted to evaluate the utility of the data, and to determine tactical and technical requirements for PATRIC-type processing. Step II includes completion of design requirements, and selection of computer equipment and a basic program system to support specialized PATRIC processing. Step III calls for implementation of a City-wide operating system using specialized equipment. When completed, the system will provide an automated police information processing system capable of manipulating large volumes of crime report data rapidly, and relaying selected information to support line officers.

2.1.2 PRODUCTS DEVELOPED FOR THE LAW ENFORCEMENT ENVIRONMENT

Many software and hardware companies and information technology specialists have offered their services and expertise to police departments across the country to aid in the development and implementation of new advanced services or products designed for modern law enforcement applications. The following is a discussion of those that are in actual operation, part of a pilot program, or in stages of experimentation in various parts of the country.

To assist the police in determining their manpower requirements in answering the public's calls for service, the International Business Machines Corporation developed (LEMRAS) Law Enforcement Manpower Resource Allocation System to provide police administrators with geographic and time oriented data that assists in the allocation of patrol manpower. The system is designed to provide information concerning the projected average calls for service with corresponding average workloads on a near term basis available by geographic area and time periods. The information can then be utilized to assist the administrator in designing and/or reviewing patrol areas. The system does not predict crime or exact time and location of call for police service nor does it provide guidance for preventive patrol. But using well standardized statistical techniques, LEMRAS does forecast the average number of calls for police service that may be expected to occur in a given area during a given period of time, and the average amount of police time it will take to service those calls. Because of the high cost of patrol operations, any improvement in personnel deployment can have major importance, thus work and research is continuing in an effort to improve the techniques for the deployment of police agencies basic field forces.

To locate police cars and transmit their status through digital communication,The Boeing Company - Wichita Division has

developed (FLAIR) Fleet Location and Information Reporting to reduce response time for arrival at the scene of an incident and significantly improve the day-to-day efficiency and effectiveness of command and control features of law enforcement elements. FLAIR is a vehicle location and information system which automatically updates each vehicle's location and corresponding officer's status once a second and presents this information to the police dispatchers. The locations of all vehicles "available for assignment" are continuously displayed on a video map at each dispatcher's console. This gives each dispatcher a continuous picture of the deployment of the total "available for assignment" elements under his control. The system consists of four basic units as shown in Figure 2.1-4: The Vehicle Locator Unit, Base Station Unit, Computer Unit, and Situation Display Unit. The Vehicle Locator Unit in Figure 2.1-5 works on the fundamental navigation principle that if the original location of a vehicle is known, its location at any future time can be determined if heading and distance change are added to its original location. The heading and incremental distance moved each second are transmitted from the Vehicle Locator Unit to the Base Station Unit. The Base Station Unit interfaces with the Computer Unit which updates the vehicle location. The Situation Display Unit receives the vehicle location information from the computer and presents it at the proper position, in the form of bright spots on a video map-TV monitor. The computer, also, continuously updates the service status of each officer assigned to the vehicles by turning the officer status panel lights on and off. The control and status panels, which are part of the Situation Display Unit, serve to assist the dispatcher in accomplishing his command and control function shown in Figure 2.1-6. Since the dispatcher can view the continuous movement of his field forces, communication security can be provided by directing the officer to the incident by

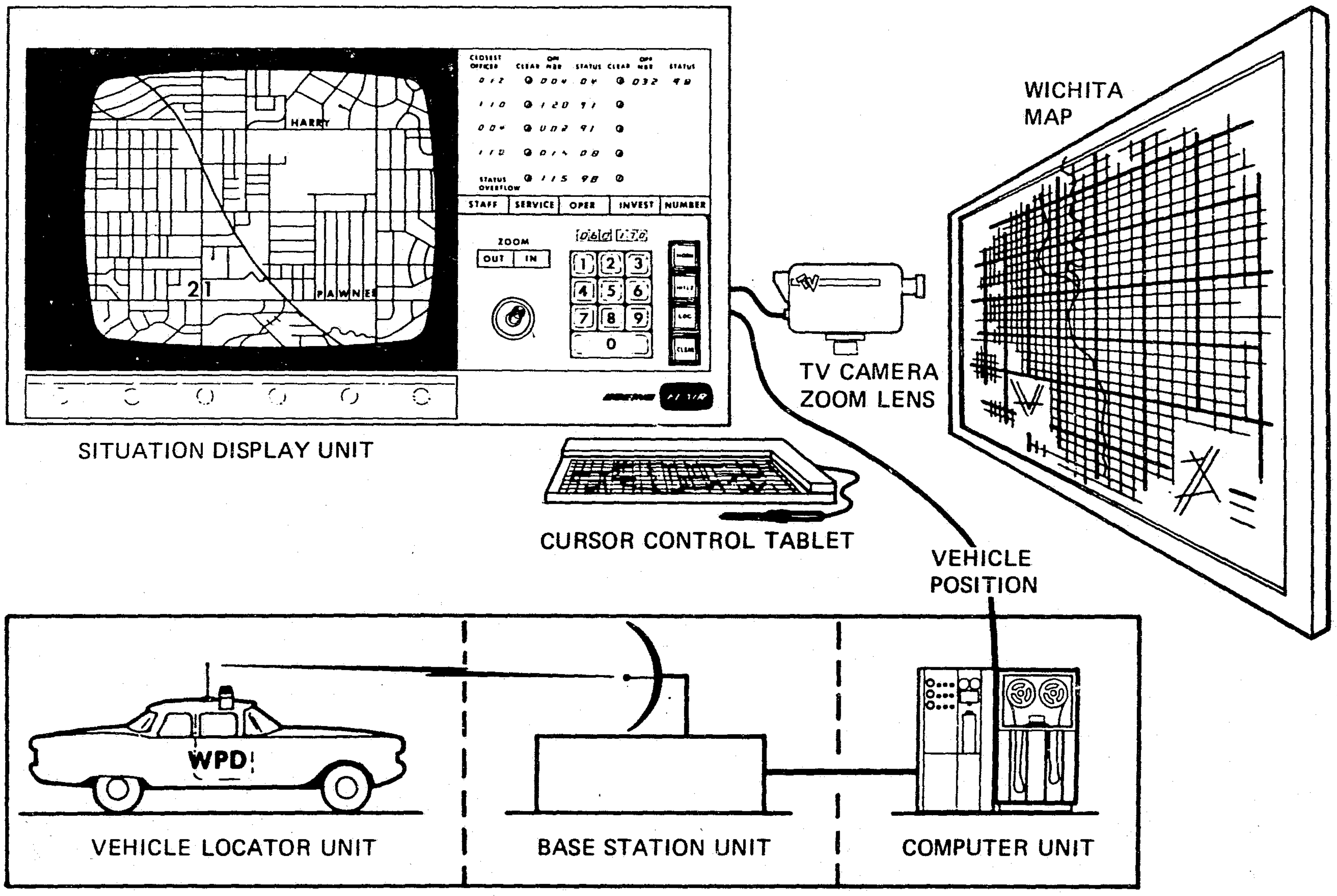

FIGURE 2.1–4. SYSTEM CONCEPT

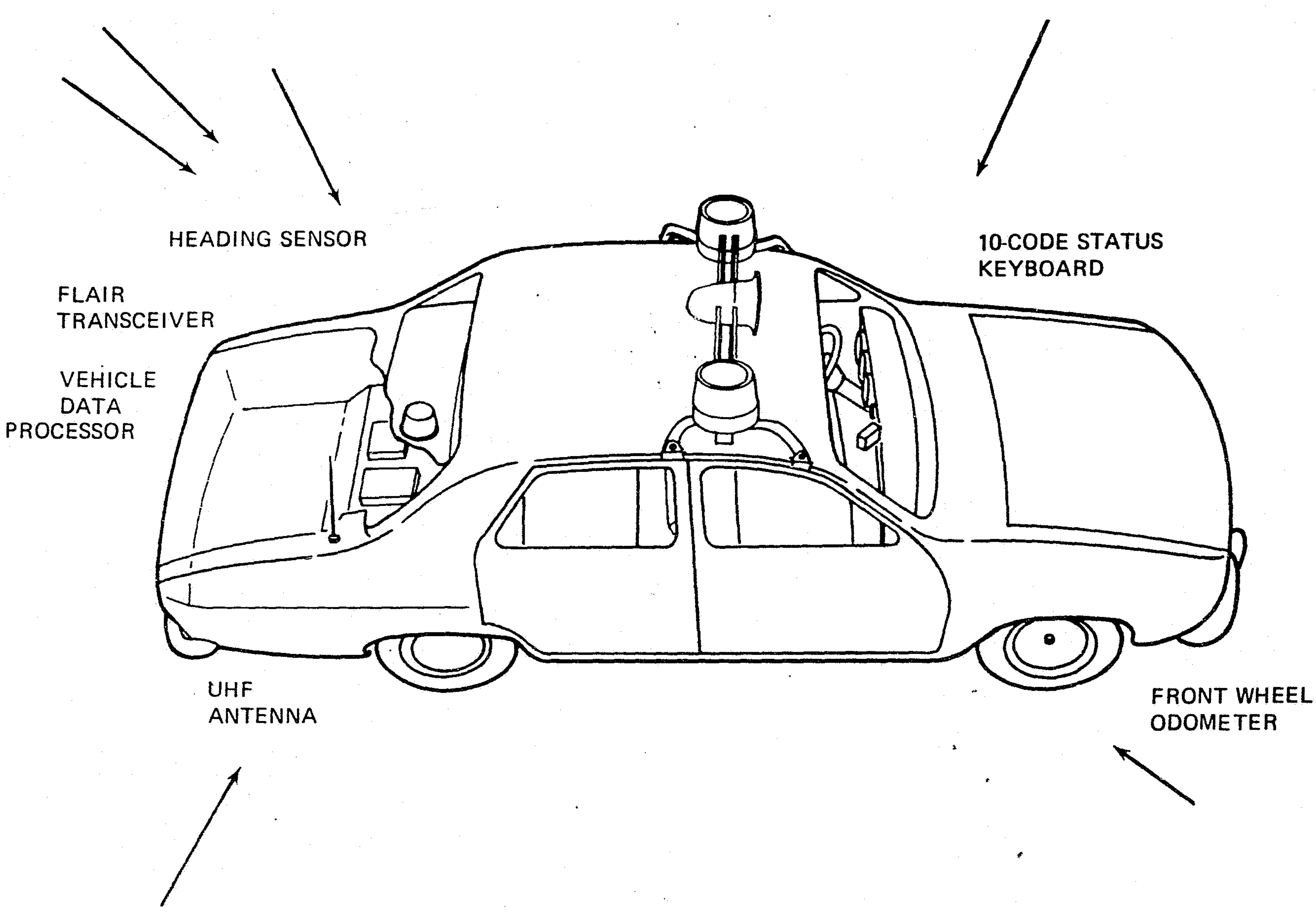

FIGURE 2.1–5. TYPICAL VEHICLE LOCATOR UNIT INSTALLATION

route to travel rather than by incident address. The dispatcher can also use this information to direct officers around barriers, such as street construction, and to assist the officers in finding an address. The operation of the system by the officers in the car and his status is transmitted by depressing two keys on the Vehicle 10 Code Keyboard as shown in Figure 2.1-7. This digital transmission of 10 codes from the police cars to the dispatcher provides communication security and reduces voice communication congestion. Testing and performance goals for the prototype system are still under evaluation and full operating results will not be known until the total functional checkout is complete.

The Patrol function being what it is, officers are away from their cars at varied times during a tour of duty. To communicate messages under this situation the Xerox Corporation has developed a Mobile Printer System which allows the element to receive hardcopy messages by radio. This provides fast, accurate information from the dispatcher concerning recently stolen autos, wanted persons, vehicle identification number, and firearms registration. The compact printer, as shown in Figure 2.1-8, is compatible with FM radio systems and permits digital messages to be transmitted and printed automatically. Each printer is capable of selecting, decoding, and printing at three levels of addressing--all call, group, and its own unique address. The heart of the system is the Xerox central translator that accepts digital information from a CRT display, computer, or punched paper tape. Information is translated into a matrix code for transmission. The Mobile Printer then decodes the information and silently prints permanent, high contrast black-on-white messages via electrography. The main advantage is the reduction of radio traffic channel loading, and message security since the silent printer cannot be monitored. The Police Departments of Gary, Indiana and Minneapolis, Minnesota have found this type equipment best suited for their needs.

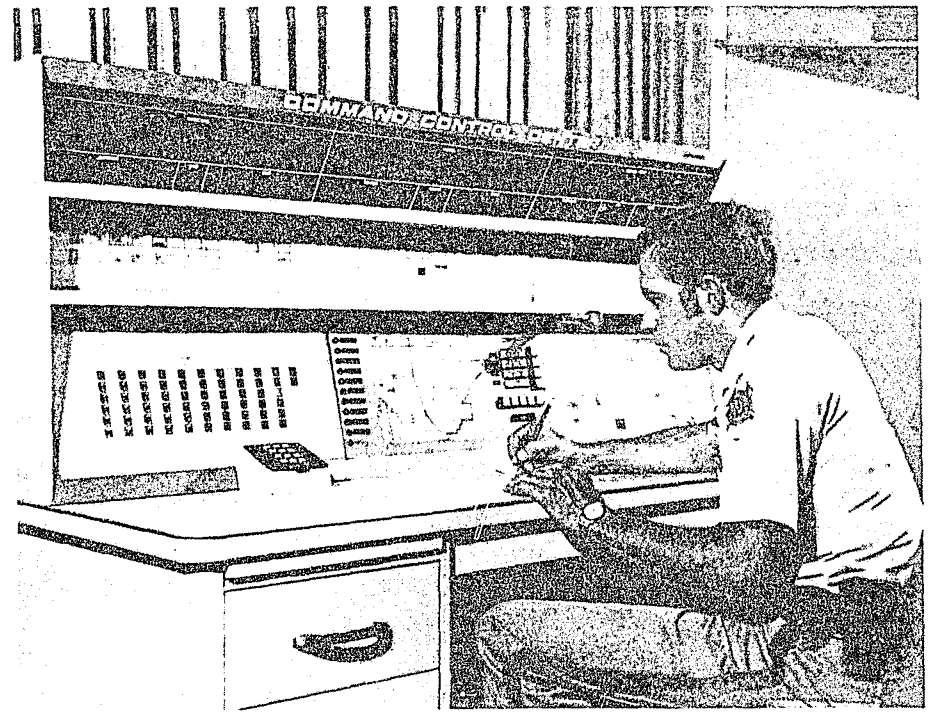

FIGURE 2.1-6 COMMAND AND CONTROL CONSOLE

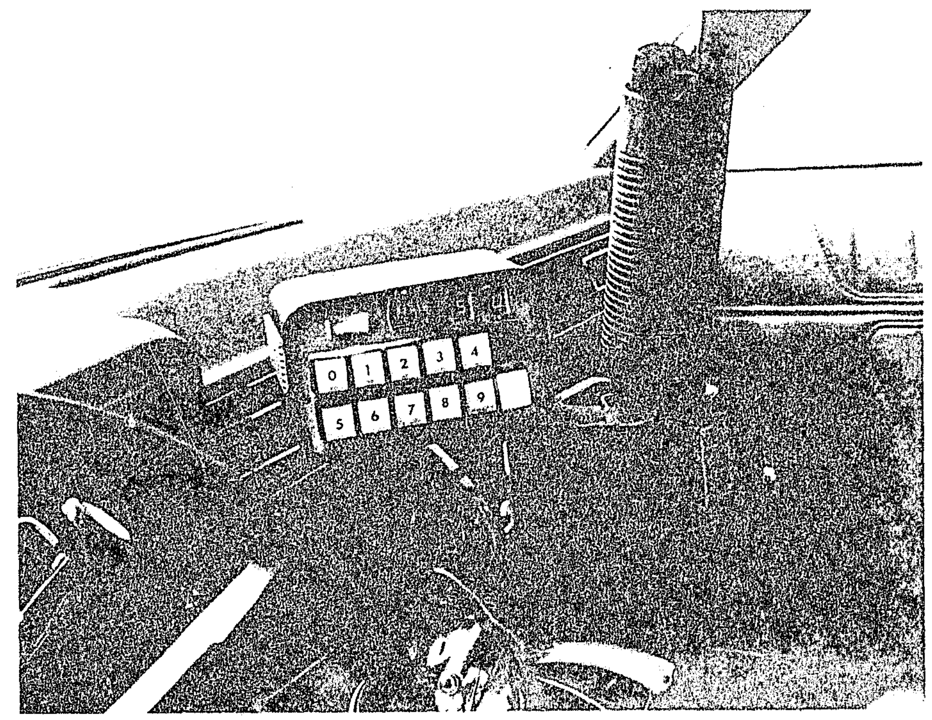

FIGURE 2.1-7 VEHICLE 10 CODE KEYBOARD

Data terminals are finding their way into police cars as companies such as IBM Corp., Kustom Electronics Inc., and others have introduced Mobile Terminal System which gives the officer on patrol a means of making direct contact with a central computer and the information contained therein. With mobile terminals, such as the one shown in Figure 2.1-9, inquires can continue regardless of how busy the dispatchers are. Data can be transmitted to and from the patrol car at 1,200 bits per second* and the radio frequency is not tied up while information is keyed or printed. These terminals are provided with a typewriter-like keyboard for quick, simple entry of name, license number or other inquiry information. Special-function keys permit designated message transmission by pressing a single designated key. The dot-matrix display feature of the Kustom terminal offers large, easy-to-read characters and a broad viewing area, while the self-contained printer on the IBM terminals turns out 21 character lines at the rate of 53 characters a second. With the hard copy print-out or visual display there is no need for the officer to take notes or lengthy descriptions of assignments, and multiple messages can be recorded while the officer is away from his car. With all dispatching in digital rather than voice mode, the possibility of unauthorized interception of police communications by criminals or others is greatly reduced. With full capabilities applied, an officer has the ability to enter his report directly via the terminal. Once he enters the type of incident, a specific format can lead through the desired information required supplying codes as needed. Date and time are automatically supplied by the computer, thus saving manual entry and increasing report accuracy. Through the use of these mobile terminals, in-the-field units and appropriate automatic switching in the command and control center, the work load on the dispatchers is lessened and the ability of field officers to send and receive information is greatly improved. As further

* or as limited by the bandwidth of the communications system

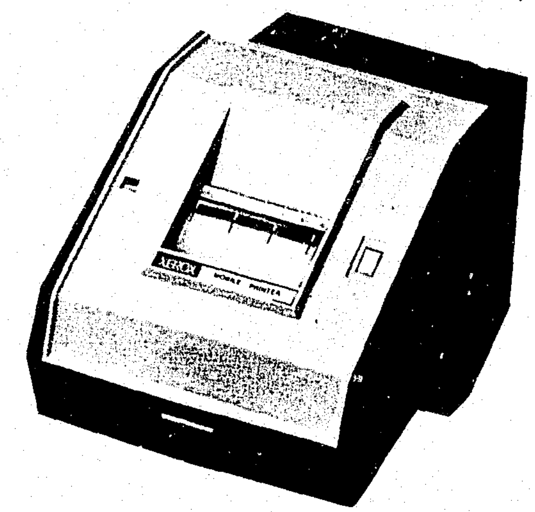

FIGURE 2.1–8 XEROX MOBILE PRINTER

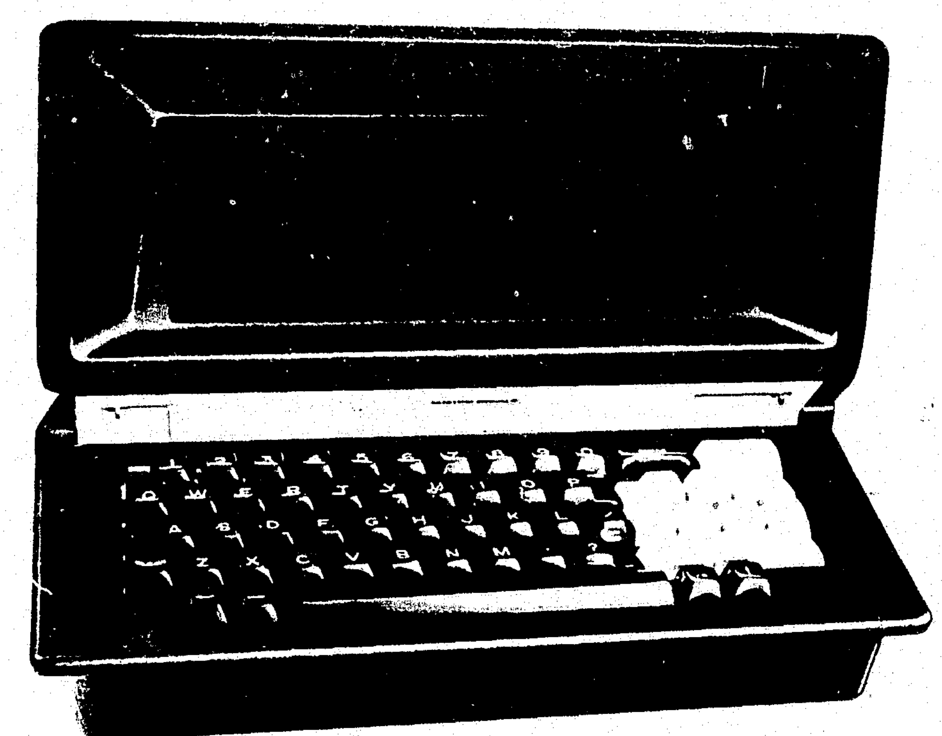

FIGURE 2.1–9. KUSTOM MOBILE COMMUNICATION TERMINAL

research is done and further refinements made, these and other similar devices will certainly take their place and play a vital role in strengthening law enforcement activities now and in the future.

Not only have the problems relating to Communications and field patrol functions been addressed, but companies such as Eastman Kodak have provided solutions and answers to records management for administrative and support functions through the development of advanced microfilm information recording and retrieval system. Designed for modern Law Enforcement Information Systems,the new MIRACODE (Microfilm Information Retrieval Access CODE) System provides for high speed storage and retrieval of mug shots, rap sheets, fingerprint cards, accident reports, arrest records, and motor vehicle information. The Atlanta Police Department has made use of this microfilming and search technology in the retrieval of finger prints. The fingerprint filming and coding technique is more individual than the standard Henry System, yet it is simple enough so that an experienced I. D. man can completely code a card in 3 to 5 minutes. Each finger is coded by two characteristics in addition to pattern type and finger number. Loops are coded radial or ulnar, and also by ridge count and core type. Whorls are coded by tracing type and by core type. Arches are coded plain or tented and by tent type. In addition each card is coded by sex, race, date of birth, and height. Thus by using all known latent fingerpring information and any known physical information, searching can be done in seconds. Once coded and filmed the cards are placed in an automatic threading film magazine. When request information is keyed into the MIRACODE Retrieval Unit, shown in Figure 2.1-10, the film is searched and each matching card is displayed in an enlarged, easy-comparison image on the viewing screen. The system has a well-conceived indexing plan. It is simply a systematic guide to follow for asking questions of the

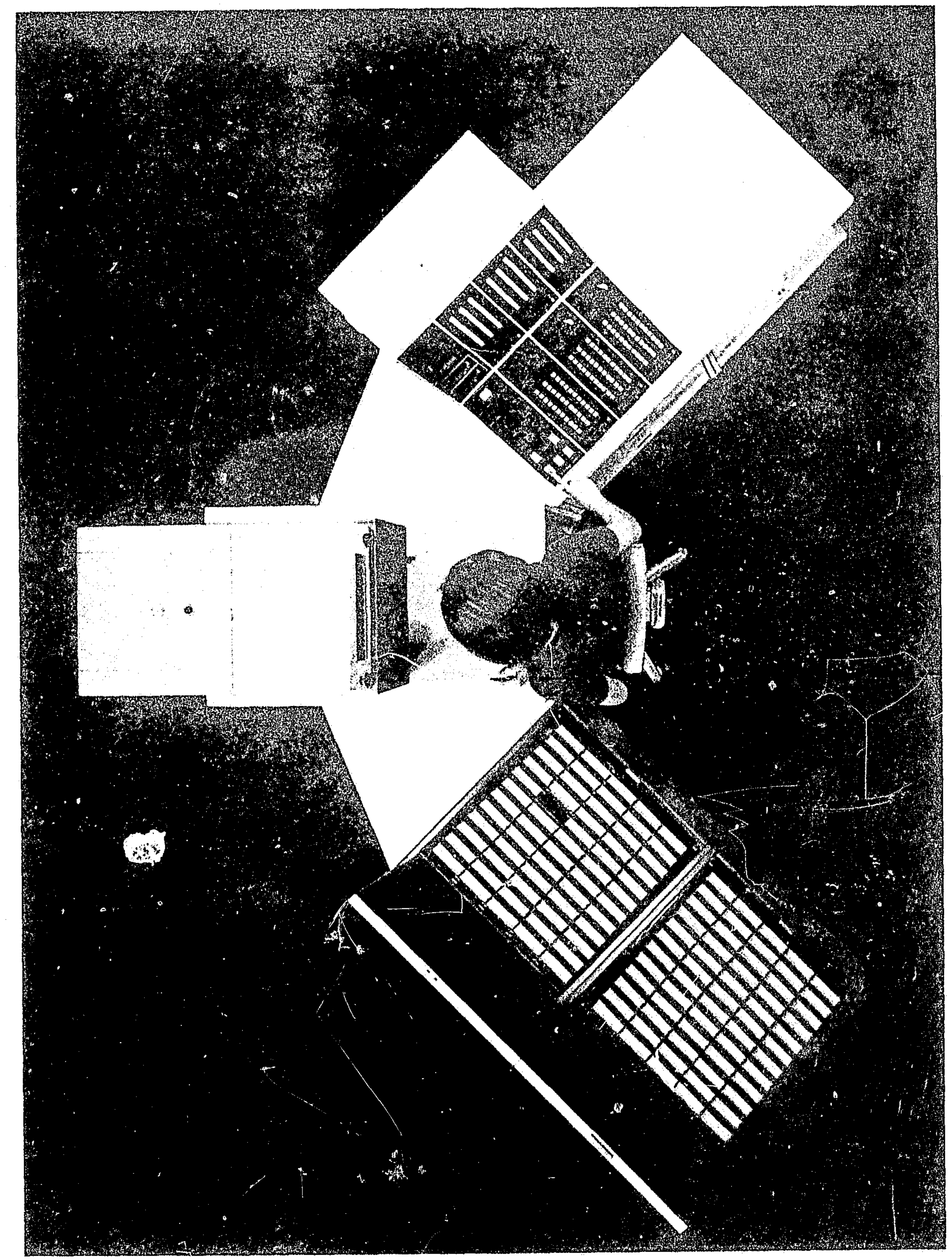

FIGURE 2.1-10. MIRACODE RETRIEVAL UNIT

system, compiled in a manner that can be depicted by numeric characters in the code field. Every document on the film is assigned an identifying code field, comprised of one or more code columns. Each column includes an arrangement of bits. The System reads these bit or binary codes to answer the keyed-in question in a matter of milliseconds. Code columns in combination are arranged to provide fixed and open code fields, depictting a million or more retrieval terms in making optimum use of machine logic search capabilities. At a glance the operator determines the microfilm access file magazine, the category, and selects the required range of search within that category. From the single Keyboard Control Unit and set of Retrieval Keyboards, all the basic functions of the system are performed by push-button control by the retrieval station operator. The retrieval system will find the document answering the request question, no matter where that document appears on the film - beginning, middle, or end. Because of this advantage, each magazine is open-ended and can be added to in a random fashion. Thus, supplements to offenses or additional information can easily be inserted.

The Atlanta Georgia, Texarkana Texas, and Shreveport Louisiana Police Departments and other southern Law Enforcement agencies have Miracode equipment installed and are storing and retrieving, mug shots, palm prints, fingerprint records, arrest, offense, and accident reports. These departments have found solutions to their paperwork problems through this new dimension in records filing and accelerated information retrieval. Paper costs, manual filing, and clerical man-hours have been greatly reduced and lost information and records are a thing of the past.

The Ampex Corporation has provided the marriage of computer technology and videotape recording with the introduction of Videofile Information Systems, which provides accurate sophisticated

high-speed search of electronic document images stored on videotape. The document is permanently filed for retrieval by a high resolution television camera which creates an electronic image on a video magnetic tape. A standard keyboard is used to enter an identifying member code. The recorder/reproducer records the document image and its identifying numbers onto tape. When an image is retrieved for viewing on a Display Section, the Buffer holds the images so they can be displayed continuously or printed out as hard paper copies through the electrostatic printer. Where data processing equipment already exists, the two systems can be interfaced by means of EAM cards, digital magnetic tape, or direct computer-to-computer interface. The Royal Canadian Mounted Police are using a Videofile installation for all their storing of fingerprints and reviewing and comparing various suspects' prints with those already on file for possible positive matches.

To further take the drudgery out of records management filing and retrieval, the Trans-A-File Systems Company, through digital technology, has developed a comprehensive automated electronic filing and retrieval system tailor made for law enforcement agencies. Although digital in origin, the Trans-A-File System is neither a computer, a microfilm system, a COM system (Computer Output Microfilm) nor an OCR (Optical Character Reader). The Trans-A-File System shares some of the characteristics and capabilities of these deivces but is the first of its kind to put selected elements of these technologies together to bring about total automation. Original source documents can be entered directly into the system where they are digitized and stored on magnetic tape for fast retrieval at local or remote locations in the form of paper copies or high resolution images on a CRT display. The main advantage is that the copy is an exact full-size duplicate of the entire source document, including signatures, drawings, photographs, narrative and etc. The

Process Control Unit directs the operation of each hardware unit within the system. It monitors and controls each device on a real-time basis and is completely flexible in terms of expansion. The basic unit as applicable to law enforcement is a filing unit, buffer unit, display unit, printer unit, high density magnetic tape unit, and the process control unit. Because of the system's capability to handle large volumes of assorted data, the Riverside County Sheriff's office has installed Trans-A-File equipment to aid in the development of an area-wide records center for the law enforcement and criminal justice agencies of Riverside County.

In summary, all papers and related surveys on Law Enforcement substantiate a sizeable degree of involvement and increased interest by police agencies with data processing communications and microfilming technology. As sophistication and professionalism are developed and state-of-the-art technology is advanced in police departments, and as a result of the continued impact of current and future federal assistance, it is projected that the development of equipment and applications will increase at a previously unanticipated rate.

2.2 INDUSTRIAL TECHNOLOGY APPLICABLE TO LAW ENFORCEMENT INFORMATION SYSTEMS

Since World War II, industry has turned increasingly to systems engineering methods for the solution of planning and operational problems. The space program, under the auspices of NASA, is a prime example of the successful employment of such techniques. In this Section we shall discuss some methods which could possibly be applied to law enforcement information management. The particular problem areas addressed will be:

1. File Management
2. Computer Information Retrieval
3. Car Location And Assignment
4. Beat Construction
5. Equipment Re placement And Overhaul
6. Statistical Analysis of Police Operations

2.2.1 FILE MANAGEMENT

Many law enforcement information systems today seem to be less automated than their industrial counterparts. As metropolitan areas grow one can expect the work load on the predominantly manual information systems to become intolerable. A case for systems analysis and subsequent automation of information management can be made.

Computer file management usually involves the following functions:

(1) File creation and maintenance,
(2) Data processing,
(3) Information retrieval,
(4) Data manipulation,
(5) Report preparation.

When data file dictionaries have been defined, the format of specific files has been described. Programs which are controlled by the file management system are created to perform the above functions. The development of such file management programs becomes a very important facet of the file management process. A prominent concept in data management, and consequently in file management, is the data base. The data base consolidates several files so that logically related data is placed in a common pool. For example, the Dallas Police Department could develop a property data base by consolidating files related to control of property. A central problem in connection with the data base definition is the organization of the file structure. The data base is user oriented and hence the data to be placed in the data base can be arranged in suitable "clusters" in order that certain organizational units which retrieve certain types of information will receive a high quality of service. The definition of such clusters can be made by the procedures of Bonner /9/ and Rocchio /10/. These procedures are designed to produce overlapping clusters by statistical analyses. With Rocchio's method, the number of clusters generated, the cluster size and the amount of overlap can all be controlled. There are a number of other weaker clustering techniques available /11/.

Data manipulation involves operations which are necessary to rearrange data in suitable form for further processing or for information output. This may involve merging, sorting, matching and scanning. There is considerable literature available on these topics since much research effort has been applied to these areas. A discussion of these topics is contained in /3/, /11/, /40/.

Report generation may require considerable software development. Much effort can be expended in the development of report generation methods and reference /3/ treats report generation programs. A report generation package for assistance in the management decision

making process should be flexible, i.e., all possible report requirements by management should be easily and rapidly accommodated.

2.2.2 EVALUATION OF A COMPUTER INFORMATION RETRIEVAL SYSTEM

Cleverdon /24/ has put forward six criteria by which a user may evaluate a retrieval system.

They are:

(1) Coverage - the average time required for a response by the system,

(2) Time lag - the time from the inquiry to response,

(3) The form of the output,

(4) Recall - the proportion of the pertinent material retrieved in a response,

(5) Precision - the proportion of retrieved material which is pertinent,

(6) User effort.

Criteria (1), (2) and (6) are relatively easy to evaluate while any assessment by criteria (3) is governed by aesthetic and other factors. Criteria (4) and (5) are more difficult to deal with. An overriding consideration in any information retrieval system is cost and any retrieval scheme must be economical for the user.

Some measures of recall and precision will now be introduced. There are four parts into which a file may be partitioned with respect to inquiries by a set of users:

(a) Not pertinent and not retrieved,

(b) Pertinent and not retrieved,

(c) Pertinent and retrieved,

(d) Not pertinent and retrieved.

What type of information is pertinent for a particular user set? This question may have to be settled by the user family. Given pertinent information has been identified for a particular user sets, we can define the recall as

$$\frac{\text{no. data items in (c)}}{\text{all pertinent data items}},$$

and the precision as

$$\frac{\text{no. data items in (c)}}{\text{total retrieved}}.$$

Data items can be ranked by assigning similarity coefficients to them. A set of pertinent data items can be arranged in decreasing order of similarity. One measure of recall is the normalized recall:

$$1 - (\Sigma r_i - \Sigma i)/n(N - n),$$

where n is the number of relevant data items, N is the total number of data items in the system and r_i is the rank of data item i, with i = 1, . . . , n. A normalized precision measure is

$$1 - (\Sigma \log r_i - \Sigma \log i)/\log[N!/(N - n)!n!].$$

The following simplified measures of recall and pre cision are also used:

$$\Sigma i / \Sigma r_i \; ; \; \Sigma \log i / \Sigma \log r_i.$$

(Note: all logarithms are taken base e.)

Some attempts have been made to optimize information search using feedback information /33/. Distance functions have been defined and an inquiry is deemed optimal if the difference between the average distance from the inquiry to the pertinent data item set and the distance from the inquiry to the nonpertinent data item set is maximized; however, user effort can increase because of the feed back requirement.

The above approach to evaluation of information retrieval systems is an example of the types of techniques which should be applied to data base development for the Dallas Police Department.

2.2.3 CAR LOCATION AND ASSIGNMENT

The car location problem as envisaged here consists of calculating, to a prescribed level of accuracy, the position of a patrol element in the field. The calculations can be carried out every t time units; t must be taken small enough to insure that a patrol element will not have the opportunity, on average, to move an excessive distance from the last known location. The location point of a car can be a grid point in the plane, or an arc in the street network. It may be possible to arrange the grid system so that most or all grid points lie on streets or intersections. It seems that the important factor here is the correspondence between location points and the street network.

If it is assumed that the location of a car in a street can be calculated readily, the problem of assigning a car to a crime incident has to be solved.

Let (N, A) denote the street network, where N is set of all street intersections and A is set of all streets. The elements of A will be called arcs and will have directions associated with them. Thus if a_1, a_2 are in N, and (a_1, a_2) is in A, there exists a set of traffic lanes from intersection a_1 to intersection a_2. Using the network concept, turn penalties can be introduced. Each turn will have a time penalty which is finite or infinite. An infinite time penalty implies that travel along this set of traffic lanes is not allowed. The time to traverse an arc (a_1, a_2) in A, denoted by $t(a_1, a_2)$, is the time necessary to travel along the street from intersection a_1 to intersection a_2. Travel time is necessarily a function of weather, traffic density, number of lanes, and so on. Thus $t(a_1, a_2)$ is a random variable. The distribution function for this variable would have to be estimated.

Given that the coordinate of the position of a patrol element can be obtained every t time units (seconds say), it may be possible to use an algorithm such as Dijkstra's /27/ to calculate the nearest element to the scene of a crime. However, in large networks this procedure could require excessive time. Instead of using time as arc length in (N, A), physical distance to be traveled can be used. Typically, in network route calculations many routes are not likely to be part of the shortest route: A large number of routes between an element and the scene of a crime could be eliminated. The distance calculation could be reduced by storing a distance matrix in a permanent file and accessing a matrix element. These files could be constructed for each beat, and would contain the shortest distance between each distinct pair of street intersections. The 'Cascade' algorithm of Murchland et al. can be utilized for these computations /25/.

If the number of street intersections is large, maintaining a street network file requires a considerable amount of storage. Various other approaches to the assignment problem can be visualized in order to overcome, at least in part, this difficulty. It is common practice in traffic engineering to define centroid nodes; these nodes represent a smaller subnetwork and distances between centroids are calculated /29/. The definition of a centroid is critical here.

It may be feasible to collect pairs of intersections into sets, with each set defined so that the distance between each pair of intersections in the set is within certain limits. When a distance is to be calculated, the set is identified by an appropriate mapping.

When a location 'point' is taken as a point in the plane and as the street network has regular characteristics, the 'taxi-cab' metric could be used to calculate the distance of an element from the scene of an incident. The distance calculation could be carried out quickly.

The concept of distance applied to position of a patrol element from a crime scene can be expanded. So far in the discussion,

physical distance along streets or travel time along streets has been emphasized. Selecting a patrol element which is nearest in either of these senses may not necessarily be the best overall policy in terms of controlling the mean time to travel to the scene of a crime incident over a given period of time.

2.2.4 BEAT CONSTRUCTION

The political redistricting problem and the beat construction problem have many common features. If a region is to be divided into political districts, centers for each district can be located and population can be assigned to each district so that district populations are as near equal as possible, i.e., almost equal representation is achieved. (It is necessary to insure that no two districts share any population - one man, one vote.) Algorithms for solution of such problems already exist /7/.

The beat construction problem involves determination of beats in order that patrol elements assigned to these beats will have approximately the same work loads. This problem can be considered as an integer program.

Let k be the number of beats to be assigned and n be the number of regions (say census tracts) in a city. Take

$x_{ij} = 1$ if region R_j is assigned to a beat with center as region T_i,

$= 0$ otherwise.

The central region could contain a substation.

Let n_{sj} denote the number of occurrences over a given period of crime s in region j. (Crimes are presently categorized by the Dallas Police Department according to the Uniform Crime Reporting scheme /31/.)

The IACP uses certain weights for various categories of crime. On this basis, a weighted crime load for each region can be developed.

If w_s is the weight for crime category s, then the weighted crime load for region j, denoted by C_j is

$$\sum_s w_s n_{sj}$$

The measure of effectiveness used is

$$\Sigma\, \Sigma\, (D^2_{ij} C_j)\, x_{ij},$$

where D_{ij} is the distance between the centers of region i and region j. This function takes into account distance and crime incidence; it can be considered a measure of inertia of weighted crime load. Restrictions on the allowable crime level in a beat i can be expressed as

$$aCx_{ii}/k \leqslant \Sigma C_j x_{ij} \leqslant bCx_{ii}/k$$

where $C = \Sigma C_j$ is total weighted crime load over all regions, and $0 \leqslant a, b \leqslant 1$. The quantity C/k is the average weight crime load per beat.

The beat construction problem can now be stated as the problem of finding the minimum of

$$\Sigma\, \Sigma\, (D^2_{ij} C_j)\, x_{ij},$$

subject to

(1) $aCx_{ii}/k \leqslant \Sigma C_j x_{ij} \leqslant bCx_{ii}/k, \quad i = 1, \ldots, n,$

(2) $\sum_i x_{ij} = 1, \quad j = 1, \ldots, n,$

(3) $\Sigma x_{ii} = k,$

(4) $x_{ij} = 0 \text{ or } 1, \quad i, j = 1, \ldots, n.$

Condition (2) insures that region j is assigned to only one control region i, while condition (3) insures that k central regions are used.

The algorithm of Hess et al. /7/ can be used to solve this problem.

The concept of a center for a region can be interpreted in different ways. For instance, the center can be located at approximately the center of gravity of the region area. Alternatively, one can consider the portion of the street network lying in the region and define a subnetwork center in the following fashion. Denote that part of the street network in the region by (N' j, A); here N' is the set of street intersections and A is the set of streets. Where a street intersects the boundary of the region, the intersection point can be considered a street intersection and added to the set N'. (If a street intersection from N' falls on a boundary, then no new intersections need to be added to N'.) Let the augmented set of street intersections be denoted by N. The new street subnetwork is (N, A) and its diameter, d, can be defined as

$$d = \max(D_{ij} : i \neq j)$$

where D_{ij} the length of the shortest path from intersection N_i to intersection N_j. If N_i and N_j are not connected by a street, then the associated street length is taken to be infinity. The radius of the region can be defined as d/2. In order to locate the center of the region, one determines a street intersection such that the distance from this intersection to any other intersection is less than or equal to d/2. This intersection can be found by calculating the distance between all pairs of intersections using, for example, the 'Cascade' algorithm of Murchland et al. /25/.

In the calculation of shortest path from intersection N_i to intersection N_j, turn penalties and one way streets can be considered. Turn penalties are dealt with by augmenting the network or by constructing a psuedo network as done by Caldwell /28/. There exist comprehensive computer program packages for computations of these types /29/.

2.2.5 EQUIPMENT REPLACEMENT AND OVERHAUL

The Dallas Police Department operates a fleet of patrol cars and thus is concerned with maintenance and overhaul problems. In this section a method of calculating an overhaul and maintenance policy is outlined. Suppose an (N-1) - year planning period is to be used, and let c_{ij} denote the sum of the expected operating costs and purchase costs in period (i, j) - less the expected salvage value at the beginning of period j. The problem can be represented by a network; the nodes correspond to years and the arcs have length c_{ij}. The network for a 5-year planning period is shown in Figure 2.2-1.

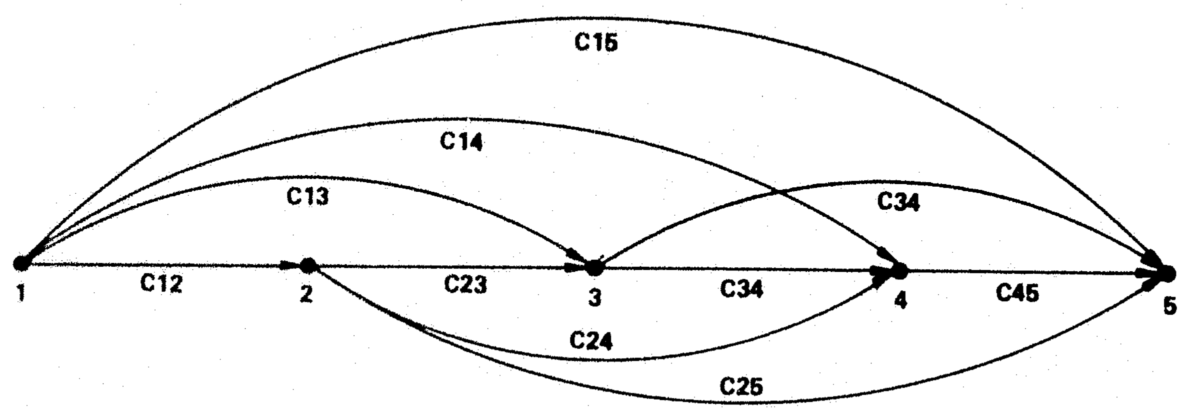

FIGURE 2.2–1.

Notice that this network does not contain any cycles. The least cost policy corresponds to the length of the shortest path from node 1 to node N. A dynamic programming recursion can be written for solution of this problem /34/.

The model discussed above can be refined to include major overhaul program costs. If necessary, the planning period can be divided into one month segments.

What has been described is a simple deterministic version of the replacement problem. A stochastic replacement problem can be received in the following way. Consider again an (N-1) - year planning horizon. Suppose that equipment may break down before some planned replacement in period t + k, where k is the length of time a new piece of equipment is to be used. Thus, breakdown can occur at period t + j, where $j < k$. In this event, replacement is made in time period t + j + 1. Take k as the length of replacement interval, and let p_j be the probability the equipment breaks down for the first time during period j of usage; $\Sigma p_j = 1$. If r_j is the cost of operating the equipment period j without breakdown occurs during using period j where s_j is a penalty cost for breakdown. An optimal policy can be defined as a policy which minimizes expected discounted cost. The problem can be solved using dynamic programming.

2.2.6 STATISTICAL METHODS

Many phenomena associated with police operations can be considered in terms of probability density functions. In this study, it was found that a negative exponential density function adequately described certain input processes. Thus, for example, the interarrival time density function for calls for service from the public was approximated by a negative exponential density function.

Police activity, in large part, is generated by crime incidents in the field. The occurrence of these incidents is random in nature. At present, the city is divided into beats. Continuous crime sampling in these beats could be carried out and tolerance levels on crime activity could be set, based on the available manpower and other factors. This type of continuous sampling is utilized in quality control methods in industry /41/. Data collected in this manner could possibly be used to forecast crime levels in various sectors of the city over the near term.

The density functions associated with such processes as telephone clerk service time, expediter service time, dispatcher service time could possibly be approximated by members of the Stacy family /8/; if a random variable v has a Stacy type distribution, its density function has the form

$$f(v;a, b, c) = |c|\, v^{bc-1} \exp[-(v/a)^{c}]/(a^{bc}\Gamma(b)),\ v > 0,$$
$$= 0,\ v < 0.$$

The Stacy family includes the Gamma family, the Weibull family, the Erlang family, the Maxwell, Rayleigh and normal families. It could be useful to put together procedures for goodness-of-fit tests. Such tests could be used to study various operation times and ascertain if their distributions can be approximated by members of the above family.

An important factor in police service is the response time for a service call from a member of the public. This response time includes telephone clerk and dispatcher service time and travel time for a patrol element. Approximate distributions for these important times could be very useful in attempting to improve response time. The probability of occurrence of a crime incident on a particular street can be of importance in construction of a distance matrix from a street network. A discrete bi-variate density function could be employed; the street network can be thought of as a regular lattice in the plane. One could also label street intersections and use a univariate discrete density function to describe crime incidence.

2.2.7 COMMENTS

The areas described above are examples of areas in police work where good, solid results can be achieved by drawing from the fields of police science, statistical analysis, computer technology, cartography and urban traffic analysis and control. Unfortunately, further work in these areas is beyond the scope of work on Operation LEADER. However, the above areas will be referred to in Phase III, as part of the work to be done in developing some specifications for use with the Unified Data Base.

3.0 SYSTEM TRADE-OFF STUDIES

3.1 MODELING AND ANALYSIS

The modeling and analysis section of this report deals with the formulation of mathematical models in order to represent the present configuration of specific entities of the Dallas Police Department Information System. These models, described in detail in this section, are based on the statistics contained in Appendix A, Parts 1 and 2, and the evaluation by both LEADER and Dallas Police Department personnel. Block diagrams, response time charts, cost evaluation and alternate configurations are presented in this section as the results of the modeling effort.

3.1.1 SUBSYSTEM MODELS

3.1.1.1 COMMUNICATIONS SECTION MODEL

The Communications Section is the source of the majority of incoming requests for service from the Dallas Police Department. For this reason, the Communications Section was picked as a candidate for modeling. Figure 3.1-1 is a block diagram of the communication subsystem. The following major functions are identified: telephone clerk, expediter, computer interface, dispatcher, and patrol element. The flow of information through the Communications Section is generally along the path described below. Information enters the system via the telephone clerks in the form of a call for service. The telephone clerk then makes a decision, based on the nature of the call, to either handle the request himself, give the request to an expediter or to forward the request to the dispatcher. When an expediter receives the request, he either takes it immediately or finishes his present assignment and then

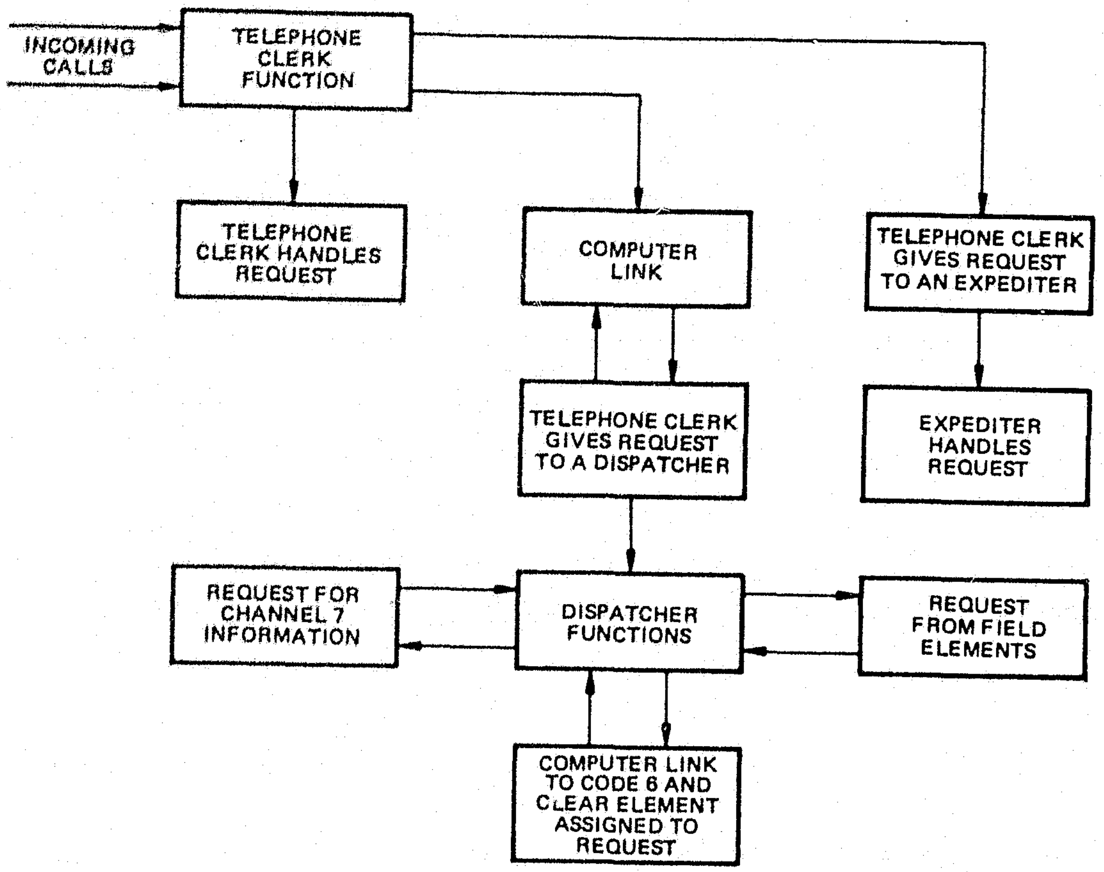

FIGURE 3.1–1 COMMUNICATIONS MODEL OVERVIEW

deals with the request. When the dispatcher receives the request, an available element is dispatched to the scene and information concerning the request is logged into the computer.

The dispatchers handle the NCIC and field initiated requests as well as calls for service from the public.

3.1.1-2 PATROL MODEL

The Patrol Bureau was chosen for modeling because it represents one of the main arteries of information flow within the Dallas Police Department. In addition, the Field Elements of the Patrol are a direct visible interface with the public. These reasons indicate that effective

management control of this section is a necessity, and precipitated the in-depth study of the Patrol operations.

The Patrol Model Simulation is designed to facilitate the study of information flow through the various Divisions of the Patrol Bureau.

Figure 3.1-2 shows the basic operation performed by the Patrol Element and the interfaces that exist between the Patrol Element, the Communication Section, the Public and the Reports Section.

Information enters the Patrol Division from the Communications Section via the dispatchers and is directed to a particular element in a specific district. The element then interfaces with the dispatcher when he arrives on the scene and again interfaces with the dispatcher after his interface with the public. During this process, the dispatchers

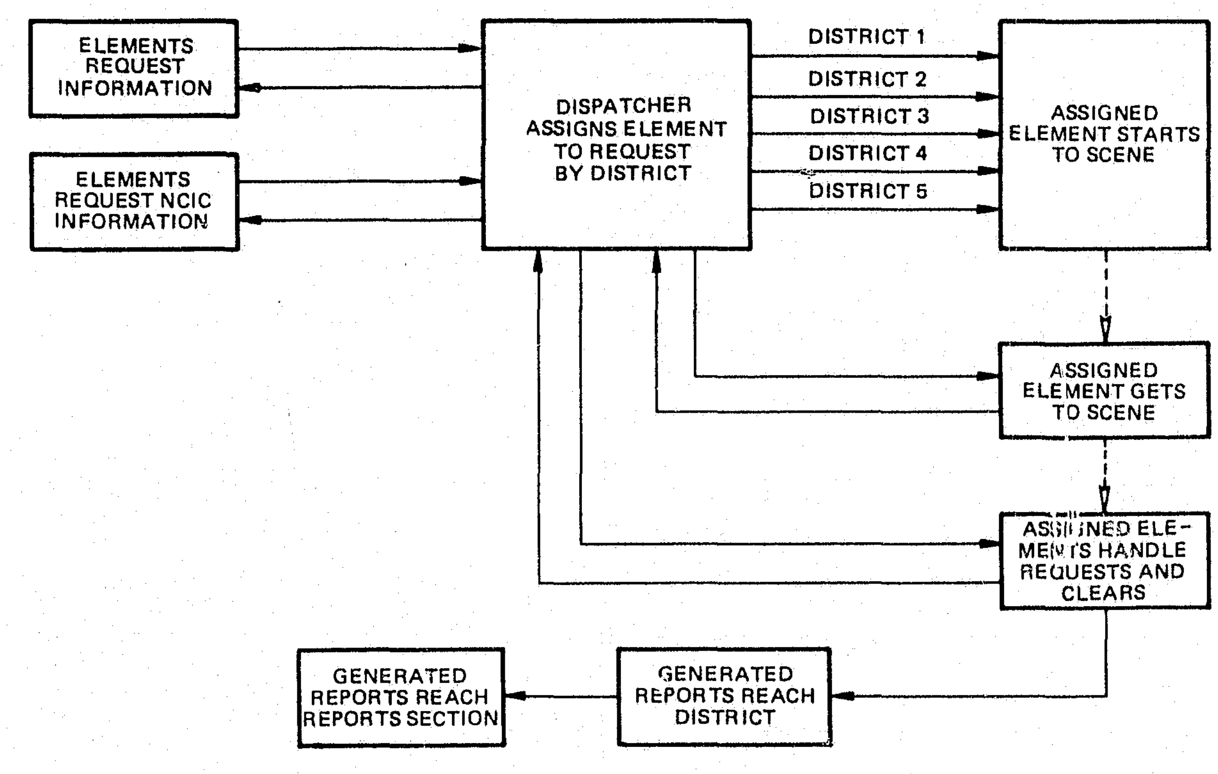

FIGURE 3.1–2. PATROL MODEL OVERVIEW

also handle general information requests and requests for NCIC information.

Another process that is examined in the Patrol Operations Model is the flow of information from the Patrol Element to the substation, if applicable, and then to the Reports Section.

3.1.1-3 REPORTS SECTION MODEL

The Reports Section of the Dallas Police Department is responsible for a large amount of valuable data concerning the public and police personnel. This section was modeled because of its position in the overall information system and the strong interface that exists between the public and other agencies and bureaus in the Dallas Police Department.

The operations performed on information in the Reports Section are as follows: Information generated in the form of a report (Offense/Incident Reports, etc.) comes into the Reports Section from various areas. These reports are then reviewed for completeness and correctness by the staff reviewers. The staff reviewers also note any need for the NCIC terminal operator to obtain the report. If needed, the NCIC terminal operator performs checks and updates NCIC files and returns the report for further processing. The report then goes to the update section; here the information contained in the report is used to update and correct existing records or create new records in the computer files using a VDT (Video Data Terminal). The report is then reproduced for distribution to relevant sections and is finally filed in the open shelf files. Figure 3.1-3 shows the sequence of functions which can be performed on a report.

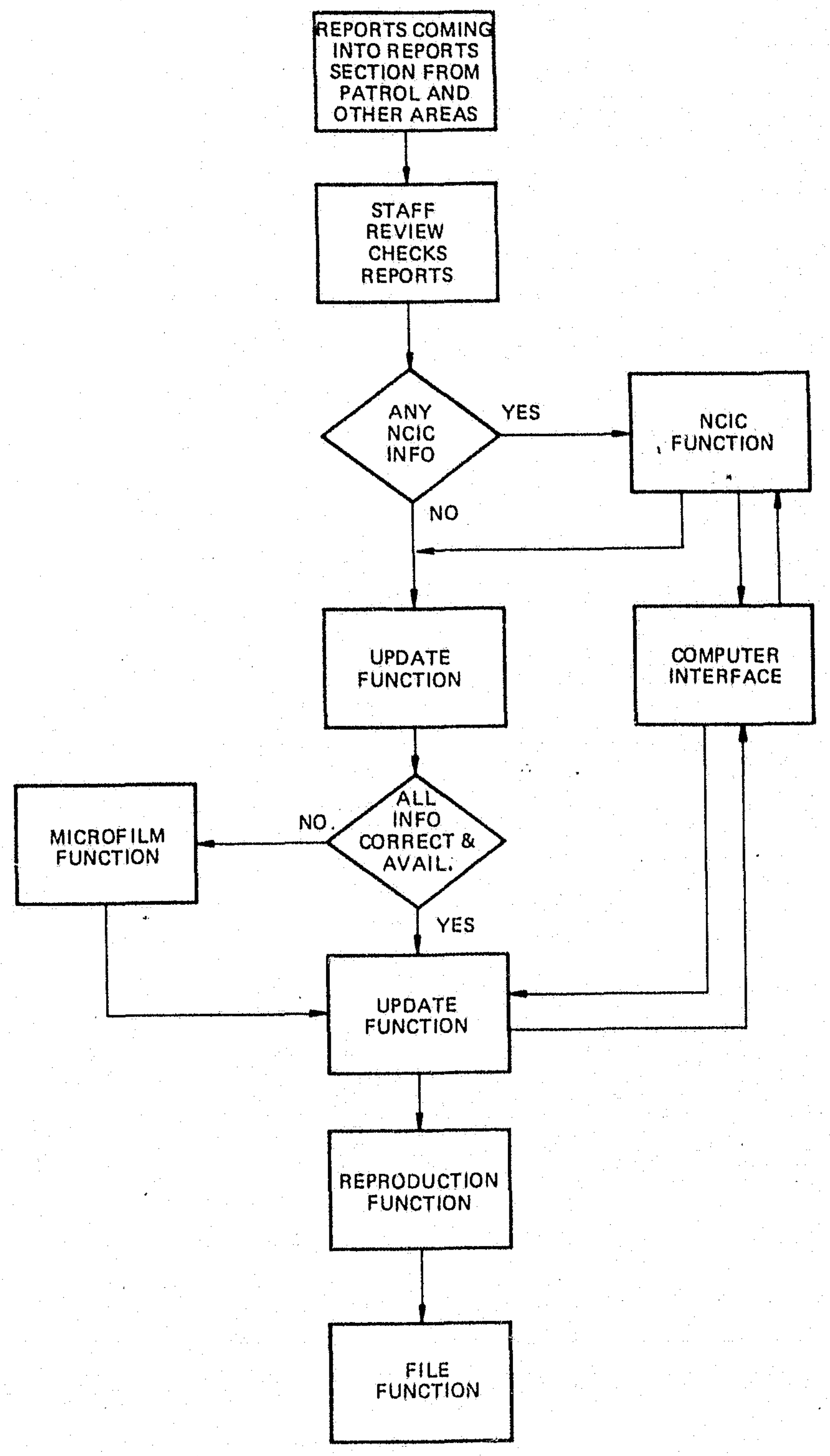

FIGURE 3.1–3. REPORTS MODEL OVERVIEW

3.1.1.4 IDENTIFICATION SECTION MODEL

The Identification Section of the Dallas Police Department maintains all criminal record files that are accessible by agencies and personnel both inside and outside the Dallas Police Department. Most operations in the Identification Section involve the access of files and the updating of these files. These tasks are very time consuming and this type of repeated manual process is consistently error prone. The functions performed by the Crime Scene Search Unit and the Polygraph Unit are not incorporated in this model.

Hence nine major functions are identified in Figure 3.1-4. These functions are: Front Desk, Microfilm, Clearance Request, Fingerprint, Other Bureaus, Detention Services, Courts, Dallas Police Department Personnel, and Reports Section Interface.

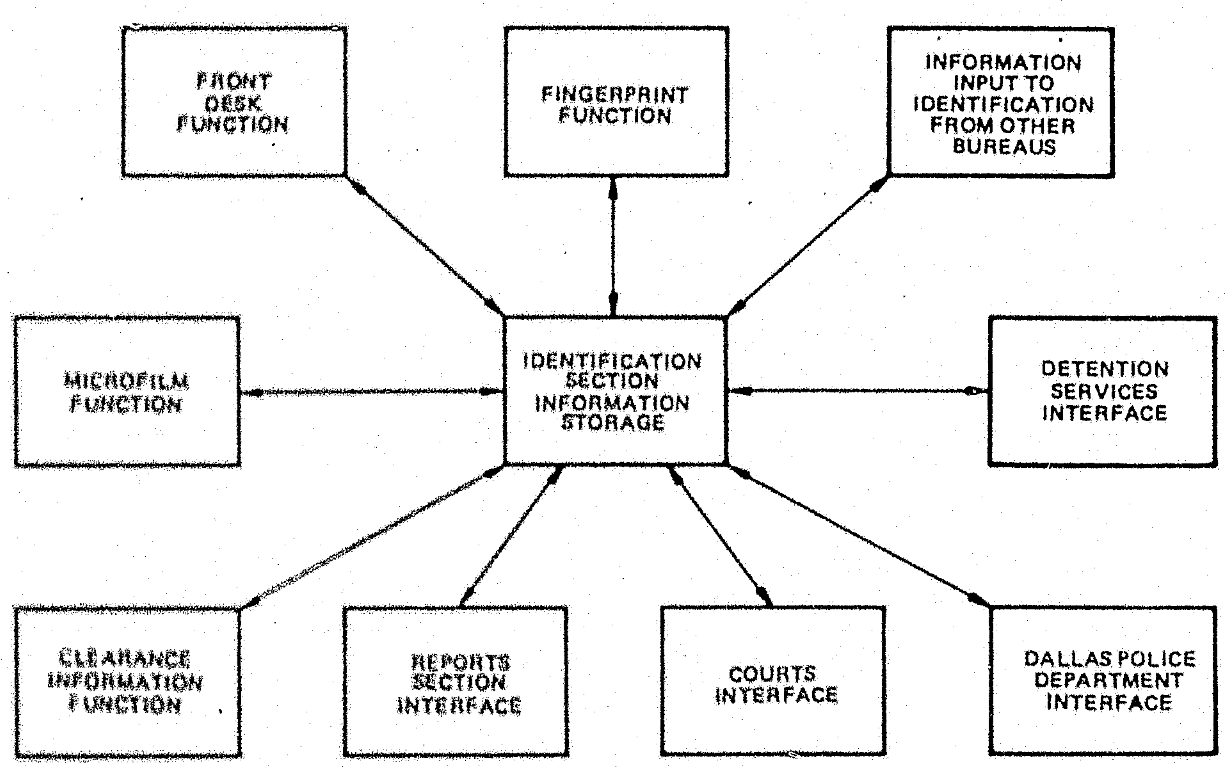

FIGURE 3.1-4. IDENTIFICATION MODEL OVERVIEW

3.1.2 DISCUSSION OF SUBSYSTEMS MODELS

3.1.2.1 COMMUNICATIONS SECTION MODEL

The main information source for the Communications Section is in the form of incoming calls on two trunk lines. The inter-arrival time probability distributions for these calls have been approximated by negative exponential distributions. Goodness-of-fit tests were conducted in these cases using the Kolmogorov-Smirnov test /39/. The results of the tests are presented in Table 3.1-1.

A certain percentage of incoming calls are 'lost' to the system because of telephone clerks being busy, impatience on part of the caller and other reasons. To account for this, a small number of calls is randomly removed from the system before they can be assigned to a telephone clerk. The statistics for queue 19 contain lost call counts.

Calls are distributed with equal probability among the telephone clerks. Associated with each call is an initial service period during which the clerk obtains relevant details and decides on the destination of the call. Thus the call may be routed to a dispatcher or to an expediter, or the call can be processed entirely by the telephone clerk. The initial service period time distribution was approximated by a negative exponential distribution. An estimate of the percentage of calls remaining with the telephone clerks was obtained by sampling the call file. Likewise, an estimate of the percentage of calls handled by the expediters was arrived at from a call file sample.

Figure 3.1-5. contains data related to calls which were processed entirely by telephone clerks. The telephone clerk processing time distribution was approximated from a frequency distribution derived from a call file sample.

In the model, calls were assigned to each expediter with equal probability, Estimates of the expediter processing times

TABLE 3.1-1

GOODNESS-OF-FIT TESTS

Trunk Line	Sample Size	Maximum Deviation D_n	Acceptance Limit .05 Signifance Level
STA-ITR	67	.075	.166
CO-ITR	56	.130	.182

were calculated from the call file sample; this process time distribution was approximated by a frequency distribution. The time required by the telephone clerk to transfer a call to an expediter was taken to be negative exponentially distributed. Figure 3.1-5 contains some statistics for calls which terminate with the expediters.

When the telephone clerk decides a call is dispatcher bound, appropriate information must be passed to the computer. The time for this transfer of information by the clerk is determined from a frequency distribution derived from a call file sample. Computer process time was estimated by experienced personnel in the Communications Section to be approximately 7 seconds: These times were calculated in the model by sampling from a uniform distribution over the interval [3, 11].

Calls are assigned to dispatchers by use of a frequency distribution which was obtained from a call file sample. The time required to dispatch an element is calculated from a frequency distribution derived from the call file. Figure 3.1-5 contains statistics for dispatch times, i.e., time elapsed between receipt of a call and the dispatch of an element.

Patrol element travel times are taken to be negative exponentially distributed as are service times at the scene. In re-

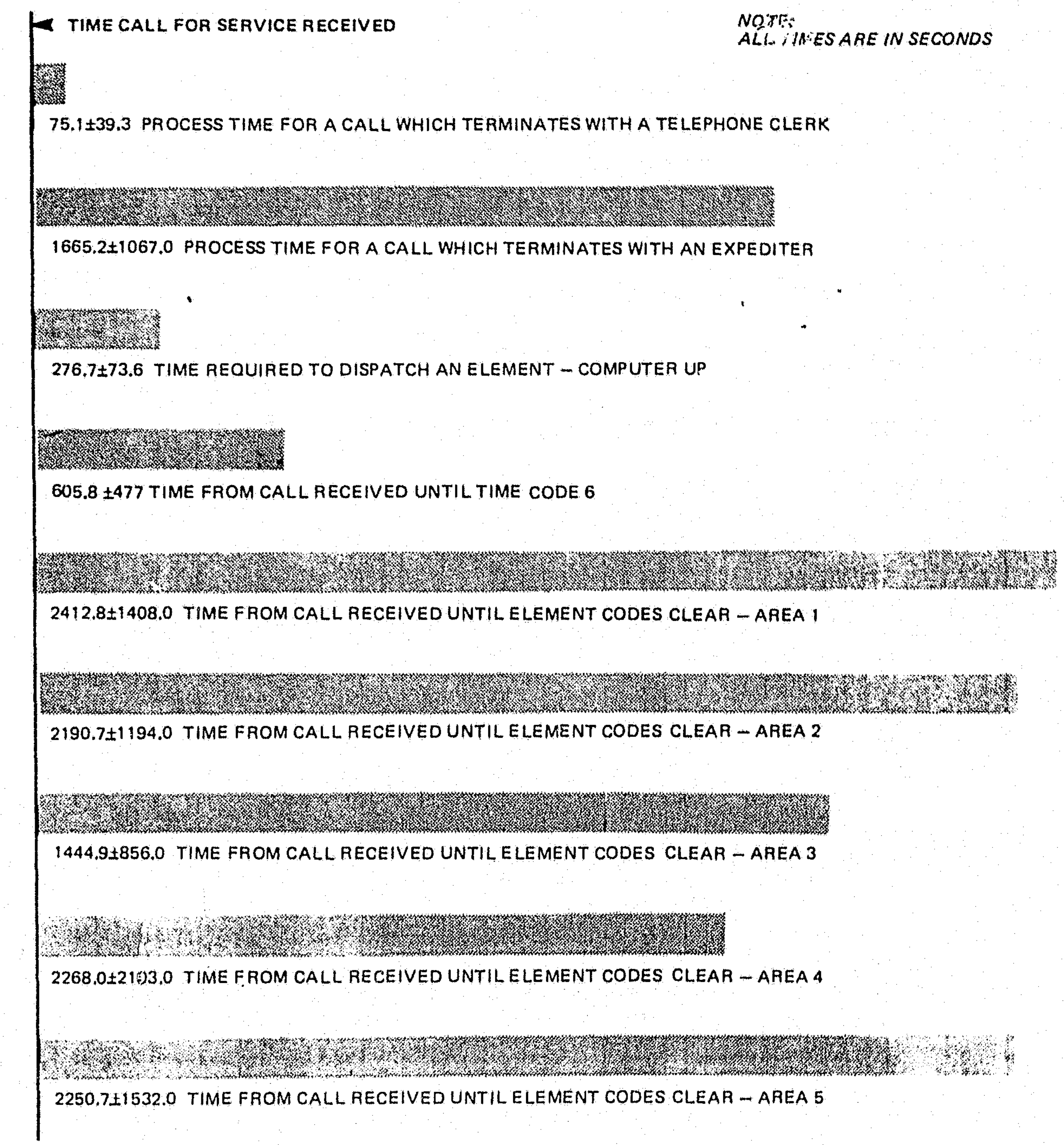

FIGURE 3.1–5. COMMUNICATIONS SECTION MODEL – LOW ACTIVITY (SHEET 1 OF 3)

NOTE:

ALL TIMES ARE IN SECONDS

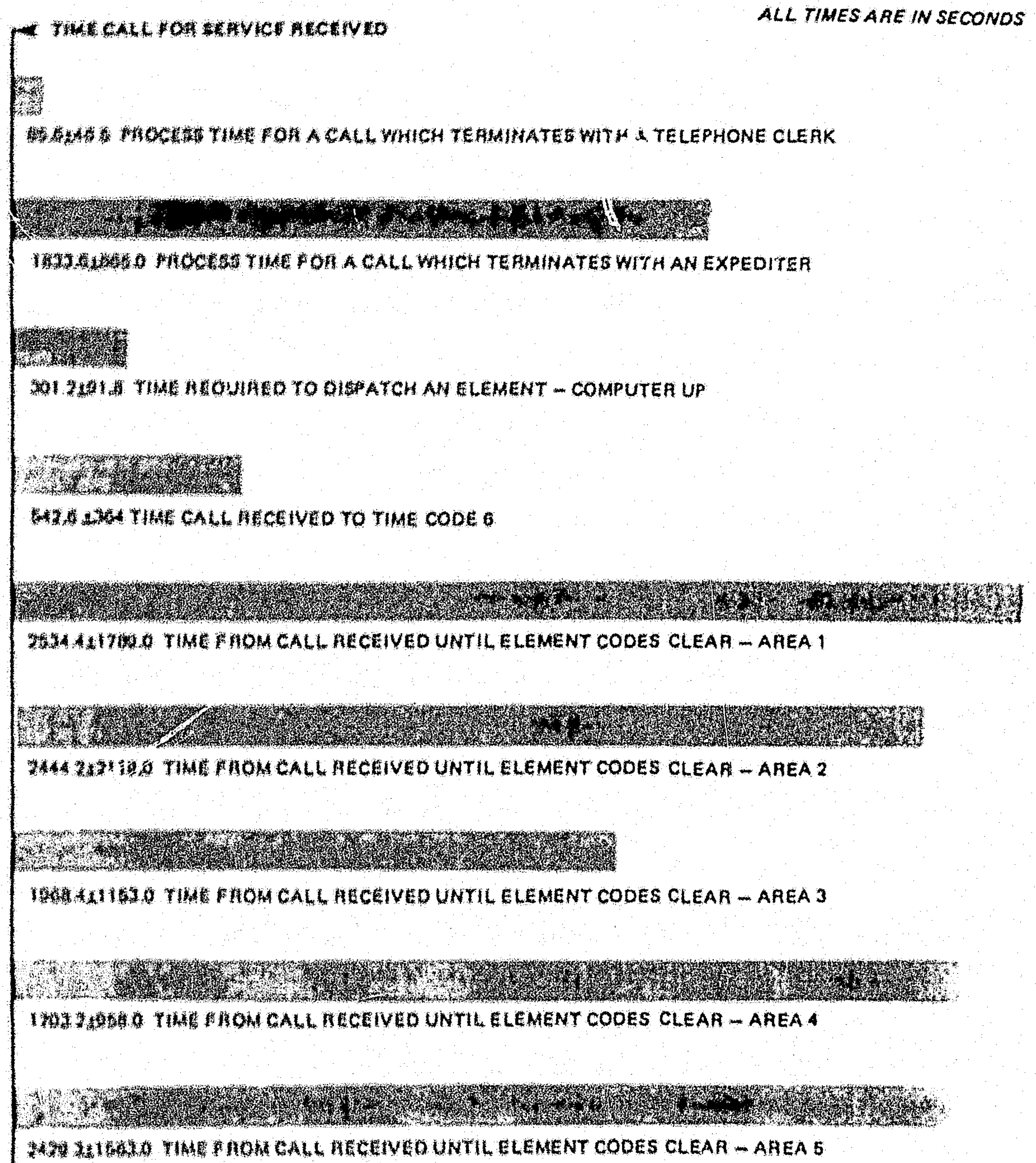

FIGURE 3.1-5 COMMUNICATIONS SECTION MODEL – HIGH ACTIVITY (SHEET 2 OF 3)

NOTE:

1. ALL TIMES ARE IN SECONDS
2. DOWN DURATION WAS 500 SECONDS
3. TOTAL RUN TIME WAS 30 MINUTES AND ELEMENTS ARRIVED AT THE SCENE ONLY IN AREAS 1 AND 3

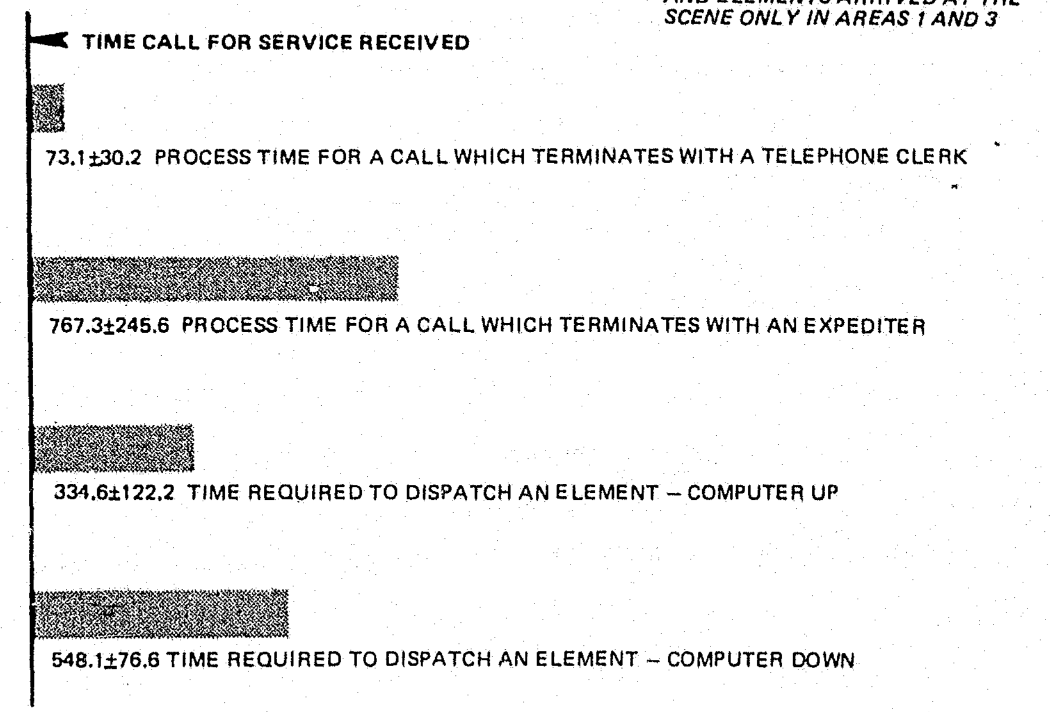

FIGURE 3.1–5. COMMUNICATIONS SECTION MODEL – COMPUTER DOWN – LOW ACTIVITY (SHEET 3 OF 3)

gular police terminology, time from dispatch to code 6 and time from code 6 to code clear are considered here. The time for a patrol element to complete the paperwork has been estimated from discussions with personnel and is calculated in the model by sampling from a uniform distribution over the interval [900, 2700]. Statistics for overall process times for dispatched calls are contained in Figures 3.1-5.

Computer down-time is started at a random time for the simulation run. The down-time interval can be randomly assigned. A down-time interval of 500 seconds was used in a down-time simulation. Figure 3.1-5 contains statistics for the down-time mode. The process times for the dispatchers and patrol elements are calculated using the data employed for the up-time simulations. The telephone clerk transfers a call to a dispatcher using an X-card; the time to process an X-card has been estimated by experienced personnel and is calculated in the model by sampling from a uniform distribution over the interval [210, 270].

Channel 7 is reserved for handling NCIC and other such requests. Calls for channel 7 service are taken to be negatively exponentially distributed. Dispatchers have to accomodate calls from patrol elements. This field-initiated communication process is modeled by generating calls from a negative exponential distribution and attempting to assign them to a dispatcher. If the dispatcher is not available, the call is terminated. The duration of field-initiated calls is calculated from a frequency distribution which was obtained from the call file. The process time for channel 7 calls by dispatches is taken to be negative exponentially distributed.

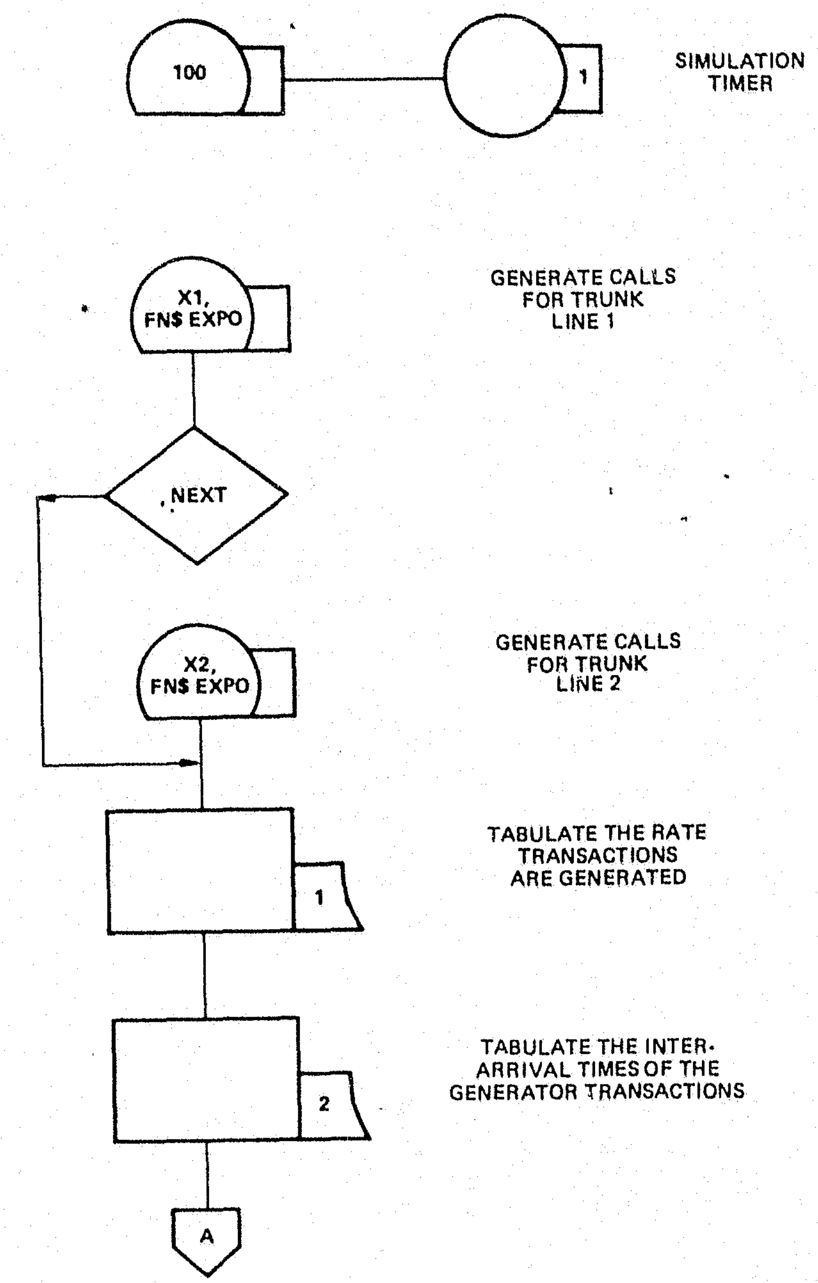

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 1 OF 13)

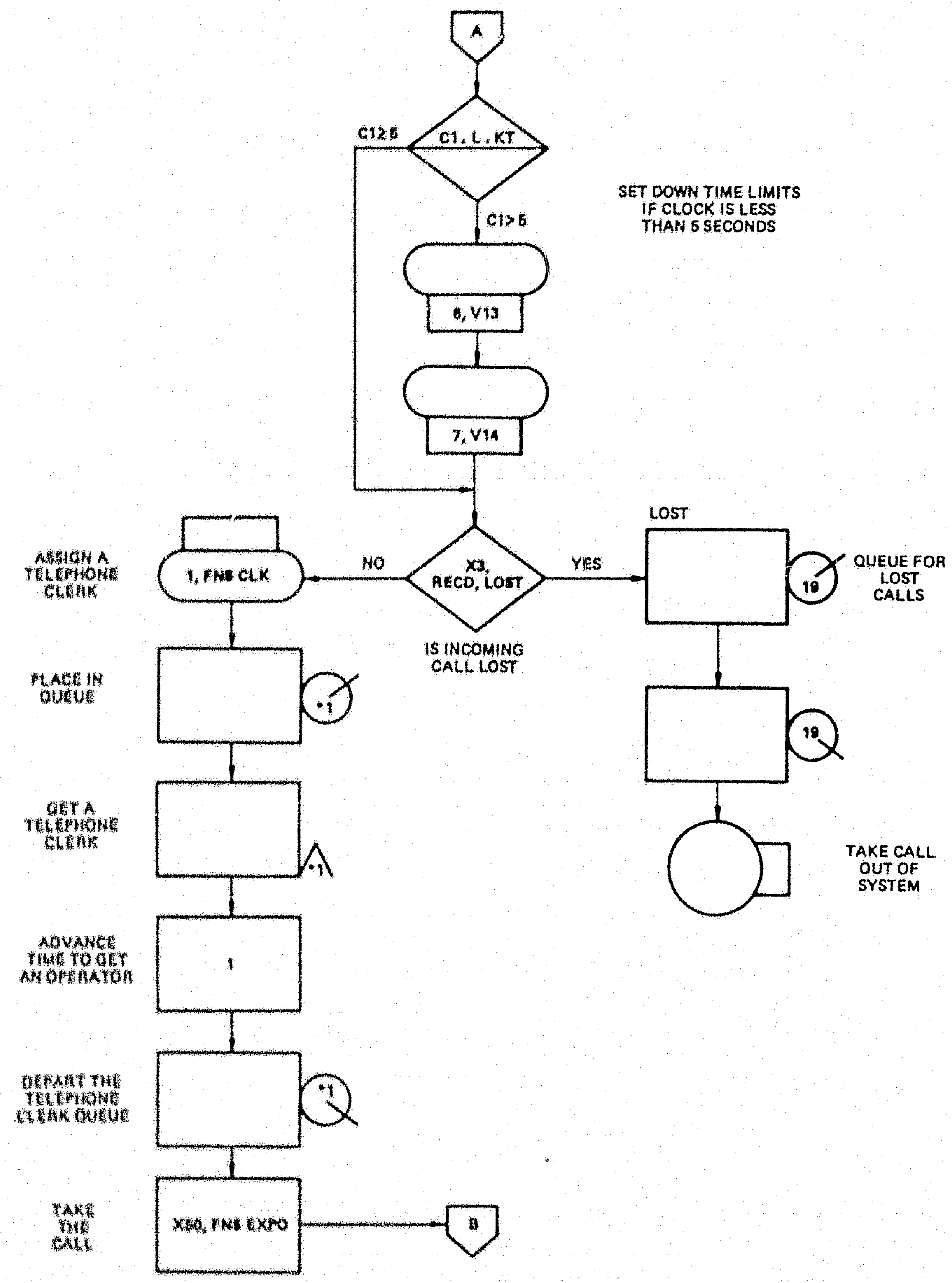

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 2 OF 13)

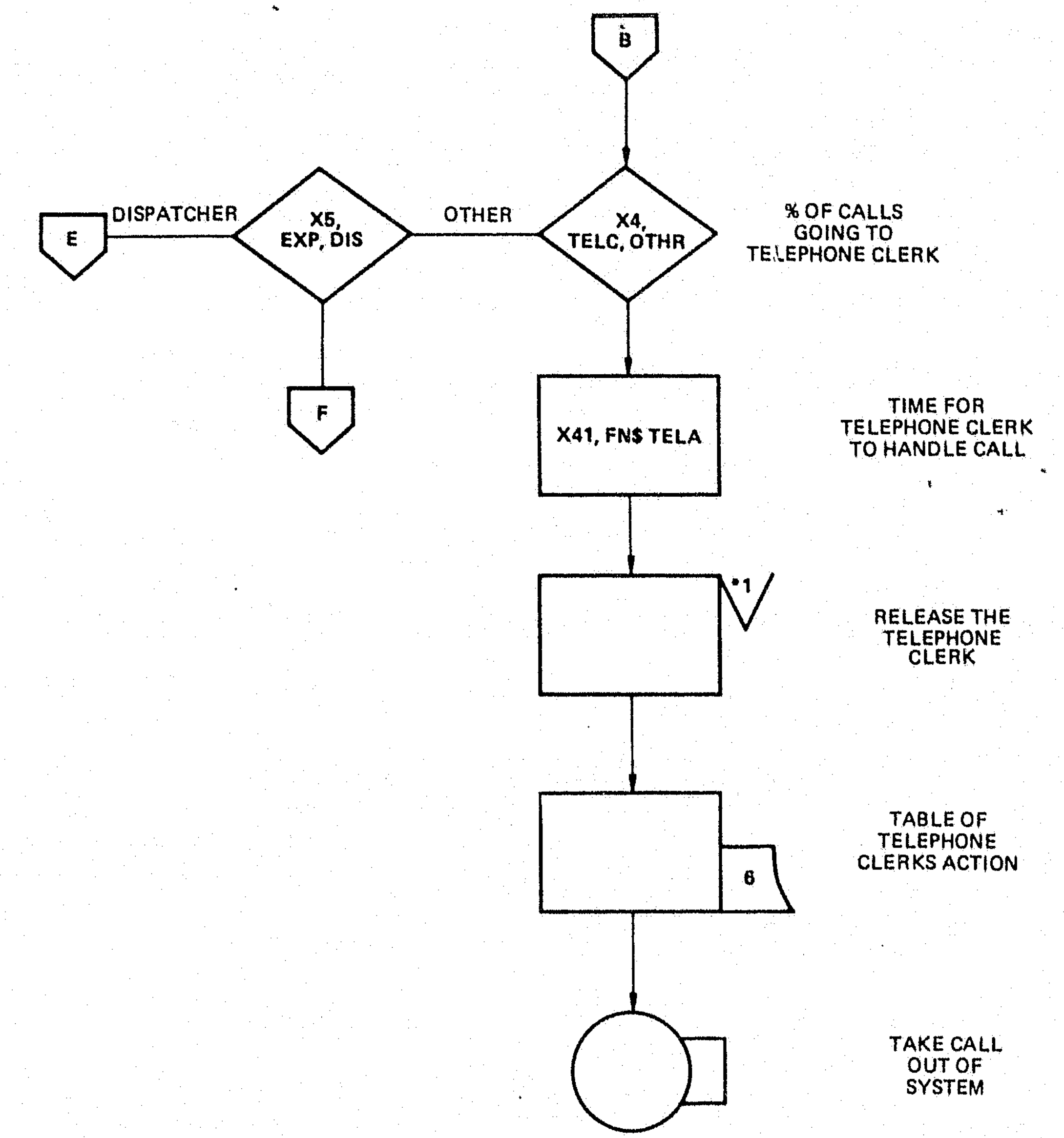

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 3 OF 13)

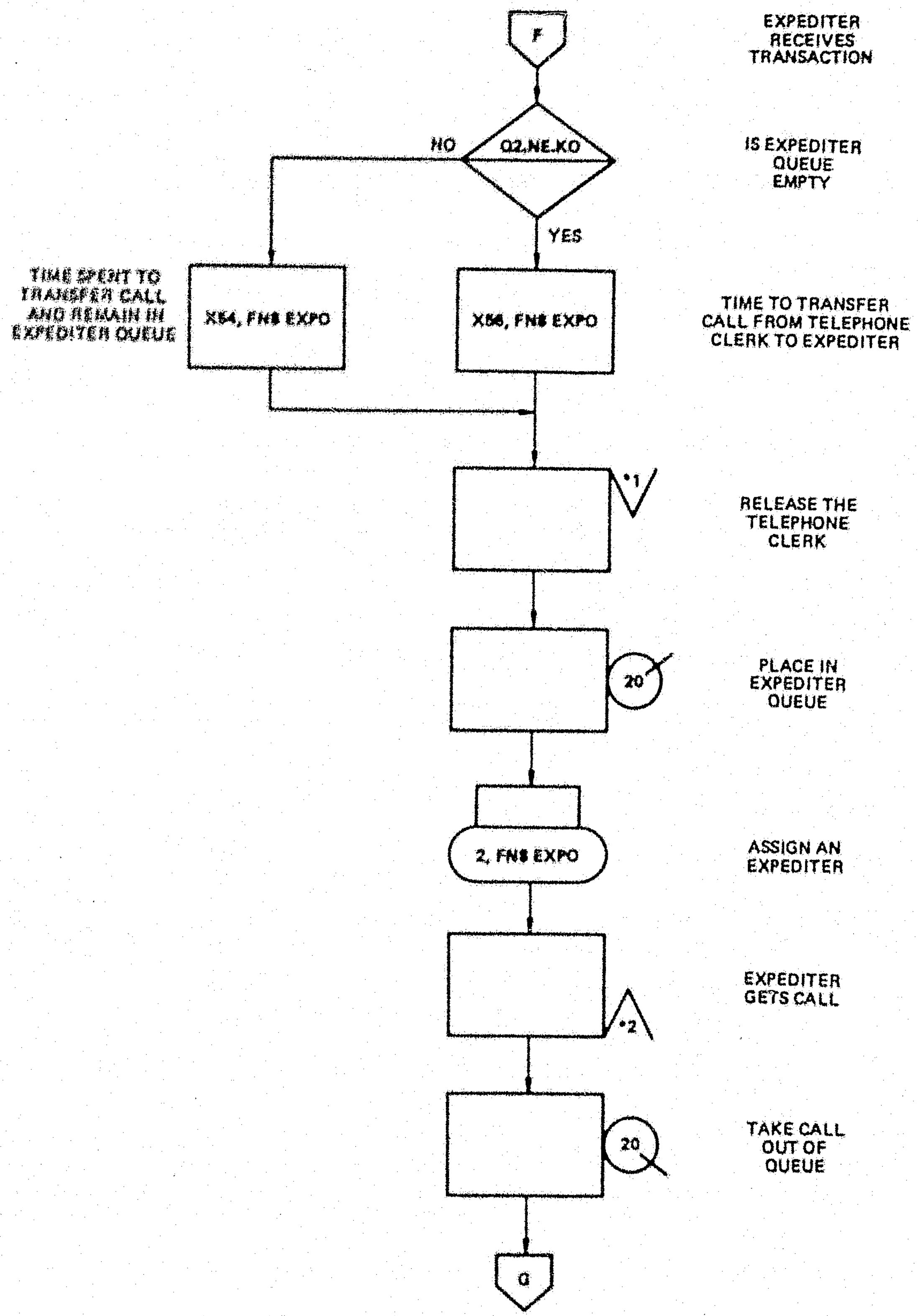

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 4 OF 13)

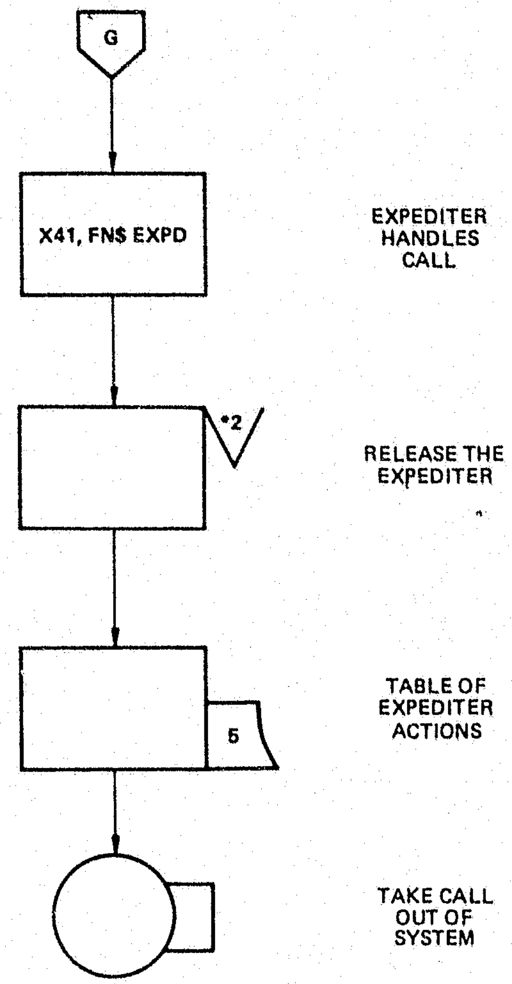

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 5 OF 13)

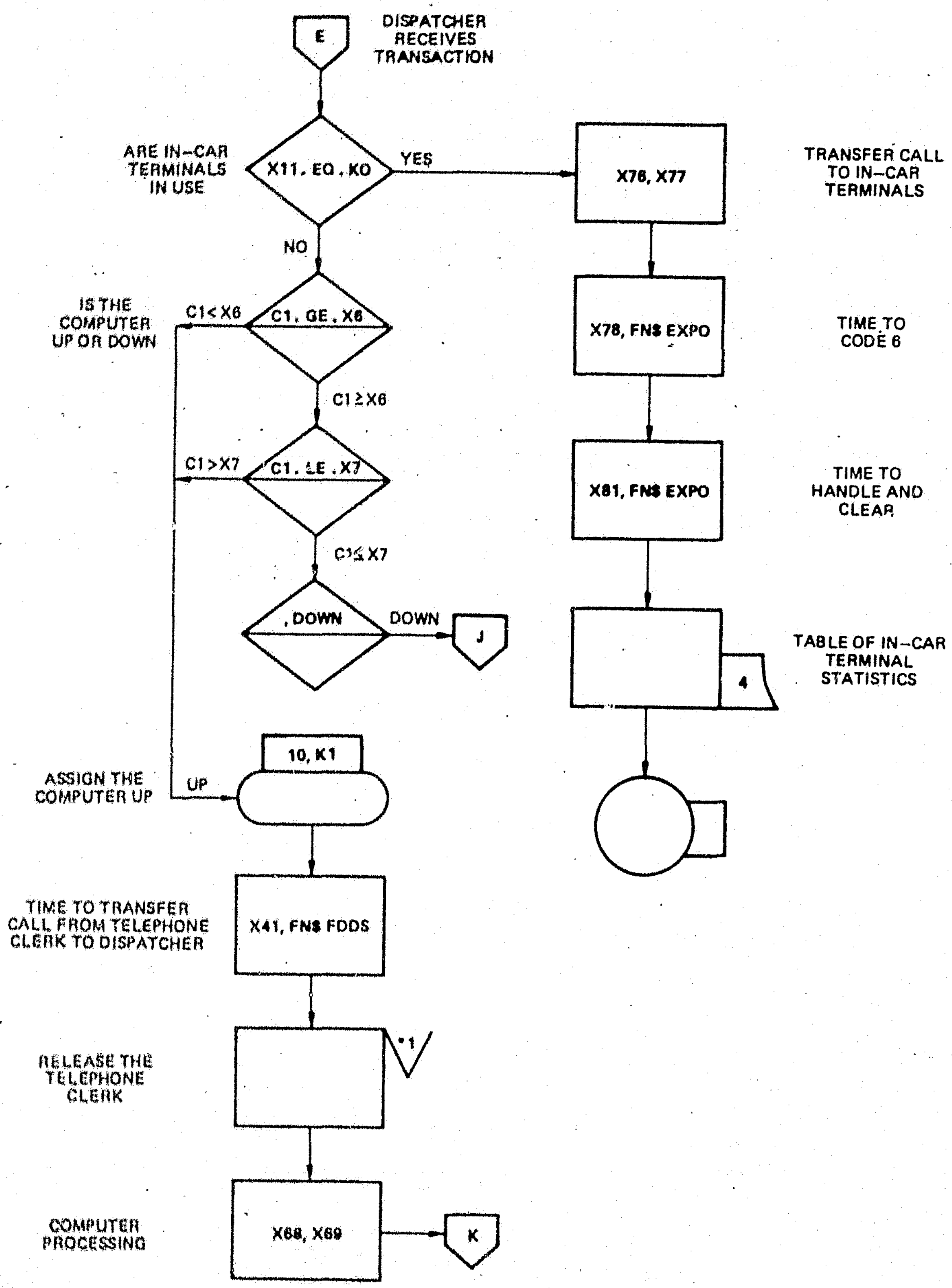

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 6 OF 13)

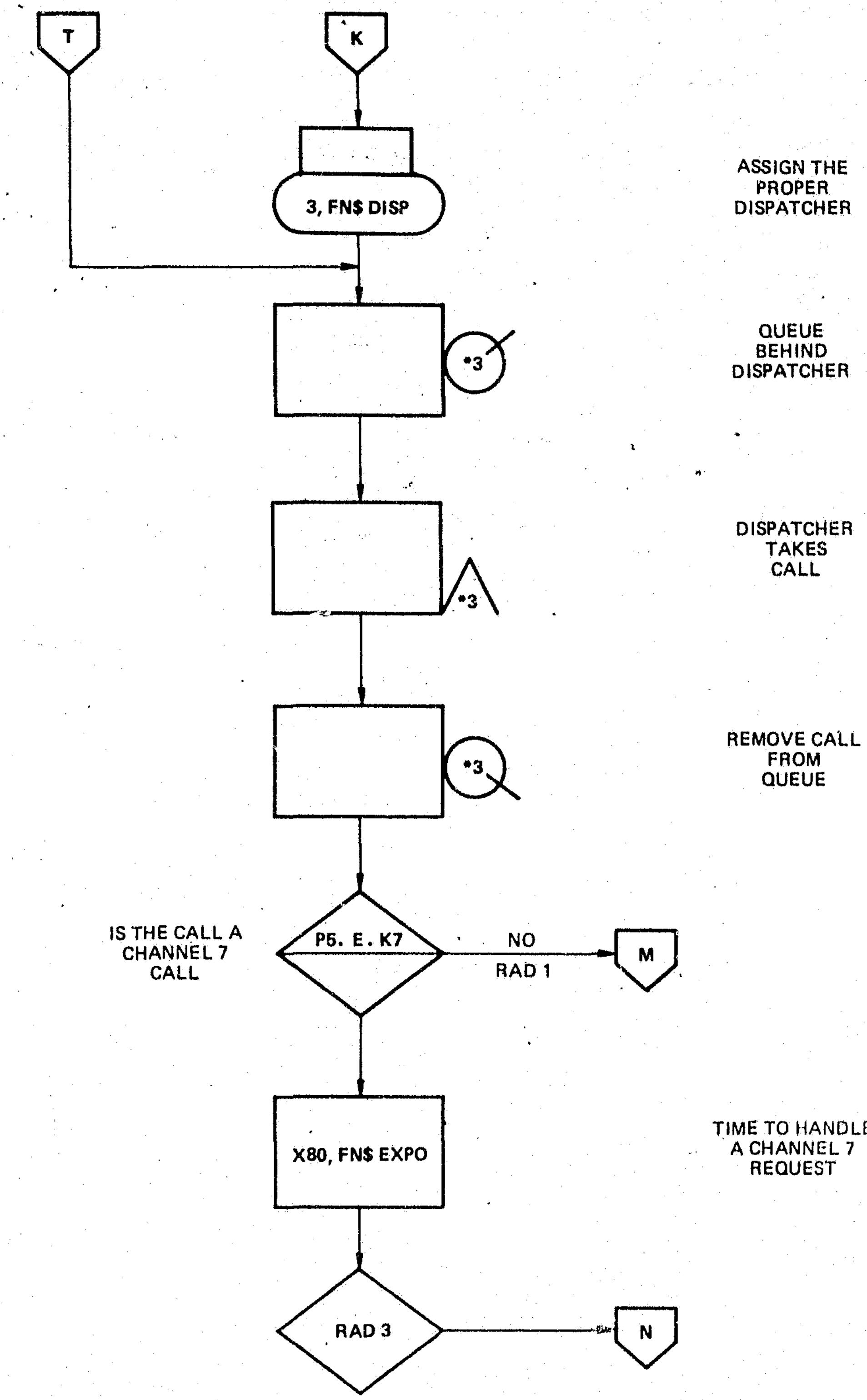

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 7 OF 13)

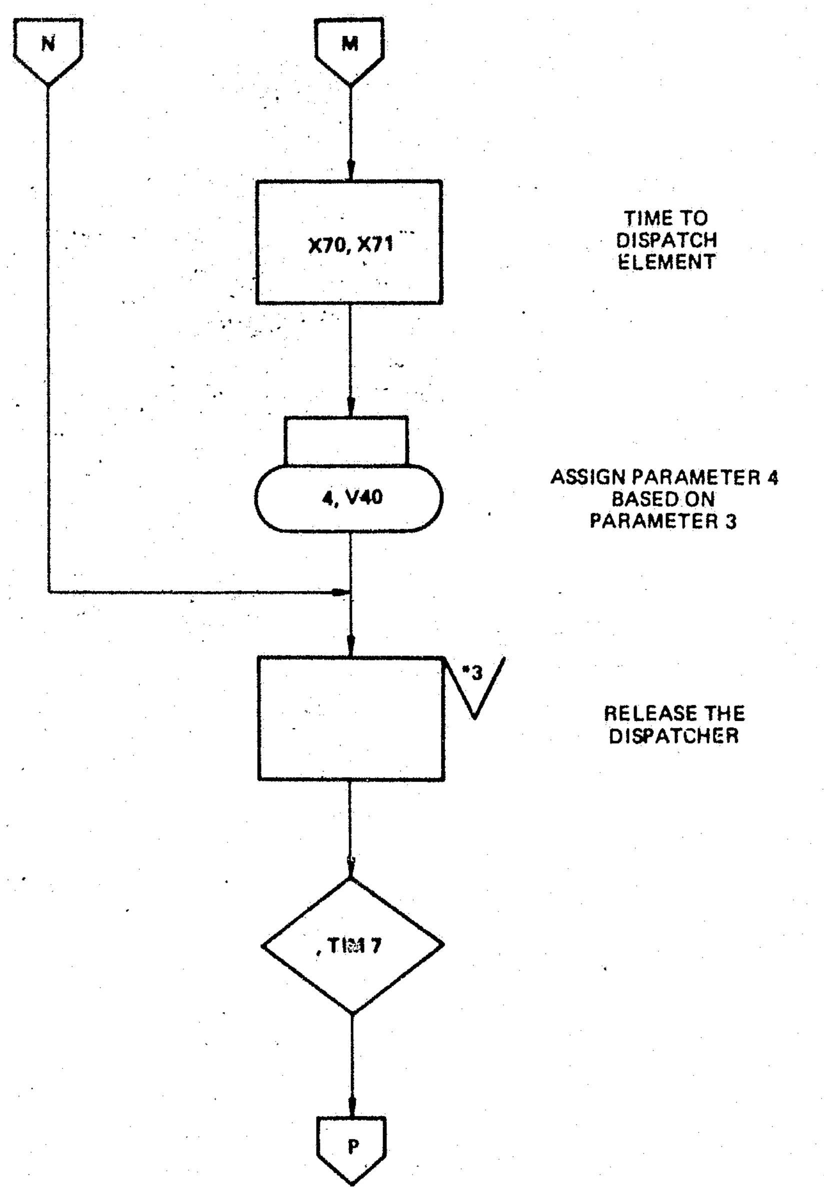

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 8 OF 13)

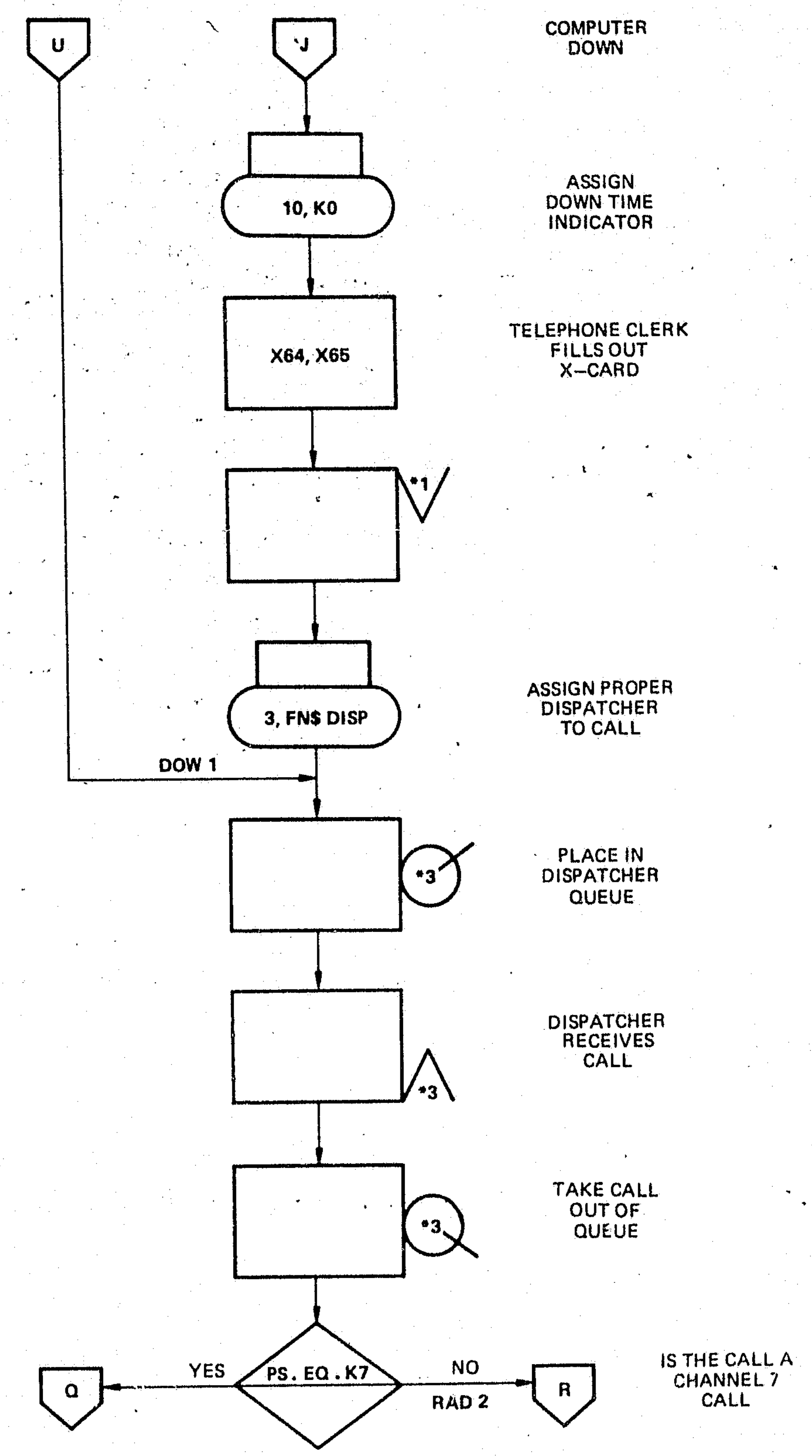

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 9 OF 13)

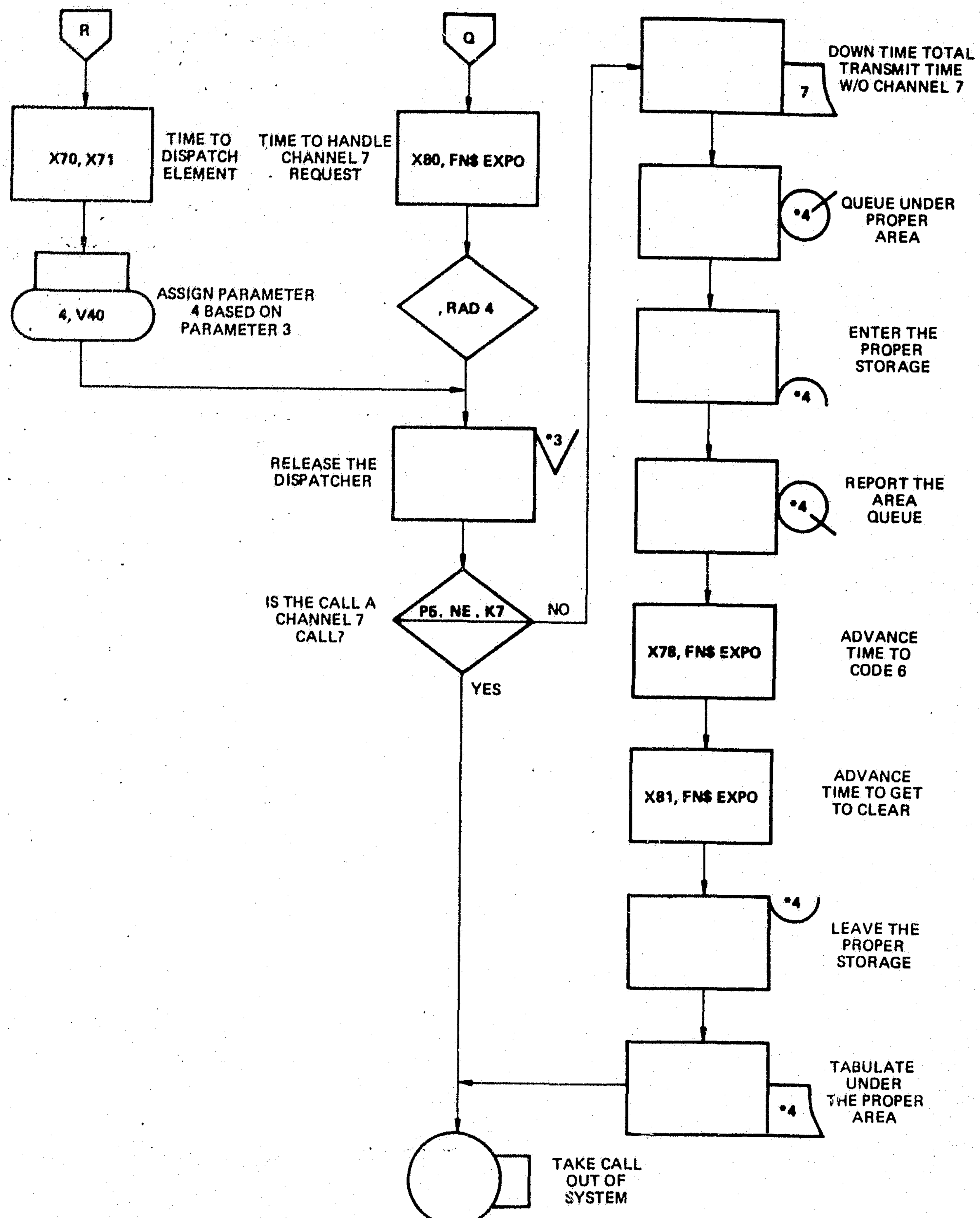

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 10 OF 13)

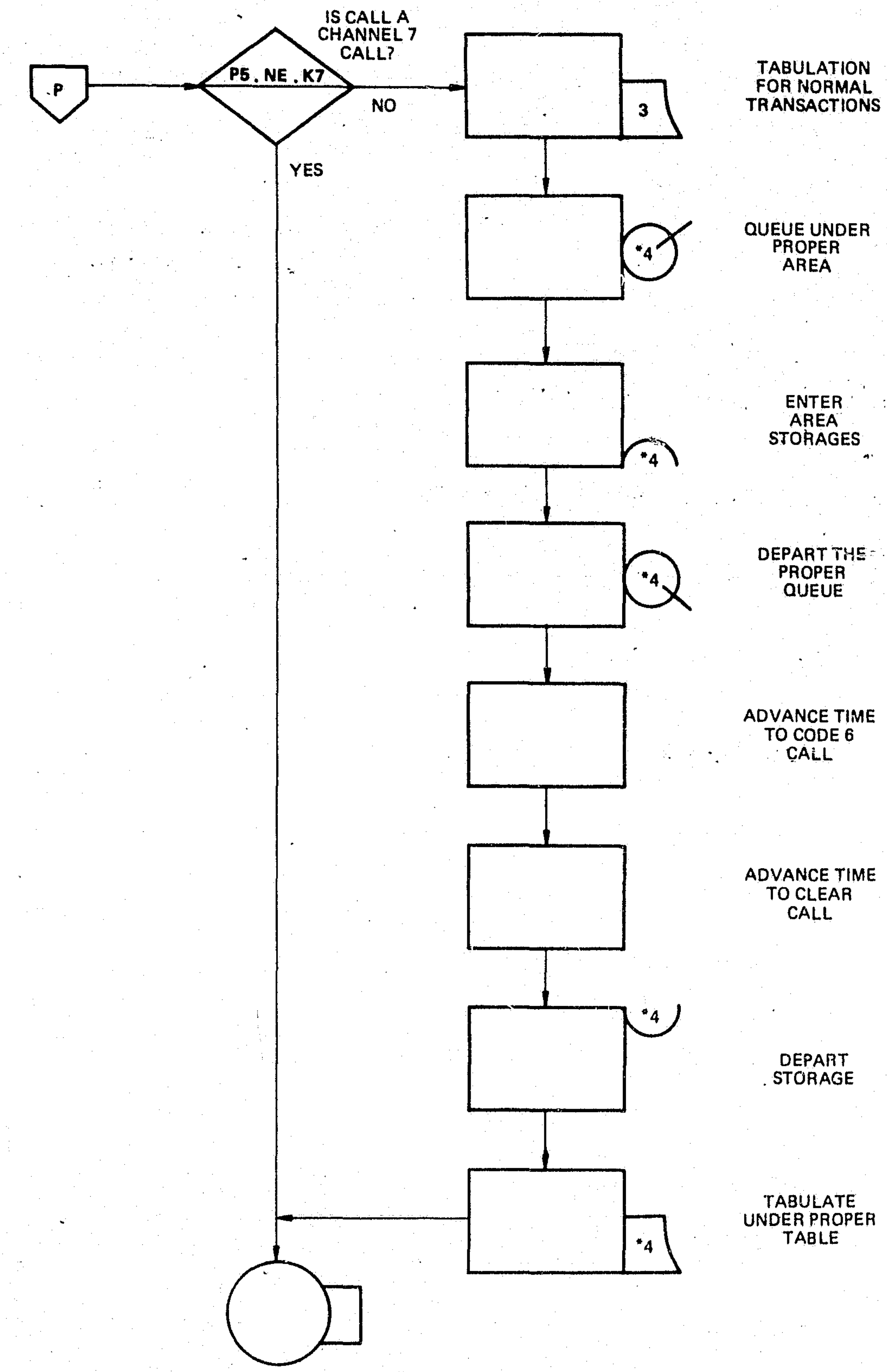

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 11 OF 13)

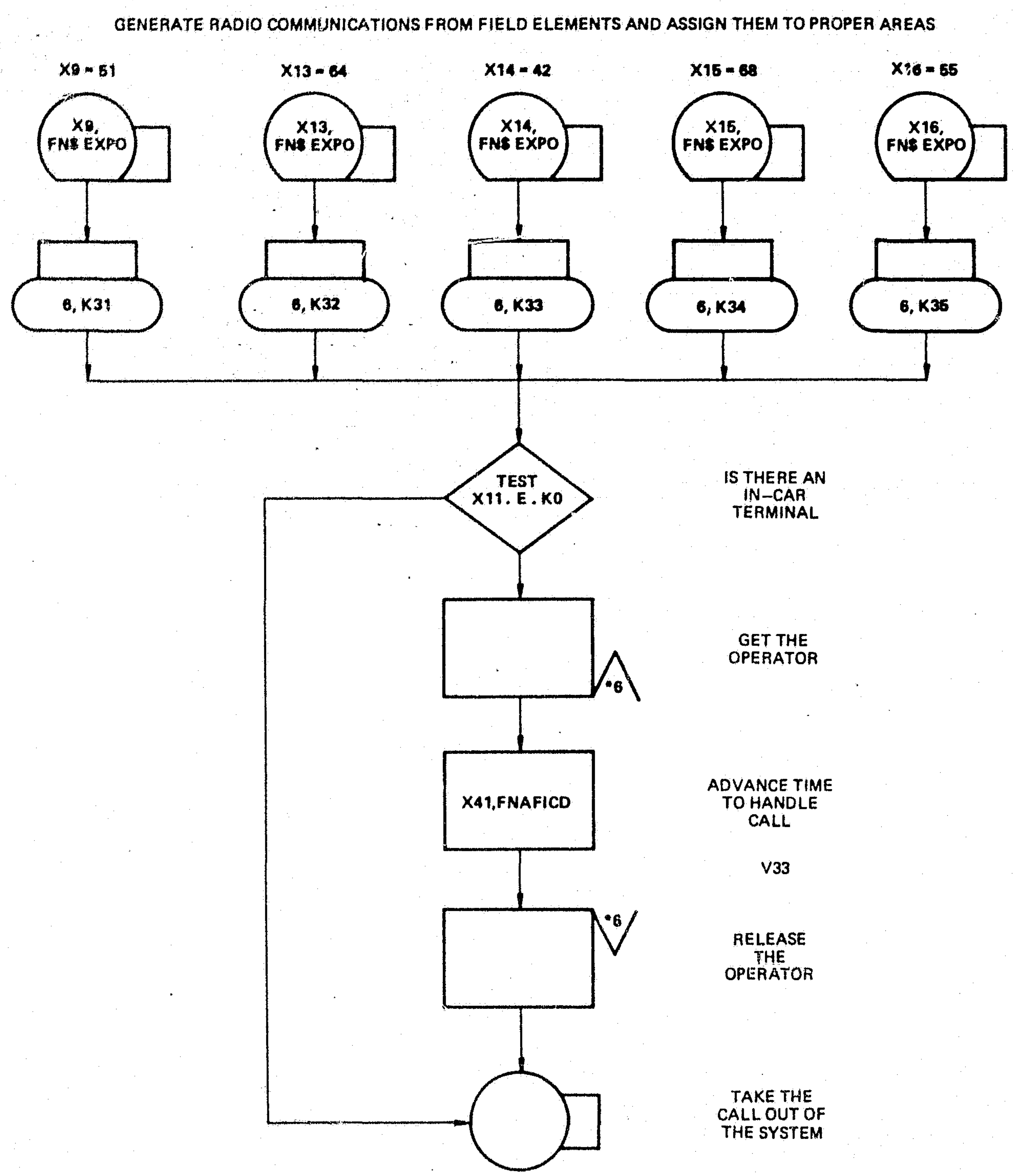

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 12 OF 13)

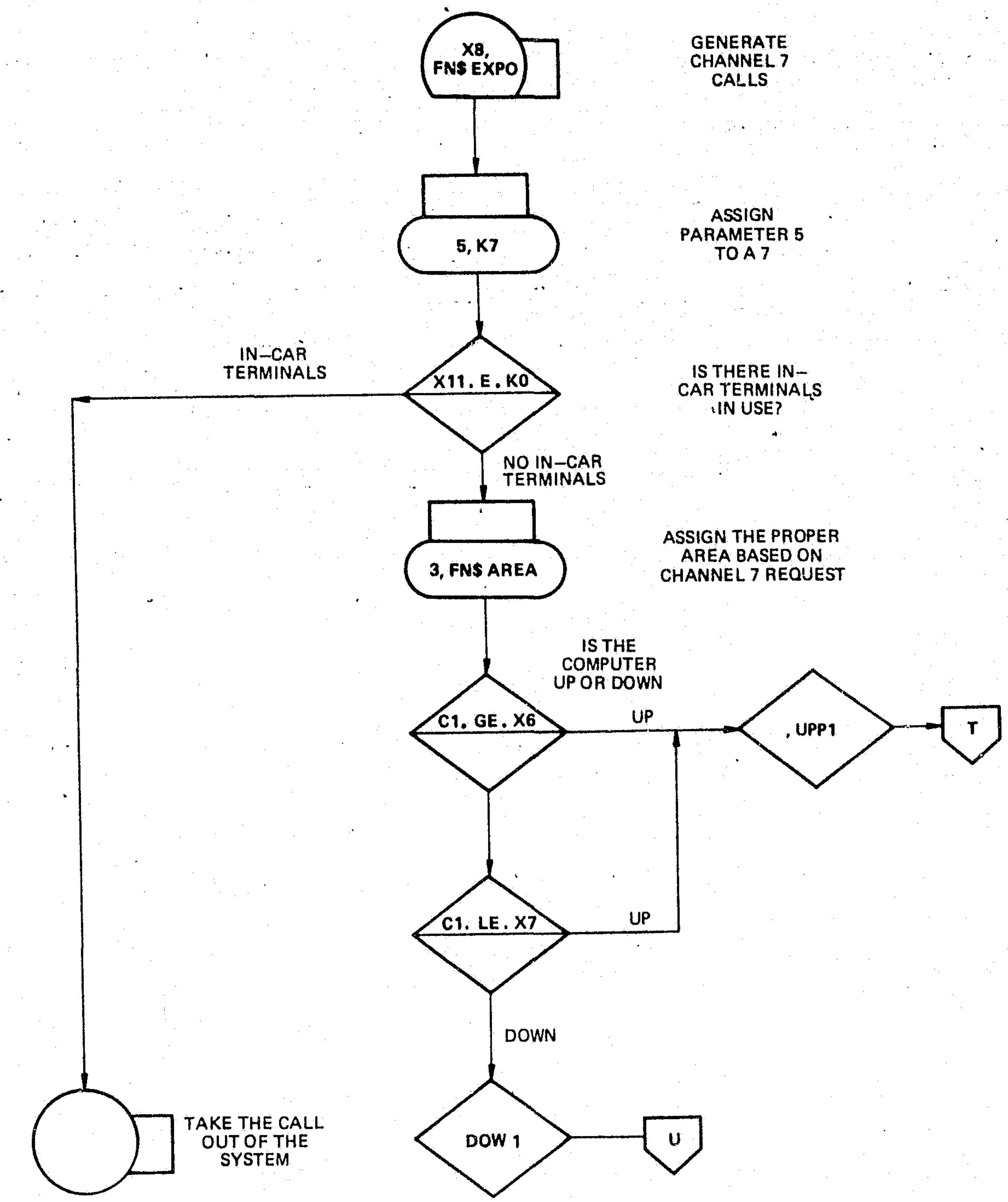

FIGURE 3.1–6. COMMUNICATIONS SECTION MODEL GPSS/360 FLOW CHART (SHEET 13 OF 13)

COMMUNICATIONS MODEL SYMBOL TABLE

X1	=	Mean Interarrival Time Of Incoming Calls Line One
X2	=	Mean Interarrival Time Of Incoming Calls Line Two
X3	=	Percent Of Calls Lost
X4	=	Percent Of Calls Handled By Dispatcher And Expediter
X5	=	Percent Of Calls Handled By Dispatcher
X6	=	Start Of Computer Down Time
X7	=	End Of Computer Down Time
X8	=	Mean Interarrival Time For Channel 7 Incoming Calls
X9	=	Mean Interarrival Time For Area 1 Radio Communications
X11	=	In Car Terminal Flag
X13	=	Mean Interarrival Time For Area 2 Radio Communications
X14	=	Mean Interarrival Time For Area 3 Radio Communications
X15	=	Mean Interarrival Time For Area 4 Radio Communications
X16	=	Mean Interarrival Time For Area 5 Radio Communications
X50	=	Mean Time For Telephone Clerk To Handle Call
X54	=	Mean Time For Expediter To Receive Call If Not Busy
X56	=	Mean Time For Expediter To Receive Call If Busy
X64	=	Mean Time To Handle An X-Card
X65	=	Spread Of X64
X68	=	Mean Computer Processing Time
X69	=	Spread of X68
X70	=	Time To Dispatch Element - Mean
X71	=	Time To Dispatch Element - Spread
X76	=	In Car Terminal Delay Time - Mean
X77	=	In Car Terminal Delay Time - Spread
X78	=	Mean Time To Code 6
X80	=	Duration Of Channel 7 Request On Channel 1-5
X81	=	Mean Time To Clear

COMMUNICATIONS MODEL SYMBOL TABLE (CONT'D)

Function

EXPO	=	Negative Exponential
TELA	=	Telephone Clerk Handling Time
FEXP	=	Time For Expediter To Handle Call
FDDS	=	Time To Transfer Call From Telephone Clerk To Dispatcher
DISP	=	Time For Dispatcher To Handle Call
FICD	=	Distribution Of Field Initiated Calls
AREA	=	Distribution Of Channel 7 Calls To Dispatcher

Storages

S11	=	Number Of Available Patrol Vehicles
S12	=	Number Of Available Patrol Vehicles
S13	=	Number Of Available Patrol Vehicles
S14	=	Number Of Available Patrol Vehicles
S15	=	Number Of Available Patrol Vehicles

Tables

T1	=	Arrival Rate Of Incoming Calls
T2	=	Interarrival Times For Incoming Calls
T3	=	Time From Call Received To Time Code 6 With Computer Up
T4	=	In Car Terminal Statistics
T5	=	Table Of Expediter Calls
T6	=	Telephone Clerk Transit Times
T7	=	Time From Call Received To Time Code 6 With Computer Down
T11	=	Time To Clear Area 1
T12	=	Time To Clear Area 2
T13	=	Time To Clear Area 3
T14	=	Time To Clear Area 4
T15	=	Time To Clear Area 5

COMMUNICATIONS MODEL SYMBOL TABLE (CONT'D)

Variables

V40	=	Channel Calls By Area Range 11-15

Queues

Q1	=	Incoming Calls
Q2	=	Expediter Calls
Q11	=	Line Up To Get Patrol Element By Area
Q12	=	Line Up To Get Patrol Element By Area
Q13	=	Line Up To Get Patrol Element By Area
Q14	=	Line Up To Get Patrol Element By Area
Q15	=	Line Up To Get Patrol Element By Area
Q19	=	Lost Call Queue
Q31	=	Dispatcher Calls From Telephone Clerks
Q32	=	Dispatcher Calls From Telephone Clerks
Q33	=	Dispatcher Calls From Telephone Clerks
Q34	=	Dispatcher Calls From Telephone Clerks
Q35	=	Dispatcher Calls From Telephone Clerks

COMMUNICATIONS MODEL VALUE TABLE

	VALUES IN SECONDS	
SYMBOL	LOW ACTIVITY	HIGH ACTIVITY
X1	62	44
X2	70	65
X3	10	10
X4	560	560
X5	773	773
X8	105	43
X9	51	24
X10	1800	1800
X11	0	0
X12	900	900
X13	64	38
X14	42	29
X15	68	36
X16	55	32
X41	1	1
X50	31	38
X54	63	63
X56	120	120
X64	240	240
X65	30	30
X68	7	7
X69	4	4
X70	208	208
X76	0	0
X77	0	0
X78	406	406
X80	10	10
X81	2063	2063

CONTINUED

1 OF 2

3.1.2.2 PATROL OPERATIONS MODEL

The following discussion will reference Figure 3.1-9 (sheets 1-3,) the Patrol Model flowchart. The sequence of events within the Patrol Model begins with a request for service from a dispatcher to a patrol element. The arrival pattern for these requests suggests that a Poisson distribution is applicable /4/. The poisson distributed pattern results in a negative exponential interarrival time distribution /4/. At this time the area in which the request originated is identified. The signal type i is generated by the function SIGi, i = 1, ..., 5, and recorded in parameter 2 of the transaction. The code designation of the signal is now determined. A transit time representing the time required for the assigned patrol element to reach its destination is derived from this code designation. A tabulation of these transit times now occurs. Program Table 1 contains transit times for Code 1 calls, Program Table 2 contains transit times for Code 2 calls, and program Table 3 contains transit times on Code 3 calls. Once the patrol element has arrived at the scene a mean time to work the request is determined and stored in parameter 11. The spread time also based on signal, is stored in parameter 12. A time to work the request and fill out paperwork now elapses. At this time, work on a percentage of requests ends. These requests, which represent N Coded calls, are removed from the system. Their transit times are recorded in program Table 6. Sheet three of the flowchart illustrates the data flow for non-N Coded requests. A test of parameter one separates requests worked in District 1 from those worked in District 2-5. This distinction is made because requests worked in District 1 have a shorter processing time from this point on. Requests worked in Districts 2-5 require a mean time of 5.5 hours to reach Reports Section. From this point calls in District 1 require only 4.3 hours. The processing time of requests worked in District 1 are tabulated in

program Table 7, processing time for requests worked in Districts 2-5 are tabulated in program Table 4.

The outputs generated by the model were compared with data collected during the study of the Patrol Division. The degree of correlation between real-world statistical data and tabulated program outputs indicates the accuracy with which the model approximates the real system. The program outputs were found to be a good fit of the real-world data for both high and low activity periods.

Table 3.4-2 summarizes the program outputs and compares them to real-world statistical data. Figures 3.1-7 and 3.1-8 show the relative times required for information to move through the Patrol Bureau to the Reports Section. Careful note should be made of the large lag between the time a report is created in the field and the time this report is received in Reports Section.

TABLE 3.1-2

COMPARISON OF PROGRAM OUTPUTS WITH REAL-WORLD DATA

	Program		Real-World
Normal Activity			
Arrival Time			
Code 6 on Code 1	6.21 Minutes		6.89 Minutes
Code 6 on Code 3	3.48 Minutes		4.26 Minutes
Time Required To Work Call	34.67 Minutes		34.38 Minutes
Time For O/I Reports To Reach Reports Section			
Area 2-5	6.25 Hours	= 5.67	5.24
Area 1	5.09 Hours		
High Activity			
Arrival Time			
Code 6 On Code 1	2.42 Minutes		3.43 Minutes
Code 6 On Code 3	1.47 Minutes		1.90 Minutes
Time To Work Call	32.90 Minutes		25.45 Minutes
Time For O/I Reports To Reach Reports Section			
Area 2-5	6.18 Hours	= 5.29	5.24
Area 1	5.0 Hours		

Note: The Real-World Data includes time required for the dispatcher to enter information into computer.

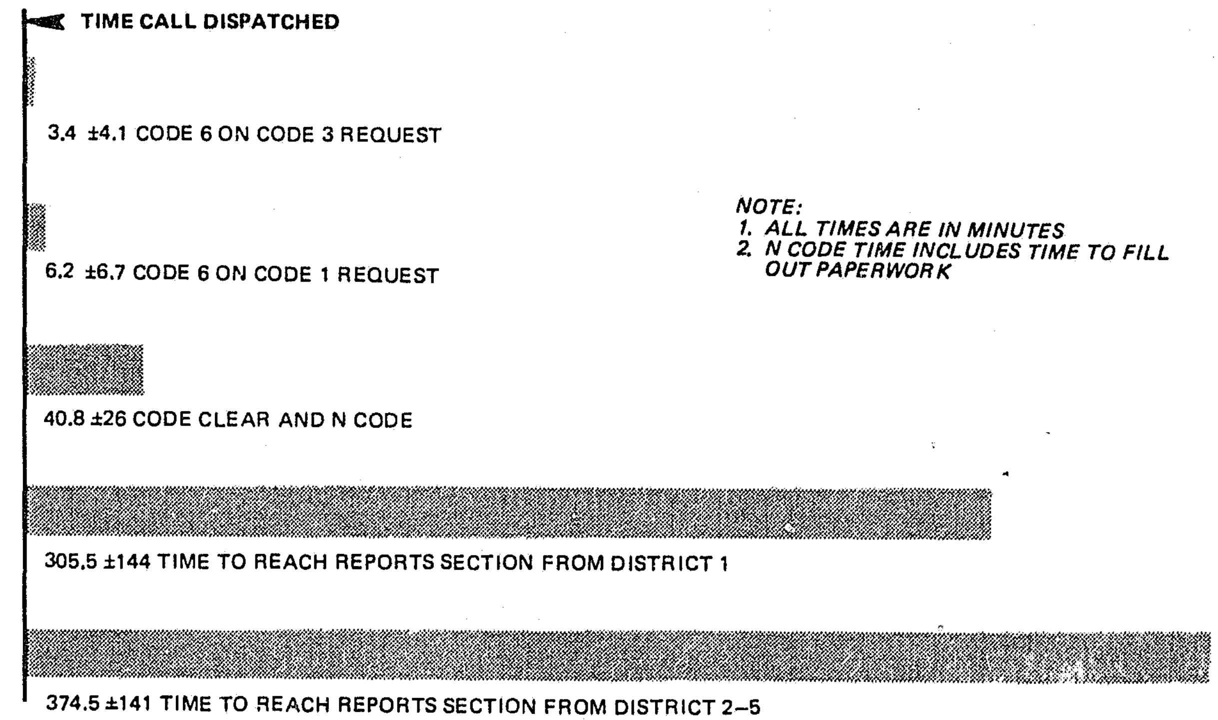

FIGURE 3.1–7. PATROL MODEL – LOW ACTIVITY RESPONSE TIME

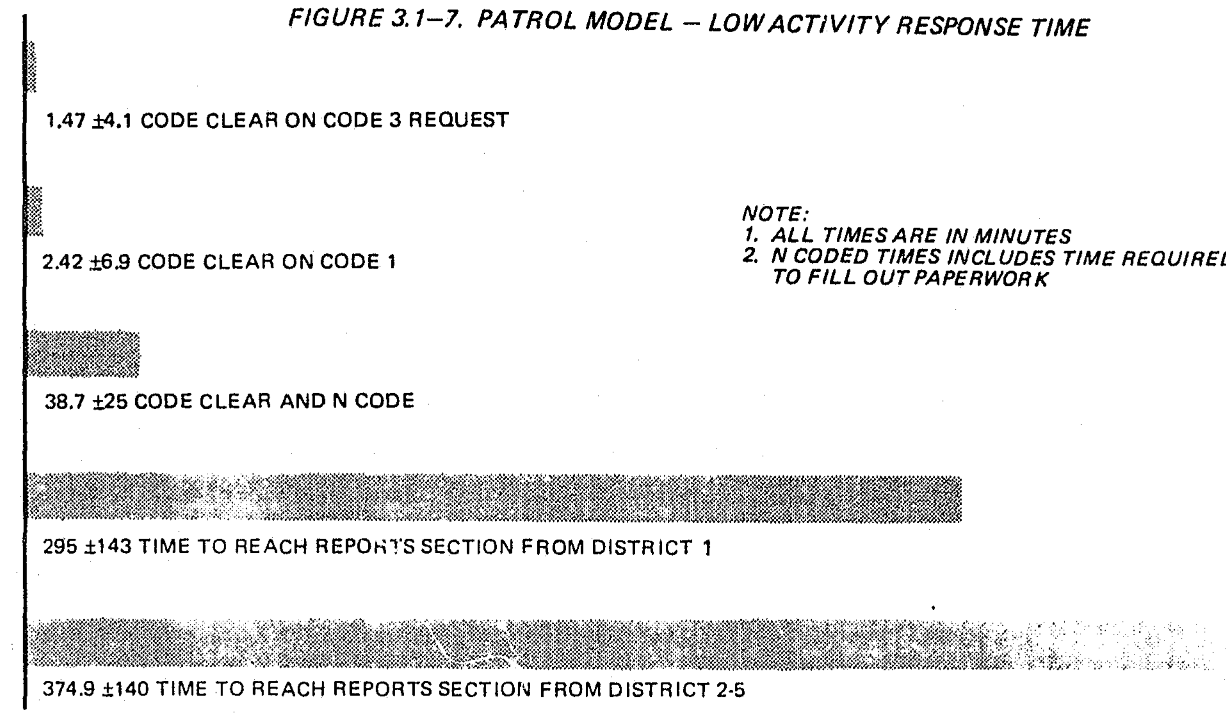

FIGURE 3.1–8. PATROL MODEL HIGH ACTIVITY RESPONSE TIME

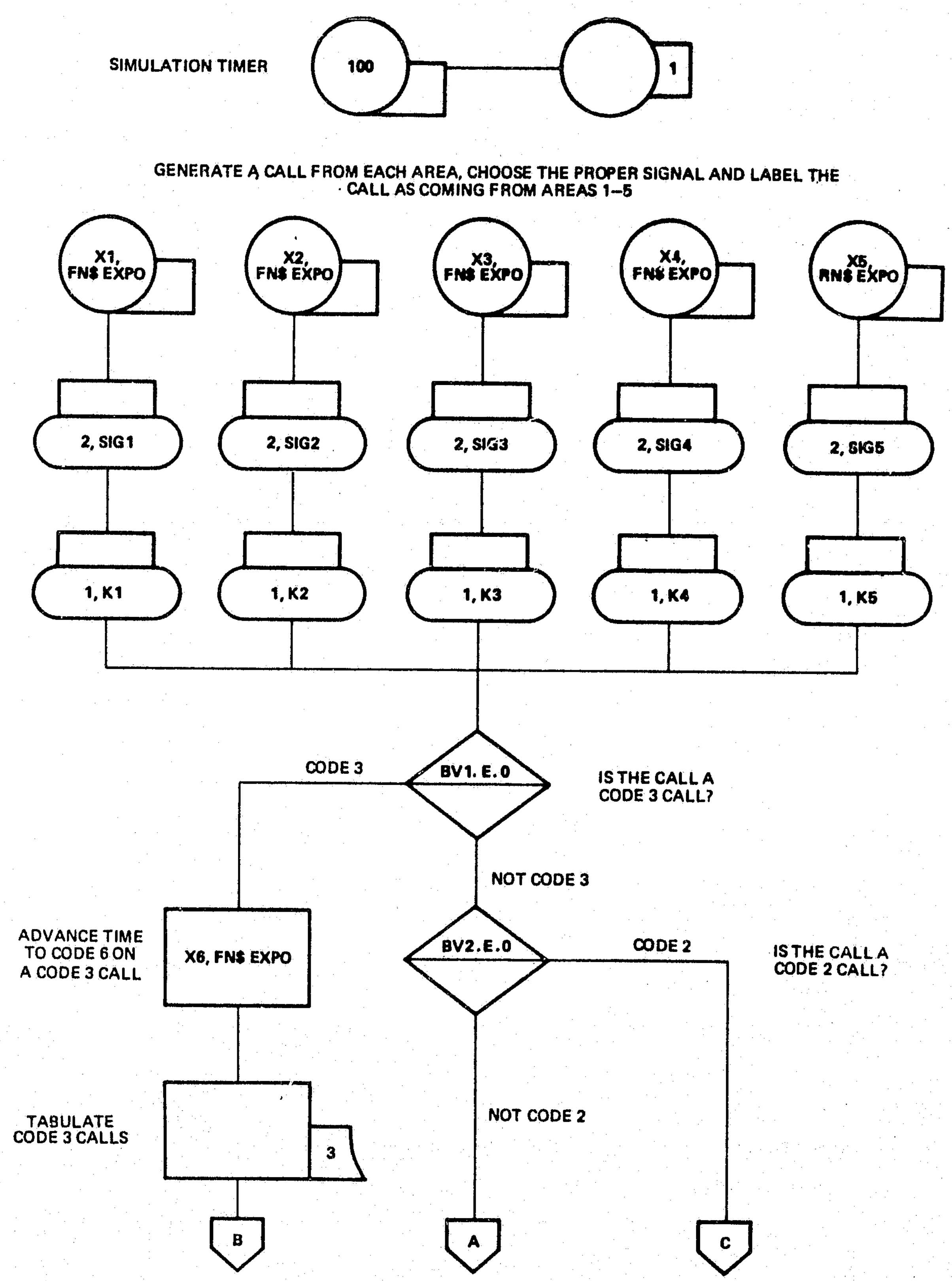

FIGURE 3.1–9. PATROL SECTION MODEL GPSS/360 FLOW CHART (SHEET 1 OF 3)

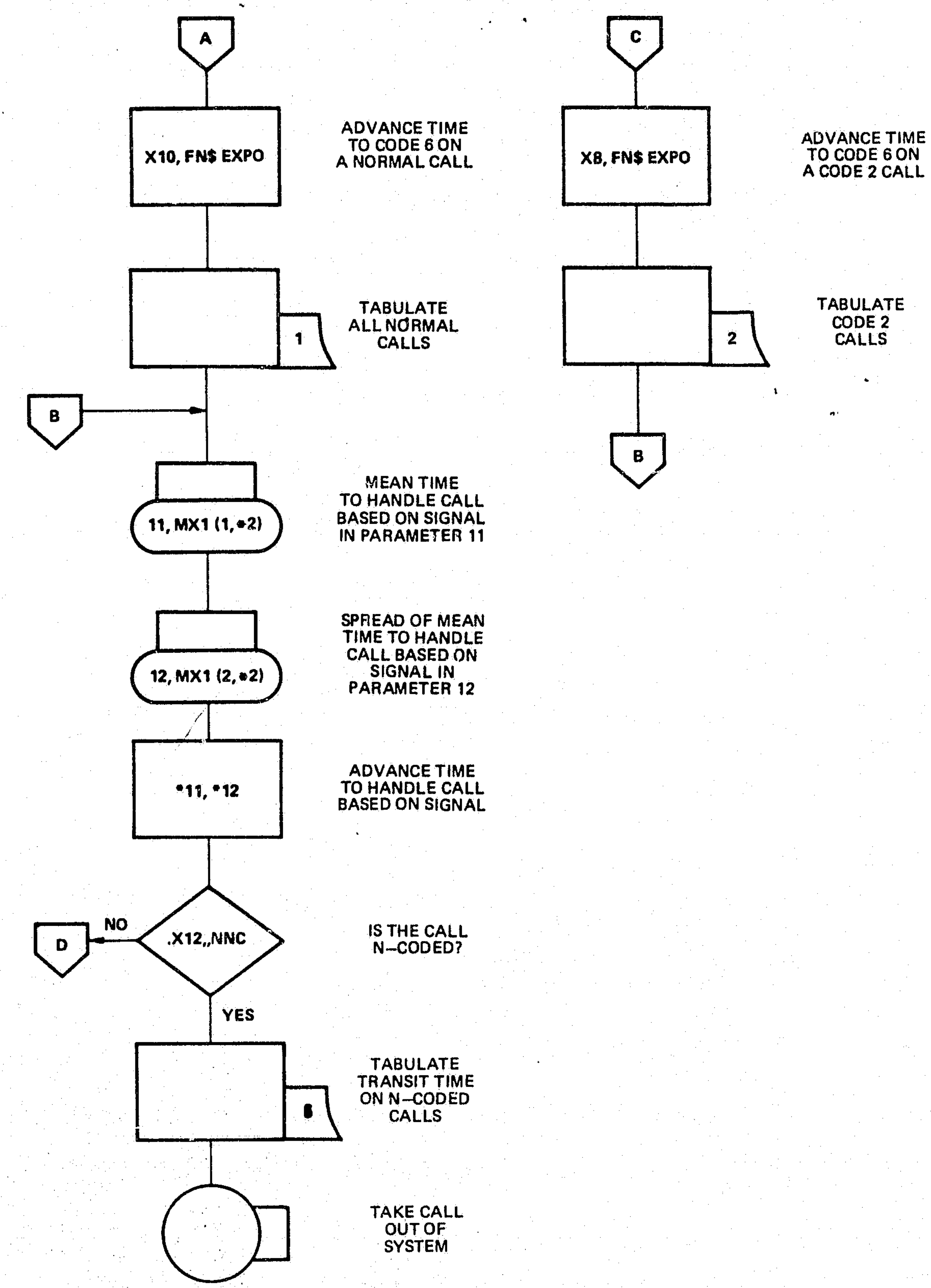

FIGURE 3.1–9. PATROL SECTION MODEL GPSS/360 FLOW CHART (SHEET 2 OF 3)

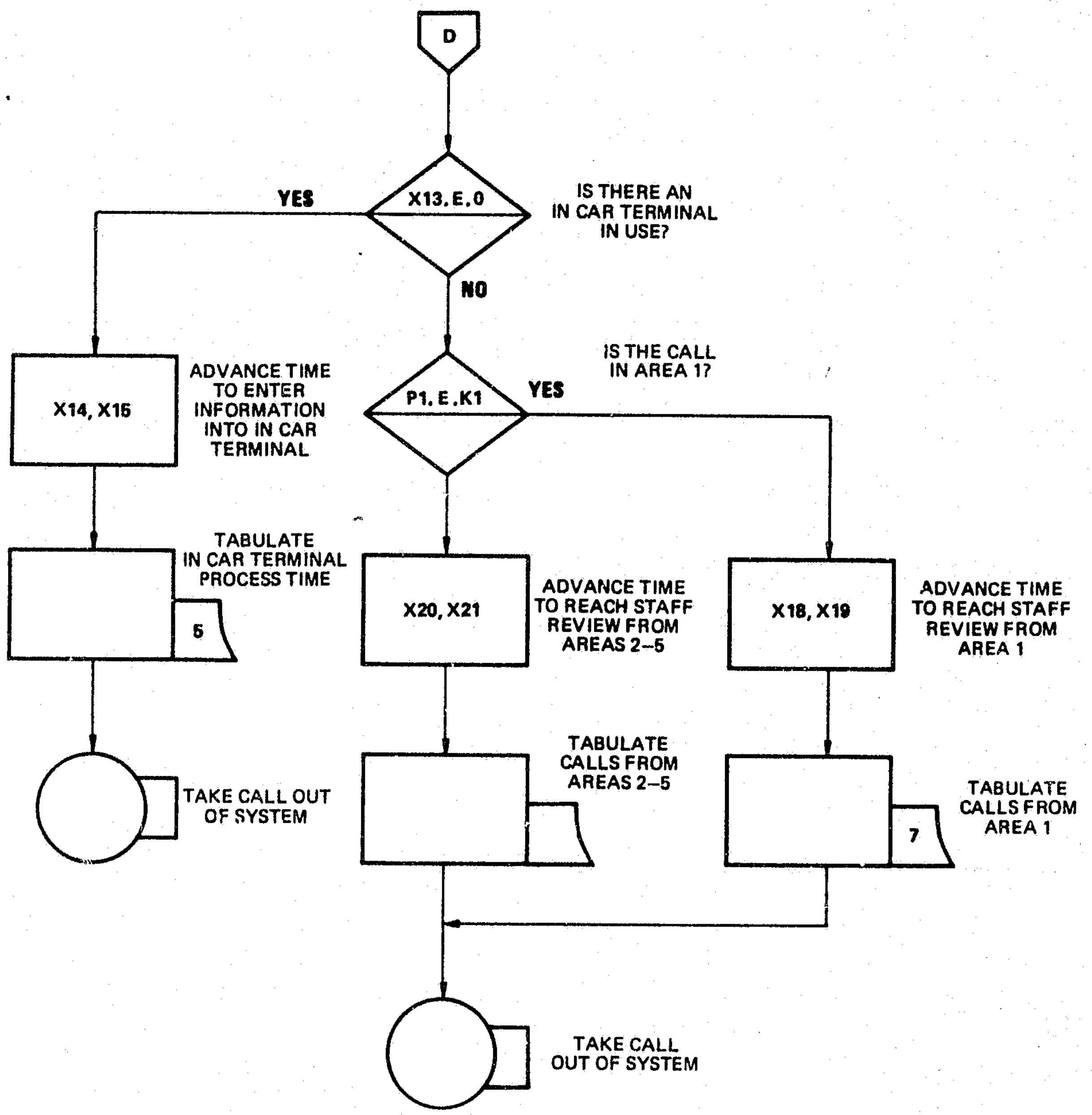

FIGURE 3.1–9. PATROL SECTION MODEL GPSS/360 FLOW CHART (SHEET 3 OF 3)

PATROL MODEL SYMBOL TABLE

X1	=	Mean Interarrival Time For Calls To Area 1
X2	=	Mean Interarrival Time For Calls To Area 2
X3	=	Mean Interarrival Time For Calls To Area 3
X4	=	Mean Interarrival Time For Calls To Area 4
X5	=	Mean Interarrival Time For Calls To Area 5
X6	=	Mean Time To Arrive At Scene (Code 6) On Code 3 Calls
X8	=	Mean Time To Arrive At Scene On Code 2 Calls
X10	=	Mean Time To Arrive At Scene On Code 1 Calls
X12	=	Percent Of Calls N-Coded
X13	=	In Car Terminal Flag
X14	=	Mean Time To Input Through In Car Terminal
X15	=	Spread Of X14
X18	=	Time Required To Reach Staff Review From Central District
X19	=	Spread Of X18
X20	=	Mean Time To Reach Staff Review From District 2-5
X21	=	Spread Of X20

Functions

EXPO	=	Negative Exponential
SIG1	=	Assigns Proper Mix Of Signals To District 1
SIG2	=	Assigns Proper Mix Of Signals To District 2
SIG3	=	Assigns Proper Mix Of Signals To District 3
SIG4	=	Assigns Proper Mix Of Signals To District 4
SIG5	=	Assigns Proper Mix Of Signals To District 5

Matrix

Row 1	=	Mean Time To Clear (TCC-TC6) By Signal
Row 2	=	Spread Time To Clear (TCC-TC6) By Signal

PATROL MODEL SYMBOL TABLE (CONT'D)

Tables

Table 1	=	Arrival Times Of Patrol Elements On Code 1 Calls
Table 2	=	Arrival Times Of Patrol Elements On Code 2 Calls
Table 3	=	Arrival Times Of Patrol Elements On Code 3 Calls
Table 4	=	Input Time Of Patrol Reports From Areas 2 Through 5 To Staff Review
Table 5	=	Input Times To Staff Review If An In Car Terminal Is Used
Table 6	=	Times Required To Work N-Coded Calls
Table 7	=	Input Times Of Patrol Reports From Area 1

PATROL MODEL VALUE TABLE

SYMBOL	VALUE IN MINUTES HIGH ACTIVITY	VALUE IN MINUTES LOW ACTIVITY
X1	6	9
X2	5	8
X3	3	8
X4	5	9
X5	5	8
X6	2	4
X8	6	6
X10	3	7
X12	680	430
X13	0	0
X14	45	45
X15	15	15
X18	259	259
X19	240	240
X20	337	337
X21	240	240

3.1.2.3 REPORTS SECTION MODEL

The flowchart Figure 3.1-10, shows in detail the functions performed in the Reports Section. The following paragraphs explain the basic functions performed on a report as it is processed through the Reports Section.

A number of reports are input to the Reports Section at the beginning of the process. The reports are given to a staff reviewer and he processes the reports. The mean time taken for the review of arrest forms and accident forms is assumed to be different than that required for other forms. The staff reviewer determines if the form received is correct. If the report fails the test, the staff reviewer returns the form to the originator and prepares a suspense file notation. If the report is a corrected form the staff reviewer pulls data associated with the report from the suspense file and processes the report. If the report passes all of the checks, the staff reviewer routes the report for NCIC processing if necessary. The NCIC process is completed. Information from some forms is teletyped to Austin. The report then is processed through the Update Clerk Unit. Decisions are made by the update clerk as to the completeness of the report as contained in the computer and if necessary, obtain information from microfilm records. The update clerks also create new records in the computer file. When up-dating is completed, the report is reproduced in the quantity specified by the copy code of the staff reviewer and is then filed in the open shelf file.

Some of the process times used in the Reports Model were estimated from very small samples. In a few other cases, process times had to be estimated through discussions with personnel involved.

Figure 3.1-11 is a time chart of the various functions performed on a report which passes through the Reports Section. It can be seen from Figure 3.1-11 that the time to review and NCIC process a normal length report for which a computer record already exists is, on the average, approximately 4 minutes. This time does not include time for transit from one function area to another, but indicates that time spent on a report from the time when it enters staff review until it is filed averages 4 minutes. If no NCIC information is processed, the average transit time is about 2 minutes. A total of 380 forms was used to simulate the Reports Section's handling of a single shift's workload.

GENERATE ORIGINAL AND CORRECTED FORMS COMING IN TO STAFF REVIEW

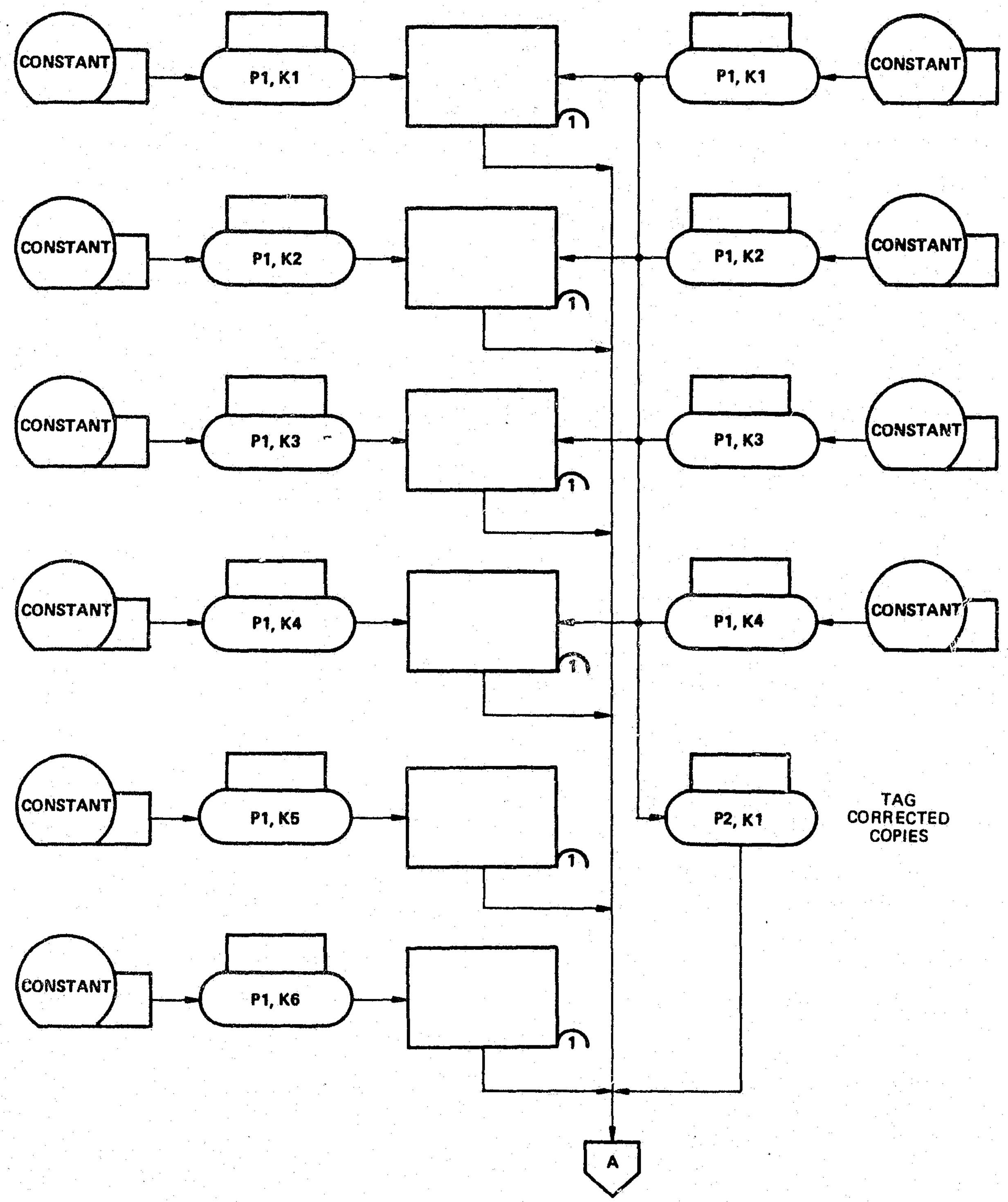

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 1 OF 6)

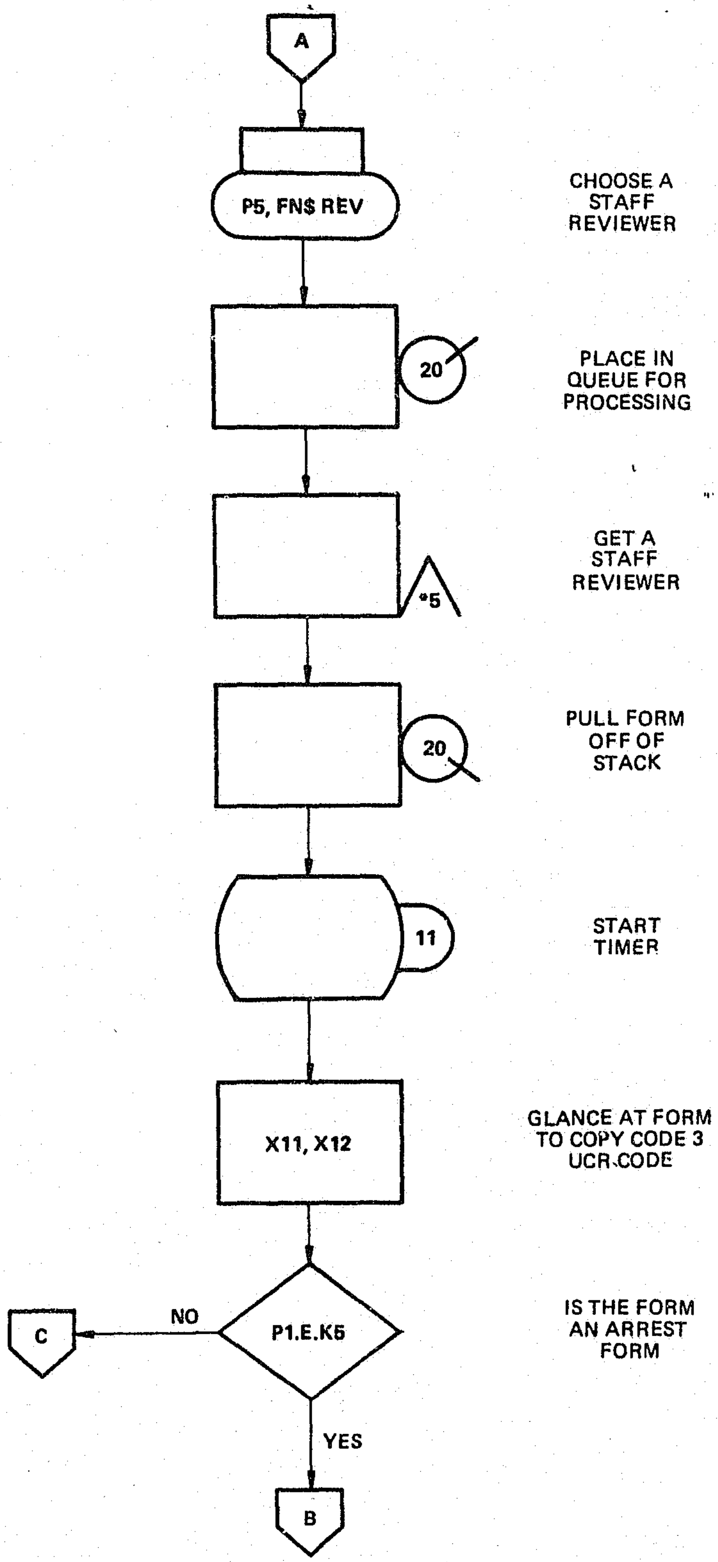

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 2 OF 6)

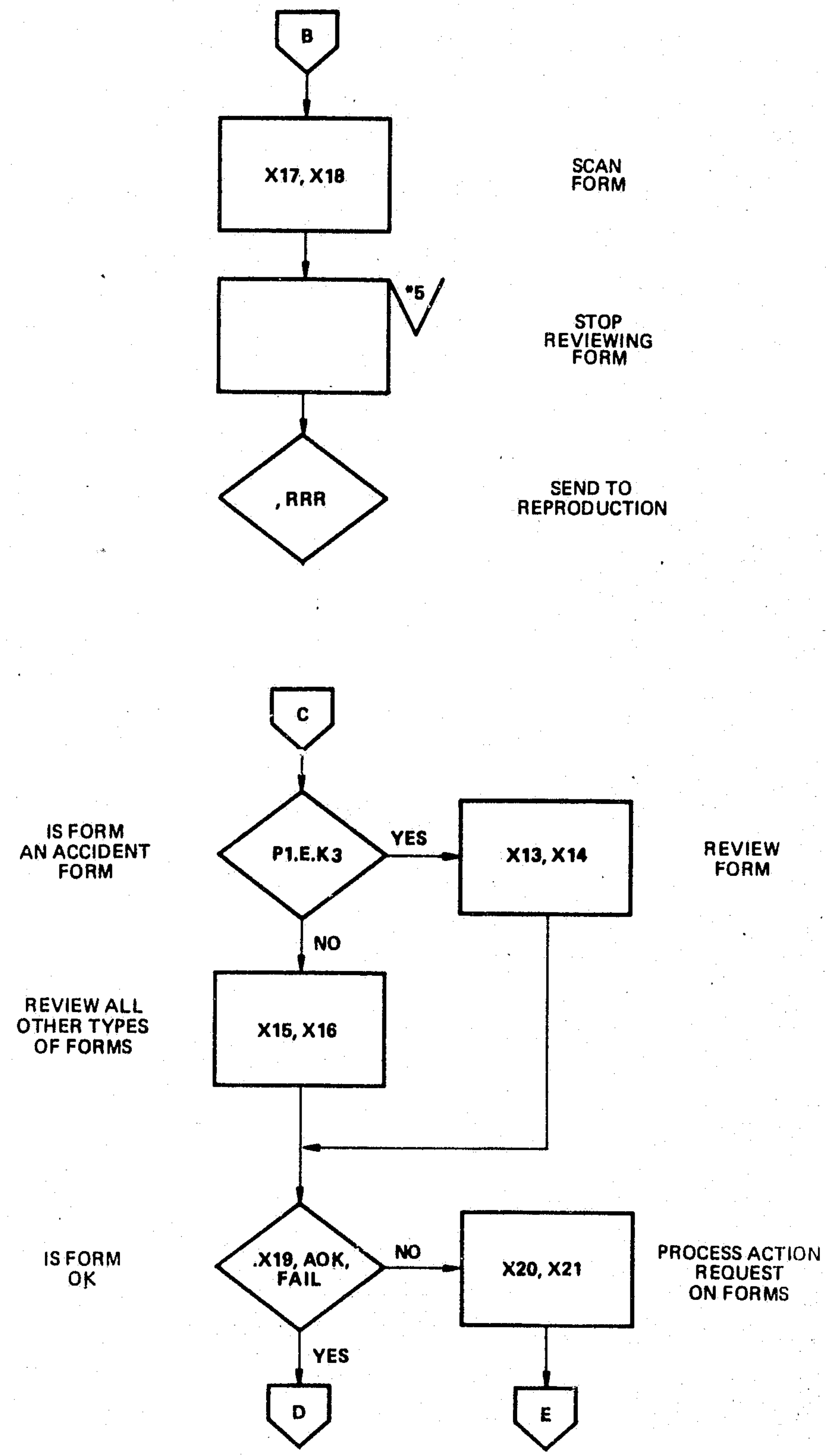

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 3 OF 6)

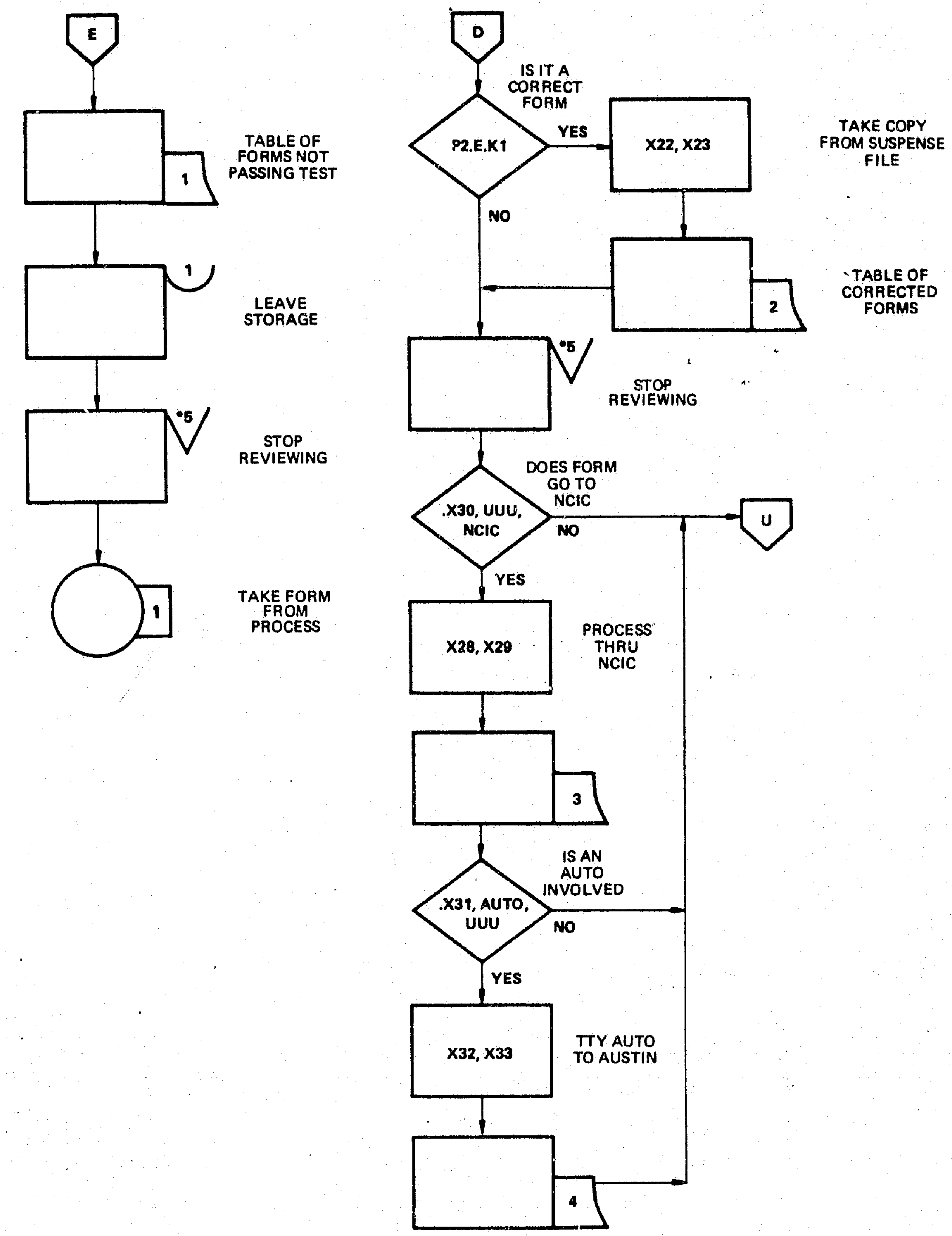

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 4 OF 6)

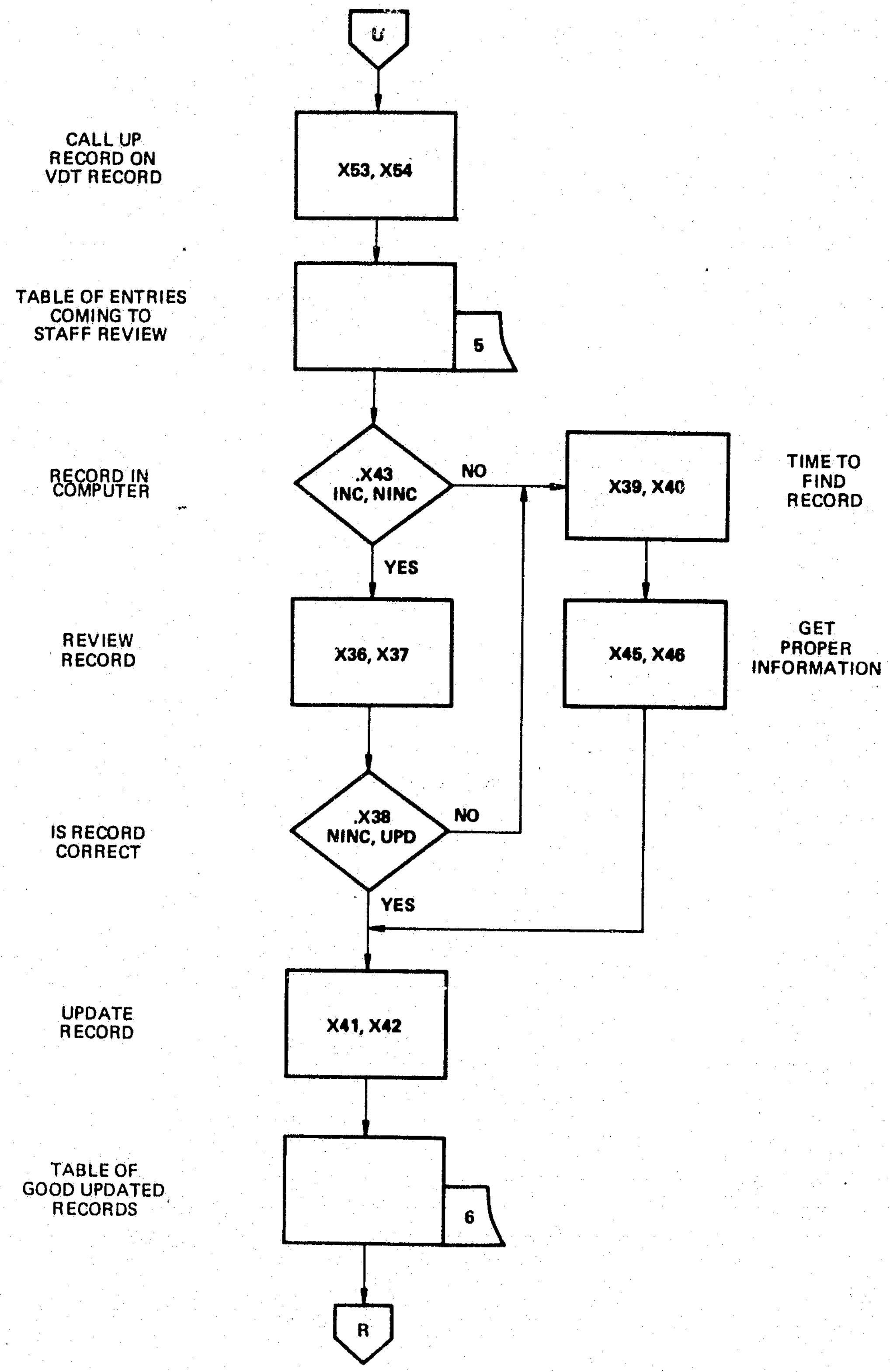

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 5 OF 6)

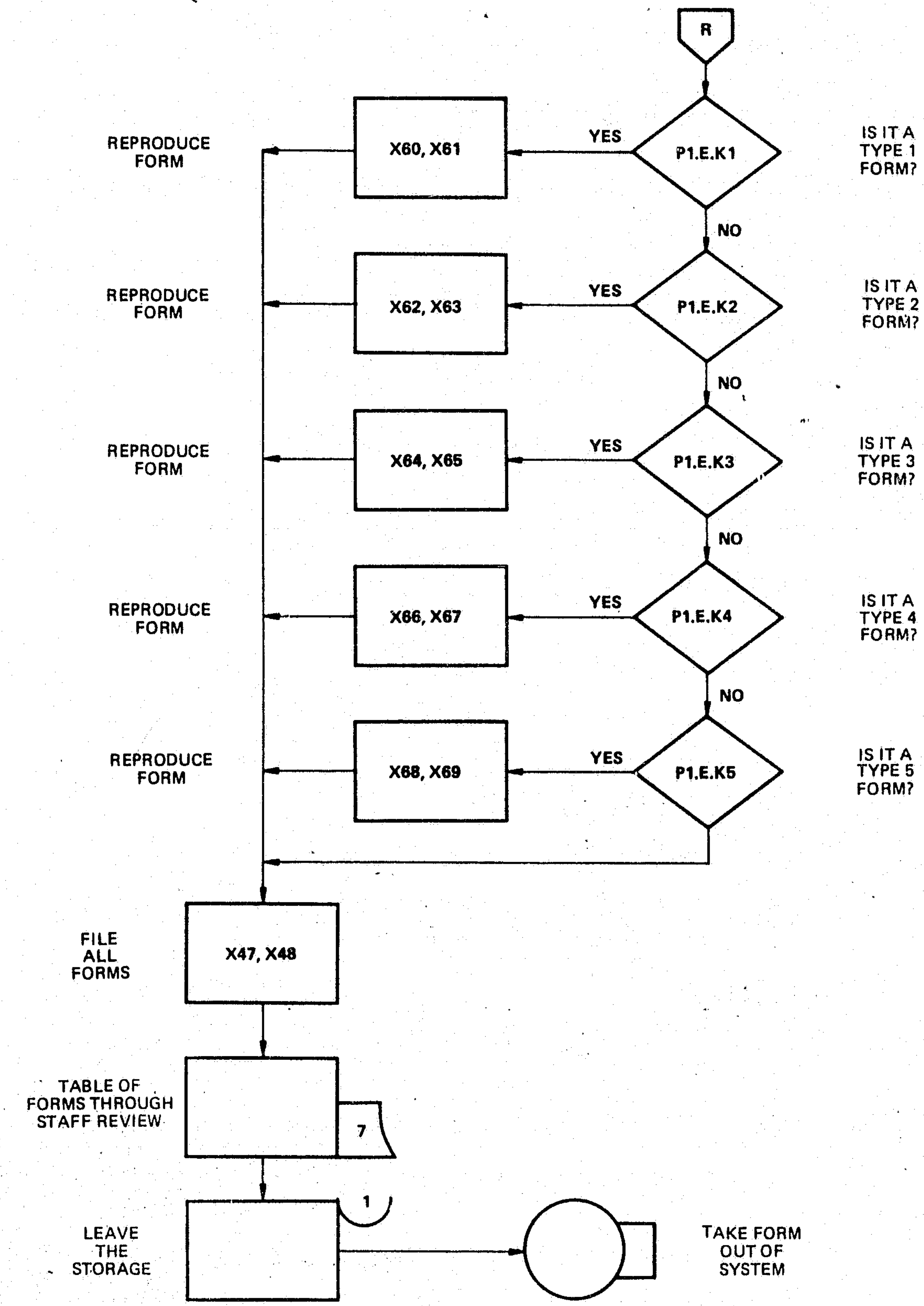

FIGURE 3.1–10. REPORTS SECTION MODEL GPSS/360 FLOW CHART (SHEET 6 OF 6)

REPORTS MODEL SYMBOL TABLE

X11	=	Mean Time To Copy Code And UCR Code Each Report
X12	=	Spread Of X11
X13	=	Mean Time To Review An Accident Form
X14	=	Spread Of X13
X15	=	Mean Time To Review Other Types Of Forms
X16	=	Spread Of X15
X17	=	Mean Time To Review Arrest Forms
X18	=	Spread Of X17
X19	=	Percentage Of Forms Failing Review Test
X20	=	Mean Time To Process Action Request On Form
X21	=	Spread Of X20
X22	=	Mean Time To Handle Incoming Corrected Form
X23	=	Spread Of X22
X30	=	Percent Of Forms Requiring NCIC Routing
X28	=	Mean Time To Process Through NCIC
X29	=	Spread Of X28
X31	=	Percent Of Forms Not Requiring TTY To Austin
X32	=	Mean Time Of TTY To Austin
X33	=	Spread Of X32
X53	=	Mean Time To Call Up A Record On The VDT
X54	=	Spread Of X53
X43	=	Percent Of Records Not In The Computer
X39	=	Mean Time To Find Record
X40	=	Spread Of X39
X45	=	Mean Time To Get Proper Information
X46	=	Spread Of X45
X36	=	Mean Time To Review Record

REPORTS MODEL SYMBOL TABLE (CONT'D)

X37	=	Spread Of X36
X41	=	Mean Time To Update Record
X42	=	Spread Of X41
X60	=	Mean Time To Reproduce Type 1 Forms
X61	=	Spread Of X60
X62	=	Mean Time To Reproduce Type 2 Forms
X63	=	Spread Of X62
X64	=	Mean Time To Reproduce Type 3 Forms
X65	=	Spread Of X64
X66	=	Mean Time To Reproduce Type 4 Forms
X67	=	Spread Of X66
X68	=	Mean Time To Reproduce Type 5 Forms
X69	=	Spread Of X68
X47	=	Mean Time To File Form
X48	=	Spread Of X47

Functions

REV	=	Choose A Staff Reviewer

TABLES

Table 1=	Table Of Forms That Fail Staff Review Test
Table 2=	Table Of Corrected Forms
Table 3=	Table Of NCIC Processes Without Auto
Table 4=	Table Of NCIC Processes With Auto
Table 5=	Table Of Review Of Record
Table 6=	Table Of Update Processes
Table 7=	Table Of Total Transit Time Of Report

REPORTS MODEL VALUE TABLE

SYMBOL	VALUE IN SECONDS
X11	5
X12	2
X13	36
X14	15
X15	36
X16	20
X17	9
X18	6
X19	8
X20	183
X21	30
X22	44
X23	20
X30	22
X28	114
X29	50
X31	545
X32	34
X33	25
X53	12
X54	10
X43	30
X39	185
X40	30
X45	100
X46	70

REPORTS MODEL VALUE TABLE (CONT'D)

SYMBOL	VALUE IN SECONDS
X36	21
X37	15
X41	60
X42	55
X60	14
X61	6
X62	7
X63	3
X64	6
X65	1
X66	5
X67	2
X68	4
X69	3
X47	14
X48	5

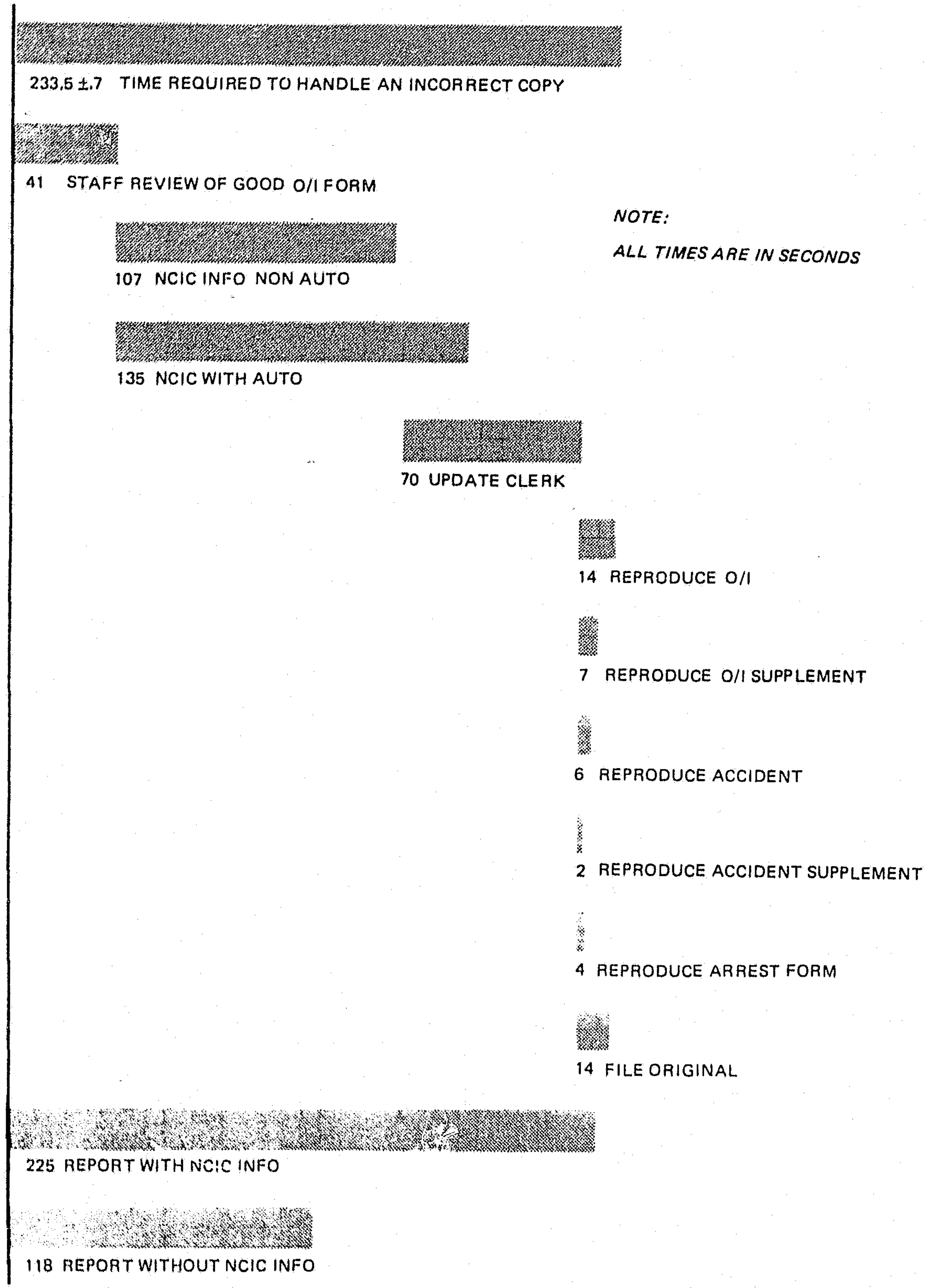

FIGURE 3.1–11. REPORT MODEL – MEAN TIME TO PERFORM FUNCTIONS

3.1.2.4 IDENTIFICATION SECTION MODEL

The flowchart Figure 3.1-12, shows in detail the functions performed in the Identification Section. In the paragraphs below, eac: function in the Identification Section which contributes to the main flow of information is explained. The model of the Identification Section examines nine areas to create the information flow through the section. These nine areas are examined individually with comments concerning the access to the most important files in the section. The front desk function handles most of the incoming request for information contained in the Identification Section records. When a request for information comes to the front desk, the first decision that is made is to determine if the request is an investigation request. If it is not, then the assumption is made that it is a parolee or job applicant. In either case, the needed information is obtained and the request is then taken out of the system. If the request is from an investigative agency, the index card file is checked and if no information is found, the request is terminated. If an index card is found, the decision is made to either get the Criminal ID Jacket or not. If no Criminal ID Jacket is required, the arrest card file is examined and information on the arrest card is given to the requester if found. The request is then terminated. When the Criminal ID Jacket is requested, the front desk clerk pulls the Criminal ID Jacket and the requester reviews the contents and copies what is essential. The Jacket is then replaced and the request is terminated. The microfilm function receives requests from various areas. The request is given to the microfilm clerk and the search for the information is made. If the desired information is not found, the request is terminated. If the desired information is found, a decision is made to determine if a copy of the information is desired. If no copy is needed, the request is terminated. If a copy is desired, the copy is made and given to the requester, and then the request is terminated.

Another function handled in the Identification Section is the information checks made for other sections such as the Reports Section. The request is received, and the index card file is referenced. If information is available, the Criminal ID Jacket is examined and all available information is given to the requester.

Another interface with the Reports Section is the NCIC interface. The Identification Section requests information from the Reports Section in the form of an NCIC information request. The request is filled out and when the check is finished, the reply is either positive or negative. In either case, the requester is informed of the results of the NCIC check and the request for check is filed for later reference.

Clearance information is often requested from the Dallas Police Department. When clearance information is requested, the index card file, the arrest card file and, if it exists, the Criminal ID Jacket is referenced. The results of the checks are then returned to the requesting agency. The fingerprinting procedure consists of making three sets of fingerprint cards and copying the master, updating the index card file and updating or creating the associated Criminal ID Jacket.

When information from other law enforcement agencies such as the FBI and Department of Public Safety is put into the information system of the Identification Section, several files must be accessed. The index card file is referenced and if a card exists, it is updated and the Criminal ID Jacket is referenced and updated. If no index card exists, an index card is made and filed, and the information is filed for future reference.

The process is then terminated.

Other agencies of law enforcement require access to the criminal records of the Identification Section. When requested, the index card file is referenced and the Criminal ID Jacket is updated and the photo is copied and the file is replaced after viewing of the information. The request is then terminated.

One of the interfaces of the Identification Section with the courts is in the form of prosecution reports. When a prosecution report is received, the first decision to be made is if the report concerns a juvenile. If the report is on a juvenile it is filed. If the prosecution report concerns an adult, the UCR Code is placed on it and it is reviewed and a flexwriter tape is made to be sent to the Data Processing Section. A new disposition card is created, or an existing disposition card is updated, and then the prosecution report filed.

When arrest and prisoner activity reports come into the information system, they are assembled with other papers and filed in the open shelf files. These are available for reference by several methods.

A summary of the output data of the Identification Model is shown in Figure 3.1-13 and Figure 3.1-14. The process time data used in this model are based on statistics gathered in Phase I, observation of the tasks being accomplished and by assumptions arrived at by discussing specific job functions with those individuals performing the task. The Identification Model is designed so that process time data gathered in future statistical surveys can be easily incorporated into the model.

Based on the assumptions made, the following data was derived from the modeling effort; during a period of 8 hours,

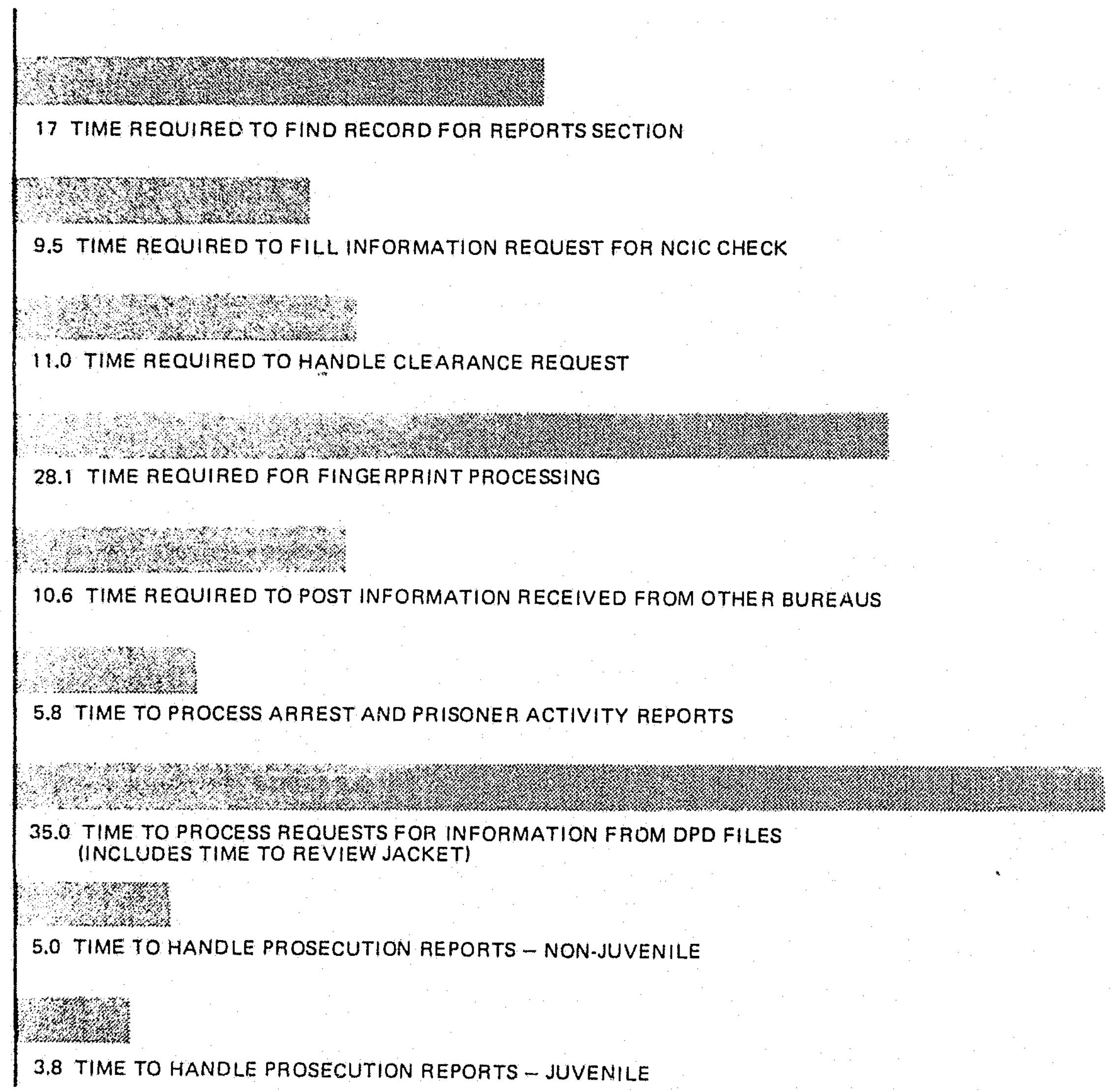

FIGURE 3.1–13. ID MODEL – TIME TO ACCESS FILES

the arrest card file was referenced 47 times, the Criminal ID Jacket file was referenced 72 times, the index card file was referenced 112 times, and there were 86 prosecution reports handled during this period.

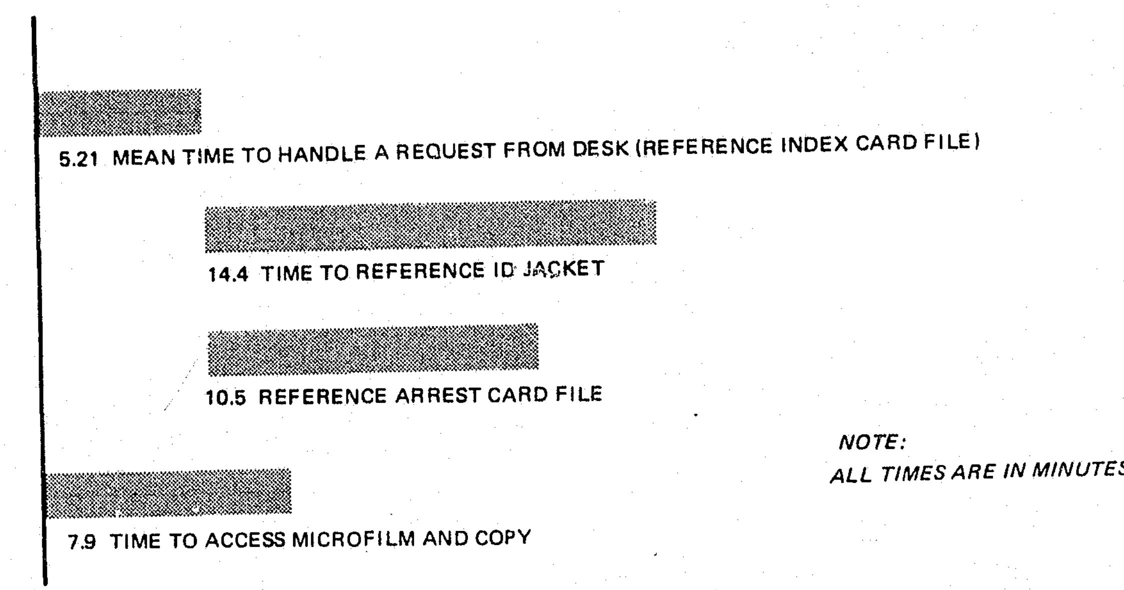

FIGURE 3.1–14. ID MODEL – TIME TO PROCESS REQUESTS

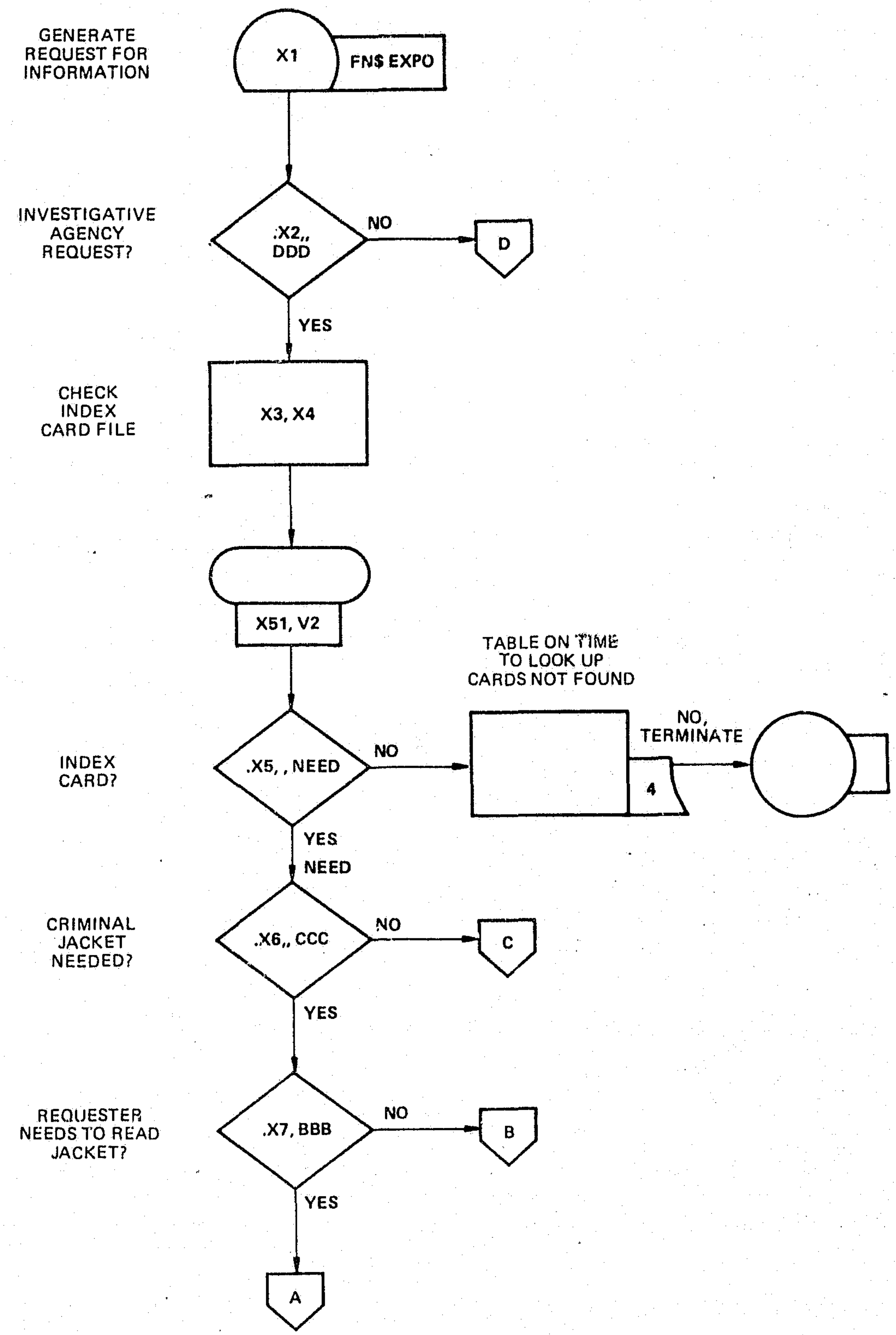

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 1 OF 12)

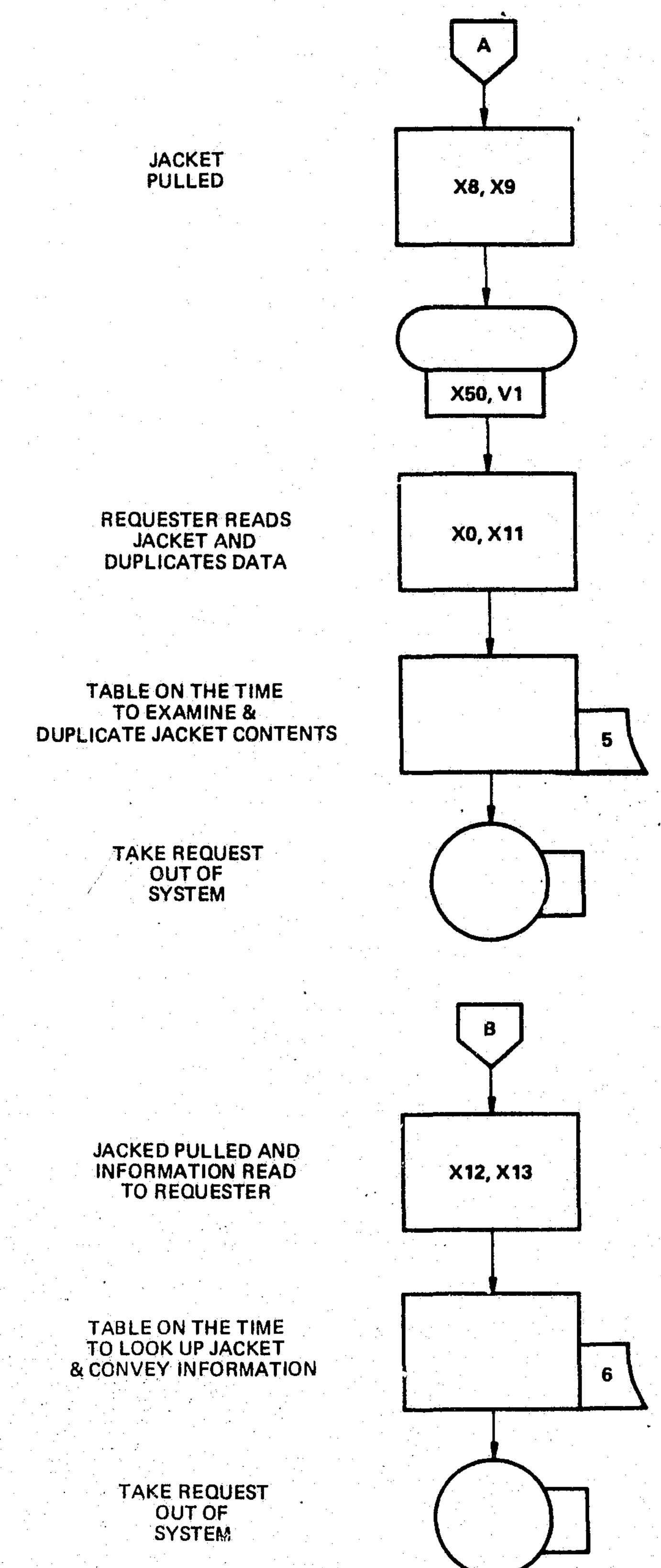

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 2 OF 12)

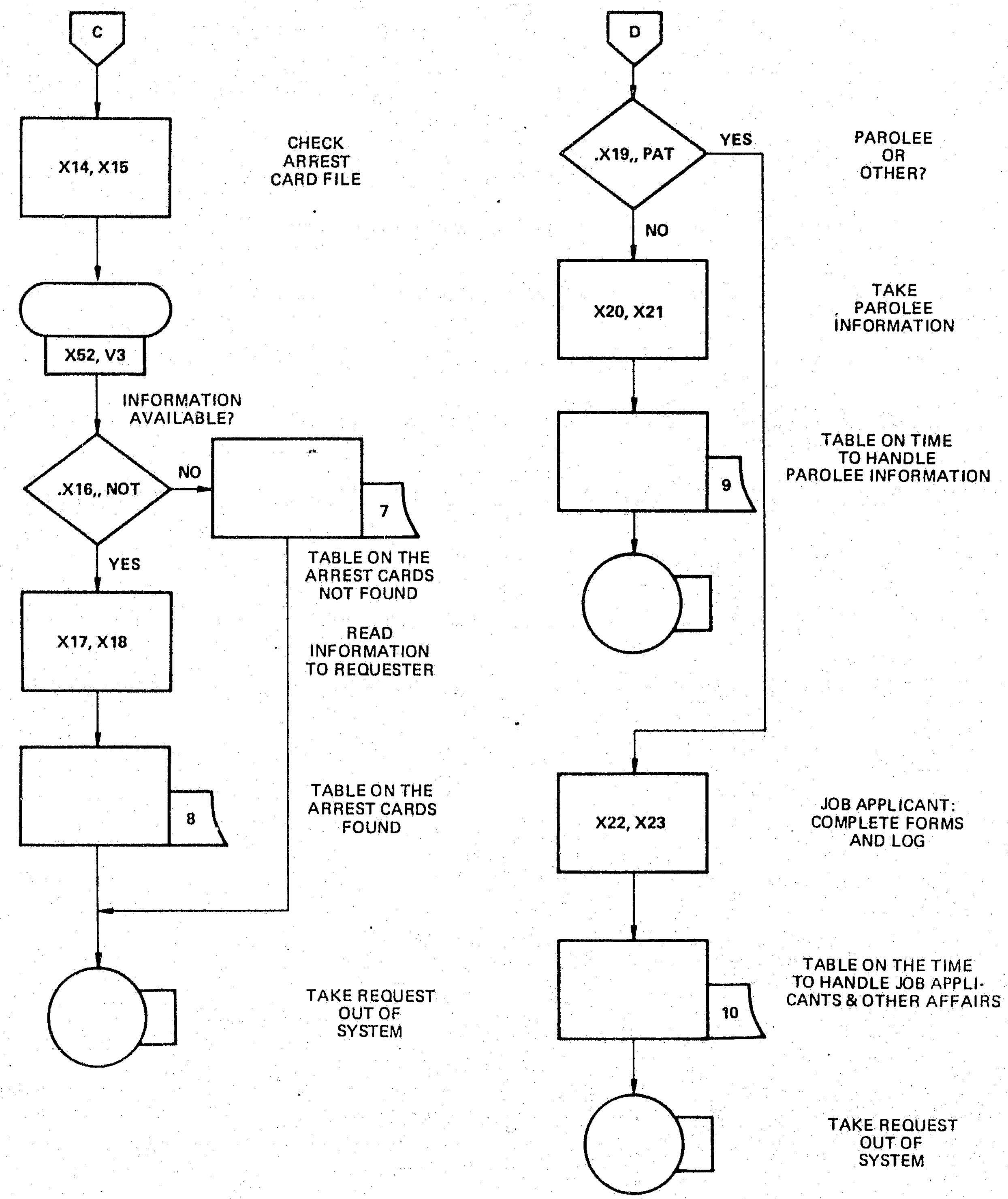

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 3 OF 12)

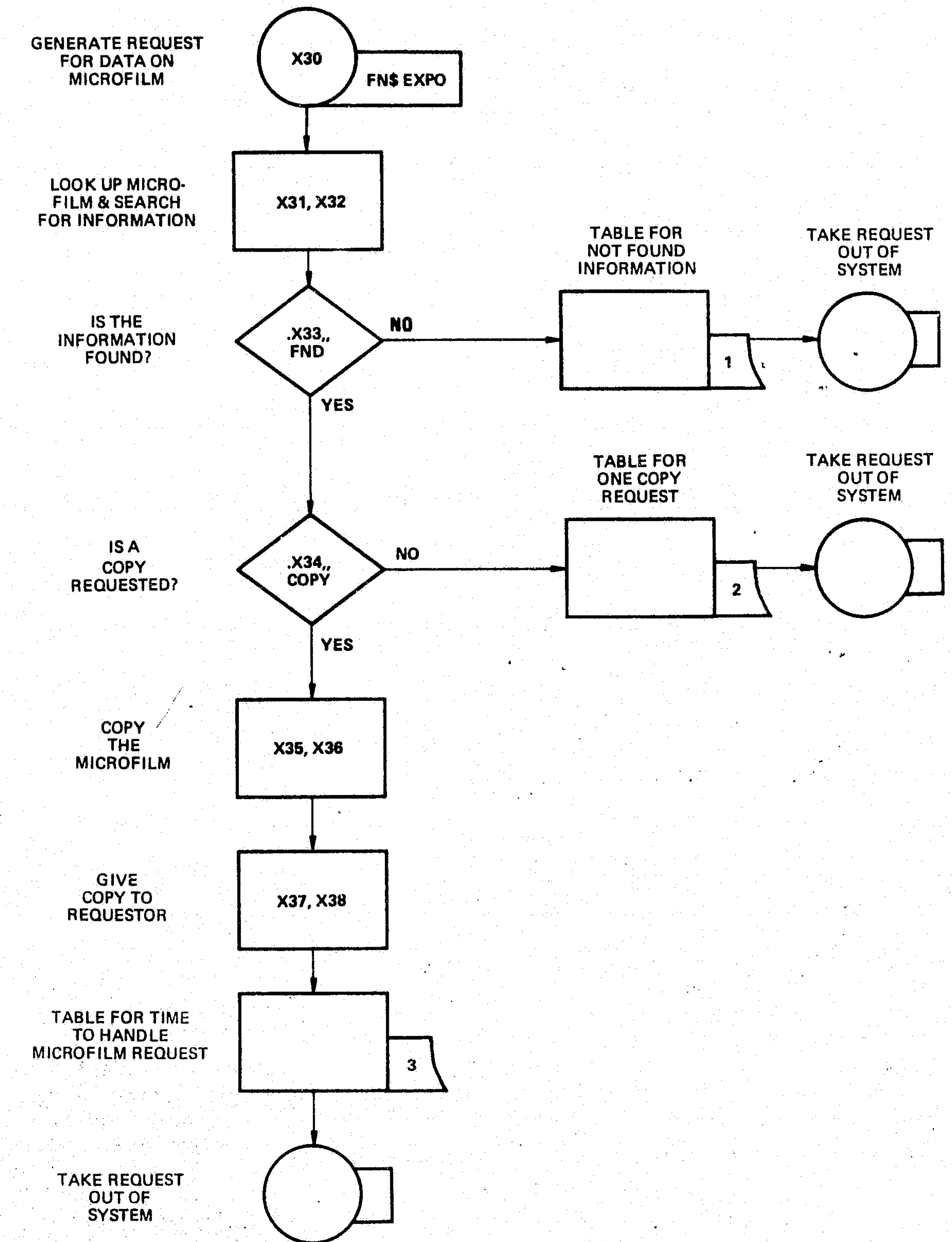

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 4 OF 12)

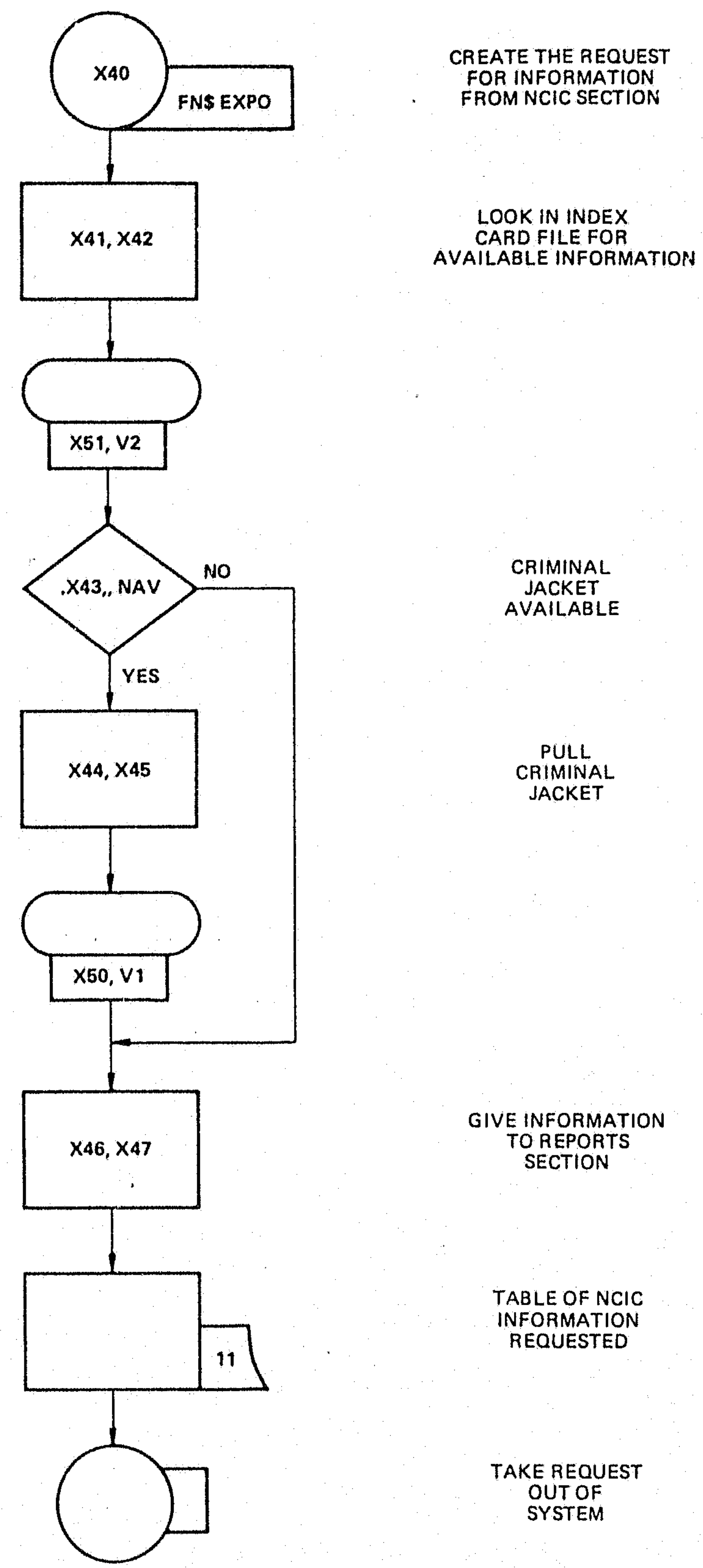

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 5 OF 12)

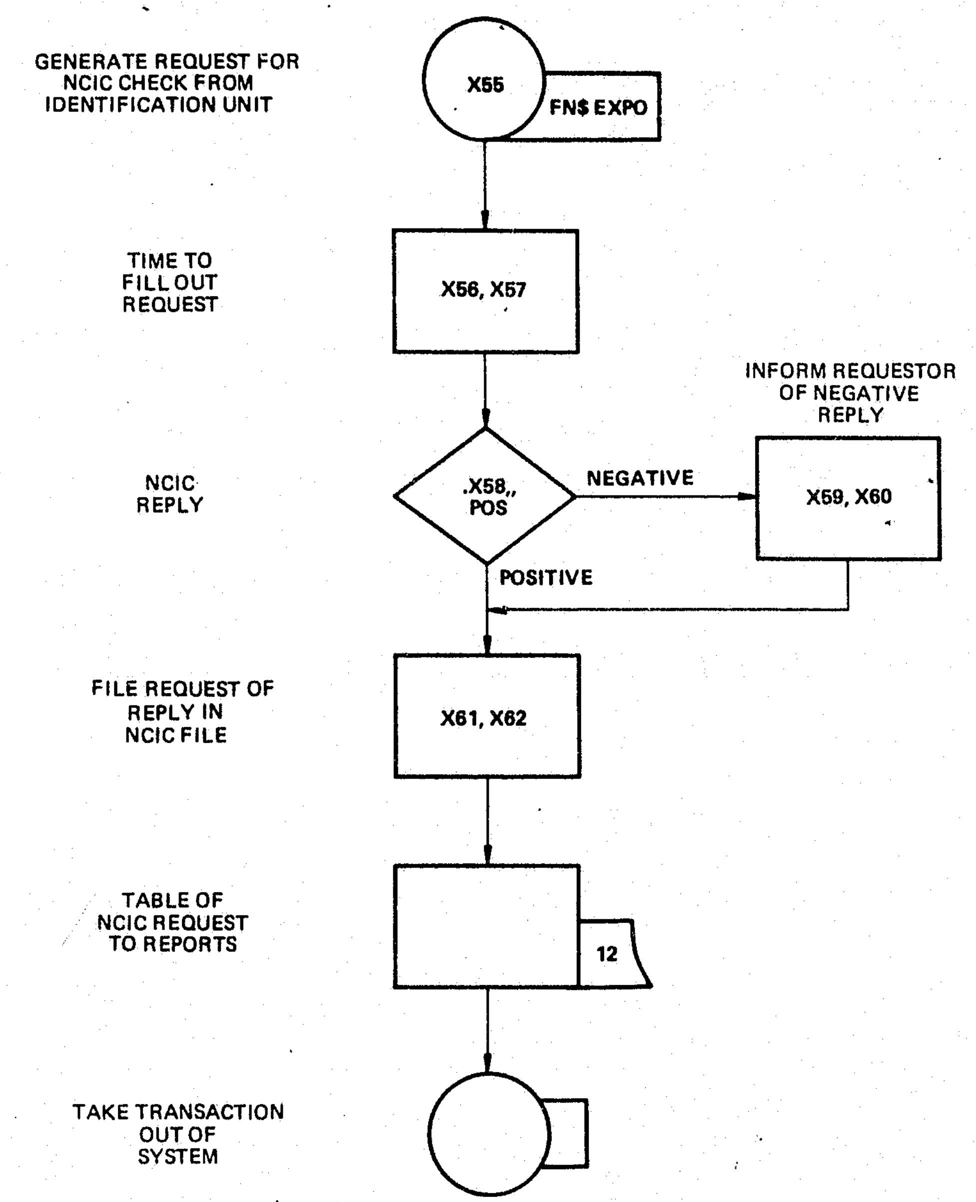

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 6 OF 12)

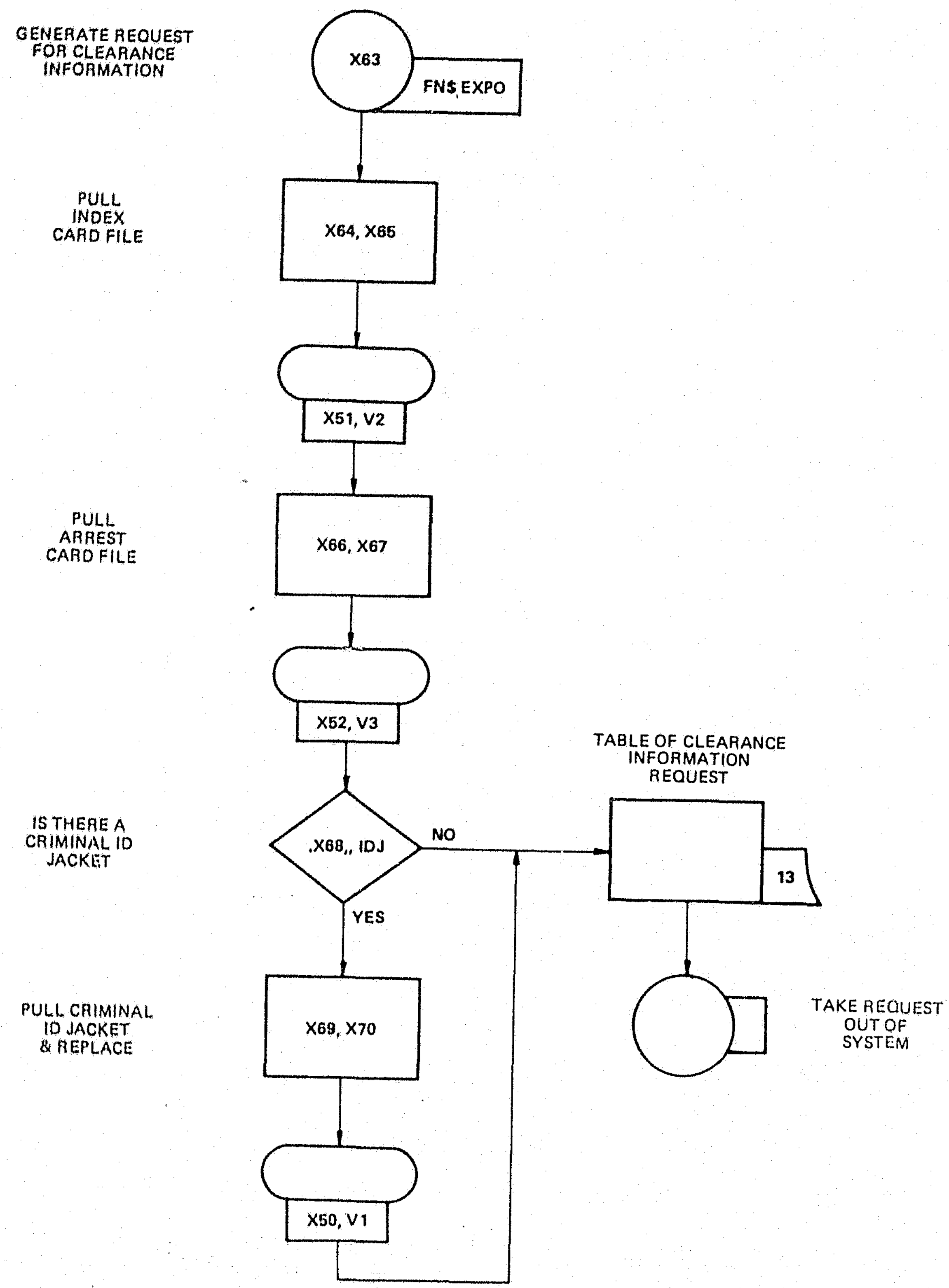

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 7 OF 12)

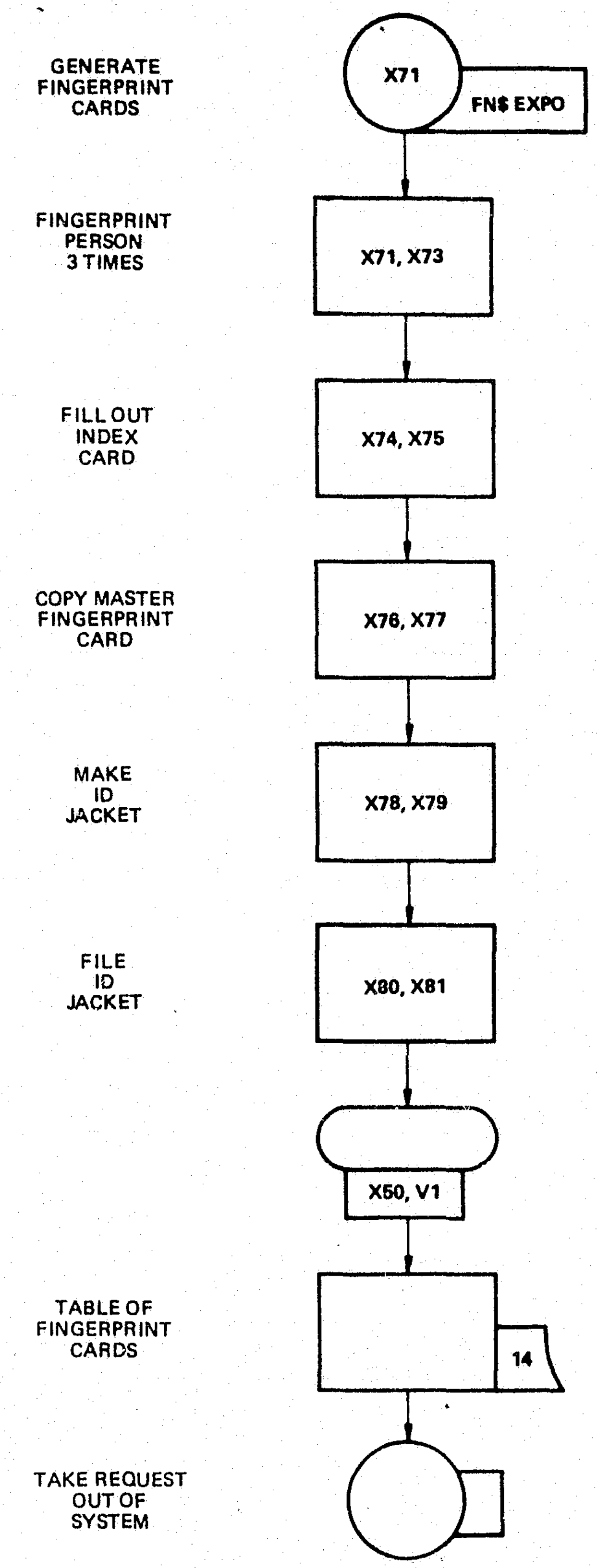

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 8 OF 12)

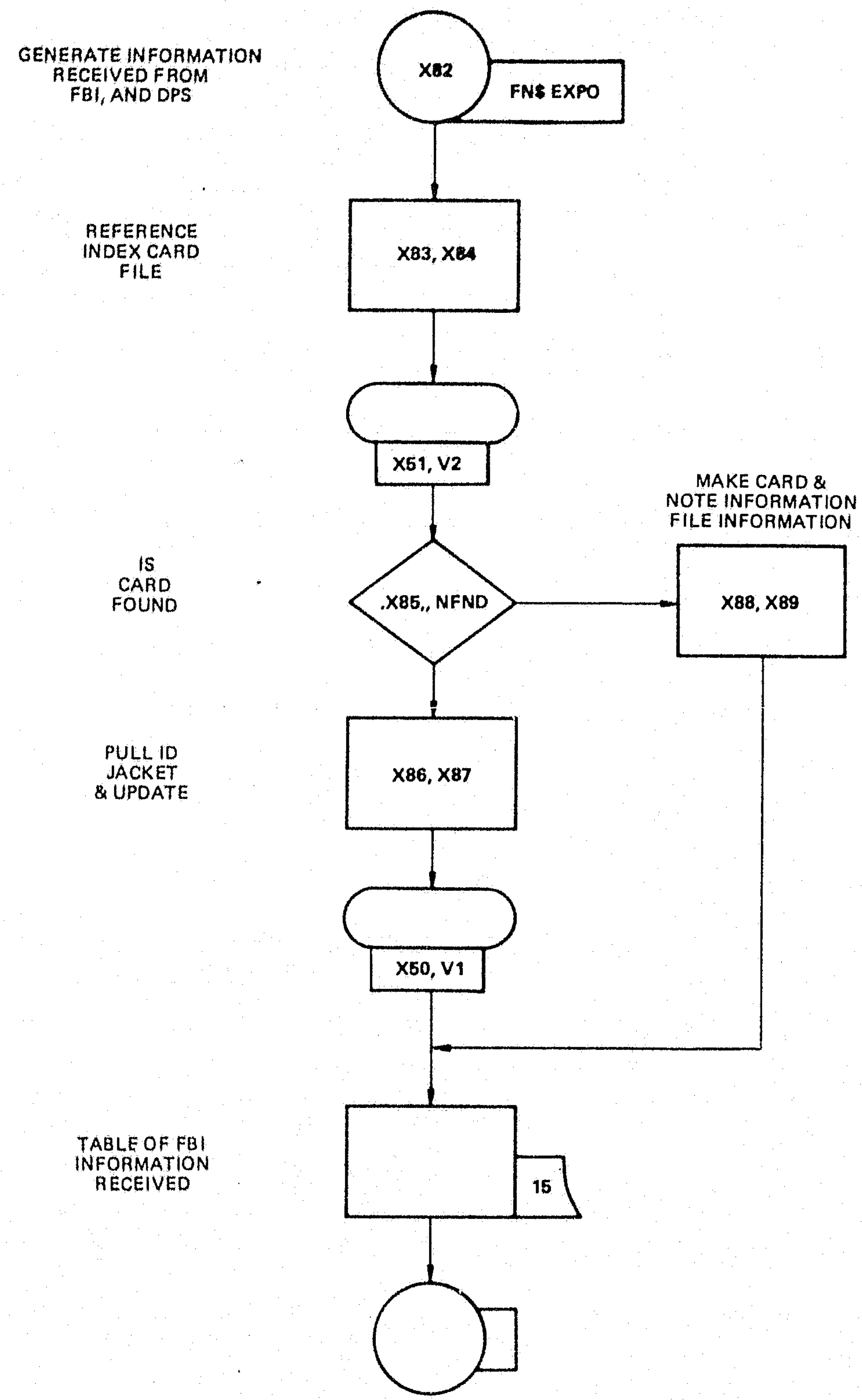

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 9 OF 12)

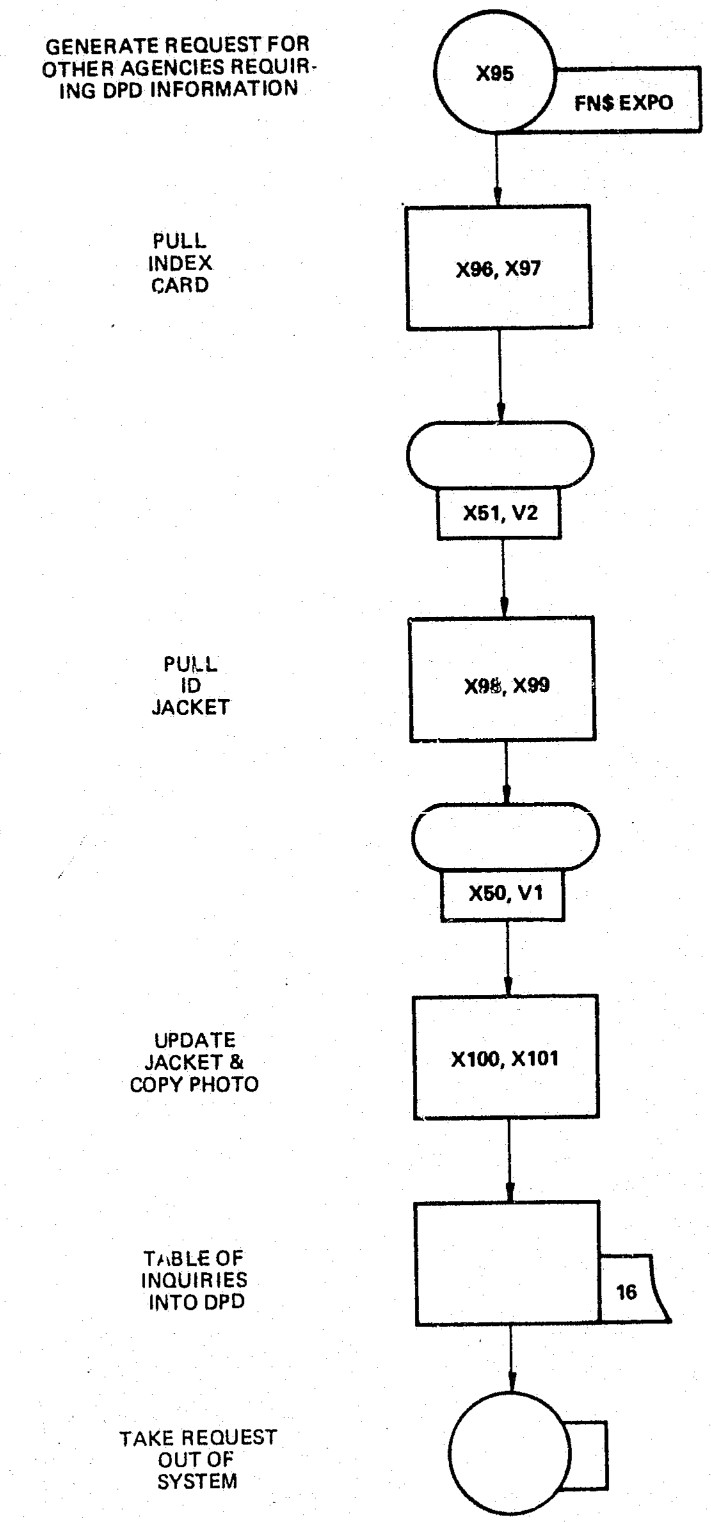

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 10 OF 12)

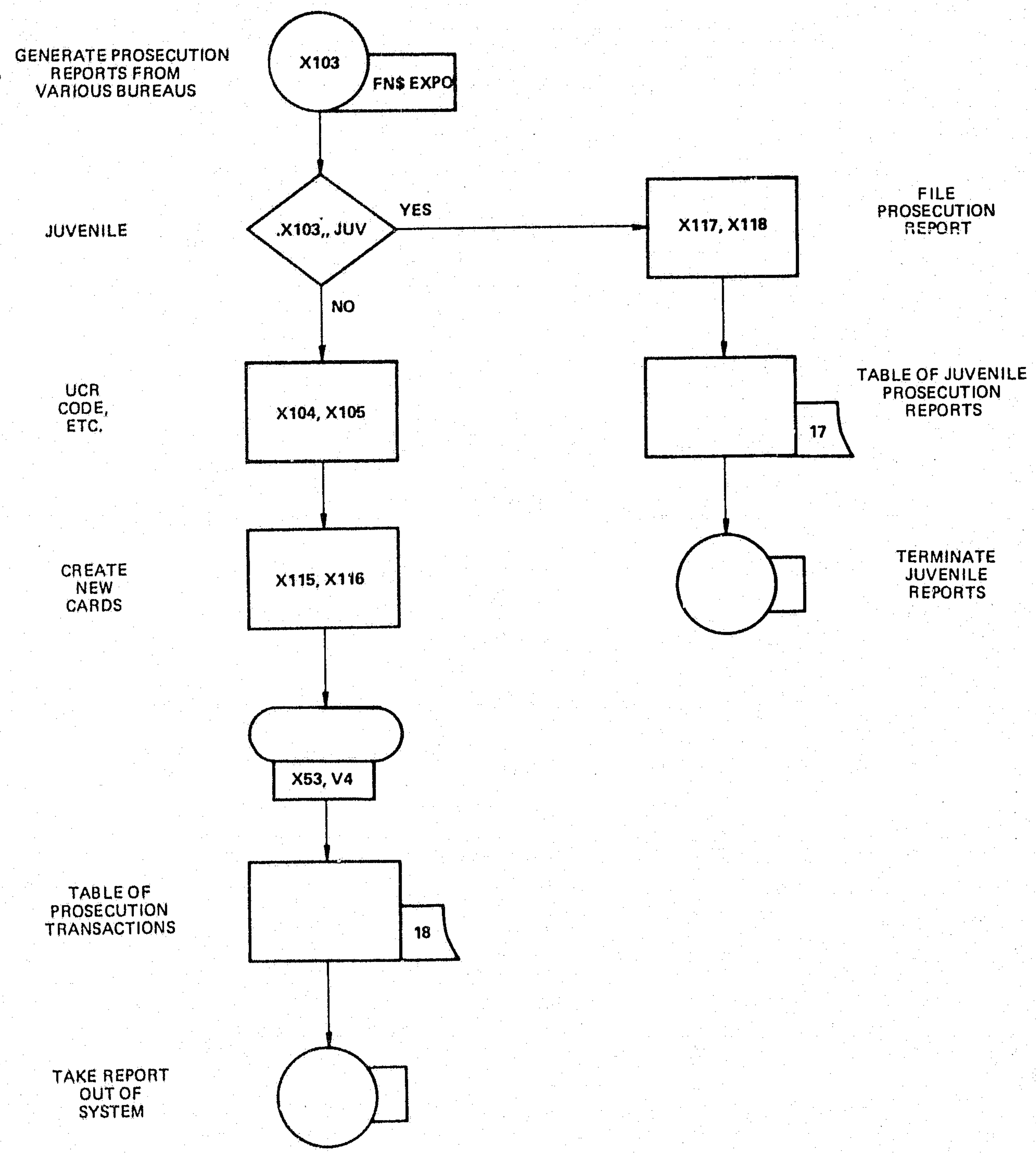

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 11 OF 12)

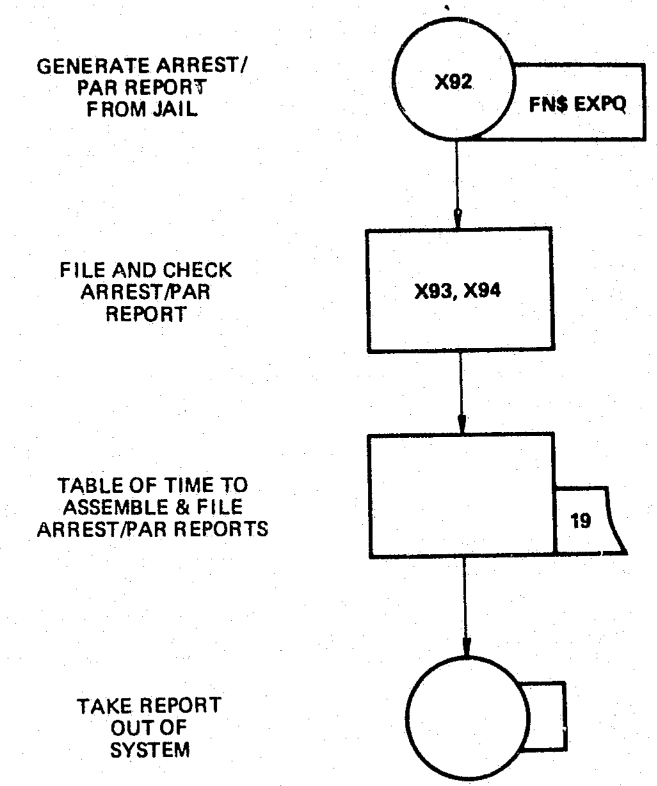

FIGURE 3.1–12. IDENTIFICATION SECTION MODEL GPSS/360 FLOW CHART (SHEET 12 OF 12)

IDENTIFICATION MODEL SYMBOL TABLE

X1	=	Mean Interarrival Time For Informations Requests At Front Desk
X2	=	Percent Of Requests From Investigative Agencies
X3	=	Mean Time To Access Index Card File
X4	=	Spread Of X3
X5	=	Percent Of Index Card File Accesses Which Result In A Find
X6	=	Percent Of Index Card File Finds For Which An ID Jacket Must Be Pulled
X7	=	Percent Of X6 Type Requests For Which An ID Jacket Must Be Read
X8	=	Mean Time To Pull ID Jacket
X9	=	Spread Of X8
X10	=	Mean Time For Requests To Read ID Jacket Material
X11	=	Spread Of X10
X12	=	Mean Time To Pull ID Jacket And Read Material
X13	=	Spread Of X12
X14	=	Mean Time To Access Arrest Card File
X15	=	Spread Of X14
X16	=	Percent Of Arrest Card File Accesses Which Result In A Find
X17	=	Mean Time To Read Arrest Card Information To Requestor
X18	=	Spread Of X17
X19	=	Percent Of Requests Involving A Parolee
X20	=	Mean Time To Process Parolee Information
X21	=	Spread Of X20
X22	=	Mean Time To Process Job Applicant Information
X23	=	Spread Of X22
X30	=	Mean Interarrival Time For Microfilm Information Requests
X31	=	Mean Time To Conduct Microfilm Search

IDENTIFICATION MODEL SYMBOL TABLE (CONT'D)

X32	=	Spread Of X31
X33	=	Percent Of Microfilm Searches Which Result In A Find
X34	=	Percent Of Microfilm Finds For Which Copies Are Made
X35	=	Mean Time To Copy Microfilm
X36	=	Spread Of X35
X37	=	Mean Time To Give Requestor Microfilm Information
X38	=	Spread Of X37
X40	=	Mean Interarrival Time For Information Requests From Reports Section
X41	=	Mean Time To Access Index Card File
X42	=	Spread Of X41
X43	=	Percent Of Requests Which Result In A Find
X44	=	Mean Time To Pull ID Jacket
X45	=	Spread Of X44
X46	=	Mean Time To Relay Information To Reports Section
X47	=	Spread Of X46
X55	=	Mean Interarrival Time For NCIC Information Requests From Reports Section
X56	=	Mean Time To Complete Information Request Form
X57	=	Spread Of X56
X58	=	Percent Of Requests Resulting In A Find
X59	=	Mean Time To Inform Of No Find
X60	=	Spread Of X59
X61	=	Mean Time To File Request And Make Reply
X62	=	Spread Of X61
X63	=	Mean Interarrival Time For Clearance Requests
X64	=	Mean Time To Access Index Card File
X65	=	Spread Of X64

IDENTIFICATION MODEL SYMBOL TABLE (CONT'D)

X66	=	Mean Time To Access Arrest Card File
X67	=	Spread Of X66
X68	=	Percent Of Requests For Which There Is An ID Jacket
X69	=	Mean Time To Process ID Jacket
X70	=	Spread Of X69
X71	=	Mean Interarrival Time For Fingerprint Requests
X72	=	Mean Time To Fingerprint
X73	=	Spread Of X72
X74	=	Mean Time To Make Index Card
X75	=	Spread Of X74
X76	=	Mean Time To Copy Fingerprint Form
X77	=	Spread Of X76
X78	=	Mean Time To Create ID Jacket
X79	=	Spread Of X78
X80	=	Mean Time To File ID Jacket
X81	=	Spread Of X80
X82	=	Mean Interarrival Time For FBI/DPS Bulletin Information
X83	=	Mean Time To Access Index Card File
X84	=	Spread Of X83
X85	=	Percent Of Cases Where An Index Card Is Not Found
X86	=	Mean Time To Access ID Jacket File
X87	=	Spread Of X86
X88	=	Mean Time To Make An Index Card
X89	=	Spread Of X88
X92	=	Mean Interarrival Time For Arrest And Prisoner Activity Reports From Jail
X93	=	Mean Time To File An Check Arrest And Prisoner Activity Reports

IDENTIFICATION MODEL SYMBOL TABLE (CONT'D)

X94	=	Spread Of X93
X95	=	Mean Interarrival Time For Information Requests From Dallas Police Department File By Other Law Enforcement Agencies
X96	=	Mean Time To Access Index Card File
X97	=	Spread Of X96
X98	=	Mean Time To Pull ID Jacket
X99	=	Spread Of X98
X100	=	Mean Time To Update ID Jacket And Copy Photo
X101	=	Spread Of X101
X102	=	Mean Interarrival Time For Prosecution Reports
X103	=	Percent Of Prosecution Reports Which Are For Juveniles
X104	=	Mean Time To NCR Code, etc.
X105	=	Spread Of X104
X115	=	Mean Time To Process Disposition Data
X116	=	Spread Of X115
X117	=	Mean Time To Process Juvenile Prosecution Report
X118	=	Spread Of X117

Functions

EXPO	=	Negative Exponential Function

Tables

Table 1	=	Time For Microfilm Records Which Result In No Find
Table 2	=	Time For Requests For Microfilm Search, Where Information Is Found But Not Copied
Table 3	=	Time For Requests For Microfilm Search Which Result In Copied Information Delivered
Table 4	=	Time For Requests Which Result In Index Card Not Found

IDENTIFICATION MODEL SYMBOL TABLE (CONT'D)

Table 5	=	Time For Requests Which Require ID Jacket Duplication And Examination
Table 6	=	Time For Requests Which Require Pulling ID Jacket
Table 7	=	Time For Requests Which Result In Arrest Card Not Found
Table 8	=	Time For Requests Which Result In An Arrest Card Find
Table 9	=	Time For Registration Of Parolees
Table 10	=	Time For Registration Of Job Applicants
Table 11	=	Time For NCIC Information Requests
Table 12	=	Time For Request For NCIC Information From Reports Section
Table 13	=	Time For Handling Clearance Requests
Table 14	=	Time For Fingerprint Operations
Table 15	=	Time For Posting FBI/DPS Information
Table 16	=	Time For Handling Information Requests From Other Law Enforcement Agencies
Table 17	=	Time For Handling Juvenile Prosecution Reports
Table 18	=	Process Time For Handling Adult Prosecution Reports
Table 19	=	Time For Handling Arrest And Prisoner Activity Reports

IDENTIFICATION MODEL VALUE TABLE

SYMBOL	VALUE IN MINUTES
X1	4
X2	500
X3	5
X4	2
X5	800
X6	750
X7	750
X8	5
X9	2
X10	10
X11	2
X12	10
X13	3
X14	5
X15	2
X16	500
X17	5
X18	1
X19	50
X20	3
X21	1
X22	3
X23	1
X30	9
X31	3
X32	1
X33	500

IDENTIFICATION MODEL VALUE TABLE (CONT'D)

SYMBOL	VALUE IN MINUTES
X33	500
X34	800
X35	3
X36	1
X37	2
X38	1
X40	60
X41	5
X42	2
X43	500
X44	15
X45	5
X46	5
X47	3
X55	48
X56	3
X57	1
X58	100
X59	2
X60	1
X61	5
X62	1
X63	16
X64	5
X65	2
X66	5
X67	2

IDENTIFICATION MODEL VALUE TABLE (CONT'D)

SYMBOL	VALUE IN MINUTES
X68	10
X69	15
X70	5
X71	8
X72	15
X73	3
X74	2
X75	1
X76	4
X77	1
X78	5
X79	1
X80	2
X81	1
X82	120
X83	5
X84	1
X85	900
X86	15
X87	5
X102	8
X88	5
X89	2
X92	1
X93	5
X94	2
X95	70

IDENTIFICATION MODEL VALUE TABLE (CONT'D)

SYMBOL	VALUE IN MINUTES
X96	5
X97	2
X98	15
X99	5
X100	15
X101	5
X103	100
X104	5
X105	1
X117	5
X118	3
X115	2
X116	1

3.2 ALTERNATE SUBSYSTEMS

Variations to the base line configuration were performed by altering two subsystems. These two subsystems, Communications and Patrol, were selected because of the need to study the response time in dealing directly with the public and the facilities utilized in dealing with persons requesting information and/or assistance.

The In Car terminal concept was applied to the Communications Model. The dispatcher function was bypassed.

The Patrol Model was also altered to include the In Car terminal concept: an alternate subsystem where reports were transmitted from the substations was also considered.

The following paragraphs give the details of these studies for each model.

3.2.1 ALTERNATE COMMUNICATION SUBSYSTEMS

3.2.1.1 DIRECT IN CAR TERMINAL

The baseline communications model was altered to conduct an examination of the response times associated with the In Car terminal use. An In Car terminal is considered to be a black box capable of sending and receiving video information and printed information. It should be noted that products of this type have not been thoroughly field-tested at this point in time and hence reliable statistics regarding usage, etc., are not available. (See Section 2.1.) The following results indicate that such information handling methods reduce the time for sending and receiving messages.

The results obtained from the simulation model of the Communication Section are used as the basis for all computations in this section of the report. The time delay from the time a call comes into the Communications Section until an element is on the scene is approximately 358 seconds during low activity periods; in high activity periods the time is somewhat higher, 461 seconds. Figures 3.2-1 and 3.2-2 show breakdowns of these times. As seen in the patrol model results, the time to code 6 decreases when the activity increases. This indicates that a build up of calls takes place during high activity at the telephone clerk-dispatcher interface. This condition is still present with use of the In Car terminal but is less prominent than when a dispatcher function is utilized.

When the In Car terminal is utilized by the patrol element to input a report, Figures 3.2-1 and 3.2-2 show the total time to enter the full report into the unified data base is less than 4000 seconds. This time includes the time to receive the call, send the request to the proper element, assuming an adequate car locator system, and the time for the element to handle the call and type the report into the unified data base.

This type of information routing disregards the use of a dispatcher, and a large portion of the Reports Section if it is assumed that a unified data base is in existance.

3.2.1.2 EFFECTS OF PATROL ELEMENT TRAVEL TIME

Travel time for a patrol element is defined to be the time elapsed from receipt of a dispatcher call by the element until the element codes 6 at the scene. It was assumed that beats could be configured in such a way that patrol element assignments would allow a mean 2 minutes travel time. The Communications model was modified to examine the following situations:

(1) A mean 2 minute travel time with no In Car terminal in use,

(2) A mean 2 minute travel time with an In Car terminal in use.

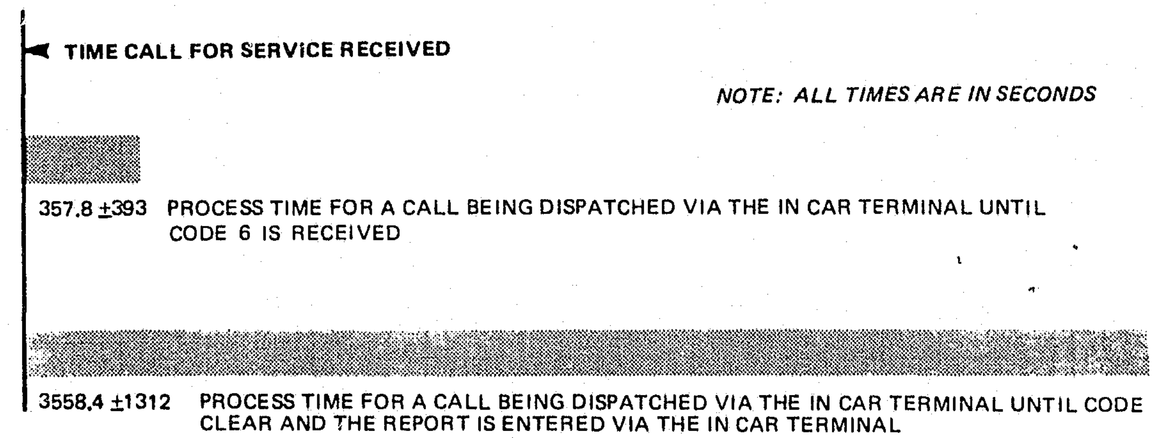

FIGURE 3.2–1. COMMUNICATIONS SECTION MODEL: LOW ACTIVITY WITH IN CAR TERMINAL

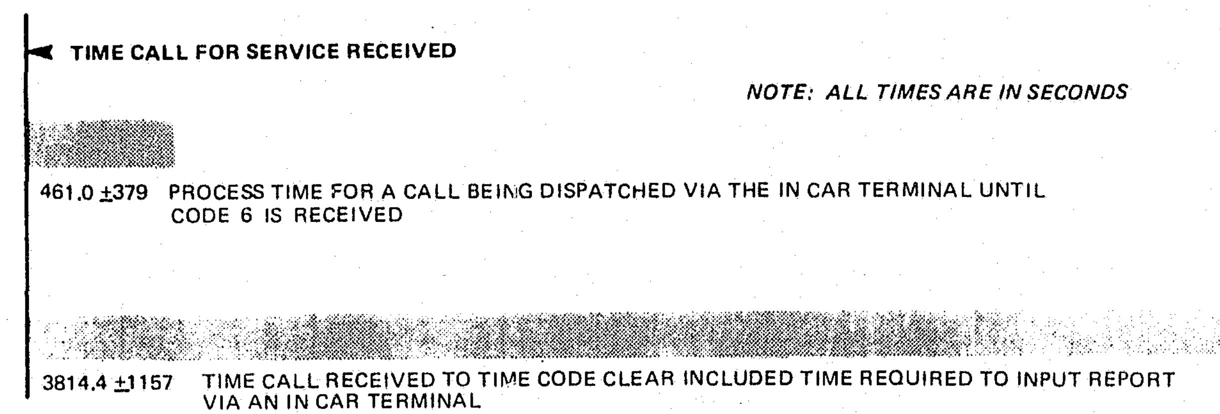

FIGURE 3.2–2. COMMUNICATIONS SYSTEM MODEL: HIGH ACTIVITY WITH IN CAR TERMINALS

Low activity data was employed in the simulations. The travel time data was obtained from the call file and is not completely accurate since for instance dispatch times are usually recorded in the computer some time after the dispatch call is made. The mean 2 minutes travel time was arrived at by calculating travel time from a negative exponential distribution.

Figures 3.2-3 thru 3.2-6 contain frequency distributions obtained as output from the simulation runs. These frequency distributions show the number of dispatches having travel times in certain ranges. For example, in Figure 3.2-3 it can be seen that 14 dispatches had travel times in the range 2-3 minutes. Figure 3.2-6 shows that 178 out of a total of 231 dispatches resulted in travel times in the range 0-3 minutes. This represents a considerable improvement when compared with the situation shown in Figure 3.2-3, where only 14 dispatches out of 211 had travel times less than or equal to 3 minutes.

In the baseline system model 27 dispatches resulted in a 4-5 minute travel time range, while in the model incorporating In Car terminals and a mean 2 minute travel time. Seventy-four dispatches had travel time no greater than 1 minute.

3.2.2 ALTERNATE PATROL SUBSYSTEMS

3.2.2.1 SUBSTATION TERMINAL

A study of the time charts for the Patrol Model is quite informative. The charts show a delay between the time an offense occurs and the time the Offense/Incident Report reaches the Reports Section. This delay time is often in excess of six hours. It seems that, in the future, delays of this magnitude cannot be tolerated. Possible methods to reduce this delay time were modeled.

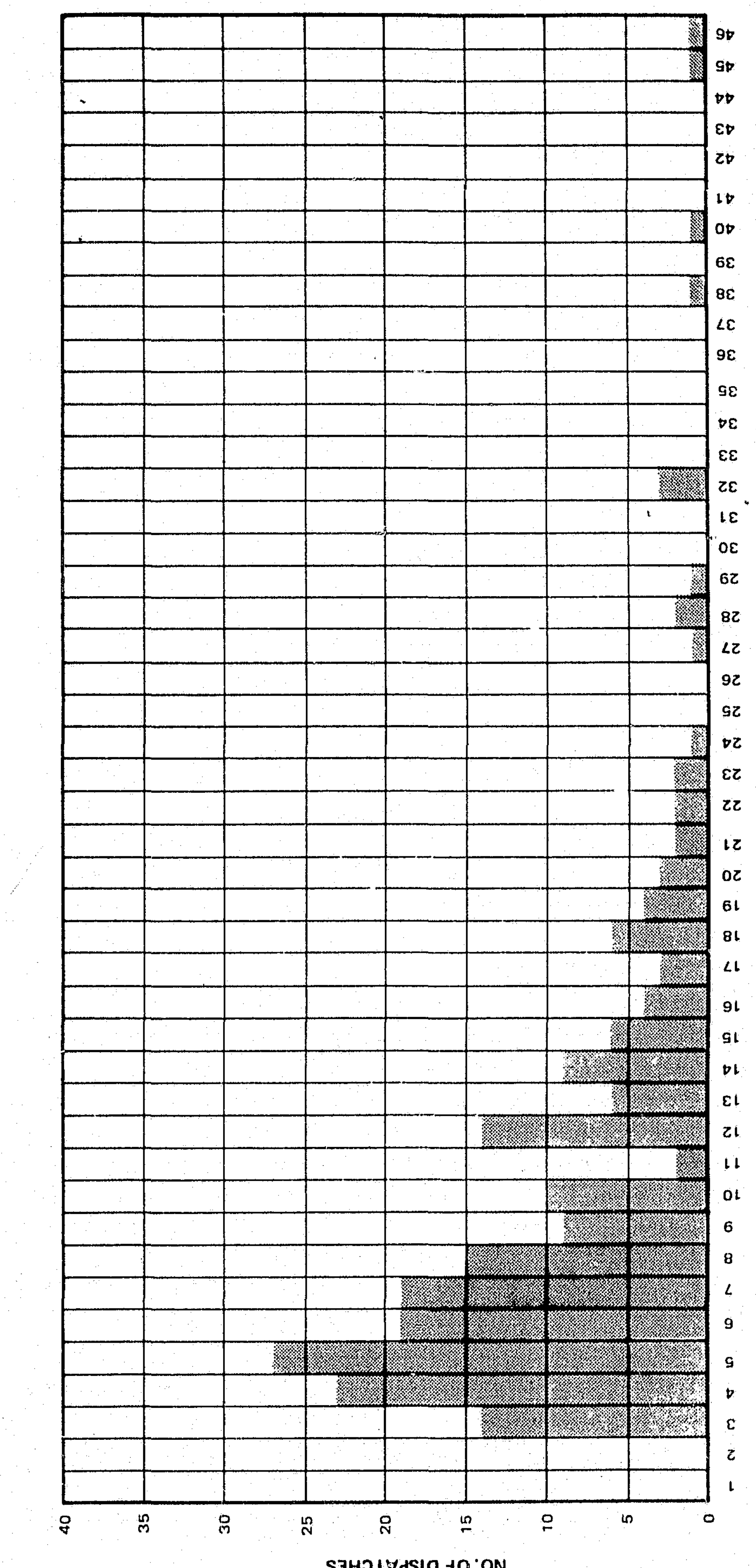

FIGURE 3.2-3. BASELINE SYSTEM

6. SYMBOLS
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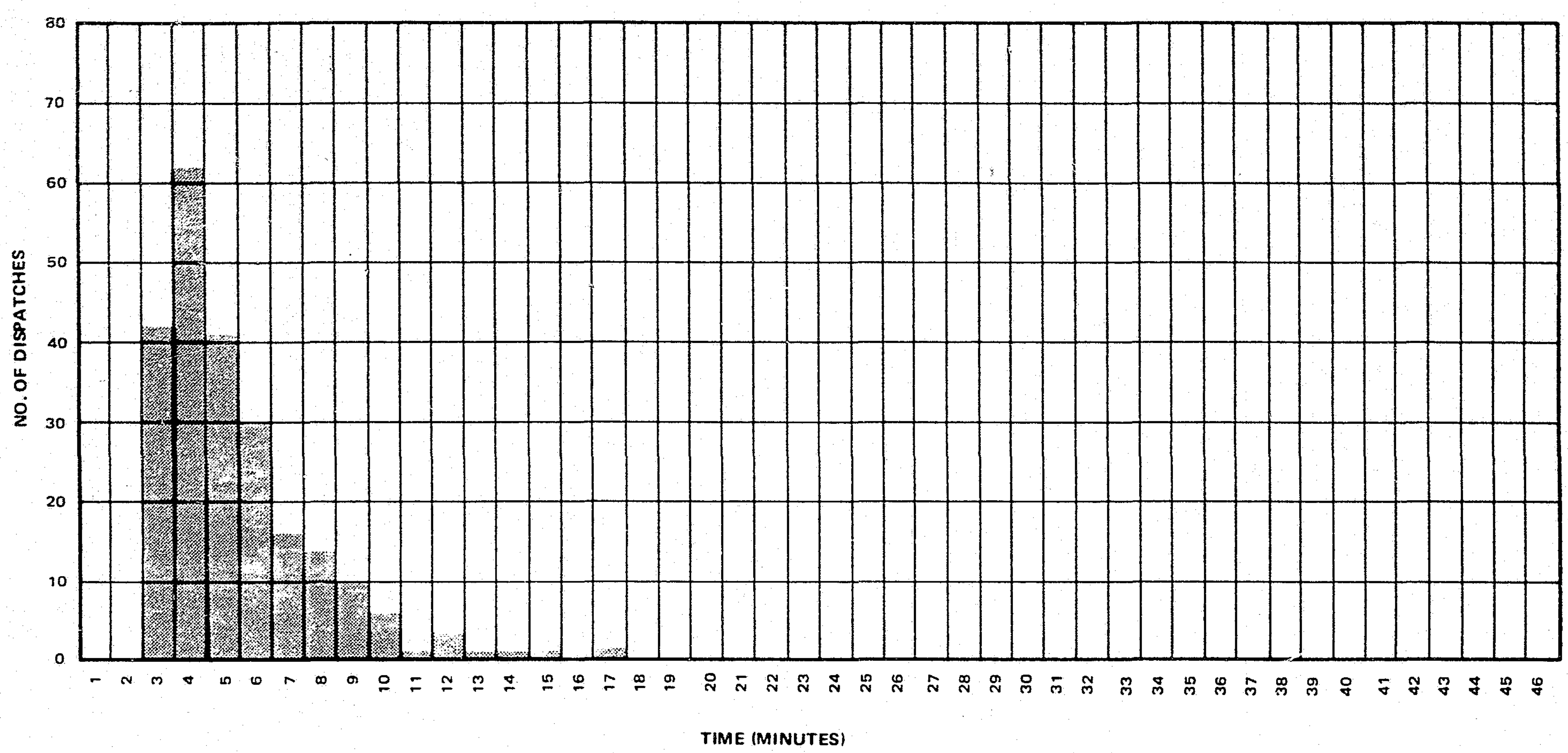


FIGURE 3.2–4. NO IN CAR TERMINAL AND A MEAN 2 MINUTE TRAVEL TIME

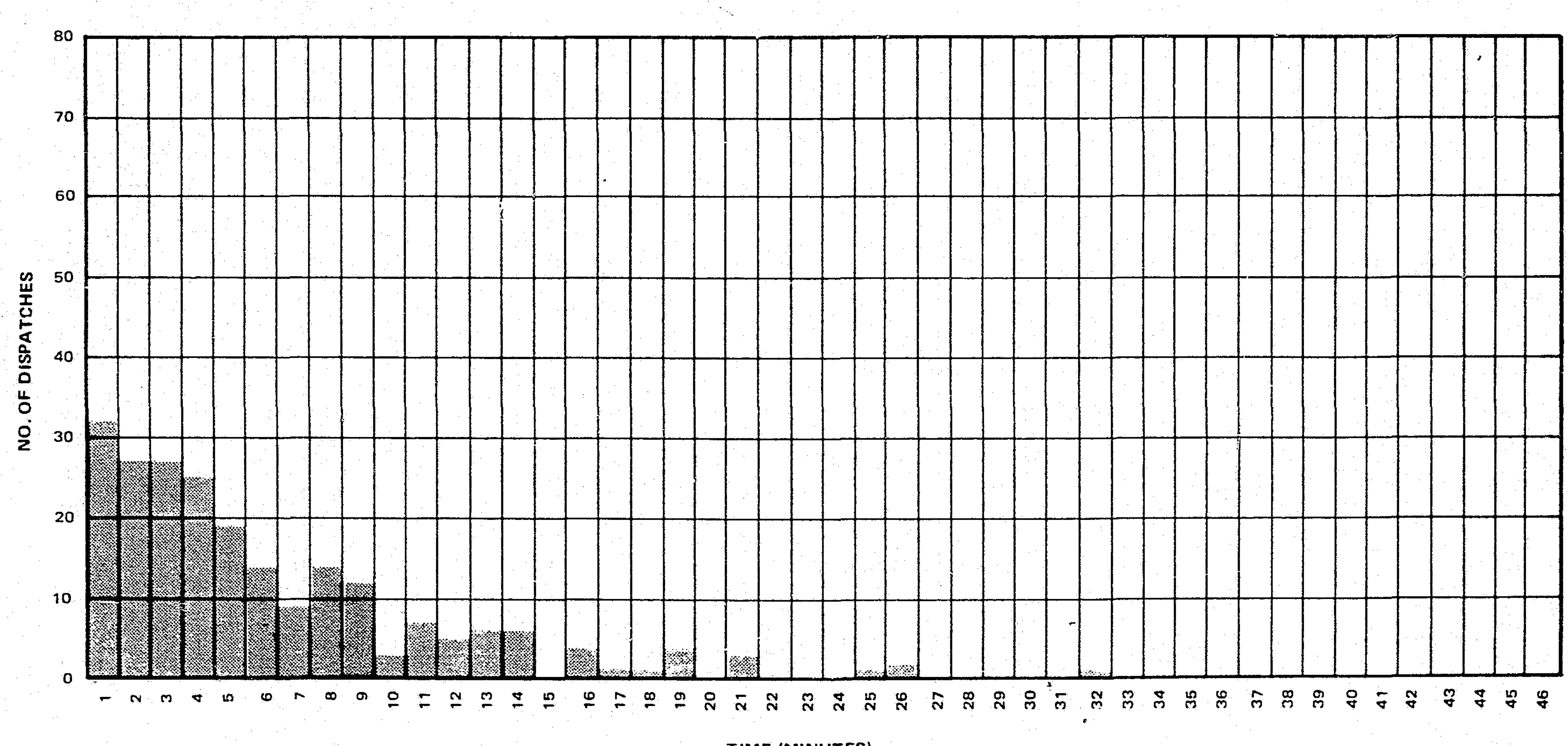


FIGURE 3.2–5. IN CAR TERMINAL USED

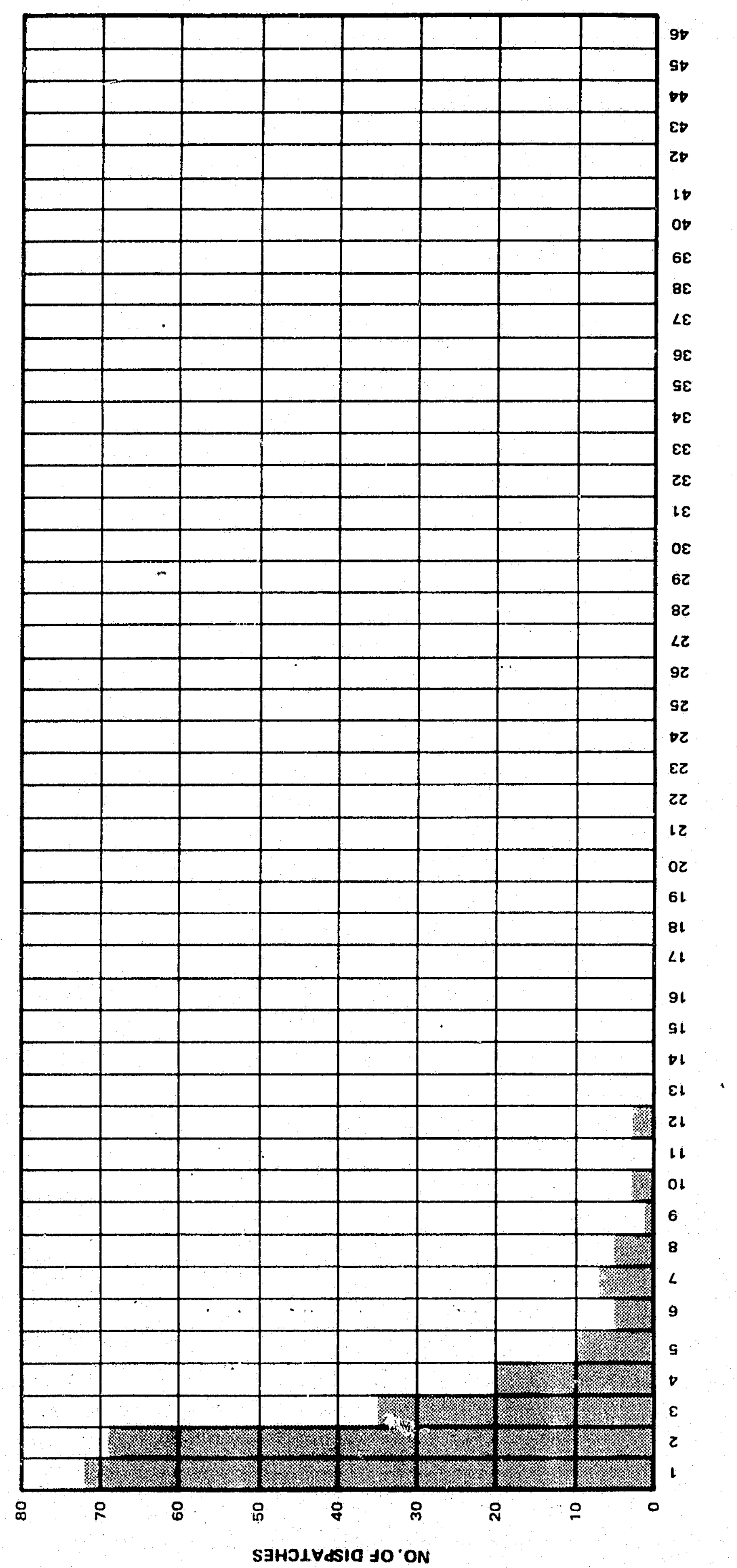
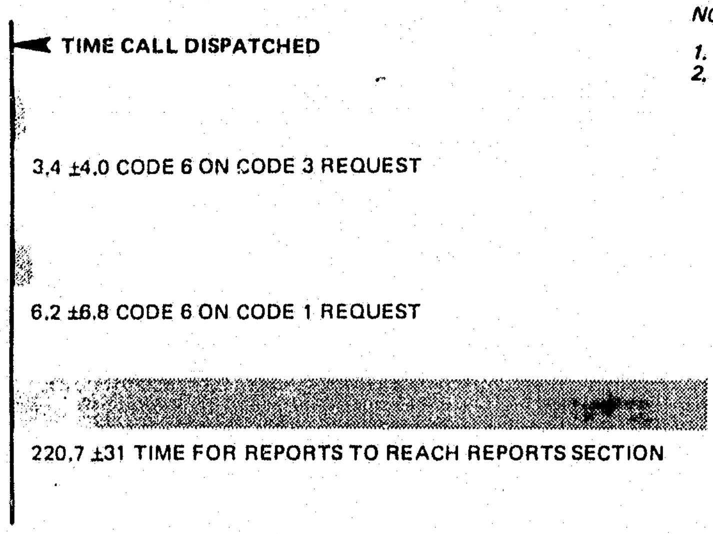


FIGURE 3.2-6. IN CAR TERMINAL AND A MEAN 2 MINUTE TRAVEL TIME

The model was first modified to study the gains achieved by the use of Video Data Terminals to transmit reports from the field substation to the Reports Section. When received at the substation the handwritten reports were reviewed, corrected, and then transmitted to the Central Reports Section via a Video Data Terminal. The operations of reviewing the report and entering it via a Video Data Terminal were not simulated. The times required for operations prior to review at the substation were calculated from data compiled for the baseline models. The modifications resulted in a mean time of 3.66 hours for a report to reach a substation. It was felt that a mean time of 4.66 hours would elapse prior to entry of the report into the data base. This is a noteworthy improvement, however, it was felt that further improvements were possible.

3.2.2.2 DIRECT IN CAR TERMINALS

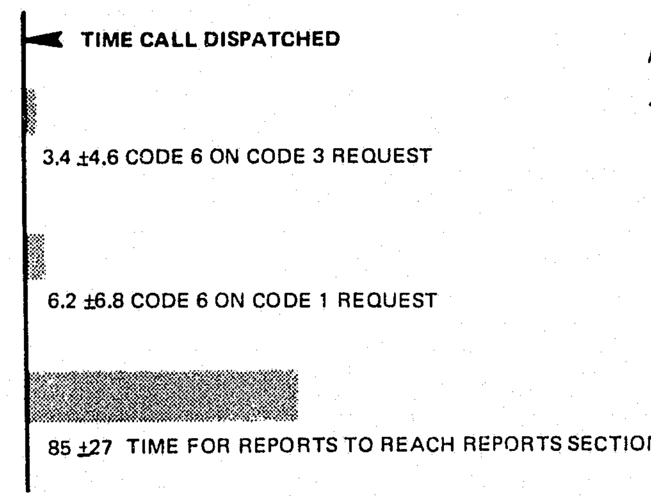
A study of the offense reports in Reports Section showed that less than ten percent were returned to the field for corrections. In view of this low figure it was decided that direct input to the Unified Data Base with subsequent editing of the record would also represent a practical approach to the problem. The model was modified to simulate this operational procedure. It was assumed that it would require a mean time of 30 minutes to type in a report in the field. These times were calculated in the model by sampling from a uniform distribution over the interval [15, 45]. The simulation runs for this operation indicated a dramatic improvement in response time. Mean input time for a report during a normal activity period was 85.5 minutes. Mean input time for a high activity period was reduced to 80.3 minutes.



NOTES:

1. *ALL TIMES ARE IN MINUTES*
2. *THIS SIMULATION REFLECTS THE USE OF VIDEO DATA TERMINALS AT THE SUBSTATION TO INPUT REPORTS TO THE UNIFIED DATA BASE*

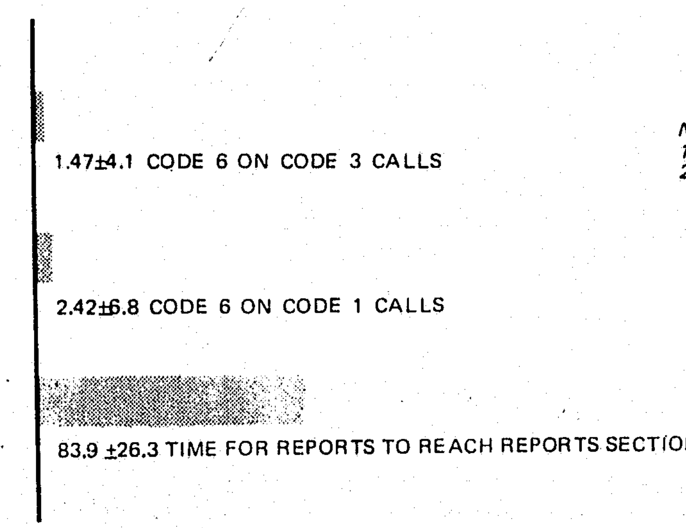
FIGURE 3.2–7. PATROL MODEL LOW ACTIVITY RESPONSE TIME [1] SPECIAL [2]



NOTE:

1. *ALL TIMES ARE IN MINUTES*
2. *DATA IS INPUT DIRECTLY INTO THE DATA BASE*

FIGURE 3.2–8. PATROL MODEL LOW ACTIVITY RESPONSE TIME [1] WITH IN CAR TERMINALS [2] (PART 1)



NOTE:

1. *ALL TIMES ARE IN MINUTES*
2. *DATA IS INPUT DIRECTLY INTO DATA BASE*

FIGURE 3.2–8. PATROL MODEL HIGH ACTIVITY RESPONSE TIME USING IN CAR TERMINALS [2] (PART 2)

3.3 COST ANALYSIS OF SUBSYSTEMS

The following section contains cost analysis calculations which are based on the results of the computer simulation models except where noted. Dollar value figures used in the calculations were based on data obtained in the form of section or bureau average monthly salary including administrative function costs. Table 3.3-1 below is the table of salaries used in computing the cost figures.

Certain types of cost data are not readily available at present. For instance, reasonably accurate operating costs for In Car terminals cannot be obtained because these items are just now undergoing field tests. The cost data presented will furnish a basis for a cost-effectiveness analysis of the various modified subsystem models.

TABLE 3.3-1

AVERAGE SALARIES OF PERSONNEL

Function	Salary In Dollars/ Year	Salary In Dollars/ Hour	Salary In Cents/ Second
Telephone Clerk	$6600.00	$3.17	.09
Radio Dispatcher	$8450.00	$4.06	.11
Regular Patrolman	$9800.00	$4.71	.13
Technical Services Personnel	$7664.00	$3.69	.10

3.3.1 COMMUNICATION SECTION

The cost associated with one request being handled by personnel in the Communications Section, based on the simulation data, is as follows:

Cost Estimate 1: Telephone Clerk Handles The Call

Function	Cost In Cents/ Second	Time/Used	Cost In Cents/Call
Telephone Clerk	.09	75 Seconds	6.75

Cost Estimate 2: Expediter Handles The Call

Function	Cost In Cents/ Second	Time/Used	Cost In Cents/Call
Expediter	.09	1590 Seconds	143.1

Cost Estimate 3: Dispatcher Handles The Call

Function	Cost In Cents/ Second	Time Used	Cost In Cents/Call
Dispatcher	.11	194 Seconds	21.34

Cost Estimate 4: A call routed through the Communications Section from the telephone clerk to the dispatcher would have the following cost, assuming three inquiries into the computer files.

Function	Cost In Cents/Call
Telephone Clerk	6.75
Computer	5.2
Dispatcher	21.34
Computer	5.2
Computer	5.2
Total Cost In Cents	43.69

3.3.2 PATROL SECTION

The following cost figures are associated with a patrol element handling a dispatched call:

Cost Estimate 1: Non-N-Coded Calls

Function	Cost In Cents/ Minute	Time Used	Cost In Cents/Call
Patrol Element	7.85	41 minutes	321.85

Cost Estimate 2: N-Coded Calls

Function	Cost In Cents/ Minute	Time Used	Cost In Cents/Call
Patrol Element	7.85	*14.79 minutes	116.10

* Data Not Obtained From The Simulation Data

3.3.3 REPORTS SECTION

The costs associated with specific functions handled in the Reports Section are as follows:

Cost Estimate 1: Individual Tasks

Function	Cost In Cents/ Second	Time Used	Cost In Cents/Form
Staff Review	.10	41 seconds	4.1
NCIC Clerk (No Auto Involved)	.10	107 seconds	10.7
Update Clerk	.10	70 seconds	7.0
Reproduction	.10	6.6 seconds (average)	.66
File Clerk	.10	14 seconds	1.4

Cost Estimate 2: Total Records Process

Assume a form is processed through the following functions:

Function	Cost In Cents/Form
Staff Review	4.1
NCIC Clerk (No Auto Involved)	10.7
Update Clerk	7.0
Reproduction	.66
File Clerk	1.4

Total Cost In Cents/Form = 23.86

3.4 RECOMMENDED STUDIES

The following paragraphs describe areas within each subsystem where possibilities of study efforts to increase the total efficiency of the information system of the Dallas Police Department exist. These recommended studies are included here to point out possible alternative solutions to the particular subsystem problems. The dollar value figure concerning personnel performing these tasks is found in Table 3.3-1.

3.4.1 COMMUNICATION SECTION

A pilot study for the Patrol Section should begin in the area of utilizing In Car terminals for the dispatching of requests for service. The desire for the reduction of time to get to the scene demands facilities be incorporated into the present configuration to include such systems as car locators and direct computer dispatch.

Another study that should be undertaken in order to speed the time between when the calls are received and when the call is dispatched is the utilization of sworn police personnel to answer the calls for service from the public: the decision to deploy an element by sworn officers rather than to deploy an element by civilian personnel could be important.

The expediter function should be examined from the viewpoint of using Video Data Terminals in order to enter information into a unified data base. This permits data on expediter taken calls to be immediately accessible to all concerned bureaus.

3.4.2 PATROL SECTION

A discourse on all possible alterations to the Patrol System would require more space than is available. The presentation of one of the most promising avenues of exploration will follow.

In Car Video Data terminals would seem to allow the most significant reduction of information flow times at present. Use of this equipment and properly configured software would present the opportunity for a smooth evolution of the present system into a completely automated computer controlled system.

Appropriate areas for study would include:

1. Direct interrogation of NCIC data
2. Terminal to Data Base entry of reports
3. Automated Dispatch Function
4. Terminal-toTerminal Dialogue for a secure communications link.
5. Vehicle Location Function

Of the mentioned studies, terminal to Data Base entry of reports and Direct Interrogation of NCIC data hold the promise of shortening data flow times and lightened clerical work loads associated with these tasks. An automated Dispatch Function would free the dispatcher of routine operations and decrease the number of dispatchers required.

There are likely to be some training problems associated with the use of Video Data terminals. The use of various types of ancillary equipment to ease these problems should be considered.

3.4.3 REPORTS SECTION

A re-organization of the processing of information through the Reports Section is a definite requirement for study. The present configuration does not allow for fast transit of reports through the system and creates a delay in the time a report arrives at the bureau of concern.

Studies should begin immediately on a method of distributing the reports directly to the bureaus of concern as opposed to the present method of duplicating the report and then the distribution of this massive amount of paperwork.

Another immediate need in the Reports Section is a study to formulate the outline for the gathering of data for statistical and management reports on a regular basis.

3.4.4 IDENTIFICATION SECTION

There is need for a study in the Identification Section for the purpose of establishing a means by which all information contained in the index card files could be more readily accessed and updated. At present, as seen in section 3.1.2.4 of this report, there are approximately 2100 references to the index card file each week. This type of manual access creates problems of misfiling and lost information. A means of locating all information concerning a particular individual with a single inquiry would decrease the time to handle many of the incoming requests to the Identification Section and increase the efficiency of the total operation.

Another study effort recommended for the Identification Section is the problem associated with the filing and cross-referencing of the fingerprint cards. Some in-depth research has been done in recent years concerning this particular problem. Assuming that the current growth rate of the fingerprint card file continues, this will become a major problem in the near future.

4.0 SYSTEM RECOMMENDATIONS

Assistant Chief D. F. Steele has requested that the contents of this section be kept out of the main report and be handled separately. The recommendations are provided in accordance with the provisions of E-Systems Technical Proposal 416-08050, Page 3-3. Those wishing a copy of Section 4.0 of this report should contact Chief Steele directly.

6. SYMBOLS
7. REFERENCES
5. GLOSSARY

5.0 GLOSSARY

Automatic Data Processing (ADP). The application of electro-mechanical devices to process data and compute problem solutions, designed to be so interconnected and interacting that the need for human assistance or intervention is at a minimum.

Cathode Ray Output. A cathode ray tube used to display output information in graphic or linear form. (VDT)

Communication. The act of transmitting, imparting, or making known and/or the flow of information from one point (the source) to another (the receiver).

Configuration. A group of machines which are interconnected and are programmed to operate as a system.

Data Base. A concept whereby all data for an entire information system are located in a common file rather than separate files.

Discrete Simulation. In a discrete system, the interest is the events and the conditions that control the events. The simulation follows the changes in the state of the system. The steps that are followed are discrete increments in time.

Display Unit. A device which provides a visual representation of information.

Dynamic Model. In a dynamic environment, the changes of the system attributes are derived as a function of time.

Electronic Data Processing (EDP). A general term used to define a system for processing data by means of machines utilizing electronic circuitry at electronic speed as opposed to electro-mechanical equipment.

Electrostatic Printer. An electro-mechanical device that electrostatically charges specially coated paper, which is then dusted with ink particles to bring out the character impressions.

Event. The instantaneous modifications of one or more state variables of a simulation model.

File Management. The development and use of specific rules, procedures, and methods for creating the file, updating it, and retrieving information from it.

Frequency Distribution. An arrangement of statistical data that exhibits the frequency of the occurrence of the values of a variable.

Histogram. A representation of a frequency distribution by means of rectangles whose widths represent class intervals and whose heights represent corresponding frequencies.

Information System. The set of independent objects, both human and machine which under human control, assemble data and disseminate information.

Iteration. A repetition of the specifications for and the observation of the response emanating from a model.

Mathematical Model. In a mathematical model, the entities of a system are represented by mathematical variables and the activities of

the model are described by mathematical functions that interrelate the variables.

Mean. An average.

Median. The middle or center of a set of data.

Mode. The value which occurs with the highest frequency.

Model Building. The abstract construction of an ideal state of affairs which usually acts as a guide for subsequent design, development, and implementation of the concept.

Real-Time Processing. The introduction of data to processing activities as the data originate, so that the results of the processing are immediately available to the user on a continuous basis, or at any time an inquiry is made.

Simulation. The representation of physical systems and real-world phenomena by computers, in which the processing done by the computer represents the real-world process itself.

Standard Deviation. The square root of the arithmetic mean of the squares of the deviation from the arithmetic mean of a probability distribution.

Subsystem. An organizational unit or units handling similar types of information and/or performing similar designated functions on information.

Systems Approach. A methodology of problem solving which involves an analysis of the present system and subsequently, an improved design of a new system.

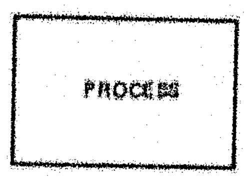
System Automation Technology. The investigation, design, development and application of methods of rendering processes automatic, self-moving or self-controlling.

Trade-Off Analysis. The comparison of attributes of a system or systems in order to determine a workable resultant system in terms of these attributes.

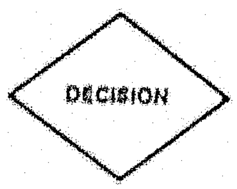
6.0 SYMBOLS

The symbols used throughout this report are utilized to convey the concepts of systems description, information flow, and program logic flow. Figure 6.0-1 are the block diagram symbols used to illustrate a sequence of system procedures and Figure 6.0-2 contains the American National Standard Flowchart Symbols and terminology. The flowchart symbols found in Figure 6.0-3 are the accepted Standard GPSS/360 symbols.

THESE TWO BLOCKS CONSTITUTE THE MAIN ELEMENTS OF THE BLOCK DIAGRAM SYMBOLS.



THE FIRST BLOCK CONSIDERS ALL OPERATIONS RELEVANT TO THE SYSTEM ORGANIZATION EXCEPT DECISION FUNCTIONS.



THE SECOND BLOCK CONSIDERS ALL DECISIONS TO BE MADE IN THE SYSTEM.

FIGURE 6.0–1. BLOCK DIAGRAM SYMBOLS

THE SYMBOLS SHOWN BELOW ARE THOSE USED IN THE DESCRIPTION OF INFORMATION PROCESSING SYSTEMS.

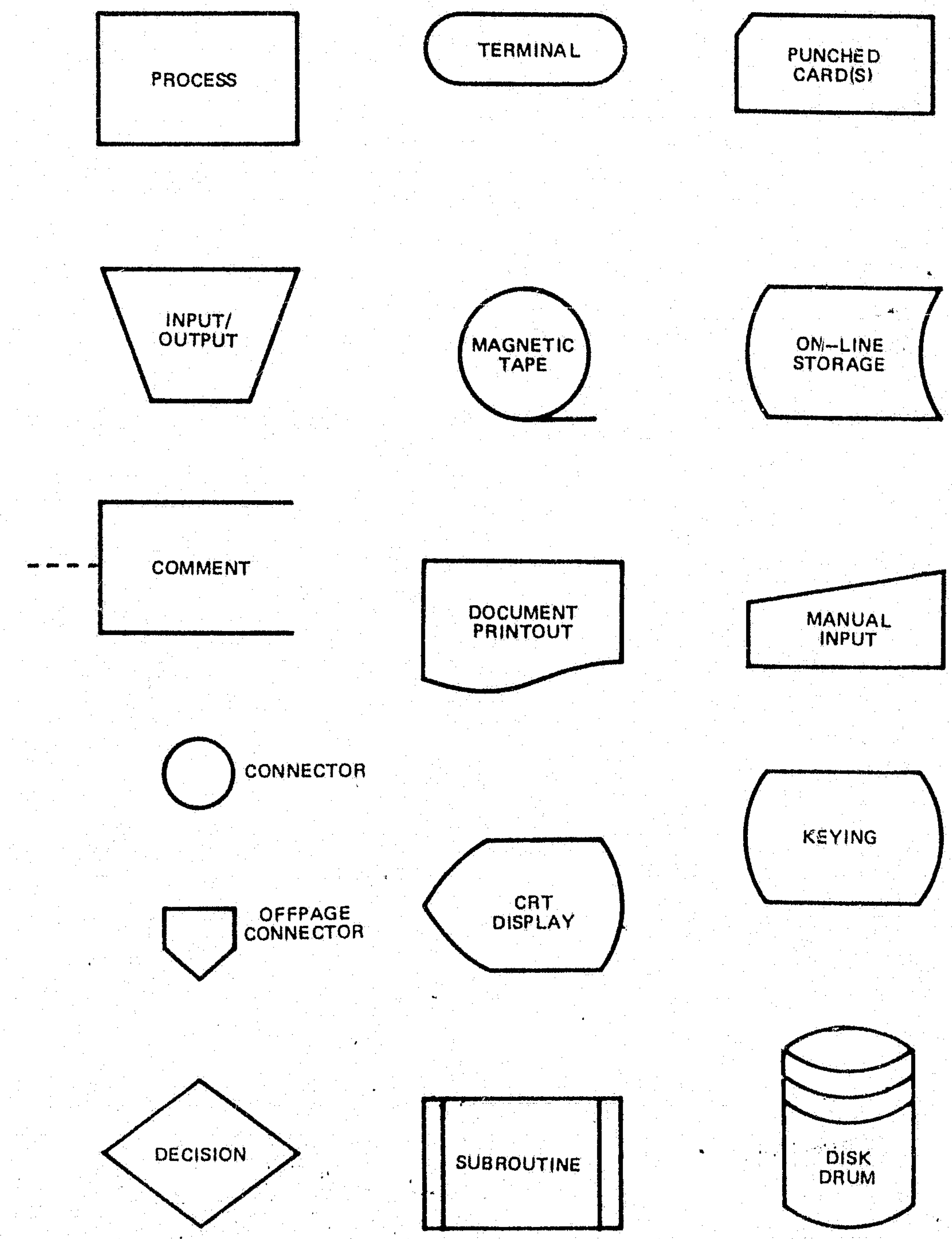


FIGURE 6.0–2. AMERICAN NATIONAL STANDARD FLOWCHART SYMBOLS

THE SYMBOLS SHOWN BELOW ARE THOSE USED IN THE PROGRAM FLOW CHARTING OF GPSS/360.

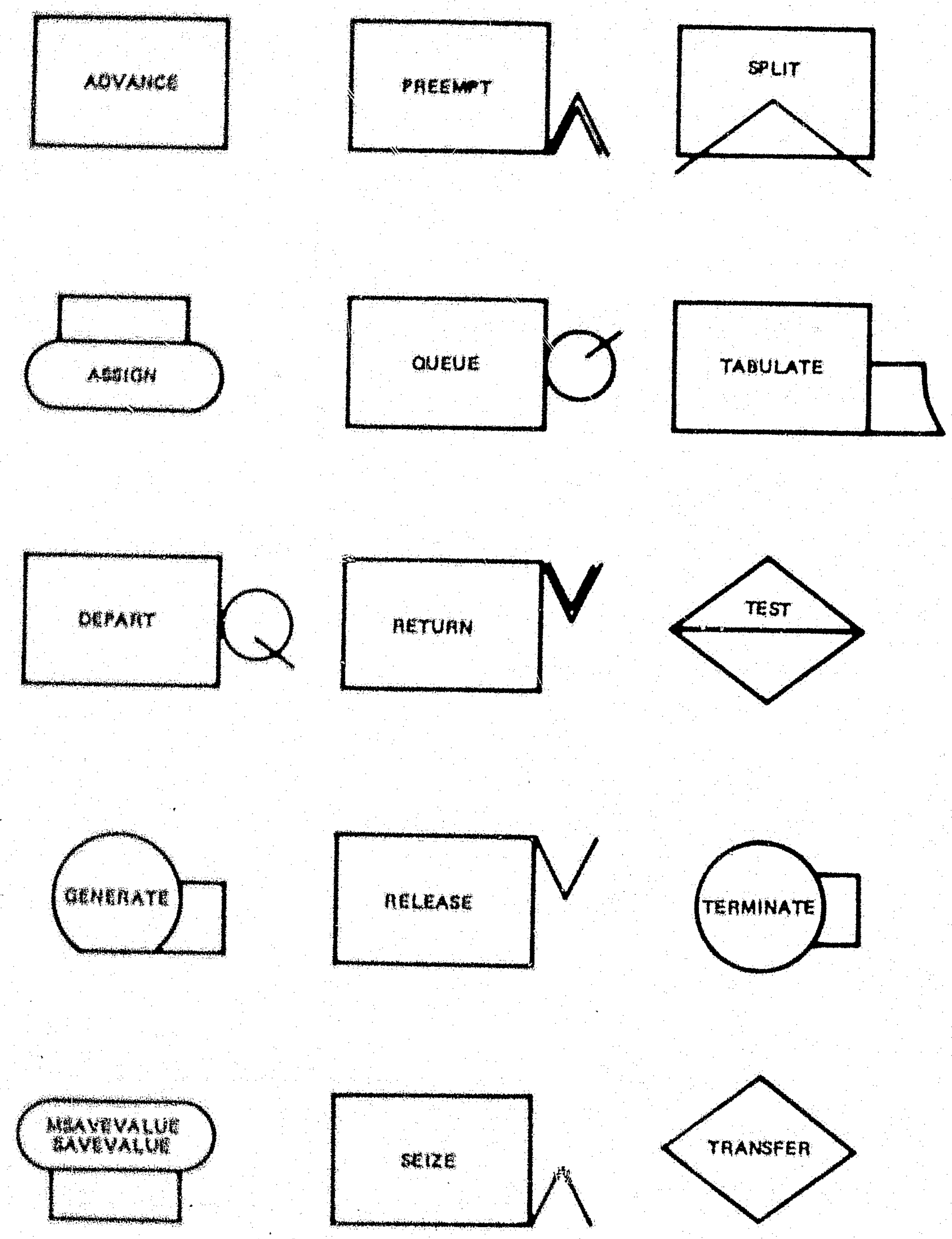


FIGURE 6.0–3. GPSS/360 FLOW CHART SYMBOLS

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