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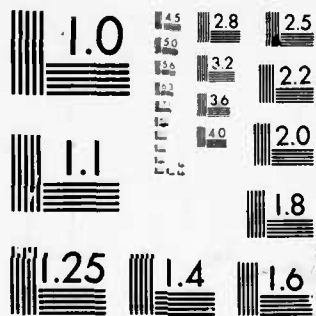
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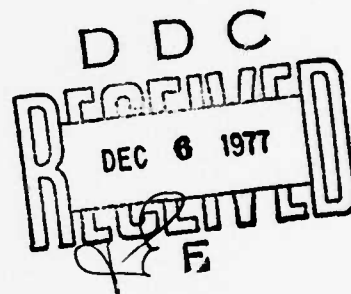


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NAVAL POSTGRADUATE SCHOOL
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THESIS

A VESSEL INSPECTION INFORMATION SYSTEM

by

Larry Mark Wilson

September 1977

Thesis Advisor:

N. F. Schneidewind

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A VESSEL INSPECTION INFORMATION SYSTEM

by

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Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1971

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

Marine safety is a major responsibility of the United States Coast Guard. In carrying out this task, the Coast Guard conducts periodic inspections of existing merchant vessels and supervises construction of new vessels. To support and help promote marine safety, a Vessel Inspection Information System (VIIS) has been proposed. The system would be used to capture design information, inspection data, and other relevant information; store it in a centralized data base; and make the information available to Coast Guard Units as needed through the use of interactive computer terminals. The purpose of this thesis is to present the results of a computer program which provides cost estimates of the communications networks in VIIS and provides information on network performance.

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I. INTRODUCTION

Merchant Marine Safety is one of the primary missions of the United States Coast Guard. The merchant marine safety function was developed in the Coast Guard in 1942 when it was transferred from the former Bureau of Marine Inspection and Navigation of the Department of Commerce [1]. This thesis traces the development of the Merchant Marine Safety Function in the Coast Guard, describes a proposed Vessel Inspection Information System for improving the Coast Guard's efficiency in this field, and provides a model for evaluating costs and performance of the proposed system.

A. HISTORY OF UNITED STATES MERCHANT MARINE SAFETY

Some events of historical significance which contributed to the development of merchant marine safety follow.

1807 Robert Fulton's development of the steamboat CLERMONT was followed by the use of numerous river steamboats [1, 2].

1819 The SAVANNAH became the first American steamboat to cross the Atlantic Ocean [1].

1824 Due to increasing numbers of lives lost in steamboat boiler explosions, Congress directed the Secretary of the Treasury to conduct investigations to determine their causes [2].

1838 The first actual recognition of federal responsibility in the marine safety field was contained in Congressional legislation looking to better security of the lives of passengers embarked on steam-propelled vessels. Certificated inspections of hulls and boilers were required, as well as an adequate number of experienced engineers and provision of lifeboats, signal lights, and firefighting equipment [1, 2].

1852 The Steamboat Inspection Service was formed in the Treasury Department as part of the "Steamboat Act". This act required that inspectors be paid fixed salaries from the Treasury Department in lieu of the fees they had previously received from the vessel owners and masters. The act also provided for the licensing of all engineers and pilots of passenger-carrying steam vessels and required permits for carrying certain dangerous or inflammable cargoes [2].

1871 Administration of inspection laws was reorganized under the office of "Supervising Inspector General" by an act of Congress. The act also required all steam vessels except public and foreign vessels to be inspected and their masters, chief mates, engineers, and pilots to be licensed. A significant aspect of the act was that it was directed toward the promotion of safety of all persons, passengers and crew, on board steam vessels [1].

1897 It was recognized that the internal-combustion engine had become a major means of large vessel propulsion. Inspection laws were extended to cover all mechanically propelled vessels of more than 15 tons carrying passengers and freight for hire [2].

1903 The Department of Commerce and Labor was formed. The Steamboat Inspection Service and all duties, powers,

authority and jurisdiction related to shipping were transferred from the Secretary of the Treasury to the new Secretary of Commerce and Labor [1].

1904 Inspection laws were strengthened and the authority of inspectors was markedly increased after the GENERAL SLOCUM fire which took 955 lives. The responsibility for the tragedy was placed largely upon the officers of the Steamboat Inspection Service for failing to carry out their duties [2].

1910 The "Motorboat Act" extended inspection laws to boats under 65 feet in length propelled by machinery. Safety regulations relating to equipment were established. The "Wireless-Ship Act" required certain ocean steamers to be equipped with operators and apparatus for radio communications before leaving any United States port [1, 2].

1913 The Department of Labor was organized. Those functions related to merchant marine safety remained with the Department of Commerce [1].

1915 The "Seaman's Act" granted local inspectors the authority to issue certificates to able seamen and lifeboatmen after examination. It provided for the supervision of payment of seamen's wages and included provisions as to required lifesaving equipment for the crew [2].

1932 As part of the "Economy Act" during the depression, the Bureau of Navigation and the Steamboat Inspection Service were merged into the Bureau of Navigation and Steamboat Inspection [1, 2].

1934 The MORRO CASTLE disaster resulted in the death of 134 persons. The MORRO CASTLE was constructed, equipped,

and fitted to meet all requirements of the Bureau of Navigation and Steamboat Inspection in effect at that time. A Congressional investigation revealed many weaknesses in the laws concerning maritime safety. Because of demands from the press, the public, and members of Congress itself, Congress took action and passed two important acts relating to maritime safety. The first act changed the name of the bureau to the Bureau of Marine Inspection and Navigation (BMIN), recognizing the fact that with new types of power available, "steamboat" was no longer appropriate. It provided for the establishment of Marine Casualty Inspection Boards whose jurisdiction covered all marine casualties, not just those involving licensed personnel. Finally, it provided for the establishment of a technical division and required that all plans and design specifications for United States passenger vessels of 100 gross tons and over, propelled by machinery, must be approved by the Director of BMIN with the advice of this technical staff. The second act known as the "Merchant Marine Act of 1936" provided for qualifications, examinations, and issuance of certificates of service to unlicensed personnel, and the issuance of continuous discharge books to all seagoing personnel [2].

1940 The "Motorboat Act of 1940" was the first federal attempt to regulate the operation of motorboats from the safety standpoint. This act required a minimum of safety equipment to be aboard, such as proper navigational lights, fog signal devices, fire extinguishers, and life preservers. It did not, however, provide for an inspection of the boat itself for safety nor did it establish standards for operators [2].

1942 The functions of the BMIN related, directly or indirectly, to safety at sea were transferred to the United States Coast Guard by Executive Order. Thus the Coast Guard became the sole federal agency charged with the

responsibility for safety at sea. A Merchant Marine Council was established to study and recommend to the Commandant of the Coast Guard steps to improve the efficiency and welfare of American merchant seamen and to determine the effectiveness of safety equipment in use aboard ships [1, 2].

1956 Inspection laws were extended to cover passenger-carrying vessels of not more than 65 feet in length and under 100 gross tons, carrying more than six passengers [1].

1959 Several old inspection laws containing detailed requirements on lifesaving equipment, firefighting and other safety equipment were repealed and authorization was granted to the Commandant of the Coast Guard to promulgate regulations covering these items thereby making it possible to adjust to changing technology [1].

1977 In the past decade and a half, significant additions in maritime safety laws and regulations have occurred, pertaining to special vessel classes, due to changing technologies and ship designs. These include but are not limited to nuclear powered ships, containerized cargo vessels, super tankers, and liquefied natural gas (LNG) transports now under construction. After several major disasters in the 1976-1977 winter season involving foreign tankers, foreign tank vessels are now required to pass U. S. inspections prior to entering a U.S. port.

B. CURRENT MERCHANT MARINE SAFETY FUNCTIONS OF THE COAST GUARD

The Coast Guard is charged with the responsibility of the inspection and regulation of vessels and equipment for the protection of passengers, crew, and cargo. They must carry out periodic inspections of merchant vessels and enforce regulations pertaining to lifesaving, firefighting, and other safety equipment in determining the seaworthiness of the vessel prior to issuing a certificate of inspection. To fulfill this obligation, factory inspections of certain equipment and materials for use in merchant vessels are made; navigational rules are developed and enforced; Federal regulations regarding vessel numbering are developed and enforced as well as the review of state motorboat regulation systems; and penalty procedures for violations of navigation and inspection laws are administered [1, 2, 3].

The Coast Guard is responsible for the regulation of marine personnel; which includes examining, licensing, and certifying them. They also prescribe vessel manning requirements for safe navigation; supervise shipment and discharge of merchant seamen; maintain merchant marine personnel records; and administer the security program as it relates to merchant seamen [1, 2].

In the engineering and technical fields, the Coast Guard approves plans and specifications for construction and alteration of merchant vessels; classifies vessels; conducts stability tests; and examines and tests equipment and devices submitted for approval or for determination of suitability. They also review vessel load-line certificates and enforce load-line regulations; and develop regulations

in the areas of naval architecture, marine, chemical, and electrical engineering, firefighting and other safety functions [1].

The Coast Guard investigates and reviews marine casualties and acts of incompetency or misconduct; licenses or certificates may be revoked or suspended as appropriate. They are also responsible for presenting these cases before the proper authorities as required [1].

Continuous liaison is maintained with maritime industry through the Merchant Marine Council. Maritime industry and other interested parties are kept informed of proposed regulations or changes to regulations through public hearings. Liaison is also maintained with the international maritime bodies through the International Co-ordinating Staff. They are responsible for presenting the position of the United States regarding international maritime issues [1].

Collection of data, formulation of reports, and transmission of information pertaining to the duties and responsibilities listed above involves a significant amount of manpower and effort on the part of the Coast Guard. Problems exist in several areas, and particularly those related to transmission of information. The Coast Guard has an obligation to schedule vessel inspections, whenever possible, to coincide with a vessel's operating schedule [1]. Requiring a vessel to remain in port for routine inspections costs the ship's owners thousands of dollars per day; it is most desirable to hold inspections when the vessel would normally be in port. In fulfilling this obligation to vessel owners and masters, problems develop in that today's higher speed vessels can travel between ports faster than their inspection records. An example of this problem is a ship travelling from its

homeport of Los Angeles to San Francisco, and requesting an inspection while in San Francisco, will probably arrive, have the inspection while cargo is being loaded or off-loaded, and depart before its inspection records have arrived from Los Angeles. The San Francisco inspector is at a disadvantage in conducting his inspection since he does not have a list of previous discrepancies or problem areas that were observed during past inspections and required correction by the owners or master. The San Francisco inspector can get some information from the homeport over the phone, but the information is generally incomplete.

Transmission of information on merchant seamen is also a problem since they change vessels frequently and it takes time for the information to be updated. By the time files are updated, a seaman could have moved to another vessel.

To assist the Coast Guard in the merchant marine function, a Vessel Inspection Information System was suggested to provide real-time access to and updating of data at major ports throughout the United States. The system was to be used primarily in relation to the Coast Guard's merchant marine inspection function, with capabilities for expansion to include law enforcement and pollution investigation functions [4, 5].

Battelle Columbus Laboratories was contracted by the Coast Guard to develop a Vessel Inspection Information System.

II. VESSEL INSPECTION INFORMATION SYSTEM

The Vessel Inspection Information System (VIIS), as proposed, is a large-scale, comprehensive, computer-based information system to be utilized by Coast Guard personnel involved with the administration and execution of the Coast Guard's Merchant Vessel Safety Programs [4]. The system designs of VIIS are based on user needs as determined by interviews of potential users, and on availability of funds.

A. USER NEEDS

VIIS should be used as a tool for the capture, transmission, manipulation, and feedback of relevant information to support improvements in the vessel safety and inspection programs. VIIS must be able to maintain a comprehensive historical safety data base on each inspected vessel along with sufficient information on system capabilities to be useful in supporting the inspection function. The information about a vessel (its inspection requirements, safety requirements, and past inspection performance) must be readily available to Coast Guard Inspectors. Additionally, through the manipulation of data, VIIS should be capable of monitoring the status of a vessel with respect to periodic inspections, outstanding requirements, special examination requirements; provide administrative support in communicating with vessel owners with respect to the above requirements and with Coast Guard Headquarters with respect to required reports (periodic inspection letters and reports automatically prepared); and

provide management support in estimating future inspection requirements/workload implications for short-term planning and resource allocation [5].

B. PERFORMANCE CRITERIA

VIIS must be able to provide real-time "access to" and "updating of" vessel files. This requirement is readily apparent in cases of major marine casualties, disasters, and pollution incidents. Routine file maintenance and initial entry into the system will be accomplished with batch processing [5]. Even batch processing will provide a significant decrease in file updating time compared with today's paperwork system.

C. ALTERNATE SOLUTIONS

There were numerous options available in developing the VIIS system. The final proposals include five variations in the system. The differences are based on different funding levels and the Coast Guard's ability to extend services into the areas indicated.

1. Baseline System

The Baseline System was conservatively designed yet will be responsive to most user needs identified above. It is capable of capturing and recalling inspection histories, automatic safety and inspection status monitoring, outstanding requirements tracking, class defects detection, and communication of information among ports [4].

This system interfaces with Coast Guard inspection units only. The Baseline System would provide for coverage of the inspected fleet. This limitation requires that vessel information obtained through means other than the inspection function (casualty investigations, vessel characteristic updates, pollution incidents, etc.) must be transmitted to an inspection or a headquarters function to be entered into the system [4].

This network, as its name implies, is a "base system" upon which the following, larger systems could be built. In this regard, the Baseline System could be used as a test system to determine actual cost and performance data and compare this information with the predicted data prior to expanding to one of the larger systems.

2. All Merchant Marine System

This is an extension of the Baseline System to include the investigation and documentation functions. Coverage would include all inspected and documented vessels, and foreign vessels involved in casualties [4].

3. All Merchant Marine + Law Enforcement System

The All Merchant Marine System evolves into this system by including the Coast Guard's law enforcement functions; e.g., boarding and violation information [4].

4. Full System

With the addition of the Coast Guard's Environmental Protection Office as an on-line user, the Full System is

developed. Coverage is extended to include pollution incidents, and the investigation, reporting and analysis activities associated with them. The Full System provides coverage in virtually all areas of the Coast Guard's Merchant Vessel Safety Programs [4].

5. Ocean Ports System

The Ocean Ports System incorporates the same basic functions as the Baseline System but it is reduced in scope to provide coverage for large ocean-going vessels only; terminals are located at those ports where ocean-going vessels are inspected [4].

D. EQUIPMENT AND SPECIFICATIONS

1. Communication Lines

The communications network will be one of the following: (a) a network comprised of dedicated communications lines (General Services Administration (GSA) leased), dedicated lines shared with other Coast Guard activities (existing GSA leased), Federal Telecommunications System (FTS) lines and Direct Distance Dial (DDD) lines for low volume and non-CONTinental United States (CONUS) ports; (b) a network made up of all FTS lines used on a non-dedicated basis; (c) utilization of a network provided by a commercial time-sharing computer company [4, 5].

2. Communications Hardware

The communications hardware at each location is a function of the system being used and the type of lines available; e.g., New York. It is assigned a teleprinter in the Ocean Ports System, but CRT's in all other systems.

a. Modems

Modems are used to link the processing units and the terminals which are basically digital in nature with an analog telecommunications network [4, 6, 7, 8]. Several types of modems are used depending on the hardware at each terminal location. Asynchronous modems are used at ports using teleprinters while synchronous modems are utilized at ports having CRT's and/or high speed printers.

Asynchronous modems will be used to interface slow-speed teleprinters to the telephone network [4]. These modems allow the transmission of one character at a time as they are keyed at the terminal. The most common asynchronous modems available transmit at speeds up to 300 bits per second (approximately 30 characters per second if using an 8 bit ASCII code plus start and stop bits for each character). Asynchronous modems connected directly to a voice-grade telephone line use the entire bandwidth of the line, thereby eliminating the possibility of multiplexing signals [4, 6, 7].

Synchronous modems will be used to interface CRT terminals and high-speed printers to the communications network [4]. This type of modem allows information to be transmitted as blocks or strings of characters between buffered devices. As the transmission rate is not governed

by the typing rate at the terminal and start and stop bits are not required for each character, higher transmission rates are obtained [4, 6, 7]. 2400 bit per second modems (300 characters per second) will be used at CRT/Printer locations. In areas where VIIS lines are multiplexed into existing Coast Guard dedicated lines, 4800, 7200, or 9600 bit per second modems are used depending on anticipated traffic loads [4].

b. Modem Sharing Devices

Modem Sharing Devices (MSD) are used in conjunction with a modem to allow several terminals in the same vicinity to share a common modem [4]. In ports having a large volume of transactions and several terminals, MSD's will reduce the cost that would be incurred if each terminal had its own modem.

c. Alternate Dial-up Devices

Alternate Dial-up Devices (ADD) are introduced into the system to provide a backup capability for accessing VIIS via the FTS or DDD network in the event that service on the primary dedicated link is disrupted [4].

d. Data Access Arrangements

Data Access Arrangements (DAA) are inserted between user provided modems and the common carrier's network allegedly to prevent the network from being damaged by the alien equipment [4]. DAA's are not required for common carrier furnished modems or some user provided modems which meet required specifications.

e. Multiplexors

Multiplexors are used to consolidate several low-speed channels into a single line for long-distance transmissions. Multiplexors can significantly reduce communication line costs by decreasing the number of lines required [4, 6, 9].

Frequency Division Multiplexors(FDM) partition the voice grade communication link, having a bandwidth of 2700 cycles, into several sub-bands capable of supporting 150 bps or 300 bps transmission. In those locations where FDM's are used, modems are not required as the FDM performs that function. A disadvantage of FDM's is that only six 300 bps terminals can be multiplexed for a voice grade line. This problem can be reduced by splitting 300 bps channels into two 150 bps channels or by having more than one terminal share a channel and operate in a contention mode [4, 6, 9]. FDM's will be used where low transaction volume offices are spread over a large geographical area and can be linked with a single line.

Time Division Multiplexors(TDM) divide the voice grade channel into time slots, and each terminal is assigned to a given time slot. Time division multiplexing is basically a digital process; therefore, modems are required to interface the TDM with the communications network [4, 6, 8, 9]. TDM's will be used to multiplex both synchronous and asynchronous channels into a single synchronous channel for long-distance transmission.

f. User Terminal Devices

Six types of user terminal devices are utilized for communications with the host computer. The terminal devices located at each office depend upon the system being used and the volume of transactions at that location.

CRT Keyboard Displays with minimal capabilities of keyboard input and video display output will be required. The keyboard must include a full set of 64 upper-case ASCII characters, including a message control subset. The video display should have a minimum of 24 lines of 80 characters each. The CRT must be a buffered device capable of storing at least 1920 characters, should normally operate at a rate of 2400 bps, and should have an editing feature for character insertion, deletion and typeover [4].

Printers will be used in those offices with CRT's and high transaction volumes. Printers will be used to capture hardcopy output of information on the CRT video display that is necessary for permanent retention [4]. For those ports employing more than one CRT, a lesser number of printers might be required as not all information needs to be in hard-copy form. Printers should have a minimum of 64 upper-case ASCII characters, print at a rate of 150-300 characters per second, print six lines per inch, and have 80-132 characters per line. Where transaction volume does not warrant the use of a high-speed printer, slow-speed (30 characters per second) printers will be used. Slow-speed printers are used whenever possible due to their cost advantage.

Teleprinters are used for certain system configurations and in offices with low traffic volumes.

These devices will be used to communicate with the host computer asynchronously at 150 or 300 bps in ASCII code. These devices should be used primarily for data retrieval; data entry is feasible but inefficient due to the slower speeds and screen formats. Where teleprinters are used in conjunction with dedicated lines, teleprinters with integrated acoustic couplers will be used. The integrated acoustic coupler provides for alternate dial-up capabilities over the FTS or DDD networks in the event of disrupted service on the dedicated line [4].

Auxilliary Cassette Units will be used to permit "off-line" data entry operations in those networks using FTS or DDD lines (networks involving connect time charges) until sufficient data has been accumulated for continuous transmission to the host computer [4].

III. COMMUNICATIONS NETWORK, COST AND PERFORMANCE

The cost of setting up and maintaining the communications network for VIIS is a significant part of the systems total cost as is typical with any computer communications network. The Coast Guard required realistic cost estimates of the network prior to proceeding with any implementation options. The Coast Guard, as well as every other federal agency, is required to set minimum desired performance levels as well as keeping costs below established budget ceilings. Estimated cost and performance data become very important in deciding whether it is the right system at the right price and whether to proceed with or scrap the project.

To assist the Coast Guard in their decision-making process in regards to VIIS, a computer program was written to provide cost and performance estimates. The program is general and can provide cost and performance information for many computer communications networks with little or no modification required. The program was specifically written for use in a CP/CMS interactive mode, but the fortran program is also functional in a batch mode.

To provide cost and performance data, the program requires for each node in the network, the node name, the name of the predecessor node, the type of communication line between them, the line number, the distance between the two nodes or telephone company "V" and "H" coordinates for determining the distance, the expected number of characters transmitted to and from the node each month, and a codified list of communications equipment at the node. Where two or

more types of communications lines intersect at a node, individual data records are required for each line. Also required as inputs are the number of types of equipment available and the costs associated with each. The number of types of lines and their costs, whether it be by the hour or by the mile, are required. Finally, the number of characters per transaction broken down into the mean number of typed-in characters and the number of characters per frame, their standard deviations, the mean typing speed of the terminal user, estimated central processing unit (CPU) queueing and access times, and whether the lines will be operated in a full-duplex or half-duplex mode are required. (Frame is the name given to the display formats to be used in the system.)

The program uses the above inputs to determine the number of each type of equipment required for the network, the one-time and recurring equipment costs for each node, the cost of the communications line which links the node to the system, and the total number of connect hours for each node. The program also determines the equipment costs and communication line costs for each line in the network and for the network as a whole. Where distances were not included as input, the program computes the distances between nodes and provides a sum of the total number of the distances between nodes and provides the total number of miles of leased/dedicated lines and leased/shared lines. Also included as output is the total number of connect hours per month, a list of the independent lines in the network with the total number of characters per month on the line, the line number, the mean service time per transaction on the line, the mean number of transactions arriving for service each second, the overall utilization of the line, i.e., the fraction of time that the line is actually in use, the mean number of transactions waiting for service, the mean number of transactions in the network being served or

waiting to be served, the mean waiting time for service, and the total time in the system, being served and waiting to be served.

The program uses the following assumptions in arriving at the above output: if the distance is an input, the program assumes that it is correct and does not compute a distance for comparison; the program assumes that distances for FTS lines are not required and therefore not determined; that all CRT's operate at a data rate of 2400 bits per second and all teleprinters operate at a 300 bit per second rate; that the mean number of connect hours for each terminal is a function of the number of transactions per month, the mean number of characters per transaction, the mean typing rate of the user, the mean number of characters typed-in per transaction, the data rate, the idle time of the user at the terminal, and the CPU access and queueing times. The program assumes that the cost of any one piece of equipment or communication line is associated with one terminal only, i.e., the cost of any equipment which is shared between two or more terminals is assigned in whole to one of those terminals; whenever an FTS night circuit is used, it is assumed that all transactions are over the night circuit, to circumvent this, two data records can be used for one terminal, one containing the number of characters to be transmitted over the night circuit and the other containing the number of characters transmitted over the normal FTS circuit. The program assumes that the total monthly recurring cost is the sum of the monthly line costs, equipment lease costs, and estimated equipment maintenance costs; the total one-time cost is the sum of the equipment purchase costs and shipping/installation charges.

For performance calculations, the program assumes that all transactions are of equal priority, transaction arrivals are Poisson, the number of characters per frame and number

of characters typed-in per transaction are independent variables, that no more than two terminals operate in contention over any given channel, and that terminals in contention are assigned such that the terminal with the largest traffic volume is in contention with the terminal having the smallest traffic volume for a more uniformly distributed workload. The program assumes that the typed-in characters and characters per frame are independent to provide a first approximation to performance. When actual data is available and the relationship between these values is determined, it can be incorporated into the program. For all VIIS networks, no more than two terminals operate in contention; the program can be easily modified to accommodate other arrangements. The program also assumes that the service time for CRT terminals on leased lines is a function of the number of characters and data rate only, that the service time for all teleprinters is equivalent to the connect time; and that all terminals on any one line have the same operating hours, i.e., time zone differences are not considered. The program uses standard queueing equations for determining utilization, wait times, service times, etc. A more detailed description of what the program accomplishes and how it operates follows.

A. COST

The cost of the VIIS communications network is dependent upon several factors. The costs are of two types: one-time expenditures which include the purchase price of any equipment bought plus shipping/installation charges; recurring costs which include monthly charges for leased equipment, anticipated monthly maintenance charges, and monthly charges for the communications lines.

Estimated network costs are determined with the program in the manner described below.

1. For each node in the network, the following data is required as input:

a. The designation of the node in four character alphanumeric code (NO).

b. The designation of the predecessor node in the network in four character alphanumeric code (NOA).

c. The type of communication line being used between two nodes as a one character numeric code (L); for example, GSA-leased/dedicated lines are coded 1, GSA-leased/shared lines are coded 2.

d. The line numbers in two character numeric code (LINENO) are then entered. The network is divided into several independent groups of terminals with the only common link being the central processing unit. These sub-networks are basically arranged by geographical areas to minimize the number of miles of leased lines required. The northeastern portion of the United States is on line number 10 and the west coast is line number 60. The second digit is used if the main line is further divided into smaller networks.

e. For those major cities where more than one office requires access to VIIS, an additional four character alphanumeric code is optional (LDESIG). This provides the capability of distinguishing the District Office functions, Captain of the Port functions, and Marine Inspection functions from each other.

f. Where slow speed teleprinters are operated in contention, a one character alphanumeric code provides the

vehicle by which the program identifies and combines contention terminals (CONTEN).

g. The distance in miles between the last node and the location under consideration is an optional input (DIST). If distances are not provided, telephone company "V" and "H" coordinates should be used as inputs (V), (H). Neither distances nor coordinates are required for FTS lines; charges associated with these lines are a function of connect times only.

h. The estimated traffic volume in thousands of characters per month is required. This figure is the sum of both the characters to be transmitted to the CPU as well as those received at the terminal. In this program, the value read in is in thousands of characters per month (CHARMO).

i. The equipment at each location is read in as a string of two character numeric codes (NEQUIP).

2. For those nodes where distances were not provided, the program will calculate the distance using the "V" and "H" coordinates [6].

$$DIST = (((VA - VB)^2 + (HA - HB)^2) / 10)^{1/2}$$

Total distances are also provided for all GSA-leased dedicated and shared lines.

3. At this point in the program, a selection is made to determine costs of the system based on purchased or leased equipment by use of a three character numeric code (M). If the program is being run in an interactive mode, the user will be queried for this input.

4. The program reads in the number of types of

equipment being used, then reads in the proper set of cost data for each equipment type based upon the selection of purchased or leased equipment. The cost data includes the one-time and monthly recurring costs.

5. The program then determines the one-time (ECOST) and recurring (ECOSTM) equipment costs at each node, the total one-time (TCOST) and recurring (TCOSTM) equipment costs, the total number of each type of equipment in use (NEQUIP), and the number of CRT's, teleprinters, and data access arrangements at each location.

6. At this point in the program, if in an interactive mode, the user is queried for the mean number of characters per frame (XLAM), its standard deviation (XSIG), the mean number of characters to be typed in per transaction (YLAM), its standard deviation (YSIG), the estimated typing rate of the user in characters per second (ZLAM), and the working hours per month (WKHRS). He is also queried for the estimated CPU turnaround times which include queueing time at the CPU, memory cycle times, and disc access times (WLAM). Since the CPU and other computer hardware components have not as yet been specified, only gross estimates for memory cycle, disc access and queueing times are available. The idle time at the terminal can also be included in the WLAM value.

7. The number of line types are read in and the costs associated with each type. The costs for leased lines are in dollars per mile; the costs for FTS lines are in dollars per connect hour.

8. Using the information determined in (5) pertaining to the use of CRT's or teleprinters at a particular location, connect hours per month are calculated (LUSE).

Where CRT's are in use, the connect time determined by the program is

$$\text{LUSE} = (1000 * \text{CHARMO} / ((\text{XLAM} + \text{YLAM}) * 3600)) \\ * (((\text{XLAM} + \text{YLAM}) / 300) + (\text{YLAM} / \text{ZLAM}) + (\text{WLAM}))$$

and for teleprinters, connect time is

$$\text{LUSE} = (1000 * \text{CHARMO} / ((\text{XLAM} + \text{YLAM}) * 3600)) \\ * (((\text{XLAM} + \text{YLAM}) / 30.) + (\text{YLAM} / \text{ZLAM}) + (\text{WLAM}))$$

Total connect hours is also provided (LUSETO). Since all CRT's in VIIS are associated with high speed synchronous transmission and teleprinters with low speed asynchronous transmission, the above equations hold. In adapting this program to another system where all terminals of the same type do not necessarily have the same transmission speeds, different equipment numbers could be assigned to allow for the different speeds.

9. With the connect hours determined in (8) for FTS lines or the distances between nodes determined in (2) for leased lines and the costs associated with each line type from (7), the monthly charges for communications lines are determined (COSLI). Line costs and equipment costs (one-time and recurring) are used to find the total costs associated with each of the independent sub-networks of leased lines, as well as the FTS and DDD network costs. Line costs are also combined with the previously determined total monthly recurring costs (TCOSTM) to provide a final total of recurring costs.

10. The final output includes a listing of the total numbers of each type of equipment, a breakdown of costs by line numbers and individual nodes, and total costs. These cost breakdowns allow the user the opportunity of reviewing all network costs and determining at which locations costs

may be disproportionately high or low for their particular traffic loads. It also gives him an estimate of how much he can save by deleting a terminal site or how much more it will cost to install additional terminals in the network. Since the user has the opportunity to vary several parameters, particularly those which affect the connect hours, he has the ability to develop a range of costs associated with the network.

B. PERFORMANCE

Communications network performance is based largely on the number of characters transmitted and the transmission rate. For asynchronous transmission, performance is dependent upon total connect times since the entire channel bandwidth is being utilized. For synchronous transmission, performance is dependent upon the amount of time that there are actually characters being transmitted. Much of the information required to determine performance was also used to determine costs. The equations that follow for determining performance are from standard queueing theory models in use today.

1. The first step in determining performance is the separation of terminals by line types and line numbers. For those locations having CRT's, the FTS lines, and the DDD lines, the characters per month for all terminals on that line are summed to provide the total traffic volume in thousands of characters for the line (CHAR). In the case of teleprinters which have been frequency division multiplexed, each terminal has its own channel and the total traffic in the channel is limited to that of the one terminal, except where terminals operate in contention. When in the contention mode, two terminals share one channel and the

traffic volume for the channel is the sum of the individual traffic loads. When more than one channel of a line is being utilized in a contention mode, the program pairs the locations with the highest and lowest traffic loads, next highest and next lowest, etc., to achieve a more uniform workload distribution for the channels.

2. The next step is to determine the mean service time per transaction (TS). For teleprinters and FTS or DDD CRT's, the service time bandwidth is used while connected. For CRT's on dedicated lines, separate service times are determined for the typed-in information and the information received from the CPU.

$TS = XLAM / 300$. for data received from the CPU.

$TS = YLAM / 300$. for typed-in data.

3. The average number of transaction arrivals per second (EN) is determined using the total number of characters on the line, the number of characters per transaction, and the number of working hours per month [6, 10].

$EN = ((1000 * CHAR) / ((XLAM + YLAM) * WKHRS * 3600.))$

4. Line utilization (RHO) is the percent of time that the communication line is actually in use. It is determined as the product of the mean service time per transaction and the number of arrivals per second [6, 10].

$RHO = TS * EN$

5. The number of transactions waiting for service in the system (EW) is a function of the utilization, the

expected arrivals per second, and the standard deviation of the characters per frame and typed-in characters [6, 10].

$$EW = ((EN * SIGMA)^2 + RHO^2) / (2 * (1 - RHO))$$

6. The number of transactions in the system (EQ), waiting for service or being served, is the sum of those waiting for service and the utilization [6, 10].

$$EQ = EW + RHO$$

7. The expected waiting time for service (ETW) is the quotient of the number of items waiting for service and the expected arrival rate [6, 10].

$$ETW = EW / EN$$

8. The expected time an item spends in the communications network (ETQ), waiting for service and being served, is the sum of the expected service times and expected waiting times [6, 10].

$$ETQ = ETW + TS$$

9. The performance data output is of great value in determining line usage and possible problem areas, such as over-utilization which degrades response times to the point where additional lines may be required. Since the size of the data base transaction frames and the number of characters to be typed in has not been well defined, the ability of the user to input various frame sizes and typed-in character values as well as their standard deviations, provides the user the opportunity of reviewing network utilization under a wide range of operating conditions. The general nature of the performance section of the program allows the user to get information on utilization from the best conditions where service times are constant to the worst case where they are exponentially distributed. For teleprinters, the ability to vary typing

speed and the CPU turnaround times also provides the user the opportunity to check performance of the system under various operating conditions. The performance data does have the following drawback, it does not account for time zone/working hours differences between terminal locations. For leased lines and DDD lines, this is not significant since all terminals are in the same geographical areas; for FTS lines however, terminals are spread from the east coast of the United States to Guam and performance can actually be significantly better than that determined by the program.

IV. COMMUNICATIONS NETWORK SENSITIVITY ANALYSIS

The sensitivity analyses that follow are based on the Baseline Network using mixed terminal types. Comparisons are made against the original cost and performance estimates provided in the report on VIIS made to the Coast Guard. The following parameters were used for the original estimates:

A typing rate of 3.0 characters per second, assuming only qualified clerical staff operated the terminals.

An average of 2200 characters per transaction.

There were no mileage charges associated with the GSA-leased/shared lines. The total cost for these lines would be born by present users of these lines.

Due to the very high connect time charges on the FTS-nonCCNUS lines, \$66.00 per connect hour, data transmission is pursued after business hours, whenever possible, to take advantage of the FTS night circuit rates, \$125.00 per month independent of connect hours.

A response time of 5 seconds or less is desired on all lines utilizing CRT's.

A. COST

The cost of the communications network is derived from two sources, equipment costs and line costs. Line costs can

further be divided into mileage charges for leased lines and connect time charges for FTS lines. Variations of cost with respect to equipment and connect times are discussed below.

1. Purchased Equipment

In the baseline network utilizing purchased equipment, the one-time costs are only affected by manufacturers' price changes and shipping/installation price changes. Appendix A lists several equipment types and illustrates the resultant effect on the total one-time costs with changes in equipment costs. The original estimate was \$337,300.

Changes in the cost of the teleprinters with built-in couplers have the greatest impact on the total one-time costs, 2.4% change in total costs for a 10.0% change in unit cost of the teleprinter. The total cost is relatively insensitive to price changes of individual types of equipment unless the change is a major price increase or decrease. The prices of several types of equipment increasing simultaneously could have an adverse combined effect on the total costs.

The monthly recurring costs are affected by the FTS connect hours, leased line mileage charges, maintenance charges, and common carrier service charges for conditioning and terminations. Appendix B provides a list of several items contributing to the monthly recurring costs and the impact price changes for those items would have on the total recurring costs.

If VIIS is required to share the cost of the GSA leased/shared lines, the recurring costs could change by as much as 8 %. The details of the shared line arrangement

have not been worked out and the share of the costs that VIIS will have to bear have yet to be determined.

The monthly recurring costs are affected for the most part by changes in line costs for which there is little or no control, and the FTS connect hours. The connect hours are a function of the number of transactions per month, the typing rate of the user, the access and queueing times of the host computer, and the number of characters in a transaction. Figures 1. thru 3. show the relationship between access times, typing rates, the number of characters typed, connect hours, and cost.

FTS connect charges can be reduced by using the FTS night circuit for all transactions that do not require real-time responses, use of CRT's instead of teleprinters (this particularly applies to non-CONUS terminals where a reduction in connect time of one hour will cover the rental cost of a higher speed modem required for the CRT), reducing the number of transactions entered from these terminals, or reviewing the requirements for each type of transaction and reducing the number of characters per transaction whenever possible.

2. Leased Equipment

The discussion in the last section applies here as well except that the recurring costs are substantially higher, and the impact of a price change for a particular piece of equipment or line results in a smaller percentage change in the total recurring costs. See Appendix C.

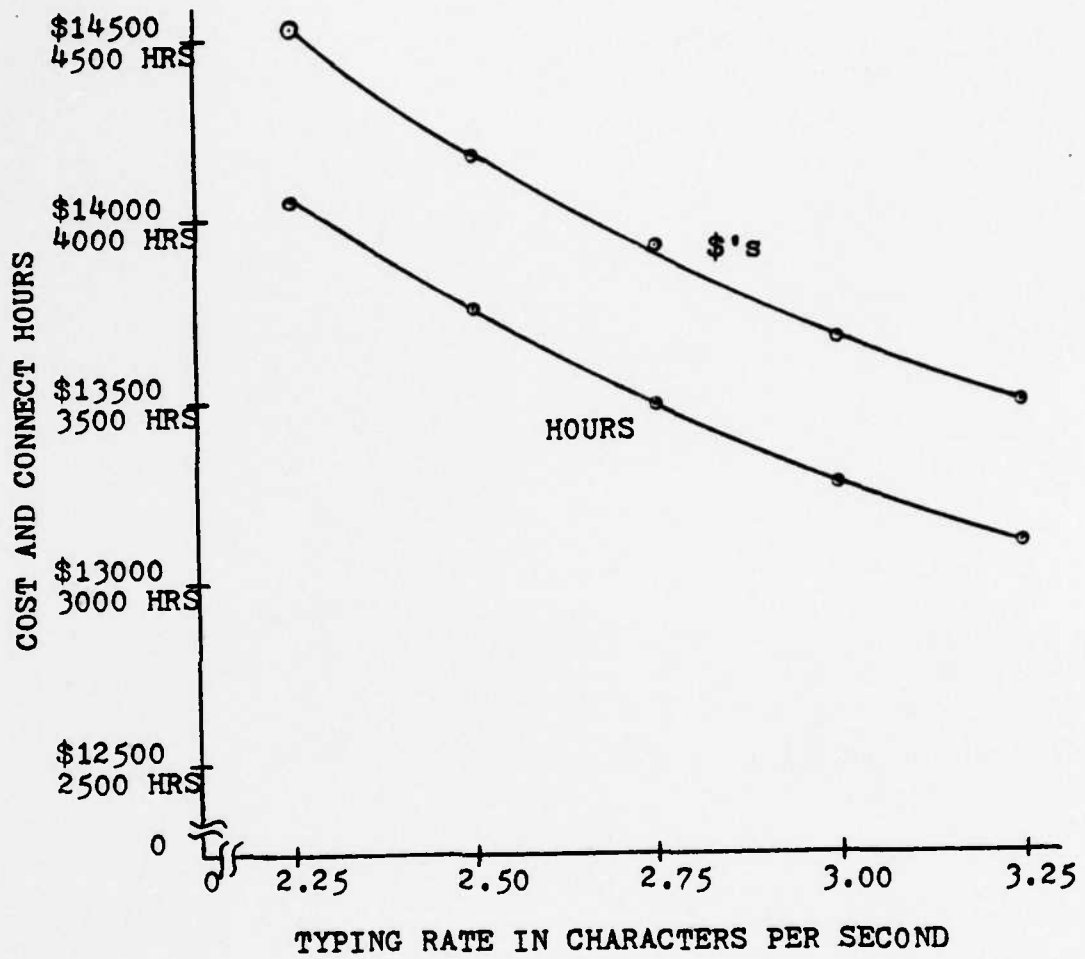


Figure 1 - TYPING RATE VS. COST AND CONNECT HOURS

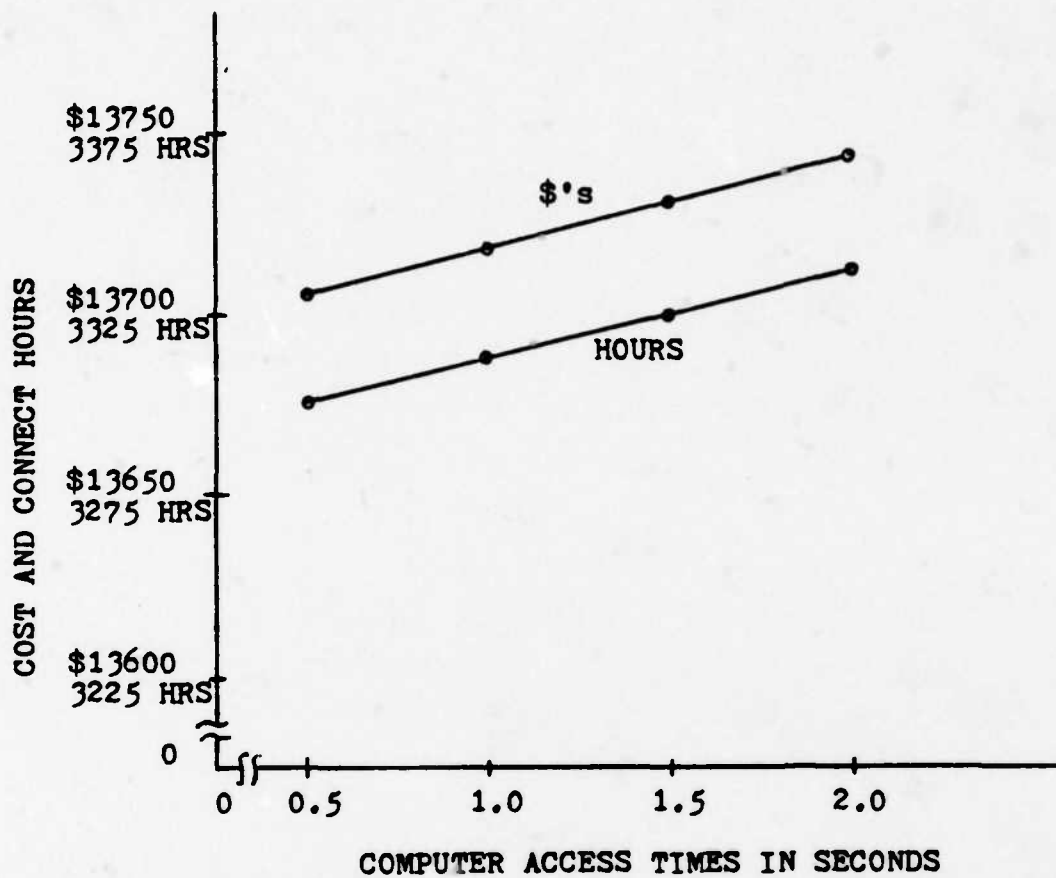


Figure 2 - COMPUTER ACCESS TIME VS. COST AND CONNECT HOURS

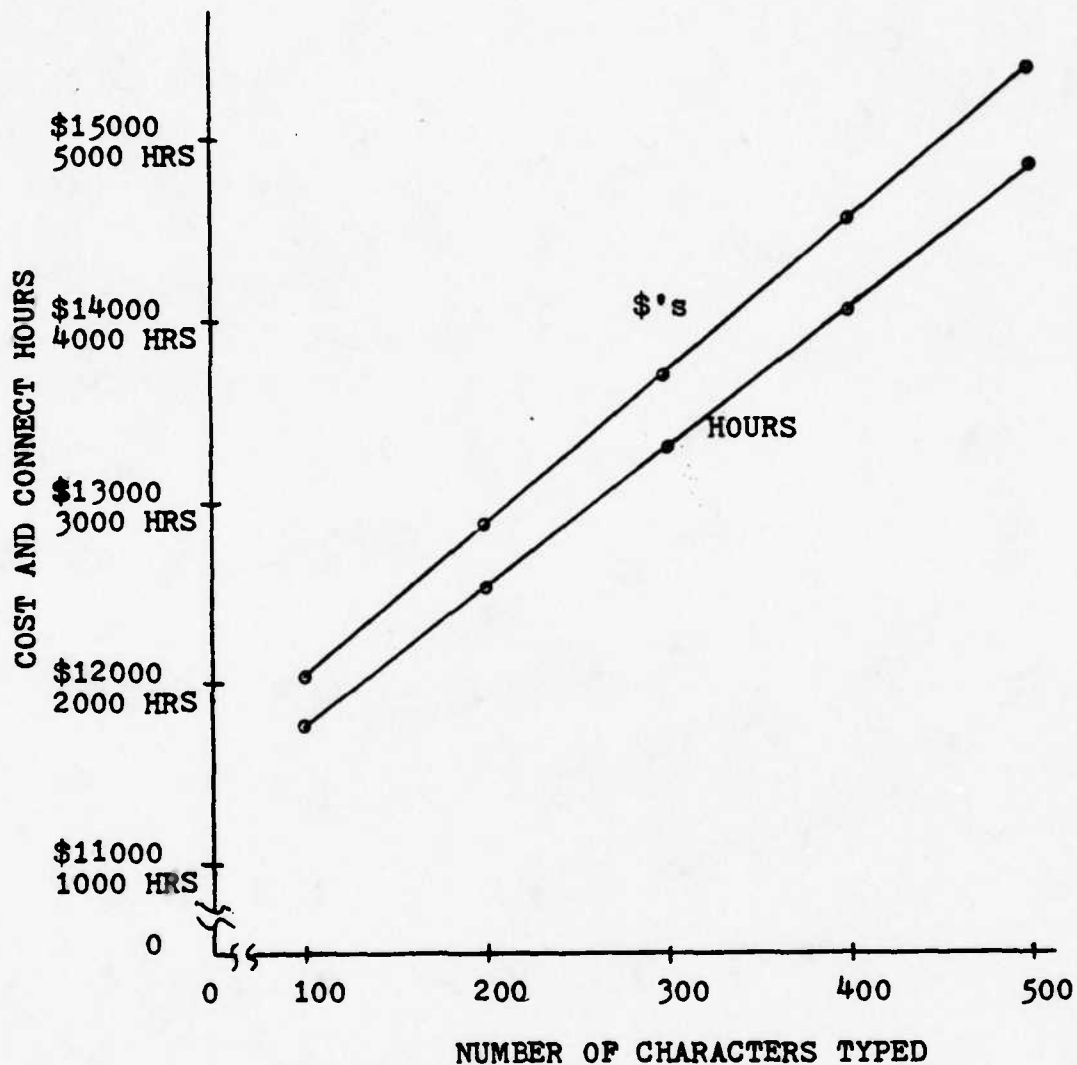


Figure 3 - NUMBER OF CHARACTERS TYPED VS. COST AND CONNECT HOURS

B. PERFORMANCE

There is no distinction between the purchased or leased equipment networks as far as performance is concerned. Performance is dependent upon the transmission rates of the lines and equipment, and the typing speed of the user and computer access times where asynchronous transmission is used. Another important aspect of performance which is often neglected is the variation in the number of characters per transaction. These variations can significantly alter the waiting times for service and the total time in the system from the values obtained by using only mean characters per transaction in performance calculations.

In reviewing performance in the baseline network, two independent lines were considered. One line involves two teleprinter terminals operated in contention. The total number of characters transmitted per month is 3441 thousand and they operate asynchronously with a data transmission rate of 30 characters per second. The other line includes four CRT terminals with synchronous data transmission of 300 characters per second and a total of 42322 thousand characters per month.

A mean frame size of 1900 characters, approximately one full CRT screen of data, and a mean of 300 characters of typed-in data were selected as starting points for performance evaluation. This gives the suggested mean number of characters per transaction of 2200. Figures 4 and 5 show the effect of the variance of the frame size and number of typed-in characters respectively, on system performance in terms of the expected time in the network per transaction.

Since the asynchronous terminals operate at a low data rate and occupy the full channel bandwidth, which means that any time the terminal is connected the network is in use, the expected time in the network starts out high and increases gradually as the standard deviation increases. If the number of characters transmitted over this line was increased, the expected time in the network would increase at an increasing rate, i.e., performance deteriorates at an increasing rate. The bulk of the time in the network with these terminals is due to the typing rate and low data rate. Reducing the number of transactions per month will not affect performance to a high degree, but will flatten out the curve slightly when the standard deviation is increased. The same applies to the number of characters per transaction. The greatest decrease in time in the network without changing equipment can be achieved through a decrease in the number of characters typed in. See Figure 6. The most effective way of reducing time in the network and improving performance is by using CRT's, synchronous high speed transmission, etc.; however, the additional costs involved may not be justified because of the low number of transactions.

The performance of the line using CRT's is at the desired response time level for transactions having zero standard deviation, constant frame sizes and number of typed-in characters, and remains virtually constant over the range of standard deviation considered. On this line, total utilization is under 25 per cent and is the major factor responsible for the insensitivity of the line's performance to variations in transaction size. If in actual use, the number of transactions was significantly higher than expected and caused network degradation, the data rate of the line and terminals could be increased or the transactions split between two or more lines to improve performance.

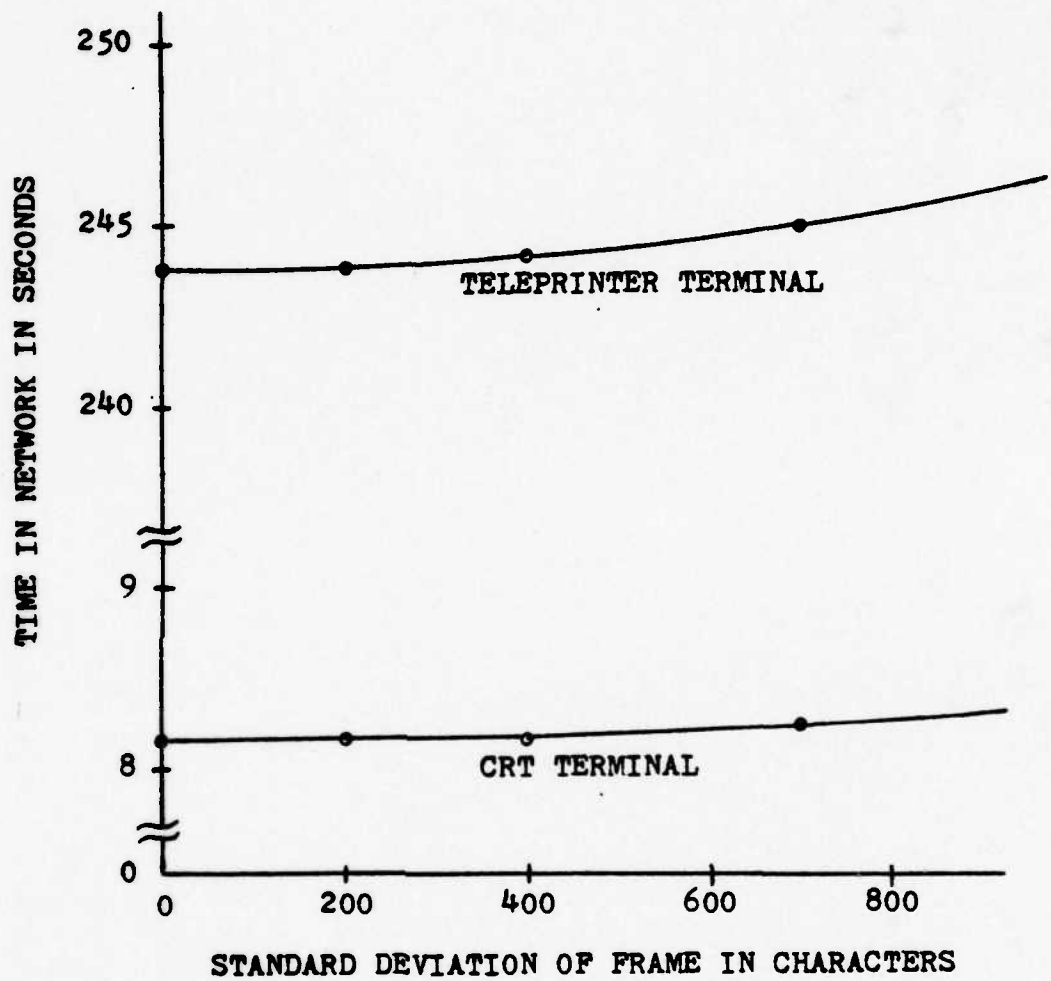


Figure 4 - TIME IN NETWORK VS. STANDARD DEVIATION OF FRAME SIZE

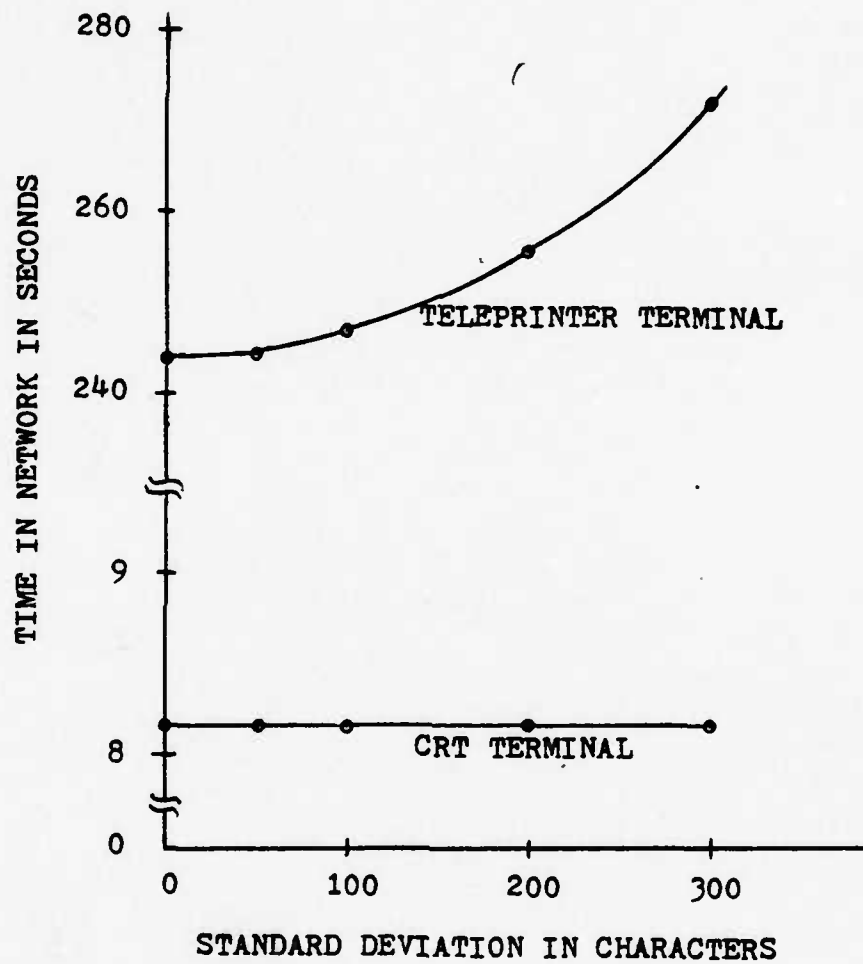


Figure 5 - TIME IN NETWORK VS. STANDARD DEVIATION OF NUMBER OF TYPED IN CHARACTERS

Figure 6 shows the relationship of the two lines with the number of characters typed in, still assuming 2200 total characters per transaction. The performance of the CRT's remains relatively constant, as expected, for each of the standard deviations considered, since the typing rate is not a factor in network performance utilizing synchronous transmission over dedicated lines.

The performance of the asynchronous terminals deteriorates with an increase in the number of typed-in characters because performance is dependent upon typing rate. Performance can be improved somewhat by arranging transactions to have as few typed in characters as possible or by typing transactions off-line onto auxilliary tape units and then transmit them over the lines at 30 characters per second.

Figure 7 shows the time in the network using half duplex and full duplex lines. Due to the relatively low utilization of the line, the time in the network for the half-duplex line is only slightly higher than that of the full-duplex line for all cases considered. The actual performance of the half-duplex line is actually somewhat poorer than that indicated since the time required to switch the line from the send to receive mode has not been included.

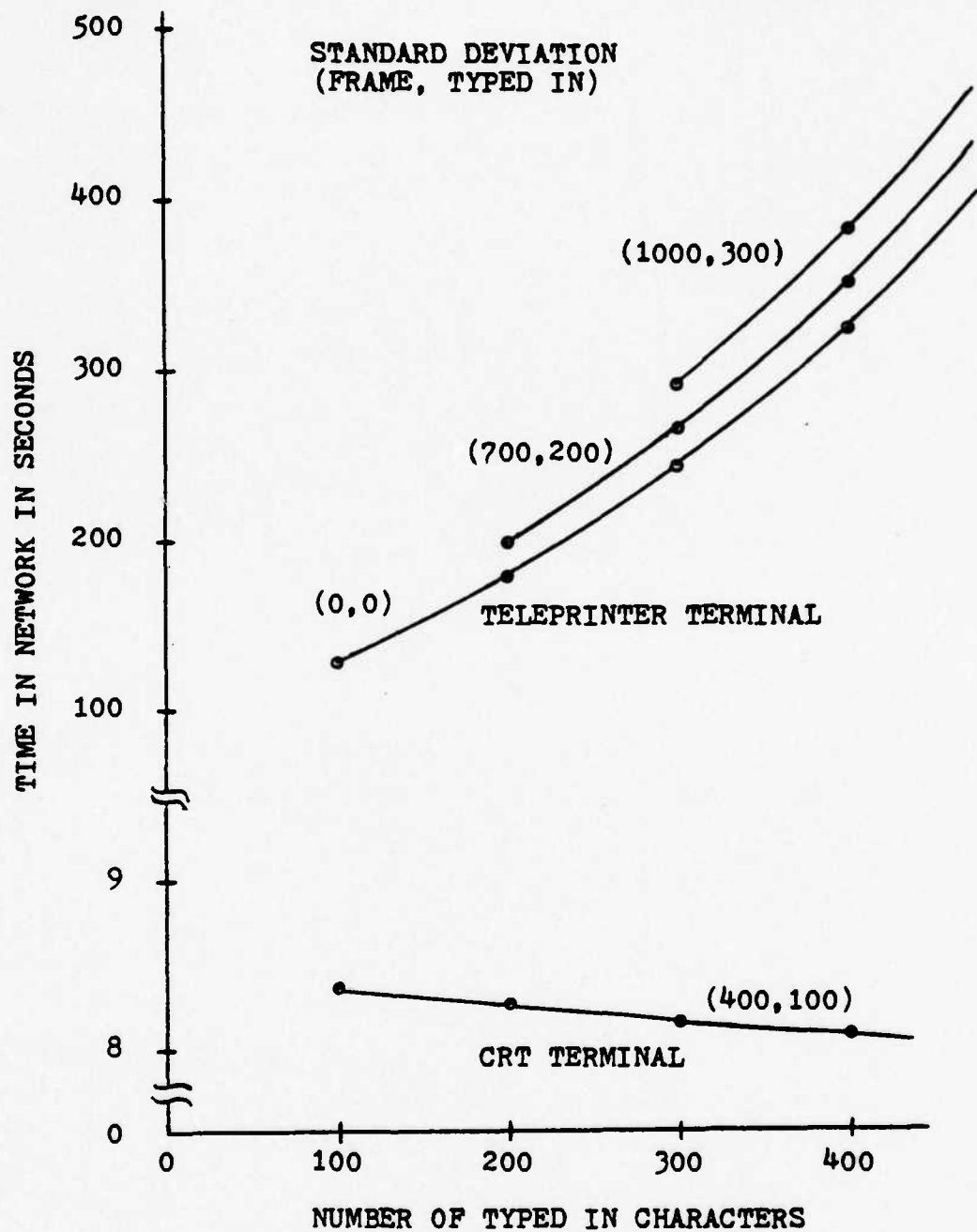


Figure 6 - TIME IN NETWORK VS. NUMBER OF TYPED IN CHARACTERS

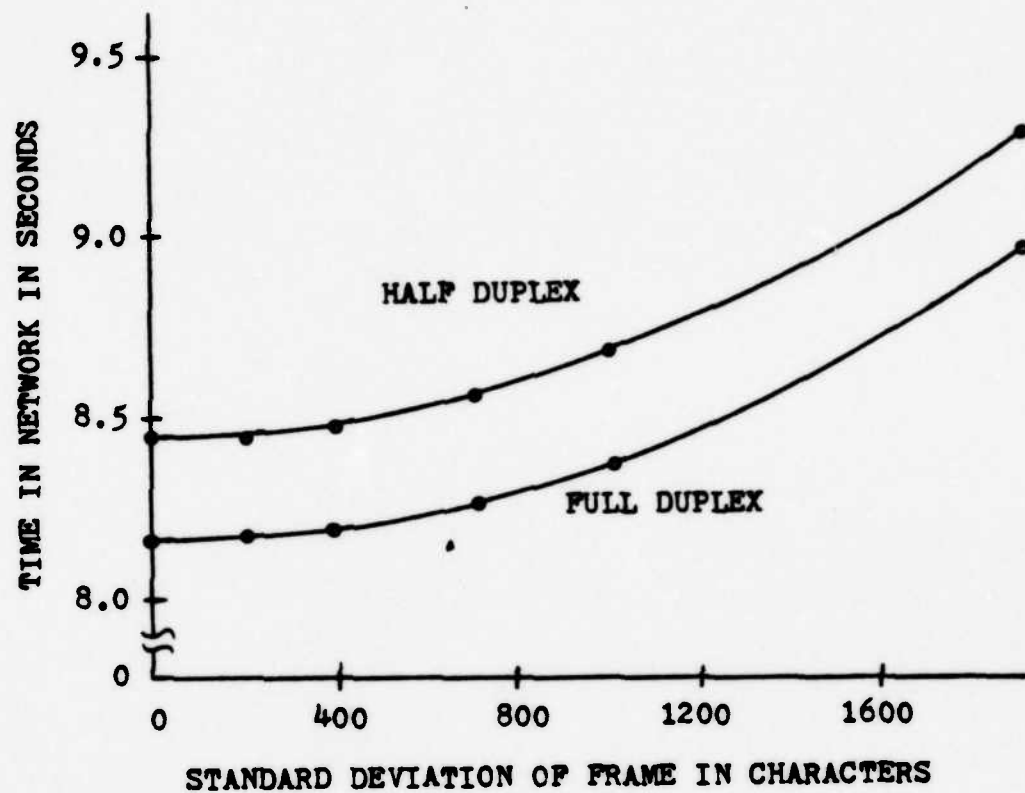


Figure 7 - TIME IN NETWORK FOR HALF AND FULL DUPLEX LINES

V. CONCLUSION

A Vessel Inspection Information System, properly designed, implemented and utilized, could prove to be an invaluable tool for the execution of the Coast Guard's Merchant Marine Safety Functions.

The estimated costs of the proposed system appear to be accurate and, except for the costs of the FTS lines, relatively constant over a range of operating conditions.

The response of the lines utilizing CRT's was estimated to be near real-time as desired and relatively constant over a wide range of operating conditions. With the low utilization of these lines, there is little problem in maintaining the desired response times as far as the communications network is concerned. For the teleprinter terminals, response times are greater than for CRT's, as expected, but user needs at low transaction volume locations are satisfied. Caution must be exercised at teleprinter locations to ensure that the number of transactions is kept low enough to keep utilization down. Some lines utilizing teleprinters are operating at 50 per cent utilization and are more sensitive to variations in transaction size or increased numbers of transactions.

An area requiring further research is that of computer access and service times. Several values for these times were used to get an indication of their effect on connect times of all lines and performance for all asynchronous terminals; however, if performance at the CPU deteriorates significantly with varying transaction sizes, time in the

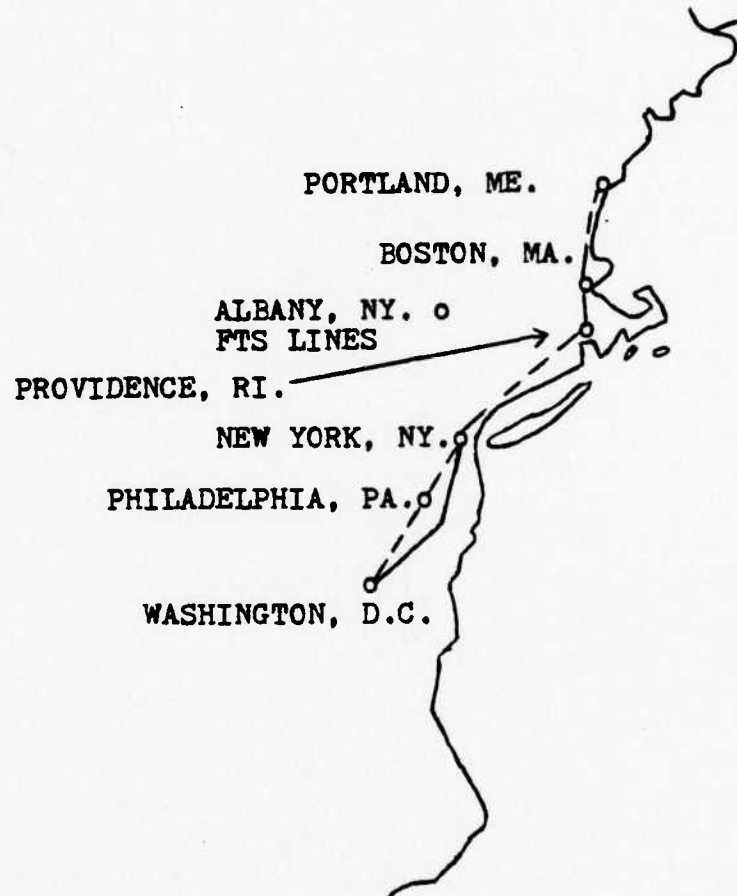
network could be much longer than the times which have been determined.

Finally, if the Baseline System is constructed and larger systems are developed from it at a later date, the additional transactions could have a degrading effect on communications network performance. Prior to expanding the baseline network, additional performance data should be obtained, using data from the Baseline System.

Upon completion of further study of the computer part of the system, including queueing, access, and response times, and upon completion of a cost-effectiveness study of the system to ensure its worth to the Coast Guard, implementation of the baseline system should be considered.

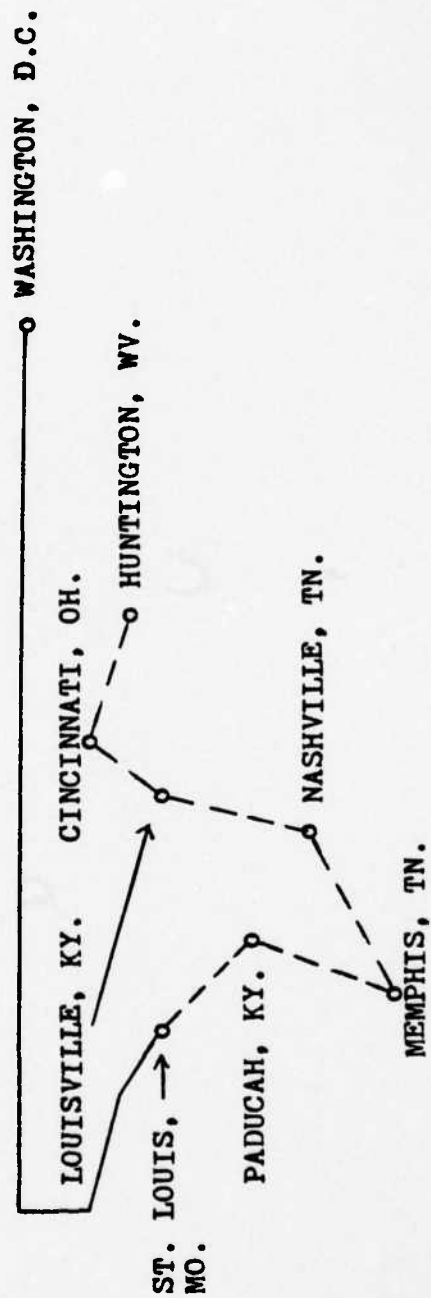
APPENDIX A
VIIS NETWORK

LINE 1

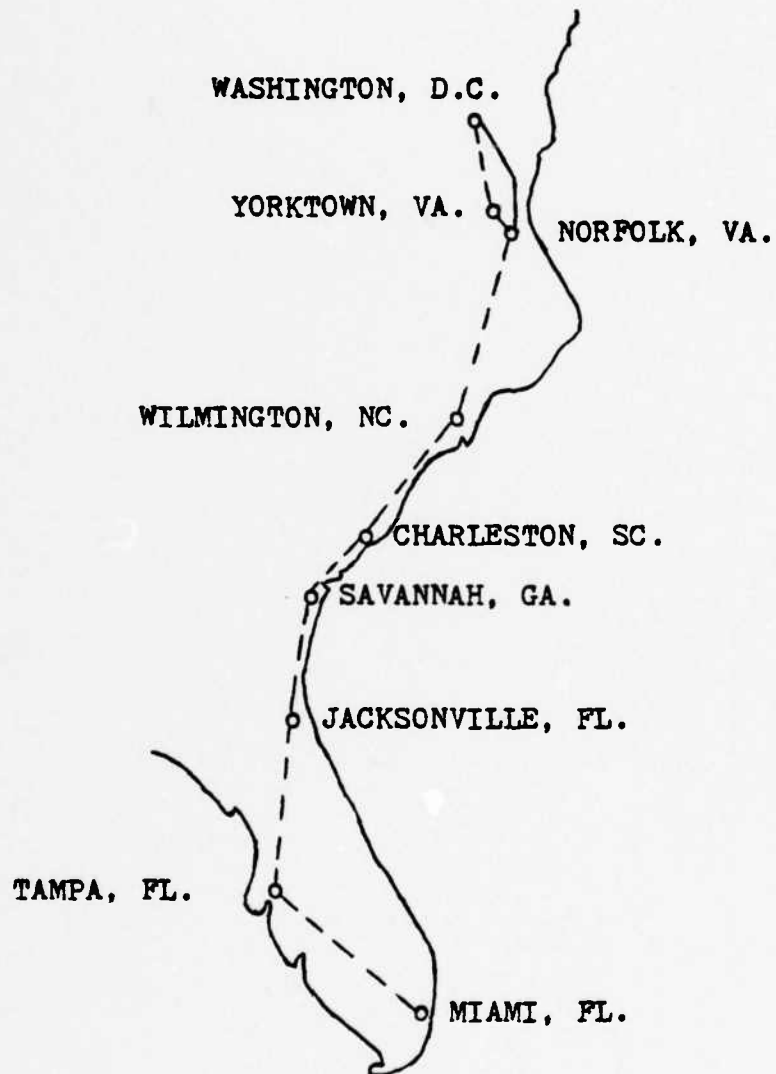


REP: 4

LINE 2



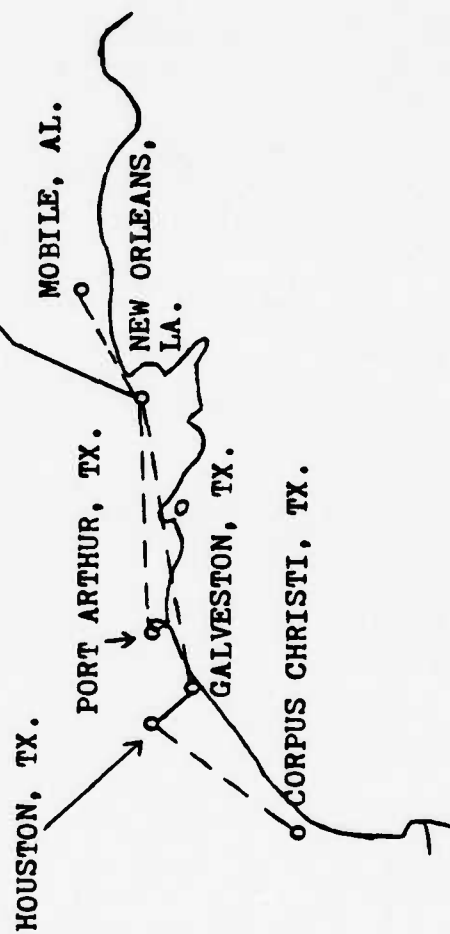
LINE 3



REF: 4

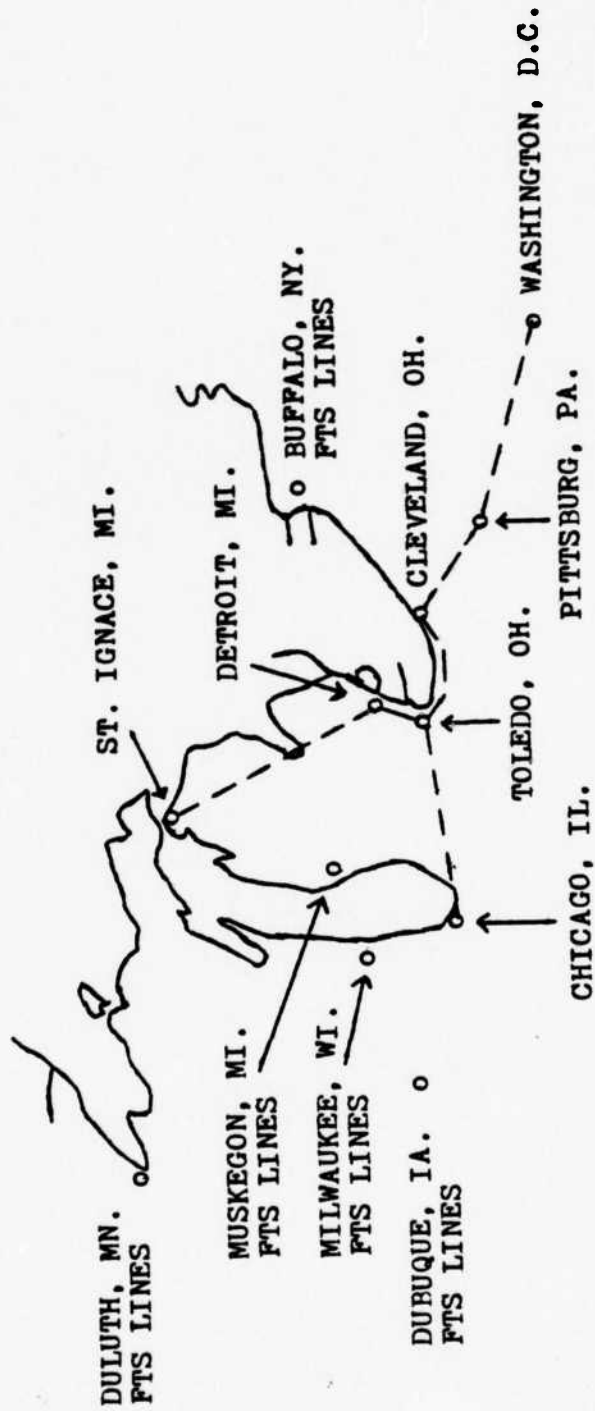
LINE 4

TO
WASHINGTON, D.C.



REF: 4

LINE 5



REF: 4

LINE 6

○ ANCHORAGE, AK.
PTS LINES

○ JUNEAU, AK.
PTS LINES

○ SEATTLE, WA.

○ PORTLAND, OR.

○ SAN FRANCISCO, CA.

○ GUAM
PTS LINES

○ HONOLULU, HI.
PTS LINES

○ LOS ANGELES, CA

TO
ST. LOUIS,
MO.

○ SAN DIEGO, CA.

REF: 4

APPENDIX B

BASELINE - PURCHASED EQUIPMENT VARIATIONS OF ONE-TIME COSTS WITH CHANGES IN EQUIPMENT PRICES

BASE COST OF 337,300

EQUIPMENT TYPE	QUANTITY	ORIGINAL COST	PER CENT CHANGE	NEW COST	NEW NETWORK COST	PER CENT CHANGE
A300 MODEM	23	570.	+10.	627.	338,610.	+0.39
S2400 MODEM	15	2138.	+10.	2352.	340,510.	+0.95
S560C MODEM	4	9600.	+10.	10560.	341,140.	+1.14
CRT	12	1850.	+10.	2035.	339,520.	+0.66
TELEPRINTER	15	2130.	+10.	2343.	340,500.	+0.95
TELEPRINTER w/COUPLER	34	2430.	+10.	2673.	345,560.	+2.45
PRINTER	7	3625.	+10.	3988.	335,840.	+0.75
FCM CHASSIS	39	480.	+10.	528.	335,170.	+0.56
FDM CHANNEL	61	350.	+10.	385.	339,440.	+0.63
TDM CHASSIS	4	1700.	+10.	1870.	337,980.	+0.20
TDM CHANNEL	28	300.	+10.	330.	338,140.	+0.25

REF: 4

APPENDIX C

BASELINE - PURCHASED EQUIPMENT VARIATIONS OF RECURRING CCSTS WITH CHANGES IN EQUIPMENT/SERVICE COSTS

BASE COST OF 13,100

EQUIPMENT TYPE	QUANTITY	ORIGINAL COST	PER CENT CHANGE	NEW COST	NEW NETWORK COST	PER CENT CHANGE
LEASED LINES /DEDICATED	6595.MI	0.54/MI	+10.	0.594/MI	13480.	+2.88
LEASED LINES /SHARED	2030.MI	0.00/MI		0.27/MI	13650.	+4.18
C2 LINE CONDITIONING	4	49.	+10.	53.90	13120.	+0.15
LINE TERMINATION	53	42.	+10.	46.20	13340.	+1.86

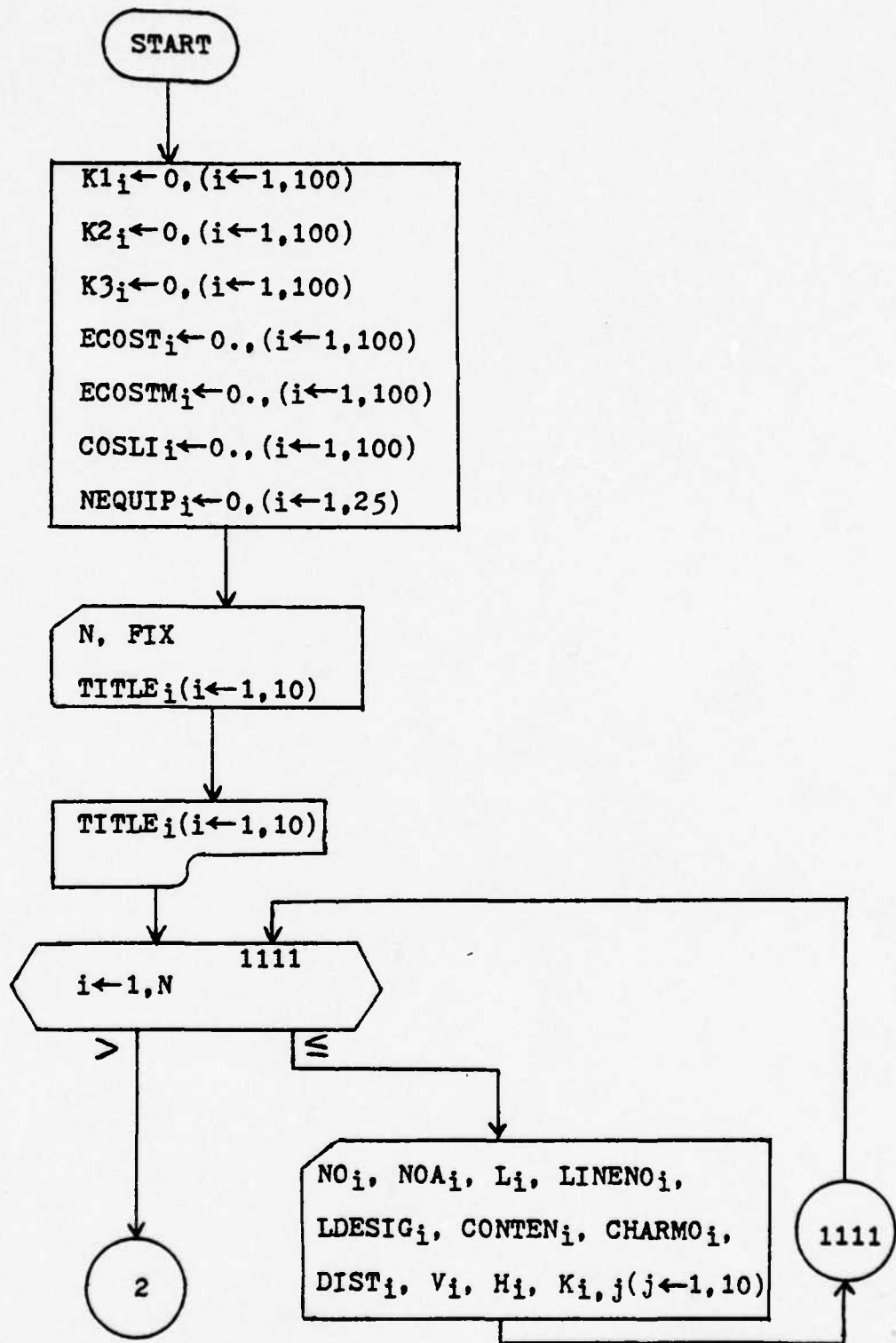
REP: 4

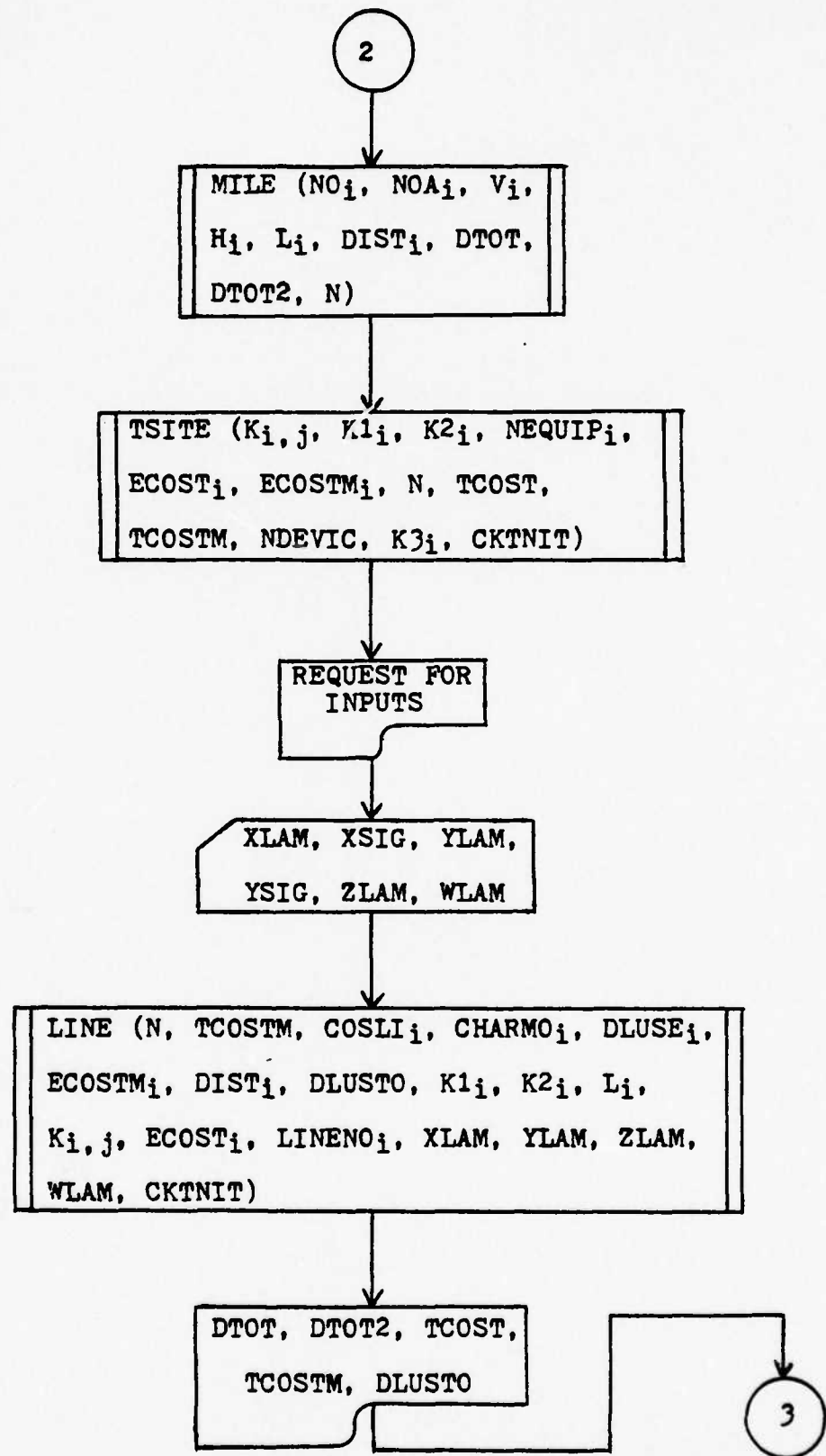
APPENDIX D

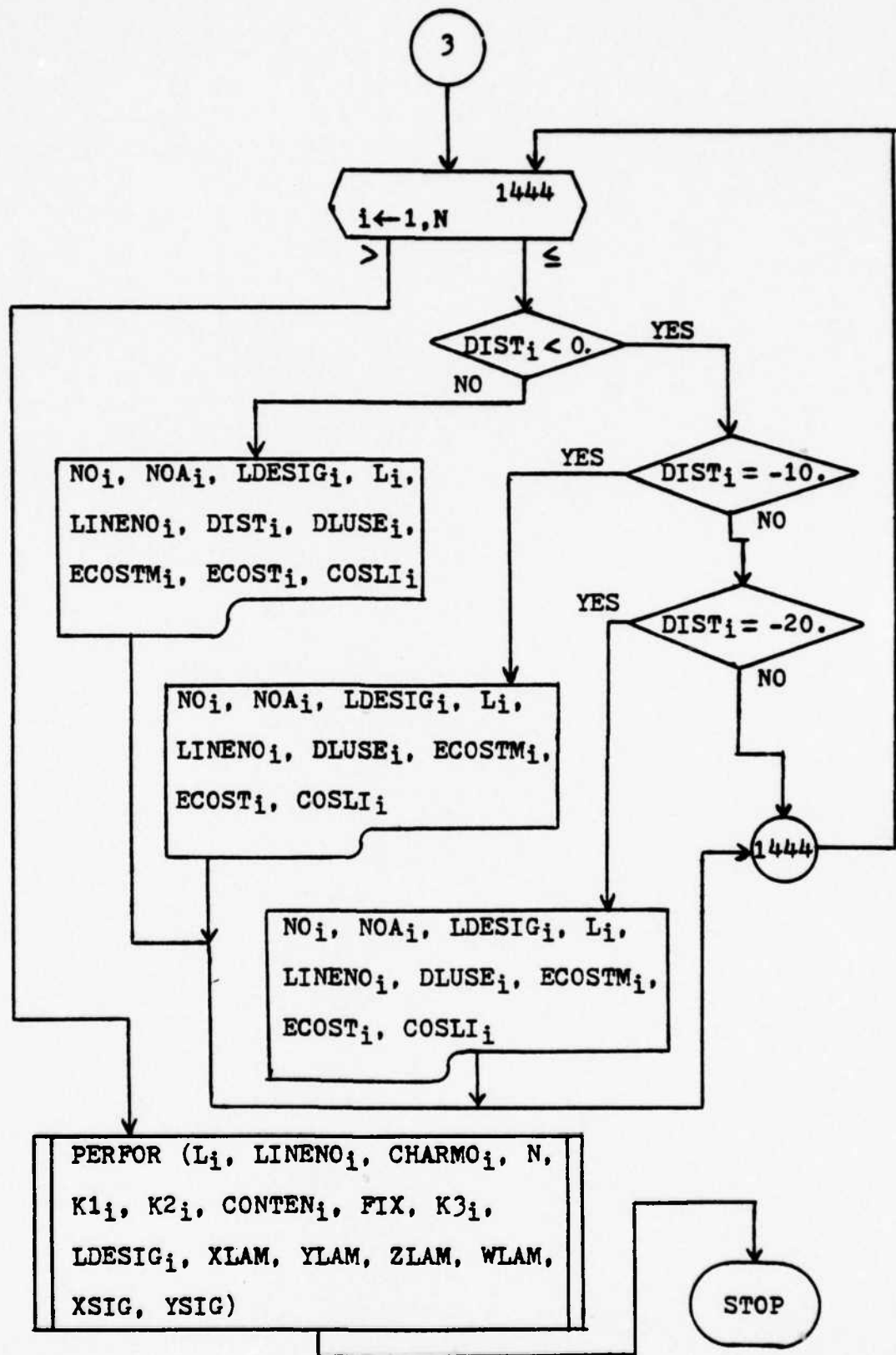
BASELINE - LEASED EQUIPMENT VARIATIONS OF RECURRING CCSTS WITH CHANGES IN EQUIPMENT/SERVICE COSTS BASE COST OF 21,620

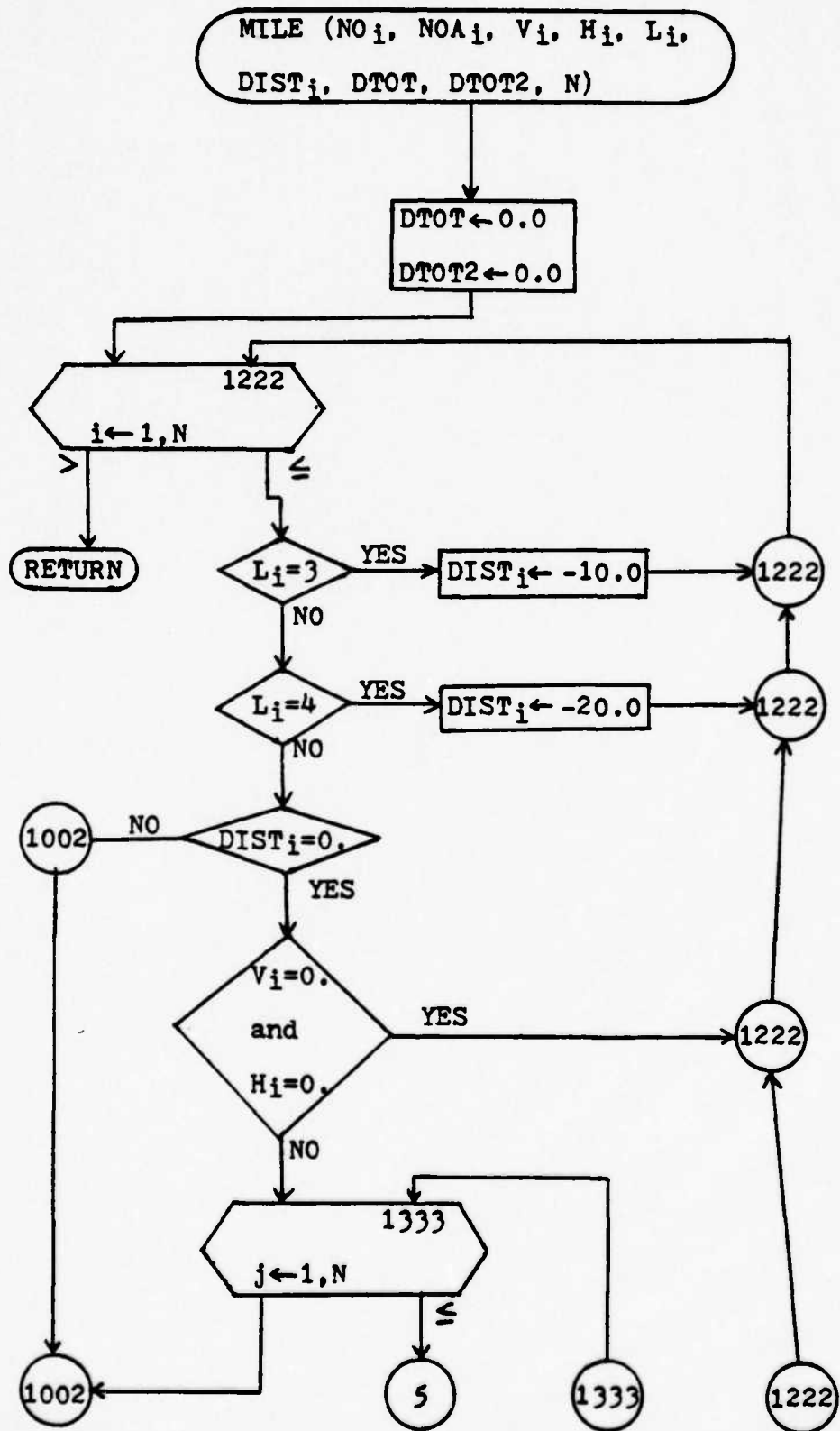
EQUIPMENT TYPE	QUANTITY	ORIGINAL COST	PER CENT CHANGE	NEW COST	NEW NETWORK COST	PER CENT CHANGE
A300 MODEM	23	12.	+10.	13.20	21810.	+0.13
S2400 MODEM	15	55.	+10.	60.50	21860.	+0.38
S5600 MODEM	4	230.	+10.	253.	21870.	+0.42
CRT	12	83.	+10.	91.30	21880.	+0.46
TELEPRINTER	15	95.	+10.	104.50	21920.	+0.65
TELEPRINTER W/COUPLER	34	107.	+10.	117.70	22140.	+1.67
PRINTER	7	170.	+10.	187.	21900.	+0.55
FDM CHASSIS	39	16.	+10.	17.60	21840.	+0.29
FDM CHANNEL	61	11.	+10.	12.10	21850.	+0.31
TDM CHASSIS	4	52.	+10.	57.20	21800.	+0.09
TDM CHANNEL	28	10.	+10.	11.	21810.	+0.13
LEASED LINES /DEDICATED	6995.MI	0.54/MI	+10.	0.594/MI	22160.	+1.73
LEASED LINES /SHARED	2030.MI	0.00/MI		0.27/MI	22330.	+2.52
LINE TERMINATION	53	42.	+10.	46.20	22000.	+1.02
C2 LINE CONDITIONING	4	49.	+10.	53.90	21800.	+0.09

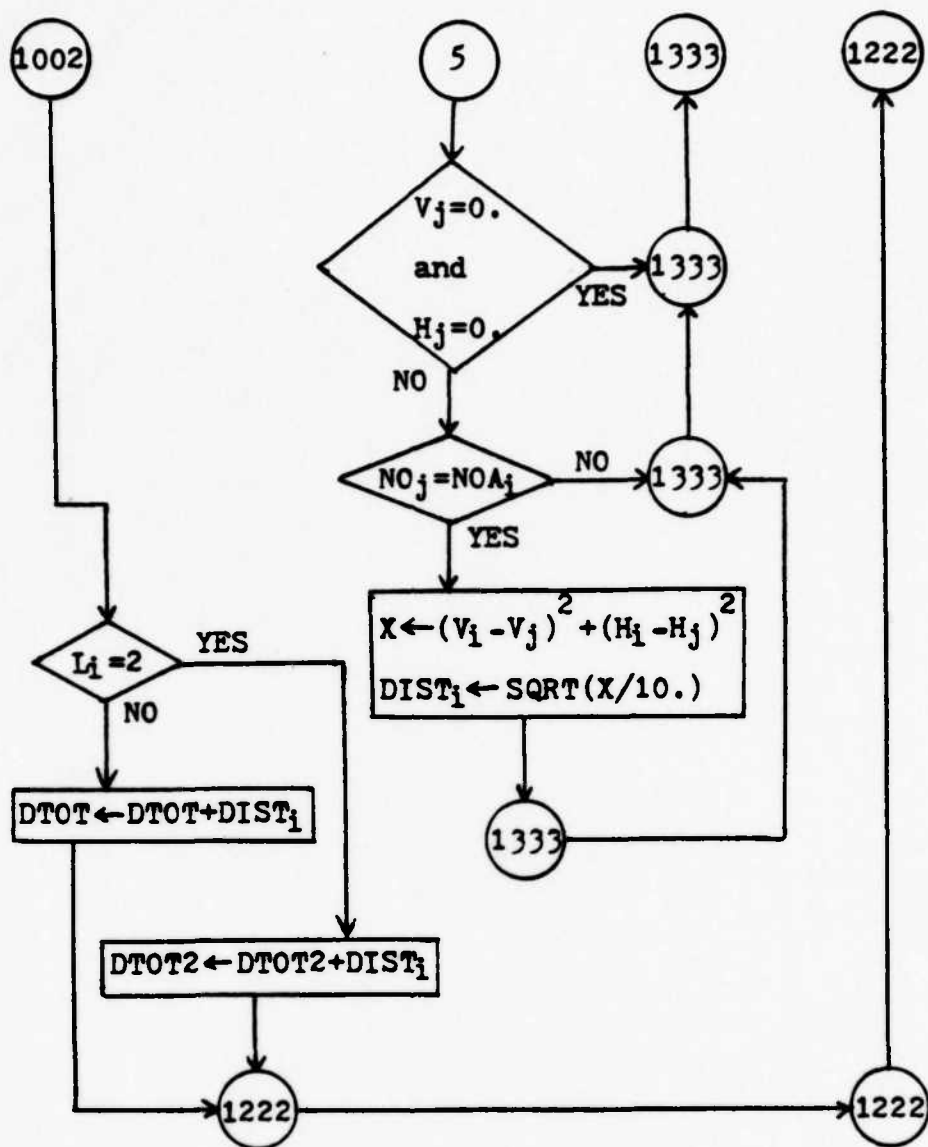
APPENDIX E
PROGRAM FLOWCHARTS



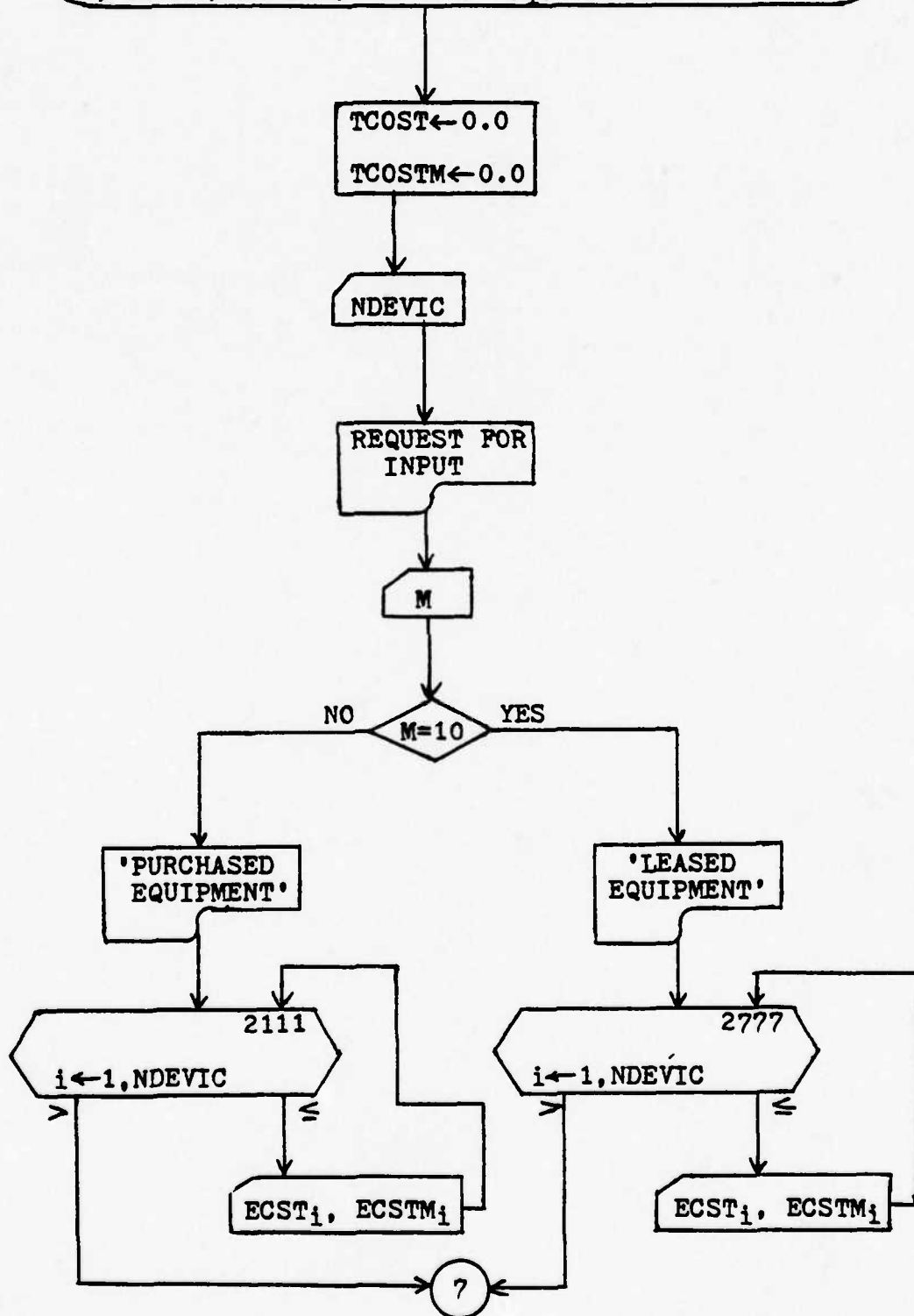


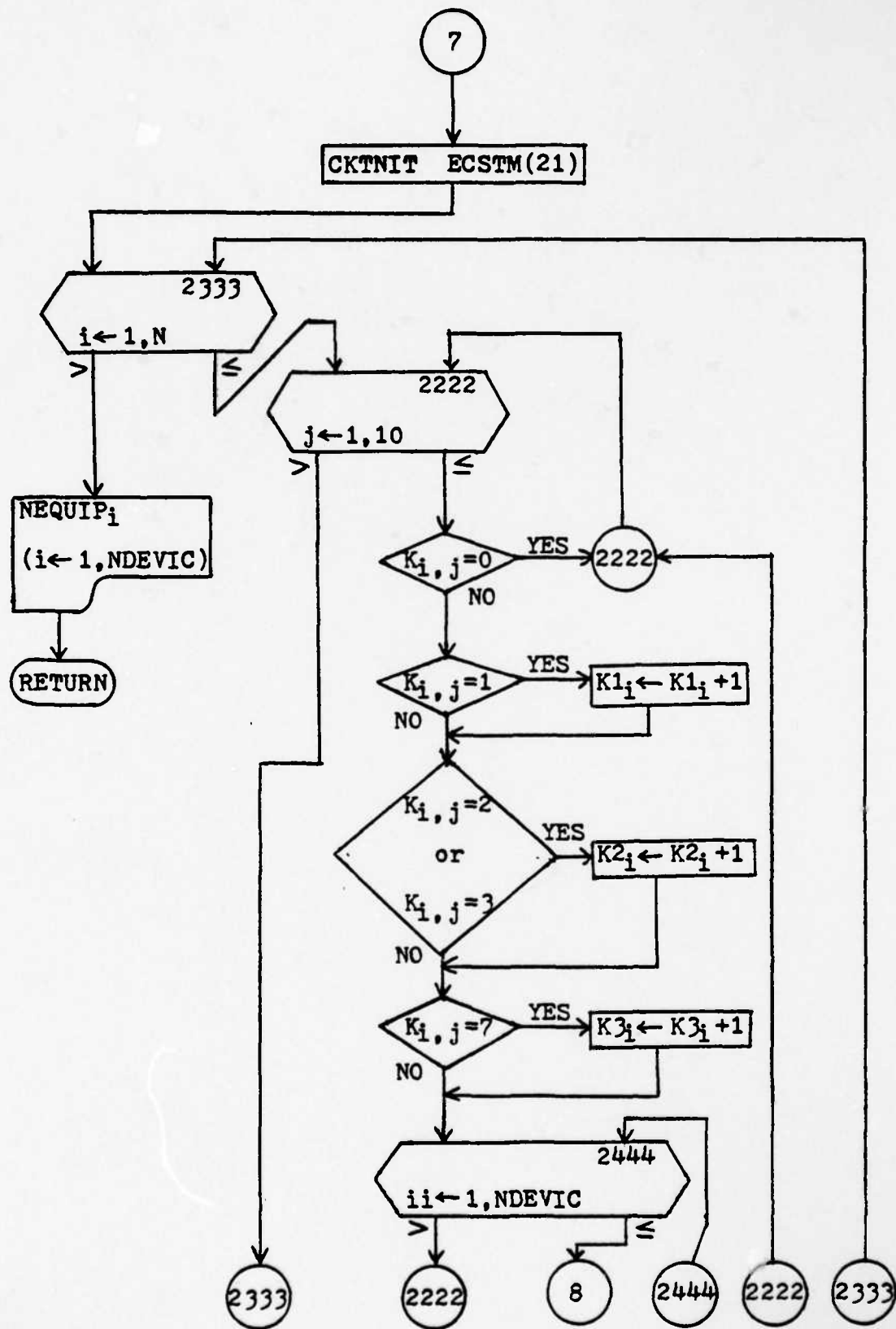


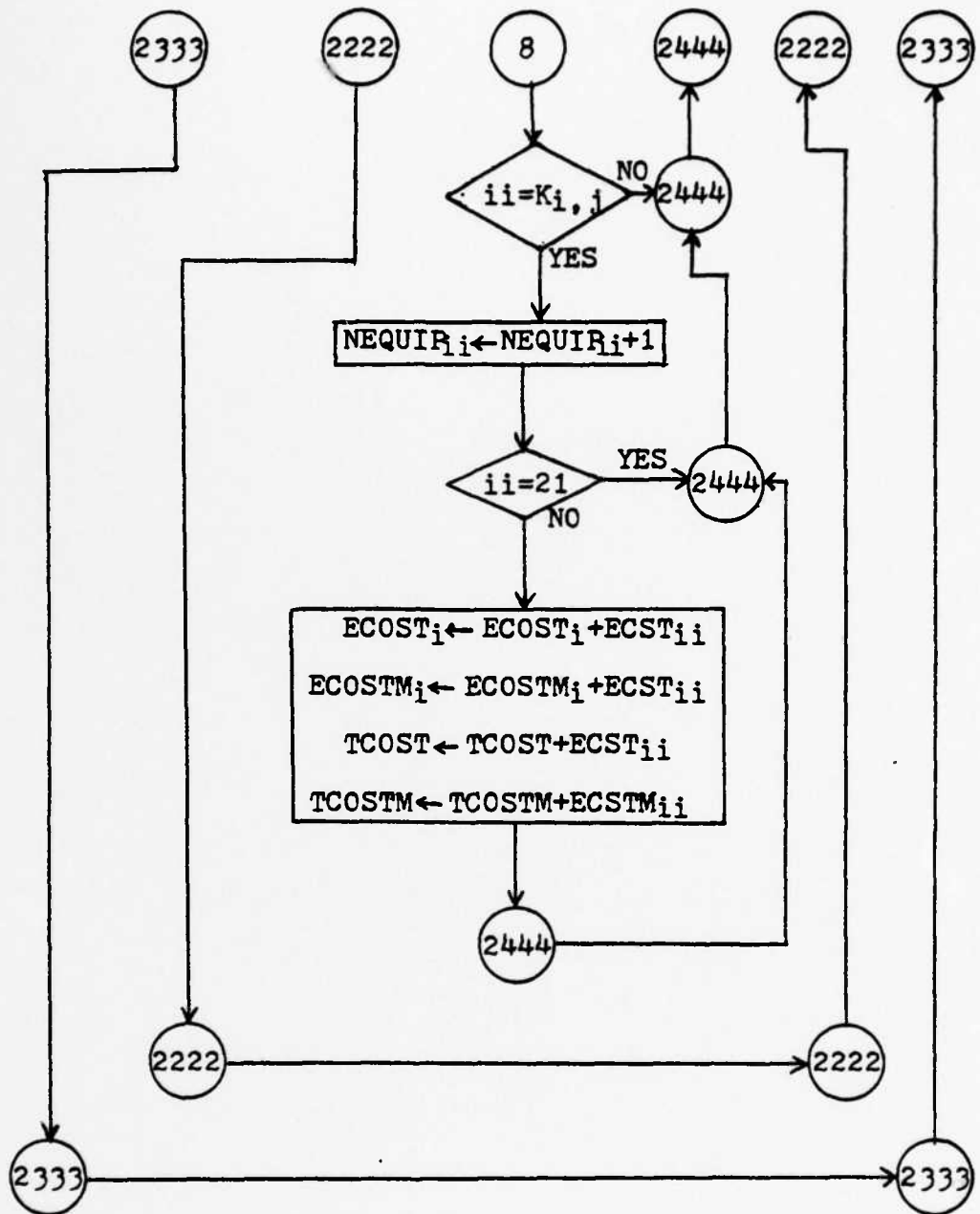




TSITE ($K_{i,j}$, $K1_i$, $K2_i$, $NEQUIP_i$, $ECOST_i$, $ECOSTM_i$,
 N , $TCOST$, $TCOSTM$, $NDEVIC$, $K3_i$, $CKTNIT$)







LINE (N, TCOSTM, COSLI_i, CHARMO_i, DLUSE_i, ECOSTM_i,
DIST_i, DLUSTO, K1_i, K2_i, Li, K_{i,j}, ECOST_i, LINENO_i,
XLAM, YLAM, ZLAM, WLAM, CKTNIT)

GSALE_i ← 0.0
 GSALM_i ← 0.0
 GSALL_i ← 0.0
 GSASE_i ← 0.0
 GSASM_i ← 0.0
 GSASL_i ← 0.0
 FTSCE ← 0.0
 FTSCM ← 0.0
 FTSCL ← 0.0
 FTSNE ← 0.0
 FTSNM ← 0.0
 FTSNL ← 0.0
 DDDE ← 0.0
 DDDM ← 0.0
 DDDL ← 0.0

NLINE

i ← 1, NLINE

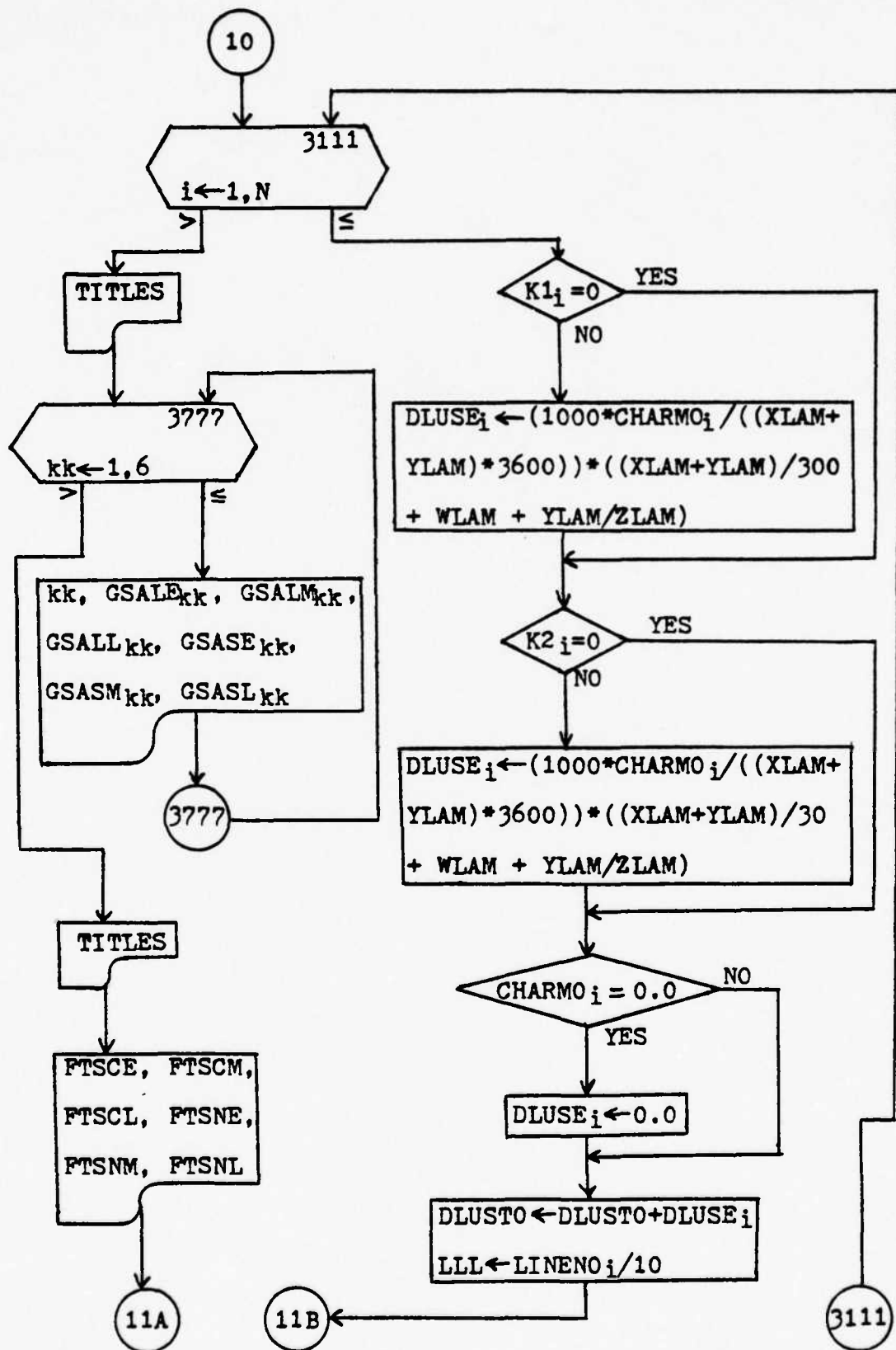
3000

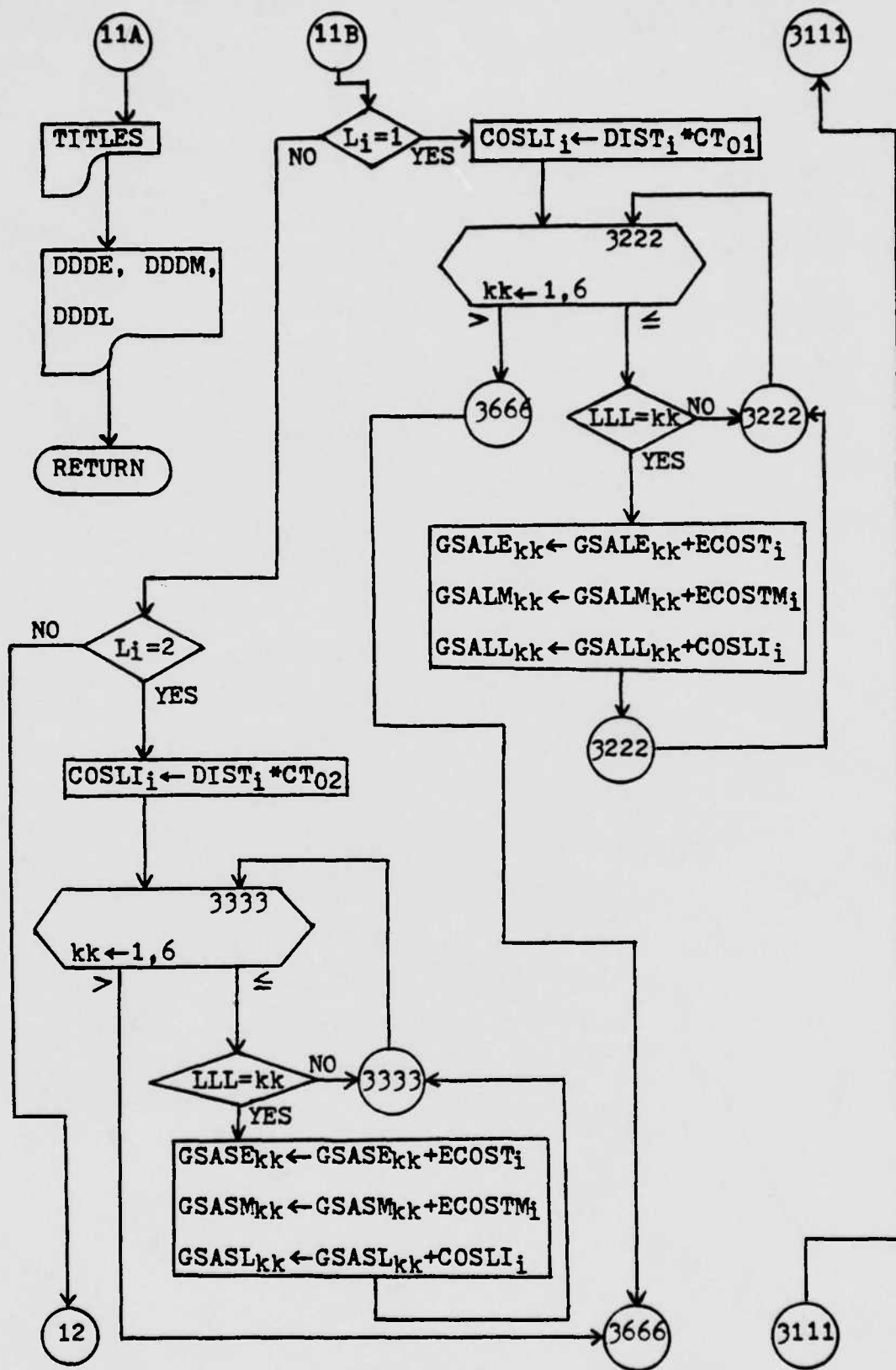
>

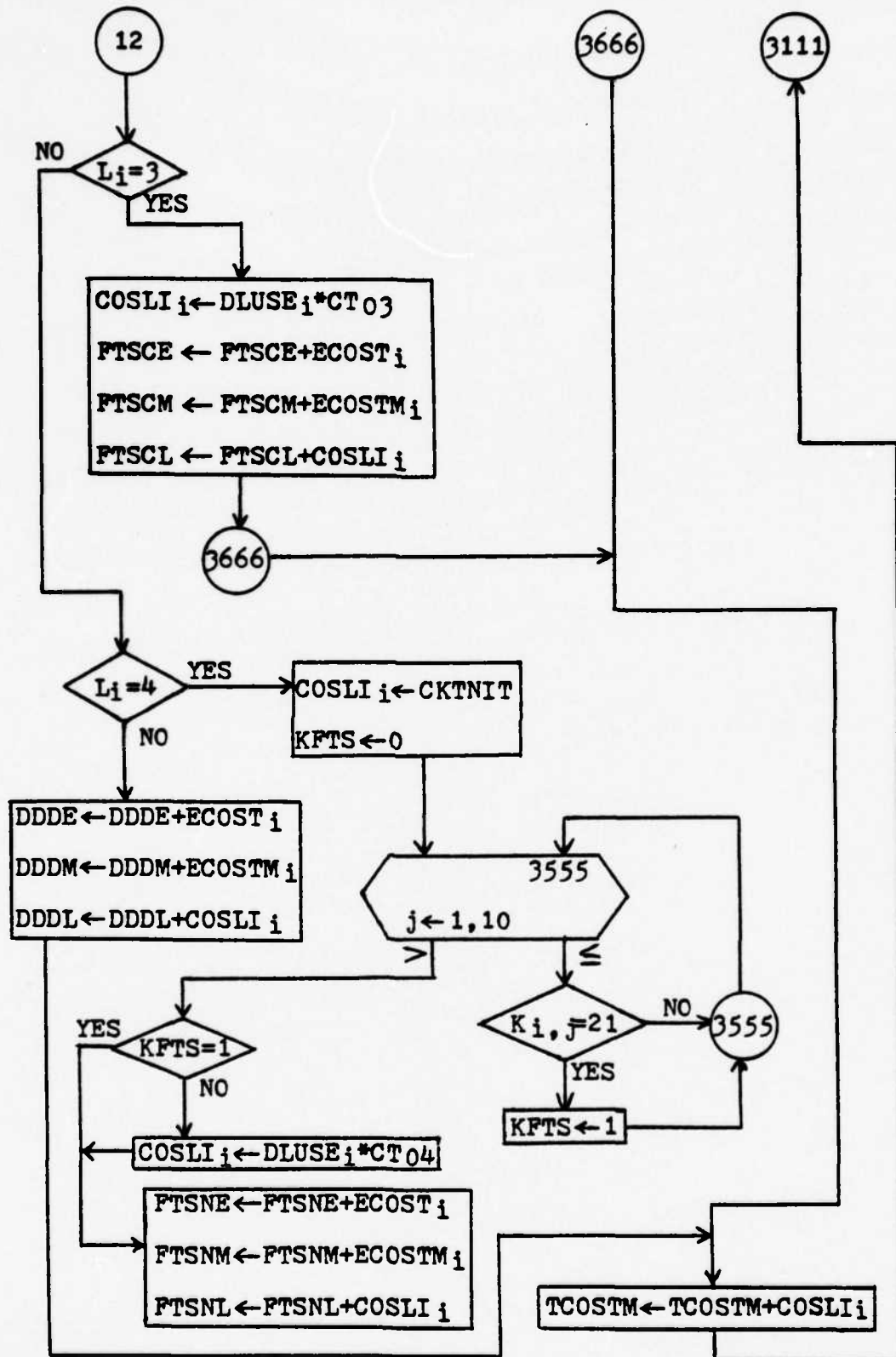
≤

CT_i

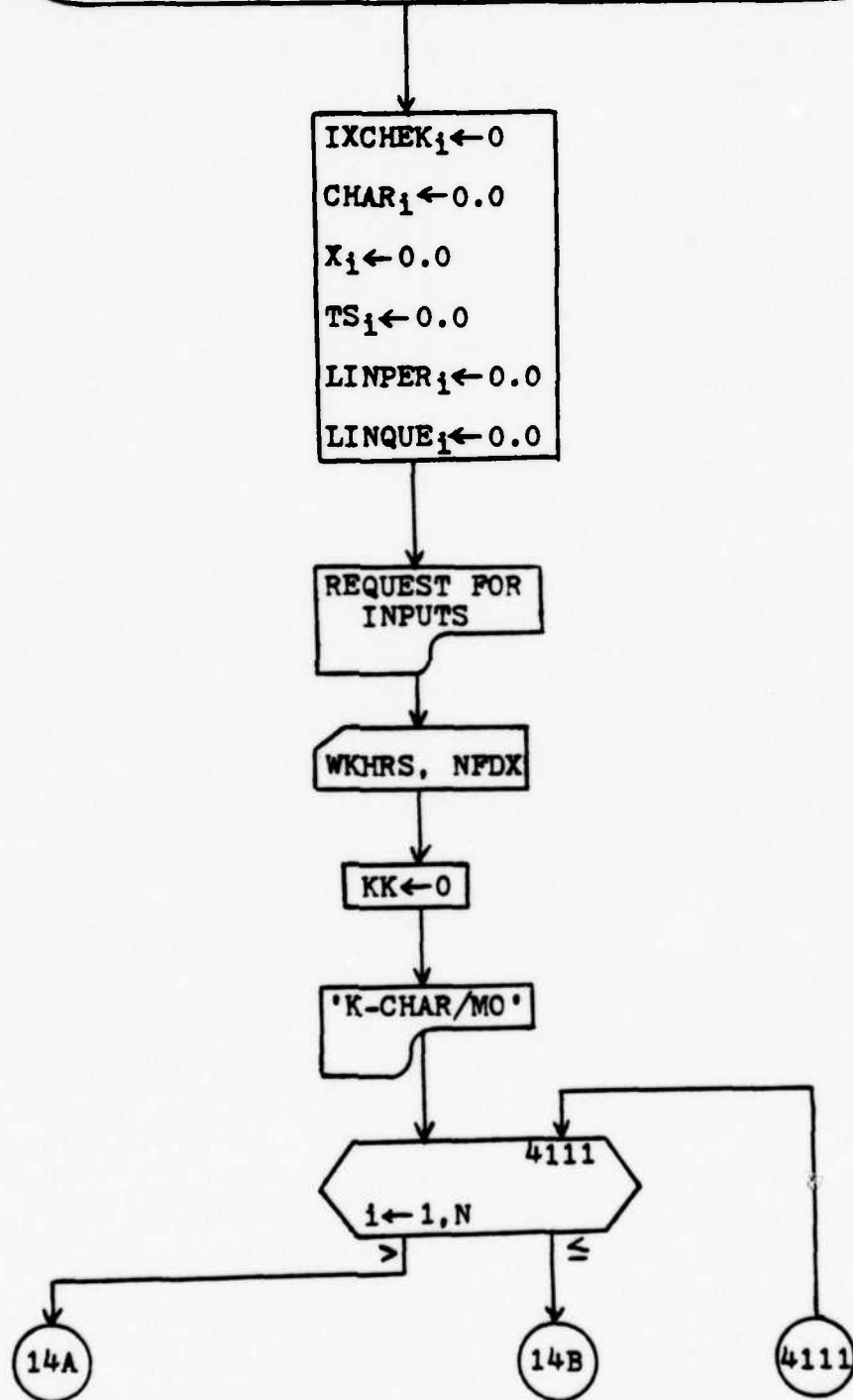
10

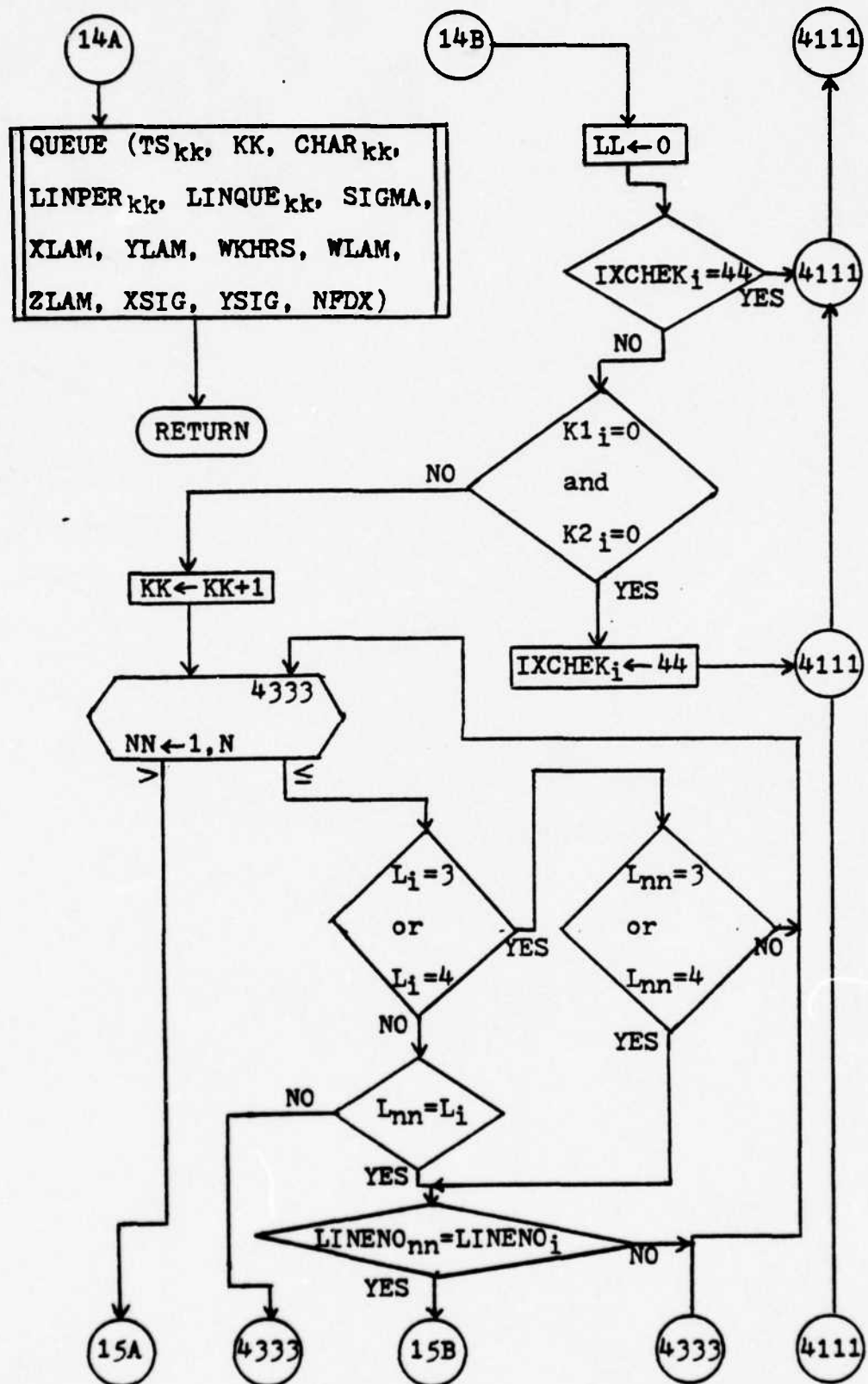


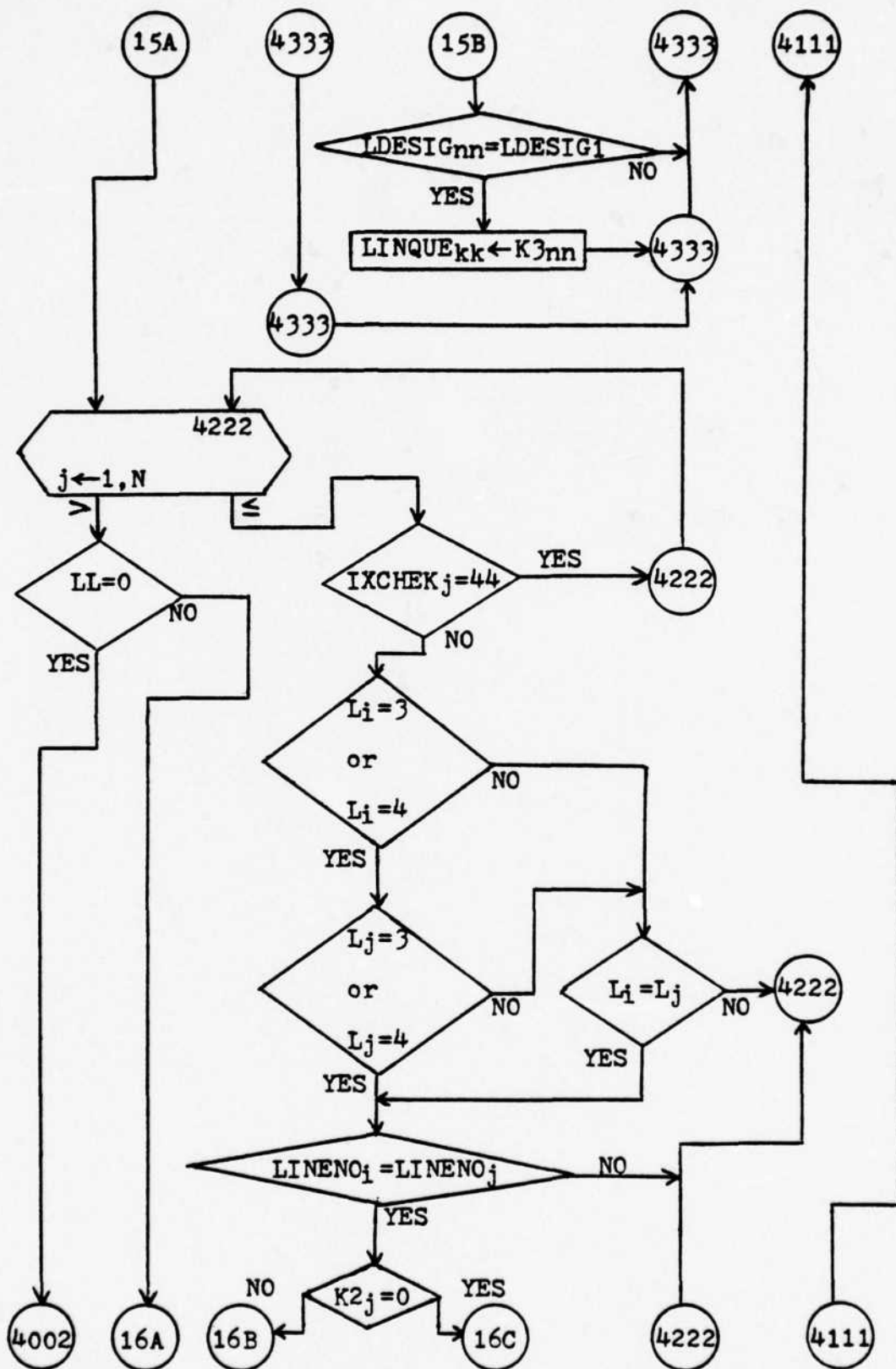


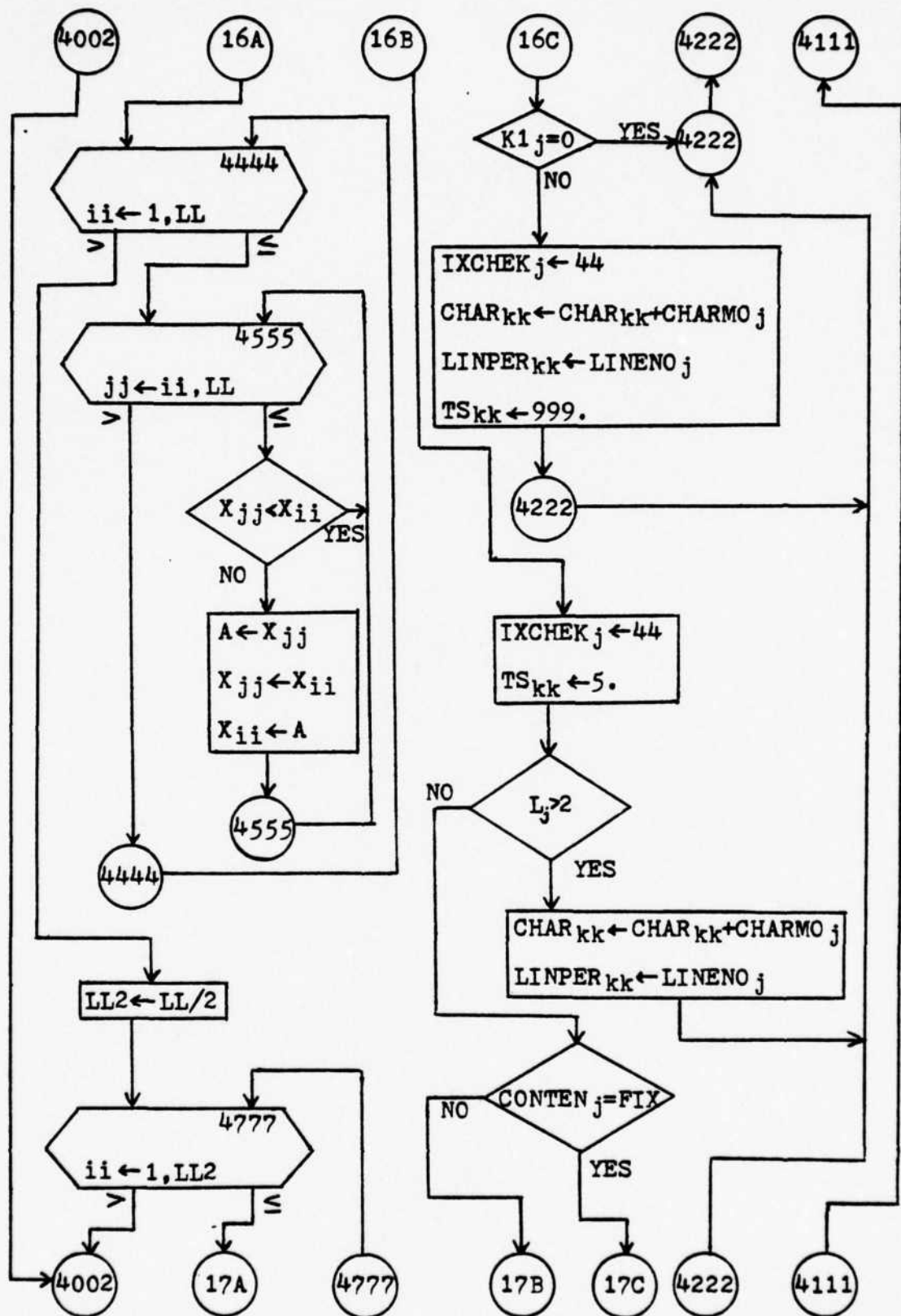


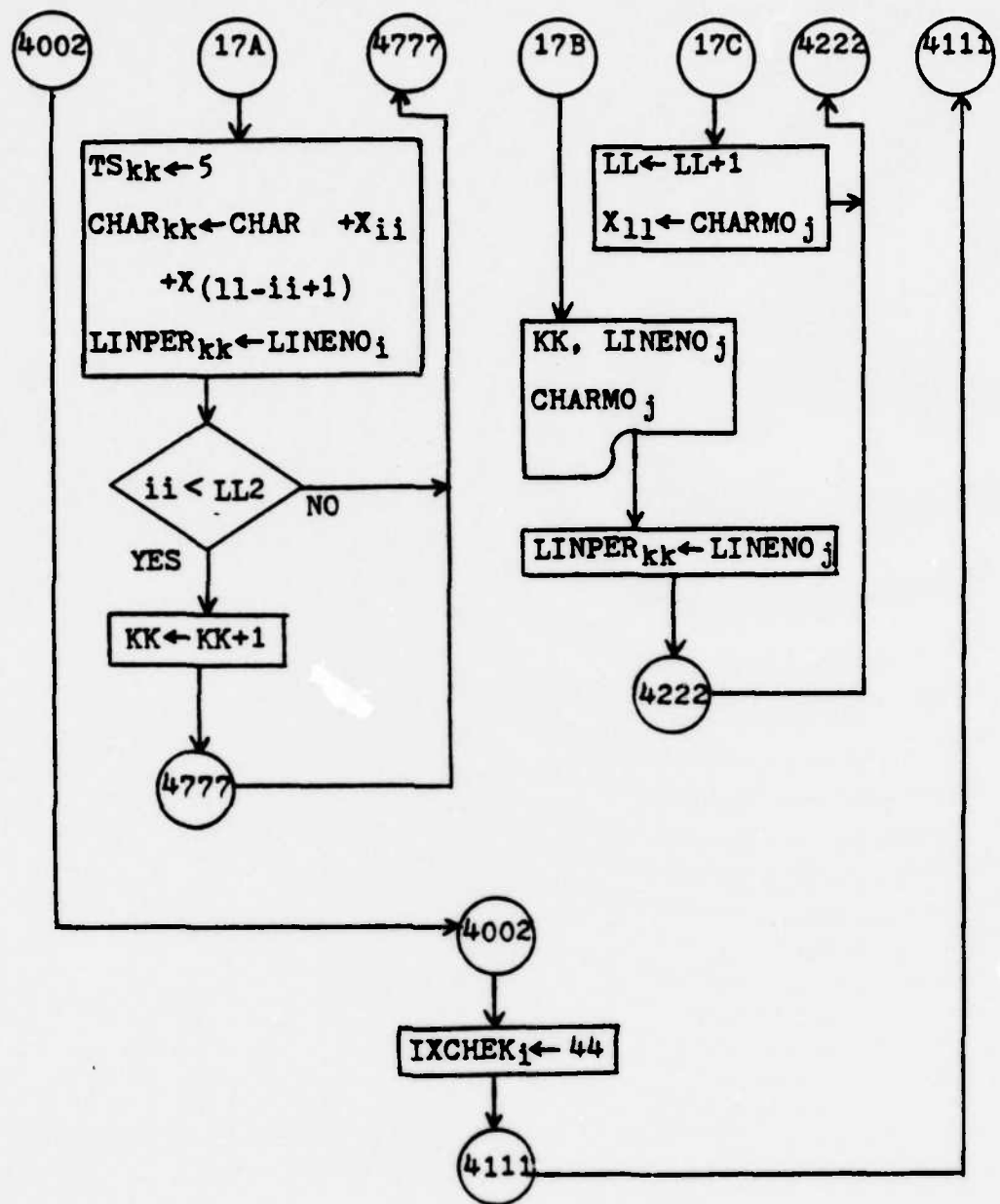
PERFOR (L_1 , $LINENO_1$, $CHARMO_1$, N , $K1_1$, $K2_1$,
 $CONTEN_1$, FIX , $K3_1$, $LDESIG_1$, $XLAM$, $YLAM$,
 $ZLAM$, $WLAM$, $XSIG$, $YSIG$)

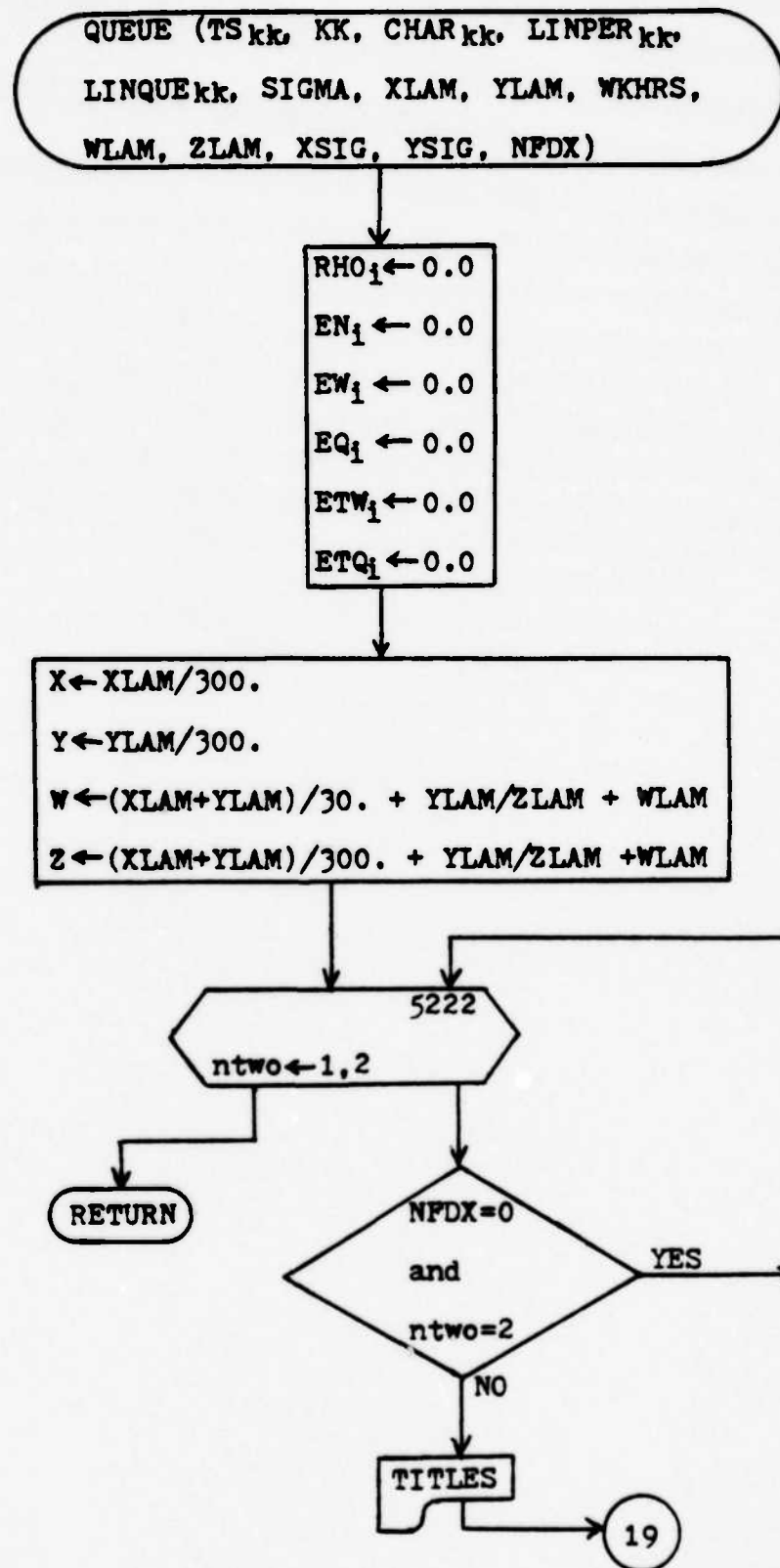




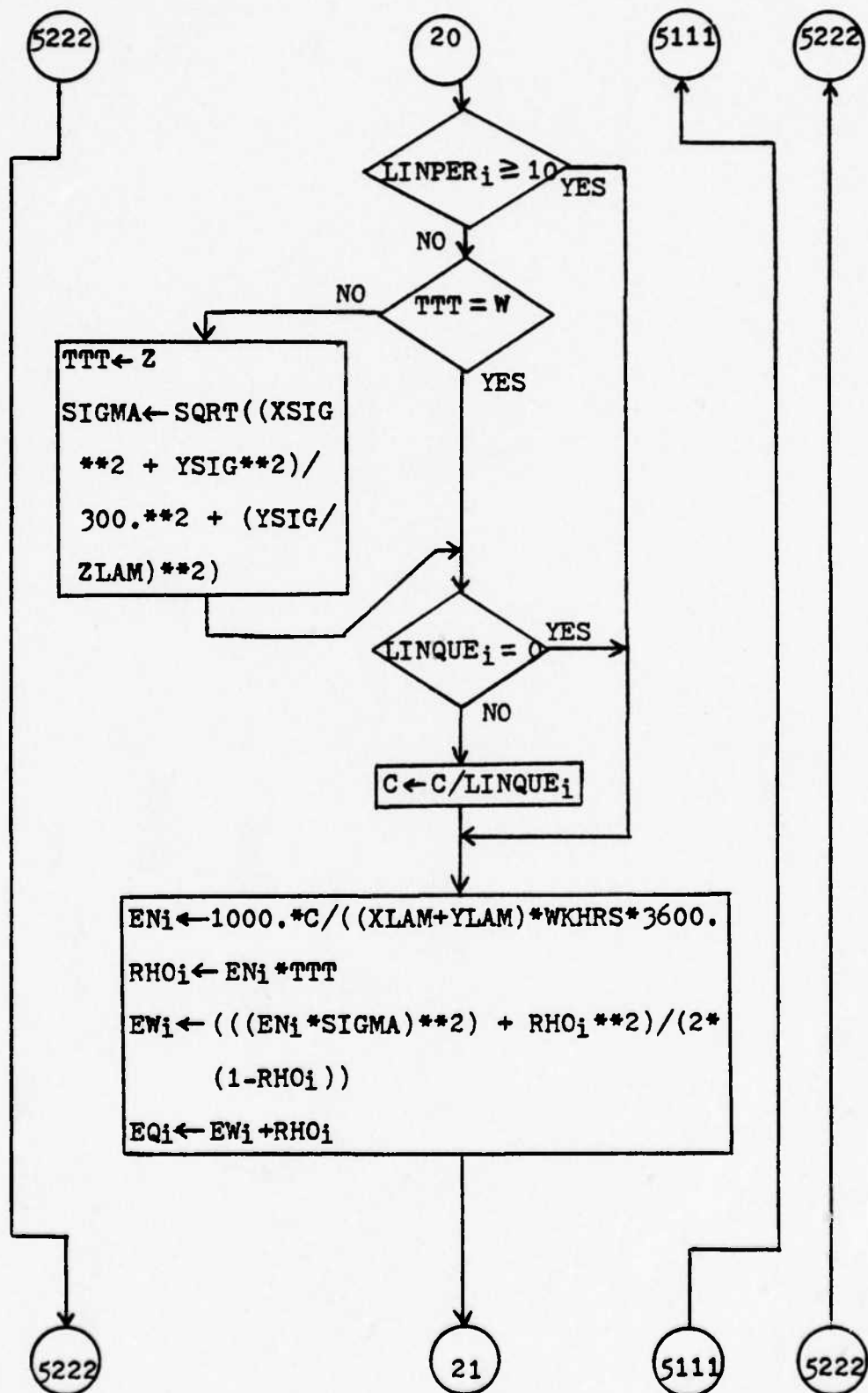


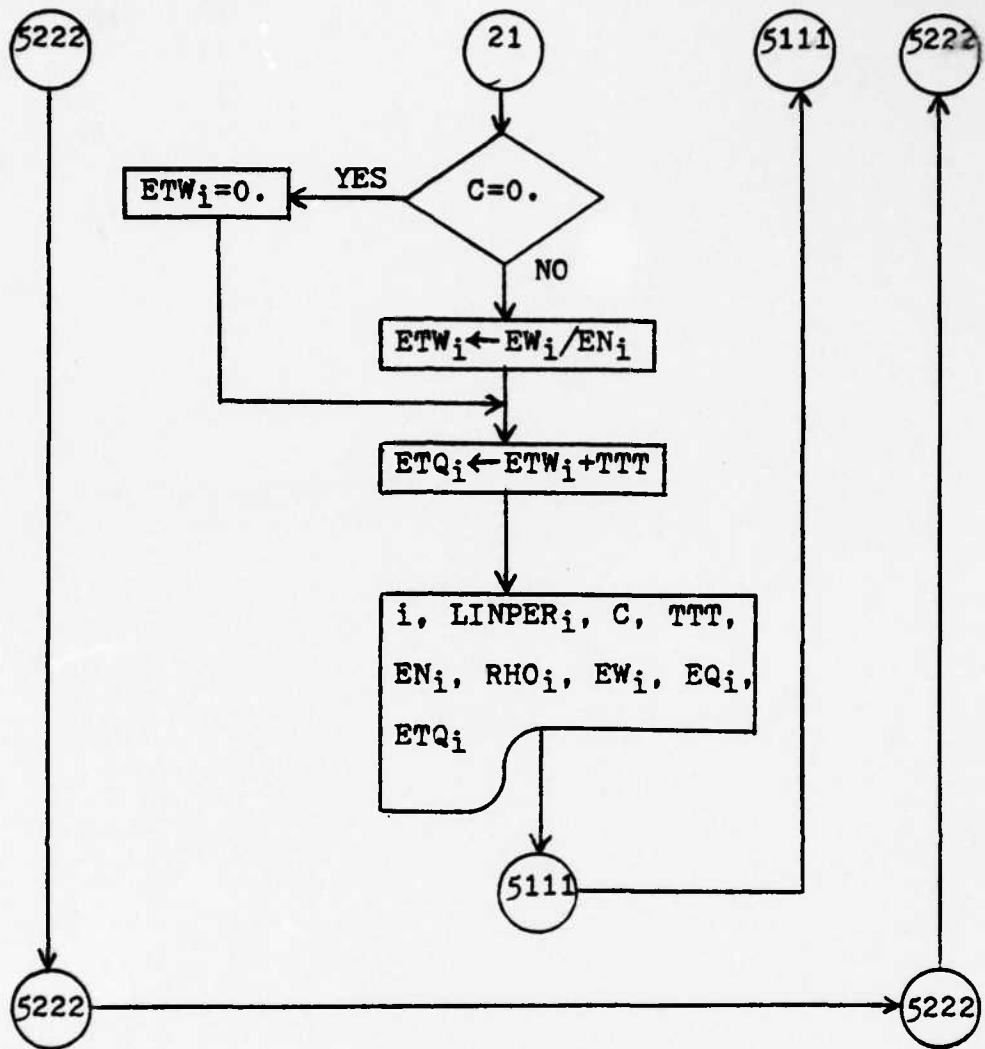












VIII COST AND PERFORMANCE PROGRAM LISTING

INPUT THE NUMBER OF DATA CARDS TO BE READ, THE CHARACTER TO INDICATE TERMINALS IN CONTENTION, AND THE SYSTEM NAME.

READ IN THE DATA FOR EACH NODE IN THE NETWORK. FOR THOSE LOCATIONS WITH MORE THAN ONE OFFICE OR HAVING SEVERAL TYPES OF LINES, SEPARATE DATA CARDS ARE REQUIRED FOR EACH. DATA TO BE READ IN INCLUDES THE NODE DESIGNATION, PREVIOUS NODE IN THE NETWORK, LINE TYPE, LINE NUMBER, SPECIAL DESIGNATIONS FOR LOCATIONS WITH MORE THAN ONE OFFICE, CONTENTION CHARACTER IF REQUIRED, DISTANCE BETWEEN THIS NODE AND LAST NODE, CHARACTERS PER MONTH SENT OR RECEIVED AT THE TERMINAL, "VV" AND "H" COORDINATES IF DISTANCES WERE NOT USED, AND THE EQUIPMENT AT THE NODE AS A STRING OF TWO CHARACTER NUMERIC CODES.

INPUT THE MEAN NUMBER OF CHARACTERS PER FRAME, ITS STANDARD DEVIATION, THE MEAN NUMBER OF CHARACTERS TYPED IN, ITS STANDARD DEVIATION, THE MEAN TYPING SPEED, AND THE MEAN COMPUTER TURNAROUND TIMES.

MSI00010
MSI00020
MSI00030
MSI00040
MSI00050
MSI00060
MSI00070
MSI00080
MSI00090
MSI00100
MSI00110
MSI00120
MSI00130
MSI00140
MSI00150
MSI00160
MSI00170
MSI00180
MSI00190
MSI00200
MSI00210
MSI00220
MSI00230
MSI00240
MSI00250
MSI00260
MSI00270
MSI00280
MSI00290
MSI00300
MSI00310
MSI00320
MSI00330
MSI00340
MSI00350
MSI00360
MSI00370
MSI00380
MSI00390
MSI00400
MSI00410
MSI00420
MSI00430
MSI00440

VIII COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

1002 WRITE (6,110)
110  FORMAT (1) INPUT THE MEAN CHARACTERS PER FRAME')
    READ (5,111) XLAM
    IF (XLAM.LT.0.0) GO TO 1001
111  FORMAT (F10.0)
    WRITE (6,112)
112  FORMAT (1) INPUT THE STANDARD DEVIATION')
    READ (5,111) XSIG
    WRITE (6,113)
113  FORMAT (1) INPUT MEAN CHARACTERS TYPED-IN PER TRANSACTION')
    READ (5,111) YLAM
    WRITE (6,114)
114  FORMAT (1) INPUT THE STANDARD DEVIATION')
    READ (5,111) YSIG
115  WRITE (6,115)
    FORMAT (1) INPUT THE MEAN TYPING SPEED IN CHAR PER SECOND')
    READ (5,111) ZLAM
    WRITE (6,116)
116  FORMAT (1) INPUT THE MEAN ACCESS TIME PER TRANSACTION')
    READ (5,111) WLAM
    CALL LINE (N,TCOSTM,COSLI,CHARMO,DLUSE,ECOSTM,DIST,DLUSTC,
    1K1,K2,L,K,ECOST,LINENO,XLAM,YLAM,ZLAM,WLAM,CKINIT)

C      OUTPUT THE LEASED LINE TOTAL DISTANCES (DEDICATED AND
C      SHARED), THE TOTAL ONE-TIME AND MONTHLY RECURRING COSTS,
C      AND THE TOTAL CONNECT HOURS.
C
104  WRITE (7,104) DTOT,DTOT2,TCOST,TCOSTM,DLUSTC
    FORMAT (1) DTOT =,F10.2//, DTOT2 =,F10.2//,F10.2//,F10.2//
    1,TCOST =,F10.2//,TCOSTM =,F10.2//,DLUSTC =,F10.2//

C      OUTPUT THE NODE DESIGNATION, THE PREVIOUS NCDES DESIGNATION,
C      ANY SPECIAL DESIGNATION, THE LINE TYPE AND NUMBER, DISTANCE,
C      THE CONNECT HOURS PER MONTH, THE MONTHLY EQUIPMENT COSTS,
C      THE ONE-TIME EQUIPMENT COSTS, AND THE LINE COSTS FOR EACH
C      LOCATION.
C
107  WRITE (7,107)
    FORMAT (1) NODE',4X,DESIG',1X,LINE',5X,MILAGE',4X,CONNECT',
    19X,EQUIPMENT COST',6X,LINE COST',16X,NO.',16X,HOURS',
    16X,RECURRING',3X,ONE-TIME',/
    DO 1444 I=1,N
    IF (DIST(I).LT.0.0) GO TO 1100
    WRITE (7,103) NO(I),NDA(I),LDESIG(I),L(I),LINENO(I),DIST(I),
    DLUSE(I),ECOSTM(I),ECOST(I),COSLI(I)
    1 GO TO 1444

```

MSI00450
MSI00460
MSI00470
MSI00480
MSI00490
MSI00500
MSI00510
MSI00520
MSI00530
MSI00540
MSI00550
MSI00560
MSI00570
MSI00580
MSI00590
MSI00600
MSI00610
MSI00620
MSI00630
MSI00640
MSI00650
MSI00660
MSI00670
MSI00680
MSI00690
MSI00700
MSI00710
MSI00720
MSI00730
MSI00740
MSI00750
MSI00760
MSI00770
MSI00780
MSI00790
MSI00800
MSI00810
MSI00820
MSI00830
MSI00840
MSI00850
MSI00860
MSI00870
MSI00880
MSI00890
MSI00900

VIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

1100 IF (DIST(I).EQ.-10.0) WRITE (7,108) NO(I),NOA(I),LDESIG(I),
1 L(I),LINENO(I),DLUSE(I),ECOST(I),COSLI(I)
1 IF (DIST(I).EQ.-20.0) WRITE (7,109) NO(I),NOA(I),LDESIG(I),
1 L(I),LINENO(I),DLUSE(I),ECOST(I),COSLI(I)
1+44 CONTINUE
CALL PERFOR (L,LINENO,CHARMO,N,K1,K2,CONTEN,FIX,K3,LDESIG,
1XLAM,YLAM,ZLAM,WLAM,XSIG,YSIG)
1001 STOP
END

```

MSI000910
MSI000920
MSI000930
MSI000940
MSI000950
MSI000960
MSI000970
MSI000980
MSI000990

```

SUBROUTINE MILE (NO,NOA,V,H,L,DIST,DTOT,DTCT2,N)
DIMENSION NO(100),NOA(100),L(100),V(100),H(100),DIST(100)

```

MIL000010
MIL000020
MIL000030
MIL000040
MIL000050
MIL000060
MIL000070
MIL000080
MIL000090
MIL000100
MIL000110
MIL000120
MIL000130
MIL000140
MIL000150
MIL000160
MIL000170
MIL000180
MIL000190
MIL000200
MIL000210
MIL000220
MIL000230
MIL000240
MIL000250
MIL000260
MIL000270
MIL000280
MIL000290
MIL000300
MIL000310
MIL000320
MIL000330
MIL000340
MIL000350

```

C CALCULATE DISTANCES BETWEEN TERMINAL LOCATIONS USING
C TELEPHONE COMPANY "V" AND "H" COORDINATES OR BY READING
C IN DISTANCES. FTS CONUS LINES AND FTS NON-CONUS LINES ARE
C ASSIGNED SPECIAL VALUES FOR EASE OF IDENTIFICATION.

```

```

DTOT=0.0
DTOT2=0.0
DO 1222 I=1,N
IF (L(I).EQ.3) GO TO 1000
IF (L(I).EQ.4) GO TO 1001
IF (DIST(I).NE.0.0) GO TO 1002
IF (V(I).EQ.0.0.AND.H(I).EQ.0.0) GO TO 1222
DO 1333 J=1,N
IF (V(J).EQ.0.0.AND.H(J).EQ.0.0) GO TO 1333
IF (NO(J).NE.NOA(I)) GO TO 1333
X=(V(I)-V(J))*(V(I)-V(J))+(H(I)-H(J))*(H(I)-H(J))
DIST(I)=SQRT(X/10.0)
CONTINUE
IF (L(I).EQ.2) GO TO 1999

```

```

1333
C DETERMINE TOTAL DISTANCE OF LEASED LINES.
C
C

```

```

1002 DTOT=DTOT+DIST(I)
GO TO 1222
1999 DTOT2=DTOT2+DIST(I)
GO TO 1222
1000 DIST(I)=-10.0
GO TO 1222
1001 DIST(I)=-20.
CCCONTINUE
RETURN
END

```

MSI000910
MSI000920
MSI000930
MSI000940
MSI000950
MSI000960
MSI000970
MSI000980
MSI000990

VIIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

SUBROUTINE TSITE (K,K1,K2,NEQUIP,ECOST,ECOSTM,N,TCOST,TCOSTM,
INDEVIC,K3,CKTINT)
DIMENSION K(100),K1(100),K2(100),NEQUIP(25),ECOST(100),
1ECOSTM(100),ECST(25),ECSTM(25),K3(100)
DATA ECST/25*0./,ECSTM/25*0./

```

```

C
C DETERMINE THE NUMBER OF DATA ACCESS ARRANGEMENTS AT EACH
C LOCATION.

```

```

DO 222 II=1,N
DO 233 JJ=1,10
IF (K(II,JJ).EQ.7) K3(II)=K3(II)+1
CONTINUE
CONTINUE
TCOST=0.0
TCOSTM=0.0

```

233
222

```

C
C READ THE NUMBER OF TYPES OF EQUIPMENT TO BE USED IN THE SYSTEM.

```

```

READ (1,113) NDEVIC
WRITE (6,115)
FORMAT (' INPUT 010 FOR LEASED EQUIP')

```

115

```

C
C SELECT THE TYPE OF EQUIPMENT TO BE USED IN THE SYSTEM,
C LEASED OR PURCHASED.

```

```

READ (5,113) M
FCRMT {13}
IF (M.EQ.10) GO TO 2555
WRITE (7,121)
FCRMT (' PURCHASED EQUIPMENT')

```

121

```

C
C READ IN THE ONE-TIME AND RECURRING COSTS FOR EACH PIECE
C OF EQUIPMENT.

```

```

THE ORDERING OF EQUIPMENT IS OPTIONAL, EXCEPT THAT 01 IS
FOR CRT'S, 02 FOR TELEPRINTERS, 03 FOR TELEPK INTERS WITH
COUPLERS, 07 IS DATA ACCESS ARRANGEMENTS AND 21 IS FTS NIGHT
CIRCUIT. A CHANGE IN THE ORDER WILL REQUIRE A CHANGE
IN THE OUTPUT FORMAT.

```

```

DO 2111 I=1,NDEVIC
READ (1,114) ECST(I),ECSTM(I)
FORMAT (2F10.0)
CCCONTINUE
GO TO 2666

```

114
2111

TSI000010
TSI000020
TSI000030
TSI000040
TSI000041
TSI000050
TSI000060
TSI000070
TSI000080
TSI000090
TSI000100
TSI000110
TSI000120
TSI000130
TSI000140
TSI000150
TSI000160
TSI000170
TSI000180
TSI000190
TSI000200
TSI000210
TSI000220
TSI000230
TSI000240
TSI000250
TSI000260
TSI000270
TSI000280
TSI000290
TSI000300
TSI000310
TSI000320
TSI000330
TSI000340
TSI000350
TSI000360
TSI000370
TSI000380
TSI000390
TSI000400
TSI000410
TSI000420
TSI000430
TSI000440
TSI000450

CONTINUED

LIN00010
LIN00020
LIN00030

VIIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

LDIST(100),K1(100),K2(100),L(100),K(100,10),ECOST(100),GSALE(6),
1GSALM(6),GSALL(6),GSALE(6),GSASM(6),GSASL(6),LINENO(100)
DATA GSALE/6*0.0/,GSALM/6*0.0/,GSALL/6*0.0/,GSALE/6*0.0/,
1GSASM/6*0.0/,GSASL/6*0.0/
DLUSTO=0.
FTSCE=0.0
FTSCM=0.0
FTSCL=0.0
FTSNE=0.0
FTSNM=0.0
FTSNL=0.0
DDDE=0.0
DDDM=0.0
DDDL=0.0
READ IN THE NUMBER OF LINE TYPES .
READ (2,116) NLINE
READ IN THE COST ASSOCIATED WITH EACH OF THE LINE TYPES.
DO 3000 I=1,NLINE
  READ (2,117) CT(I)
  CONTINUE
3000
  DETERMINE THE NUMBER OF CONNECT HOURS FOR EACH TERMINAL SITE.
  DO 3111 I=1,N
    DETERMINE THE CONNECT HOURS FOR THOSE LOCATIONS
    IF (K1(I).NE.0) DLUSE(I)=(1000.*CHARMO(I))/(XLAM+YLAM))*
      1 ((XLAM + YLAM)/300. + YLAM/ZLAM + WLAM)/(60.*60.)
    IF (K2(I).NE.0) DLUSE(I)=(1000.*CHARMO(I))/(XLAM+YLAM))*
      1 ((XLAM + YLAM)/30. + YLAM/ZLAM + WLAM)/(60.*60.)
    IF (CHARMO(I).EQ.0) DLUSE(I)=0.
  DETERMINE THE TOTAL MONTHLY CONNECT HOURS OF THE NETWORK.
  DLUSTO=DLUSTO+DLUSE(I)
  USE THE TWO DIGIT LINE NUMBER TO DETERMINE WHAT THE MAJOR LINE
  IS.
  LLL=LINEAD(I)/10
  IF (L(I).NE.01) GO TO 3001
  DETERMINE THE COST OF THE GSA-LEASED/DEDICATED LINES.

```

LIN00040
 LIN00050
 LIN00060
 LIN00070
 LIN00080
 LIN00090
 LIN00100
 LIN00110
 LIN00120
 LIN00130
 LIN00140
 LIN00150
 LIN00160
 LIN00170
 LIN00180
 LIN00190
 LIN00200
 LIN00210
 LIN00220
 LIN00230
 LIN00240
 LIN00250
 LIN00260
 LIN00270
 LIN00280
 LIN00290
 LIN00300
 LIN00310
 LIN00320
 LIN00330
 LIN00340
 LIN00350
 LIN00360
 LIN00370
 LIN00380
 LIN00390
 LIN00400
 LIN00410
 LIN00420
 LIN00430
 LIN00440
 LIN00450
 LIN00460
 LIN00470
 LIN00480
 LIN00490

VIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

C      DETERMINE THE COST FOR EQUIPMENT (ONE-TIME AND RECURRING)
C      AND LINE COSTS FOR EACH GSA DEDICATED LINE.
C      COSLI(I)=DIST(I)*CT(01)
C      DO 3222 KK=1,6
C      IF (LLL.NE.KK) GO TO 3222
C      GSALE(KK)=GSALE(KK)+ECOST(I)
C      GSALM(KK)=GSALM(KK)+ECOSTM(I)
C      GSALL(KK)=GSALL(KK)+COSLI(I)
C      CONTINUE
3222   GO TO 3666
3001   IF (L(I).NE.02) GO TO 3002
C      DETERMINE THE COST OF THE GSA-LEASED/SHARED LINES.
C      DETERMINE THE COST FOR EQUIPMENT (ONE-TIME AND RECURRING)
C      AND LINE COSTS FOR EACH GSA SHARED LINE.
C      COSLI(I)=DIST(I)*CT(02)
C      DO 3333 KK=1,6
C      IF (LLL.NE.KK) GO TO 3333
C      GSALE(KK)=GSALE(KK)+ECOST(I)
C      GSALM(KK)=GSALM(KK)+ECOSTM(I)
C      GSASL(KK)=GSASL(KK)+COSLI(I)
C      CONTINUE
3333   GO TO 3666
3002   IF (L(I).NE.03) GO TO 3003
C      DETERMINE THE LINE COSTS FOR THE FTS-CONUS LINES.
C      DETERMINE THE EQUIPMENT COSTS AND LINE COSTS OF THE FTS NETWORK.
C      COSLI(I)=DLUSE(I)*CT(03)
C      FTSCE=FTSCE+ECOST(I)
C      FTSCM=FTSCM+ECOSTM(I)
C      FTSCL=FTSCL+COSLI(I)
C      GO TO 3666
3003   IF (L(I).NE.04) GO TO 3004
C      DETERMINE THE LINE COSTS (CONNECT TIME CHARGES) FOR THE FTS
C      NCN-CONUS NETWORK. DETERMINE THE EQUIPMENT COSTS ALSO.
C      COSLI(I)=CKTNIT
C      KFTS=0
C      DO 3555 J=1,10
C      IF (K(I,J).EQ.21) KFTS=1
C      CONTINUE
3555   IF (KFTS.NE.1) COSLI(I)=DLUSE(I)*CT(04)

```

LIN00500
LIN00510
LIN00520
LIN00530
LIN00540
LIN00550
LIN00560
LIN00570
LIN00580
LIN00590
LIN00600
LIN00610
LIN00620
LIN00630
LIN00640
LIN00650
LIN00660
LIN00670
LIN00680
LIN00690
LIN00700
LIN00710
LIN00720
LIN00730
LIN00740
LIN00750
LIN00760
LIN00770
LIN00780
LIN00790
LIN00800
LIN00810
LIN00820
LIN00830
LIN00840
LIN00850
LIN00860
LIN00870
LIN00880
LIN00890
LIN00900
LIN00910
LIN00920
LIN00930
LIN00940
LIN00950

CONT INUED

LI N00960
LI N00970
LI N00980
LI N00990
LI N01000
LI N01010
LI N01020
LI N01030
LI N01040
LI N01050
LI N01060
LI N01070
LI N01080
LI N01090
LI N01100
LI N01110
LI N01120
LI N01130
LI N01140
LI N01150
LI N01160
LI N01170
LI N01180
LI N01190
LI N01200
LI N01210
LI N01220
LI N01230
LI N01240
LI N01250
LI N01260
LI N01270
LI N01280
LI N01290
LI N01300
LI N01310
LI N01320
LI N01330
LI N01340
LI N01350
LI N01360
LI N01370
LI N01380
LI N01390

VIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

SUBROUTINE PERFOR (L,LINENO,CHARMG,N,K1,K2,CONTEN,FIX,K3,LDESIG,
1XLAM,YLAM,ZLAM,WLAM,XSIG,YSIG)
DIMENSION L(100),LINENO(100),CHARMO(100),CHAR(30),IXCHEK(100),
IK1(100),K2(100),CONTEN(100),X(10),TS(30),LINPER(30),K3(100),
ILINQUE(30),LDESIG(100)
DATA IXCHEK/100*0/,CHAR/30*0./,X/10*0./,TS/30*0./,LINPER/30*0/,
ILINQUE/30*0/
C
C      READ IN THE NUMBER OF WORKING HOURS PER MONTH.
C
104      WRITE (6,104)
105      FORMAT (1, INPUT THE NUMBER OF WORKING HOURS PER MONTH*)
C      FCFORMAT (F10.0)
C
C      SELECT FULL OR HALF DUPLEX LINES.
C
106      WRITE (6,106)
107      FORMAT (1, INPUT 0 FOR HALF DUPLEX LINES*)
C      READ (5,107) NFOX
C      FCFORMAT (11)
C
C      INITIALIZE THE NUMBER OF INDEPENDENT SUB-NETWORKS.
C
      KK=0
      WRITE (7,102)
      DO 4111 I=1,N
      LL=0
C
C      IF THE FLAG (IXCHEK) IS 44, THE NODE HAS ALREADY BEEN
C      CONSIDERED.
C
      IF (IXCHEK(I).EQ.44) GO TO 4111
C
      IF THERE ARE NO TERMINALS AT THIS LOCATION, ASSIGN THE
      FLAG A VALUE OF 44 AND CONTINUE.
C
      IF (K1(I).EQ.0.AND.K2(I).EQ.0) GO TO 4002
C
      THERE ARE TERMINALS AND THEY HAVE NOT BEEN PREVIOUSLY INCLUDED.
      INCREMENT THE SUB-NETWORK NUMBER AND CONTINUE.
C
      KK=KK+1
      DO 4333 NN=1,N
C
C      CCMPARE LINE TYPES, NUMBERS, AND DESIGNATIONS TO INSURE
C
PER00010
PER00020
PERJ0030
PER00040
PER00050
PER00060
PER00070
PER00080
PER00090
PER00100
PER00110
PER00120
PER00130
PER00140
PER00150
PER00160
PER00170
PER00180
PER00190
PER00200
PER00210
PER00220
PER00230
PER00240
PER00250
PER00260
PER00270
PER00280
PER00290
PER00300
PER00310
PER00320
PER00330
PER00340
PER00350
PER00360
PER00370
PER00380
PER00390
PER00400
PER00410
PER00420
PER00430
PER00440
PER00450
PER00460

```

		VIIS COST AND PERFORMANCE PROGRAM LISTING	CONTINUED
C		PRCPR CORRESPONDENCE. LINE TYPE 3 AND 4 ARE CONSIDERED	PER00470
C		EQUIVALENT FOR PERFORMANCE CALCULATIONS.	PER00480
C			PER00490
	4010	IF (L(I)).EQ.3.OR.L(I).EQ.4) GO TO 4010	PER00500
		GO TO 4333	PER00510
	4011	IF (L(NN)).EQ.3.OR.L(NN).EQ.4) GO TO 4011	PER00520
		GO TO 4333	PER00530
		IF (LINENO(NN)).NE.LINENO(I)) GO TO 4333	PER00540
		IF (LDESIG(NN)).NE.LDESIG(I)) GO TO 4333	PER00550
C		TRANSFER THE VALUE FOR THE NUMBER OF DATA ACCESS ARRANGEMENTS	PER00560
C		AT WASHINGTON FOR THIS LINE NUMBER.	PER00570
C			PER00580
	4333	LINQUE(KK)=K3(NN)	PER00590
		CONTINUE	PER00600
C		CCMPARE LINE TYPES AND NUMBERS FOR PROPER CORRESPONDENCE.	PER00610
C		LINE TYPES 3 AND 4 ARE EQUIVALENT.	PER00620
C			PER00630
C			PER00640
	4007	DO 4222 J=1,N	PER00650
	4004	IF (IXCHEK(J)).EQ.44) GO TO 4222	PER00660
	4008	IF (L(I)).EQ.3.OR.L(I).EQ.4) GO TO 4007	PER00670
		GO TO 4004	PER00680
		IF (L(J)).EQ.3.OR.L(J).EQ.4) GO TO 4008	PER00690
		IF (L(I)).NE.L(J)) GO TO 4222	PER00700
		IF (LINENO(I)).NE.LINENO(J)) GO TO 4222	PER00710
C		CHECK FOR CRT OR TELEPRINTER TERMINALS.	PER00720
C			PER00730
C		IF (K2(J)).NE.0) GO TO 4001	PER00740
C		IF (K1(J)).EQ.0) GO TO 4222	PER00750
C		ASSIGN THE FLAG VALUE, SUM THE CHARACTERS ON THIS SUB-NETWORK,	PER00760
C		TRANSFER THE LINE NUMBER VALUE, AND ASSIGN A VALUE FOR TS	PER00770
C		REPRESENTING HIGH SPEED CRT TERMINALS.	PER00780
C			PER00790
C		IXCHEK(J)=44	PER00800
C		CHAR(KK)=CHAR(KK)+CHARMO(J)	PER00810
C		LINPER(KK)=LINENO(J)	PER00820
C		TS(KK)=999.	PER00830
		GO TO 4222	PER00840
			PER00850
			PER00860
			PER00870
			PER00880
C		ASSIGN THE FLAG VALUE, ASSIGN A VALUE TO TS REPRESENTING SLOW	PER00890
C		SPEED TELEPRINTER TERMINALS, CHECK TO SEE IF THE LINE TYPE	PER00900
C		IS FTS OR DDD, AND CHECK FOR CONTENTION.	PER00910
			PER00920

VIIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

C 40C1      IXCHEK(J)=44
            TS(KK)=5.
            IF (L(J).GT.2) GO TO 4006
            IF (CONTEN(J).NE.FIX) GO TO 4005

C          INCREMENT THE CONTENTION VARIABLE AND ASSIGN X THE VALUE FOR
C          CHARACTERS PER MONTH IN CONTENTION.
            LL=LL+1
            X(LL)=CHARMO(J)
            GO TO 4222

C          FOR FTS AND DDD LINES, SUM THE CHARACTERS IN THE SUB-NETWORK.
C 40C6      CHAR(KK)=CHAR(KK)+CHARMO(J)
            LINPER(KK)=LINENO(J)
            GO TO 4222

C          FOR THOSE TERMINALS WHICH ARE FREQUENCY DIVISION MULTIPLEXED AND
C          NCT IN CONTENTION, OUTPUT THE NUMBER OF CHARACTERS ON THE
C          CHANNEL.
C 4005      WRITE (7,101) KK,LINENO(J),CHARMO(J)
            LINPER(KK)=LINENO(J)
            CONTINUE
            IF (LL.EQ.0) GO TO 4002

C          FOR THOSE TERMINALS IN CONTENTION ON THE LINE, ARRANGE THEM
C          IN DESCENDING ORDER BY NUMBER OF CHARACTERS.
            DO 4444 II=1,LL
            DO 4555 JJ=II,LL
            IF (X(JJ).LT.X(II)) GO TO 4555
            A=X(JJ)
            X(JJ)=X(II)
            X(II)=A
            CONTINUE
            LL2=LL/2

C          PAIR THE CONTENTION TERMINALS SUCH THAT THE ONE WITH THE LARGEST
C          NUMBER OF CHARACTERS IS MATED WITH THE TERMINAL WITH THE LOWEST
C          NUMBER, ETC.
            DO 4777 II=1,LL2
            TS(KK)=5.
C 40C3

```

PER00930
 PER00940
 PER00950
 PER00960
 PER00970
 PER00980
 PER00990
 PER01000
 PER01010
 PER01020
 PER01030
 PER01040
 PER01050
 PER01060
 PER01070
 PER01080
 PER01090
 PER01100
 PER01110
 PER01120
 PER01130
 PER01140
 PER01150
 PER01160
 PER01170
 PER01180
 PER01190
 PER01200
 PER01210
 PER01220
 PER01230
 PER01240
 PER01250
 PER01260
 PER01270
 PER01280
 PER01290
 PER01300
 PER01310
 PER01320
 PER01330
 PER01340
 PER01350
 PER01360
 PER01370
 PER01380

VIIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

PER01390
PER01400
PER01410
PER01420
PER01430
PER01440
PER01450
PER01460
PER01470
PER01480
PER01490
PER01500

```

4777 CHAR(KK)=CHAR(KK)+X(II)+X(LL-II+1)
4002 LINPER(KK)=LINENO(I)
4111 IF (II.LT.LL2) KK=KK+1
101 CONTINUE
      IXCHECK(I)=44
      CONTINUE
      FCRMAT (I2,I3,F10.2)
      CALL QUEUE (TS,KK,CHAR,LINPER,LINQUE,SIGMA,XLAM,YLAM,WKHSR,
102      IWLAM,ZLAM,XSIG,YSIG,NFDX)
      FCRMAT (//, K-CHAR/MO//)
      RETURN
      END

```

```

SUBROUTINE QUEUE (TS,KK,CHAR,LINPER,LINQUE,SIGMA,XLAM,YLAM,
1WKHSR,WLAM,ZLAM,XSIG,YSIG,NFDX)
DIMENSION TS(30),RHD(30),EN(30),EW(30),EQ(30),ETW(30),
1ETC(30),LINPER(30),LINQUE(30)
DATA RHD/30*0./,EN/30*0./,EW/30*0./,EQ/30*0./,ETW/30*0./,
1ETC/30*0./

```

QUE00010
QUE00020
QUE00030
QUE00040
QUE00050
QUE00060
QUE00070
QUE00080
QUE00090
QUE00100
QUE00110
QUE00120
QUE00130
QUE00140
QUE00150
QUE00160
QUE00170
QUE00180
QUE00190
QUE00200
QUE00210
QUE00220
QUE00230
QUE00240
QUE00250
QUE00260
QUE00270
QUE00280
QUE00290
QUE00300
QUE00310

```

C DETERMINE THE MEAN SERVICE TIME FOR THE FRAME.
C
C X=XLAM/300.
C
C DETERMINE THE MEAN SERVICE TIME FOR TYPED IN CHARACTERS.
C
C Y=YLAM/300.
C
C DETERMINE THE MEAN SERVICE TIME FOR TELEPRINTERS.
C
C W=(XLAM+YLAM)/30. + YLAM/ZLAM + WLAM
C
C DETERMINE THE MEAN SERVICE TIME FOR CRT'S IN THE ODD OR FTS
C NETWORK.
C
C Z=(XLAM+YLAM)/300. + YLAM/ZLAM + WLAM
C
C IF HALF DUPLEX LINES ARE UTILIZED, INFORMATION CAN ONLY PASS
C IN ONE DIRECTION ON THE LINE. THE CHARACTERS TYPED IN ARE
C COMBINED WITH THE FRAMES FROM THE CPU TO DETERMINE LINE USE.
C THIS ALSO INCREASES TURNAROUND TIME AS THE LINE CHANGES FROM
C ONE DIRECTION TO ANOTHER. FOR FULL DUPLEX LINES, INFORMATION
C CAN BE TRAVELLING IN BOTH DIRECTIONS AT ONE TIME.

```

VIIIS COST AND PERFORMANCE PROGRAM LISTING

CONTINUED

```

DO 5222 NTWO=1,2
IF (NFDX.EQ.0.AND.NTWO.EQ.2) GO TO 5222
WRITE (6,999)
WRITE (7,102)
999 FORMAT (1X,LINE,1X,K-CHAR,3X,SERVICE,4X,ARRIVAL,
102 2X,UTILIZATION,2X,TRANS,4X,TRANS,IN,3X,TIME IN,
1 2X/2X,NO,1X,MONTH,4X,TIME,7X,RATE,16X,WAITING,
1 5X,SYSTEM,5X,SYSTEM/)
DO 5111 I=1,KK
C=CHAR(I)
IF (TS(I).EQ.5.) GO TO 5005
IF (NTWO.EQ.1) GO TO 5006
TTT=Y
SIGMA=YSIG/300.
GO TO 5007
5006 TTT=X
IF (NFDX.EQ.0) TTT=X+Y
SIGMA=XSIG/300.
IF (NFDX.EQ.0) SIGMA=(SQRT(XSIG**2.+YSIG**2.))/300.
GO TO 5007
5005 TTT=W
SIGMA=SQRT((XSIG**2.+YSIG**2.)/(30.))*2.+(YSIG/ZLAM)**2.)
IF (LINPER(I).GE.10) GO TO 5020
IF (TTT.EQ.W) GO TO 5021
TTT=Z
SIGMA=SQRT((XSIG**2.+YSIG**2.)/(300.))*2.+(YSIG/ZLAM)**2.)
IF (LINQUE(I).EQ.0) GO TO 5020
C=C/LINQUE(I)
C
C DETERMINE THE MEAN ARRIVAL RATE OF TRANSACTIONS ON THE LINE.
C
5020 EN(I)=1000.*C/((XLAM+YLAM)*WKHRS*3600.)
C
C DETERMINE THE LINE UTILIZATION.
C
C RHO(I)=EN(I)*TTT
C
C DETERMINE THE NUMBER OF TRANSACTIONS IN THE NETWORK WAITING
FOR SERVICE.
C
C EW(I)=(((EN(I)*SIGMA)**2.)+(RHO(I)**2.))/(2.*(1.-RHO(I)))
C
C DETERMINE THE TOTAL NUMBER OF TRANSACTIONS IN THE NETWORK,
BEING SERVED OR WAITING TO BE SERVED.
C

```

QUE00320
 QUE00330
 QUE00340
 QUE00350
 QUE00360
 QUE00370
 QUE00380
 QUE00390
 QUE00400
 QUE00410
 QUE00420
 QUE00430
 QUE00440
 QUE00450
 QUE00460
 QUE00470
 QUE00480
 QUE00490
 QUE00500
 QUE00510
 QUE00520
 QUE00530
 QUE00540
 QUE00550
 QUE00560
 QUE00570
 QUE00580
 QUE00590
 QUE00600
 QUE00610
 QUE00620
 QUE00630
 QUE00640
 QUE00650
 QUE00660
 QUE00670
 QUE00680
 QUE00690
 QUE00700
 QUE00710
 QUE00720
 QUE00730
 QUE00740
 QUE00750
 QUE00760
 QUE00770

VIIS COST AND PERFORMANCE PROGRAM LISTING		CONTINUED
C	EQ(I)=EW(I)+RHO(I)	QUE00760
C	DETERMINE THE MEAN WAITING TIME FOR SERVICE.	QUE00790
C	IF (C.EQ.0.) GO TO 5001	QUE00800
	ETW(I)=EW(I)/EN(I)	QUE00810
	GO TO 5002	QUE00820
	ETW(I)=0.	QUE00830
5001		QUE00840
C	DETERMINE THE TOTAL TIME IN THE SYSTEM, WAITING TO BE SERVED	QUE00850
C	AND BEING SERVED.	QUE00860
C		QUE00870
C		QUE00880
C		QUE00890
5002	ETQ(I)=ETW(I)+TTT	QUE00900
C	OUTPUT THE TOTAL CHARACTERS ON THE LINE, THE LINE NUMBER, THE	QUE00910
C	MEAN SERVICE RATE, THE UTILIZATION, THE MEAN NUMBER OF	QUE00920
C	TRANSACTIONS WAITING FOR SERVICE, THE TOTAL NUMBER OF TRANSACTIONS	QUE00930
C	IN THE SYSTEM, THE WAIT TIME FOR SERVICE, AND THE MEAN TOTAL TIME	QUE00940
C	IN THE SYSTEM.	QUE00950
C		QUE00960
	WRITE (7,101) I,LINPER(I),C,TTT,EN(I),RHO(I),EW(I),	QUE00970
	EQ(I),ETQ(I)	QUE00980
5111	CONTINUE	QUE00990
5222	CONTINUE	QUE01000
101	FORMAT (12,13,F8.0,6(2X,E9.3)/)	QUE01010
	RETURN	QUE01020
	END	QUE01030
		QUE01040

AD-A047 165

NAVAL POSTGRADUATE SCHOOL MONTEREY CALIF
A VESSEL INSPECTION INFORMATION SYSTEM.(U)
SEP 77 L M WILSON

F/G 5/2

UNCLASSIFIED

2 OF 2
AD
A047165



END

DATE
FILMED

1 - 78

DOC

NL



0471



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX G

VIIIS - SAMPLE INPUT

BASELINE	MIXED	TERMINALS			
0000		0000	5622.	1503.	06191616161616
0001		0000			1019
0002		0000			1119
0003		0000			1219
0004		0000			1319
0005		0000			1419
0006		0000			1519
0007		0000			1619
0008		0000			1719
0009		0000			1819
0010		0000			1919
0011		0000			2019
0012		0000			2119
0013		0000			2219
0014		0000			2319
0015		0000			2419
0016		0000			2519
0017		0000			2619
0018		0000			2719
0019		0000			2819
0020		0000			2919
0021		0000			3019
0022		0000			3119
0023		0000			3219
0024		0000			3319
0025		0000			3419
0026		0000			3519
0027		0000			3619
0028		0000			3719
0029		0000			3819
0030		0000			3919
0031		0000			4019
0032		0000			4119
0033		0000			4219
0034		0000			4319
0035		0000			4419
0036		0000			4519
0037		0000			4619
0038		0000			4719
0039		0000			4819
0040		0000			4919
0041		0000			5019
0042		0000			5119
0043		0000			5219
0044		0000			5319
0045		0000			5419
0046		0000			5519
0047		0000			5619
0048		0000			5719
0049		0000			5819
0050		0000			5919
0051		0000			6019
0052		0000			6119
0053		0000			6219
0054		0000			6319
0055		0000			6419
0056		0000			6519
0057		0000			6619
0058		0000			6719
0059		0000			6819
0060		0000			6919
0061		0000			7019
0062		0000			7119
0063		0000			7219
0064		0000			7319
0065		0000			7419
0066		0000			7519
0067		0000			7619
0068		0000			7719
0069		0000			7819
0070		0000			7919
0071		0000			8019
0072		0000			8119
0073		0000			8219
0074		0000			8319
0075		0000			8419
0076		0000			8519
0077		0000			8619
0078		0000			8719
0079		0000			8819
0080		0000			8919
0081		0000			9019
0082		0000			9119
0083		0000			9219
0084		0000			9319
0085		0000			9419
0086		0000			9519
0087		0000			9619
0088		0000			9719
0089		0000			9819
0090		0000			9919
0091		0000			0019
0092		0000			0119
0093		0000			0219
0094		0000			0319
0095		0000			0419
0096		0000			0519
0097		0000			0619
0098		0000			0719
0099		0000			0819
0100		0000			0919
0101		0000			1019
0102		0000			1119
0103		0000			1219
0104		0000			1319
0105		0000			1419
0106		0000			1519
0107		0000			1619
0108		0000			1719
0109		0000			1819
0110		0000			1919
0111		0000			2019
0112		0000			2119
0113		0000			2219
0114		0000			2319
0115		0000			2419
0116		0000			2519
0117		0000			2619
0118		0000			2719
0119		0000			2819
0120		0000			2919
0121		0000			3019
0122		0000			3119
0123		0000			3219
0124		0000			3319
0125		0000			3419
0126		0000			3519
0127		0000			3619
0128		0000			3719
0129		0000			3819
0130		0000			3919
0131		0000			4019
0132		0000			4119
0133		0000			4219
0134		0000			4319
0135		0000			4419
0136		0000			4519
0137		0000			4619
0138		0000			4719
0139		0000			4819
0140		0000			4919
0141		0000			5019
0142		0000			5119
0143		0000			5219
0144		0000			5319
0145		0000			5419
0146		0000			5519
0147		0000			5619
0148		0000			5719
0149		0000			5819
0150		0000			5919
0151		0000			6019
0152		0000			6119
0153		0000			6219
0154		0000			6319
0155		0000			6419
0156		0000			6519
0157		0000			6619
0158		0000			6719
0159		0000			6819
0160		0000			6919
0161		0000			7019
0162		0000			7119
0163		0000			7219
0164		0000			7319
0165		0000			7419
0166		0000			7519
0167		0000			7619
0168		0000			7719
0169		0000			7819
0170		0000			7919
0171		0000			8019
0172		0000			8119
0173		0000			8219
0174		0000			8319
0175		0000			8419
0176		0000			8519
0177		0000			8619
0178		0000			8719
0179		0000			8819
0180		0000			8919
0181		0000			9019
0182		0000			9119
0183		0000			9219
0184		0000			9319
0185		0000			9419
0186		0000			9519
0187		0000			9619
0188		0000			9719
0189		0000			9819
0190		0000			9919
0191		0000			0019
0192		0000			0119
0193		0000			0219
0194		0000			0319
0195		0000			0419
0196		0000			0519
0197		0000			0619
0198		0000			0719
0199		0000			0819
0200		0000			0919

VLS - SAMPLE INPUT

INPUT MEAN CHARACTERS TYPED-IN PER TRANSACTION
 300.
 INPUT THE STANDARD DEVIATION
 60.
 INPUT THE MEAN TYPING SPEED IN CHARACTERS PER SECOND
 10.
 INPUT THE MEAN ACCESS TIME PER TRANSACTION
 0.
 INPUT THE NUMBER OF WORKING HOURS PER MONTH
 68.
 INPUT 0 FOR HALF DUPLEX LINES

22 EQUIPMENT COSTS

The image displays four distinct horizontal bands of text, each rendered in a high-contrast, black-and-white style that obscures the original content. The text within these bands is dense and appears to be in a non-Latin script, likely Thai, but is completely illegible due to the extreme contrast and potential distortion. The bands are separated by large, empty white spaces, creating a fragmented visual structure.

03 LINE COSTS

THE

APPENDIX H

VIII - SAMPLE OUTPUT

00000

BASELINE - MIXED TERMINAL

PURCHASED EQUIPMENT

CRT	12	CATHODE RAY TUBE DISPLAY TERMINAL
TPR	15	TELEPRINTER
TPM/C	34	TELEPRINTER WITH COUPLER
PTA	7	HIGH SPEED PRINTER
MDCPY	5	SLOW SPEED PRINTER
FDPCCS	39	FDM CHASSIS
DAA	33	DATA ACCESS ARRANGEMENT
S2400M	15	SYNCHRONOUS 2400 BIT PER SECOND MODEM
S4800M	0	SYNCHRONOUS 4800 BIT PER SECOND MODEM
S7200M	4	SYNCHRONOUS 7200 BIT PER SECOND MODEM
S9600M	4	SYNCHRONOUS 9600 BIT PER SECOND MODEM
A3CCM	23	ASYNCHRONOUS 300 BIT PER SECOND MODEM
MSC	1	MODEM SHARING DEVICE
ADD	10	ALTERNATE DIAL-UP DEVICE
TDPCCS	4	TDM CHASSIS
FDPCHL	61	FDM CHANNEL
TDPCHL	20	TDM CHANNEL
C2CCND	4	C2 LINE CONDITIONING
GSATER	53	GSA LINE TERMINATIONS
LCLTEL	0	LOCAL TELEPHONE LINE

CONT INUED

VLS - SAMPLE OUTPUT

FTSATC	4	FTS NIGHT CIRCUIT								
FTSEXT	5	FTS EXTENSION								
			VLS LINE-TIME	VLS MONTHLY	VLS LINE-COST	SHARED ONE-TIME	SHARED MONTHLY	SHARED LINE-COST		
	1		31561.00	562.50	319.14	14700.00	175.00	0.0		
	2		29400.00	512.00	417.54	26000.00	213.00	0.0		
	3		40091.00	801.50	606.42	14700.00	175.00	0.0		
	4		40259.00	655.00	476.28	26000.00	213.00	0.0		
	5		25050.00	511.00	497.34	0.0	0.0	0.0		
	6		46874.00	561.00	1460.16	0.0	0.0	0.0		
			FTS COM ONE-TIME	FTS COM MONTHLY	FTS COM LINE-COST	FTS COM ONE-TIME	FTS COM MONTHLY	FTS COM LINE-COST		
			13080.00	152.00	685.70	13500.00	220.00	4345.11		
			DDO LINE-TIME	DDO MONTHLY	DDO LINE-COST					
			18480.00	215.00	0.0					

CONTINUED

VIII - SAMPLE OUTPUT

LINE NO.	CHAR NO.	SERVICE TIME	ARRIVAL RATE	UTILIZATION	TRANS. WAITING	TRANS. IN SYSTEM	TIME IN SYSTEM
1	11	2621.	0.173E 03	0.367E 00	0.111E 00	0.479E 00	0.224E 03
2	12	16150.	0.623E 01	0.404E-01	0.120E-02	0.496E-01	0.650E 01
3	1	2775.	0.173E 03	0.361E 00	0.107E 00	0.460E 00	0.225E 03
4	21	1542.	0.173E 03	0.201E 00	0.263E-01	0.227E 00	0.196E 03
5	31	3212.	0.173E 03	0.410E 00	0.157E 00	0.575E 00	0.230E 03
6	31	3133.	0.173E 03	0.400E 00	0.147E 00	0.555E 00	0.230E 03
7	31	3073.	0.173E 03	0.400E 00	0.139E 00	0.540E 00	0.234E 03
8	31	3441.	0.173E 03	0.440E 00	0.150E 00	0.630E 00	0.247E 03
9	22	6000.	0.633E 01	0.286E-01	0.430E-03	0.290E-01	0.643E 01
10	41	0.	0.0	0.0	0.0	0.0	0.173E 03
11	42	42322.	0.633E 01	0.201E 00	0.265E-01	0.220E 00	0.717E 01
12	51	1641.	0.173E 03	0.214E 00	0.303E-01	0.244E 00	0.190E 03
13	51	1552.	0.173E 03	0.202E 00	0.267E-01	0.229E 00	0.196E 03
14	61	24587.	0.633E 01	0.119E 00	0.830E-02	0.127E 00	0.670E 01
15	5	4000.	0.173E 03	0.301E-02	0.294E 00	0.817E 00	0.272E 03

VIMS - SAMPLE OUTPUT							CONTINUED	
LINE NO.	K-CHAR /PCTN	SERVICE TIME	ARRIVAL RATE	UTILIZATION	TRANS. WAITING	TRANS. IN SYSTEM	TIME IN SYSTEM	
1	11	2021.	0.173E 03	0.212E-02	0.367E 00	0.111E 00	0.479E 00	0.226E 03
2	12	1C150.	0.100E 01	0.763E-02	0.763E-02	0.326E-04	0.767E-02	0.100E 01
3	1	2775.	0.173E 03	0.209E-02	0.361E 00	0.107E 00	0.460E 00	0.225E 03
4	21	1542.	0.173E 03	0.116E-02	0.201E 00	0.263E-01	0.227E 00	0.196E 03
5	21	2212.	0.173E 03	0.241E-02	0.410E 00	0.157E 00	0.575E 00	0.230E 03
6	31	3133.	0.173E 03	0.235E-02	0.400E 00	0.147E 00	0.559E 00	0.236E 03
7	31	3073.	0.173E 03	0.231E-02	0.400E 00	0.139E 00	0.540E 00	0.234E 03
8	31	3441.	0.173E 03	0.234E-02	0.440E 00	0.150E 00	0.630E 00	0.247E 03
9	22	2000.	0.100E 01	0.451E-02	0.451E-02	0.113E-04	0.452E-02	0.100E 01
10	41	0.	0.173E 03	0.0	0.0	0.0	0.0	0.173E 03
11	42	42322.	0.100E 01	0.310E-01	0.310E-01	0.501E-03	0.324E-01	0.102E 01
12	51	1641.	0.173E 03	0.123E-02	0.214E 00	0.303E-01	0.244E 00	0.190E 03
13	51	1552.	0.173E 03	0.117E-02	0.202E 00	0.267E-01	0.229E 00	0.196E 03
14	21	24987.	0.100E 01	0.100E-01	0.100E-01	0.200E-03	0.190E-01	0.101E 01
15	5	4000.	0.173E 03	0.301E-02	0.521E 00	0.296E 00	0.817E 00	0.272E 03

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