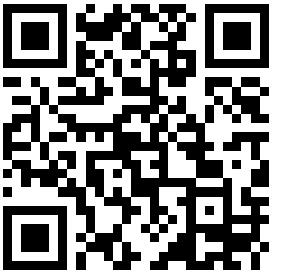

NAVELEX
0101,111

NAVAL SHORE ELECTRONICS CRITERIA

DIGITAL COMPUTER SYSTEMS
Vol. I of II

DEPARTMENT OF THE NAVY
NAVAL ELECTRONIC SYSTEMS COMMAND
WASHINGTON, D.C. 20360

FSN 0280-900-9000

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MARCH 1972

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Total number of pages in this manual is 158 consisting of the following:

Page Number	Effective Date
Title	March 1972
A, B	March 1972
Foreword	March 1972
i through iv	March 1972
1-1	March 1972
2-1 through 2-7	March 1972
3-1 through 3-11	March 1972
4-1 through 4-31	March 1972
5-1 through 5-7	March 1972
A-1 through A-2	March 1972
B-1 through B-15	March 1972
C-1 through C-25	March 1972
D-1 through D-9	March 1972
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FOREWORD

This volume presents a basic source of information to assist Naval Electronic Systems Command (NAVELEX) personnel in their assigned responsibilities of digital computer site planning, installation, test and acceptance. The more theoretical aspects of how a digital computer functions is covered in " Digital Computer Systems, " Volume II (NAVELEX 0101,115).

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Chapter Page

APPENDIXES

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

The Naval Electronic Systems Command (NAVELEX) is assigned responsibility for the planning, development, design, acquisition, test, evaluation, and acceptance of computer-oriented information processing and display systems. It provides support to all Navy shore and assigned ship systems in all matters associated with digital, stored-program computers along with the attendant peripheral devices required to form a complete system, including those required to process, display, and transmit data as defined by these applications: data collection, data distribution, inquiry processing, computer time-sharing, and message switching.

This volume will provide the following to NAVELEX personnel:

o A basic source of information to aid in the understanding of the Navy's digital computer systems.

o The technical information needed to aid in computer site planning, installation, test and acceptance of digital computer systems.

CHAPTER 2

NAVY COMPUTER SYSTEMS

The most important mission-oriented computer systems in the Navy presently can be grouped into two general categories. These categories are:

- o Command and Control
- o Communication Message Center

2.1 COMMAND AND CONTROL

The Worldwide Military Command Control System (WWMCCS) is an integrated network of separate command and control systems. It includes the National Military Command System, the Command and Control Systems of the unified and specified commands, the Command and Control Systems of the component commands, and those system elements of other agencies of the Department of Defense and offices which directly support the command and control function.

While the Worldwide Military Command and Control System is not yet in existence, it was selected as an example because of the impact it will have when inaugurated in all the Services.

These systems consist of the personnel, facilities, equipment, communications, and procedures that provide technical and operational support to the command and control function. They provide the means by which the President and the Secretary of Defense receive information, apply the resources of the military departments, and provide, through the Joint Chiefs of Staff, strategic and broad operational direction to the commanders of U.S. military forces.

Each member of the WWMCCS has an autonomous role, in which it assists the commander (or director) and his staff, and a system role in which it acts as an element of one or more larger systems. In the autonomous role, each member system performs data collection, storage, retrieval, manipulation, and distribution tasks for its own command or agency. In the system role, each member system responds to requirements imposed by the larger systems. For example, the command and control system of the Navy's Atlantic Fleet is a member of both the U.S. Atlantic Command and the command and control system of the U.S. Navy.

ADP systems are used extensively throughout the WWMCCS to assist all command and staff levels in a variety of tasks associated with their assigned missions. In general, these ADP systems can be considered to operate 24 hours a day, seven days a week, and consist of the subsystems shown in figure 2-1.

o Computer Subsystem. The computer subsystem consists of the computer itself, common peripheral equipment, and vendor-supplied documentation.

o Real-Time Subsystem. The real-time subsystem consists of digital data link (DDL) terminals (such as AUTODIN) and signal converters/conditioners (such as analog-to-digital converters) through which data is introduced directly into the computer subsystem without local manual intervention.

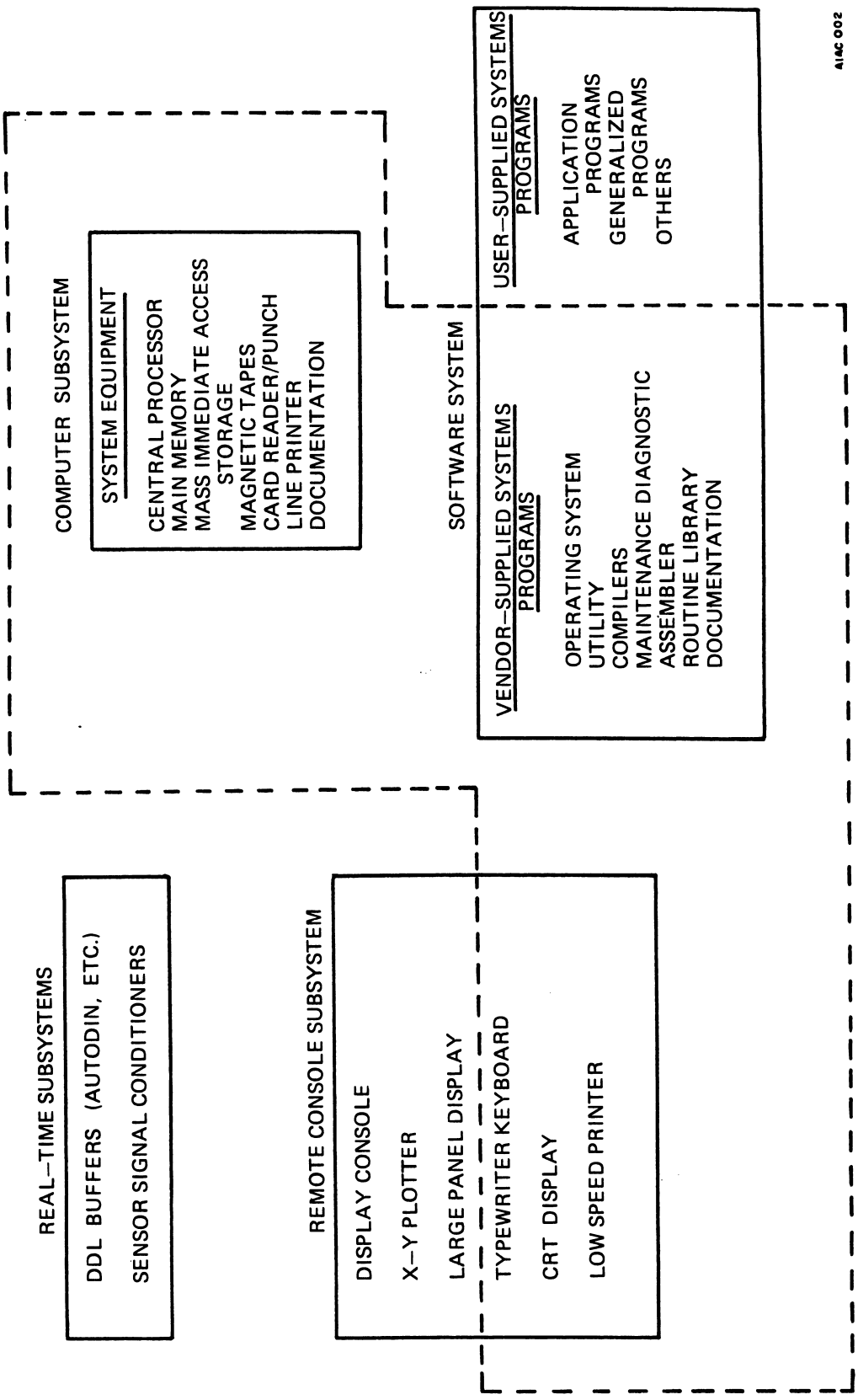

Figure 2-1. WWMCCS ADP Center System

o Remote Console Subsystem. The remote console subsystem consists of manual input/output (I/O) devices remotely located from the central processing unit (CPU) (such as cathode-ray tube (CRT) displays, typewriter, keyboards, console printers, logic pushbuttons, plotters and other devices situated apart from the computer locations) through which on-line interactive request can be made and system responses provided.

o Software Subsystem. The total software subsystem consists of the files and programs provided by user organizations and the programs supplied by the vendor. All user and vendor programs operate under control of an operating system. Thus, any necessary program can be called for by the computer operator, by the data user at his console, or through the real-time subsystem.

2.2 COMMUNICATION MESSAGE CENTER

Increasing traffic volumes, and the necessity for near real-time record communications for command and control, present a burden to communications centers ashore. Being able to transmit a message across the globe with the speed of light is of little value if excessive delay deprives the ultimate reader of timely delivery of his traffic. Writer-to-reader delays have always plagued the communicator, and the situation is aggravated by higher traffic volumes. Improved transmission facilities, such as 4800 bits-per-second AUTODIN circuits, serve to increase the stream of record traffic, getting it there faster than ever before and further taxing the capabilities of the message center. The motive for current automation effort is to achieve improved message handling time. Handling times which were once acceptable are no longer tolerable. A message center must be able to provide and maintain reliable, secure, and rapid communications, and is accountable for the reception, transmission and distribution of record communication traffic. The immediacy desired for satisfying real-time requirements cannot be achieved in a manual message processing environment. The Local Digital Message Exchange System (LDMX) will provide more responsive message handling at the message centers.

The LDMX will recognize predetermined message categories by precedence, flagword, addressee, standard subject code or descriptive subject line in accordance with current routing guides maintained within the system.

Incoming messages (see figure 2-2), regardless of Language Media Format (LMF), will be received directly from the AUTODIN and/or dedicated circuits at the speed of the circuit, and queued for validation, processing, and routing by the system. Disk storage units will be utilized to queue the messages for processing on the basis of first-in, first-out, and by precedence.

Messages which cannot be routed automatically will be presented to an Inrouter via a Visual Display Terminal (VDT) for manual assignment of distribution.

Edited messages with assigned distribution will be printed on a high-speed line printer on multilith mats for offset press reproduction. The LDMX will record all messages as received, with their assigned distribution, in on-line files.

Outgoing messages (see figure 2-3) will be processed in much the same manner. Released messages on Joint Message Form DD-173 will be fed into an Optical Character Reader (OCR).

The LDMX will assign routing indicators, an SSN, and a DTG, then select an outgoing circuit, format the message in ACP 127 or JANAP 128 format as appropriate for the circuit to be used, and transmit the message.

The LDMX will record the time of transmission and the message as transmitted in the on-line files. The only paper copies of messages to be handled in the communication center will be released originals of outgoings, and distribution copies of incomings.

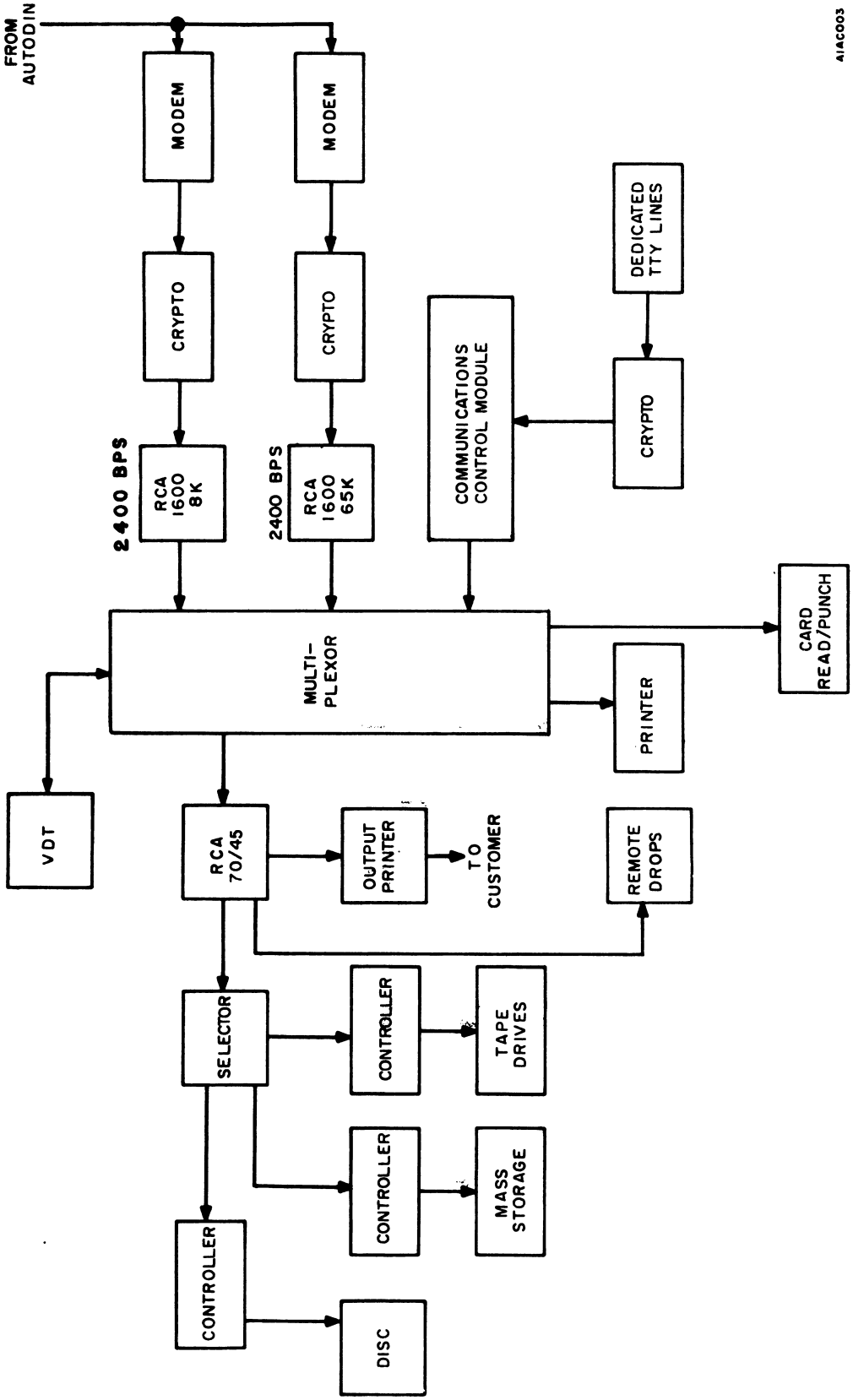

Figure 2 - 2. LDMX Incoming Messages Processing, Schematic Diagram

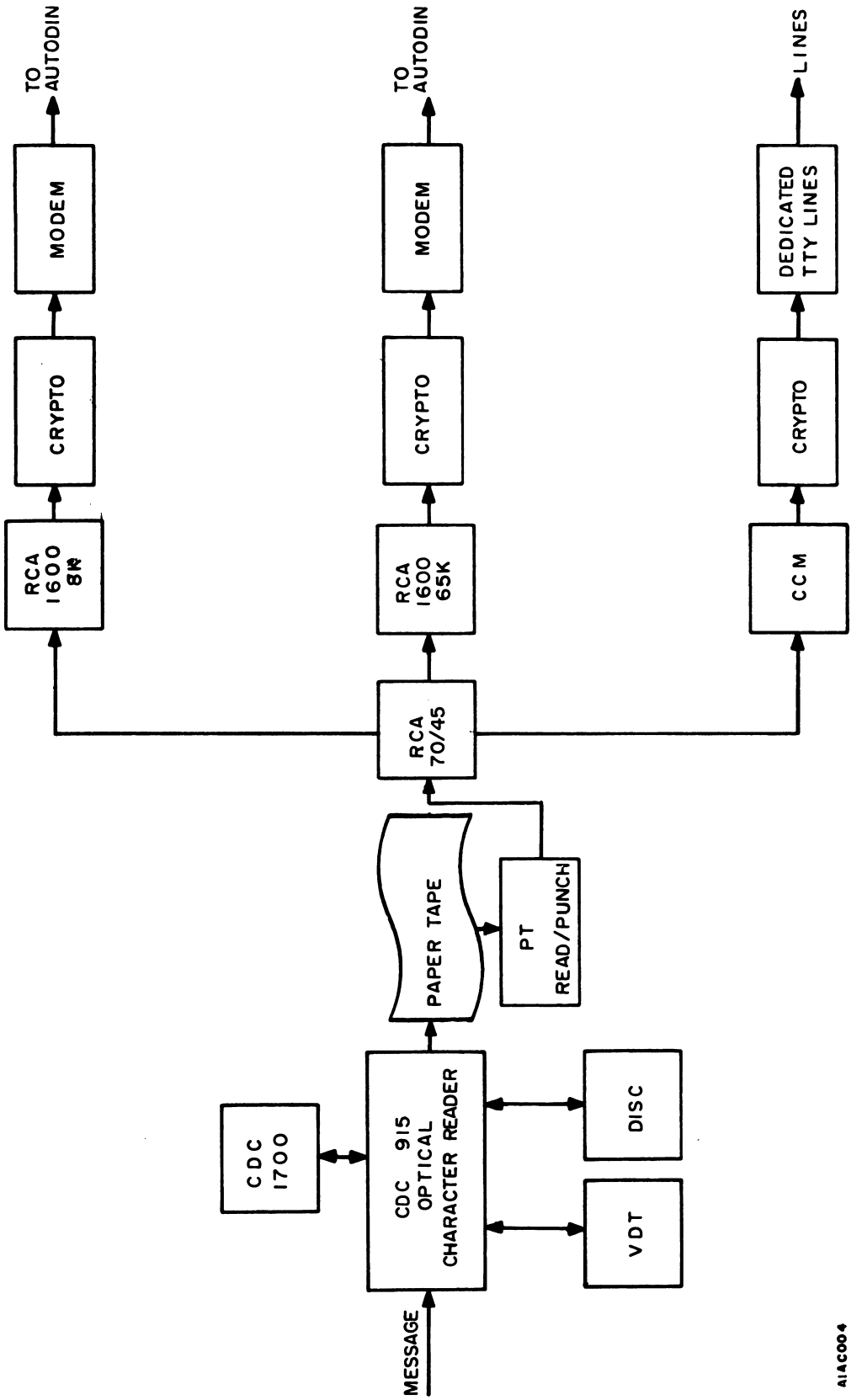

Figure 2 - 3. LDMX Outgoing Messages Processing, Schematic Diagram

The fallback mode (see figure 2-4), in case the RCA 70/45 goes down, is to route the messages through a switch to tape for storage. It is thus available for future processing.

Messages will be processed automatically by the LDMX in times measurable in seconds and milliseconds, rather than minutes or hours. The capacity of the system, if used for nothing but message processing, is calculated to be 62,000 messages per day, based on an average message length of 1,400 characters.

The LDMX will check channel number continuity, validate classification redundancy, check for stragglers, and verify completeness of every message received.

It will keep tabs on messages from entry until processing has been completed. Status of any message can be immediately determined upon demand by an operator.

The LDMX files will be constructed in such a manner as to permit retrieval of a message with a minimum of information, such as DTG only, Originator and DTG, TOF and SSN, or even Originator with an unknown DTG in a given day.

Messages up to 45 days old will be retained in the LDMX files with immediate retrievability.

Messages can be recalled, corrected, and retransmitted within moments, without paper, and all duly recorded.

Readdressals will be accomplished automatically upon entry into the OCR of a properly prepared and released readdressal request on a Joint Message Form DD-173.

A complete ACP 117 routing indicator file can be maintained in the LDMX.

Statistics can be obtained upon demand to provide pertinent information regarding accountability and other data concerning message processing, such as speed of service, circuit usage, message length, queue status, etc.

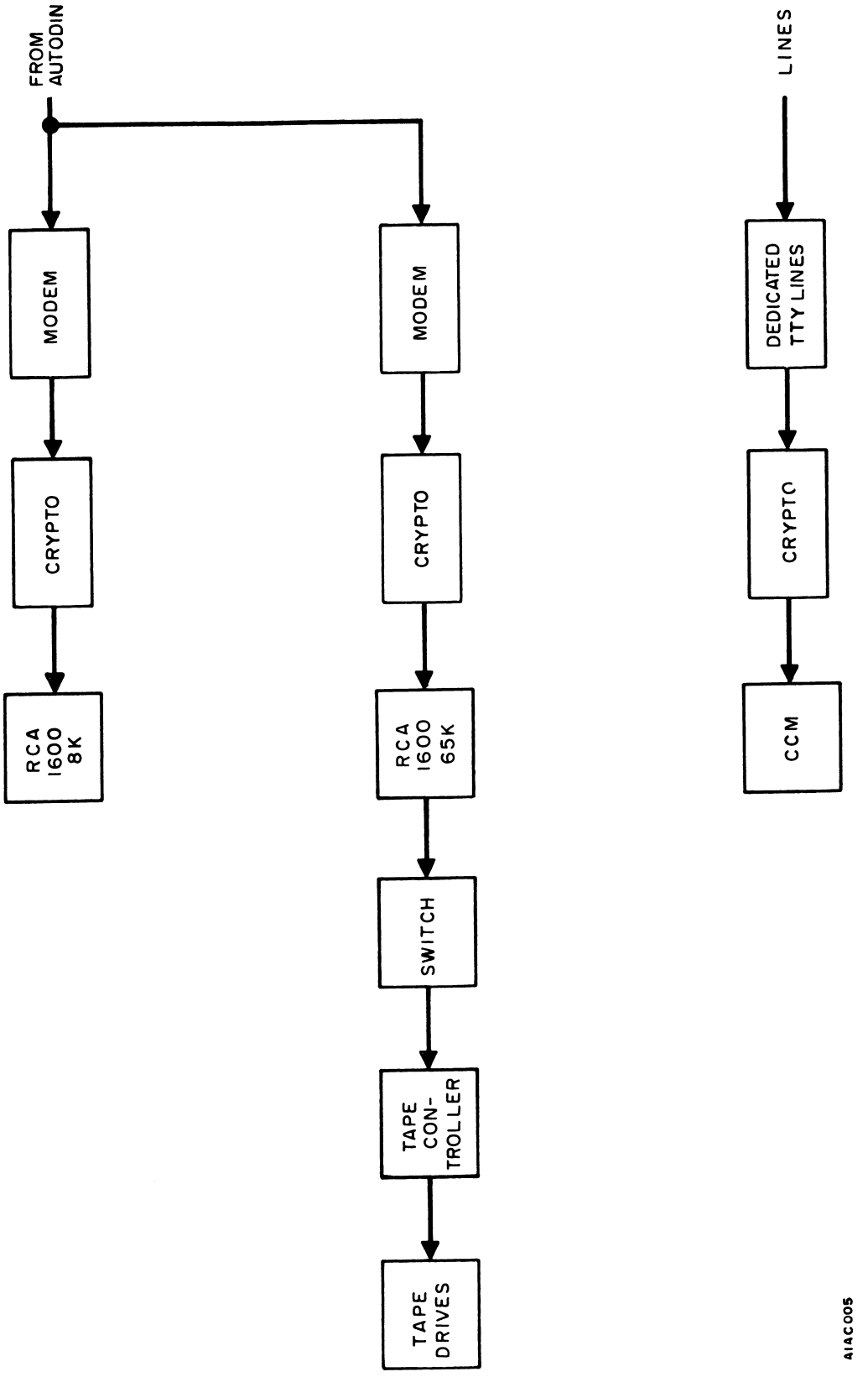

Figure 2-4. LDMX Fallback Mode, Schematic Diagram

CHAPTER 3

MILITARIZED COMPUTER SYSTEMS

The Navy presently has several militarized computer systems in operational use. The two described below are general-purpose, stored-program machines capable of processing a large quantity of complex data. The CP-642B Computer is designed for compatibility with the AN/USQ-20 data set of the Naval Tactical Data System (NTDS) but can also interface with high-speed peripheral equipment. The AN/UYK-7 Computer is designed to meet small, medium or large military system requirements by use of modules. By combining basic modules in different ways, the AN/UYK-7 can be tailored or adapted to a particular application.

The decision by a user or prospective user of the need for ADPE or the expansion/replacement/modification of his present equipment initiates a highly structured series of requirements. For a complete detailed outline and policy guidance on the subject of the ADPE acquisition, refer to the latest SECNAVINST 10462.13, Specification, Selection, and Acquisition of ADPE.

3.1 CP-642B COMPUTER SYSTEM

3.1.1 General Characteristics

The computer is housed in a single cabinet, 37 inches deep, 38 inches wide, and 72 inches high. Thirteen chassis trays (viz., seven of logic, one of control memory, and five of main memory) are horizontally arranged within the cabinet. Logic modules are encapsulated printed circuit cards which plug into the trays. Maintenance test points at the front of the trays are readily accessible.

Computer cabinet doors, closed during normal operation, can be opened for maintenance. The maintenance and control panel, built into the upper part of the cabinet, contains register indicators, set and clear pushbuttons, and operating switches.

Primary power to the computer is provided from a motor-alternator that has a 60-cycle input and a 400-cycle output. The alternator, in addition to converting frequency, isolates the computer from the main power source. A maximum of 3.0 kilowatts input to the alternator is required for the computer.

The standard computer is equipped with a water-cooled heat exchanger, but a plenum which uses ambient air as a coolant is available as an option. Interequipment cabling enters the computer at the top of the cabinet and may be run either overhead or through floor ducts.

The computer is designed and constructed to withstand severe shock and vibration. It may be installed aboard ship or in a trailer without modification.

The UNIVAC CP-642B Computer is especially suitable for such real-time applications as missile guidance, range safety, processing monitoring, and tactical control and display. Relative to other general-purpose systems, the computer emphasizes rapid communication with external devices and large, randomly accessible, internal storage.

Single address instructions are employed, most of which have an execution time of 8-12 microseconds.

Internal storage of the computer consists of a 32,672-word, ferrite-core main memory. A complete cycle for storage of a 30-bit word requires 4 microseconds.

An additional storage area, designated as control memory, provides 64 addressable locations with a read/restore cycle time of 2/3 microsecond. Fifty-six of these locations are special purpose and provide storage for input buffer control words, output buffer control words, output command buffer control words, the real-time clock, and seven index registers. The other eight memory locations are used for data storage. Instructions cannot be run from the control memory; however, input/output transfers can take place to or from this memory, and any operand reference can be accomplished.

Arithmetic and logical operations are performed in the parallel binary mode. For most operations, the result appears in a 30-bit accumulator register. Arithmetic is one's complement, subtractive, with a modulus (2^{30} -1). Computer operation is controlled by a stored program capable of self-modification. Each program instruction contains a function code (6 bits), an instruction operand designator (15 bits), and three execution modifiers (2, 3, or 4 bits). Execution modifiers provide for address incrementation, operand interpretation, branch-point designation, input/output channel or minor function. The operand designator may be increased by the amount contained in any one of seven index registers. The operand specified by the execution address may be interpreted as a 30-bit quantity, or as a 15-bit half-word with or without sign extension. The next sequential program step may be skipped when the branch-point designator places it under control of the contents of either the accumulator or the Q-register.

Communication between the computer and its associated external equipment is normally accomplished by a buffered transfer of data, with timing under control of the external device. Operating asynchronously with the main computer program, such transfers of data have independent access to storage. The number of data words transferred is under program control by specifying the first and last memory address in the buffer.

The input/output section of the computer is capable of communicating with other CP-642B Computers, with the CP-642A Computer, with the UNIVAC 1218 Computer, with NTDS peripheral equipment, and with other military and commercial peripheral equipment.

A communication path is established by a sequence of request and response signals between external equipment and computer. The request signal may originate in either the computer or the external device. External request signals interrupt the main computer program and cause the computer to establish a communications channel between the external equipment and the computer core memory. Once the communication line has been created, the computer returns to the main program sequence, and transfer of input or output data proceeds without program reference until completed.

Sixteen input and 16 output channels are provided in the computer; each channel consists of 30 parallel data lines plus control lines. Two different interface options are provided, and a group of four channels may be converted from Type I to Type II and vice versa by simply changing plug-in, printed circuit cards within the channel circuitry.

- o Type I input/output chassis is capable of communicating with peripheral equipment only. (Either fast or slow interface may be used, depending upon the type of I/O amplifiers plugged into the chassis.)

- o Type II input/output chassis is capable of communicating with either another computer, or by changing printed circuit jumper cards, with peripheral equipment. (Either fast of slow interface may be used, depending upon the type of I/O amplifiers plugged into the chassis.)

In addition to data words, output channels carry external function words to the external equipment. These words specify the function that the external device is to perform. Control of the external function transfer is accomplished in the buffer mode. This feature allows the computer to continue engaging an external device after

the completion of each function. An external function word to a tape control unit, for example, may specify "Rewind Tape Unit 2". When Tape Unit 2 has informed the computer that the operation has been initiated, the computer can respond by transmitting another external function word, for example, "Write on Tape Unit 1" without program interruption.

Transfers of input and output data are controlled by priority and access control logic. This circuitry assigns access to control and core memory. If two or more requests for access to memory are received simultaneously, the priority and access circuitry evaluates the requests and assigns function priority according to an established sequence as follows:

- o Advance Real-Time Clock
- o External Function
- o Output Request
- o Input Request
- o External Interrupt
- o External Function Monitor Interrupts
- o Output Monitor Interrupt
- o Input Monitor Interrupt

If two or more channels simultaneously request the same type of function, the priority and access circuitry assigns channel priority in descending order of channel numbers.

3.1.2 Components

The Components of the CP-642B system are: Control Section, Arithmetic Section, Storage Section, and the Input/Output Section.

a. Control Section. The Control Section (See figure 3-1) consists of those registers and circuits necessary to procure, modify, and execute the instructions of the program.

The U-register (30 bits) is the program control register. It holds the instruction word during execution of an instruction. The function code and the various execution modifiers are translated from appropriate sections of the register. The lower order 15 bits of the U-register have additional properties, modulus 2^{15} -1.

The 15-bit B-registers, B_1 through B_7, store the quantities used for U_L modification. These B-registers, also called index registers, occupy the lower 15 bits of the control memory addresses.

The R-register (15 bits) has counting properties to increase the contents of a selected B-register. The output of this register is made available to the control adder for modifying the lower 15 bits of the U-register.

The B-register (15 bits) is a nonaddressable control communications register. It holds the quantity added to the lower order 15 bits of the U-register during address modification (i.e., the contents of the selected B-register).

The P-register (15 bits) holds the memory address of a computer instruction word - that of the current instruction or a new instruction (e.g., as a result of a jump conditions).

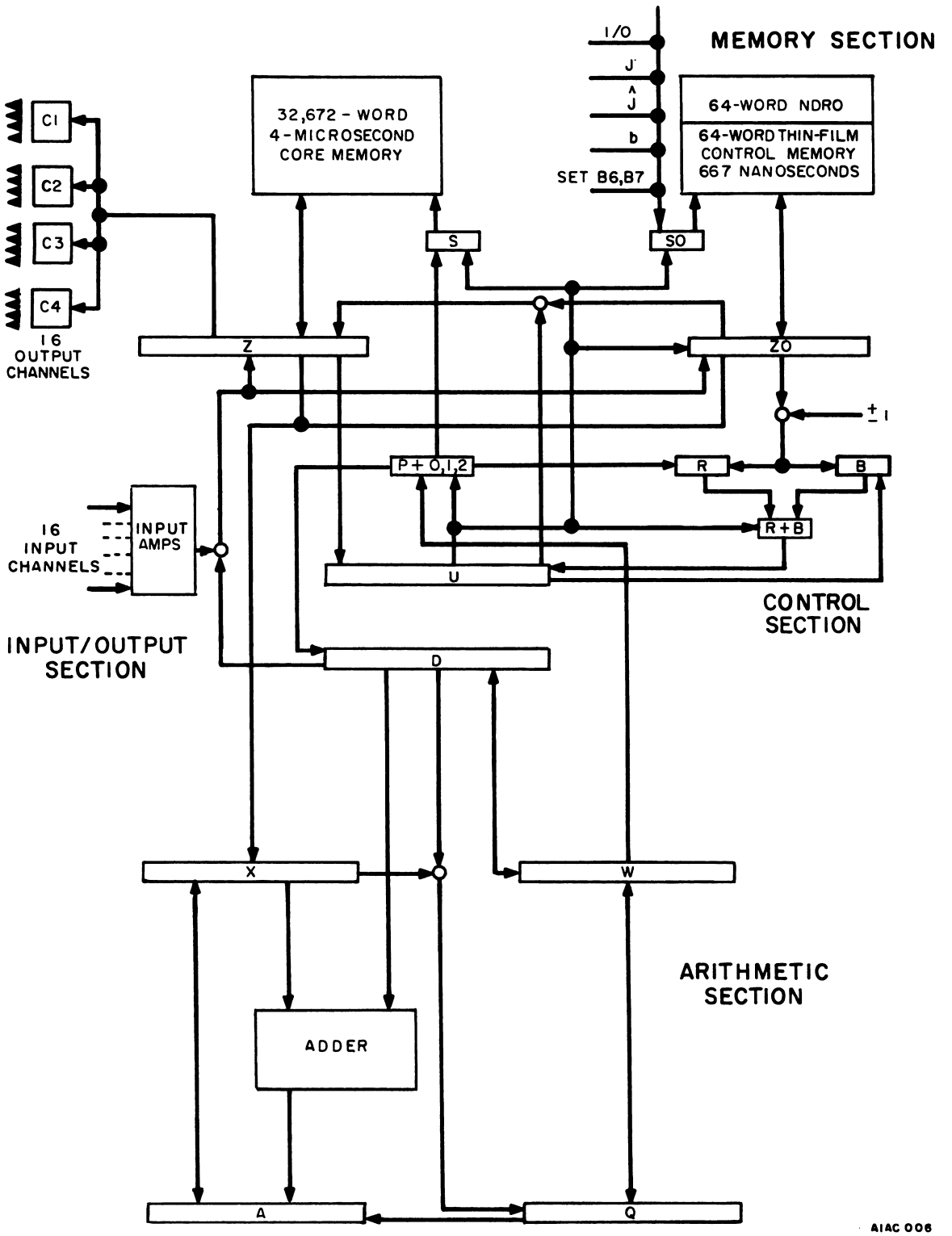

Figure 3 - 1. CP-642B Computer, Block Diagram

The S-register (15 bits) holds the storage address during memory references. At the beginning of a memory cycle period, the address is transferred to the S-register. The contents of the S-register are then translated to activate the storage selection system.

The S-register (7 bits) acts in the same manner as the S-register except that it holds the address for control memory and NDRO memory during the memory cycle time.

The K-register (K_1, K_2, and K_3) function as a shift counter for all arithmetic operations that involve shifts. Other instructions employing the K-registers are multiply, divide, and square root.

b. Arithmetic Section. The arithmetic section performs numeric and logical calculations. Although greatly simplified, figure 3-1 is a block diagram of the CP-642B Computer.

The A-register (30 bits) may be thought of, for programming purposes, as a conventional accumulator. Because of the logic employed, however, the A-register is actually only the main rank of the accumulator; the D-register serves as a second rank.

The add operation is typical of the relationship between the A- and D-registers: the augend and addend are initially contained in the A- and D-registers. Before the addition is performed, the contents of the A-register are transmitted to the X-register. The values of X and D are combined by the add network to form the sum of the two numbers in a parallel manner and placed in the A-register.

The Q-register (30 bits) is used principally during multiply and divide operations. The contents of both A and Q may be shifted left or right, either individually or as one double-length, 60-bit word.

The X-D, and W-registers are 30-bit, nonaddressable registers. These registers are used primarily for the exchange of data within the arithmetic section and for communicating with the remaining sections of the computer. The W-register is not displayed on the control panel of the computer; the A-, X-, and D-registers have indicators which allow the operator to inspect the contents of these registers during debugging and maintenance operations. The A- and Q-registers are addressable arithmetic registers.

c. Storage Section. The storage section consists of three basic memories:

- o Main storage section constructed of modular arrays of ferrite cores.
- o Control memory constructed from magnetic thin-film elements.
- o Bootstrap memory, a nondestructive readout type, which utilizes the UNIFLUXOR type of storage.

The main storage section has a capacity of 32,672 words, each of 30 bits. It is coincident-current driven and is addressed via the address translator. The Z-register (30 bits) is the core memory buffer register through which all information to and from a core location must pass. Because of the optional use of 15-bit half-words, Z is split into two 15-bit sections termed Z-upper (Z_u) and Z-lower (Z_l).

The memory operates in the destructive readout mode. Time required for the read/restore cycle is 4 microseconds.

The magnetic thin-film memory is the fastest form of memory yet developed for computer use. Storage media consist of spots of a Permalloy (registered trademark of Western Electric Company) ferromagnetic material, deposited upon a substrate such as thin glass plate. The Permalloy spots are 50 mils in diameter and 1,000 angstroms thick. The geometry of these spots permits the magnetic state of a spot to be switched in billionths of a second with only a small amount of power applied. Since these spots have only two stable states of magnetization, they can readily store binary information.

Cycle time for read/restore of data in the control storage is 667 nanoseconds (2/3 microsecond). This rapid access to the memory increases the range of applications of the computer.

The UNIFLUXOR storage is a nondestructive readout (NDRO) type of memory used in the computer for automatic program recovery (i.e., in bootstrap programs). This storage area is capable of reading 64 words with a read cycle time of 2/3 microsecond per word. Either one of the two 32-word bootstrap programs in the UNIFLUXOR storage may be selected by a switch. The UNIFLUXOR memory may be entered from any point in a program, and the exit from this memory area requires no special instruction.

The ZO (30 bits) register is the memory buffer register for the control and UNIFLUXOR memories. All information read from these memories must pass through this register. All information stored in the control memory locations must pass through this register. No storage is possible to UNIFLUXOR locations. A list of the memory address assignments is shown in table 3-1.

Table 3 - 1. UNIVAC CP-642B Memory Address Assignment

Computer Component	Address Assignment	
	Numerical	Nomenclature
Magnetic Core	00000	Fault Entrance
	00001 - 00017	Unassigned
	00020 - 00037	External Interrupt Entrance
	00040 - 00057	Input Monitor Interrupt Entrance
	00060 - 00077	Output Monitor Interrupt Entrance
Magnetic Thin Film	00100 - 00117	Input Buffer Control Registers
	00120 - 00137	Output Buffer Control Registers
	00140 - 00157	External Function Buffer Control Registers
	00160	Real-Time Clock
	00161 - 00167	B1 through B7 Index Registers
	00170 - 00177	Unassigned Film Locations
Magnetic Core	00200 - 00477	Unassigned Core Locations
	00500 - 00517	External Function Monitor Interrupt Entrance
	00520 - 00537	External Interrupt Code Storage
UNIFLUXOR	00540 - 00577	INDRO Bootstrap Program I
	00540 - 00577	INDRO Bootstrap Program II
Magnetic Core	00600 - 00617	Intercomputer Time-Out Interrupt Entrance
	00620 - 77777	Unassigned Core

d. Input/Output Section

All references to input or output in this discussion are made from the standpoint of the computer; that is, input is always input to the computer, and output is always output from the computer.

Communication with the CP-642B Computer is carried on in a 30-bit, parallel mode over the input/output channels. Each computer is equipped with 16 channels (numbered 0 through 15). These channels are assembled on four chassis, each of which contains four identical input/output channels. Two different types of chassis can be used with the CP-642B Computer: Type I communicates with peripheral equipment, and Type II communicates either with peripheral equipment or with another computer. The conversion from a peripheral equipment channel to an intercomputer channel on Type II chassis involves the changing of one plug-in jumper card per channel.

The four C-registers (C_1, C_2, C_3, and C_4); one for each chassis holds information for peripheral equipment during output or external function transfers. Each is 30 bits in length and acts as a buffer register for four out channels. Groups of four channels may be adapted to Type I or Type II communication.

Either of the two types of chassis can be provided with a fast or slow interface. The slow interface provides communications transfers rates of up to a nominal 40K words per second. The CP-642A/USQ-20 Computer provided transfer rates up to a nominal 30K words per second. The fast interface will provide transfer rates of up to 125K words per second.

In the CP-642A Computer, the transfer of input and output data words is asynchronous with the computer program, but the program maintains synchronous control over the issuance of External Functions. In the CP-642B Computer, transmission of External Functions may be handled the same as data transmission. To utilize this method, the peripheral equipment must set a line indicating it is capable of accepting a command word from the buffer; therefore, the transmission of the word need not be synchronous with the computer program. Provision has been made, however, to achieve synchronization of program and input/output control to be compatible with existing peripheral equipment. Transmission of External Functions to equipment not containing logic for requesting functions (commands) is provided by the Force External Function instruction.

3.2 AN/UYK-7 COMPUTER SYSTEMS

3.2.1 General Characteristics

A fundamental design objective of the AN/UYK-7 Computer is its modularity, that is, the capability to integrate basic units into a wide variety of configurations. The basic units available are:

- o Central Processor unit (CPU).
- o Input/output controller words (IOC).
- o Input/output adapter unit (IOA).
- o Memory unit of $16{,}384_{10}$ words.
- o Power supply unit.
- o Cabinet.
- o Remote operating console unit.
- o Maintenance console unit.
- o Dummy units.

All of the units except the consoles are mounted into one or more cabinets. The CPU, IOU, power supply units, and memory unit all have the same physical dimensions. (See figure 3-2).

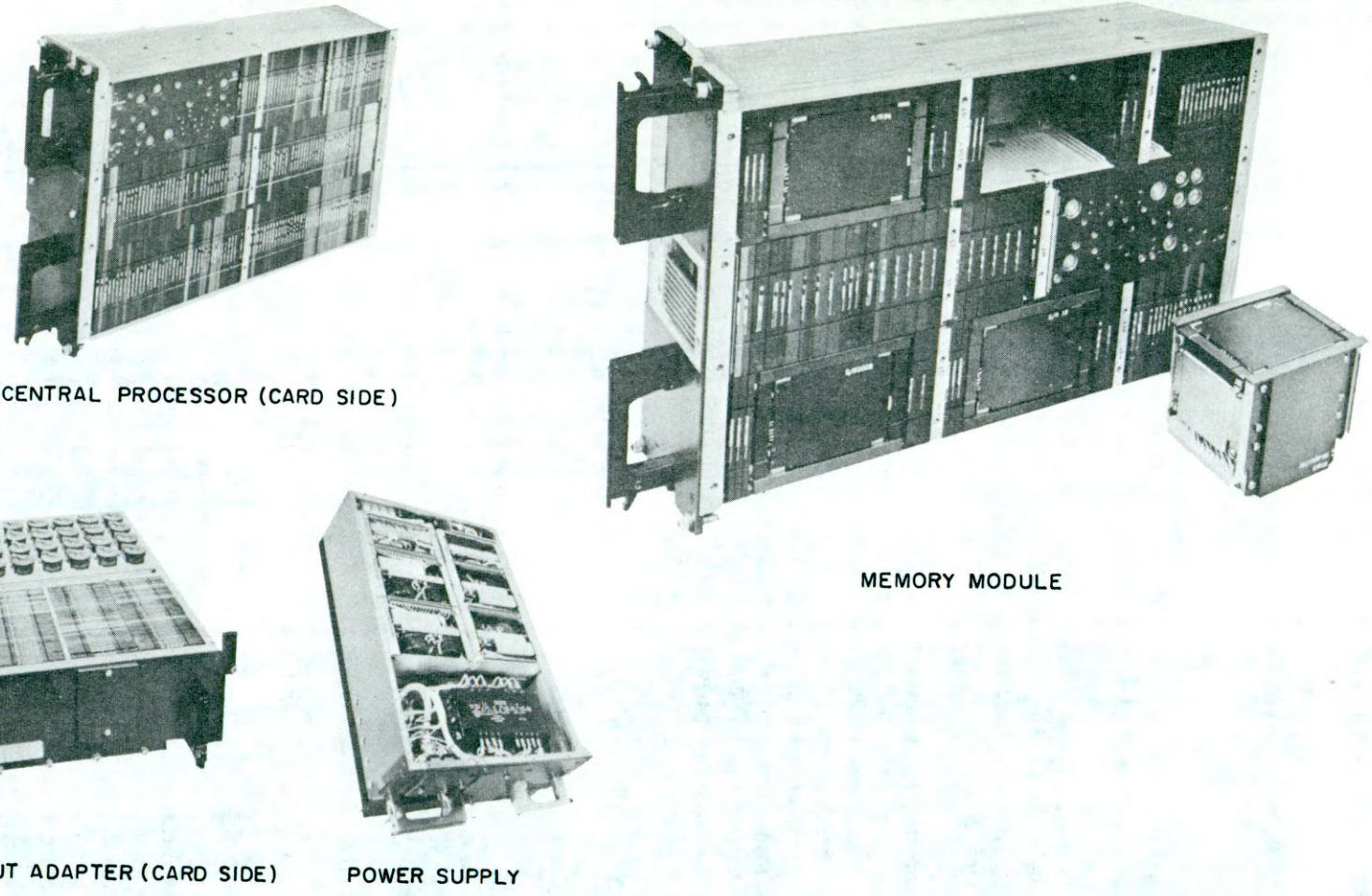

Figure 3 - 2. AN/UYK-7 Computer Units

Each cabinet will accommodate up to six of these types of units or dummy unit replacements. There is also space in each cabinet reserved for one I/O adapter unit or its corresponding dummy unit. Data buses accomplish communication between units. All connections between units are contained within the cabinet. See figure 3-3 for Functional Block Diagram.

3.2.2 Components

A brief description of the components given in paragraph 3.2.1, is as follows:

a. Central Processor Unit. The CPU controls the overall operation of a computing system. It automatically references memory for the stored program instructions, interprets the instructions, and performs what the instructions demand. The CPU has the capability of referencing a maximum of 16 possible memory units where each memory units contains $16{,}384_{10}$ words. Instructions are obtained from one of the 16 possible memory units via a communications bus called the Instruction or I bus. Operands are obtained and stored via another communications bus called the Operand or 0 bus. The CPU can communicate with a maximum of four IOCs. The 0 bus accomplishes transfer of data between IOCs and the CPU. Each unit operates as an independent unit with its own power distribution, timing, etc. Discrete control signals between units provide asynchronous (request/reply) operation. When the processor requests one of the 16 possible memory banks or one of the four IOCs, it suspends its own operation until the unit requested responds. A maximum of one central processor can be mounted within any one cabinet.

b. I/O Controller Unit. The IOC is dimensionally equivalent to the CPU. Its function is to control the input/output transfers between external peripheral equipment and memory. Once the CPU initiates the IOC, it can operate independently from processor control. The IOC is capable of addressing a maximum of 16 memory units via its own IOC/memory bus. The I/O adapter communicates with external devices. Any IOC can be controlled by a maximum of three central processors. A maximum of one IOC can be mounted within any one cabinet.

c. I/O Adapter Unit. The I/O adapter provides the interfaces between the IOC and external peripheral devices. Each I/O adapter can have 4, 8, 12, or 16 input and output channels. One of three possible electrical interfaces are available to a group of four input/output channels. These are:

- o NTDS Slow Interface - minus 15 volts, 33,000 words per second maximum.
- o NTDS Fast Interface - minus 3 volts, 167,000 words per second maximum.
- o ANEW Interface - plus 3.5 volts, 167,000 words per second maximum.

d. Memory Unit. The memory unit is dimensionally equivalent to the CPU and IOC. Its function is to provide $16{,}384_{10}$, nonvolatile 32-bit words (information is retained when power is removed) storage. The memory unit is capable of being addressed by any combination of CPU and IOCs with the restriction that the total number of accesses does not exceed eight. Each CPU requires two accesses (operand and instruction) whereas each IOC requires only one. Only one of a possible eight memory requests can be honored by the memory unit at any given time; therefore, each access part of the unit is assigned a position in a fixed priority selection scheme. A maximum of 16 memory units can be addressed by the CPU and IOC. Each memory reference requires a read/restore time of 1.5 microseconds.

e. Power Supply Unit. The power supply unit is dimensionally equivalent to the CPU, IOC, and memory units. Each cabinet requires one power supply unit sufficient to supply regulated direct current to any combination of modules located within a cabinet, an operator's console, and a maintenance console. Each individual unit (CPU, IOC, and Memory) contains a unique power converter that is not a part of the power supply units. The power supply unit is designed to provide protection against over-voltage, over-current, and over-temperature conditions. If power fails, the CPU is notified by an interrupt control signal from the power supply. After this condition occurs, the power supply has enough stored energy to supply the computer for 250 microseconds; enough time to store all volatile information.

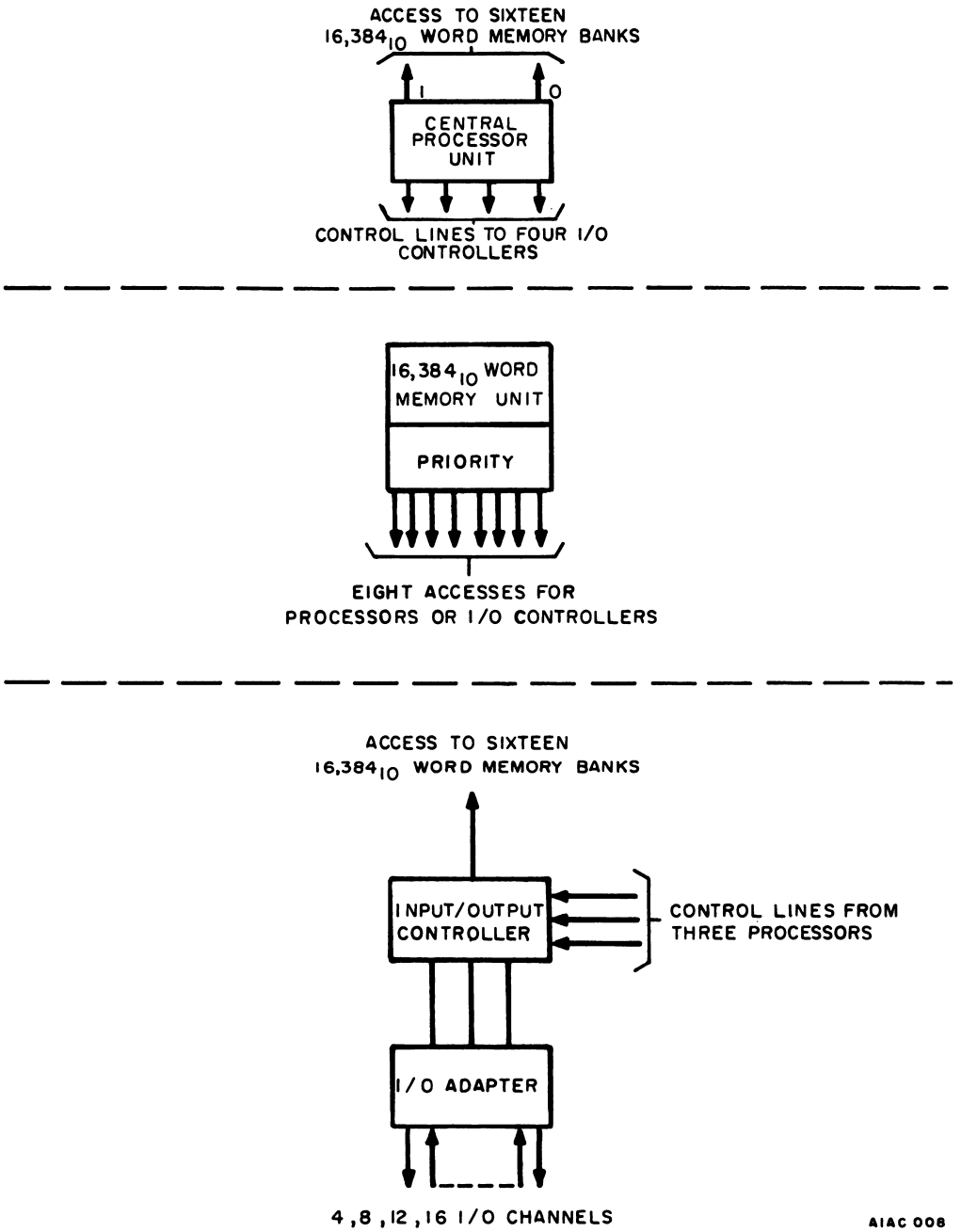

Figure 3 - 3. AN/UYK-7 Computer Functional Block Diagram

f. Cabinet. The cabinet consists of a welded aluminum frame which can accommodate one I/O adapter module and six common size modules. The cabinet contains module mounting slides and retaining hardware, module electrical connections and interconnecting wiring harness, operator's control panel, a blower and a system of air ducts allowing cooling air to circulate through all module heat exchangers.

g. Remote Operating Console Unit. An operator's control panel can be attached to the AN/UYK-7 which permits operational control from up to 300 feet from the cabinet(s). A minimum number of indicators and switches is provided to allow only program control operations.

h. Maintenance Console Unit. A remote maintenance unit may be located up to 15 feet from a CPU/IOC cabinet or may affix to the top of such a cabinet. The maintenance console provides set/indicate capability for many of the operating registers of the CPU and IOC. Various switches and controls enable the maintenance man to control the CPU processor and/or IOC in a number of ways. The maintenance console also provides indication of various status conditions in these two units.

i. Dummy Units. There are two dummy units which are empty drawers of the same physical dimensions as the functional modules. These are used to fill in the spaces not used in a cabinet by a functional unit.

CHAPTER 4

FACILITY PLANNING CONSIDERATIONS

Detailed planning and coordination are essential for the successful installation of a computer. Because the completion of each step in the planning and installation phases is presumed by the next step, it is essential that a planned and carefully sequenced schedule of steps be formulated and adhered to.

Ideally, no engineering requirements in support of a system should be initiated until system definition has reached a high degree of stability. Unfortunately, this idealized approach is generally not practical. Normal system planning, scheduling, and funding procedures do not allow sufficient time for a totally serialized system implementation approach. As a result, parallel efforts are often required.

Guidance for the engineering of a computer system installation can be provided either in the form of detailed application, to a specified location, of plans such as the Base Electronic System Engineering Survey Report (see Appendix B) and the Base Electronic System Engineering Plan (BESEP) (see Appendix C). Alternatively, information of a more basic and general nature applicable to the situations that are typical of the system under consideration can be provided. Each approach has limitations and advantages. The first approach, while providing inputs that are directly usable (for engineering personnel) in a stable system environment, is extremely intolerant of system configuration changes. The second approach, while placing a greater burden upon capabilities of the engineering personnel, can provide inputs that are useful under all but the most extreme system reconfigurations.

The information presented in this chapter is typical, as opposed to site-oriented. The term "typical" as used here, has connotations that might be slightly different from its usual usage. "Typical" generally implies that the possibilities addressed are not intended to be all inclusive, but merely indicative of the range of situations that may be encountered. The intention in this chapter is, therefore, to address as many contingencies as possible and to leave it to the personnel responsible for engineering a given location to make appropriate choices from the possibilities presented. This chapter presents guidance applicable to the solution of what are considered to be the likely individual problems. In addition, examples are presented that show how a possible set of requirements might be satisfied using the "individual problem oriented" information presented. Therefore, the information presented in this chapter is "typical" as far as the combined problems of a particular location are concerned, but tends to be "specific" relative to particular problems.

4.1 SITE PLANNING

Should the installation of the system require a new building design, or if the existing space is to be altered radically, a suggested machine layout should be made prior to any building planning.

In selecting a location for the computer installation, consideration should be given to the following:

- Availability and location of proper and adequate power.
- Space to house air-conditioning equipment (compressor and air-handling equipment location, placement of cooling tower or evaporative condenser).
- Ceiling height, outside wall area and glass area, since these factors will affect the ease of air conditioning the area.
- Work flow to other areas.
- Floor loading capacity and type.
- Proper safety and fire prevention procedures.
- Security or area control.

4.1.1 Installation Planning Checklist

Initially, a preliminary site survey should be made along the lines suggested in Appendix B. In conducting the site survey, the sample checklist (figure 4-1) may be used in order to provide a more complete and comprehensive survey report and BESEP for a particular site.

4.1.2 Installation Schedule

In addition to the BESEP and Installation Checklist, an Installation Schedule should be developed and used as an additional guideline. A generalized Installation Schedule, Table 4-1, can be used with variations to meet the specific needs of the individual installations. The schedule would be a series of milestones to be accomplished during the installation phase of the computer.

4.2 FACILITY CONSTRUCTION

4.2.1 Lighting

All lighting fixtures should be recessed within the ceiling where possible. Care should be taken that any fixtures that hang below will not interfere with equipment installation.

An average illumination of 90 minimum foot-candles measured 50 inches (76.2 cm) above the floor should be maintained in the general machine room area.

Direct sunlight should be avoided because lower levels of illumination are needed to observe the various console and signal lamps. The lights for general illumination should be sectionally controlled by switches so that a portion of the lighting can be turned off as desired.

Lighting in other areas of Computer Center should be designed to meet the following illumination levels.

Area	Illumination Level Foot-Candles at 30 Inches Above Floor
Office Area	75
Tape Library	75
Key Punch Room (min.)	90
EAM Room	75
Data Storage Room	40
Storage Room	20

MIL-STD-1472, "Human Engineering Design Criteria for Military System, Equipment and Facilities," Table XV lists additional lighting criteria. Design Manual (DM-1) NAVDOCKS should also be consulted for all architectural design.

4.2.2 Floor Construction

The floor upon which the computer will be located should be capable of supporting the equipment weights specified for the system. The floor under the equipment should be true and level. For fire preventive reasons, areas with wooden floors should not, if at all possible, be selected as sites for computer systems.

Command _____ Date _____

System Type _____ System _____ Scheduled Installation Date _____

Contact: Command _____ NAVFAC _____ FTA _____ NAVELEX Hq _____

Contractor _____ GSA _____ Bldg. Contr. _____ Other _____

Vendor Representative _____

Field Engr. (FE) _____ Field Mgr. _____

SITE

Computer Room Area _____ sq. ft. Dimensions _____ x _____ Adequate - Yes ____ No _____

Existing Facilities _____ New Construction _____ Estimated Completion Date _____

Storage Space: Forms _____ Cards _____ Tape _____ Disk _____

Location of Site (basement or floor) _____ Future Expansion _____

Proper Drainage (if below ground level) _____ Vibration _____

Rated Floor Loading _____ Raised Floor - Yes _____ No _____ Type _____

Rated Floor Height (clear space) _____ Ceiling Height _____

Observation Area: Yes _____ No _____

Access Adequate for Equipment: Corridors _____ Ramps _____ Doors _____

Elevator Ratings _____ Size _____ Rigging Required - Yes _____ No _____

Hazardous Area Adjacent - Yes _____ No ----

Maint. Area _____ sq. ft. Same level - Yes _____ No _____ Adequate - Yes ____ No ____

Is present system to be retained temporarily? Yes _____ No _____

If yes, if sufficient space, power and air conditioning available or planned? _____

Present System Type _____ KVA Load _____ BTU Load _____

Remarks - Site: _____

AIACOO9

Figure 4 - 1. Sample Installation Planning Checklist (Sheet 1 of 3)

Electrical Power

System Load _____ KVA

Specifications: _____

Transformer Connection _____ Delta/Wye Recommended - Yes _____ No _____

Grounding _____

Regulation Required - Yes _____ No _____ Emergency power planned - Yes _____ No _____

Distribution panel in computer room - Yes _____ No _____

Other loads on panel or feeder - Yes _____ No _____

If yes, describe: _____

_____

Remarks - Electrical Power: _____

_____

_____

Environmental Requirements

Design conditions recommended _____ ^{o}F _____ %RH.

Temperature and humidity will be controlled at _____ to _____ ^{o}F; ____ % to _____ %RH.

Temperature-Humidity recorder recommended _____ Installed - Yes _____ No _____

Methods of controlling static discussed _____

Requirements for year around operation discussed _____

Filtration and dust control discussed _____

Possible contaminants in air - Yes _____ No _____ Describe _____

BTU load of equipment _____ Estimated tons required _____

A/C capacity to be supplied: Tons _____ CFM _____ Type _____

Type of distribution: Supply and return _____

Remarks - Environment: _____

_____

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Figure 4 - 1. Sample Installation Planning Checklist (Sheet 2 of 3)

Layout and Cable Order

Layout reviewed: Date: _____

Service clearances maintained: Yes _____ No _____

Meets cabling requirements: Yes _____ No _____

Service requirements (line-of-sight, access, etc.): Adequate - Yes _____ No _____

Plan adequate for: Workflow - Yes ___ No ___ Expansion: Yes ____ No _____

Cable order: Date due _____ Date ordered _____

Remarks - Layout and Cable Order: _____

_____

_____

Teleprocessing and Remote Terminals

Types _____

Command supplied line or multiwire cable specifications discussed _____

Line tests required - Yes _____ No _____ Test dates _____

Data set requirements discussed _____

Remarks - Teleprocessing and Remote Terminals: _____

_____

_____

Safety

Emergency lighting _____ Emergency exits _____

Fire detection system - Yes _____ No _____ Type _____

Sprinkler system - Yes ____ No _____ Sprinkler head rating _____ ^{o}F

CO_2: Portable _____ CO_2 Flooding: Manual _____ Automatic _____

Other _____

Emergency power off switch - Yes _____ No _____

Housekeeping _____

Remarks - Safety: _____

_____

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Figure 4 - 1. Sample Installation Planning Checklist (Sheet 3 of 3)

Table 4-1. Installation Schedule

SEQUENCE OF DELIVERY ITEMS	TIME PRIOR TO DELIVERY	EVENTS
1.	Nine to 18 months before system delivery	Brief description of system components Equipment list and system power requirements Air-conditioning requirements, plenum, ambient Fire protection system Building requirements, any unusual restricting housing requirements Review manufacturer's delivery schedule
2.	Five to 9 months before system delivery	Air-conditioning requirements reviewed Power requirements reviewed Review site construction progress
3.	Three to 6 months before system delivery	Systems equipment layout made and approved Systems design frozen Review site construction progress Installation work schedules derived
4.	One to 2 months before system delivery	Determine detailed requirements involved in moving equipment from the delivery platform to the computer system's final installation area Preparation made for supplying miscellaneous hardware, expendable materials, and engineering assistance during system installation Review manufacturer's shipping schedule ADP readiness survey
5.	Four to 5 weeks before system delivery	System cables delivered and installed Power panels wired, M/G and M/G controllers installed Maintenance facilities and shops established, required test equipment available
6.	Two to 3 weeks before system delivery	Air conditioning equipment installed, tested, and ready for operation Power panels checked, (number and type breakers per power panel) Electrical facilities, lighting, floor ramps (portable or permanent), painting, plastering and decorating all complete
7.	One week before system delivery	Complete inspection of computer system area Final arrangements completed for equipment handling

a. Types of Flooring. Flooring is usually one of two types: raceway or false. Raceway flooring is a solid concrete floor with trenches at appropriate locations for wiring and cables. See figure 4-2. The main advantages of the raceway floor are that it is solid and virtually vibration-free. However, it offers very little flexibility. For this reason, the raceway floor is not often used in computer installations.

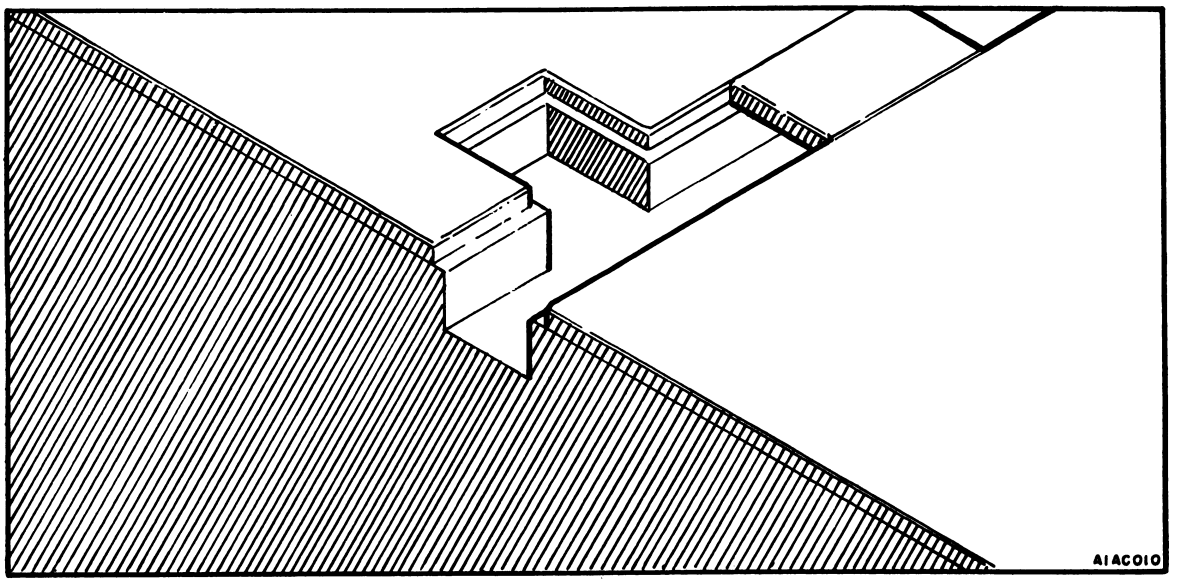

Figure 4 - 2. Raceway Floor (Covers Removable)

Raised or false floors are used for most large third-generation data processing installations. For this reason the remainder of this section will be dedicated to this type of flooring.

Some advantages afforded by a raised floor are:

o Facilitates and conceals routing of signal cables and power wiring.

o Greater flexibility in locating equipment.

o Greater flexibility in equipment relocation or expansion.

o Distribution of cooling air for the equipment (not all systems).

o Better weight distribution for some of the heavier cabinets and capability of increasing structural floor load capacity.

If a new building is to be constructed, it is advantageous to install the computer room floor 8 to 12 inches (15 to 30 centimeters) lower than the normal building floor. The raised floor can then be installed flush with the normal building floor, eliminating the need for ramps.

Power wiring from the distribution panels to the equipment is generally routed beneath the floor in ducts, raceways, or other approved devices to simplify maintenance. This wiring is provided by the user and should conform to local wiring codes. The routing of signal cables under a raised floor should also comply with the local wiring codes.

Most raised floors are not watertight and if an open or non-waterproof raceway is used beneath them, wet mopping of floor may result in a serious shock hazard to cleaning personnel. It is, therefore, recommended that suitable precautions be taken to protect all underfloor power wiring.

b. Floor Requirements. The raised floor system shall be a product of a manufacturer who is regularly engaged in the production of raised floor systems. The system shall include modular prefabricated structural floor panels supported by a pedestal system or a pedestal-stringers system, as standard with the manufacturer. The system shall be designed to permit self-alignment of panels. Panels shall be of one size, except where odd-sized closure panels may be necessary at wall, columns, pipes, ducts, or other projections through the floor, or because of construction irregularities. The pedestals shall be adjustable to the extent that a uniformly level and true floor surface will be provided. The floor panels shall have a homogeneous vinyl tile-wearing surface. The panels, with the exception of closure panels, at walls, columns, etc. shall be readily removable from the top side by means of a suction lifting device, in order to provide free and easy access to all, or any part of the concealed space beneath. Before any work is started, the concrete slab or other structural sub-base shall be checked for elevation with an instrument at 10-foot intervals in both directions. Any excessive irregularities, which cannot be rectified by adjustment in pedestal height, shall be corrected before the floor system is installed.

c. Design Loads. The weights listed in the equipment data sheets provided by the manufacturer shall be used to calculate floor loading.

Equipment with casters or leveling pads will present concentrated loads and should be considered in this light.

Floor loading should be checked for both the raised floor and subfloor. In calculating loading for the subfloor, these items should be considered in addition to equipment weight.

- o Weight of raised floor - approximately 10 pounds per square foot (48.7 kilograms per square meter).
- o Weight of signal cables - approximately 0.4 pound per foot (0.6 kilogram per meter).
- o Weight of power cables and ducts - approximately 2.0 pounds per foot (3 kilograms per meter).

Floors which have small individual panels, e.g., 2 feet by 2 feet (0.37 square meters), are usually able to withstand greater loads than those with larger dimensions. In addition, small panels are easier to handle when making layout changes.

The suggested maximum design load for raised floor systems in 1000 pounds concentrated load or 250 pounds per square foot uniformly distributed load. The design stresses should provide a safety factor of not less than 2, based on the yield strength of the material being used.

d. Floor Installation. The floor system shall be installed in accordance with approved shop drawings and the manufacturer's instructions, except as specified in the latest type specification published by the Naval Facilities Command, TS-F12B, edition of 21 March 1967.

e. Water Alarm Indicator. The normal room floor (under the raised floor) should be equipped with one or more devices to warn of the presence of water in the event of a broken pipe or hose. A float-operated switch controlling both an audible alarm and a sump pump is recommended.

4.2.3 Ceiling Construction

The structural ceiling in the computer area should be watertight, where possible, to reduce the possibility of water damage to the equipment from water coming from the floor if so situated. In multistoried buildings, the floor above the computer room should be made reasonably watertight to avoid water damage to equipment. Any openings, including those for beams and pipes, should be sealed to watertightness.

An acoustical, suspended ceiling, in the computer room, to aid in reducing the noise level and to enhance the appearance of the area, is recommended. The suspended ceiling is practical for mounting fixtures, and will conceal water pipes and air conditioning ducts. The area above the suspended ceiling may also be used for a return air plenum allowing greater flexibility in the location of return air grilles. Some systems require a suspended ceiling at the 96-inch height so that all cabling and power wiring may be routed in the overhead ceiling area.

A minimum of 8-1/2 feet between the equipment floor level and the ceiling should be provided with the optimum being 10 feet. In rooms where the floor area is small, the ceiling should be 9 or 10 feet to insure adequate ventilation.

A commercial-type ceiling is recommended, mounted on a mechanical suspension system with removable angles or T-bars between panels. The suspended ceiling shall be of noncombustible construction, with a flame-spread rating of 25 or less (see NFPA Standard Method of Test of Surface Burning Characteristics of Building Materials, No. 255).

4.2.4 Wall Construction

The computer area should be enclosed by walls on all sides, from structural floor to structural ceiling, with entrances and fire exits as required. Existing wall structure will be utilized wherever possible in determining the system layout plan. Reconstruction of walls, entrances, etc., may be necessary to obtain a desirable layout.

All walls and partitions should be of a noncombustible material that has a flame spread rating of 25 or less. The fire resistance rating of the walls will depend upon the exposure to other areas, but should not be less than one hour.

4.3 ACOUSTICS AND VIBRATION

The principal sources of noise in the computing system are electromechanical mechanisms such as printers and card punches. These should be located in an area where relatively high noise level is not objectional. Although not essential for system operation, the user may desire to acoustically treat the computing area as follows:

o The floor construction should be of a nature that will retard vibration to other areas.

o Walls should be constructed to prevent the transmission of noise to the adjacent areas. Walls should be constructed from the floor to the base ceiling and properly sealed. Wall surfaces should be made soft to prevent reverberation.

o The doors must have a good seal.

o Greatest sound reduction is obtained by properly treating the ceiling. The best results are obtained when a porous drop ceiling is used. Care must be taken with overhead duct work if there is a requirement that the noise generated by the computer system is not to be transmitted to other areas. See NAVDOCK's DM-1, Chapter 10 for additional guidance.

The vibration in the computer area must be negligible. Most system will withstand Richter Scale shocks or intermittent vibrations occurring at low frequency. Commercial computers can usually stand sustained vibrations of up to 0.25 G (G gravitational acceleration). Should vibrations of greater magnitude be suspected, measurements should be taken prior to completion of site preparations and submitted to the equipment manufacturer for approval.

Computer equipment vibrations should also be considered, i.e., disk, drums. Any requirements to satisfy equipment vibration should be noted in the BESEP. The equipment manufacturer should be consulted as to the necessary measures needed to control the vibrations, if required.

4.4 SPACE AND LAYOUT REQUIREMENTS

Although space and layout requirements differ for each system, a few general rules can be given.

The floor area required for the system will be determined by the specific components, length-to-width ratio of the room, location of columns, provision for future expansion, and so on. In order to determine the exact area required for a specific group of components, a machine layout should be made using the measurements of the room under consideration.

Space should be provided for daily tape storage within the machine room. Space may also be needed for printer-form stands, storage cabinets, card files, work tables and desks.

The integration of the computer work area with that of other areas and with storage areas should be considered. The work flow from various punched card equipment to and from the system should be considered when aisles and intermediate storage locations are planned. Such items as permanent master document files, card files, and magnetic tape files require different types of storage areas and should be carefully planned to minimize both the amount of space necessary and the travel time between areas.

A substantial amount of test equipment may be assigned to the installation to maintain the equipment in the machine room. Some machines may be moved to the test area, depending upon the type of work to be done. These areas should be, whenever possible, on the same floor level. If they are not, ramps should be provided for moving test equipment and machine components.

The test area for a single installation should contain between 70 and 400 square feet of space, depending upon the size of the system, and be air conditioned to the same specifications as the machine room. The air conditioning should be sized to include the heat load of at least one magnetic tape unit.

4.4.1 Layout of Machine Components

Operational requirements should determine the specific location of the various components in the machine room. However, because the separate components are connected by cables of restricted length, and because of space limitations, priority, and the necessity of maintaining clearances between machines for servicing, work space, and aisles, the user may need to prepare and analyze several tentative layouts before deciding upon the final one.

Because each user has a different room size, column spacing, a combination of machine components, and a different procedure for using auxiliary input/output units, each installation should be considered individually to reach the best arrangement.

To make a layout, it is necessary to prepare an accurate scaled drawing of the proposed area. Templates, available from the manufacturer, show the clearances required to allow maintenance between equipments and cable hole locations.

Machine components must be located so that the length of connecting cables will not exceed maximum limits. These limits are different for each type of machine; charts showing the limits may be found in the manufacturer's installation.

4.4.2 Human Engineering

In addition to the physical restrictions of the actual pieces of equipment, evaluation of human-factor engineering principles is also essential in the layout of a computer center.

To give more understanding to these principles, this paragraph briefly summarizes a recent study of the computer operator's relationship to peripheral devices. ("Computer System Peripherals and the Operator" by Wilbert O. Galitz and Thomas J. Laska, initially written in the Sperry Rand Engineering Review and reprinted in Computer Design, August 1969). Several typical large-scale system computer centers were analyzed with the following peripheral devices; magnetic tape units, printers, card readers and card punches. The amount of time spent each day by the typical operator at these devices and the kinds of activities in which the operator engaged during this time are illustrated in figure 4-3.

It can be seen that peripherals account for about one-quarter of the operator's time, and peripheral-related activities require about one-quarter of his attention. Of significant interest in figure 4-3 is the large portion of time the operators spend not performing any physical activity. This category, called inactivity/monitoring, includes all situations in which the operator is not actually physically engaged in performing a task. He may be waiting for some action to take place, monitoring system functioning, or making idle talk.

It is useful to view the computer center components in terms of the proportion of inactivity/monitoring time associated with operation, figure 4-4, as contrasted with physical activities (such as punched card handling, printer paper handling, etc.). For the majority of time an operator spends at a magnetic tape unit he is engaged in a physical activity (i.e., mounting or dismounting tape, lowering or raising doors, or activating switches). Contrast this with the console where a greater proportion of time is spent in no physical activity (i.e., inactivity/monitoring). Similarly, when he is moving about the system, he is not usually engaged in a physical activity (i.e., carrying tape, cards, etc.). Peripherals generally require a larger relative amount of physical activity than do other system components.

The time spent at peripherals is defined by the number of trips to the devices and how long these trips last (figure 4-5). For one-half of all trips, the operator remained at the device no longer than 10 to 15 seconds. Only at the console did he stay for a substantially longer period of time. It was also found that 90% of all operator trips to devices were no longer than 40 to 50 seconds in duration.

Figure 4-6 is a composite based on all sites visited showing the operator's movements between components.

o Equipment Layout. As part of the study, the operators were asked to specify their equipment layout preferences. What did they want to see from the console? How would they position each piece of equipment with relation to the console?

The results are summarized in figure 4-7. In the usual computer installation the operator is constantly bombarded with auditory and visual stimuli. These stimuli may take the form of an indicator on a control panel or the sound generated by the impact of a high-speed printer's hammers on its paper. Through these "displays", he assimilates information with respect to his performance goals and maintains control of his environment.

The data collected during the study led to the preparation of a site layout model (figure 4-8.) In this model, components have been placed so they are visible to the operator and require minimum operator movement. The arrangement provides a functional grouping to reflect the normal flow of data within the center.

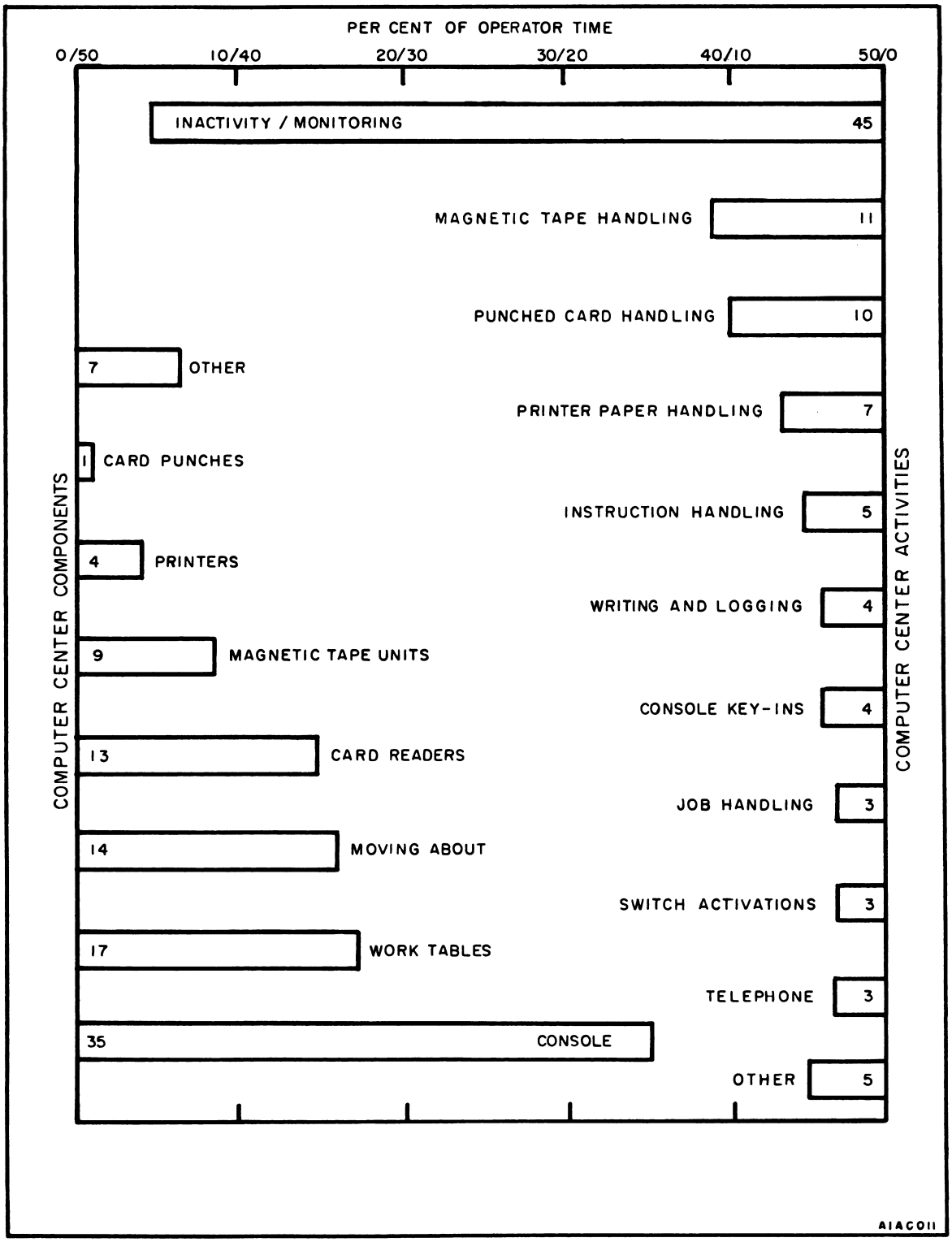

Figure 4 - 3. Percent of Operator's Activity Time
(Courtesy of Sperry Rand Engineering Review/Computer Design)

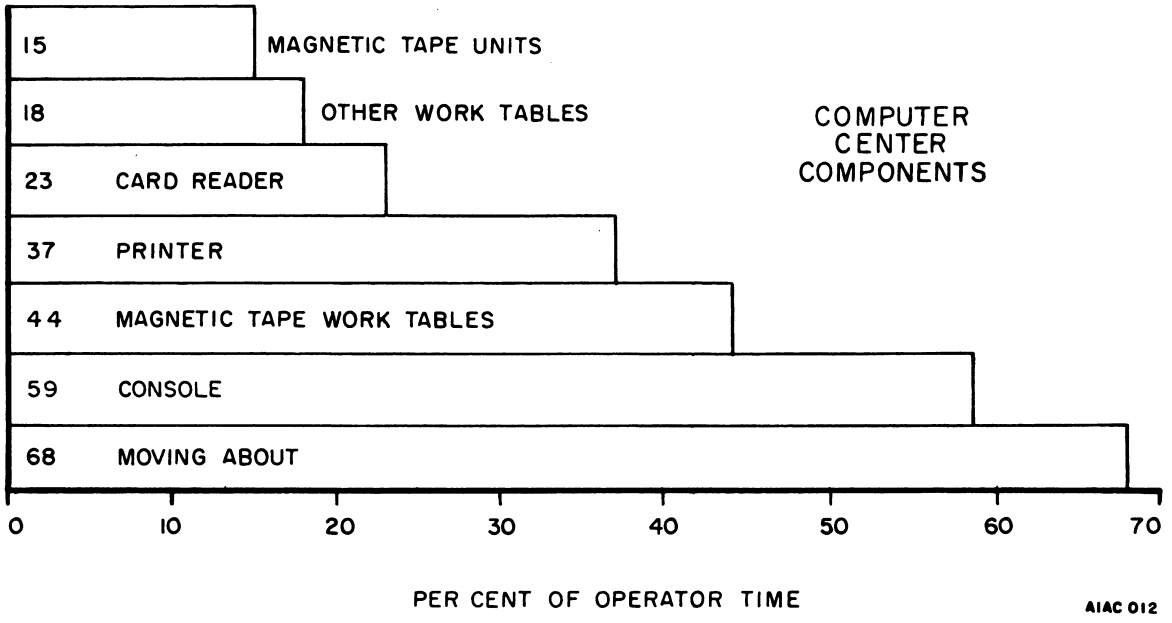

Figure 4 - 4. Percent of Operator's Monitoring Time
(Courtesy of Sperry Rand Engineering Review/Computer Design)

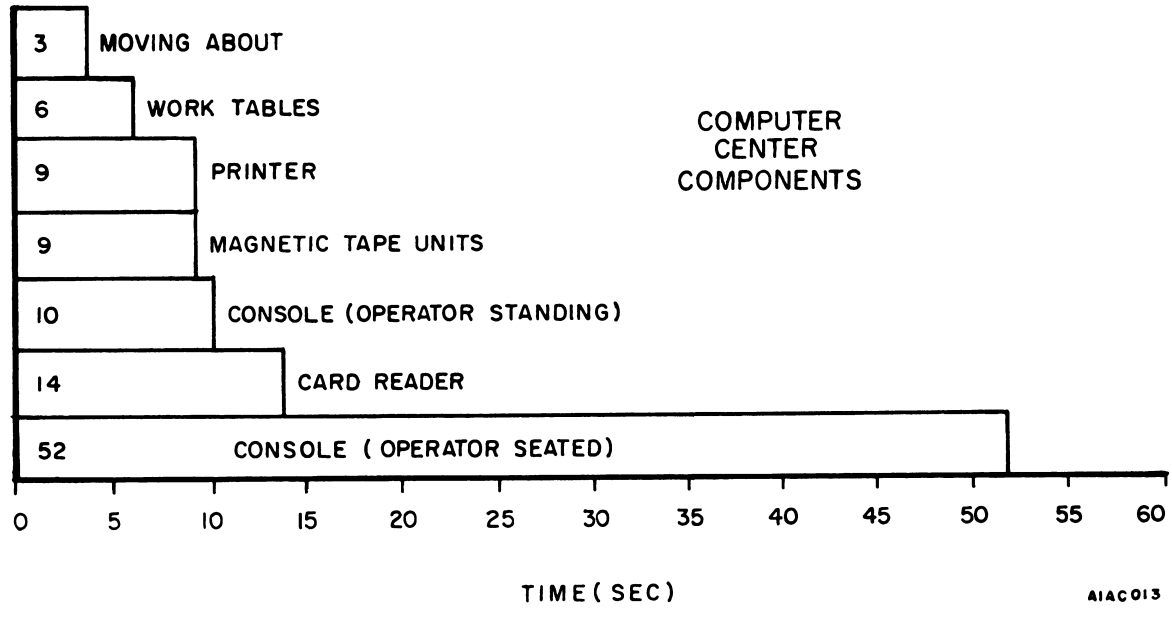

Figure 4 - 5. Median of Operator's Movements
(Courtesy of Sperry Rand Engineering Review/Computer Design)

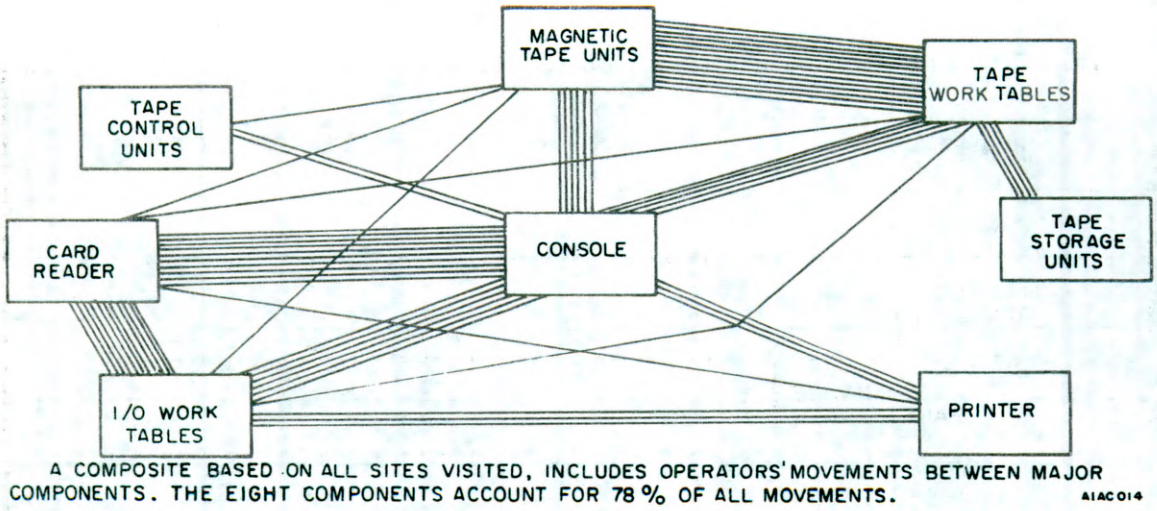

Figure 4 - 6. Schematic Diagram of Operators' Movements
(Courtesy of Sperry Rand Engineering Review/Computer Design)

4.4.3 Ancillary Space Requirements

In choosing a layout for a computer room, attention must be given to the layout of the entire data processing center. Besides the computer room, this includes the data storage room, tape/disk library, keypunch room, office space and production control. The need for future expansion should always be considered.

a. Data Storage and Tape/Disk Library. Size of the rooms will depend on amount of active storage need to support the computer operation.

Their location should be adjacent to the computer room to permit rapid retrieval and return of all material.

Air conditioning and special type storage facilities are required as outlined in paragraph 5.2.2.

b. Keypunch Room. Size of room will depend on the amount of keypunching activity needed to support the computer operation.

The location is not required to be adjacent to the computer room. Consideration also has to be given to the noise, heat and dust created by the operation of the machines as to its location.

While air conditioning is not required, a comfortable temperature and atmosphere should be maintained.

c. Office Space. Office space for the analysts, programmers, and computer operating personnel are usually provided near but not directly adjacent to the computer room. The distance helps prevent distracting the staff for trivial reasons and provides quieter office space.

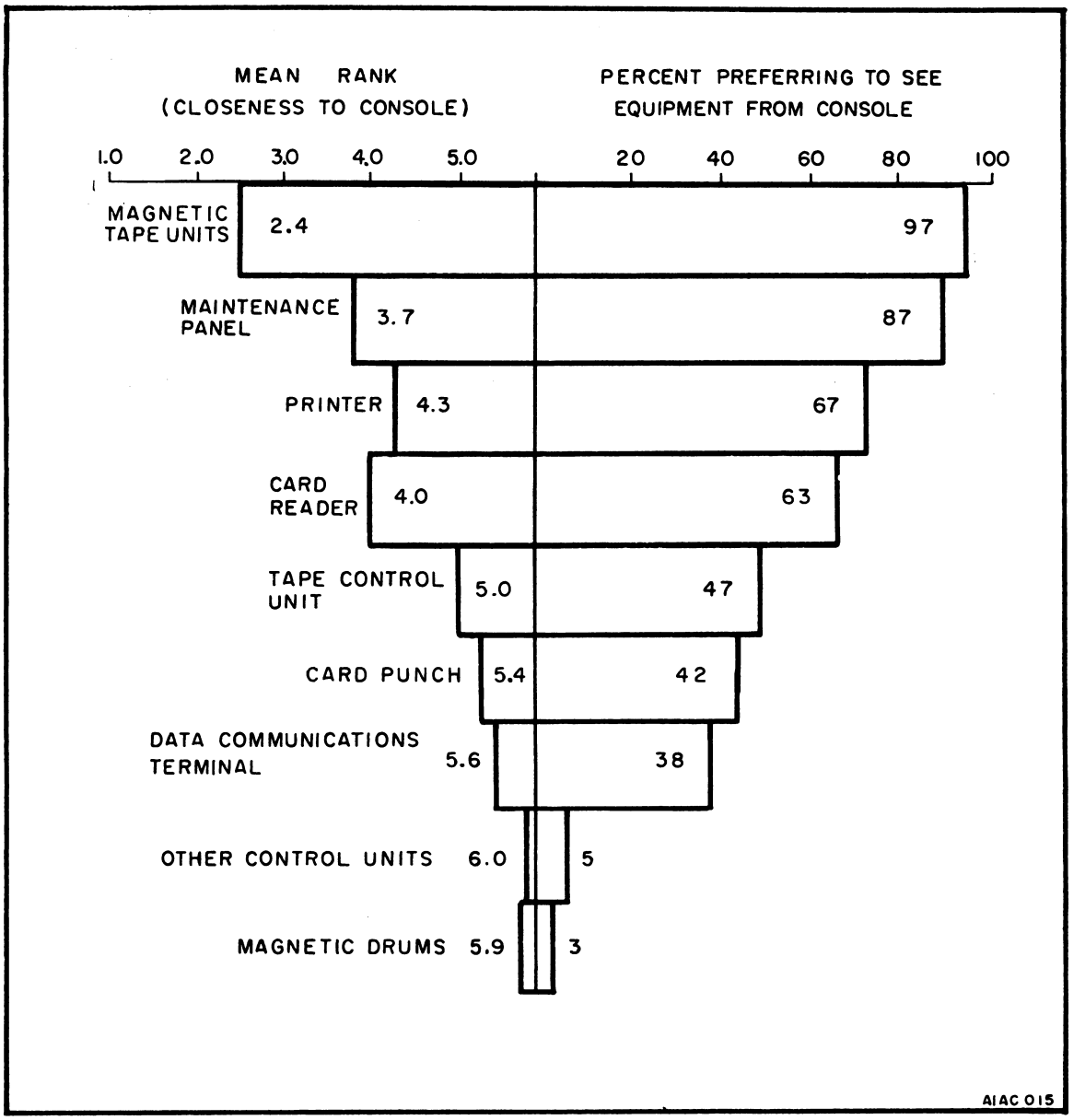

Figure 4 - 7. Operator Preferences for Equipment Location

(Courtesy of Sperry Rand Engineering Review/Computer Design)

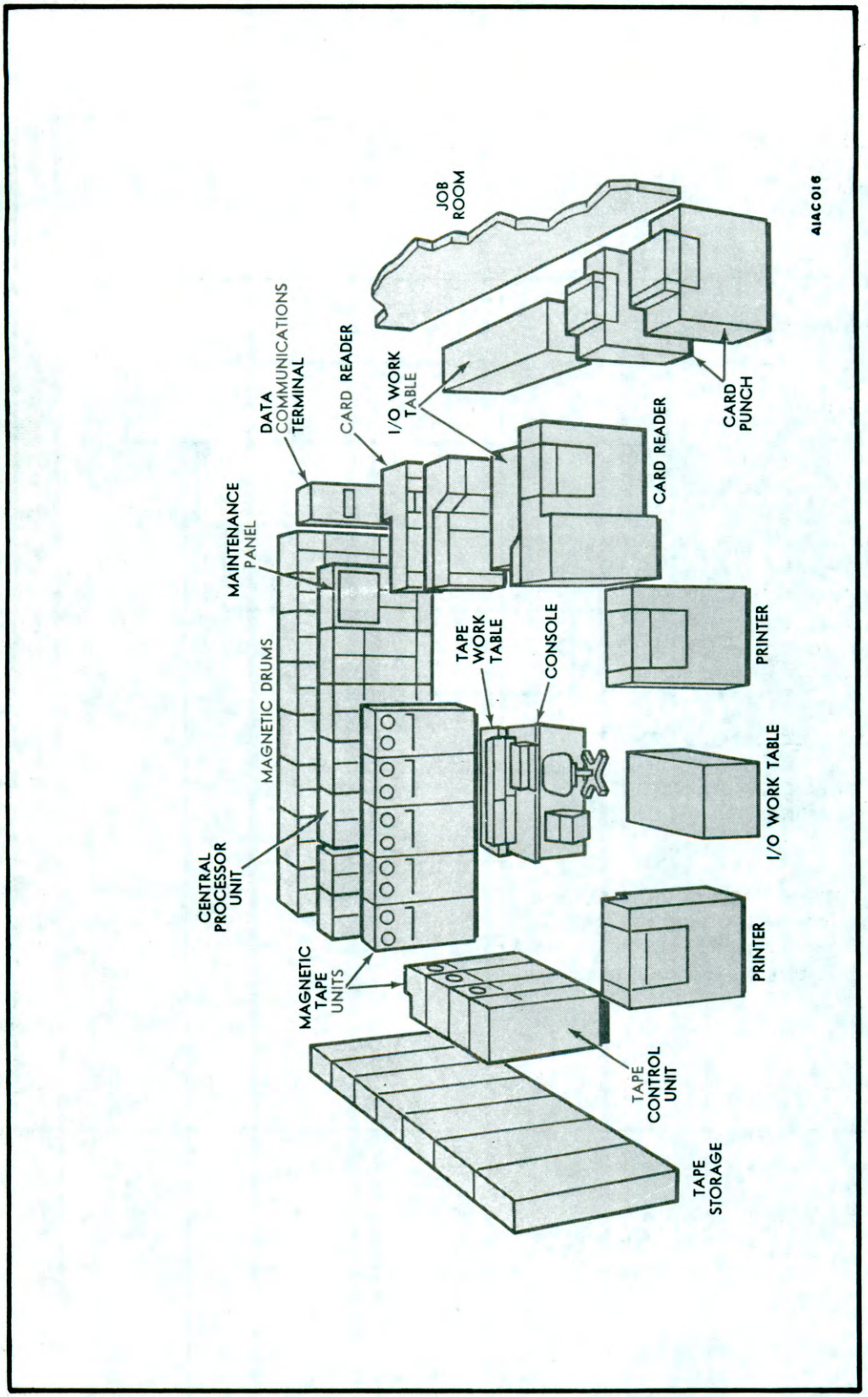

Figure 4 - 8. Recommended Site Layout
(Courtesy of Sperry Rand Engineering Review/Computer Design)

A comfortable temperature and atmosphere should be maintained. The size will depend on the number and type of personnel who will occupy the space. More area will be required if supervisory personnel have private or semiprivate spaces.

Locating of water coolers, lavatories and other facilities should be considered to minimize time away from work.

d. Production Control Room. Size of the room will depend on the amount of activity of the computer center users. This room will accept all external job requests and provide a space for pickup of all finished jobs. A counter and an array of storage boxes is generally required.

The room should be located adjacent to the computer room to reduce the amount of time lost in delivery and picking up completed jobs.

A comfortable temperature and atmosphere should be maintained.

4.5 AIR CONDITIONING

Temperature and humidity in the computer room should be controlled within the limits given in the manufacturer's equipment data sheet, if at all possible. The limits prescribed are not the same for all computer cabinets and peripheral devices. The requirements of all equipment in the system should be considered in determining the temperature and humidity limits for the installation.

The air-conditioning equipment shall conform to the requirements of NFPA No. 90A Standard for the Installation of Air Conditioning and Ventilating Systems of other than residence type, and to the additional requirements set forth in Section 7100 of NFPA No. 75, "Standard for the Protection of Electronic Computer/Data Processing Equipment."

4.5.1 Design Requirements

Continuous, reliable operation of any computer system depends on an efficient, well-designed and properly controlled air-conditioning system. Lack of adequate cooling is as contributive to failure as is inadequate regulated power.

Even though certain individual units may be operated outside the limits of the overall specifications, the system environmental requirements are dictated by the most restrictive unit of the system. The requirements of the computer system are the major considerations in design of the air-conditioning system. However, good design will also consider personnel comfort and architectural design.

An air-conditioning system for a computer installation differs from ordinary comfort air conditioning as follows:

o Heat dissipation by the computers is relatively constant; therefore, cooling is required on year-round basis.

o The computer room sensible heat ratio is near unity, because heat dissipated by the computer system is all sensible.

o Above-average air filtration is required to prevent errors caused by dust particles on magnetic tapes.

o Number of air changes per hour varies between 30 and 60 because of the high heat dissipation of the computer equipment.

o Humidity control is required year round to maintain necessary humidity conditions in the computer room.

As in any other air-conditioning system design, the point of departure is the establishment of indoor-outdoor design conditions. The outdoor design conditions depend on the geographical location of the computer site and are as specified by the latest issue of the NAVFAC P-89. The indoor design criteria varies somewhat for different makes of computer equipment and it is of paramount importance for the air-conditioning engineer to obtain the design criteria from the computer manufacturer. This information is readily available from the computer manufacturer's Installation Planning Guide.

The engineer must also familiarize himself with computer equipment from the thermodynamic and construction point of view. How much heat does it dissipate? Does it take the air through the bottom openings or through the sides? Does it have internal fans in the cabinet? All these answers can be found in the computer manufacturer's Installation Planning Guide. Then the type of air-conditioning system can be selected. (Note, usually computer room air-conditioning systems are a separate system serving only the computer. However, depending on site location and size of equipment, this requirement may not be necessary.) The engineer should determine whether the cooling load will be fixed or whether a provision need be made for future expansion. Is the computer operation around the clock, seven days a week, or only 40 hours per week? Provisions to prevent over-cooling of the computer rooms during the ADP equipment downtime must be made, since low temperature and high relative humidity is detrimental to the computers. Then, the type of air distribution system can be selected. Several methods of air distribution are acceptable and will be discussed in later paragraphs.

4.5.2 Air-Conditioning Systems

The computer room air-conditioning system is generally separate and independent from the building system for the following reasons:

- o System must operate year-round
- o Temperature and humidity must remain relatively constant
- o Computer system load is all sensible.

The system should conform to the requirements of NFPA Standards No. 90A and No. 75 as previously stated.

Basically, the selection of the computer room air-conditioning system is not different from any other system. Thus, depending on the load, the system selected can be packaged units with direct expansion coils or a centrifugal chiller with a number of air handling units. When making the selection, it must be remembered that the sensible to total heat ratio of the computer room is near unity and, therefore, the cooling equipment should be selected for maximum sensible cooling capacity and minimum dehumidification capacity. This is extremely important for small computer installations where packaged units are selected, since their nominal sensible heat factor is approximately 0.75. Thus, whenever possible, a split packaged system should be selected which allows variation of the fan-coil section.

The air-conditioning manufacturers, recognizing the potential in the computer industry, designed a special packaged air conditioning unit for computer room application. This unit is a self-contained system for accurate control of temperature, humidity and cleanliness to meet the exacting requirements of computer rooms. These units are modular and have capacity range of 3 to 15 tons. The average sensible heat factor is above 0.90. The most common application of these units is with a down-flow arrangement, discharging the air directly to the underfloor plenum and returning the air through the top of the cabinet. These units are also available with an up-flow arrangement. Most of these units are sold by the computer floor manufacturers, although there are several independent manufacturers.

For better environmental control, zoning should be considered for larger computer system installations. Zoning is generally required where more than three computer systems are located in one room.

4.5.3 Design Procedures

The design procedure for a computer installation shall follow standard engineering practices in making calculations of heat gains and losses. However, an understanding of equipment layout within the space is necessary in order to provide heat gain calculations that are accurate in relation to space use.

a. Internal Equipment Loads. The design engineer should place the heat rejection from each system component on the system layout plan. This procedure will identify the area of high heat dissipation and will assist in determining the air distribution requirements. Some computer equipment may be subject to variation in use; however, the calculations should be based on worst-case conditions with maximum heat rejection from all equipment. The total heat load should include a consideration for future computer system expansion. If specific future expansion plans are not available, a factor of approximately 25% of present equipment heat load should be added.

b. Building Loads. When all the system component loads have been indicated on the layout drawing, the design engineer is in a position to prepare the heat gain and loss requirements of the building or area. The procedures for determining these loads are the same as used in an office building or office area.

c. Zoning. A study of the internal heat gains by areas and a study of the building heat gains or losses will allow the designer to establish whether zoning is necessary. In most instances, one zone will be required to serve the interior area. If the space has exterior walls, it may be necessary to provide a zone to handle the entire perimeter.

d. Outside Air. The fresh air requirements are small and should be based upon the number of persons occupying the area for periods of one hour or longer. Twenty cfm of outside air is recommended for each person. This quantity will not cause undue swings of humidity within the space.

e. Temperature Control. The space thermostat should be capable of controlling the dry-bulb temperature within 1-1/2 degrees above and below the set point of 72^{o} F (22^{o} C).

The key to good final control within each space lies in obtaining the proper apparatus dew point with the corresponding wet bulb and dry bulb air temperatures leaving with air outlet. With these conditions properly maintained, it is necessary to have only a single space thermostat in each zone. This space thermostat should control temperature components and should have priority control over the humidity control.

The outside air opening is usually provided with a motorized damper to open and close as the air handling unit is running or shut down. The quantity of fresh air taken into the system shall be controlled by a manual damper in the outside air opening.

The use of multiple-circuit refrigeration units on a water chiller controlled by a sequencing switch or unloaders make it possible to accurately maintain the proper temperature of water to the cooling coil. The quantity of water entering the cooling coil should be controlled by a 3-way valve that is positioned in relation to room temperature.

The placement of the zone thermostats is important and their location should be made on the same computer equipment layout from which the heat gain calculations were made. The designer can then be certain that the particular zone thermostat will sense conditions that are average for its specific area and will not be subject to the performance of a specific component within the zone.

f. Humidity Requirements. In areas with outside design conditions lower than $+10^{o}$ F (-12^{o} C), it will be necessary to install a humidifier to add moisture to the air to compensate for the dry air entering the space by infiltration and ventilation.

The relative humidity in a computer installation is generally maintained between 40% and 50% but should satisfy the manufacturer's requirements. The space humidistat should be capable of controlling the relative humidity within 5% of the set point. In cold climates, the area of outside-exposed glass should be minimized to prevent condensation on the inside glass surface.

The type of humidifier selected should be one that is easily maintained and provides moisture without adding sensible heat to the air stream. If, however, a system is chosen that does add sensible heat, it should be considered in the load calculations. A humidifying section in the air-handling unit that sprays water directly on the cooling coil is not recommended as the mineral buildup that will occur on the coil surfaces will result in loss of efficiency on the air and water sides of the system. The live stream humidifying method is considered the better type.

g. Monitoring Programs. It is essential that continuous service be provided for a computer installation; therefore, it is recommended that a monitoring program be established whereby abnormal conditions may be sensed prior to failure of the system. It is recommended that alarm devices be provided to indicate an abnormal condition on (1) the chilled water to the cooling coil, (2) the dry-bulb temperature of the air leaving the apparatus, (3) the space conditions for the respective areas. These alarm devices must be independent of any alarm devices built into the computer equipment. In addition, the computer system operating personnel should maintain a daily log of the operation of the air-conditioning system with respect to at least two points:

- o Chilled water temperature
- o Return-air dry-bulb temperature.

A scheduled maintenance program should be established on the equipment maintaining the space environment. A log on each piece of environmental equipment should be updated at each scheduled service period, thereby permitting maintenance personnel to actually measure the conditions provided in relation to design conditions established on the log sheet.

There are two main types of air conditioning usually recommended by manufacturers unless the system is really unique. The first system uses only the room air for cooling; the second type has the conditioned air entering from beneath the raised floor through registers.

The following information is needed by the air-conditioning engineer to make the load calculations, select the best type of air-conditioning system and prepare working drawings from which accurate cost estimates for an air-conditioning system that meets the specific requirements of a particular site.

No attempt is made to delineate the limits of operating conditions for the computer equipment. The Equipment Data Sheet or Installation Planning Manual contains the allowable ranges of inlet air temperatures for the individual units in the system.

4.5.4 Room Temperature System

The inside design considerations for a computer installation shall be based on the manufacturer's specifications. The following temperature and relative humidity are typical criteria:

- o Temperature 72^{o} F (22^{o} C)
- o Relative humidity 50% (60.1^{o} F WB)

Computer installations having outside walls should maintain the inside wall and glass surface temperature above the maximum dew point of the room air. In geographic areas having outside design temperatures below $+10^{o}$ F (-12^{o} C), a controlled heat source near the floor may be necessary along all outside exposures.

The heat source should have a capacity sufficient to meet 50% of the total transmission loss through the wall and glass areas. Where outside design temperatures are above +10°F (-12° C), it should not be necessary to have a controlled heat source near the floor.

The following gives a basis for determining the requirements for a computer installation where the equipment is to be cooled with air at room temperature.

a. Methods of Air Distribution. It is said that no air conditioning system is better than its air distribution. This could not be more true than in computer room air conditioning. The cool air is vital to the computer and, unless it is delivered to the proper place, the computer will malfunction.

Depending upon the make of the computer, the cold air is introduced through openings in the floor under the cabinet or through registers located in front and back of the cabinet. When using the method of air distribution from under the flooring, cable openings under the computer cabinets, depending on manufacturer's requirements, are usually sealed. This aids in the prevention of any damage to the computer components by cold and humid air and allows for proper air balancing throughout the computer room. In some computer rooms the underfloor plenum is used for return air and cold air is introduced from ceiling diffusers, light troffers and/or "Airson" ceiling panels. This type air distribution is especially ineffective in computer rooms with a ceiling height under 10 feet because of the large quantities of air being moved. In such cases, special directional ceiling-mounted air-distribution devices should be used.

(1) Ceiling Mounted System. The air distribution may be either a ceiling plenum, which uses the suspended ceiling as the supply diffuser, or overhead ducts with individual ceiling diffusers. See Figure 4-9.

The quantity of air required for specific areas within the computer room will be dictated by the equipment layout. Air quantities must be supplied in relation to the dissipation of heat which occurs in the computer room. When a ceiling plenum air distribution system is used it may be necessary to provide a supplementary air distribution device in the suspended ceiling to deliver the increased volume of air required to absorb the dissipated heat.

Certain computer equipment cabinets employ self-contained cooling devices. Supply air should include the effects of this equipment.

The return air inlets should desirably be located either high on the walls or in the ceiling. It is desirable to have the return air inlets near the areas of greatest heat rejection. Dust-producing equipment should be located near the return air inlet with respect to other equipment in the room.

The air-conditioning duct system shall be balanced after the computer equipment is installed and operating such that the inlet air to any equipment is within limits specified in the manufacturer's specifications.

(2) Underfloor System. This paragraph describes a room air distribution system which uses the underfloor space as a supply air plenum. (See figure 4-10.)

The supply air shall be ducted directly from the air conditioning unit to the underfloor plenum for distribution to the room. The required room air distribution can be accomplished by locating floor registers around the perimeter of the room and near equipment in relation to the heat release. Care should be given to the placement of floor registers so as to provide the necessary cooling while avoiding conditions which may cause operator discomfort.

Because of noise and draft conditions, it is recommended that the floor registers be sized to deliver the quantity of air desired at a velocity of not more than 650 fpm.

Supply registers should be provided with volume dampers to facilitate balancing air quantities and to provide maximum flexibility for future room changes.

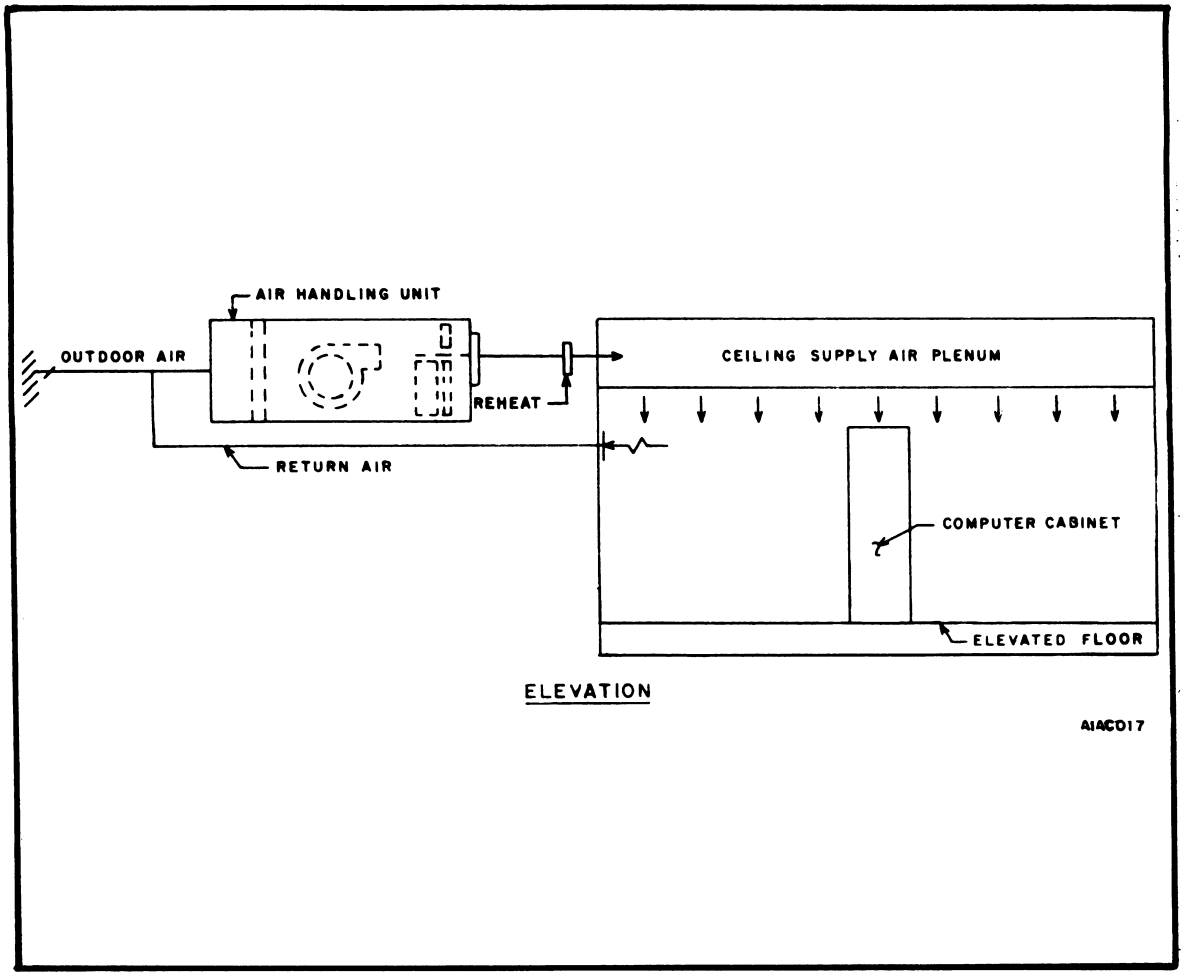

Figure 4 - 9. Air Conditioning System for Ambient-Cooled Computer Equipment
(Courtesy of Control Data Corporation)

b. Air Side Equipment. Basically, a computer installation is an office area with added internal heat-producing equipment. A typical system of air side equipment which would meet the requirements of the space is a multizone air-handling unit with the hot-deck coil omitted and zone terminal reheat provided. This type of unit provides a bypass apparatus with the capability of giving zone control by terminal reheat. By using a bypass apparatus, operating efficiencies are improved because the space sensible heat in the return air can be used as reheat.

The cooling coil must be able to provide the desired leaving air temperature while maintaining the required apparatus dewpoint. Suggested considerations for the selection of the coil are:

(1) Larger-than-usual surface area because of the high sensible-heat ratio in the computer center

(2) Lower temperature rise in the chilled water

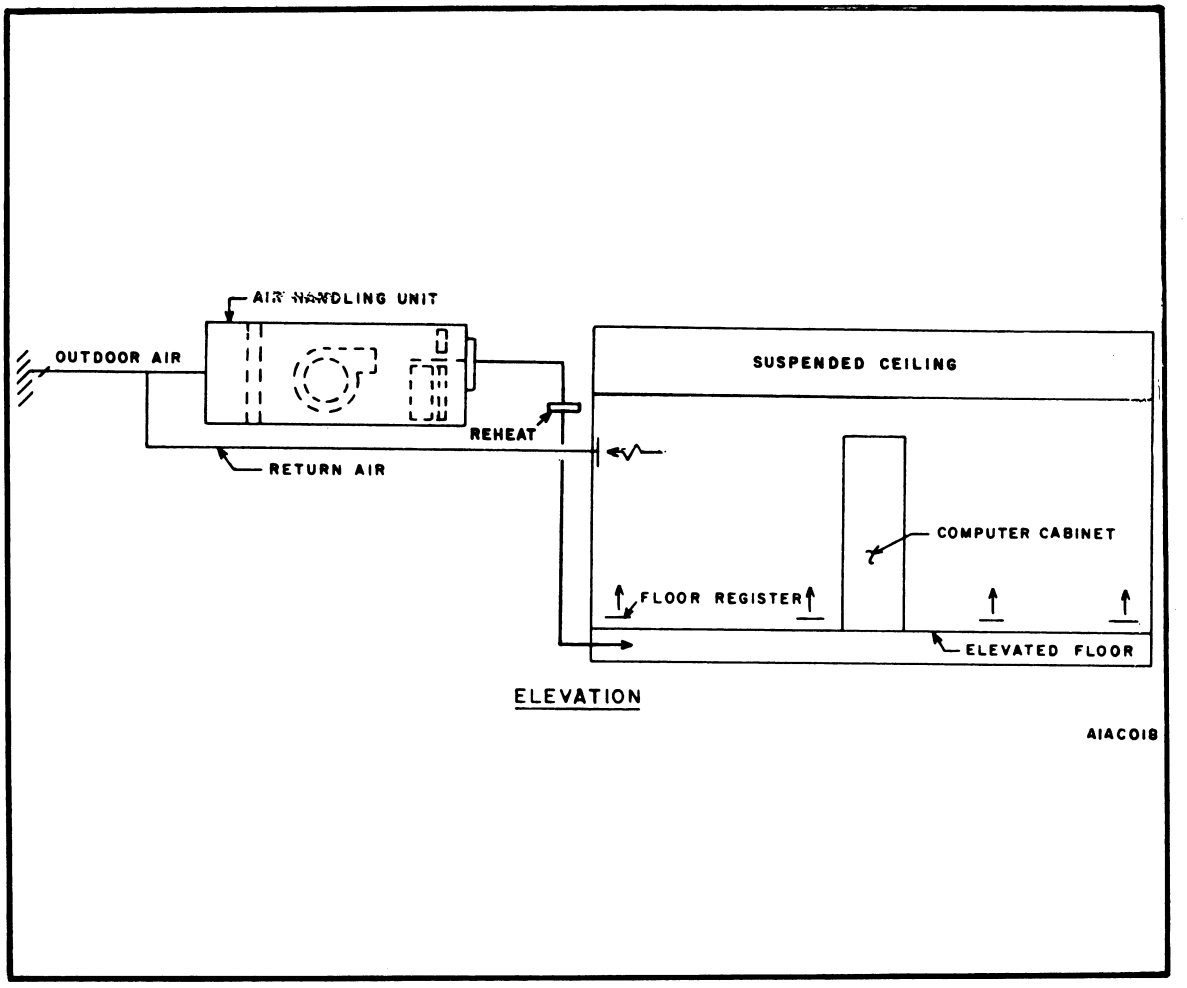

Figure 4 - 10. Underfloor Air Conditioning System for Ambient-Cooled Computer Equipment
(Courtesy of Control Data Corporation)

(3) Fewer fins per inch

(4) Higher face velocity

c. Refrigeration Side Equipment. One method of assuring a continuity of operation and minimum maintenance is to use a chilled-water system as the cooling medium. The water-chilling equipment should be the multiple refrigeration circuit type so that the loss of one circuit will not result in a loss of capability to carry the design load.

The refrigeration units should be sequenced to maintain leaving water temperatures as indicated by the coil requirements; however, it is recommended that the leaving water temperature not be lower than 42^{o} F (6^{o} C). In order to provide continuity of service and allow opportunities for maintenance, dual pumps should be provided for reliability.

d. Condensing Medium. For reliability and minimum maintenance, air cooled condensing is recommended with a condenser provided for each refrigeration compressor. With systems in excess of 100 tons, cooling towers and water-cooled condensors are recommended; however, a program of continuous water treatment is required and dual towers should be installed in order to assure continuous operation of the system.

Some computer equipments use the equipment container itself as the plenum. This type of air conditioning is the least desirable because of uneven cooling of the equipment, possible errors introduced by too much humidity, and difficulty in insuring uniform air velocity. (See figure 4-11.)

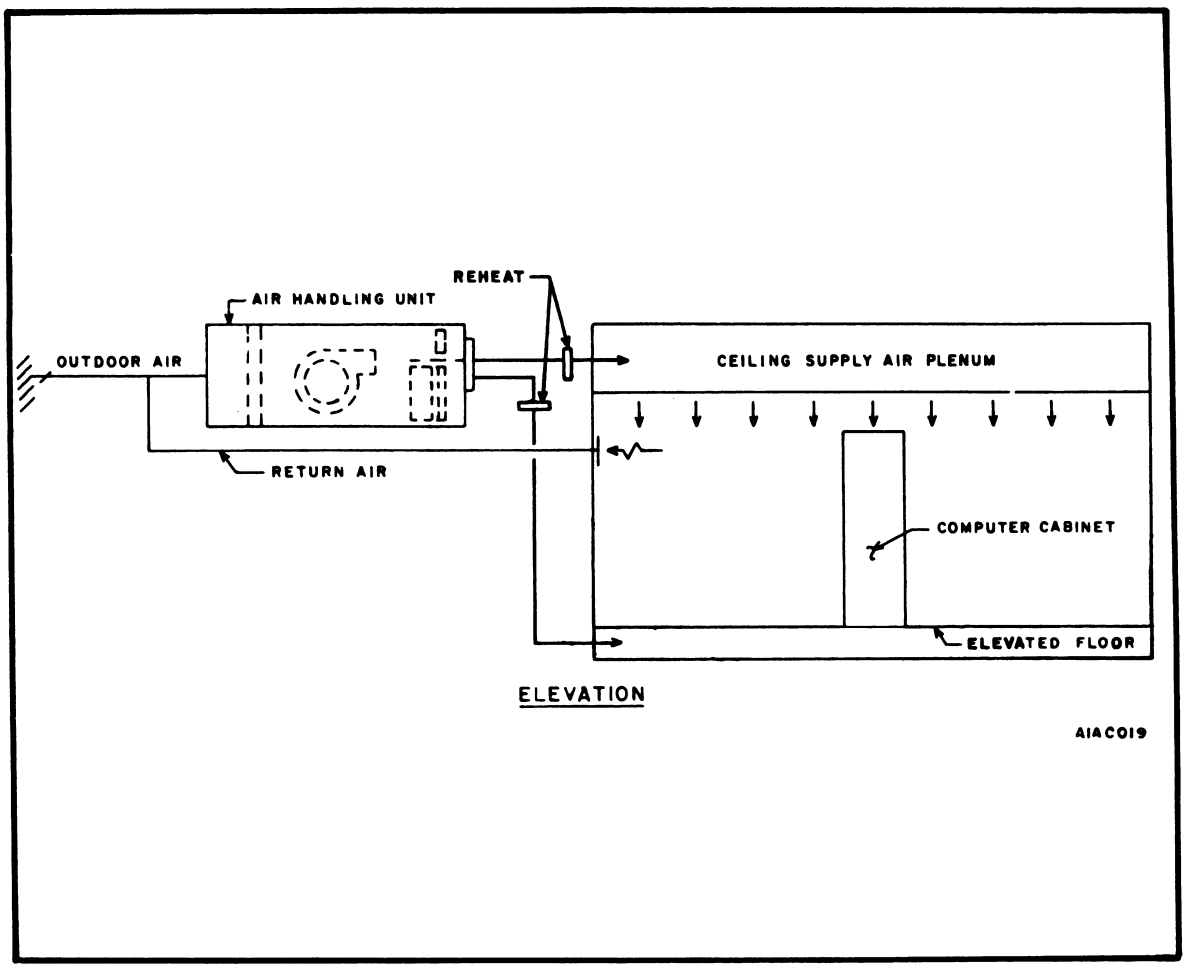

Figure 4 - 11. Air Conditioning System for Plenum-Cooled Computer Equipment
(Courtesy of Control Data Corporation)

e. Humidification. Because of the high sensible-heat load of the computer room, moisture is usually added to the conditioned air to maintain required humidity levels. The moisture added must compensate, first, for the moisture lost by exfiltration and, second, for the moisture removed by the cooling coil. Various devices may be used to accomplish humidification of the air.

- o Live stream sprays,
- o Electrically or steam-heated evaporative pans, or
- o Packaged in-space evaporative units.

Direct, in-space, water spray injection should not be used, since mineral contents in the water often precipitate as dust which will deposit itself in a fine layer over equipment and supplies and destroy data stored on some media.

4.6 TEMPERATURE AND HUMIDITY RECORDING INSTRUMENTS

Recording instruments are necessary to provide a continuous record of temperature and humidity conditions in the machine area. Also, if the air conditioning requirements are not met, a record is available to indicate the extent and duration of the undesirable condition and indicate whether a drying-out period is required. This may, in some cases, save machine shut-down time.

The record of temperature and humidity can be used:

o To assure that the air conditioning installation is continuously performing its job properly. Installation errors and loss of efficiency due to malfunction of some part of the air-conditioning system can be quickly detected.

o To determine if a mandatory drying-out period is necessary when humidity limitations are exceeded. The drying-out may be necessary if the excess humidity occurs either during periods of actual machine operation or during periods when the machine is shut down and unattended. The extent and duration of the excess humidity is used to determine the duration of the drying-out period.

o To determine if the environment in the area meets the requirements for the machine.

A visual or audible signal device is desirable in the instrument. Its purpose is to provide a visual or audible indication that the temperature or humidity conditions in the computer area are nearing the maximum limitations.

Direct-reading instruments with a 7-day electric-drive chart is sometimes used in installations to monitor the ambient room conditions. The recorder is usually located at a representative location within the room and adjacent to the control devices.

For use in monitoring the underfloor air conditions, a remote indicating instrument is recommended. This is usually a 7-day electric-drive chart and can be the wet and dry bulb or electronic type if direct reading is not available. The recording instrument can be located on the wall in the room or in the mechanical equipment room or any other location convenient to the building engineer.

4.7 AIR FILTER REQUIREMENTS

The air-filtering system consists of the filters in the air conditioning units and the filters in the computing system cabinets. This is the principal means of removing dust and dirt particles which tend to recirculate in the atmosphere of the computer room. All filters should be checked and cleaned regularly as recommended by the manufacturer.

4.7.1 Filters

The filters in the air-conditioning units generally equal the filtering capability of the equipment filters in the computing system cabinets. In general, these should have low pressure loss and be capable of removing the large-sized nuisance particles as well as an appreciable portion of the smaller particle size.

The quality of the filters should be consistent with the requirements of the equipment and the efficiency of the filters in the equipment.

Outside air should always be filtered to an efficiency of 50% using NBS Dirt Spot Test using atmospheric dust. A minimum of 20% efficiency is recommended for return air.

4.7.2 Area Cleanliness

The principal function of the air filters in the computing system cabinets is to capture dust which may be circulating in the room atmosphere. The equipment air filters in the computing system cabinets should be cleaned or replaced periodically.

It is suggested that the filters in the air-conditioning units be cleaned according to manufacturer's recommendation.

When an underfloor plenum system is used to cool the computer cabinets, some dust may originate beneath the raised floor. This is produced chiefly by deterioration effects of the normal room floor and can be held to a minimum if the floor is properly conditioned. In particular, if the normal room floor is of concrete, it should be sealed and treated to prevent dusting.

All paper-handling equipment is subject to varying amounts of static charge which attracts dust particles and tobacco ash. Static buildup on magnetic tape handlers will attract small particles. For this reason, smoking usually is not permitted in the computer area.

4.8 MAGNETIC RECORDING MEDIA STORAGE

In determining the layout of the computing system the user should consider the requirements for storing magnetic tapes and disk packs. Tape reels should be stored vertically in steel bins; disk packs should be stored horizontally (never vertically) in steel cabinets.

The reels of tape and disk packs should be stored in self-sealing cases for protection from dust and sharp environmental changes.

4.8.1 Magnetic Tape Storage

Extremes in temperature and humidity should be avoided. Recommended conditions are 35% to 60% relative humidity and 62^{o} F to 78^{o} F (16.7^{o} C to 25.5^{o} C) temperature. If environmental extremes occur, the tape should be brought to ambient conditions before use. The time required for reconditioning will vary from 4 to 16 hours, depending upon the conditions to which it was subjected. Direct heat, such as lamps or heating coils, should never be used to warm a tape. Errors will occur less frequently if the tape storage area is the same temperature and humidity as the computing area.

It is recommended that tape be rewound once or twice each year to release stress due to expansion and/or contraction.

Tape should not come in contact with any magnetic material, and reels should not be stored in cabinets having magnetic latches. Any magnetic field intensity greater than 70 gauss may cause loss of data.

4.8.2 Magnetic-Disk-Pack Storage

Disk-packs (recorded or unrecorded) may be stored for up to five years (minimum) in areas where the temperature range of -40^{o} F to 150^{o} F (-40^{o} C to 65.5^{o} C) and a relative humidity range of 8% to 80% are maintained providing a wet-bulb reading never exceeds 85^{o} F (29.4^{o} C).

Disk-packs should be operated in ambient environmental conditions not exceeding 60° F to 120° F (16.6° C to 48.8° C) and 8% to 80% relative humidity with a wet-bulb reading never to exceed 78° F (25.5° C). The disk pack should be conditioned in the ambient environmental a minimum of two hours before use.

In either case (storage or operational), recorded packs should never be exposed to any stray magnetic field intensity exceeding 50 gauss.

4.9 ELECTRICAL POWER

Power requirements for the computer center shall be provided as a minimum in accordance with the National Electric Code, Military Handbook 411 (MIL-HDBK 411), manufacturer's requirements and as discussed below. Naval Facilities Command (NAVFAC) has the responsibility for providing suitable power for a facility in accordance with the requirement found in BESEP. Power sources and system distribution are planned and designed by NAVFAC or its field activity.

4.9.1 Requirements

Power requirements and characteristics peculiar to each piece of computer equipment are supplied by the manufacturer and are listed in the manufacturer's installation manual or available from the manufacturer's site engineer.

Power used to supply equipment that processes Red information may require special service to ensure security. NAVELEX instruction 05510.2 is the controlling document governing this power service. The BESEP should conform with the above instruction and amplify all requirements.

a. Frequency Conversion. Due to the varying frequency requirements of some computer manufacturers there is not always available frequencies compatible with their requirements. Hence, some form of frequency conversion may be required. The conversion is usually 50/60 Hz to 400 Hz. Two types of converters, motor generators and static converters will be discussed.

(1) Motor generators. The size and type of unit used should be determined by the equipment requirements. The location of the equipment is not generally pertinent to the operation of the system if it is accessible for maintenance. However, to minimize computer room heat gain and noise levels, the equipment should be located in a room separate from the computer. The area of installation should be adequately controlled as to satisfy temperature and humidity requirements listed by the manufacturer.

(2) Static converters. The size and type of unit to be used should be determined by the equipment requirements. Unlike the motor generator, the static converter is solid state, can be physically placed in the computer room and produces a minimum amount of noise and heat. The unit(s) however, must be adequately grounded to prevent EMI. The unit(s) require a similar environment as the computer facility and a minimum of maintenance.

b. Standby Requirements. There are situations where two converters will be required to meet the user's requirements. This additional converter should be noted in the BESEP. The object of one of the converter is to act as a standby in case of the other failing or off the line for maintenance requirements.

c. Emergency Power Requirements. All computer centers require and will be provided with emergency power. Emergency power, or Class C Auxiliary Power, is defined in MIL-HDBK-411 as a quick-start (10-60 seconds) unit(s) to cover short-term outages and used for the purposes of maintaining essential computer system power, air conditioning, ventilation, and lighting.

d. No-Break Power Requirements. Each computer center will have to justify no-break power requirements and so indicate in the BESEP. No-Break Power, or Class D Auxiliary Power, is defined in MIL-HDBK-411 as an uninterruptible (no-break) power unit(s) using stored energy to provide continuous power within specified voltages and frequency tolerances.

e. Convenience Outlets Requirements. Various units of the computer equipment will contain convenience outlets for technical maintenance. These outlets will be run off the technical bus.

Additional outlets around the perimeter of the room 12- to 14- foot intervals should be provided. These outlets will be run off the nontechnical bus and be used mainly for houskeeping.

f. Starting (Inrush) Currents Requirements. When planning the electrical layouts, it can be assumed that starting current and steady running currents are the same. In certain instances however, special consideration is required for a particular piece of equipment designed by a certain manufacturer. Refer to the appropriate manufacturer's manual for a listing of starting currents to be considered in each system. In addition, consideration should be given to surge-protection in power lines, as well as protection against lightning transients.

g. Emergency Power Monitor System Controls. A facility's monitoring panel in the computer room and electrical equipment room, with the following controls, indicators and alarms for the emergency power system should be provided.

- o Emergency Power On - Indicator when on emergency source or non-break.
- o Emergency Power Alarm - Audible signal, with manual shut-off when on emergency source or no-break.
- o Telephone-communications link between computer room and alternate power supply.

4.9.2 Distribution

Power is to be distributed in a split bus system with one bus serving the technical load and the other the nontechnical load as specified in MIL-HDBK-411.

The technical bus should serve the computer equipment, minimum lighting and necessary noncyclic environmental requirements (ventilation). The nontechnical bus should serve all other power requirements.

The power feeder for the computer system should be protected by a main-line circuit breaker. The individual branch circuits on the distribution panel should be protected by suitable circuit breakers. The circuit breaker sizes are to be determined by the equipment requirements. All circuit breakers shall be clearly identified as to which equipments it services.

The distribution panel should be located in an unobstructed, well-lighted area and readily accessible during emergencies. The main disconnect switch should be clearly marked and as close to the main exit door as possible.

4.10 GROUNDING SYSTEMS

Two primary objectives of grounding computer equipment are:

- o Safety, and
- o Interference reduction.

Proper grounds will:

- o Provide a low impedance path for fault currents,
- o Limit voltages that may appear between equipments and ground, and
- o Minimize noise voltages that may develop.

Prior to designing an adequate grounding system access to and knowledge of, the following is recommended.

- o National Electric Code
- o The manufacturer's requirements
- o Interference levels that may appear on the grounds on a case-by-case basis.
- o NAVELEX 0101,102 and 05510.2, as applicable.

Combining all of the above and classifying all grounds according to interference and susceptibility levels, allows the rough grounding layout to be made.

A schematic diagram for each equipment and system should be drawn to define specifically the grounding details. This schematic would be useful in keeping track of the grounding scheme and allowing risk areas to be defined with changes. They are also invaluable troubleshooting timesavers if ground noise problems do occur.

A study of NAVELEX 0101,102, Chapter 12, and 0101,106 as mentioned should be made before commencing a grounding design if applicable. This chapter points out the following major factors in design.

- o Personnel protection,
- o Equipment protection,
- o Interference reduction,
- o RF efficiency,
- o Signal ground distribution, and
- o Separation of the Red and Black signal ground.

Several general rules should be followed when a ground system is designed.

o Personnel protection must be provided by installing an electrical path between the equipment and the earth. The resistance of the path must be less than that of the human body and cannot be greater than 25 ohms to the earth.

o Building protection against lightning must be provided by a low resistance electrical path between the metal structural portions of the building and the earth.

o RF interference caused by standing waves on ground leads must be eliminated by keeping the ground leads to lengths less than that of one wavelength.

o Where possible, a single ground system must be installed. A single ground system prevents potential differences between systems and reduces to a minimum the possible circulation of ground currents.

4.11 SAFETY AND FIRE PRECAUTIONS

Fire protection in the computer room should be predicated on the following facts:

o The hardware in a computer system presents no fire hazard since all items are made of noncombustible or flame retardant materials.

o The system is sensitive to heat and smoke damage; particularly those components with magnetic recording surfaces.

o The system is extremely sensitive to water damage if power is on. However, damage is greatly reduced if power is turned off.

o Computer input/output media are combustible. Materials such as line printer paper are stored in large quantities and present a severe hazard.

Most computer rooms are air conditioned, which poses the hazard of transmitting fire from an unrelated area to the computer room.

4.11.1 Fire Protection

NAVMAT Instruction 11320.8 of 22 June 1967, and NAVFAC design Manual No. 8, "Fire Protection Engineering," provides that new building housing critical of high-value electronics operations shall be of noncombustible or fire resistive construction. These instructions also stipulate that where the existing buildings of combustible construction must be used for this type of occupancy, automatic sprinkler protection shall be installed. See TS-F4a of 5 April 1966, "Sprinkler System, Automatic, Dry Pipe Type."

In the past, concern has been expressed by users of electronic equipment concerning the use of the sprinkler system for protection of electronic-type operations because of the possibility of water damage and/or electrical shock. The possibility of accidental operation is reduced by using high temperature (175^{o} F range) sprinkler heads installed in a special preaction-type system. In this type of system, the piping normally contains no water. The possibility of electrical shock can be virtually eliminated by electrically interlocking power supplies so that they are turned off before water is admitted to the preaction-type sprinkler system. Automatic sprinkler systems protection computer rooms or computer areas shall conform to the "Standard for the Installation of Sprinkler Systems," NBFU No. 13. The air conditioning should also be turned off to prevent transmission of smoke through the building. All filters installed within the confines of the computer area should be the type which will not burn freely or emit large volumes of smoke.

Approved portable carbon dioxide extinguishers or hose reel shall be provided and maintained within the computer area as applicable. The number of extinguishers should be commensurate with the size and quantity of computer equipment to be protected. Soda-acid extinguishers should also be maintained for ordinary combustible material such as paper. In installations where conditions may require the provision of inside hose, it shall be 1-1/2-inch rubber lined with shutoff combination solid stream, water-spray nozzles.

The computer room's relationship with the remainder of the facility should be reviewed to ensure that fire is not transmitted into the computer room. If the possibility exists, appropriate fire door should be installed. The possibility of water from other sprinklers running into the computer room through ceilings or walls should be examined.

4.11.2 Fire Detection

The detection system should be tripped by combustion by-products. The detectors should be located in the computer room both at the ceiling and below the raised floor, if the floor does not comply with NFPA No. 75 standards. Detectors should also be located in other areas such as the tape library and storage room. The detection system, when tripped by fire, should drop all power to the computer room and power panel, however, the power should remain on when the detection system is tested.

The detection system, when tripped, should also sound an audible alarm throughout the computer center. The system should be tied into the main building alarm system. See TS16F21 of 26 January 1968, Fire Alarm System (Positive, Noninterfering) and TS16F1 of 30 January 1968.

4.11.3 Control Panel

A read-out or control panel should be located within the computer area such that the panel is under constant surveillance. The panel should be so designed that whenever a detector is tripped, one may discern from the panel which location within the computer area has generated the alarm. This panel should also incorporate a means of testing the entire detection system as well as the audible alarm.

4.11.4 Electrical Control

In emergency situations, power to the computer room and power panels should be dropped by:

o Actuating emergency off switches located adjacent to each exit from the computer room. Other emergency switches should be placed where readily accessible to personnel in case of emergency

o Testing of the detection system should in no way drop power to the computer or air handlers.

4.11.5 Emergency Egress Lights

Battery-operated lights, conforming to Federal Specification W-L-305, shall be installed so as to adequately light the computer area when house lights are off due to an emergency evacuation condition.

CHAPTER 5

COMPUTER TESTING AND ACCEPTANCE

The testing and acceptance will differ with each contract manufacturer, piece of equipment, and site. What follows is a general outline of what can be expected in the process of testing and accepting a computer system or its components.

All materials and equipment to be furnished and all work performed should be subject to contractually required inspection and tests. No materials or equipment should be shipped until all required inspections and tests have been made and the equipment has been approved for shipment by the contracting officer or his authorized representative.

5.1 TEST PLANS AND REPORTS

5.1.1 Test Plans

The contractor shall submit test plans prior to actual testing, for all factory and site acceptance tests as specified contractually. Hardware test plans should explain the purpose of the test, define test inputs, specify test procedures and define outputs to be expected. Software test plans should include a summary of the method of initiating the tests, a list of test programs, the sequence of their application, and the expected results.

5.1.2 Test Reports

The contractor should submit test reports for factory and site acceptance tests specified in the contract. Each report should reiterate the purpose and method of the test, indicating any deviation from procedures described in the previously approved test plan. Complete test data should be included in each report and compared with the expected results predicted in the test plan. (The test report and test plan should be on the same document in a side-by-side format.)

5.1.3 Submittal, Review, and Approval

Submittal, review, and approval of test plans and test reports should be made in accordance with all applicable procedures of the contract. Test plans are usually submitted 30 days prior to actual testing and test reports usually submitted within 15 days after completion of each test.

5.2 IN-PLANT TESTING

Factory acceptance of the system should depend upon achieving satisfactory results for the tests specified as well as any additional tests requested by the contracting officer. (These tests are essentially to verify hardware equipment.) Whenever these factory tests indicate that the equipment does not meet the specification requirements, the contractor should replace components and assemblies as necessary to correct the deficiencies. Factory tests should consist of routine tests to assure quality control of all components and assemblies, unit design performance tests to demonstrate acceptable operation of each unit or subsystem, and system performance tests to demonstrate the acceptable operation of the complete system. Should the equipment module to be accepted be a part of an already existing system, the testing program should ensure that the module will function properly with the existing system. The contractor should provide the necessary testing software required to demonstrate the acceptable operation of all hardware units and subsystems. Test software descriptions and listings should be submitted as part of the contractor's test plans.

5.2.1 Unit Design Performance Tests

Upon the completion of manufacture of each unit or subsystem, the contractor should perform a preliminary unit design performance test to assure unit or subsystem operational characteristics in compliance with the specifications. The contractor should notify the contracting officer in writing, 15 days in advance, that the pertinent unit design performance test is ready to be conducted.

5.2.2 System Performance Tests

Upon completion of all routine and unit design performance tests, the contractor should assemble each unit and subsystem into the configuration of the proposed system utilizing the actual cables to be furnished with the systems in order that actual site operating conditions may be simulated. Preliminary performance tests should be conducted by the contractor to verify compliance with the functional and operational requirements of this specification. Upon completion of the preliminary tests, the contractor should notify the contracting officer that the formal system performance tests are ready to be conducted. The formal system performance tests should include, but are not limited to, the following:

a. Each device should be thoroughly exercised, individually and with rest of the system.

b. All contractor-furnished software (supervisor, diagnostics, etc.) should be demonstrated to be operational.

c. All switchable units and subsystems should be exercised in both the primary and secondary modes of operation.

d. The functional interface between the system and each data acquisition system should be simulated, if applicable.

e. All man/machine interface functions should be demonstrated.

f. The benchmark program or demonstration program should be run to satisfy the contract specification.

g. All failure-turnover switching and configurations should be demonstrated.

h. All device diagnostics should be demonstrated.

i. Power failure protection should be demonstrated by inducing a complete power failure.

5.2.3 In-Plant Acceptance

Upon completion of the manufacturer's in-plant testing and under certain contractual arrangements, the equipments may be accepted by the Navy at the plant. Once accepted, the equipments are usually moved, installed and tested under Navy guidance. (However, some procurements are a "turnkey" operation.)

5.2.4 Navy Site Tests

Upon completion of the manufacturer's in-plant testing and under certain contractual arrangements, the equipment will be forwarded to a Navy site for compatibility testing. Usually, this type of testing deals with a piece of equipment that will become a module of an already established system. The manufacturer, usually not possessing such a system, must be prepared to demonstrate the module's compatibility and workability in the environment for which it is designed.

5.3 USER REQUIREMENTS

Prior to and after the installation of commercial ADP equipment, the user is required to demonstrate effective and efficient utilization of his ADP resources. Secretary of the Navy's Instruction 10462.18 outlines in-depth the procedures required by the user in demonstrating these requirements. The following is a brief outline of the purpose of the Instruction.

5.3.1 ADP Readiness Review

The ADP Readiness Review, sometimes referred to as a preinstallation survey, provides for an on-site evaluation of an installation's readiness to productively use ADP equipment.

A fully documented on-site review and certification of readiness is normally required prior to installation of all equipment specifically approved in accordance with SECNAVINST 10462.18. The certification of readinesss will be issued only upon documented indications that sufficient staff is on board and trained; that the operating programs planned for the initial workload are, or will be, ready to run by the scheduled equipment installation date; that a realistic schedule for conversion, including phased equipment-receipt and parallel operations, is available; that the site and supporting services will be ready to accommodate the equipment by the scheduled delivery date, etc. The objective of this review is to insure that the equipment will be effectively and efficiently used for processing the planned workload expressly approved relative to the selection of the equipment.

5.3.2 Demonstration Program

In addition to the above, the Navy usually develops benchmark and/or demonstration programs. The benchmark and/or demonstration programs are used by the contracting officer in determining qualified bidders on the proposed system, and later used to judge if the successful bidder has in fact met the specifications of the equipment/system.

5.4 FINAL ACCEPTANCE TESTING

After the system equipment has been completely installed and all contractor and government interface connections have been made, the contractor should conduct technical and final technical site acceptance tests. The contracting officer or his authorized representative should witness all field acceptance tests if possible. The contracting officer should be notified in writing, a minimum of seven days prior to the commencement of each test, that the tests are ready to be conducted.

5.4.1 Technical Field Acceptance Tests

Following installation of the equipment at the site, all equipment should be adjusted and all meter readings recorded in accordance with the manufacturer's recommended (and government approved) test procedures. The contractor should include in his test reports a list of all equipment or components replaced or interchanged after completion of factory tests and prior to the commencement of field acceptance tests.

No further adjustments should be made to any of the equipment in the system during the acceptance tests.

After completion of the unit performance tests, a system performance test should be conducted to verify that correct data interchange is secured over all interfaces with external equipment and systems and that the system hardware is operational in the site environment.

Each manufacturer will use different diagnostic and software routines to perform this task. Appendix E contains a sample test plan that was used in demonstrating the concurrent functional operation of all subsystems of the AN/UYK-4(V). While this is not the "ultimate" type test plan, it indicates what should be expected and how the manufacturer goes about testing his system. Since standard tests have not been developed, testing has been largely placed in the hands of the manufacturers.

The Integrated Programmed Operational Functional Analysis (IPOFA) Program in Appendix E has the following general objectives:

a. To demonstrate the ability of the subsystems to operate together as an integrated system under normal conditions of data flow or equipment configuration.

b. To evaluate subsystem performance under conditions of overlap conflict where two or more subsystems are being exercised simultaneously.

c. To demonstrate the ability of the overall system to achieve continuous operational capability through extended testing, and tests the following functions:

- o Computer input/output
- o Multiple input/output buffering
- o Reliability of data transfers
- o Functional performance of each subsystem utilizing natural and/or test inputs.

The IPOFA program is specifically a verification of the system hardware capability (a verification of system performance with respect to hardware specifications), and no attempt is made to evaluate the system with respect to any intended software function(s). The IPOFA is designed for use in the integration and checkout effort, on formal acceptance testing, and in normal day-to-day maintenance testing.

5.4.2 Contractor Software Testing

The primary objective of testing operating system software programs (supplied by the contractor) is to verify and demonstrate that these programs operate as required by the specifications.

The evaluation of these programs (supervisors, report generators, utility routines, etc.) should be based on tests that cause measurable effects on the central processor functions, interfacing equipment, personnel, facilities, and communication links. The Operating System program cannot be tested until it is exercised in a computer with access to input data and a standard application program (for example, a simplified message processing program). The results of operating these programs with input data must then be observed by means of the output devices such as display consoles, teletype machines, and printers. These observations, in order to fulfill the function of testing, must be collated according to prescribed procedures and compared with results that have been predicted prior to the test. If actual observed results are identical with expected results, the software program performance for the function being tested is verified; that is, the program operates as required in the program specifications. Discrepancies between actual and expected results require detailed analysis to determine their cause. If the cause is an Operating System program error, correction and some degree of retesting is required to verify that the error no longer exists and that additional errors were not introduced by the computer program modification. (For example, if the program is supposed to delete leading zeros, in the Edit Mode, and the printer output does not show that this has happened, then the Edit portion of the Operating System is a suspect; it is possible that the hardware is at fault. However, before software testing takes place, the hardware should have been tested and accepted by means of hardware diagnostics, etc. (see paragraph 5.2).

The installation of Operating System programs at the location where they will be operationally employed (or at a nonoperational facility established for this purpose often provides the first opportunity to examine the compatibility of these programs with: (1) operationally configured computer; (2) other interfacing hardware; (3) operating personnel; and (4) communication links. All prior testing relies heavily on an artificial environment to test program reactions. Testing with simulated inputs can provide a high degree of confidence in the capabilities of the Operating System programs, but final acquisition-phase verification and qualification of this program subsystem must concentrate on assessing the performance of the subsystem as it is to be operationally employed.

5.4.3 Standard of Performance and Acceptance of Equipment

Following the completion of all technical field acceptance tests as contractually required, the acceptance period shall begin.

The acceptance period is controlled by the Federal Supply Schedule or any applicable specification in the contract. These specifications can be more stringent than the Federal Supply Schedule requirements for acceptance.

The following is typical of the established standard of performance which must be met before any equipment listed on the delivery order is accepted by the government.

a. The performance period shall begin on the installation date and shall end when the equipment has met the standard of performance for a period of 30 consecutive days by operating in conformance with the technical specifications or as quoted in the specific proposal at an effectiveness level of 90 percent or more. Should it be necessary, the government may delay the start of performance period, but such delay shall not exceed 30 consecutive days, therefore, the performance period must start not later than the 31st day after the installation date. If the government delays the start of the performance period, the period to pass the acceptance test shall be correspondingly extended.

b. In the event the equipment does not meet the standard of performance during the initial 30 consecutive days, the standard of performance test shall continue on a day-by-day basis until the standard of performance is met for a total of 30 consecutive days.

c. If the equipment fails to meet the standard of performance after 120 calendar days from the installation date, the government may, at its option, request a replacement or terminate the order.

d. The effectiveness level for a system is computed by dividing the operational use time by the sum of that time plus system failure downtime.

e. The effectiveness level for an added, field modified, substitute, or replacement machine is a percentage figure determined by dividing the operational use time of the machine by the sum of that time plus downtime resulting from equipment failure of the machine being tested, and therefore, the hours prescribed previously in paragraph b. are not applicable.

f. Operational use time for performance testing of a system is defined as the accumulated time during which the Central Processing Unit is in actual operation, including any interval of time between the start and stop of the Central Processing Unit.

g. Operational use time for performance testing of a machine added, field modified, substitute, or replacement machine is defined as the accumulated time during which the machine is in actual use.

h. System failure downtime is that period of time during which it is not possible to continue to run the program (the program being processed at the time of equipment failure) on available operable equipment immediately after equipment failure of a part of the system.

i. During a period of system downtime, the government may use operable equipment when such action does not interfere with maintenance of the inoperable equipment. The entire system will be considered down during such period of use. The manufacturer's maintenance personnel will determine whether or not government use of operable equipment will or will not interfere with maintenance of the inoperable equipment.

j. Machine failure downtime for added, field modified, substitute, or replacement machines after the system has completed a successful performance period is that period of time when such machines are inoperable due to their failure.

k. Downtime for each incident shall start from the time the government contacts the manufacturer's designated representatives, including answering services at the prearranged contact points until the system or machine(s) is returned to the government in proper operating condition, exclusive of actual travel time required by the manufacturer's maintenance personnel, but not in excess of one hour on the day such services were requested.

l. During the performance period for a system, a minimum of 100 hours of operational use time with productive or simulated work will be required as a basis for computation of the effectiveness level. However, in computing the effectiveness level, the actual number of operational use hours shall be used when in excess of the minimum of 100 hours.

m. The government shall maintain appropriate daily records to satisfy the requirements of this paragraph and shall notify the manufacturer in writing of the date of the first day of the successful performance period. These records may be reviewed by the manufacturer.

n. Equipment shall not be accepted and payment shall not be made until the Standard of Performance is met. The government shall notify the manufacturer immediately in writing of the first day of the successful performance period and authorize payment.

o. Operational use time and downtime shall be measured in hours and whole minutes.

p. Should it be necessary, the government may delay the start of the performance period, but such delay shall not exceed 30 consecutive days; therefore, the performance period must start not later than the 31st day after the installation date and the government shall pay maintenance for the period of delay.

q. All maintenance and parts shall be furnished by the manufacturer without charge for the period prior to acceptance of the equipment by the government, unless such maintenance and parts are required as a result of fault or negligence of the government.

5.4.4 User Participation

During the 30-day acceptance period, the user should rerun his benchmark programs developed during system acquisition.

Also, during this period, the user is encouraged to exercise all facets of the system to their maximum. This is his chance to detect any hardware or software discrepancies.

5.4.5 Operational Turnover by NAVELEX

A joint inspection and check-off of the completed facility shall be made by the Electronic Field Authority (EFA) or NAVELEX representative, and the Commanding Officer or his representative. The EFA shall advise the Commanding Officer, as far in advance as possible, of the projected completion date and request scheduling of the inspection. In cases where a new facility consists of both new and reinstalled equipment, inspection of the new equipment and scheduling of the cut-over poriton shall be included in the request. Upon completion of the inspection, the Commanding Officer shall be requested to give written acceptance in one of the following categories:

a. Unconditional. Installation complete and operationally satisfactory.

b. Conditional. Installation operational but not fully satisfactory or complete. The deficiencies responsible for this type acceptance shall be corrected by the installing activity and an unconditional acceptance obtained as soon as possible.

c. Partial. Interim acceptance of a part of the total installation. This category is appropriate where incremental activation of a facility is required by the command in order to maintain the station operations schedule.

5.4.6 As-Built Drawing Requirements

Upon acceptance of the computer site and equipment by the Navy, the following "As-Built" drawings should be forwarded to NAVELEX by the Field Technical Authority (FTA) in accordance with the BESEP.

- o Floor plan showing location of power panels and breakers (technical and nontechnical).
- o Floor plan showing placement of equipment cabinets with"door swings".
- o Floor plan showing placement of equipment cabinets with floor panel cut-outs.
- o Floor plan showing cable troughs, if any.
- o Floor plan showing signal cables between equipment cabinets, if Navy maintained.
- o Elevation view of each cabinet showing locations of individual equipments, if more than one per cabinet.
- o An equipment characteristics tabulation sheet.

APPENDIX A

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1. ANSI X3.1-1969, "American National Standard (ANSI), Synchronous Signalling Rates for Data Transmission."
2. ANSI X3.5-1970, "American National Standard (ANSI), Flowchart Symbols and Their Usage in Information Processing."
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11. MIL-STD 1472, "Human Engineering Design Criteria for Military System Equipment and Facilities."
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13. NAVDOCK DM-8, "Fire Protection Engineering."

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15. NAVFAC TS-F12B.
16. NAVFAC TS-F4a, "Sprinkler System, Automatic, Dry Pipe Type," April 1966.
17. NAVSO P-3097, "ADP Glossary," 1970.
18. NBFU No. 70, "Standard of the National Board of Fire Underwriters," National Electrical Code, 1962.
19. NFPA No. 75, "Standard for the Protection of Electronic Computer/Data Processing Equipment."
20. NFPA No. 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
21. NFPA No. 255, "Standard Method of Test of Surface Burning Characteristics of Building Materials."
22. OPNAVINST 05510.82A, "Standards for Security of Electrically Processed Classified Information," 21 February 1968.
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3. Galitz W.O., and Laska, T. J., "Computer System Peripherals and the Operator," initially written in the Sperry Rand Engineering Review and reprinted in Computer Design, August 1969.
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APPENDIX B

BASE ELECTRONIC SYSTEMS ENGINEERING SURVEY REPORT

This Site Survey Guide is intended to be a standard guide for compiling an accurate listing of pertinent data required for proper installation planning of an Operations Control Center, along with its required supporting facilities. It is not intended that this guide attempt to establish or interpret the operational requirements of an activity. If sufficient data and site information is obtained to complete the sections of this guide, a valuable reference will be available for immediate and future planning, design, and development for the installation of equipment comprising an Operations Control Center. An attempt should be made to acquire information that is germane to a primary and two alternate locations for the facilities planned.

B.1 GENERAL INFORMATION

COMMAND/ACTIVITY NAME: _____

OTHER TITLES/JOINT COMMANDS: _____

LOCATION: _____

BASE TELEPHONE NUMBERS: AUTOVON: _____
COMMERCIAL: _____

KEY PERSONNEL — TOUR COMPLETION DATE TCD — EXT

FLAG OFFICER: _____

CHIEF OF STAFF: _____

OPERATIONS OFFICER: _____

ADP OFFICER: _____

COMMUNICATIONS OFFICER: _____

PERSONNEL OFFICER: _____

OTHER STAFF PERS: _____

_____

_____

SUPPORTING ACTIVITIES/OFFICES: — EXT

PUBLIC WORKS: _____

NAVFACENGCOM REP: _____

NAVELECSYSCOM FTA REP: _____

NAVELECSYSCOM HQ REP: _____

OTHER RELATED CONTACTS: _____

KEY PROJECT REFERENCES:

(a) _____

(b) _____

(c) _____

B.2 OPERATIONAL INFORMATION

B.2.1 Data Processing Facilities:

INFO: CONTACT: _____
TCD: _____

(a) Presently Installed:

(b) Principal Utilization:

(c) Interim/Final Installations:

(d) Remote ADP support (Specify):

(e) Future plans regarding upgrading (Specify):

(f) Planned future other ADP systems:

(g) Planned utilization:

(h) Estimated dates of installation:

(i) Present/planned future space utilization:

(j) Presently installed/Future ADP I/O Requirement for system support:

(k) Programming/Maintenance Support and responsibility (specify):

B.2.2 Communication Facilities

INFO: CONTACT: _____
TCD: _____

(a) General Description of facilities:

(b) Location relative to OPCONCEN

(c) System Comm. Equip No. Model Age Ded.

(d) Adequate for normal system comm. requirements?

(e) Can handle load during peak periods?

(f) Planned communication project affecting OPCONCEN

(g) Planning for High Speed Data Links, Inc. AUTODIN

(h) Present/Planned useage of cryptographic equipment

(i) Highest classification authorized for communication equipment

(j) Highest classification expected

(k) Communication Maintenance Responsibility (specific)

B.2.3 OPCONCENTER Information

INFO: CONTACT: _____
TCD: _____

(a) Area utilized:

(b) Approximate physical dimensions of space:

(c) Present personnel capacity:

(d) Environmental conditions:

(e) Considered adequate for current Operations?

(f) Planned/Estimated changes:

(g) OPCONCEN equipment utilized:

Front/Rear view screens

Types of projectors

Recording capabilities

Internal communications

Graphic reproduction capabilities

(h) Security considerations:

Of OPCONCEN:

Min security clearance of "on floor" personnel?

B.2.4 Related/Other Operational Support INFO: CONTACT: _____
TCD: _____

(a) ASTAC--SCAEC--TSC--NAVFAC--OTHER (SPECIFY):

B.2.5 Personnel Considerations INFO: CONTACT: _____
TCD: _____

(a) Personnel Operating OPCONCEN RATINGS

RATINGS

GRADES/SERIALS

NEC

OFFICER BILLETS (NOBC)

(b) BOQ/Enlisted Quarters availability of:

(c) Major personnel reorganizations in process/planning and reasoning

B.2.6 Additional Comments

(Add additional sheets if necessary)

B.3 FACILITIES INFORMATION

B.3.1 OPCONCENTER Building Information

INFO: CONTACT: _____
TCD: _____

(a) Building No.

(b) Location on station (attach site & vicinity plan)

(c) Specific type of construction:

(d) Specific floor loading limitations:

(e) No. of floors: Age of Building:

(f) Occupied by Staff departments/Others:

(g) Availability of extra space:

(h) MILCON/Minor Construction Planning:

(i) General condition of OPCONCTR building:

B.3.2 Electrical Power Considerations:

INFO: CONTACT: _____
TCD: _____

(a) Station Primary Source:

(b) Station emergency source:

(c) Normal regulation of prime source:

(d) Reliability of power experienced:

(e) Building primary source:

(f) Building emergency source:

(g) No Break power availability/required?

(h) Prime power source in OPCON Area:

(i) Other users this source:

(j) Filtered power available?

(k) Estimated power available for system use:

(l) Building grounding: Meets R/B?

(m) Planned/pending electrical project affecting available power:

B.4 GENERAL CONSTRUCTION INFORMATION

INFO: CONTACT: _____
TCD: _____

B.4.1 Availability of:

Labor:

Materials:

B.4.2 Construction Constraints: (Including seasonal construction; base policy; foreign country limitations; overseas billeting personnel clearances, passport requirements; min security clearance of const workers and etc.)

B.4.3 Planned/Related Construction Projects:

Considerations/Ramifications of these projects:

B.4.4 Additional Comments:

(Add additional sheets as necessary.)

B.5 SECURITY INFORMATION

INFO: CONTACT: _____
TCD: _____

B.5.1 Operations area/spaces generally considered a controlled zone?

B.5.2 Define area of "controlled zone"

B.5.3 Describe security measures/area control procedures in effect

B.5.4 Highest classification of material currently handled in space:

Communications:

Registered Publications:

Other:

B.5.5 Highest expected:

B.5.6 Access and control of foreign nationals in area.

B.5.7 Present/Planned shielding efforts.

B.5.8 Overall security observation

B.5.9 Does present installation meet the intent of National Policy on Compromising Emanation; OPNAVINST 5510.93A?

B.5.10 EMI problems and noise levels noted

B.5.11 Recent "TEMPEST" tests, dates and reference report

B.6 GENERAL COMMENTS

B.6.1 Facilities Conclusions

B.6.2 New Construction Considerations

B.6.3 Basic Recommendations

(a) Primary plan

(b) Alternative No. 1

(c) Alternative No. 2

B.6.4 Personnel Changes/Staff Relocations Required - In Order To Implement Any Of The Recommendations:

B.6.5 Related Host/Tenants' Agreements:

B.7 RECOMMENDED PRIMARY AND/OR ALTERNATIVE PLAN

B.7.1 Area Selected For Advanced System Implementation

(a) Specific location in building no.

(b) Total square footage of selected area;

ADP/LLT Space:

M/G-A/C Space:

MAINT./STORE Space:

ADP OFFICE Space:

(c) Floor support adequate (min 200 LSF)?

(d) Ceiling height adequate (8 ft min w/raised flooring)

(e) Adequate power available in immediate vicinity?

(f) Adequate lighting in space selected?

(g) "Operating" distance from:

Communications:

Other ADP:

OPCONCEN

Other related (specify)

(i) Brief description of MILCON/INSTALLATION requirements for this recommendation:

(j) Estimated BOD after start:

(k) Estimated total of funding for MILCON/INSTALLATION for this recommendation:

(l) Interference/Coordination/Utilization with other related MILCON projects.

B.7.2 Considerations of this Recommendation:

ADVANTAGES:

DISADVANTAGES:

B.7.3 General Staff Acceptance This Recommendation.

B.7.4 Participants' Signatures:

Using Command:

NAVFACENGCOM Rep:

Public Works:

NAVELECSYSCOM FTA:

NAVELECSYSCOMHQ Rep:

B.7.5 Additional Comments Concerning Primary Recommendation

(Add additional sheets if necessary.)

APPENDIX C

BASE ELECTRONIC SYSTEMS ENGINEERING PLAN FOR LOCAL DIGITAL MESSAGE EXCHANGE SYSTEM (LDMX)

This sample BESEP should be considered only as a guide. Inconsistencies will be found, and are essentially unavoidable, in the desire to make this sample BESEP as general as possible. Also, there are references made to various outdated instructions. Furthermore, the Red-Black criteria and NAVELEXINST 05510.2 were omitted.

C.1 INTRODUCTION

C.1.1 Scope

a. This project is concerned with the installation and checkout of the RCA 70/45 system in the OPNAV Message Center at the Pentagon. This new system will replace the existing RCA-301 and UNIVAC 1004 system presently in the OPNAV Message Center. The new system will improve and more completely automate the existing message processing system.

b. No additional space will be available or provided. At a given point in time, there will be some dual operation in the existing spaces. No alterations to the walls will be done to relieve this situation. Careful operational planning will be necessary to make space available for the new system at the same time the existing system is still operational.

C.1.2 Requirements

The required construction/alteration for the site will be described in paragraph C.6 under the heading of Physical Plant.

C.1.3 Responsibilities

a. NAVFACWASDIV (EFD) will prepare the facility plans in accordance with the requirements specified in the PCE and this BESEP.

b. The PWC of the above EFD will perform the facility construction and alterations.

c. NAVELEXWASHDIV (FTA) will be responsible for the interconnection of the power cables and the cable pulling between electronic units power panels, and availability of power, as well as equipment placement and floor panel cutouts.

d. GSA will be responsible for the air conditioning installation.

e. NAVELEX will be responsible for the overall planning of Message Center installation and the development of the BESEP.

f. RCA has the responsibility for the actual system hook-up, equipment checkout, and system turnover. Western Union will install the commercial modem equipment.

C.2 GENERAL REQUIREMENTS

C.2.1 Historical Background

a. CNO ltr OP-94V/V30 Ser 15462P94 of 3 May 1967; request NAVCOSSACT perform sufficient systems analysis to permit definition of a hardware/software system to meet CNO Message Center requirements.

b. NAVCOSSACT ltr Code 12 Ser 2392/12 of 26 Oct. 1967; proposes NAVELEX take hardware responsibility and NAVCOSSACT take software responsibility.

c. CNM ltr MAT 019B/265 of 1 Nov. 1967; CNM request NAVELEX to initiate BESEP action for CNO Message Center LDMX.

d. NAVELEX ltr ELEX 00 Ser 85 of 7 Nov. 1967; Commander NAVELEX express nonconcurrance with NAVCOSSACT ltr Code 12 Ser 2392/12 of 26 Oct. 1967 which proposed splitting responsibility between NAVCOSSACT and NAVELEX; rather proposed NAVELEX take lead responsibility.

e. SECNAVINST 11120.1D of 19 Nov. 1968; procedures for submission of Telecommunications requirements.

f. COMNAVCOM ltr Ser 3124 of 21 Nov. 1967; NAVELEX given lead responsibility for development, and acquisition of OPNAV Message Center, Project 540012 (LDMX). NAVCOSSACT to provide software support. BUPERS responsible for training.

g. CNO ltr OP-94-N2 Ser 32200P4 of 25 Nov. 1967; policy for automation of Naval Communications (LDMX).

h. COMNAVCOMM ltr NC/N2 Ser 3146 of 4 Dec. 1967; COMNAVCOMM requests services of NAVCOSSACT, with NAVELEX to select LDMX system for OPNAV Message Center subject to COMNAVCOMM, CNO, and SASN approval. CNO ltr OP-942J Ser 16938P94 of 22 Oct. 1968; contingent approval of Telecommunications Program Objective (TPO DNC-105) of CNO Message Center by ASD (I&L) memo 8 Oct. 1968.

i. CNO ltr OP-094N/N23 Ser 507P094 of 14 Feb. 1969; replaces and satisfies requirement for System Management Directive and System Package Program (specifically LDMX).

j. DCA ltr 522 of 6 Mar. 1069; approval of ADPESO specifications concerning equipment and software interface with the DCS AUTODIN.

k. CNO ltr OP-914G Ser 1721P91 of 30 Jun. 1969; requirement for an ADPE system at OPNAV Message Center, as modified by SASN Memo Control No. 1032 of 16 Jun. 1969, is approved. Source Selection Advisory Council (SSAC) and Source Selection Evaluation Board (SSEB) also established.

l. DCA Circular 370-D195 of 24 July 1969; DCS AUTODIN TEMPEST Phase II Testing.

m. NAVELEX ltr Ser 696-053 of 4 Nov. 1969; System Performance Specification by NAVELEX and NAVCOSSACT to be reviewed and controlled by ADPESO.

C.2.2 Objectives

a. Increasing traffic volumes, and the necessity for near real-time record communications for command and control, present a burden to communications centers ashore. Being able to transmit a message across the globe with the speed of light is of little value if excessive delay deprives the ultimate reader of timely delivery of his traffic. Writer-to-reader delays have always plagued the communicator, and the situation is aggravated by higher traffic volumes. Improved transmission facilities such as 4800 bits per second AUTODIN circuits, serve to increase the stream of record traffic, getting it there faster than ever before and further taxing the capabilities of the message center. The motive for current automation effort is to achieve improved message handling time.

Handling times which were once acceptable are no longer tolerable. A message center must be able to provide and maintain reliable, secure, and rapid communications, and is accountable for the reception, transmission and distribution of record communication traffic. The immediacy desired for satisfying real-time requirements cannot be achieved in a manual message processing environment. LDMX is to provide more responsive message handling at the message centers.

b. The primary mission of the OPNAV Message Center is to furnish the Secretary of the Navy and the Chief of Operations with communications service for the transmission, receipt, reproduction, and distribution of communications and message traffic. Additionally, the Message Center serves other Naval and government activities in the Washington area. Approximately 120 activities are served directly from the Message Center by scheduled courier, office delivery, pneumatic tubes, or teletypewriter circuits. The OPNAV Message Center Guard List and the list of offices and activities served is shown in Table C-1.

C.2.3 Operational Requirements

a. The OPNAV Message Center must have the capability of operating in a real-time multi-programming environment which fulfills the overall system requirement to switch and terminate messages.

b. The proposed system must service the OPNAV Message Center on a continuous basis, simultaneously gathering incoming messages and processing others previously received. These messages will be processed on a priority basis to permit high precedence messages to be expedited throughout the system. The system is also required to continuously interface with operational personnel via on-line interactive devices, providing the means for human assistance when required, and to provide recognition of and response to, corrective information and directions.

c. The communications systems requirements of the OPNAV Message Center consist of the following items:

(1) Communications Interface: The communications system must handle the following type circuits: AUTODIN, other network (JCS AMPS, DACC) local and remote dedicated teletypewriter lines, line printers, and on-line video data terminals. The following codes and format conversions are necessary: Baudot 5 level, ASCII, and Fieldata. Next, the following types of messages must be processed between the system and AUTODIN: narrative paper tape, punched card data, and magnetic tape data. Finally, the system must process messages from AUTODIN in JANAP 128 and in ACP 127 format from other systems.

(2) The OPNAV Message Center must provide for alternate routing/misrouting and store and forward operations.

(3) The communications system must be capable of maintaining orderly queues at all points of message buildup.

(4) The communications system must also be capable of accounting for all messages which enter and leave the system.

(5) The continuity and recovery of the communications system should also be an operational requirement.

d. The message processing requirements are the following: validation, sus-dupe check, distribution assignment, message filing, query processing, edit and formatting, and reproduction and delivery.

e. The support system requirements consist of message retrieval, report generation, and transaction balancing.

f. All the above functions must enable prompt terminal processing and delivery of messages.

Table C-1. Activities Served by OPNAV Message Centers

A. ACTIVITIES FOR WHICH THE CNO COMMUNICATIONS CENTER IS COMMUNICATIONS GUARD

Assistant Secretary of the Navy (Administration) (Research and Development) (Financial Management)
Chief of Naval Information
Chief of Naval Operations
Director Navy Department Organization Task Force
Director Naval Communications
Director Naval Intelligence
Frequency Allocation Panel, U.S. Military Communication Equipment Board
Naval Aide to the Military Aide to the President of the United States
Naval Comptroller
Naval Field Operational Support Group
Navy Analysis Center
Naval Intelligence Processing Systems Support Activity
Naval Investigative Service Headquarters
Office of Civilian Manpower Management
Office of Management Information
Office of Legislative Affairs
Office of Program Appraisal
Secretary of the Navy
Special Liaison Data Accounting Activity
Scientific and Technical Intelligence Center
U.S. Liaison Office for Supreme Allied Command Atlantic, Washington, D.C. Under Secretary of the Navy

B. PENTAGON OFFICES OF CHIEF OF NAVAL OPERATIONS SERVED BY THE MESSAGE CENTER DELIVERY DESK

OP-00	Chief of Naval Operations
OP-09	Vice Chief of Naval Operations
OP-09B	Office of Naval Administration
OP-09B1C	OPNAV Comptroller
OP-09B2	Administration Division
OP-09B4	Field Support Division
OP-09B8	Administrative Services and Management Division
OP-09D	Special Studies and Presentation Group
OP-09M	Marine Corps Liaison
OP-090	Navy Program Planning Office
OP-90	Office of General Planning and Programming
OP-91	Office of Naval Warfare Analysis
OP-92	Office of Naval Intelligence
OP-93	Long Range Objectives Group
OP-93R	Naval Objectives Analysis Group
OP-94	Office of Naval Communications
OP-95	Office of Anti-Submarine Warfare Programs
OP-96	Systems and Analysis
OP-007	Chief of Information
OP-008	Office of the Naval Inspector General
OP-81	Special Investigation Division
OP-82	Inspections and Studies Division

Table C-1. Activities Served by OPNAV Message Centers (Continued)

OP-83	Manpower Validation Division
OP-01	Office of the DCNO (Manpower and Naval Reserve)
OP-10	Manpower Division
OP-11	Naval Reserve Plans Division
OP-03	Office of the DCNO (Fleet Operations Readiness)
OP-03EG	Operation Evaluation Group
OP-30	Programs and Plans Division
OP-31	Submarine Warfare Division
OP-32	Anti-Submarine Warfare and Ocean Surveillance Division
OP-33	Fleet Operations Division
OP-34	Strike Warfare Division
OP-35	Command, Control and Electronics Division
OP-36	Ship Characteristics Division
OP-04	Office of the DCNO (Logistics)
OP-40	Logistic Plans Division
OP-41	Material Division
OP-42	International Logistics Division
OP-43	Ship Material Readiness Division
OP-44	Shore Activities Development and Control Division
OP-05	Office of the DCNO (AIR)
OP-50	Aviation Plans and Requirements Division
OP-51	Aviation Programs Division
OP-52	Marine Aviation Division
OP-53	Flight Operations Division
OP-56	Aviation Training Division
OP-06	Office of the DCNO (Plans and Policy)

C. OTHER OFFICES OUTSIDE PENTAGON SERVED BY THE MESSAGE CENTER DELIVERY DESK

OP-008	Naval Inspector General
DIRNSA	Director National Security Agency, Fort Meade
NATMAPUS	Naval Aide to the President
BUPERS	Bureau of Personnel
STATE	State Department
CIA	Central Intelligence Agency
COGARD	Coast Guard

D. MAIN NAVY OFFICES SERVED BY MESSAGE CENTER TO MAIN NAVY DELIVERY DESK

OP09B9	Naval History Division
NAVREL	Naval Relief
OCG	Office of the General Counsel (VIA 008)

C.2.4 Conversion

a. The original system located in the OPNAV Message Center consists of two identical UNIVAC 8558-98 AUTODIN Communications Terminal Set 2 (hereafter referred to as the UNIVAC 1004 System), and the RCA 301 computer system.

This RCA 301 system consists of the following:

- o 304 Computer Processor and Controllers
- o 3464-3 Drum Storage
- o 323 Card Punch
- o 334 Card Punch
- o 322 Paper Tape Reader
- o 333 High Speed Line Printer
- o 328 I/O Typewriter

The Univac 1004 System consists of the following:

- o Data Line Terminal DLT-6-IV
- o UNIVAC 1004-06 Model 1
- o UNIVAC Printer
- o UNIVAC Paper Tape Punch
- o UNIVAC Card Punch
- o UNIVAC Card Punch
- o UNIVAC Paper Tape Reader

The new system, consisting of two RCA 70/1600's and an RCA 70/45, will replace the two UNIVAC 1004's and the RCA 301 according to the following schedule:

b. On 1 Feb. 1971, one UNIVAC 1004 will be replaced by the following RCA equipment:

Equipment	Nomenclature	Quantity
70/1600 Processor	161164	1
Console Typewriter	163703	1
Console Typewriter Control	163701	1
Standard Interface Control	162101	3
Paper Tape Reader	163704	1
Data Exchange Control (70/1600)	162501	1
AUTODIN Line Control (70/1600)	165705	1
Paper Tape Reader/Punch	70/221M	1
4N Terminate (70/221M)	5293	1
Standard Interface Switch	70/301-25	1
Card Punch	70/234/-10	1
Card Reader	70/237/-10	1
Medium Speed Printer	70/242-30	1
ASCII Print Drum Segment (70/242-30)	5332-1	1

c. By March 1971, the following RCA equipment will be placed in the OPNAV Message Center:

Equipment	Nomenclature	Quantity
Magnetic Tape Controller (Dual)	70/473-208	1
Magnetic Tape Unit	70/432-2	3
Random Access Controller	70/551	1
I/O Attachment for 70/564(70/551)	5501-14	1
I/O Attachment for 70/568(70/551)	5502-1	1
Off-Line Scan (70/551)	5511	1
Record Overflow (70/551)	5512	1
Disc Storage Unit	70/564	4
Disc Pack	70/563	4
Paper Tape Reader/Punch	70/221M	1
Comm Control Multichannel	70/668-31	1
Asynchronous Data Set Buffer	70/720-21	3
Telegraph Low Level Buffer	70/712	2
Video Data Terminal	70/7522	3
Medium Speed Printer	70/242-30	2
ACCII Print Drum Segment (70/242-30)	5332-1	2

d. On 1 Apr. 1971, while retaining the second UNIVAC 1004, the following RCA equipment will be installed:

Equipment	Nomenclature	Quantity
SPECTRA 70/45 Processor	70/45G	1
Console	70/97-20	1
Elapsed Time Clock (70/45G)	5019-45	1
Selector Channels (70/45G)	5043-45	1
Memory Store Fetch Protect (70/45G)	5036	1

e. Effective 1 Jul. 1971, the RCA 301 will be taken out of the OPNAV Message Center and will be replaced by the following RCA equipment:

Equipment	Nomenclature	Quantity
Random Access Controller	70/551	1
I/O Attachment for 70/564(70/551)	5501-14	1
I/O Attachment for 70/568(70/551)	5502-1	1
Off-Line Scan (70/551)	5511	1
Record Overflow (70/551)	5512	1
Mass Storage Unit	5512	1
Asynchronous Data Set Buffer	70/720-21	2
Synchronous Data Set Buffer	70/721	1
Telegraph Low Level Buffer	70/712	1
Video Data Terminal	70/7522	2
Magnetic Tape Unit	70/432-2	1
DCT 2000 Remote Printer	8560-00	1
Short Block Feature	F0845-00	1
Error Detect and Retransmit	F0848-00	1

f. On 1 Sept. 1971, the second UNIVAC 1004 will be removed and at the same time the following RCA equipment will be installed:

Equipment	Nomenclature	Quantity
70/1600 Processor	161108	1
AUTODIN Line Control (70/1600)	165705	1
Data Exchange Control	162501	1

g. Then, on 1 Oct. 1971, two RCA Synchronous Data Set Buffer (70/721) will be installed, and finally, on 1 Nov. 1971, twenty-four Telegraph Low Level Buffers will be installed. At this time, the transition to the new system will be complete.

C.2.5 Continuity

There will be no disruption of service during this transition period since the replacement system will be installed before the corresponding system is taken out. What will be changed is the operating procedure. This new operating procedure is described elsewhere in this BESEP. The removal of the RCA-301 and UNIVAC 1004 system, and the placement of the new RCA 70/45 system is indicated by figures C-1 to C-4. Careful planning is required to provide for the requisite power and air-conditioning for the new system prior to its arrival.

All floor panels must be properly cut for cabling prior to the arrival of the new equipments so that the transition period will cause the least amount of disruption. The electricians, technicians, engineers, and movers, whether they be Navy or RCA personnel, must be on site upon arrival of the new equipment, both to remove the old equipment and to install the new equipment on a timely basis to minimize disruption of system operation. Commercial Contractors, such as Western Union, must also be scheduled to be on site, on time.

C.2.6 Site

The OPNAV Message Center is located in the Pentagon in room 4C686, and adjacent spaces. This site will not expand its present confines. The environment of the site enables relatively easy access to additional air conditioning and power. Raised flooring exists and will be suitable for the new system, except for those panels requiring change for reasons of cable cut-outs. The floor-loading of the primary floor is adequate for all the new equipment to be installed. Equipment vibration (such as disks) can by suitably handled by this existing primary floor. Maintenance space is inadequate at the existing site and will require alteration to the existing site. The same applies to storage space. The present site has poor access doors.

Thus, additional time must be allowed for the removal of the old equipment and delivery of the new equipment. Heating facilities at the site are adequate for all conditions.

C.3 ELECTRONIC SYSTEM DESIGN AND INSTALLATION

C.3.1 Existing General System Description

The OPNAV Message Center provides service to the Secretary of the Navy, the Chief of Naval Operations, the Secretary of Defense, the Joint Chiefs of Staff, and other high-level officials in the Washington area. Due to its unique position in the overall military command and control system, speed, accuracy, and reliability of service are paramount requirements of the CNO Communications Center.

Record communications volume is increasing at an unprecedented rate and is expected to double in the next two years. An increasing number of circuits, some of which operate at much higher speeds than their predecessors, provide a significant new communications capability which in turn contributes to the increase in message volume. As various offices served relocate outside the Pentagon, additional dedicated circuits will be required to effect high-speed, electrical distribution.

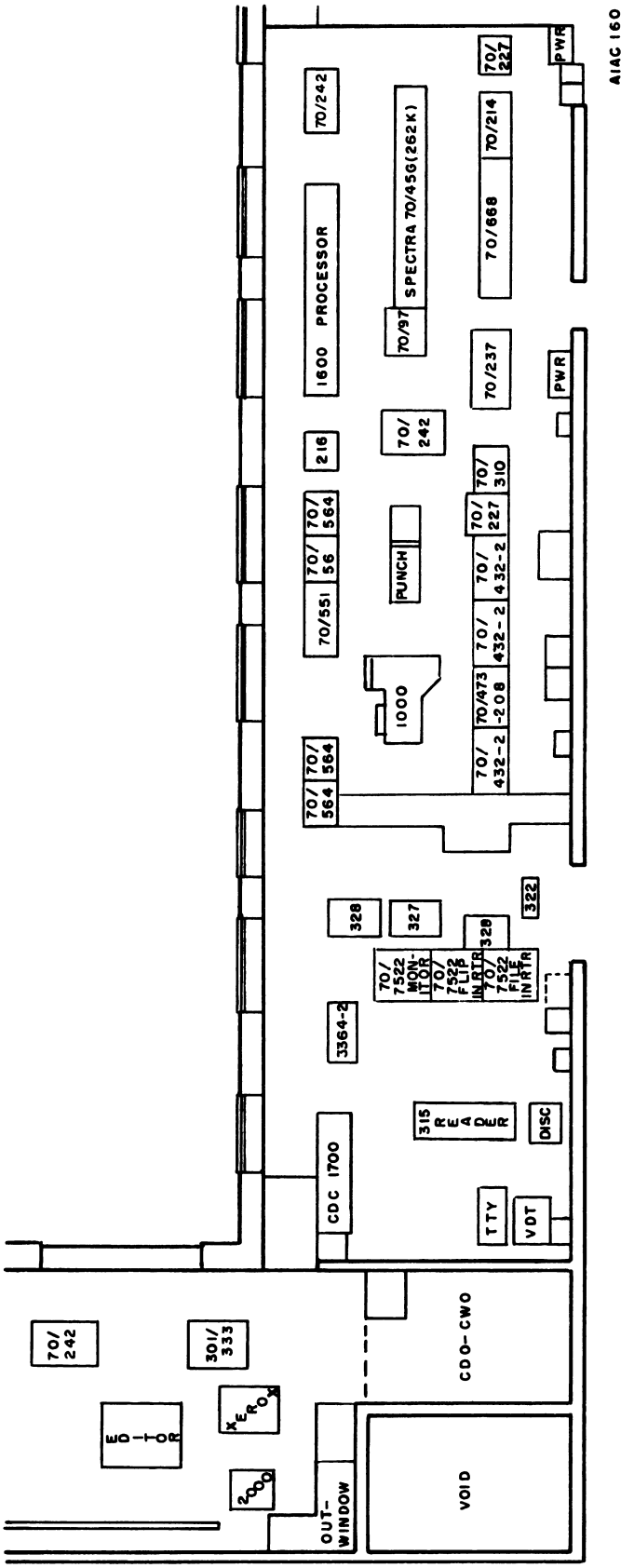

Figure C - 1. NAVCOMCEN CNO - Equipment Layout (April 1971)

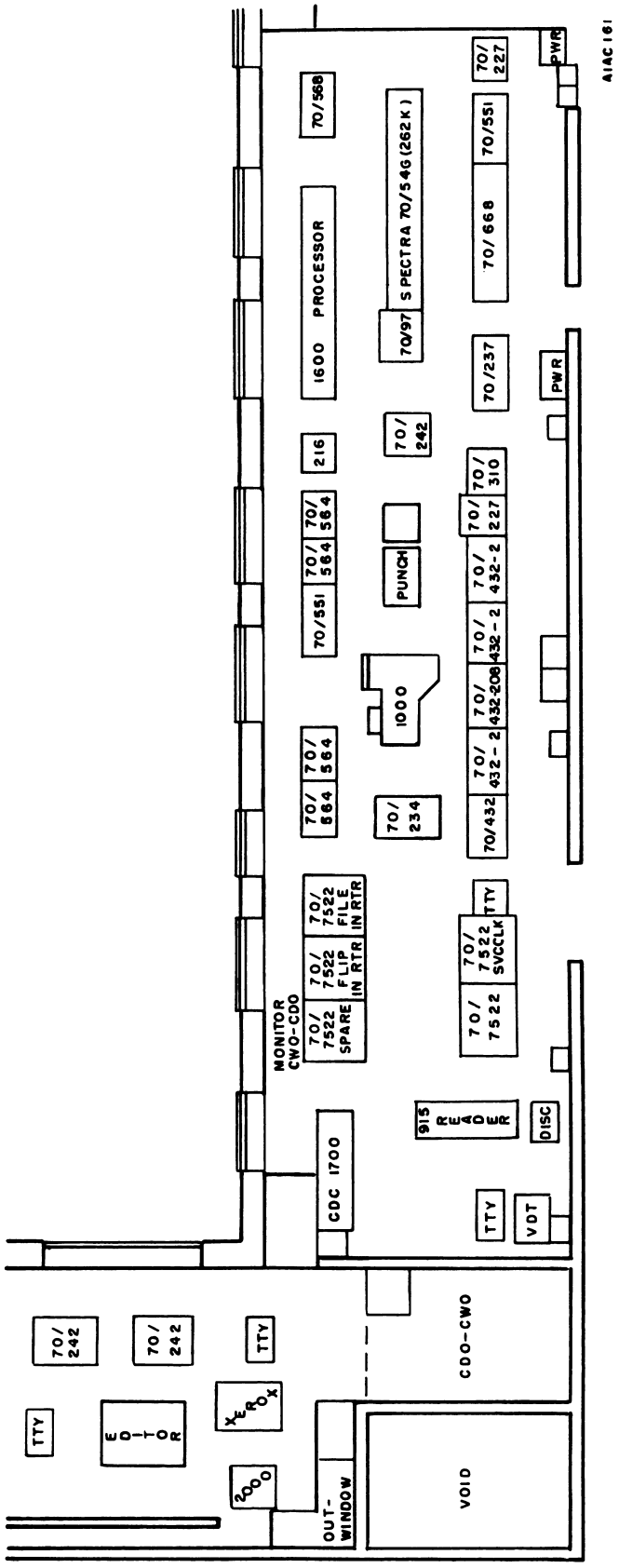

Figure C-2. NAVCOMCEN CNO - Equipment Layout (July 1971)

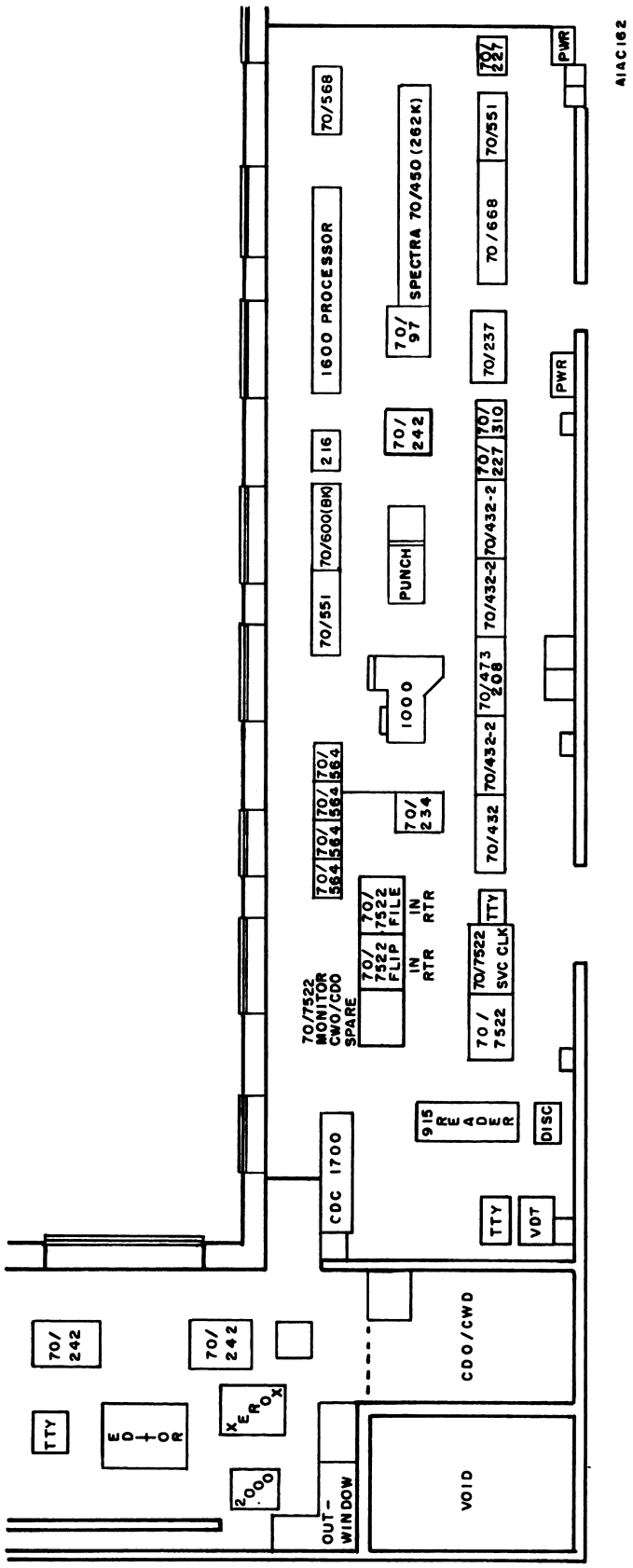

Figure C - 3. NAVCOMCEN CNO - Equipment Layout (September 1971)

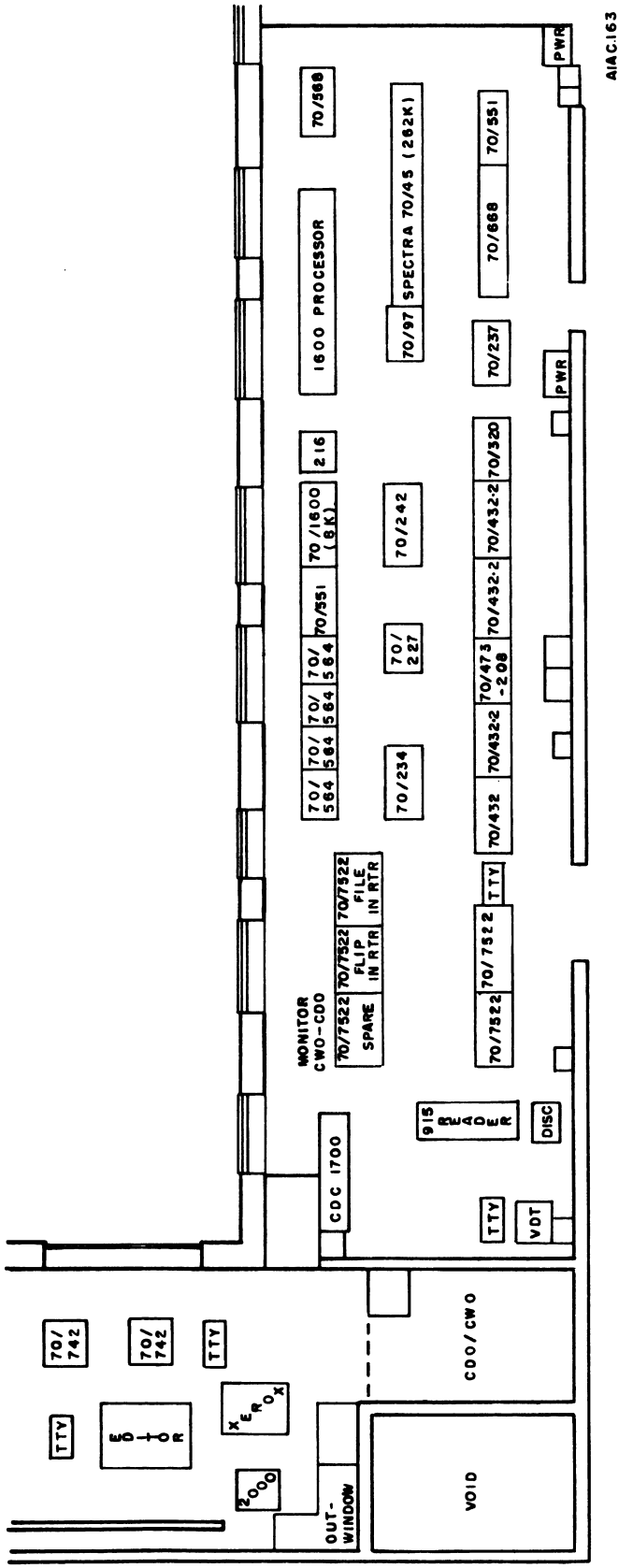

Figure C - 4. NAVCOMCEN CNO - Equipment Layout (October 1971)

The Message Center is currently processing a volume in excess of 100,000 messages per month. Messages are received electrically on seventeen full duplex teletypewriter circuits of which twelve are maintained continuously and five are on-call and available for contingencies. Direct, dedicated "Flash News" are maintained with the Commandant of the Marine Corps and the three major fleet commands: CINCPACFLT in Hawaii, CINCLANTFLT in Norfolk, Virginia; and CINCUSNAVEUR in London, England. The Message Center also operates a terminal of the NAVCOMMOPNET, a Navy-operated worldwide tactical operational traffic network. The major source of common user electrical traffic is two AUTODIN terminals which are connected to Automatic Electronic Switching Centers at Gentile Air Force Base, Ohio and McClellan Air Force Base, California. Additionally, a heavy volume of operational or "war traffic" comes to Washington addressed to the Joint Chiefs of Staff. This traffic is routed from the Department of the Army Communications Center directly to the National Military Command Center and the "War Rooms" of the Military Services. Two local loop circuits are maintained to receive and simultaneously retransmit this information to the Navy Flag Plot. Other means of receipt include pneumatic tube, mail, and courier.

The OPNAV Message Center must be responsive to the immediate needs of commands for timely and specific information as well as the general communications requirements of all offices served. The first is accomplished by having an officer monitor all incoming traffic in order to identify and select important mission-oriented messages and ensure delivery of the traffic in a timely manner. The second is accomplished by careful control of internal distribution, facilitated by automatic data processing devices. At present, a computer memory bank contains 4,500 internal distribution combinations for 1,500 different subject and the system is readily adaptable to changing requirements through daily updating and reprogramming. Further personalized responsiveness to the upper echelons of command is provided by a liaison group known as Special Folders which annotate and deliver messages to and from the more senior officials served.

The Message Center handles an average of 3,400 messages per day. This figure represents messages received by all means, some of which are received by mail or pneumatic tube and do not require computer processing. The computer processing capacity of the Message Center is approximately 5,000 messages per day. This figure has not yet been attained, but recent daily volumes have been in excess of 4,500 messages. It is apparent that the present Message Center is frequently operating at near capacity level.

The OPNAV Message Center has a complement of 31 officers, 109 enlisted men, and 28 civilians. Of these, 115 are committed to narrative traffic handling, 88 military personnel are assigned to four crews of 3 officers and 19 men each. The crew, or watch section, is augmented by a Communications Duty Officer, a Special Folders Watch Officer, and two civilian routers. In addition, 16 enlisted and civilian personnel are assigned as peak load support to supplement the crew and assist during periods of high message volume. Approximately 680 man hours are required daily to process narrative traffic. Present personnel strength levels were authorized in 1961.

The OPNAV Message Center is compact. A total floor area of 6,750 feet is divided into three contiguous segments forming a rectangular horseshoe. Each space is approximately 20 feet wide and 100 feet long. The equipment must be contained in this space.

The purpose of this communications project is to develop a total system design that will provide the faster writer-to-reader service possible, consistent with reliability and security. The OPNAV Message Center requires the service of a real-time, on-line, record communication processing system. The purpose of this system is to fully automate all message processing functions within the Communications Center. In addition to improving its local delivery service, this system will enable the OPNAV Message Center to:

- Perform message switching functions.
- Accommodate growing traffic volumes.
- Reduce manpower demands (numbers rank/rate, training).
- Adapt to changing message procedures.
- Provide more efficient management, accounting, and administrative functions.
- Provide a precedent for further Navy and Joint projects in the automatic message processing field.

C.3.2 LDMX System Description

Incoming messages (see figure C-5) regardless of Language Media Format (LMF) will be received directly from the AUTODIN and/or dedicated circuits at the speed of the circuit, and queued for validation, processing, and routing by the system. Disk Storage units will be utilized to queue the messages for processing on the basis of first-in, first-out, by precedence.

The LDMX will recognize predetermined message categories by precedence, flagword, addressee, standard subject code, etc., for immediate automatic delivery to the Command Center. Internal distribution will then be assigned automatically, according to cited references, standard subject code or descriptive subject line in accordance with current routing guides maintained within the system.

Messages which cannot be routed automatically will be presented to an Inrouter via a Visual Display Terminal (VDT) for manual assignment of distribution.

Edited messages with assigned distribution will be printed on a high-speed line printer on multilith mats for offset press reproduction. The LDMX will record all messages as received, with their assigned distribution, in on-line files.

Outgoing messages (see figure C-6) will be processed in much the same manner. Released messages on Joint Message Form DD-173 will be fed into an OCR, the LDMX will assign routing indicators, an SSN, and a DTG, then select an outgoing circuit, format the message in ACP 127 or JANAP 128 format as appropriate for the circuit to be used, and transmit the message.

The LDMX will record the time of transmission and the message as transmitted in the on-line files. The only paper copies of messages to be handled in the communication center will be released originals of outgoings, and distribution copies of incomings.

The Fallback mode (see figure C-7), if the RCA 70/45 goes down, is to route the messages through a switch to tape for storage. It is thus available for future processing.

Messages will be processed automatically by the LDMX in times measureable in seconds and milliseconds, rather than minutes or hours. The capacity of the system, if used for nothing but message processing, is calculated to be 62,000 messages per day, based on an average message length of 1,400 characters.

The LDMX will check channel number continuity, validate classification redundancy, check for stragglers, and verify completeness of every message received.

It will keep tabs on messages from entry until processing has been completed. Status of any message can be immediately determined upon demand by an operator.

The LDMX files will be constructed in such a manner as to permit retrieval of a message with a minimum of information, such as DTG only, Originator and DTG, TOF & SSN, or even Originator with an unknown DTG in a given day.

Messages up to 45 days old will be retained in the LDMX files with immediate retrievability.

Messages can be recalled, corrected, and retransmitted within moments, without paper, and all duly recorded.

Readdressals will be accomplished automatically upon entry into the OCR of a properly prepared and released readdressal request on a Joint Message Form DD-173.

A complete ACP 117 routing indicator file can be maintained in the LDMX.

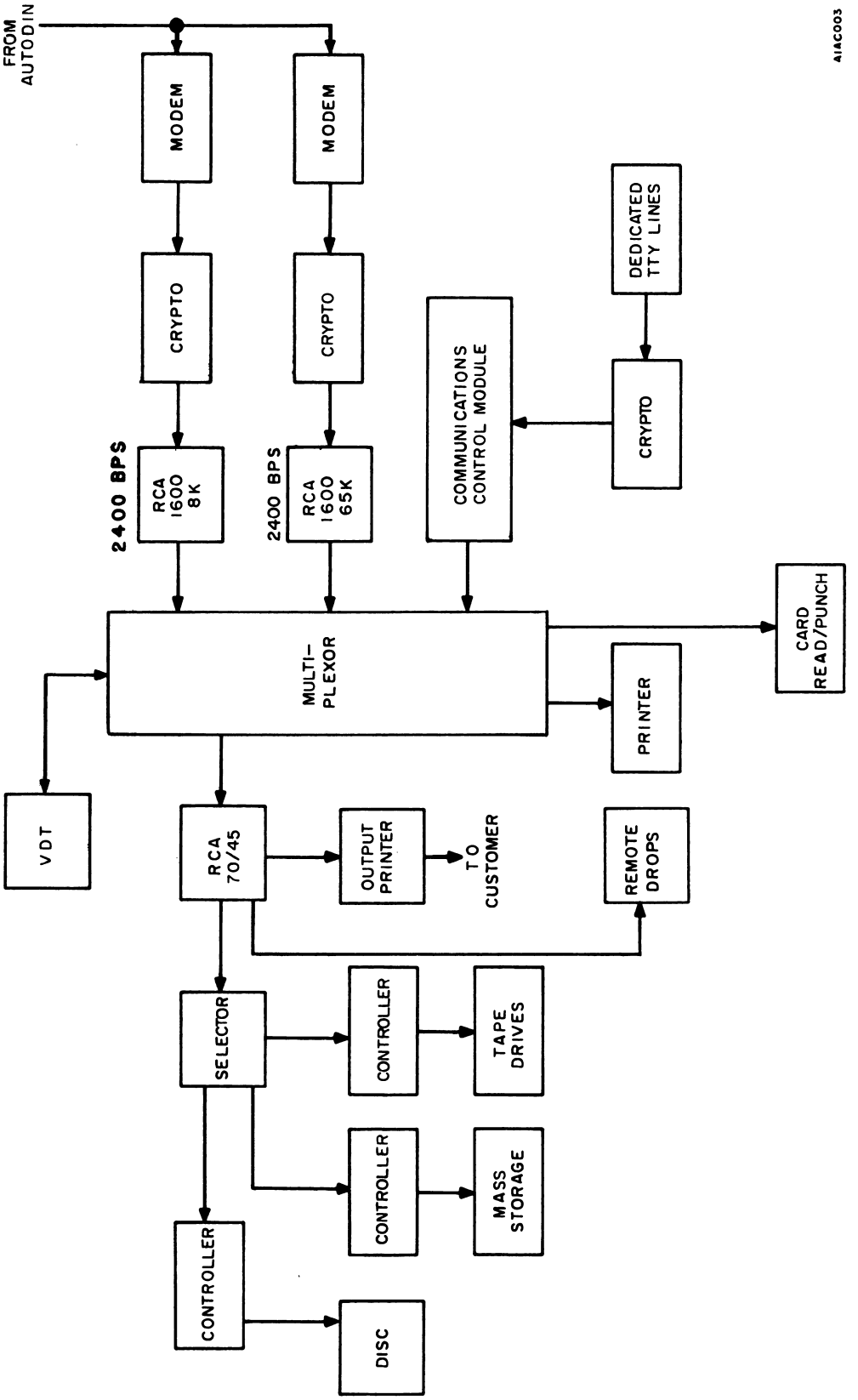

Figure C - 5. LDMX Incoming Messages Processing, Schematic Diagram

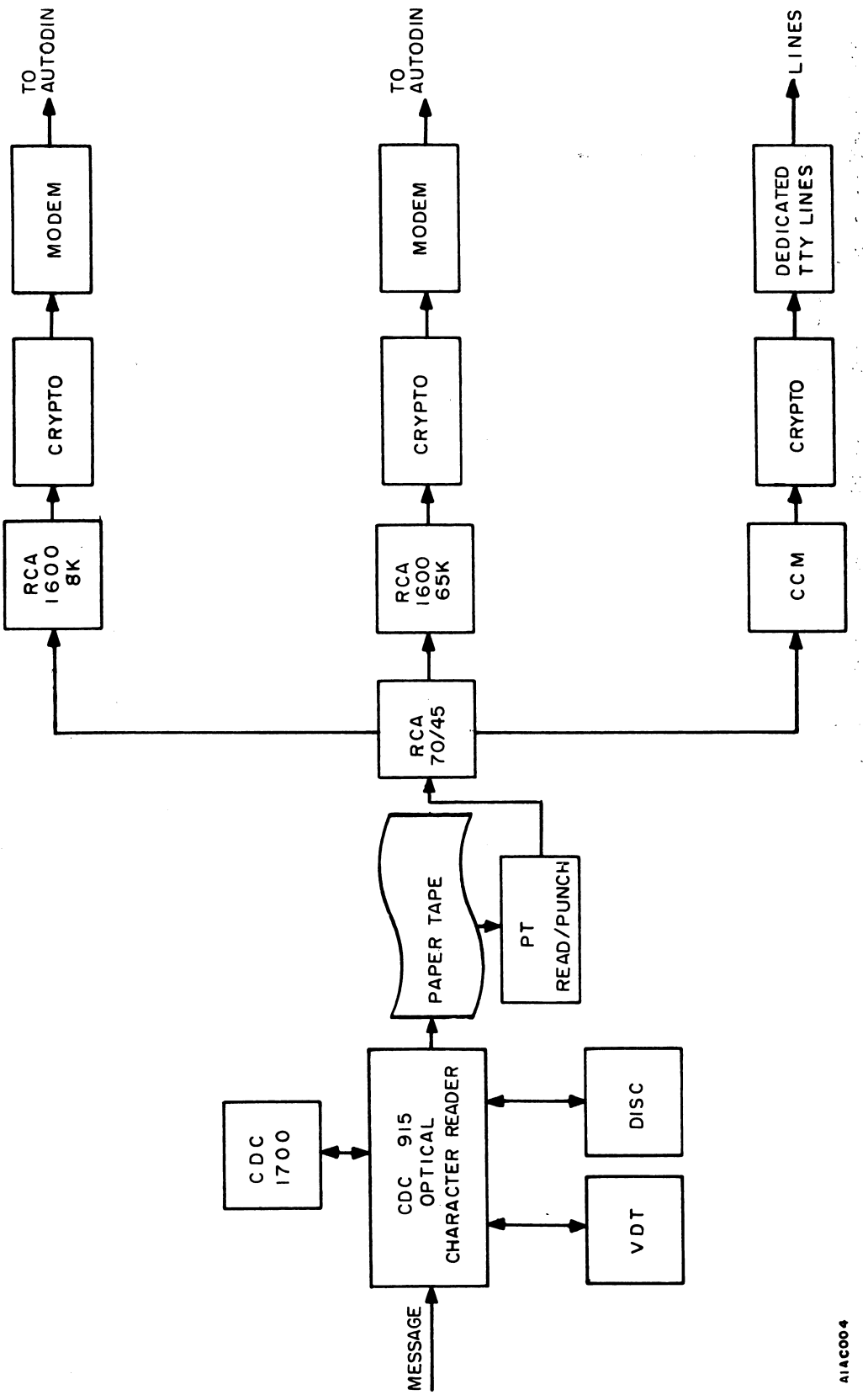

Figure C - 6. LDMX Outgoing Messages Processing, Schematic Diagram

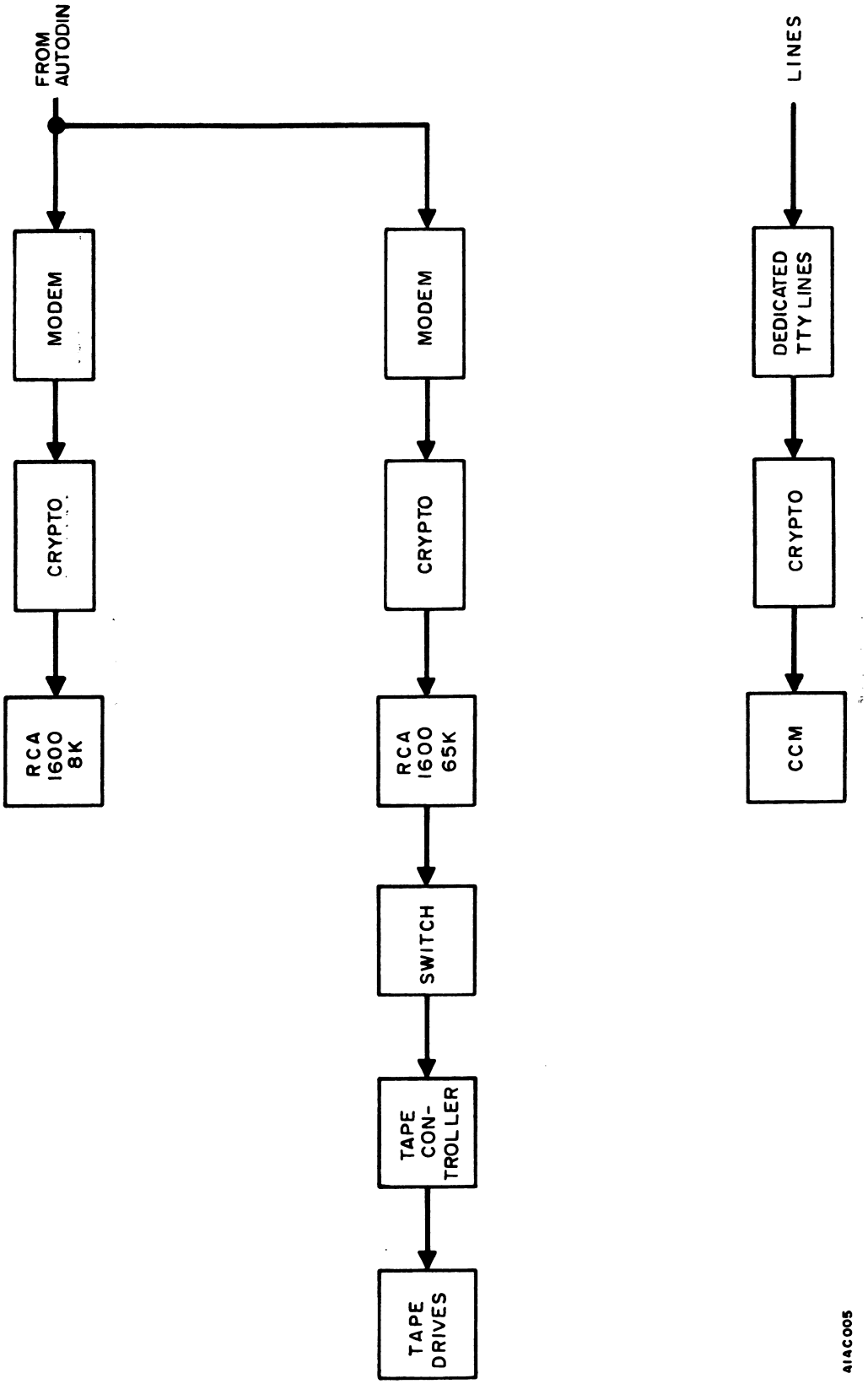

Figure C - 7. LDMX Fallback Mode, Schematic Diagram

Statistics can be obtained upon demand to provide pertinent information regarding accountability and other data concerning message processing, such as speed of service, circuit usage, message length, queue status, etc.

C.4 ELECTRONIC EQUIPMENT

The characteristics and quantities of the electronic equipment to be installed are shown in Table C-2.

C.5 SYSTEM CHECKOUT AND ACCEPTANCE

C.5.1 General

The equipments to be installed for this project require a checkout or pre-acceptance performance testing to ascertain that they have been properly installed, will function adequately, and meet the prescribed performance standards. An operational checkout is then performed to ensure that operational requirements of the facility, the sponsor, and the Navy are met.

C.5.2 Contractor Tests

RCA will run their standard tests which checkout the hardware components and their interactions as part of the overall system. These should process special data designed to test all the special features of the equipment and any program packages supplied. These standard tests should include diagnostic routines, which, in addition to exercising the main frame processor, also exercise the peripheral units.

C.5.3 Test Requirements

In general, the individual equipment tests are to be made in accordance with the procedures prescribed in the Maintenance Standards Manual for each piece of equipment, or as prescribed by the equipment manufacturer. If the results of these performance tests show that any equipment does not meet the level of performance set forth by the specifications, it shall be noted as a deficiency and will delay acceptance of the installation. NAVELECSYSCOMHQ and NAVELECSYSCOMWASHDIV will provide any support required by the OPNAV Message Center up to and including final acceptance. The system will be operated with the OPNAV Message Center Operating System for 30 days continuously at the normal work schedule. If the system functions properly during this period at 95 percent effectiveness, the system should be deemed acceptable. (See GSA schedule to amplify this statement).

C.6 PHYSICAL PLANT

C.6.1 General

This section of the BESEP provides the known site preparation requirements for the installation and operation of the electronic equipment. The physical plant for this project is located from room 4C654 to 4C583 of the Pentagon. Figure C-8 shows the existing area.

The intent of this section is to aid the site preparation agency in developing plans and specifications for adequate, operational structures. It is not intended to preclude the site preparation agency from using good engineering practices. NAVELEXWASHDIV will provide, by direct liaison with the site preparation agency, further guidance and detailed information as needed on the electronics equipment requirements. A submittal of the final design drawings and specifications by the site preparation agency for review by NAVELEXWASHDIV is required.

Table C - 2. LDMX Equipment Characteristics Tabluation

QUANTITY	EQUIPMENT NOMENCLATURE	POWER REQUIREMENTS					BTU/Hr	DIMENSIONS (in.)			WEIGHT (lbs.)	REMARKS
		VOLTAGE (V)	FREQUENCY (Hz)	PHASE	KVA	BREAKERS		HEIGHT	WIDTH	DEPTH		
1	70/45 FE-II Processor	208	60	3	9.15	50A	28,750	62	168	25	2,600	5-Wires (4-wire plus ground)
1	5019-45 Elapsed Time Clock											RCA supplied cables
1	5043-45 Selector (Channels, 2)				0.85							RCA supplied cables
1	5056 Memory Store/Fetch Protect				0.42							RCA supplied cables
1	70/97-20 Console											RCA supplied cables
1	70/227 Paper Tape Reader/ Punch			3	2.25	15A						
1	70/234-10 Card Punch	208	60	3	1.52	15A	4,300	50	54	24	700	5-Wires (4-wire plus ground)
1	70/237-10 Card Reader	208	60	3	4.50	30A	10,200	44	63	30	950	5-Wires (4-wire plus ground)
3	70/242-30 Medium Speed Printer	208	60	3	*12.30	(3) 20A	10,600	54	57	30	1,600	5-Wires (4-wire plus ground)
1	70/310-25 Standard Interface Switch	208	60	3	0.10	15A	150	62	25	25	280	5-Wires (4-wire plus ground)
1	70/473-108 Magnetic Tape Controller	208	60	3	0.60	20A	1,700	62	50	30	500	5-Wires (4-wire plus ground)
4	70/432-1 Magnetic Tape Unit	208	60	3	*12.00	60A	6,600	62	50	25	650	RCA supplied cables 3KVA @ 208V., 3P, 60Hz power from 1600 Processor
2	70/551 Random Access Controller	208	60	3	*2.60	(2)40A	3,600	62	50	25	600	5-Wires (4-wire plus ground)
4	70/564 Disc Storage Unit				*5.04		3,500				390	RCA supplied cables power from 70/551 Random Access Controller
1	70/568 Mass Storage Unit	208	60	3	5.76	40A	1,100	62	50	25	2,600	5-Wires (4-wire plus ground)
1	70/668 Communications Controller	208	60	3	3.80	40A	12,000	62	55	25	2,200	Type II 5-Wire (4-wire plus ground)
5	70/7522 Video Data Terminal	120	60	1	*1.75	(5)15A	1,135	15	17	30	140	Convenience Outlet
1	8560-00 DCT 2000 Remote Printer	208	60	2	2.80	30A	5,000	50	65	28	900	
1	161164 Processor	120/208	60	3	3.10	40A	6,880	62	58	25	1,000	*Width to 100" dependent on I/O buffer requirement
3	162101 Standard Interface Control				*0.15		738				45	RCA supplied cables
1	163703 Console Typewriter	120	60	1	0.38	20A	660	38	40	24	225	
1	163701 Console Typewriter Control				0.03		98				15	RCA supplied cables
1	161108 Processor	120/208	60	3	3.10	40A	6,880	62	58	25	1,000	Plus 15 lbs. for each row of control electronics
2	162501 Data Exchange Control				*0.10		342				30	RCA supplied cables
2	165705 AUTODIN Line Control				*0.02		624				30	RCA supplied cables
					* Total							

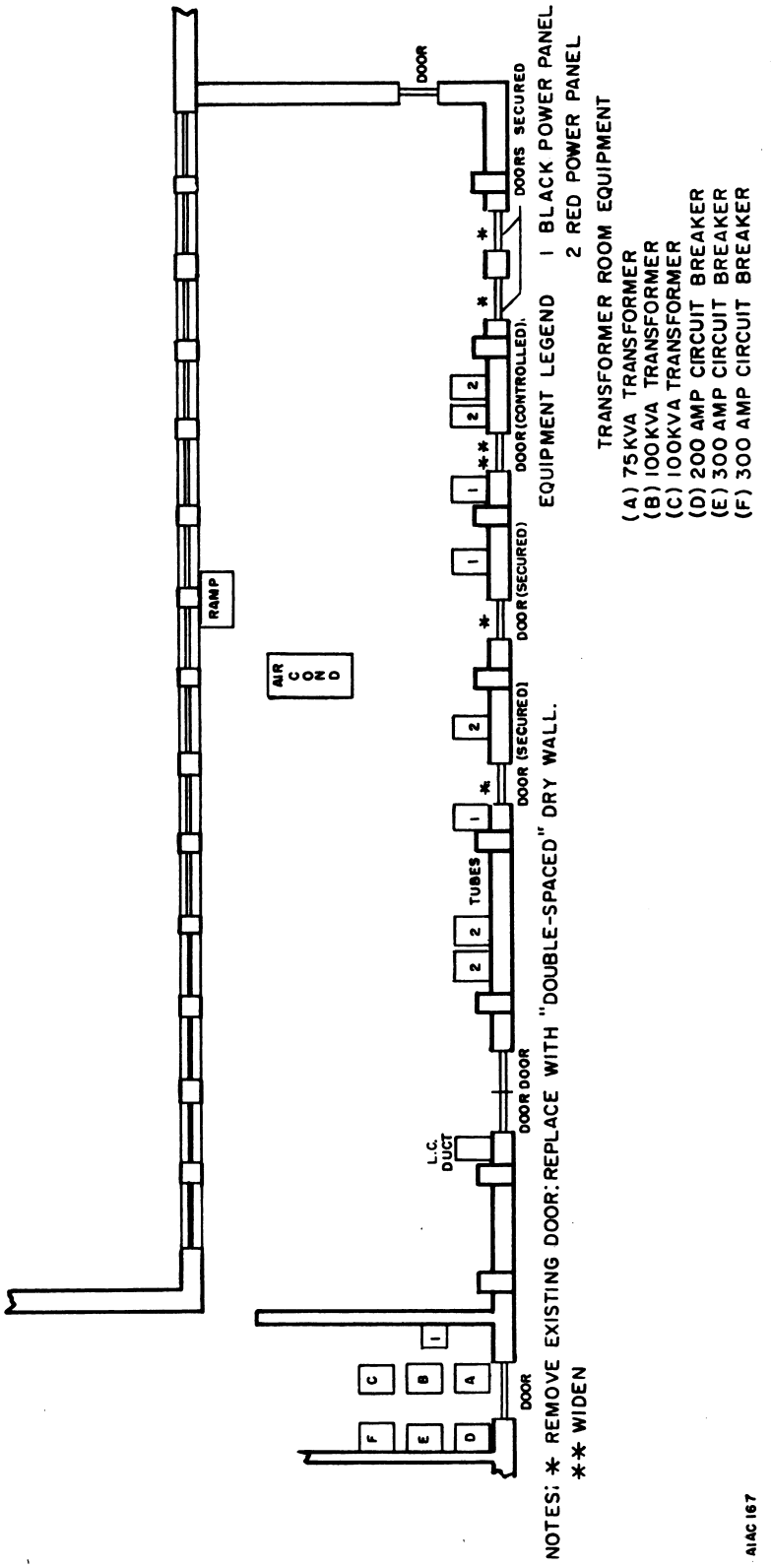

Figure C - 8. Floor Plan of Operations Naval Communications Center (NAVCOMCEN CNO)

C.6.2 Structural Requirements

Demolition of existing structures and new construction are required to provide suitable spaces for the equipment installation. The equipment layouts are shown on Figures C-1 through C-4. Consideration has been given to adjoining spaces that are intergral parts of the operational requirements of the equipment installation. Figure C-8 shows the existing floor plan and demolition/construction requirements. All new structural work shall be of non-combustible or fire retardant material. The Computer Room will require a raised floor approximately 9 inches from the existing floor. All exposed concrete in the Computer Room shall receive a sealer-hardener finish to prevent dusting. Four doors will be removed and replaced with "double-spaced" dry-wall, a door frame and door removed, and a new, larger door frame and door installed in its place, to allow easier access to the computer spaces.

C.6.3 Windows

The windows facing the south will be painted and then covered with drapes.

C.6.4 Raised Flooring

A removable type raised floor system will be required. The floor system shall be of the pedestal type, with stringers. Panels shall be approximately 24 inches x 24 inches and shall be covered with vinyl tile. The use of a plastic laminate covering, in lieu of vinyl tile, should be considered to reduce maintenance cost and time. The clear space between the sub-floor and lowest portion of the raised floor system shall be not less than 9 inches. BUDOCKS type specification TS-F12 may be used as a guide. The minimum design load for the system shall be 1000 lbs. concentrated load and 250 lbs. uniformly distributed load.

C.6.5 Ramps

Ramps will be installed at any location where floor levels differ.

C.6.6 Ceiling

The existing tiling of the suspended ceiling will be replaced by acoustic tiling.

C.6.7 Acoustics

Due to the inherent high noise level of the peripherals, acoustic tile or panels shall be applied to all walls and ceilings not already so covered. They shall be composed of non-combustible, non-dusting material.

C.6.8 Vibrations

The mass storage device has a series of rotating disks. These disks will set up vibrations of sufficient intensity to require isolating supports. Also, the floor at this location will require reinforcement to the false floor to support the excessive pounds-per-square-foot of this mass storage device.

C.6.9 Air Conditioning

The existing air conditioning system is operating at the saturation point for the existing system, paragraph C.3.1, and since there will be a period of 100,000 BTU/hr additional heat load during dual operation, additional air conditioning will be required. The unit is a chilled-water system. This will necessitate plumbing alterations to the exsiting system. An adequate lead time should thus be planned. Due to a rearrangement of equipment, the temperature and humidity controls and recorders ought to be removed to new locations. This in turn will require minor electrical alterations. Some new air conditioning ducting will be required to counteract a hot-spot due to a rearrangement of the equipment. This in turn will necessitate rearrangement of some overhead cable conduits. It is anticipated that the increased cooling capacity will require the addition of humidifying equipment. This in turn will require masonry work to prepare for the installation of this humidifier.

a. The ambient air control shall provide for a mean dry bulb temperature of 70°F (min. 60°F to max. 80°F) having a mean relative humidity of 45% (min. 20% to max. 65%). For the Computer Room, the ambient air control filtration system shall be designed for 40% - 80% relative humidity and a maximum of 25 people. Provisions shall also be made to monitor the temperature and humidity in the Computer Room. These monitors shall be separate from the controls provided with the ambient air control system. Of particular importance are the problems of concentrated heat loads.

b. The air conditioning equipment installed will not exceed a noise level of 72 dB at a distance of 3 feet from its cabinet.

C.6.10 Electronic Power

The electronic equipment power requirements are tabulated in Table C-2. The power systems shall be installed in accordance with Naval Facilities Engineering Command Design Manual DM-4 and the latest RED/BLACK Installation guidance. The ADP system requires approximately 74 KVA of electrical power, at 208 V, 3 phase, and both 60 Hz and 400 Hz. The 400 Hz power will be supplied from two 400 Hz Motor/Generator (M/G) Sets with a controller cabinet containing controls for each M/G Set and a selector switch. The M/G Sets and the controller cabinet will be government furnished equipment (GFE) and installation shall be the responsibility of the site preparation agency. Reduced voltage starters for each M/G Set are contained in the controller cabinet. The 60 Hz power shall be obtained from the existing transformer vault. No power will be required for the air conditioning system. A four-wire system is now available at the site. This system is brought to both red and black power panels. However, several additional power panels will be required.

a. Due to the operational requirements of this system, emergency, no-break power will be provided to support all the electronic equipment. It will also support, as much as possible, the lighting system as specified in this section. No provisions for new emergency power generators for this project will be made.

b. No-break power is a requirement for this project, but the requirement can be satisified for the next 3 to 5 years from existing available resources. This requirement should be reviewed, however, prior to drawing final plans.

No-break power is required for the equipment to be installed in the AUTOSEVOCOM Space. It is recommended that the power panel for the AUTOSEVOCOM Space be of sufficient size to facilitate future expansion. It is recommended that an additional 5 kW of power be made available with spare circuit breakers to facilitate the additional equipment. The size and quantity of the spare circuit breakers shall be determined using the existing system as a guide.

c. Provisions for surge protection shall be made for those circuits providing power to the RCA 70/1600 Processor and the RCA 70/45 Processor.

d. All circuits shall be frequency regulated between ± 5% of the nominal value of 60 Hz and 400 Hz.

C.6.11 Power Panels

Four power panels are available for black requirements, and two power panels are available for red requirements (see figure C-9). Each power panel shall be preceded by a main disconnect switch by which the power to all electronic equipment may be disconnected in case of emergency. The size of the main line disconnect switches and the capacity of the circuit breaker panels shall be determined by the site preparation agency. Filters will be required only on the 60 Hz red power panels. See table C-2 for the individual equipment requirements.

A special panel is required to receive the communications cabling to the modem. Commercial contractors will be required to be present when this panel is installed.

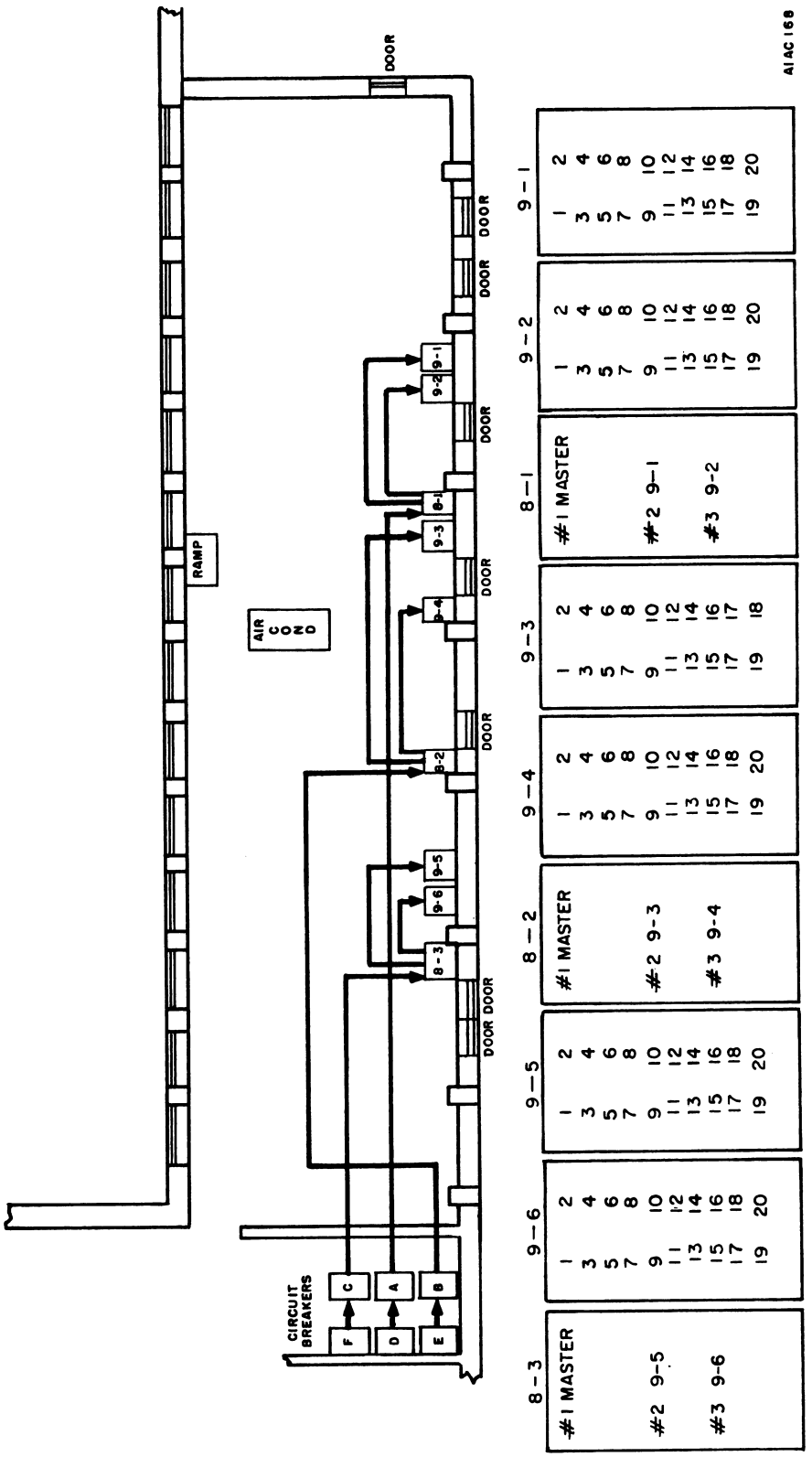

Figure C-9. NAVCOMCEN CNO - Power Panel Locations

C.6.12 Illumination

Normal interior illumination of the building shall be designed and installed in accordance with the latest criteria as set forth in the Naval Facilities Engineering Command, Design Manual DM-4 and also DM-23 where applicable. Flush recessed type fixtures are desired. RF attenuation treatments and similar special installation consideration for the illumination are not required.

a. Emergency Illumination

The normal interior illumination for the electronic equipment spaces and the operating areas shall be connected, by appropriate switching, to the emergency power system. The space shall have sufficient lighting to facilitate personnel movement without creating a safety hazard. If there is not sufficient power in the emergency power system to provide the above lighting, the electronic equipment from panels and the applicable operating areas shall be illuminated with lamps. The lamps will be of the battery type, with a minimum 30 minutes operational period. The batteries shall be rechargeable from the primary power supply, shall be an integral part of the lamp and shall be portable. The lamp shall have an integral part of the lamp and shall be portable. The lamp shall have an automatic on-off switch and manual on-off switch. The two switches will be integrated to the extent that, when the automatic switch is in the on-position, the manual on-off switch can be used; but when the automatic switch is in the off-position, the manual switch is disconnected. Lamps will be distributed throughout the remaining areas of the building in sufficient quantities to facilitate personnel movement.

b. Lights should be sectionally controlled by switches so that sections of the lighting may be turned off or on as desired.

c. Mount all lighting, conduit and air plenum duct so that its displacement from the floor to the lowest ceiling mounted equipment is at least 10 feet.

d. Standard fluorescent fixtures are acceptable for lighting. A minimum average illumination of 40 foot candles measures 2.5 feet above the floor shall be provided.

C.6.13 Grounding Requirements

The entire electrical power system, including conduit systems, panels, motors, frames, equipment, controllers, transformers and all apparatus shall be permanently and effectively grounded in accordance with Naval Facilities Engineering Command Design Manual DM-4. All building steel, etc., shall be bonded and grounded, where applicable, in accordance with NAVFAC DM-23, section 6, and commensurate with project funding.

A grounding system, separate from the above, shall be installed for the electronic equipment signal ground. The electronic equipment signal ground shall be installed in accordance with Handbook of Naval Shore Station Electronics Criteria, NAVSHIPS 92675 unless otherwise stated.

C.6.14 Fire Protection

A CO_2 hose reel system using low pressure storage tank or high pressure cylinder should be provided for fire protection of the electronic equipment. The design should include a reserve capacity of CO_2 equal to the ready storage amount. High pressure systems should utilize 75 no. size CO_2 cylinders. Length of travel for hose reel stations should be approximately 50 feet. Activation of the CO_2 system should be by a manual operation. Consideration should also be given to providing an early warning smoke detection system of the ionization chamber type. The detection should be of the multi-zone design which immediately indicates the zone or circuit in which the detector initiating the alarm is located. If this detection system is used, the location of the monitor unit shall be determined by the Construction Design Activity and the "User" activity. Use of water sprinkler protection for the building interior is not a requirement.

C.6.15 Security

The integrity of the power and signal filters, doors, chilled-water lines, air conditioning, duct, and pneumatic message tubes all require special design considerations and shall be in accordance with NSA Specification 65-6 of 30 Oct. 1964.

a. The lighting systems, the power systems, the grounding system, the ambient air control systems and the telephone and intercom systems will be designed and installed in the crypto space in accordance with the guidelines of Naval Electronic Systems Command Note 011120 of Oct. 1966.

b. The OPNAV Message Center personnel are responsible for the security of the spaces. The entire Message Center is considered a secure area.

Cipher locks will be installed on the door to room 4C686. Windows will have permanent bars placed over the window frames. All other accesses to the Message Center will be "permanently" secured.

C.6.16 Wiring Diagrams

Equipment interconnecting cable diagrams, power wiring diagrams, etc. shall be prepared by the Installation Design Activity (WASHDIV) in accordance with RCA recommendations and known operational requirements of the user. The manufacturer (RCA) will supply all cables, cabling diagrams, signal flow diagrams, and wiring diagrams necessary to complete the installation. These as-built drawings will be required by the user activity. The originals will be turned over to NAVELECSYSCOMWASHDIV. The cables will be precut to the appropriate length and terminated in the required plugs. It is necessary, therefore, that the equipment arrangement not deviate from that of figures C-1 through C-4 since the interconnecting cables will be cut to fit that arrangement. Figure C-9 shows power panels and wiring.

Conduits will be run between the xerox and its power panel because no false floor exists in this area.

C.6.17 Telephones

New telephones shall be located by OPNAV Message Center as required. Telephones located within the Computer Room shall be installed in accordance with the latest RED/BLACK installation guidance.

C.6.18 Integration of Systems

The fire protection alarm system, the security alarm for secure areas and the exterior door alarm system shall be similar to and integrated with the existing systems. Also, an instrumented TEMPEST survey shall be made after acceptance of the complete system. See figures C-1 through C-4.

C.7 SUPPLEMENTARY MANUALS

- o NAVCOSSACT Functional Description
- o RCA Installation Guide
- o RCA Recommended Installation Plans for OPNAV Message Center

APPENDIX D

AUTOMATIC DATA PROCESSING REVIEW AND EVALUATION PROGRAM

This Appendix covers the documentation requirements of ADP Readiness Review in accordance with SECNAVINST 10462.18.

The ADP Readiness Review, sometimes is referred to as a pre-installation survey, provides for an on-site evaluation of an installation's readiness to productively use ADP Equipment as soon as it is installed and operational.

D.1 DOCUMENTATION PREPARATION

D.1.1 Documentation requirements have been prepared to cover many different equipment installations at various types of activities. It is important that the format be followed and responses tailored specifically to the ADPE involved. Any questions about applicability should be resolved by discussion with the command which will conduct the Review.

D.1.2 Assembly of documentation should not be elaborate. Responses should be typewritten on standard size (8" X 10 1/2") pages and numbered sequentially. Use of attachments is encouraged.

D.1.3 Sufficient copies should be prepared so that each member of the evaluation team will have a "working" copy available for use while on board.

D.1.4 At the conclusion of the evaluation, all changes, additions, or deletions recommended by the evaluation team should be incorporated into the formalized documentation which must be forwarded to the official approving the acquisition via the appropriate chain of command. (A copy for each echelon should be provided).

D.1.5 The following items will not be part of the formal documentation, but shall be available for review and reference by the evaluation team:

- ADP Readiness Review documentation
- ADP System Specifications
- Request for Proposal (RFP)
- Proposal (supplier's)
- Correspondence relevant to installation of ADPE
- Higher-Level Language Conversion Plan (OPNAVINST 10462.8)
- Utilization records
- Systems and Programming documentation
- ADP Standards
- ADPE billing data
- Contracts:
  - Equipment
  - Software services
  - Management consulting
  - Other ADP services
- Post-Installation Evaluation report(s)
- Position descriptions for key personnel

D.1.6 Ensure that a copy of the ADP Readiness Review documentation is retained on-site for use by auditors during the Post-Installation Evaluation which is normally conducted 12-18 months after installation of ADPE.

D.1.7 In all cases, arrival and exit interviews will be held with the Commanding Officer or his delegated representative.

D.1.8 It should be emphasized that the scope and depth of documentation for any case is dependent on the nature of that case. The outline, or table of contents, represents general guidance, not absolute requirements. If there is any doubt or reason to modify the documentation indicated, the appropriate documentation required for each case should be resolved in advance jointly by the reviewing authority and the organization to be reviewed.

D.2 DOCUMENTATION REQUIREMENTS

TYPE OF EVALUATION: ADP Readiness Review

D.2.1 General Information

a. Activity Name and Location:

b. Nature of ADP Workload:

c. Dates Evaluation Conducted:

d. Reviewing Personnel:

e. Activity Personnel Contacted:

f. ADPE Installation Date (only for ADP Readiness Reviews):

D.2.2 Table of Contents

D.3 SPECIFIC REQUIREMENTS

Specific requirements to be included in the ADP Readiness Review are as follows:

D.3.1 Requirement for ADPE

Provide brief, concise statement of justification for acquiring the ADPE being evaluated. This is expected to serve only as an introduction, but should indicate if it is a pilot/prototype system. Describe the relationship with the organization responsible for development of the system.

D.3.2 Organization

a. Provide:

(1) Brief statement of mission of activity
(2) Chart of overall organization of activity
(3) Chart of Data Processing Organization showing where the following functions are performed:

- o Systems analysis and design
- o Programming
- o Computer operations
- o Advance planning and analysis of ADPE requirements
- o Data processing administration
- o Maintenance of old systems, subsystems, and programs
- o Development of ADP Standards
- o Punch Card Accounting Machines (PCAM) operations
- o Card punch and verification

b. Briefly explain anticipated organizational changes or problems.

D.3.3 History of Data Processing Organization

Provide brief history of the Data Processing Organization leading to present ADPE.

D.3.4 Personnel

a. List positions (by grade/rank and title) assigned to organizational elements shown in D.3.2.a.3 with lower case letters in parentheses after each showing which of the listed functions are assigned thereto. (Specify vacancies).

b. Provide a summary of officer, enlisted and civilian personnel on board (by grade/rank and title) at time of:

(1) Twelve months prior to this evaluation
(2) This evaluation
(3) Twelve months after this evaluation (estimated requirements)

c. Specify:

(1) Personnel turnover (military and civilian) for the last two years on an annual basis. List each vacant position by title, date it became vacant, and reason why it became vacant.
(2) Number of personnel (military and civilian) with less than one year of ADP experience.
(3) Total overtime hours and cost used in the last twelve months.

d. Indicate personnel problems which may exist at time of evaulation and briefly explain.

D.3.5 Training

a. Provide a summary of courses attended by personnel of the Data Processing Organization associated with the ADPE being evaluated (give number of personnel, title of course, number of days, organization or manufacturer sponsoring class, and costs per course).

b. Describe ADP experience of Data Processing Management personnel and indicate total number of years experience.

c. Specify future training plans.

d. Describe indoctrination given high level management personnel and customers of the Data Processing Organization.

D.3.6 Site

a. Provide site layout plan for the ADPE to be installed (to scale on 8" X 10" paper preferred). If interim arrangements are necessary to accommodate both new and old equipment during transition period, provide sketch of temporary layout plans.

b. Provide a written statement signed by the cognizant Public Works Officer, GSA, or ADPE supplier certifying that the site is ready and acceptable or to the best of their knowledge will be ready and acceptable at the time of the delivery of the ADPE cited in the contract.

c. Describe status of the following as they pertain to the ADPE being evaluated:

(1) Space availability
(2) Electrical power (primary and secondary)
(3) Air conditioning
(4) Physical security
(5) Fire prevention and fire fighting
(6) AUTODIN or other communications requirements
(7) Storage space associated with computer operations

(8) Library space (tape/IAS)
(9) Secondary sites to be used for installation of remote terminals
(10) Procedures for maintaining cleanliness and order within the computer site
(11) Work space(s) for maintenance personnel of the equipment supplier
(12) Raised floor and adequacy of floor support

d. If applicable, provide brief description of problems associated with remote terminal sites.

D.3.7 Equipment

a. List in-house ADPE at time of evaluation (use format specified in Figure D-1). Include special features and remote terminals. Use asterisk to identify equipment acquired subsequent to ADPE selection or installation. Use double asterisks to identify ADPE scheduled for release but which is still on-site.

b. Indicate what ADPE is to be installed or to be released within eighteen months from this evaluation. Indicate monthly rental and scheduled release/installation date(s).

c. Indicate if the information requested in paragraphs a. and b. of this paragraph has been reported under the Department of the Navy Automatic Data Processing Program Reporting System of SECNAVINST 10462.12B. If not, explain.

D.3.8 Workload

a. Regarding the workload to be run on the ADPE to be installed, provide the following information for each system/application:

(1) Name
(2) Language(s) used
(3) Number of programs
(4) Number of master files, record volume, and type (e.g., cards, tape, immediate access storage)
(5) Status of workload for the following phases in terms of completion requirements (man/days), percent accomplished and estimated completion date:

- o Analysis
- o Design
- o Programming
- o Test and debugging
- o File conversion
- o Documentation
- o Parallel operations

b. Have documentation for systems/applications available for review and evaluation.

c. Cite the directives, instructions, etc. that establish the requirement to implement the systems/applications. This documentation should be available for review.

D.3.9 Utilization

a. Have utilization records (monthly and daily computer log books) available for review and evaluation. Records should cover the twelve months preceding the evaluation.

b. Specify the projected meter hours of daily utilization upon date of installation. Specify if computer will be running in multiprogramming, and if so, how many hours per month.

Manufacturer's model processor*	Available core in characters, words or bytes	Number of Tape stations, model density and no. tracks	Number and model of Immediate Access Equipment (indicate storage capacity)	Number of card readers, speed, model	Number of printers, model, speed, print positions per line	Other peripherals, and special features	Remote terminal(s) (model)**

* Indicate EDPE System Designation and Identification Number (e.g., B283/04, 36050/01) reported under the ADP Reporting System required by SECNAVINST 10462.12B.

** Also, specify location and distance between the computer site and remote terminals.

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Figure D - 1. List of Equipment

D.3.10 Performance

a. Software

(1) Indicate languages used with ADPE being evaluated (if not COBOL, FORTRAN or JOVIAL, explain).

(2) Identify the software used or to be used. Indicate origin (vendor/activity), maintenance responsibility and briefly discuss respective degree of efficiency, i.e., speed of execution; amount of memory required; adequate documentation of parameter requirements; error halts; operating procedures; versatility and reliability.

(3) Indicate the version and type of operating system and briefly discuss its performance, i.e., versatility, accuracy of documentation, use of memory, speed, adequacy of options available, etc. Specify if the options available are adequate in relation to the activity's mission requirements.

(4) Explain any problems that have been encountered in any of the above software and indicate action taken to eliminate them.

(5) If applicable, describe status of software being developed and specify developer.

(6) Specify software the supplier has provided and/or will provide for the ADPE to be installed. Indicate dates software is to be provided, or was provided.

(7) Indicate supplier software considered to be inefficient and/or whose successful completion has been delayed or postponed. Briefly discuss.

b. Operations

(1) State if multiprogramming (spooling) multiprocessing, on-line processing, or real time is used.

(2) Briefly describe plans or procedures used (or to be used) to improve ADPE utilization and reduce set-up time; give dates and estimates of projected improvement.

(3) Write a brief statement describing restart procedures. Include comments on the frequency of use of checkpoints.

(4) Indicate file retention procedures used for reconstruction of files.

c. Systems/applications

(1) Briefly discuss the general performance of the systems/applications in relation to the configuration of the ADPE being evaluated. Specify whether the systems/applications are considered compatible to the hardware. Explain.

(2) Specify memory size required for execution by average program.

(3) If multiprogramming is or will be utilized, specify core partitioning and equipment constraints.

(4) Give memory requirements of the operating system (in characters).

(5) Indicate if the average system/application is input/output bound or processor bound.

(6) Are the systems/applications considered to be well designed, efficient, and properly documented? Explain.

d. Communications. If applicable describe status of communications equipment. State if there are any problems and what corrective actions have been taken.

D.3.11 Conversion

a. If conversion is required, specify whether conversion requirement is a result of system(s) redesign, or hardware differences between present ADPE and the ADPE to be installed.

b. Indicate if file conversion complies with the Department of the Navy standard data elements requirements. For information refer to SECNAVINST 5200.20A, the Department of the Navy Index of Data Elements and Related Features.

c. Indicate whether program conversion involves only program recompilations and retesting, or whether programs require partial/total reprogramming.

d. Explain plan for parallel operations.

D.3.12 Contractual Support

List existing ADP contracts for ADPE services, management consulting services, and management studies. Provide name of contractor, amount of money expended to date and length of contractual service (from-to). Indicate whether contracts are initial or extended.

D.3.13 Costs, Savings and Benefits

Information furnished in this section should be consistent with the requirements and definitions of SECNAVINST 10462.12B (Department of the Navy Automatic Data Processing Program Reporting System) and SECNAVINST 7000.14 (Economic Analysis of Proposed Department of the Navy Investments).

a. Costs

(1) Provide monthly rental and maintenance costs of both the ADPE configuration to be replaced and the ADPE configuration to be installed.

(2) Provide one-time costs for the following categories related to impending installation (figures should reflect estimated completion costs including: costs on salaries, and ADPE rental charges).

o Main site (one-time costs for permanent site, and costs for temporary site which may be required for parallel operations)
o Remote terminal sites
o Conversion of systems, files, programs
o Training pertaining to new equipment (operators, management personnel, systems analysts, programmers and others)
o Application studies and systems development
o Travel associated with new equipment
o Development of new standards and procedures
o Associated materials such as new tapes and disk packs
o Parallel operations
o Contractual support
o Other one-time costs
o Total one-time costs.

(3) Provide a copy of the economic analysis prepared at time of acquisition of each system being reviewed.

b. Benefits and Savings

(1) Specify if the impending ADPE installation will result in any monetary savings (identify areas and amount of savings).

(2) If additional workload is to be accomplished, estimate personnel and costs saved.

(3) Briefly describe each benefit or improvement as a result of the acquisition/augmentation of the computer.

(4) Describe improvement which may result from systems redesign or hardware changes (i.e., reduction of number of programs, time improvements, integration and improvements of data files).

(5) Describe other tangible and intangible benefits anticipated (i.e., improvement in control, scheduling, hardware performance, etc.).

D.3.14 Standards

Specify which of applicable standard data elements have been or will be implemented in accordance with policies and procedures outlined in SECNAVINST 5200.24, Implementation of Standard Data Elements and Related Features, and as published in SECNAVINST 5200.20A, The Department of the Navy Catalog of Standard Data Elements and Related Features.

D.3.15 Planning Document

Provide planning document (with milestones and events) utilized in implementing the ADPE installation (to include conversion effort, systems design, programming, training, parallel operations, installation, site preparation, release of ADPE and associated equipment, preparation of standards, software, debugging, etc.).

D.3.16 Back-up Facilities

a. Describe back-up facilities where workload may be run in case of emergency. Specify distance, briefly describe location and site, time requirements, costs, availability of similar computer features and software. Is this back-up support the result of written or verbal agreement?

b. Specify if and when back-up facilities were used and costs involved.

D.3.17 Supplier(s) Support

a. Describe quality of training provided by software supplier(s).

b. Indicate inclusive dates and the number of systems analysts, programmers and other personnel supplier provided for each specific commitment.

D.3.18 Support Provided Other Activities

List activities that are supported by the Data Processing Organization. Inform representatives of these activities that they may be requested to answer questions by the evaluation team.

D.3.19 Reserve Capacity

In addition to provisions for continuity of operations reflected in previous sections specify whatever unused ADPE capacity is reserved for readiness to support relatively sudden and emergency military operations, such as mobilization, implementation of the contingency plans, and other surges, the occasion for which is a reasonable expectation but the time of need for it is unpredictable. Prior consultation by the Installation with higher authority in its command channels is to be expected on this subject and the information should be authoritative, i.e., capacity directed by higher authority to be reserved and whatever additional reserve capacity is considered to be important to readiness. This information should take into account gains in capacity that could be made available by adjustments or elimination of current processing. Whatever plans the Installation has for specific actions to be taken in the case of sudden increase of workload should be available at the time of review.

APPENDIX E

INTEGRATED PROGRAMMED OPERATIONAL FUNCTIONAL ANALYSIS

E.1 INTRODUCTION

This Appendix is presented to furnish a "SAMPLE" of acceptable test and acceptance procedures of a computer system.

E.1.1 Purpose

The purpose of the AN/UYK-4 (V) Computer System IPOFA is to demonstrate the concurrent functional operation of all subsystems. The general objectives of the IPOFA program are:

o To demonstrate the ability of the subsystems to operate together as an integrated system under normal conditions of data flow or equipment configuration.

o To evaluate subsystem performance under conditions of overlap conflict where two or more subsystems are being exercised simultaneously.

o To demonstrate the ability of the overall system to achieve continuous operational capability through extended testing.

The IPOFA program tests the following system functions:

o Computer input output

o Multiple input output buffering

o Reliability of data transfers

o Functional performance of each subsystem utilizing natural and/or test inputs

E.1.2 Method

The IPOFA program may be divided into two parts:

o IPOFA control

o Subsystem tests

The IPOFA control provides the timing and priority logic for the simultaneous, real-time operation of the system. The control program is used in association with some peripheral device in order to facilitate communication between the computer and the (system) operator. The control capability is further discussed in E.4. The subsystem tests are basically independent programs designed to test one peripheral device and to interface with the control program. The system operator has the capability to initiate the simultaneous testing of any number of the available equipments and to monitor the testing through manually requested and automatic status indications at the peripheral device used for IPOFA control.

Detection of equipment failures is also the responsibility of individual equipment operators. These failures are reported to the system operator for determining if the testing of that device should be discontinued. The evaluation of system performance is accomplished through examination of both computer detected and equipment operator detected failures. Test evaluation is further discussed in E.5.

E.1.3 Scope

The IPOFA program is specifically a verification of the system hardware capability (a verification of system performance with respect to hardware specifications) and no attempt is made to evaluate the system with respect to any intended software functions. The IPOFA is designed for use in the integration and checkout effort, in formal acceptance testing, and in normal day-to-day maintenance testing.

The procedures contained in this document provide the system operator with the information necessary to control the IPOFA program, direct the actions of the equipment operators, and evaluate the overall system performance. Equipment procedures are available for use by the individual equipment operators in performing the IPOFA tests and for use in evaluating subsystem performance.

E.2 OPERATING REQUIREMENTS

E.2.1 Hardware

The minimum equipment configuration required for operation includes the computer, the control device, and a means for program loading. Any number of peripheral equipments may then be tested as they become available. For system acceptance testing all equipments comprising the system must be available. Additional testing is required as additional equipments are added to the system. Figure E-1 shows the system equipment block diagram.

E.2.2 Hardware Documentation

Information pertaining to the individual system equipments may be obtained from those documents listed in figure E-2 (System Hardware).

E.2.3 Software

The complete IPOFA program is provided on magnetic tape. The only additional software required is the Utility Package, also contained on magnetic tape, that provides the IPOFA loading capability. Any support software that may be used as a tool in subsystem initialization or evaluation is defined in the appropriate subsystem documentation.

E.2.4 Software Documentation

Each of the individual subsystem test programs which comprise the IPOFA are separately documented. These documents are required in performance of the IPOFA and contain a description of the test, the IPOFA operating procedures, and the subsystem performance evaluation criteria. These documents are listed in figure E-2 (Test Procedures). This document contains the description and procedures for the control segment of the IPOFA.

E.2.5 Personnel

Figure E-2 lists the number of personnel required for IPOFA testing according to the equipments comprising the system. These personnel are the individual equipment operators and the control (system) operator. In addition the accepting agency may employ any number of test monitors for system performance evaluation.

E.3 PREOPERATING PROCEDURES

E.3.1 Equipment Configuration

Figure E-2 contains a list of the system equipments and their associated channel number.

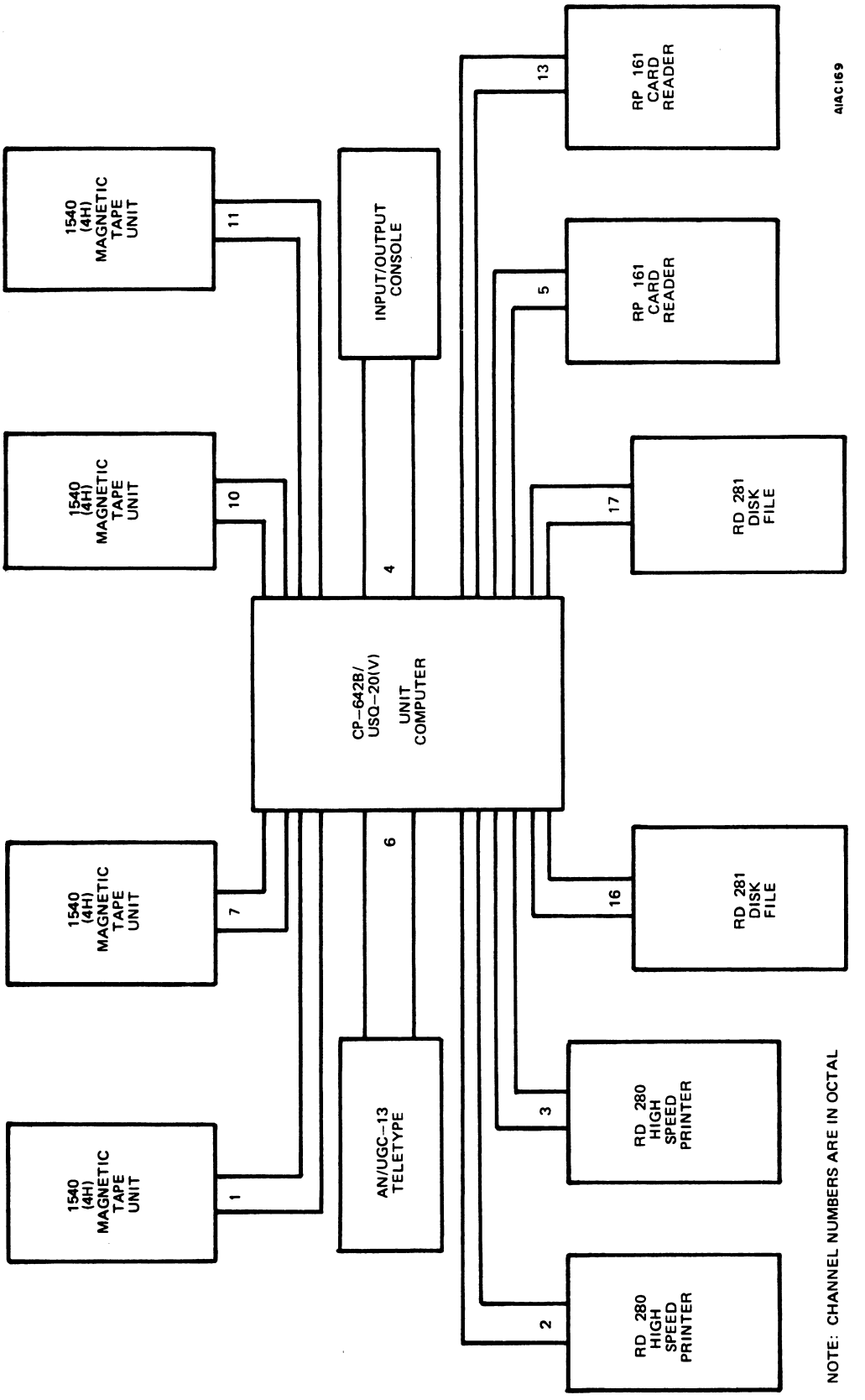

Figure E - 1. CP-642B, System Block Diagram

SYSTEM EQUIPMENT		TEST PERSONNEL REQUIRED	DOCUMENTATION		TEST SCHEDULE							
			System Hardware	Test Procedures	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7	Hour 8
CP-62B/USQ-20 Computer Channel	Subsystems											
17	RD-281 Disk File	1(1)	0967-273-0010	0967-028-4530	Select Param 217							
16	RD-281 Disk File	(1)		0967-028-4530	Select Param 217							
15	Not Used											
14	Not Used											
13	RP-161 Card Reader	1(2)	0967-238-6010	0967-028-4860	Select Param 1		Drop/Select Param 2		Drop/Select Param 3		Drop/Select Param 4	
12	Not Used											
11	RD-294 MTU No. 1	1(3)	PX-3334 PX-3873	0967-028-4920	Select Param 172			Drop/Select Param 173	Drop/Select Param 176			
10	RD-294 MTU No. 2	(3)		0967-028-4920	Select Param 172			Drop/Select Param 173	Drop/Select Param 176			
7	RD-294 MTU No. 3	(3)		0967-028-4920	Select Param 172			Drop/Select Param 173	Drop/Select Param 176			
6	UGC-13 TTY	1	NAVSHIPS 94104		IPOFA Control							
5	RP161 Card Reader	(2)		0967-028-4860	Select Param 4		Drop/Select Param 3		Drop/Select Param 2		Drop/Select Param 1	
4	CA-7984 I/O Console	1(4)	PX-3618	0967-028-4890	Select							
3	RO-280 UYK HSP No. 1	1(4)		0967-028-4800	Select							
2	RD-280-UYK HSP No. 2			0967-028-4800								
1	RD-294 MTU (Spare)			0967-028-4920								
0	Not Used											

Notes:
(1) One operator required for both Disk Files
(2) One operator required for both Card Readers
(3) One operator required for all MTU's
(4) One operator required for the HSP and the I/O Console

AIAC202

Figure E-2. IPOFA Procedure Summary

E.3.2 Power Application

Turn power on at the computer and at all other equipments as specified in the applicable equipment IPOFA procedures. If possible this should be accomplished two hours prior to test execution to allow the equipments to reach their operating temperatures.

E.3.3 Equipment Initialization

Initialize all peripheral equipment according to the applicable IPOFA procedures, and for the test mode specified in figure E-2. Initialization for the disk files will require execution of the disk file POFA program. The POFA must be loaded into the computer and initiated according to the disk file POFA procedures.

E.3.4 Program Loading

Load the CP-642B Utility Package (UPACK) into the computer by performing the following steps:

a. Place the IPOFA program tape on transport 1, of the MTU on channel 11 (octal).

b. At the computer, release all SELECT JUMP and SELECT STOP switches, and place all DISCONNECT switches in the normal operating position.

c. Press MASTER CLEAR.

d. Press PROGRAM I.

e. Press LOAD.

f. Press START.

The UPACK program will be loaded into the computer memory, and the computer will 4-STOP with the P-register equal to 00001.

Load the IPOFA program into the computer by performing the following steps:

g. With the IPOFA tape on transport 1 and without changing the switch settings at the computer console, press MASTER CLEAR.

h. Set the Q-register to 00001 04001 to perform a read from transport 1, the second block of data. (Note: The block number specified in UQ may vary.)

i. Set the P-register to 00002.

j. Set the SELECT STOP 5 for error stops

k. Press START. If a 5-STOP occurs, see the program listing for the error condition. Normally if an incorrect parameter was entered (step h) the parameter may be corrected and the program reinitiated by pressing START. In some cases, however, the load must be reinitiated by restarting at step g.

The IPOFA program will be loaded, and computer will 4-STOP with the A-register equal to zero for a successful load. If the A-register is not zero, reload the IPOFA by restarting at step g.

Initiate the IPOFA program by performing the following steps:

l. Release SELECT STOP-5

m. Press MASTER CLEAR

n. Set the P-register to 03200.

o. Press START.

"SYSTEM IPOFA TEST" will be printed at the TTY and the IPOFA program will be cycling, awaiting commands from the system operator.

NOTE

The program assumes the TTY is associated with computer channel six. If, at step n, the AU-register is set negative, the program will be modified to assume the TTY is associated with the channel number expressed in AL.

E.4 DETAILED OPERATION

E.4.1 Test Control Procedures

Discussed below are the TTY entries available to the system operator for control of the IPOFA. Also discussed are the program initiated printouts which indicate automatically-detected subsystem errors and operator errors.

E.4.1.1 System Operator Entries

The following entries are initiated by the system operator at the TTY keyboard once the IPOFA program is loaded and initiated as described in paragraph E.3.4. The entries may be initiated at anytime when the TTY Adapter Input light is illuminated (anytime a computer or operator-initiated printout is not active). Should the operator attempt to enter data while output is active, the message being printed will be garbled. In the operator-initiated entries listed below, those characters which are underscored are entered by the system operator; all other data is automatically printed by the control program:

a. TIME ZZZZ. This entry is used to enter realtime into the computer. The time is then automatically updated and used to time-tag any subsequent printouts. The Z's represent realtime in hours and minutes.

b. SELECT CHAN XX PARAMETER YY TIME ZZZZ. This entry is used to select the subsystem test associated with the channel entered (XX represents the channel number in octal-00 through 17). After the second channel digit is selected "PARAMETER" is printed (YY represents the parameter, entered in octal). PARAMETER is not printed if no parameter is required. The control program will accept the proper number of parameter digits (depending on the channel selected) and then transfer the current time. Selection of a previously selected channel, the TTY channel, or an unused channel is illegal. Upon selection, all error counters associated with the selected channel are cleared.

c. DROP CHAN XX TIME ZZZZ. This entry terminates the subsystem test associated with the entered channel (the channel number is entered as in b) above. Dropping an unselected channel is illegal. Time is automatically printed.

d. LIST CHAN STATUS

```
CHAN ERRORS
 00      1
 04      0
 11    104
 17     29
TIME     ZZZZ
```

This entry lists all channels currently selected and the cumulative errors detected. Once the "L" is entered the printout continues automatically and terminates with the TIME printout. All channel numbers are octal; the numbers of errors are decimal. Should more than 999 errors be recorded, 999 is printed.

e. AMPLIFY CHAN XX
TYPE ERRORS
1 2
3 10
TIME ZZZZ

This entry lists the number of errors detected (where that number is one or more) by error type, for the channel specified. After the channel number has been entered, the printout continues automatically until the TIME is printed. Both the error types and the number of errors are in decimal. The error types are defined for each channel in table E-1.

f. CLEAR CHAN XX TIME ZZZZ. This entry is used to clear all accumulated errors detected for the channel specified. The channel number is entered as in b. above and the TIME is automatically printed.

g. INSPECT XXXXX YYYYYYYYYY. This entry (normally used for maintenance purposes only) is used to determine the content of any memory location. The X's represent the memory address and the Y's represent the contents of that location. Both address and contents are in octal. The TIME printout does not follow the contents data.

h. UPDATE XXXXX YYYYYYYYYY. This entry is used to change the contents of any memory location. Both the address (X's) and the contents (Y's) are entered by the system operator in octal. Two spaces are automatically transferred after receipt of the address. This, similar to INSPECT, is normally not used during formal testing. A TIME printout is not initiated.

E.4.1.2 Program Initiated Printouts

The TTY IPOFA control program also provides automatic printouts. These are listed and discussed below:

a. ILLEGAL. This printout results from a computer detected operator entry error and it automatically aborts the entry initiated and resets the TTY for acceptance of the next entry. Example: SELECT CHAN 09 ILLEGAL.

b. ABORT. This printout results when an error indication (see c. below) is to be printed but, because the TTY is accepting a system operator entry, the error indication cannot be intitiated. The control program then allows a wait time and if after that time the manually initiated printout has not been completed, ABORT is printed, the entry is aborted, and the error message is transferred. Control is not returned to the operator for additional entries until all error messages are completed. Example: SELECT CHAN ABORT where the channel number was not entered within the wait time and an error message was to be printed.

c. ERROR CHAN XX TYPE YY TIME ZZZZ. This printout is initiated upon detection of any error where it is the first error detected of the type specified (YY) and on the channel specified (XX). A CLEAR entry will re-enable the printout for the next error (each type) detected on the channel cleared.

d. FAULT. This printout occurs as a result of a computer fault. Any current TTY activity is interrupted, FAULT is printed and the computer 4-STOP with the computer A-register set to the memory address at which the illegal instruction was found and the contents of that address in the Q-register.

E.4.2 Test Initiation and Execution

Once the equipment has been initialized and the IPOFA program is cycling as described in paragraph E.3, the system operator may initiate testing by performing the following steps:

Table E-1. Subsystem Error Types

TABLE 1a	RP161 CARD READER
1	TEMPORARY READ ERROR
2	HARD READ ERROR
3	CARD JAM
4	ILLEGAL INTERRUPT
5	DATA ERROR
6	CARD TIMEOUT (may be mispick error)
TABLE 1b	MAGNETIC TAPE UNITS
1	CHECKSUM ERROR
2	IMPROPER CONDITION
3	WRITE RECOVERY ERROR
4	READ RECOVERY ERROR
5	SEARCH COMPARE ERROR
6	TAPE MARK DETECTION ERROR
TABLE 1c	1532 I/O CONSOLE
1	UNEXPECTED INTERRUPT CODE
2	WRONG INTERRUPT CODE
3	MESSAGE TOO LONG
4	PUNCH FASTER THAN READER
5	DATA ERROR
TABLE 1d	R0280 HIGH SPEED PRINTER
1	OFF LINE
2	INOPERATIVE
3	PAPER BREAK
4	PAPER OUT
5	ILLEGAL INSTRUCTION
6	INVALID INTERRUPT
7	POWER OUT
TABLE 1e	RD281 DISK FILE
1	OUTPUT TIMING ERROR
2	INPUT TIMING ERROR
3	CHECKSUM ERROR
4	INVALID DATA
5	UNSAFE
6	DRIVE INOPERATIVE
7	ADDRESS NO COMPARE
8	SECTOR COUNTER ERROR
9	RFI FAULT
10	OVERTEMPERATURE
11	CYLINDER COUNTER BUSY
12	ILLEGAL MESSAGE LENGTH
13	ILLEGAL INSTRUCTION
14	INTERRUPT NOT RECEIVED
15	IMPROPER INTERRUPT

a. Enter the current time (see paragraph E.4.1.1 a.).

b. Initiate each subsystem test using the SELECT entry (see paragraph E.4.1.1 b.) and entering the proper parameter (if required) as listed in figure E-2, Hour 1.

c. After each subsystem has been selected, instruct the associated equipment operator to initiate any test procedures required.

After all subsystem tests have been selected the system operator must perform the necessary DROP and SELECT entries, for each subsequent hour during the test as indicated in table E-1. Where testing is to be continued with a change of test mode (parameter change), the following steps must be followed:

o DROP the subsystem test (see paragraph E.4.1.1 c.).

o Initiate the AMPLIFY printout for a listing of errors detected during the test period. (See paragraph E.4.1.1 e.).

o Request the equipment operator to perform the necessary initialization procedures for the next test mode according to the equipment test procedures.

o SELECT the channel and enter the new parameter indicated in figure E-2.

E.4.3 Control Monitoring

During the test the system operator must monitor the printouts in order to determine system performance. Detection of the first occurrence of any error type will result in an error printout (see paragraph E.4.1.2 c.). However, if any critical error occurs and the test is continued without clearing that error, the system operator must initiate an AMPLIFY entry to determine if that error was incurred again.

The LIST and AMPLIFY entries may be used by the system operator as required. The LIST entry may be used to insure that all desired channels are selected, and to list the total number of errors detected on each of the selected channels.

The CLEAR entry may be used to permit the automatic printout of any subsequent errors, but should be used only after previous errors have been recorded. The INSPECT entry may be used where the contents of any memory location would facilitate evaluation of subsystem performance. The equipment procedures will provide information regarding any critical locations and the method of interpretation. The UPDATE entry is normally used for flexibility in specialized maintenance or as a debugging tool and is not required in formal system testing.

The system operator must also note any unusual situations observed or reported by the equipment operators for possible correlation with any equipment failures. Finally, because no specific test is performed for the TTY, the system operator must evaluate its performance during execution of the IPOFA control functions.

E.4.4 Equipment Monitoring

The system operator shall instruct each equipment operator to monitor his equipment in accordance with the associated Test Procedures. The frequency and duration of the various equipment tests will be accomplished according to the Test Procedures associated with each subsystem and according to the Test Schedule in Figure E-2.

E.4.5 Error Procedures

All subsystem errors (whether automatically detected or reported by the equipment operators) must be evaluated to determine if:

- o The test may be continued.
- o The failing subsystem should be dropped.
- o The test should be discontinued.

Evaluation of the subsystem errors is further discussed in paragraph E.5. Table E-1 itemizes the individual error types.

The ABORT printout is not an error but a program initiated message intended to re-establish communication when the error message is to be printed and a TTY data transfer hang-up condition may exist. The ILLEGAL printout indicates either a system operator entry or a TTY error. Repeating the entry should indicate which of these was encountered. The FAULT printout indicates a computer failure or a software error, and, in either case, the test must be terminated.

E.4.6 Test Termination

Upon completion of the test, the system operator shall drop all selected channels and request error printouts for all channels just dropped. Any errors shown shall be evaluated according to the procedure described in paragraph E.5.

E.5 RESULTS

E.5.1 General

Appraisal of the system IPOFA performance shall be based upon the number and nature of errors which occurred in each of the subsystems during the testing. If no errors occurred the performance shall be appraised satisfactory. If errors did occur the erring equipment shall be appraised in accordance with the following paragraphs.

E.5.2 Test Evaluation

E.5.2.1 Acceptance Criteria

Acceptance of the system requires that the criteria in the following paragraphs are satisfied.

a. The IPOFA program shall be exercised for the entire test period without stopping and restarting or reloading the computer.

b. The TTY shall be used for IPOFA control and test monitoring and shall perform these functions satisfactorily for the duration of the testing.

c. Each subsystem shall be tested in accordance with the test periods and test parameters specified in Figure E-2.

d. Each subsystem shall perform in accordance with the individual acceptance criteria set forth in the following paragraphs:

(1) Magnetic Tape Unit. The occurrence of a type 1, 2, 5 or 6 error shall be considered an equipment failure. The time required to restore the MTU to proper operating condition shall be recorded as down time. No more than one hour cumulative down time shall be recorded for all MTU's during the entire test period. No more than one type 3 or type 4 error shall occur for each MTU per hour of testing.

(2) High Speed Printer. The occurrence of a type 2, 5 or 6 error shall be considered an equipment failure. The time required to restore the printer to proper operating condition shall be recorded as down time. Types 1, 3, 4 and 7 shall be considered invalid unless the condition indicated by these errors does not exist. In that case the error shall be considered an indication of a failure. No more than one hour cumulative down time shall be recorded for both HSP's during the entire test period.

(3) Disk File. The occurrence of any error types 5-15 shall be considered as equipment failures. The time required to restore the disk file to proper operating condition shall be recorded as down time. No more than one hour cumulative down time shall be recorded for each disk file during the entire test period. No more than one type 1, 2, and 3 errors shall occur for each disk file per hour of testing. No more than two type 4 errors shall occur for each disk file per hour of testing.

(4) Card Reader. The occurrence of a type 5 error or the occurrence of a type 4 error when it is not detected with a type 3 error shall be considered an equipment failure. The time required to restore the reader to proper operating condition shall be recorded as down time. No more than one hour cumulative down time shall be recorded for both readers during the entire test period. No more than one type 3 error shall occur for each reader per hour of testing (2000 cards). No more than 10 type 2 and 6 errors shall occur for each reader during the entire test period. Any type one error shall not be considered as an equipment failure, or as an error condition.

(5) I/O Console. The occurrence of any program detected error shall be considered an equipment failure. The time required to restore the unit to proper operating condition shall be recorded as down time. No more than one hour cumulative down time shall be recorded during the entire test period.

e. Any operator-detected error constituting an equipment failure shall result in the recording of down time for the period required to restore the unit to proper operating condition.

f. Intermittent failures (even if they would normally be designated as invalid) which occur so frequently that a disruption to system testing results, shall not be allowed.

E.5.2.2 Invalid Errors

Any of the errors described in paragraph E.5.2.1 which are caused by or result from any of the following conditions shall be designated invalid:

o A loss or interruption of primary power.

o Any operator error.

o Any error on an individual subsystem that is designated as invalid according to the associated subsystem Operating Procedures.

Determination of whether an error is valid or invalid is the responsibility of the accepting agency. In the event of an invalid error the following provisions shall apply:

o No accumulated test time shall be lost.

o The IPOFA shall be continued as specified in paragraph E.5.3.

o The cause of the error and time of occurrence shall be entered on the operator's comment sheet and noted as invalid.

E.5.2.3 Evaluation Procedure

System performance shall be evaluated according to the following procedure:

a. Evaluate the individual subsystems according to the requirements stated in paragraph E.5.2.1.

b. Evaluate the system performance using the information recorded on the system operator's comment sheet and the equipment operator's comment sheet according to the requirements stated in paragraph E.5.2.1.

c. At the completion of testing, the data from comment sheets shall be transferred to the System IPOFA Checkoff Sheets. The Checkoff Sheets shall comprise the official record of the IPOFA test. (See table E-2.)

E.5.3 Error Recovery

Recovery from most subsystem error conditions is automatic. If, however, recovery is not automatic, or if the dropping and reselection of any subsystem test is necessary, the following provision shall apply:

Upon detection of an equipment failure, efforts to correct that failure shall be allowed, however system testing must continue. The IPOFA test for the failing subsystems may be either selected or dropped but the total time required to restore the subsystem to proper operating condition shall be recorded as down time.

During the period in which an equipment failure exists the system operator shall assist the equipment operator by dropping, reselecting and inspecting memory (INSPECT) as requested by the equipment operator. This assistance shall be provided only to the extent that it does not disrupt the system testing in progress. The equipment operator shall inform the system operator when the subsystem is available for system testing. At that time the system operator shall reselect the subsystem and enter the necessary information on the System IPOFA Comment Sheet.

E.6 SUPPLEMENTARY INFORMATION

E.6.1 IPOFA Program Control Synopses

This section contains a description, in programmers' language, of the IPOFA control program. The description primarily concerns the program operation as it occurs within the computer. Individual segments of the control program are described separately with all necessary information regarding the relationships between the program segments, input/output, data tables, logic design, and logic flow.

The following table lists the synopsis and flow charts as they appear in this Appendix.

Subroutine Name	Label	Figure Number	
		Synopsis	Flow Chart
IPOFA Executive	EXEC	E-3	E-4
TTY Control Program	TTYCNTRL	E-5	E-6
TTY Input Monitor Interrupt Routine	TTYINMON	E-7	E-8
TTY Output Monitor Interrupt Routine	TTYOUTMON	E-9	E-10
Fault Interrupt Routine	FAULT	E-11	E-12
Error Recording Subroutines	ERROR and IERROR	E-13	E-14

Table E - 2. System IPOFA Checkoff Sheet

INSTALLATION _____ COMPUTER SERIAL _____

DATE of TEST _____ SYSTEM OPERATOR _____

IPOFA RESULTS

Computer Channel	Subsystem	Summary of Errors	Cumulative Downtime	Satis	Unsat
0					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

Comments

System Operator _____ Signature _____ Date

Representative of Accepting Agency _____ Signature _____ Date

SYNOPSIS

TITLE: IPOFA EXECUTIVE

LABEL: EXEC

PURPOSE: The Executive program provides the overall IPOFA control. It includes all logic necessary for maintaining simultaneous, real-time execution of all subsystems. Also, Executive scheduling provides for I/O channel usage delay, if current I/O activity indicates a possible overload condition (criteria is chassis oriented).

METHOD: Upon entry to the Executive routine, two local subroutines (INITIAL and CONTROL) are referenced to initialize the tables, flags, I/O, etc, and to preset the control programs (interfacing these programs with the Executive). The Executive loop is then initiated by setting the priority index (B6) to the initial value and selecting the channel associated with the index.

The channel is then considered for referencing by selecting the associated EXECFLAG. If zero, the priority index is incremented and the next priority channel is considered. If not zero, the EXECFLAG value is compared to the current time (CLOCK). If EXECFLAG is greater than the current time, the next priority is considered. If the channel passes the time criteria, the EXSCHED parameter is examined to determine if channel usage may occur. If no I/O criteria exists (EXSCHED negative), or if the I/O criteria is met (as described below), the associated subsystem test is referenced. The Executive resets EXECFLAG to the value contained in EXPERIOD plus the current time and return jumps to four more than the address contained in the lower half of EXJUMP. Upon returning from any subsystem test program, or after deciding not to reference any subsystem, the Executive resets the priority index and again considers the highest priority channel.

The I/O criteria for Executive scheduling considers only the activity on specified channels according to a prestored parameter for the considered channel. For each I/O chassis, the parameter specifies the channels in contention and the number allowed active. When the activity of the specified channels exceeds the limit (I/O chassis oriented), the IPOFA for the considered channel is delayed.

The parameter format is shown below:

A	D	B1	C1	B2	C2	B3	C3	B4	C4

where: A:(bit 29) when set indicates no I/O criteria for this channel
D:(bit 28) not used

AIAC270

Figure E - 3. IPOFA Executive Program (Sheet 1 of 3)

METHOD: (continued)

Bn:(a 3 bit field) contains the number of active channels permitted of those specified in Cn. When Bn = 5, no checks are required for that chassis.
Cn:(a 4 bit field) contains one bit for each channel and when set, indicates that the I/O activity is to be considered.
Bits 0-3 represent channels 0-3 and bits 7-10, 14-17 and 21-24 represent channels 4-7, 10-13 and 14-17 respectively.

INPUT PARAMETERS: The Executive program provides the capability to change the channel associated with the peripheral device used for IPOFA control. This is accomplished in the subroutine CONTROL which is a separate program associated with the teletype.

INPUT CONDITIONS: The input for a channel change is manually entered at the computer console after program loading but before program initiation (starting at 03200). If a channel change is desired (the program expects the TTY on channel 6) the A upper register is set negative and the A lower register is set to the desired channel number.

OUTPUT PARAMETERS: None.

OUTPUT CONDITIONS: None.

SYSTEM DATA REFERENCED: The Executive program is channel oriented (referencing all subsystem tests by channel number) and uses the tables listed below in support of the decision making logic. Should the IPOFA contain any programs not associated with an I/O channel (such as computer diagnostics) or should any subsystem test require more than one exec-controlled program, these tables may be expanded to accomodate those routines. These tables must be preestablished for each individual system. The tables are:

a) PRIORITY: A 16 word table the lower of which contains the channels, ordered by the preassigned channel priority where the first channel number in the table represents the highest priority channel. The upper half of this table is ordered by channel number and contains the number of characters required for the PARAMETER in the SELECT entry.

AIAC 271

Figure E - 3. IPOFA Executive Program (Sheet 2 of 3)

SYSTEM DATA REFERENCED: (continued)

b) EXECFLAG: A 16 word table containing a time representing when that channel should be considered for Executive reference.

c) EXPERIOD: A 16 word table containing a prestored time representing the frequency of Executive referencing to be established by the Executive. It is used by the Executive to reset EXECFLAG when referencing a subsystem test however the EXECFLAG value may be modified by any of the IPOFA subprograms or interrupt routines.

d) EXJUMP: A 16 word table the lower 15 bits of which contain the absolute memory location of each of the subsystem tests. The upper half word is used as a flag to indicate if the subsystem has been selected (nonzero if selected).

e) EXSCHED: A 16 word table containing a prestored parameter used in determining if a subsystem test should be referenced, based on the I/O activity on other (selected) channels.

STORAGE:		
	Executive logic	50
	Executive tables	80
	INITIAL Subroutine	30
	CONTROL (for TTY)	50

ALARMS: None.

REMARKS: The EXEC base address (03200) represents the starting address of the IPOFA program.

AIAC272

Figure E - 3. IPOFA Executive Program (Sheet 3 of 3)

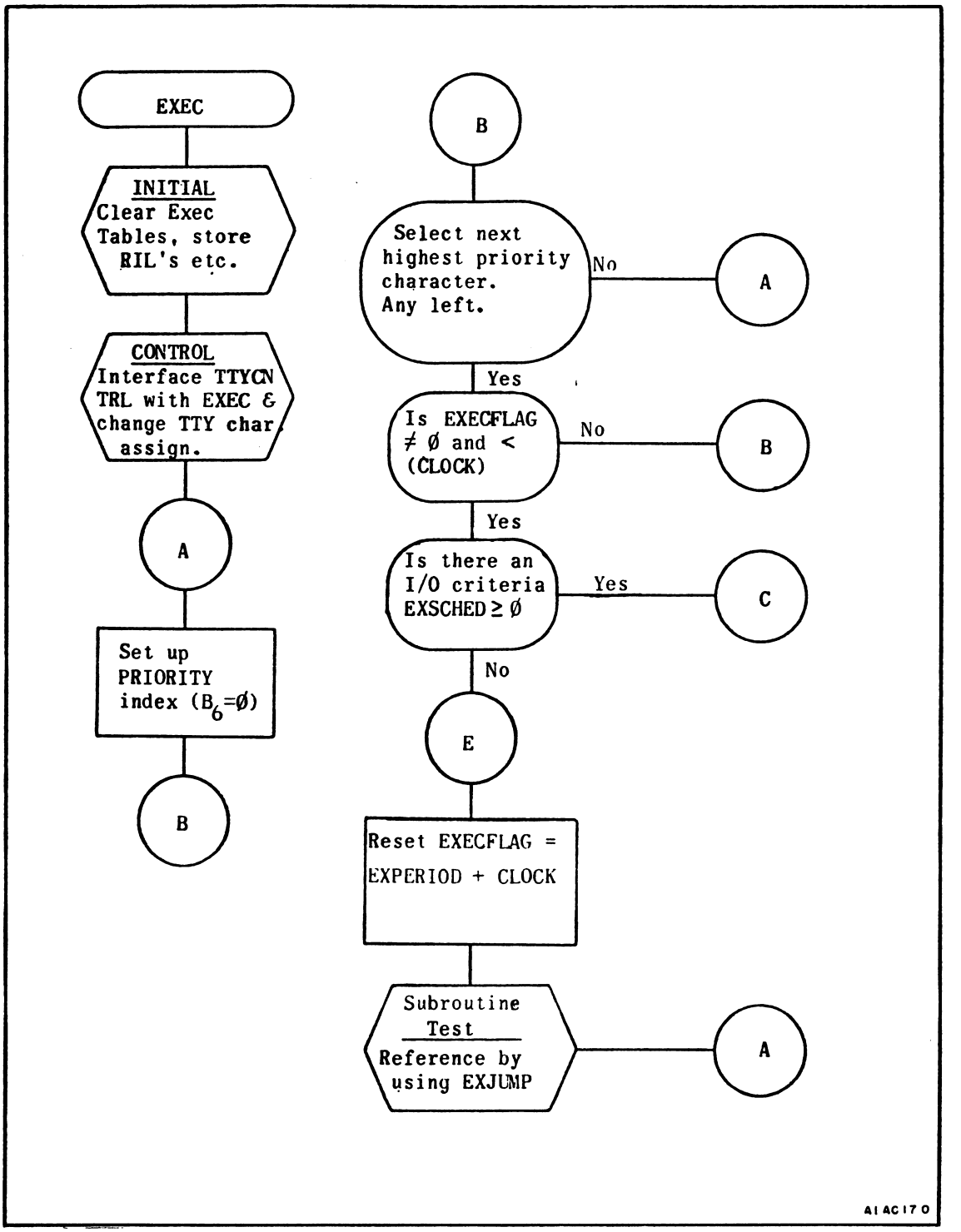

Figure E - 4. IPOFA Executive Flow Diagram (Sheet 1 of 2)

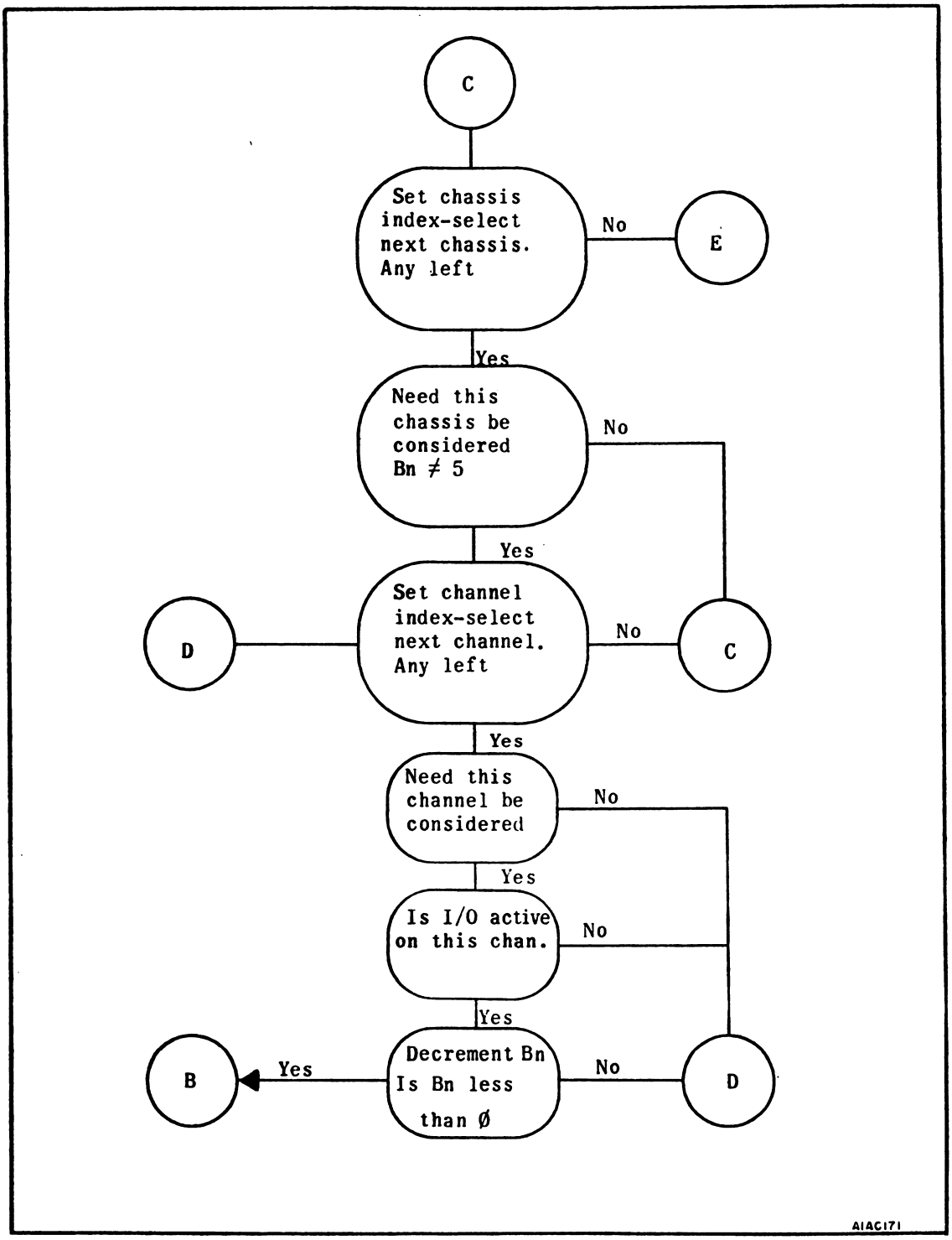

Figure E - 4. IPOFA Executive Flow Diagram (Sheet 2 of 2)

SYNOPSIS

TITLE: TTY CONTROL PROGRAM

LABEL: TTYCNTRL

PURPOSE: The TTY Control subroutine is referenced from the Executive to complete the necessary processing for all system operator entries and for any error printouts required. Initial input processing for TTY data is performed by the Input Monitor Interrupt routine. The TTY Output Monitor Interrupt routine also supports TTYCNTRL. The ERROR and IERROR routines setup the error printout requests.

METHOD: The Executive flag for TTYCNTRL is set to current time by ERROR and IERROR, to current time plus 100 milliseconds by CONTROL and TTYCNTRL itself, and to current time plus 150 milliseconds by TTYINMON and TTYOUTMON. TTYCNTRL's Executive flag is set to maximum by the Executive when this program is referenced.

Upon entry TTYCNTRL disables all interrupts to insure no adjustments are made to the REQUEST, TBUSY, TPROCESS or TINITIATE flags. TTYCNTRL then checks the TINITIATE flag. TINITIATE, when set (by either this program, TTYINMON or CONTROL), contains the buffer limits of some message requiring transfer to the TTY. If TINITIATE is set, TTYCNTRL initiates the output transfer, clears the TINITIATE flag, releases the interrupt lockout, and returns control to the Executive. The TTY will be in the output mode when TINITIATE is found set (the E.F. selecting output is transferred at the time TINITIATE is set). Reentry to TTYCNTRL is provided by TTYOUTMON upon completion of the output transfer.

If TINITIATE is not set, REQUEST is checked. REQUEST is a nine word table the first of which contains the number of error messages required to be printed. It is set by the individual test programs using the ERROR and IERROR routines. If an error message is to be printed (REQUEST not zero), the TBUSY flag is checked to determine if a system operator entry has been initiated. If not (TBUSY zero) and if the TTY is in the output mode (TINSEL zero), the error message is prepared, the REQUEST count is decremented and the output transfer is initiated. If TINSEL is set, TTYCNTRL resets its Executive flag for current time plus 100 milliseconds, transfers the E.F. to select the output mode, releases the interrupt lockout and returns control to the Executive. The 100 millisecond delay is necessary to allow the TTY to accept the E. F. before the output is initiated. Upon reentry the error printout will be initiated unless the input monitor interrupt was received (setting TBUSY) just after the interrupts were released. In this case both REQUEST and TBUSY will be set upon entry.

AIAC273

Figure E - 5. TTY Control Program (Sheet 1 of 4)

METHOD: (continued)

If it is found that REQUEST and TBUSY are both set, TTYCNTRL attempts to complete the system operator entry before initiating the error printout. However, to protect against any input hang-up condition a TIMEOUT flag is employed to abort the operator initiated function if it is not completed within a reasonable length of time (this time parameter is currently set at 20 seconds). When TTYCNTRL finds request and TBUSY set, the TIMEOUT flag is checked. If not set it is set to current time plus 20 seconds, the Executive flag is also set to that value, and processing continues with a check of the TPROCESS flag. If the TPROCESS flag is set (indicating processing is required for completion of the operator entry), the interrupt is released and the required processing is performed. If TPROCESS is not set, the interrupt is released and control is returned to the Executive. Reentry will be made upon receipt of additional operator input or after the 20 second delay has elapsed.

If TIMEOUT is found set but greater than realtime the processing continues with the TPROCESS flag check as above. If TIMEOUT is found set and less than or equal to the realtime the operator entry is aborted: TBUSY is cleared, TINITIATE is set to the buffer limits for a printout of "ABORT", TIMEOUT is cleared, and, if TINSEL is zero the printout is initiated. If the TTY is in the input mode, an E.F. is sent to the TTY to select output, the Executive flag is set for reentry after 100 milliseconds, the interrupt lockout is released, and control is returned to the Executive. Upon reentry ABORT will be printed and, upon completion of that transfer, TTYCNTRL will be reentered and the error message transfer will be initiated.

If, upon entry to TTYCNTRL, neither TINITIATE or REQUEST are set, the TPROCESS flag is checked. TPROCESS is set by TTYINMON when processing of operator entered data is required and it is cleared upon completion of that processing. If TPROCESS is set, TBUSY (which contains the function code index) is used to transfer control to the proper processing logic. Before control is transferred the interrupt lockout is removed since modification to REQUEST will not adversely affect the program. If TTYCNTRL completes all processing required for the selected function, the last output buffer (normally containing the time printout) is initiated and the TBUSY and TPROCESS flags are cleared. If the function is not completed the TPROCESS flag is cleared only if additional TTY input is required.

AIAC274

Figure E - 5. TTY Control Program (Sheet 2 of 4)

METHOD: (continued)

If TINITIATE, REQUEST and TPROCESS are all clear upon entry, TTYCNTRL assumes entry was effected upon completion of an output transfer and, regardless of whether or not the function was completed (TYBUSY set or not set), an E.F. is transferred to the TTY to select input, a one word input buffer is initiated with monitor, the interrupt lockout is removed and control is returned to the EXECutive leaving the Executive flag at maximum.

Although in many cases the interrupt lockout is set until returning control to the Executive, the maximum number of instructions executed with the lockout is 18 or approximately 200 microseconds. This should not adversly affect any other subprograms within the IPOFA.

INPUT PARAMETERS: Data received from the TTY is packed by TTYINMON and stored in TWORD1. Other communication flags include TINITIATE, TBUSY, TPROCESS, TINSEL and REQUEST.

INPUT CONDICTIONS: None

OUTPUT PARAMETERS: Output to the TTY is contained in prestored data buffers. These buffers are modified online for various printouts (e.g. the channel number error type and time are all inserted in the printout ERROR CHAN 01 TYPE 12 TIME 0345).

OUTPUT CONDITIONS: None

SYSTEM DATA REFERENCED: TTYCNTRL uses the EXJUMP table to determine the location (entrance address) of each subsystem test's PRESET and DROP routines. These are referenced upon receipt of the SELECT and DROP entries. The test base address and the test base address plus 2 define the PRESET and DROP entrance addresses, respectively.

The PRIORITY (upper 15 bits) are used upon receipt of the SELECT to determine if a PARAMETER is required and, if so, the number of characters required (1-3). Additional characters are not permitted because each PRESET must also interface with SMP Executive Control. TTYCNTRL uses the TDIGIT table (10 words) for encoding TTY output data and TWORD2 to save TTY input data until all remaining data is received.

STORAGE:		
	TTYCNTRL logic (including constants, etc)	300
	Prestored Output Data Buffers	230

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Figure E - 5. TTY Control Program (Sheet 3 of 4)

ALARMS: None.

REMARKS: None.

AIAC276

Figure E - 5. TTY Control Program (Sheet 4 of 4)

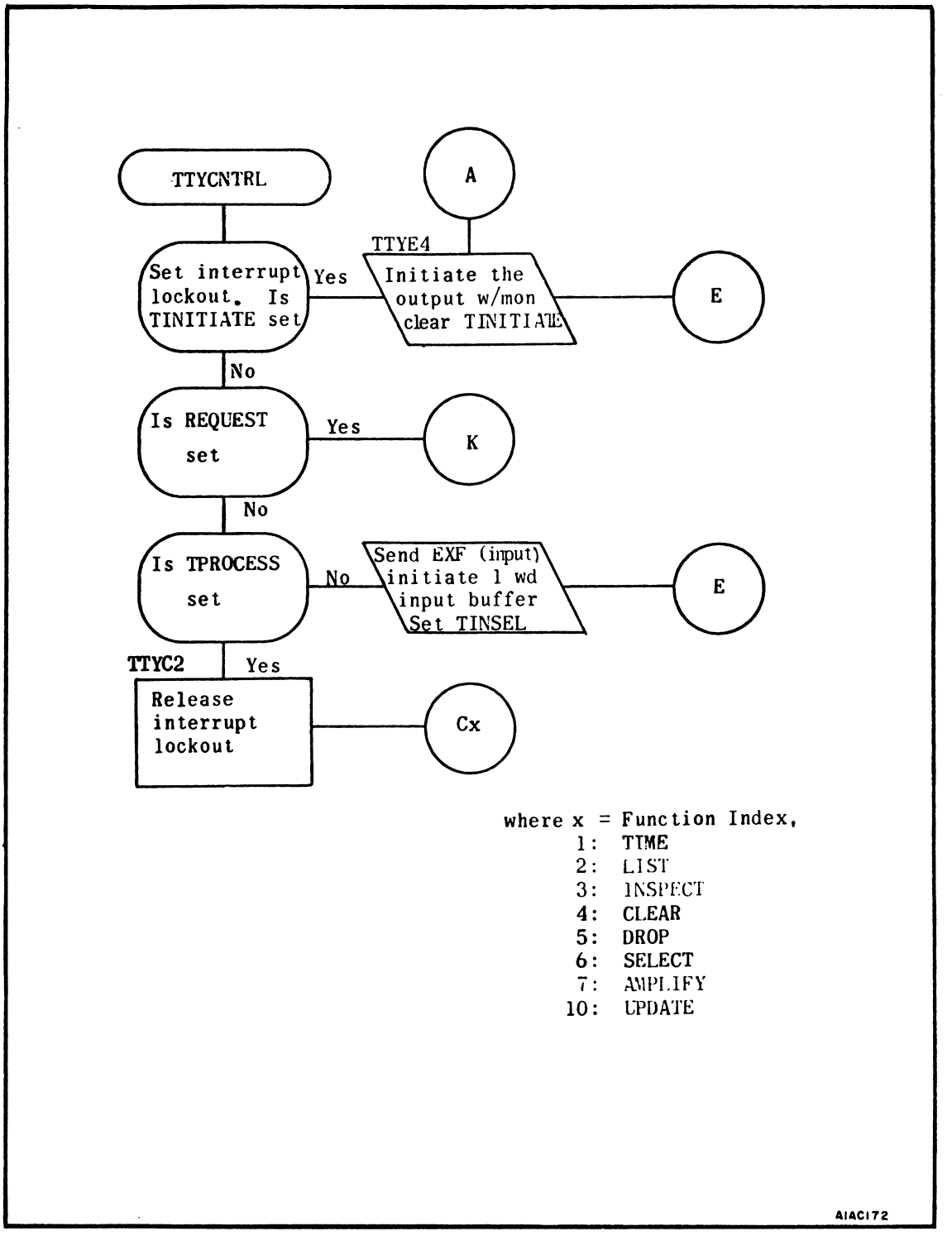

Figure E - 6. TTY Control Program Flow Diagram (Sheet 1 of 7)

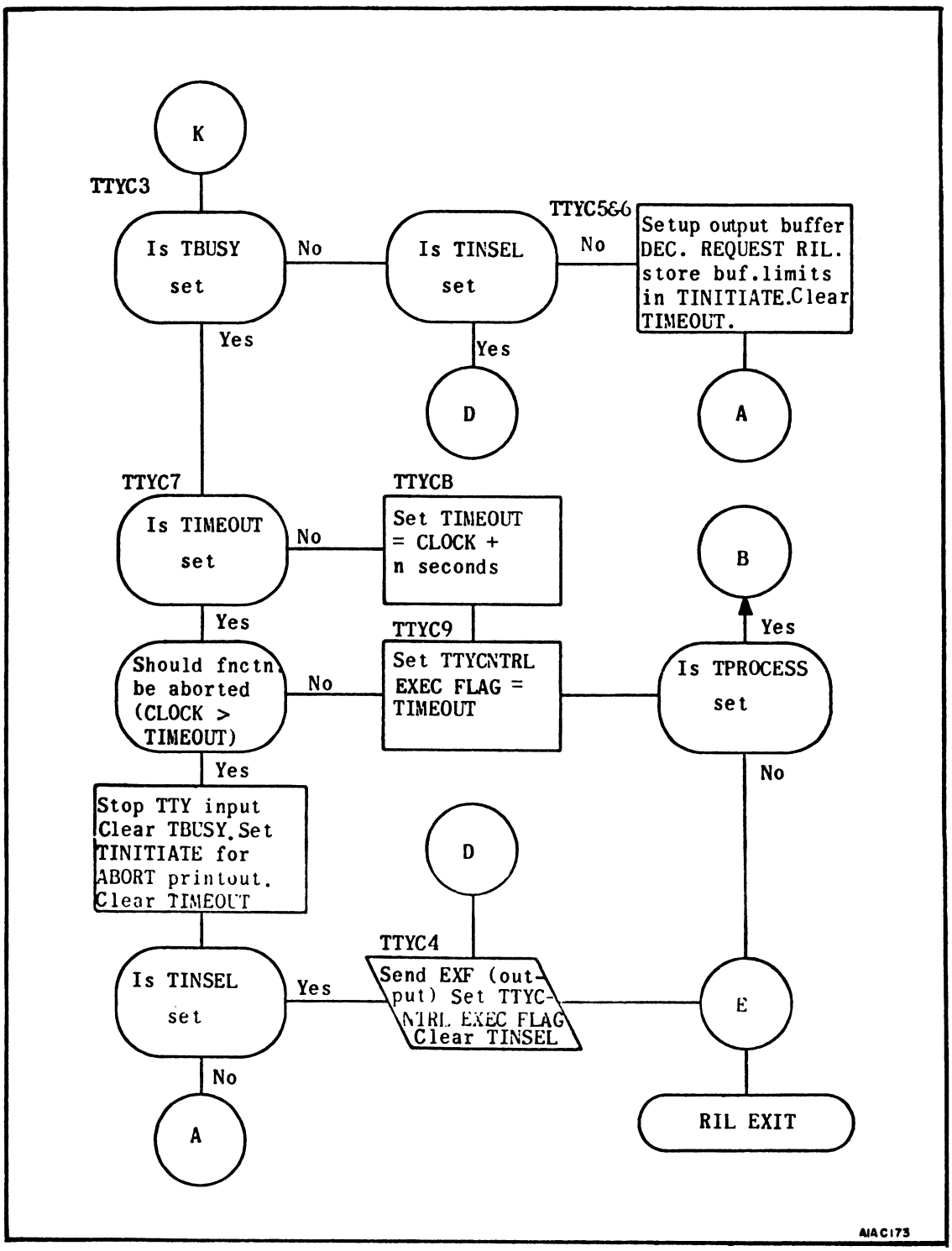

Figure E - 6. TTY Control Program Flow Diagram (Sheet 2 of 7)

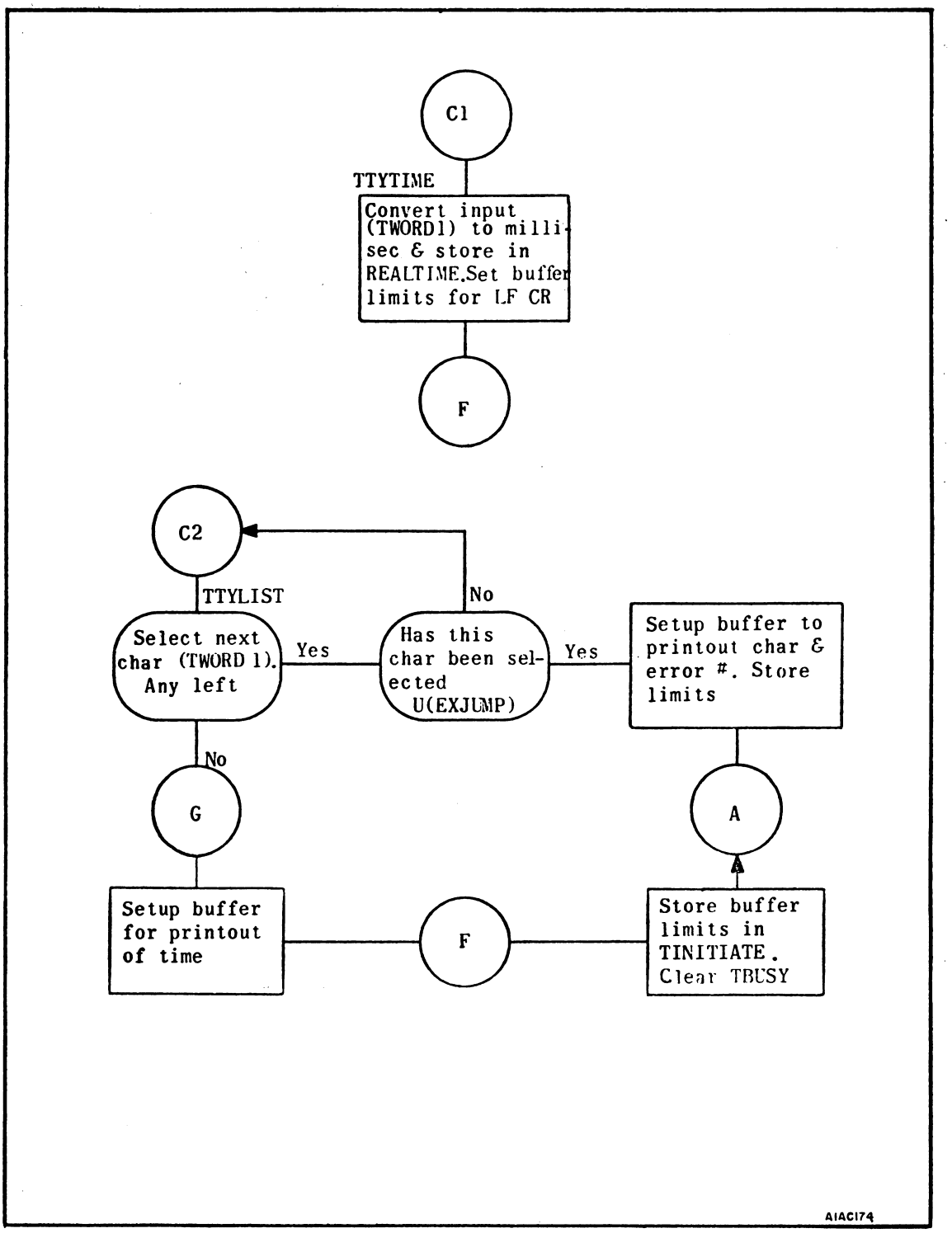

Figure E - 6. TTY Control Program Flow Diagram (Sheet 3 of 7)

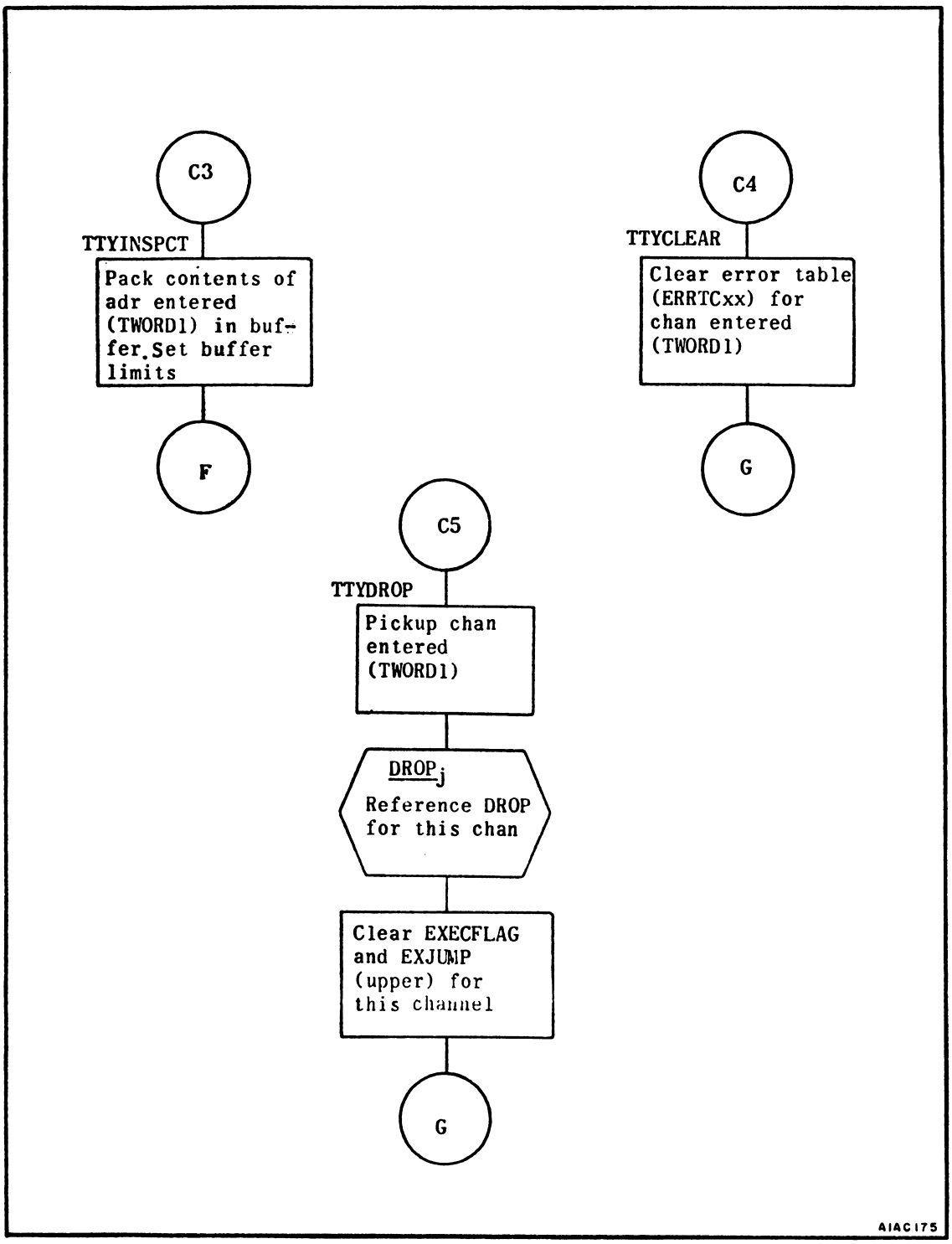

Figure E - 6. TTY Control Program Flow Diagram (Sheet 4 of 7)

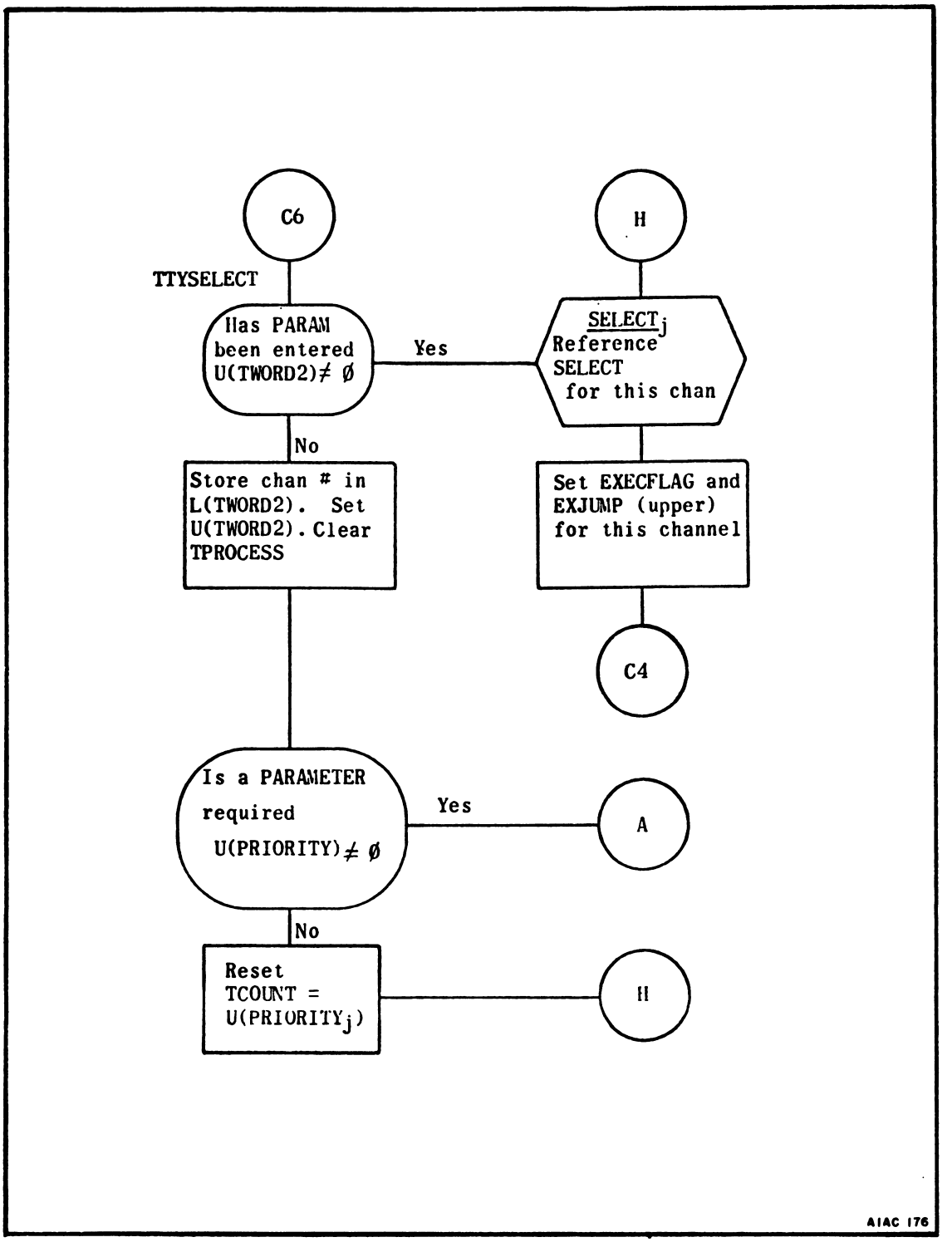

Figure E - 6. TTY Control Program Flow Diagram (Sheet 5 of 7)

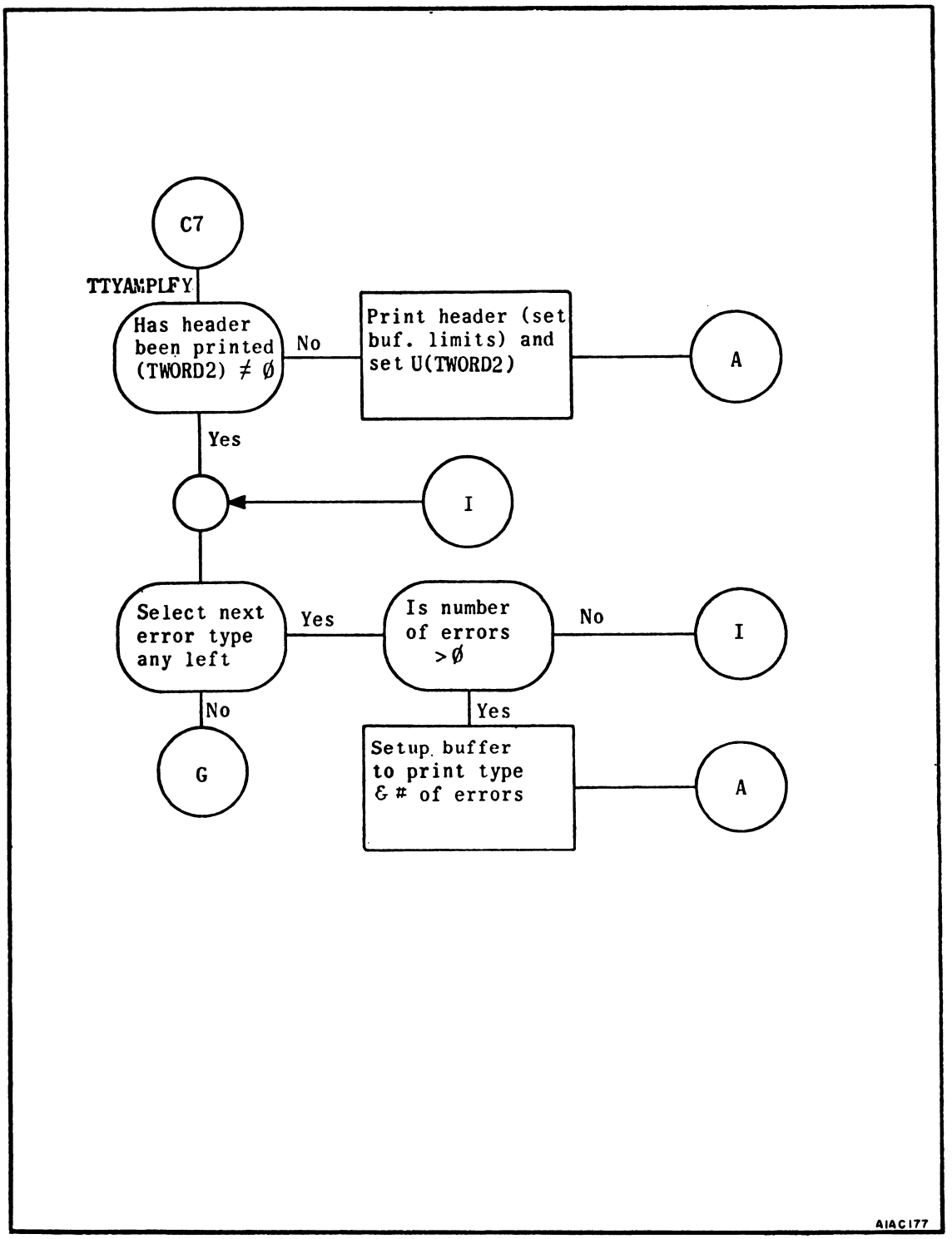

Figure E - 6. TTY Control Program Flow Diagram (Sheet 6 of 7)

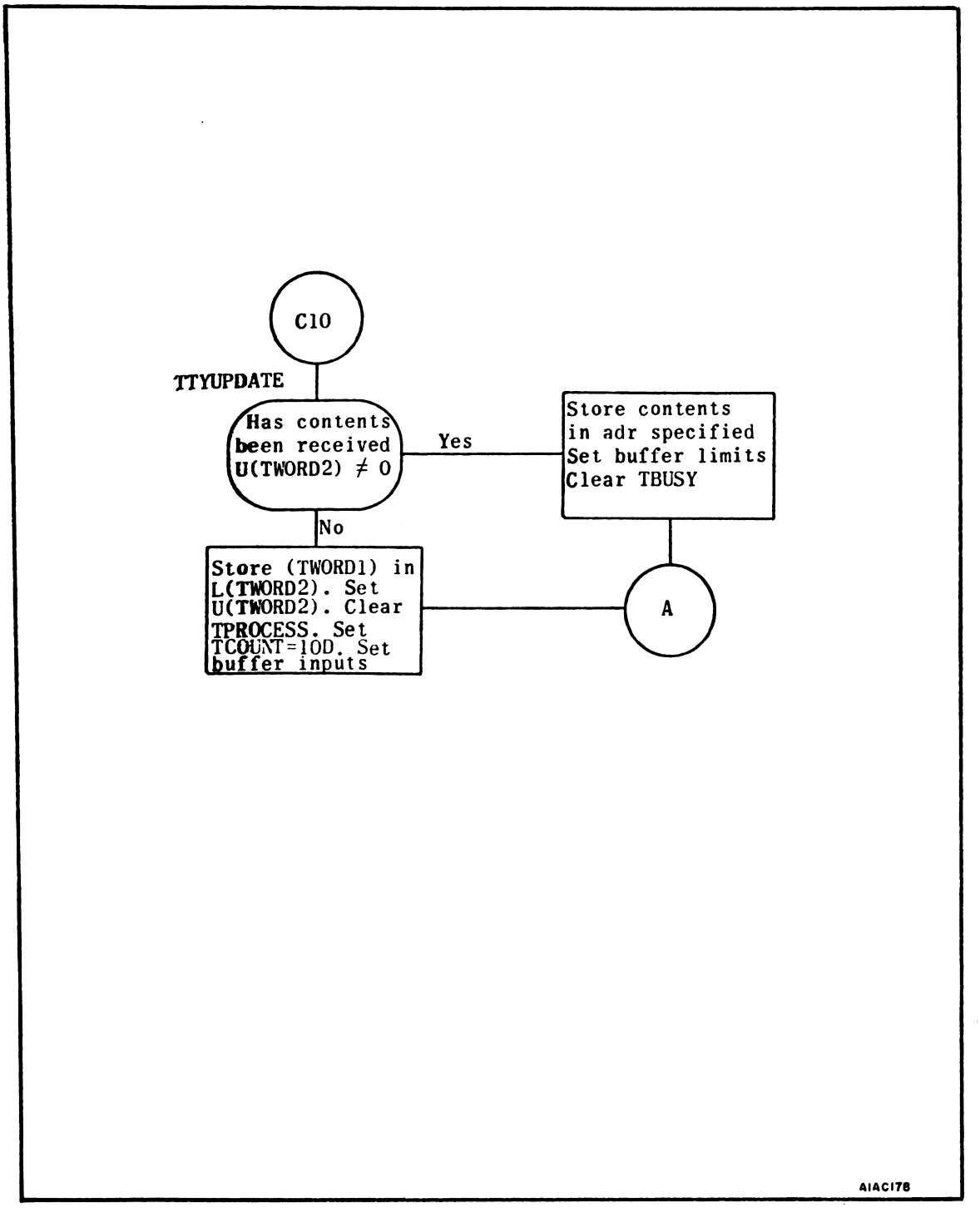

Figure E - 6. TTY Control Program Flow Diagram (Sheet 7 of 7)

SYNOPSIS

TITLE: TTY Input Monitor Interrupt Routine

LABEL: TTYINMON

PURPOSE: TTYINMON performs the preprocessing of any TTY input (manually entered by the system operator). Input is accepted one character at a time and TTYINMON either reinitiates the input (when additional data is required) or references TTYCNTRL via the Executive.

METHOD: TTYINMON is entered whenever a character is received from the TTY. After storing the registers and picking up the input character (from TINWORD), TTYINMON checks TBUSY to determine if a function had already been initiated. If not (TBUSY zero) the character is compared to the function characters in TFNCTNC. If it is a legal function character the TFNCTNC index is stored in TBUSY as the function index and TCOUNTBL is examined to determine if any additional characters are required. If none, TPROCESS is set. In either case TINITIATE is then set to the initial buffer limits for the function entered, and TTYCNTRL's Executive flag is set to current time plus 150 milliseconds.

If the character is not a legal function code the character is compared to the list of control characters. If one of these, it is ignored, input is reinitiated and no further processing is required. If it is not one of the control characters, TINITIATE is set to the buffer limits for a printout of "ILLEGAL" TTYCNTRL's executive flag is set and an E.F. is transferred to select output.

If, TBUSY is set upon entry, the character is compared to the TDIGIT table using the function's octal, decimal index in TCOUNTBL. If the character is illegal, TBUSY is cleared and the ILLEGAL printout is initiated as described above. If legal, it is packed into TWORD1 and TCOUNTBL (upper) is used to determine if all required input has been received. If so, TPROCESS is set, the E.F. (output) is transferred and TTYCNTRL's Executive flag is set. If not, input is reinitiated. TCOUNT (one word) is used for temporary storage of the number of characters required (from TCOUNTBL). It is set upon initiation of a function and used as an index as characters are received. It is also reset by TTYCNTRL when, upon processing of the data received, it is determined that additional input is required.

Maximum execution time of TTYINMON is 485 microseconds.

AIAC277

Figure E - 7. TTY Input Monitor Interrupt Routine Program (Sheet 1 of 2)

INPUT PARAMETERS: A one word input buffer (TINWORD) is established (with monitor) for all manually entered TTY data.

INPUT CONDITIONS: The input buffer is established by this routine or by TTYCNTRL.

OUTPUT PARAMETERS: TTYINMON uses the following words for communication with TTYCNTRL:

TINITIATE - Output buffer limits.
TPROCESS - Requesting TTYCNTRL action.
TBUSY - Indicating an entry in progress.
TINSEL - Indicating TTY input is selected.

TTYINMON also transfers an E.F. (output) to the TTY prior to requesting Executive reference of TTYCNTRL. The executive reference request is made by setting TTYCNTRL's executive flag to current time plus 150 milliseconds.

OUTPUT CONDITIONS: None

SYSTEM DATA REFERENCED:

TTYINMON uses the TFNCTN table (9 words) to decode the initial character entered for the individual functions. The upper 15 bits of the first 6 words of the table contain control codes which, when received as input, are ignored unless a function has already been initiated. TCOUNTBL is a nine word table ordered by function index. The lower half word contains an octal decimal index used to determine the type of characters to be entered for each function. The upper half word contains an index to the number of characters to be entered for each function. Input data is stored in TWORD1 and TWORD2 for processing by TTYCNTRL.

STORAGE: TTYINMON requires approximately 85 memory locations including tables and temporary stores.

ALARMS: None

REMARKS: None

AIAC278

Figure E - 7. TTY Input Monitor Interrupt Routine Program (Sheet 2 of 2)

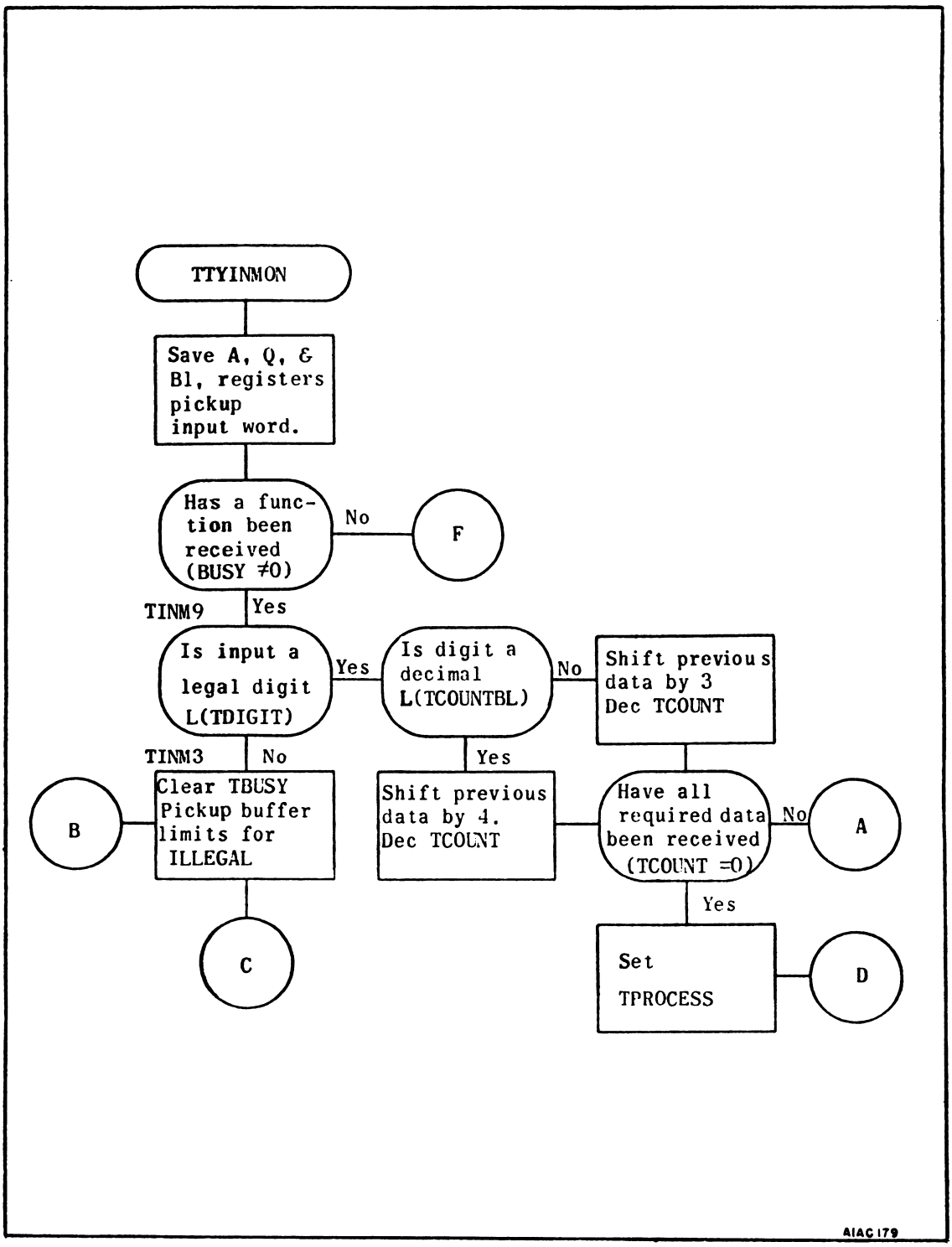

Figure E - 8. TTY Input Monitor Interrupt Routine Flow Diagram (Sheet 1 of 2)

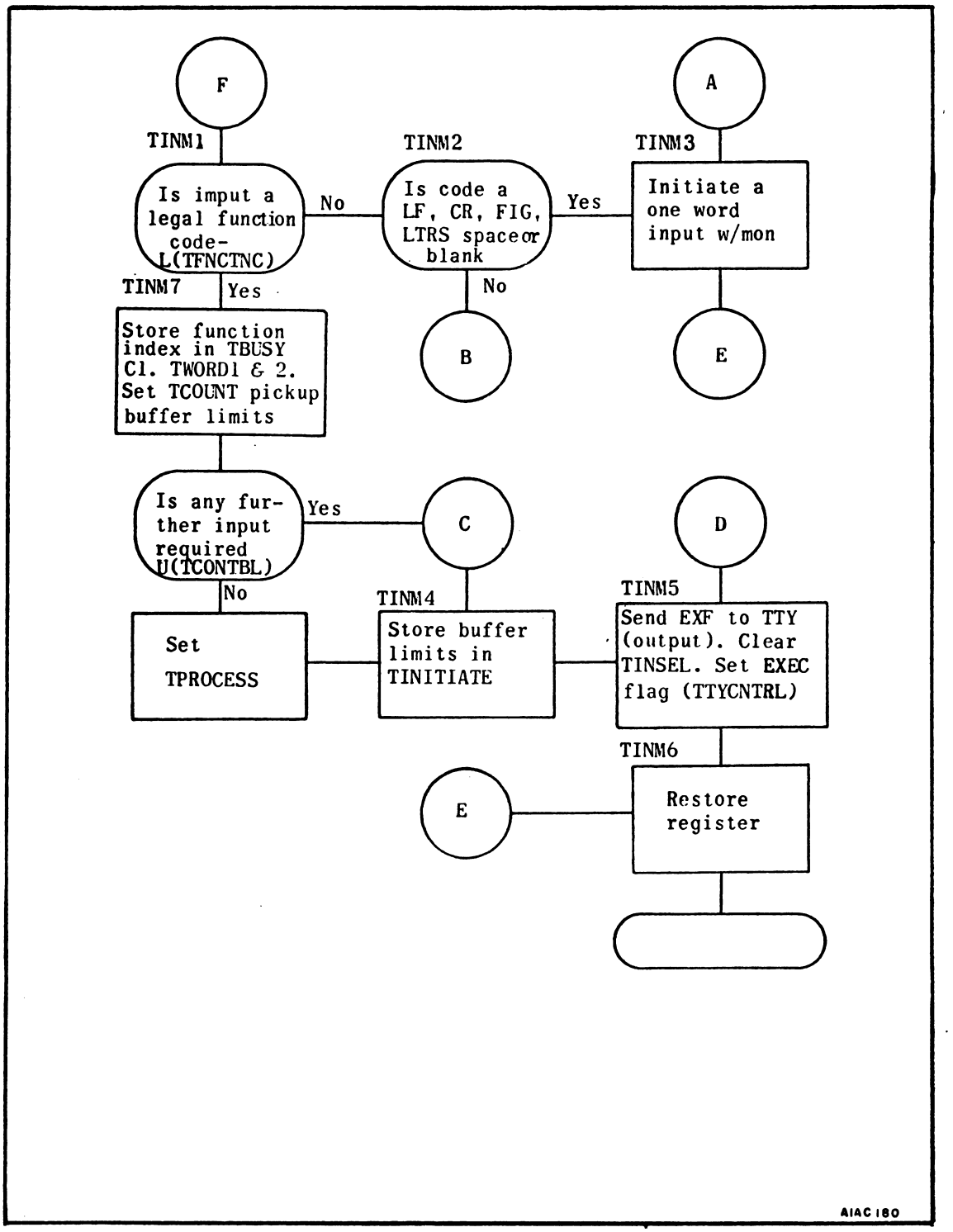

Figure E - 8. TTY Input Monitor Interrupt Routine Flow Diagram (Sheet 2 of 2)

SYNOPSIS

TITLE: TTY Output Monitor Interrupt Routine

LABEL: TTYOUTMON

PURPOSE: TTYOUTMON is used to enable reentry to TTYCNTRL from the Executive upon completion of all output transfers.

METHOD: Upon entry TTYOUTMON sets TTYCNTRL's Executive flag to current time plus 150 milliseconds. No other processing is required.

INPUT PARAMETERS: None

INPUT CONDITIONS: None

OUTPUT PARAMETERS: None

OUTPUT CONDITIONS: None

SYSTEM DATA REFERENCED: The EXECFLAG table is adjusted.

STORAGE: 10D

ALARMS: None

REMARKS: None

AIAC 279

Figure E - 9. TTY Output Monitor Interrupt Routine Program (Sheet 1 of 1)

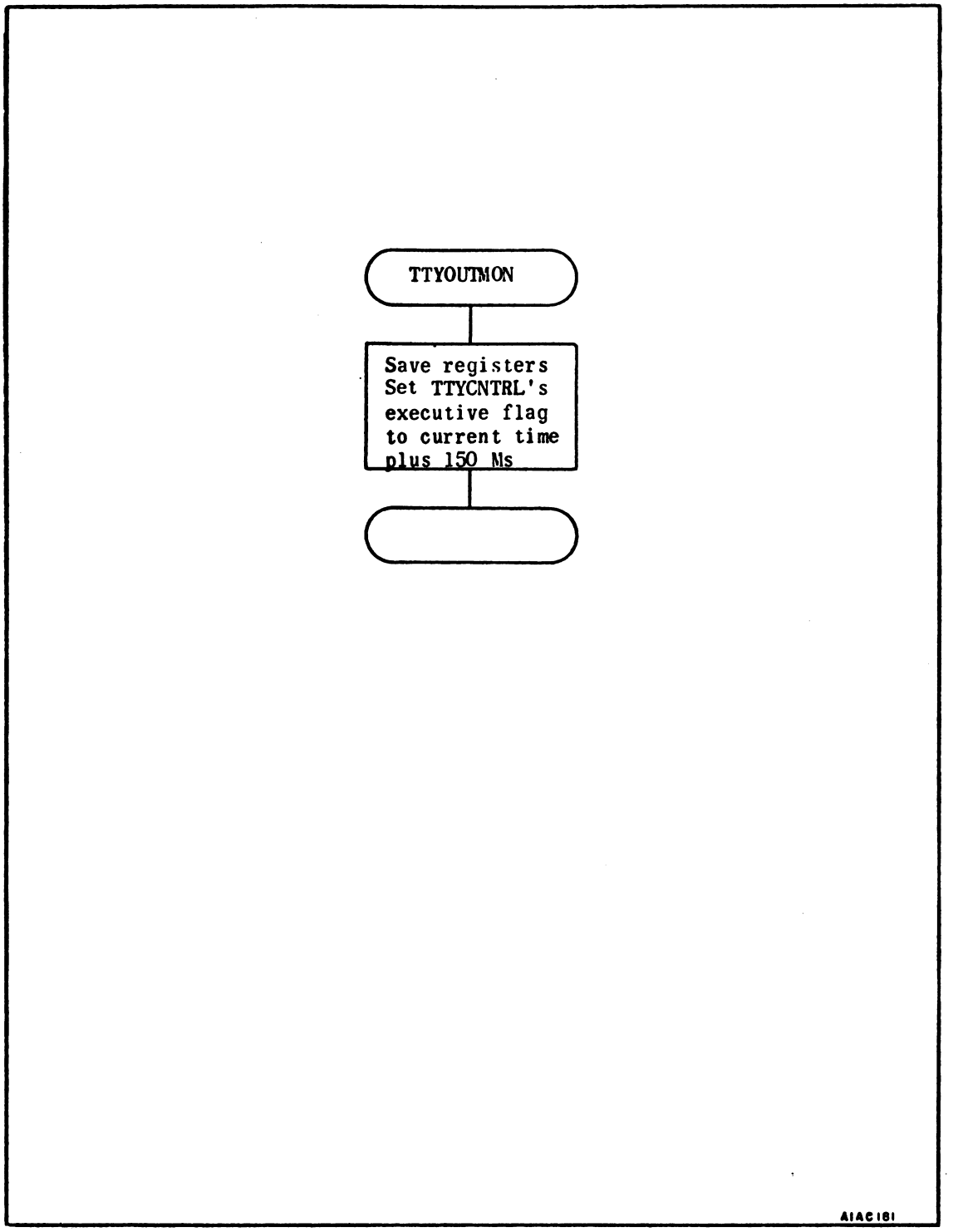

Figure E - 10. TTY Output Monitor Interrupt Routine Flow Diagram (Sheet 1 of 1)

SYNOPSIS

TITLE: Fault Interrupt Routine

LABEL: FAULT

PURPOSE: FAULT is entered when an illegal instruction is encountered. No automatic recovery is attempted. FAULT initiates a printout on the TTY (FAULT) and stops with the memory address at which the illegal instruction was found in the A register and the contents of that location in the Q register.

METHOD: FAULT is entered from the fault interrupt execution of the instruction at location zero. This is stored by the INITIAL routine. The A, Q, and B registers are stored with the clock value. FAULT terminates all output, transfers an E.F. to the TTY to select output, waits 100 milliseconds and then initiates the output buffer. The A and Q registers are then loaded and, after the output transfer has terminated, the computer stops.

INPUT PARAMETERS: The contents of the entrance address of FAULT less one indicate the erring memory address.

INPUT CONDITIONS: None

OUTPUT PARAMETERS: The A register contains the memory address at which the fault condition was encountered. The Q register contains the contents of that address. ERRTC04 thru ERRTC04+11 contain the A register, Q register, clock, and B1 thru B7 registers.

OUTPUT CONDITIONS: None

SYSTEM DATA REFERENCED:

ERRTC04	A register	ERRTC04+5	B3 register
ERRTC04+1	Q register	ERRTC04+6	B4 register
ERRTC04+2	Clock	ERRTC04+7	B5 register
ERRTC04+3	B1 register	ERRTC04+10	B6 register
ERRTC04+4	B2 register	ERRTC04+11	B7 register

STORAGE: FAULT requires 33 memory locations including the prestored TTY output buffer.

ALARMS: This is an alarm routine.

REMARKS: None

AIAC280

Figure E - 11. Fault Interrupt Routine Program (Sheet 1 of 1)

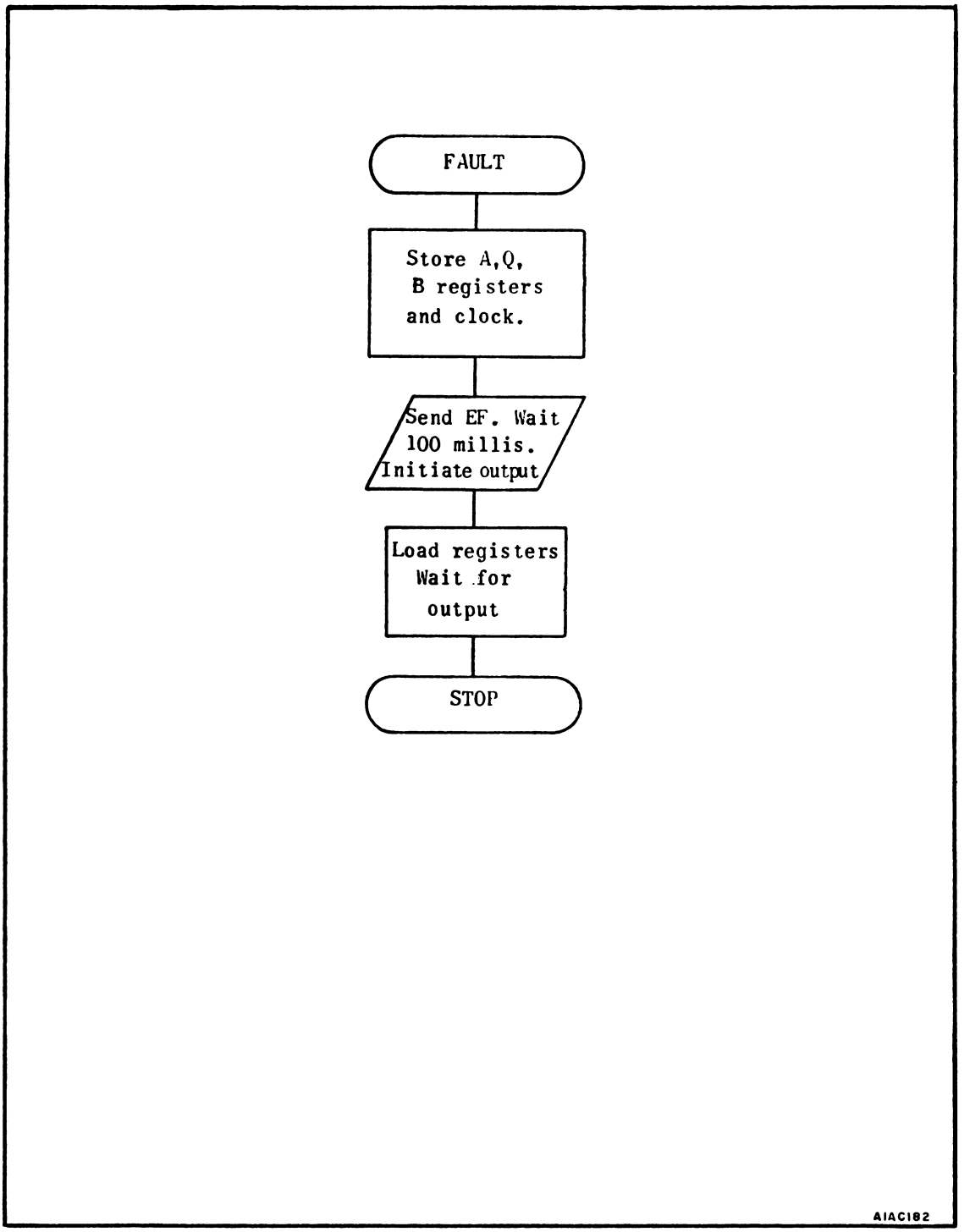

Figure E - 12. Fault Interrupt Routine Flow Diagram (Sheet 1 of 1)

SYNOPSIS

TITLE: Error Recording Subroutines

LABEL: ERROR and IERROR

PURPOSE: The two error recording routines are used by the individual subsystem test programs to record errors and to request any TTY printout necessary. The routines are basically identical. IERROR is used by any interrupt routine, ERROR is used by any subprogram or subroutine.

METHOD: Upon entry this routine determines the error type and channel number from Q, increments the individual error table (ERRTCxx) and then checks the total number of errors recorded for that error type. If this was the first to be recorded, REQUEST is incremented and the initial contents of Q are stored in the REQUEST table using the contents of REQUEST as the table index. (If REQUEST is equal to eight the REQUEST table is not incremented). Then if an error printout is required this routine checks TINSEL to determine if TTYCNTRL's Executive flag should be set. If TINSEL is not set no action need be taken. If set, TTYCNTRL's Executive flag is set for immediate entry from the Executive. Control is then returned to the user.

INPUT PARAMETERS: The Q-register contains the error type (bits 0-3) and the channel number (bits 4-7).

INPUT CONDITIONS: None

OUTPUT PARAMETERS: These routines increment the REQUEST table (used by TTYCNTRL to determine error printouts requested). REQUEST is a nine word table the first of which contains the number of printouts requested. The remaining words provide for up to 15 error types for each I/O channel. These tables are labeled ERRTCxx where xx represents the channel number.

STORAGE: These routines require a total of 70 memory locations plus the 265 core required for the error tables.

ALARMS: None

REMARKS: No more than eight error printout requests can be held in queue at one time. When additional requests are received, the error will be recorded but no printout will be requested.

AIAC281

Figure E - 13. Error Recording Subroutines Program (Sheet 1 of 1)

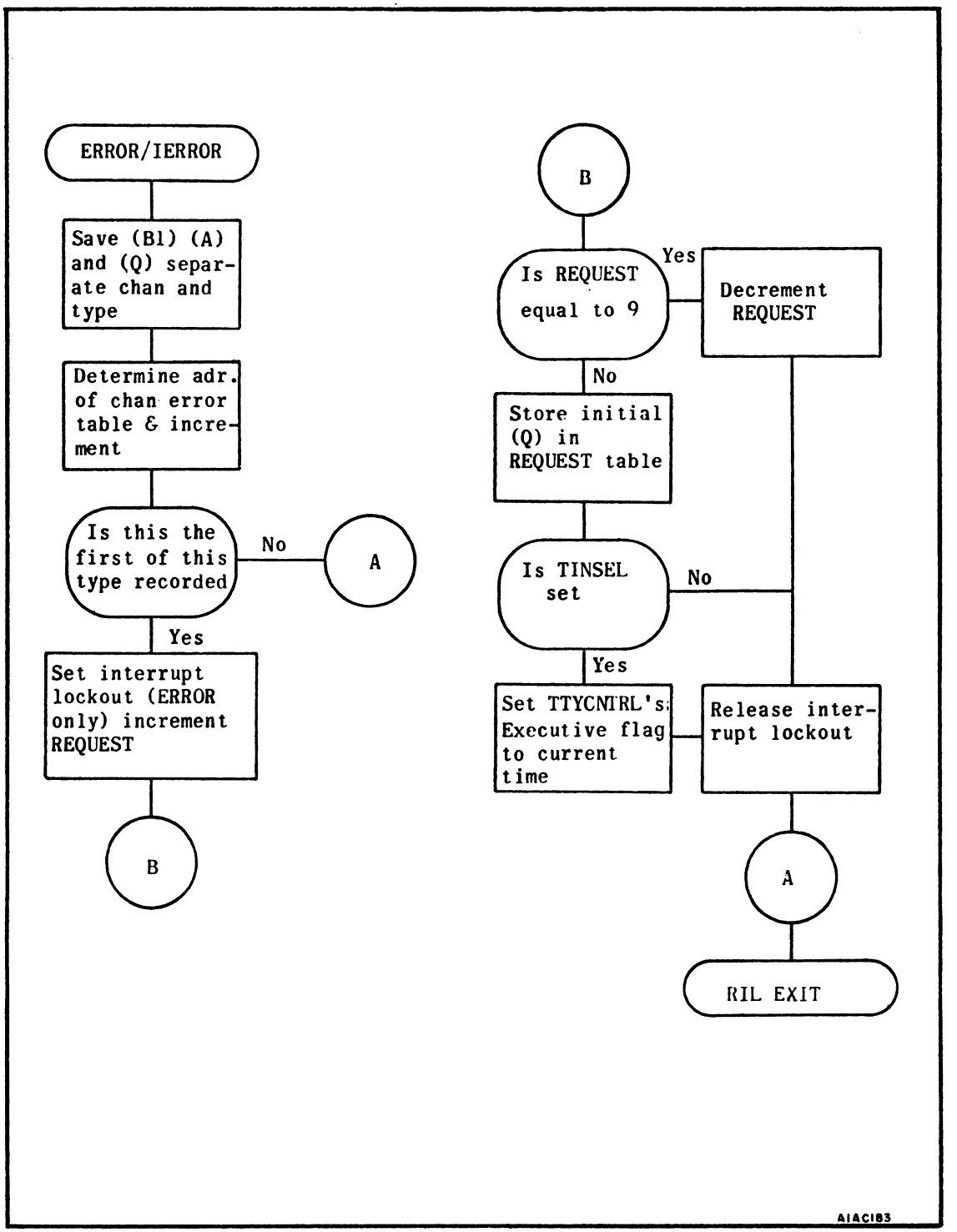

Figure E - 14. Error Recording Subroutines Flow Diagram (Sheet 1 of 1)

E.6.2 Preparation of the IPOFA Program

This section provides the user with information to build, modify or expand the AN/UKY-4 System IPOFA program. Materials required include only the Utility Package (UPAK), the IPOFA Executive Control Program and the equipment test programs.

The IPOFA program consists of equipment test programs and an executive control program, all of which operate with the CP-642B/USQ-20(V) Computer. The equipment test programs exercise one or more specific peripheral equipments and are designed to interface with the executive control program. Each is channel independent, relocatable in computer memory, and is provided on mylar or paper tape. Each subsystem test program must conform to the following format:

Program base address: Preset entrance
Base address plus 2: Termination (Drop) entrance
Base address plus 4: Executive entrance

The executive control program is also provided on mylar or paper tape but is allocated in memory. It assumes the TTY is assigned to channel 6 but this may be modified upon program initiation (see paragraph E.3.4). In order to interface the separate test programs with the executive program, several internal executive tables must be defined by the user and will be discussed. Executive utilization of these tables is described in E.6.1.

o EXJUMP. A sixteen word table, ordered by channel number (00-17), allocated to memory address 03060, containing the base address of the individual test programs in the lower 15 bits. Table E-3 contains the test program memory requirements for determining program allocations.

o EXPERIOD. A sixteen word table, ordered by channel number (00-17), allocated to memory address 03100, containing the desired executive reference rate for the associated test program. The rate is stored in seconds, scaled +10. Table E-3 contains the suggested reference rate for several of the available test programs.

o PRIORITY. A sixteen word table, the lower 15 bits of which are ordered by channel priority and contain each of the 16 channel numbers, the upper 15 bits of which are ordered by channel number (00-17) and contain the number of characters required in the parameter for test selection. The PRIORITY table is allocated to memory address 03020. The number of characters required in the selection parameter are listed in table E-3 for the available test programs. The channel priority is determined by examination of the various test programs (time-critical programs must be high priority, those programs most often referenced should follow in priority and the unused channels will be last in the priority list).

o EXSCHED. A sixteen word table, ordered by channel number, allocated to memory address 03040, containing an executive parameter which may be used to control I/O activity on various (selected) channels. The EXSCHED parameter is further discussed in paragraph E.6.1. This table has been compiled with parameters for all channels indicating no scheduling criteria.

The following are provided for building a new IPOFA program on magnetic tape.

o Load the UPAK into memory (location 00620-02774) using the procedures outlined in paragraph E.3.4.

o Load the Executive Control program provided on absolute bioctal mylar or paper tape according to the UPAK procedures. This program is stored in locations 03000-05377.

o Complete table E-4 using the information provided in table E-3.

o Using the UPAK INSPECT AND CHANGE, store the required data in EXJUMP, EXPERIOD, PRIORITY AND EXSCHED.

o Load each test program (provided on relocatable bioctal mylar or paper tape) according to the UPAK procedures, and at the memory addresses indicated in table E-4 as an aid in IPOFA program preparation. It should be completed by the user and retained as a record of the IPOFA program structure.

o Using the UPAK, Magnetic Tape Package write memory (locations 03000-77700) on the desired tape.

Table E - 3. Test Program Characteristics

IPOFA TEST PROGRAM	MEMORY REQUIRE-MENTS (OCTAL)	EXECUTIVE REFERENCE RATE	PARAM. CHAR. REQ.
RD-294/RD-270 Magnetic Tape Unit	1,641	00000 00113 (75 ms)	3
RD-281 Disk File	10,422	00000 00144 (100 ms)	3
RP-161 Card Reader	1,107	20000 00000 (Maximum)	1
UNIVAC 705 Card Reader	1.500*	20000 00000 (Maximum)	0
RO-304 Card Punch	3,100*	20000 00000 (Maximum)	0
RO-280 High Speed Printer	4,405	00003 60000 (2 min)	0
OA-7984 I/O Console	1,751	00011 30000 (5 min)	0
RD-231 Paper Tape Reader/Punch	1,751	00011 30000 (5 min)	0
AN/UYA-5 or -6 Displays	12,000*	20000 00000 (Maximum)	0
UNIVAC 1469 Printer	5,000	00003 60000 (2 min)	0

* Memory requirements are approximate.

Table E - 4. System IPOFA Test Structure

SYSTEM EQUIPMENT		EXECUTIVE TABLE STRUCTURE			
CP-642B/USQ-20(V) COMPUTER		SUBSYSTEM TEST BASE ADDRESS (LOWER OF EXJUMP)	EXECUTIVE REFERENCE RATE (EXPERIOD)	EXECUTIVE I/O SCHEDULING (EXSCHED)	SUBSYSTEM PRIORITY (PRIORITY)
CHANNEL	SUBSYSTEM				
17					
16					
15					
14					
13					
12					
11					
10					
7					
6					
5					
4					
3					
2					
1					
0					

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