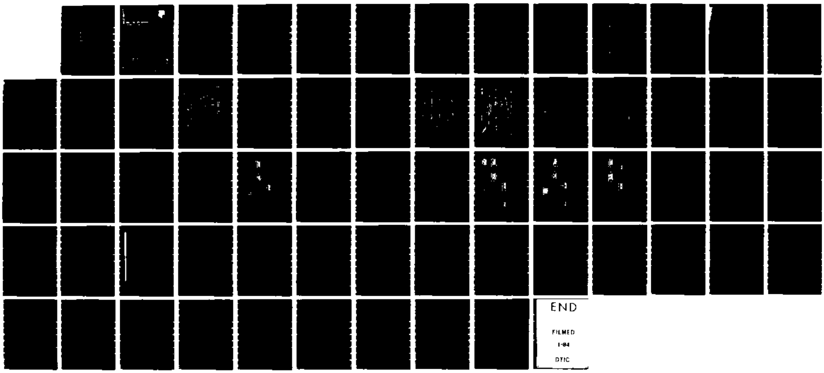
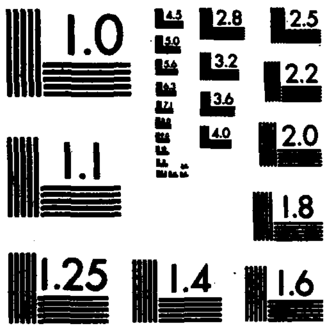
AD-A136 047 INDICATIONS AND WARNING FACILITY SUPPORT SYSTEM(U) PAR TECHNOLOGY CORP NEW HARTFORD NY G BROWN ET AL. AUG 83 RADC-TR-83-191 F30602-81-C-0201 1/1

UNCLASSIFIED F/G 9/2 NL





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

AD-A136047

(12)

RADC-TR-83-191
Final Technical Report
August 1983

INDICATIONS AND WARNING FACILITY SUPPORT SYSTEM

PAR Technology Corporation

George Brown, Therese Cavaiola, Mark Maginn and Jeanne Mauzy

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: RADC-TR-83-191	2. GOVT ACCESSION NO. AD-A136047
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): INDICATIONS AND WARNING FACILITY SUPPORT SYSTEM	5. TYPE OF REPORT & PERIOD COVERED: Final Technical Report, 6 Jun 81 - 2 May 83
	6. PERFORMING ORG. REPORT NUMBER: N/A
7. AUTHOR(s): George Brown, Therese Cavaiola, Mark Maginn, Jeanne Mauzy	8. CONTRACT OR GRANT NUMBER(s): F30602-81-C-0201
9. PERFORMING ORGANIZATION NAME AND ADDRESS: PAR Technology Corporation, Seneca Plaza, Rte 5, New Hartford NY 13413	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 64750F, 19550210
11. CONTROLLING OFFICE NAME AND ADDRESS: Rome Air Development Center (IRDT), Griffiss AFB NY 13441	12. REPORT DATE: August 1983
	13. NUMBER OF PAGES: 68
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Same	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same

18. SUPPLEMENTARY NOTES

RADC Project Engineer: Douglas A. Poore (IRDT)

Accession For	
NTIS GRA&I	☑
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A1	

DTIC COPY INSPECTED 3

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Indications and Warning
Flight Following
File Processing

Indications and Warning Facilities Support

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of the IWFS efforts was to develop an Intelligence Data Handling System for small I&W facilities. A prototype was developed and installed at Alaskan Air Command. The system alleviated problems of manual intelligence data collection and processing of graphics and alphanumeric display capabilities were implemented for interactive flight following and file processing, respectively.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS

RE: RADC-TR-83-191, Distribution Unlimited
Distribution statement is correct per Mr.
Mark Lomery, RADC/TSR

LIST OF FIGURES

1. *INTRODUCTION*

This Final Technical Report documents the accomplishments of the Indications and Warning Facility Support (IWFS) effort. The work was conducted for the Rome Air Development Center (RADC) under contract F30602-81-C-0201. This document is being delivered in compliance with Data Items A010 and A011.

The objective of the IWFS effort was to develop a general intelligence data handling system for small USAF Indications and Warning (I&W) facilities. The emphasis of this effort was on implementing an operational system at Alaskan Air Command (AAC). This system will serve as a model for other I&W facilities.

Previously, AAC personnel performed most of their intelligence analysis and production manually. Many of the intelligence functions performed at AAC are typical of small I&W facilities, and a study of data handling functions performed at AAC showed several areas that would lend themselves to automation. Information on intelligence documents, photo/viewgraphs, foreign and domestic installations capabilities, and personnel security clearances are examples of the functions that were automated for AAC. Moreover, the creation of automatic briefing aids and report production capabilities can significantly enhance and support daily operations.

Limited numbers of personnel and a substantial staff turnover rate were important considerations with respect to the man-machine interface design and to computer system training. An analyst can expect to remain assigned to AAC for an average of two years. Because of this staff turnover problem, the IWFS system was implemented so as to be easy to use and maintain, minimizing training and maintenance requirements while maximizing analyst effectiveness.

The remainder of this report describes significant items of interest involved with the development and demonstration of the IWFS system. The report is divided into seven sections, with Section 2 describing the system architecture in terms of its hardware and software, Section 3 reviewing the system development phases, and

Section 4 analyzing the hardware/software reliability and maintainability (Data Item A010). Section 5 discusses the impact of the IWFS system on the AAC operational environment, and Section 6 summarizes the IWFS effort, including system effectiveness. Finally, suggested enhancements are discussed in Section 7. A complete list of the terms and abbreviations used in this document can be found in Appendix A.

2. *SYSTEM ARCHITECTURE*

2.1 System Description

A high-level functional overview of the processes that make up the IWFS system is shown in Figure 2-1. Each of these processes 1) File Processor, 2) Flight Following, and 3) Utilities, may be viewed as a separate subsystem. These major processes are briefly described below:

File Processor

The File Processor subsystem of the IWFS system supports automatic storage and retrieval of intelligence data used by AAC and other small I&W facilities. Previously, this data was processed by hand. Such items as clearance and billeting information, library document holdings, and historic flight track data are stored in this data repository. Three data base access capabilities are provided for each IWFS file:

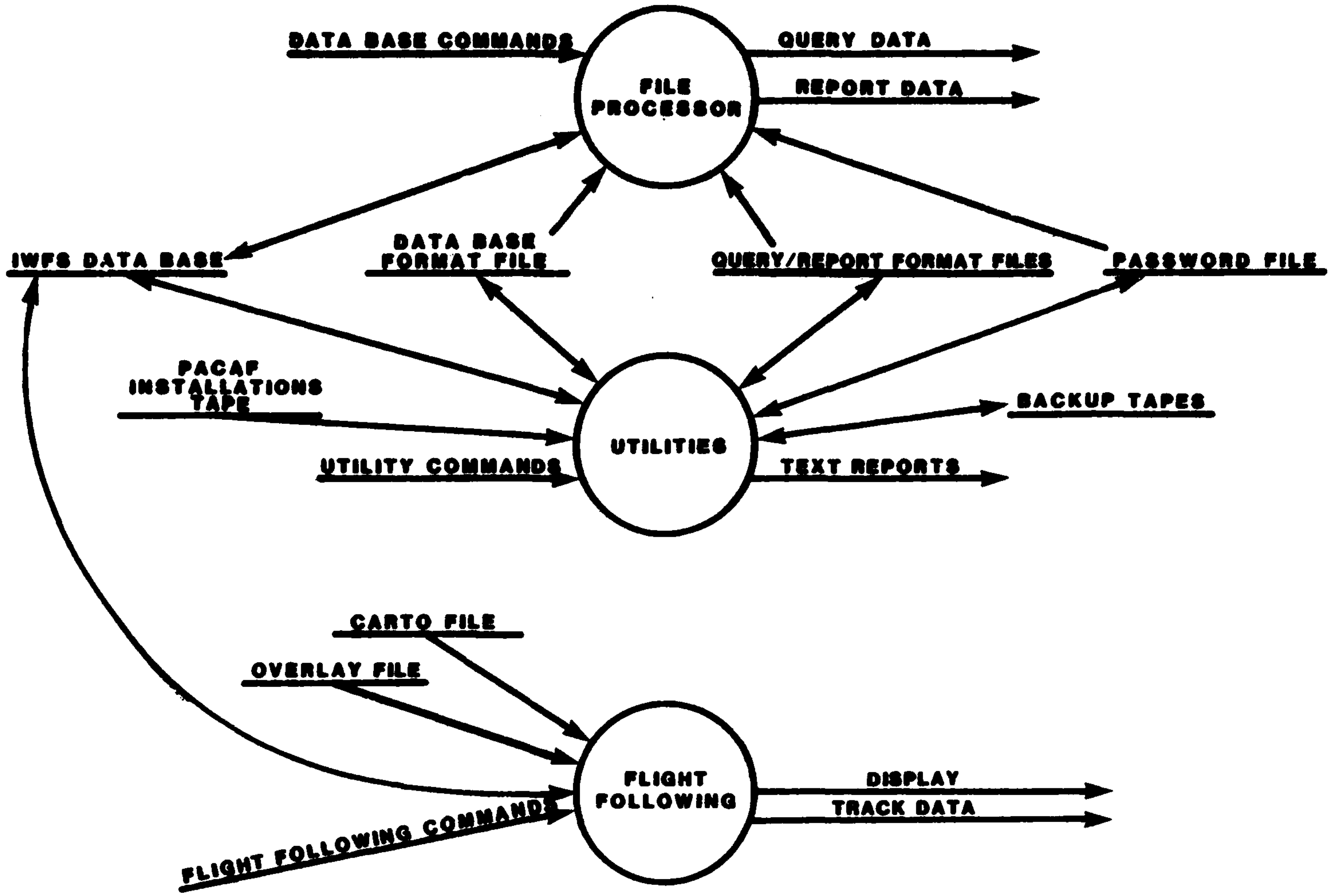
1. A report production capability that will produce hardcopy reports of data base information in a pre-specified format;

2. A query capability that will allow the user to view data base information, at the analyst terminal, in a pre-specified format;

3. A maintenance capability that allows existing data base information to be changed or new information to be added to the data base.

Flight Following

The Flight-Following Subsystem provides a graphic representation of flight tracks on a number of different cartographic backgrounds and reference overlays. It supports near-real-time tracking of flights currently in progress and allows



IWFS SYSTEM OVERVIEW
FIGURE 2-1

This report has been reviewed by the RADC Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

RADC-TR-83-191 has been reviewed and is approved for publication.

APPROVED: *Douglas A. Poore*

DOUGLAS A. POORE
Project Engineer

APPROVED: *Thadeus Domurat*

THADEUS J. DOMURAT
Acting Technical Director
Intelligence & Reconnaissance Division

FOR THE COMMANDER: *John P. Huss*

JOHN P. HUSS
Acting Chief, Plans Office

If your address has changed or if you wish to be removed from the RADC mailing list, or if the addressee is no longer employed by your organization, please notify RADC (IRDT) Griffiss AFB NY 13441. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document requires that it be returned.

analysts to relate these flights to, for example, pre-set historic track data, AAC radar coverage, and the Defense Early Warning Indicator Zone (DEWIZ). Figure 2-2 shows an example of a typical flight-following display. Target identification and threat assessment missions currently done by hand will be aided by these flight-following functions. Briefing aids and reports may be generated from hardcopies of the graphics display.

Utilities

IWFS utilities are special functions that assist with support requirements such as data base backup and recovery, PACAF Installations file updates, and text editing and formatting capabilities. Backup/recovery, text editing, and text formatting utilities are provided as part of the DEC-supplied software.

2.2 Hardware

The IWFS system was developed to run on a TEMPEST-certified Digital Equipment Corporation (DEC) PDP-11/34 processor with 256 kilobytes of main memory, 2 RL02 10-megabyte removable cartridge disk drives, and a DZ11 8-line terminal multiplexer. Supporting peripherals include four TEMPEST VT100 video display terminals, a TEMPEST Tektronix 4014 graphic display terminal and hardcopy device, an LA120 hardcopy console terminal, a TS11 1600 bits-per-inch magnetic tape drive, and a TEMPEST Systematics General line printer. A diagram of the hardware components of the IWFS system is shown in Figure 2-3.

All of the above equipment is TEMPEST certified, with the exception of the LA120 console terminal. This exception did not pose a problem, since the LA120 is contained within the computer room's primary control zone.

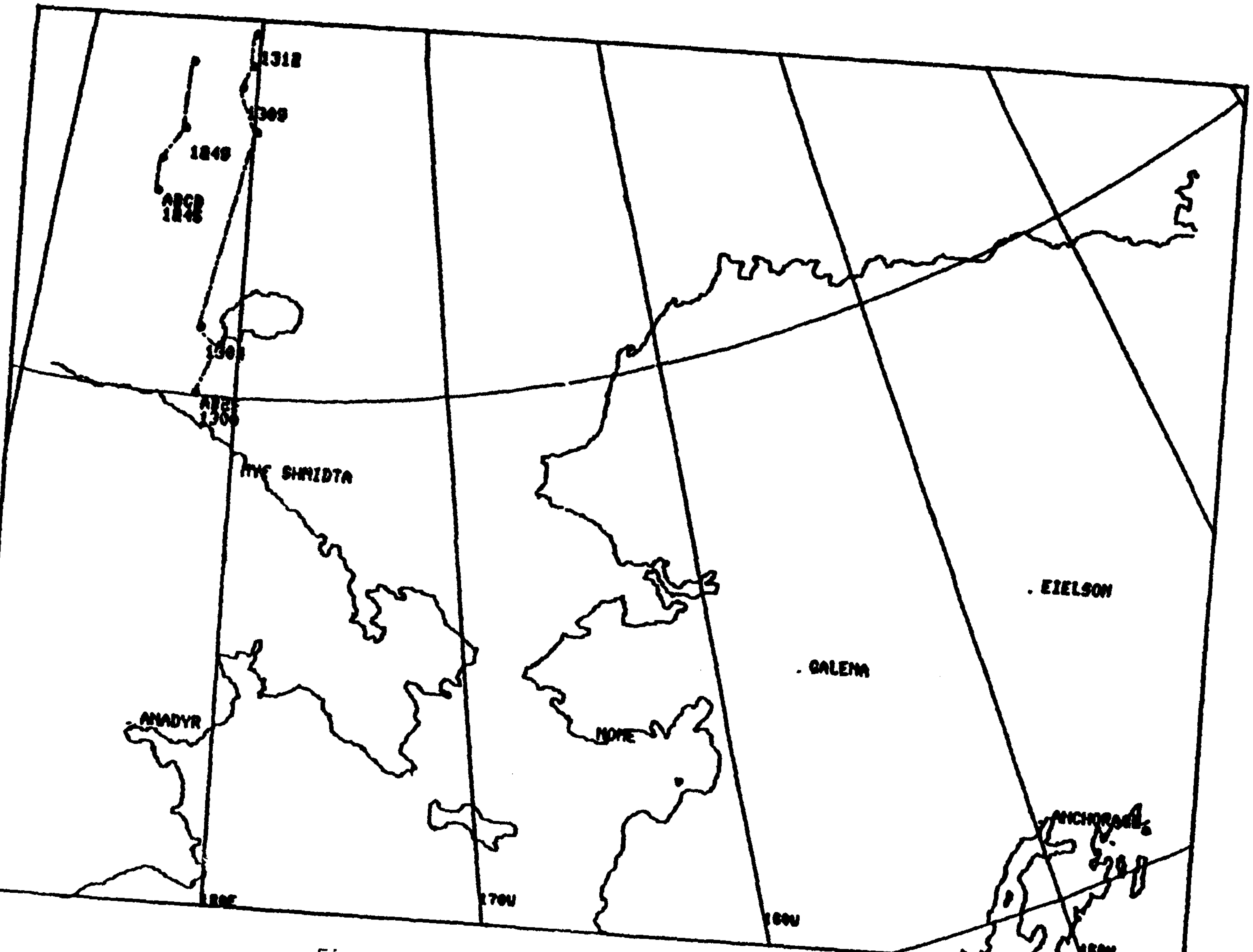
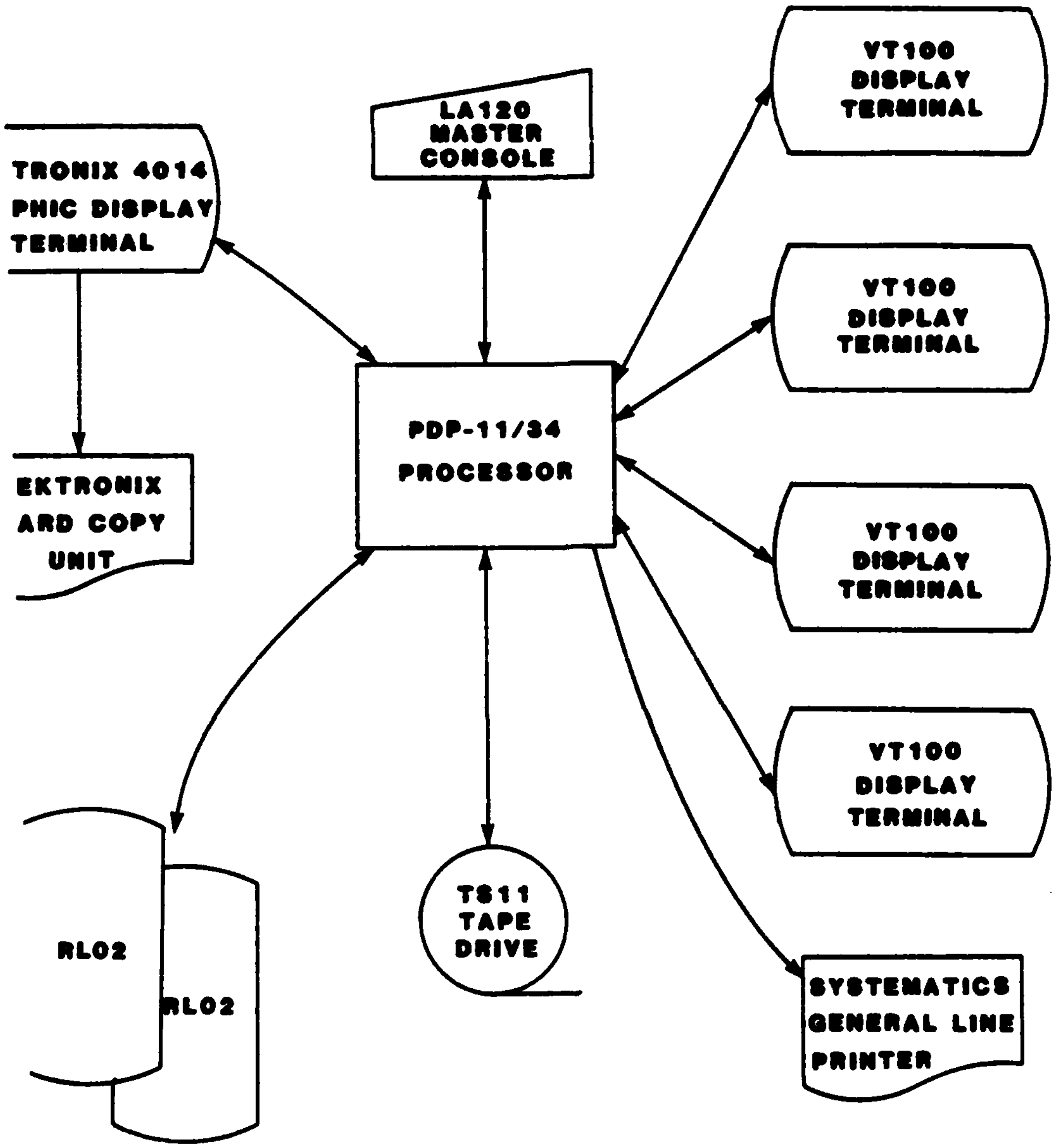


Figure 2-2 Sample Flight Following Display



IWFS HARDWARE CONFIGURATION
FIGURE 2-3

2.3 Software

To satisfy portability and maintainability requirements, the IWFS system implementation used as much vendor-supplied software as possible, with no modification. IWFS software was developed under the DEC RSX-11M V3.2 operating system. This operating system supports multiuser time-sharing as well as expandability of both software and hardware. In addition, DEC's RMS-11 (Record Management System) V1.8 was used to provide the low-level data base file interface. All applications software development used DEC's FORTRAN IV-PLUS, V3.0.

3. *REVIEW OF IWFS SYSTEM DEVELOPMENT*

The development of the IWFS system was divided into three phases: 1) Requirements Analysis and System Design, 2) Implementation, and 3) Installation and Training. The successful completion of the tasks associated with each particular phase marked the transition to the next phase. Figure 3-1 shows the IWFS program schedule with tasks and interdependencies shown at the top and key items (as a result of those tasks) shown at the bottom.

3.1 Requirements Analysis and Design Phase

The Requirements Analysis and Design Phase was the first phase of the IWFS effort. In this phase, Statement of Work (SOW) tasks were identified and detailed. Once the major SOW requirements were identified, a survey of industry-available hardware and software was conducted. Upon completion of the hardware/software survey, a data collection and site-survey trip to AAC was completed to ensure proper direction and coordination. Finally, a detailed design of the IWFS system components was produced and, then, reviewed by RADC and AAC.

3.1.1 *Hardware/Software Survey*

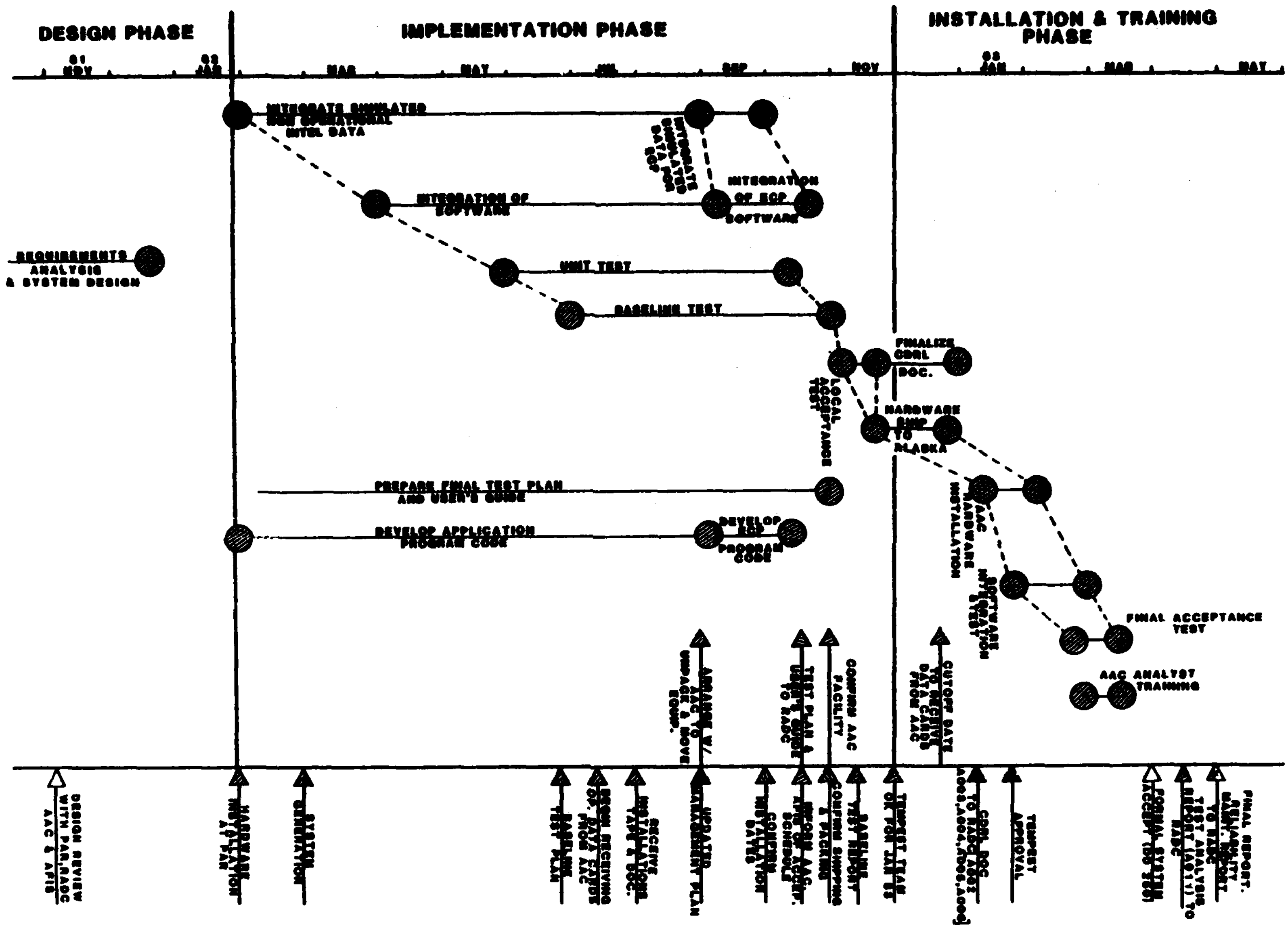
The primary requirements of the IWFS hardware/software were identified as:

- It must satisfy the TEMPEST requirements outlined in NACSEM 5100, "Compromising Emanations Laboratory Test Standard Electromagnetics."

- It must be:

  - Reliable

  - Easy to maintain



I & W FACILITY SUPPORT PROGRAM SCHEDULE
FIGURE 3-1

— Easy to operate

— Easy to use

To satisfy TEMPEST requirements, the hardware would have to be TEMPEST-certified or the facility containing the hardware would have to be shielded. Alaskan Air Command could not assure a shielded site for the hardware prior to it being ordered; thus, it was decided to purchase TEMPEST-certified hardware. TEMPEST-certified hardware has the advantage of being somewhat mobile, in the sense that it can be placed in any room, regardless of whether the room has been shielded.

The primary considerations in selecting the computer hardware were reliability and maintainability. To satisfy the first of these requirements, a TEMPEST-certified DEC PDP-11/34 computer was chosen because of its high degree of reliability. (Details on the reliability and maintainability of the hardware are provided in Section 4 of this report.) The analysis indicated that the maintenance requirements of the PDP-11/34 were much less than those typically experienced by comparable computer equipment. This was a very important consideration for Alaskan Air Command since no on-site maintenance is or will be available, and, thus, maintenance must be contracted for from outside sources.

Another aspect of system maintainability is software maintainability. To increase its software maintainability, the IWFS system made use of as much standard, vendor-supplied software as possible. The RMS-11 (Record Management Services) operating system was used to provide the low-level data base interface for indexed sequential file access, and F4P (FORTRAN IV-PLUS) was used for the implementation programming language. FORTRAN was chosen because of its widespread use and also because, as a high-level language, it allows programs to be developed quickly and efficiently.

As mentioned previously, staff turnover is prevalent within the Air Force. Staff effectiveness is significantly reduced if systems are manpower-intense. The PDP series of computers require minimal training to operate, and the IWFS system itself was designed to be "user friendly," providing maximum effectiveness with minimal training.

The IWFS system provides an extensive help facility so that new or infrequent users need not be "retrained."

3.1.2 *Data Collection and Site Survey*

A data collection and site survey trip was conducted in Alaska early in the contract. The purpose of this trip was to discuss the project's schedule and management, to discuss the results of the hardware/software survey, to examine the proposed computer facility with respect to the PDP-11/34 requirements, and to collect data on the IWFS system inputs, functions, and outputs. The resultant information established the groundwork for the specification, implementation, and delivery of the computer system to Alaska.

Before the survey trip, a questionnaire was developed to cover the following areas:

- Computer facilities power, space, and air-conditioning deficiencies
- Man-machine interface concepts
- Operator functions

The trip was summarized with a statement of the modifications to the existing computer facility which would be required to allow it to accept the IWFS computer. In addition, PAR developed sample menu displays and a high-level man-machine interface concept for data base processing and flight following. Primary system functions and data base formats were specified.

3.1.3 *Design Approach*

As a prerequisite to the IWFS system design, a detailed concept of operations was produced which described the specific screen menus as well as the man-machine interface. Once it was approved, this document served as the primary system description.

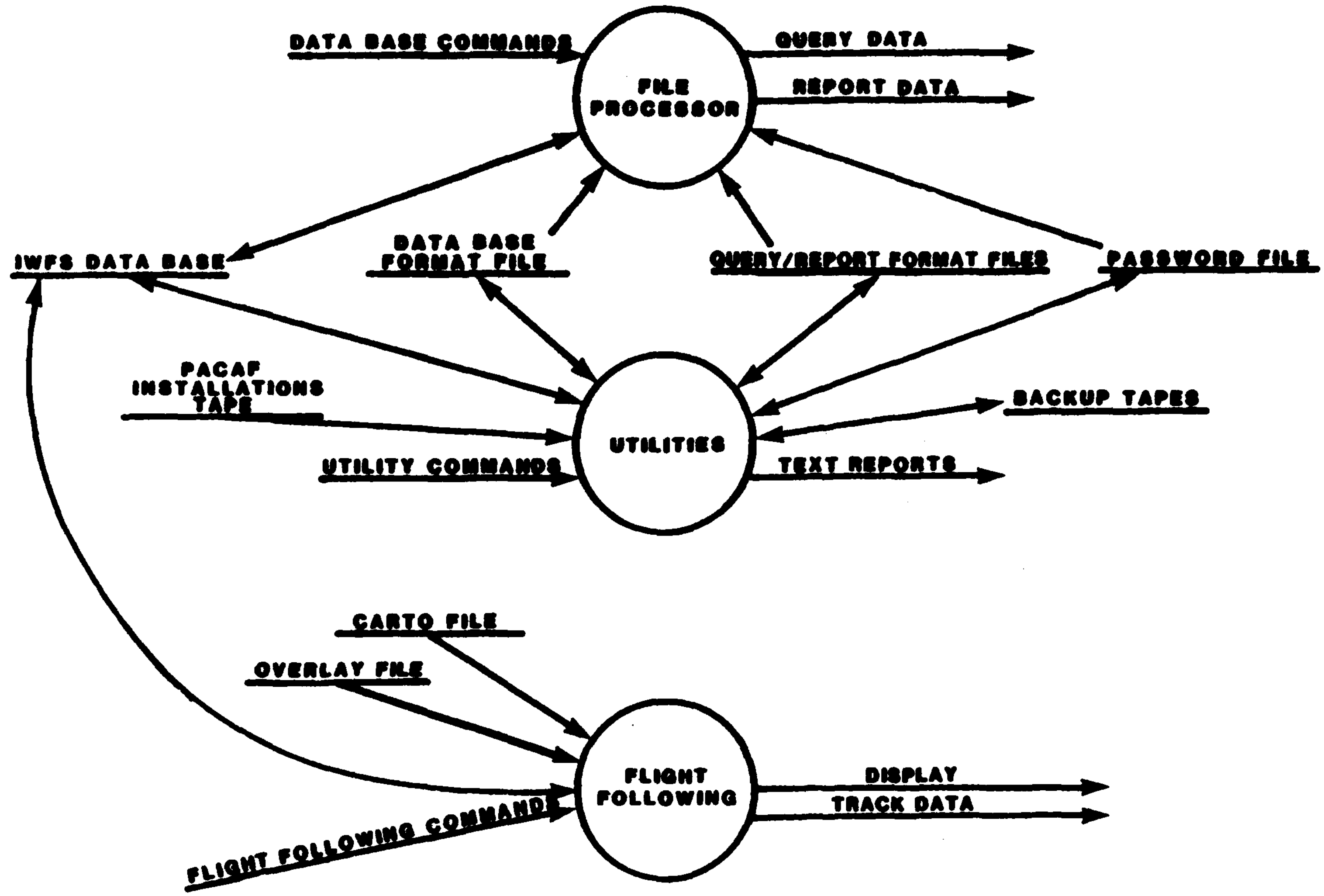
Often in the design of a system, what appears in a design document is not necessarily what the user expects or wants. The emphasis of this effort was on iterating the design and implementation of the system to produce a more responsive product. To eliminate any confusion or misconception, an initial operating capability was developed to demonstrate to the user the ideas brought forth in the concept of operations document. The man-machine interface was demonstrated to the user, comments were solicited, and the interface was further refined and improved. Once the man-machine interface was refined, the system was again demonstrated to ensure agreement between the user and the systems analyst. This iterative approach to the system implementation was made possible by the top-down design methodology employed throughout the effort.

The functional design of the IWFS system was developed using DeMarco Data Flow Diagrams (DFDs) and Data Dictionaries (DDs.) This structured analysis and design technique permitted the functional decomposition of the system in terms of the processes performed and the data flows between these processes. Ambiguities and deficiencies were resolved by examining the relationships of each DFD and its associated Data Dictionary.

A DFD consists of four basic elements. They are: 1) data flows, represented by arrows, 2) processes, represented by circles, 3) files, represented by straight lines, and 4) data sources and sinks, represented by boxes. System decomposition is done through leveling; that is, a circle which represents a process within a given DFD is decomposed into its respective subprocesses and data flows in the next-lower-level DFD.

3.1.4 *System Design*

As a result of the data flow analysis, the first two levels of DeMarco Data Flow Diagrams for the IWFS system were specified as shown in the following four pages. Figure 3-2 shows the overall system organization, the File Processor is detailed in Figure 3-3, Flight Following in Figure 3-4, and Utilities in Figure 3-5. The results of the data flow analysis were used to define and order the actual implementation of the IWFS



IWFS SYSTEM OVERVIEW
FIGURE 3-2

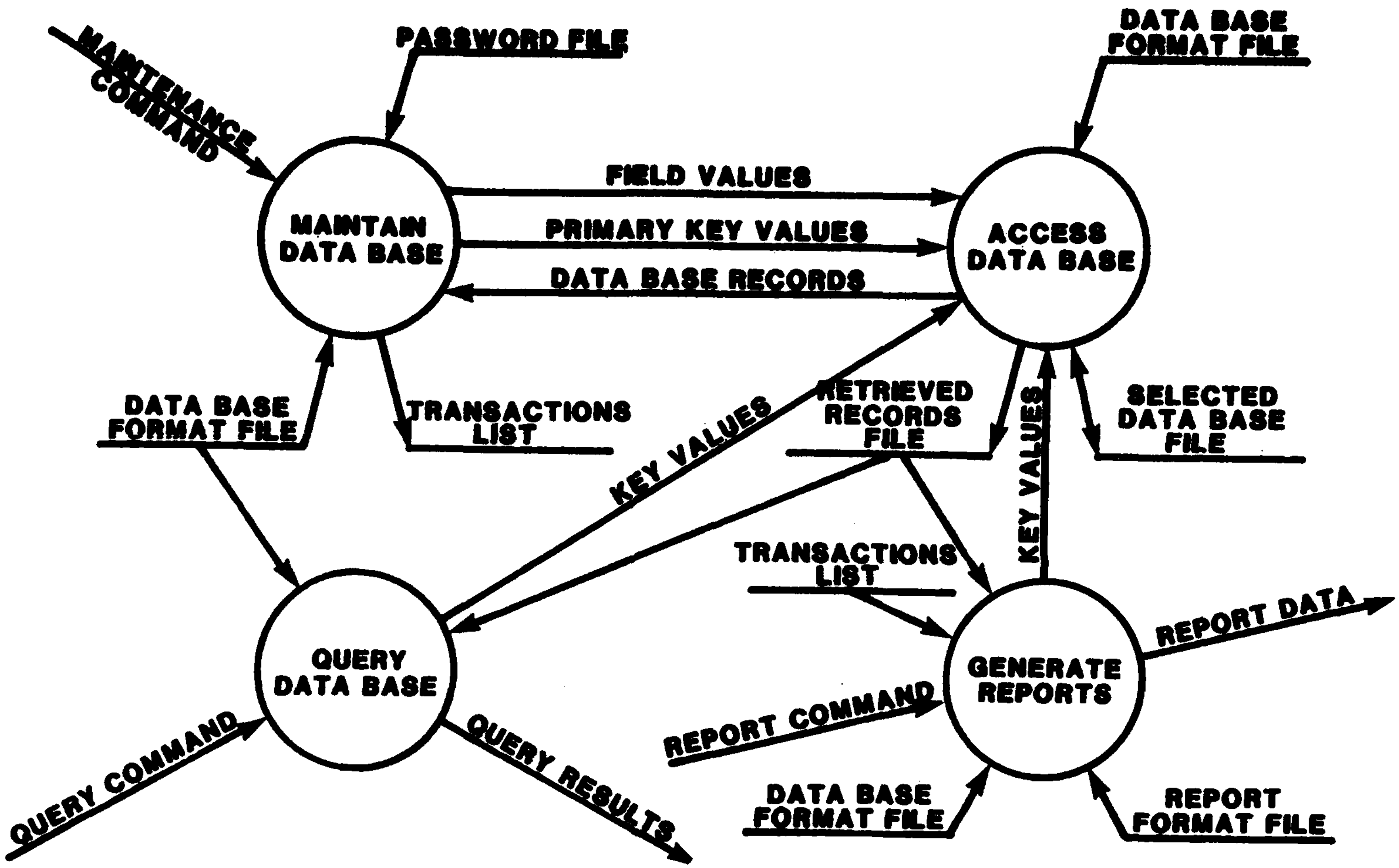
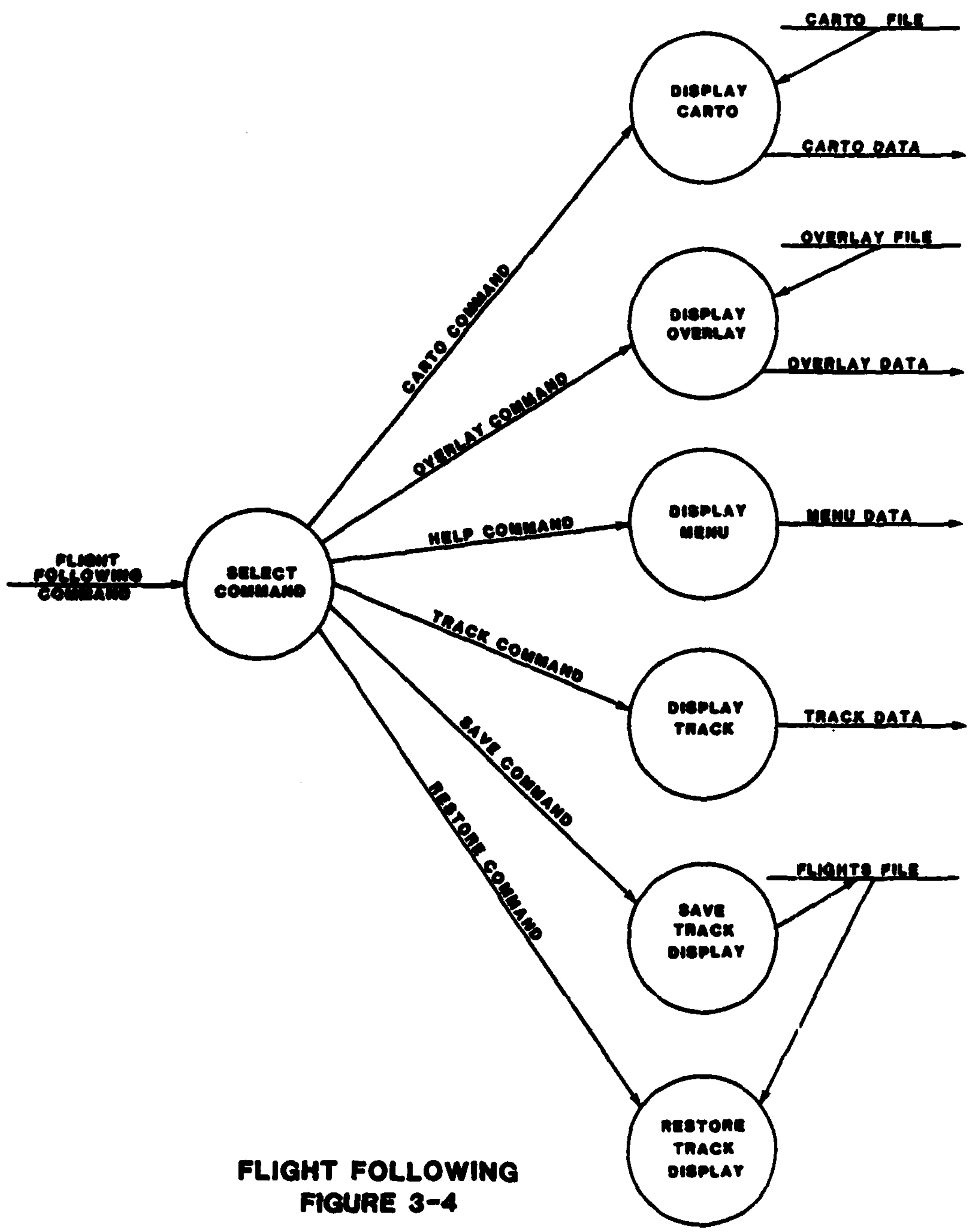
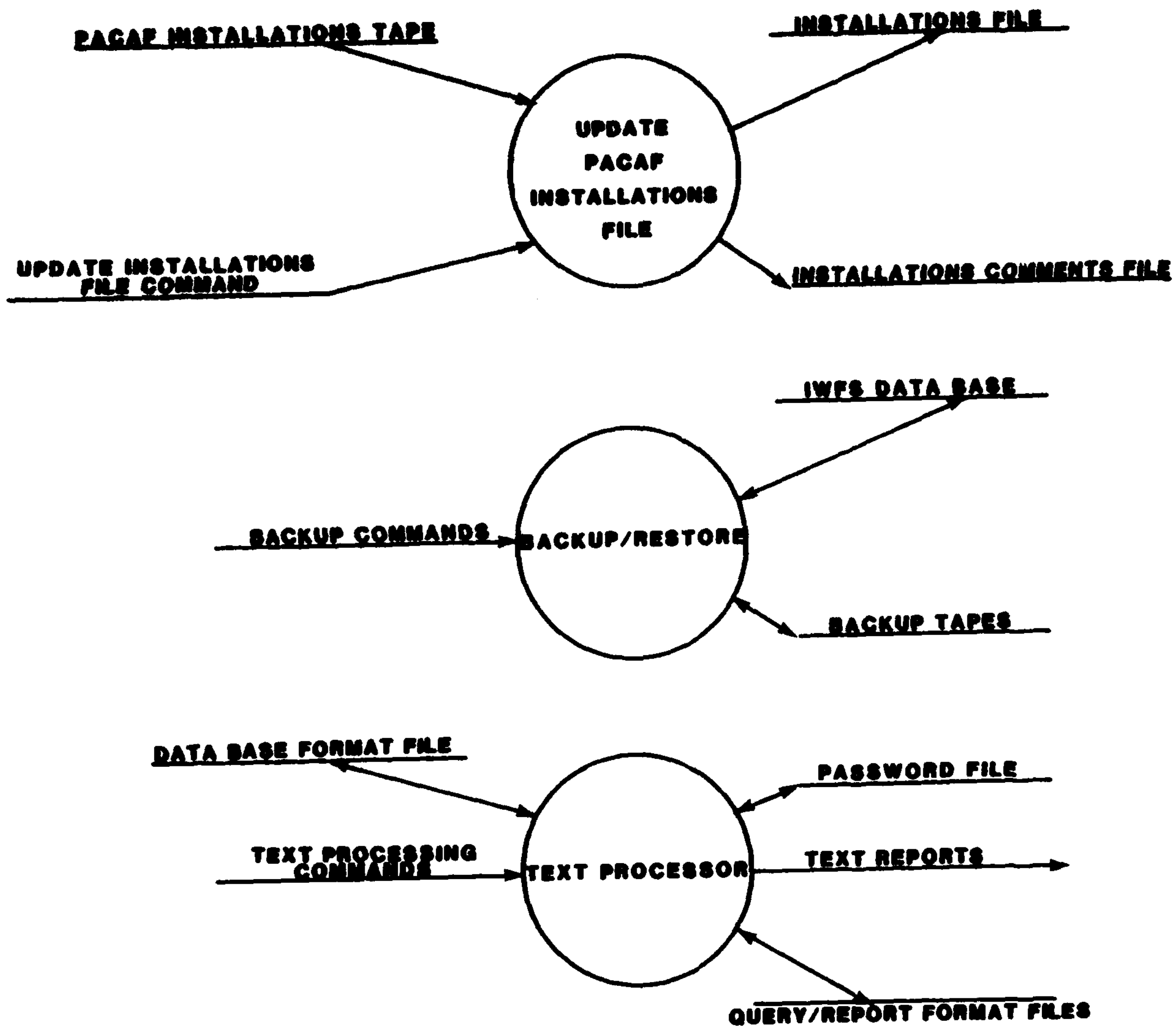


FIGURE 3-3
FILE PROCESSOR



FLIGHT FOLLOWING
FIGURE 3-4



UTILITIES
FIGURE 3-5

software.

As a result of the data flow analysis, the three IWFS subsystems shown in Figure 3-2 interact primarily through the IWFS data base files. Both the File Processor and Flight-Following subsystems accept user commands and input from support files and generate query/report data or display/track data. The Utilities subsystem accepts utility commands to produce updated support files and text reports.

The File Processor subsystem is divided into four components: 1) Access Data Base, 2) Query Data Base, 3) Maintain Data Base, and 4) Generate Reports. Access Data Base provides the data base interface for the other three components. User commands are input to Query Data Base, Maintain Data Base, and Generate Reports and the appropriate outputs, either query/report results or modified data base records, are generated.

The Flight-Following subsystem is divided into seven components: 1) Select Command, 2) Display Carto, 3) Display Overlay, 4) Display Menu, 5) Display Track, 6) Save Track Display, and 7) Restore Track Display. Select Command inputs the user command, checks for correctness, and generates appropriate error messages, then passes the command to the corresponding component to be processed. The display components update the screen display accordingly. Save Track Display writes the specified track's related information to the Flights data base file, while Restore Track Display reads the related track information from the Flights data base file and generates the track display on the screen.

The Utilities subsystem is divided into three independent components: 1) PACAF Installations File Update, 2) Backup/Restore, and 3) Text Processor. The PACAF Installations File Update component inputs the Installations tape and updates the data base file; the Backup/Restore Component creates or reads backup tapes or disks; the Text Processor component updates the IWFS format files and, also, generates text files and reports.

3.2 Implementation Phase

The Implementation Phase of the IWFS effort was started following the completion of the Analysis and Design Phase. In this phase, the system components specified in the IWFS Program Specifications, the Data Base Specifications, and Concept of Operations Manuals were coded and tested. The IWFS system's implementation was unique because a number of structured techniques were used to speed the software development and to ensure its correctness.

All software developed for the IWFS system was written in FORTRAN. The system implementation used a combination of two common software development techniques: "top-down" and "bottom-up" development. The IWFS system's implementation was also unique in that a majority of the coding and testing was cross-developed on a VAX-11/780.

3.2.1 *Top-Down/Bottom-Up Development*

Top-down development consists of writing code for the highest-level modules first, testing these modules together, and then proceeding to the lower-level modules. Bottom-up development consists of writing code for the lowest level modules first. Top-down development requires the use of "stubs" for testing; that is, empty modules are substituted for modules that are called by higher-level modules but that have not been coded yet. As coding proceeds, stubs are replaced by their coded counterparts. Top-down development allows the system to be coded and tested as a whole, but integral low-level modules are coded and tested last. When the lowest-level modules have been integrated, the system is, therefore, complete.

Bottom-up development, on the other hand, consists of writing the lower-level routines first, then writing and interfacing them to the next level's modules. Bottom-up development requires the use of "driver" programs to test the low-level modules. Testing is done in components and requires an integration phase once each component has been separately developed. Integration problems are often associated with bottom-up development.

Each of these methods has advantages and disadvantages. The combination of top-down and bottom-up development combines the positive aspects of both methods. Top-down development most closely resembles the structured design process described in Section 3.1.3. Systems can be broken down into components and continually refined and detailed. The problem with this method is that it is difficult to test the entire system effectively in a strictly top-down manner. To help counteract this, certain key low-level modules in any system can generally be identified and coded early in the development of a system. Such modules as data base access routines and user interfaces can be coded and tested, then interfaced with the top-level modules being developed. This allows the top-level modules, in fact, the entire system, to be tested more effectively and completely.

3.2.2 *VAX Cross-Development*

The development of the IWFS system was unique in that almost all of the software testing was done on a DEC VAX-11/780. The VAX programming environment provides significant advantages over that of the PDP-11/34 for a number of reasons. First, program development time on the VAX is reduced simply because the VAX central processing unit (CPU) is approximately seven times faster than the PDP-11/34 CPU. This means that the compilation, linking, and execution take less time. Since programs are recompiled and relinked frequently to test changes during the program debugging stage, processor speed can significantly increase programmer productivity by increasing the number of test runs a programmer can make while debugging.

VAX utilities are more powerful than those on the PDP 11; text editors, dump utilities, and debuggers are available on the VAX. For example, the VAX has a very powerful symbolic debugger for FORTRAN. A number of actions can be taken dynamically during program execution, including examining or changing the values of variables, controlling execution, displaying the execution hierarchy, and examining source code. Also, since the VAX is a virtual memory machine, there are no limits on program address space. A program can be developed on the VAX without concern about address limitations. Once the program has been debugged on the VAX, it can then be ported to the PDP-11/34 and modified as required to fit the limited 32K address space restriction. The resulting programming errors will probably be caused by the modifications needed to make it run on (interface with) the PDP-11. This distinguishes logic errors (that occur independent of the target machine) from PDP-11 interface errors. Logic errors, which must be solved regardless of the target machine for which the system is being implemented, are more easily found when address limitations are not a concern and a symbolic debugger is available.

All of the advantages described above allowed the IWFS system to be coded and tested in a much shorter time than would be possible if it were done solely on the PDP-11/34. The Implementation Phase culminated in the preliminary acceptance test (PAT) performed at PAR on 29 November 1982. The PAT was witnessed by RADC and AAC on 3 December 1982 and was documented as having been successfully completed.

3.2.3 *Operational Data Collection*

During the Implementation phase of the effort, AAC collected operational data in card, tape, and paper format and sent it to PAR for integration into the IWFS data bases. This data was processed with special-purpose programs that input machine-readable data (on cards or tape) and output it to the corresponding IWFS data base. Data that was generated by AAC on paper was manually entered into the data bases by PAR, using the File Processor.

Once all of the data was processed, a tape containing the classified portions of all of the data bases was made and mailed to Alaska in time for the installation effort. After the IWFS system was verified with test data, this tape was loaded onto the system for use in the analyst and operator training required by the contract.

3.3 Installation and Training

With the system coding and testing completed, the IWFS hardware was shipped to Alaska. This marked the start of the Installation and Training Phase. The IWFS system was installed in Alaska, and AAC analysts and operators were trained in its use and operation.

3.3.1 *System Installation*

During the time that the hardware was enroute to Alaska, the Computer Operations Manual and the Users Manual were written. Once the hardware arrived in Alaska, DEC was contacted to perform the hardware installation. Upon completion of the documentation and the installation of DEC hardware, PAR traveled to Alaska (with two peripherals) to complete the hardware installation and to verify the entire IWFS system (both hardware and software) against the approved Test Plan. This was done by performing the same tests done during the preliminary acceptance test and using the same test data.

Next, the tape containing the operational data processed at PAR was loaded onto the system. The system was then verified for correctness against the operational data, again to ensure integrity. With the operational data loaded onto the system, analyst and operator training could then begin.

3.3.2 *Training*

For convenience, AAC trainees were divided into two groups: analysts and operators. Nearly all of the training was done at the command console or the display terminals. Two groups of operators were trained. The primary training aid for operators was the Computer Operations Manual. Each item in the Operations Manual was covered, with operators performing the various functions. This gave them a better understanding of the descriptions in the manual. The RSX, Systematics General, and Tektronix reference manuals were also discussed as additional sources of information. To complete operator training, the operators were given total responsibility for system operations during the last week of the installation/training trip. This included doing system startup and shutdown, performing backups, fixing line printer paper jams, and doing general system monitoring. PAR was available for questions as needed. This ensured that the operators gained a complete knowledge of and control over the system and could respond to user requests during actual operation.

Analyst trainees were subdivided into two groups: watch analysts and intelligence analysts. The watch analysts were trained in the use of Flight Following and intelligence analysts were trained in the use of the File Processor. Some intelligence analysts learned both systems, but most only required knowledge of the File Processor. Watch analysts were briefly shown the File Processor and how some of its functions could be applied to their mission. Analyst training also made use of "hands-on" experience. As part of the training sessions, operational conditions were simulated to show analysts how to respond to those situations. The quick-reference cards, the on-line help features, and the Users Manuals for both systems were discussed as additional sources of information.

Since both systems are quite simple to use and provide extensive help facilities, the initial training sessions merely acquainted the users with the basic functions. The users who were trained were generally familiar with computers, but most had not actually used one. The first step was to indoctrinate the analysts with using computers. Once they felt comfortable with sitting at a display terminal and interacting with the computer, a particular operational problem tailored to their mission was presented and a solution was outlined using the IWFS system. This gave the analysts some familiarity with the particular functions performed by the system and how it could be used as a tool in solving intelligence problems. For watch analysts, a test flight track was input using various flight-following commands and display backgrounds. Differences were pointed out between the training environment and the operational environment. For intelligence analysts, a specific data requirement was given and they queried the appropriate files to determine the answer. Data base maintenance functions were demonstrated by actually entering and updating operational data as required during the training period.

Once the analysts and operators had received their initial training, they were encouraged to use the system as frequently as possible without a training aid. User's comments on system functions and system performance were noted and discussed. Approximately ten intelligence analysts and seven operators, representing various AAC agencies, were trained during the one-month training session.

4. *RELIABILITY/MAINTAINABILITY ANALYSIS*

This section contains a detailed analysis of the reliability and maintainability of the IWFS system hardware. The reliability analysis presented in Section 4.1 was performed in accordance with MIL-STD-756A, "Military Standard Reliability Prediction," and the maintainability analysis presented in Section 4.2 was performed in accordance with Procedure IV of MIL-STD-472, "Maintainability Prediction." This section satisfies contract Data Item A010.

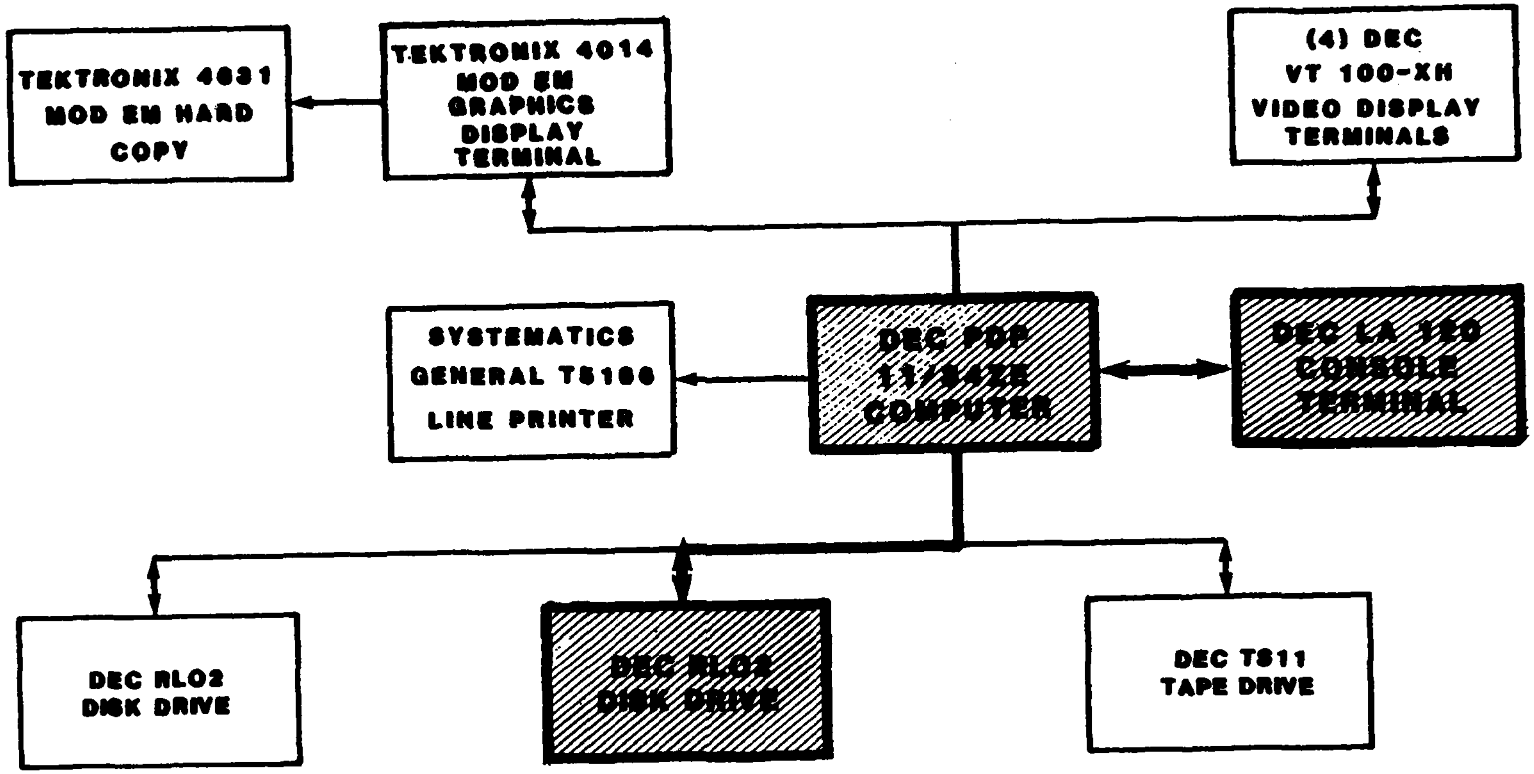
Some of the data presented in this section describe the failure rates of the IWFS equipment. This data was obtained by telephone conversations with the appropriate vendor representatives and was compiled from field service and PAR experience records. These statistics in no way obligate the vendors nor do they imply product specifications.

4.1 Reliability Analysis

The reliability analysis presented here assumes a ground-benign facility (laboratory or computer room) that met the site preparation requirements at the time the equipment was installed. Any deviation from the vendor-allowable environment requirements will most likely increase the failure rate. A reliability model will be established in terms of equipment mean-time-between-failure (MTBF) and is based on vendor-experienced failure rates. This model will be used to predict the reliability of the three IWFS operating modes as well as the reliability of the entire system. A comparison will be made between the industry-experienced reliability statistics and the actual IWFS-experienced reliability statistics. From this comparison, the total IWFS system hardware reliability will be predicted.

4.1.1 *Reliability Model*

A block diagram of the IWFS system is shown in Figure 4-1. The PDP-11/34 computer, RL02 disk drive, and LA120 console terminal are critical components (shown



IWFS SYSTEM BLOCK DIAGRAM

FIGURE 4-1

as bold) and all must function properly for the system to operate properly. Three alternate modes of operation exist in the IWFS system. They are the File-Processing mode, the Flight-Following mode, and the utilities mode. The Systematics General line printer and Tektronix hardcopy unit are not critical to the operability of the alternate modes but are useful in support of the file processing or flight following functions. Only one disk drive is required for the operating system, but both drives are required for file processing and flight following. Both disk drives are required if a disk backup/recovery is to be performed, but only one disk drive and the tape drive are required if a tape backup/recovery is to be performed.

The part failure rates of each of the components of each of the functional blocks are assumed to be independent and constant over time. Thus, the exponential failure law can be applied, allowing the summation of component failure rates to approximate the total failure rate. The model is represented as:

$$\lambda_t = \sum_{i=0}^{n} \alpha_i \lambda_i \qquad (1)$$

where:

λ_t = *Function failure rate (failure / year)*

λ_i = *Failure rate* for *the i^{th} function component* $\left(2500 \ \frac{hours / year}{MTBF \ hours}\right)$

α_i = *operating times* $0 \le \alpha_i \le 1$

n = *number of system components*

4.1.2 *Functional Block Reliability*

The functional block reliability is given in Figure 4-2. For each block shown in Figure 4-1, Figure 4-2 gives the vendor's MTBF, the % operating times, and PAR's source of information. Component failure rates per year were computed based on a 2500-hour operating year: that is, 5 days a week, 10 hours per day for 50 weeks. Failure rate is then 2500 hours divided by the MTBF (in hours.)

Block	Vendor MTBF (Hrs)	% Operating Time	Information Source/Date
DEC PDP-11/34 Computer	2028	1.0	DEC verbal (Barry Pardee) - 20 April 83
DEC LA120 Console Terminal	3942	0.1	"
DEC RL02 Disk Drive	5033	1.0	"
DEC TS11 Tape Drive	2000	0.1	"
DEC VT100 Video Terminal	8000	1.0[1]	"
Systematics General Line Printer	5000	1.0	Systematics General verbal (Bill Carrol) - 20 April 83
Tektronix 4014 Graphics Terminal	4680	0.75	Tektronix verbal (Bill Murray) - 4 May 83
Tektronix 4631 Hardcopy	2583	0.5	"

[1] On the average, any single terminal operated at 0.25

Figure 4-2 Functional Block Reliability Statistics

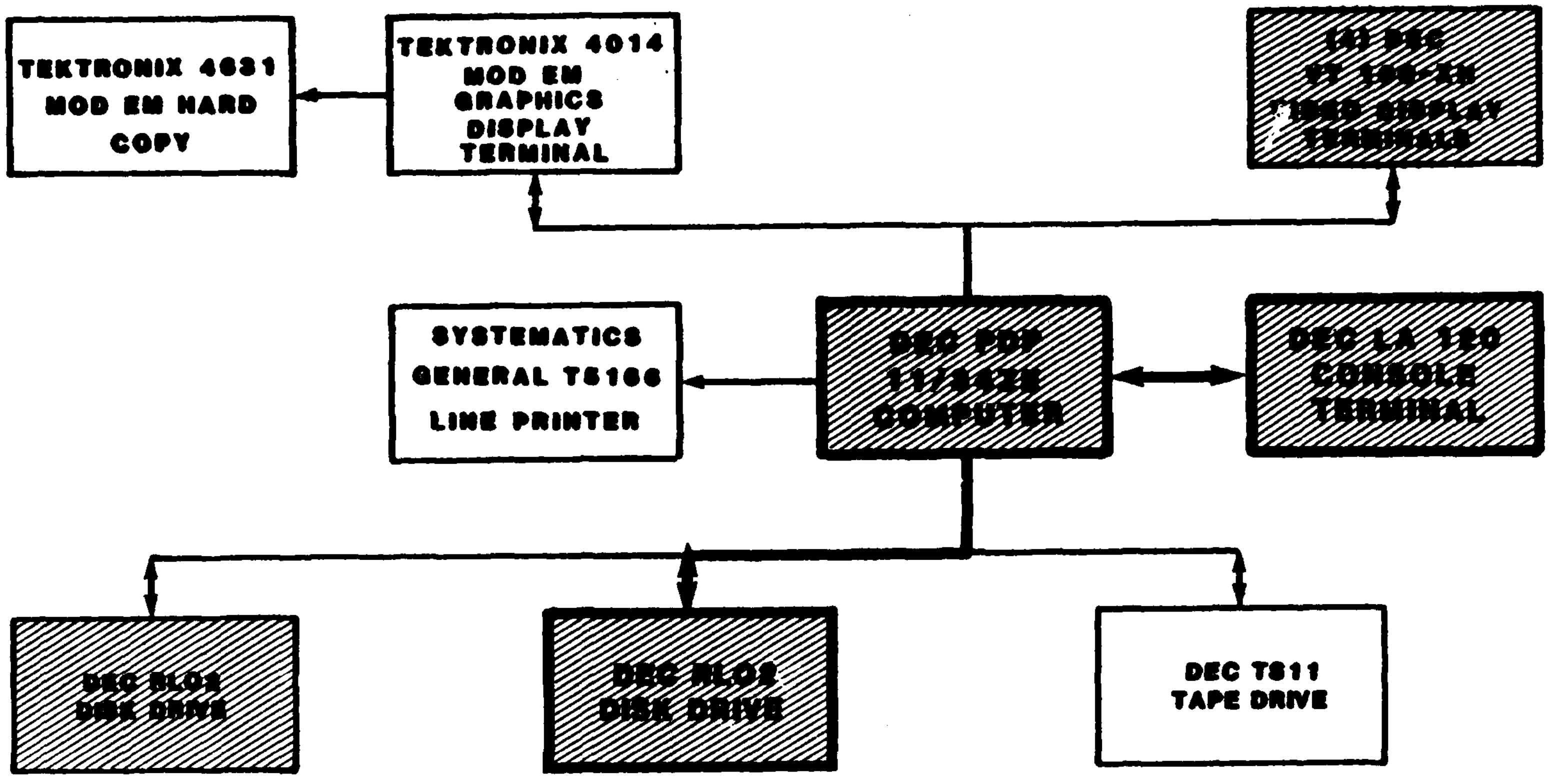
4.1.3 *Alternate Modes Reliability*

As mentioned previously, the IWFS system has three alternate modes of operation. Considering the alternate modes' reliability is important when comparing them to the overall system's reliability, since none of the alternate modes require all the components of the entire system to be operative at the same time. The reliability measure will be computed for each of the three alternate IWFS operating modes, using both vendor-supplied and observed MTBF figures.

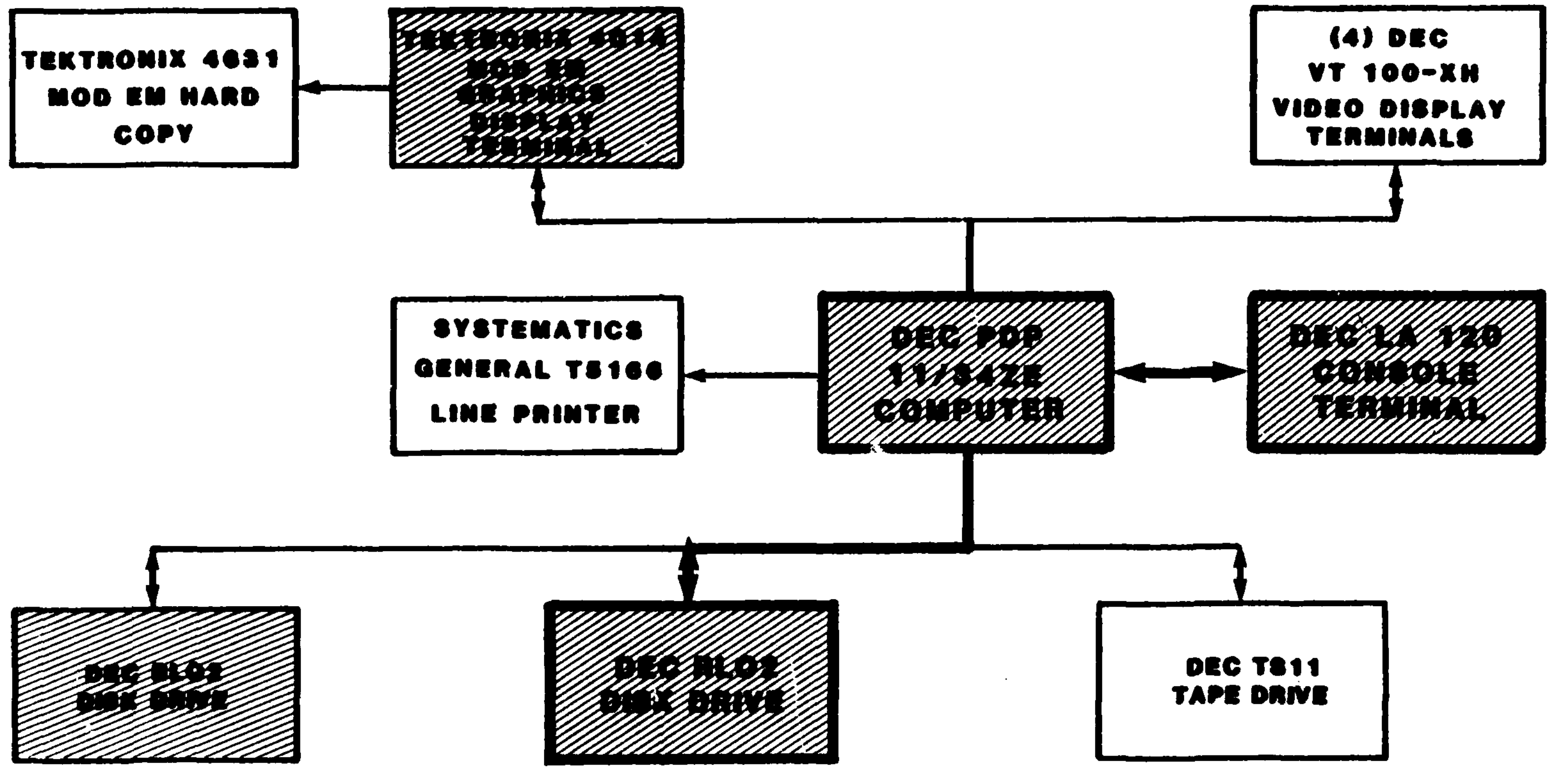
The critical hardware components for the File-Processing mode are shown shaded in Figure 4-3. The Systematics General line printer supports the File-Processing mode in the generation of hardcopy queries and reports, but is not essential to its operation. Using equation (1) in Section 4.1.1 and computing λ_t using the vendor-supplied MTBF figures from Figure 4-2 for the file-processing mode's critical components yields 637 hours. This number is a low estimate, since the File-Processing mode possesses redundancy in the form of four VT100 display terminals. Given the vendor's MTBF figures, it is reasonable to assume that the probability of all four VT100 terminals being inoperative at the same time is near zero. The MTBF factor for the VT100 then drops out, yielding 1047 hours. This figure is perhaps a more realistic estimate of the File-Processing mode's reliability.

The critical hardware components for the Flight-Following mode are shown shaded in Figure 4-4. The Tektronix hardcopy supports the Flight-Following mode in the generation of hardcopies of flight-following displays, but it is not essential to the mode's operation. Using equation (1) to compute λ_t using the vendor-supplied MTBF figures from Figure 4-2 for the Flight-Following mode's critical components yields 898 hours.

The critical hardware components for the utilities mode are shown shaded in Figure 4-5. Of the Utilities submodes, only the tape backup/recovery submode requires the use of the tape drive. In the case of the password update utility, the critical hardware components and a VT100 are required, and λ_t is the same as for file processing. For the Installations file update utility, only the critical IWFS hardware

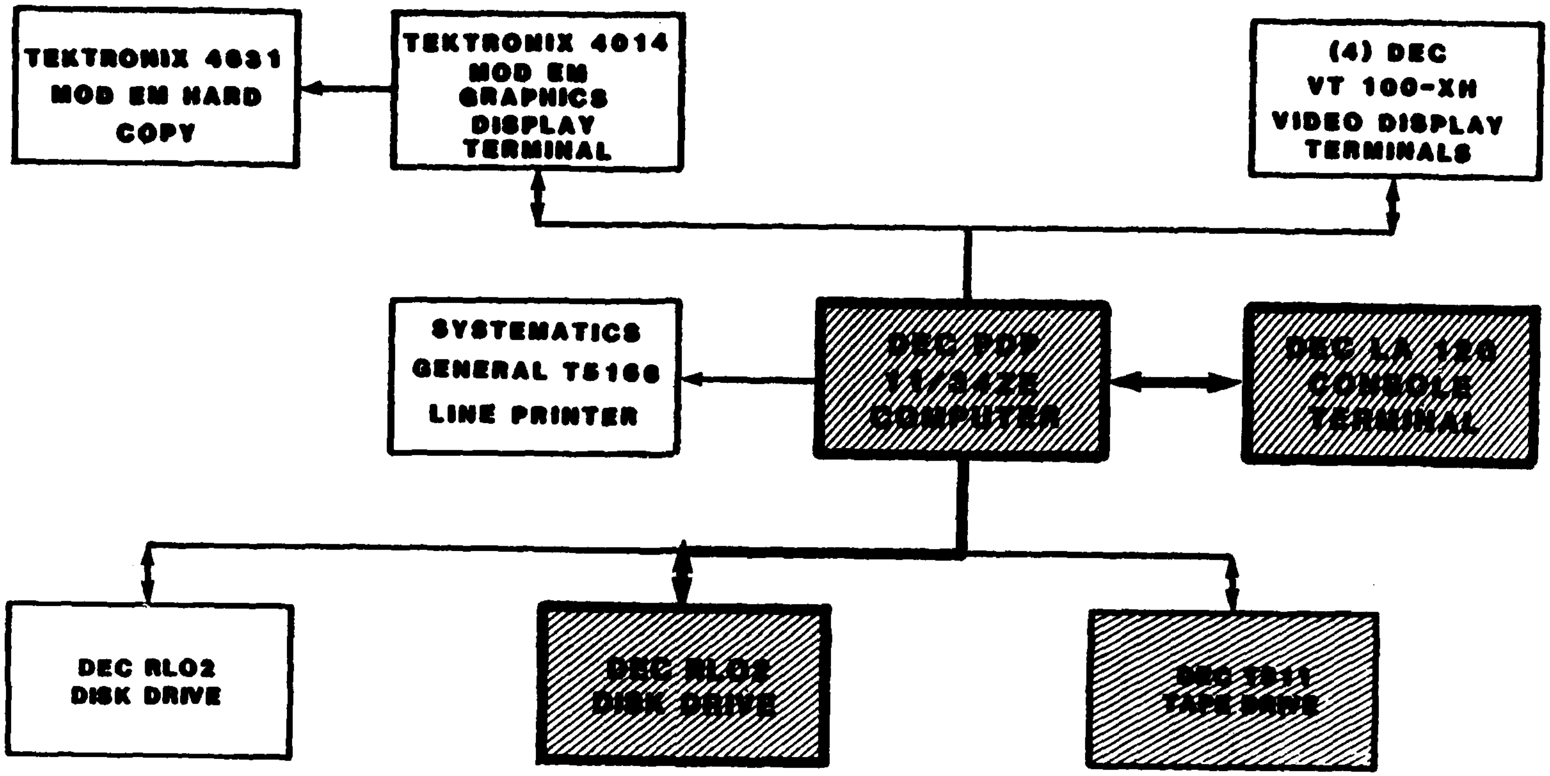


FILE PROCESSOR MODES CRITICAL HARDWARE COMPONENTS
FIGURE 4-3



FLIGHT FOLLOWING MODES CRITICAL HARDWARE COMPONENTS

FIGURE 4-4



TAPE BACKUP/RECOVERY SUBMODES CRITICAL HARDWARE COMPONENTS

FIGURE 4-5

components are required; thus λ_t is 1047 hours. Computing λ_t for the tape backup/recovery utility yields 1242 hours.

4.1.4 *System Reliability*

Once the functional blocks of the IWFS system were identified and their reliability computed, the entire system's reliability could be computed. With equation (1) in Section 4.1.1, computing λ_t using the vendor-supplied MTBF figures yields 594 hours. This estimate is based on the assumed operating times of all system components (critical or otherwise.)

As one can see, the reliability of the entire IWFS system is lower than the reliabilities of the three alternate modes. The tape backup/recovery submode is the most reliable, primarily because of the few components involved in its operation. Flight-Following has the lowest alternate-mode reliability because it does not have the redundant terminals that the File-Processing mode has. Because of its importance to flight-following, the Tektronix graphics terminal is a key component.

PAR experienced a higher mean-time-between-failure rate than those supplied by the vendors. At the rate quoted above, the system can be expected to operate (on the average) for two months without a failure. One can also see that the alternate modes have a higher reliability: on the order of three to four months. Actual equipment reliability is, of course, related to the operating environment, the operating procedures, and the preventive maintenance schedule.

4.2 Maintainability Analysis

Maintainability, in the context of the IWFS hardware, will be defined as the mean time that some critical component, required by one of the three alternate operating modes, will be down for maintenance. This maintenance includes both preventive and corrective maintenance, since both affect the system's operability. The maintainability measure parameters will be identified, and the system's end items will be listed, along with their MTBF figures and failure/recovery status. Finally, the preventive and corrective maintenance task times will be analyzed.

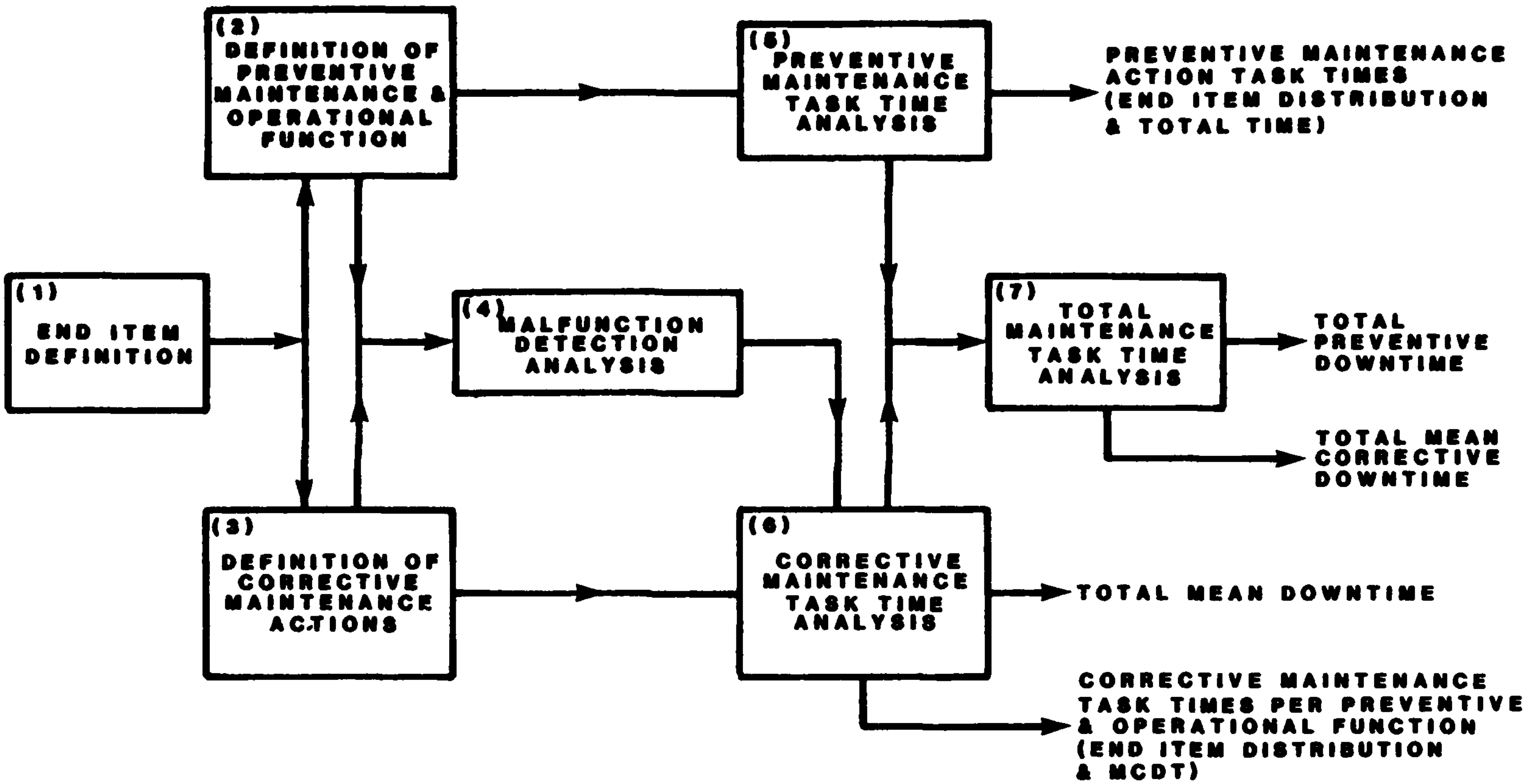
4.2.1 *Parameter Identification*

The IWFS system is made up entirely of commercially available equipment built to industry standards. Although most of the equipment has been TEMPEST certified, the basic hardware elements are identical to non-TEMPEST equipment. Special TEMPEST cabinetry was designed to contain the standard hardware components. Considerable data was gathered on the field maintainability of this equipment. The end item is to produce a compilation of these observations that will enable an accurate estimate of the total system downtime.

The basic failure rate parameters that will be used to measure system maintainability are:

- mean system maintenance downtime (including the total yearly downtime estimate)
- mean corrective downtimes in an operational period
- total corrective downtimes in an operational period
- total preventive maintenance downtime per operational period.

Figure 4-6, from MIL-HDBK-472, shows the procedure flow for establishing these figures. The procedure begins by defining the system end items (1). End items are the major equipment components that can be considered to be independent with respect to the other equipment components. Operational functions are then defined as those integral functions that the system performs and, also, the equipment associated with each function (2). Preventive and corrective maintenance actions (2 and 3) are defined for the system. Malfunction detection analysis (4) is performed to determine the corrective maintenance task times. The total preventive (5) and corrective maintenance (6) task times can be computed for each operational function, yielding



PROCEDURAL FLOW BLOCK DIAGRAM
FIGURE 4-6

the total maintenance task time (7) in terms of the total preventive, malfunction detection, and corrective maintenance task times.

4.2.2 *Equipment Configuration and End Item Identification*

Figures 4-7 and 4-8 show the system configuration's front and top views, respectively. These diagrams show that each piece of equipment presents no maintenance accessibility problem.

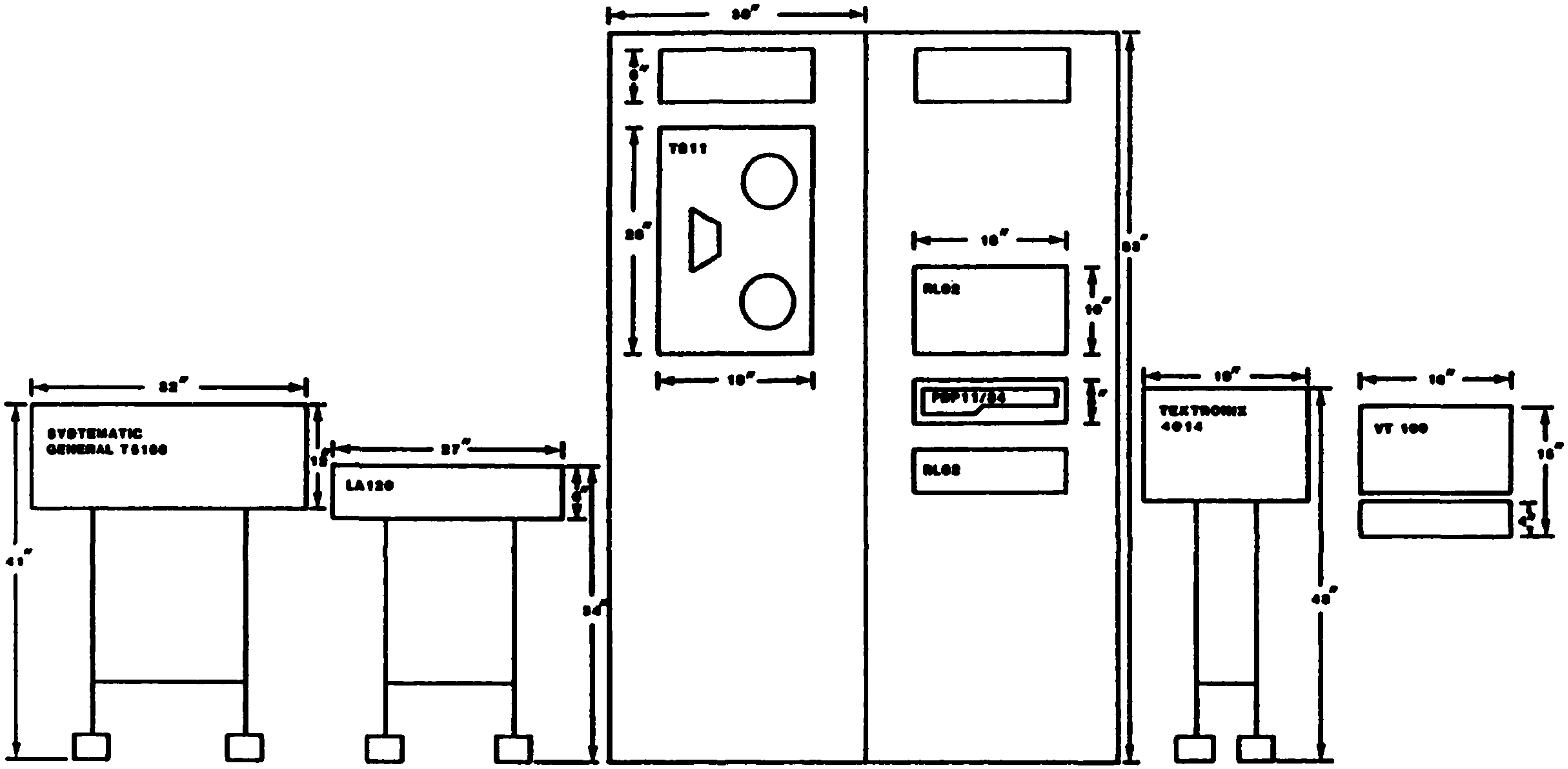
Figure 4-9 lists each end item derived from the block diagram in Figure 4-1, along with its predicted number of failures per year, preventive maintenance requirement, and failure/recovery status. The MTBF figures were obtained from the appropriate vendors. Predicted failures per year are based on a worst-case operating time of 2500 hours per year on all components, based on a 5-day, 10-hours-per-day operating cycle for 50 weeks. Thus,

$$failures\ per\ year\ (\lambda) = \frac{2500\ hours/year}{MTBF\ (hours/failure)} \tag{2}$$

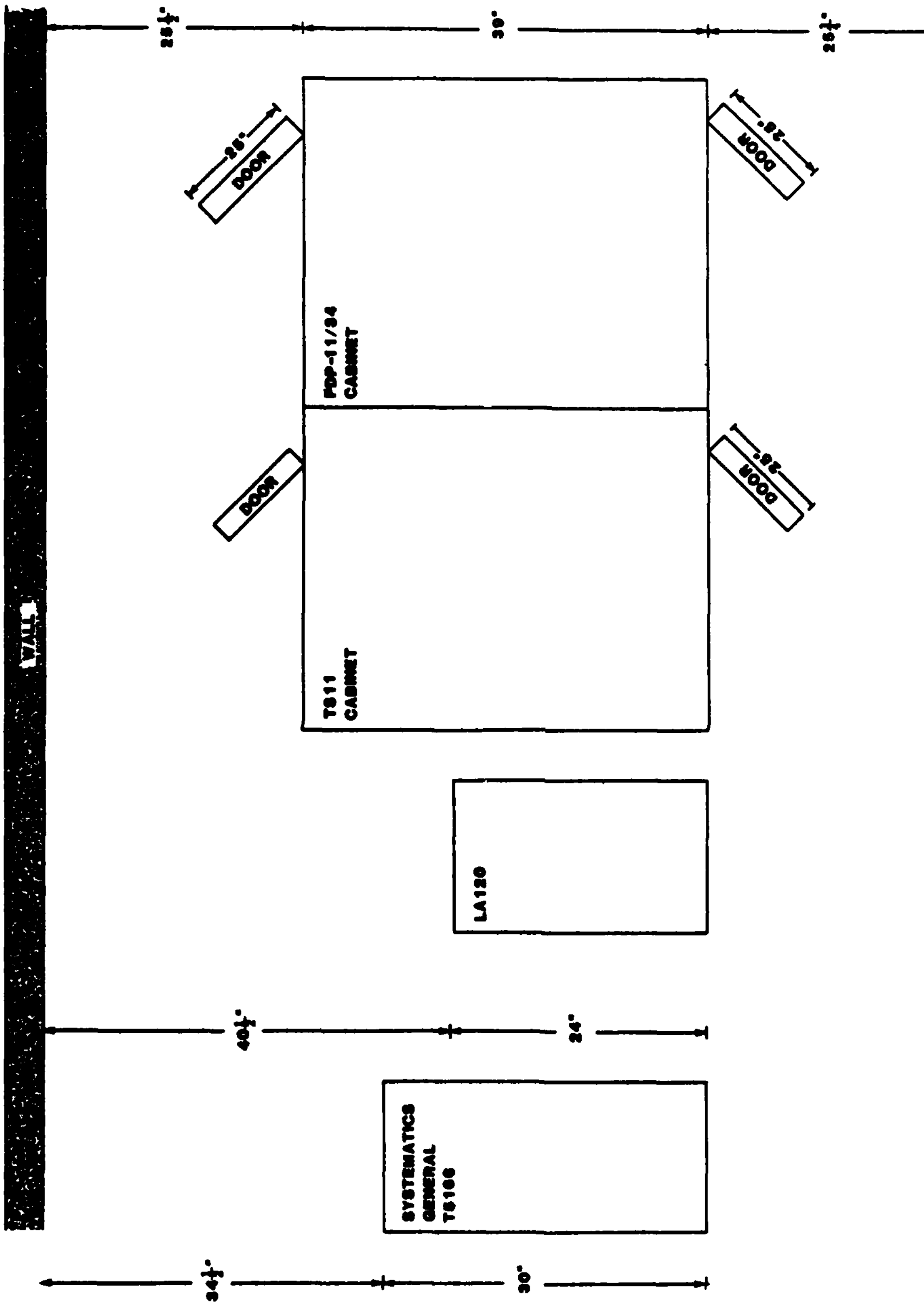
4.2.3 *Operational Functions*

An operational function of the IWFS system is one that produces a useful result. For example, file processing is an operational function that allows the user to interrogate the IWFS data bases and, then, to display the resultant information in various ways. The downtime of a particular end item for preventive maintenance has an effect on an operational function.

Figure 4-10 defines the seven operating functions of the IWFS system and Figure 4-11 shows the preventive maintenance task-time analysis on the basis of the individual equipment end items. The end item equipments are categorized on the basis of:



IWFS HARDWARE CONFIGURATION (FRONT VIEW)
FIGURE 4-7



IWFS HARDWARE CONFIGURATION(TOP VIEW)

FIGURE 4-8

End item Description	MTBF (Hrs)	Failures/ year (λ)	Prev. Maint.	Failure Status	Recovery Procedure
DEC PDP-11/34	2028	1.23	Yes	Fatal	Repair
DEC LA120	3942	1.58	No	"	"
DEC $RL02_1$	5033	0.5	Yes	"	"
DEC $RL02_2$	5033	0.5	"	Non-Fatal	Use I_3 disk
DEC TS11	2000	1.25	"	"	Repair
DEC $VT100_1$	8000	0.31	No	Non-Fatal	Use another VT100
DEC $VT100_2$	8000	0.31	"	"	"
DEC $VT100_3$	8000	0.31	"	"	"
DEC $VT100_4$	8000	0.31	"	"	"
SG T5166	5000	0.5	Yes	"	Generate queries
Tektronix 4014	4680	0.53	No	Fatal	Repair
Tektronix 4631	2583	0.97	"	Non-Fatal	Plot tracks on paper

Figure 4-9 End Item Description

Operation	Description	Required Items
O_1	File-processing - including data base query, report, maintenance, text editing, and hardcopy capabilities	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $RL02_2$, DEC $VT100_1$, SG T5166
O_2	Flight-following - including track display, update, store, recall, and hardcopy generation capabilities	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $RL02_2$, Tektronix 4014, Tektronix 4631
O_3	Tape backup/recovery	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC TS11
O_4	Disk backup/recovery	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $RL02_2$
O_5	Installations file update utility	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $RL02_2$, DEC TS11
O_6	Password update utility	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $VT100_1$
O_7	Program development	DEC PDP-11/34, DEC LA120, DEC $RL02_1$, DEC $RL02_2$, DEC TS11, DEC $VT100_1$, SG T5166, Tektronix 4014, Tektronix 4631

Figure 4-10 IWFS System Operational Functions

End Item	PM Elapsed (Hrs)(no malfunctions)	Elapsed time to correct (Hrs)	Corr. Maint. Action	PM freq/ year (Mths)	Total yearly PM downtime (Hrs)(no malfunctions)	Estimated Maint. downtime/ year (Hrs)
DEC PDP-11/34	1.0	8.0	Service	12	12.0	9.84
DEC LA 120	0.1	1.0	"	3	0.4	1.58
DEC RL02$_1$	0.5	4.0	"	12	6.0	2.0
DEC RL02$_2$	0.5	4.0	"	12	6.0	2.0
DEC TS11	0.5	8.0	"	12	6.0	10.
DEC VT100$_1$	0.1	1.0	"	3	0.4	0.31
DEC VT100$_2$	0.1	1.0	"	3	0.4	0.31
DEC VT100$_3$	0.1	1.0	"	3	0.4	0.31
DEC VT100$_4$	0.1	1.0	"	3	0.4	0.31
SG T5166u	0.1	4.0	"	3	0.4	2.0
Tektronix 4014u	0.1	4.0	"	3	0.4	2.12
Tektronix 4631u	0.1	2.0	"	3	0.4	1.94

Figure 4-11 Distribution of PM Task Times

- Elapsed time to perform Preventive Maintenance (PM), assuming that there is no detectable malfunction
- Elapsed time to correct malfunctioning end items during PM
- Corrective maintenance actions
- Frequency of PMs per year
- Total yearly downtime for PM
- Maintenance downtime based on MTBF figures

Total system operation requires all twelve end items to be functional. Each item is covered under a service contract, so the appropriate vendor would be contacted to fix malfunctions. The estimated maintenance downtime for the equipment depends upon its frequency of use and the operating procedures. The more complicated or difficult-to-adjust hardware components such as the PDP-11/34 and TS-11 tape drive require more expenditure of time to properly diagnose and fix malfunctions (as seen in Figure 4-11). The terminals and the line printer do not require significant PM, but they do require periodic cleaning to ensure proper working order. These end items were nominally given a PM time (with no malfunctions) of 0.1. The frequency and time associated with the maintenance of these equipments depends on their usage patterns and on environmental conditions.

4.2.4 *Preventive Maintenance Task Time Analysis*

The probable system downtime due to preventive maintenance for the entire IWFS system can be represented as the sum of all end items' maintenance task times. This is given by the equation:

$$PDT_m = \sum_{i=1}^{12} TI_i \qquad (3)$$

where:

PDT_m = *Probable downtime* for *PM on a yearly basis (from Figure* 4−11)

TI_i = *Task time preventive maintenance for end item* I_i

Using equation (3), the total preventive maintenance downtime is 33.2 hours out of a 2500-hour operating year. This is equal to the system being down approximately three operating days per year as a result of preventive maintenance tasks.

4.2.5 *Corrective Maintenance Task Time Analysis*

Corrective maintenance task time is the time it takes to isolate a malfunction, whether it occurs during preventive maintenance or during an operational function. This time may be described as:

$$PDT_c = (\sum T_{si}) + T_{ci} + T_{vi} \qquad (4)$$

where:

PDT_c = *Probable downtime to correct malfunctions in the* i^{th} *component*

T_{si} = *Time to isolate a problem in the* i^{th} *component during an operational function*

T_{ci} = *Repair time*

T_{vi} = *Verification time*

For repair during PM, PDT_C is the time to correct malfunctioning end item *i*. During an operational function, PDT_C is the time to troubleshoot and correct the malfunctioning end item *i* while an operational function is being performed. Since the verification of a change to an end item is rather simple and can be done by performing the appropriate operational function, time T_{vi} is negligible. Thus, from equation (4), PDT_C is computed as 30.78 hours per year.

4.2.6 *Total Maintenance Task Time Analysis*

Using the results of the previous sections, the total preventive and corrective maintenance downtimes can be summarized as well as the mean corrective downtimes. These figures are based on the MTBF figures of the end item components and associated downtimes.

From the end item downtime values in Figure 4-11, the total yearly downtimes can be computed as the sum of the preventive maintenance and corrective maintenance downtimes. Figure 4-12 contains a summary of the yearly downtime estimates, both preventive and corrective, for the entire system. The probable downtime of the entire system (PDT_t) is equal to the sum of the downtimes for PM and for operational failures. From the previous two sections:

$$PDT_t = PDT_p + PDT_c \qquad (5)$$

where:

PDT_t = *The probable downtime of the entire system*

PDT_p = *The probable downtime* for *PM*

PDT_c = *The probable downtime* for *corrective maintenance*

The mean-corrective-downtime of the system (MCDT) is represented by:

$$MCDT = \frac{PDT_t\ (\text{Total system downtime in hours})}{\sum_{i=1}^{12} \lambda_i\ (\text{Total failures per year})} \qquad (6)$$

Since MTBF figures were used to compute PDT_t:

$PDT_t = 33.2 + 30.78 = 63.98$ and

$\sum_{i=1}^{12} \lambda_i = 7.33$

thus:

End Items		Maintenance Actions (per year)		Operational Functions (Prev. + Corr.)						
I_i	λ_i	Prev.	Corr.	O_1	O_2	O_3	O_4	O_5	O_6	O_7
DEC PDP-11/34	1.23	12.0	9.84	21.84	21.84	21.84	21.84	21.84	21.84	21.84
DEC LA120	1.58	0.4	1.58	1.98	1.98	1.98	1.98	1.98	1.98	1.98
DEC $RL02_1$	0.5	6.0	2.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
DEC $RL02_2$	0.5	6.0	2.0	8.0	8.0		8.0	8.0		8.0
DEC TS11	1.25	6.0	10.0			16.0		16.0		16.0
DEC $VT100_1$	0.31	0.4	0.31	0.71					0.71	0.71
DEC $VT100_2$	0.31	0.4	0.31							
DEC $VT100_3$	0.31	0.4	0.31							
DEC $VT100_4$	0.31	0.4	0.31							
SG T5166	0.5	0.4	2.0	2.4						2.4
Tektronix 4014	0.53	0.4	2.12		2.52					
Tektronix 4631	0.97	0.4	1.94	2.37						
Totals	8.3	33.2	30.78	45.3	23.34	47.82	39.82	55.82	32.53	56.53

Figure 4-12 System Yearly Downtime Estimate

$$MCDT = \frac{63.98}{7.33} = 8.73 \ hours$$

This downtime corresponds to a loss of approximately one operating day for PM-related functions. The equation deriving the MCDT for the operating functions O_i (including both preventive and corrective) is:

$$MCDT_{O_i} = \frac{\sum_{i=1}^{12} PDT_{O_i}}{\sum_{i=1}^{12} \lambda_{O_i}} \qquad (7)$$

The derived MCDT figures for the seven operating functions are:

O_1 = 6.48,
O_2 = 5.38,
O_3 = 10.49,
O_4 = 10.45,
O_5 = 11.03,
O_6 = 8.99, and
O_7 = 9.63.

5. *OPERATIONAL IMPACT*

The IWFS system will have a significant effect on Alaskan Air Command intelligence operations. It is AAC/IN's first stand-alone computer-automated information system. How the IWFS system affected the operations of the Alaskan Air Command is important not only in evaluating its effectiveness but also in determining its impact on other small I&W facilities as well.

This section will discuss the ways in which intelligence processing was changed by the IWFS computer. Its impact on the computer operations will be covered, as well as its effect on the watch analysts, the intelligence analysts, and the support personnel.

5.1 COMPUTER OPERATIONS

During the Installation and Training Phase of the IWFS effort, eight computer operators were trained in the operations of the PDP-11/34 computer. During that time, and to the end of the effort, operators manned the system during normal duty hours. Structured training sessions were held for an hour a day, four days a week, for three weeks. Impromptu questions were answered by using the computer when possible.

Primary operator functions involve bringing up the computer before the intelligence analysts arrive in the morning and overseeing the computer's operation. Daily disk backups are done on a rotating basis to protect intelligence information from hardware failures. Weekly tape backups are done as an alternate backup medium.

Operators are also responsible for replacing the paper supplies of the line printer, hardcopy console terminal, and graphics hardcopy device. They respond to unscheduled operations requirements such as correcting paper jams, enabling or disabling, updating passwords, updating access lists, and mounting/dismounting tapes and disks. In addition to the unscheduled operations functions, operators monitor system utilization. Audit trail output is reviewed for security violations, identification of potential problems, and system usage patterns. Disk integrity is checked periodically and disk usage is monitored and controlled.

Currently, the system requires about 10 hours a day, 5 days a week, of operator monitoring. Only one operator at a time is needed to operate and monitor the computer. The computer system does not require large amounts of the operator's attention, so he can manage other systems at the same time. In the future, the system is expected to be in operation 24 hours a day. This will require 24-hour operator coverage, which will affect scheduling. After normal duty hours, the operator will be required to respond to watch analyst problems that may occur during critical flight-following periods or during Intelligence research efforts.

5.2 WATCH ANALYSTS

Five watch analysts were trained in the use of the flight-following system during the Installation and Training Phase of the IWFS effort. Training sessions varied in length from an hour to four hours at a time, depending on particular operational requirements. Most watch analysts only received two or three formal training sessions.

When the flight-following system was instituted operationally, it had a greater effect on the watch analysts than on any other group. Previously teletype track information was transcribed onto a large map. Depending upon the situation, the map became cluttered and inaccurate during periods of high activity. Along with plotting track coordinates, watch analysts organized teletype information, reviewed message traffic, and hand-converted GEOREF track coordinates to latitude-longitude. In contrast, the flight-following system allows the watch analyst to enter the track coordinates directly without having to plot tracks manually on a map. GEOREF coordinates are automatically converted to latitude-longitude and displayed on the screen along with the track points and times.

5.3 INTELLIGENCE ANALYSTS

Ten intelligence analysts were trained in the use of the file-processing system during the IWFS Installation and Training Phase. Training sessions depended upon analyst availability and lasted no longer than two to three hours. Analysts were first shown the basic functions of the file-processor, then how to solve an operational problem. Because of the variety of data stored in the IWFS data bases, the file-processor's impact on the intelligence personnel was varied.

Of primary importance to AAC personnel was the need to obtain a stand-alone processing capability, specifically one containing the installation information in AAC's area of interest. Previously, this information was maintained at PACAF and was accessible to AAC through unreliable batch communications. The IWFS system provides access to installations information sent to AAC on tape from PACAF. If communications between Alaska and the continental United States were cut off during wartime, this backup source of information would still allow AAC to function effectively with the latest PACAF installations tape.

Another main function performed by AAC is the analysis of flights flown against Alaska. Previously, hardcopy teletype information on flight tracks was plotted manually. This information was later analyzed, and a refined track showing major turn points was again manually plotted and filed. Analysts compiled notebooks of information pertaining to previous flight activity. With the IWFS system, all flights will have the raw track data displayed automatically and the Flights file updated. The intelligence analyst can restore any track from the Flights file and can compare various tracks displayed on the graphics terminal. He can also extract flight tracks that satisfy various historical parameters. A correlation of these flights can be compared by plotting them on the graphics terminal. This automatic retrieval of information will save the analyst from manually searching hardcopy records. It also eliminates the possibility of misfiled information, making his analysis more accurate with less "busy work." Eliminating the manual steps associated with analysis will provide the analyst with more time to investigate new areas of related intelligence information.

5.4 SUPPORT PERSONNEL

The IWFS file-processing system also provides automatic processing of such items as personnel security clearance information, code-subject cross references, and intelligence library documents. Information can be extracted from appropriate data bases, and the formatted information can be displayed at the video terminal or on the line printer. For example, personnel security clearance information is maintained easily and automatically, and hardcopies can be generated for information such as access, roster, data returned from overseas, duty, and access reindoctrination dates. For the intelligence library, relevant document information can be displayed based on related intelligence product codes, subject, title, data entered, and date produced. An automatic accessions list is also maintained.

A text editor is provided with the IWFS system to allow analysts and support personnel to do limited text processing. Text files can be maintained by each user for internal communications. These files can be easily updated and reprinted without costly retyping.

6. *SUMMARY*

The IWFS effort, as summarized in this report, was successful in its objective of developing a computer-automated information processing system for the Alaskan Air Command. The Alaskan Air Command is typical of small, mission-oriented I&W facilities that can benefit greatly by an easy-to-operate, easy-to-maintain, and easy-to-use computer. With this computer, AAC personnel will be able to process a larger amount of intelligence data with greater efficiency and less effort than they could manually. The system supports their primary mission objective. It has proven its applicability to the data processing requirements of small I&W facilities and could easily be installed elsewhere.

The emphasis of this effort was on providing a stand-alone processing capability that minimizes the training impact on a small organization. A PDP-11/34 processor was chosen for its easy operability while providing sufficient data handling capabilities to satisfy I&W operational requirements. The IWFS system as designed to be user-friendly, with a detailed help and error-detection facility and good screen organization. Its development was aided by cross-developing the software on a VAX-11/780 so that code could be developed faster with fewer errors. In addition, developing the system prior to installation, as opposed to on-site, maximized productivity while minimizing on-site impact. The achievements of the IWFS effort are summarized below:

- Provided Alaskan Air Command with a stand-alone intelligence data processing capability.
- Provided detailed intelligence information to infrequent, as well as expert, computer users with an easy-to-use system.
- Required minimal manpower to operate and to use.
- Provided a flexible implementation that can easily be changed or expanded.

- Produced the hardware in support of NACSEM 500 Standards.

- Produced the software security in support of DIA manual 50-4.

- Cross-developed the IWFS applications software on a DEC VAX-11/780.

The IWFS system employed some special features to enhance its user-friendliness. These features include:

- Small number of commands to remember

- Self-instructive

- Extensive help facility

- Good screen organization

- Use of special *terminal* features

- Fast initial user response

- Accurate response to errors

7. *FUTURE ENHANCEMENTS*

As a result of the IWFS effort, some enhancements to the Alaskan Air Command computer processing capabilities have been suggested. Some of the resulting comments related specifically to the IWFS system, others to the overall processing capabilities of AAC. Now that AAC's stand-alone processing requirements have been satisfied, other requirements have surfaced to further enhance the intelligence processing capabilities.

7.1 IWFS Specific Enhancements

Once the IWFS system became operational, users noted some additional capabilities that would further aid intelligence data processing. Additional fields were suggested for some of the existing IWFS files to accommodate new data requirements. For example, fields such as:

- POL storage,
- runway type,
- runway type, and
- aircraft

could be added to the Facilities file to enhance analysis and planning of exercises and facility capabilities evaluation. These additional fields may also require more queries to be added.

Other suggestions included a more specialized query mode that would allow the more experienced user to bypass some of the menus of the file processor. The addition of a World Wide Indicator Monitoring System (WWIMS) file was also discussed.

Relating to Alaskan Air Command flight following, further analytical tools could be developed to provide such capabilities as estimated time of arrival and route prediction of aircraft. Point estimated time of arrival could be computed based upon a series of analyst-input points outlining the anticipated flight path and air speed. Off-line and on-line algorithms could be developed to graphically display the predicted flight route of current flight tracks. Flight routes could also be predicted either based upon the Flight data file or based upon analyst-derived historic flight profiles. In addition to these analytical tools, additional cartographic displays could be added to the flight-following subsystem. These could include:

- Aleutians South Focus
- Central Soviet Focus
- Northern Polar Focus

and would allow flight-following displays to be generated.

7.2 General AAC Capabilities

Alaskan Air Command is considering options to connect itself to the rest of the intelligence community in a more uniform manner. AAC can greatly benefit from intelligence information that is available throughout the intelligence community. At present, AAC has a requirement for an automated message handling capability. This would be provided by the Communications Support Processor (CSP) and Modular Architecture for the Exchange of Intelligence (MAXI). Both of these systems are part of the 21(V)-available software. This connection could be provided through either a remote Sperry Univac 1652 terminal or an in-house 21(V) configuration that was linked to another Intelligence Inforn.ation (I^2) network node.

In the future, AAC would make use of such systems as:

- DIA On-line System (DIAOLS),

- Community On-line Intelligence System (COINS),

- DIA mail service,

- Advanced Imagery Requirements Exploitation System (AIRES),

- SIGINT On-line Information System (SOLIS),

- Storage and Retrieval Processor (SARP) data base capability, and

- Various wire services such as the Foreign Broadcast Information Service (FBIS), United Press International (UPI), and Reuters.

via the MAXI interface. Long-term acquisitions would involve a host-processing capability, exercise planning and evaluation support, responsibilities for delegated intelligence production (such as a third-world data base), communications lines, printers, and MAXI-compatible terminals (such as Sperry Univac 1652 and Delta Data 726XT.)

Appendix A

Terms and Abbreviations

Term	*Definition*
AAC	Alaskan Air Command
AIRES	Advanced Imagery Requirements Exploitation System
CC/IPC	Country Code/Intelligence Production Code
COINS	Community On-Line Intelligence System
DEC	Digital Equipment Corporation
DIAOLS	DIA On-Line System
FBIS	Foreign Broadcast Information System
IWFF	I&W Flight Following
IWFP	I&W File Processor
IWFS	I&W Facility Support
PAR	Pattern Analysis and Recognition Corporation
PARPRO	Peace Time Aerial Reconnaissance
TRESTORE	Restore Track from Flights File Program

TSAVE	**Save track into Flights File Program**
RADC	**Rome Air Development Center**
RMS	**Record Management System**
RSX	**PDP-11 Operating System**
SARP	**Storage and Retrieval Processor**
SCIBS	**Sensitive Compartmented Information Billet System**
SOLIS	**SIGINT On-Line Information System**

MISSION

of

Rome Air Development Center

RADC plans and executes research, development, test and selected acquisition programs in support of Command, Control Communications and Intelligence (C^3I) activities. Technical and engineering support within areas of technical competence is provided to ESD Program Offices (POs) and other ESD elements. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.

LME

1-84