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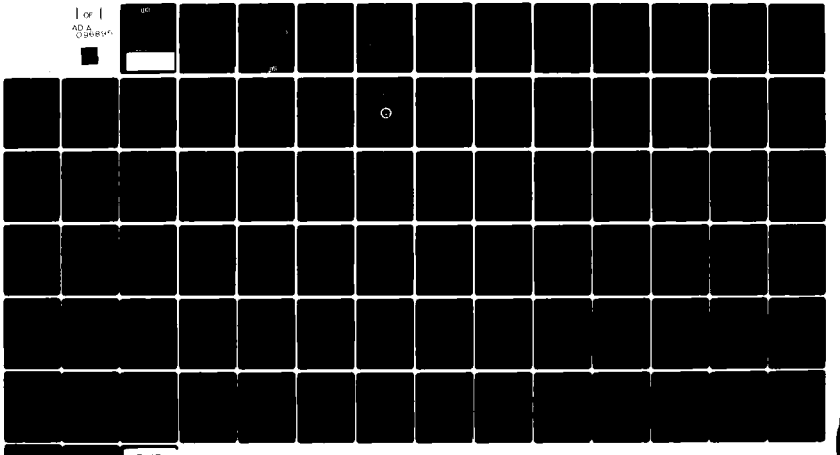

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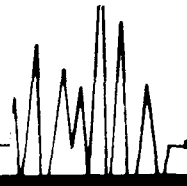
FINAL SUMMARY REPORT

PLATFORM ADAPTOR GROUP INTEGRATION SUPPORT FOR THE JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM

February 1981

Prepared for
SEA 612
NAVAL SEA SYSTEMS COMMAND
DEPARTMENT OF THE NAVY
WASHINGTON, D.C. 20362
under Contract N00140-80-D-1059



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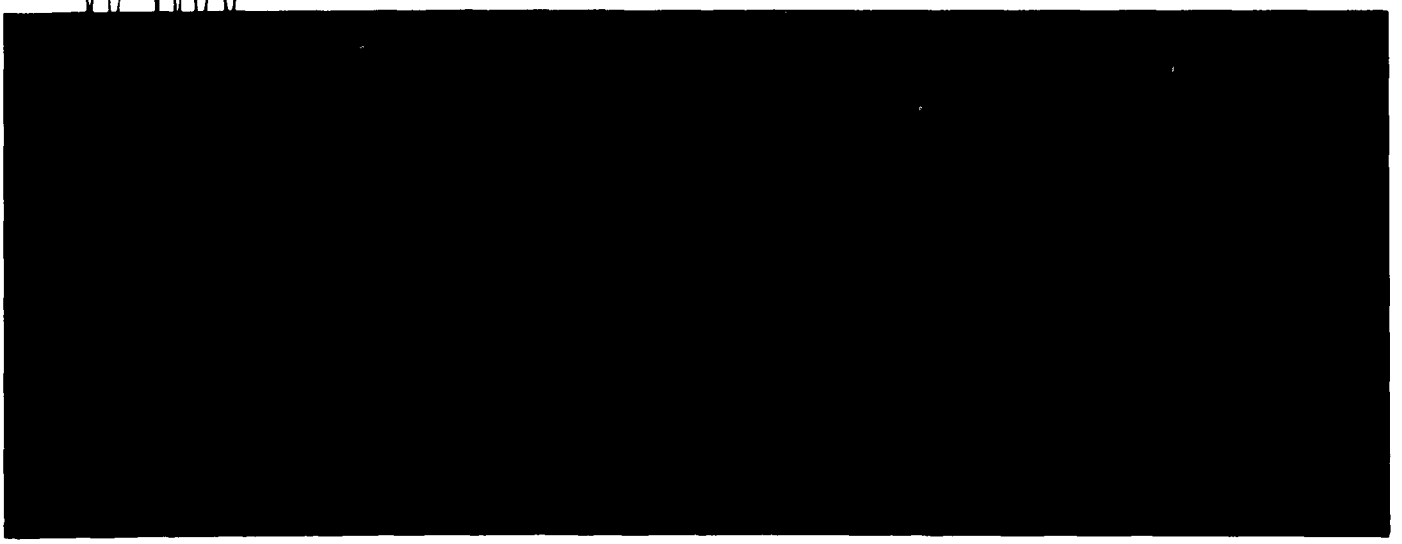

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The Joint Tactical Information Distribution System (JTIDS) is an advanced information distribution system that provides communications, navigation, and identification (CNI) capabilities in an integrated form for application to military and air defense operations. This study for the Naval Sea Systems Command (NAVSEA) was conducted in support of the development of a Platform Adaptor Group (PAG). The PAG Provides a transparent subscriber interface between the shipboard JTIDS terminal and existing ships' Combat Direction System (CDSs).

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ARINC Research Corporation
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2551 Riva Road
Annapolis, Maryland 21401

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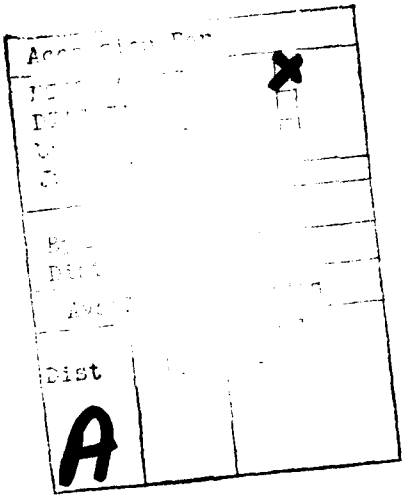
ABSTRACT

This report presents the results of a study for the Naval Sea Systems Command conducted in support of the development of a Platform Adaptor Group (PAG) for the Joint Tactical Information Distribution System (JTIDS).



SUMMARY

The Joint Tactical Information Distribution System (JTIDS) is an advanced information distribution system that provides communications, navigation, and identification (CNI) capabilities in an integrated form for application to military and air defense operations. This study for the Naval Sea Systems Command (NAVSEA) was conducted in support of the development of a Platform Adaptor Group (PAG). The PAG provides a transparent subscriber interface between the shipboard JTIDS terminal and existing ships' Combat Direction Systems (CDSs).

The study developed a Software Quality Assurance (QA) Plan for use by NAVSEA during PAG software development. The QA Plan identifies software QA tasks and responsibilities for tasks that should be performed during the various phases of PAG software development. It should be promulgated for use by all participants in the PAG development, particularly the software developer and the independant V&V agent.

The study also developed a structure for a life-cycle-cost model to be used during the design of the PAG. The model structure describes life-cycle-cost elements to be included in a future cost model. It is recommended that NAVSEA complete the model, including detailed cost relationships, as a computerized tool for use in conducting PAG design trade-off studies.

CONTENTS

CHAPTER ONE

INTRODUCTION

Under contract N00140-80-D-1052 with the Naval Sea Systems Command (NAVSEA), ARINC Research Corporation was tasked to conduct a study in support of the development of a Platform Adaptor Group (PAG) for the Joint Tactical Information Distribution System (JTIDS). This final summary report describes the results of the contract efforts performed for NAVSEA.

1.1 BACKGROUND

The Joint Tactical Information Distribution System (JTIDS) is an advanced information distribution system that provides communications, navigation, and identification (CNI) capabilities in an integrated form for application to military and air defense operations. The Naval Sea Systems Command (NAVSEA) is responsible for shipboard integration of this system into U.S. Navy ships and submarines, including the development of a PAG to provide a transparent subscriber interface between the JTIDS terminal and existing ships' Combat Direction Systems (CDSs). The PAG will contain a preprocessor providing JTIDS capability to communicate and exchange data with other shipboard systems without major modifications to existing shipboard CDSs.

1.2 OBJECTIVES

The purpose of this study was to provide program support to NAVSEA in developing the PAG. Since a major portion of the PAG functions will be performed by computer programs, verification and validation (V&V) procedures are required for the PAG software and associated CDS software modifications. A major objective of this study, then, was to provide a comprehensive set of software V&V procedures to be used during PAG development.

In addition. techniques will be needed for early development of life-cycle-cost (LCC) estimates. These estimates are required for evaluating alternate system concepts and support procedures, detecting cost problems, and providing a basis for formal cost-of-ownership considerations, such as logistics support and preoperational support costs. Thus the second major objective of the study was to develop a structure for a life-cycle-cost model that could subsequently be expanded to a full life-cycle-cost model for use in conducting trade-off studies during PAG design.

1.3 REPORT ORGANIZATION

Chapter Two of this report presents a description of the technical approach used to prepare PAG software V&V procedures and to develop a

structure for a life-cycle-cost model. Chapter Three introduces the software V&V procedures and describes the development of a cost-model structure and the life-cycle-cost elements to be included in a future model for the conduct of design trade-offs. Chapter Four presents the conclusions and recommendations resulting from the study.

The V&V procedures to be used during PAG software development are presented in a separately bound attachment to this report, the Software Quality Assurance Plan.

CHAPTER TWO

TECHNICAL APPROACH

Two tasks were performed to achieve the desired objectives: (1) develop V&V procedures for controlling, implementing, testing, and reviewing the PAG software as it is developed; and (2) formulate a structure for a life-cycle-cost model to be used during PAG design in the conduct of trade-off studies. The technical approaches used for these tasks are described in Sections 2.1 and 2.2.

2.1 TASK 1: PREPARE PAG SOFTWARE V&V PROCEDURES

During the software development process, it is necessary to have a set of procedures for reviewing the products of each phase of the software development process to ensure that these products meet all requirements. This process is referred to as V&V. Verification is the iterative process of determining whether the documents produced during successive steps of the program development process satisfy the requirements created by the previous steps. Validation comprises those test and evaluation activities carried out to ensure that software performance is consistent with design documents.

The approach used to develop the PAG V&V procedures was to perform the following steps:

1. Identify the requirements for performing PAG software development
2. Identify the responsibilities of the performing organizations
3. Define potential methods for performing V&V
4. Identify existing methods for performing V&V
5. Develop a cost-effective set of methods for performing V&V based on PAG program requirements
6. Coordinate findings with Fleet Combat Direction System Support Agency, San Diego (FCDSSASD) and NAVSEA
7. Document results

The following documents were reviewed in the performance of these steps:

- NAVSEA Program Management Plan
- Software Management Plan
- V&V Management Plan
- MIL-STD-1679, Weapon System Software Development
- JTIDS PAG Functional System Analysis
- JTIDS Program Plan, Stage I
- JTIDS Configuration Management Plan
- JTIDS Test Concepts
- JTIDS Quality Assurance Plan

2.2 TASK 2: DEVELOP STRUCTURE FOR LIFE-CYCLE-COST MODEL FOR PAG

Task 2 does not develop the model itself, but only the structure of the model. Existing in-house models that apply to equipment of a similar nature were analyzed. The first is the life-cycle-cost model developed to support an engineering and cost analysis for the JTIDS Phase II terminals. It is documented in ARINC Research Publication 1731-01-2-1945*. The second is a model used to conduct a cost analysis for Army User Equipment of the NAVSTAR Global Positioning System; it is documented in ARINC Research Publication 1172-02-3-1712**.

Both models were analyzed to determine if their cost categories and cost elements corresponded to those anticipated for the PAG. The results of this analysis were used to develop a structure for the PAG life-cycle-cost model. Particular attention was placed on software costs, since a large part of PAG development costs will be incurred in the development of computer programs.

*Joint Tactical Information Distribution System (JTIDS) Phase II: Terminals Engineering and Cost Analysis, Volume I, 25 June 1979.

**Global Positioning System Life-Cycle-Cost Estimates to Support Positioning and Navigation Cost and Operational Effectiveness Analysis, February 1978.

CHAPTER THREE

V&V PROCEDURES AND LCC MODEL STRUCTURE

3.1 PAG SOFTWARE V&V PROCEDURES

Software development is a structured, organized process that can be divided into a number of distinct phases. Each phase has a unique purpose and produces a specific output. The output of each phase is established as a baseline for development of the succeeding phase. V&V procedures are necessary for each phase of the development process and should be tailored to the specific activity of each phase.

With the concurrence of NAVSEA 612, the V&V procedures to be used during PAG software development have been published as a separately bound document, the Software Quality Assurance (QA) Plan. This plan, submitted as an attachment to this report, describes all of the tasks necessary to perform V&V on the PAG software during the following phases:

- Requirements definition
- Program design
- Program code, compile, and debug
- Program acceptance test
- System test

3.2 LCC MODEL STRUCTURE

This section describes the development of a cost-model structure to be used during PAG design. It describes the life-cycle-cost elements to be included in a future model that will be used to conduct design trade-offs. As discussed in Section 2.2, the cost-model structure is based on two models previously developed by ARINC Research Corporation. The cost categories and cost elements in these two models were analyzed to determine if they corresponded to anticipated PAG life-cycle costs. The models were generally applicable, with the exception that software costs were not adequately addressed. Hence, a separate category for software costs was included in the PAG cost model's structure.

As a result of this analysis, the total life-cycle cost was divided into four categories:

- Research and development (R&D)
- Investment
- Operating and support (O&S)
- Software development and support

The cost elements that constitute each of the categories are defined in the following sections.

3.2.1 R&D Costs

R&D costs are all costs required to develop the PAG from concept design to production. Software costs are excluded since they have been assigned to a separate category. R&D costs include the following elements:

- Development engineering - engineering cost associated with the development of PAG equipment, including all prototypes and production equipment
- Producibility engineering and planning - cost associated with equipment producibility studies and producibility plans
- Tooling - cost of developing the unique manufacturing tooling necessary to produce PAG equipment
- Prototype manufacturing - manufacturing cost associated with prototype equipment
- Data - cost associated with obtaining data needed to develop PAG equipment
- Test and evaluation - cost of performing developmental test and evaluation on prototype equipment
- Program management - cost of program management for PAG development
- Training - cost of training personnel to perform developmental test and evaluation or other developmental tasks
- Facilities - cost of new or modified facilities to develop PAG or conduct developmental test and evaluation
- Other - other cost not falling into one of the above categories

3.2.2 Investment Costs

Investment costs are those costs incurred in procuring and installing production equipment on a ship or other platform and making it ready for use by operational forces. Investment costs include the following:

- Equipment purchase - cost of purchasing production PAG equipment
- Initial spares purchase - cost of installation and checkout (I&C) spares and the initial spares inventory
- Installation - cost of installing the PAG on a ship or other platform, including all labor and material required for the installation
- Initial training - cost of initial training of personnel to operate each delivered unit
- Special support equipment acquisition - cost of special support equipment required to support PAG production and installation
- First destination shipping - cost of shipping each production equipment to the initial destination
- Engineering change proposals (ECPs) - cost of developing and implementing engineering change proposals in production equipment
- Program management - cost of program management for PAG production
- Documentation - cost of documentation required for production
- Initial inventory management - cost of management required to establish initial inventory
- New facilities acquisition - cost of acquiring or modifying facilities required for production

3.2.3 O&S Costs

O&S costs are those costs incurred in operating, maintaining, supplying, and supporting equipment in operational use. O&S costs include:

- Recurring spares - cost of providing the necessary spares to maintain and operate the PAG
- Labor - costs of personnel to operate, maintain, supply, and support the PAG
- Materials - costs of other materials and services (e.g., electricity) required to maintain and operate the PAG
- Support equipment operation - cost of maintaining and operating support equipment necessary for PAG maintenance and operation

- Recurring training - cost of training personnel on a recurring basis
- Inventory holding - cost of holding the necessary inventory to support the PAG
- Facility operation - cost of operating and maintaining facilities required for PAG support
- Program management - cost of program management required for PAG support
- Recurring inventory management - cost of management required to manage inventory
- Maintenance transportation - shipping charges for material required to maintain the PAG

3.2.4 Software Development and Support Costs

Software development and support costs are those costs of developing and maintaining all software associated with the PAG. These costs include:

- Operational software development - cost of developing the operational PAG software
- Test software development - cost of developing the test software required for PAG test and evaluation
- Support software development - cost of developing any support software (e.g., compilers and models) required during PAG software development
- Operational software maintenance - cost of maintaining operational software, such as correcting design errors and incorporating ECPs
- Test software maintenance - cost of maintaining test software and developing new test software required for maintenance of operational software
- Support software maintenance - cost of maintaining support software and developing new support software required for maintenance of operational software

3.2.5 Life-Cycle Costs

Table 3-1 summarizes the cost categories and cost elements that constitute total life-cycle cost. The total PAG life-cycle costs are the sum of R&D, investment, O&S, and software development and support costs. The cost for each of these categories is the sum of the individual cost elements within that category.

Subsequent tasks are planned for the actual development of the model itself. This will require developing cost equations for each cost element

Table 3-1. LIFE-CYCLE-COST CATEGORIES AND COST ELEMENTS

Cost Category	Cost Element
Research and Development (R&D)	Development Engineering Producibility Engineering and Planning Tooling Prototype Manufacturing Data Test and Evaluation Program Management Training Facilities Other
Investment	Equipment Purchase Initial Spares Purchase Installation Initial Training Special Support Equipment Acquisition First-Destination Shipping Engineering Change Proposals Program Management Documentation Initial Inventory Management New Facilities Acquisition
Operating and Support (O&S)	Recurring Spares Labor Materials Support Equipment Operation Recurring Training Inventory Holding Facility Operation Program Management Recurring Inventory Management Maintenance Transportation
Software Development and Support	Operational Software Development Test Software Development Support Software Development Operational Software Maintenance Test Software Maintenance Support Software Maintenance

in the model. For example, the cost of recurring spares is a function of the following variables at a minimum:

- Number of PAGs in operation
- Average monthly hours of operation
- Number of line replaceable units (LRUs) in the PAG
- Mean time between failures (MTBF) for each LRU
- Average cost of repairing/replacing each LRU
- MTBF growth for each LRU (if applicable)

In the development of the cost of recurring spares, these and possibly additional variables that affect the total cost of recurring spares for the PAG must be accounted for and incorporated in the cost equation.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

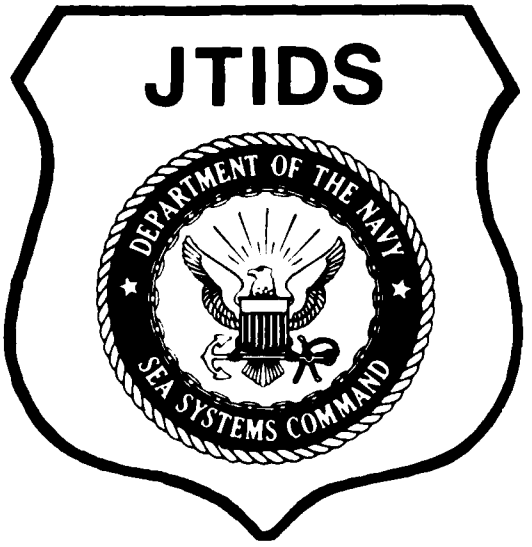
The Software QA Plan, submitted as an attachment to this report, describes the tasks and responsibilities necessary to ensure that the PAG computer programs are adequately specified, developed, and tested. It is recommended that this plan be promulgated by NAVSEA 612 for use by all participants in the PAG development. In particular, it should be referenced in the statements of work for both the PAG software developer and the independent V&V agent, so that each organization clearly understands its role and the other's role.

The cost-model structure contained in this report is the basis for the actual development of the cost model itself. This model can serve a useful purpose during PAG design as a tool in conducting trade-off studies. It is recommended that NAVSEA complete the model by tasking ARINC Research Corporation to develop the detailed cost equations needed to exercise the model. Because of the complexity of the model, it is further recommended that a computer program be developed to facilitate use of the model.

SOFTWARE QUALITY ASSURANCE PLAN
FOR THE
JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM

PLATFORM ADAPTOR GROUP

(Attachment to ARINC Research Publication 2613-11-1-2401)



SEA 612

Naval Sea Systems Command
Department of the Navy
Washington, D.C. 20362

SOFTWARE QUALITY ASSURANCE PLAN
FOR
JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM (JTIDS)
PLATFORM ADAPTOR GROUP (PAG)

February 1981

Prepared for

NAVSEA 612
Naval Sea Systems Command
Department of the Navy
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SUMMARY

The Joint Tactical Information Distribution System (JTIDS) is an advanced information distribution system that provides communications, navigation, and identification (CNI) capabilities in an integrated form for application to military and air defense operations. The Naval Sea Systems Command (NAVSEA) is responsible for shipboard integration of this system into USN ships and submarines, including the development of a Platform Adaptor Group (PAG) to provide a subscriber interface between the JTIDS terminal and the existing ships' combat direction systems (CDSs). This study for NAVSEA developed a software quality assurance (QA) plan for use by NAVSEA during PAG software development. It identifies software QA tasks and responsibilities for those tasks that should be performed during the following phases of software development: requirements definition, program design, program code, compiling and debugging, acceptance test, and system test.

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 PURPOSE

The purpose of the Platform Adaptor Group (PAG) software quality assurance (QA) plan is to identify the specific responsibilities and actions required of organizations participating in the development and test of PAG software. Emphasis will be placed primarily on the responsibilities and actions required of the PAG software developer, although other organizations such as FCDSSASD, NAVSEA, and the verification and validation (V&V) agent will be covered as well. The primary objective of these procedures is to define a plan for software QA that will support the software development approach already established by FCDSSASD. Identification of the specific plan in advance of actual software development will establish a baseline against which participating organizations can plan their efforts.

1.2 BACKGROUND

Prior to the establishment of the Joint Tactical Information Distribution System (JTIDS) program, the Air Force and the Navy were independently planning and developing tactical command and control systems based on time-division multiple-access (TDMA) signal technology. The Navy's programs were the Integrated Tactical Navigation System (ITNS) and the Integrated Tactical Air Control System (ITACS). The former developed and tested a TDMA system that provided relative position determination to system participants, and the latter demonstrated the use of common equipment for communications, navigation, and identification and was able to transmit secure, jam-protected digital information. The Air Force's program was SEEK BUS, which developed a TDMA secure, jam-protected digital information system that emphasized connectivity between subscribers.

Because of the similarities, the programs were merged in 1974 to form the JTIDS program. A Joint Program Office (JPO) was formed, and the Air Force was designated as the lead service, with the Air Force Systems Command (AFSC) as the implementing command. The JTIDS JPO has a joint program manager who is responsible for planning, organizing, coordinating, controlling, and directing the definition, development, production, procurement, and financial management of the program. He is assisted by a deputy program manager from each service. The deputy program manager (Navy) is the single

point of contact between the Navy and the JTIDS joint program manager. Information on the Navy JTIDS organization is contained in Section 2.3.

1.3 JTIDS PROGRAM DESCRIPTION

JTIDS provides CNI capabilities through its ability to distribute information at high rates, encrypted to provide security and reliability in hostile environments. Security and jamming resistance are achieved through the use of pseudorandom signal-processing techniques.

The system provides the capability of interconnecting scattered sources of surveillance, support, and intelligence information, weapons controllers, weapons systems, and decision-making commanders -- with selectable levels of connectivity among these elements -- so that the tactical commander may structure and restructure his forces on a continuing real-time basis as he views the combat situation. It provides mobile surface and airborne force elements with a relative navigation capability within a common position-reference grid and with an intrinsic identification capability through the dissemination of crypto-secure position, velocity, and identity information concerning both friendly and hostile force elements.

Three time-division multiple-access signal architectures have been developed. They are all based on a single communications circuit that simultaneously services multiple users. The basic architecture is referred to as TDMA. Advanced TDMA (ATDMA) is an extension of TDMA to provide capability for greater information throughput, and distributed TDMA (DTDMA) uses the same transmission symbols as TDMA and ATDMA but also disperses those symbols pseudorandomly in time. Each participant in the TDMA or ATDMA network is equipped with a synchronized clock and is assigned a sufficient number of time slots to accommodate the number of messages likely to be required by his mission. During his assigned time slot, each user broadcasts data into a commonly accessible communications data stream. DTDMA network participants are not assigned time slots but transmit pseudorandomly. All network participants can extract information they require by continuously monitoring and sampling the data transmission.

Three classes of terminal equipment are provided, and the characteristics of each class are defined to satisfy the needs and capabilities of the various types of user systems, particularly with respect to size and weight. Class 1 terminals provide the highest level of capability for use by large-scale airborne and surface command and control systems. Class 2 terminals provide similar capabilities but have a lower level of RF power output and may have less capability for information throughput. The smaller, lighter Class 2 terminals are intended for use by force elements such as fighter aircraft and small ships. Class 3 terminals are more compact, lower-cost versions for applications such as man-packs and missile guidance. Modular additions to Class 2 terminals to obtain Class 1 terminal capability and "command terminal" capability for use on aircraft carriers and E-2 aircraft have also been identified.

JTIDS will be implemented in a two-stage approach to ensure that interoperability and compatibility requirements are met completely. Stage I will seek to minimize the impact of the JTIDS terminal on existing combat direction systems (CDSs) by using the PAG as an interfacing device to communicate between the CDS and the JTIDS terminal. The PAG will allow JTIDS-equipped platforms to communicate with each other via Link 16 and still maintain a communication capability via existing digital links, Link 4A and Link 11.

Stage I will provide simultaneous operation of the following:

- Existing Link 4A and Link 11 capabilities
- Jam-resistant, secure data exchange via JTIDS using existing TADIL-A, TADIL-C, and selected TADIL-J message standards in the existing CDS
- Rel-Nav capability
- Jam-resistant, secure, digital voice
- JTIDS relay capability
- Interoperability with other services on voice channels and precise position location identification (PPLI) data channels

Stage II will provide full JTIDS capabilities that will totally integrate the J-series messages into the CDS.

1.4 SCOPE

This software QA plan defines all software QA activity that is required during the development of the PAG software, beginning with the establishment of the PAG functional baseline and ending with the establishment of the operational baseline. It includes the following activities:

- Program requirements definition
- Program design
- Program code and debug
- Subprogram and module test (SP/MT)
- Function test (FT)
- Program acceptance test (PAT)
- System integration test (SIT)
- Navy interoperability test (NIT)

The goal of software QA is to provide a structured approach to software development that results in a high-quality product. It includes all activities designed to achieve this goal, particularly V&V and configuration-management (CM) activities.

This plan applies to JTIDS Stage I only. The software QA plan for JTIDS Stage II will be defined at a later date. The PAG requirements discussed herein are those intended to interface a Class 1 terminal with a shipboard CDS. Class 2 terminal PAG requirements may be similar, but these are not addressed in this report.

1.5 APPLICABLE DOCUMENTS

The documents listed below contain guidance and direction necessary to the performance of software QA tasks for the PAG computer programs.

- DOD-STD-480A, *Configuration Control - Engineering Changes, Deviations and Waivers,* dated 29 December 1978
- MIL-STD-483, *Configuration Management Practices for Systems, Equipment, Munitions and Computer Programs,* dated 21 March 1979
- MIL-STD-1679, *Military Standard Weapon System Software Development,* dated 1 December 1978
- SECNAVINST 3560.1, *Department of the Navy Tactical Digital Systems Documentation Standards,* dated 8 August 1974
- OPNAVINST 3960.10, *Test and Evaluation,* dated 22 October 1975
- *FCDSSASD JTIDS Program Plan,* Stage I, M(P)-5118, dated 31 October 1980
- *FCDSSASD JTIDS Test Concepts,* IR(P)-2427, dated 31 October 1980
- *FCDSSASD JTIDS Configuration Management Plan,* M(P)-5132, dated 23 December 1980
- *FCDSSASD JTIDS Quality Assurance Plan,* M(P)-5133, dated 23 December 1980
- *FCDSSA Technical Report on JTIDS PAG System Functional Analysis,* FR(P)-3162, dated 31 October 1980

CHAPTER TWO

QA PLAN OVERVIEW

2.1 JTIDS FUNCTIONAL DESCRIPTION

A top-level diagram illustrating the integration of JTIDS shipboard equipment with a shipboard CDS is shown in Figure 2-1. The essential elements of the diagram are as follows:

- A TADIL-J terminal group providing secure, jam-resistant, high-capacity information distribution in accordance with systems specification DCB 76S0000
- A Platform Adaptor Group (PAG) consisting of a PAG computer suite, control and display terminals, and support and test equipment that provides for the integration of JTIDS, TADIL-A, and TADIL-C terminal classes and signal architectures with a CDS
- A voice control group providing automated switching of analog and digital voice communications as dictated by an external subscriber network controlled by the PAG
- A TADIL-A terminal group providing for subscriber information exchange via M-series messages in accordance with OPSPEC 411.1
- A TADIL-C terminal group providing for subscriber information exchange via V/R-series messages in accordance with OPSPEC 404
- A CV/CVN combat direction system (CDS) group consisting of NTDS Model 4.0 equipment suites and computer programs that support the CV/CVN mission
- A navigation group consisting of a Ship's Inertial Navigation System (SINS) computer suite and associated manual-navigation-input sources

In addition, a group of switches (SW-1/1A, SW-2/2A, SW-3/3A) has been provided for interconnection of the TADIL-A, TADIL-C and navigation groups with the PAG and CDS for casualty-mode operations.

2.2 PAG DESCRIPTION

The PAG serves as the interfacing unit to allow the CDS to communicate with the JTIDS terminal. The PAG has been designed to allow for a minimal

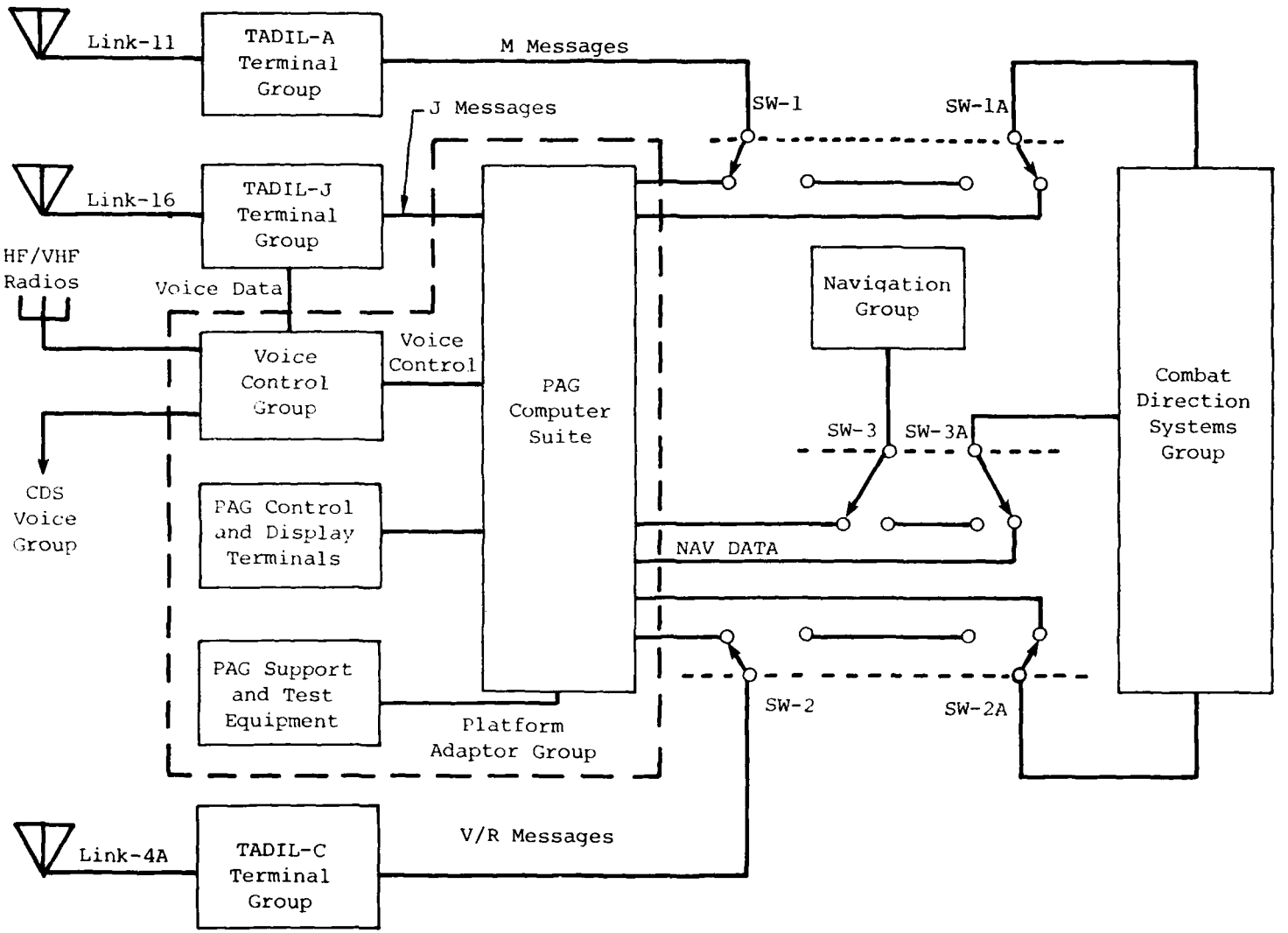


Figure 2-1. JTIDS/CDS TOP LEVEL DIAGRAM

impact on the existing shipboard CDS. Figure 2-1 shows the equipment comprising the PAG: a computer suite, control and display terminals, and support and test equipment. Functional allocations to specific hardware components or between hardware and software have not yet been made; the following sections describe functions that will be contained within the PAG functional elements.

2.2.1 PAG Computer Suite

The PAG computer suite will contain all software programs necessary to the following functions:

- Executive control functions - software that controls program execution, which includes such functions as initialization, interrupt processing, scheduling, dispatching, I/O processing, executive-service-request processing, and error processing
- TADIL-J interface function - software that implements protocol and I/O techniques to allow communication and exchange of J-series messages via the TADIL-J terminal group
- TADIL-C interface function - software that implements protocol and I/O techniques to allow communication and exchange of V/R-series messages via the TADIL-C terminal group
- TADIL-A interface function - software that implements protocol and I/O techniques to allow communication and exchange of M-series messages via the TADIL-A terminal group
- Navigation function - software that implements the capability to interface REL-NAV data from the TADIL-J terminal group with ownship's navigation group and CDS group
- Man-machine interface function - software that implements the capability to monitor on-line status of net operations, system software, and system hardware as required to maintain specified levels of operational capability.
- Voice-control function - software that implements the capability to control voice communications between JTIDS units and ownship's voice-transmission equipments
- On-line test function - software that implements the capability to perform on-line nondestructive tests designed to provide fault detection and isolation of hardware and/or software malfunctions
- Data extraction and reduction function - software that implements the capability to extract and record selected data in real-time for both on-line and off-line reduction in support of system test and evaluation as well as post-mission analysis
- Netway - software that permits the simultaneous operation of TADIL-A and JTIDS nets and the exchange of information between subscribers on both nets

- Biway - software that permits the simultaneous operation of Link-4A and JTIDS nets.

2.2.2 PAG Control and Display Terminals

One or more PAG control and display terminals of the keyboard-input/CRT-output type will be required to permit exchange between the operator(s) and the PAG for system control and operation. The terminal(s) will allow the operator(s) to initialize and control system operation, monitor and control net activity, control voice-mode operation, perform on-line tests, perform data extraction and reduction, and initiate casualty-mode operations.

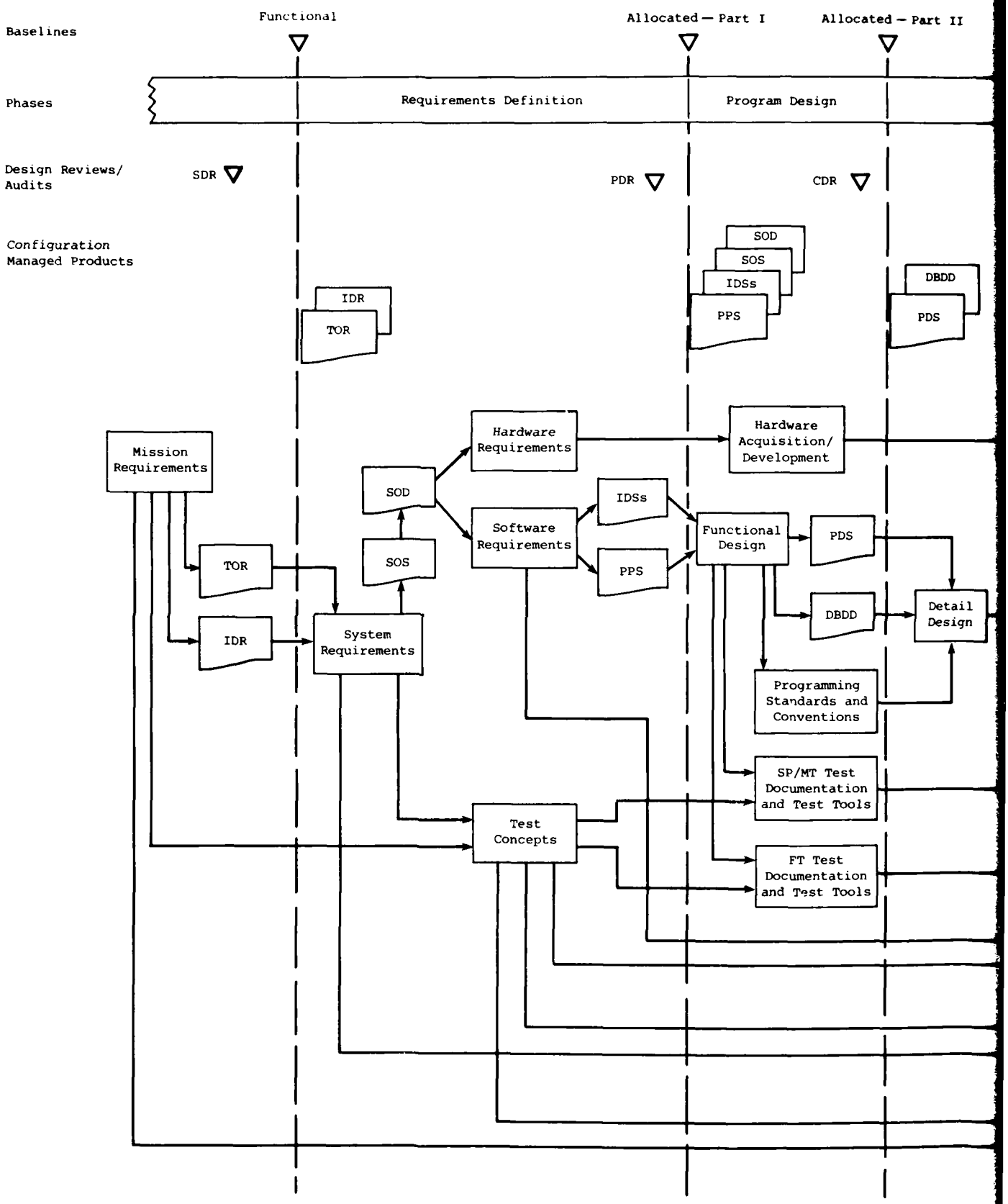
2.2.3 PAG Support and Test Equipment

Exact specifications for PAG support and test equipment have not been determined. It is anticipated that a magnetic-tape unit will be required for program loading, and on-line data extraction and reduction for system test, evaluation, and post-mission analysis.

2.3 SOFTWARE DEVELOPMENT

The software development approach that will be used by FCDSSASD for PAG software is shown in Figure 2-2. It consists of a series of distinct, well-defined phases. Each phase produces an output that serves as the input for the next phase. QA activity takes place during each phase and assists the program manager to determine whether the next phase can begin.

As an aid in providing an orderly, controlled transition from one phase to the next, baselines are defined and established at the conclusion of each phase and serve as points of departure for the next phase. A baseline consists of formally approved and configuration-controlled technical documentation that defines the output of each phase. Figure 2-3 shows the different baselines that FCDSSA will establish during PAG software development. Table 2-1 specifies when each baseline is established and which defining documentation is approved and placed under configuration management for each baseline. Table 2-2 defines the phases of the software-development process that occur between baselines. Chapter Three gives specific V&V procedures for each phase listed in Table 2-2.


Baselines
Functional
Allocated — Part I
Allocated — Part II
Phases
Requirements Definition
Program Design
Design Reviews/ Audits
SDR
PDR
CDR
Configuration Managed Products
IDR
TOR
SOD
SOS
IDSs
PPS
DBDD
PDS
Mission Requirements
Hardware Requirements
Hardware Acquisition/ Development
Software Requirements
Functional Design
System Requirements
Programming Standards and Conventions
Detail Design
Test Concepts
SP/MT Test Documentation and Test Tools
FT Test Documentation and Test Tools

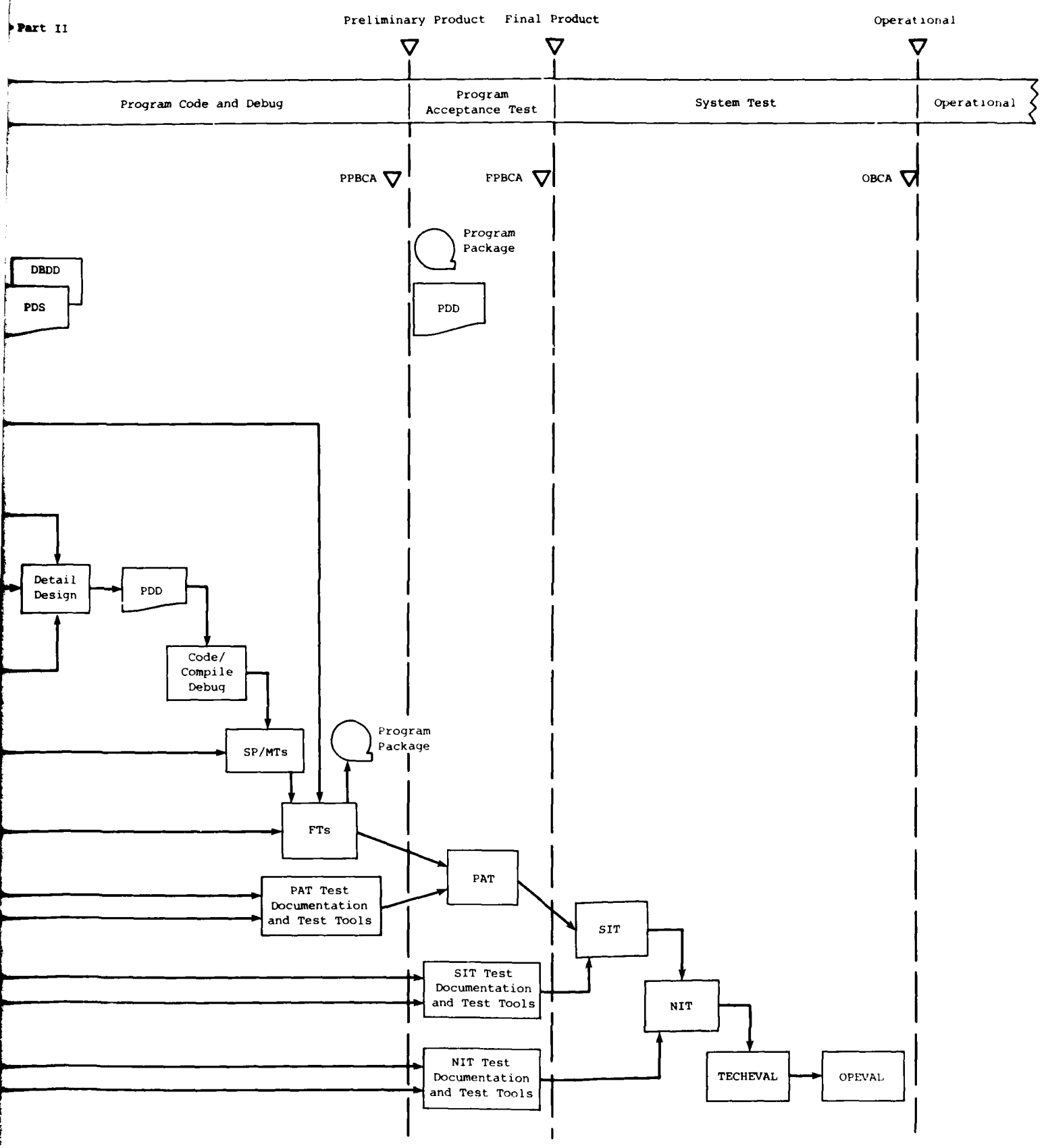


Figure 2-2. JTIDS PAG SOFTWARE DEVELOPMENT PROCESS

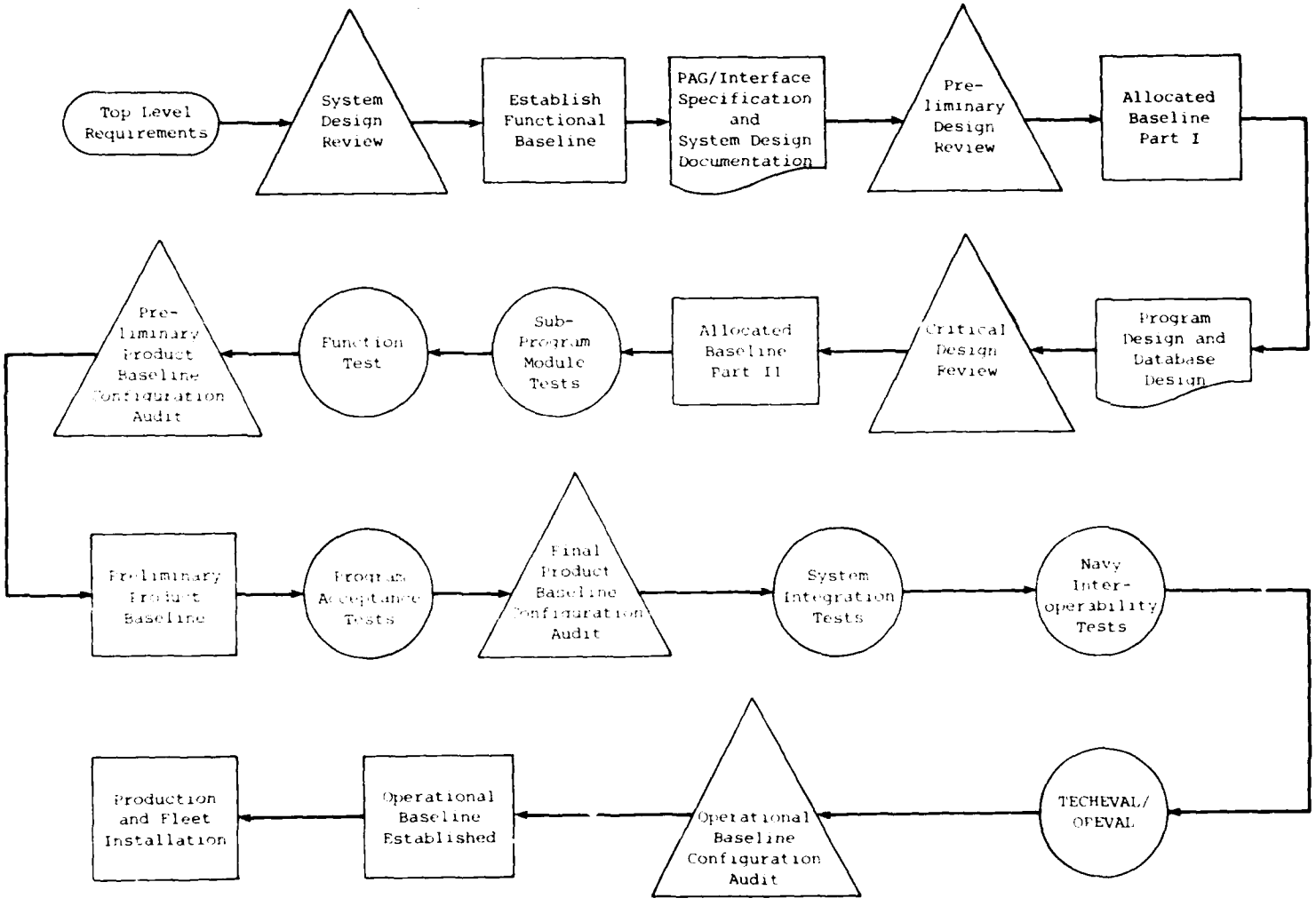


Figure 2-3. STAGE I JTIDS SOFTWARE BASELINES

Table 2-1. BASELINE ESTABLISHMENT AND DOCUMENTATION

Baseline	When Established	Approved Defining Documentation
Functional (ABL)	Prior to start of full-scale development	System specification
Allocated Part I (ABL I)	Following the preliminary design review	Interface design specifications and program performance specifications
Allocated Part II (ABL)	Following the critical design review	Program design specifications and data base design documents
Preliminary product (PPBL)	Following FT and PPBL configuration audit	Program design document and program package
Final Product (FBL)	Following the PAT and FBL configuration audit	Update of PPBL documentation
Operational (PBL)	Following SIT and NIT	Update of FBL documentation

Table 2-2. SOFTWARE-DEVELOPMENT PHASES BETWEEN BASELINES

Software-Development Phase	Beginning Baseline	Ending Baseline
Requirements definition	Functional	Allocated Part I
Program design	Allocated Part I	Allocated Part II
Program code and delay	Allocated Part II	Product
Program acceptance test	Preliminary product	Final product
System test	Final product	Operational
Maintenance	Operational	End of system life

2.4 SUPPORTING ORGANIZATIONS

JTIDS responsibilities within the Navy are assigned as directed in OPNAVINST C3510.13: The Command and Control Directorate, Chief of Naval Operations (OP-094), is the Navy JTIDS program and resource sponsor; the Office of Antisubmarine Warfare, Chief of Naval Operations (OP-95), is the Navy JTIDS mission sponsor; and Chief of Naval Material (CNM) is the executive agent for Navy JTIDS development. As executive agent, Chief of Naval Material issued a letter (Serial 031/DJS of 27 August 1975) defining the responsibilities of the commands to which JTIDS development activities are assigned in OPNAVINST C3510.13.

2.4.1 Naval Electronics Systems Command (NAVELEX)

OPNAVINST C3510.13 assigned NAVELEX the responsibilities of system engineer for JTIDS. The CNM letter letter designated NAVELEX as the principal development activity for Project XCC-24, JTIDS architecture and nonavionics, and as the systems command responsible for supporting the Joint Program Office.

2.4.2 Naval Sea Systems Command (NAVSEA)

NAVSEA is responsible for shipboard integration of all systems into USN ships and submarines. OPNAVINST C3510.13 assigned NAVSEA the following responsibilities:

- Maintenance and enhancement, during and following JTIDS implementation, of interoperability among joint and allied systems achieved by the tactical air control systems and tactical air defense systems (TACS and TADS) interface efforts using TADIL-A (Link 11)
- Planning the installation of JTIDS in specific units so as to ensure minimum interference and provide maximum operational capability to the fleet commander
- Preparation of modifications to existing combat-direction systems software in coordination with JTIDS terminal software to maximize effectiveness and minimize costs for each system
- Development and implementation of integrated logistic support for NAVSEA-cognizant equipment so that an effective reliability and maintainability program will be applied from initial design through development, engineering, test and evaluation (T&E), production, installation, operation, and support phases
- Identification of resources for installation and life-cycle support for JTIDS as early as possible

The CNM designated NAVSEA as a principal development activity for accomplishing the following:

- Integration with NTDS and other combat-direction systems in ships and submarines

- Coordination of all internal NAVSEASYSCOM JTIDS efforts, including planning and liaison with all ship program management and ship logistic management offices
- Development of shipboard installation and integration plans in support of overall JTIDS program goals
- Assistance to NAVELEX in an integrated plan to incorporate JTIDS capabilities for surface and subsurface use other than directly interfacing into NTDS
- Development of a NAVSEASYSCOM budget as a separate JTIDS project number for shipboard TDS integration
- Maintenance of a NAVSEA project office to carry out these responsibilities under the Navy program manager.

2.4.3 Fleet Combat Direction System Support Activity (FCDSSA)

FCDSSAs at San Diego and Dam Neck are responsible for assisting NAVSEA by developing the necessary software for interfacing JTIDS and NTDS and other combat-direction systems installed in Navy ships. FCDSSA, San Diego, is responsible for developing interface processor software and modifications to CDS operational programs for CV/CVN, LCC, and LHA ships. FCDSSA, Dam Neck, is responsible for developing modifications to interface processor software and CDS operational programs for CG, CGN, DDG, DD, and FFG ships.

2.4.4 Operational Test and Evaluation Force (OPTEVFOR)

OPTEVFOR is the Navy's independent testing agency for planning, conducting, and reporting the operational test and evaluation of equipment and systems being procured for the Navy. OPTEVFOR also monitors all pertinent phases of developmental test and evaluation (T&E). OPTEVFOR is tasked by the deputy program manager (Navy) in support of the Joint Program Test and Evaluation Master Plan, and by the Navy program manager in support of the Navy Test and Evaluation Master Plan.

2.4.5 Independent V&V Agent

The independent V&V agent is responsible for performing V&V for the PAG software modifications during full-scale development. The independent V&V agent should be a government agency or contractor not associated with any other part of the PAG software development, and he has the following responsibilities:

- Ensuring the interoperability of the PAG software with the JTIDS Class 1 terminal and the shipboard CDS
- Performing V&V on all support programs, such as simulators and data recorders and reducers
- Reviewing all documentation for completeness, conformance to military standards, and consistency with other program documentation and the computer program package itself

- Monitoring test conduct
- Independently assessing system status
- Verifying that test plans, specifications, and procedures adequately test the system
- Independently analyzing test results
- Developing the PAT test documentation
- Directing the conduct of the PAT

2.5 VERIFICATION AND VALIDATION

Verification is the iterative process of determining whether the documents produced during successive steps of a program-development process fulfill the requirements levied by the previous steps. The purpose of verification is to demonstrate the consistency, completeness, and correctness of the software at each stage of development.

Verification activities can take place during each stage of the development process: requirements definition, design, code, and test. The extent of verification varies from program to program. Pertinent factors that affect the amount of verification performed include program size, available budget, and criticality of the software.

Validation consists of test and evaluation activities that are performed to ensure that software performance is consistent with specification requirements. Validation also determines that the software properly meets the user's needs and requirements, a task that includes an evaluation of the software requirements themselves. Like verification, the scope of validation can vary from program to program.

Chapter Three of this report contains verification and validation procedures that are judged to be cost-effective for the PAG software development. It is not the intent of this report to define specific test plans, methods, specifications, or procedures, but rather to provide a set of procedures for defining the verification and validation activity that must take place.

CHAPTER THREE

SOFTWARE QA APPROACH BY PHASE

This chapter contains a detailed discussion of the approach for performing software QA during each phase of software development. QA activity is defined separately for each phase. These phases are related to the software baselines established during software development, as shown in Table 2-2. Detailed QA approaches for use with all phases are given in the following sections of this chapter:

- Requirements definition
- Program design
- Program code and debug
- Program acceptance test
- System test
- Maintenance

Each section describes the major activity that takes place during each phase, starting with the beginning baseline for each phase and ending with the establishment of the baseline for the next phase, or, in the case of the maintenance phase, the end of the system life cycle. Once the major activity of each phase is described, there follows an account of the specific QA activity for each phase, the QA tasks to be performed, and the responsibilities for performing QA tasks. To provide an orderly discussion, the QA tasks to be performed in each phase are placed in the following general categories:

- Documentation review
- Design reviews and audits
- Configuration management
- Test and evaluation
- Status reports

3.1 REQUIREMENTS-DEFINITION PHASE

The requirements-definition phase begins with the establishment of the functional baseline and ends with the establishment of the allocated-Part I

baseline. The functional baseline is established in accordance with the top-level operational requirements (TOR) and the interface design requirements (IDR) after a system design review (SDR) has been held to review preliminary versions of these documents. Once all comments from the SDR have been resolved, the TOR and IDR are approved and placed under CM control. This represents the departure point for the software requirements-definition phase.

Figure 2-2 shows the activity that occurs during the requirements-definition phase. The object of this phase is to develop the performance requirements for the overall system, the hardware, and the computer programs that support the mission requirements defined in the functional baseline, i.e., the TOR and IDR. The primary system and computer program documentation produced during this phase is as follows:

- System operational specification (SOS)
- System operational design (SOD)
- PAG program performance specification (PPS)
- PAG interface design specifications (IDSs)

The SOS describes in detail guidelines for implementing the mission requirements contained in the TOR and provides program performance guidance and equipment constraints. The SOD is then prepared to provide a technical planning document that defines the hardware environment, the software functional operations, and the interfaces between the PAG and the JTIDS terminal and existing CDS.

Detailed software performance requirements are now prepared. The IDSs specify the software interfaces between the PAG and external systems. Five IDSs involving the PAG are anticipated. These will specify the software interface between the PAG and the following systems and equipment:

- JTIDS terminal
- Link 4A data terminal set
- Link 11 data terminal set
- Navigation system
- CDS

The PPS contains all operational and technical requirements necessary to design, test, and maintain the PAG computer program. The development of the PPS and that of the IDS normally take place simultaneously.

Another activity normally conducted during this phase is planning to define the requirements for any test tools that will be required in subsequent phases. This planning is done early in the development process to ensure that adequate lead time is allowed to design, implement, test, and certify these tools before they are required.

At the conclusion of the requirements-definition phase, the SOS, SOD, PPS, and IDSs are all approved by the Navy and placed under CM control. These documents then constitute the allocated-Part I baseline for the PAG computer programs and constitute the stepping-off point for the next phase - program design. The following sections contain detailed QA tasks to be performed during the requirements-definition phase.

3.1.1 Documentation Review

As shown in Figure 2-2, four primary documents are developed during the requirements-definition phase: the SOS, SOD, PPS, and IDSs. While all four are formally reviewed at a preliminary design review (PDR), the purpose of this document review is to evaluate their acceptability prior to the PDR. Three types of document review will be conducted for the SOS, SOD, PPS, and IDSs, as follows:

- Format review
- Content review
- Comprehensive review

3.1.1.1 Format Review

The purpose of the format review is to determine that the expression and format meet all applicable specifications. Each document is reviewed for format against the requirements contained in the following instructions and data item descriptions (DIDs):

- SOS - Secretary of the Navy Instruction (SECNAVINST) 3560.1
- SOD - SECNAVINST 3560.1
- PPS - DID DI-E-2136
- IDSs - DID DI-2135

3.1.1.2 Content Review

The purpose of the content review is to determine that the operational and technical content of the document is operationally and technically feasible. The higher-level documents, the SOS, SOD, and PPS, are written in terms of fleet operations and missions, and are reviewed for operational feasibility. The lower-level documents, the PPS and IDSs, are written in terms of software architecture and interfaces, and are reviewed for technical feasibility. Note that the PPS is a combination of the operational and the technical and is reviewed both ways. The operational and technical content review are conducted by specialists in their respective areas. An important factor in this review is that the "shotgun" approach, where each expert reviews the entire document, is to be avoided. A document should be divided into various areas, with reviewers assigned to review specific areas in which they are expert. This ensures that the entire document is reviewed, and it minimizes the duplication of effort.

3.1.1.3 Comprehensive Review

The purpose of the comprehensive review is to determine overall document comprehensiveness. Reviewers assigned to conduct a comprehensive review will accomplish the following:

- Evaluate document content structure
- Determine if boundaries are properly described
- Ensure traceability of requirements to higher-level documents
- Determine if the document is consistent within itself
- Ensure that it is unambiguous

An explanation of these tasks follows.

Document Content Structure

The content structure is guided by either SECNAVINST 3560.1 or MIL-STD-1679. Each specifies the section and paragraph titles required for each document and provides guidelines for the content of each paragraph. This review ensures that each paragraph addresses the specified content. The reviewer does not have to check style or format; he checks for technical accuracy only to the extent of determining that the specified requirements are addressed.

Document Boundary Description

This review determines whether the boundaries of a document are properly described and observed. A document can easily extend into adjacent areas rather than stopping at the prescribed limit. While this extra information is nice to know, the document should reference the precedent document rather than duplicating the information. The problem with duplicating information is that it increases the costs for maintaining documents over the life cycle of the system when the duplicated material is changed.

Document Traceability

This review ensures that all high-level requirements are properly contained in lower-level documents and that all requirements in low-level documents are derived from higher-level requirements. This can be accomplished manually or with the support of a computer program to keep an accounting of each requirement, such as the functional cross-verification reference index (FCVRI) available on Share/7 at FCDSSA, San Diego. This review requires that each document be decomposed into element titles and element descriptions, and that these be traced to elements in both higher and lower documents. The result of this review produces document cross-reference reports. Figures 3-1, 3-2, and 3-3 provide examples of an SOS-to-SOD downward cross-reference, an SOD-to-SOS upward cross-reference, and

ELEM	REQUIREMENT/DESIGN	PARAGRAPH	CORRELATED ELEMENT NAME	ELEM	PARAGRAPH
	CONTINUED				
90	PROVIDE NTDS CAPABILITY FOR OFF-LINE SYSTEM GENERATOR: CAPABILITY TO COPY AND BUILD SYSTEM TAPES,PERMIT CHECK READING AND COMPARISON OF SYSTEM TAPES -SYSTEM CONTROL	1.5.3.6.3	NR-SOD-000-C-P	558	3.2.1.5.1.9/1.5.8.1
			NR-SOD-000-C-P	560	3.2.1.5.1.10/1.5.8.1
			NR-SOD-000-C-P	562	3.2.1.5.1.11/1.5.8.1
			NR-SOD-000-C-P	564	3.2.1.5.1.12/1.5.8.1 /6.2.4.3.1
			NR-SOD-000-C-P	566	3.2.1.5.1.13/1.5.8.1 /6.2.4.3.2
			NR-SOD-000-C-P	568	3.2.1.5.1.14/1.5.8.1
			NR-SOD-000-C-P	570	3.2.1.5.1.15/1.5.8.1
			NR-SOD-000-C-P	9148	1.5.8.3
100	PROVIDE NTDS CAPABILITY FOR I/O PROCESSING:ACCOMPLISHED BY PROCESSORS DESIGNED TO PROVIDE SYSTEM INTERFACE WITH EACH PERIPHERAL DEVICE AND SUBSYSTEM BY SYMBOLIC REFERENCE -SYSTEM CONTROL	3.3.1.5/1.5.3.6.1/1.5.4.6.1/1.5.4.6.2	NR-SOD-000-C-P	9544	6.4.C
110	PROVIDE NTDS CAPABILITY FOR COMMON SERVICES:ROUTINES FOR DIRECT REFERENCE BY ALL SYSTEM TASKS INCLUDING MATH CALCULATIONS,DROP TRACK LOGIC,OR ROUTINES THAT FULFILL SPECIFIED PROCESSING REQUIRED BY SEVERAL APPLICATION TASKS SUCH AS COMPUTATIONS TO AID,DISPLAY ON DEMAND TACTICAL MANEUVERING,THREAT EVALUATION,WEAPON ASSIGNMENT -SYSTEM CONTROL	3.3.1.6/1.5.3.6.1/1.5.4.6.1/1.5.4.6.2/1.5.3.2/1.5.4.2	NR-SOD-000-C-P	618	3.2.3/6.2/1.5.1.2/1.5.1.1.1.D/6.2.2C/6.2.3
			NR-SOD-000-C-P	620	3.2.3.1/1.5.1.2/6.2/6.2.2C/1.5.1.1.1.D/6.2.3
			NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D

Figure 3-1. EXAMPLE OF A SOS-TO-SOD DOWNWARD CROSS-REFERENCE

ELEM	REQUIREMENT/DESIGN	PARAGRAPH	HIGHER LEVEL REFERENCE NAME	ELEM	PARAGRAPH
820	MAINTAIN DATA BASE FOR TRACK STORES (E.G.,POSITION,VELOCITY,TIME OF LAST UPDATE,SPEED HEADING,CATEGORY,IDENTIFICATION,CLASSIFICATION),AND CONSOLE STORES (E.G.,CURRENT CONSOLE MODE AND FUNCTION,SWITCH POSITIONS OF RADAR AND RANGE SCALE,CONSOLE TYPE)	3.2.3.1/1.5.1.2/6.2/6.2.2C/1.5.1.1.1.D/5.2.3	NR-SOS-000-C-P	110	3.3.1.6/1.5.3.6.1/1.5.4.6.1/1.5.4.6.2/1.5.3.2/1.6.4.2
822	PROVIDE COMMON SERVICE ROUTINES TO ALLOW SIMULTANEOUS ACCESSING BY DIFFERENT CPU'S FOR MATH-RELATED TYPES(E.G.,SQUARE ROOT,SINE,COSINE,CLOSEST POINT OF APPROACH(CPA),BINARY CODED DECIMAL TO BINARY,POLAR TO CARTESIAN COORDINATE TRANLATORS),AND NON-MATH RELATED(E.G.,DROP SYSTEM TRACKS,ENTER NEW TRACKS,TRACK UPDATES)	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D	NR-SOS-000-C-P	110	3.3.1.6/1.5.3.6.1/1.5.4.6.1/1.5.4.6.2/1.5.3.2/1.5.4.2

Figure 3-2. EXAMPLE OF A SOD-TO-SOS UPWARD CROSS-REFERENCE

ELEM	REQUIREMENT/DESIGN	PARAGRAPH	HIGHER LEVEL REFERENCE NAME	ELEM	PARAGRAPH
10	CALCULATE THE SINE OF A GIVEN ANGLE	3.4.5.1.1.1	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
20	CALCULATE THE COSINE OF A GIVEN ANGLE	3.4.5.1.1.2	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
30	CALCULATE THE TANGENT OF A GIVEN ANGLE	3.4.5.1.1.3	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
40	CALCULATE THE COTANGENT OF A GIVEN ANGLE	3.4.5.1.1.4	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
50	CALCULATE THE ANGLE FOR A GIVEN SINE	3.4.5.1.1.5	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
60	CALCULATE THE ANGLE FOR GIVEN X AND Y COORDINATES	3.4.5.1.1.6	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
70	CALCULATE THE SINE AND COSINE OF A GIVEN ANGLE	3.4.5.1.1.7	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
80	CALCULATE THE SQUARE ROOT OF A GIVEN NUMBER	3.4.5.1.1.8	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
90	CALCULATE 10 RAISED TO THE X POWER WHERE X IS GREATER THAN ZERO AND LESS THAN ONE	3.4.5.1.1.9	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
100	CALCULATE AZIMUTH,GIVEN X,Y COORDINATES IN DATA MILES	3.4.5.1.1.10	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
110	CONVERT CARTESIAN TO POLAR COORDINATES	3.4.5.1.1.11	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
120	CONVERT POLAR COORDINATES TO CARTESIAN COORDINATES	3.4.5.1.1.12	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D
130	CALCULATE THE DISTANCE BETWEEN TWO POINTS	3.4.5.1.1.13	NR-SOD-000-C-P	622	3.2.3/6.2/3.2.3.2/1.5.1.1.1.D

Figure 3-3. EXAMPLE OF A PPS-TO-SOD UPWARD CROSS-REFERENCE

a PPS-to-SOD upward cross-reference. As part of this review, the V&V agent shall provide the following reports:

- SOS-to-SOD upward and downward cross-reference
- SOD-to-PPS upward and downward cross-reference
- Summary of unsatisfied requirements
- Summary of extraneous elements

In addition, horizonal traceability should be determined between the PPS and each IDS to verify that each interface defined in the IDSs is also contained in the PPS.

Document Completeness

This review ensures that all requirements and specifications from the precedent document are fully described in the detail required. This facilitates the preparation of the traceability reports and the SECNAVINST 3560.1 checkoff lists. When all elements listed in SECNAVINST 3560.1 are satisfied and all elements from the precedent documents are completely described, the document will be complete.

Document Consistency

This review provides a horizontal review of the document. Internal consistency means even and equal development of all material. This review can be an extension of the completeness review and should use the traceability report. It should identify any requirement that is being traced only to the introduction of a document and is not amplified in the body of the document. It seeks to ensure that equally important elements receive equal treatment.

Document Clarity

This review is conducted to ensure that the document is clear. Abbreviations and acronyms should be defined when first used.

3.1.1.4 Document Review Tasks

The following actions are to be taken upon delivery of the SOS, SOD, PPS, and IDSs to the FCDSSA PAG program manager.

- The program manager receives the document and logs it into his document library.
- The program manager designates responsible reviewers for the format and content review, determines the schedule for the review and whether the comprehensive review will be conducted in parallel or in series with the content and format review, and distributes the document.
- The designated reviewers conduct the format and content reviews.

- The V&V agent conducts the comprehensive review, receives all comments from the format and content review, consolidates all comments, and delivers the consolidated comments and an assessment of overall document quality to the program manager.
- The program manager reviews and assesses the comments received from the V&V agent and transmits them to the PAG software developer with appropriate instructions.
- The PAG software developer updates the document and redelivers it as necessary.
- The program manager determines the extent of further review required. He may start another complete review or may only verify the incorporation of comments with the assistance of the V&V agent.
- When the program manager approves the document, he places it under informal configuration control until it is formally approved after the PDR.

3.1.2 Design Reviews and Audits

Before any phase of the software-development process is completed, either a design review or an audit is conducted to ensure that the documents or products that constitute the baseline for the next phase are satisfactory. For the requirements-definition phase, that function is fulfilled by the PDR.

The PDR is a formal review of the documents that constitute the allocated-Part I baseline. The responsibility for establishing and scheduling PDRs lies within PME-109. Several PDRs may be conducted during the requirements-definition phase to review products as they are developed; this is done at the conclusion of the document review discussed in Section 3.1.1.

At the conclusion of the requirements-definition phase, the SOS, SOD, PPS, and IDSs should all have been the subject of at least one PDR. The result of these reviews should be a clear definition and establishment of the following:

- Detailed performance requirements
- Program construction, including an identification of subprogram, program support functions, general supervisory functions, program execution and operation, and types of stores and service routines
- Input, output, and processing requirements for each of the program functions or tasks
- Consoles, console modes, and number of consoles on-line for different conditions of systems operation
- Functions implemented for operator support
- Interfaces with other systems, peripherals, and operators
- I/O utilization plans

- Computer resource requirements, i.e., computer memory, processing time, and input and output allocations, and their expected utilization
- Traceability of all requirements upward and downward between the SOS, SOD, and PPS
- Traceability of requirements between the PPS and the IDSs

The FCDSSA program manager for PAG software development has the responsibility to establish the plan for conducting each PDR. Advance planning is essential for a meaningful review. The following paragraphs address activities that are to be performed.

FCDSSA, San Diego, shall develop the PDR plan. They shall transmit a copy of the document being reviewed to each reviewing agency via official correspondence approximately 40 days in advance. The correspondence shall also contain the following information:

- Date and location of the PDR
- Review objectives
- Review agencies and associated review responsibility
- Response date for comments
- Standard form for providing comments (if desired)
- Name and address of individual who is to receive the comments

Attendees at each PDR shall include, but will not necessarily be limited to, the following organizations:

- NAVELEX, PME-109
- NAVSEA 612
- FCDSSA, San Diego
- V&V agent
- Software developer
- OPTEVFOR
- Naval Ocean System Center (NOSC)
- PAG IDS interfacing agencies

The V&V agent shall be responsible for receiving, logging, and consolidating all comments, and providing them to FDCSSA and the software developer. The software developer shall provide written responses to FDCSSA for all comments received. FCDSSA, with support from the V&V agent, shall evaluate the responses prior to the PDR. If necessary, the responses shall be revised by the software developer until they are satisfactory.

The agenda for the PDR shall be established by FDCSSA. The meeting should be structured to derive maximum benefits from the attendees in the minimum

amount of time. It is recommended that, where possible, splinter meetings be held on specific topics to reduce the length of the PDR, with reviewers attending splinter meetings in their area of expertise. A suggested division of agenda topics is as follows:

- Hardware-related agenda items
- Software-related agenda items
- Management-related agenda items
- Operational agenda items

The PAG software developer is responsible for submitting minutes of the PDR to FCDSSA within two weeks after the completion of the PDR. These minutes shall contain the following:

- All comments received and the final response
- All action items arising from the PDR, including responsible agencies, individuals, and due dates
- Significant items discussed during the PDR

The V&V agent shall monitor the incorporation into the applicable document of all changes either agreed to during the PDR or resulting from PDR action. Upon incorporation of all changes, NAVSEA 612 will establish the allocated-Part I baseline.

3.1.3 Configuration Management

Configuration management is a discipline that applies technical and administrative direction and surveillance (1) to identify and document the functional and physical characteristics of a configuration item, (2) to control changes to those characteristics, and (3) to record and report change processing and implementation status. The discipline of configuration management is made up of the following elements:

- Configuration identification - the precise identification of approved, or conditionally approved, technical documentation for a configuration item as set forth in specifications, drawings, and associated lists
- Configuration control - the systematic evaluation, coordination, approval or disapproval, and implementation of all approved changes to a configuration item after formal establishment of its configuration baseline
- Configuration status accounting - the recording and reporting of information needed to manage a configuration effectively, including a listing of the approved configuration identification, the status of proposed changes to the configuration, and the implementation status of approved changes

The requirements-definition phase begins with the establishment of the functional baseline and ends with the establishment of the allocated-Part I baseline. Hence, only the TOR and IDR are configuration-managed at the beginning of this phase; the SOS, SOD, PPS, and IDSs are added to them during this phase. When these documents are all approved, the requirements-definition phase is completed and the program-design phase begins.

CM during the program-design phase is confined to the activity associated with the CM of the documents noted in the preceding paragraph. Each document is treated as a separately configuration-controlled item that can be changed only by approval of an engineering change proposal (ECP). The following paragraphs discuss the process of ECP development and approval.

An ECP may be originated by FCDSSA, the software developer, the V&V agent, or any other agency associated with PAG software development who establishes a need for change. Changes should be limited to those which are necessary or offer a significant benefit to the Navy, such as changes to accomplish the following:

- Correct deficiencies
- Satisfy changes in operational requirements
- Cause life-cycle-cost savings
- Improve schedules

The originating agency shall prepare all ECPs on DD Form 1692 in accordance with DoD-STD-480A. The form should contain the following information:

- Originator's name and organization
- Baseline affected
- Title of change
- Priority
- Description of change
- Need for change
- Effect on cost (if known)
- Effect on schedule (if known)
- Effect on other configuration items (if known)

The last three items may not be known completely or at all to the originator, particularly if the originator is not the software developer. This should not be a deterrent to submitting ECPs, however.

The originator shall also submit a specification change notice (SCN) for each configuration-managed document affected by the proposed ECP. SCNs shall be prepared on DD Form 1696 in accordance with MIL-STD-480. They

will provide the exact changes that are being proposed to the baseline document. Changes will be highlighted by a vertical line in the margin.

Upon submission of an ECP to PCDSSA, the following actions occur:

- The V&V agent is requested to evaluate the change, particularly with respect to the adequacy of the description of the proposed change, the need for the change, alternatives, as compared with the change, and the potential impact of the change on the SA hardware and software or other interfaces and equipment.
- The ECP is distributed by PCDSSA to all potentially affected participants requesting comments, assessments of the technical, cost, schedule, and performance impacts of ECP approval, and the need for additional associated ECPs to fully implement the proposed change in the affected documents.
- The V&V agent reviews all documents, impact assessments, and associated ECPs to develop a complete evaluation of the effect of the proposed ECP.
- The ECP is scheduled for review by the Configuration Control Board (CCB). PCDSSA, as CCB chairman, reviews the change package and approves or disapproves it.
- If an approved ECP is within the scope of the CCB authority, PCDSSA directs the implementation of the ECP. If an approved ECP is outside the scope of CCB authority, the CCB submits its recommendations to the NAVSEA 05Z Configuration Control Board (CCB). The NAVSEA 05Z CCB approves or disapproves the ECP and then returns it to PCDSSA for appropriate action in accordance with the latter authority.

The V&V agent shall maintain and update participating organizations' status accounting report showing the disposition of all ECPs. This report shall list the following:

- All documents under configuration management
- All ECPs originated against each document
- The status of all ECPs in accordance with the following categories:
  - Open
  - Withdrawn
  - Disapproved
  - Approved
  - Implemented

[illegible] Test and Evaluation

A [illegible] test and evaluation activity during this [illegible] phases. [illegible] TEMP [illegible] report [illegible] ensure that [illegible] and simulation [illegible] are [illegible].

[illegible] Reports

[illegible] reports [illegible] and NAVSEA [illegible] activity, such as a [illegible]. These reports shall contain at least the [illegible]:

- [illegible] with respect to planned schedules
- [illegible] problems requiring resolution
- [illegible] past month
- [illegible] month.

[illegible] PHASE

[illegible] with the establishment of the allocated-Part I [illegible] of the allocated-Part II [illegible] that occurs during the program-[illegible] the design specifica-[illegible] the data base, that will support [illegible] allocated-Part I baseline, [illegible] The primary computer program documentation [illegible]:

- [illegible]
- [illegible]

[illegible] program design description developed [illegible] specified in the PPS and the [illegible] IDS. It contains a comprehensive [illegible] input-output processing, including [illegible] storage and processing alloca-[illegible] guidelines.

[illegible] description of all common data [illegible] functions. Common data are [illegible]. It includes detailed sections [illegible] all tables, variables, constants, and [illegible] matrix [illegible] all common data base items with [illegible].

It is during the program-design phase that programming standards and conventions are written by the software developer. These standards and conventions will be used by the software developer during the actual coding of the computer program. Typical programming standards and conventions could include standard commenting procedures, naming conventions, limits on code complexity, and limitations on branching statements.

Test and evaluation activity during the program-design phase comprises the specification, development, and certification of test tools required in subsequent phases and the development of test documentation for subprogram-module test (SP/MT) and function test (FT). Test tools should be certified in the phase prior to their actual use. For example, a test tool required for the program-code-and-debug phase should be certified during the program-design phase, and a test tool required for the program-acceptance-test phase should be certified during the program-code-and-debug phase. Similarly, test documentation is developed in the phase before the one in which it is required.

3.2.1 Documentation Review

The PDS and the DBDD will both be reviewed as described in Section 3.1.1, i.e., they will be subject to a format, content, and comprehensive review. The governing requirements for their review are as follows:

- PDS - MIL-STD-1679 and DID DI-E-2138
- DBDD - MIL-STD-1679 and DID DI-S-2140

As with the PPS and IDSs, the content review requires that a document traceability analysis be performed. This requires that each element in the PDS be identified, tiedd, and traced back to a requirement in the PPS. Similarly, every element previously identified in the PPS must be traceable to an element in the PDS. This assures that all design features included are due to performance requirements and that all performance requirements are reflected in design elements. The V&V agent shall submit a report to FCDSSA containing the following as a result of the traceability analysis:

- A report of PPS-to-PDS downward traceability
- A report of PDS-to-PPS upward traceability
- A summary of unsatisfied design requirements
- A summary of extraneous elements

When reviewing the PDS, the V&V agent shall verify that the software developer has designed the computer program by a systematic top-down method. To accomplish this, the V&V agent shall verify that the following features are reflected in the PDS:

- The design is a hierarchical structure of identifiable programs, subprograms, modules, procedures, and routines.
- The highest level of control lies at the top of the hierarchy.

- The computational or arithmetic functions reside at the lower levels.
- The program is divided into constituent parts and then these constituent parts are broken down into their constituents.
- Each level of design is continued until a level is reached where there is no subordinate level.
- A lower level does not call a higher level.

The V&V agent shall review the proposed design to ascertain the capability to support the computational load imposed by maximum operation of all functions required to be simultaneously serviced. If modeling is required in the performance of this function, the V&V agent should first obtain approval from FCDSSA. The V&V agent shall also verify that the resource allocations for computer memory, processing time, and input and output channels contained in the PDS are within the resource requirements in the PPS.

During this phase the software developer shall also prepare programming standards and conventions, which shall be reviewed for adherence to the programming standards and programming conventions sections of MIL-STD-1679 and for conformity to other established standards used in the JTIDS program. The V&V agent should specifically verify that the programming standards prepared by the software developer meet the requirements of the programming standards section of MIL-STD-1679 for the following areas:

- Control structures
- Included copies or segments
- Entry-exit structure
- Program traceability
- Self-modification
- Recursive programs
- Size
- Branching
- Relocatability
- Indentation

Similarly, the V&V agent shall verify that the programming conventions meet the requirements of the programming conventions section of MIL-STD-1679 for the following areas:

- Naming
- Symbolic constants and variables
- Mixed-mode expressions
- Grouping
- Significant digits

- Narrative descriptions
- Source-record formats

3.2.2 Design Reviews and Audits

The critical design review (CDR) is held at the conclusion of the program-design phase to review the products that will constitute the allocated-Part II baseline. The purpose of the CDR is to ensure that the software design satisfies the performance requirements established in the PPS and to evaluate the FT plans, specifications, and procedures prior to conduct of the FT program. Additionally, the CDR serves to focus management and designer's attention on the products of the design effort and quality of the design prior to initiating programming activity. The CDR is therefore scheduled by FCDSSA at a point in the development cycle coincident with completion of design documents. The basic documents subject to the CDR process consist primarily of the PDS supported by the DBDD and FT plans, specifications, and procedures.

At the option of FCDSSA, the CDR may be conducted in several discrete parts, each part oriented toward evaluation and acceptance of the PDS for operational programs, maintenance and diagnostic programs, and training and simulation programs or computers. The specific elements of the CDR process shall be established by FCDSSA as part of the initial program-planning process. As each CDR is completed the documents reviewed during the CDR will be baselined and changes to the documents formally controlled. When the last CDR has been completed, the allocated-Part II baseline will be established.

The primary product of the CDR is the formal identification of computer program documentation that will be released for coding and testing. The CDR will be oriented toward the following:

- Establishing program-design compatibility with performance specifications.
- Establishing system compatibility by review of all interfaces between computer programs and between subprograms by analysis of detailed flow diagrams and other descriptive documentation
- Review and evaluation of data base design
- Review of design integrity by review of available analytical data in the form of flow diagrams, logic diagrams, algorithms, and storage allocations
- Review and evaluation of the function test plan, test specifications, and test procedures

FCDSSA, San Diego, shall develop the CDR plan. They shall transmit a copy of the PDS and DBDD to each reviewing agency via official correspondence

approximately 40 days in advance. The correspondence shall also contain the following information:

- Date and location of the CDR
- Review objectives
- Review agencies and associated review responsibility
- Response date for comments
- Standard form for providing comments (if desired)
- Name and address of individual who is to receive the comments

Attendees for each CDR shall include, but will not necessarily be limited to, the following organizations:

- NAVELEX, PME-109
- NAVSEA 612
- FCDSSA, San Diego
- V&V agent
- Software developer
- OPTEVFOR
- NOSC
- PAG IDS interfacing agencies

The responsibilities of the software developer, the V&V agent, and FCDSSA during the planning, conduct, and reporting of the CDR are identical to the responsibilities for these organizations described in Section 3.1.2 with respect to the PDR. Upon satisfactory completion of the CDR, NAVSEA 612 will establish the allocated baseline.

3.2.3 Configuration Management

CM during the program-design phase is similar to the CM conducted during the requirements-definition phase described in Section 3.1.3. The only change is the increased number of documents under the discipline of CM. The additional documents are as follows:

- SOS
- SOD
- PPS
- IDSs

The procedures and responsibilities for processing ECPs to documents being configuration-managed is the same as that described in Section 3.1.3.

3.2.4 Test and Evaluation

As shown in Figure 2-2, the test and evaluation activity during the program-design phase is as follows:

- Test tool specification, development, and certification for SP/MT and FT
- Test documentation development for SP/MT and FT

As mentioned previously, the general policy is that all items required for a particular phase of testing are certified or approved in the previous phase. Since the following phase includes the conduct of SP/MT and FT, all test tools, including simulation programs, needed to support these tests must be certified in the program-design phase, and test documentation for SP/MT and FT must be developed and approved during this phase.

SP/MT is the first step in testing a computer system. The purpose of this test is to demonstrate that the internal logic of the module is correct. This is accomplished by exercising each module sufficiently to verify that it conforms to the program design. Responsibilities for developing test documentation and test tools for SP/MT are listed in Table 3-1. There is a minimum of formal accountability for SP/MT test documentation, since this level of testing is normally accomplished by the individual programmers with the software developer's organization and the Government does not take formal delivery of the software until after the completion of the FTs. However, all test documentation developed by the software developer should be available to the V&V agent for review.

Table 3-1. RESPONSIBILITIES FOR SP/MT TEST DOCUMENTATION AND TEST TOOLS

Item	Responsibility				
	Requirements Analysis	Development	Testing	Reviewing	Approval
Test plan	Software developer	Software developer	N/A	V&V agent	Not required
Test specifications	Software developer	Software developer	N/A	V&V agent	Not required
Test procedures	Software developer	Software developer	N/A	V&V agent	Not required
Test tools	PCMSSA/ software developer	PCMSSA/ software developer	PCMSSA/ software developer	V&V agent	PCMSSA*

* Certification.

Test tools for SP/MT are developed by either FCDSSA or the software developer. Normally, existing test tools under FCDSSA cognizance that require modification to be used for PAG software testing will be developed by FCDSSA. New test tools are usually developed by the software developer. In either case, all test tools used for SP/MT are to be reviewed and verified by the V&V agent and approved by FCDSSA prior to the completion of the program-design phase.

FTs are the second step in testing the PAG software. FTs are conducted to validate that the modules, when combined into operating functions, will perform as specified in the PPS and PDS. FTs are therefore the beginning of testing the integrated software modules within the PAG computer. An FT is conducted for each function allocated to the PAG in accordance with test plans, specifications, and procedures prepared by the software developer and approved by FCDSSA. Table 3-2 lists the responsibilities for developing FT test documentation and test tools. This level of testing requires that the modules be operationally combined to verify the overall program subsystem operation as described in the PPS and PDS. Functions are executed and tested one at a time. There is no simultaneous execution of functions, so FTs are the simplest level of integration-oriented testing.

Table 3-2. RESPONSIBILITIES FOR FT TEST DOCUMENTATION AND TEST TOOLS

Item	Responsibility				
	Requirements Analysis	Development	Testing	Reviewing	Approval
Test plan	FCDSSA	Software developer	N/A	V&V agent	FCDSSA
Test specification	FCDSSA	Software developer	N/A	V&V agent	FCDSSA
Test procedures	Software developer	Software developer	N/A	V&V agent	FCDSSA
Test tools	FCDSSA/ software developer	FCDSSA/ software developer	FCDSSA/ software developer	V&V agent	FCDSSA*

*Certification.

FT test plans, specifications, and procedures are to be reviewed by the V&V agent for conformity to MIL-STD-1679 and the following applicable DIDs:

- Test plan - DI-T-2142
- Test specification - DI-E-2143
- Test procedures - DI-T-2144

The FT test plan will define the total scope of the testing to be performed, containing precise statements of the purpose, scope, and schedule for the individual test being planned. In reviewing the FT test plan, the V&V agent should specifically verify that tests are planned to accomplish the following:

- Ensure error-free linkage of each module
- Ensure that each tested function fully satisfies the detailed performance and design requirements
- Exercise each function in terms of input-output performance and ensure that the results satisfy the applicable detailed performance and review requirements
- Ensure that each function man-machine interface is as specified in the PPS
- Ensure the capability of the subprogram to handle erroneous inputs properly and survive them.

In addition, a traceability analysis shall be performed by the V&V agent to ensure that each requirement in the PPS and PDS is covered by a test in the FT test plan. An analysis is also to be conducted upward from the FT test plan to ensure that each test being planned is traceable to either a design requirement or a performance requirement. Results of each analysis are to be reported to FCDSSA.

The FT test specification contains test specifications for each test contained in the FT test plan. The V&V agent shall review this document to ensure the following:

- Each test in the FT test plan has a corresponding test specification.
- Test criteria are identified.
- Test methods are explained.
- The purpose of each test is identified.
- The software to be tested and the scope of each test are identified.
- Support requirements, inputs, required accuracies, expected output, and data collection methods for each test are identified.

The FT test procedures present detailed instructions for test execution and for evaluation of the results of each level of testing specified. They are developed from the FT test specification and the relevant design document, and give detailed instructions for test setup, execution, and evaluation of the test results. The V&V agent should review the FT test procedures to ensure the following:

- The organization or structure of the procedure and any assumptions or any constraints on its use are identified.
- Detailed instructions for the setup and operation of each test are presented.

- The total equipment, manpower, digital processor programs, and supporting documentation required for each operation are described.
- The requirements for various modes of operation are specified if they differ from the total requirements.
- Equipment required for operation is identified by official nomenclature.
- Revisions or modifications to required equipments are specified, as well as any pretest checkout of the hardware required.
- Materials and personnel required for the performance of the test are identified.
- The test setup and energizing procedures are given.
- The program loading procedure is given.

Test tools for FT are developed by either FCDSSA or the software developer, as with SP/MT. All test tools used for FT are to be reviewed and verified by the V&V agent and certified by FCDSSA prior to the completion of the program-design phase. Once the FT test tools have been certified, they shall be configuration-managed by FCDSSA in a manner similar to that for the PAG documentation and computer programs.

3.2.5 Status Reports

During the program-design phase the V&V agent shall submit monthly status reports to FCDSSA and NAVSEA, in addition to those submitted as a result of specific activities, such as document or ECP review. These reports shall contain at least the following:

- An assessment of program progress with respect to planned schedules
- A description of outstanding technical problems requiring resolution
- A summary of the tasks performed during the past month
- A summary of the tasks planned for the coming month

3.3 PROGRAM-CODE-AND-DEBUG PHASE

The program-code-and-debug phase begins with the establishment of the allocated-Part II baseline and ends with the establishment of the preliminary product baseline. Figure 3-2 shows the activity that occurs during the code-and-debug phase. The object of this phase is to code and debug the PAG computer program in accordance with the PDS and DBDD, and begin the initial testing of the program. The primary computer program documentation produced during this phase is as follows:

- Program design document (PDD)
- Program package document

The PDD contains a complete technical description of all PAG software subprogram functions, structures, operation environments, operating constraints, data base organization, source and object code listing, and diagrammatic and narrative flows. The PDD is specifically oriented to programming logic and programmer's language. Program listings are referenced as appendixes to the PDD.

The program package document consists of the program-source listing, an error-free source/object listing produced by an assembly or compilation of the source, a complete cross-reference listing produced by a compilation of the source, and any data necessary to cause programs to run properly, e.g., adaptation data or program parameter values.

Test and evaluation activity that occurs during the program-code-and-debug phase is the conduct of SP/MT and FT, development and certification of test tools for program acceptance tests (PATs), and development of test documentation for PATs.

3.3.1 Documentation Review

The PDD will be reviewed as described in Section 3.1.1, i.e., it will be subjected to a format review, a content review, and a comprehensive review. The governing requirements for these reviews are contained in MIL-STD-1679 and DID DI-S-2139.

The comprehensive review will include a traceability analysis between the PDS and the PDD. This requires that each element in the PDS be identified, titled, and traced downward to an element in the PDD. Similarly, every element in the PDD must be traceable to an element in the PDS. This traceability analysis assures that all design elements in the PDS are accounted for in the PDD and that all procedures and routines in the PDD can be traced to a design element in the PDS. The V&V agent shall submit a report to FCDSSA containing the following:

- A PDS-to-PDD downward cross-reference
- A PDD-to-PDS upward cross-reference
- A summary of unsatisfied design elements
- A summary of extraneous elements

In reviewing the PDD, the V&V agent shall verify that the software developer has implemented the design in the PDS in a systematic top-down method. Criteria for verifying this feature are contained in Section 3.2.1 and should be used in the reviewing of the PDS.

It is impractical for the V&V agent to review the actual code produced by the software developer at the completion of the program-code-and-debug phase, since the sheer amount of code precludes this review. However, considerable time can be saved by detecting errors as early in the design cycle as possible. To accomplish this two forms of manual checking shall be

performed by the software developer as part of the program-code-and-debug phase: desk-checking and code walkthroughs.

Desk-checking shall be performed by the programmers in the software development organization. It can include a number of check-out efforts performed manually, but it normally includes one or all of the following:

- Reviewing a source list for faults
- Performing arithmetic calculations manually to verify program output values
- Manually simulating program execution to verify program logic and data flow.

Since these activities are performed at the individual programmer's desk, no V&V agent review is appropriate, but management policies of the software developer should require that desk-checking be performed.

Code walkthroughs are a peer group review of the code as it is developed. They are to be conducted by the software developer as the code is being developed. The following guidelines are to be followed in the conduct of code walkthroughs:

- The walkthrough is to be an informal review of the code conducted by the peers of the individual programmer.
- The size of the code under review should not exceed the amount that can be reviewed in approximately one hour.
- The walkthrough is to be held after the code has been compiled.

The purpose of the code walkthrough is to conduct a review of the code in a nondefensive environment for the programmer. Software managers as such are normally discouraged from attending code walkthroughs to avoid the appearance of a formal performance review. Attendance of the V&V agent at code walkthroughs is likewise not conducive to achieving the proper setting.

The responsibility of the V&V agent with respect to code walkthroughs is only to ensure that the software developer is conducting code walkthroughs. In addition, the software developer shall furnish source listings to the V&V agent after code has been reviewed at a code walkthrough and found to be acceptable. The V&V agent shall review these listings to ensure the following:

- Approved programming standards and conventions are being followed.
- The code is completely written in CMS-2Y (Subset 0). Use of direct code or assembly code is prohibited without the written permission of PME-109.
- A top-down structured approach is being followed.
- The code is not too complex for the intended application.

- Comments are included throughout the code so that program maintenance is improved.
- The code is free of logical faults and design faults.
- Computer resource allocations for computer memory, processing time, and input-output channels are being observed during the program-code-and-debug phase.

All review comments shall be provided to the software developer for resolution. Problems that cannot be resolved directly between the software developer and the V&V agent shall be resolved by FCDSSA.

3.3.2 Design Reviews and Audits

The preliminary product baseline configuration audit (PPBCA) is held at the completion of the program-code-and-debug phase. The purpose of the audit is to provide formal evaluations of the tested program to verify achievement of the requirements in the PPS and PDS, ensure that the product under test, the computer program, is consistent with the program documentation, and verify that all modifications found necessary as a result of FT have been properly incorporated into the program package and supporting documentation.

FCDSSA has the responsibility to schedule and conduct the PPBCA. It shall notify attendees by official correspondence at least 30 days in advance of the scheduled date. Attendees at the PPBCA shall include the following:

- NAVELEX, PME-109
- NAVSEA 612
- FCDSSA, San Diego
- V&V agent
- Software developer
- OPTEVFOR
- NOSC
- PAG IDS interfacing agencies

Unlike the design review, the PPBCA requires attendees to review the PAG computer program at the lowest level. Hence, attendees should be limited to those individuals with the expertise to conduct a thorough review at this level. FCDSSA shall ensure that the software developer has key programming and design personnel in attendance or on call to provide assistance as necessary. The V&V agent has the responsibility to be the technical lead for the PPBCA and to describe all findings of the PPBCA audit team for transmittal

by FCDSSA to the software developer. The V&V agent shall ensure that following documents are reviewed in accordance with the following criteria:

- FT test reports document the results of function testing and summarize the discrepancies between the intended design and the actual program capability. Review of FT reports as a part of the PPBCA should ensure the following:
  - The tests were conducted in accordance with the approved test procedures.
  - All deviations from the FT specification and function test procedures are clearly described, and rationale provided of the necessity for the deviation.
  - Each test discrepancy is adequately described and is supported by statements of its significance and its impact on the program.
  - The test report includes an overall analysis of the functional performance of the program tested.
  - The number of software errors is within the limits specified by MIL-STD-1679.
  - The number of object patches is within the limits specified by MIL-STD-1679.
  - Test data are maintained in a test data file for future reference.
- The PDD provides a complete technical description of all digital processor subprogram functions, structures, operation environments, operating constraints, data base organization, source and object code listing, and diagramatic and narrative flows. Development of the PDD is based on the requirements of the PDS and the common data items contained in the DBDD. During conduct of the PPBCA the review and evaluation of the PDD should ensure the following:
  - All of the major functions (subprograms) described in the program design specification are presented in the PDD.
  - All program logic is fully described.
  - The detailed design of each subprogram is fully described.
  - For each major procedure or subroutine a flow diagram is provided that specifies all operations performed and includes all equations used in mathematical computations.
  - The PDD contains the required level of detail for all subprogram tables, variables, flags, and indexes.
  - The PDD contains a complete listing of all local and common data base references and the location of each reference.
  - A brief description and graphic representation of each input and output message, card format, and tape format is presented.
  - All system library subroutines are listed.
  - System conditions that must exist for subprogram initiation are described.

- •• All known or anticipated subprogram limitations are summarized.
- •• An interface description is provided showing the functional relationships of the subprogram with other subprograms, system subroutines, and executives with which it interfaces.
- •• The computer resource limitations established in the PPS and PDS are being met.

- The program package document includes the source form of the digital processor program (card deck, mag tape, paper tape) and all of the program material items such as the sources listing, source/object listings, and other data necessary for proper program running. When reviewing this data during PPBCA, the audit team should ensure the following:
  - •• All items making up the program package are properly identified.
  - •• The source form of the digital processor program is compatible with the equipment in the user's facility.
  - •• The source program listing is an exact duplication of the data contained on the magnetic tape or card deck that includes the source form.
  - •• The source/object listing is error-free and reflects an exact presentation of the source and object programs (the source/object listing is provided by the supporting compiler or assembler).
  - •• The program package contains a cross-referenced table of statements that make up the digital processor program. Statements are cross-referenced by mnemonic labels and the address of each reference to the label.
  - •• Object patches within the limits of MIL-STD-1679 are properly documented as part of the configuration item.
  - •• PAT test documentation - The FAT demonstrates the total operating capability of the PA with all its functions integrated into one complete program. The criteria to be considered in a review of the PAT test documentation are the same as those contained in Section 3.3.4.

Minutes of the PPBCA containing all findings of the audits shall be submitted to PCDSSA within two weeks by the V&V agent. The V&V agent shall monitor the completion of all post-audit action items necessary to complete the audit satisfactorily. When this is accomplished, PCDSSA will request NAVSEA 612 to establish the preliminary product baseline.

3.3.3 Configuration Management

CM during the program-design phase is concerned with two types of products: documentation and computer programs. CM of documentation is

similar to that described in Section 3.1.3, except that the following additional documents are under CM:

- PDS
- DBDD

The procedures and responsibilities for processing ECPs to documents being configuration-managed are the same as these described in Section 3.1.3.

Computer programs, like documentation, require the discipline of CM once they have been approved by the customer and established as a baseline. This approval occurs at the establishment of the preliminary product baseline. During the program-code-and-debug phase, the computer program has not yet been defined as a baseline, and formal code control procedures mandated by the Government are not necessary. However, it is incumbent upon the software developer to use proper CM procedures internally. Thus, it is required that the software developer, at the completion of SP/MT, adopt procedures for code control internal to his organization. These procedures shall require that the programmer be prohibited from modifying, either by patch or recompile, any code that has successfully passed SP/MT unless a written software problem report, or an ECP, exists to justify the change. The format for the software problem reports may be of the developer's own choosing. The procedures shall be furnished to the V&V agent, who shall be responsible for auditing their use.

3.3.4 Test and Evaluation

As shown in Figure 2-2, the test and evaluation activity during the program-code-and-debug phase is as follows:

- Conduct of SP/MT and FT
- Development of PAT test documentation
- Test tool specification, development, and certification for PAT

3.3.4.1 Conduct of SP/MT

Both SP/MT and FT are conducted during this phase. SP/MT is accomplished primarily by individual programmers using module drivers, such as the static environment test tool (SETT) on Share/7 at FCDSSA. The primary purpose of SP/MT tests is to demonstrate that the internal logic of the module is correct. Because of the nature of the SP/MT tests, the witnessing of each SP/MT test by the V&V agent is impractical. The software developer, however, shall provide a duplicated Share/7 file of the code undergoing SP/MT to the V&V agent, so that he can independently test the code with the SETT. The V&V agent shall not attempt to duplicate test cases used by the software developer, but shall concentrate on the following:

- Testing for unexpected inputs
- Testing for boundary conditions

- Testing unusual test cases
- Testing accuracy of all equations over the entire range of expected inputs
- Testing other cases not exercised by the software developer

Test coverage analyzers and test data generators may be used by the V&V agent if available. Test problems are reported directly to the software developer, with resolution by FCDSSA if agreement cannot be reached between the V&V agent and the software developer.

At the conclusion of all SP/MTs, the software developer submits a written test report to FCDSSA. This report shall be reviewed by the V&V agent to determine if the SP/MT test results are satisfactory. He advises FCDSSA whether the software developer should be authorized to begin FTs.

3.3.4.2 Conduct of FT

The software developer is responsible for scheduling, conducting, and reporting all FTs. The V&V agent has the responsibility to monitor the conduct of FTs and independently assess test status for FCDSSA. The software developer shall supply the V&V agent with the latest version of the internally approved computer program object code, in a form suitable for direct loading. The V&V agent shall use this program to conduct independent evaluations of the program if he judges this necessary for proper evaluation of the code. Problems found by the V&V agent during test monitoring and independent evaluations shall be reported to FCDSSA on the same form the software developer is using internally. These reports shall be treated by the software developer like problem reports written by his own test personnel.

At the conclusion of FT, the software developer submits a formal test report documenting the results of all FTs. The V&V agent shall review the FT test report to ensure the following:

- All tests contained in the FT test procedures have been conducted and reported.
- FT acceptance criteria are met.
- Unresolved problems requiring resolution prior to FAT are identified.
- The number of software errors is less than the limits specified by MIL-STD-1679.
- The number of object patches does not exceed the limit specified in MIL-STD-1679.

All comments on the FT test report by the V&V agent are to be resolved prior to the FFBCA.

3.3.4.3 Development of PAT Documentation

PAT involves the integration of all PAG functions into a complete program that is tested as a complete system. Since PAT requires the proper operation of all functions, it is not started until FT requirements are completely satisfied. PAT is performed to accomplish the following:

- Ensure that the total man-machine interface is completely validated
- Ensure proper system initiation, data entries via peripheral devices, program loading, restarting, and the monitoring and controlling of PAG operation from appropriate control stations
- Ensure the proper interfacing of all equipment specified in the PPS
- Ensure the capability of the PAG to satisfy all PAG requirements contained in the SOD and PPS
- Ensure the capability of the system to handle erroneous inputs properly and survive them
- Ensure the proper interfacing of all computer programs specified in the IDSs

Table 3-3 lists the responsibilities for developing the PAT test plan, test specification, test procedures, and test tools.

Table 3-3. RESPONSIBILITIES FOR PAT TEST DOCUMENTATION AND TEST TOOLS

Item	Responsibility				
	Requirements Analysis	Development	Testing	Reviewing	Approval
Test plan	V&V agent	V&V agent	N/A	FCDSSA	NAVSEA 612
Test specification	V&V agent	V&V agent	N/A	FCDSSA	FCDSSA
Test procedures	V&V agent	V&V agent	N/A	FCDSSA	FCDSSA
Test tools	FCDSSA	Software developer	Software developer	V&V agent	FCDSSA*

*Certification.

The PAT test plan shall define the total scope of the testing to be performed, containing precise statements of the purpose, scope, and schedule of the individual test being planned. It shall be prepared by the V&V agent in accordance with the requirements of MIL-STD-1679 and DID DI-T-2142. In addition, a traceability analysis shall be performed by the V&V agent to ensure that each requirement in the PPS and PDS is covered by a test in the PAT test plan and that each test in the PAT test plan is traceable to a performance requirement in the SOD or PPS. Results of this analysis are to be reported to FCDSSA. The completed PAT test plan is to be submitted to FCDSSA, who will review it for acceptability and submit it to NAVSEA 612 for final approval.

The PAT test specification contains test specifications for each test contained in the PAT test plan. The V&V agent shall prepare the PAT test specification in accordance with the requirements of MIL-STD-1679 and DID DI-E-2143. Specifically the PAT test specification shall meet the following criteria:

- Each test in the PAT test plan has a corresponding test specification.
- Test criteria are identified.
- Test methods are explained.
- The purpose of each test is identified.
- The software to be tested and the scope of each test is identified.
- Support requirements, inputs, required accuracies, expected output, and data collection methods for each test are identified.
- System interfaces, method of data exchange, timing requirements, degraded operations, casualty recovery, and display requirements are identified.

The PAT test specifications are submitted to FCDSSA for review and approval.

The PAT test procedures give detailed instructions for test execution and for evaluation of the results of each test specified. They shall be developed from the PAT test specification and relevant design documents by the V&V agent in accordance with MIL-STD-1679 and DID DI-T-2144. The PAT test procedures shall meet the following criteria:

- The organization or structure of the procedure and any assumptions or any constraints on its usage are identified.
- Detailed instructions for the setup and operation of each test are presented.
- The total equipment, hardware, digital processor programs, and support items required for each operation are described.
- The requirements for each mode of operation are specified if they differ from the total requirements.

- Equipment required for operation is identified by official nomenclature.
- Materials and personnel required for the performance of the test are identified.
- The test setup and energizing procedures are given.
- The program loading procedure is given.

Completed PAT test procedures are reviewed and approved by FCDSSA.

Requirements for test tools used during PAT are specified by FCDSSA and developed by the software developer, as shown in Table 3-3. All test tools used for PAT are to be reviewed and verified by the V&V agent and certified by FCDSSA prior to completion of the program-code-and-debug phase. Once the PAT test tools have been certified, they shall be configuration-managed by FCDSSA in a manner similar to that for the PAG documentation and computer programs.

3.3.5 Status Reports

During the program-code-and-debug phase, the V&V agent shall submit monthly status reports to FCDSSA and NAVSEA in addition to those submitted as a result of specific activity, such as document review or PAT test documentation. These reports shall contain at least the following information:

- An assessment of program progress with respect to planned schedules
- A description of outstanding technical problems requiring resolution
- Reports of FT test status, including number of tests planned, number of tests conducted, and number of problems reported
- A summary of the tasks performed during the past month
- A summary of tasks planned for the coming month

3.4 PROGRAM-ACCEPTANCE-TEST PHASE

The program-acceptance-test phase begins with the establishment of the preliminary product baseline and ends with the establishment of the final product baseline. Figure 2-2 shows the activity that occurs during this phase. The object of this phase is to test the developed product to ensure that it meets all PAG requirements contained in the SOD and PPS. The formal acceptance of the product by the Navy is based on the results of the testing conducted during this phase. This is the last phase where the PAG is tested as an entity; the next phase (the system-test phase) tests the entire JTIDS system end-to-end, and the PAG is only one component of the system under test.

The only other activity that occurs during this phase is the development of test documentation for the system integration test (SIT) and Navy interoperability test (NIT), and the specification, development, and

certification of any test tools required for SIT and NIT that have not previously been required.

3.4.1 Documentation Review

Except for the test documentation addressed in Section 3.4.4, no formal documentation is developed during this phase. All PAG specification and design documents have already been approved and are under CM. Updates to the configuration-managed documents will only reflect the incorporation of approved ECPs and problem resolutions. Updated documentation that is revised to include approved SCNs shall be reviewed by the V&V agent to ensure that all SCNs are properly incorporated and are highlighted by a vertical black bar in the margin.

3.4.2 Design Reviews and Audits

The final product baseline configuration audit (FPBCA) is held at the completion of the program-acceptance-test phase. The purpose of the FPBCA is to verify formally that the PAG computer program meets the performance requirements in the SOD and the PPS, that it is consistent with program documentation, and that all modifications found necessary as a result of PAT have been properly incorporated into the program package and supporting documentation. Upon satisfactory completion of the audit, the final product baseline is established.

FCDSSA has the responsibility to schedule and conduct the FPBCA. It shall notify attendees by official correspondence at least 30 days in advance of the scheduled date. Attendees at the FPBCA shall include the following:

- NAVELEX, PME-109
- NAVSEA 612
- FCDSSA, San Diego
- V&V agent
- Software developer
- OPTEVFOR
- NOSC
- PAG IDS interfacing agencies

The latest version of the following documents shall be made available to the FPBCA attendees:

- FPS
- FDS
- DBDD
- PDD

- Source code listings
- PAT test reports

Attendees are required to review the PAG computer program at the lowest level. Attendees should therefore be limited to those individuals with the expertise to conduct a thorough review at this level. FCDSSA shall ensure that the software developer has key programming and design personnel in attendance or on call to provide assistance as necessary. The V&V agent has the responsibility to be the technical lead for the FPBCA and describe all findings of the FPBCA audit team for transmittal by FCDSSA to the software developer. The V&V agent shall ensure that the following documents are reviewed in accordance with the following criteria:

- PAT test reports document the results of PAT and provide the basis for contractual acceptance of the product by the Government. The audit team shall ensure the following:
  - PAT was conducted in accordance with the approved PAT test procedures.
  - All deviations from the PAT procedures are adequately documented, with supporting rationale to explain their necessity.
  - All discrepancies and anomalies that occurred during testing are resolved to the satisfaction of the audit team.
  - The PAT test report includes an overall analysis of the performance of the PAG with respect to the PAG requirements contained in the SOD and PPS.
  - The number of software errors is within the limits specified by MIL-STD-1679.
  - The number of object patches is within the limits specified by MIL-STD-1679.
  - Test data are maintained in a test data file for future reference.
- The PDD is reviewed to ensure that all changes to the computer program as a result of PAT are properly contained in the PDD. The updated PDD shall be reviewed to ensure that it still meets the requirements applicable to the PPBCA contained in Section 3.3.2.
- The program package document shall be reviewed to ensure that all changes to the computer program as a result of PAT are properly contained in the program package document. Criteria contained in Section 3.3.2 for review of the program package document shall be used during the FPBCA.
- SIT test documentation: The SIT validates the integration of hardware and software of all JTIDS platform components (terminal, PAG, and CDS) into a total system. These documents are reviewed to ensure that the functions of the PAG are extensively and correctly tested during the JTIDS SIT.

- NIT test documentations: The NIT demonstrates the simultaneous interoperability in a realistic operational environment of three JTIDS equipped platforms: a carrier (CV), an E-2C aircraft, and an F-14A aircraft. These documents are reviewed to ensure that the functions of the PAG are extensively and correctly tested during the JTIDS NIT.

Minutes of the FFBCA containing all findings of the audit team shall be submitted to FCDSSA within two weeks by the V&V agent. The V&V agent shall monitor the completion of all post-audit action items necessary to complete the audit satisfactorily. When this is completed, FCDSSA will request NAVSEA 612 to establish the final product baseline.

3.4.3 Configuration Management

During the program-acceptance-test phase, all PAG products are under formal CM, including the program specifications and design documents and the computer program itself. Procedures and responsibilities for processing ECPs to all configuration-managed documents are the same as those described in Section 3.1.3. This is the first phase, however, where the computer programs have been under the formal discipline of CM.

During PAT, it is imperative that the configuration of the PAG computer program undergoing test be known at any time. This is accomplished by placing the computer program that forms the basis of the preliminary product baseline under the control of a software library maintained by the FCDSSA Configuration Management Office (CMO). All formal tests conducted during the program-acceptance-test phase are to be run with a computer program obtained by the software librarian. The software librarian is not authorized to change the computer program stored in his library and has the responsibility to safeguard it against changes, inadvertent or intentional, by others. He will therefore maintain duplicate master records and make periodic comparisons of the programs checked out of the library with the master records. The only method of updating the software library is to accept from FCDSSA an approved, recompiled computer program or approved object patches resulting from either a resolution of a software trouble report (TR) or new requirements contained in an approved ECP.

Software TRs are written to record any discrepancy found during any part of PAT, whether informal testing, dry runs, or formal testing. TRs may be initiated as a result of any of the following:

- Discrepancies in documentation
- Incomplete or inaccurate test documentation
- Computer program errors

Software TRs shall show all essential data on each software problem detected during test, including the following as applicable:

- Date
- Category in accordance with MIL-STD-1679
- Priority in accordance with MIL-STD-1679
- Control number
- Title
- Program designation
- Program document against which the TR is written
- Site
- Identification of computer program under test (not applicable for documentation)
- Reference document
- Function affected
- Module affected
- Test step
- Originator
- Activity and/or code of originator
- Telephone number of originator
- Elapsed time into test from program start
- Simulation used
- Other sites and programs linked with
- Transients loaded in memory when problem occurred
- Ability of problem to be duplicated
- Memory dump data reference
- Trouble description
- Computer hardware and register status

The test conductor shall have the authority to designate the responsible personnel to prepare and submit TRs during any test.

All TRs shall be forwarded to the FCDSSA CMO for action and record-keeping purposes. Upon receipt of a TR, the CMO will assign a serial number and log it into a TR data base. Duplicate TRs will be eliminated by the CMO. The TR is then forwarded to the FCDSSA program manager, who verifies the priority designated by the originator, assigns the responsibility for

recommending corrective action, and determines the response data based on the priority. The following priority categories shall be used:

- Priority 1 - An error that prevents the accomplishment of an operational or mission-essential function in accordance with official requirements (e.g., causes a program stop), that affects an operator to the extent that the operator prevents the accomplishment of an operational or mission-essential function, or that jeopardizes personnel safety

- Priority 2 - An error that adversely affects the accomplishment of an operational or mission-essential function in accordance with official requirements so as to degrade performance and for which no work-around solution exists, or that interferes with an operator to the extent that the operator adversely affects the accomplishment of an operational or mission-essential function so as to degrade performance and for which no work-around alternative exists (Reloading or restarting the program is not an acceptable work-around alternative.)

- Priority 3 - An error that adversely affects the accomplishment of an operational or mission-essential function in accordance with official requirements so as to degrade performance and for which there is a reasonable work-around alternative, or that interferes with an operator to the extent that the operator adversely affects the accomplishment of an operational or mission-essential function so as to degrade performance and for which there is a reasonable work-around alternative (Reloading or restarting the program is not an acceptable work-around alternative.)

- Priority 4 - An error that is an inconvenience or annoyance to the operator but does not affect a required operational or mission-essential function

- Priority 5 - All other errors

The FCDSSA CMO shall maintain a historical TR data base containing the following information about each TR written against the PAG computer program:

- Identification number
- Title
- Summary description problem
- Priority
- Required resolution date
- Action assignee
- Actual resolution date

- Summary of resolution
- Status (open, closed, withdrawn)

The CMO shall also publish a weekly written report on the status of all open (unresolved) TRs.

Corrective-action assignees shall recommend one of the following types of corrective action, or a corrective action not listed below if a special situation exists:

- Correction by object patch
- Correction by source recompile
- Correction by documentation change
- Correction by ECP
- Waiver
- Withdrawal because problem cannot be duplicated
- Withdrawal because program was operating correctly

The V&V agent shall review all recommended problem corrections and advise FCDSSA on their acceptability. He shall monitor the extent of object patches in the system with respect to the limits established by MIL-STD-1679 and recommend when all or part of the computer program must be recompiled to eliminate object patches. He shall also identify the specific corrections recommended for inclusion in the recompile.

When FCDSSA approves a problem correction that requires either the development of an object patch or a recompile of the computer program by the software developer, the V&V agent shall determine the amount of retest or regression testing required before delivery of the patch or recompiled program to FCDSSA, witness the required testing, and evaluate the test results. Upon satisfactory completion of the required testing, the FCDSSA program manager shall authorize the software library to accept the recompiled computer program or object patches.

3.4.4 Test and Evaluation

As shown in Figure 2-2, the test and evaluation activity during the program acceptance test phase is as follows:

- Conduct of PAT
- Development of SIT and NIT test documentation
- Specification, development, and certification of test tools for SIT and NIT

The purpose of the PAT is to ensure that the PAG satisfies all the requirements of the SOD and PPS. The interaction of all component functions

shall be tested. The operating capabilities to be demonstrated include the following:

- Program loading and initialization
- Interface communication and message traffic exchange
- System capacities, accuracies, and limitations
- Visual display indicators
- Data entry
- Operator interface
- Data processing and output
- Degraded modes and system recovery

FCDSSA is responsible for scheduling and directing all the test activities associated with PAT. The V&V agent is to act as test conductor and report the results of PAT. Formal PAT is to be conducted in accordance with approved PAT test plans, test specifications, and test procedures using configuration-managed software obtained from the software library. Formal PAT may be preceded, however, by informal testing using unapproved test procedures and unapproved object patches to facilitate the resolution of problems.

At the conclusion of PAT, the V&V agent shall submit a formal test report to FCDSSA documenting the results of PAT and containing the following:

- A report of the conduct of each test included in the PAT test specification
- A report on whether PAT acceptance criteria have been met
- A list of open TRs requiring resolution prior to SIT
- A report on whether a twenty-percent reserve exists for total system memory, input and output channels, and processing time
- A report on whether the number of software errors is within the limits specified by MIL-STD-1679.
- A report on whether the number of object patches is within the limit specified in MIL-STD-1679.

The purpose of SIT is twofold. First, SIT validates the integration of hardware and software of all JTIDS platform components (terminal, PAG, and CDS) into a complete platform system consisting of the hardware and software of the JTIDS terminal, the PAG, and the CDS. SIT includes such tests as validation of the total platform man-machine interface and validation of system initiation, program loading, and controlling of system operation. Second, SIT validates the system capability of JTIDS against the requirements of the SOS and SOD. This includes validation of the capability to perform the following functions:

- Transmit information received from the host platform CDS in the proper format

- Forward properly formatted messages received from an external source to the host platform CDS

Table 3-4 lists the responsibilities for developing the SIT test plan, test specification, test procedures, and test tools.

Table 3-4. RESPONSIBILITIES FOR SIT TEST DOCUMENTATION AND TEST TOOLS

Item	Responsibility				
	Requirements Analysis	Development	Testing	Reviewing	Approval
Test plan	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test specification	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test procedures	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test tools	FCDSSA*	FCDSSA*	FCDSSA*	NAVSEA 612	PME-109

*Assisted by V&V agent.

The SIT test plan will define the total scope of the testing to be performed, containing precise statements of the purpose, scope, and schedule for the individual tests being planned. Specific testing shall include the following:

- Connectivity
- Message selection and addressing
- Relative navigation
- Subscriber functions
- Secure voice
- Platform CDS to PAG to terminal translation, protocol, and buffering

The V&V agent shall assist FCDSSA in ensuring that system tests are defined that test the PAG computer programs to the maximum practical extent.

The SIT test specification contains test specifications for each test contained in the SIT test plan. The V&V agent shall assist FCDSSA by reviewing test specifications that involve the PAG and by preparing technical inputs to the SIT test specifications as required.

The SIT test procedures contain detailed instructions for test execution and evaluation of the results of each test specified. The V&V agent shall assist FCDSSA by preparing detailed test procedures for those tests involving PAG operation and by reviewing all test procedures to ensure that PAG operations are properly identified.

The purpose of NIT is to demonstrate, in a realistic operational environment, the simultaneous interoperability of F-14A, E-2C, and CV platforms equipped with JTIDS. NIT will validate the capability of the JTIDS platforms to interoperate and perform the following functions:

- Transfer information
- Compute and transmit own relative position
- Identify targets
- Process and disseminate tactical data

Table 3-5 lists the responsibilities for developing the NIT test plan, test specification, test procedures, and test tools. The role of the V&V agent during the development of the NIT test documentation is the same as during the development of the SIT test documentation: assisting FCDSSA by providing technical input and review to ensure that PAG is extensively and correctly tested.

Requirements for test tools used during SIT are specified and developed by FCDSSA. All test tools involving the PAG shall be verified by the V&V agent prior to certification by FCDSSA. Once the SIT and NIT test tools have been certified, they shall be configuration-managed by FCDSSA like the PAG documentation and computer programs.

Table 3-5. RESPONSIBILITIES FOR NIT TEST DOCUMENTATION AND TEST TOOLS

Item	Responsibility				
	Requirements Analysis	Development	Testing	Reviewing	Approval
Test plan	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test specification	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test procedures	FCDSSA*	FCDSSA*	N/A	NAVSEA 612	PME-109
Test tools	FCDSSA*	FCDSSA*	FCDSSA*	NAVSEA 612	PME-109

*As assisted by V&V agent.

3.4.5 Status Reports

During the program-acceptance-test phase, the V&V agent shall submit monthly status reports to FCDSSA and NAVSEA, in addition to those submitted as a result of specific activities, such as document review or PAT test plan development. They will contain at least the following information:

- An assessment of program progress with respect to planned schedules
- A description of outstanding technical problems requiring resolution
- Reports of PAT test status, including number of tests planned, number of tests conducted, and number of TRs reported
- A summary of the tasks performed during the past month
- A summary of tasks planned for the coming month

3.5 SYSTEM-TEST PHASE

The system-test phase begins with the establishment of the final product baseline and ends with the establishment of the operational baseline. At this point the JTIDS system is ready to be deployed. The object of this phase is to test the integration of the hardware and software of all the JTIDS components and validate the interoperability of JTIDS-equipped platforms. This testing validates that the complete JTIDS system can meet the requirements contained in the TOR and IDR. During this phase of testing the PAG is not tested as an entity, but only as a unit of the overall system being tested. Consequently, personnel associated with PAG development and test have only a support role in this phase.

The activity that occurs during the system-test phase is shown in Figure 2-2 as follows:

- Conduct of SIT
- Conduct of NIT
- Technical evaluation (TECHEVAL)
- Operational evaluation (OPEVAL)

3.5.1 Documentation Review

No formal documentation is developed during the system-test phase. All PAG specifications and design documents have already been approved and are under CM. Updates to the configuration-managed documents will only reflect the incorporation of approved ECPs and TR resolutions. Updated documentation that is revised to include approved SCNs and TRs shall be reviewed by the V&V agent to ensure that all SCNs are properly incorporated and are highlighted by a vertical black bar in the margin.

3.5.2 Design Reviews and Audits

The operational baseline configuration audit (OBCA) is held at the completion of the system-test phase. The purpose of the OBCA is to evaluate the results of SIT, NIT, TECHEVAL, and OPEVAL and to verify that the JTIDS system meets the requirements of the TOR and IDR. Upon successful completion of the OBCA, the operational baseline will be established and the system will be ready for production and fleet installation..

NAVELEX, PME-109 has the responsibility to schedule and conduct the OBCA. In conducting the OBCA, it will follow the same general policies and procedures defined for FCDSSA during the FPCBA, as contained in Section 3.4.2. The VAV agent shall assist in the review of the following documents as they apply to the IAS computer programs:

- SIT test report
- NIT test report
- TECHEVAL report
- OPEVAL report

3.5.3 [illegible]

[illegible] the system-test phase, all IAS products, both documentation and computer programs, are under CM. Procedures and responsibilities for [illegible] to all configuration-managed documents are the same as described in Section 3.4.3; "Software Management of computer programs shall [illegible] as defined in Section 3.4.3. Therefore, changes to the [illegible] shall result from an approved ECP or TR resolution. [illegible] as defined in the Software Guidelines in Section 3.4.3.

The VAV agent shall assist to review the recommended corrective actions, and shall then advise FCDSSA of their acceptability. The extent of [illegible] present in the IAS computer program shall also be monitored by the VAV agent, with appropriate recommendations to recompile as the limits specified in MIL-STD-1679 are approached. When a recompile recommendation is made, the VAV agent shall specify the amount of regression testing required. Recommendations to recompile shall be approved by NAVSEA 612 during the system-test phase, and the VAV agent shall conduct the necessary regression tests after recompilation by the software developer. Test results shall be [illegible], who shall obtain the approval of NAVSEA 612 before [illegible] the software library to accept an updated computer program delivery.

3.5.4 Test and Evaluation

As shown in Figure 3-, the test and evaluation activity during the system-test phase is as follows:

- SIT conduct
- NIT conduct

- TECHEVAL
- OPEVAL

The purpose of SIT is to validate the integration of hardware and software of all JTIDS platform components and to validate the system capability of JTIDS against the requirements contained in the SOS and SOD. SIT will be conducted in the integrated combat system test facility (ICSTF). NAVELEX, PME-109 is responsible for the conduct of SIT. The V&V agent shall witness all testing to assess the performance of the IAS during SIT and assist in conducting tests involving the IAS.

The purpose of NIT is to demonstrate, in a realistic operational environment, the simultaneous interoperability of F-14A, F-2C, and CV platforms equipped with JTIDS. NIT will be conducted in the ICSTF. NAVELEX, PME-109 is responsible for the conduct of NIT. The V&V agent shall witness all testing to assess the performance of the IAS during NIT and assist in conducting tests involving the IAS.

TECHEVAL certifies that the [illegible] meets the requirements of the TOR and IDR and is ready for [illegible] OPEVAL is conducted in a combination of shore-based laboratories and [illegible] platforms. The JTIDS components are tested for proper interface [illegible] pseudo-operational conditions. TECHEVAL evaluates the [illegible] and technical design and the ease with which Navy personnel can operate, maintain, and logistically support the JTIDS platform [illegible] part of the platform suite of equipment.

NAVELEX, PME-109 is responsible for the planning, preparation of test documentation, conduct, and [illegible] TECHEVAL. Commander, OPTEVFOR (COMOPTEVFOR) is responsible for the conduct of Navy platform or shore-based [illegible], as directed by the Chief of Naval Operations (CNO), for the [illegible] OPEVAL. At the conclusion of TECHEVAL, COMOPTEVFOR will prepare a TECHEVAL report for submission to CNO. The V&V agent will prepare a TECHEVAL report on the performance of IAS, and prepare a report of the SIT data to NAVELEX. NAVELEX will evaluate its findings along with those of the V&V agent and submit a report to PME-109.

The intent of OPEVAL is to evaluate the mission effectiveness, suitability, and capability of the JTIDS system to meet the performance requirements contained in the TOR and IDR.

OPEVAL will begin when PME-109 judges the system ready for OPEVAL and will be conducted on board the host platforms. COMOPTEVFOR is responsible for overall OPEVAL execution and will develop the OPEVAL test documentation, coordinate the activities of the JTIDS test platforms, coordinate the test conduct, and report the results to CNO. PME-109 shall provide all personnel needed to install and certify all equipments and computer programs and will provide technical support for the JTIDS equipment and computer programs. Witnessing of OPEVAL by the V&V agent will be as determined by PME-109.

3.5.5 Status Reports

During the system-test phase, the V&V agent shall submit monthly status reports to FCDSSA and NAVSEA, in addition to those submitted as a result of specific activities, such as an ECP review. They will contain the following:

- An assessment of program progress with respect to planned schedules
- A description of outstanding technical problems requiring resolution
- Reports of SIT, NIT, and TECHEVAL test status as applicable to the PAG, including number of tests planned, number of tests conducted, and number of TRs reported
- A summary of the tasks performed during the past month
- A summary of tasks planned for the coming month

3.6 MAINTENANCE PHASE

The maintenance phase begins with the establishment of the operational baseline at the conclusion of the OBCA. The JTIDS system is not deployed operationally as full production begins.

Although development has been completed, there is still a need for software QA activity in the maintenance phase. Previously undiscovered problems will normally be encountered by operational forces. The need for changes to the system requirements may become more apparent when the system is deployed than while it is undergoing testing. Thus, error corrections and incorporation of new requirements will cause the PAG computer programs to be modified.

The need to maintain the PAG computer programs under CM is not reduced merely because the computer programs are no longer under development. To control the configuration of the PAG computer programs properly, the changes to the operational baseline should be controlled as rigidly as changes to previous baselines. This requires that changes to the PAG computer programs be made only in response to an approved TR (or its equivalent) or ECP. The incorporation of tested, approved object patches into the PAG computer programs by operational forces will be governed by future Navy policy decisions, but should be reviewed for emergency situations.

Software QA tasks that should be performed during this phase will include the following:

- Evaluation of TRs
- Validation of ECPs
- Test and evaluation of proposed changes
- Performance of periodic audits to ensure CM integrity of the operational baseline

Since these QA tasks will likely be performed by organic Navy personnel, specific requirements for task performance will not be specified by this plan. In general, however, they should be performed as carefully during the operational life of the PAG as during development.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