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ONE-YEAR PROGRAM PLAN FOR TEST PROGRAM SET QUALITY ASSURANCE, (U)

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CERCOM/CORADCOM

Product Assurance Directorate

**ONE-YEAR PROGRAM PLAN FOR TEST PROGRAM SET
QUALITY ASSURANCE**

Prepared for

U.S. ARMY COMMUNICATIONS AND ELECTRONICS READINESS
COMMAND/COMMUNICATIONS RESEARCH AND DEVELOPMENT COMMAND

DIRECTORATE OF MAINTENANCE
DIRECTORATE OF PRODUCT ASSURANCE
FORT MONMOUTH, NEW JERSEY 17703

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PREPARED
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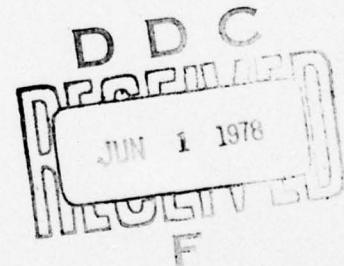
One-Year Program Plan for Test Program Set
Quality Assurance

Prepared for

U.S. Army Communications and Electronics Readiness
Command/Communications Research and Development Command
Directorate of Maintenance
Directorate of Product Assurance
Fort Monmouth, New Jersey 17703
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1. INTRODUCTION

1.1 Background

The United States Army is developing and deploying billions of dollars worth of sophisticated electronically controlled weapon and support systems. These systems perform more functions and have more complex circuits and subsystems than conventional systems; more highly skilled personnel and more advanced automated support systems are therefore required to maintain them.

→ The Automatic Test Equipment (ATE) is ^{2/a} ~~one of the~~ major items considered during Integrated Logistic Support (ILS) ^g Planning (AR-700-127) which is required for all weapon systems. A number of studies have shown that ATE is cost-effective, provides more consistently accurate and faster results, and offers the level of test integrity required to ensure acceptable material readiness.

→ Critical elements of automatic test support are the applications software programs written to test the individual parts or subsystems of the system. These software programs are called Test Program Sets (TPSs), and the subsystems ^a that they test are called the Units Under Test (UUTs). The TPS consists of a hardware Interface Device (ID) ^g that physically connects the UUT to the ATE, and a computer program that controls the ATE functions by automatically selecting and routing stimuli to the UUT and automatically measuring UUT response. ^g ~~Test Program Sets~~ constitute more than 70 ^g percent of ATE expenditures in the Army today, and will continue to represent an increasingly larger percentage of the total ATE expenditure; ^{→ cont. on p 2} ensuring their effectiveness in terms of both performance and maintainability has thus become a major concern of the Army. For example, Tobyhanna

Army Depot today maintains fewer than 1000 Test Program Sets for all the Army commodities that it supports. The CORADCOM Program Managers alone are expected to develop more than 2000 Test Program Sets in the next few years. CERCOM/CORADCOM Product Assurance Directorates (PADs) have a vested interest in establishing plans and guidelines for TPS acquisition, operation, and support. This one-year near-term plan has been developed to coordinate management efforts toward improving acquisition, use, and configuration control of Test Program Sets.

1.2 Purpose

This one-year plan outlines the Product Assurance Directorate near-term proposed objectives and establishes near-term tasks and responsibilities for initiating CERCOM/CORADCOM Product Assurance activities that will ultimately provide satisfactory material readiness through the use of effective ATE.

1.3 Scope

→ This report addresses the

The one-year plan addresses Government Product Assurance Directorate activities to initiate the establishment of effective policies and procedures for TPS quality assurance. It is applicable to the Product Assurance Directorates of both CERCOM and CORADCOM and will be distributed to other directorates, offices, and activities for information and guidance.

1.4 Applicable Documents

(CERCOM/CORADCOM Regulations were not available at publication time; therefore, applicable ECOM Regulations are listed.)

1. ECOMR 10-1, Product Assurance Directorate Charter
2. ECOMR 702-13, Management of Computer Software QA
3. MIL-S-52779, Software QA Program Requirements
4. AR 702-4, Procurement QA

5. ASPR XIV, Procurement QA

6. MIL-Q-9858A, Quality Program Requirements

1.5 Organization

The plan is organized in three sections. This section has provided a brief historical background, the purpose and scope of the plan, and a list of applicable documents.

Section 2 briefly describes the primary phases in the life cycle of TPSs, beginning with the development of the UUT and ending with TPS operational support and maintenance. This description is included in the plan to provide the reader a basic definition of the TPS life cycle during which quality assurance activities will be occurring.

Section 3 sets forth the overall Product Assurance Directorate quality assurance objectives. For each of these objectives, near-term Product Assurance Directorate tasks are described in detail and task responsibilities are established; a proposed implementation schedule is also presented.

2. TEST PROGRAM SET LIFE-CYCLE ACTIVITIES

The major phases in the life cycle of TPSs are illustrated in Figure 1. Most of the activities described here are performed by the TPS contractor, who is responsible for developing a program to control TPS quality. The role of Government quality assurance personnel is to review the analysis, implementation, and tests, and to perform evaluations to determine compliance with the procurement guidelines. Witnessing of final acceptance tests is not sufficient to ensure TPS quality. It is recommended that the Government participate in the various stages of TPS development and use throughout the TPS life cycle. The following paragraphs describe Government and contractor activities as the TPS life cycle progresses.

2.1 Contractor QA Plan and Source Data Familiarization

In the initial step of TPS development, the contractor prepares a Test Program Set Quality Assurance Plan for control of the TPS development activities. The plan addresses schedules of activities, audits and reviews, configuration management practices, and documentation requirements. Interface device design and reliability, maintainability, and test requirements will also be included in the QA plan, as will UUT and ATE station requirements and any other facilities and equipment requirements for TPS quality control and acceptance.

An important part of the TPS QA Plan will be the provision for compatibility with the ATE and procedures to ensure proper configuration control of the TPS, handling of change proposals, and maintenance and updates of the configuration control baselines.

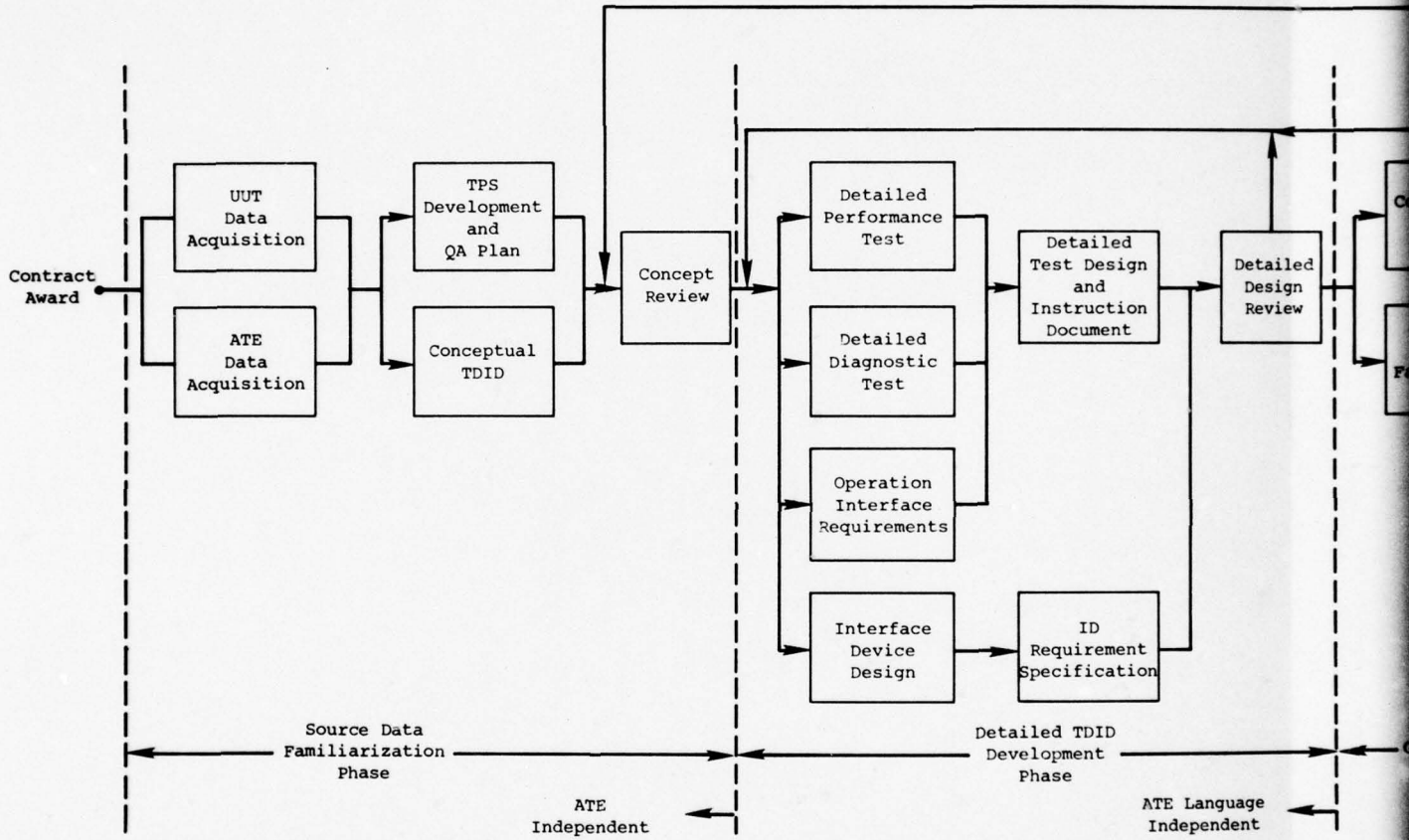


Figure 1. TPS LIFE

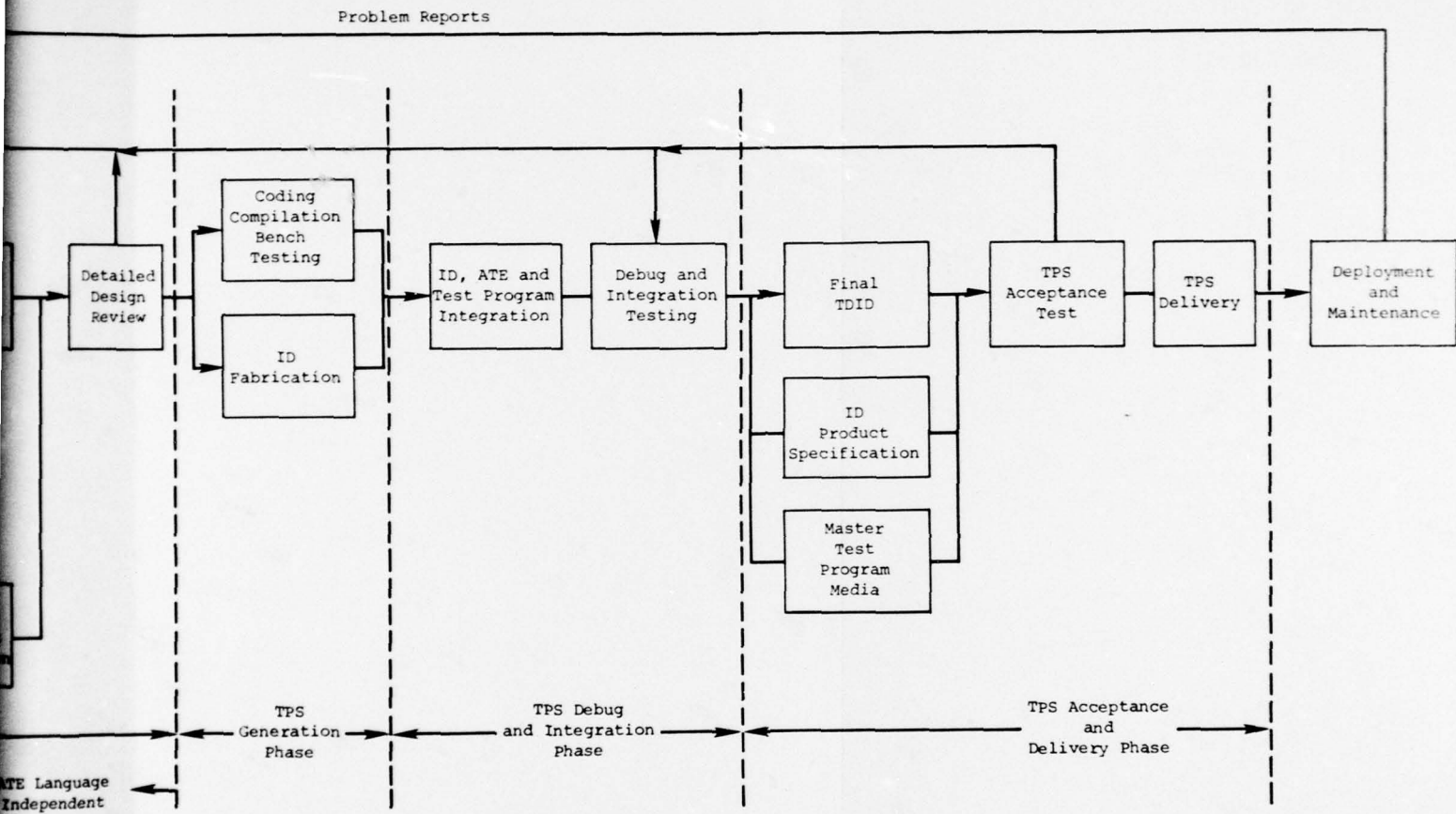


Figure 1. TPS LIFE CYCLE PHASES

TPS development starts when the contractor test design engineers familiarize themselves with available data on the UUTs and the proposed ATE. The following types of data represent the minimum that should be available to the test designer:

- UUT - Test Requirements Document (TRD), which includes specifications, block diagrams, schematics, failure analyses, reliability/maintainability analyses, acceptance test procedures, built-in-test description, design-to-testability analyses, operations manuals, etc.
- ATE - Complete performance specifications for both system and building blocks, operations and maintenance manuals, performance history reports, etc.
- General - Test Program Set development guidelines, including test structure and design guides, coding documentation, and test and acceptance requirements.
- ATE Software - a complete set of programming manual, users' guide, compiler operations manual, higher order language description, software trouble reports, etc.

From analysis of these data, the test designer will develop an outline of the approach to testing the UUT and identify any incompatibilities between UUT performance requirements and ATE capabilities.

The contractor design engineers will prepare the test design data (TDD) package, which includes preliminary test strategy for performance and fault isolation, proposed ATE/UUT interconnection diagrams, UUT failure profiles, and a list of potential problem areas and recommended solutions.

Government QA activities at this point will be to review and approve the QA Plan and assure that the TPS contractor receives all documentation he requires. In addition, the Government QA representatives will familiarize themselves with the UUTs and ATE hardware and software.

2.2 Concept Review

The concept review is conducted to evaluate the proposed test strategy developed by the test engineers prior to development of detailed test design data. At this stage the test designer will have formulated the optimum automatic fault detection and isolation strategy based on the UUT testability and the conceptual end-to-end performance testing requirements. The operational acceptability of the TPS will also be addressed at this stage. Estimates of setup, run time, teardown, and human-engineering aspects of the TPS will be provided.

Government QA personnel also participate in an advisory capacity, providing assistance where interpretation of contractual requirements is necessary and, in general, increasing their understanding of the contractor's approach to development of the TPS. The Government's early participation and close coordination establish whether the contractor can develop and deliver a TPS that will comply with Government quality requirements throughout its life. The Government's participation in this review, the test design data review, debugging and integration, and acceptance testing phases, as described in the remaining paragraphs, will ensure high Government confidence that the delivered TPS will be acceptable and that it will be unnecessary to perform extensive and costly fault-insertion tests.

2.3 Test Design Data (TDD) Development

Upon approval of the preliminary TDD by the Government, the contractor is authorized to proceed with the detailed UUT TDD, referred to as an English Language Procedure (ELP). The detailed TDD will contain all the sequences of tests, test setups, adjustments, test limits, response tolerances, and man-machine communications, together with performance and diagnostic flow charts, detailed ATE/UUT interconnection diagrams, and a description of each test.

2.4 Test Design Data Review

The second major review checks the TDD's technical content, completeness, and readiness for coding. A selected group of faults should be analyzed by proceeding through the test sequences, step-by-step, to verify that each fault has been detected and correctly isolated. Enough faults should be traced through the test sequences to provide confidence that the contractual fault-isolation requirements will be met. If not enough faults are detected, rework and a second design review will be required. Interface Device (ID) design at this stage will be complete, as will the technical and economic justifications for the number of proposed IDs and the proposed ID schemes such as internal or external wrap-around functions and self tests for the ID and the cables. Government QA will review the ID-related data for accuracy and completeness and will seek to minimize the total number of IDs by using the same ID for similar UUTs where such use is warranted by UUT characteristic similarities and can be justified economically.

2.5 TPS Generation

The actual coding of the test sequences and the fabrication of the interface device will be initiated only after Government approval of the detailed TDD review. The contractor will comply with the Government standards for coding and documentation as stated in the contract or in the contractor's approved TPS QA Plan. All documentation for use and maintenance of the TPS will be developed. It will include English Language Test Description (ELTD); operator instructions for setup, execution, and tear-down procedures; identification of support equipment; safety and other precautions; and data related to future modifications and enhancements of the TPS.

2.6 TPS Debug and Integration

Before the TPS is loaded on the ATE itself, a pre-integration review is conducted to verify that the TPS, both software and ID, is ready to go on station. After the TPS has been integrated with the ATE, a large number of faults are actually inserted in the UUT itself to check the performance of the program. Any errors that are encountered will be noted, and appropriate rework will be started. Records will be kept of all fault-insertion and testing activities in a certified logbook, which will include the time expended on the ATE or development stations, number and description of faults inserted and isolated, corrections made to the TPS, and any problems encountered during the tests.

Government QA personnel will participate in the fault-insertion testing occurring at this time. Their observations will form the best historical data on the TPS performance and will affect the Government confidence level in the final product.

2.7 TPS Acceptance and Delivery

At the conclusion of Debug and Integration, the contractor will formally notify the Government that the TPS is ready for acceptance and provide to the Government all materials to be used in the demonstration. This formal submission will be at least 15 days prior to the scheduled acceptance testing. The Government will review the submitted material for completeness and correctness and participate in the demonstration, including fault insertion if necessary. As set forth in the material fielding plan for the TPS, included in the contract, the Government may require the contractor to perform environmental testing to simulate the intended deployment environment (depot, general support, direct support, etc.). A post-demonstration meeting will be held to discuss the Government's acceptance or rejection of the TPS. If the TPS is rejected, the alternatives will be discussed and a course of action will be recommended by the Government; this may include redesign or rework of the TPS.

2.8 TPS Deployment and Maintenance

The final phase of the TPS life cycle is installation of the TPS in the operational environment and provision for its modification and enhancement to meet current operational requirements -- including revisions to the TPS for UUT changes, improvements in TPS software and ID design, and error corrections. When any of these events occur, the appropriate maintenance agency should start the revision process at the concept review stage described in Section 2.2 and continue the phases as detailed here. The process may be abbreviated depending on the significance of the changes, but the reviews and tests should not be omitted. The basic premise for assuring quality of the TPS is to allocate sufficient time to the design

stages prior to actual implementation and acceptance testing. Bimonthly review sessions for assessment of the TPS development progress are essential to acquisition of high-quality TPS products. Early involvement in the design reviews and observation of the test phases as well as continued involvement throughout the development will greatly improve Government confidence in the quality of the delivered TPS.

3. PRODUCT ASSURANCE DIRECTORATE OBJECTIVES AND NEAR-TERM TASKS

3.1 Plan Objectives

This one-year plan has been developed to outline and define near-term tasks, responsibilities, and milestones. The primary objectives for the Product Assurance Directorate are described in the following paragraphs. Specific tasks and schedules for each objective are detailed in Section 3.2.

3.1.1 Objective A: Established Responsibilities for Life-Cycle Quality Assurance of TPS

The management activities in building the organizational framework for the TPS quality assurance must be defined. Guidelines have been developed for the acquisition, use, and configuration control of TPS. The tasks associated with Objective A will consist of orientation briefings for QA personnel on the application of the guidelines; augmentation of the Product Assurance Directorate charter for inclusion of an ATE division to form the QA core of expertise of TPS; development of job descriptions and a training plan for the personnel assigned to this core; and development of a long-term, five-year plan to continue the activities initiated in this short-term plan.

3.1.2 Objective B: Uniform TPS Life-Cycle Policies and Procedures

Implementation of the guidelines described in Objective A will require a number of years and will culminate in uniform TPS life-cycle policies and procedures for the CERCOM/CORADCOM Product Assurance Directorate. The management activities described here will be for the immediate one-year term following approval of this plan. Two major tasks have been identified for the near term: (1) provide interim guidance to QA personnel and (2) develop appropriate regulations that will establish policies and assign responsibilities as recommended by the guidelines.

3.1.3 Objective C: TPS Quality Factor Measures, Tools, and Methodologies

It is necessary to initiate activities that will provide a historical data base for analysis of candidate TPS QA measures and development of tools and methodologies by which TPS quality can be evaluated. The data base will be developed from historical information from users, contractual data, TPS performance data, and TPS identifiers and characteristics. The emphasis in the near term will be to obtain these data to provide the basis for long-term identification of reliable TPS QA measures, tools, and methodologies.

3.1.4 Objective D: Certified TPS ATE Hardware and Software

The ATE must be well defined in terms of performance limits, calibration, and component organization, as well as operating system, language standards, and compiler. It is vital for the TPS user to know precisely the contents of the ATE for which the TPS was developed. Certification of the ATE ensures that it is functioning properly according to a set of predefined standards. Although it will not be the Product Assurance Directorates' mission to certify ATE, it is necessary to establish the basis for certification to ensure quality TPSs.

3.1.5 Objective E: Centralized Configuration Management Facility

Objective E is directed toward establishing Government needs for centralized configuration management of Test Program Sets. The great quantity of TPSs that will be in the inventory dictates a need for central facility to ensure compatibility of the numerous test installations with the TPSs. The primary role of this facility will be to maintain a record of all TPSs and the various versions of them as corrections and improvements are made to the UUT, the TPS itself, or the ATE hardware/software.

3.2 Near-Term Tasks

This section describes the tasks that will be initiated and the schedule of related activities within a period of one year from the date of approval of this plan. For each of the objectives previously discussed, the tasks will be presented in a uniform manner, stating the task title, responsible agency, task description, and activity schedule. An overall schedule, including all objectives and tasks, is illustrated in Figure 2.

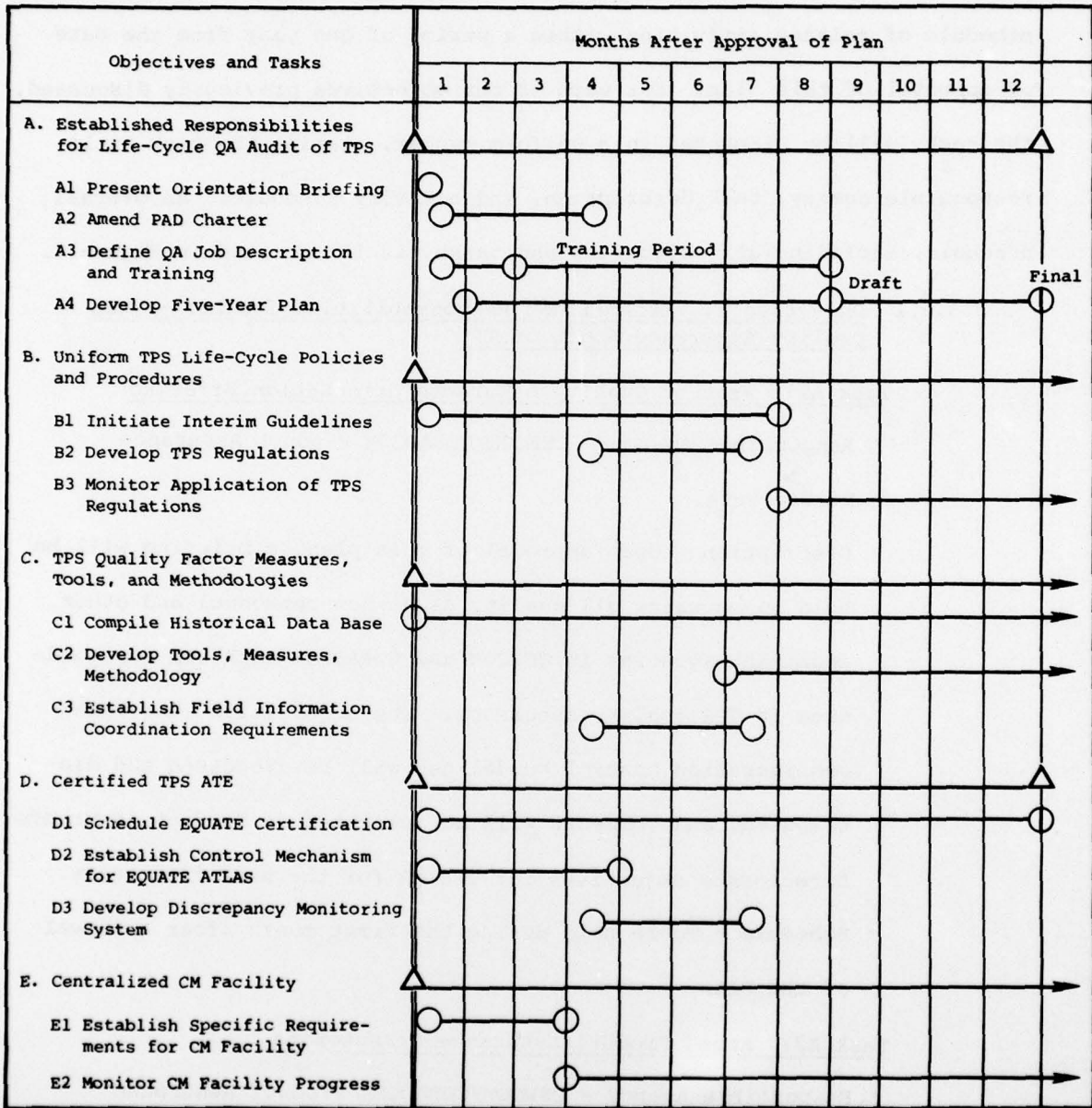
3.2.1 Objective A: Established Responsibilities for Life-Cycle Quality Assurance Audit of TPS

Task A1: Present Quality Assurance Orientation Briefing

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - Upon approval of this plan, a briefing will be held to acquaint all quality assurance personnel and other cognizant agencies in CERCOM and CORADCOM with the new guidance in TPS quality assurance. The acquisition, use, and configuration control guidelines will be discussed and distributed, and comments will be solicited on Product Assurance Directorate objectives for TPS QA for the next five years.
- Schedule - To be held during the first month after approval of the Plan.

Task A2: Amend Product Assurance Directorate

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - The purpose of this task is to describe the structure and authority of the newly created ATE division within the Product Assurance Directorate.



▲- Objectives; ○- Tasks.

Figure 2. NEAR-TERM TASK SCHEDULE

- Schedule - Update of mission and function statement for CERCOM and CORADCOM Product Assurance Directorate beginning first month, with completion in fourth month after approval of plan.

Task A3: Define TPS QA Job Description and Training Requirements

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - Personnel requirements identifying special skills, training, staff levels, schedule, and contractor support will be identified and defined for the newly formed ATE division within the Product Assurance Directorate. TPS quality assurance has unique support requirements in specialized personnel skills that must be identified during the initial implementation phase to ensure adequate lead times for training. Some of the more essential skills required to support TPS quality assurance are as follows:
 - Technical management capability for overall integration of ATE, UUT, TPS requirements
 - Ability to develop, revise, and document test programs
 - Ability to analyze and evaluate the performance of TPS, using data acquired during fault inspection and end-to-end tests
 - Engineering capability to analyze the test program interface with the ATE hardware and operational and support software
 - Ability to assess operational, human engineering, and maintainability aspects of the TPSs

After the job descriptions have been completed, assignment of personnel will be initiated, with a period of intensive training.

- Schedule
 - Job Description - completion within two months of plan approval
 - Training - six months following job description approval

Task A4: Develop Product Assurance Directorate Five-Year TPS QA Program Plan

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - The CERCOM/CORADCOM Product Assurance Directorate Five-Year TPS QA Program Plan will be a requirements document identifying all TPS quality assurance activities within CERCOM/CORADCOM. TPS quality assurance management and technical activities will be described. The document will establish objectives and describe the tasks required to achieve them; it will be an extension of the one-year plan. The five-year plan will be updated annually; tasks may be proposed or updated at any time during the year.
- Schedule
 - Draft Five-Year Plan - Eight months after one-year plan approval
 - Final Plan - Four months after draft completion

3.2.2 Objective B: Uniform TPS Life-Cycle Policies and Procedures

Task B1: Initiate Implementation of Interim Guidelines

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - Prior to becoming CERCOM/CORADCOM policy, a number of the actions and recommendations contained in the guidelines may be applied immediately to current TPS developments. These include development of TPS documentation standards that describe the contents of deliverable data, consideration of TPS as a configuration item (CI) to be included in all configuration management plans, and application of MIL-STD-483 to TPS procurements. All currently assigned program QA personnel will comply with QA Procedures and Practices as outlined in the TPS acquisition, use, and configuration guidelines.
- Schedule
 - Assignment of QA Responsibilities - completed seven months after approval of Plan
 - Application of New Guidelines - continuous through the first seven months

Task B2: Develop TPS Regulations

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - This task provides for conversion of the guidelines into appropriate Army regulations following mandatory review and approval cycles.

- Schedule - Initiated in month four and completed in month seven following Plan approval.

Task B3: Monitor, Via Audit, Application of TPS Regulations

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - Beginning with the dissemination of the TPS acquisition, use, and configuration control regulations, it is important to trace progress on resolving problems associated with the new regulations. In this way, appropriate action can be initiated immediately and a measure of the effectiveness of the regulation will be obtained.
- Schedule - continuous from month eight after Plan approval.

3.2.3 Objective C: TPS Quality Factor Measures, Tools, and Methodologies

Task C1: Compile Historical Data Base

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - To form the basis for development of techniques to be utilized in evaluating TPS quality, a number of historical data bases should be compiled from past TPS life-cycle activities and updated with each newly developed one. The types of data to be collected include the following:
 - TPS Identifiers: the project it is written for; the manufacturer's acceptance data (how many times the test was performed before successful completion); the controlling authority for this contract.

- TPS Characteristics: the ATE on which it is used; language support system; complexity of program and ID; size of the program and its data base; the run time for end-to-end performance test and average diagnostic time; and any tools and techniques used by the contractor in TPS production.
- TPS Performance Data: How frequently has the TPS been used? How many ECPs have been written on the hardware? How many SCPs were written? For the SCPs, was the correction due to an error in analysis, design, or implementation? Were any SCPs written to accommodate changes in the environment or to enhance the software?
- TPS Acquisition Data: type of contract; application of warranty; effectiveness of customer/contractor interface; progress/performance review procedures and frequency; technical risks that were apparent when the contract was initiated; and extent of redirection the contractor received.
- TPS User Data: the qualifications of the TPS user in terms of his experience level, training, and installation size. How difficult was it to use the TPS? How often did he use it? Does the ATE have any peculiarities? How mature is the support software? Have the ATE hardware and software been certified? What are the numbers of shifts, people per shift, and ATE operators?
- Schedule - ongoing effort -- system specifications for computerized data base management complete within 12 months.

Task C2: Develop Tools, Quality Factor Measures, Methodologies for
for TPS

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - The data collected during Task C1 will be used to develop TPS quality assurance metrics, along with tools and methodologies to obtain the measures and assure that they are correct and adequate. A number of software metrics listed in ECOMR 702-13 can be directly applied to TPSs, such as adaptability, efficiency, and flexibility. Others may include total shop turnaround time and total number of faults detected prior to acceptance testing.
- Schedule - Beginning in the seventh month and continuing past the one-year Plan period.

Task C3: Establish Field Information Coordination Requirements

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate.
- Description - This task will establish the policy and procedures for Product Assurance Directorate interface with the various CERCOM, CORADCOM, and DESCOM agencies to collect and update the information for the data bases and provide the results from the application of the tools and methodologies developed in Task C2.
- Schedule - Concurrently with TPS regulations development.

3.2.4 Objective D: Certified TPS ATE Hardware and Software

Task D1: Schedule EQUATE Certification

- Responsible Agency - PMS ATSS (Product Assurance Directorate monitor).
- Description - The AN/USM-410, known as the EQUATE, is the primary ATE being used or planned to be used by the CERCOM/CORADCOM PMS and agencies. Although the certification of EQUATE hardware and software, including the compiler, will be the direct responsibility of PM ATSS, the Product Assurance Directorate should develop and propose a certification schedule that will allow the EQUATE to be certified by the end of the one-year Product Assurance Directorate Program Plan period. Close coordination with PM ATSS will be established to ensure that certification will have no impact on EQUATE's maintenance role. In addition to EQUATE, the Product Assurance Directorate will propose schedules for any future ATE certification and will develop a policy statement regarding the use of certified ATE during acceptance testing of UUTs and during field and depot operation.
- Schedule - Complete certification by end of the one-year Plan period.

Task D2: Establish Control Mechanism for EQUATE ATLAS Language

- Responsible Agency - PM ATSS.
- Description - Initial certification and future control of the EQUATE ATLAS language for the CERCOM/CORADCOM commodities is necessary to assure TPS correctness and maintainability.

Product Assurance Directorate will establish milestones and define the requirements for the EQUATE ATLAS certification and will participate in the control mechanism of this language on a continuing basis.

- Schedule - EQUATE ATLAS certification will be scheduled four months following adoption of this Plan. The EQUATE ATLAS control board will be established four months following adoption of this Plan.

Task D3: Develop Discrepancy Monitoring System

- Responsible Agency - CORADCOM.
- Description - In association with the field information reporting organization developed in Task C3, policy and procedures will be developed for recording discrepancies that occur during contractor, field, and depot use of the certified ATE. These reports will be submitted to the certification agency and PAD for appropriate action.
- Schedule - Concurrently with Task C3.

3.2.5 Objective E: Centralized Configuration Management Facility

Task E1: Establish Specific Requirements for CM Facility

- Responsible Agency - CERCOM/CORADCOM.
- Description - The need for a central facility for the configuration management of TPS has become apparent. This task will develop the specific organizational structure and recommended charter that would assist the Product Assurance Directorate in ensuring that high-quality and up-to-date TPSs are provided to the maintenance facilities.

- Schedule - Completed within the first three months of Plan approval.

Task E2: Monitor Progress of Configuration Management Facility

- Responsible Agency - CERCOM/CORADCOM Product Assurance Directorate and Maintenance Directorate.
- Description - This task will develop the policy for interface between Product Assurance Directorate and the Configuration Management Directorate of CORADCOM, which will be responsible for implementing the required TPS configuration management facility. Close cooperation between CERCOM/CORADCOM Product Assurance Directorate, maintenance, and the users -- including U.S. Army Depots, material developers, and PMS -- will be required to ensure the timely development of this facility.
Schedule - Continuing from the third month after approval on this Plan.