ELECTRONIC RECORDS ARCHIVES

TESTING MANAGEMENT PLAN (TSP)

(TOMP V2.0, TASK 4.3.11)

for the

NATIONAL ARCHIVES AND
RECORDS ADMINISTRATION

ELECTRONIC RECORDS ARCHIVES
PROGRAM MANAGEMENT OFFICE
(NARA ERA PMO)

Final
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ERA Testing Management Plan (TSP)

Signature Page

Program Director,

I recommend approval of the Testing Management Plan (TSP).

Approved,

_____   _____
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Document Change Control Sheet

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Testing Management Plan (TSP)

1.0   Introduction

This Testing Management Plan (TSP) addresses and provides guidance for the testing management activities to be performed in support of the National Archives and Records Administration (NARA) Electronic Records Archives (ERA) system acquisition. It is designed to capture and convey the overall structure and objectives of the ERA Test and Evaluation (T&E) activities.

1.1   Purpose

This document provides a basis for planning, performing, managing, monitoring, and measuring the ERA system testing activities. Specifically, this plan documents the following:

- References that will be used as the basis for test management, planning, development, and documentation;
- The organizations responsible for planning, management, and test execution;
- Management of a testing strategy that addresses the evolution of the design, incremental delivery, testing efficiency, and testing coverage as well as the system's known areas of risk;
- An overview of the testing process to include testing phases and processes for evaluating test adequacy;
- Test facility, test equipment, and test support requirements;
- Approach for documenting, tracking, and resolving issues found during testing;
- Measurement and reporting of test work products and test results; and
- The approach for developing acceptance criteria.

The TSP is a program level document and is applicable to ERA testing activities in system acquisition and development lifecycle phases. This TSP focuses on the overall test management approach used to ensure a high quality system that meets user acceptance criteria. Thus, this TSP is analogous to a master test and evaluation plan. ERA testing will include the full system (i.e., application, distributed infrastructure, middleware, and supporting system services). In the acquisition phase, the ERA Testing Team is responsible for assessing the validity of the requirements before they are affixed to the Request for Proposal (RFP). During the development of a release products and the subsequent development efforts leading to Initial Operating Capability (IOC), the ERA Testing Team will be responsible for overseeing and monitoring the Development Contractor's test efforts, ensuring the product is tested against the requirements, and ensuring the deliverables derived from their test efforts comply with requirements. The ERA Testing Team also will have responsibilities in the acceptance process at the end of each development iteration (i.e., releases and increments). Further ERA Testing Team duties, activities, and responsibilities will be discussed later in this document.

Credible sources such as the IEEE Std 12207.1, *Standard for Information Technology: Software Life Cycle Processes – Life Cycle Data* and the Software Engineering Institute's (SEI) Software

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Capability Maturity Model (SW-CMM) address and provide guidance for a managed test process but do not recommend a format or framework for a document detailing testing management. Consequently the methodology found in this TSP is based on guidance from the Department of Defense (DoD) Standard 5000.2-R, *Test and Evaluation Master Plan (TEMP), April 2002* and IEEE Std 829-1998, *Standard for Software Test Documentation*. The TSP has been modified and updated to fit ERA's system requirements as well as industries "Best Practices" for testing large systems.

1.2   ERA Program Overview

ERA will be a comprehensive, systematic, and dynamic means for storing, preserving, and accessing virtually any kind of electronic record, free from dependence on any specific hardware or software. The ERA system, when operational, will make it easy for NARA customers to find the records they want and easy for NARA to deliver those records in formats suited to customers' needs. The success of the ERA Program Management Office (PMO) in building and deploying the ERA system will depend on professional program and project management with an emphasis on satisfying NARA's requirements for a viable system.

1.3   Mission Description

The testing management methodology and activities depicted in this TSP will ensure that the ERA system meets NARA's strategic goals by addressing the deficiencies identified in the *ERA Mission Needs Statement (MNS).*

1.4   System Description

ERA will be an agency-wide system that is capable of managing the entire lifecycle of the electronic records that NARA receives. The system will be developed to satisfy a core set of requirements that address the entire lifecycle of electronic holdings, and the needs of the system's users. When fully operational, ERA will authentically preserve and provide access to any kind of archived electronic record, free from dependency on any specific hardware or software.

1.4.1   Key Features

ERA system key features are described in the *ERA Requirements Document* (RD).

1.4.2   Interfaces

The system will be capable of interfacing and interacting with other systems as needed. Specific interfaces are yet to be determined, and will be described in the Interface Requirements Document (IRD) and Interface Control Document (ICD). For each system that ERA will interface with an IRD and ICD will be created.

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1.5   Security Assessment

Early in the development lifecycle, threats to the ERA system will be minimal. As the ERA system matures from the IOC state to the Full Operational Capability (FOC) state, threats will increase. The vast amount of information stored, processed, and transferred by ERA could make it a likely target of diverse threats, compromise of data, disruption of service, or loss of information. Testing of the ERA system will be performed to establish a high degree of confidence in the security of ERA and minimize system threats.

NARA and the ERA PMO will determine the level of security required for the ERA system, the Development Contractor, the ERA Testing Team, test environments, test facilities, and proprietary components.

The *ERA System Security Plan* (SSP) and the *National Institute of Standards and Technology (NIST) System Assessment Questionnaire* for ERA provide more detail on the anticipated ERA system security posture.

1.6   Measures of Effectiveness and Suitability

The ERA system must meet the requirements set forth in the ERA RD. The RD presents the ERA requirements and reflects the critical components of the ERA. The requirements baselines that are developed will provide detailed and system level criteria that will be the basis for the testing and evaluation of the design and performance of the system and its components.

The ERA Testing Team will ensure that the ERA system meets the system performance objectives identified in the ERA RD. The primary system and program level performance standards are the Key Performance Parameters (KPPs). The Acquisition Program Baseline (APB) will define the KPPs.

2.0   Acronyms and Definitions

The terms used in this document are defined in IEEE Std 610.12-1990, *IEEE Standard Glossary of Software Engineering Terminology* and in the Joint Publication 1-02, *"DoD Dictionary of Military and Associated Terms."*

2.1   Acronyms

ACRONYM	DESCRIPTION
16 CSP	16 Critical Software Practices
ANSI	American National Standards Institute
APB	Acquisition Program Baseline
AS	Acquisition Strategy
AT	Acceptance Test
CCB	Configuration Control Board
CI	Configuration Item

ACRONYM	DESCRIPTION
CM	Configuration Management
CMM	Capability Maturity Model
CMP	Configuration Management Plan
CMTP	Contractor's Master Test Plan
CO	Contracting Officer
COTS	Computer Off-the-Shelf
CR	Change Request
CSCI	Computer Software Configuration Items
DoD	Department of Defense
DT	Development Test
ERA	Electronic Records Archives
ERB	Engineering Review Board
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
FOC	Full Operational Capability
GOTS	Government Off-the-Shelf
HWCI	Hardware Configuration Items
IAT	Installation Acceptance Tests
ICD	Interface Control Document
ICE	Integrated Computer Engineering
IEEE	Institute of Electrical and Electronics Engineers
IOC	Initial Operational Capability
IRD	Interface Requirements Document
IV&V	Independent Verification & Validation
IVP	Independent Verification and Validation Plan
KPP	Key Performance Parameters
MNS	Mission Needs Statement
MP	Metrics Plan
NARA	National Archives and Records Administration
NIST	National Institute of Standards and Technology
OAT	Operational Acceptance Tests
ORR	Operational Readiness Review
PAT	Production Acceptance Tests
PCA	Physical Configuration Audit
PD	Program Director
PMO	Program Management Office
PMP	Program Management Plan
PRP	Peer Review Process
PWS	Performance Work Statement
QA	Quality Assurance
QC	Quality Control

ACRONYM	DESCRIPTION
QM	Quality Management
QMP	Quality Management Plan
RD	Requirements Document
RFP	Request for Proposal
RKM	Risk Management Plan
SED	Systems Engineering Division
SEI	Software Engineering Institute
SME	Subject Matter Expert
SOW	Statement of Work
SPMN	Software Program Manager Network
SQA	Software Quality Assurance
SSP	System Security Plan
SW-CMM	Software Capability Maturity Model
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TEP	Technical Review Process
TOMP	Task Order Management Plan
TRR	Test Readiness Review
TSP	Testing Management Plan
VS	Vision Statement

Table 2-1: Acronyms List

2.2   Definitions

Acceptance criteria: The criteria that a system or component must satisfy in order to be accepted by a user, customer, or other authorized entity.

Acceptance testing: (1) Formal testing conducted to determine whether a system satisfies its acceptance criteria and enables the customer to determine whether to accept the system. (2) Formal testing conducted to enable a user, customer, or other authorized entity to determine whether to accept a system or component.

Computer Software Configuration Item (CSCI): An aggregation of software that is designated for configuration management and treated as a single entity in the configuration management process. Contrast with: *Hardware configuration item* See also: *Configuration item*

Configuration item (CI): An aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management process. See also: *Hardware configuration item; Computer software configuration item*.

Development testing: Formal or informal testing conducted during the development of a system or component, usually in the development environment by the developer.

Functional testing: (1) Testing that ignores the internal mechanism of a system or component and focuses solely on the outputs generated in response to selected inputs and execution conditions. Contrast with: ***Structural testing***. (2) Testing conducted to evaluate the compliance of a system or component with specified functional requirements. See also: ***Performance testing***.

Hardware Configuration Item: Hardware items that include disks, disk drives, display screens, keyboards, printers, boards, and chips.

Independent Verification and Validation (IV&V): Verification and validation performed by an organization that is technically, managerially, and financially independent of the development organization.

Installation and checkout phase: The period of time in the software life cycle during which a software product is integrated into its operational environment and tested in this environment to ensure that it performs as required.

Integration testing: Testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them. See also: ***System testing; Unit testing***.

Load testing: Testing that studies the behavior of the program when it is working at its limits. See also: ***Stress Testing***.

Operational testing: Testing conducted to evaluate a system or component in its operational environment.

Path testing (coverage): Testing that is designed to execute all or selected paths through a computer program.

Pass/Fail criteria: Decision rules used to determine whether a software item or software feature passes or fails a test.

Performance testing: Testing conducted to evaluate the compliance of a system or component with specified performance requirements. See also: ***Functional testing***.

Quality Assurance (QA): (1) The process of evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards. (2) The organizational unit that is assigned responsibility for quality assurance. [*A Guide to the Project Management Body of Knowledge (PMBOK Guide), 2000 Edition*]

Quality Control (QC): (1) The process of monitoring specific project results to determine if they comply with relevant quality standards and identifying ways to eliminate causes of unsatisfactory performance. (2) The organizational unit that is assigned responsibility for quality

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control. [*A Guide to the Project Management Body of Knowledge (PMBOK Guide), 2000 Edition*]

Quality Management (QM): The processes required to ensure that the project would satisfy the needs for which it was undertaken.

Regression testing: Selective retesting of a system or component to verify that modifications have not caused unintended effects and that the system or component still complies with its specified requirements.

Scenario: (1) A description of a series of events that could be expected to occur simultaneously or sequentially. (2) An account or synopsis of a projected course of events or actions. [*IEEE Std 1362-1998, Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document*]

Software item: Source code, object code, job control code, control data, or a collection of items.

Stress testing: Testing conducted to evaluate a system or component at or beyond the limits of its specified requirements. See also: ***Load testing***.

Structural testing: Testing that takes into account the internal mechanism of a system or component. Types include branch testing, path testing, statement testing. Contrast with: ***Functional testing***.

System testing: Testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. See also: ***Integration testing; Unit testing***.

Test: An activity in which a system or component is executed under specified conditions, the results are observed or recorded, and an evaluation is made of some aspect of the system or component.

Test case specification: A document specifying inputs, predicted results, and a set of execution conditions for a test item.

Test design specification: Documentation specifying the details of the test approach for a software feature or combination of software features and identifying the associated tests.

Test Incident Report (TIR): A document reporting on any event that occurs during the testing process that requires investigation.

Test item: A software item that is an object of testing.

Test log: A chronological record of relevant details about the execution tests.

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Test phase: The period of time in the life cycle during which components of a system are integrated, and the product is evaluated to determine whether or not requirements have been satisfied.

Test plan: A document describing the scope, approach, resources, and schedule of intended testing activities. It identifies test items, the features to be tested, the testing tasks, who will do each task, and any risks requiring contingency planning.

Test procedure: (1) Detailed instructions for the set-up, execution, and evaluation of results for a given test case. (2) A document containing a set of associated instructions as in (1). (3) Documentation specifying a sequence of actions for the execution of a test.

Test Readiness Review (TRR): A review conducted to evaluate preliminary test results for one or more configuration items and verify that the test procedures for each configuration item are complete, comply with test plans and descriptions, and satisfy test requirements. Verify that a project is prepared to proceed to formal testing of the configuration item.

Test summary report: A document summarizing testing activities and results. It also contains an evaluation of the corresponding test items.

Testability: (1) The degree to which a system or component facilitates the establishment of test criteria and the performance of tests to determine whether those criteria have been met. (2) The degree to which a requirement is stated in terms that permit establishment of test criteria and performance of tests to determine whether those criteria have been met.

Testing: (1) The process of operating a system or component under specified conditions, observing or recording the results, and making an evaluation of some aspect of the system or component. (2)The process of analyzing a software item to detect the differences between existing and required conditions (i.e., bugs) and to evaluate the features of the software items. See also: ***Acceptance testing; Development testing; Integration testing; Operational testing; Performance testing; Regression testing; System testing; Unit testing***.

Unit Testing: The testing of individual hardware or software units or groups of related units (i.e., component, modules). See also: ***Integration testing; System testing***.

3.0   Referenced Documents

This section lists the documents that provide guidance in the development of the TSP.

3.1   ERA PMO References

- ERA Configuration Management Plan (CMP)
- ERA Quality Management Plan (QMP)
- ERA Peer Review Process (PRP)
- ERA Task Order Management Plan (TOMP)

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- ERA Program Management Plan (PMP)
- ERA Metrics Plan (MP)
- ERA Risk Management Plan (RKM)
- ERA Systems Security Plan (SSP)
- ERA Vision Statement (VS)
- ERA Missions Needs Statement (MNS)
- ERA National Institute of Standards and Technology (NIST) System Assessment Questionnaire
- ERA Independent Verification and Validation Plan (IVVP)
- ERA Technical Review Process (TEP)
- ERA Acquisition Program Baseline (APB)

Note: Refer to most recent version.

3.2   Industry Standards and References

- IEEE Std 829-1998, Standard for Software Test Documentation
- IEEE Std 12207.1, Standard for Information Technology: Software Life Cycle Processes – Life Cycle Data
- American National Standards Institute (ANSI)/IEEE Std 1008-1987, Standard for Software Unit Testing
- DoD Standard 5000.2-R, Test and Evaluation Master Test Plan (TEMP), April 2002
- Testing Computer Software (Second Edition), Cem Kaner et. al., Wiley Computer Publishing, 1999
- Software Testing and Continuous Quality Improvement, William E. Lewis, CRC Press LLC, 2000
- Software Program Manager Network (SPMN), Road to Performance-Based Management, Based on 16 Critical Software Practices (16 CSP)
- IEEE Std 610.12-1990, Standard Glossary of Software Engineering Terminology
- Integrated Computer Engineering (ICE) Integration & Test Process Guidance
- Software Engineering Institute, "Capability Maturity Model, Version 1.1"
- Joint Publication 1-02, "DoD Dictionary of Military and Associated Terms"
- IEEE Std 1362-1998, Guide for Information Technology – System Definition – Concept of Operations (ConOps) Document
- A Guide to the Project Management Body of Knowledge (PMBOK Guide), 2000 Edition

4.0   ERA Testing Management Structure

The ERA PMO Test Organization consists of representatives from the ERA PMO in each of the following roles:

- Program Director (PD)
- Senior Systems Engineer
- Testing Officer

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- Testing Team
- Configuration Management (CM) Specialist
- Development Contractor
- Quality Assurance (QA) Specialist
- Risk Officer

Figure 4-1, PMO Test Organization Chart, on the following page defines the organizational chart and categories of personnel who participate in testing management and the test process.
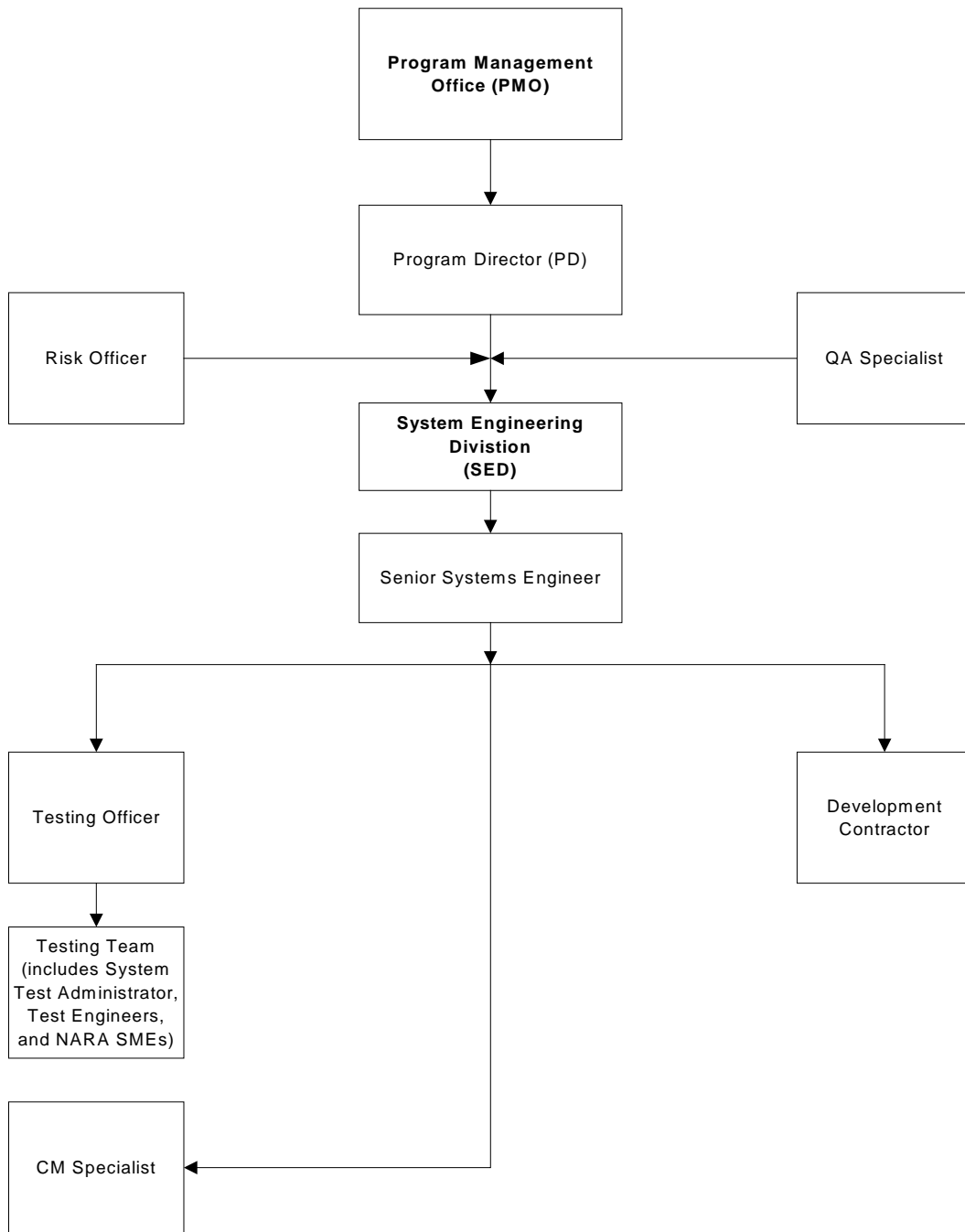
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Figure 4-1: PMO Test Organization Chart

4.1   Roles and Responsibilities

Table 4-1, Test Organization Roles and Responsibilities, lists the primary responsibilities of each role of the Test Organization.

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Roles	Required Responsibilities
Program Director (PD)	• Ensure testing resources are assigned early enough to provide for adequate test preparation • Periodically review test results to ensure the software satisfies its requirements • Define a project level software testing organization and identify the responsibilities of the testing organization
Senior Systems Engineer	• Review the TSP and provide feedback to the Testing Officer • Provide the Testing Officer with the standards, policies, tools, and procedures applicable to the project • Support testing activities by confirming the Testing Officer's and Testing Team's responsibilities and authority
Testing Officer	• Responsible for identifying any formal testing standards, then ensuring that those standards are being followed • Ensure that system acquisition activities relative to the test effort adhere to relevant standards, best practices, and conventions • Identify what to test and determine when testing resources are needed to ensure adequate test preparation • Determine and acquire needed test environment and support • Monitor and control test work products and test results • Oversee overall testing effort • Develop acceptance test plan and revise the plan, as needed • Review test work products to ensure that they are complete and are developed according to plan • Review test scripts and scenarios to ensure they satisfy acceptance criteria • Review and validate test plans, procedures, scripts, and scenarios • Review test report templates • Review test results to determine whether software satisfies its requirements • Identify and manage testing tools

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Roles	Required Responsibilities
	• Attend test related peer reviews • Attend Test Readiness Reviews (TRRs)
Testing Team	• Execute test plan(s) • Develop and execute test design specifications, procedures, scenarios, cases, and scripts • Attend peer reviews of requirements and software to ensure in depth knowledge of the functionality of the software • Peer review test plan(s), procedures, test cases, test scripts, and scenarios • Analyze each requirement to verify it can be tested • Document and monitor test issues and track to closure • Perform tool administration • Participate in test related peer reviews • Participate in TRRs
NARA Subject Matter Expert (SME)	• Witness test execution during development testing • Execute and validate tests during acceptance testing
CM Specialist	• Schedule and conduct software builds • Ensure test environment configuration is controlled • Conduct CM audits
QA Specialist	• Review test scripts and scenarios to ensure they satisfy acceptance criteria • Review test results • Ensure testing is conducted per the test plan or procedures • Conduct QA audits of testing process • Perform QA inspections
Risk Officer	• Uncover and assess technical risks during testing phases • Assist in developing risk mitigation plans • Track and report risk information to the PD
Development Contractor	• Ensure program development documentation maps to the PMO documents • Develop and execute test design specifications, procedures, scenarios, cases, and scripts • Review and validate all development test plans, test design specifications, procedures, scenarios, cases, and scripts

Table 4-1: Test Organization Roles and Responsibilities

4.2   Staffing

Table 4-2, Skill of Personnel by Type and Test Phase, lists the ERA PMO personnel types required to adequately test the ERA System.

Type	Skill	Test Phase
Testing Officer	Management of testing knowledge and issue resolution management	All
Test Engineers	• Monitor testing at the all levels • Prepare test scripts, data, and environment • Execute and validate all test scripts and scenarios, as needed • Analyze technical test results • Resolve technical issues as they arise	All
CM Specialist	Confirm and control changes over approved configuration items	All
QA Specialist	Review testing documentation and perform audits, as required	All
Risk Officer	Manage risk assessment strategy and report risk information	All
System Test Administrator	Manage the problem report database, system software and hardware configuration items (HWCIs), database loading/refresh scheduling, and test tracking tool	All
NARA Subject Matter Expert (SME)	Execute and validate tests	System, Acceptance

Table 4-2: Skill of Personnel by Type and Test Phase

4.3   Incremental Approach

The solicitation process is in its early stages. The acquisition strategy calls for two vendors to do a design fly-off that will result in a downselect to a single Development Contractor. That contractor will be awarded an option to develop ERA Increment 1. Options for subsequent increments will be awarded subject to availability of funding and adequate contractor performance on the preceding increment.

The ERA Testing Team will use an incremental approach to T&E. This approach will provide usable, operational outputs at the completion of each increment. There will be three releases within the first increment of ERA, the third release being the IOC release. There will be two

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releases for each subsequent increment, the second release within each increment being the operational release. At preliminary releases, the Development Contractor will be subject to Test Readiness Reviews (TRRs). At operational releases TRRs will be conducted, as well as Operational Readiness Reviews (ORRs). TRRs are discussed in **Section 4.6**. ORRs are discussed in **Section 4.7**. The operational releases or increments are contractually binding milestones. The increments can be roughly described as:

- **Increment #1** – Provides IOC that incorporates testing of the core system functionality.
- **Later Increments –** Incorporates the testing of improvements and additions to Increment #1. The final increment will complete the FOC.

The ERA acquisition strategy calls for multiple releases per increment. The ERA testing strategy will support the strategy with Unit, Integration, System and Product Acceptance Tests (PATs) for preliminary releases. For operational releases, the same phases of tests will be executed with the addition of Operational Acceptance Tests (OATs) and Installation Acceptance Tests (IATs).

The timing of milestones is described in the *ERA Program Management Plan (PMP)* and the *ERA Acquisition Strategy (AS)*. ERA system installation will occur according to the contractual terms and conditions.

4.4   Status Reports

Testing activities will be reported on a regular basis. During the development testing activities, the Development Contractor will provide testing activity status reports to the ERA PMO and any other affected groups. During the acceptance testing activities, the ERA Testing Team will provide testing activity status reports to ERA senior program management.

The frequency and process for posting these reports will be consistent with the ERA Program Reporting section defined in the *ERA PMP*.

4.5   Management and Software Quality Assurance (SQA) Reviews

All testing activities (i.e., Development Test (DT) and Acceptance Test (AT)) will be reviewed with senior management in ERA Program Management Meetings, and with Development Contractor project management in review meetings. In addition, the testing process will be subject to QM reviews and audits. Refer to the *ERA Quality Management Plan (QMP)* for information on the role of QM in SQA reviews.

4.6   Test Readiness Reviews (TRRs)

TRRs are technical in nature and will be conducted by the Development Contractor (e.g., development engineers, testing engineers, QA specialists, CM specialists) with the ERA PMO in attendance. The goal of the review is to ensure that all related test items and materials have been completed and are ready for turnover to the next test phase. Additionally, the TRR provides management with the assurance that the software has undergone a thorough test process. Reviews will be held for each operational increment at the completion of system testing for that

increment. The *ERA Technical Review Process (TEP)* document provides guidance on review activities and process.

4.7   Operational Readiness Review (ORR)

An ORR is intended to determine the status of completion of the specific actions, which must be satisfactory and accomplished prior to executing an operational go-ahead decision. ORRs will be conducted by the ERA PMO with the support of the Development Contractor, as needed. The *ERA TEP* provides guidance on review activities and process.

5.0   Test and Evaluation (T&E)

ERA Test and Evaluation (T&E) involves Development Test (DT) and Acceptance Test (AT). Details on DT and AT activities are provided within the DT and AT sections of this document.

In general, T&E is structured to:

- Provide essential information to support decision-making,
- Provide essential information for assessing technical risk,
- Determine the technical performance parameters of the design and architecture,
- Verify the attainment of technical performance specifications and objectives, and
- Verify that systems are operationally effective and suitable for their intended use.

The ERA Testing Team will monitor test items, features, methods, processes, and documentation for compliance with standards and testing adequacy. To improve the testing process, the ERA Testing Team will capture metrics. The ERA Testing Team will use metric reports to analyze and report on the status of testing. Refer to the *ERA Metrics Plan (MP)* for comprehensive metric activities.

DT and AT will be oriented toward demonstrating system performance as listed in the KPPs. Assessments will be conducted by QM and CM during the DT effort in order to determine programmatic risk, to support TRRs, and subsequent AT. The AT effort will collect data to support overall test objectives, which will demonstrate that ERA meets the KPPs. The ERA PD or the appropriate Testing Team leader will conduct TRRs to ensure that the software, hardware, test environments, test facilities, and test engineers are ready to begin testing.

The ERA Testing Team will establish the necessary discipline, rigor, and structure to achieve the objectives of T&E by implementing and managing the testing strategy, assigning resources, witnessing testing, and monitoring results.

The *ERA QMP* outlines additional processes that precede testing.

An overview of T&E is illustrated in **Appendix A, Testing Execution**.

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5.1 Development Test (DT) Overview

The objectives of DT are to verify the status of development, verify that design risks have been minimized, demonstrate that all technical and performance requirements specified in the contract are met, and certify readiness for AT. DT is structural in nature and will consist of Unit, Integration, and System Testing. DT will be performed by the ERA Development Contractor and can be witnessed by Independent Verification and Validations (IV&V), QM, the ERA Testing Team, and any other designated representatives. The Development Contractor will prepare a Contractors Master Test Plan (CMTP) which is the highest level development test plan and describes all tests that will be conducted to demonstrate that the technical and performance requirements specified in the contract have been met. The CMTP also identifies lower level development test plans that will be prepared to describe tests such as Unit, Integration, and System tests. The CMTP is developed in accordance with the guidance described in **Appendix B, Contractor's Master Test Plan**.

The Development Contractor will prepare test reports following the completion of each phase of testing (i.e., Unit, Integration, and System). Refer to **Section 6.0** for information on test reporting.

Although the specific DT events have yet to be determined, it is important to note that DT will occur for every release (i.e., preliminary, operational). All DT activities will be performed and associated documentation (e.g., test plans, test case specifications, and test logs) will be generated for each release.

5.1.1 Unit Testing

This phase of testing is considered the basic level of testing that focuses on the smaller building blocks of a program (e.g., components, modules) or system separately. Unit Testing is the earliest phase of testing and is the most cost-effective phase in removing defects. Unit Testing permits the testing and debugging of small units, thereby providing a better way to manage the integration of the units into larger units. The detailed unit design is used as a basis to compare how and what the unit is able to perform. Unit Testing will be conducted by the Development Contractor and can be witnessed by IV&V and the ERA Testing Team. The Development Contractor will be responsible not only for conducting the unit tests, but will also be required to document all testing performed along with the results. Unit Test plans, prepared in accordance to IEEE Std 829-1998, Standard for Software Test Documentation, will be generated. The Unit Test plan is subject to review by QM, CM, IV&V, and the ERA Testing Team.

5.1.2 Integration Testing

Following Unit Testing and prior to the beginning of System Testing, groups of units are fully tested. Units are systematically added one or more units at a time to the core of already integrated modules. The goals of integration testing are to verify that units interact correctly and Hardware Configuration Items (HWCIs) and Computer Software Configuration Items (CSCIs) are integrated adequately. Integration Testing will be conducted by the Development Contractor to demonstrate accurate operation of the integrated units. Integration Testing will be conducted

by the Development Contractor and can be witnessed by IV&V and the ERA Testing Team. Integration test plans, prepared in accordance to *IEEE Std 829-1998, Standard for Software Test Documentation*, will be generated. The Integration Test plan is subject to review by QM, CM, IV&V, and the ERA Testing Team.

5.1.3   System Testing

This phase of testing occurs prior to acceptance. Its purpose is to test the system as a whole for functionality and fitness for use based on the system test plan. The goals of System Testing are to verify that the functions are carried out correctly and that certain nonfunctional characteristics are present (e.g., usability testing, performance testing, stress testing). System Testing will be conducted by the Development Contractor and can be witnessed by IV&V and the ERA Testing Team. System test plans, prepared in accordance to *IEEE Std 829-1998, Standard for Software Test Documentation*, will be generated. The System Test plan is subject to review by QM, CM, IV&V, and the ERA Testing Team.

A recommended format for Unit, Integration, and System test plans appears in **Appendix C, Test & Evaluation Test Plans**.

Future DT activities will demonstrate the integration of the Computer Off-the-Shelf (COTS) and Government Off-the-Shelf (GOTS) applications. Also, DT activities will include an integrated, end-to-end test of the entire ERA system.

5.2   Development Test (DT) Entrance and Exit Criteria

The DT entrance criteria includes baselined requirements, a completed and approved CMTP, and approved test cases and test procedures. Exit criteria or successful completion of DT testing requires that:

- All the test documentation has been approved (e.g., test plans and test procedures),
- All test scripts have been executed and trouble reports are generated for each failure or anomaly,
- All trouble reports have been resolved (i.e., trouble reports have been fixed or deferred to a later release with government approval),
- All changes made as a result of trouble reports have been tested,
- The test report has been reviewed and approved, and
- All documentation associated with the ERA system has been updated to reflect changes made during testing.

The Development Contractor is responsible for the documentation associated with DT activities.

5.3   Acceptance Test (AT) Overview

AT is a contractual decision point where the ERA system and documentation is handed from the Development Contractor to the ERA PMO for T&E from a user's perspective. AT is functional in nature and will consist of PAT, OAT, and Installation Testing. AT will also include two CM

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and QM audits, Physical Configuration Audit (PCA) and Functional Configuration Audit (FCA). These audits will verify that the configuration identification for a configured item is accurate, complete, and meets specified program needs. Guidance for conducting audits is found in the *ERA CMP*.

The objectives during AT are to demonstrate that the ERA system is operationally effective and operationally suitable for use, to assess and determine the extent to which the ERA increments discussed earlier are operative by ERA trained users in a representative operational environment, and to determine that NARA's infrastructure is ready to accept the system in a realistic environment before deployment. During AT, the involvement of NARA users and SMEs will be encouraged to ensure that operational system issues are identified early.

A frequent perception of testing is that the principal goal is program verification; however, several other goals exist. The main AT goals are to:

- Ensure the software satisfies the user requirements and expectations;
- Stress the software at all levels by identifying discrepancies, discovering deficiencies, determining limitations, and verifying interfaces;
- Demonstrate and integrate capabilities by proving the software's ability to handle a wide spectrum of data values, recognize data dependency on the expected environment, and demonstrate requirements satisfaction; and
- Demonstrate system usefulness by demonstrating operational capabilities, proving adequacy of documentation, and gaining user acceptance.

AT activity certifies that the software system satisfies all the requirements. AT will not be performed until the software has successfully completed development testing. AT will involve trained users exercising production representative ERA system configurations in a realistic manner to determine the degree to which the system satisfies the stated operational requirements in the *ERA RD*. Specific AT facilities have yet to be identified and established.

AT objectives provide insight into each of the ERA increment's operational effectiveness and suitability, along with its state of maturity, integration, stability, and readiness for formal acceptance. To the extent possible, AT activity will assess each increment's progress towards satisfying the KPPs. In determining each increment's readiness to proceed to formal acceptance, through AT, the status of each increment will be judged against the DT exit criteria and the AT entrance criteria.

Throughout AT testing techniques such as stress, regression, performance, and load/volume tests will be used. AT activities will be carried out in accordance with this TSP, the CMP, the QMP, and the ERA Acceptance Test Plans.

Using the VS, MNS, RD, and NARA's Strategic Goals, the ERA Testing Team will prepare the AT plan. The AT plan is subject to review by QM, IV&V, and CM. **Appendix C, Test & Evaluation Test Plans** shows a recommended format for Acceptance Test Plans.

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AT test results form the basis of the ERA Testing Team's recommendation to the Contracting Officer (CO) and the PD regarding acceptance and deployability of the product.

5.3.1   Production Acceptance Tests (PAT)

TRRs will be conducted prior to PAT. The primary goal of the PAT will be to complete a thorough test to ensure functional robustness of the entire ERA system. ERA system documentation (e.g., User Manual, online help, online tutorial) will also be tested (i.e., compare documentation and system keystroke by keystroke) and evaluated for technical accuracy, conformance, and usability. PAT will be performed in a test environment by a group of NARA functional end users (i.e., SMEs) in conjunction with the ERA Testing Team, QM, and IV&V. The Development Contractor will support PAT, as needed.

5.3.2   Operational Acceptance Tests (OAT)

Operational readiness is the state of system preparedness to perform the missions and functions for which ERA is designed. An ORR will occur prior to OAT.

The primary goal of the OAT will be to ensure that normal production operations sustain the level of required performance documented in the RD. ERA system documentation (e.g., Operations Manual, online help, online tutorial) will also be tested (i.e., compare documentation and system keystroke by keystroke) and evaluated for technical accuracy, conformance, and usability. OAT testing will involve a limited number of users at the test facility performing normal business functions. OAT will be performed by a group of NARA functional end users (i.e., SMEs) in conjunction with the ERA Testing Team, QM, IV&V, and SMEs from the facility at which ERA is deployed for OAT. The Development Contractor will support OAT, as needed. Results from OAT will be documented and provided to the PD for evaluation and determination on whether to continue the fielding of ERA to other NARA ERA facilities.

5.3.3   Installation Acceptance Tests (IAT)

After the first increment of ERA is tested, accepted, and declared operational at the first site, copies of that increment may be produced and installed at other facilities as necessary. Following delivery to the site, each increment will undergo installation and testing (e.g., communication, interoperability, and connectivity). IAT will be performed at every NARA ERA system installation facility by designated functional end users. These tests will be conducted by the ERA Testing Team along with the Development Contractor to ensure that the system is installed and functioning properly. ERA system documentation (e.g., Installation Manual, online help, online tutorial) will also be tested (i.e., compare documentation and system keystroke by keystroke) and evaluated for technical accuracy, conformance, and usability.

5.4   Installation, Testing, and Control

Installation, Testing, and Control are all integral elements of the testing environment. All three elements need to work in an effectively cohesive manner so that the ERA testing effort can accurately locate, correct, and track requirements, defects, and enhancements. Since the test

environments will emulate a normal operational facility, the procedures for the test environment operation and management are similar. Installation and inspection of the testing environment occurs at the test facilities prior to the start of software testing. The ERA System Test Administrator is responsible for the management, control, scheduling, and maintenance of the testing environment.

The Development Contractor will be required to use a CM Tool for checking-in and checking-out such things as source code files, installation scripts, test scripts, and documentation so that revision history information can be monitored and tracked. For detailed procedures on this task, refer to the *ERA CMP*. Migration checklists will be developed to assist in the compilation of components for testing. The checklists detail the execution of migration procedures in sequence throughout the testing levels and provide useful information in the TRR.

The incorporation of application software and test elements into the test environments is highlighted as follows.

- Execute the migration checklist form throughout the migration process. This checklist ensures all elements in the migration from Unit Test to System Test take place. CM, QM, and ERA Testing Team are responsible for this task.

- Create/modify the needed test database files and tables. The Development Contractor and the ERA System Test Administrator coordinate this task.

- Identify and assemble the elements of the application software for testing. CM initiates this task.

- Review and identify any new procedure(s) used for installing the test software. QM review will be performed on new procedure(s) before CM performs its review.

- Conduct a TRR. This step is performed prior to moving from one testing level to another. The CM, system test administrator, QM, and the ERA Testing Team are responsible for this task. The PD or a designated representative chairs the review.

- Check the testing environment. This step ensures that the migration is successfully executed in the test environment and everything is ready for System Testing. CM confirms proper operation of the application software. The ERA System Test Administrator checks the database operations.

All policies and procedures specified in the *ERA CMP* will be adhered to in all test-related artifacts and documentation. Refer to the *ERA CMP* for information on Change Request (CR) management.

Once all or part of the ERA system is fielded as an operational system, it will be necessary to have a maintenance test environment or staging area where problems can be replicated and resolved without impact on the production or development environments.

5.5   Acceptance Test (AT) Entrance and Exit Criteria

Entrance criteria for AT include successful completion of DT, and baselined CM controlled documentation, software, and hardware.

Upon the completion of AT, an Acceptance Test Report will be prepared. Refer to **Appendix D, Acceptance Test Report** for a recommended test report format.

Only critical or "show-stopper" issues found in AT of new functionality or regressions from prior functionality are fixed prior to product acceptance. Other issues identified are either formally dispositioned for maintenance, or identified as training issues or enhancements for consideration by the Engineering Review Board (ERB).

6.0   Test Reporting

Issues and results will be documented in testing logs and the ERA Issue Tracking database. All test plans, test procedures, and test cases or other test work products will not be considered complete until the work products undergo peer reviews. The test product peer review procedures are documented in the *ERA Peer Review Process (PRP)*.

Problem Reports and Test Reports are required. Problem Reports will be used to document discovered anomalies, deficiencies, or discrepancies. Ideally the problem report, also referred to as the issue or bug report, captures how to reproduce the problem and an analysis of the error.

Minimally, the problem report will include:

- Tester (name of tester);
- Problem report number (unique identifier assigned to the problem);
- Severity (indicate seriousness of the problem on a scale, e.g., low to high);
- Problem summary/description (briefly describe the problem);
- Steps to reproduce the problem (describe steps, symptoms, and error messages); and
- Module/program/functional area where error occurred (identify where the problem exists).

Test reports will be used to document the results of a test and will recommend a course of action based on those results. Test reports for each phase of DT and AT will be produced. When testing for an increment is complete, a test report will be generated. The test report describes the testing performed and evaluates the results.

Minimally, the test report will include:

- Test Report Identifier (unique identifier assigned to the report);
- Summary of Tests (summarize the evaluation of test items);
- Variances (report any inconsistencies of test items from their design specifications);
- Comprehensiveness Assessment (evaluate comprehensiveness of the testing process);

- Summary of Results (summarize the results of testing);
- Evaluation (provide an overall evaluation of each test item, e.g., impact of any deviation from goals);
- Summary of Activities (summarize major testing activities and events); and
- Approvals (specify names and titles of persons who must approve the report).

7.0   Independent Verification and Validation (IV&V)

The ERA IV&V Team will be an integral element throughout the ERA system lifecycle. IV&V processes determine whether development products of a given activity conform to the requirements of that activity, and whether the software satisfies its intended use and user needs. The Team may analyze, evaluate, review, inspect, assess, and test software products and processes. Specific IV&V activities are detailed in the *ERA IV&V Plan (IVVP)*.

8.0   Test and Evaluation Resource Summary

This section describes test and evaluation resources that will be used during the course of the ERA acquisition program.

8.1   Test Items

All testable items that comprise the ERA system will be tested. The versions to be tested will be placed in the appropriate libraries by the CM Specialist. The CM Specialist will also control changes to the versions under test, perform system builds, and notify the ERA Testing Team when new versions are available.

The actual COTS products to be used have not been specified as the program is in the solicitation process and COTS products will be specified after contract award. Hardware configurations will consist of these minimum configuration areas:

- Workstation hardware,
- Workstation software,
- Communications hardware,
- Communications software,
- Database Server hardware,
- Database Server software, and
- Peripherals.

Specific items (e.g., hardware and software) and associated details within these configuration areas will be addressed in an updated version of this document.

8.2   Test Environments and Facilities

Test environments (i.e., staging areas or regions) will be established to perform test preparation, build verification, and unit, integration, system, and acceptance tests prior to deploying the ERA system. The test environments will be separate from the development environment and identical

to the operational or production environment. During AT, testing will not be conducted using the development environment. All test environments will be approved by the ERA PMO and placed under CM control. Specific test facilities will be determined by the design phase of Increment 1. Test environment and facilities support resources will be coordinated through the ERA PMO and key representatives at each facility.

To establish the operational test environment, the following steps will be taken.

- **Review and expand technical environment** -The purpose of this step is to ensure that adequate computer hardware and the appropriate system software has been installed and is available through the testing phase.

- **Inspect the test environment** -The purpose of this step is to ensure that an effective test environment has been established for the testing phase. The ERA Systems Engineers, Testing Officer, and CM will review the test environments to make certain that HWCIs needed to support the testing are available and operating properly.

- **Prepare system software to support testing** -The purpose of this step is to ensure that the system software in the test environment is ready for the testing effort. The ERA Testing Team will confirm proper operation of the following types of system software: operating systems, utilities, network software, network management software, LAN utilities, testing tools, and legacy software by physically observing every HWCI in the test environment.

8.3   Test Support Equipment

The source selection process is in its early stages and any test support equipment that may be used will be specified after contract award. Specific equipment or tools and associated details will be addressed in an updated version of this document. Various test support equipment may be used during each of the testing phases. When applicable, testing tools will be used (e.g., to generate and load test data, to conduct stress testing, and to perform regression testing).

8.4   Test Beds

Specific requirements for test beds will require further evaluation and be presented in a future update to this document.

8.5   Special Requirements

Federal Acquisition Regulations (FARs) require that the ERA system comply with Section 508 of the Rehabilitation Act of 1973. The need for special testing tools and resources to test Section 508 compliance will require further evaluation and be presented in a future update to this document.

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8.6   Staffing and Personnel Training

Training on the ERA system will be provided, as required, to all test and end user personnel prior to the start of AT. In addition, training will be given to all test personnel on how to conduct the test to ensure familiarity with any special requirements, forms, and reporting methods.

As ERA continues to mature in its development, the test resource requirements will be reassessed and refined and subsequent TSP updates will reflect any changed system concepts or resource requirements.
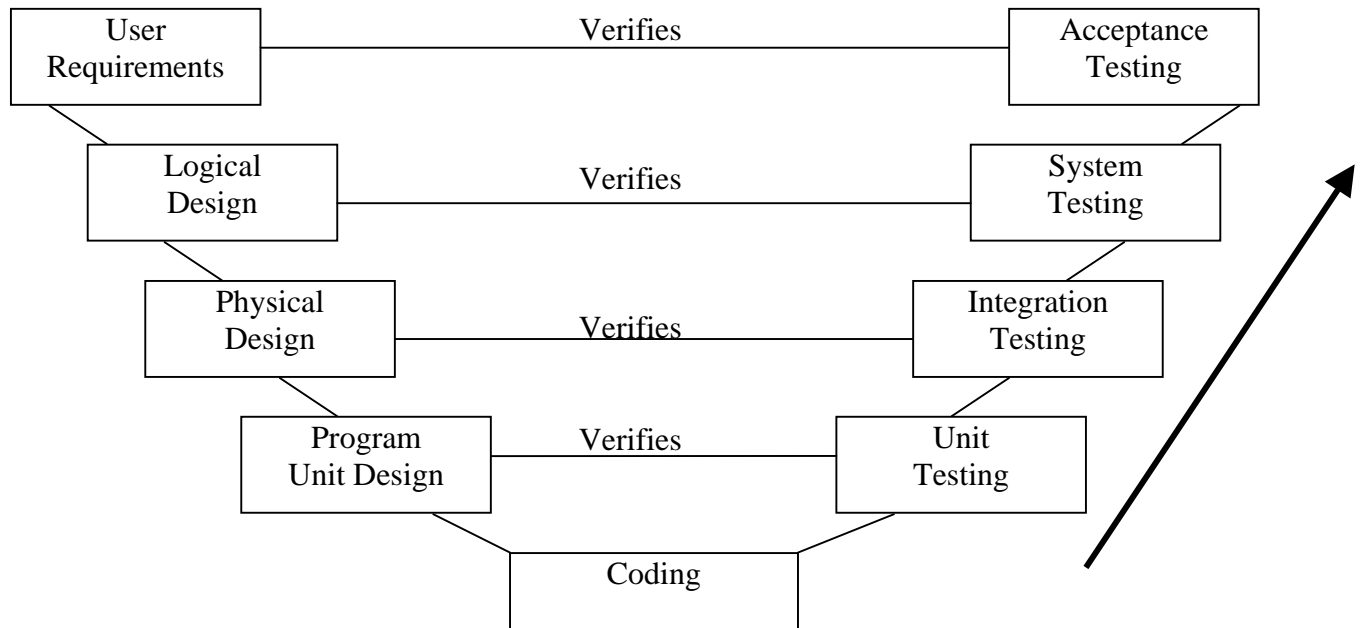
9.0   Risks and Contingencies

A system of ERA's magnitude will not be void of risk and associated mitigations. Similarly, there will be risks that ERA Testing Team will encounter. A solid test management strategy; the involvement of IV&V, QM, CM; various reviews; and reporting methods will prove beneficial to the ERA Testing Team and may help lessen risks. When risks and contingencies arise, they will be handled using formal risk management as is discussed in the *ERA Risk Management Plan (RKM)*.

10.0   Plan Maintenance

The ERA Testing Officer is responsible for this plan. As a part of process improvement (e.g., IV&V assessments, lessons learned, QM assessments), the TSP and the overall testing management approach will continue to be adapted for use in future releases of the ERA System. The plan will be updated as needed to maintain current and sufficient testing management activities. The plan will be placed under CM control following its initial approval by the ERA PMO. Its update will be controlled by the Configuration Control Board (CCB) as defined in the *ERA CMP*.

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APPENDIX A: Testing Execution

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┌──────────────┐           Verifies           ┌──────────────┐
│     User     │──────────────────────────────│  Acceptance  │
│ Requirements │                              │   Testing    │
└──────────────┘                              └──────────────┘
      ┌──────────────┐      Verifies       ┌──────────────┐
      │   Logical    │─────────────────────│    System    │
      │    Design    │                     │   Testing    │
      └──────────────┘                     └──────────────┘
           ┌──────────────┐   Verifies    ┌──────────────┐
           │   Physical   │───────────────│ Integration  │
           │    Design    │               │   Testing    │
           └──────────────┘               └──────────────┘
                ┌──────────────┐ Verifies ┌──────────────┐
                │   Program    │──────────│     Unit     │
                │ Unit Design  │          │   Testing    │
                └──────────────┘          └──────────────┘
                       ┌──────────────┐
                       │    Coding    │
                       └──────────────┘
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An overview of each testing phase and its relationship to the system design. This is a notional diagram that does not prescribe a classic waterfall development approach for the entire ERA system, but rather is intended to convey levels of testing that may be conducted in an iterative manner.

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APPENDIX B: Contractor's Master Test Plan

Content and Format of
Contractor's Master Test Plan (CMTP)

Title Page: The title page contains the name of the program and the words "Contractor's Master Test Plan." The title page also contains the document version (e.g., strawman, draft, final), version number, date of delivery, contract number and delivery order number.

Signature Page: The signature page is signed by everyone listed before the test plan is submitted for review.

Document Change Control Sheet: The Document Change Control Sheet allows the author to record the document's history.

Table of Contents: The table of contents contains paragraph titles and page numbers. It lists each test description. Illustrations, tables, and figures are listed separately.

1.0 Introduction: This section is divided into the following paragraphs.

1.1 Purpose: The following statement will be included in the introduction: "The purpose of this test plan is to validate requirements in system specification _____ *(enter contract system specification number)* for the _____*(enter official system title and contract number)*. This CMTP documents _____*(enter contractor's company name)* test program strategy in order to meet the requirements of the contract."

1.2 Scope: This paragraph describes the amount and type of testing to be performed, any limitations imposed, and indicates the amount of test data from prior testing that is proposed for use in verifying requirements.

2.0 Reference Documents: This section contains all reference documents used in the development of the CMTP, including all requirements documents listed or referenced in the system specification and contract.

3.0 System Description: This section will be divided into the following paragraphs.

3.1 System: This paragraph describes the system(s) to be tested, and included the major functions of subsystems. The contractor also provides a functional block diagram of the system and subsystems.

3.2 Interfaces: This paragraph contains a simplified system block diagram with a functional description of each interface. This includes any interface required to validate the system specification requirements (e.g., facility interfaces, remote maintenance monitoring interface, voice communications interface, operator interface, etc.).

4.0 <u>Test Program Description</u>: This section will be divided into the following paragraphs.

4.1 <u>Management</u>: This paragraph describes the contractor's management responsibilities for the test program. This includes an organizational chart with names of individuals responsible for each department and/or subcontractor(s) participating in the test program.

4.2 <u>Test Identification</u>: This paragraph shall list all tests to be accomplished in the contractor's test program, both specification required and any other contractor tests. Tests shall be labeled with a unique identifier for ease and consistency of reference throughout the test program.

4.3 <u>Subordinate Test Plans</u>: This paragraph identifies all the appropriate test plan(s) that will further detail each test referenced in paragraph 4.2 (above). All critical functionalities and test criteria required to complete each test are itemized. The contractors identify all subordinate test plans required in order to meet the requirements of the contract. This includes unit/module level software and hardware test plans, inspection plans (e.g., sub-First Article), subordinate reliability plans (e.g., for screenings, failure analysis, etc., if required by contract).

4.4 <u>Integrated Schedule</u>. This paragraph contains the test program integrated schedule. The integrated schedule contains major contract milestones and test program milestones that show how the contractor intends to meet the contract schedule.

4.5 <u>Configuration Management (CM) on Unit Under Test</u>: This paragraph describes how the software and hardware configurations of each unit under test will be controlled in the context of each specification, etc. test. The contractor shall also describe the methods and personnel to be employed for the production, certification, and control of test software that is planned for these tests. (The Contractor's CM Plan may be referenced if applicable.)

4.6 <u>Problem Reporting and Resolution</u>: This paragraph describes the failure/problem identification, reporting, and resolution process. It also identifies the documentation to be used in this process. This paragraph also describes the role of the Quality organization and CM in the resolution process. (The Contractor's Performance Work Statement (PWS), similar to a Statement of Work (SOW) and/or Contractor's CM Plan may be referenced if applicable.)

5.0 <u>Verification Requirements Traceability:</u> A single matrix will be constructed which addresses the broad test methods to be employed for each contract requirement. The matrix is based upon the System Specification, contract, and other subordinate requirements deemed appropriate for the testing program. The matrix shall:

    1. Clearly itemize the method of test (e.g., Inspection, Analysis, Documentation, or Test) for each specification requirement, and,

    2. Clearly identify the specification test to which each specification requirement shall be allocated for testing and which T&E test plan documents the verification of the particular requirement.

    Each specification requirement shall be allocated to at least one, specification defined test category. Upon Government approval, the matrix shall be changed only with the approval of the ERA PMO.

APPENDIX C: Test & Evaluation Test Plans

Format of Development and Acceptance Test Plans

Development and Acceptance Test Plans will be prepared in accordance with IEEE 829 Std-1998, Standard for Software Test Documentation. Refer to the standard for content requirements.

1. Test plan identifier

2.   Introduction

3. Test items

4. Features to be tested

5. Features not to be tested

6. Approach

7. Item pass/fail criteria

8. Suspension criteria and resumption

9. Test deliverables

10. Testing tasks

11. Environmental needs

12. Responsibilities

13. Staffing and training needs

14. Schedule

15. Risks and contingencies

16. Approvals

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APPENDIX D: Acceptance Test Report

Content and Format of Acceptance Test Report

Acceptance Test Reports will be prepared in accordance with IEEE 829 Std-1998, Standard for Software Test Documentation. Refer to the standard for content requirements.

1. Test Report Identifier

2. Summary of Tests

3. Variances

4. Comprehensiveness Assessment

5. Summary of Results

6. Evaluation

7. Summary of Activities

8. Approvals