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EOSDIS Core System Project

Acceptance Testing Management Plan for the ECS Project

Final

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May 1994

Hughes Applied Information Systems
Landover, Maryland

Acceptance Testing Management Plan for the ECS Project

May 1994

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Abstract

This Acceptance Testing Management Plan (DID 415/VE1) describes the Independent Acceptance Test Organization (IATO) charter and organization. It defines the responsibilities, processes, and procedures used by the organization, and the IATO interfaces with the System Integration and Planning (SI&P), the Development Organization, Quality Office, Configuration Management, Contract Management, the Government, Maintenance and Operations, and the IV&V contractor. This document outlines the procedure for delivery of test items to the IATO, and defines how the development organizations will deliver initial releases and release upgrades to the IATO. It outlines the procedure for preparation and conduct of acceptance tests; defines the procedure for documenting and processing nonconformances; and defines the procedure for submitting releases that have passed acceptance testing to configuration management.

Keywords: *acceptance testing, configuration management, nonconformances, element, integration, release, segment, system, verification.*

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Preface

This document is a formal contract deliverable with an approval code 1. It requires Government review and approval prior to acceptance and use. Changes to this document also require Government approval prior to acceptance and use. Changes to this document shall be made by document change notice (DCN) or by complete revision.

This document is under ECS Project Configuration Control. Any questions or proposed changes should be addressed to:

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Change Information Page

List of Effective Pages	
Page Number	**Issue**
Title	Original
iii through xii	Original
1-1 and 1-2	Original
2-1 and 2-2	Original
3-1 through 3-12	Original
4-1 through 4-4	Original
5-1 and 5-2	Original
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Contents

Abstract

Preface

1. Introduction

1.1 Identification 1-1
1.2 Scope 1-1
1.3 Purpose and Objectives 1-1
1.4 Status and Schedule 1-1
1.5 Document Organization 1-2

2. Related Documentation

2.1 Parent Documents 2-1
2.2 Applicable Documents 2-1
2.3 Information Documents 2-2

3. Independent Acceptance Test Organization (IATO)

3.1 IATO Charter and Organization 3-1
3.2 Responsibilities 3-4
3.3 IATO Processes and Procedures 3-5
3.3.1 COTS Hardware and Software 3-6
3.3.2 Heritage Software 3-7
3.3.3 Evaluation Packages 3-7
3.3.4 Science Algorithms 3-8
3.3.5 Toolkits 3-8

3.4 IATO Interfaces 3-9
3.4.1 Interfaces with the System Integration and Planning Office (SI&P) 3-9
3.4.2 Interfaces with the Development Organization 3-9
3.4.3 Interfaces with the Quality Office 3-9
3.4.4 Interfaces with Configuration Management 3-10
3.4.5 Interfaces with the Government 3-10
3.4.6 Interfaces with ESDIS Contractors 3-10
3.4.7 Interfaces with Maintenance and Operations (M&O) 3-11

4. Procedure for Delivery of Test Items to the IATO

4.1 Review Schedules 4-1
4.1.1 Test Readiness Review (TRR) 4-1
4.1.2 Element Test Review (ETR) 4-1
4.1.3 Segment Operational Readiness Review (SORR) 4-1
4.1.4 Consent to Ship Review (CSR) 4-2
4.1.5 Release Readiness Review (RRR) 4-3
4.2 Initial Releases 4-3
4.3 Release Upgrades 4-3

5. Preparation and Conduct of Acceptance Tests

5.1 Preparation and Review of Verification and Test Plans and Procedures 5-1
5.2 Conduct of Acceptance Tests 5-1

6. Nonconformance Reporting

6.1 General 6-1
6.2 Nonconformance Processing 6-1

7. Delivery of Items to Configuration and Data Management

7.1 Configuration Management 7-1
7.2 Data Management 7-1

Figures

3-1. ECS HAIS Project Organization 3-2
3-2. IATO Functional Organization 3-3
4-1. Release Schedule Showing Test Milestones 4-2

Tables

7-1. IATO Generated CDRLs 7-2

Abbreviations and Acronyms

Glossary

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1. Introduction

1.1 Identification

This Acceptance Testing Management Plan, Contract Data Requirements List (CDRL) item 074, whose requirements are specified in Data Item Description (DID) 415/VE1, is a required deliverable under the Earth Observing System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-60000).

1.2 Scope

This document defines the management plan for the Hughes Applied Information System (HAIS) ECS Acceptance Test Program. The major element of this program is carried out by the Independent Acceptance Test Organization (IATO), which is part of the System Integration and Planning Office (SI&P) of the ECS project. This plan describes the IATO charter and organization. It defines the responsibilities, processes, and procedures used by the organization and its interfaces with other offices within the ECS project. This document outlines the methods the development organizations will use to deliver initial releases and release upgrades to the IATO. It also describes the methods for preparing and conducting acceptance tests. Nonconformance reporting and resolution is described insofar as it relates to the IATO. The methods used for submitting releases that have passed acceptance testing to configuration management are defined. The Maintenance and Operations Management Plan (DID 601/OP1) addresses IATO's involvement in emergency updates. The processes described in this plan apply to all aspects of the ECS system.

1.3 Purpose and Objectives

The purpose of this document is to define how the independent acceptance test program is organized, managed, and implemented. Its objective is to provide the basis for an effective and efficient overall testing plan for the IATO with clearly defined roles and responsibilities and clear, unambiguous interfaces to all external contractor organizations (i.e., investigators, spacecraft vendor, etc.), the Government, and the Independent Verification and Validation (IV&V) contractor.

1.4 Status and Schedule

This is an update of the Acceptance Testing Management Plan, scheduled for delivery in June 1994. This update reflects Government comments received after its last publication in October 1993.

1.5 Document Organization

This document is composed of seven sections, plus an acronym list and glossary.

Section 1	Introduction, identifies the document, describes its scope, purpose and objectives, delivery status and schedule, and document organization.
Section 2	Related Documentation, identifies the parent documents, applicable documents, and information documents related to this plan.
Section 3	Independent Acceptance Test Organization (IATO), describes the IATO charter and organization, responsibilities, processes, and procedures used by the organization, and the IATO interfaces with the SI&P, the Development Organization, Quality Office, Configuration Management, Contract Management, the Government, Maintenance and Operations, and the IV&V contractor.
Section 4	Procedure for Delivery of Test Items to the IATO, defines how the IATO participates in reviews and how the development organizations deliver initial releases and release upgrades for all software and hardware to the IATO.
Section 5	Preparation and Conduct of Acceptance Tests, describes the process for preparation and review of verification and test plans and procedures developed by the IATO, the review of test plans and procedures developed by either the System Integration and Test Group or the segment development organizations, and the method of conducting Acceptance Tests.
Section 6	Nonconformance Reporting, defines the procedure for documenting and tracking nonconformances.
Section 7	Delivery of Items to Configuration and Data Management, defines the items that the IATO submit to these two organizations.

2. Related Documentation

2.1 Parent Documents

The following documents are the parents from which the scope and content of this document derives:

GSFC	EOSDIS Core System Statement of Work, 2/16/93
GSFC	EOSDIS Core System Contract Data Requirements Document, 2/16/93
GSFC	Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System (ECS), 5/23/91
GSFC	Earth Observing System Configuration Management Plan, 1/90
216/SE1	ECS Requirements Specification, 8/93
107/MG1	Level 1 Master Schedule for the ECS Project, 3/94

2.2 Applicable Documents

The following documents are directly applicable to this plan. In the event of conflict between any of these documents and this plan, this Acceptance Testing Management Plan shall take precedence.

102/MG1	ECS Configuration Management Plan, 3/94
103/MG3	Configuration Management Procedures, 10/93
207/SE1	ECS System Design Specification
308/DV2	Software Development Plan, 11/93
319/DV1	Segment/Element Integration & Test Plan
322/DV3	Segment/Element Integration and Test Procedures
401/VE1	Verification Plan, 12/93
405/VE3	ECS System Integration Test Report
409/VE1	ECS System Acceptance Test Plan
411/VE1	ECS System Acceptance Test Procedures
412/VE2	ECS System Acceptance Test Report
414/VE1	ECS System Integration and Test Procedures

535/PA1	Acceptance Data Package
601/OP1	Maintenance and Operations Management Plan

2.3 Information Documents

The following documents, although not directly applicable, amplify or clarify the information presented in this document, but are not binding:

GSFC	Mission Operations and Data Systems Directorate Performance Verification Plan for the EOS Data and Information System Core System, 4/94
FB9403V1	Release Plan Content Description, 2/94
FB9404V2	Multi-Track Development for the ECS Project, 11/94
PI-QO-1-009	Project Instruction for Nonconformance Reporting and Corrective Action (NRCA)

3. Independent Acceptance Test Organization (IATO)

3.1 IATO Charter and Organization

The IATO is independent of the ECS development organization and is contained within the System Integration and Planning Office (SI&P). The top-level organization chart for the ECS project, showing the position of the SI&P, is shown in Figure 3-1. The organization of the IATO, showing its functional alignment within the SI&P, is shown in Figure 3-2.

The IATO functional organization have assigned six liaison individuals, within the IATO, to the various departments involved with testing. These representatives relay information from the IATO to their assigned departments as well as bring information from their departments to the IATO. The Flight Operations Segment (FOS) liaison, the Science Data Processing Segment (SDPS) liaison, and the Communication and System Management Segment (CSMS) liaison each bring information regarding software development, test efforts, and other issues of concern to the IATO. The Commercial Off-the-Shelf (COTS) liaison keeps the IATO informed of the status of all COTS hardware/software testing, problems, and updates. This relay of information is accomplished through contact with the ECS Procurement Office and the operations side of the Integrated Logistics Support (ILS) part of the M&O organization. The Maintenance and Operations (M&O) representative helps in planning for the transition of the Integration and Test phase to the Maintenance and Operations phase. The liaison also provides continuity in phasing in of future releases. The IV&V representative keeps the IV&V contractor informed of the status of the acceptance testing efforts as well as other ongoing issues. With the expertise of these liaisons, the IATO has the breadth of knowledge and understanding necessary to perform acceptance testing on the ECS.

The IATO has varying degrees of responsibility for testing activities during the ECS development and operations phases. Although the responsibility of segment/element testing belongs to the segment integration and test, the IATO participates by attending reviews of test plans and procedures, and monitoring and witnessing the testing efforts. The IATO also reviews documentation independently from documentation reviews. The IATO has total responsibility for conducting system acceptance testing at the release level. It provides oversight and evaluation during the segment and system integration and test phases. The IATO is also the primary interface for the IV&V contractor during the integration and test, acceptance testing, and operations phases.

The ECS project utilizes the science community as valuable sources of information. Their experience and knowledge are instrumental to the success of acceptance testing. The ECS project works with the science community to develop operational scenarios and insure that science related capabilities of ECS are tested to their satisfaction. The IATO interfaces with the science community through the ECS Science Office. The IATO collaborates with the M&O staff to ensure operational correctness.

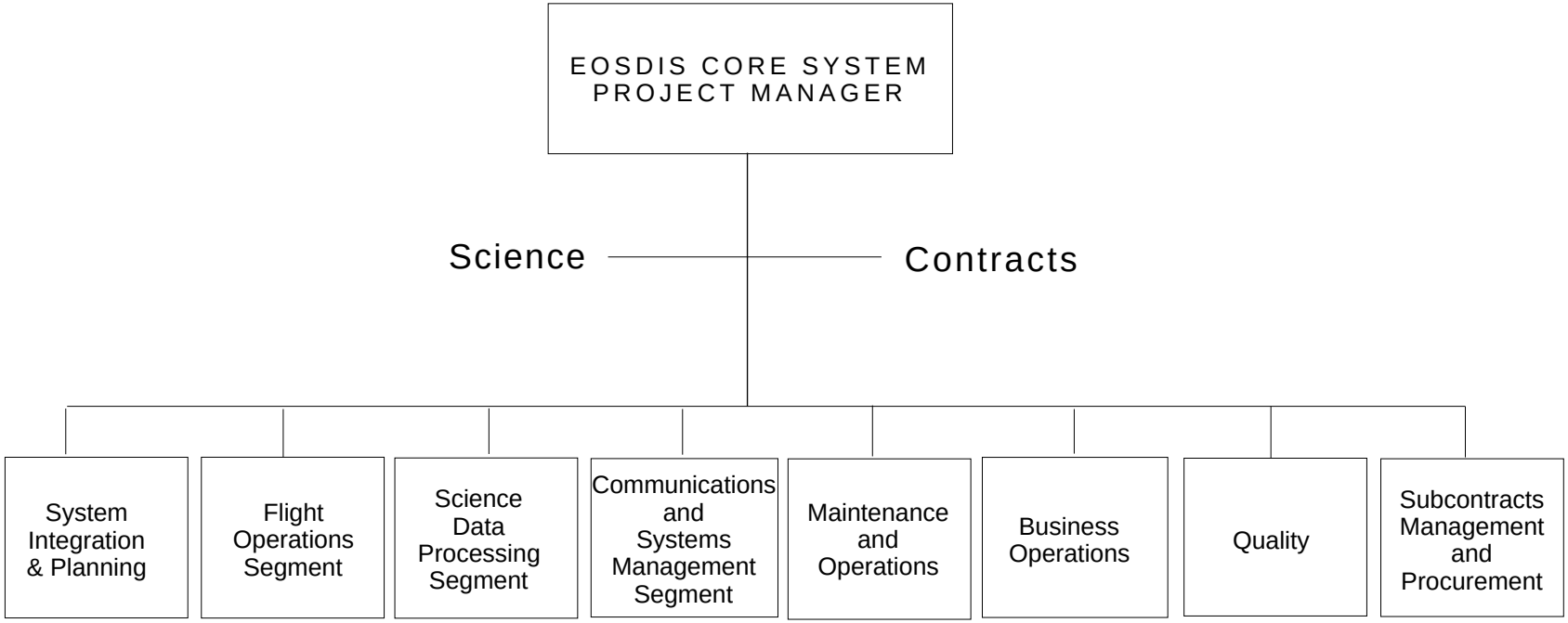

Figure 3-1. ECS HAIS Project Organization

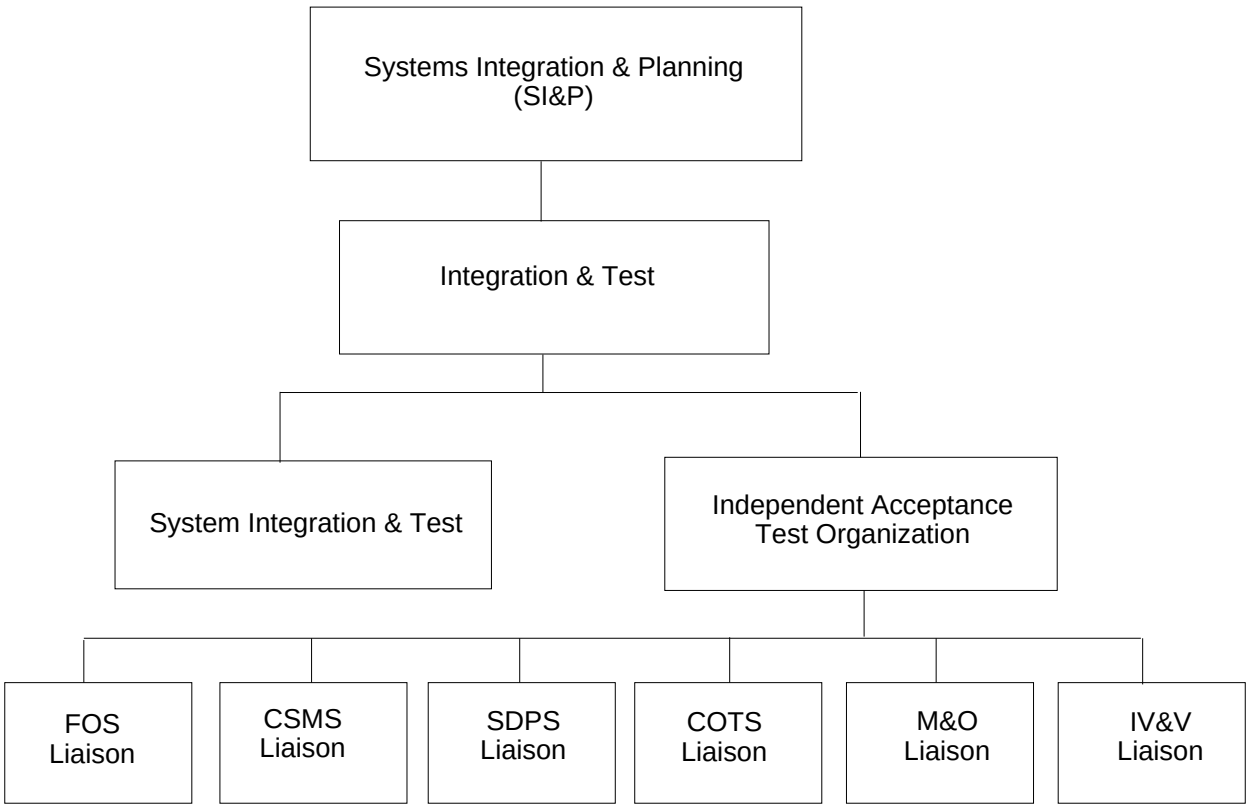

Figure 3-2. IATO Functional Organization

The IATO develops the ECS System Acceptance Test Plan in accordance with DID 409/VE1 to delineate the tests, acceptance criteria, and schedule for ECS acceptance testing. The procedures for reporting nonconformances and discrepancy reports is documented in the Project Instruction for Nonconformance Reporting and Corrective Action (NRCA) Process (PI-QO-1-009).

Testing is conducted by the IATO using plans documented in the ECS System Acceptance Test Plan (DID 409/VE1). This plan will be developed using test procedures and include references from the Segment/Element Integration and Test Procedures (DID 322/DV3) and the ECS System Integration and Test Procedures (DID 414/VE1). The tests are conducted in accordance with established procedures. The IATO will not use development personnel or software tools in the setup, exercise, or evaluation of the acceptance testing in accordance with the EOSDIS Core System Statement of Work.

The IATO documents the results in an ECS System Acceptance Test Report prepared in accordance with DID 412/VE2. A preliminary version of these documented results are delivered to the Contracting Officer/Contracting Officer's Technical Representative (CO/COTR) for review at the Release Readiness Review (RRR) and subsequent approval. The IATO assists the CO/COTR in determining whether a release is ready for turnover for integration with other elements of the EOS Ground System (EGS). All problems with the release are reported and the final decision is made by the CO/COTR as to the readiness of the release.

3.2 Responsibilities

The IATO aggressively participates in the overall ECS verification and validation process to ensure independent assessment, analysis, and testing at key points of the ECS development and operations phases. The IATO implements an independent acceptance test program under the direction of the HAIS SI&P Manager in accordance with the Government Acceptance Test Team's (GATT's) technical direction.

The IATO is actively involved throughout the various phases of evolution of the ECS project. During the concept definition phase, the IATO evaluates requirements testability. During the system analysis phase, the IATO establishes acceptance test requirements and acceptance criteria specifically developed to test the functionality and performance of each release. During the design phase, the IATO formulates acceptance test plans and scenarios, outlines acceptance test cases and procedures, and evaluates and selects test tools to be used during acceptance testing. During the implementation phase the IATO monitors and evaluates ECS development testing to provide focus for future acceptance testing. During the integration and test phase, the IATO monitors progress, notes areas of concern, and refines acceptance test plans, scenarios, cases, and procedures. This refinement of procedures reflects I&T lessons learned. Procedures and data are incorporated where appropriate. The IATO also identifies and develops test data, code, and procedures where those provided by development organizations are inadequate or need modification or enhancements. Prior to release acceptance testing, the IATO develops system test scenarios; test scripts; drivers; simulated source data or, if feasible, real data sets; and expected output data for use in acceptance tests. During acceptance testing, the IATO conducts release tests, identifies nonconformances, and files discrepancy reports. The IATO tracks anomaly and discrepancy resolution, verifies configuration status, analyzes test results, plans and conducts retesting, and conducts regression tests required by configuration updates. At the conclusion of release acceptance testing, the IATO reports its findings to the ECS COTR, who decides on the acceptability of the release. The IATO assists the GATT in evaluating the openness of delivered ECS systems. Differences between installations of similar ECS elements are identified from which ECS portability is determined. Openness is determined by inspection and analysis.

External and internal interfaces are tested against interface requirements in the ECS Requirements Specification (DID 216/SE1) to insure that external and internal systems pass information or control to one another. External interfaces will only be tested using simulators, the EOSDIS Test System (ETS) or other test tools that are available and only with external elements that are mature, available and proven in their environment. The transportable ETS will tentatively be implemented in three releases in 1996 and 1997. The primary purpose of the ETS is to support verification of data throughput and system performance. The ETS has limited capability to support fault isolation and functional verification of the EOS Operations Center (EOC), the System Management Center (SMC), and the Distributed Active Archive Centers (DAACs). It is not the intention of the IATO to provide complete external interface testing, but to test the ECS portion of the external interfaces.

ECS thread and build testing occurs on both the segment and system levels. The segment test organization creates threads and builds to meet release deadlines and allow testing of functional elements as they are developed. On the system level, the threads and builds are tested against a

subset of Level 3 system requirements developed to establish a level of testable requirements. The IATO's role in the thread and build process is to review and evaluate test plans and to monitor and witness the actual tests. The IATO is also taking part in the System Integration and Test (SI&T) Organization's effort to verify the functionality as specified for each release and validate the requirements listed in the ECS Requirements Specification (DID 216/SE1) against the overall approach documented in the Release Plan Content Description (FB9403V1). Acceptance testing on the release level will focus on using operational and science scenarios and lessons learned.

3.3 IATO Processes and Procedures

The IATO plans, executes, and analyzes the acceptance tests, including regression tests, for each ECS release. This process includes operational procedures and all software and hardware to provide impartial verification of the ECS design and performance. The IATO conducts the acceptance tests and reports all discrepancies and anomalies. The acceptance tests are described in the ECS System Acceptance Test Plan (DID 409/VE1), which is approved at SDR for general acceptance tests planning content and at PDR for release-specific content. Acceptance testing is conducted on an approved configuration baseline using the ECS System Acceptance Test Procedures (DID 411/VE1). Analysis of acceptance testing is documented in the ECS System Acceptance Test Report (DID 412/VE2).

The IATO performs assessments of requirements, design, system I&T results, and segment/element I&T results, providing additional verification of the ECS. All nonconformances filed during segment/element, system, and acceptance testing, using an automated tracking system, are tracked and a monthly tabulation indicating type and severity of anomalies is delivered to the CO/COTR. The IATO reviews and evaluates all segment/element and system test plans, procedures, and reports to ensure requirements compliance. The IATO witnesses segment/element tests to gain the knowledge base necessary to ensure that acceptance tests are comprehensive and focused toward risk reduction of discrepancies. The IATO analyzes the results of selected segment/element tests witnessed by the IATO. In addition to verification of the ECS, the IATO supports the overall verification and validation of the EGS through its support of the IV&V contractor.

Test scenarios are the driving mechanism for the overall approach of the IATO to evaluate ECS software and hardware against established acceptance test criteria. The objective is to generate test scenarios to demonstrate that the end-to-end operations of the system satisfy the requirements as specified in the ECS Requirement Specification (DID 216/SE1). The requirements and the scenarios through which they are tested are tracked and maintained through the use of the Requirements Traceability Management (RTM) test tool. These ECS acceptance testing scenarios are built upon element, segment, and system level testing and verification, but have several different focuses. First, by use of test scenarios, the acceptance testing focuses on broad system capability verification, especially in later releases. For the first release, the IATO performs individual requirements verification and acceptance testing, within the context of defining and executing specific test cases in the context of test scenarios. Second, the IATO emphasizes site operational testing, with operations personnel in the loop and participating actively in the acceptance test process. All testing performed on the element, segment, and

system-level testing are performed extensively in the ECS Development Facility (EDF), in coordination with the M&O liaison representative. Finally, acceptance testing interfaces more directly with the Earth Sciences Data and Information System (ESDIS) project inasmuch as the IATO provides the final ECS contractors' validation that the ECS performs as required and expected. This final acceptance requires testing under typical and certain atypical conditions. The IATO's testing at the ECS sites thoroughly demonstrates ECS performance in an environment intended for its use.

Preparation of acceptance testing takes place at the EDF. In the final phases of integration and testing prior to CSR, the IATO makes preparations for formal acceptance testing by conducting informal walk-throughs of the entire test procedure at the EDF. In the event that any nonconformances are observed they will be formally filed as discrepancy reports (DRs) to be addressed at the CSR by the Integration and Test Team.

Acceptance testing consists of end-to-end science and operational scenarios. The prime focus of acceptance testing is the verification of ECS Level-3 functional, operational, and performance requirements. Nonconformances are tracked via system-level DRs. Delivered code is transferred to the site library in accordance with the ECS Configuration Management Plan (DID 102/MG1) and the Configuration Management Procedures (DID 103/MG3). Final acceptance testing of each release is performed at the ECS sites using the site-specific configuration to confirm baseline capabilities and to demonstrate capabilities that could not be performed in the development environment. The actual test plans to be used at all sites are presented in the ECS System Acceptance Test Plan (DID 409/VE1), and the procedures to be used at each site are contained in the ECS System Acceptance Test Procedures (DID 411/VE1), which are tailored to the unique configuration and capabilities at each site.

The acceptance testing of the FOS at the EOC is fundamentally different due to the critical nature of a flight control system and its functions. As such FOS testing of the EOC at Goddard Space Flight Center (GSFC) is conducted using a different suite of test scenarios on a concurrent testing cycle with the DAACs. During the all-up testing, where all applicable centers are tested simultaneously as a unit, the EOC and SMC participate with the DAACs in order to demonstrate spacecraft control. These tests also demonstrate ECS interoperability for storing historical data and for processing data acquisition requests at the DAACs.

SMC testing also covers the period up to all-up testing, though the reasons are different. Initial SMC testing begins in parallel with GSFC activities. After the first test period, the SMC participates in subsequent remote site testing by virtue of the control functions it performs in configuring the environments for each remote site. Finally, during the all-up testing, SMC's ability to orchestrate the overall ECS is verified.

3.3.1 COTS Hardware and Software

COTS resources are divided into two categories: (1) those which are essentially part of the platforms provided to the DAACs and EOC, and SMC centers for use in their operations, and (2) those which are used by the FOS, CSMS and SDPS segment teams to satisfy the ECS Requirements Specification (DID 216/SE1) requirements of their respective segments.

3.3.1.1 Center Platforms

For COTS that provide platform support, the IATO oversees and monitors the integration tests, which are conducted by the Integrated Logistics Support (ILS) part of the M&O organization following the installation of new ECS COTS hardware and associated COTS software (i.e. operating systems, compilers, etc.). These tests are designed by ILS to demonstrate that the equipment and software are properly installed and integrated with the Local Area Network (LAN), that they meet the ECS specific technical requirements, and that they meet the general regulations applying to the acquisition of Automatic Data Processing Equipment (ADPE). These tests are reviewed by the IATO. These tests are performed by ILS at every DAAC and the EOC, and SMC centers, and consist of a series of four tests: (1) COTS hardware tests, which verify that all hardware components are operational; (2) COTS software tests, which verify that all COTS software components are operational; and (3) COTS hardware/software interface test, which verifies the inter-operability and functionality between ECS COTS hardware and software.

3.3.1.2 Segment Development

COTS software packages used by the segments are specified by them to meet certain functional and performance requirements. Upon receipt, COTS packages are tested for compliance with vendor specifications within the context of segment requirements.

General adherence to these requirements are verified by the ILS and later by the segment organizations prior to their use at the subsystem development level. In this way vendor noncompliance to COTS requirements is communicated to the vendor early in the development cycle. As these COTS packages are integrated into the system at the subsystem, element, and segment levels, the functionality of COTS software and its inter-operability with the custom designed software are verified by the Segment I&T organizations. Likewise, COTS conformance to ECS Requirements Specification (DID 216/SE1) requirements are regularly verified as the evolving system undergoes higher order testing performed at the thread and build levels by the System I&T organization, and finally as an entire system at the release level by the IATO.

3.3.2 Heritage Software

Heritage software is software used successfully in previous applications which has general utility for use in ECS. When the IATO performs system level acceptance tests, the entire system is tested against the system level requirements regardless if the software is heritage or newly developed.

3.3.3 Evaluation Packages

An Evaluation Package (EP) is a delivery mechanism for incrementally developed components and selected prototypes. The IATO does not acceptance test the Evaluation Packages. The objectives of evaluation packages are to increase user involvement in system evolution by rapid evaluation and incorporation of user feedback in to the incremental development process. The Evaluation Packages integrate the results of ECS prototyping, analysis of ECS trade-off study and modeling results, and knowledge gained from Version 0 and other systems currently being implemented and in operation. For all EPs, the package content and plan for evaluation is

developed in collaboration with the NASA ESDIS Project Office. The IATO participates in the evaluation of EPs by providing a member to the I&T EP test team. The test team supports the integration of the various functions of the EP as well as the deployment of the EP. Users assess the utility and capability of the EPs and report their findings to the ECS Project Office.

3.3.4 Science Algorithms

The Algorithm Integration & Test Team (AIT) is responsible for the integration and testing of science algorithms. The IATO has no involvement with the AIT. The procedure for testing these algorithms involves three distinct phases—evaluation, integration, and acceptance testing with reviews completing each phase. Since the EOS concept is for the algorithm code delivered from the science community to be the operational software, the main activities of the AIT is restricted to:

- evaluation of the delivered algorithm for completeness and compatibility with the ECS environment
- integration with the operational DAAC software interfaces
- development of additional system tests to fully test the algorithm in the Product Generation System (PGS) environment
- acceptance testing for DAAC operations (not for science validity)
- documentation of the operational procedures for the production algorithm

In general, if any problems are encountered which involve modification of the algorithm source code in any of the Product Generation Executables (PGEs), they are returned to the algorithm development team for modification.

3.3.5 Toolkits

Toolkits are used throughout the ECS system to provide a controlled interface into the services provided by the ECS. The User Interface Toolkits and the Application Program Interface (API) Toolkits are tested as a part of the formal system release in a manner similar to that used by other elements within the ECS.

The Algorithm Interface PGS Toolkit is an exception. The developmental version of the PGS Toolkit is delivered to scientists at the Science Computing Facilities (SCFs) to provide an environment in which algorithms destined for operational use within the ECS Product Generation System (PGS) may be developed and tested. The SCF version of the PGS Toolkit is delivered before formal delivery of the releases to allow algorithm developers an early start. Thus, the toolkit is tested separately through the use of a test tool or set of test tools (test suite) that make calls to the PGS Toolkit to test the toolkit routines. These tools will resemble an algorithm only from the point of view of making the same toolkit calls that an algorithm would. There is no intention to develop an algorithm capable of performing any science processing for PGS Toolkit Testing. Most of these tools will be developed by the SDPS I&T organization. The SDPS I&T organization is responsible for the adequacy of test tools used by them to verify

Level 4 requirements (the PGS Toolkit Specification). Further details can be found in the Segment/Element Integration & Test Plan (DID 319/DV1).

The IATO will certify the toolkit test tools developed by SDPS I&T. Toolkit test tool certification will be done with the Quality Office, to ensure that the test tool is accurate and complete. Included in these toolkit test tools will be at lease one algorithm to be benchmarked for use in SDPS testing. After certification, toolkit test tools will be placed under configuration control along with the toolkits, and treated in the same manner as the rest of the Release software. The operational version of the PGS Toolkit is delivered as part of a complete Release and is tested with that release. The toolkit is tested coincident with the testing of the PGS itself through the use of one or more test tools. The focus of the test it to prove that the interfaces to the algorithm meet the interface definitions of the PGS Toolkit Specification, and that the PGS, as a whole, interfaces with the algorithm for the delivery/receipt of data and the scheduling/control of algorithms.

3.4 IATO Interfaces

The following subsections identify each organization with which the IATO interfaces. The Hughes Applied Information System (HAIS) ECS Project Organization chart (Figure 3-1) shows the relationship of the organizations within the HAIS ECS Project.

3.4.1 Interfaces with the System Integration and Planning Office (SI&P)

The IATO is a component of the Integration and Test Group within the SI&P. Thus, the IATO is part of the SI&P staff. IATO personnel coordinate with the SI&P on test-related schedules and activities and provide technical information as well as recommendations dealing with testing issues. The IATO works closely with the System Integration organization during system integration. The IATO also provides the SI&P with draft versions of verification-related documentation, such as acceptance test plans and procedures, for SI&P review and comment prior to delivery to the COTR.

3.4.2 Interfaces with the Development Organization

The IATO monitors and evaluates development test activities that occur at the element and segment level. The IATO reviews element/segment-level test documentation, witnesses segment testing, analyzes test results, and review test reports. These activities allow the IATO to gain an overall understanding of the software and potential risk areas that may warrant additional attention when the software is promoted to the next level of testing. As shown in Figure 3-2, the IATO identifies a key person within the IATO to coordinate with each segment test lead on all segment test activities.

3.4.3 Interfaces with the Quality Office

The IATO routinely communicates with the Quality Office concerning acceptance test plans, procedures, schedules, and status for the purpose of providing the Quality Office with information regarding acceptance testing activities and issues. The Quality Office witnesses acceptance tests and maintains the NRCA system.

3.4.4 Interfaces with Configuration Management

The IATO coordinates with the Configuration Management Office in identifying all acceptance test items placed under configuration control. These include test plans and procedures, test data sets, the software and hardware used to perform acceptance testing, the software and hardware to be tested, and test reports resulting from acceptance testing. The Configuration Management Office supports the IATO through all testing. The IATO maintains close contact with the Configuration Management Office. One method of maintaining contact with the CM Office is through the ECS HAIS Configuration Control Board (CCB) and the three segment-level CCBs, i.e., the FOS CCB, the SDPS CCB, and the CSMS CCB. For each of these CCBs, the Configuration Management Office provides the assistant chair, and the IATO provides a standing member.

3.4.5 Interfaces with the Government

The ECS Acceptance Test Team (ATT) consists of the Government Acceptance Test Team (GATT) and the IATO. The IATO maintains regular contact with the Government Integration and Acceptance Test (I&AT) Manager, who is the head of the ATT. The GATT is responsible for independently assessing the acceptability of each ECS release. In doing so the GATT relies heavily on the activities performed by the IATO. All IATO documents are reviewed by the GATT, to ensure that the IATO develops thorough acceptance test plans, procedures, and reports. The IATO reports all acceptance test findings to the GATT and the COTR. This close working relationship enables the GATT to assess the acceptability of the release. Based on the IATO and GATT test reports, the COTR decides the acceptability of the release. Both the ESDIS Integration Contractor and the IV&V Contractor are members of the GATT.

3.4.6 Interfaces with ESDIS Contractors

Clear lines of responsibility between the IATO, the EOSDIS IV&V contractor, and the NASA project team facilitates thorough testing at all levels. The IATO acts as the primary ECS point-of-contact for the IV&V contractor. In this role, the IATO helps ensure the IV&V contractor has complete and open access to all ECS test activities and technical information for review and analysis. Examples of technical information include the following:

- ECS test activities at the segment I&T, system I&T, and acceptance test levels include test plans, procedures, and results .
- The IV&V has open access to all ECS technical contract deliverables for analysis and review. The IV&V contractor ensures that the documents are accurate, complete, and consistent with ECS and EOSDIS requirements.
- The centralized nonconformance reporting system, containing all software/hardware problem reports, is made available to the IV&V contractor throughout the program.
- Engineering Change Proposals (ECPs) are available to the IV&V contractor.

The IATO reviews IV&V test plans and procedures and provides IATO personnel and equipment (hardware and software) support during IV&V test activities. The IATO provides inputs to IV&V schedules. In order to maintain efficient two-way contractor communication, the IATO

requests, through the COTR, copies of technical reports sent to NASA by the IV&V contractor be made available to the IATO. Following the successful completion of EOSDIS system-level testing, the IV&V contractor hands over a release to M&O for operational use. After the release is turned over to M&O, ESDIS intends to subject it to EOSDIS system-wide testing during which ECS external elements are tested and adherence to Level 2 requirements is validated.

The IATO interfaces with the ESDIS Integration Contractor in its role as GATT representative for activities relating to the acceptance testing of the ECS system.

3.4.7 Interfaces with Maintenance and Operations (M&O)

As part of acceptance testing at the DAACs, a small group of M&O personnel are integrated into the test team to help execute acceptance tests. The early first-hand involvement of operations personnel in site acceptance testing provides the M&O Team with early visibility into each new release and hastens the smooth transition. This involvement and familiarity with ECS software in the stages before release to the user base greatly enhance the effectiveness and productivity of the M&O staff and positions a highly competent and responsive user support staff on-site at the DAACs. In addition, during the M&O phase, the IATO assists by providing benchmark tests to verify operational performance of the ECS system. The IATO provides acceptance testing procedures for use during the verification of approved changes and enhancements.

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4. Procedure for Delivery of Test Items to the IATO

4.1 Review Schedules

The IATO reviews, evaluates, and analyzes the results of selected increments of test activities throughout the system life cycle. These evaluations focus on the adequacy of the tests, test results, and discrepancy reports and resolution. Based on the results of the evaluations, IATO enhances and modifies the system acceptance test procedures.

In addition to informal in-process reviews and evaluations, the IATO attends formal test reviews. Based on these reviews, a generic schedule for ECS releases has been established. This schedule is depicted in Figure 4-1. These test reviews, and IATO's role during each review, are described in the following paragraphs.

4.1.1 Test Readiness Review (TRR)

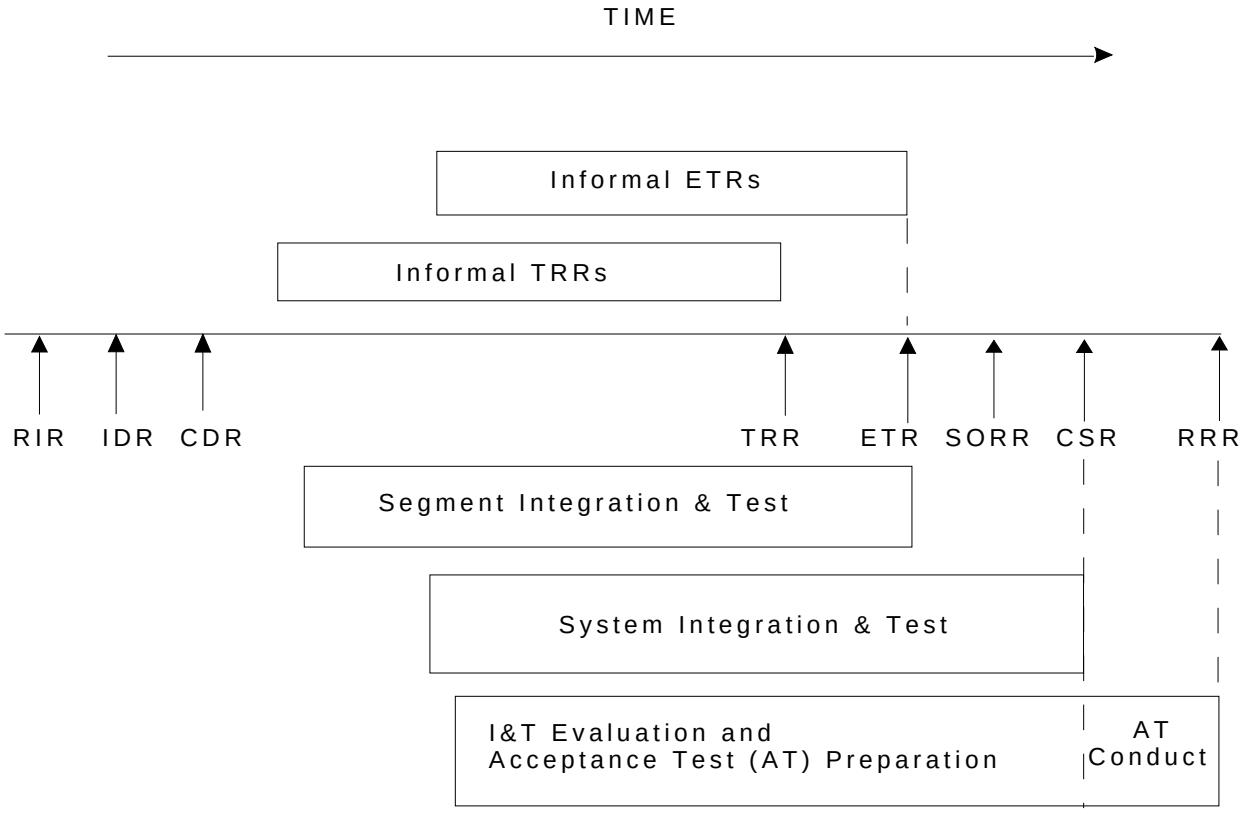
For each major release, TRRs are conducted by the ECS contractor at the segment and element levels to review the plans for the integration and verification of the subsystems with the elements and the elements with their segments. The TRR is a transition between unit testing and Segment I&T. The TRRs will be conducted as series of discrete reviews leading to a single summary TRR. TRRs are scheduled as functional threads are completed by development organizations and are ready to be tested. The review ensures that the tests will adequately verify the applicable segment functional, performance, and interface requirements of the ECS. The TRR determines if the element/subsystem is ready for testing. The IATO monitors and evaluates test activities at this level, in order to gain an understanding of the system, and identify possible areas of concern to acceptance testing.

4.1.2 Element Test Review (ETR)

The ETR is conducted to determine if element development level testing (for each release) has successfully been completed. The ETR is a transition from Segment I&T to System I&T. The IATO reviews and comments on the results of the Element and Segment testing presented at this review. The results of the ETR are used to help focus the acceptance testing on areas that may be weak or complex.

4.1.3 Segment Operational Readiness Review (SORR)

SORRs are conducted to determine the readiness of each ECS segment to provide service. These reviews are held at segment/element facilities to baseline the functional capabilities, performances, and operational characteristics of each ECS segment. The IATO attends this review to gain a greater understanding of operational procedures, human interfaces, ECS standards and procedures, and operational readiness.



RIR = Release Initiation Review
IDR = Incremental Design Reveiw (Segment)
CDR = Critical Design Review (Element)
TRR = Test Readiness Review
(Element/Segment - Last thread within an Element/Segment)
ETR = Element Test Review
SORR = Segment Operations Readiness Review
CSR = Consent to Ship Review
RRR = Release Readiness Review

Figure 4-1. Release Schedule Showing Test Milestones

4.1.4 Consent to Ship Review (CSR)

The CSR is led by the IATO. The CSR reviews a release readiness for transition to sites for final integration and acceptance testing. The review covers the plans, as specified in the ECS System Acceptance Test Plan (DID 409/VE1) for verification of the segments and the over-all system during the acceptance test program. The CSR reviews the tests to verify the design requirements, as specified in the ECS System Design Specification (DID 207/SE1), as well as maintainability demonstrations for restoration of failed critical real-time functions. The CSR also reviews the preliminary ECS System Integration and Test Report (DID 405/VE3), any discrepancy reports,

and the ECS System Acceptance Test Procedures (DID 411/VE1). The ECS System Integration and Test Report contains the results of release integration testing, which is executed by the Integration and Test organization. At the CSR, the IATO is actively involved in working with the GATT to determine if the release is ready to be shipped to the field sites (DAACs) for final acceptance testing.

4.1.5 Release Readiness Review (RRR)

For each release, the RRR is conducted at the ECS system level for the GSFC Project Review Team. It addresses the readiness of the release for installation in the ECS system. Review areas include integration test results and acceptance test results, and the success of implementation of the new capabilities and changes since the previous release, the status and adequacy of operations guides and users' documentation, the status of DAAC interface and installation, and the plans for installation of the release into the operational ECS system in a manner that minimizes disruptions of ongoing service. The RRR is conducted upon completion of release acceptance testing to determine if the release is ready for transition to IV&V and EOSDIS system-level testing. The IATO leads the RRR in order to determine, with the GATT and the COTR, if a release is ready to be incorporated into the operational system.

4.2 Initial Releases

The HAIS Configuration Management Office (CMO) establishes the baseline hardware/software configuration, captures the "as built" configuration, and establishes procedures for using the hardware/software configuration management tools. The System Integration and Test Office relies on the configuration data as a foundation for its hardware/software integration process. The configuration management tools are used by the CMO to populate test environments.

Each of the three segment-level CCBs, i.e., the FOS, SDPS, and CSMS CCBs, controls changes to its individual product development libraries during the implementation phase of each release. To ensure effective integration into the total ECS environment, the ECS HAIS CCB takes over the change control role as the product hand-over to IATO testing occurs.

4.3 Release Upgrades

The Configuration Management (CM) organization operates as though each ECS phased implementation release is a product acquisition. This point of view accommodates the flow of products between releases that have concurrent periods of performance. The overlap of scheduled releases can be viewed in the Level 1 Master Schedule for the ECS Project (DID 107/MG1), which shows the scheduled dates for each release. Each release reevaluates the system specification, system interfaces, design criteria and tradeoff analyses as established in the first release. Due to the significant time periods between the completion of releases, it can be expected that performance specifications, interface documents, hardware allocations, and other design data will change. The CCB processes these changes and updates the allocated baseline as required with each release cycle.

The IATO organization has high visibility of release requirements through involvement in the evaluation and analysis of testing activities at all life cycle phases. Although the responsibility

for tracing ECS requirements, maintaining the currency of requirements, and maintaining the requirements tracability data base lie within the System Integration and Planning Office, the IATO offers assistance and reviews changes and updates to the requirement baseline. Therefore, when new release requirements are received, IATO can adjust acceptance test plans and procedures accordingly. The acquisition phase of each release, which culminates in the establishment of the product baseline, is highly focused on a given release. The control of changes from one release's baseline into other releases is the responsibility of the ECS CM organization. The IATO conducts system acceptance tests for release requirements using the validated product baseline under configuration control. In addition, regression tests are performed to verify that continuing ECS development and repair activities did not result in any system degradation. Regression tests are used to verify that a new release does not affect the performance or functionality of elements of the previous release that are unchanged in a subsequent release.

ECS's configuration management activities are described further in the ECS Configuration Management Plan (DID 102/MG1), the ECS Configuration Management Procedures (DID 103/MG3), and the Software Development Plan (DID 308/DV2).

5. Preparation and Conduct of Acceptance Tests

5.1 Preparation and Review of Verification and Test Plans and Procedures

The IATO is responsible for developing the ECS System Acceptance Test Plan (DID 409/VE1), ECS System Acceptance Test Procedures (DID 411/VE1), and the Verification Plan (DID 401/VE1). An update to the ECS System Acceptance Test Plan and ECS System Acceptance Test Procedures document are generated for each release based on the ECS Requirement Specification (DID 216/SE1) requirements established for that release. The same basic methodology guides the preparation and review of each of these documents. The first step in the preparation consists of a thorough review and analysis of all ECS Requirement Specification (DID 216/SE1) requirements applicable to the release or releases currently under development.

Based on this analysis, test and verification plans, which identify a test or tests that verify each applicable requirement, are formulated by the IATO. The IATO reviews these plans internally with the Integration and Test group of the SI&P and the Segment managers and identifies any issues requiring resolution. A similar process occurs for the development of procedures, with the IATO developing the procedures and having them reviewed internally by the Segment Managers and the SI&P.

5.2 Conduct of Acceptance Tests

After the delivery of test items, described in Section 4, to the IATO has been completed, the CO/COTR and the GATT shall be given notice at least three weeks in advance of the planned commencement for acceptance tests in accordance with the EOSDIS Core System Statement of Work. Attendance to witness the tests is at the option of the CO/COTR.

Preparation of the acceptance test takes place at the ECS Development Facility (EDF). Acceptance testing consists primarily of conducting end-to-end operational scenarios. The prime focus of acceptance testing is the verification of ECS Level 3 Functional, Operational and Performance requirements as discussed in the ECS Requirement Specification (DID 216/SE1). The IATO witnesses lower level tests and may use data from these tests as analytical data to verify Level 3 requirements. Nonconformances are tracked via system-level DRs. Success of the acceptance test preparation at the EDF is documented in the ECS System Acceptance Test Report (DID 412/VE2). Delivered code is transferred to the DAAC library as described in the ECS Configuration Management Plan (DID 102/MG1) and the Configuration Management Procedures (DID 103/MG3).

Formal acceptance testing occurs at each of the remote sites depending upon the content of the release. The actual sequence of testing is defined in the ECS System Acceptance Test Procedures (DID 411/VE1).

The second release is an example of a delivery to all sites. A possible scenario for the site integration and test process is as follows:

a. The acceptance test team is split into two groups. One travels to the GSFC DAAC, SMC, EOC, and the other to the Langley Research Center (LaRC) DAAC. A three-week period of DAAC testing is performed beginning with an informal re-execution of the system integration test as a readiness exercise. SMC and EOC testing continues for about 9 weeks. The formal acceptance tests are witnessed by the GATT and the IV&V contractor. Personnel from DAAC customer operations and M&O operations are included in the team to serve as test personnel. This method provides these personnel with early visibility into the new release and a smoother transition of the new code into operations. Post-test meetings are held to evaluate test reports and a final summary is presented of the test results. The local team members formulate a quick-look report upon test completion and forward it to the rest of the GATT via electronic mail.

b. The two DAAC teams then split into three parts. One travels to the EROS Data Center (EDC) DAAC, the second to the Marshall Space Flight Center (MSFC) DAAC, and the third to the Oak Ridge National Laboratory (ORNL) DAAC. The above process for DAAC testing is repeated.

c. Next, one team moves on to the National Snow and Ice Data Center (NSIDC), one to the Jet Propulsion Laboratory (JPL), and the third to the Alaska Synthetic Aperture Radar (SAR) Facility (ASF). The test cycle for DAACs is repeated.

d. The teams are then dispersed so there is representation at each DAAC, the SMC and EOC. Three weeks of all-up testing is performed to verify interfaces among all eight DAACs, the SMC, and EOC.

e. Finally the full results of the test are collected into a single test report. Recommendations are formulated and forwarded to the GATT. The GATT assesses acceptance test success/failure. All problem reports are dispositioned either to each DAAC's tracking system for M&O action or to the ECS Project's system for subsequent resolution . The GATT presents its conclusions to the COTR at the Release Readiness Review (RRR) one week after completion of the acceptance test. The final report is delivered four weeks after RRR.

The actual operators of the system during acceptance testing are local M&O personnel. They are assisted by members of the SI&P, IATO, and GATT. The reason for this mix of personnel is twofold. First, it provides the government with a cost-effective method of executing the test by using available personnel without the need to hire and train additional personnel to run the acceptance tests. Secondly, the wide knowledge base of the various personnel assists in the understanding of the systems requirements. The M&O personnel also gain an understanding of the system that they will be running as well as getting a first look at changes to the existing system.

6. Nonconformance Reporting

6.1 General

The nonconformance reporting and corrective action (NRCA) system is a closed-loop system to control identified problems. A nonconformance, often called a problem, discrepancy, anomaly, fault, error, failure, or malfunction, is defined as a condition of any hardware, software, material or service in which one or more characteristics do not conform to requirements of hardware, software, safety, Reliability, Maintainability and Availability (RMA) or documentation. The NRCA system supports the development, integration and test, acceptance testing, and implementation. Nonconformances fall into two categories: discrepancies and malfunctions. A discrepancy is a departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating. A malfunction is a departure from the specification that is discovered in the functioning or operations of the hardware or software.

This system tracks nonconformances, assigns priorities, records dispositions, identifies the version of the product in which they are corrected, notifies the originator of current status, and produces management reports. All problems, regardless of their source (life cycle phase) will be maintained in the NRCA system. During the incremental track, nonconformances are available for review by GSFC representative or authorized agent. Nonconformances during the formal track will be reported on a monthly basis to GSFC starting in the system integration and test phase.

Corrective action is a general name for the process by which nonconformances are resolved and controlled.

6.2 Nonconformance Processing

During the software development and integration and test phase, software problems are identified as discrepancies and are resolved and managed internally by the development and test activity. Once the problem has been identified, it will be entered in the NRCA system. The information will be forwarded to the segment manager or technical lead for further analysis and review. If the discrepancy is in the code or a data product, those responsible for segment, systems, and acceptance test activities develop tests to ensure that the problem is satisfactorily corrected. In addition, regression testing is conducted to make sure that no new problems have been introduced by the fix. The Quality Assurance representatives responsible for monitoring and witnessing test activities ensure proper tests are conducted against the discrepancy reports. Both in-process audits and formal audits are conducted against these activities.

Identification, resolution, and management of problems continues to be applied at the beginning of integration and test activity for each release between Critical Design Review (CDR) and Test Readiness Review (TRR). When the initial resolution is complete, the problem is submitted to the Review Board for disposition. If the disposition is approve, the Review Board will sign off

on the problem and the process will continue with the verification and testing phase. If the problem is assigned to a Configuration Change Request (CCR), it will be submitted to the ECS Change Control Board (CCB) and progress through the CM process. CM tracks the product changes and versions that result from correcting discrepancies. Some discrepancy reports contain proposed requirement changes. These reports result in the opening of a change request and are handled by the CM process and acted upon at the CCB meetings. If the problem is approved by the board, the Configuration Management reporting process will begin. The CM process involves identifying a requirement change, determining the cost, if any, for repairing the problem, whether the repair will have a negative or a positive impact on the scheduling for the project, and whether any changes to the specifications need to be addressed. Last, a determination needs to be made regarding the segment and/or limited classification of the action. If the problem is given a Class 1 code, then approval must come from NASA. A Class 2 code can be approved internally. The close-out report is signed by the Review Board Chairperson and submitted to NASA for authorized closure. GSFC Performance Assurance Office is notified of nonconformance reports and their status through several required reports. Specifically, the Quality Office will deliver contract deliverables identifying nonconformances throughout the project.

7. Delivery of Items to Configuration and Data Management

7.1 Configuration Management

ECS test documents, software and hardware configurations under test, test data sets, and software and hardware used for testing are maintained in the CM library. All changes to these items, including the addition of new components at all levels of integration and the implementation of corrective action, is performed in accordance with the Software Development Plan (DID 308/DV2), Configuration Management Plan (DID 102/MG1), and the Configuration Management Procedures (DID 103/MG3).

Once the following test items are finalized, they are stored and baselined by the CM organization in the segment/element I&T, system I&T, or acceptance testing portion of the controlled CM library, as appropriate. The required items are retrieved from the CM library when needed to perform the various verification activities.

- Verification documents, including test plans, procedures, and reports. They are used by the Segment I&T and System I&T organizations and the IATO to provide direction, procedures, and other relevant information about the segment/element I&T, system I&T, and acceptance testing to be performed.
- Test data sets, software, and hardware configuration, including test tools. They are used by the Segment I&T and System I&T organizations and the IATO to perform testing.
- Unit-tested components, data sets, segment hardware configuration, and COTS software. They are tested and integrated by the Segment I&T organization during segment/element I&T.
- Verified segment/element threads and builds. They are tested and integrated by the System I&T organization during system I&T.
- Verified system builds. They are tested by the IATO during acceptance test dry runs at the EDF.
- Integrated system build for a release. It is tested by the IATO during formal acceptance testing at ECS sites.
- Evaluation of test results. These results are evaluated against the acceptance criteria.

7.2 Data Management

The IATO is producing a series of documents to aid in the acceptance test process. Table 7-1 depicts this documentation which the IATO delivers to the Data Management Office in accordance with the scheduled milestones.

Table 7-1. IATO Generated CDRLs

Contract Data Requirement List Number	Document Title	Milestone Schedule
DID 409/VE1	ECS System Acceptance Test Plan	One month prior to System Design Review
DID 411/VE1	ECS System Acceptance Test Procedures	Delivered for the Consent to Ship Review
DID 412/VE2	ECS System Acceptance Test Report	One month after the Release Readiness Review
DID 535/PA1	Acceptance Data Package	One month after the Release Readiness Review.

Abbreviations and Acronyms

AIT	Algorithm Integration & Test Team
ADPE	Automated Data Processing Equipment
API	Application Program Interface
ASF	Alaska SAR Facility
ATT	Acceptance Test Team
CCB	Configuration Control Board
CCR	Configuration Change Request
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CM	Configuration Management
CMO	Configuration Management Office
CO	Contracting Officer
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-the-Shelf
CSCI	Computer software configuration item
CSMS	Communications and System Management Segment
CSR	Consent to Ship Review
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
DID	Data Item Description
DR	Discrepancy Report
DV	Development
ECP	Engineering Change Proposal
ECS	EOSDIS Core System
EDC	EROS Data Center
EDF	ECS Development Facility
EGS	EOS Ground System
EOC	EOS Operations Center

EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EP	Evaluation Package
ESDIS	Earth Sciences Data and Information System
ETR	Element Test Review
ETS	EOSDIS Test System
FOS	Flight Operations Segment
GATT	Government Acceptance Test Team
GSFC	Goddard Space Flight Center
HAIS	Hughes Applied Information Systems
I&AT	Integration and Acceptance Test
IATO	Independent Acceptance Test Organization
ILS	Integrated Logistics Support
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
LAN	Local Area Network
M&O	Maintenance and Operations
MG	Management
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NRCA	Nonconformance Reporting and Corrective Action
NSIDC	National Snow and Ice Data Center
ORNL	Oak Ridge National Laboratory
ORR	Operational Readiness Review
PA	Performance Assurance
PGE	Product Generation Executable
PGS	Product Generation System
RMA	Reliability, Maintainability, and Availability
RRR	Release Readiness Review
RTM	Requirement Tracability Management

SAR	Synthetic Aperture Radar; system architecture review
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
SDR	System Design Review
SE	System Engineering
SI&P	System Integration and Planning Office
SI&T	System Integration and Test Organization
SMC	System Management Center
SORR	Segment Operational Readiness Review
TRR	Test Readiness Review
V&V	Verification and Validation
VE	Verification

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Glossary

Analysis	Technical or mathematical evaluation based on calculation, interpolation, or other analytical methods. Analysis involves the processing of accumulated data obtained from other verification methods.
Consent to Ship Review (CSR)	Review to determine the readiness of a release for transition to sites for integration testing.
Critical Design Review (CDR)	A detailed review of the element/segment-level design, including such details as Program Design Language (PDL) for key software modules, and element interfaces associated with a release.
Demonstration	Observation of the functional operation of the verification item in a controlled environment to yield qualitative results without the use of elaborate instrumentation, procedure, or special test equipment.
Element Test Review (ETR)	Determines if development level testing (for each release) has successfully been completed.
Incremental Design Review (IDR)	Review conducted to evaluate segment designs associated with a release.
Inspection	The visual, manual examination of the verification item and comparison to the applicable requirement or other compliance documentation, such as engineering drawings.
Release Initiation Review (RIR)	An internal review conducted at the start of the development phase of a release to revisit the requirements and issues associated with that particular release.
Release Readiness Review (RRR)	Conducted at the ECS system level for a GSFC Project Review Team upon completion of release acceptance testing. The IATO leads the RRR to determine, with the GATT and the COTR, if the release is ready to be delivered, installed, and incorporated into the operational system.
Segment Operational Readiness Review (SORR)	Conducted for each release to determine if the operation plans are in place prior to turnover to IV&V and operations.
Test Readiness Review (TRR)	Conducted by the Project for each release at the segment and element levels to review the plans for the integration and verification of the subsystems with the elements and the elements with their segments.

Validation	The process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements.
Verification	The process of evaluating the products of a given development activity to determine correctness and consistency with respect to the products and standards provided as input to that activity.