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EOSDIS Core System Project

Release A COTS Maintenance Plan for the ECS Project

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not intended for general distribution.**

September 1995

Hughes Information Technology Corporation
Upper Marlboro, Maryland

Release A COTS Maintenance Plan for the ECS Project

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CDRL Item 119

SUBMITTED BY

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Preface

This document is a formal contract deliverable with an approval code 1 and is intended as a final submittal. It requires Government review and approval prior to acceptance and use. Once this document is approved, Contractor approved changes are handled in accordance with Class I and Class II change control requirements described in the EOS Configuration Management Plan, and changes to this document shall be made by document change notice (DCN) or by complete revision.

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Abstract

This COTS Maintenance Plan addresses the Release A maintenance concept and the responsibilities of the ECS Project for the commercial off-the-shelf hardware and software supplied by the ECS Contractor and government furnished equipment (GFE). The plan identifies the sources of maintenance support at ECS sites, periods of coverage, and responsibilities of the M&O staff and contracted maintenance providers. ECS sites included for maintenance support include GSFC, LaRC, MSFC, EDC, and the EDF.

Keywords: maintenance, PPM, support, LMC, diagnostics, corrective, preventive, PM, operational, availability, line, replaceable, unit , LRU, spares, provisioning, problem, resolution

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Change Information Page

List of Effective Pages			
Page Number		Issue	
Title			Release A
iii through xii			Release A
1-1 and 1-2			Release A
2-1 and 2-2			Release A
3-1 through 3-6			Release A
4-1 through 4-12			Release A
5-1 and 5-2			Release A
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Contents

Preface

Abstract

1. Introduction

1.1	Identification of Document	1-1
1.2	Scope of Document	1-1
1.3	Purpose and Objectives of Document.....	1-1
1.4	Document 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. System Description

3.1	System To Be Supported.....	3-1
3.1.1	Functions of ECS Segments	3-1
3.1.2	Equipment to be Supported	3-3
3.1.3	ECS Locations.....	3-3
3.2	Operations and Maintenance Requirements	3-4
3.3	Operational Availability (Ao) and Mean Down Time (MDT).....	3-4
3.4	Human Engineering Factors	3-5
3.5	Standardization of Support Equipment	3-6
3.6	Environmental and Facility Requirements.....	3-6

4. Technical Approach

4.1	Maintenance Objectives.....	4-1
4.2	Maintenance Organization.....	4-1
4.3	ECS Maintenance Resources.....	4-2
4.3.1	Site Maintenance Resources.....	4-2
4.3.2	SMC and SEO Support.....	4-3
4.3.3	ILS Maintenance Coordinator.....	4-4
4.4	Maintenance Support Concept.....	4-4
4.4.1	On-Site Support.....	4-4
4.4.2	Sustaining Engineering Office (SEO) Support.....	4-5
4.4.3	Backup Maintenance Support.....	4-5
4.5	Preventive Maintenance (PM).....	4-6
4.6	Corrective Maintenance.....	4-6
4.6.1	Fault Diagnostics and Problem Isolation.....	4-6
4.6.2	Maintenance Response Time.....	4-6
4.6.3	Spares Provisioning.....	4-7
4.6.4	Non-reparable Spares Replenishment.....	4-7
4.6.5	Reparable Spares Replacement.....	4-7
4.6.6	Vendor- and OEM-Stocked Spares.....	4-8
4.7	COTS Software Maintenance.....	4-8
4.8	COTS HW and SW Problem Resolution Process.....	4-8
4.9	Escalation Procedures.....	4-9
4.10	Maintenance Reporting.....	4-10
4.10.1	Maintenance Analysis.....	4-10
4.10.2	External Maintenance Reporting.....	4-10
4.10.3	Tools and Test Equipment.....	4-10
4.11	Government Furnished Equipment.....	4-11
4.12	Property Reporting.....	4-11

5. Configuration Management and Data Management

5.1	Configuration Management	5-1
5.2	Document Management.....	5-2

6. Certification and Training

6.1	Certification	6-1
6.2	Recertification.....	6-1
6.3	Training.....	6-1

7. Safety

7.1	Safety	7-1
7.2	Policies and Procedures	7-1
7.3	Maintenance Input.....	7-1
7.4	Electrostatic Discharge.....	7-1

Figures

3-1.	ECS Conceptual Architecture	3-2
4-1.	COTS HW and SW Maintenance Organization.....	4-2
4-2.	Local Site Maintenance Support	4-9

Tables

3-1.	ECS Operational Requirements.....	3-5
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Abbreviations and Acronyms

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1. Introduction

1.1 Identification of Document

This document, Contract Data Requirements List (CDRL) item 119, whose requirements are specified in Data Item Description (DID) 613/OP1, is a required deliverable under the Earth Observing System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-6000).

1.2 Scope of Document

This document applies to all commercial off-the-shelf (COTS) hardware (HW) and software (SW) supplied by the ECS Contractor. It defines the responsibilities of the ECS Project organization for the maintenance of COTS products at four Release A distributed active archive centers (DAACs), EOS Operations Center (EOC), System Monitoring and Coordination Center (SMC), and the ECS Development Facility (EDF). This document lays the foundation for performing and managing the COTS HW and SW maintenance for the ECS during Release A.

This document reflects the August 23, 1995 Technical Baseline maintained by the contractor configuration control board in accordance with ECS Technical Direction No. 11, dated December 6, 1994.

1.3 Purpose and Objectives of Document

This document describes the general concept and plan for maintaining ECS commercial-off-the-shelf (COTS) HW and SW in support of ECS objectives. It is applicable to the maintenance support of ECS COTS HW and SW from initial product installation until maintenance responsibility is transferred to NASA or its designated follow-on maintenance contractor. This document describes the responsibilities of the ECS contractor, original equipment manufacturers, and third party maintenance contractors in providing maintenance support to the ECS project.

1.4 Document Status and Schedule

This document submittal addresses the CDRL requirement for SDPS /CSMS and FOS Critical Design Reviews (CDRs), and is intended as a final submittal for Release A data. It is anticipated that the next submittal of DID 613 will contain Release B data and is scheduled for the CDR-B timeframe.

1.5 Document Organization

The contents of the document are as follows:

- Section 1: Introduction - Introduces the COTS Maintenance Plan scope, purpose and objectives, status and schedule, and document organization
- Section 2: Related Documentation - Describes the parent, reference, and applicable documents useful in understanding the details of subjects discussed in this document.
- Section 3: System Description - Describes the ECS conceptual architecture and operational requirements.
- Section 4: Technical Approach - Describes the maintenance objectives, organization, responsibilities, and approach to maintenance of ECS COTS equipment and software
- Section 5: Configuration Management and Data Management - Identifies the applicable configuration and data management processes.
- Section 6: Certification and Training - Describes the certification criteria for maintenance functions.
- Section 7: Safety - Discusses the applicable safety practices, standards, and procedures.

2. Related Documentation

2.1 Parent Documents

The following documents are the parents from which the scope and content of this COTS Maintenance Plan derive:

194-102-MG1-001	ECS Configuration Management Plan
423-41-01	Goddard Space Flight Center, EOSDIS Core System (ECS) Statement of Work
423-41-02	Goddard Space Flight Center, Functional and Performance Requirements Specification for the EOSDIS Core System (ECS)
420-05-03	Goddard Space Flight Center, Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System (ECS)

2.2 Applicable Documents

The following documents are referenced within this COTS Maintenance Plan, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume:

STDN 402	Goddard Space Flight Center, Spaceflight Tracking and Data Network System Maintenance Program
500-TIP-2110	Goddard Space Flight Center, Mission Operations and Data Systems Directorate (MO&DSD) Technical Information Program Specifications for Document Formats
none	Goddard Space Flight Center, EOSDIS Core System (ECS) Integrated Logistics Support Plan
DOD-STD-1686	Military Standard: Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
MIL STD 1388-1A	Military Standard: Logistics Support Analysis

2.3 Information Documents

The following documents amplify or clarify the information presented in this document. These documents are not binding on the content of the COTS Maintenance Plan:

193-103-MG3-001	Configuration Management Procedures for the ECS Project
194-201 SE-001	ECS Systems Engineering Plan for the ECS Project
194-207-SE1-001	System Design Specification for the ECS Project
194-302-DV1-002	ECS Facilities Plan for the ECS Project
101-303-DV1-001	Individual Facility Requirements for the ECS Project
194-501-PA1-001	Performance Assurance Implementation Plan (PAIP) for the ECS Project
601-CD-001-004	Maintenance and Operations Management Plan for the ECS Project
194-602-OP1-001	Property Management Plan for the ECS Project
604-CD-001-004	Operations Concept for the ECS Project: Part 1-- ECS Overview
604-CD-002-001	Operations Concept for the ECS project: Part 2B -- ECS Release B, Annotated Outline
604-CD-003-001	ECS Operations Concept for the ECS Project: Part 2A -- ECS Release A
616-CD-001-002	Release A Integrated Support Plan for the ECS Project, Final
617-CD-001-002	Logistics Support Analysis Plan for the ECS Project
101-620-OP2-001	List of Recommended Maintenance Equipment for the ECS Project
622-CD-001-001	Training Plan for the ECS Project

3. System Description

3.1 System To Be Supported

Release A, including its incremental releases, is the initial fielding of COTS products for the ECS. ECS is the geographically distributed ground system network of hardware (HW) and software (SW) for the collection, processing, storage, and distribution of data obtained from a system of space platforms as well as storage and distribution of selected non-EOS data sets of the ECS. ECS also supports the operation and management of the EOS in-orbit payloads, US observatories and the interaction of its components. The overall ECS is an expandable, technology adaptable and modularly designed hierarchy of segments, elements, subsystems and components.

3.1.1 Functions of ECS Segments

The ECS is composed of three functional segments that are arranged into two of the three organizational components for managing their development. The functional segments are: The Flight Operations Segment (FOS), the Science Data Processing Segment (SDPS), and the Communications and Systems Management Segment (CSMS). Each segment has unique functions and availability requirements. The ECS, with its components and interfaces, is depicted in Figure 3.1, *ECS Conceptual Architecture*.

The functional segments are aligned into two of the three organizational components for development. The third organizational component provides selected services in support of developing the functional segments. The alignment is:

<u>Functional Segment</u>	<u>Development Organization</u>
FOS	Flight Operations Segment
SDPS and CSMS	Science and Communications Development Organization (SCDO) System Management Office (SMO) (DAAC operations, Test and Acceptance, and Modeling and Validation)

The Flight Operations Segment (FOS) manages and controls the EOS-AM1 space platform and instruments (observatory). The FOS contains the most time-sensitive functions and is composed of two elements. The EOS Operations Center (EOC) plans, schedules, controls and monitors EOS mission operations and the EOS observatory. Instrument Support Toolkits (ISTs) schedule, command, and operate the science instruments and monitor instrument performance.

The SCDO combines science data processing and communications/network management. The science element provides a set of processing, archival, and distribution elements for science data and a data information system for the entire ECS. The SCDO/Science element consists of seven subsystems: 1) client, 2) interoperability, 3) data management, 4) data server, 5) ingest, 6)

planning and 7) data processing. Together, these subsystems support the services required to receive, process, archive and manage the NASA Probe flight missions, EOS-AM1 space platform and instruments, other selected remotely sensed data, and their associated data products.

The Communications/Networks element provides overall ECS management and operation of the ground system resources, facilities, and networking services. It consists of 3 subsystems: 1) the Communications Subsystem (CSS), which is a collection of services providing flexible interoperability and information transfer between clients and servers; 2) the Internetworking Subsystem (ISS), which is the layered stack of communications services consisting of the data link and physical services, the network services, and the transport services; and 3) the Management Subsystem (MSS) which is a collection of applications that manages all ECS resources. Using these functions, the SMC will monitor and coordinate the operations of the ground system resources, facilities and communications network and interfaces to NASA's EOS Communication Network (Ecom). The Ecom provides a dedicated communications network and services for interconnections of the ECS and non-ECS facilities within the EOS Program.

The System Management Office (SMO) provides the modeling to predict the functionality and reliability of a design and validates the design through test and acceptance procedures. SMO's efforts are provided to the FOS and SCDO organizations and encompass the FOS, SDPS, and CSMS functional segments.

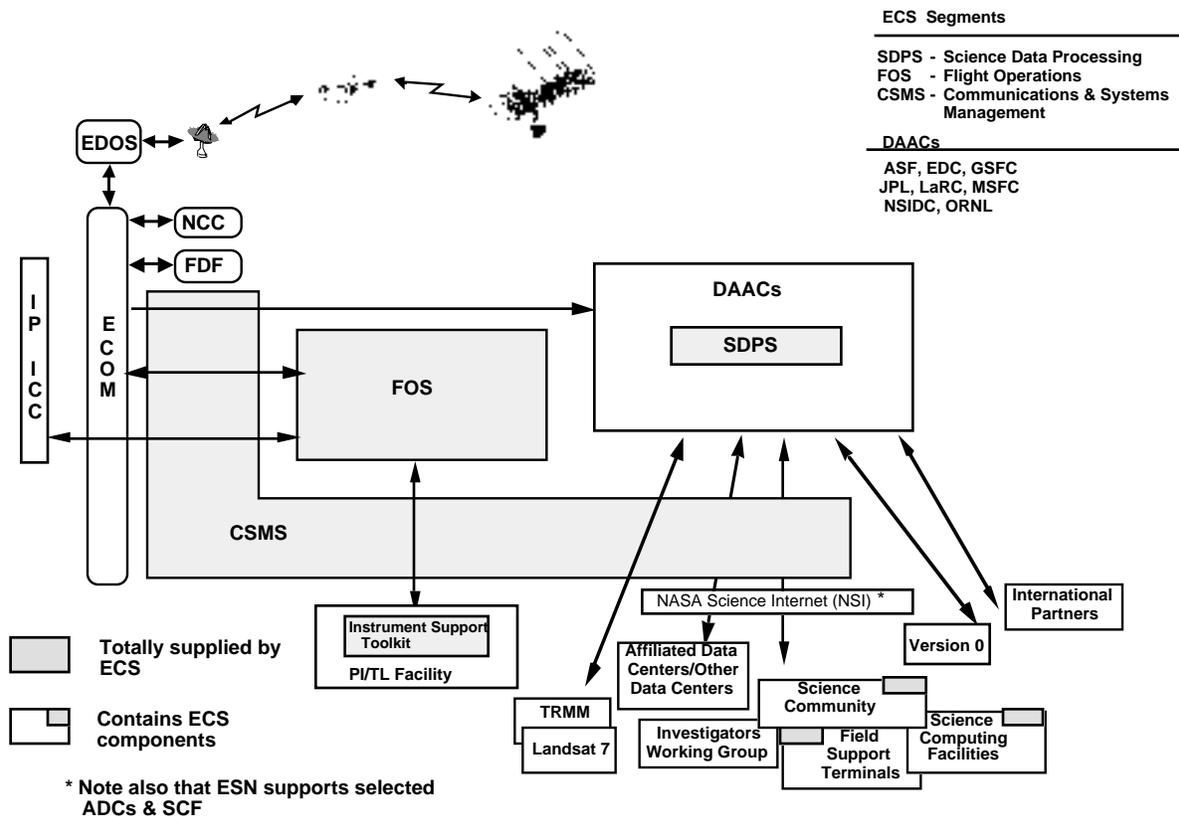


Figure 3-1. ECS Conceptual Architecture

3.1.2 Equipment to be Supported

The ECS is comprised of COTS HW and SW, ECS-developed applications, government furnished equipment (GFE), and science SW. Release A equipment includes UNIX workstations, servers, supercomputers, robotics storage subsystems; communications components (i.e., concentrators, routers, bridges); and various computer peripherals.

3.1.3 ECS Locations

The multiple locations of the ECS ground facilities will influence the logistics support required. ECS DAACs will be at the following facilities:

- Release A:
 - Goddard Space Flight Center (GSFC), Greenbelt, Maryland, (includes EOC and SMC)
 - Earth Resources Observation Systems (EROS) Data Center (EDC), Sioux Falls, South Dakota
 - Marshall Space Flight Center (MSFC), Huntsville, Alabama
 - Langley Research Center (LaRC), Hampton, Virginia
- Releases B through D:
 - University of Colorado, National Snow and Ice Data Center (NSIDC), Boulder, Colorado
 - University of Alaska Synthetic Aperture Radar (SAR) Facility (ASF), Fairbanks, Alaska
 - Jet Propulsion Laboratory (JPL), Pasadena, California
 - Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (software only)

Additional DAAC locations may be incorporated into the ECS as operational needs warrant. The ECS will be located in facilities belonging to a sponsor (host) organization. The sponsor facilities will provide space for maintenance administration, spare parts, tools, and consumables storage in accordance with the ECS Facilities Plan (302-DV2-001).

The ECS Development Facility (EDF), located in Landover, MD., is used to design the ECS and to develop its component applications. The SMC, which is co-located with the GSFC DAAC, monitors and coordinates ECS operations. The EDF, SMC, and the EOC are supported by the maintenance program described in this plan. During Release A installation and test the diagnosis and resolution of COTS HW and SW problems are the responsibility of the installation team and the COTS vendors under the 1-year warranty provided for all COTS products.

3.2 Operations and Maintenance Requirements

ECS operations will commence at Release Readiness Review, which is December 1, 1996. Currently, Release A DAACs are scheduled to be operational 8 hours per day, 5 days per week until May '97. At that time, LaRC will go into 16 hours/day, 7 days/week operations and MSFC will go into 8 hours/day, 7 days/week operations to support TRMM launch. Specific DAAC operations hours are established by the DAAC managers. Planned operations schedules are identified in the ECS Operations Plan, CDRL 115.

Once operations commence, COTS maintenance coverage to the DAACs, SMC, and EOC will be consistent with the operations requirements of ECS-supported missions (e.g. TRMM, Landsat-7, etc.). Because of the higher costs of maintenance support during extended operations hours (i.e. nights, weekends, and holidays), maintenance coverage during these periods will be limited to that required to sustain mission-critical operations and to satisfy ECS A_0 and MDT requirements. Generally, the principal period of maintenance (PPM) at the DAACs, EOC, SMC, and EDF will be 8AM to 5PM local, Monday through Friday, excluding local holidays. Maintenance support provided outside the PPM will depend on the criticality of the failure and the level of support required to satisfy the ECS operational availability (A_0) and Mean Down Time (MDT) requirements described below.

3.3 Operational Availability (A_0) and Mean Down Time (MDT)

The ECS A_0 and MDT requirements differ between the FOS, SDPS, and CSMS functions, depending on the criticality of the function involved. The specific A_0 and MDT objectives for the segments and functions within segments are stated in Section 5 of GSFC 423-41-02, Rev A, dated June 2, 1994, and are shown in Table 3-1, "ECS Operations Requirements." These requirements do not accrue to individual components, but to the system and sub-systems as indicated in the table.

Table 3-1. ECS Operation Requirements

ECS Function	Functions	A_O Minimum	MDT Maximum
	Flight Operations Segment (FOS)		
3800	Critical Real-time Functions*	0.9998	1 Min.
3810	Non-Critical Real-time Functions*	0.99925	5 Min.
3820	Targets of Opportunity (TOO) *	0.992	1 Hr
3700	ECS Functions Not Otherwise Specified	0.96	4 Hrs
3710	ECS shall have no single point of failure for functions associated with real time operations of the spacecraft and instruments		
	Science Data Processing Segment (SDPS)		
3900	Science Data Receiving	0.999	2 Hrs
3910	Switchover from Primary Science Data Receipt to Backup	NA	15 Min.
3920	Archiving & Distributing Data	0.98	2 Hrs
3930	User Interfaces to IMS Services at DAACs	0.993	2 Hrs
3940	Information Searches on the ECS Directory	0.993	2 Hrs
3950	Data Acquisition Request Submittals including TOOs*	0.993	2 Hrs
3960	Metadata Ingest and Update	0.96	4 Hrs
3970	Information Searches on Local Holdings	0.96	4 Hrs
3980	Local Data Order Submission	0.96	4 Hrs
3990	Data Order Submission Across DAACs	0.96	4 Hrs
4000	IMS Data Base Management and Maintenance Interface	0.96	4 Hrs
4010	Product Generation Computers	0.95	NA
4020	Product generation computers shall provide a "Fail soft" environment		
	Communications and System Monitoring Segment (CSMS)		
4030	SMC functions of Gathering and Disseminating System Management Information	0.998	20 Min.
4035	ESN shall have no single point of failure for functions associated with network databases and configuration data		
4036	ESN A _O shall be consistent with the specified A _O of the ECS functions.		
3630	Maximum down time shall not exceed twice the required MDT in 99 percent of failure occurrences		
A _O = Operational Availability		* = Required for Release B	
MDT= Mean Down Time			

3.4 Human Engineering Factors

Because the ECS is a COTS-intensive system, human engineering factors (human/machine interface) have been incorporated by equipment manufacturers into COTS product designs. Human-machine interface factors are addressed in the ECS Facilities Plan, the Standard Repair Procedures, and Hazard Analysis (DID 513).

3.5 Standardization of Support Equipment

Release A equipment has no requirements for specialized test or support equipment. Where it was determined to be beneficial to the ECS Project, equipment and SW was standardized to minimize training, spares, and support costs.

3.6 Environmental and Facility Requirements

ECS COTS HW will be operated in an environment that is dust, temperature, and humidity controlled. Because of the sensitivity of data media to these elements, ECS data is archived in a restricted-access, controlled environment separate from the operations areas. These requirements are addressed in the ECS Facilities Plan and the Environmental Control Plan (DID 532).

DAAC sites should have Government-furnished and sponsor-site maintained uninterruptable power supplies (UPS) to provide immediate backup power in the event of a power outage. These UPS systems should have the capacity to sustain power to ECS systems for 20 minutes to allow graceful shutdown of equipment and shifting to auxiliary power sources, if available.

4. Technical Approach

4.1 Maintenance Objectives

The primary objective of ECS maintenance operations is to achieve and sustain the operational availability (A_O) and mean down time (MDT) objectives (ref. Table 3-1) of the ECS at the least life cycle cost. Management of the logistics, maintenance, training, property, and facilities effort to obtain and sustain the A_O and MDT is supported by the management applications services of the CSMS. For release A, some of the management functions will be automated, such as fault management, configuration management, and network management. Management functions that are not automated for Release A will be performed manually and the process transitioned to an automated capability when available.

4.2 Maintenance Organization

Working under the general direction of the M&O Manager, the ILS Manager manages the ECS COTS maintenance program and other logistics operations depicted in Figure 4-1, “COTS Maintenance Organization.” This includes the budget and expenditures associated with COTS HW and SW maintenance and the provisioning of spares in support of maintenance operations. The ILS Office (ILSO) assists ESDIS in the development of ECS COTS HW and SW maintenance policy; monitors and coordinates maintenance operations at the ECS sites; and manages maintenance support provided by vendors and OEMs. Daily management and execution of DAAC, SMC, and EOC HW and SW maintenance is under the operational control of the DAAC, SMC, and EOC managers. Each site has a designated local maintenance coordinator (LMC) who executes maintenance support at the site, including problem diagnosis and isolation, maintenance support coordination, problem resolution, and recording COTS HW/SW maintenance actions performed at the site.

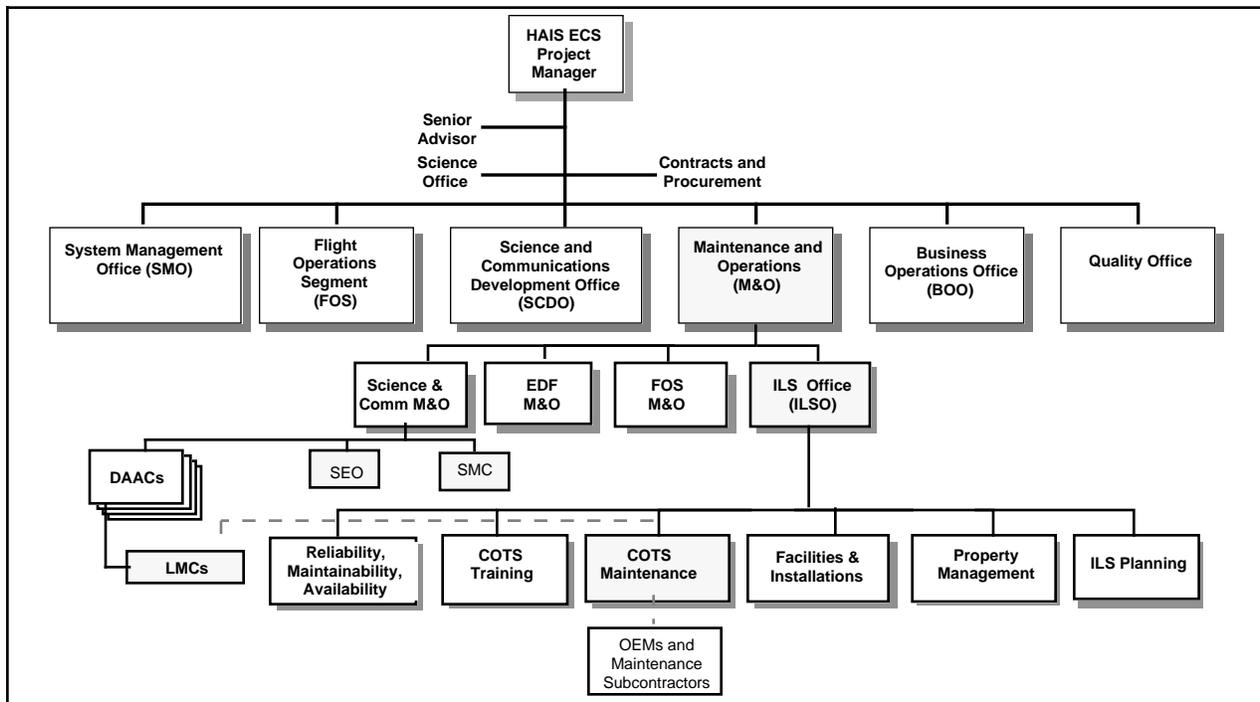


Figure 4-1. COTS HW and SW Maintenance Organization

4.3 ECS Maintenance Resources

The maintenance and engineering resources established at ECS sites are based upon the level of maintenance support required to achieve ECS A_0 and MDT requirements at reasonable costs.

4.3.1 Site Maintenance Resources

The principal COTS HW and SW maintenance resource at the sites is the local maintenance coordinator (LMC), who also functions as the site’s maintenance engineer. The LMC performs the initial fault diagnostics to isolate the cause of COTS HW and SW problems; determines the source of the maintenance support for the failed unit; and records the problem and its resolution into the management systems. The LMC may be the principal maintenance source for selected equipment having high A_0 and or low MDT requirements. As a principal maintenance source, the LMC is responsible for isolating failures to the LRU and replacing it with an on-site spare. This self-maintenance approach provides faster maintenance response than contracted maintenance support. The LMC is immediately available, understands the ECS architecture and operational requirements, and represents a lower cost maintenance approach for certain equipment.

The principal provider of COTS HW maintenance support at the sites is determined on a site-by-site basis depending on the quantity and complexity of equipment at the site, the maintenance response required to achieve A_0 and MDT objectives, and relative costs of contracted, OEM, and

self maintenance. Sites with large quantities of equipment, high A₀ and low MDT requirements (e.g. EOC), and/or extended hours of operation (such as GSFC) are supported by dedicated ECS maintenance engineers. For sites with less equipment, the principal provider of equipment maintenance support will be a maintenance subcontractor and the OEMs. For some equipment, the labor, training, and spares costs do not make self-maintenance a cost-effective approach.

The LMC is assisted by the site's system and network administrators to isolate and resolve problems. The DAAC's local help desk (for science user problems) and systems administrators (for operator problems) initiate the maintenance action by preparing a Trouble Ticket. The trouble Ticket is forwarded to the System Administrator to isolate the problem to one of the following:

- a. System configuration -- System administrator resolves
- b. Network configuration -- Network administrator resolves
- c. Custom software (i.e. ECS custom SW or science SW) -- Sustaining engineers resolve
- d. COTS SW -- LMC and sustaining engineers resolve with SW vendor support
- e. COTS HW -- LMC resolves, possibly with OEM or maintenance subcontractor support

Trouble Tickets are monitored until problems are resolved and their resolution verified. Once verified, the system administrator or the LMC closes the Trouble Tickets and updates the Baseline Manager (if a change to the configuration baseline was required). Changes to custom SW are accomplished by ECS sustaining engineers using the SW configuration management system (i.e. ClearCase) following the ECS Developed SW CM Plan and procedures described in Project Instruction 193-103-MG3-001, Configuration Management Procedures for the ECS Project.

The LMC coordinates resolution of COTS HW and SW maintenance actions. If problems cannot be corrected using site or contracted maintenance support resources, the LMC can escalate the problem to the SMC or the ILS Maintenance Coordinator, as described below.

4.3.2 SMC and SEO Support

The SMC Help Desk provides support for developed application SW, network, and design problems and monitors Trouble Tickets logged by the sites. Using the Trouble Ticketing system to recall similar problems, the SMC can assist the sites in problem diagnosis/resolution through reviewing previous configuration changes and problems reported against the equipment and subsystems. The SMC can also review similar problems experienced at other DAACS to identify possible causes and offer corrective actions.

Also available is the Sustaining Engineer Office (SEO), which has senior systems engineers, who are technical experts in the ECS design, equipment, and its applications, to assist in the diagnosis and resolution of site HW, SW, and network problems. The SEO provides a system-wide view to assist the site in diagnosing local DAAC problems. COTS HW or SW problems that cannot be resolved using local site, SMC, or SEO resources are escalated to the appropriate OEMs.

4.3.3 ILS Maintenance Coordinator

The ILS Maintenance Coordinator within the ILS Office assists the ESDIS Project Office to develop maintenance policy and procedures applicable to the ECS and monitors COTS HW/SW maintenance. The ILS Maintenance Coordinator performs the following functions:

- Monitors DAAC maintenance activities and records to ensure maintenance vendor and OEM contractual obligations are being met.
- Obtains and coordinates OEM support for COTS HW or SW problems escalated by the SMC/SEO.
- Obtains additional resources (e.g. OEM support), if required, to resolve maintenance problems and coordinates their delivery.
- Monitors, evaluates, and reports ECS maintenance program performance to determine if and where adjustments are needed to improve support to the Project.
- Establishes contracts with suppliers for spares acquisition and replenishment.
- Establishes, monitors, and renews HW maintenance contracts and SW licensing and support agreements. Resolves contractual issues relating to COTS HW and SW vendor/OEM support to ECS sites.
- Serves as the ILS Manager's representative on the Failure Review Board reviewing corrective actions taken on COTS products. If a corrective action is found to be insufficient, the ILS Maintenance Coordinator becomes the lead to ensure appropriate action is taken.

4.4 Maintenance Support Concept

4.4.1 On-Site Support

Because of the low equipment quantities at the DAACs during Release A, full time maintenance engineers are not positioned at all sites. However, an on-site maintenance capability is provided by LMCs to satisfy the operational availability and MDT requirements for some ECS functions (e.g. communications and science processing). Factors considered in the selection of COTS HW to be maintained by LMCs include criticality of the equipment and redundancy of components/systems; technical expertise needed to diagnosis and replace failed LRUs; and the cost of training, spares, and support equipment.

LMCs are trained and certified to perform maintenance on selected ECS equipment. Where the LMC has been designated as the principal maintenance provider for COTS HW and SW, his responsibilities include fault diagnostics and identification to the LRU level; replacement of failed LRUs with site spares or escalating the problem to the responsible contractor; or escalating the problem to the SMC for further assistance in diagnosing the cause of the problem.

When a COTS HW or SW problem occurs, the LMC uses diagnostics tools, such as Open View and built-in diagnostics to identify and isolate the problem to the malfunctioning component, which may be SW or a failed LRU. If HW is identified as the source, the LMC or maintenance subcontractor corrects the problem by replacing the failed LRU with site spares, putting the unit

back into operation, and testing the equipment and subsystem to verify the problem has been corrected. Malfunctioning COTS SW is reported to the LMC, who escalates the problem to the applicable vendor to obtain a temporary or permanent solution. This on-site, immediately available, maintenance support is available during the principal period of maintenance (PPM), which is 8AM to 5PM local, Monday through Friday, except holidays.

Site engineering staffs and their LMC may be unable to resolve some of the more difficult maintenance problems. For this reason, backup support is available from a number of sources, including the SMC, SEO, maintenance subcontractors, and OEMs. The LMC, following local procedures and ECS policy, determines if backup support is required based upon the nature of the problem. Network and SW-related problems may be referred to the SMC for assistance, while HW problems are normally referred to the local maintenance subcontractor for resolution.

4.4.2 Sustaining Engineering Office (SEO) Support

The Sustaining Engineer Office (SEO), co-located with the SMC, has resources available to assist the sites in diagnosing problems related to the configuration of ECS subsystems, the ESN, and ECS applications. Using the diagnostics and monitoring capabilities of the enterprise management system (i.e. Open View) and the fault management system (the Tivoli Management Environment), the SEO can identify recent indications of problems with the network and subsystems. The SEO can also obtain support from ECS development resources, who are experts on the design and functions of the equipment and the SW. The SEO can also assist by identifying a work-around to reestablish operational capabilities.

Problems attributed to ECS developed applications and science SW are referred to the SEO. Maintenance of ECS developed SW and science SW is addressed in the ECS Software Maintenance Plan. Problems attributed to malfunctioning COTS SW are referred to the COTS SW vendor.

4.4.3 Backup Maintenance Support

Back-up maintenance support is available from COTS OEMs and maintenance subcontractors on an on-call basis. If the efforts of site personnel and the SEO have not resolved the problem, additional HW maintenance support can be provided by an on-call maintenance subcontractor or the OEM. This on-call maintenance capability is the first level of maintenance support for most ECS equipment during Release A. Such equipment includes Cray supercomputers and robotics data archive systems, which may be capable of being maintained only by highly trained OEM maintenance engineers. On-call maintenance subcontractors and OEMs are also available outside the PPM, generally on a time and materials basis. Because of the high cost of such support, the use of OEM and vendor support outside the PPM should be used prudently.

The ILS Maintenance Coordinator negotiates the terms and conditions for backup maintenance coverage of COTS HW and SW by maintenance subcontractors and OEMs based on Project needs. Subcontractor and OEM maintenance personnel must acknowledge their presence to the site's LMC before commencing work on ECS equipment and report maintenance actions performed and parts replaced to the LMC prior to leaving the site.

4.5 Preventive Maintenance (PM)

Advances in technology has eliminated most PM requirements except for routine cleaning, normally performed by the operator. Except for the robotics archive systems, Release A equipment has no requirements for scheduled preventive maintenance (PM). Maintenance personnel will inspect equipment during corrective maintenance for evidence of impending failures and clean, repair, or replace any affected LRUs, as appropriate.

There are currently no requirements for the calibration of ECS equipment, other than the robotics data archive system, which is the responsibility of the OEM. Requirements for calibration of tools, gages, or equipment used in the test and inspection of ECS hardware will be performed and recorded in accordance with guidance contained in 501-PA1-001, Performance Assurance Implementation Plan.

4.6 Corrective Maintenance

Corrective maintenance actions include fault detection, diagnosis, isolation, and resolution through replacement of failed LRUs. Removal and replacement of failed LRUs is performed without the need to interrupt the critical operations of the ECS. Failed LRUs are replaced with site spares, if available, or with LRUs provided by the maintenance subcontractor or OEM. Replacement LRUs will be the same make and model as the original LRU or a suitable substitute that has capability equal to or exceeding that of the original item being replaced. In the event a substitute item is used, ECS configuration management policies apply.

4.6.1 Fault Diagnostics and Problem Isolation

COTS operating systems, communications equipment, and peripherals generally have significant diagnostics capabilities built in to facilitate fault diagnosis to the equipment LRU. Such tools are used to expedite problem resolution, reduce maintenance downtime, and minimize the need to call in outside maintenance support.

4.6.2 Maintenance Response Time

Maintenance response requirements consider the criticality of the HW, SW, and functions supported; location of the maintenance resource; site operations hours; and relative response costs. Responses to COTS HW or SW malfunctions are initially provided by the LMC, site maintenance subcontractor, or OEM. Response time of on-site LMCs is normally less than 10 minutes. Third-party maintenance providers and OEMs under maintenance subcontract are required to be on-site within 4 hours after being notified of an equipment failure during the principal period of maintenance (PPM). Generally, response for contracted maintenance support outside the PPM is provided on an as-available basis, generally within 6 hours. If failures occur outside the PPM, the site should consider deferring OEM or maintenance subcontractor response until the next day if the malfunctioning system is not critical to ECS operations. This includes maintenance actions that would extend outside the PPM hours.

4.6.3 Spares Provisioning

Spare parts are provisioned at the sites to ensure replacement LRUs are available to effect the immediate repair of failed equipment. Recommendations to the ESDIS Project Office regarding spares quantities and locations will be presented to the ILS Management Team at provisioning conferences and approved at the Release Readiness Review (RRR). These recommendations are documented in the Replacement and Spare Parts List (DID 618). Spares provisioning levels may be adjusted after sufficient failure data is gathered during ECS operations to warrant adjusting site spares quantities and types.

Site spares are limited to LRUs that can be replaced by the LMC and provide a cost effective solution to meeting the A₀ and MDT requirements of ECS. Site spares are the reparable and non-reparable repair parts (i.e. LRUs) required to replace failed equipment components in order to bring systems back to full operating capability. Spares used at the sites are reported to the ILS Maintenance Coordinator, who will replenish site stocks, as needed. The use and replenishment of site spares is monitored by the ILS Maintenance Coordinator.

4.6.4 Non-reparable Spares Replenishment

Replacement parts used in the repair of ECS equipment under maintenance contract by a third-party maintenance subcontractor or OEM are normally provided by the maintenance provider. In cases where the maintenance provider cannot readily obtain the required replacement part, site spares may be used to effect essential repairs, but will be replaced at the earliest possible date by the maintenance provider.

Until the inventory management capabilities of the Configuration Management Services system are available at Release B, sites will report, via internet message to the ILS Maintenance Coordinator, the use of site stocks of non-reparable spares. The message should identify the related Trouble Ticket and the specific part number, part name, and make and model of the end item in which the part was obtained. The ILS Maintenance Coordinator monitors non-reparable spares use and replenishes them, as needed, to bring site quantities to the recommended stock levels. Sites will dispose of non-reparable spares following procedures described in the ECS Property Management Plan (DID 602).

4.6.5 Reparable Spares Replacement

Sites replace reparable spares by sending the failed LRU to the responsible maintenance source (i.e. OEM or maintenance subcontractor), which will replace them with new or repaired and tested LRUs of the same make and model. Maintenance sources will use expedited shipping (i.e. next day air) to return replacement/repaired LRUs to sites to minimize the time in which the site is without a spare LRU.

Failed reparable LRUs replaced with site spares will not be repaired by the ECS contractor, but are forwarded by the LMC to the appropriate vendor or OEM for component level repair. Such returns will be shipped within the next business day after obtaining a Return Authorization number from the maintenance source. Generally, provisions will have been made with vendors/OEMs that will result in the shipment of a replacement LRU to the site while the failed unit is enroute to them. The

OEMs determine whether their equipment LRUs are repairable based on repair and replacement costs. When a failed LRU is returned the OEM or vendor, it is repaired, tested, and certified as fully operational and then returned to stock in like-new condition. Failed LRUs replaced by the maintenance subcontractor or OEM from their stocks, become their property. Appropriate adjustments to ECS property records are made by the local property administrator at the time of the maintenance action.

4.6.6 Vendor- and OEM-Stocked Spares

In some cases the maintenance vendor or OEM may stock spares on or off site to support ECS maintenance operations. In such cases, the quantities, locations, and types of spares will be determined by the vendor or OEM. Storage, transportation, and repair/replacement charges will be per agreements reached with the vendor/OEM.

4.7 COTS Software Maintenance

The ILS Maintenance Coordinator establishes SW maintenance support contracts with COTS SW providers to assist ECS sites and the SEO in the resolution of SW problems. COTS SW problems are reported to the responsible SW vendor for resolution. If the SW vendor is unable to provide an immediate patch to resolve the problem, the SEO can attempt to provide a temporary work-around solution until a more permanent resolution (i.e. patch) is provided by the SW vendor. The SEO coordinates and monitors such efforts.

4.8 COTS HW and SW Problem Resolution Process

ECS sites are provided the resources to manage and resolve the majority of SW, HW, network, and developed applications problems. This local capability, comprised of a systems administrator, network administrator, LMC, and a local maintenance subcontractor, is depicted in Figure 4-2, "Local Site Maintenance Support". The site LMC manages the day-to-day COTS HW and SW maintenance actions at the DAACs, SMC, and EOC.

COTS HW or SW malfunctions are referred to the LMC, system administrator, or network administrator, as appropriate for the type of suspected malfunction. These resources, acting as a team or independently, investigate and attempt to resolve the problem. Initially, through discussion with the operator or user, they will attempt to diagnose and isolate the source of the problem. Problems may be any one of the following; user/operator error, developed application or interface problem, system or network configuration problem, or COTS HW or SW malfunction. If the problem is related to a developed application, system configuration, or the network configuration, the site sustainment engineer, system administrator, or network administrator will take corrective action to resolve the problem. Where equipment or component redundancy exists, the operations staff will switch processing over to the redundant equipment or component to restore the system to operation.

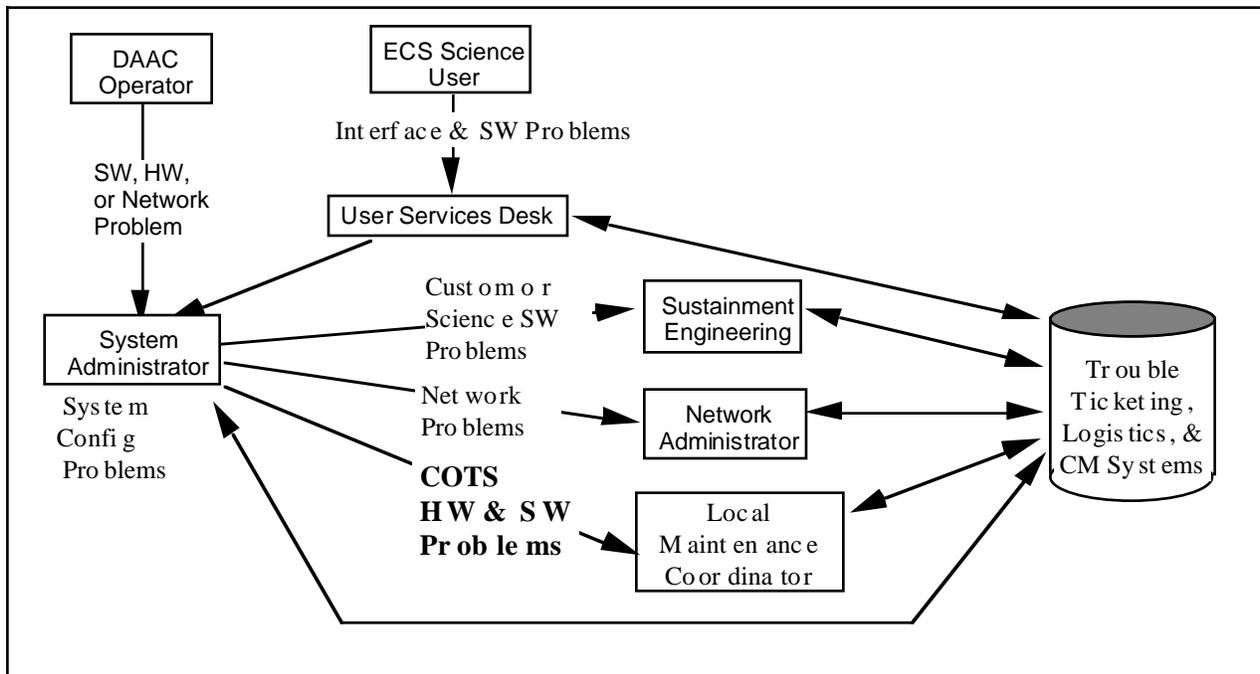


Figure 4-2. Local Site Maintenance Support

For problems confirmed to be attributed to COTS HW failure, the LMC determines if the item is under warranty or maintenance contract. Items under warranty are repaired or replaced only by the OEM or HW vendor to comply with the terms of the warranty agreements. Items in which the warranty has expired are repaired or replaced by the responsible maintenance provider or the LMC, depending upon who is designated as the principal maintenance source for the item.

COTS SW problems are forwarded to the COTS SW developer for resolution, either through provision of a temporary work-around, patch, or correction of the problem in the next SW release. Problems in which the site cannot isolate the cause to specific COTS HW or SW can be escalated to the SMC Help Desk, as described earlier in Section 4.4.2.

In all cases where a science user has reported a problem, the User Services Desk will keep the user informed of the status of its resolution.

4.9 Escalation Procedures

ECS sites will establish parameters and instructions for escalating problems to the SMC and the ILS Maintenance Coordinator. The SMC, using its diagnostic and engineering resources, will assist the site in diagnosing the cause of the problem and in developing a solution. The SMC will determine if the problem needs to be escalated further to the equipment manufacturer or software

developer. After eight PPM hours, malfunctions that are preventing the accomplishment of a critical operations function are reported to the M&O Manager.

4.10 Maintenance Reporting

Trouble Tickets are used to record ECS HW and SW malfunctions. They can be initiated by the User Services Desk, the LMC, or any of the operations personnel at the site. Trouble Tickets are on-line and accessible by the site operations personnel, the LMC, SMC Help Desk, ILS Maintenance Coordinator, and the ECS development organization at the EDF. Trouble tickets are updated when there is a change in status, when it has been routed to a new action, or when the problem is escalated. As problems are resolved, the corrective action taken is entered and the Trouble Ticket closed by the systems administrator, network administrator, or the LMC.

The ILS Maintenance Coordinator monitors COTS maintenance actions by periodically reviewing the MRs. In addition, the ILS Maintenance Coordinator is alerted via the escalation notification procedures of aging MRs.

4.10.1 Maintenance Analysis

The Trouble Ticketing system contains the history of COTS HW and SW malfunctions, thereby providing traceability for COTS HW and SW malfunctions and corrective actions. Trouble Tickets are analyzed by the ILS Maintenance Coordinator to identify failure trends, to assess whether A₀ and MDT objectives are being achieved, and to ensure that contractual obligations are being met.

4.10.2 External Maintenance Reporting

Malfunction Reports (MRs) will be provided monthly to NASA using procedures of DID 529, Malfunction/Failure Report, as a guide. Five working days after the end of the month, information from all Trouble Tickets that are open at the end of the previous month will be downloaded from the Trouble Ticketing System and placed on MS-DOS compatible DS/DD 3.5 inch floppy disks in ASCII format for delivery to NASA Code 505.

Information included in Malfunction Reports includes Trouble Ticket number, problem description, date of problem, equipment, location, actions taken, results of actions taken/proposed action, and estimated closure date. When Trouble Tickets are closed, the next month's report to NASA will identify the closure information. Information previously provided to NASA as an open Trouble Ticket is also included, along with any new corrective actions. The closure action and date is displayed adjacent to the malfunction date. The closure information on the MR will include a reference of all actions taken to correct the malfunction. This includes such data as the reference documentation containing corrective action guidance and HW or SW documentation information providing specifications, part number, model, and serial number.

4.10.3 Tools and Test Equipment

COTS equipment maintenance is accomplished using tools and test equipment comparable to that recommended by the OEM. Release A equipment planned for maintenance by ECS personnel (i.e. LMCs) requires no special tools or test equipment, as documented in the document "Special

Maintenance and Test Equipment “(DID 615). Any standard or special support equipment required to test ECS systems prior to being returned to operational service will be documented in DID 620, “List of Recommended Maintenance Equipment”, to be delivered prior to Release Readiness Review.

4.11 Government Furnished Equipment

Currently, no Government Furnished Equipment has been assigned to the ECS contractor for maintenance responsibility. However, if the Government later directs the ECS contractor to maintain such equipment, the terms for that support will be negotiated on an individual item basis.

4.12 Property Reporting

All ECS COTS equipment and SW is accountable to the ECS contractor, specifically the ILS Office. When an ECS component containing an ECS property tag is replaced, LMCs will remove the tag from the replaced item, apply a new tag to the new unit, and record both the old and new Equipment Identification Numbers (EINs) in the Trouble Ticket.

Replacement of an equipment component with a like component from the site spares kit will be noted on the Trouble Ticket along with the model and serial numbers of the replacement unit. The LMC will update the site’s inventory record and route the failed unit in accordance with the ECS Property Management Plan, 602-OP1-001. Components that are installed that do not require and an Equipment Identification Number will have a 1-inch circular ECS property tag affixed. Property tags will be affixed by the LMC in accordance with procedures specified in the ECS Property Management Plan .

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5. Configuration Management and Data Management

5.1 Configuration Management

Throughout the course of ECS releases, frequent changes in the configurations of equipment (models, LRUs, components, specifications) and SW will occur. This requires control of all changes in HW and SW to ensure traceability to the original configuration baseline. COTS documentation will likewise undergo numerous revisions to reflect systems changes. This data will accurately reflect past and current status of COTS equipment.

Maintenance of COTS HW and SW is performed in compliance with the M&O Configuration Management Plan and ECS Configuration Management Procedures. To maintain control of the COTS equipment environment (operation, maintenance, LRUs, technical documentation), changes are controlled and documented over the life of the ECS. Changes to COTS HW and SW configurations resulting from maintenance actions are documented in Trouble Tickets and Configuration Change Requests (CCRs) and reported to the site CM manager for entry into the Baseline Manager system.

At the time that COTS HW and SW is installed at a site, the operational baseline for the site is established and recorded in the Baseline Manager. Subsequent to that installation, changes resulting from maintenance actions are recorded in Trouble Tickets and CCRs and entered into the Baseline Manager database to update the configuration record.

COTS equipment and SW, consisting of many HW models and SW versions and releases, will be obtained from many vendors. Vendor-issued changes and updates will be approved by the appropriate CCB prior to implementation.

The ECS contractor will obtain licenses to permit use and upgrades to COTS SW. Licenses are retained and maintained current by the ILS Maintenance Coordinator. Site-specific controls for COTS SW installed at operational sites are specified by the local site CCB. COTS SW upgrades will be tested to ensure COTS compatibility prior to implementation.

Plans to install COTS SW revisions or patches will be brought before the SW CCB. Updates to the Baseline Manager will record the implementation of any such change in the ECS operational environment. The SW Configuration Management Plan describes the procedures for control and modification of COTS SW.

The site LMC is responsible for the site master copy of COTS SW. It will be used for back up and maintenance purposes, as required. The master SW copy will be maintained at the most current level in accordance with the ECS Configuration Management Plan.

5.2 Document Management

Document management is accomplished in compliance with the ECS Document Management Plan and the Document Management Procedures. DAACs will establish and maintain a technical reference library that includes COTS HW, SW, and firmware documentation relevant to the site configurations in accordance with the ECS Document Management Plan. DAACs will update COTS-related documents (schematics, operator or technical references, maintenance manuals, etc.) as up-dates are received.

The site's document manager controls and updates technical and user documentation whenever OEMs issue new technical manuals or revisions to existing documents. As new or updated documents arrive at a site, the document manager will update the documentation to reflect the most current applicable version. The documents will be kept in a controlled master library for use as reference or for producing copies, if authorized. The document manager will record all revisions in accordance with the Data Management Plan.

6. Certification and Training

6.1 Certification

ECS maintenance and operations personnel are certified prior to permanent assignment. Certification is the verification through written, oral and/or performance evaluation, that an individual meets the minimum level of proficiency necessary to perform the duties associated with a system/subsystem or position. The specific details of the M&O certification program are contained in the M&O Certification Plan (DID 626, estimate publication 11/96).

Certification criteria for maintenance functions will be established in certification skills catalogs. The maintenance engineer position will have a catalog associated with the function. The catalog will contain a list of the skills and knowledge which define job proficiency in the function. The ILS Maintenance Coordinator establishes the certification criteria for maintenance personnel.

Maintenance vendor's will provide certified personnel to ECS and maintain records for training provided and tests administered. Training and certification records maintained by maintenance vendors are subject to review by the ILS Maintenance Coordinator upon request.

6.2 Recertification

Maintenance personnel are re-certified annually. ECS site managers may direct rectification prior to the annual date in cases where job proficiency of an individual has declined, or when changes in system design or technology have established new performance criteria. Responsibilities for re-certification are the same as those for certification.

6.3 Training

It is the responsibility of maintenance vendors to provide the training necessary for their personnel to meet the certification criteria. Maintenance training should contain course objectives that match the certification criteria established.

Training of ECS Contractor maintenance personnel is performed in accordance with the ECS Training Plan, 622-CD-001.

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7. Safety

7.1 Safety

The ECS System Safety Implementation Plan is referenced in Section 6 of the ECS Performance Assurance Implementation Plan (PAIP), 501-CD-001. It provides guidance in establishment of safety practices, standards, and procedures applicable to COTS maintenance and operations personnel. Safety requirements are to be updated on a continuing basis and in compliance with all related federal, state, and local laws and regulations, and emergency procedures.

7.2 Policies and Procedures

The policies contained in the SSIP and the guidelines and procedures contained in the Contractor's "Manual of Safety and Environmental Health" will be used to implement safety practices during planning and implementation of COTS HW and SW maintenance support actions. The emphasis of maintenance safety will be to protect ECS and user personnel from inherent or accidental equipment or system safety faults in addition to protecting the system from damage.

7.3 Maintenance Input

The ILS Office will provide COTS HW and SW maintenance safety input to the SSIP when the results of various analysis reveal an actual or potential safety impact. These analyzes will be from the Failure Modes, and Effects Analyses (FMEA), Maintainability Analysis, Availability Analysis, Training Requirements, and Certification Analysis. The results of the Critical Item portion of the FMEA will be provided to the Quality Assurance organization for consideration for inclusion in the System Safety Implementation Plan.

7.4 Electrostatic Discharge

Control of Electrostatic Discharge (ESD) will be a subject for the Environmental Control Plan (DID 532) and the Maintenance and Operations Management Plan, 601-CD-001. The Environmental Control Plan sets policy for an awareness program of ESD and addresses maintenance practices that are to be followed to eliminate ESD hazards to HW, SW, or people. Procedures for the program will be developed in accordance with DOD-HDBK-263 and DOD-STD-1686 guidance. Included in the program will be policies and procedures for prevention and safe dissipation of static electricity; workplace common grounding requirements; and parts handling and protection when in storage, outside the manufacturer's protective packaging, and being readied for installation or removal. ESD hazard awareness and prevention will be an element in the training and certification process of ECS operations and maintenance personnel. All ESD hazard awareness and prevention requirements will be passed through as requirements to all operations or maintenance subcontractors.

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Abbreviations and Acronyms

A _o	Operational Availability
ASF	University of Alaska Synthetic Aperture Radar (SAR) Facility
CCB	Configuration Control Board
CDR	Critical Design Review
CDRD	Contract Data Requirement Document
CDRL	Contract Data Requirements List
CM	Configuration Management
COTS	Commercial Off-the-Shelf
CSMS	Communications and Systems Management Segment
CSS	Communications subsystem
DAACs	Distributed Active Archive Centers
DID	Data Item Description
DM	Data Management
ECS	EOSDIS Core System
EDC	Earth Resources Observation Systems (EROS) Data Center
EDF	ECS Development Facility
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System (EOS) Data and Information System (DIS)
EROS	Earth Resources Observation Systems
ESD	Electrostatic Discharge
ESDIS	Earth Science Data and Information System
ESN	EOSDIS Science Network
FMEA	Failure Modes, and Effects Analyses
FOS	Flight Operations Segment
GFSC	Goddard Space Flight Center
HW	Hardware
IDR	Increment Design Review
ILS	Integrated Logistics Support
ILSO	ILS Office

IMS	Information Management System
ISS	Internetworking Subsystem
IST	Instrument Support Toolkits
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
LMC	Local Maintenance Coordinator
LORA	Level of Repair Analysis
LRU	Line Replaceable Unit
LSA	Logistics Support Analysis
M&O	Maintenance and Operations
MDT	Mean Down Time
MR	Malfunction Report
MSFC	Marshall Space Flight Center
MSS	Management Subsystem
NA	Network Administrator
NASA	National Aeronautics and Space Administration
NSIDC	University of Colorado, National Snow and Ice Data Center
OEM	Original Equipment Manufacturer
OPPM	Outside PPM Hours
ORNL	Oak Ridge National Laboratory
PAIP	Performance Assurance Implementation Plan
PHS&T	Packaging, Handling, Storage, and Transportation
PM	Preventive Maintenance
PPM	Principal Period of Maintenance
RMA	Reliability, Maintainability, and Availability
SA	System Administrator
SAR	University of Alaska Synthetic Aperture Radar
SDPS	Science Data Processing Segment
SMC	System Monitoring and Coordination Center
SOW	Statement of Work
SW	Software
TOO	Target of Opportunity
UPS	Uninterruptable Power Supply