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## **EOSDIS Core System Project**

# **Release A Reliability Predictions for the ECS Project**

Final

July 1995

Hughes Information Technology Corporation  
Landover, Maryland

# Release A Reliability Predictions for the ECS Project

July 1995

Prepared Under Contract NAS5-60000  
CDRL Item #089

## APPROVED BY

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# Preface

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This document is a contract deliverable with an approval code 2. As such, it does not require formal Government approval, however, the Government reserves the right to request changes within 45 days of the initial submittal. Once approved, contractor changes to this document 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

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This Release A Reliability Predictions report (CDRL #89, DID #516) presents Commercial-Off-The-Shelf (COTS) vendors predicted and actual field mean-time-between-failures (MTBF) of all the ECS hardware configuration items (HWCIs) which are presented at the Release A Critical Design Review (CDR). These MTBFs are required to support the availability modeling task in which the results are documented in CDRL #88, DID #515.

**Keywords:** reliability, prediction, MTBF, failure rate, availability, COTS data, GFE, MIL-HDBK-217F, NPRD, relex

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# 1. Introduction

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## 1.1 Identification of Document

This Release A Reliability Predictions Report, Contract Data Requirements List (CDRL) Item 089, whose requirements are specified in Data Item Description (DID) 516/PA2, is a required deliverable under the Earth Observing System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-60000).

## 1.2 Scope of Document

This report is the updated version of the preliminary submittal which was generated at the ECS Release A Preliminary Design Review (PDR) time frame. This report version presents detailed predicted and operational MTBFs of the proposed ECS hardware configuration items (HWCI) presented at the Release A CDR time frame. These HWCI's MTBFs are provided by the commercial-off-the shelf (COTS) vendors and are thoroughly reviewed for accuracy by the ECS reliability and hardware procurement organizations. These HWCI's represent the Flight Operation Segment (FOS) Release A/B configuration, the Science and Data Processing Segment (SDPS) and the Communications and Systems Management Segment (CSMS) Release A configuration. The applicable Distributed Active Archive Center (DAAC) sites for the Release A SDPS and CSMS are: Goddard Space Flight Center (GSFC), Earth Resources Observations System (EROS) Data Center (EDC), Marshall Space Flight Center (MSFC), and Langley Research Center (LaRC). FOS Release A/B is only applied to GSFC.

The report also presents the Parts Count reliability prediction methodology, ground rules and assumptions in accordance with MIL-Handbook-217F and Non Electronic Parts Reliability Data (NPRD-91) which are required when specific COTS vendor data or comparable vendor data are not available. The reliability software tool named Relex that supports the parts count prediction is also described in this report.

This document reflects the June 21, 1995 Technical Baseline maintained by the contractor configuration control board in accordance with the ECS Technical Direction No.11, dated 12/06/1994.

## 1.3 Purpose and Objectives of Document

This Reliability Predictions report provides the ECS predicted hardware reliability data to support the availability modeling activity which was documented in DID #515/PA2, Availability Models/Predictions, and to support the maintainability predictions activity which was documented in DID #518/PA3, Maintainability Predictions. The Reliability prediction is a continuous and iterative process throughout the program life cycle to ensure that the ECS system will achieve its functional availability requirements. This task is performed early in the design process or once hardware is identified, in order to be an effective aid in evaluating the ECS design by providing information that can be used as the basis for design decisions such as redundancy and fault

management design approach. High failure rate items are also identified so that special consideration can be given to areas that constitute potential risks to the system.

Results from this report will be used to serve as inputs for determining life cycle costs, sparring requirements, maintenance planning, and the development of the Maintainability Predictions and Availability Models reports.

## **1.4 Document Status and Schedule**

This submittal of DID 516/PA2 meets the milestone specified in the Contract Data Requirements List (CDRL) of NASA Contract NAS5-60000. It is anticipated that this submittal will be reviewed during the Release A Critical Design Review (CDR), and that subsequent changes to the document will be incorporated into a resubmittal to be delivered two weeks after receiving comments from the customer.

Subsequent reliability prediction updates for each release configuration will be submitted at each release Incremental Design Review (IDR), CDR, and throughout the ECS life cycle.

## **1.5 Document Organization**

The document is organized into five (5) sections and one Appendix:

- Section 1 Introduction, contains the identification, scope, purpose and objectives, status and schedule, and document organization.
- Section 2 Related Documentation, provides a bibliography of parent, applicable and information documents for the Reliability Predictions.
- Section 3 ECS Reliability Predictions Methodology, describes the reliability requirements, assumptions and ground rules, and prediction techniques.
- Section 4 Other Failure Rate Data Sources, identifies vendor, GFE, and non-electronic parts data sources.
- Section 5 Reliability Prediction Data, describes the reliability data for the FOS, SDPS, and CSMS.
- Appendix A Reliability Data, provides detailed spreadsheets divided into three sections. One for FOS, one for SDPS, and one for CSMS hardware configuration items.

## 2. Related Documentation

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### 2.1 Parent Documents

The parent document is the document from which this Reliability Predictions document scope and content are derived.

194-207-SE1-001	Systems Design Specification for the ECS Project
420-05-03	Goddard Space Flight Center, Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System (ECS)
423-41-01	Goddard Space Flight Center, EOSDIS Core System Statement of Work
423-41-02	Goddard Space Flight Center, Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System
423-41-03	Goddard Space Flight Center, EOSDIS Core System Contract Data Requirement Document

### 2.2 Applicable Documents

The following documents are referenced within this Reliability Predictions document, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume.

194-501-PA1-001	Performance Assurance Implementation Plan (PAIP) for the ECS Project
194-502-PA1-001	Contractor's Practices & Procedures Referenced in the PAIP for the ECS Project
515-CD-001-003	Availability Models/Predictions for the ECS Project
518-CD-001-003	Maintainability Predictions for the ECS Project
MIL-HDBK-217F	Department of Defense Military Handbook: Reliability Prediction of Electronic Equipment
NPRD-91	Reliability Analysis Center/Rome Laboratory/Griffiss AFB; Nonelectronic Parts Reliability Data

## 2.3 Information Documents

The following documents, although not referenced herein and/or not directly applicable, do amplify or clarify the information presented in this document. These documents are not binding on the content of the Reliability Predictions document.

MIL-STD-785	Department of Defense Military Standard: Reliability Program For Systems and Equipment Development and Production, Task 203
none	Innovative Software Designs, Inc.; Relex for Windows Version 5.1 Reference Guide, copyright 1987-1994

## 3. ECS Reliability Predictions Methodology

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### 3.1 Reliability Prediction Requirements

The ECS design uses state-of-the-art COTS hardware to meet requirements and take advantage of the rapidly changing technology; therefore, the primary source for failure rates is COTS vendor supplied data.

Reliability Predictions are required to support the Availability Modeling/Prediction activity (DID 515/PA2). The reliability data supporting the reliability predictions will be obtained or developed in the following order of priority in accordance with the ECS performance requirements of paragraph 5.3.3 in document 420-05-03:

- 1) COTS vendor supplied reliability data will be utilized at the purchased hardware unit level. If this data is unavailable;
- 2) Historical or comparable data for like hardware items using similar technologies in similar environments will be utilized. If this data is unavailable;
- 3) A Parts Count Reliability Prediction will be performed on the hardware per MIL-HDBK-217F, Appendix A. This parts count prediction will use engineering parts lists (EPLs) and/or schematic diagrams provided by the COTS vendors. Predictions for non-electronic parts will be made using NPRD-91, Nonelectronic Parts Reliability Data 1991, which supersedes NPRD-3.

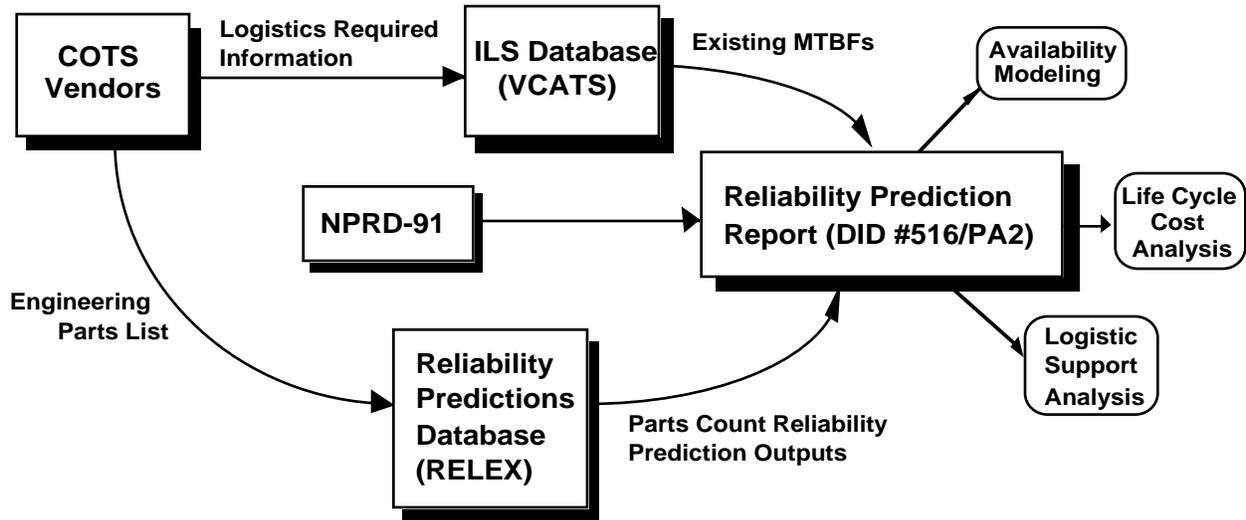
### 3.2 COTS Vendor Data

All COTS vendors will be required to provide reliability values down to the line-replaceable-unit (LRU) level with their identified source. Reliability data sources can be either of the following:

- a. Field service data,
- b. Test data,
- c. Predicted data.

Vendor reliability data will be collected by EDS as part of the procurement process. ECS Systems Reliability engineers will participate in this process to ensure the validation and integrity of the reliability data. This process is detailed in document 194-502-PA1-001, Contractor's Practices & Procedures Referenced in the PAIP for the ECS Project, project instruction (PI) RM-1-002, Control of COTS Subcontractors and Suppliers. Figure 3.2-1 presents the COTS vendor reliability data flow process for the ECS program. This data will first be recorded in the Integrated Logistic System (ILS) data base called the Vendor Costing And Tracking System (VCATS). The Systems Engineering group will then receive a report identifying the hardware description, vendor, and reliability data. This data is then used as the basis for the reliability predictions (MTBF values) for each segment and is shown in Appendix A.1 for FOS, and Appendix A.2 for SDPS, and Appendix A.3 for CSMS with detailed explanations in Section 5.0. If vendor data on specific

COTS products is not available, historical or comparable data for like hardware using similar technology in similar environments will be utilized if available and acceptable. In the case where vendor reliability data is unavailable, COTS vendor Engineering Parts Lists (EPLs) will be requested from the vendor and input into the reliability prediction software called Relex. Relex will then generate the piece parts reliability prediction output which will become part of the Reliability Predictions Report.



**Figure 3.2-1. COTS Vendor Reliability Data Flow Process**

### 3.3 Parts Count Technique of MIL-HDBK-217F

If vendor reliability data is unavailable and no historical or comparable data for like items using similar technology are available, a reliability calculation will be made using the methodology defined in Appendix A: Parts Count Reliability Prediction, of MIL-HDBK-217F. The general mathematical expression for equipment failure rate using this method is:

$$\lambda_{EQUIP} = \sum_{i=1}^{i=n} N_i(\lambda_g \pi_Q)_i$$

for a given equipment environment where:

$\lambda_{EQUIP}$  = Total equipment failure rate (failures /  $10^6$ )

$\lambda_g$  = Generic failure rate for the  $i^{th}$  generic part (failures /  $10^6 hrs$ )

$\pi_Q$  = Quality factor for the  $i^{th}$  generic part

$N_i$  = Quantity of  $i^{th}$  generic part

$n$  = Number of different generic part categories in the equipment

The prediction data will account for the generic part types, piece part quantities, part quality levels, and equipment environment when calculating the part's generic failure rate.

### 3.4 Assumptions and Ground Rules

The following are assumptions and ground rules for the ECS reliability predictions in accordance with MIL-HDBK-217F Parts Count methodology:

- 1) The operating environment is Ground Benign ( $G_B$ ). This environment pertains to scientific computer complexes which are non mobile, have temperature and humidity controlled environments, and are readily accessible for maintenance.
- 2) The average parts junction temperature  $T_j$  is  $50^\circ C$ .

If there is insufficient information to define a part's parameters, then:

- 3) The quality factor ( $Q$ ) for discrete semiconductors, resistors, and capacitors will be "Lower".
- 4) The quality factor for electro-mechanical parts in Table A-11 of MIL-HDBK-217F will be "Non-MIL".

### 3.5 Reliability Predictions Software Tool - Relex

Reliability and Maintainability predictions data will be maintained in VCATS. If reliability data is unavailable from the COTS vendors and no comparable and similar hardware reliability data is available, a request for Engineering Parts Lists (EPLs) will be sent to the vendor. When EPLs are received, the components will be entered into the Relex reliability prediction software. Relex is MIL-HDBK-217F compliant and is produced by Innovative Software Designs, Inc. The software produces the predicted MTBF of an assembly by utilizing built-in libraries to look up each

individual component's failure rate parameters. The predicted reliability data is then entered into the worksheet's MTBF column in Appendix A for the appropriate assembly/item and segment. A sample output report from this automated reliability prediction software tool is shown in Figure 3.5-1.

Item	Part Number	Reference Designator	Quantity	Failure Rate	MTBF
BOX	7800901-1	B1	1	0.082978	1.205140e+07
BOARD1.SUB	123X456	A1	1	0.055386	1.805510e+07
BOARD2.SUB	234X567	A2	1	0.027592	3.624260e+07
BOARD3.SUB	345X678	A3	1	0.028070	3.562570e+07

**Figure 3.5-1. Sample Relex Output Report (1 of 2)**

Part Number :123X456 Description :Sample Relex Subassembly  
 Reference Des:A1 File Name :BOARD1.SUB  
 Date :January 10, 1995 Time :08:07 a.m.  
 Environment :Ground Benign Failure Rate :0.055386  
 Temperature :30.0 MTBF :1.805510e+07

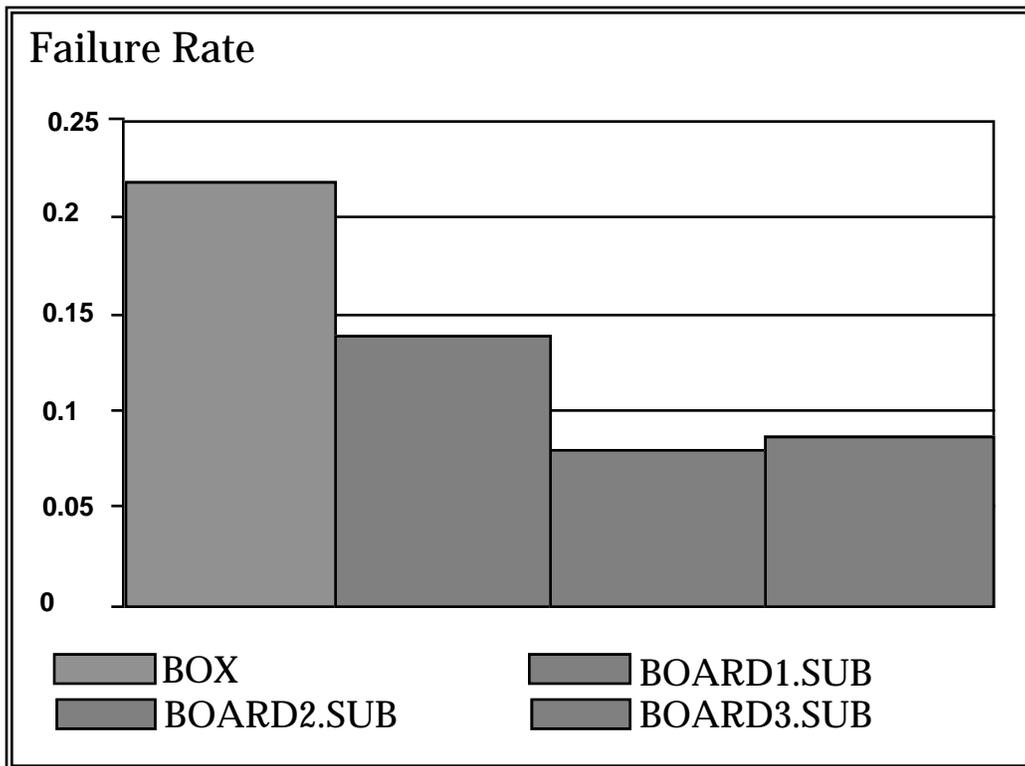
Record Number	Part Number	Part Category	Ref. Des.	Failure Rate, Unit	Qty	Failure Rate
1	74LS00	Integrated Circuit	U1	0.005549	1	0.005549
2	74LS04	Integrated Circuit	U2-U3	0.005562	2	0.011124
3	74HC374	Integrated Circuit	U4	0.009621	1	0.009621
4	2147	Integrated Circuit	U5	0.029092	1	0.029092

**Figure 3.5-1. Sample Relex Output Report (2 of 2)**

In addition to the prediction computation and report generation, Relex can also be used to graphically identify high failure rate LRUs, perform trade studies; varying hardware configurations, temperature, environment, part quality levels, and part stress levels.

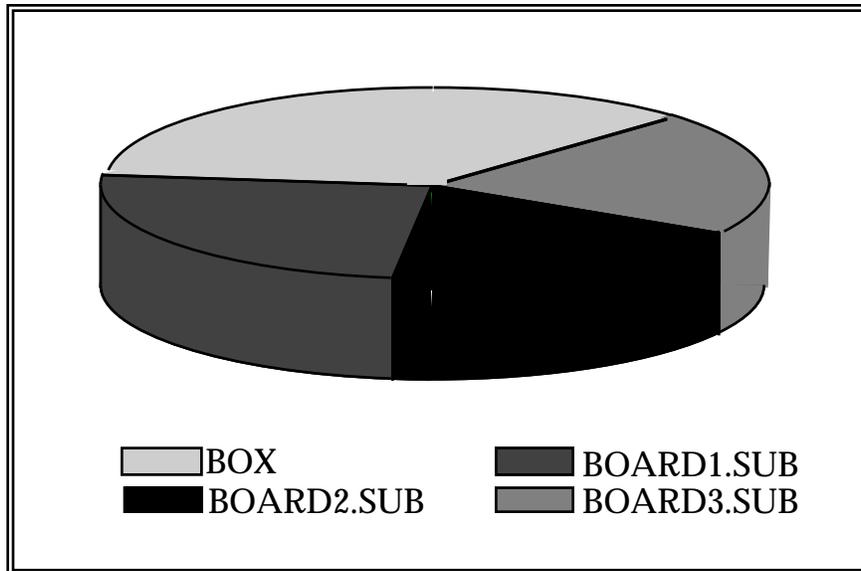
The following figures graphically show some of these additional capabilities of the Relex reliability prediction software tool.

Figure 3.5-2 graphically compares sample hardware failure rates to help highlight high failure rate LRUs.



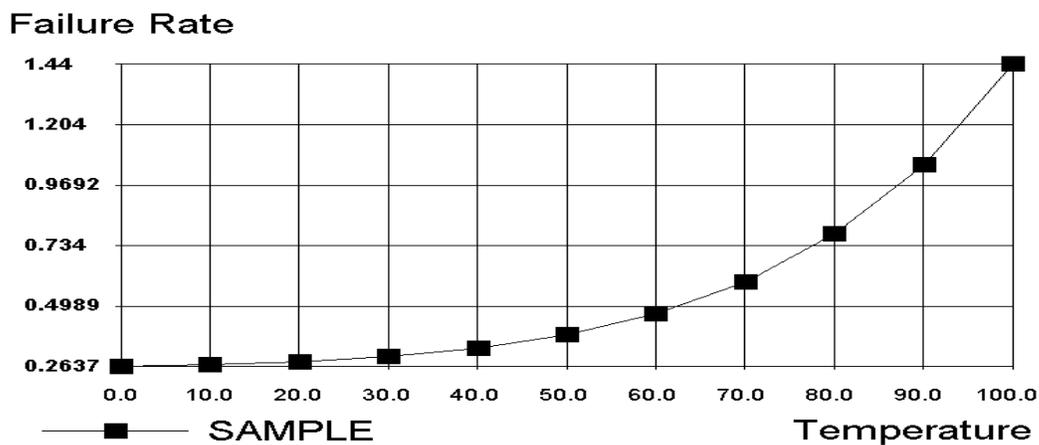
**Figure 3.5-2. Sample Relex Bar Chart Comparison of Hardware Failure Rates**

Figure 3.5-3 shows the same data as Figure 3.5-2 but displays the sample hardware failure rates in a pie chart format for a graphical comparison.



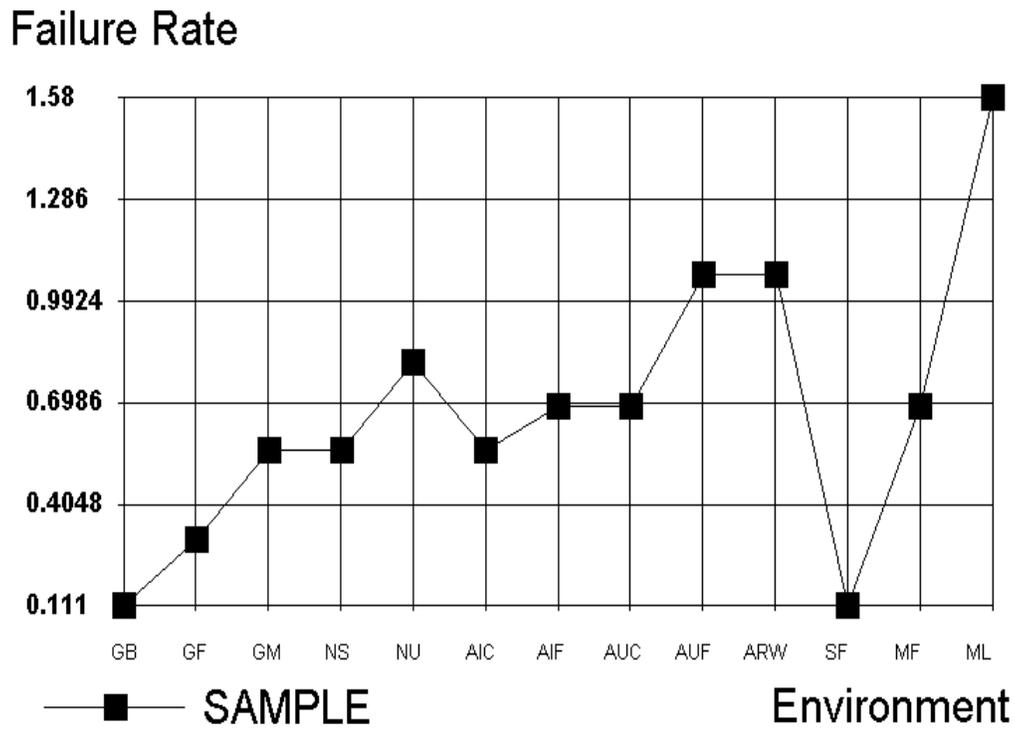
**Figure 3.5-3. Sample Relex Pie Chart Comparison of Hardware Failure Rates**

Figure 3.5-4 below displays a sample of a system's failure rate sensitivity to operating temperature.



**Figure 3.5-4. Sample Relex Graph of Failure Rate vs Temperature**

Figure 3.5-5 below shows a line graph of a sample system's failure rate versus the system's operating environment (E) as defined in MIL-HDBK-217F.



**Figure 3.5-5. Sample Relx Graph of Failure Rate vs Operating Environment**

## 4. Other Failure Rate Data Sources

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### 4.1 Government Furnished Equipment (GFE) Provided Data

Since all required RMA functional hardware strings within the DAACs consist of COTS equipment, a GFE provided data list is not required for these functions.

For the inter-DAAC required function (EOSD3990: SDPS Function of Data Order Submission Across DAACs), a GFE list will be requested and incorporated by the WAN network provider. ECS Reliability Engineering group will ensure that quantitative RMA requirements are appropriately specified for the network by the WAN provider so that the overall functional requirement can be achieved.

### 4.2 Nonelectronic Parts Reliability Data 91 (NPRD-91)

Nonelectronic Parts Reliability Data 91 is used to complement the MIL-HDBK-217 parts count prediction by providing failure rate data on various electrical, electromechanical, and mechanical parts and assemblies which are not modeled in MIL-HDBK-217. NPRD-91 provides historical reliability data (failure rates) to aid engineers in estimating the reliability of systems.

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## 5. Reliability Prediction Data

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The reliability data presented in Appendix A is divided into three sections. Each section contains a segment. The first section A.1 contains FOS reliability data and the second section A.2 contains SDPS reliability data, and the third section A.3 contains CSMS reliability data.

The definition for each worksheet column follows:

<u>Column Title</u>	<u>Description</u>
Site	Physical location of hardware
HWCI	Hardware Configuration Item within the Segments
Rel	Release in which hardware is delivered
Qty	Number of items used in this subsystem
Item Description	Hardware name and/or description
Model	Manufacturer model number of hardware
MTBF	Mean Time Between Failure
Data Source	Source of MTBF data. (i.e. Vendor, Parts Count Prediction, NPRD, Similar to..., etc.)

### 5.1 Flight Operations Segment (FOS) Reliability Data

Appendix A.1 presents the detailed listings of the FOS hardware for Release A/B at GSFC with their associated MTBFs. These MTBFs are predicted and/or field return reliability data which were provided by the COTS vendors. The hardware models in Appendix A.1 are selected hardware candidates for Release A/B which will be presented at the FOS CDR time frame. As the FOS design evolves, any changes to the hardware list will be updated with latest vendor's MTBF data.

### 5.2 Science Data Processing Segment (SDPS) Reliability Data

Appendix A.2 presents the detailed listings of the SDPS hardware for Release A at GSFC, LaRC, MFSC, and EDC DAAC sites with their associated MTBFs. These MTBFs are predicted and/or field return reliability data which were provided by the COTS vendors. The hardware models in Appendix A.2 are selected SDPS hardware candidates for Release A which will be presented at the Release A CDR time frame. As the SDPS design evolves, any changes to the hardware list will be updated with latest vendor's MTBF data.

### **5.3 Communications and System Management (CSMS) Reliability Data**

Appendix A.3 presents the detailed listings of the CSMS hardware for Release A at GSFC, LaRC, MSFC, and EDC DAAC sites with their associated MTBFs. These MTBFs are predicted and/or field return reliability data which were provided by the COTS vendors. The hardware models in Appendix A.3 are selected CSMS hardware candidates for Release A which will be presented at the Release A CDR time frame. As the CSMS design evolves, any changes to the hardware list will be updated with latest vendor's MTBF data.

## Appendix A. Reliability Data

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### A.1 Flight Operations Segment (FOS) Reliability Prediction Data

*FOS COTS Hardware RMA Data For Releases A and B*

Site	HWC I	Rel.	Qty	Item Description	Model	MTBF (Hours)	Data Source
GSFC	EOC-SRV	A/B	3	Real Time Server: 256MB,2GB,CDROM, Dual FDDI Card	DEC Alpha 1000 4/233	14,327	Vendor
GSFC	EOC-SRV	A/B	3	Data Server:256MB,2GB,CDROM, Dual FDDI Card	DEC Alpha 1000 4/200	12,853	Vendor
GSFC	EOC-WS	A/B	36	User Station: 64MB,2GB, CD ROM, Ethernet Card, 20" monitor	SUN Sparc20 Model 71	8,918	Vendor
GSFC	EOC-T-SRV	A/B	2	Timing System and Rack	TYMESERV2000 IRIG	70,000	Vendor
GSFC	EOC-RAID	A/B	2	RAID Front End Processor: 64MB, CD ROM, Dual FDDI Card	DEC Alpha 1000	19,455	Vendor
GSFC	EOC	A/B	1	Network attached RAID 5, 25-2.1GB	DEC Storage Works	500,000	Vendor
GSFC	EOC	A/B	7	Laser Printer	HP Laser Jet 4M	8,000	Vendor
GSFC	EOC	A/B	5	Color Printer	HP Laser Jet	6,000	Vendor
GSFC	EOC	A/B	12	20-Inch Color Monitor GX	SUN Monitor	25,000	Vendor

## A.2 Science Data Processing Segment (SDPS) Reliability Prediction Data

### *SDPS COTS Hardware RMA Data For Release A (1 of 5)*

Site	HWCI	Rel	Qty	Item Description	Model	MTBF (Hours)	Data Source
GSFC	ACM	A	1	RAID	SGI 42 GB RAID	150,000	Vendor
GSFC	ACM	A	2	SERVER HOST	SGI Challenge L, 2CPU,256MB,6GB,FDDI	8,000	Vendor
GSFC	ACM	A	2	OPS WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
GSFC	AQA	A	1	QA WORKSTATION	SUN Sparcstation 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
GSFC	AIT	A	1	AIT WORKSTATION	SUN Sparc 20/50	8,211	Vendor
GSFC	AIT	A	1	AIT WS/DBMS SERVER	SUN Sparc 20/50, 128 MB, 4 GB disk	8,211	Vendor
GSFC	AIT	A	1	PRINTER	HP LaserJet 4M+, 12ppm, 14 MB RAM	8,000	Vendor
GSFC	DIP	A	1	1600/6250 BPI Tape Drive	1600/6250 BPI Tape Drive - DEC3490 Drive - EMASS	35,000	Vendor
GSFC	DIP	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
GSFC	DIP	A	1	CD ROM JUKEBOX	CD ROM Jukebox - JVC	14,598	Vendor
GSFC	DIP	A	1	RAID	SGI 22 GB RAID	150,000	Vendor
GSFC	DIP	A	2	LASER PRINTER	HP LaserJet 4M - HP	8,000	Vendor
GSFC	DIP	A	2	DISTRIBUTION SERVER	SUN Sparcstation 20/712, 256MB, 6GB,20" Mon.,FDDI	8,211	Vendor
GSFC	DMG	A	1	DMG SERVER	HP K200/1,1CPU, 256MB, 6GB RAID,FDDI	16,560	Vendor
GSFC	DMG	A	1	DMG SERVER	HP J200/1,1CPU,512MB, 6GB RAID,FDDI	16,560	Vendor
GSFC	DMG	A	3	DATA SPECIALIST WORKSTATION	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
GSFC	DMG	A	1	OPS WS	HP 715/64, 8mm	37,300	Vendor
GSFC	DRP	A	1	ARCHIVE ROBOTICS	G-Series robotic archive - EMASS 57 TB capacity	13,166	Vendor
GSFC	DRP	A	1	RAID	SGI 10 GB RAID	150,000	Vendor
GSFC	DRP	A	2	LINEAR MAG DR	NTP Linear Tape Drive - EMASS	35,000	Vendor
GSFC	DRP	A	2	DBMS SERVER	SGI Challenge XL, 4CPU, 256MB, 4GB,FDDI	5,914	Vendor
GSFC	DRP	A	2	FSMS SERVER	SGI Challenge XL, 4CPU, 256MB, 6GB,FDDI	5,914	Vendor

**SDPS COTS Hardware RMA Data For Release A (2 of 5)**

Site	HWC I	Rel .	Qty	Item Description	Model	MTBF (Hours)	Data Source
GSFC	DRP	A	1	DOCUMENT SERVER	SUN Sparcstation 20/712, 256MB, 6GB	8,918	Vendor
GSFC	ICL	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
GSFC	ICL	A	1	INGEST SERVER	SGI Indigo 2, 6GB	8,000	Vendor
GSFC	PLAN	A	1	PLANNING DBMS SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
GSFC	PLAN	A	1	PLANNING WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
GSFC	SPR	A	1	SCIENCE PROCESSOR	SGI Power Challenge XL, 14CPU, 1024MB, 8GB,FDDI	5,914	Vendor
GSFC	SPR	A	1	QUEUEING SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
GSFC	SPR	A	1	RAID	SGI 68 GB RAID	150,000	Vendor
GSFC	SPR	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
GSFC	SPR	A	2	X Terminals	X Terminals (NCD)	27,548	Vendor
GSFC	WKS	A	1	RAID 30 GB	SGI 30 GB RAID	500,000	Vendor
LARC	ACM	A	1	RAID	SGI 35 GB RAID	150,000	Vendor
LARC	ACM	A	2	SERVER HOST	SGI Challenge L, 2CPU,256MB,6GB,FDDI	8,000	Vendor
LARC	ACM	A	2	OPS WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
LARC	AQA	A	1	QA WORKSTATION	SUN Sparcstation 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
LARC	AIT	A	1	AIT WORKSTATION	SUN Sparc 20/50	8,211	Vendor
LARC	AIT	A	1	AIT WS/DBMS SERVER	SUN Sparc 20/50, 128 MB, 4 GB disk	8,211	Vendor
LARC	AIT	A	1	PRINTER	HP LaserJet 4M+, 12ppm, 14 MB RAM	8,000	Vendor
LARC	DIP	A	1	1600/6250 BPI Tape Drive	1600/6250 BPI Tape Drive - DEC3490 Drive - EMASS	35,000	Vendor
LARC	DIP	A	2	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
LARC	DIP	A	1	CD ROM JUKEBOX	CD ROM Jukebox - JVC	14,598	Vendor
LARC	DIP	A	1	RAID	SGI 20GB RAID	150,000	Vendor
LARC	DIP	A	2	LASER PRINTER	HP LaserJet 4M - HP	8,000	Vendor

**SDPS COTS Hardware RMA Data For Release A (3 of 5)**

Site	HWC	Rel	Qty	Item Description	Model	MTBF (Hours)	Data Source
LARC	DIP	A	2	DISTRIBUTION SERVER	SUN Sparcstation 20/712, 256MB, 4GB,20" Mon.,FDDI	8,918	Vendor
LARC	DMG	A	1	DMG SERVER	HP K2000/1,1CPU, 256MB, 6GB RAID,FDDI	16,560	Vendor
LARC	DMG	A	1	DMG SERVER	HP J200/1,1CPU,512MB, 6GB RAID,FDDI	16,560	Vendor
LARC	DMG	A	3	DATA SPECIALIST WORKSTATION	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
LARC	DMG	A	1	OPS WS	HP 715/64, 8mm	37,300	Vendor
LARC	DRP	A	1	ARCHIVE ROBOTICS	G-Series robotic archive - EMASS 57 TB capacity	13,166	Vendor
LARC	DRP	A	1	RAID	SGI 10 GB RAID	150,000	Vendor
LARC	DRP	A	2	LINEAR MAG DR	NTP Linear Tape Drive - EMASS	35,000	Vendor
LARC	DRP	A	2	DBMS SERVER	SGI Challenge XL, 4CPU, 256MB, 4GB,FDDI	5,914	Vendor
LARC	DRP	A	2	FSMS SERVER	SGI Challenge XL, 4CPU, 256MB, 4GB,FDDI	5,914	Vendor
LARC	DRP	A	1	DOCUMENT SERVER	SUN Sparcstation 20/712, 256MB, 6GB	8,918	Vendor
LARC	ICL	A	1	RAID	SGI 100 GB RAID	500,000	Vendor
LARC	ICL	A	2	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
LARC	ICL	A	2	INGEST SERVER	SGI Challenge L, 2CPU, 256MB, 6GB,FDDI	8,000	Vendor
LARC	ICL	A	1	X TERMINAL	X TERMINAL (NCD)	27,548	Vendor
LARC	PLAN	A	2	PLANNING DBMS SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
LARC	PLAN	A	1	PLANNING WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
LARC	SPR	A	2	SCIENCE PROCESSOR	SGI Power Challenge XL, 12 CPU, 1024MB, 8GB,FDDI	6,150	Vendor
LARC	SPR	A	1	QUEUING SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
LARC	SPR	A	2	RAID	SGI 68.8 GB RAID	150,000	Vendor
LARC	SPR	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
LARC	SPR	A	3	X TERMINAL	X TERMINAL (NCD)	27,548	Vendor
LARC	WKS	A	1	RAID	SGI 40 GB RAID	500,000	Vendor

**SDPS COTS Hardware RMA Data For Release A (4 of 5)**

Site	HWC I	Rel .	Qty	Item Description	Model	MTBF (Hours)	Data Source
MSFC	ACM	A	1	RAID	SGI 42 GB RAID	150,000	Vendor
MSFC	ACM	A	2	SERVER HOST	SGI Challenge L, 2CPU,256MB,6GB,FDDI	8,000	Vendor
MSFC	ACM	A	2	OPS WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
MSFC	AQA	A	1	QA WORKSTATION	SUN Sparcstation 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
MSFC	AIT	A	1	AIT WORKSTATION	SUN Sparc 20/50	8,211	Vendor
MSFC	AIT	A	1	AIT WS/DBMS SERVER	SUN Sparc 20/50, 128 MB, 4 GB disk	8,211	Vendor
MSFC	AIT	A	1	PRINTER	HP LaserJet 4M+, 12ppm, 14 MB RAM	8,000	Vendor
MSFC	DIP	A	1	1600/6250 BPI Tape Drive	1600/6250 BPI Tape Drive - DEC3490 Drive - EMASS	35,000	Vendor
MSFC	DIP	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
MSFC	DIP	A	1	CD ROM JUKEBOX	CD ROM Jukebox - JVC	14,598	Vendor
MSFC	DIP	A		RAID	SGI 22GB RAID	150,000	Vendor
MSFC	DIP	A	2	LASER PRINTER	HP LaserJet 4M - HP	8,000	Vendor
MSFC	DIP	A	2	DISTRIBUTION SERVER	SUN Sparcstation 20/712, 256MB, 4GB,20" Mon.,FDDI	8,211	Vendor
MSFC	DMG	A	1	DMG SERVER	HP K2000/1,1CPU, 256MB, 6GB RAID,FDDI	16,560	Vendor
MSFC	DMG	A	1	DMG SERVER	HP J200/1,1CPU,512MB, 6GB RAID,FDDI	16,560	Vendor
MSFC	DMG	A	2	DATA SPECIALIST WORKSTATION	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
MSFC	DMG	A	1	OPS WS	HP 715/64, 8mm	37,300	Vendor
MSFC	DRP	A	1	ARCHIVE ROBOTICS	G-Series robotic archive - EMASS 57 TB capacity	13,166	Vendor
MSFC	DRP	A	1	RAID	SGI 25 GB RAID	150,000	Vendor
MSFC	DRP	A	2	LINEAR MAG DR	NTP Linear Tape Drive - EMASS	35,000	Vendor
MSFC	DRP	A	2	DBMS SERVER	SGI Challenge XL, 4CPU, 256MB, 4GB,FDDI	5,914	Vendor
MSFC	DRP	A	2	FSMS SERVER	SGI Challenge XL, 4CPU, 256MB, 4GB,FDDI	5,914	Vendor
MSFC	ICL	A	1	RAID	SGI 100 GB RAID	500,000	Vendor
MSFC	ICL	A	2	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
MSFC	ICL	A	2	INGEST SERVER	SGI Challenge L, 2CPU, 256MB, 6GB,FDDI	8,000	Vendor
MSFC	ICL	A	1	X TERMINAL	X TERMINAL (NCD)	27,548	Vendor

**SDPS COTS Hardware RMA Data For Release A (5 of 5)**

Site	HWC I	Rel.	Qty	Item Description	Model	MTBF (Hours)	Data Source
MSFC	PLAN	A	1	PLANNING DBMS SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
MSFC	PLAN	A	1	PLANNING WS	SUN Sparcstation 20/50, 64MB, 2GB,20" Mon.,FDDI	8,211	Vendor
MSFC	SPR	A	2	SCIENCE PROCESSOR	SGI Indy, 256MB, 6GB	5,288	Vendor
MSFC	SPR	A	1	QUEUEING SERVER	SUN Sparcstation 20/71, 384MB, 8GB,20" Mon.,FDDI	8,918	Vendor
MSFC	SPR	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
MSFC	SPR	A	1	X Terminal	X TERMINAL (NCD)	27,548	Vendor
MSFC	WKS	A	1	RAID 30 GB	SGI 25 GB RAID	500,000	Vendor
EDC	AIT	A	1	AIT WORKSTATION	SUN Sparc 20/50	8,211	Vendor
EDC	AIT	A	1	AIT WS/DBMS SERVER	SUN Sparc 20/50, 128 MB, 4 GB disk	8,211	Vendor
EDC	AIT	A	1	PRINTER	HP LaserJet 4M+, 12ppm, 14 MB RAM	8,000	Vendor
EDC	ICL	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
EDC	ICL	A	1	INGEST SERV	SGI Indigo2, 128MB, 6GB, FDDI	4,684	Vendor
EDC	SPR	A	1	RAID	SGI 3 GB RAID	500,000	Vendor
EDC	SPR	A	1	8MM TP STACKER W/4 DR	8mm Drive w/stacker - EXABYTE 210	27,000	Vendor
EDC	SPR	A	1	SCIENCE PROCESSOR	SGI PC XL 2 CPU, 4mm CD-ROM	5,914	Vendor
EDC	SPR	A	2	X Terminal	X Terminal (NCD)	27,548	Vendor

### A.3 Communications and System Management (CSMS) Reliability Prediction Data

#### CSMS COTS Hardware RMA Data For Release A (1 of 2)

Site	HWC I	Rel.	Qty	Item Description	Model	MTBF (Hrs)	Data Source
GSFC	CSS	A	1	COMM SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
GSFC	MSS	A	1	LASER PRINTER	HP LaserJet 4M +	8,000	Vendor
GSFC	MSS	A	1	ENT MGT SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
GSFC	MSS	A	3	MGT WS	SUN Sparcstation 20/50, 128MB, 4GB,20" Mon.,FDDI	8,211	Vendor
GSFC	ISS	A	8	FDDI CONCENTRATOR	FDDI Concentrator - SynOptics 2914-04	100,000	Vendor
GSFC	ISS	A	1	FDDI SWITCH	PowerHub7000 - ALANTEC	146,520	Vendor
GSFC	ISS	A	1	ETHERNET HUB	Ethernet Hub - SynOptics	161,000	Vendor
GSFC SMC	CSS	A	1	COMM SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
GSFC SMC	MSS	A	1	LASER PRINTER	HP LaserJet 4M +	8,000	Vendor
GSFC SMC	MSS	A	1	ENT MGT SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
GSFC SMC	MSS	A	3	MGT WS	SUN Sparcstation 20/50, 128MB, 4GB,20" Mon.,FDDI	8,211	Vendor
GSFC SMC	ISS	A	2	FDDI CONCENTRATOR	FDDI Concentrator - SynOptics 2914-04	100,000	Vendor
GSFC SMC	ISS	A	1	ETHERNET HUB	Ethernet Hub - SynOptics	161,000	Vendor
GSFC EOC	ISS	A	6	FDDI CONCENTRATOR	FDDI Concentrator - SynOptics 2914-04	100,000	Vendor
GSFC EOC	ISS	A	2	ETHERNET HUB	Ethernet Hub - SynOptics	161,000	Vendor
LARC	CSS	A	1	COMM SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
LARC	MSS	A	1	LASER PRINTER	HP LaserJet 4M +	8,000	Vendor
LARC	MSS	A	1	ENT MGT SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
LARC	MSS	A	2	MGT WS	SUN Sparcstation 20/50, 128MB, 4GB,20" Mon.,FDDI	8,211	Vendor
LARC	ISS	A	8	FDDI CONCENTRATOR	FDDI Concentrator - SynOptics 2914-04	100,000	Vendor
LARC	ISS	A	1	FDDI SWITCH	PowerHub7000 - ALANTEC	146,520	Vendor

LARC	ISS	A	1	ETHERNET HUB	Ethernet Hub - SynOptics	161,000	Vendor
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**CSMS COTS Hardware RMA Data For Release A (2 of 2)**

Site	HWCI	Rel	Qty	Item Description	Model	MTBF (Hrs)	Data Source
MSFC	CSS	A	1	COMM SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
MSFC	MSS	A	1	LASER PRINTER	HP LaserJet 4M +	8,000	Vendor
MSFC	MSS	A	1	ENT MGT SERVER	HP 755, 256 MB, 6 GB	23,900	Vendor
MSFC	MSS	A	2	MGT WS	SUN Sparcstation 20/50, 128MB, 4GB,20" Mon.,FDDI	8,211	Vendor
MSFC	ISS	A	8	FDDI CONCENTRATOR	FDDI Concentrator - SynOptics 2914-04	100,000	Vendor
MSFC	ISS	A	1	FDDI SWITCH	PowerHub7000 - ALANTEC	146,520	Vendor
MSFC	ISS	A	1	ETHERNET HUB	Ethernet Hub - SynOptics	161,000	Vendor

# Abbreviations and Acronyms

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ACMHW	Access and Control Management Hardware CI
AITHW	Algorithm Integration and Test Hardware CI
AQAHW	Algorithm Quality Assurance Hardware CI
CCR	Configuration Change Request
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CI	Configuration Item
CN	Change Notice
COTS	Commercial Off The Shelf
CSS	Communication Subsystem
CSMS	Communications and Systems Management Segment (ECS)
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
DID	Data Item Description
DIPHW	Distribution and Ingest Peripheral Hardware CI
DMGHW	Data Management Server Hardware CI
DRPHW	Data Repository Hardware CI
ECS	EODIS Core System
EDC	EROS Data Center (DAAC)
EDS	Electronic Data Systems
EOC	EOS Operations Center (ECS)
EOC-SRV	EOS Operations Center (ECS) Server
EOC-WS	EOS Operations Center (ECS) Workstation
EOC-T-SRV	EOS Operations Center (ECS) Timing Server
EOC-RAID	Earth Observing System RAID
EOSDIS	Earth Observing System Data and Information System
EPL	Engineering Parts List
EROS	Earth Resources Observation System

ESDIS	Earth Science Data and Information System (GSFC)
FPMH	Failure Per Million Hours
FOS	Flight Operations Segment (ECS)
GFE	Government Furnished Equipment
GSFC	Goddard Space Flight Center
ICLHW	Ingest Client Hardware CI
IDR	Incremental Design Review
ILS	Integrated Logistics Support
ISS	Internetworking Subsystem
LaRC	Langley Research Center (DAAC)
LRU	Line Replaceable Unit
MTBF	Mean Time Between Failure
MSFC	Marshall Space Flight Center
MSS	Management Subsystem
NASA	National Aeronautics and Space Administration
NPRD	Nonelectronic Parts Reliability Data
PAIP	Performance Assurance Implementation Plan
PDR	Preliminary Design Review
PLNHW	Planning Hardware CI
RAID	Redundant Array of Independent Disks
RMA	Reliability, Maintainability, Availability
SDPS	Science Data Processing Segment (ECS)
SMC	System Management Center (ECS)
SPRHW	Science Processing Hardware CI
VCATS	Vendor Costing And Tracking System (ECS)
WKSHW	Working Storage Hardware CI