

SGSS Mission Assurance Requirements (MAR)

Baseline

Publication Date: September 18, 2009

Expiration Date: September 18, 2014

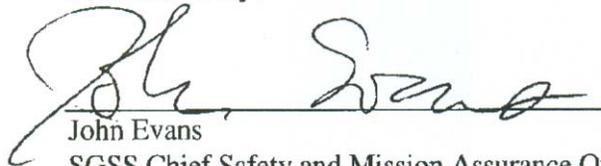


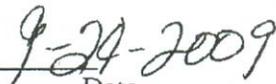
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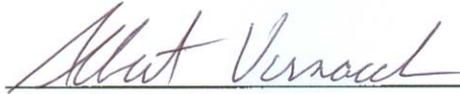
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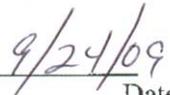
Submitted by:


John Evans
SGSS Chief Safety and Mission Assurance Officer
NASA/GSFC, Code 322


Date

Approved by:


Albert Vernacchio
SGSS Project Manager
NASA/GSFC, Code 458


Date

Goddard Space Flight Center
Greenbelt, Maryland

Preface

This document is under the configuration management of the Space Network Ground Segment Sustainment (SGSS) Project (Code 458) Configuration Control Board (CCB). Configuration Change Requests (CCRs) to this document **shall** be submitted to the SGSS Project CCB, along with supportive material justifying the proposed change. Changes to this document **shall** be made by Documentation Change Notice (DCN) or by complete revision.

Direct all comments, questions, or suggestions regarding this document to:

Space Network Ground Segment Sustainment (SGSS) Project
Code 458
Goddard Space Flight Center
Greenbelt, MD 20771

Change Information Page

List of Effective Pages			
Page Number		Issue	
Title		Original	
i through vi		Original	
1-1		Original	
2-1		Original	
3-1 and 3-2		Original	
4-1		Original	
5-1 through 5-3		Original	
6-1 through 6-6		Original	
7-1 and 7-2		Original	
8-1 and 8-2		Original	
9-1		Original	
10-1		Original	
11-1		Original	
12-1		Original	
13-1		Original	
A-1 and A-2		Original	
Document History			
Document Number	Status/Issue	Publication Date	CCR Number
458-MAR-0001	Baseline	09/18/2009	CCR 458/000015
Change History			
Revision	Effective Date	Description of Change	
Baseline (CCR 458/000015)	09/18/2009	Initial Release	

Table of Contents

Section 1 Introduction	1-1
1.1 Purpose	1-1
1.2 Scope	1-1
Section 2 Definitions and Related Documentation	2-1
2.1 Definitions and Terms	2-1
2.2 Applicable and Reference Documents	2-1
Section 3 General	3-1
3.1 Description of Overall Requirements	3-1
3.2 Surveillance of the Contractor	3-1
3.3 Applicable Documents	3-1
3.4 Mission Assurance Implementation Plan	3-2
3.5 Suspension of Work Activities	3-2
Section 4 Quality Management System	4-1
4.1 General	4-1
4.1.1 Material Processing	4-1
4.1.2 Calibration	4-1
4.1.3 Flow-Down of Requirements	4-1
Section 5 System Safety	5-1
5.1 General	5-1
5.2 System Safety Deliverables	5-1
5.2.1 System Safety Program Plan	5-1
5.2.2 Safety Requirements Compliance Checklist	5-2
5.2.3 Safety Assessment Report and Hazard Analyses	5-2
5.3 Verification Tracking Log	5-3
5.4 Safety Non-Compliance/Waiver Requests	5-3
5.5 Support for Safety Working Group Meetings	5-3
5.6 Mishap Reporting	5-3

Section 6 Probabilistic Risk Analysis and Reliability, Maintainability, and Availability	6-1
6.1 Probabilistic Risk Assessment and Reliability, Maintainability, and Availability Program Plan (PRA and RMA Program Plan)	6-1
6.2 Maintainability	6-2
6.3 Probabilistic Risk Assessment (PRA)	6-2
6.4 Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)	6-3
6.5 Fault Tree Analysis	6-4
6.6 Parts Stress Analysis	6-4
6.7 Worst Case Analysis	6-4
6.8 Availability Assessments and Predictions	6-5
6.9 Trend Analysis	6-5
6.10 Limited Life Items	6-6
6.11 Life Cycle Cost	6-6
6.12 Long Lead Items	6-6
Section 7 Software Assurance	7-1
7.1 Applicable Requirements	7-1
7.2 Software Quality Assurance	7-1
7.3 Software Reliability	7-1
Section 8 Workmanship Standards	8-1
8.1 General	8-1
8.2 Training and Certification	8-1
8.3 Documentation	8-1
8.4 Handling	8-1
8.5 Preservation and Packaging	8-2
Section 9 Component, Module, and Unit Control	9-1
9.1 General	9-1
9.2 Custom or Advanced Technology Devices	9-1
9.3 Equipment Lists	9-1
9.4 Lead-free and Tin Whisker Control	9-1
Section 10 Testing, Verification, and Validation	10-1
10.1 Verification and Validation	10-1
10.2 Testing of Spare Hardware	10-1

10.2.1	General	10-1
10.2.2	Extent of Testing	10-1
10.2.3	Rework of Spares	10-1
Section 11 Test Facility Readiness		11-1
11.1	General	11-1
Section 12 Electro-Static Discharge (ESD) Control		12-1
12.1	General	12-1
Section 13 Government-Industry Data Exchange Program (GIDEP) Alert and Problem Advisories		13-1
13.1	General	13-1
Appendix A - Acronyms		A-1

Section 1 Introduction

1.1 Purpose

The Mission Assurance Requirements (MAR) complement the Statement of Work (SOW), and define the Contractor's efforts required to assure the integrity and safety of the Space Network (SN) and its Users during and after the development of the SN Ground Segment Sustainment (SGSS) system.

The purpose of the SGSS project is to implement a modern ground segment that will enable the SN to continue to deliver high quality services to the SN community, meet stakeholder requirements, and significantly reduce required operations and maintenance resources. This effort will:

- Address obsolescence of the existing systems
- Create a more flexible and expandable architecture
- Facilitate integration of the NASA Space Communications and Navigation (SCaN) networks
- Address evolving customer requirements and advances in technology
- Implement new methods and capabilities for using the TDRS to support SN User spacecraft
- Expand and improve the methods by which the SN User control centers interface with the SNGS for data and service planning and control
- Maintain long-term operational performance, reliability and maintainability.

1.2 Scope

The MAR defines the requirements for overall Mission Assurance; Quality Management; System Safety; Probability Risk Analysis and Reliability, Maintainability And Availability; Software Assurance; Workmanship Standards; Component, Module and Unit Control; Testing, Verification and Validation; Test Facility Readiness; Electrostatic Discharge (ESD) Control; and Government-Industry Data Exchange Program (GIDEP) Alerts and Problem Advisories; associated with SGSS and its interfaces.

Section 2 Definitions and Related Documentation

2.1 Definitions and Terms

The following definitions apply to this document:

Shall – Compliance by the Contractor is mandatory. Any deviation from these contractually imposed mandatory requirements requires the approval of the contracting officer.

May – At the discretion of the Contractor or Government.

Will – Designates the intent of the Government. Unless required by other contract provisions, noncompliance with the *will* requirements does not require approval of the Contracting Officer and does not require documented technical substantiation.

The term “(CDRL -)” refer to items in the Contract Data Requirements List (CDRL).

Throughout this document, the term “Government personnel” includes anyone designated by the SGSS Project Manager to act on behalf of the Government.

Throughout this document, the term “days” refers to business days unless specified as a calendar period (e.g., “1 month”), calendar days after contract award (DACA), or explicitly identified as calendar days.

2.2 Applicable and Reference Documents

The SGSS Statement of Work, 458-SOW-0001, provides a consolidated list of applicable and reference documents to the MAR and SOW.

Section 3 General

3.1 Description of Overall Requirements

[MAR 101] The Contractor **shall** plan and implement an organized Mission Assurance (MA) program to assure the integrity and safety of the Space Network (SN) that encompasses SGSS hardware, software and processes whether designed/built by the Contractor, subcontractors or suppliers from project initiation through deployment and sustainment.

[MAR 268] The Contractor **shall** document critical software and hardware items in the Make Versus Buy Plan, **Contract Data Requirements List (CDRL) SE-21**.

[MAR 102] The Contractor **shall** document waivers/deviations and submit them to the Government for approval as described in **CDRL CM-08**. These deviations/waivers will be controlled and maintained by SGSS Configuration Management.

[MAR 271] The Contractor **shall** identify a primary MA point of contact (MA POC) with responsibility for leading the Contractor's SGSS MA activities.

[MAR 103] The Contractor's MA POC **shall** have direct access to Contractor management, independent of project management, with the functional freedom and authority to interact with other elements of the Contractor's and subcontractors' project teams.

[MAR 104] The Contractor **shall** ensure that review processes are in place at Levels 1 through 6 as defined in the Statement of Work (SOW), Section 8.3, to certify the safety and operational readiness of the hardware/software, support equipment, facilities, and operations.

3.2 Surveillance of the Contractor

[MAR 105] The work activities, operations, and documentation performed by the Contractor, subcontractors, and suppliers **shall** be subject to evaluation, review, audit, and inspection by the Government.

[MAR 106] The Contractor **shall** grant access for NASA and NASA assurance representatives to conduct an audit, assessment, or survey upon notice.

Note: See Federal Acquisition Regulations (FAR) Parts 46.103, 46.104, 46.202-2, 46.4, and 46.5 for government quality assurance requirements at Contractor facilities. See FAR Part 52.246 for inspection clauses by contract type.

[MAR 107] The Contractor **shall** provide resources to assist with the assessments/surveys, with minimal disruption to work activities.

[MAR 108] The Contractor, upon request, **shall** provide NASA assurance representatives with documents, records, and use of project equipment required to perform their assurance and safety activities.

3.3 Applicable Documents

[MAR 111] In the event of conflict between documents specified in the MAR, and other detailed content of the MAR, the MAR **shall** be the superseding document, except for documents that have precedence over the MAR as defined in the SOW, Section 2.2.3.

3.4 Mission Assurance Implementation Plan

[MAR 112] The Contractor **shall** develop and deliver an SGSS Mission Assurance Implementation Plan (MAIP) (**CDRL MA-01**).

[MAR 113] The Contractor **shall** document the method used to verify compliance for each requirement in the SGSS Requirements Traceability Verification Matrix (RTVM) (**CDRL SE-07**).

[MAR 114] The Contractor's Safety and Mission Assurance (S&MA) function **shall** verify the correctness and completeness of the SGSS Requirements Traceability Verification Matrix (RTVM) (**CDRL SE-07**).

3.5 Suspension of Work Activities

[MAR 287] The Contractor shall direct the suspension of any work activity that presents a present hazard, imminent danger, or future hazard to personnel, property, or mission operations resulting from unsafe acts or conditions that are identified by inspection, test, or analysis.

Section 4 Quality Management System

4.1 General

[MAR 115] The Contractor and suppliers **shall** have a Quality Management System (QMS) that is compliant with the minimum requirements of ANSI/ISO/ASQC Q9001:2008, American National Standard Quality Management Systems-Requirements.

[MAR 116] The Contractor **shall** provide a copy of the Contractor's Quality Manual to the government (CDRL MA-03).

4.1.1 Material Processing

[MAR 117] The Contractor **shall** utilize the SGSS Discrepancy Reporting (DR) system for any anomalies that are material-related (CDRL PM-13).

[MAR 118] The material review process **shall** be initiated with the identification and documentation of a material nonconformance.

[MAR 119] Material nonconformance dispositions **shall** include: scrap, rework, return to supplier, repair use-as-is, upon concurrence with the Government Quality Assurance (QA) organization, or request for a waiver.

[MAR 120] All repair procedures proposed for use **shall** have Government approval prior to use.

[MAR 121] For each reported material nonconformance, there **shall** be an investigation and engineering analysis sufficient to determine cause and corrective actions for the nonconformance.

[MAR 122] The Contractor **shall** not disposition nonconforming products without written authorization from the Government.

[MAR 123] The Contractor **shall** complete all failure analyses on a unit/module including failure mode analysis, root cause analysis, and recommended corrective actions, within 30 days.

4.1.2 Calibration

[MAR 124] The Contractor **shall** plan and implement a documented metrology and calibration program.

[MAR 125] The Contractor **shall** comply with ANSI/NCSL Z540.3-2006, Requirements for the Calibration of Measuring and Test Equipment.

[MAR 126] The Contractor **shall** limit the use of non-calibrated instruments to applications where substantiated accuracy is not required and for indication-only purposes in non-hazardous, non-critical applications.

4.1.3 Flow-Down of Requirements

[MAR 127] The Contractor **shall** ensure the flow-down of mission assurance requirements to suppliers of critical hardware and software items as defined in CDRL SE-21.

[MAR 128] The Contractor Contract Review and Purchasing processes **shall** establish the process for documenting, communicating, and reviewing requirements with suppliers to ensure MAR Requirements are met.

Section 5 System Safety

5.1 General

[MAR 129] The Contractor **shall** plan and implement a safety program in accordance with NASA Procedural Requirements (NPR) 8715.3C, NASA General Safety Program Requirements. Military Standard (MIL-STD) 882D can be used as guidance in developing a safety program.

[MAR 130] The Contractor **shall** initiate the safety program in the concept phase of the design and continue implementing it throughout all phases of the project.

[MAR 131] The Contractor **shall** implement a safety program that provides for early identification and control of hazards during design, modifications, construction, fabrication, assembly, test, operation, transportation, and ground activities. The safety program identifies and controls hazards to personnel, facilities, support equipment, and deliverable equipment during all stages of development.

[MAR 132] The Contractor **shall** address hazards in the hardware, associated software, ground support equipment, and support facilities to ensure that they meet applicable existing safety standards and/or applicable consensus standards.

[MAR 133] In the event that there are no known applicable safety standards then special supplemental safety standards **shall** be developed by the Contractor (**CDRL MA-04**).

[MAR 135] In the event a requirement does not apply to a particular program element, the rationale for not complying with that requirement **shall** be presented to the Government prior to approval of the System Safety Program Plan (SSPP) (**CDRL MA-04**).

[MAR 136] The Contractor **shall** plan and implement a system safety program that ensures the following safety requirements:

- a. If a system failure may lead to a catastrophic hazard, the system will have three independent inhibits (dual fault tolerant). A Catastrophic hazard is defined as a hazard that could result in a mishap causing fatal or disabling injury to personnel, loss of Space Network Ground System (SNGS) elements required to continue the SN mission without loss of User Services and/or inability to maintain Tracking and Data Relay Satellite (TDRS) State of Health.
- b. If a system failure may lead to a critical hazard, the system will have two independent inhibits (single fault tolerant). A Critical hazard is defined as a condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, or mission critical hardware.
- c. Hazards which cannot be controlled by fault tolerance **shall** be "Design for Minimum Risk". Hazard controls related to these "Design for Minimum Risk" items are extremely important and warrant careful attention to the details for verification of compliance on the part of the Contractor.

5.2 System Safety Deliverables System Safety Program Plan

[MAR 137] The Contractor **shall** prepare a System Safety Program Plan (SSPP) (**CDRL MA-04**) in accordance with NASA Procedural Requirements (NPR) 8715.3C, NASA, General Safety Program Requirements. MIL-STD-882D can be used as guidance in developing a safety program.

[MAR 138] The Contractor **shall** ensure the SSPP (**CDRL MA-04**) describes the system safety implementation process which includes hazard analysis and the process to track mitigations that reduce the effect of or eliminate hazards.

[MAR 139] The Contractor **shall** ensure the SSPP (**CDRL MA-04**) defines the required safety documentation, applicable standards, associated schedules for completion, roles and responsibilities on the project, and methodologies for the conduct of any required safety analyses and reviews as defined by NPR 8715.3C, NASA General Safety Program Requirements.

[MAR 140] The SSPP (**CDRL MA-04**) **shall** be approved by the Government prior to the Contractor performing work on the hardware.

5.2.2 Safety Requirements Compliance Checklist

[MAR 141] The Contractor **shall** develop a Safety Requirements Compliance Checklist (**CDRL MA-05**) that demonstrates that systems and operations are in compliance with safety requirements.

[MAR 142] The Contractor **shall** identify and communicate non-compliant areas to the Government.

5.2.3 Safety Assessment Report and Hazard Analyses

[MAR 286] The Contractor **shall** prepare and submit a Safety Assessment Report (**CDRL MA-06**) which addresses results of hazard analyses performed to date (e.g. Preliminary Hazard Analysis (PHA), Operational Hazard Analysis (OHA), Software Safety Analysis) and includes a Verification Tracking Log (VTL) in the final submittal.

5.2.3.1 Preliminary Hazard Analysis

[MAR 143] The Contractor **shall** perform and document a PHA (**CDRL MA-06**) to obtain an initial risk assessment of the SGSS system. The purpose of this task is to perform and document a hazard analysis (HA) to identify safety critical areas, to provide an initial assessment of hazards including software, and to identify recommended hazard controls and follow-on actions.

[MAR 145] In the PHA (**CDRL MA-06**), the Contractor **shall** evaluate hazards associated with the proposed design or function for hazard severity, hazard probability, and operational constraint based on the best available data, including mishap data from similar systems and other lessons learned.

[MAR 146] In the PHA (**CDRL MA-06**), the Contractor **shall** include safety provisions and alternatives needed to eliminate hazards or reduce their associated risk to an acceptable level.

5.2.3.2 Operations Hazard Analysis

[MAR 147] The Contractor **shall** perform an OHA (**CDRL MA-06**) to identify the hazards to personnel and hardware as a result of operations and maintenance activities.

[MAR 148] The Contractor **shall** document in the OHA (**CDRL MA-06**) controls and methods of verifications for each hazard listed. The OHA process considers the timing and sequence of tasks with respect to the equipment/hardware/software design, human engineering provisions, assembly, test, and operating procedures, and the facility environments for each specific operation being performed.

5.2.3.3 Software Safety Analysis

[MAR 149] The Contractor **shall** identify hazards caused by software as a part of the nominal hazard analysis process; their controls will be verified prior to acceptance per NASA-STD- 8719.13B, NASA Software Safety Standard.

[MAR 150] The Contractor **shall** deliver the Software Safety Analysis as part of the Safety Assessment Report (CDRL MA-06).

5.3 Verification Tracking Log

[MAR 151] The Contractor **shall** establish a “closed loop” process for tracking all hazards to acceptable closure through the use of a Verification Tracking Log (VTL) (CDRL MA-06).

[MAR 152] The Contractor **shall** close individual VTL (CDRL MA-06) items with appropriate documentation verifying the stated hazard control has been implemented.

[MAR 153] The Contractor **shall** complete individual closures prior to first operational use/restraint.

5.4 Safety Non-Compliance/Waiver Requests

[MAR 154] When a specific safety requirement cannot be met, the Contractor **shall** submit an associated safety noncompliance/waiver request (CDRL MA-09) which identifies the hazard and shows rationale for approval of the waiver.

[MAR 155] The Contractor **shall** deliver a request for a Safety Variance (exception, deviation, or waiver) in accordance with CDRL MA-09.

5.5 Support for Safety Working Group Meetings

[MAR 156] The Contractor **shall** provide technical support at Project Safety Working Group meetings (SWG).

[MAR 285] The SWG **shall** meet as necessary to review procedures and analyses that contain or examine safety critical functions, or as convened by the Project Safety Manager (PSM) to discuss any situations that may arise with respect to overall project safety.

5.6 Mishap Reporting

[MAR 157] The Contractor **shall** report mishaps, incidents, hazards, and close calls in accordance with NPR 8621.1B, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping.

Section 6 Probabilistic Risk Analysis and Reliability, Maintainability, and Availability

6.1 Probabilistic Risk Assessment and Reliability, Maintainability, and Availability Program Plan (PRA and RMA Program Plan)

[MAR 161] The Contractor **shall** prepare, submit, and implement an integrated (hardware and software) PRA and RMA Program Plan (**CDRL MA-11**) using both qualitative and quantitative techniques to support decisions regarding mission success and safety throughout all life cycle phases, as appropriate.

[MAR 162] The Contractor **shall** ensure that equipment vendors, subcontractors, and suppliers provide data to the Contractor for implementation of the Contractor's PRA and RMA Program Plan (**CDRL MA-11**) and reports (**CDRL MA-12**, **CDRL MA-15**).

[MAR 163] The Contractor **shall** present the implementation of the PRA and RMA Program Plan (**CDRL MA-11**) and related activities at Critical Milestone Reviews (CMR) beginning with the System Requirements Review (SRR).

[MAR 164] The Contractor **shall** specify in the PRA and RMA Program Plan (**CDRL MA-11**) how to define, measure, control, and report on RMA in all lifecycle phases as appropriate.

[MAR 165] Starting in the conceptual design stage, the Contractor **shall** clearly define and evaluate levels of performance based upon System Requirements Document (SRD) reliability, maintainability, and availability requirements.

[MAR 166] The Contractor **shall** allocate RMA requirements to the configuration item level. RMA requirements are to be used to establish baseline requirements against which the design alternatives are evaluated. Requirements consistent with the allocations are to be imposed on any subcontractors, suppliers and/or Commercial Off-the-Shelf (COTS) vendors, whenever appropriate.

[MAR 167] The Contractor **shall** continue RMA activities throughout the Period of Performance in accordance with the PRA and RMA Program Plan (**CDRL MA-11**) by replacing calculated data analysis with analysis of the actual reliability and maintainability statistics of the SGSS, as well as updating analyses to cover any changes in configuration, hardware, or software.

[MAR 168] The Contractor **shall** track and report the operational availability metrics as downtime metrics on a weekly basis starting with the parallel operation of any deployed SGSS system (**CDRL MA-14**).

[MAR 169] The Contractor **shall** ensure that the SGSS has no silent failures. A silent failure is any equipment failure that would result in either a loss of service or a loss of protection without an audible alarm and/or remote signaling to initiate corrective action.

[MAR 170] The Contractor **shall** implement corrective actions whenever reliability, maintainability, and availability related requirements are not satisfied.

[MAR 171] The Contractor **shall** prepare and submit a Reliability, Maintainability, and Availability Model and Predictions Report (**CDRL MA-12**).

[MAR 172] The Contractor **shall** perform maintainability evaluation, including demonstration tests (**CDRL MA-13**) for all critical hardware and software items as defined in **CDRL SE-21**, to verify that

preventive and corrective maintenance activities, such as, but not limited to, system and data level backups can be successfully executed.

[MAR 173] The Contractor **shall** prepare and submit a Maintainability Demonstration Report (CDRL MA-13).

[MAR 174] The Contractor **shall** ensure and document that PCBs or subassemblies of line replaceable units, as included in the list of critical items as defined in **CDRL SE-21**, that suffer a failure after being repaired twice are not returned to service.

[MAR 175] The Contractor **shall** provide a sparing plan in accordance with **CDRL MO-04**, that takes into account the quantities and failure rates of line replaceable units, as well as logistics-related times such as replenishment times and processing times.

6.2 Maintainability

[MAR 176] The Contractor **shall**, based on the definition of acceptable levels of performance, define the following minimum acceptable maintainability parameters for all hardware and software:

1. Diagnostic time to detect and fault isolate to the defective components/sub-systems/applications.
2. Time required to carry out appropriate corrective action (e.g. replacing, integrating updates, restoring data, restoring to previous stable software version or establishing workaround procedures) to defective components/sub-systems/applications that are necessary to return the affected components/sub-systems/applications to operational status.
3. Time required to complete checkout and to restore operational status.

[MAR 177] The Contractor **shall** establish and implement specific design criteria needed to mitigate unacceptable levels of performance.

[MAR 178] The Contractor **shall** make accessible the design criteria for Government review at any time and present updates at all formal design reviews in conjunction with the PRA and RMA Program Plan (CDRL MA-11).

[MAR 179] The Contractor **shall** assure that software, equipment, and components obtained from COTS and Government Off-the-Shelf (GOTS) providers meet allocated reliability, maintainability, and availability requirements.

[MAR 180] The Contractor **shall** verify and assure that equipment and components obtained from subcontractors, suppliers, and COTS/GOTS providers, including Installation Accountable Government Property (IAGP), meet allocated requirements. If not, the Contractor **shall** report such discrepancies to the SGSS Project Office for review per **CDRL PM-13**.

[MAR 181] The Contractor **shall** develop and implement specific design criteria to facilitate maintenance or repair activities.

[MAR 182] The Contractor **shall** use data obtained from similar system installations in establishing maintainability design criteria that meet the specifications.

[MAR 183] The Contractor **shall** include design for modularity, accurate fault diagnostics, standardization, and commonality in the design criteria.

6.3 Probabilistic Risk Assessment (PRA)

[MAR 184] The Contractor **shall** perform a PRA (CDRL MA-15) encompassing the critical hardware and software items as defined in **CDRL SE-21**.

[MAR 185] The Contractor **shall** perform a full PRA for the system except the Operational Test System (OTS) and the Maintenance and Training Facility (MTF) (CDRL MA-15).

[MAR 186] The PRA (CDRL MA-15) **shall** address equipment failures and degraded modes of operation.

6.4 Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)

[MAR 187] The Contractor **shall** perform a Failure Modes and Effects Analysis (FMEA) (CDRL MA-16) for all mission critical hardware and software items and prepare and maintain a Critical Items List (CIL) (CDRL MA-16).

[MAR 188] The Contractor **shall** ensure that equipment vendors, subcontractors, and/or suppliers provide relevant inputs to the development and implementation of the Contractor’s FMEA (CDRL MA-16).

[MAR 189] In the FMEA (CDRL MA-16), the Contractor **shall** assign each failure mode a severity category in accordance with Table 6.4.1, FMEA Severity Categories Table, based on the most severe effect caused by the failure:

Table 6.4.1: FMEA Severity Categories Table

Category	FMEA Severity Categories	Description
1	Catastrophic / Critical	Catastrophic failure modes that may cause death or a permanent disabling injury or the destruction of a major system or facility on the ground or of the vehicle during the mission. Critical failure modes that could in a condition that may cause a severe injury or occupational illness to personnel or major property damage to facilities, systems, or flight hardware.
1R	Catastrophic	Failure modes of identical or equivalent redundant hardware items that, if all failed, could result in Category 1 effects.
1S	Catastrophic	Failure in a safety or hazard monitoring system that could cause the system to fail to detect a hazardous condition or fail to operate during such condition and lead to Severity Category 1 consequences.
2	Critical	Failure modes that could result in the loss of one or more mission objectives as defined by the SGSS PM.
2R	Critical	Failure modes of identical or equivalent redundant hardware items that could result in Category 2 effects if all failed.
3	Significant	Failure modes that could cause degradation to mission objectives.
4	Minor	Failure modes that could result in insignificant or no loss to mission objectives.

[MAR 190] The Contractor **shall** itemize on the CIL (CDRL MA-16), and **shall** analyze at a greater depth failure modes resulting in FMEA Severity Categories 1, 1R, 1S or 2 of the FMEA Severity Categories Table.

[MAR 191] The Contractor **shall** provide in the FMEA report (**CDRL MA-16**) the rationale for including items on the CIL.

[MAR 192] The Contractor **shall** analyze single point failure modes to determine the root cause, corresponding mitigation actions, and retention rationale.

[MAR 193] The Contractor **shall** address in the FMEA (**CDRL MA-16**) hardware and software that is designed, built, or provided by their organization or subcontractors, from project initiation through mission operations.

[MAR 194] When redundancies are required, the Contractor **shall** analyze in the FMEA (**CDRL MA-16**) such redundancies to ensure that redundant paths are isolated or protected such that any single failure that causes the loss of a functional path will not affect the other functional path(s) or the capability to switch operation to that redundant path.

[MAR 195] The Contractor **shall** use the results of the FMEA (**CDRL MA-16**) to evaluate the design relative to requirements.

[MAR 196] The Contractor **shall** ensure that discrepancies identified in the FMEA (**CDRL MA-16**) are evaluated by SGSS Project Office for assessment of the need for corrective actions.

[MAR 197] The Contractor **shall** document and present how the FMEA was used to perform design tradeoffs and how the FMEA results were taken into consideration when making design or risk management decisions (**CDRL MA-16**).

[MAR 198] The Contractor **shall** use the FMEA (**CDRL MA-16**) to assist in the development of planned maintenance activities (**CDRL MO-02** and **CDRL MO-04**) required to operate the system.

[MAR 199] Results of the FMEA (**CDRL MA-16**) **shall** be presented at design reviews starting with the SRR.

6.5 Fault Tree Analysis

[MAR 200] The Contractor **shall** perform qualitative fault tree analyses (FTAs) (**CDRL MA-17**) to address mission failures and degraded modes of operation.

[MAR 201] The Contractor **shall** perform quantitative FTAs to address undesirable fault propagation scenarios as part of the PRA (**CDRL MA-17**).

[MAR 202] The Contractor **shall** address in the FTA (**CDRL MA-17**) safety critical software, as defined in NASA-STD-8719.13B, NASA Software Safety Standard, that is identified as part of the FMEA process.

6.6 Parts Stress Analysis

[MAR 290] For custom built and MOTS equipment, the Contractor **shall** perform parts stress and derating analyses for electrical, electronic, and electromechanical (EEE) parts in accordance with GSFC INST-EEE-002 (**CDRL MA-24**).

6.7 Worst Case Analysis

[MAR 205] The Contractor **shall** perform worst-case analyses for custom-built circuits, MOTS hardware, and MOTS hardware (**CDRL MA-19**).

[MAR 269] The Contractor **shall** evaluate all equipment for compatibility with the operational environment at each site (**CDRL MA-19**).

6.8 Availability Assessments and Predictions

[MAR 206] The Contractor **shall** substantiate availability with:

1. Measures of Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) for all hardware and software configuration items (CIs).
2. Measures/Estimates of logistics downtime, administrative downtime, and preventive maintenance downtime.
3. Reliability Block Diagrams and Predictions and Analyses addressing redundancies including hardware and software components (**CDRL MA-12**).
4. Failover times of redundant strings/item.

[MAR 207] The Contractor **shall** perform and report comparative numerical RMA predictions (**CDRL MA-12**) to validate that the design meets specification requirements and to assist with:

- a. Evaluation of alternative design concepts, redundancy, and failover approaches.
- b. Identification of the elements of the design with the lowest reliability or highest maintenance cost.
- c. Identification of potential mission-limiting elements and components that will require special attention in testing, part selection, environmental isolation, and/or special operations.
- d. Evaluation of the impact of proposed engineering change and waiver requests.

[MAR 208] The Contractor **shall** use any of the following sources to determine failure rates for reliability predictions:

- a. The performance of similar items (with approval of SGSS project management).
- b. Test data at the 95% confidence level (with approval of SGSS project management).
- c. MIL-HDBK-217F, Reliability Prediction of Electronic Equipment, with updated failure rates, (e.g., “Handbook of 217 Plus”, “MIL-HDBK-472”) from the Reliability Information Analysis Center, or equivalent.
- d. Telcordia SR-332 Issue 2 (after approval by SGSS project management).

[MAR 209] The Contractor **shall** submit assessments and updates to the COTR in accordance with the RMA Model and Predictions Report (**CDRL MA-12**).

[MAR 210] The results of reliability/availability assessments and predictions (**CDRL MA-12**), particularly those impacting design or risk management decisions, **shall** be reported at Monthly Project Status Reviews (MPSRs) (**CDRL PM-06**) and at all CMRs as defined in SOW, Section 3.13.3.

6.9 Trend Analysis

[MAR 211] The Contractor **shall** prepare and maintain a list of subsystem and components to be assessed, parameters to be monitored, and trend analysis reports, as defined in the approved PRA and RMA Program Plan (**CDRL MA-11**).

[MAR 212] The Contractor **shall** begin the monitoring, collection, and analysis at component acceptance testing and continue through the system integration and test phases until the end of the project (**CDRL MA-20**).

[MAR 213] The Contractor **shall** document and report the analysis of test information, trend data, and failure investigations with respect to reliability and maintainability, and report the results as defined in the approved PRA and Reliability Program Plan (**CDRL MA-20**).

6.10 Limited Life Items

[MAR 214] The Contractor **shall** prepare and implement a plan to identify and manage limited life items (CDRL MA-21).

[MAR 215] Identified limited-life items (CDRL MA-21) **shall** be controlled from the date of manufacture to operational use, including while in storage.

6.11 Life Cycle Cost

Deleted

6.12 Long Lead Items

[MAR 218] The Contractor **shall** establish a process mechanism that ensures the delivery of long lead-time items before they are required.

Section 7 Software Assurance

7.1 Applicable Requirements

[MAR 219] The Contractor **shall** comply with the following requirements and standards for software, databases, and firmware, hereafter collectively referred to as software:

- NPR 7150.2, NASA Software Engineering Requirements
- NASA-STD-8719.13B, NASA Software Safety Standard
- NASA-STD-8739.8 NASA Standard for Software Assurance

7.2 Software Quality Assurance

[MAR 220] The Contractor **shall** prepare and implement a software quality assurance plan for software, including GOTS software, Modified Off-The-Shelf (MOTS) software, and COTS software (CDRL MA-02).

[MAR 221] The Contractor **shall** identify the organizational entity responsible for directing and managing the software quality assurance program.

[MAR 270] The Contractor **shall** provide software quality assurance status reports as part of the monthly Software and Systems Metrics Report (CDRL SE-17).

7.3 Software Reliability

[MAR 222] The Contractor **shall** develop and submit a software reliability program within the PRA and RMA Program Plan (CDRL MA-11) that includes a process for measuring and analyzing defects in the software products during development activities in order to identify and address possible problem areas within the software.

[MAR 223] The Contractor **shall** tailor the software reliability program to the appropriate level based upon criticality of the software to the mission, software safety criticality, software complexity, cost, consequence of failure, and other parameters.

[MAR 224] The Contractor **shall** prepare and implement a software reliability program that is compliant with Institute of Electrical and Electronics Engineers (IEEE) -Std-1633, IEEE Recommended Practice on Software Reliability, or an alternate software reliability program that is approved by the COTR.

[MAR 225] The Contractor **shall** assure that fault tolerance and redundancy have been correctly specified, implemented, and verified by testing.

[MAR 226] The Contractor **shall** perform analysis and measurements on all software modules to identify specific software modules that may have reliability issues.

[MAR 227] The Contractor **shall** document, monitor, analyze, and track software metrics during each stage of development, and across development and operational phases (CDRL SE-17) (e.g., fault counts by severity levels, time between discovery and fault removal, and number of faults found in a time period per lines of code).

[MAR 228] The Contractor **shall** include in the software metrics the collection and classification of software defects (CDRL SE-17).

[MAR 229] The Contractor **shall** define and make readily available to the Government upon request the software metrics required to implement IEEE-Std-1633, IEEE Recommended Practice on Software Reliability.

[MAR 230] The Contractor **shall** utilize the SGSS DR system (**CDRL PM-13**) to provide software problem reporting, corrective action reporting and tracking, that addresses reporting, analyzing, and correction of software nonconformance and software test failures throughout the development lifecycle, starting at PDR.

[MAR 231] The Contractor **shall** establish a corrective action process that tracks every software nonconformance to its final disposition.

[MAR 232] The Contractor **shall** report all software reliability activities (**CDRL MA-12**) at CMR as defined in the SOW, Section 3.13.3.

[MAR 233] The Contractor **shall** submit the selected Reliability Growth Model for approval by the Government no later than PDR (**CDRL MA-11**).

[MAR 234] The Contractor **shall** perform and report trend analysis on the software defects (**CDRL MA-20**) and provide the analysis results for use with lessons learned and root cause analysis.

Section 8 Workmanship Standards

8.1 General

[MAR 235] The Contractor **shall** implement a Workmanship Program for SGSS hardware to ensure that workmanship, electronic packaging technologies, and process activities are selected and applied to meet mission objectives for quality and reliability.

[MAR 289] For custom built and MOTS equipment, the Contractor **shall** develop a plan for workmanship standards and document it in CDRL MA-25 for approval by the government.

[MAR 236] The Contractor **shall** use the IPC-J-STD-001D (Class 3 Requirements) workmanship standard, for critical hardware items as defined in **CDRL SE-21**. The Contractor may propose the use of similar, but not identical, workmanship standards, procedures and training, contingent upon Contracting Officer's Technical Representative (COTR) approval.

[MAR 237] Any such alternatives **shall** be accompanied by a comparison to the standards and a discussion of significant differences and rationale for use of the alternative.

8.2 Training and Certification

[MAR 238] The Contractor personnel working on SGSS hardware **shall** maintain certification for successful workmanship training appropriate to their involvement.

[MAR 239] The workmanship certification **shall** include successful completion of formal training and demonstrated performance in the appropriate discipline as defined in the Contractor's applicable requirements.

[MAR 240] The Contractor **shall** document the procedures and processes of their training program.

8.3 Documentation

[MAR 241] The Contractor **shall** document the procedures and processes that will be used to implement the referenced workmanship, design, and ESD control standards.

8.4 Handling

[MAR 242] The Contractor **shall** establish handling (including storage) procedures for critical hardware and software items as defined in **CDRL SE-21** and in accordance with NPR 6000.1G, Requirements for Packaging, Handling, and Transportation for Aeronautical, and Space Systems, Equipment, and Associated Components.

[MAR 244] The following criteria **shall** be used for establishing handling and storage procedures for parts and materials:

- Control of environment, such as temperature, humidity and contamination.
- Measures and facilities to segregate and protect parts and materials routed to different locations (i.e., to the materials review crib, or to a laboratory for inspection, or returned to the manufacturer from unaccepted shipments).
- Facilities, if needed, for interim storage of parts and materials.

- Provisions for protective cushioning, as required, on storage area shelves, and in storage and transportation containers.
- Protective features of transportation equipment design to prevent packages from being dropped or dislodged in transit.
- Protective bench surfaces on which parts and materials are handled during operations (i.e., test, assembly, inspection, and organizing kits).
- Provisions for protection of parts susceptible to damage by electrostatic discharge.

8.5 Preservation and Packaging

[MAR 245] Parts that are subject to degradation by electrostatic discharge **shall** be packaged in accordance with the approved Electrostatic Discharge (ESD) procedures.

Section 9 Component, Module, and Unit Control

9.1 General

[MAR 246] The Contractor **shall** verify that Units and Modules are manufactured, processed, screened, and qualified, at a minimum, to good commercial practice, in accordance with UL-60950-1, Information Technology Equipment, Safety Part 1, General Requirements.

[MAR 247] For custom built and MOTS hardware systems, the Contractor **shall** develop and submit to the COTR a copy of the electrical, electronic, and electro-mechanical (EEE) Parts List (**CDRL MA-18**).

[MAR 248] The Contractor **shall** provide appropriate detailed drawings and component detail for units and assemblies (**CDRL SE-15**).

[MAR 249] The Contractor **shall** inform the government of any modification to software and hardware COTS products/components within ten days of incorporation of the modification.

9.2 Custom or Advanced Technology Devices

[MAR 250] All custom technology devices such as custom microcircuits, hybrid microcircuits, Multi-Chip Module (MCM's), Application Specific Integrated Circuits (ASIC's), etc., **shall** be included in the Make Versus Buy Plan (**CDRL SE-21**).

[MAR 251] The Contractor **shall** fully identify in procurement documentation or specification custom devices being procured, and include physical, mechanical, electrical, and environmental test requirements, as well as quality assurance provisions necessary to control manufacture and acceptance.

9.3 Equipment Lists

Deleted.

9.4 Lead-free and Tin Whisker Control

This section applies to critical ground support/test systems in accordance with NPD 8730.2C, NASA Parts Policy.

[MAR 255] The Contractor **shall** meet the following requirements for solders and surface finishes that are less than 3% lead by weight:

- GEIA-STD-0005-1: Performance Standard for Aerospace and High Performance Electronics Systems Containing Lead-free Solder
- GEIA-STD-0005-2: Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems

[MAR 256] The Contractor **shall** prepare, implement, and submit a lead-free control plan (**CDRL MA-22**) in accordance with GEIA-STD-0005-2, Control Level 2C.

Section 10 Testing, Verification, and Validation

10.1 Verification and Validation

[MAR 272] The Contractor's MA **shall** document the process for monitoring, inspecting, evaluating, and auditing the Validation & Verification activities for the project in the Mission Assurance Implementation Plan (**CDRL MA-01**).

[MAR 274] The Contractor's MA **shall** ensure that the Contractor's Validation and Verification activities are in accordance with NPR 7150.2 and the Contractor's approved Capability Maturity Model Integration (CMMI) Level 3 processes.

[MAR 276] The Contractor's MA **shall** review for correctness and completeness all test procedures, test reports, and test plans at all levels of testing.

[MAR 277] The Contractor's MA **shall** ensure that all defects and non-conformances are documented in the DR system (**CDRL PM-13**) and tracked to closure.

[MAR 278] The Contractor's MA **shall** ensure that peer reviews are conducted in accordance with the SGSS Peer Review Plan (**CDRL SE-09**).

[MAR 281] The Contractor's MA **shall** ensure that all test results are reviewed and approved prior to moving to the next level of testing.

[MAR 284] The Contractor's MA POC **shall** audit the Project's Validation & Verification activities (processes/products) and present the findings/updates periodically included in the MPSR (**CDRL PM-06**).

10.2 Testing of Spare Hardware

10.2.1 General

[MAR 257] As a minimum, verification testing of spares for critical hardware items as defined in **CDRL SE-21 shall** be included in the SGSS Verification and Validation Plan (**CDRL SE-02**).

[MAR 258] Spares of critical hardware items as defined in **CDRL SE-21** shall be manufactured, tested and repaired according to the same quality and reliability standards and processes used to manufacture original hardware.

10.2.2 Extent of Testing

[MAR 259] The Contractor **shall** determine the extent and type of testing of spares for critical hardware items as defined in **CDRL SE-21** as part of the SGSS Verification and Validation Plan (**CDRL SE-02**).

10.2.3 Rework of Spares

[MAR 260] The Contractor **shall** conduct appropriate regression or re-verification testing if a critical hardware item, as defined in **CDRL SE-21**, is removed due to failure, repaired and then re-designated as a spare.

Section 11 Test Facility Readiness

11.1 General

[MAR 261] The Contractor's MA POC **shall** verify and document the readiness for test, including test plan, test procedures, test equipment, and test facility, in accordance with the Contractor's approved Quality Management System (QMS) prior to commencing testing.

[MAR 262] Equipment used for tests **shall** be in current calibration and so noted with tags or stickers.

Section 12 Electro-Static Discharge (ESD) Control

12.1 General

[MAR 263] The Contractor **shall** document and implement an ESD Control Program in accordance with ANSI/ESD S20.20-2007, ESD Control Program Standard.

[MAR 264] The ESD plan (**CDRL MA-23**) **shall** be submitted and approved by the Government.

Section 13 Government-Industry Data Exchange Program (GIDEP) Alert and Problem Advisories

13.1 General

[MAR 265] The Contractor **shall** participate in the GIDEP to evaluate and disposition GIDEP ALERTS, GIDEP SAFE-ALERTS, GIDEP Problem Advisories, GIDEP Agency Action Notices, as well as NASA Advisories. The following applicable documents apply: SO300-BT-PRO-010, GIDEP Operations Manual, and S0300-BU-GYD- 010 Government Industry Data Exchange Program Requirements Guide.

[MAR 291] For COTS items, the Contractor **shall** report and disposition GIDEP Safe Alerts to the government on the GSFC report form 4-37 according to Goddard Procedural Requirements (GPR) 5340.3F.

[MAR 292] For COTS items, the Contractor **shall** report and disposition GIDEP Alerts and Advisories for EEE parts that incur failure.

[MAR 293] For custom circuits, the Contractor **shall** report and disposition GIDEP Alerts and Advisories for the as-built parts list.

[MAR 266] The Contractor **shall** report alerts that are determined to affect the SGSS project (i.e., GIDEP ALERTS, GIDEP SAFE-ALERTS, GIDEP Problem Advisories, GIDEP Agency Action Notices, and NASA Advisories) to the COTR, as well as respond to the COTR GIDEP and NASA Advisory notices.

[MAR 267] All GIDEP mitigation approaches **shall** have prior COTR approval.

Appendix A - Acronyms

ANSI	American National Standards Institute
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CI	Configuration Item
CIL	Critical Items List
CMR	Critical Milestone Review
COTS	Commercial Off-the-Shelf
DACA	Days after Contract Award
DCN	Document Change Notice
EEE	Electrical, Electronic, and Electromechanical
ESD	Electro-Static Discharge
FAR	Federal Acquisition Regulations
FAR	Final Acceptance Review
FTA	Fault Tree Analysis
FMEA	Failure Modes and Effects Analysis
GEIA	Government Electronics and Information Technology Association
GIA	Government Inspection Agency
GIDEP	Government-Industry Data Exchange Program
GOTS	Government Off-the-Shelf
GSFC	Goddard Space Flight Center
HA	Hazard Analysis
IAC	Independent Assurance Contractor
IAGP	Installation Accountable Government Property
IEEE	Institute of Electrical and Electronics Engineers
MAIP	Mission Assurance Implementation Plan
MAR	Mission Assurance Requirements
MCM	Multi-Chip Module

MOTS	Modified Off-the-Shelf
MTBF	Mean Time Between Failure
MPSR	Monthly Project Status Review
MTTR	Mean Time To Repair
NASA	National Aeronautic and Space Administration
NCSI	National Centre for Science Information
NPR	NASA Procedural Requirements
OHA	Operations Hazard Analysis
PDR	Preliminary Design Review
PHA	Preliminary Hazard Analysis
PM	Project Management
PRA	Probabilistic Risk Assessment
PSM	Project Safety Manager
QA	Quality Assurance
QMS	Quality Management System
RMA	Reliability, Maintainability and Availability
RTVM	Requirements Traceability Verification Matrix
SGSS	Space Network Ground Segment Sustainment
SNGS	Space Network Ground Segment
SN	Space Network
SRD	System Requirements Document
SRR	System Requirements Review
SSPP	System Safety Program Plan
SWG	Safety Working Group
TIM	Technical Interface Meeting
VTL	Verification Tracking Log