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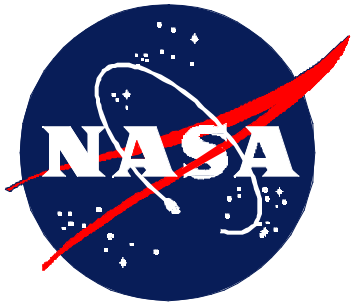
Earth Explorers Program Mission Assurance Guidelines and Requirements

February 2001



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

470-PLAN-0002

Earth Explorers Program

Mission Assurance Guidelines

and Requirements

February 2001

Goddard Space Flight Center

Greenbelt, Maryland

EARTH EXPLORERS PROGRAM

MISSION ASSURANCE GUIDLINES and REQUIREMENTS

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PREFACE

The purpose of this document is to serve as a set of requirements and guidelines to the Project/Mission Team in preparing an appropriate mission assurance program and its implementation. Each section of this document contains requirements and a series of guidelines for implementing mission assurance in accordance with the Earth Explorers Program. The guidelines may be tailored to meet the specific needs of each mission, but this tailoring shall be reviewed and accepted by the Earth Explorers Program Office (EEPO) and must meet the intent of the requirements. Each Earth Explorers project/mission is required to be implemented in accordance with the aerospace industry best practices for mission assurance, as they apply to that particular mission.

1.0 Overview

1.1 Overview

It is the responsibility of the Project/Mission Team to plan and implement a comprehensive Mission Assurance program for all flight and ground hardware, software, Ground Support Equipment (GSE), and mission operations. This responsibility extends to all of the mission subcontracts and suppliers. Mission assurance insight is planned by the Earth Explorers Program Office and shall be focused primarily on those activities that contribute most to product integrity. Deliverable documentation may be reduced, provided the mission team maintains an adequate internal record keeping system that provides the necessary traceability and documentation to the Earth Explorers Program Office. The Earth Explorers Program Office shall support and participate with the mission team in assuring that the mission assurance program being implemented is valid, complete, and effective. The Earth Explorers Program Office is prepared to assist the mission team in any aspect of mission assurance, and to be the mission team's point-of-contact for ready and regular access to the Goddard Space Flight Center's mission assurance expertise.

Earth Explorers missions that are predominately "single string" systems with emphasis on simplicity of design and cost control require a rigorous and disciplined systems engineering effort. Utilization of quality parts and materials and high standards of workmanship, have allowed a limited reliability and quality assurance program, guarded by the test program, to achieve the adequate reliability and mission success. It is recommended that each mission team consider similar approaches that envelop all aspects of the mission development. A philosophy based on hurried design and development, followed by an extensive test and repair program, has been shown to be a costly and unreliable approach.

An agreement between the mission team and the Earth Explorers Program Office on the quality assurance, reviews, safety, design assurance and verification system to be implemented shall be required prior to the confirmation of the mission and shall be documented in a Mission Assurance Plan. This plan is required for review by the Earth Explorers Program Office prior to the agreement. The plan may be developed during a mission study, if one is planned, or during the formulation phase.

2.0 Mission Assurance

2.1 Quality System

The Project/Mission Team shall define and implement a quality system based on ANSI/ASQC Q9001-1994 that meets the intent of ISO 9001. The Project/Mission Team's quality system shall encompass all flight and ground hardware, flight software and ground support equipment development, as well as mission operations.

2.2 Workmanship

The Project/Mission Team shall impose workmanship standards which help assure that the required mission lifetime and performance are met. The following commercial or NASA workmanship standards are given as guidelines and shall be considered for use:

Soldering of Electrical Connections: NASA Technical Standard NASA-STD-8739.3, Soldered Electrical Connections

Cabling, Harnessing, and Crimping: NASA Technical Standard NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring. Note: MIL-STD-1130B, Connections, Electrical, Solderless Wrapped can be used if the missions are planning to use wire wrap for flight hardware or mission critical ground support equipment.

Conformal Coating and Staking: NAS 5300.4(3J-1), Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies

ESD Control: NASA Technical Standard NASA-STD-8739.7, Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)

Surface Mount Technology (SMT): NHS 5300.4 (3M), Workmanship Standard for Surface Mount Technology.

Note: SMT processes must be qualified to the mission profile and life expectancy of the mission.

Printed Wiring Board Design: ANSI/IPC-D-275, Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies, Class 3

Printed Wiring Board Procurement: IPC 6011 and IPC 6012, Class 3 as the basic specification requirements with GSFC S-312-P-003B, Procurement Specification for Rigid Printed Wiring Boards for Space Applications and other High Reliability Uses as a supplement.

The Project/Mission Team and their subcontractors shall provide printed wiring board coupons to GSFC, or to a GSFC approved laboratory, for test, analysis and review.

Fiber Optic: NASA Technical Standard NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation

Use of other workmanship standards (e.g., MIL-STD, IEEE, IPC, ISO, ANSI, etc.) shall be permitted with the concurrence of the EEPO.

2.3 Failure Reporting

A documented Failure Reporting System shall be implemented. A problem/failure report shall be written for any departure from design, performance, testing, or handling requirement that affects the function of flight equipment, or ground support equipment that interfaces with flight equipment, or that could compromise mission objectives.

Reporting of failures to the Earth Explorers Program Office shall begin with the first power application at the box, instrument, or spacecraft levels. This reporting shall continue through formal acceptance of the hardware. For software problems, failure reporting shall begin with formal qualification testing of each computer software configuration item or first use of the computer software configuration item with the flight hardware. All failure reporting records shall be submitted to the Earth Explorers System Assurance Manager for information. Either paper or electronic format is acceptable. The Project/Mission Team can use any failure report format they deem acceptable, as long as the Earth Explorers Program Office has concurred with the format. The Project/Mission Team shall maintain failure-reporting records of problems encountered at the lower levels of assembly for information.

3.0 Reviews

The implementation of the mission shall be periodically reviewed by a competent and independent assessment team or teams of experts, to assure that satisfactory progress is being made toward meeting mission requirements.

All system level reviews (see Section 3.1) shall be conducted by GSFC personnel. These reviews shall concentrate on the critical system and end-to-end technical and programmatic aspects of the mission. Additional reviews at the subsystem and system levels shall be conducted by the Project/Mission Team to ensure a detailed examination of the project/mission. The review plan shall thoroughly examine subsystem designs and their interfaces during the formulation subprocess in order to mitigate risk and resolve potential problems without major impact to the project/mission. It shall provide a continual examination of the technical and programmatic progress throughout the implementation subprocess as an ongoing means to reduce risk, address issues and resolve problems to further ensure mission success. If requested through the Earth Explorers Program Office, the GSFC shall provide technical expertise for participation in these additional reviews. The GSFC is required to assess the thoroughness, competence and independence of the total review process and shall be invited to attend all technical reviews.

A Confirmation Review Process shall also be conducted. These reviews may be coordinated with the Project/Mission Team so that they coincide with other reviews. It is the Project/Mission Team's responsibility to address all concerns and action items identified during these reviews.

3.1 System Reviews

The required reviews for Earth Explorers projects/missions are the System Requirements Review (SRR), Preliminary Design Review (PDR), Mission Design Review (MDR), Mission Confirmation Readiness Review (MCRR), Mission Confirmation Review (MCR), Critical Design Review (CDR), Pre-Environmental Review (PER), Pre-Ship/Operational Readiness Review (PSR/ORR), Mission Readiness Review (MRR), Launch Readiness Review (LRR). Each review chairman, in concert with the Earth Explorers Program Office and GSFC directorates, appoints independent key technical experts as review team members. The Chief Systems Engineer for the Earth Explorers Program Office shall be a review team member for each of these reviews. Every effort will be made to maintain continuity of the chairman and the key technical experts for the duration of the mission. Other experts shall be added to and/or deleted from the review team, according to the technical needs and phase of the mission. The scope and function of these required reviews is as follows:

System Requirements Review (SRR): The SRR shall be the first major mission review during the Formulation Subprocess. The purpose of this review is to formally examine the agreed-to

mission science, operations and technical requirements. Traceability of these requirements shall be demonstrated. The SRR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Preliminary Design Review (PDR): The PDR shall occur during the Formulation Subprocess, but after final definition of the mission science and technical requirements. The purpose of the PDR is to examine preliminary designs of all mission subsystem and system components for technical feasibility with respect to the mission requirements and to assess the mission design at the subsystem and system levels as it relates to the mission requirements. The PDR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Mission Design Review (MDR): The MDR shall be held at the end of the mission Formulation Subprocess and shall follow the PDR or be combined with the PDR. It combines the technical findings of the PDR with a programmatic and process review of the proposed mission implementation. The purpose of this review is to confirm:

- final design, fabrication and test plans for each subsystem
- final interface control documents
- mission integration and verification plans
- complete programmatic plan through launch
- requirements flow-down traceability
- risk identification and mitigation plans, including descopes
- comprehensive cost, schedule and resource plans
- complete ground system architecture
- comprehensive system engineering plan
- final definition of mission science requirements
- thoroughly defined roles and responsibilities of all mission team members

The GSFC Systems Review Office, Code 301 and an independent appointee by the Earth Explorers Program Office shall co-chair the MDR.

Mission Confirmation Readiness Review (MCRR): The MCRR shall be held after the MDR and is the Earth Explorers Program gate for mission approval to proceed into the Implementation Subprocess. The findings from the MDR are presented to the GSFC Governing Program Management Council (GPMC) for consideration and subsequent project/mission confirmation. The results from this review are either Mission Confirmation or conditional Mission Confirmation pending action item closure or Mission Termination.

Mission Confirmation Review (MCR): The GSFC PMC Chair and the Explorers Program Office present the results and recommendations of the MCRR to the Associate Administrator, Office of Earth Science for concurrence and final approval for the mission to proceed into the Implementation Subprocess.

Critical Design Review (CDR): The CDR should occur after the design has been completed, but prior to the start of flight hardware manufacturing or coding of the flight software. It shall emphasize implementations of design approaches, mission operations planning, as well as test planning for all flight systems. In the case of long lead procurements, manufacturing may be initiated prior to CDR, if approved by the Earth Explorers Program Office, as required to meet schedule. The CDR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Pre-Environmental Review (PER): The PER shall assess the readiness of the flight hardware, software and required environmental test facilities to begin acceptance testing. The PER shall also cover:

- design changes since CDR
- status of nonconformances
- test documentation (plans, procedures, waivers) and facilities readiness
- hardware and software configuration
- mission operations status

The PER shall be held prior to the full system integration and functional test in preparation for environmental testing. The PER shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Pre-Ship Review/Operational Readiness Review (PSR/ORR): The mission PSR is conducted at the end of the mission Implementation Subprocess. The mission PSR shall verify that all system elements meet the requirements of the mission and are ready to proceed into final launch preparations. The mission PSR shall verify that testing has been completed with no unacceptable open issues and to validate the readiness of the flight hardware and software and ground system. Included as part of the above review is the Operations Readiness Review (ORR). This part of the review shall assess the readiness, and document the final details of the approach agreed to be used for flight operations. The mission PSR/ORR shall at a minimum, cover:

- determination of completion of testing flight hardware and software
- verification of system requirements
- verification and documentation of final hardware and software configuration
- identification and status of outstanding safety risks
- disposition of waivers, deviations, open issues
- results of compatibility testing of spacecraft and ground support equipment
- results of end-to-end system level testing and verification
- orbital operations plans
- mission operations, ground system and data processing system readiness
- launch system readiness (interfaces, vehicle)
- evaluation of the acceptance data packages

The result of this review shall be reported at the Mission Readiness Review. The mission operations agreement reached at the ORR cannot be changed without NASA concurrence.

The PSR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Mission Readiness Review (MRR): The MRR is typically held 4-6 weeks prior to launch. The review shall cover all components of mission readiness; project status, science objectives and mission performance, instrument readiness, spacecraft readiness, ground system readiness, launch service readiness and launch site assessment, resolution of all open items, liens and waivers, public affairs plan and other topics as appropriate to ensure all aspects critical to mission success have been reviewed. The MRR is presented to the GSFC Governing Program Management Council (GPMC) for review and certification of the readiness of all mission components to proceed toward launch. The results of the MRR are presented to the Associate Administrator, Office of Earth Science.

Launch Readiness Review (LRR): The LRR shall take place at the launch site 2-3 days prior to launch. This review is to assess overall readiness of the total system to support the flight objectives of the mission.

The GSFC Systems Review Office, Code 301, shall chair the LRR.

3.2 Peer Reviews

The Project/Mission Team shall focus resources on engineering working-level reviews (peer reviews) throughout the mission formulation and implementation subprocesses to identify and resolve concerns prior to formal, system level reviews. Engineering peer reviews are required and typically occur during all phases of the project life cycle. These reviews are expected to present more detail than system-level formal reviews. Peer review is defined as a detailed independent engineering design review focused at the Subsystem and box level, conducted informally with recognized internal or external experts having current detailed knowledge of the design specialties associated with the item under review. Primary design documentation, such as drawings, schematics, wiring diagrams, and analyses are the review vehicles. Its purpose is to substantiate a detailed understanding of the design's ability to meet all of its performance and interface requirements, to surface correctable problems early, and to ensure best known practices are used that enhance robustness by avoiding known or predictable problems.

The intent of the peer reviews is to have participants gain a detailed understanding of component and subsystem design and assess the ability to meet higher level system and mission requirements. Effective peer reviews will enable the content of higher level formal reviews described in Section 3.1 to be significantly streamlined.

For each review a written record shall be kept of time, place, and attendees. Timely, accurate insight, through action item documentation and follow-up activities, is vital to the process. The Project/Mission Team's quality system shall track and close-out all actions items identified during these peer reviews to ensure that issues are resolved promptly, at the lowest levels and

before system level reviews. A list of action items and responses or closure plans from each peer review shall be maintained by the Project/Mission Team's quality system and shall be made available to the Earth Explorers Program Office at least one week prior to the subsequent system-level formal review. The results of the peer reviews and all open action items with closure plans shall be presented at the system-level formal reviews.

To promote continuity of the entire review program, the Earth Explorers Program Office shall be invited to attend and participate in any peer review session held by the Project/Mission Team. Upon request, the Program Office can supply additional technical expertise as required for participation in the areas undergoing peer reviews.

Some of the topics that shall be addressed in the peer reviews are as follows:

- interface control design verification
- parts and materials review
- analysis and studies
- safety issues
- risk assessment, resolution and contingency plans
- procurements
- confirmation of technology items
- hardware and software configuration management
- detailed cost, schedule and resource availability
- manufacturability and testability
- integration and test planning, including test anomalies and resolution

4.0 Design Assurance

4.1 Parts

The Project/Mission Team shall implement a parts program that assures mission reliability and performance requirements are met. GSFC 311-INST-001, Instructions for EEE Parts Selection, Screening, and Qualification, shall be used as a guide in selecting and processing parts.

The Project/Mission Team shall control the management, selection, application, evaluation, and acceptance of all parts through a Parts Control Board, or another similar documented parts control system. Board members shall be responsible for the review and approval of all parts for conformance to the GSFC 311-INST-001. The Board shall define any parts screening, Destructive Physical Analysis and other tests needed to insure that mission and performance requirements will be met. The Board shall maintain an EEE Parts Identification List prior to and during the Project/Mission Team's hardware built. This list shall be updated and submitted as part of the Mission Readiness Review. The final as-built list shall be provided as part of the hardware documentation package.

The Project/Mission Team shall have access to and maintain knowledge of parts problems as reported in the Government Industry Data Exchange Program (GIDEP). Any provided NASA Alerts shall also be reviewed.

All Electrical, Electronic, and Electro-mechanical (EEE) parts shall be derated in accordance with the guidelines specified in GSFC PPL-21, Appendix B. The Project/Mission Team shall be responsible for the implementation and verification of the derating guidelines.

System design and EEE parts selection shall be such that their intended application shall be met in the predicted mission radiation environment. The resulting design shall be latch-up immune and shall minimize Single Event Upsets (SEU).

4.2 Materials and Processes

The Project/Mission Team shall implement a Materials and Processes program. NASA Reference Publication 1124 entitled "Outgassing Data for Selecting Spacecraft Materials" shall be used as a guide for materials selection on this program. Materials that have a total mass loss (TML) <1.00% and a collected volatile condensable mass (CVCM) <0.10% shall be used on this program. If requested, the Earth Explorers Program Office may provide technical guidance in this area.

Fastener selection and use shall be controlled. GSFC S-313-100, Goddard Space Flight Center Fastener Integrity Requirements, shall be used as a guide.

Materials selected shall meet the stress corrosion cracking requirements of MSFC-SPEC-522.

Each Project/Mission Team shall maintain a list of materials (polymeric, composites and inorganic), lubricants, processes, and appropriate usage records prior to and during the hardware development. This list shall be updated and submitted as part of the Mission Readiness Review. The final as-built list shall be provided as part of the final hardware documentation package.

4.3 Reliability

The Project/Mission Team shall plan and implement a reliability program that interacts with other mission disciplines including systems engineering, hardware design, parts selection, and systems safety. This program shall be conceived and organized to effectively, efficiently, and responsively to perform tasks which enhance the expected mission lifetime. The Project/Mission Team shall develop and implement a program plan that addresses mission objectives, assigns responsibilities, and schedules tasks relative to program milestones.

A Failure Modes and Effects Analysis (FMEA) shall be performed early in the design process to identify problem areas that do not meet these objectives and corrective action shall be recommended. The FMEA shall be updated as the design matures. GSFC Procedure No. S-302-89-01 entitled “Procedures for Performing a Failure Modes and Effects Analysis” and/or MIL-STD-1629A, “Procedures for Performing a Failure Mode, Effects and Critical Analysis” can be used as guides. The FMEA shall be available for review by the Earth Explorers Program Office. Worst case circuit analysis shall be performed for electrical and electronic component designs. Flight software timing and sizing utilizations and margins (memory, CPU throughput, and Bus I/O) shall be documented and updated periodically throughout the life of the Project/Mission.

Fault Tree Analyses (FTA) and Probability Risk Assessments (PRA) shall be performed and the results shall be made available for review by the Earth Explorers Program Office.

The reliability program, at a minimum, shall address the following objectives:

I. <u>Design</u>

a) Graceful degradation is a design objective.

b) Reduce series complexity by eliminating unnecessary parts and components.

c) Promote failure workarounds that allow continued successful but degraded operation.

d) By design, wherever practicable, failures shall allow continued successful, albeit degraded operation.

e) Isolate failure impact so that effects do not propagate to other functions.

f) Failure of non-critical functions shall not affect critical functions.

g) Show that electrical stress applied to parts and devices meets derating requirements over the extremes of operating temperature range, voltage temperature range, and current variations.

h) Parts meet total dose and single event effects radiation requirements.

i) Verification that a consistent reliability process is flowed down to subcontractor(s) and suppliers.

II. Manufacture

a) An in-process inspection program that verifies hardware is assembled as designed.

b) A verification program that assures specified manufacturing processes are followed.

III. Test

a) A test program that verifies finished product meets specification.

b) A test program that verifies finished product functions as designed.

4.4 Software

The Project/Mission Team shall employ a formal, systematic program for the development of software using the guidelines of ISO 9000-3:1991. The program shall address appropriate development life cycle phases such as: requirements analysis, design, code and unit test, integration and build test, performance verification, and maintenance. Code produced shall be structured, error-free, and maintainable. Verification and Validation (V&V) and Independent Verification and Validation (IV&V) processes shall be developed and implemented for the software.

During the preliminary design process, the Project/Mission Team shall establish and document software requirements and any appropriate external interface specifications and user guides.

The Project/Mission Team shall participate in a program of internal and external software reviews to validate software requirements, design, operating characteristics, and external interface requirements. Software reviews shall include, as a minimum, a Software Requirements Review, Software Preliminary (Architectural) Design Review, Software Critical (Detailed) Design Review, Software Test Readiness Review, Software Acceptance Review.

The Project/Mission Team shall employ a software configuration management process to manage requirements, code, documentation, and data, and to track and report on the status of changes to them. The process shall include a software problem reporting and corrective action system to track and disposition identified discrepancies in the product.

5.0 Verification

Each Project/Mission Team shall conduct a verification program to ensure that the flight hardware meets the specified mission requirements. The program shall consist of functional demonstrations, analytical investigations, physical measurements and tests that simulate all expected environments. Each Project/Mission Team shall provide adequate verification documentation including a verification plan and matrix, environmental test matrix, and verification procedures.

Guidelines for developing a verification program are contained in the GSFC General Environmental Verification Specification for STS and ELV Payloads, Subsystems and Components (GEVS), which is available on the World Wide Web at the following URL: http://arioch.gsfc.nasa.gov/302/verifhp.htm.

6.0 Contamination

The Project/Mission Team shall identify contamination requirements and establish and maintain a contamination control program consistent with mission requirements.

7.0 Independent Mission Operations Requirements

Missions being operated by a Principal Investigator (PI) independent of NASA must meet the following additional requirements. After on-orbit checkout, incident reports must be provided to the GSFC Earth Science Mission Operations (ESMO) Project in accordance with "GSFC Flight Program Incident Reporting System Guidelines." Weekly on-orbit status summary reports shall be provided to ESMO. It is the PI institution's responsibility to contractually ensure the availability of spacecraft developer support of anomaly resolution efforts during the mission's operational phase. Structured management approaches to risk management and orbital mission configuration control must be in place during the operational phase. An annual mission risk assessment status report shall be provided to ESMO.

8.0 Red Team Reviews

Red Team Reviews shall be implemented as part of the review process beginning as early as PDR. These reviews will enhance the probability of mission success by bringing to bear additional technical expertise to review all mission critical aspects of each program.

The mission elements to be fully addressed and evaluated during the review process shall be as follows:

- Spacecraft/Instruments/Initial operations safety
- Payload to launch vehicle integration
- Launch vehicle mission unique changes
- Uniques-to-mission operations

SOMO/Institutional mission operations shall be addressed on a mission unique requirements basis only. Mission science operations shall be limited to systems needed for data capture, processing, archiving and distribution only.

The reviews shall consist of a critical technical implementation and operations review on each individual mission from the perspective of looking at what could go wrong and cause the mission to be less than fully successful. Specific key processes used by the project in the implementation of the mission shall be reviewed. The results of some of these key processes shall be reviewed and assessed as well. From this information the Review Team shall identify and document all remaining risk that could prevent complete mission success. Each Project shall be required to assemble all pertinent information (using specific formats) and present that information to the Review Team.

Addressing all of the in-scope mission elements as specified above, the Project shall assemble and present data in specified formats, that addresses (or provides) the following:

1. The level, competence and independence of technical peer reviews that were performed on each of the elements and components.

2. The performance, level and independence of system level reviews that were conducted.

3. The level and thoroughness to which the test and verification program was implemented. The test and verification program at all levels from black box to spacecraft and integrated mission shall be detailed. This shall also include the V&V and IV&V processes used on software.

4. The level of mission assurance that was imposed on the implementation of the mission. This shall include parts usage as well as workmanship standards imposed. It shall also address the software assurance processes implemented.

5. The systems management imposed and implemented the mission. This shall include the performance and thoroughness of analyses, requirement management, systems engineering, software metrics, configuration management, documentation and technical record-keeping and workmanship and test process management.

6. Factors such as staffing and the experience of the implementing organization.

7. The results of the test and integration process of all of the hardware and software elements of the mission. This shall include information on the review and assessment of all failures and anomalies and their resolution.

8. Information on the failure-free as well as the total operating time on all mission critical hardware and software.

9. The results of the technical review process shall be detailed. It shall include an assessment of all request for action (RFAs) and the Project responses to those RFAs.

10. The amount, level and fidelity of mission simulations and launch/operations training that was done or is planned to be done to prepare the mission for launch and on orbit operations including identification of all planned contingency operations and of those operations which were or will be practiced by the ops team. Identify any green card exercises (postulated mission contingencies which require action by the ops team) planned or conducted with the ops team. Provide a spacecraft mission timeline from liftoff to commencement of normal science operations and identify for each step the corrective action to be taken if the mission event does not occur as planned.

11. Provide the Failure Mode and Effects Analyses (FMEA) and the Fault Tree Analyses (FTA) that were performed for the program with appropriate annotations and tutorials. Provide the results of the Probability Risk Assessments (PRA) and Worst Case Circuit Analyses (WCCAs) that were performed.

12. The amount, level and fidelity of mission simulations and launch/operations training that was done or is planned to be done to prepare the mission for launch and on orbit operations.

13. Provide a mission requirements Verification Matrix that shows the pre launch verification of the mission level requirements. This matrix shall address both the fidelity and type of verification.

14. Identify all single point failures and provide a subjective assessment of the probability of each such failure mode causing a mission failure. Also provide adequate rationale to substantiate the subjective assessment.

In reviewing the above items, the Review Team shall focus on implementations that could contain unevaluated risk to mission success.

9.0 Continuous Risk Management

All Project/Mission Teams shall implement a Continuous Risk Management System (CRMS) that provides for the identification; analysis; tracking; communication; resolution; mitigation; and retirement of Project/Mission Risks. The CRMS shall include the development; maintenance; and presentation of a Mission Top Ten Risk List. This list will include a description of the risk, along with a mitigation/elimination strategy and status. The CRMS shall be implemented in accordance with the guidelines set forth in the Earth Explorers Risk Management Plan (470-PLAN-0007).

Earth Explorers Program Acronym List

AA	Associate Administrator
AO	Announcement of Opportunity
CCB	Configuration Control Board
CDR	Critical Design Review
CFO	Chief Financial Officer
CIC	Capital Investment Council
CM	Configuration Management
COTR	Contracting Officer's Technical Representative
CPM	Critical Path Method
CRMS	Continuous Risk Management System
CVCM	Collected Volatile Condensable Mass
CTC	Cost to Complete
DPAF	Dual Payload Attachment Fitting
EE	Earth Explorers
EEPO	Earth Explorers Program Office
EIK	Extended Interaction Klystron
EOS-G	Earth Observing System-GSFC
ESE	Earth Science Enterprise
ESMO	Earth Science Mission Operations
ESSP	Earth System Science Pathfinder
ETC	Estimate to Complete
FMEA	Failure Modes and Effects Analysis
FTA	Fault Tree Analysis
FY	Fiscal Year
GEVS	General Environmental Verification Specification
GIDEP	Government Industry Data Exchange Program
GPMC	Goddard Program Management Council
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
H/W	Hardware
HQ	Headquarters
I&T	Integration and Test
IFM	Integrated Financial Management
ISO	International Standards Organization
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory

Earth Explorers Program Acronym List -Continued

JSC	Johnson Space Center
KSC	Kennedy Space Center
L/V	Launch Vehicle
LaRC	Langley Research Center
LRR	Launch Readiness Review
MBM	Mission Business Manager
MCR	Mission Confirmation Review
MCRR	Mission Confirmation Readiness Review
MDR	Mission Design Review
MDRA	Mission Definition and Requirements Agreement
MM	Mission Manager
MOCD	Mission Operations Concept Document
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
MSFC	Marshall Space Flight Center
MSR	Monthly Status Review
NEPA	National Environmental Program Assessments
NET	No Earlier Than
NHB	NASA Handbook
NMC	NASA Mission Cost
NOA	New Obligational Authority
NPG	NASA Procedures and Guidelines
OMB	Office of Management and Budget
ORR	Operational Readiness Review
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PI	Principal Investigator
PM	Program Manager
PMC	Program Management Council
POP	Program Operating Plan
PRA	Probability Risk Assessment
PSM	Project Support Manager
PSR	Pre-Ship Review
PSS	Project Support Specialist

Earth Explorers Program Acronym List -Continued

RA	Resource Analyst
RAO	Resource Analysis Office
RFA	Request For Action
RFP	Request for Proposal
S/C	Spacecraft
SDB	Small and Disadvantage Business
SEU	Single Event Upset
SMRD	Science and Mission Requirements Document
SOW	Statement of Work
SRR	System Requirements Review
STS	Space Transportation System
TMC	Total Mission Cost
TML	Total Mass Loss
TRL	Technology Readiness Levels
WBS	Work Breakdown Structure
WCCA	Worst Case Circuit Analyses
WFF	Wallops Flight Facility