CCR Number: 0030	CRITICALITY: ROUTINE	DUE 4/13/98

DISTRIBUTION SHEET
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NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM EO-1

CCR NO. 0030

DATE INITIATED 03/24/99

TITLE BASELINE EO-1 MISSION ASSURANCE REQUIREMENTS

ORIGINATOR P. Spidaliere/GSFC

ORIGINATOR'S CHG. NO.

SPONSOR/CODE P. Spidaliere PHONE x4797

EFFECTIVITY

ITEM: EO-1

S / N

ITEM:

S / N

ITEM:

S / N

CHANGE CLASS

	I	II
PRELIMINARY	☐	☐
FORMAL	☐	☐

TYPE OF CHANGE

MILESTONE	☐	INTERFACE	☐	SOFTWARE	☐
DOCUMENT	☒	POWER	☐	OTHER	☐
COST ____	☐	WEIGHT	☐	____	☐

DOCUMENTS OR SOFTWARE AFFECTED

EO-1-MR-001

PROBLEM

The attached draft version of EO1-MR-001, Earth Orbiter -1 (EO-1) Mission Assurance Requirements Document requires baselining. This document describes the plan to implement an organized safety, reliability and mission assurance program for flight hardware, software and ground support equipment.

PROPOSED SOLUTION

Approve the attached draft version of EO-MR-001, Mission Assurance Requirements document by the EO-1 Level II Configuration Control Board (CCB). This draft issue will be formally released after CCB approval. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and Preliminary Specification Change Notices (PSCNs) for CCB approval. This document is maintained by the EO-1 Configuration Management Office (CMO).

BOARD ACTION

APPROVE	☐
APPROVE WITH CHANGE	☐
DISAPPROVE	☐
WITHDRAW	☑

APPROVAL LEVEL REQUIRED

LEVEL I HQS	☐
LEVEL II GSFC	☒
LEVEL III	☐

CRITICALITY LEVEL

EMERGENCY	☐
URGENT	☐
ROUTINE	☒

PROCUREMENT CHANGE ORDER CLASSIFICATION

ROUTINE		URGENT		EMERGENCY	
OPTION 1	☐	OPTION 1	☐		
OPTION 2	☐	OPTION 2	☐		

COMMENTS

Withdraw due to Mission Reqts Changes.

CHAIRPERSON _____ DATE 3/26/99

3/28/96

OVERVIEW

The developer shall plan and implement an organized safety, reliability and mission assurance program for flight hardware, software and ground support equipment. The developer shall support and participate with the Earth Orbiter (EO-1) Project at GSFC in validating and periodically reviewing the safety, reliability and mission assurance program. This document presents a concise statement of EO-1 project minimum requirements.

2.0 MISSION ASSURANCE

2.1 Quality System

During Phase B, the developer shall define and implement a quality system which meets the intent of ISO 9001. It should be noted that the developer's quality system shall properly encompass all EO-1 flight hardware, flight software, and ground support equipment. The quality manual, as required by this standard, shall be provided for GSFC review prior to Phase C.

2.2 **Workmanship** The following commercial or NASA workmanship standards shall be used for the EO-1 mission:

Soldering of Electrical Connections: NHB 5300.4 (3A-2), Requirements for Soldered Electrical Connections
Alternate: J-STD-001B Class 3 with addendum's to provide for training and low volume, high reliability flight hardware.
J-STD-002 through -006

Cabling and Harnessing: NAS 5300.4(3G-1), Workmanship Standard for Interconnecting Cables, Harnesses, and Wiring

Crimping: NHB 5300.4(3H), Requirements for Crimping and Wire Wrap

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: NHB 5300.4 (3L), Requirements for Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)
Alternate: MIL-STD-1686 in conjunction with MIL-HDBK-263 with utilization of sections that meet the intent of the NASA Standard.

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 EO-1.

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

The developer's internal workmanship standards may be utilized if they meet the intent of the NASA standards and are approved by the EO-1 project.

The developer and their subcontractors shall provide printed wiring board coupons to GSFC, or to a GSFC approved laboratory for evaluation. Approval shall be obtained prior to population of printed wiring boards.

2.3 Failure Reporting

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

Depending on the hardware level, reporting of failures and EO-1 project approval of corrective action 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 the first test use of the software item with the hardware item. The developer can use any failure report format they deem acceptable, as long as the EO-1 project office has concurred with their format.

In addition, the developer shall maintain failure reporting records of problems encountered at the lower levels of assembly for information. These records should be available for GSFC inspection at any time during the project.

2.4 Surveillance of the Contractor

The work activities, operations, and documentation performed by the developer or his subcontractors are subject to evaluation, review, audit, and inspection by government-designated representatives from GSFC. The developer will delegate in-plant responsibilities and authority to those agencies via letter of delegation.

The developer, upon request, will provide government quality assurance representatives with documents, records, and equipment required to perform their assurance and safety activities. The developer will also provide the government quality assurance representative(s) with an acceptable work area within the developer's facilities.

3.0 REVIEWS

The EO-1 project office philosophy is to focus resources early and throughout the program on engineering working level reviews to identify and resolve concerns before these issues reach formal, high level system reviews. The developer is responsible for conducting engineering peer reviews. Upon request through the EO-1 Project, GSFC will provide technical expertise as required for participation in the areas undergoing detailed engineering review.

The formal system level reviews will concentrate on the critical system and end to end mission level technical and programmatic issues. There will be five formal system level reviews:

- Confirmation Review (in Phase B)
- Critical Design Review (in Phase C/D)
- Pre-Environmental Review (in Phase C/D)
- Pre-Ship Review (in Phase C/D)
- Flight Readiness Review (Spacecraft Only)

Except for the Confirmation Review, these formal reviews will be chaired by the GSFC Office of Flight Assurance Systems Review Office, Code 301. Scheduling of these reviews will be coordinated with the EO-1 Project. The review chairman, in concert with the Project and other Directorates, appoints independent key technical experts as review team members. Every effort will be made to maintain the chairman and the key technical experts for the duration of the Project. Other experts will be added and/or deleted from the review team according to the technical needs and phases of the Project.

For mission and flight operations on the EO-1 project, there will be three GSFC chaired reviews. They are as follows:

- Critical Design Review for the Mission Operations Center
- Mission Operations Review
- Flight Operations Review

3.1 Formal Reviews

The Confirmation Review represents the review leading to the closure of Phase B. 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
- cost, schedule and resource plans

Phase C/D starts with the confirmation of the mission and a signed contractual agreement for the development, launch and validation in orbit (typically within 30 days after launch) of the mission. It is expected that the informal engineering weekly meetings and peer reviews will continue throughout Phase C/D. Topics covered in these meetings/peer reviews will include:

- 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
- test anomalies and resolution

The Critical Design Review (CDR) will occur after the design has been completed but prior to the start of flight hardware manufacturing or coding of the flight software. It will emphasize implementations of design approaches as well as test planning for all flight systems. However, in the case of long lead procurements, manufacturing may be initiated prior to CDR as required to meet schedule.

The Pre-Environmental Review (PER) will assess the readiness of the flight hardware, software and required environmental test facilities to begin acceptance testing. The PER will 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 will be held prior to the full system integration and functional test in preparation for environmental testing.

The Pre-Ship Review (PSR) will verify that testing has been completed with no unacceptable open issues and to evaluate the readiness of the flight hardware and flight software. The PSR will also cover:

- determination of completion of testing flight hardware and software
- verification and documentation of hardware and software configuration
- identification of outstanding safety risks
- disposition of waivers, deviations, open issues
- compatibility of spacecraft and ground support equipment
- orbital operations plans
- evaluation of the acceptance data packages

The PSR will be held immediately prior to the shipment of the flight hardware to the installation site, and prior to the shipment of the satellite to the launch site.

The Flight Readiness Review (FRR) will assess the overall readiness of the total system to support the flight objectives of the mission. The FRR is held at the launch site 2-3 days prior to launch.

The Mission Operations Review (MOR) will be conducted prior to significant integration and test of the flight system and ground system. Its purpose is to review the status of the system components, including the ground system and its operational interface with the flight system. Discussions will include mission integration, test planning and the status of preparations for flight operations.

The Flight Operations Review (FOR) will emphasize the final orbital operation plans as well as the compatibility of the flight components with ground support equipment and ground network, including summary results of the network compatibility tests.

3.2 Peer Reviews

Engineering peer reviews will occur during all phases of the project life cycle. These reviews are expected to be the most detailed of the EO-1 reviews. It is the intent of the peer reviews that participants generate a detailed understanding of the component and subsystem designs ability to meet higher level system and mission requirements. Effective peer reviews will enable significant streamlining of the content of higher level formal reviews described in section 3.1 herein. To promote continuity of the whole review program, the Systems Review Office may attend any peer review session.

4.0 SAFETY

The payload developer, identified as Swales for EO-1, is responsible for the overall safety of the mission, from start of development through launch activities (as stated in the EO-1 SOW). In fulfilling this responsibility, the payload developer is required to establish a comprehensive safety program. This includes documenting hazard analyses, hazard reports, and operations hazards analyses in safety data packages. The EO-1 Project Office will provide advice, support, and the interfaces with GSFC facilities (if applicable), the launch vehicle and/or launch range safety (if applicable).

4.1 General

The payload developer is required to plan and implement a system safety program that accomplishes the following:

- Identifies and controls hazards to personnel, facilities, support equipment, and the flight system during all stages of the mission development. The program is to address hazards in the flight hardware, associated software, ground support equipment, and support facilities.

- Meets the system safety requirements stated in EWR 127-1 for the Western Range.

- Meets the payload ground safety requirements stated in KHB 1710.2 for the Western Range.

The payload developer is required to provide a description of the system down to the subsystem level, and a preliminary assessment of the system's compliance with the requirements of this section at the Confirmation Review.

The payload developer is required to submit, in accordance with an agreed to schedule, all ground operations procedures to be used at GSFC facilities, other NASA integration facilities, or the launch site, for review and approval by NASA. All hazardous operations,

as well as the procedures to control them, are to be identified and highlighted. All launch site procedures are to comply with the applicable launch site safety regulations.

The payload developer is required to submit a safety data package consistent with the requirements in EWR 127-1. When a specific safety requirement cannot be met, the payload developer shall develop an associated safety noncompliance request that identifies the hazard and shows the rationale for approval of a noncompliance, as defined in EWR 127-1. The payload developer will submit the noncompliance request to the GSFC Project Safety Manager (PSM) for review prior to submittal to the Range for approval.

4.2 Safety Data Package

The payload developer shall submit a Missile System Prelaunch Safety Package (MSPSP) to the PSM for review prior to submittal to the Range for approval. The preliminary MSPSP delivery date is at Critical Design Review. The final MSPSP delivery date is 45 days prior to S/C shipment to the Range. The contents of the MSPSP will be consistent with the requirements of the applicable launch vehicle and the Western Range.

4.3 Launch Site Safety Plan

The payload developer is required to submit a Launch Site Safety Plan, consistent with the launch site requirements, for review by the PSM prior to submittal to the range for approval. The details of the plan and submittal milestones are dependent on the selected launch site safety regulations.

5.0 DESIGN ASSURANCE

5.1 Parts

The developer shall implement an appropriate parts program. All parts shall be selected and processed in accordance with GSFC 311-INST-001, entitled "Instructions for EEE Parts Selection, Screening, and Qualification" for Grade 3 quality level. The developer shall control the management, selection, application, evaluation, and acceptance of all parts through a parts control board, or another similar, documented, parts control system. The parts control board (or system) may be very informal. It shall require the participation of, as a minimum, the EO-1 Project Parts Engineer and the developer's part representatives. These individuals shall be responsible for the review and approval of all parts for conformance to the GSFC 311-INST-001, Grade 3 quality level. Under this system, part information is shared between the developer and GSFC to identify all parts used, failure investigations, disposition of non-conformances, and problem resolutions. If there are any part issues, which the developer and GSFC cannot resolve at the engineering level, then the EO-1 Project Parts Engineer will inform the EO-1 Flight Assurance Manager and the EO-1 Project Manager of the issue and the associated risk. After this

discussion, the project will decide whether to accept the risk and ask the developer to submit a deviation or waiver (as applicable) to document the issue, or to elevate the issue to the developer's management for resolution.

The developer shall maintain an EEE Parts Identification List prior to and during the developer's hardware built. This as-built list shall be updated and submitted as part of the Acceptance Data Package for the flight hardware.

Destructive Physical Analysis (DPA) will not be required, unless specific issues, such as part failure history, Government Industry Data Exchange Program (GIDEP) Alerts and Problem Advisories, new/unknown technology, or other similar concerns, warrant it. The Parts Control Board (or system) participants shall be responsible for determining which parts, if any, require DPA. DPA performance, when required, shall be in accordance with GSFC S-311-M-70.

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

All EEE parts shall be selected to meet the predicted EO-1 mission ionizing radiation level requirements, as defined in "EO-1 Mission Ionizing Radiation Specification".

5.2 Materials and Lubrication

The developer shall implement a Materials and Processes program beginning at Phase B. NASA Reference Publication 1124 entitled "Outgassing Data for Selecting Spacecraft Materials" shall be used as a guide for materials selection on this project.
Only materials that have a total mass loss (TML) <1.00% and a collected volatile condensable mass (CVCM) <0.10% shall be used on this project unless a waiver is submitted and granted by the EO-1 project office. Each developer shall deliver one list which is inclusive of the polymeric materials, inorganic materials, composites, lubricant usage, and the material process utilization. Each developer shall submit their list for GSFC review prior to the Critical Design Review. As part of the project systems engineering team, all proposed materials and processes shall be reviewed with the EO-1 Project Materials Engineer. If there are any materials issues, which the developer and GSFC cannot resolve at the engineering level, then the GSFC material engineer will inform the EO-1 Flight Assurance Manager and the EO-1 Project Manager of the issue and the associated risk. After this discussion, the project will decide whether to accept the risk and ask the developer to submit a waiver to document the issue, or to elevate the issue to the developer's management for resolution.

Each developer shall maintain a list of materials, processes, and appropriate usage records prior to and during the hardware development. This as-built list shall be updated and submitted as part of the Acceptance Data Package for the flight hardware.

5.3 Reliability

The developer(s) shall plan and implement a reliability program that interacts with other EO-1 program disciplines, including systems engineering, hardware design, parts selection, and systems safety. This program shall be conceived and organized to effectively, efficiently, and timely perform tasks that enhance the expected mission life time. The developer(s) shall develop and implement a program plan that addresses mission objectives, assigns responsibilities, and schedules tasks relative to program milestones. The reliability program shall at least respond to the following objectives:

I. Design
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 developer(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.

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. Corrective action may 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 EO-1 Project.

5.4 Software

Each developer shall employ a structured program for the development of software. A Software Management Plan 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, and maintainable.

During the preliminary design process, each developer shall establish and document software requirements and any appropriate external interface specifications and user guides.

Each developer shall conduct software reviews to validate software requirements, design, operating characteristics, and external interface requirements.

6.0 VERIFICATION

Each developer will conduct a verification program to ensure that the flight hardware meets the specified mission requirements.

Each developer shall provide adequate verification documentation including a verification matrix, environmental test matrix and verification procedures.

7.0 CONTAMINATION

Each developer shall plan and implement a contamination control program applicable to the EO-1 mission. A Contamination Control Plan shall be prepared by the developer which describes the procedures that will be followed to control contamination. The plan shall establish the implementation and describe the methods the developer will use to measure and maintain the levels of cleanliness required during each of the various phases of the flight hardware's lifetime.