

EARTH OBSERVING SYSTEM (EOS)

PERFORMANCE ASSURANCE

REQUIREMENTS

FOR EOS GENERAL INSTRUMENTS

August 2, 1991



GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

GSFC 420-05-01
Revision A
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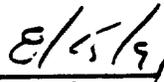
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This is a Project Office controlled document. Changes require prior approval of the Project Manager. Proposed changes shall be submitted to the EOS Instruments Project Configuration Management Officer (Code 422).





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SECTION 1

GENERAL REQUIREMENTS

1.1 BASIS AND SCOPE OF THE REQUIREMENTS

This document is an adaptation of the applicable requirements of NASA reliability, quality assurance, and EEE parts management Handbooks NHB 5300.4 (1A, 1B and 1F). It establishes common hardware and software product assurance minimum requirements with respect to safety, reliability, maintainability, and quality for all developers involved in the design, development, production, test and operation of instruments and their support equipment for the Earth Observing System (EOS).

This document also defines expanded performance assurance requirements in areas of reviews, functional and environmental testing, contamination control, parts control, materials control, mission simulations and end-to-end operational testing. It also requires compliance with applicable parts of WSMCR 127-1, "Range Safety Requirements, Range Safety Regulation", Western Space and Missile Center.

This document, is applicable to flight instruments for the EOS missions. It is also applicable to flight and flight support hardware and software for payload instruments under the responsibility of the EOS Project. The developer, when referred to herein, is defined as NASA in-house organizations, experimenters, out-of-house contractors, subcontractors, and suppliers.

1.2 GENERAL REQUIREMENTS

The developer shall establish and conduct an organized program which will demonstrate that the instrument design meets the functional requirements, including specified margins, has been manufactured properly and will operate properly in association with all other project components. This will be accomplished by conducting analyses, reviews, tests, and inspections.

The developer is required to implement and maintain a performance assurance program that encompasses all the developer's flight equipment and software including flight spares and associated Government furnished flight equipment. The program applies to all work accomplished by the developer and his subcontractors and suppliers (also termed "contractor") who provide flight hardware and support.

1.3 PERFORMANCE ASSURANCE IMPLEMENTATION PLAN (PAIP)

The Performance Assurance Implementation Plan (PAIP) describes

the developer's system for accomplishing the assurance activities in compliance with the requirements herein. The developer shall prepare the Implementation Plan and submit it in accordance with Appendix C herein. The approved Plan and this document shall become part of the contract negotiated between the developer and the Goddard Space Flight Center. If any inconsistencies between the approved Implementation Plan and this document become evident, this document shall take precedence, except where a Deviation has been formally approved by the Contracting Officer (use Deviation/Waiver request form, Figure 4-3, herein).

The developer is encouraged to make maximum use of his existing practices and procedures in complying with this document. Applicable practices and procedures shall be submitted with the PAIP.

1.3.1 PREPARATION OF THE PAIP

The PAIP shall address each of the ten sections of this document and shall describe specifically and in detail how the requirements are to be accomplished; in addition, the Plan shall include:

- a. Organization chart and defined responsibilities.
- b. Matrix of the requirements, referencing the applicable paragraph numbers in the PAIP versus the implementation procedures, instructions and specifications and indicating the organizations responsible for implementing and auditing each requirement.
- c. A list of assurance services that may be procured, identifying the proposed subcontractor.
- d. Identification of significant hardware and software items to be purchased and a detailed description of the portions of this document to be imposed on each item.

1.3.2 IMPLEMENTING PROCEDURES

The developer shall provide one copy of each procedure and documented instruction referenced in the plan. These documents and any subsequent revision to any of them shall be submitted in accordance with Appendix C herein.

1.4 USE OF PREVIOUSLY DESIGNED, FABRICATED, OR FLOWN HARDWARE

The developer is required to demonstrate that the hardware proposed will comply with the requirements of this document as well as the performance requirements. When previously designed, fabricated, or flown hardware is proposed for use on this Project and is considered to have demonstrated compliance with the

participate as appropriate in test planning activities and review activities.

1.6 PERFORMANCE ASSURANCE STATUS REPORT

Each month a Performance Assurance Status Report shall be prepared that contains the status of the assurance activities and any deficiencies that could affect the end item product; the causes of the deficiencies and intended or actual corrective action shall be included. The report shall cover, as appropriate, the following items as well as those called for in the individual sections of this document:

- a. Significant assurance problems,
- b. Key organization and personnel changes,
- c. Unresolved hazards (safety program),
- d. Summary of significant analysis, inspection, and test activities,
- e. Status of procurements and subcontractor performance assurance programs,
- f. Audit report summaries of internal and subcontractor audits (see par. 1.9.2);
- g. Summary reports of Developer reviews (see par. 2.5);
- h. Results of Alert and special problem surveys.
- i. NSPAR status.
- j. Parts or devices procurement or screening activities.
- k. Results of Trend Analyses;
- l. Status Summaries of open malfunction reports. (See par. 8.13.2.1b.);

The Performance Assurance Status Report shall be submitted either as part of the developer's monthly report or as a separate submittal to NASA in accordance with Appendix C herein. The developer shall indicate in the PAIP which method of submittal will be used. Negative reports are required.

1.7 SURVEILLANCE OF THE DEVELOPER

The work activities and operations of the developer, subcontractors, and suppliers are subject to evaluation, review,

requirements of this document, the developer shall submit documentation substantiating that conclusion. The documents must provide the following information:

(a) Compare each performance, design, environmental, and interface requirement, including margins, for this Project (as delineated in other documents related to this procurement) with the corresponding previous requirement. For any mission requirement or environmental difference from the previous use, either describe the modifications to be made to the hardware and software to meet EOS mission requirements, or provide a rationale and supporting information stating why use without modification is considered acceptable.

(b) Compare each performance assurance requirement for this Project (as delineated in this document) with the corresponding previous requirement. Also, identify all waivers and deviations from the performance assurance requirements accepted on the previous program. For any requirement of the previous program that does not comply with the requirements of this Project, or for any previous deviation or waiver, describe what will be done to achieve compliance or provide a rationale and supporting information stating why the difference is considered acceptable. In addition, state how any modifications proposed as a result of (a), above, will be shown to comply with the performance assurance requirements of this document.

(c) Compare the manufacturing information for the hardware proposed for this Project with that for the previous hardware. This shall include as a minimum the name and location of the manufacturer, the date of manufacture, any design changes, any changes to parts or materials, any modification to packaging techniques, and any change to fabrication or assembly controls or processes.

(d) Describe all flight experience with the proposed hardware including, in particular, a description of all failures or anomalies, their cause, and any corrective action that was taken as a result.

The documentation described above shall be submitted to NASA in accordance with Appendix C herein.

1.5 MANAGEMENT OF THE ASSURANCE PROGRAM

The developer shall implement a system for effective management control and audit of the assurance program. He shall assign responsibility and authority for managing the assurance activities to individuals having unimpeded access to higher management. The developer shall ensure that developer assurance personnel have timely unimpeded access to products in order to perform pertinent assurance functions and that these personnel

survey, and inspection by Government-designated representatives from the NASA project office, the cognizant Government inspection agency (GIA), or an independent assurance contractor (IAC). NASA will delegate comprehensive and specific in-plant responsibilities and authority to those agencies in a letter of delegation (LOD) or the NASA contract with the IAC.

The developer shall provide the Government representative with documents (including an approved PAIP), records, equipment, and working areas within his facilities that are required by the Government representative to perform his overview activities.

Where developer source inspection is used, the developer shall provide a list of duties, responsibilities, and authorities of his at-source quality assurance (QA) personnel to the designated Government quality representative at the developer's facility. When both developer and Government source inspection personnel are used at any developer's facility, the listing shall also be provided to the Government source representative at that facility, upon issuance of the procurement. At no time shall Government source inspection be used in lieu of developer's source inspection.

1.8 GENERAL PROCUREMENT REQUIREMENTS

1.8.1 SELECTION OF SOURCES

When the developer selects procurement sources, he shall assign assurance personnel to participate in the selection. Performance history, receiving inspection and test results, supplier rating system, and survey results shall be used to assess the capability of each potential procurement source in producing reliable products.

1.8.2 REQUIREMENTS ON SUBCONTRACTOR AND SUPPLIERS

The developer shall ensure that his procurement documents impose the applicable requirements of this document on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on their procurement sources.

1.9 AUDITS

The developer shall conduct audits of his assurance activities and those of his subcontractors and suppliers to ensure compliance with all provisions of the PAIP and the provisions of the procurement document. To verify the effectiveness of the performance assurance systems, each audit shall include examination of operations and documents as well as examination of articles and materials. The audit program shall be defined in the PAIP and shall be submitted in accordance with Appendix C herein.

1.9.1 SUBCONTRACTORS AND SUPPLIER AUDITS

The developer shall perform audits of his subcontractors and suppliers as necessary to ensure compliance with the subcontractor performance assurance requirements. The developer's schedule and conduct of the audits shall be based on the following:

- a. Criticality of items being procured, or those items identified by failure mode and effects analyses, or information from trend analyses,
- b. Known problems or difficulties,
- c. Supplier quality history,
- d. Remaining period of supplier performance.

The audit program for the subcontractors and suppliers shall be defined in the PAIP and shall be submitted in accordance with Appendix C herein.

1.9.2 AUDIT REPORTS

A documented account of audits shall be provided to management of the audited organization with recommendations for correction of deficiencies. Management action shall be taken to ensure correction of the deficiencies, and reviews shall be conducted to ensure that the corrections have been made. Audit reports shall be made available to the Government representative upon request, and a summary of the audit reports shall be submitted to NASA as part of the Performance Assurance Status Report (par. 1.6) in accordance with Appendix C herein.

1.10 APPLICABLE DOCUMENTS (APPENDIX A)

To the extent referenced herein, applicable portions of the documents listed in Appendix A, at the revision levels in effect at the time of issuance of the Request for Proposals, form a part of this document. Where any referenced document conflicts with the requirements of this document, developers shall obtain guidance from the EOS Flight Assurance Manager.

1.11 ABBREVIATIONS, ACRONYMS, and GLOSSARY (APPENDIX B)

Appendix B lists abbreviations, acronyms, and definitions that are needed for a common understanding of terms as applied in this document.

1.12 PERFORMANCE ASSURANCE DATA REQUIREMENTS LIST (APPENDIX C)

Deliverable data required by this PAR are specified in Appendix C "Performance Assurance Data Requirements List". These requirements are to be considered a part of the Contract Data Requirements List (CDRL) for each EOS instrument. In the event of a conflict between Appendix C and the CDRL, Appendix C shall take precedence over the instrument CDRL for the documents required by this PAR. Appendix C also cites when each data item shall be delivered and whether it is required for NASA approval, review, or information.

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SECTION 2

ASSURANCE REVIEW REQUIREMENTS

2.1 GENERAL REQUIREMENTS

The instrument developer shall support a series of comprehensive instrument-level and system-level design reviews that are conducted by a GSFC Flight Assurance Review Team. The reviews shall cover all aspects of flight and ground hardware, software and operations for which the developer has responsibility. The developer shall also conduct a program of planned, scheduled and documented developer reviews (see par. 2.5) at component and subsystem levels of all hardware and software in his area of responsibility.

2.2 GSFC FLIGHT ASSURANCE REVIEW REQUIREMENTS

For each specified review conducted by a GSFC Flight Assurance Review Team, the developer shall:

- a. Develop and organize material for oral presentation to the GSFC review team. Copies of visual aids and other supporting material that are pertinent to the review shall be submitted in accordance with Appendix C herein.
- b. Support splinter review meetings resulting from the major review.
- c. Submit written responses to recommendations and action items resulting from the review in accordance with Appendix C herein.

For the instrument-level reviews the review material shall deal with all aspects of the instrument and its functions. For the EOS Observatory-level reviews the material and presentations shall be of a degree of detail appropriate to the support of the review at this level. The developer shall provide support pertinent to the developer's instrument for the Observatory level reviews (see par. 2.3b(2)).

2.3 GSFC FLIGHT ASSURANCE REVIEW PROGRAM

The Flight Assurance Review Program shall consist of individual reviews of each instrument and its associated systems, as well as reviews of the EOS Platform and the integrated EOS Observatory as described herein:

- a. Each instrument and its associated subsystems shall have the following series of reviews at the instrument level; these shall include information in sufficient detail to facilitate understanding of the instrument, its functions and operations, as

well as its relationship to the EOS Observatory and mission. The developer shall also support NASA reviews of the instrument flight software as required by par. 10.2.5. The instrument-level reviews are:

- Conceptual Design and Cost Review (CDCR). This review is keyed to the end of the definition study phase and evaluates the instrument's design approaches and operational concepts.

- Preliminary Design Review (PDR). This review usually occurs early in the design phase but prior to manufacture of engineering hardware. Where applicable it should include the results of test bedding, breadboard testing, and simulation and/or prototyping for software.

- Critical Design Review (CDR). This review is conducted to buy off the "frozen" design prior to the start of manufacture of flight components. It will emphasize implementations of design as well as test plans for flight systems including the results of engineering model testing.

- Pre-environmental Review (PER). This review occurs prior to the start of environmental testing of the (instrument) protoflight or flight system. The primary purposes of this review are to establish the readiness of the system for test and to evaluate the environmental test plans. (At the Observatory level, this review serves the analogous purposes for the integrated Observatory.)

- Pre-shipment Review (PSR). This review will take place prior to shipment of the instrument to the Observatory for integration, and will concentrate on instrument performance during acceptance testing. (At the Observatory level, this review will take place prior to shipment of the Observatory to the launch site and will concentrate on overall system performance during acceptance testing.)

b. In addition to the instrument-level reviews named above, the overall GSFC review program for EOS will include Platform-level reviews and Observatory-level reviews:

(1) Review of the Platform and its associated systems will include a Platform level PDR and CDR and an STR. (these reviews do not directly involve instrument developers, although participation by the developers is open.). The STR is described as follows:

System Test Review (STR) - This review occurs prior to acceptance of the EOS Platform by NASA and delivery (in place) for integration of the Observatory. It is analogous to a pre-shipment review.

(2) Review of the Observatory will include an Observatory level MOR, PER, PSR, FOR, and FRR; these shall include information on the instruments provided by the developer in sufficient detail to facilitate understanding of their relationship to the flight segment and mission. The MOR, FOR and FRR are described as follows:

Mission Operations Review (MOR) - This mission-oriented review will normally take place prior to significant integration of the flight system. The purpose is to review the status of the system components, including the ground system and its operational interfaces with the flight system. Discussions will include integration and test planning.

Flight Operations Review (FOR) - While all of the previous reviews involve operations, this review will emphasize the final orbital operations plans, as well as the compatibility of the Observatory with ground support equipment and ground network, including summary results of the network compatibility tests.

Flight Readiness Review (FRR) - This review is to assess the overall readiness of the total system to support the flight objectives of the mission.

2.4 SYSTEM SAFETY

System safety shall be an agenda item for each review in paragraph 2.3 and as such shall serve to support the total system safety review program specified in paragraph 4.7.

2.5 DEVELOPER REVIEW REQUIREMENTS

The developer shall conduct a program of reviews at the component and subsystem levels of the instrument. The program shall, as a minimum, consist of a PDR and a CDR at these levels of assembly. In addition, packaging reviews shall be conducted on all electrical, electronic, and electromechanical components in the instrument system.

The developer shall also conduct design reviews of any custom designed microcircuits, including hybrids, as required by paragraph 5.3.2.4.

The PDR and CDR shall evaluate the ability of the component or subsystem concept and design to successfully perform its function under operating and environmental conditions during both testing and flight.

The packaging reviews shall be conducted in accordance with GSFC S-311-98, "Guidelines for Conducting a Packaging Review" (see Appendix A). In addition to these packaging guidelines, the

reviews shall specifically address the following:

- a. Placement, mounting, and interconnection of each EEE part or circuit board or substrate.
- b. Structural support and thermal accommodation of the boards and substrates and their interconnecting in the component design.
- c. Provisions for protection of the parts and ease of inspection.

Pertinent parts stress analyses required by paragraph 7.3.3 and reports of the corresponding component packaging reviews, including the results of associated tests and analyses, shall be included in the PDR's and CDR's for each component.

Reviews shall be conducted by developer personnel who are not directly responsible for hardware design. NASA reserves the right to attend the reviews and participate as reviewers and requires 20 working days notification. If so requested by the NASA Technical Officer, the developer shall provide NASA a copy of the review input data package 15 working days in advance of the review. The results of the reviews shall be documented, and a summary of each review shall be included in the Performance Assurance Status Report in accordance with Appendix C herein. The review data shall be available to NASA upon request.

SECTION 3

PERFORMANCE VERIFICATION REQUIREMENTS

3.1 GENERAL REQUIREMENTS

A Performance Verification Program shall be conducted to ensure that the payload instrument meets the specified mission requirements. The program consists of a series of functional demonstrations, prototyping efforts, analytical investigations, calibration tests, physical property measurements, and environmental and performance tests that simulate the environments encountered during handling and transportation, prelaunch, launch, and in-orbit operations. All protoflight hardware shall undergo qualification to demonstrate compliance with the requirements of this Section. All other flight hardware (as defined in Appendix B, "Hardware") shall undergo acceptance verification in accordance with the requirements of this Section unless specific modifications are permitted in a subparagraph entitled "Acceptance Requirements." The Performance Verification Program begins with functional testing of assemblies, continues through the functional and environmental testing, supported by appropriate analysis, at the component and instrument levels of assembly. Methods for implementing the requirements of this Section are contained in the ELV payload requirements of the General Environmental Verification Specification for STS and ELV Payloads, Subsystems, and Components ("GEVS-SE") (Appendix A herein).

The GEVS-SE establishes the general environmental test requirements for the EOS instruments. Unique requirements for the instruments and components will be provided in the EOS General Instrument Interface Specification (GIIS) and the respective unique instrument interface documents (UIIDs) and interface control documents (ICDs) and will be updated if necessary when the dynamic model of the Observatory has been verified by test.

The instrument-level vibroacoustics and mechanical shock tests required by this Section shall be conducted with the inputs at the instrument mounting interface. Tests of the instrument mounting plates and other instrument flight support equipment shall be conducted as a part of EOS Platform testing.

3.1.1 SYSTEM SAFETY CONSIDERATIONS

Certain additional activities (not identified in this Section) that are needed to satisfy the safety requirements of Section 4 may best be accomplished during the Performance Verification Program. It is therefore recommended that, in order to achieve cost and scheduling benefits, the Performance and Safety

Verification Programs be closely coordinated.

3.2 DOCUMENTATION REQUIREMENTS

The approach for accomplishing the Performance Verification Program shall be described in Section 3 of the PAIP (par. 1.3). This shall include a description of the management approach as well as the following plans, specifications, procedures, and reports, which are required to define the technical aspects of the Performance Verification Program.

3.2.1 VERIFICATION PLAN

A Verification Plan shall be prepared and maintained up-to-date that defines the tests and analyses that collectively demonstrate that the hardware complies with Sections 3.2 through 3.7 of this document. The Plan shall include all tests and analyses at the component, subsystem, and instrument level.

The Verification Plan shall provide an overview of the Verification Program and the overall approach to its accomplishment. For each test, it shall include the level of assembly, configuration of the item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, necessary functional operations, personnel responsibilities, and requirements for procedures and reports. It shall also define a rationale for retest determination that does not invalidate previous verification activities. When appropriate, the interaction of the test and analysis activity shall be described. For each analysis activity, the plan shall include objectives, a description of the mathematical model, assumptions on which the models will be based, required output, criteria for assessing the acceptability of the results, the interaction with related test activity, if any, and requirements for reports.

As an adjunct to the Verification Plan, a verification matrix (see par. 1.10.1.1 of GEVS-SE) shall be prepared that summarizes all tests and analyses that will be performed on each component, subsystem, and the instrument. The developer shall also maintain a matrix of developer/subcontractor tests actually accomplished throughout the program and present it at the pertinent GSFC reviews called for in section 2. The Verification Plan shall be delivered to NASA and updated in accordance with Appendix C herein.

3.2.2 VERIFICATION SPECIFICATION

A Verification Specification shall be prepared that stipulates the specific environmental parameters associated with each of the tests and analyses required by the Verification Plan. This specification may be combined with the Verification Plan. In

defining quantitative environmental parameters under which the hardware elements must meet their performance requirements, the Verification Specification shall consider things such as payload peculiarities and pertinent requirements of the GISS and the respective UIID and ICDs.

The Verification Specification shall be delivered to NASA and updated in accordance with Appendix C herein.

3.2.3 VERIFICATION PROCEDURES

For each functional and environmental test activity conducted at the component, subsystem, and instrument level, verification procedures shall be prepared that describe in detail the configuration of the test article and how that particular test activity contained in the Verification Specification and Verification Plan will be implemented.

The procedures shall describe details such as instrumentation monitoring, facility control sequences, test article functions, test parameters, quality control checkpoints, pass/fail criteria, data collection, and reporting requirements. The procedures also shall address safety and contamination control provisions and measures to protect the hardware (e.g. connector savers). Procedures for calibrations and performance tests shall provide for real-time display of data in easily recognized engineering terms to the maximum extent practicable. Verification Procedures at the instrument level shall be submitted to NASA in accordance with Appendix C herein.

3.2.4 CONTROL OF UNSCHEDULED ACTIVITIES DURING VERIFICATION

A documented procedure shall be established for controlling, documenting, and approving all activities not part of an approved verification procedure or flight instrument calibration procedure. The developer shall be alert to the hazard potential of last minute changes and shall institute controls at appropriate management levels to prevent accident or injury or hardware damage. Such control shall include appropriate real-time decision making mechanisms to expedite continuation (or suspension) of testing after a malfunction, with documented rationale. The control procedure shall be documented in accordance with Appendix C herein, and it shall be referenced in the PAIP (par. 1.3) and in each Verification Procedure.

In the event of a failure during qualification testing or acceptance testing of a flight instrument, the developer shall stop the test and contact the Technical Officer (TO) or the TO's designated representative before proceeding. Normally, the complete test shall be rerun, starting at the beginning of the test in which the failure occurred, unless the retest is shortened upon direction of NASA. The exact nature of retest

shall be determined by the TO.

3.2.5 VERIFICATION REPORTS

After completion of each instrument verification activity or flight instrument calibration, a report shall be submitted in accordance with Appendix C herein. For each test activity, the report shall contain, as a minimum, the information described in the sample test report (see Figures 3-1a and 3-1b). For each analysis activity, the report shall describe the degree to which the objectives were accomplished, how well the mathematical model was validated by the test data, and other significant results. Detailed test and analysis data supporting the verification reports shall be retained by the developer; this data, as well as the as-run verification procedures, shall be available for review at the developer's facility upon request.

3.3 ELECTRICAL FUNCTION TEST REQUIREMENTS

3.3.1 ELECTRICAL INTERFACE TESTS

Before the integration of an assembly, component, or subsystem into the next higher hardware assembly, electrical interface tests shall be performed to verify that all interface signals are within acceptable limits of applicable performance specifications.

During integration, the electrical harnessing shall be tested to verify proper routing of electrical signals. All such testing, as well as the accompanying integration activities, shall be performed in an area that conforms to the cleanliness criteria developed in response to Section 9.

3.3.2 PERFORMANCE TESTS

3.3.2.1 Comprehensive Performance Tests (CPT's). A CPT shall be conducted on the instrument and each component and subsystem upon completion of integration of all assemblies. When environmental testing is performed at a given level of assembly, additional CPT's shall be conducted during the hot and cold extremes of the temperature or thermal-vacuum test and at the conclusion of the environmental test sequence, as well as at other times prescribed in the Verification Specification. The CPT shall be a detailed demonstration that the hardware meets its performance requirements within allowable tolerances. The test shall demonstrate operation of all redundant circuitry. It shall also demonstrate satisfactory performance in all operational modes within practical limits of cost, schedule, and environmental simulation capabilities. The initial CPT shall serve as a baseline against which the results of all later CPTs can be readily compared.

DOCUMENTATION

VERIFICATION REQUIREMENTS

Page ____ of ____

VERIFICATION TEST REPORT

PROJECT _____

TEST ITEM _____

MANUFACTURER _____

SERIAL NUMBER _____

LEVEL OF ASSEMBLY: COMPONENT SUBSYSTEM PAYLOAD

TYPE HARDWARE: PROTOTYPE PROTOFLIGHT FLIGHT SPARE

TYPE TEST:

- STRUCTURAL LOADS
- VIBRATION
- ACOUSTICS
- MECHANICAL SHOCK
- MECHANICAL FUNCTION
- MODAL SURVEY
- PRESSURE PROFILE
- MASS PROPERTIES
- ELECTROMAGNETIC COMPATIBILITY
- MAGNETIC PROPERTIES
- THERMAL - VACUUM
- THERMAL BALANCE
- THERMAL CYCLING
- TEMPERATURE - HUMIDITY
- LEAKAGE
- COMPREHENSIVE PERFORMANCE

OTHER (explain) _____

VERIFICATION PROCEDURE NO. _____ REV. _____ DATE _____

INITIAL TEST

RETEST (PARTIAL OR FULL; STARTING DATE OF INITIAL TEST _____)

APPLICABLE VERIFICATION PLAN: _____

FACILITY DESCRIPTION: _____

LOCATION: _____

TEST LOG REFERENCE: _____

COMMENTS:

SIGNATURE:

QUALITY ASSURANCE REPRESENTATIVE: _____ DATE _____

COGNIZANT ENGINEER FOR TEST ITEM: _____ DATE _____

Figure 3-1a

At the instrument level, the CPT shall demonstrate that, with the application of known stimuli, the instrument will produce the expected responses. At lower levels of assembly, the test shall demonstrate that, when provided with appropriate stimuli, internal performance is satisfactory and outputs are within acceptable limits.

3.3.2.2 Limited Performance Tests. Limited performance tests shall be conducted before, during, and after environmental tests, as appropriate, in order to demonstrate that functional capability has not been degraded by the environmental tests. Limited performance tests are also used in cases where a CPT is not warranted or not practicable. Specific times at which limited performance tests will be conducted shall be prescribed in the Verification Specification. Limited performance tests shall demonstrate that the performance of selected functions is within acceptable limits.

3.3.2.3 Limited Life Electrical Elements. A life test program shall be considered for electrical elements that have limited lifetimes. The Verification Plan shall address the life test program, identifying the electrical elements that require such testing, describing the test hardware that will be used, and the test methods that will be employed. Limited life electrical items shall be included in the Limited Life List as required in Section 7 of this document.

3.3.2.4 Trouble Free Performance Testing. At the conclusion of the performance verification program, instruments shall have demonstrated minimum reliability acceptability by trouble-free performance testing for at least the last 100 hours of (combined) testing prior to launch. Trouble-free operation during the thermal vacuum test exposure and during testing of the integrated observatory may be included as part of the demonstration. Major hardware changes during or after the verification program shall invalidate previous demonstration.

3.4 STRUCTURAL AND MECHANICAL REQUIREMENTS

3.4.1 GENERAL REQUIREMENTS

The developer shall demonstrate compliance with structural and mechanical requirements with a series of interdependent test and analysis activities. The baseline requirements are stated in the General Instrument Interface Specification (GIIS) (for EOS) and the respective individual instrument UIID and ICDs; they will be updated, based on the results of modal survey of the EOS observatory and the designated location of the instrument. The demonstrations shall verify design and specified factors of safety, ensure interface compatibility with the EOS observatory, acceptable workmanship, and compliance with associated systems safety requirements. In the event that modal survey of the

Observatory shows the baseline environments for any instrument to be inadequate, verification and/or design modifications may be required.

3.4.2 REQUIREMENTS SUMMARY

Table 3-1 specifies the structural and mechanical verification activities. When planning the tests and analyses, the developer shall consider all expected environments including those of structural loads, vibroacoustics, mechanical shock, and pressure profiles. Mass properties and mechanical functioning shall also be verified.

3.4.3 STRUCTURAL LOADS

3.4.3.1 Verification for Design Qualification. Verification for the structural loads environment shall be accomplished by a combination of test and analysis. An analysis shall be performed to ascertain the resonant frequencies of the instrument's fixed base modes. Where the analysis clearly shows the fundamental frequency to be above 100 Hz, verification by test is not required. For instrument structures whose analysis indicates a resonant frequency below 100 Hz, a sine sweep shall be performed to determine the fundamental resonant frequency. Where this is found to be below 70 Hz, a modal survey shall be performed to verify that the analytic model of the Instrument hardware adequately represents its dynamic characteristics. Test verification for instruments with fundamental fixed-base modes above 70 Hz may be limited to the frequency verification test (low level sine sweep). Instruments with fundamental fixed-base modes above 100 Hz shall supply an analytical rigid mass representation. The test-verified model will be used in a coupled loads analysis at the Observatory level to predict for the instrument the maximum expected load for each potentially critical loading condition, including all launch environments, handling and transportation, and vibroacoustic effects during lift-off. The maximum loads resulting from the analysis define the limit loads.

The usual method of verifying adequate strength is to apply a set of loads equal to 1.25 times the limit loads after which the instrument hardware must be capable of meeting its performance criteria. Standard design criteria require that the strength verification test be accompanied by a stress analysis that predicts that no ultimate failure will occur at loads equal to 1.40 times limit and that yielding will not occur at loads equal to 1.25 times limit. If appropriate development tests are performed to verify accuracy of the stress model, and stringent quality control procedures are invoked to ensure conformance of the structure to the design, then strength verification may be accomplished by a stress analysis that demonstrates that the

Table 3-1 Structural and Mechanical Verification Requirements

Requirement	Observatory*	Instrument	Component**
Structural Loads			
Modal Survey	A/T	A/T	-
Loads Test			
- Design Qual.	A/T	T	-
- Struct. Rel.	A/T	A/T	A/T
Vibroacoustics			
- Acoustics	T	T	T1
- Random Vibration	-	T	T2
Mechanical Shock	T	T	-
Mechanical Function	A, T	T	-
Pressure Profile	-	A, T1	-
Mass Properties	A, T1	A/T	-

T = Test required

T1 = Test must be performed if indicated by analysis or other considerations.

T2 = Separate additional test at component level is normally required, but may be waived in special cases, such as for small instruments.

A = Analysis required.

A/T = Analysis and/or test

* = Observatory requirements apply when instrument is integrated. (Observatory testing is responsibility of integration contractor.)

** = Requirements for components (boxes) of the instruments.

hardware has positive margins on yield at loads equal to 2.0 times the limit load, and positive margin on ultimate at loads equal to 2.6 times the limit load. Analysis shall not be used to verify strength of elements fabricated from composite materials. The wider range of strength associated with composite structures must be taken into account by additional demonstrations such as development tests, proof tests and larger design factors.

The developer shall analyze all flight structures as well as all test structures that are subjected to the flight hardware test environments. The analyses shall utilize design limit loads predicted for all flight and testing environments and shall include all required factors of safety. The analysis shall be performed in accordance with commonly accepted methods and assumptions and culminate with a set of Margins of Safety (M.S.) equations. Buckling, crippling, and shear failures shall be considered as ultimate failures.

The stress report shall be delivered in accordance with Appendix C, herein. The analysis shall be updated when the test-verified model is delivered. As a minimum, it shall contain the following:

- a. Stress analysis results for current design limit loads, with yield and ultimate factors applied as specified above.
- b. Comprehensive M.S. Summary for all load cases.

The initial stress assignment shall be based on the preliminary design loads. The developer shall keep the M.S. Summary updated as the design of the structure changes, mathematical models are refined, and/or new loads analyses are performed.

The use of materials that are susceptible to brittle fracture or stress-corrosion cracking require development of, and strict adherence to special procedures to prevent problems. It is emphasized that all structural elements shall be in compliance with the provisions of Section 4.3.

3.4.3.2 Acceptance Requirements. Structural loads testing to limit levels is required for all flight hardware (see par. 4.3).

3.4.4 VIBROACOUSTICS

3.4.4.1 Verification for Design Qualification. For the vibroacoustics environments, limit levels are equal to the maximum expected flight environment. The verification level is defined as the limit plus 3 Db. When random vibration levels are determined, responses to the acoustic inputs plus the effects of vibration transmitted through the structure shall be considered. As a minimum, component random vibration levels shall be sufficient to demonstrate acceptable workmanship. For

qualification of hardware, tests shall be conducted at verification (protoflight) levels.

3.4.4.2 Acceptance Requirements. For the acceptance testing of previously qualified hardware, testing shall be conducted at the maximum expected flight levels (based on modal survey of the Observatory).

3.4.5 MECHANICAL SHOCK

3.4.5.1 Verification for Design Qualification. Both self-induced and externally induced shocks shall be considered in defining the mechanical shock environment. All instruments shall be exposed to all self-induced shocks by actuation of the shock-producing devices. Each device must be actuated a minimum of two times in order to account for the scatter associated with different actuations of the same device. In addition, when the most severe shock is externally induced, a suitable simulation of that shock shall be applied at the instrument interface. When it is feasible to apply this shock with a controllable shock generating device, the verification level shall be 1.4 times the maximum expected value at the instrument interface, and shall be applied once in each of the three axes. If it is not feasible to apply the shock with a controllable shock generating device (e.g., the instrument is too large for the device), this test may be conducted at the instrument level by actuation of the shock-producing devices in the instrument-integrated payload which produce the shocks external to the instrument to be tested. The shock-producing device(s) must be actuated a minimum of two times for this test.

3.4.5.2 Acceptance Requirements. Mechanical shock test requirements do not apply to the acceptance testing of previously qualified hardware if the original basis for qualification is still valid for the new application.

3.4.6 MECHANICAL FUNCTION

3.4.6.1 Verification for Design Qualification. A kinematic analysis of all instrument mechanical operations is required (a) to ensure that each mechanism can perform satisfactorily and has adequate margins under worst-case conditions, (b) to ensure that satisfactory clearances exist for both the stowed and operational configurations as well as during any mechanical operation and (c) to ensure that all mechanical elements are capable of withstanding the worst-case loads that may be encountered. In addition, instrument verification tests are required to demonstrate that the installation of each mechanical device is correct and that no problems exist that will prevent proper operation of the mechanism during mission life.

Instrument verification tests are required for each mechanical

operation at nominal, low, and high energy levels. To establish that functioning is proper for normal operations, the nominal test shall be conducted at the most probable conditions expected during normal flight. A high-energy test and a low-energy test, shall also be conducted to prove positive margins of strength and function. The levels of these tests shall demonstrate margins beyond the nominal conditions by considering adverse interaction of potential extremes of parameters such as temperature, friction, spring forces, stiffness of electrical cabling or thermal insulation, and, when applicable, spin rate. Parameters to be varied during these high- and low-energy tests shall include, to the maximum extent practicable, all those that could substantively affect the operation of the mechanism, as determined by the results of analytic predictions or development tests. As a minimum, however, successful operation at temperature extremes 10 degrees C beyond the range of expected flight temperatures shall be demonstrated.

3.4.6.2 Acceptance Requirements. Verification testing of instrument mechanical operation is required only at the nominal condition for the acceptance of previously qualified hardware if the original basis for qualification is still valid for the new application.

3.4.6.3 Life Testing. Mechanical elements that move repetitively in their normal function shall be identified and verified for adequate useful life expectancy for the mission. They shall be included in the Limited-Life List as required in Section 7 of this document. Life testing methods and hardware to be used shall be described in the Verification Plan and Specification. Verification of useful lifetime by analysis shall require a description of rationale (for not testing) and supporting analyses for each element that is not tested.

3.4.7 PRESSURE PROFILE

3.4.7.1 Verification for Design Qualification. The need for a pressure profile test shall be assessed for all instruments and components. A verification test shall be performed if analysis does not indicate a positive margin at loads equal to twice those induced by the maximum expected pressure differential during launch. If a test is required, the limit pressure profile is determined by the predicted pressure-time profile for the nominal trajectory of the particular mission. Because pressure-induced loads vary with the square of the rate of change, the verification pressure profile is determined by multiplying the predicted pressure rate of change by a factor of 1.12 (the square root of 1.25, the required verification factor on load).

3.4.7.2 Acceptance Requirements. Pressure profile test requirements do not apply for the acceptance testing of previously qualified hardware.

3.4.8 MASS PROPERTIES

Hardware mass property requirements for the instruments are stated in the EOS GIIIS and the respective individual instrument UIID and/or ICD. The developer's mass properties program must include an analytic assessment of the instrument's ability to comply with the mission requirements, supplemented as necessary by measurement.

3.5 ELECTROMAGNETIC COMPATIBILITY (EMC) REQUIREMENTS

3.5.1 GENERAL REQUIREMENTS

The general requirements for electromagnetic compatibility are stated below:

- a. The instrument and its components shall not generate electromagnetic interference that could adversely affect its own elements, other payload instruments, the EOS observatory, or the safety and operation of the launch vehicle and launch site.
- b. The instrument and its components shall not be susceptible to emissions that could adversely affect their safety and performance. This applies whether the emissions are self-generated or derive from other sources, or whether they are intentional or unintentional. The requirements in this document include an assurance that the instrument can operate satisfactorily within the environments usually encountered during integration and ground testing. However, some instruments may have particularly sensitive sensors and electrical devices that are inherently susceptible to the EMI that may be expected in those ground environments; in such cases, special work-around procedures must be developed to meet individual instrument needs.

3.5.2 REQUIREMENTS SUMMARY

3.5.2.1 The Range of Requirements. The developer shall demonstrate compliance with the general requirements of paragraph 3.5.1 by conducting an EMC test program in accordance with Table 3-2 and Section 2.5 of GEVS-SE and the Observatory EMI/EMC Control Plan. Table 3-2 prescribes tests at the component and instrument levels of assembly. Not all tests apply to all levels of assembly or to all types of instruments. The developer shall select the requirements that fit the characteristics of the mission and hardware, e.g., a transmitter would require a different group of EMC tests than a receiver. Symbols in the hardware columns will assist in the selection of an appropriate EMC test program.

3.5.2.2 Basis of the Tests. A description of the individual EMC tests listed in Table 3-2, including their nominal limits and

Table 3-2 EMC Requirements per Level of Assembly

Type	Test	GEVS-SE Para. #	Component	Instrument	Observatory (*)
CE	DC power leads	2.5.2.1a 2.5.2.1b	R R	R R	-
CE	Antenna terminals	2.5.2.1e	R	-	-
RE	AC magnetic fields	2.5.2.2b	R	R	R
RE	E-fields	2.5.2.2c 2.5.2.2d	R R	R R	R R
RE	Payload xmitters	2.5.2.2e	-	-	**
RE	Spurious (xmitter antenna)	2.5.2.2f	-	R	-
CS	Pwr lines	2.5.3.1a	R	R	-
CS	Pwr line transients	2.5.3.1e	R	R	-
CS	Inter-modulation products	2.5.3.1b	R	-	-
CS	Signal rejection	2.5.3.1c	R	-	-
CS	Cross modulation	2.5.3.1d	R	-	-
RS	E-field (general)	2.5.3.2a	R	R	R
RS	Magnetic field susceptibility	2.5.3.2d	R	R	R
	Magnetic properties	2.5.4	R	R	R

CE - Conducted Emission; CS - Conducted Susceptibility.
 R - Test to ensure reliable operation of hardware, and to help ensure compatibility with the ELV and launch site.
 RE - Radiated Emission; RS - Radiated Susceptibility.
 * - Observatory requirements apply when instrument is integrated; Test is Observatory contractor responsibility.

** - Must meet any unique requirements of the ELV and launch site for transmitters that are on during launch.

test procedures, is provided in section 2.5 of the GEVS-SE. Most of the tests are based on the requirements of MIL-STD-462, MIL-STD-461 and MIL-STD 463. The specific limits (levels) shall be as defined in the Observatory EMI/EMC Control Plan. The tests and their limits may be revised as appropriate for a particular instrument or mission if GSFC project approval is obtained. More stringent requirements may be necessary, as for example for an instrument with very sensitive electric field or magnetic field measurements. The tests and their limits shall be documented in the Verification Specification (par. 3.2.2).

Additional EMC requirements may also be placed on the Observatory by the launch vehicle organization or as a result of the launch site radiation environment; these requirements will be established during coordination between the EOS Project and the cognizant launch vehicle/site organizations. Corresponding flow-down of such additional requirements to the instrument will be negotiated similarly between the EOS Instrument Project Office and the developer.

3.6 VACUUM, THERMAL, AND HUMIDITY REQUIREMENTS

3.6.1 GENERAL REQUIREMENTS

The following instrument (or instrument equipment) capabilities shall be demonstrated to satisfy requirements in the vacuum, thermal, and humidity areas:

- a. The instrument shall perform satisfactorily in the vacuum and thermal environment of space.
- b. The thermal design and the thermal control system shall maintain the affected hardware within the established mission thermal limits.
- c. The hardware shall withstand, as necessary, the temperature and humidity conditions of fabrication, assembly, transportation, and storage.

3.6.2 SUMMARY OF REQUIREMENTS

Table 3-3 summarizes the tests and analyses that collectively will serve to fulfill the general requirements of 3.6.1. Tests noted in the table may require supporting analyses and vice versa. The order in which demonstrations are conducted shall be determined by the developer and specified in the Verification Plan (3.2.1).

Table 3-3 Vacuum, Thermal, and Humidity Requirements

Requirement	Observatory*	Instrument/ Component
Thermal-Vacuum	T	T1
Thermal Balance	T/A	**
Temperature-humidity (integration and checkout with ELV)	A	A ***
Temperature-Humidity (Transportation & Storage)	A	A ***
Leakage(1)	T3	T2

(1) = Hardware that passes this test at a lower level of assembly need not be retested at a higher level unless there is reason to suspect its integrity.

T = Test required.

A = Analysis required; tests may be required to substantiate the analysis.

T/A = Test is highly desirable, however an analysis is mandatory.

* = Observatory requirements apply when instrument is integrated. (Observatory testing is the responsibility of the integration contractor.)

** = Test required at instrument level, but not at component (box) level unless otherwise specified.

*** = Requirement pertains to instrument level; not component.

T1 = Test required at instrument level. Additional cycles at component level required if needed for components to see a total of 8 T-V temperature cycles before shipment of the instrument.

T2 = Test required for sealed items only at component level or instrument level.

T3 = Test required for sealed items only.

3.6.3 THERMAL-VACUUM

3.6.3.1 General Requirements. The thermal-vacuum test shall demonstrate the ability of the instrument to perform satisfactorily in functional modes representative of the mission in vacuum at the nominal mission operating temperatures, at temperatures 10 degrees C beyond the predicted mission extremes, and during temperature transitions. The test shall also demonstrate the ability of the instrument to perform satisfactorily after being exposed to the predicted nonfunctional extremes of the mission, including the 10 degrees C margin. Cold turn-on's shall be demonstrated where applicable.

Prior to instrument delivery, components shall be subjected to a minimum of 8 thermal-vacuum (T-V) temperature cycles, at least two of which shall be at the instrument level. (As a part of observatory testing, they will be subjected to an additional 4 T-V temperature cycles.) During any thermal-vacuum cycling, the rate of temperature change shall not exceed 20 degrees C. per hour, and soak times at temperature extremes shall not start until equilibrium is reached. Components shall be soaked for a minimum of 4 hours at each hot and cold temperature extreme of each cycle. For the (2 mandatory) instrument-level tests, the instrument shall be subjected to a minimum of 2 thermal-vacuum temperature cycles, during which the instrument shall be soaked for a minimum of 16 hours at each temperature extreme of each cycle. The developer shall state in the Verification Plan (par. 3.2.1) the proposed testing scenario for the instrument and its components. The hardware at all levels of assembly shall be operated and its performance monitored throughout the test. Instrument turn-on capability shall be demonstrated at least twice during the low temperature extremes. The ability to function through the voltage breakdown region, if applicable, shall be demonstrated.

Temperature excursions during the cycling of components shall be sufficiently large to detect latent defects in workmanship. Cold turn-on capability shall be demonstrated as part of the thermal-vacuum testing at the component level, whenever appropriate. Components that are determined by analysis to be insensitive to vacuum effects may be temperature cycled at normal room pressure in an air or gaseous nitrogen environment.

Outgassing procedures that are found necessary (see Section 9.0) may be made part of the thermal-vacuum test operations if no unacceptable hazards are introduced by these procedures.

3.6.3.2 Acceptance Requirements. For the acceptance testing of previously qualified hardware, testing shall be conducted at the predicted mission extreme temperatures at the instrument interface.

3.6.4 THERMAL BALANCE

3.6.4.1 Verification for Design Qualification. This verification shall demonstrate the validity of the thermal design and the ability of the thermal control system to maintain the instrument within the established thermal limits for the mission. The analytical thermal model shall be validated by tests conducted on a (hardware) thermal model or the flight instrument. The capability of the thermal control system shall be demonstrated in the same manner. If the flight instrument is not used in the test of the control system, verification of critical thermal properties (such as those of the thermal control coatings) shall be performed to demonstrate similarity between the item tested and the flight instrument. Although it is desirable to perform the test on a complete instrument it may be impracticable to do so; therefore, the demonstration may be accomplished by combining test and analysis.

3.6.4.2 Acceptance Requirements. The thermal balance verification may be waived in the case of previously qualified hardware if there is valid similarity between the new and original applications. Analyses/tests shall be conducted to verify the thermal similarity of the two applications.

3.6.5 TEMPERATURE-HUMIDITY: INTEGRATION, CHECKOUT, TRANSPORTATION AND STORAGE

3.6.5.1 Verification for Design Qualification. Analysis and, when necessary, test shall demonstrate that flight hardware that is not maintained in a controlled temperature-humidity environment to within demonstrated acceptable limits will perform satisfactorily after exposure to the uncontrolled environment.

The test shall include exposure of the hardware to the extremes of temperatures and humidities as follows: 10 degrees C and 10 percent RH (but not greater than 95 percent RH) higher and lower than those predicted for the transportation and storage environments. The exposure at each extreme shall be for a period of 6 hours.

3.6.5.2 Acceptance Requirements. The 10 degrees C temperature margin and the 10 percent RH margin may be waived for previously qualified hardware.

3.6.6 LEAKAGE

This test shall demonstrate that leakage rates of sealed instrument hardware are within the prescribed mission limits. Leakage rates shall be checked before and after stress-inducing portions of the verification program to disclose anomalies caused by that portion. The final check may be conducted during the final thermal-vacuum test.

Checks at the instrument level need include only those items that have not demonstrated satisfactory performance at the component level or are not fully assembled until the higher levels of integration.

3.7 END-TO-END TEST REQUIREMENTS

3.7.1 COMPATIBILITY TEST

System end-to-end testing of the instrument at the observatory level is the responsibility of the EOS system contractor. This testing will be performed by that contractor at the EOS observatory level of assembly. The developer shall support this test effort as it applies to the developer's instrument integrated with the Observatory.

3.7.2 MISSION SIMULATIONS

After completion of the end-to-end compatibility test, data flow tests shall be performed utilizing the total system in a realistic mission timeline, including external stimulus of the instruments and attitude control sensors, when practicable.

Telemetry and command demonstrations shall be conducted, incorporating all the required equipment: appropriate Network elements, Nascom, EOS Operations Center (EOC), Instrument Control Facility (ICF), data processing facilities, and, when available, the users' Instrument Support Terminal. Once the data flow paths have been verified, mission simulations will be held to validate nominal and contingency mission operating procedures and to provide for operator familiarization training. The developer shall participate in mission simulations in order to provide ample time for checkout of the developer's EOC software and hardware configurations.

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SECTION 4

SYSTEM SAFETY REQUIREMENTS

4.1 GENERAL REQUIREMENTS

The developer shall plan and conduct a system safety program for the instrument and developer supplied ground support equipment (GSE) that accomplishes the following:

a. Provides for the identification and control of hazards to personnel, facilities, support equipment, and flight systems during all stages of project development and integration. The program shall also consider hazards in the flight hardware, software, and associated equipment and potential malfunctions in instrument GSE that may affect the EOS Observatory or the launch vehicle.

b. Satisfies the applicable guidelines, constraints, and requirements stated in the revisions of the following documents current at time of Contract Award:

(1) WSMCR 127-1, Western Space and Missile Center, Range Safety Requirements

(2) MIL-STD-1574, System Safety Program for Space and Missile Systems

c. Interfaces effectively with the industrial safety requirements of the contract and the developer's existing safety program.

d. Meets flammability requirements stated in par. 6.2.4, herein.

4.2 SYSTEM SAFETY IMPLEMENTATION PLAN (SSIP)

The developer shall prepare and submit a System Safety Implementation Plan (SSIP) that constitutes Section 4 of the PAIP (see par. 1.3). The developer documents referenced therein shall be submitted with the plan.

The SSIP shall describe the safety program requirements, the plan for implementing them, and shall reference the detailed procedures the developer will invoke to ensure the identification and control of hazards to personnel and hardware during fabrication, tests, transportation, ground activities, launch, and mission operations.

The plan shall address the following areas: system safety organization, interfaces, and responsibilities; system safety

methodologies; internal and external safety review process; launch site safety; verification and operating procedures; hazardous operation surveillance; accident investigation and reporting; operator training and certification; safety audits; monitoring of subcontractors; documentation to be provided; milestone schedule of all major system safety activities which shows their time phasing with other related major activities; procedure for reporting problems and activity status; and the industrial safety program responsibilities, functions, and interfaces with the system safety program.

4.3 STRUCTURAL INTEGRITY AND FRACTURE CONTROL

Verification of the structural integrity of the instrument is required (see par. 3.4.3). When protoflight testing to verify the structural design is conducted, no further verification of fracture control is required. Where such testing is not required, or for follow-on hardware (which is not normally subjected to protoflight testing), the developer shall verify structural integrity by subjecting the instrument hardware to an appropriate series of proof loads tests to limit levels.

4.4 ANALYSES

4.4.1 HAZARD ANALYSES

Early in the design phase the developer shall perform hazard analyses to identify any potential hazard(s) originating from the instrument or developer provided GSE. The analyses shall be performed at the component and instrument levels and shall identify all hazards affecting personnel, ELV hardware, the Observatory, observatory GSE, instrument GSE, other payload instruments, or the developer's instrument. The analyses shall be oriented to the requirements/hazards areas identified in Chapters 3 and 5 of WSMCR 127-1 and shall provide all information necessary to complete the hazard identification and elimination/control requirements of the "Accident Risk Assessment Report" (ARAR) as applicable to the instrument. A separate Payload Hazard Report (Figs. 4-1 & 4-2) shall be generated for each specific hazard identified. The hazard report shall document the causes, controls, and verification methods for each hazard.

Throughout the instrument development effort, the developer shall take measures to eliminate or to minimize the effects of each hazard identified. The hazard analysis and reports shall be updated as the hardware progresses through the stages of design, fabrication, test, transportation, integration, and launch. Hazard analysis reports and their updates shall be submitted in accordance with Appendix C herein.

Summaries of the hazard analysis reports and the status of hazard

control efforts shall be reported at design and readiness reviews (Par. 4.7).

4.4.2 OPERATIONS HAZARD ANALYSES

When the use of a facility or when the performance of an activity could result in subjecting the instrument or personnel to hazards, an Operations Hazard Analysis (OHA) shall be performed to identify the hazards and document the requirements for either eliminating or adequately controlling each hazard. Operations that may require analyses include handling, transportation, functional tests, and environmental test. A report of each OHA performed shall be submitted in accordance with Appendix C herein.

4.5 HAZARD CONTROL VERIFICATION

Verification of the control of all hazards shall be accomplished by test, analysis, inspection, similarity to previously qualified hardware, or any combination of these activities. Reports of such verifications performed by the developer shall be submitted in accordance with Appendix C herein.

4.6 PROCEDURE APPROVAL

The developer's safety engineer shall review and approve all procedures affecting flight hardware and developer provided GSE for conformance with the SSIP. Hazardous operations shall be identified and procedures to control them shall be developed and implemented.

4.7 REVIEWS

The systems safety status shall be examined at the GSFC Flight Assurance Reviews as well as at other applicable WSMC safety reviews. The developer shall submit the current safety data at the time of PDR, CDR, PER and all flight readiness reviews (See par. 2.3). The developer shall provide technical support to the NASA project office for all safety reviews. The developer shall review the systems safety program of subcontractors.

4.8 WAIVER

When a specific safety requirement can not be met, the developer shall submit a waiver request (DOD Form 1694, see Figure 4-3). The waiver request shall state the requirement that cannot be met, the reason it cannot be met, the proposed method of controlling the additional risk, and the residual risk after application of the additional controls. Each waiver request shall address only one hazard and shall be submitted in accordance with Appendix C herein as soon as it is determined that one is required.

4.9 SAFETY COMPLIANCE DATA PACKAGE

The developer shall submit to NASA a safety compliance data package relative to the instrument which complies with the requirements of WSMCR 127-1 for an ARAR (see par. 4.4.1, herein). The content of the package shall be appropriate to the phase of the program at the time of delivery. The developer shall update the package as necessary to meet requirements for the instrument's portion of an acceptable Observatory package. The data package shall be submitted to NASA in accordance with Appendix C herein.

4.10 LAUNCH COMPLEX SAFETY PLAN (LCSP)

The developer shall submit a Launch Complex Safety Plan (as outlined in par. 5.7 of WSMCR 127-1) to NASA in accordance with Appendix C herein. This Plan shall describe the composition and organization of the developer's launch complex support team, as well as all procedures for transportation, lifting, servicing, and testing of the instrument at the launch site (including those for operations considered to be non-hazardous by the developer).

4.11 SPACE BASED NON-IONIZING RADIATION SOURCES

Developers of instruments containing non-ionizing radiation sources shall provide a usage plan in accordance with Appendix C, herein. The plan shall describe the type of radiation, power, wavelength, and beam divergence of the source, as well as planned pointing vectors and mission times of operation.

PAYLOAD HAZARD REPORT		No.
PAYLOAD		PHASE
SUBSYSTEM	HAZARD GROUP	DATE
HAZARD TITLE		
APPLICABLE SAFETY REQUIREMENTS		HAZARD CATEGORY
		Catastrophic
		Critical
DESCRIPTION OF HAZARD		
HAZARD CAUSES		
HAZARD CONTROLS		
SAFETY VERIFICATION METHODS		
STATUS OF VERIFICATION		
APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

PAYLOAD HAZARD REPORT CONTINUATION SHEET	No.
Payload	Phase

000-STD-480A
12 April 1978

REQUEST FOR DEVIATION/WAIVER
(SEE MIL-STD-100 OR 401 FOR INSTRUCTIONS)

DATE PREPARED

PROCURING ACTIVITY NO.

1. ORIGINATOR NAME AND ADDRESS				2. <input type="checkbox"/> DEVIATION <input type="checkbox"/> WAIVER	
				3. <input type="checkbox"/> MINOR <input type="checkbox"/> MAJOR <input type="checkbox"/> CRITICAL	
4. DESIGNATION FOR DEVIATION/WAIVER				5. SAME LINE ITEM?	
6. MODEL/TYPE	7. MFG. CODE	8. STD. DESIG.	9. REVISED NO.	10. OTHER SPECIFICATIONS/PARTS ITEMS AFFECTED	
				<input type="checkbox"/> YES <input type="checkbox"/> NO	
7. SPECIFICATIONS AFFECTED-TEST PLAN			8. DRAWINGS AFFECTED		
9. SYSTEM	MFG. CODE	SPEC./MFG. NO.	REV.	MFG. CODE	DRAWING NUMBER
10. ITEM					
11. TEST PLAN					
9. TITLE OF DEVIATION/WAIVER				10. CONTRACT NO. & LINE ITEM	
11. CONTINUATION ITEM IDENTIFICATION				12. CLASSIFICATION OF DEFECT	
				<input type="checkbox"/> MINOR <input type="checkbox"/> MAJOR <input type="checkbox"/> CRITICAL	
13. NAME OF PART OR LARGEST ASSEMBLY AFFECTED		14. PART NO. OR TYPE DESIG.		17. LOT NO.	18. QTY
15. EFFECT ON COST/PRICE				19. DECLARING DEVIATION/WAIVER	
				<input type="checkbox"/> YES <input type="checkbox"/> NO	
16. EFFECT ON INTEGRATED LOGISTIC SUPPORT, INTERFACE, ETC.				21. EFFECT ON DELIVERY SCHEDULE	
23. DESCRIPTION OF DEVIATION/WAIVER					
20. REASONS FOR DEVIATION/WAIVER					
22. PRODUCTION EFFECTIVENESS BY SERIAL NUMBER					
26. SUBMITTING ACTIVITY & REGULATING STRUCTURE				TITLE	
27. APPROVAL/DISAPPROVAL					
28. <input type="checkbox"/> APPROVAL RECOMMENDED			29. <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED		
30. SUBMITTING ACTIVITY				DATE	

DD FORM 1694

Figure 4-3

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SECTION 5

EEE PARTS CONTROL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

The developer shall plan and conduct an Electrical, Electronic, and Electromechanical (EEE) parts control program for the flight hardware based on the requirements of a modified Grade 1 parts quality level as described in the GSFC Preferred Parts List (PPL), MIL-STD-975, NHB 5300.4(1F), and this Section. Under the program, only parts with acceptable, demonstrated performance and reliability shall be used. The parts control program shall be described in a Parts Control Plan (PCP) portion of the PAIP (see par. 1.3) and shall include the plans for maintaining environmental controls for EEE parts at all times. This shall include temperature, humidity, and particulate contamination controls, and also electrostatic discharge (ESD) controls for parts which are susceptible to ESD damage. The plan shall also contain criteria for testing parts taken from storage.

5.2 ORDER OF PARTS SELECTION

5.2.1 CRITICAL APPLICATIONS

For critical applications (See par. 7.3), parts shall be selected for use in the order shown below and shall be identified on the respective parts identification lists as being used in a critical application. Critical applications are defined as part applications in circuits or assemblies whose failure, without regard to redundancy, would be critical or catastrophic to the mission. The order of selection shall be:

1. Standard Grade 1 parts.

2. Nonstandard parts specified to requirements similar to those for the nearest standard Grade 1 part. If there is a standard Grade 1 part listed in MIL-STD-975, a nonstandard part shall not be used.

5.2.2 NONCRITICAL APPLICATIONS

For noncritical applications (applications that do not meet the definition of "critical"), parts shall be selected for use in the following order:

1. Standard Grade 1 parts wherever there is a listing in MIL-STD-975.

2. Standard Grade 2 parts if MIL-STD-975 does not list a Grade 1 part.

3. Nonstandard parts specified to requirements similar to those for the nearest standard Grade 2 part. If there is a standard Grade 2 part listed in MIL-STD-975, a nonstandard part shall not be used.

5.3 PARTS CATEGORIES, APPLICATION, AND CONTROLS

5.3.1 STANDARD PARTS

Standard parts are those parts contained in the GSFC Preferred Parts List (PPL) and the NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List, MIL-STD-975 (NSPL). The PPL takes precedence whenever differences in requirements exist between the PPL and MIL-STD-975. A standard EEE part shall be procured in accordance with the specification designated for the part and from the approved sources for the specification.

5.3.2 NONSTANDARD PARTS

Nonstandard parts are any parts not defined above as standard. Grade 2 parts which are used in Grade 1 applications are nonstandard. Any exceptions taken to the requirements of a standard part cause that part to be nonstandard.

5.3.2.1 Nonstandard Parts Control. The developer shall document and approve the selection, application, evaluation, and acceptance criteria for the nonstandard part. The nonstandard parts documentation shall be submitted to NASA for approval in accordance with the Appendix C herein. GSFC Form 4-15, Nonstandard Parts Approval Request (NSPAR) shall be used for the submittal of the required documentation (Figure 5-1a and 5-1b). An equivalent developer form may be used in place of Form 4-15 as long as it contains the information required by GSFC Form 4-15. The minimum contents of the NSPAR package shall be the data necessary to support the information requested on GSFC Form 4-15.

5.3.2.2 Parts Qualification. Nonstandard parts shall have a qualification basis traceable to test and inspection data at the part level in a manner consistent with the specification requirements of the nearest standard parts. The qualification shall be based on parts which have been produced by the same manufacturer using the same manufacturing technology, controls and facilities as the nonstandard parts for which approval is being sought. Nonstandard parts may also be qualified by similarity to parts that have been qualified on previous NASA programs, consistent with the above stated conditions.

5.3.2.3 Nonstandard Parts Specifications. Nonstandard parts shall be at a quality level consistent with that of Grade 1 or Grade 2 standard parts as stated in par. 5.2. Nonstandard parts shall be procured in accordance with military, NASA, or developer controlled specifications prepared in accordance with

paragraphs 3.2, 3.3, and 4 of MIL-STD-490. Specifications for nonstandard parts shall be consistent with the requirements of the nearest applicable standard part.

The specifications or drawings shall fully identify the item being procured and shall include the physical, electrical, environmental, and screening requirements, as well as quality assurance provisions necessary to control manufacture and acceptance. EEE parts screening requirements designated for the part shall be included in the procurement specification or in a supplementary specification; they shall specify test conditions, failure criteria, and lot rejection criteria. For lot acceptance or rejection, the percent of defectives allowable (PDA) in a screened lot shall be in accordance with that prescribed in the closest related military parts specification.

Parts specifications shall require the submission of data to the developer for review and approval of qualification, quality conformance inspection, and screening results when such work is required and is performed by other than the developer.

The specifications shall describe the handling, packaging, and storage controls for the parts. As a minimum, the specification shall address the following: environmental controls for temperature, humidity, and particulate contamination; criteria for testing parts taken from storage; electrostatic discharge (ESD) controls for parts which are susceptible to ESD damage.

5.3.2.4 Hybrid and Custom Microcircuits. Hybrid microcircuits and custom microcircuits, e.g. ASIC, which are not included in the GSFC PPL or NSPL as standard parts are subject to nonstandard parts control. Their selection and approval shall be consistent with the requirements of MIL-H-38534, General Specification for Hybrid Microcircuits or MIL-M-38510, General Specification for Microcircuits, as applicable. Any custom-made microcircuits planned for use by the developer shall be subjected to design review. The developer shall give NASA 10 working days' notification of the review so that representatives may attend at NASA option. The design review shall address, at a minimum: Derating of the elements; the method used to assure that each of the elements comprising the hybrid microcircuit is of a quality level that is consistent with the requirements of the completed microcircuit; and the method used to assure adequate thermal matching of materials.

5.3.3 DERATING

All EEE Parts shall be used in accordance with the derating policy of the PPL and MIL-STD-975. The developer's derating policy may be used in place of the PPL policy if it receives NASA Contracting Officer approval.

Also, derating for ionizing radiation shall be such that a design margin of (2X) is provided for EEE parts used in all EOS flight applications.

5.3.4 RADIATION HARDNESS

Standard and nonstandard parts shall be selected to meet their mission application in the predicted radiation environment. Parts shall be selected to eliminate or minimize the possibility of latch-up from single event upsets induced by cosmic rays. The use of parts that latch-up from integral linear energy transfer (LET) equal to or less than 37,000 MeV-cm²/gm shall be avoided if possible.

The radiation environment, documented in the General Instrument Interface Specification (GIIS), will consist of two separate effects, that of total ionizing dose and that of single event upsets. The developer shall document the rationale for acceptance of each part with respect to both effects. Such rationale shall consist of either test and inspection data or analysis and shall be made available for NASA review upon request.

Flight equipment shall be immune to latch-up from single event upsets induced by cosmic rays. If this immunity is not possible, the flight equipment shall be protected by appropriate latch-up detection and recovery circuitry. The flight equipment shall also be capable of withstanding single event upsets and transients induced by the singular or combined effects of cosmic rays and geomagnetically trapped protons.

5.3.5 SCREENING VERIFICATION TESTS

All JANTXV transistors and diodes shall undergo screening verification tests in accordance with the provisions of the GSFC PPL and MIL-STD-975. Other EEE parts do not require screening verification tests unless one of the following conditions indicates the need: receiving inspection results; destructive physical analysis results; Alerts which are concerned with the part, MIL-STD-975 or GSFC PPL requirements, or such factors as special design drift tolerance.

5.3.6 DESTRUCTIVE PHYSICAL ANALYSIS

A Destructive Physical Analysis (DPA) shall be performed on a sample of each manufacturing lot or lot date code of microcircuits (including hybrid microcircuits), semiconductors, relays, ceramic capacitors, and crystal oscillators. The DPA shall be performed by the developer or other activity that is independent of the part manufacturer. DPA tests, procedures, sample size, and criteria shall be as specified in GSFC specification S-311-70, Destructive Physical Analysis. Any

defect, as defined in S-311-70, seen in any of the DPA samples shall be cause for lot rejection by Parts Control Board (PCB) action (See par. 5.4). Developer procedures for DPA may be used in place of S-311-70 if they have received NASA Contracting Officer approval.

5.3.7 SCREENING FOR PARTICULATE CONTAMINATION

Screening requirements for all parts with internal cavities shall include testing to detect particulate contamination.

5.4 PARTS CONTROL BOARD

The developer shall establish a Parts Control Board (PCB) to assist in the management, selection, standardization, and control of parts and associated documentation for the duration of the contract. The PCB shall also be responsible for review of designs to ensure that the application of parts will maximize the meeting of design life requirements. The organization and proposed membership shall be submitted as part of the PAIP required by Section 1.3.1. The NASA retains the option of designating a Government representative to the PCB. Notification of meetings, including the agenda, shall be provided in sufficient time so that the Government representative may attend. The PCB shall be chaired by the parts program manager or the designated representative thereof. The PCB shall be responsible for the selection and application of parts and for parts failure investigations. The PCB shall approve all nonstandard parts approval requests (NSPARs) before their submission to NASA. Part failures occurring at any time in the flight hardware shall be reported and processed through the Malfunction Reporting system (see par. 8.13.2). Part failures occurring during parts qualification shall be reported on the Malfunction Report Form (Figures 8-1a, b, and c, but shall be processed through the PCB only. Other part nonconformances shall be processed as discrepancies (par. 8.13.1). Part applications that do not meet derating criteria (par. 7.3.3) shall be processed for approval through the PCB. All part problems and part failure investigations and corrective actions shall be investigated and/or reviewed by the PCB. No part failure on flight hardware shall be closed until it has been approved in writing by the designated Government representative (see par. 8.13.2.2).

5.5 PARTS IDENTIFICATION LISTS

EEE parts identification lists (for as-designed and as-built configurations) shall be prepared for each component in the system. The lists shall be prepared, maintained, and updated by the developer in accordance with the requirements of this Section and paragraphs 8.4 and 8.23. All submissions to NASA shall be submitted in accordance with Appendix C herein and shall include

a hard-copy of the data and a copy on one of the following magnetic media as an ASCII file (with hard-copy documentation of file structures and file names).

- a. 1600 bit per inch (bpi) unlabeled magnetic tape(s).
- b. Flexible disk(s) compatible with IBM-PC DOS, MS DOS, or other compatible DOS. The disks may be (1) 5.25 inch, double-sided, double-density (DS-DD), 360 kilobyte, (2) 5.25 inch high density (HD), 1.2 megabyte, (3) 3.5 inch, DS-DD, 720 kilobyte, or (4) 3.5 inch, HD, 1.4 megabyte.

5.5.1 AS-DESIGNED PARTS LISTS

Each as-designed parts list shall be a composite of the parts selections for each circuit design in the component. The initial lists shall be updated as the design definition evolves prior to the system Preliminary Design Review (PDR) and shall be updated a second time prior to system Critical Design Review (CDR) to reflect further design changes and refinements. The list shall be placed under configuration control at the time of CDR and be updated as further design changes are approved for the system. The submittals and updates shall be in accordance with Appendix C herein. As a minimum, each as-designed list shall contain the following information:

- (1) Part number proposed (e.g., M39014.01-1234)
- (2) Part specification control drawing number (e.g., MIL-C-39014).
- (3) Common designator or generic number (e.g., CKR05 ceramic capacitor).
- (4) Name or Commercial and Government Entity (CAGE) Code of the part manufacturer or proposed manufacturer.
- (5) Quantity used.
- (6) Drawing number of component to which the list pertains.
- (7) Nonstandard part approval request number and status.
- (8) Applicable waivers/deviations.
- (9) Indication that any data for the line item has changed since the previous parts list submission.
- (10) Critical application designator.

5.5.2 AS-BUILT PARTS LIST

The as-built parts list for each component shall be submitted in accordance with Appendix C herein prior to NASA acceptance of each contract end item as part of the end-item data package. It may be submitted either as a collection of lists for the components making up the end item or as a single composite list. As a minimum, each line item on the parts list(s) shall contain the following information:

- (1) Part number used (e.g., M39014.01-1234)

- (2) Part specification control drawing number (e.g., MIL-C-39014).
- (3) Common designator or generic number (e.g., CKR05 ceramic capacitor).
- (4) Part designation marked on the part.
- (5) Part manufacturer or CAGE code.
- (6) Lot date code/serial number.
- (7) Circuit designator.
- (8) Drawing number of subassembly in which used (or lowest assembly level on which the part is called out).
- (9) Drawing number of component in which used or to which the list pertains.
- (10) Applicable waivers/deviations.
- (11) Indication that any data for the line item has changed since the previous as-designed parts list submission.
- (12) Critical application designator.

NSPAR**PARTS CONTROL****INSTRUCTIONS FOR ENTERING DATA ON GSFC NONSTANDARD PARTS APPROVAL REQUEST****GENERAL**

This NSPAR form is to be used to request approval of the use of a nonstandard part or device for a specific project, i.e., those parts or devices not listed in the GSFC Preferred Parts List or MIL-STD-975.

DETAIL

- Block 1** - Enter the prime contract number.
- Block 2a** - The contractor may assign a serial number to each NSPAR (optional).
- Block 2b** - If this NSPAR is being resubmitted as a result of a prior disapproval, check this block.
- Block 3** - Enter project name in full.
- Block 4a** - Enter the name of the prime contractor.
- Block 4b** - Enter the name of the subcontractor, if applicable.
- Block 5** - Enter the name of the system and component (box) in full for spacecraft systems.
Enter the name of the experiment or instrument for payload items.
- Block 6** - Enter in full, the name of the part; i.e., capacitor, solid tantalum, resistor, wire wound power. (Use listings in the GSFC Preferred Parts List as a guide.)
- Block 7** - Check the part grade requirement as defined by the Project Parts Program Plan (grade 1 or grade 2).
- Block 8** - Enter the part number which uniquely identifies the part. If it is a nonstandard mil part, enter the mil part number. If it is procured in a source control drawing (SCD), enter the SCD number and the dash number associated with the source used. Otherwise, use the commercial designation.
- Block 9** - Enter the commercial number for the parts (manufacturer's commercial catalog no.).
- Block 10** - Enter in full, the name and location of the manufacturer of the part or device and the FSCM number.
(See DOD HANDBOOK H-4-1.)
- Block 11** - Enter the procurement specification and appropriate revision letter to which the part or device is to be procured. If no procurement specification is used enter "Commercial." Attach one copy of applicable document to NSPAR for review.
- Block 12** - Enter the screening specification and appropriate revision letter to which the part or device is to be tested. Attach one copy of applicable document to NSPAR for review.
- Block 13** - Compare the nonstandard part with the closest standard part. Differences may include unique electrical characteristics, package size, etc.
- Block 14** - Enter the basis for acceptance of a nonstandard part. Indicate the qualification status of nonstandard part. Attach one copy of the qualification test data including attributes and variables data. The criteria for qualification by similarity includes similarity of design and function and includes fabrication by same manufacturer using the same process and quality controls as the standard part. If prior usage on NASA spacecraft is used as basis for acceptance indicate the programs where used with launch dates and orbital life. The part application must be congruent with that used in prior programs. Attach one copy of the qualification test plan to be used if none of the above is applicable.
- Block 15** - For NSPAR's generated by the prime contractor and/or subcontractor enter the signature and title of the preparer, the parts/reliability engineer and the project program manager or his designated representative. Subcontractor NSPAR's shall be submitted to the prime contractor for review and sign-off prior to forwarding to GSFC. The signatures provide that the NSPAR has been reviewed by appropriate contractor personnel and that the information included is accurate and complete.

Figure S-1b

GSFC 420-05-01

SECTION 6

MATERIALS AND PROCESSES CONTROL REQUIREMENTS

6.1 GENERAL REQUIREMENTS

The developer shall plan and implement a comprehensive Materials and Processes (M&P) Program in accordance with the requirements of this Section and Section 1.3. The activities of the M&P program shall begin with the design stage of the hardware and shall help ensure the safety and success of the mission by the proper selection and treatment of the materials of construction.

6.2 SELECTION REQUIREMENTS

6.2.1 CONVENTIONAL APPLICATIONS

Selection of materials and processes shall be based upon past performance, available data, or current tests. The developer shall utilize the applicable documents listed in Appendix A.

6.2.2 NONCONVENTIONAL APPLICATIONS

Any use of a material for which there is a lack of aerospace experience, such as composites or brittle ceramic materials, shall be considered a nonconventional application. In that case, the material shall be verified for the desired application on the basis of similarity, analysis, test, inspection, existing data, or a combination of these methods.

6.2.3 SPECIAL PROBLEM AREAS

The developer shall give special attention to problem areas such as radiation effects, stress-corrosion cracking, galvanic corrosion, hydrogen embrittlement, lubrication, contamination of cooled detectors, weld heat-affected zones and composite materials. Critical high-strength fasteners and pressurized systems shall be reviewed from a structural integrity viewpoint (see par. 4.3) before they are accepted for use.

6.2.4 ORGANIC MATERIALS

Materials shall be noncombustible or self-extinguishing to the greatest extent possible and conform with the flammability requirements of the Eastern Space and Missile Center Regulation (ESMCR), ESMCR 127-1, paragraph 3.10 and WSMCR 127-1, par 3.10. Where flammable materials must be used, the standard hazard elimination and control requirements apply, as follows: (a) two failure tolerance on ignition sources, (b) physical separation of the flammable material from ignition sources, and (c) elimination of flame propagation paths. The outgassing characteristics of

organic materials in vacuum shall be a prime consideration in their selection. Only those organic materials with a total mass loss (TML) of less than 1.00 percent and a collected volatile condensable mass (CVCM) of less than 0.10 percent when tested in accordance with ASTM Method E595-77 (Appendix A), are acceptable for general spaceflight use. Specific mission contamination control requirements may dictate more stringent outgassing criteria.

6.2.5 INORGANIC MATERIALS

The criteria specified in MSFC-SPEC-522 (see Appendix A) shall be used to select metallic materials to control stress corrosion cracking. Those materials that do not meet the criteria for acceptability shall be defined as noncompliant materials. If any use of such materials is planned, a request to use them including the rationale for such use shall be documented in accordance with MSFC-SPEC-522 in a Material Usage Agreement (MUA) (Figure 6-1a) along with a Stress Corrosion Evaluation Form (Figure 6-1b), and be submitted in accordance with par. 6.4c.

6.2.6 CONSIDERATIONS IN PROCESS SELECTION

Manufacturing processes shall be carefully selected if they are the type that may substantially change a material's properties (e.g., heat treatment, welding, chemical or metallic coatings). The objectives are to maintain the integrity of the materials and to avoid introducing property changes which could cause adverse effects.

6.2.7 SHELF LIFE CONTROLLED ITEMS

Polymeric materials that have a limited shelf life shall be controlled by a program that identifies the starting date (i.e., manufacturer's processing date, shipment date, or date of receipt, etc), the storage conditions associated with a specified shelf life, and the expiration date. Materials such as o-rings, rubber seals, tape, uncured polymers, lubricated bearings, and paints shall be included. The use of materials whose date-code has expired requires GSFC approval of a waiver request based on an adequate justification of need (such as schedule impact) and the developer's demonstration by means of appropriate tests that the properties of the materials have not been compromised for their intended use. Waiver requests shall be submitted in accordance with Appendix C herein. Fabricated items such as "O" rings that have out-of-date codes shall not be installed in flight hardware.

6.3 MATERIALS REVIEW

A developer materials engineer shall review the applications of the proposed materials and processes on the basis of engineering

drawings before approving their use. He shall also audit and consult with all subtier contractors and vendors to assure himself that their materials and processes are acceptable for the applications.

6.4 DOCUMENTATION

The following shall be submitted to NASA in accordance with Appendix C herein:

- a. Data supporting nonconventional application of materials.
- b. Engineering drawings for materials application.
- c. Material Usage Agreement/Stress Corrosion Evaluation Form (per MSFC Spec 522) when use of a noncompliant material is requested (Figures 6-1a and 6-1b).
- d. Polymeric Materials List. The list shall be prepared and documented on GSFC Form 18-59B (Figure 6-1c).
- e. Inorganic Materials List. The list shall be prepared and documented on GSFC Form 18-59A (Figure 6-1d).
- f. Lubrication List. The list shall be prepared and documented on GSFC Form 18-59C (Figure 6-1e).
- g. Materials Processes List. The list shall be prepared and documented on GSFC Form 18-59D (Figure 6-1f).
- h. As built materials list.

All the above listed items shall at least be submitted in hard-copy form. In addition, submissions of items d, e, f, g and h shall also include a copy of the data on a magnetic medium as an ASCII file (with hard-copy documentation of file structures and file names). The required medium is flexible disk(s) compatible with IBM-PC DOS or MS DOS. The disks may be (1) 5.25 inch, double-sided, double-density (DS-DD), 360 kilobyte, (2) 5.25 inch high density (HD), 1.2 megabyte, (3) 3.5 inch, DS-DD, 720 kilobyte, or (4) 3.5 inch, HD, 1.4 megabyte.

The developer may use his own system of reporting on both of the required media if it provides all the information requested by the GSFC forms and is approved by the Contracting Officer.

MJA

MATERIALS AND PROCESSES

MATERIAL USAGE AGREEMENT		USAGE AGREEMENT NO.:		PAGE OF	
PROJECT:	SUBSYSTEM:	ORIGINATOR:		ORGANIZATION:	
DETAIL DRAWING	NOMENCLATURE	SING ASSEMBLY	NOMENCLATURE		
MATERIAL & SPECIFICATION			MANUFACTURER & TRADE NAME		
USAGE	THICKNESS	WEIGHT	EXPOSED AREA	ENVIRONMENT	
				PRESSURE	TEMPERATURE MEDIA
APPLICATION:					
RATIONALE:					
ORIGINATOR:		PROGRAM MANAGER:		DATE:	
MSFC/MATERIALS & PROCESSES LABORATORY			MATERIALS APPLICATIONS EVALUATION BOARD		
<input type="checkbox"/> Accept <input type="checkbox"/> Reject		DATE:	<input type="checkbox"/> Accept <input type="checkbox"/> Reject		DATE:

FIGURE 6-1a MATERIALS USAGE AGREEMENT

APPENDIX C
STRESS CORROSION EVALUATION FORM

1.	Part Number _____
2.	Part Name _____
3.	Next Assembly Number _____
4.	Manufacturer _____
5.	Material _____
6.	Heat Treatment _____
7.	Size and Form _____
8.	Sustained Tensile Stresses-Magnitude and Direction
a.	Process Residual _____
b.	Assembly _____
c.	Design, Static _____
9.	Special Processing _____
10.	Weldments
a.	Alloy Form, Temper of Parent Metal _____
b.	Filler Alloy, if none, indicate _____
c.	Welding Process _____
d.	Weld Bead Removed - Yes (), No () _____
e.	Post-Weld Thermal Treatment _____
f.	Post-Weld Stress Relief _____
11.	Environment _____
12.	Protective Finish _____
13.	Function of Part _____
14.	Effect of Failure _____
15.	Evaluation of Stress Corrosion Susceptibility _____
16.	Remarks: _____

Figure 6-1b Stress Corrosion Evaluation Form

Figure 8-1c GSFC Spacecraft Polymeric Materials List

GSFC SPACECRAFT POLYMERIC TM MATERIALS LIST									
SPACECRAFT		SYSTEM/PERMENN			GSFC ID		ESTIMATE DATE		
CONTRACTOR		ADDRESS			DATE PREPARED		DATE EVALUATED		
PREPARED BY		PHONE			DATE RECEIVED		DATE EVALUATED		
GSFC MATERIALS EVALUATOR		PHONE			DATE RECEIVED		DATE EVALUATED		
ITEM NO.	MATERIAL IDENTIFICATION TM	MRB FORMULA TM	CURE TM	ASSEMBLY TIME	EXPECTED ENVIRONMENT TM	REASON FOR SELECTION TM	LIFE EVALUATION TM		
							A	NA	SA
<p>NOTES</p> <p>(1) List all polymeric (organic) materials total systems except lubrication materials which should be listed on form GSFC 18 59C</p> <p>(2) Give name of material, identifying number, manufacturer E.g. Epoxy, Epan 820, Sher Chem, Co</p> <p>(3) Provide proportions and name of resin, hardener (catalyst), filler, etc E.g. 820/V140/Sulfone 135 as 5/5/20 but</p> <p>(4) Provide cure cycle details E.g. 8 hrs @ RT + 2 hrs @ 150°C</p> <p>(5) Provide the details of the environment the material will experience as a finished S/C component both in ground test and in space Exclude vibration environments. List all materials with the same environment in a group E.g. TV - 20°C/60°C, 2 weeks 10³ hrs, UV Storage - up to 1 year at RT Space - 10°C/20°C, 2 years, 150 mi alt, UV, electron, proton</p> <p>(6) Provide any special reasons why the material was selected. If for a particular property, please give the property E.g. Cost and availability RT curing and low expansion</p> <p>(7) Evaluator's comments to be filled in by GSFC evaluator. A = approved, NA = not approved, SA = see attached documents for further comments</p>									

MATERIALS LIST

MATERIALS AND PROCESSES

Figure 6-1d GSFC Spacecraft Inorganic Materials List

GSFC SPACECRAFT INORGANIC ¹ MATERIALS LIST							
WALSHART	SYSTEM #PERIMENT		GSFC TO				
LUNARALTIM	ADDRESS						
PREPARED BY	PHONE		DATE PREPARED				
GSFC MATERIALS EVALUATOR	PHONE		DATE RECEIVED		DATE EVALUATED		
ITEM #	MATERIAL NUMBER/CLASS ²	COMPOSITION ³	APPLICATION ⁴	EXPECTED ENVIRONMENT ⁵	GSFC EVALUATION ⁶		
					A	NA	SA
<p>NOTES</p> <p>(1) List all inorganic materials (metals, ceramics, glasses, liquids) except bearing and lubrication materials which should be listed on form GSFC 18 50C</p> <p>(2) Give name of material, identifying number, manufacturer E.g. Aluminum 6061-T6 Electroless nickel plate, Epsilon No. 418, Epsilon, Inc. Fused silica, Corning 7940, Corning Glass Works</p> <p>(3) Give details of the finished condition of the material, heat treat designation (hardness or strength), surface finish and coating, cold worked state, welding brazeing etc. E.g. Heat treated to R₁ 80 hardness, gold electroplated, braze Surface coated with VDA and MgF₂ Cold worked to Full Hard condition and welded by TIG process, electroless nickel plate</p> <p>(4) Give details of where on the spacecraft the material will be used (components) and its function E.g. Electronics box structure in attitude control system, not hermetically sealed</p> <p>(5) Give the details of the environment the material will experience as a finished S/C component, both on ground test and in space. Exclude vibration environment. List all materials with the same environment in a group. E.g. T/V -20°C/+65°C, 2 weeks, 10³ serv, UV Storage - up to 1 year at RT Space - -10°C/+20°C, 2 years, 150 m/s, UV, electron, proton</p> <p>(6) Evaluator's comments to be filled in by GSFC evaluator. A = approved, NA = not approved, SA = see attached document for further comments</p>							

MATERIALS LIST

MATERIALS AND PROCESSES

Figure 6-10 GSFC Spacecraft Lubrication List

GSFC SPACECRAFT LUBRICATION LIST										
SPACECRAFT		SYSTEM/EXPERIMENT				GSFC I/O				
CONTRACTOR		ADDRESS				DATE PREPARED				
PREPARED BY		PHONE				DATE EVALUATED				
GSFC MATERIALS EVALUATOR		PHONE				DATE RECEIVED				
ITEM NO.	COMPONENT TYPE SIZE MATERIAL ⁽¹⁾	COMPONENT MANUFACTURER & MFR IDENTIFICATION	PROPOSED LUBRICATION SYSTEM & AMT OF LUBRICANT	TYPE & NO OF WEAR CYCLES ⁽²⁾	SPEED TEMP ATM OF OPERATION ⁽³⁾	TYPE OF LOADS & AMT ⁽⁴⁾	OTHER DETAILS ⁽⁵⁾	LSE EVALUATION ⁽⁶⁾		
								A	NA	SA
<p>NOTES</p> <p>(1) BB = ball bearing, SB = sleeve bearing, G = gear, SS = sliding surfaces, SEC = sliding electrical contacts. Give generic identification of materials used for the component, e.g., 648C steel, PTFE.</p> <p>(2) CUR = continuous unidirectional rotation, CO = continuous oscillation, IR = intermittent rotation, IO = intermittent oscillation, SO = small oscillation (< 30°), LO = large oscillation (> 30°), CS = continuous sliding, IS = intermittent sliding No. of wear cycles: AI - 10³, BI 10³ - 10⁴, CI 10⁴ - 10⁵, DI > 10⁵</p> <p>(3) Speed: RPM = revs/min, OPM = oscillation/min, VS = variable speed CPM = c/min (sliding applications) Temp. of operation, max & min, °C Atmosphere: vacuum, air, gas, sealed or unsealed & pressure</p> <p>(4) Type of loads: A = axial, R = radial, T = tangential (gear load). Give amount of load</p> <p>(5) If BB, give type and material of ball cage and number of shields and specified ball groove and ball finishes. If G, give surface treatment and hardness. If SB, give dia. of bore and width. If torque available is limited, give approx. value</p> <p>(6) Evaluator's comments to be filled in by GSFC evaluator. A = approved, NA = not approved, SA = see attached document for further comments</p>										

MATERIALS, PROCESSES

LUBRICATION LIST

GSFC SPACECRAFT MATERIALS PROCESSES LIST								
SPACECRAFT	SYSTEM/EXPERIMENT		GSFC ID					
CONTRACTOR	ADDRESS							
PREPARED BY	PHONE		DATE PREPARED					
GSFC MATERIALS EVALUATOR	PHONE		DATE RECEIVED		DATE EVALUATED			
ITEM NO.	PROCESS TYPE ⁽¹⁾	CONTRACTOR SPEC NO. ⁽²⁾	MIL. ASTM STD. OR OTHER SPEC. NO.	DESCRIPTION OF MATERIAL PROCESSED ⁽³⁾	SPACECRAFT/EXP. APPLICATION ⁽⁴⁾	GSFC EVALUATION ⁽⁵⁾		
						A	NA	SA
<p>NOTES</p> <p>(1) Give generic name of process, e.g., anodizing (sulfuric acid)</p> <p>(2) If process is proprietary, please state so</p> <p>(3) Identify the type and condition of the material subjected to the process E.g., 6061-T6</p> <p>(4) Identify the component or structure of which the materials are being processed E.g., Antenna dish</p> <p>(5) Evaluator's comments to be filled in by GSFC evaluator. A - approved, NA - not approved, SA - see attached document for further comment</p>								

Revision A

Figure 6-11 GSFC Spacecraft Materials Processes List

GSFC 420-05-01

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SECTION 7

DESIGN ASSURANCE AND RELIABILITY REQUIREMENTS

7.1 GENERAL REQUIREMENTS

The developer shall plan and implement a design assurance and reliability program which interacts with other assurance program elements. The required elements of the design assurance and reliability program are outlined in this Section. The developer shall describe the methods for its accomplishment in the PAIP (1.3).

7.2 DESIGN ASSURANCE

7.2.1 REQUIREMENTS

The developer shall establish design criteria and standardize and control design practices. The designs shall be reviewed in accordance with paragraph 2.5 and be capable of:

- a. Functioning properly during the required mission lifetime,
- b. Minimizing or eliminating potential sources of human-induced failures,
- c. Permitting ease of assembly, test, fault isolation, repair, servicing, and maintenance without compromising safety, reliability, quality, and performance.

7.2.2 DEVELOPER SUPPORT FOR DESIGN ASSURANCE

Developer assurance personnel shall specifically ensure that:

- a. The quality, reliability, safety, and maintainability considerations are factored into the design,
- b. The design is capable of being inspected and tested and will facilitate repair,
- c. The design is producible and repeatable,
- d. The detailed design is in accordance with the controlling design criteria,
- e. The performance, safety, and interface characteristics that require verification by analysis, inspection, and test are identified and reflected in appropriate lower-tier documentation.
- f. All processes and operations in which uniform high quality cannot be assured by inspection alone are identified and controls

are established to ensure hardware integrity.

g. Applications of fasteners are in conformance with GSFC specification S-313-100.

7.2.3 SPECIFICATIONS, DRAWINGS, AND TEST PROCEDURES

7.2.3.1 Design Specifications. The developer shall prepare a design specification for each item of hardware at the instrument and component level. Each design specification shall identify the physical and functional requirements and interfaces of the specified item.

7.2.3.2 Specification, Drawing, and Test Procedures Reviews. The developer's reliability organization shall review for concurrence all design specifications, drawings and test procedures or shall ensure that they are independently reviewed before release. The review shall ensure that the documents cover all items of hardware at the appropriate levels, that each is complete in its contents, and that each is functionally and physically consistent with interfacing design specifications, drawings, and procedures. Reviews shall also be conducted for changes to the documents.

7.3 RELIABILITY ANALYSES

Reliability analyses of the design shall be conducted in accordance with the following paragraphs.

7.3.1 FAILURE MODES AND EFFECTS ANALYSIS

A Failure Modes and Effects Analysis (FMEA) shall be performed to identify potential catastrophic and critical failures so that susceptibility to the failures and their effects can be eliminated from the system. A listing of all failure modes and severity level of the failure effects shall be provided. Catastrophic failures and critical failures are defined in Appendix B.

The analysis shall be performed for all electrical, electronic and electromechanical flight hardware. Critical mechanical and fluid systems shall also be included. The FMEA process shall be performed iteratively, as required, starting early in the design phase to ensure that the design and changes resulting from design reviews, analyses, waivers/deviations or other reasons do not introduce new failure modes or criticalities into the system.

The FMEA shall be conducted at the observatory-instrument and instrument-component interfaces. Potential component interface and/or observatory-instrument level catastrophic and critical failures shall be analyzed to the extent necessary to identify single parts that could cause the failures. Each FMEA shall be

performed in accordance with GSFC S-302-89-01 "Failure Modes and Effects Analysis Procedures for Unmanned Spacecraft and Instruments" or a developer procedure that has been approved by the Contracting Officer. Because EOS does not have a 2-fault tolerance requirement (except for ignition sources [see par. 6.2.4] and failures involving potential loss of life or serious injury to personnel), for purposes of the FMEA, the failure mode criticality classifications in GSFC S-302-89-01 shall be modified to read as follows:

Criticality 1. A single failure that could result in loss of human life or serious injury to personnel, or loss of a launch facility, the launch vehicle, or a primary mission objective. (For failures involving potential loss of life or serious injury to personnel, redundant designs, both of which if failed would result in a Criticality 1 failure, shall be considered Criticality 1.)

Criticality 2. A single failure that could result in damage to a launch facility or launch vehicle, significant degradation of science products (as defined by the Project), or loss of a secondary mission objective.

Criticality 3. Loss of redundancy or an effect less severe than that of a Criticality 2 failure mode.

Analysis of redundant equipment shall address cross-strapping to ensure that no single failure will adversely affect the performance of the redundant capability. Observatory-instrument interface analyses shall identify any single failure that would affect observatory, instrument or other instrument performance. No single failure shall prevent the successful removal of power from a failed instrument. Potential catastrophic (Criticality 1) failures that cannot be eliminated from the system, and all potential critical (Criticality 2) failures, shall be itemized on a Critical Items List (CIL) that shall be attached to the FMEA. All part applications that do not conform with derating criteria (see par. 7.3.3) shall also be listed on the CIL. Justification for retention of each item listed shall be included. Although failure modes in redundant designs are assumed to be compensated by the redundancy (and therefore not be "single failure points") for purposes of the FMEA, that assumption cannot be relied upon in dealing with design errors or test failures in redundant systems, since generic design or workmanship deficiencies in a redundant item have the potential of affecting all the redundant items of that design.

The FMEA with the attached Critical Items List and updates shall be submitted to NASA in accordance with Appendix C herein.

7.3.2 RELIABILITY ASSESSMENT

The developer shall use numerical reliability assessment techniques for: (a) sensitivity analyses; (b) evaluation of the effects of design trade-offs or configuration changes; and (c) evaluating the ability of the design to achieve the EOS mission life requirement. Results of these analyses shall be reported to cognizant design personnel for consideration in selection or updating of hardware designs and to assurance management for inclusion in the performance assurance status reports (par. 1.6). The assessments shall be provided in accordance with Appendix C herein.

The reliability assessments shall be performed iteratively as required, and be updated as more definitive information becomes available. Initial assessments shall use the parts count reliability prediction methodology of MIL-HDBK-217. As the design becomes more firm, a complete reliability block diagram, failure definitions and mathematical model shall be developed. The results of parts and devices stress analyses (paragraph 7.3.3) shall be used as the basis for performing a part stress analysis prediction in accordance with MIL-HDBK-217. The prediction shall include the reliability of non-electronic parts. Prediction results shall provide inputs to the mathematical model from which reliability assessments shall be derived. The level and detail of the model shall be sufficient to provide discrete reliability assessments of individual instrument measurements or data products. Design trade-offs and configuration alternatives shall be evaluated for impact on reliability by using the above methodology. Failure-rate data for mechanical parts shall be derived from NPRD-3 (see Appendix A herein). Historical failure data and other suitable data sources may be used for unique parts or components not listed in either MIL-HDBK-217 or NPRD-3, with approval from GSFC.

7.3.3 PARTS AND DEVICES STRESS ANALYSES

Electrical, Electronic, and Electromechanical (EEE) parts and devices, as applied in circuits within each component, shall be subjected to stress analyses for conformance with the derating policy of MIL-STD-975 and the GSFC PPL (paragraph 5.3.3). The analyses shall be performed at the most stressful part-level parameter values that can result from the specified performance and environmental requirements on the assembly or component. The analyses shall be performed in close coordination with the packaging reviews and shall be required input data for component-level design reviews (paragraph 2.5). The analyses shall be documented, and justification shall be included for all applications which do not meet the derating criteria; these shall be submitted to the PCB (par. 5.4) for approval and shall be specifically reported in the developer review summaries (see paragraphs 2.5 and 1.6). All part applications which do not meet

the derating criteria shall also be listed on the CIL (see par. 7.3.1). The analyses and updates shall be made available to NASA upon request.

7.3.4 WORST CASE ANALYSES

Worst Case Analyses shall be performed for critical parameters that are subject to variations that could degrade performance and for critical designs within the system hardware. Adequacy of margins in the design of electronic circuits, optics, electromechanical and mechanical items shall be demonstrated by analyses or test or both. The form of the analysis shall be appropriate to the type of hardware being analyzed; e.g. ray trace analysis for optics, tolerance build-up for mechanical fit, or computerized analyses for more complex electronics. The analyses shall consider all parameters set at worst-case limits and worst-case environmental stresses for the parameter or operation being evaluated. The analyses shall be updated as part of design changes. The analyses and updates shall be made available to NASA upon request.

7.3.5 PERFORMANCE TREND ANALYSES

The developer shall assess the instrument and its components to determine measurable parameters that relate to performance stability. The parameters shall be monitored for trends starting at component acceptance testing and continuing during the system integration and test phases of the instrument and observatory. The monitoring shall be accomplished within the normal test framework; i.e., during functional tests, environmental tests, etc. The developer shall establish a system for recording and analyzing the parameters as well as any changes from the first observed value even if the levels are within specified limits. A list of parameters to be monitored and the trend analysis reports shall be submitted in accordance with Appendix C herein. Trend analysis data shall be reviewed with the operational personnel prior to launch, and the operational personnel shall continue recording trends throughout mission life for early detection of possible mission failure tendencies.

7.4 LIMITED-LIFE ITEMS

Limited-life items shall be identified on a Limited-Life List and submitted in accordance with Appendix C herein. The list shall include the expected life and the rationale for the selection of each item. Limited-Life items include all hardware that is subject to degradation because of age, operating time, or cycles such that their expected useful life is less than twice the required life when fabrication, test, storage, and mission operation are combined.

7.5 RELIABILITY OF GOVERNMENT-FURNISHED PROPERTY (GFP)

When the overall instrument includes components or other elements furnished by NASA, the developer shall be responsible for identifying and requesting from the NASA project office adequate reliability data on the items. The data will be used for performing the reliability analyses (par. 7.3). When examination of the data or testing by the developer indicates that the reliability of GFP is inconsistent with the reliability requirements of the overall system, the EOS Project Office shall be formally and promptly notified.

SECTION 8

QUALITY ASSURANCE REQUIREMENTS

8.1 GENERAL REQUIREMENTS

The developer shall establish, document, and ensure compliance with design control requirements and quality criteria during all phases of contract work. In the PAIP (paragraph 1.3), the developer shall set forth his methods for meeting the quality assurance (QA) requirements of the project in all its phases. The plan shall ensure that controls are carried out according to schedule. NASA shall be kept informed of the status of the QA program by the submittal of reports in accordance with paragraph 1.6.

8.2 SUPPORT OF DESIGN REVIEWS

QA personnel shall participate in the design reviews described in Section 2.

8.3 DOCUMENT CHANGE CONTROL

The developer shall ensure control of all documents and changes thereto that affect the hardware and software. Quality assurance personnel shall ensure that documents and changes are controlled in accordance with the Project Configuration Management Plan. The developer shall ensure that the effectivity of documents and changes is clearly specified, changes are accomplished on affected articles, and changed articles are appropriately identified. Documents shall be kept current and all fabrication, inspections, and tests shall be performed according to the most recent drawings and changes. The inspection record of the product shall indicate the change level with which it is in compliance.

The issue numbers of the drawings and specifications to which the particular hardware has been fabricated, inspected, and tested shall be documented as the as-built configuration. Evidence shall be provided of compliance with the as-built documentation as a basis for acceptance of the hardware. This information shall be submitted as part of the Acceptance Data Package (8.23).

A developer QA representative shall be a member of the Configuration Control Board. The QA activities shall be defined in the Configuration Management Plan and described in detail in the QA Plan; related portions of the plans shall be cross-referenced.

8.4 IDENTIFICATION AND TRACEABILITY

8.4.1 REQUIREMENTS

The developer shall maintain a product identification and tracking system. Each product shall be identified by a unique part or type number, consistent with the configuration management system for the contract. Where control of individual products or lots of products is required, date codes, lot numbers, serial numbers, or other identification shall be used as appropriate. Serial numbers and lot numbers shall be assigned in consecutive order.

The system shall be capable of retrieving the identification and serialization record at the subassembly level. It shall also be capable of retrieving fabrication, processing and test records of identifiable articles, materials and parts (by part lot date code) in the event verification of the articles, materials or parts becomes necessary. Beginning at the subassembly level and continuing through the end product, the system shall be capable of tracing the location of any individual subassembly in the mission hardware at any given level of process, assembly, or test. Identification and serialization data lower than that for subassemblies shall be maintained in the manufacturing and processing records and shall contain date code, lot numbers, and manufacturer of the item; this includes mechanical parts and fasteners. The developer is encouraged to make use of his existing identification and traceability system. Serial numbers of scrapped products shall not be reused.

8.4.2 IDENTIFICATION LISTS

The developer shall maintain an Identification List which distinguishes between developer-designed ("make") and supplier-designed ("buy") products. The list shall indicate the part or type number and the group and individual identification. The list shall be a part of the configuration management system and changes shall be in accordance with paragraph 8.3 and shall be available to NASA on request.

8.5 PROCUREMENT REQUIREMENTS

The following detailed quality assurance requirements, as applicable, shall be included or referenced in the procurement documents, in addition to those requirements selected in conformance with paragraph 1.8.2.

8.5.1 PRODUCT CHANGES

The supplier shall notify the developer of proposed changes to products (including changes in design, fabrication methods, processes or location, and changes which may affect the quality

or intended end use of the item). The supplier shall submit these changes to the developer for processing in accordance with the developer's Configuration Management Plan. When a proprietary item is procured by the developer, the supplier shall also notify the developer of those changes.

8.5.2 PURCHASED RAW MATERIALS

Raw materials purchased by the developer shall be accompanied by the results of chemical, and physical tests performed on the lots of material delivered. When material is purchased, the suppliers of raw materials shall be required to furnish specimens for chemical and physical tests in the event that the materials are later used for critical design applications.

8.5.3 RAW MATERIALS USED IN PURCHASED PRODUCTS

The supplier shall document and make available to the developer on request the results of acceptance tests and analyses performed on raw materials.

8.5.4 AGE CONTROL AND LIMITED-LIFE PRODUCTS

Records shall be kept on products that have definite characteristics of quality degradation or drift with use, age or storage conditions. These shall include any materials to be used in fabrication, the shelf-life controlled items defined in paragraph 6.2.7, and the Limited Life items cited in paragraph 7.4. The records shall note the date, test time, or cycle when useful life was initiated, the life or cycles used, and the date, test time, or cycle when useful life will be expended.

8.5.5 INSPECTION AND TEST RECORDS

The developer shall specify that the supplier maintain inspection and test records as evidence of inspection and test results. The developer shall also specify records that are to be provided with the deliverable item.

8.5.6 GOVERNMENT SOURCE INSPECTION (GSI)

When the Government elects to perform inspection at a supplier's plant in accordance with paragraph 8.7, the following statement shall be included in the procurement document:

"All work on this order is subject to inspection and test by the Government at any time and place. The Government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon receipt of this order. The Government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test."

8.5.7 PROCUREMENTS THAT DO NOT REQUIRE GOVERNMENT SOURCE INSPECTION (GSI)

Procurements that do not require GSI shall include the following statement:

"The Government has the right to inspect any or all of the work included in this order at the supplier's plant."

8.5.8 WELD FILLER METAL AND FASTENER INTEGRITY

Weld rods, weld wire, and such procurements shall meet the requirements of MSFC-STD-655 (Appendix A).

Procurement, application, screening, inspection and test of fasteners shall conform with the requirements of GSFC specification S-313-100.

8.5.9 DEVELOPER QA ACTIVITY AT SOURCE

When developer QA activity is required at a supplier's plant as determined by paragraph 8.8, the procurement document shall so indicate.

8.5.10 RESUBMISSION OF NONCONFORMING ARTICLES OR MATERIALS

Nonconforming articles and materials returned to the supplier by the developer and subsequently resubmitted by the supplier shall bear adequate identification of such resubmission. Reference shall be made to the developer's nonconformance document, and evidence provided that the causes for the nonconformance have been corrected and actions have been taken to preclude recurrence.

8.6 REVIEW AND APPROVAL OF PROCUREMENT DOCUMENTS

Quality assurance personnel shall review and approve procurement documents before their release to ensure that applicable requirements of this document are included. The reviews shall be documented.

8.7 PROCUREMENT REVIEW BY THE GOVERNMENT

The developer shall forward procurement documents to the Government representative to review for compliance with contract requirements and to determine the need for Government source inspection. Such Government inspection shall not replace developer source inspection or relieve the developer of his responsibilities for product reliability, quality, and safety.

8.8 DEVELOPER SOURCE INSPECTION

The developer shall perform source inspection at the subcontractor's or supplier's facilities when directed by the procurement documentation or when one or more of the following conditions exist:

- a. In-process, end-item controls, or tests that are destructive in nature prevent the developer from verifying quality in the developer's facility.
- b. It is not feasible or economical for the developer to determine the quality of procured articles solely by inspections or tests performed at the developer's facility.
- c. Qualification tests are to be performed by the subcontractor or supplier.
- d. Products are shipped directly from the source to NASA, by-passing the developer's inspection facilities.

8.9 DEVELOPER RECEIVING INSPECTION

A controlled, documented receiving inspection system that covers all purchased products is required to ensure compliance with procurement documents.

All procured products shall be processed through an incoming inspection and testing system prior to fabrication. Nondestructive evaluation (NDE) may be used provided controlled documentation and certified personnel are employed. The receiving-inspection system shall consist of the following:

- a. Procured products shall be accompanied by inspection and test records as evidence that the supplier is in compliance with purchase requirements and shall be accompanied by the required data directly traceable to the products. The records shall give evidence of developer and Government source inspection.
- b. Inspections and tests shall be conducted in accordance with written procedures on selected characteristics of the products to verify their acceptability. Particular emphasis shall be placed on the selection of characteristics that have not been developer-source inspected and those for which nonconformances are difficult to detect during subsequent inspection and test. Test results shall be compared on a sample basis with test results provided by the supplier. Disassembly shall be performed periodically for detailed verification when required by the procurement document or the procedures.

c. The supplier's age control and limited-life product records shall be updated to reflect the receiving inspection activity.

d. When, during the design phase, it is determined that a material has a critical application, specimens of the material shall be delivered with the purchased product and be subjected to chemical and physical tests. Chemical analyses and physical tests shall also be performed on samples randomly selected from each lot of materials in order to verify the product's conformance to specification requirements. It shall be verified that all weld filler metal is in compliance with MSFC-STD-655.

e. Products and their records shall show acceptance or nonconformance status when released from receiving-inspection, and the products shall be protected for subsequent handling or storage. Nonconforming products shall be submitted for Material Review Board (MRB) action. Items awaiting inspection or test results or MRB action shall be segregated.

f. Sampling inspection shall be used where tests are destructive or for such items as nuts, bolts, and fasteners that are not used as critical attachments (8.19).

g. Receiving inspection and test records shall be maintained, including copies of documents submitted by the supplier.

h. Documentation shall be provided showing that the electrostatic discharge control plan (8.12) is being complied with during receiving inspection.

8.10 FABRICATION CONTROL

8.10.1 FABRICATION AND ASSEMBLY FLOW PLAN

In addition to the general performance assurance requirements set forth in Section 1 (1.3 through 1.9), the developer shall develop a Fabrication and Assembly Flow Plan that covers all operations (from start of fabrication to delivery), including the inspections and tests, GSI inspection points, and all special processes to be used. A preliminary flow plan and a final flow plan shall be submitted in accordance with Appendix C herein.

8.10.2 DOCUMENTATION

The developer shall use a documentation system (consisting of items such as fabrication orders, assembly orders, shop travelers, and repair procedures) to control the flow of hardware through the manufacturing phase. Controls shall ensure that only conforming product is released and used during fabrication and that those not required for the operation involved are removed.

from the work area and properly stored. Traceability shall be maintained in accordance with par. 8.4. Fabrication documents shall include or reference:

- a. Nomenclature and identification of the article.
- b. Tooling, jigs, fixtures, and other equipment to be used.
- c. Characteristics and tolerances to be obtained.
- d. Detailed procedures for controlling processes.
- e. Special conditions to be maintained such as environmental conditions or precautions to be observed.
- f. Workmanship standards per paragraph 8.10.3.
- g. Controls for parts, materials, and articles which have definite characteristics of quality degradation or drift with age, use, or storage. The controls shall include requirements for recording and maintaining dates, time, or cycles for determining end of life.
- h. Traceability to the individual and equipment performing each fabrication and assembly operation.

Developer assurance personnel shall ensure that manufacturing operations are in compliance with up-to-date controlling documents.

8.10.3 FABRICATION REQUIREMENTS

The requirements of NHB 5300.4(3A), NHB 5300.4(3G), NHB 5300.4(3H), NHB 5300.4(3I), NHB 5300.4(3J), and NHB 5300.4(3K) (Appendix A), shall be implemented. Workmanship standards may be used to show acceptance criteria. When samples showing acceptance criteria are necessary, they will be jointly selected by the developer and NASA or its quality representative. Standards shall be kept current and shall be used to train, certify, and recertify personnel when appropriate. Any material used for torque striping must meet the requirements of materials selection and performance as specified in Section 6.0, Materials and Processes Control Requirements. In particular, as the material is typically a pigmented epoxy, it must meet the outgassing requirements specified in paragraph 6.2.4.

8.10.4 PROCESS EVALUATION AND CONTROL

Controls shall be implemented for processes for which high uniform quality cannot be ensured by inspection of products alone. Nondestructive evaluation (NDE) methods may be used

provided controlled documentation and certified personnel are employed. Process procedures shall be prepared and shall describe the following:

- a. Preparation of the processing equipment, solutions and materials.
- b. Preparation of the products to be processed.
- c. Detailed processing operations.
- d. Conditions to be maintained during each phase of the process including environmental controls.
- e. Methods of verifying the adequacy of processing materials, solutions, equipment, environments, and their associated control parameters.
- f. Inspection and test provisions.
- g. Records for documenting the results of process inspection, test, and verification.

The developer shall provide for the certification of equipment used in selected processes. Records of certification test results shall be maintained. Equipment shall be recertified as indicated by the results of quality surveys, inspections, tests or when changes are made that may affect process integrity.

8.11 CONTAMINATION CONTROL

The quality assurance personnel shall ensure that the requirements of the Contamination Control Plan (Section 9) are being complied with during all phases of the program.

8.12 ELECTROSTATIC DISCHARGE CONTROL

The developer shall describe in the PAIP (paragraph 1.3) the program to control Electrostatic Discharge (ESD) for electrical and electronic parts, assemblies, and equipment susceptible to damage caused by static electricity. The program shall address provisions for work area protection, handling procedures, training, hardware protective covering, packaging for delivery, and Quality Assurance verification of conformance. Procedures shall be developed in accordance with DOD-HDBK-263 and DOD-STD-1686. The developer shall also invoke applicable requirements for ESD control on subcontractors and suppliers.

8.13 NONCONFORMANCE CONTROL

The developer shall operate a closed-loop nonconformance control system for failures and discrepancies. The system shall include

provisions for the following:

- a. Documentation of each nonconformance traceable to the specific product on which it occurred.
- b. Assignment of a unique and traceable document number for each failure and for those discrepancies designated for Material Review Board (MRB) action.
- c. Description of the nonconformance and the required characteristic or design criteria.
- d. Conducting and documenting analyses and examinations to determine the cause.
- e. Implementing and documenting timely and effective remedial and preventive action on the products and applicable documents.
- f. Disposition of the nonconforming product.
- g. Signatures of authorized personnel on the appropriate nonconformance documents.
- h. Accumulating data in summary reports.
- i. Performing analyses from the part level of assembly and higher to identify adverse trends and to provide for their correction.
- j. Closeout of nonconformance documentation after verifying that effective remedial and preventive actions have been taken on the nonconforming articles and any other articles affected.

On request, a report of the analyses required by items d. and i. shall be made available to NASA. Products that depart from specified requirements shall be identified and, if practicable, shall be isolated for review action. The system shall include provisions for controlling nonconforming products that cannot be isolated from the normal channels of manufacture.

If failure reporting is covered in the Reliability Section (Section 7) of the PAIP, it shall describe how the responsibilities and procedures interface with the quality assurance activities. The discrepancy and failure-control sections of the plan shall be cross-referenced.

8.13.1 CONTROL, DISPOSITION, AND REPORTING OF DISCREPANCIES

8.13.1.1 Documentation - Documentation of discrepancies shall start with the receipt of procured parts, materials, or other

products, or the initiation of in-house manufacturing, whichever occurs first. Each discrepancy shall be documented on the appropriate developer form promptly after discovery.

8.13.1.2 Initial Review Dispositions - Discrepant products shall be reviewed by developer QA and, as appropriate, engineering personnel and shall be subjected to one of the following dispositions:

a. Return for Rework or Completion of Operations - The product shall be returned using established and approved documents and operations. During rework, the product shall be resubmitted to normal inspection and tests.

b. Scrap in accordance with Government-approved developer procedures for identifying, controlling and disposing of scrap.

c. Return to Supplier - The developer shall provide the supplier with nonconformance information and assistance, as necessary, to permit remedial and preventive action.

d. Submit to Material Review Board - When the dispositions, as described above, are not appropriate, the discrepant products shall be submitted to the Material Review Board (MRB) for final disposition.

Products disposed of without referral to MRB shall be subject to review by the Government quality representative. Initial review dispositions shall be recorded on nonconformance documentation.

8.13.1.3 Material Review Board (MRB) - MRB decisions on nonconformance shall be submitted to NASA in accordance with Appendix C herein. Other provisions of the MRB follow:

a. Membership. The MRB shall comprise, as a minimum, the following members:

- 1) Developer quality representative, chairman.
- 2) Developer engineering representative.
- 3) Government quality representative.

The developer shall select members on the basis of technical competence. The Government representative on the board shall approve the membership.

b. Responsibilities - The MRB shall have the responsibility to:

1) Determine disposition of submitted products. NOTE: All MRB decisions that are not unanimous must be referred to higher authority (developer and NASA) for resolution.

2) Ensure that remedial and preventive actions, including reinspection and retest requirements, are recorded on the nonconformance document prior to disposition.

3) Perform trend analysis of discrepancies.

4) Ensure that MRB records are maintained.

c. Dispositions - In addition to the dispositions listed in 8.13.1.2, the MRB shall have authority for the following:

1) Repair - The MRB shall approve repairs, except as noted below. Standard Repair Procedures shall be submitted to NASA in accordance with Appendix C herein. The MRB shall authorize the use of the procedures for each instance of repair. The MRB shall ensure that the hardware reliability and quality are not compromised by excessive repairs.

2) Scrap.

3) Use-as-is. (Except as stated below. Also, see NOTE).

MRB disposition shall not adversely affect the safety, reliability, durability, performance, interchangeability, weight, or other basic features of the hardware.

Dispositions that, in the opinion of the MRB, will adversely affect any of the foregoing or which are contrary to any of the requirements of the contract must be submitted as a waiver request (see Figure 4-3, herein) to the Contracting Officer for approval in accordance with the project Configuration Plan, (paragraph 8.3 and Appendix C herein).

NOTE: The products shall be withheld from further processing in a controlled area until direction for disposition is given by the Contracting Officer.

8.13.1.4 Supplier Material Review Board - The developer may, with approval of NASA or its authorized quality representative, delegate MRB responsibility to suppliers.

8.13.2 CONTROL, REPORTING, AND DISPOSITION OF FAILURES

8.13.2.1 Failure Reporting. A malfunction or failure report shall be written for each departure from design, performance, testing, or handling requirements that affect the function of the flight segment or flight support equipment or could possibly

compromise mission objectives. This includes test equipment (GSE) that interfaces with the flight or flight-support equipment.

Other problems or anomalies that are unusual or that might affect other areas shall also be cited on a malfunction or failure report.

Reporting of hardware failures shall begin with the first power application at the lowest level of assembly or the first operation of a mechanical item; it shall continue through formal acceptance by the NASA project office and the postlaunch operations, as required by the contract. For software problems, operation of this malfunction reporting system shall begin with the first test use of the software item with a hardware item of the mission system at the component level or higher.

a. Report Processing- A malfunction or failure report shall be initiated immediately after the failure has occurred. (See Figure 8-1a, b, and c, for a sample report form). The developer may use his existing form for reporting if it complies with the requirements of the GSFC Malfunction Report form and is approved by the Contracting Officer. The report shall be filled out in accordance with the instructions on Figure 8-1c. It shall be given an Impact Rating as soon as practicable (see par. 8.13.2.3), to be labeled and noted on the last line of Block (17) of the form. It shall also be given a Corrective Action Effectiveness Rating as soon as the failure has been analyzed and the corrective action devised. This shall be labeled and noted on the last line of Block (19) of the form in accordance with the Risk Rating criteria stated in paragraph 8.13.2.3, below. The Corrective Action Effectiveness Rating shall be updated if appropriate, based on technical re-assessment prior to close-out and this final Corrective Action Effectiveness Rating labeled and noted on the sixth line of Block (20) of the form.

The reports shall be submitted to NASA in accordance with Appendix C herein and the identical information shall be given to the in-plant Government quality representative. The failure report data shall be submitted in hard copy and in a computer readable form which shall be as an ASCII file (with hard-copy documentation of file structures and file names). The required medium is flexible disk(s) compatible with IBM-PC DOS, MS DOS, or other compatible DOS.

The disks may be (1) 5.25 inch, double-sided, double-density (DS-DD), 360 kilobyte, (2) 5.25 inch high density (HD), 1.2 megabyte, (3) 3.5 inch, DS-DD, 720 kilobyte, or (4) 3.5 inch, HD, 1.4 megabyte. The hard copy submittals shall be made as the updating actions occur on each MR, and the iteration submitted to the NASA for closure shall include a copy of all referenced data and shall have had all corrective actions accomplished and verified.

INSTRUCTIONS FOR ENTERING DATA ON GSFC MALFUNCTION REPORT

General - This malfunction report form is to be used as a working document as well as a means of recording information that can be stored and later retrieved. Information shall be filled in each block from left side to right except for the block titled "Serial Number" under items (9) through (22). These shall be filled in from right side to left. All applicable information shall be recorded.

Detail

- Item (1) - Enter project name
- Item (2) - Enter spacecraft identification
- Item (3) - Enter operations. If hours, to tenth of hour. If cycles, to cycle.
- Item (4) - Check block to designate proper units for item (3).
- Item (5) - Enter system or experiment name. Definition "System" - The next functional subdivision of a spacecraft, and is generally composed of two or more components designed to perform an operation. Example: Electrical system, Communication system, Stabilization and Control system, etc. "Experiment" - The next functional subdivision of a spacecraft and is generally a combination of two or more components, including both the sensor and associated electronics designed for acquisition of data for space research.
- Item (6) - Enter date & time of malfunction. Example - June 8, 1967 at 3 p.m. - Year 67, Month 06, Day 08, Time 1500.
- Item (7) - Enter date the malfunction report is originated. Example June 9, 1967 - Month 06, Day 09 - Year will be determined from item (6).
- Item (8) - To be filled in by GSFC Project Office.
- Item (9) - Enter component name. Definition "Component" - The next functional subdivision of a system and generally is a self contained combination of assemblies performing a function necessary to the system's operation. Example: Power supply, transmitter, gyro package, etc. Enter component identification no., serial no., and the manufacturer's name.
- Item (10) - Enter assembly name. Definition "Assembly" - The next functional subdivision of a component and consist of parts or subassemblies which perform functions necessary to the operation of the component as a whole. Example: Regulator assembly, Power Amplifier assembly, Gyro Assembly, etc. Enter the assembly identification no., serial no., and manufacturer's name.
- Item (11) - Enter subassembly name. Definition "Subassembly" - An assembly within a larger assembly - Example: Wired printed circuit board modules, etc. - Enter subassembly identification no., serial no., and manufacturer's name.
- Item (12) - Enter part name. Definition "Part" - An element of a component, assembly or subassembly which is not normally subject to further subdivision or disassembly without destruction of designed use. Example: Resistors, transistors, diodes, etc. Enter manufacturer's part number, and the manufacturer's name.
- Item (13) - Check block that defines the type of test that was being conducted when malfunction occurred. If the type of test was other than those listed define type of test in item (17).
- Item (14) - Check block that defines the actual environment the unit was being subjected to when the malfunction occurred. **Caution** for an example do not check vibration if unit failed during a functional test prior to the actual application of the vibration environment, check ambient. If the environment in which the unit failed is not listed or the description listed does not give sufficient detail give this information in item (17).
- Item (15) - Check block that defines the hardware level at the time of failure. For example - if a power supply subassembly fails during Communications system test, check system.
- Item (16) - Enter reference information.
- Item (17) - Enter all details of the malfunction such as, inputs, outputs, tolerances, symptoms, abnormal conditions, testing phase, detail of environment and prior environment, etc.
- Item (18) - Print name, phone no. and organization.
- Item (19) - Enter detailed, but concise, narrative defining the direct cause of malfunction.
- Item (20) - Enter detailed, but concise, narrative defining the corrective action taken. The corrective action shall be sufficient to preclude the malfunction from occurring again. List other units affected by the corrective action. Enter N/A if not applicable.
- Item (21) - Check block to indicate if failure analysis was conducted. Give organization and report no. & date.
- Item (22) - Check block to indicate rework of failed unit. Give organization and date rework accomplished.
- Item (23) - Check block to indicate if retest is required. If required, state requirements.
- Item (24) - Check block to indicate test results.
- Item (25) - Check block to indicate future use of reworked unit.

Figure 8-1c Instructions for Entering Data on GSFC Malfunction Report

The submittal of the data in the above specified computer readable form shall be in monthly composited updates of all currently open malfunction reports (with each data item separately identified to its respective MR). When each MR is closed, the next monthly computer composite shall carry the closure update of all Form 4-2 data on that MR.

The developer shall maintain a master report file which contains all supplementary data such as failure analysis and records of meetings.

b. Status Summaries- A summary of the open malfunction or failure reports shall be submitted as part of the Performance Assurance Status Report (1.6). The summaries shall list each problem or failure as a separate line item and provide complete identification of the affected hardware (part and serial numbers), the environment, date of occurrence, and a brief description of the failure, its cause, and the corrective action to be taken. Before removing any item from the "open" list, the last summary report shall show the corrective actions actually taken and the date closed.

8.13.2.2 Failure Review Board. A Failure Review Board (FRB) shall be established and, as a minimum, shall comprise the following:

- a. Developer quality or reliability representative (chairman).
- b. Developer project manager or his representative.
- c. Developer engineering representative who is responsible for the failed item.
- d. Government In-plant representative.

The developer shall select members on the basis of technical competence. The Government representative on the board shall approve the membership.

The FRB shall obtain the assistance of appropriate groups and personnel to ensure that all failures are investigated, analyzed, and their causes determined. Failures involving EEE parts shall be coordinated with the PCB (par. 5.4). Investigations and actions shall be coordinated with NASA and documented on a malfunction or failure report. Trend analysis shall be performed and corrective action taken. Where it is determined that the affected item is discrepant, the FRB will refer it to the MRB for disposition in accordance with paragraph 8.13.1.3. Configuration changes, if required, shall be in accordance with paragraph 8.3 and the EOS Configuration Management Plan, GSFC 420-02-02. Closeout of each failure shall require verification that remedial

and preventive actions have been accomplished in the item on which the failure occurred, that necessary preventive design changes in the item have been accomplished and verified in test, and that effectivity of preventive actions has been established in other affected items. The FRB chairman, denoting approval of the entire Board, shall sign the malfunction or failure report closeout before submitting it to NASA in accordance with Appendix C herein. In addition, "Red Flag" reports shall be signed off as prescribed in par. 8.13.2.3. Malfunction and failure reports shall not be considered closed until signed by the authorized Government representative.

8.13.2.3 Malfunction Report Risk Rating. Each malfunction report shall be assigned a two-factored rating to be used in risk assessment, as follows:

The first rating factor, the Impact Rating, identifies the impact the problem or malfunction would have on the flight hardware and/or software performance capabilities if it occurred during the mission. This Impact Rating should be proposed at the time the MR is initiated (see par. 8.13.2.1.a), updated as a Risk Rating after failure analysis and corrective action definition, and finalized prior to closure. Redundancy shall be ignored in establishing this rating. A failure Impact Rating of "1", "2", or "3" shall be assigned on each report, based on the following criteria:

- a. "1" - Catastrophic or major degradation to mission, system or instrument performance, reliability, or safety.
- b. "2" - Significantly degrading to mission, system or instrument performance, reliability, or safety, defined as:
 - (1) Appreciable change in functional capability, or
 - (2) Appreciable degradation of engineering or science telemetry, or
 - (3) Causes significant operational difficulties or constraints, or
 - (4) Causes reduction in lifetime.
- c. "3" - Negligible or no impact on mission, system or instrument performance, reliability or safety;

The second rating factor, Corrective Action Effectiveness Rating, shall be assigned a numerical rating which depends on the confidence in understanding both the causes of the incident and

the effectiveness of the corrective action. This assessment shall be based on the following criteria:

- a. "A" - Known cause coupled with certainty of the effectiveness of corrective action.
- b. "B" - Unknown cause coupled with certainty of the effectiveness of corrective action.
- c. "C" - Known cause coupled with uncertainty of the effectiveness of corrective action.
- d. "D" - Unknown cause coupled with uncertainty of the effectiveness of corrective action.

Any report with an Impact Rating of "1" or "2", coupled with a Corrective Action Effectiveness Rating of "C" or "D" (i.e., with known or unknown cause where the confidence in the effectiveness of the corrective action is uncertain) shall be designated a "Red Flag" report.

All "Red Flag" reports require project manager signoff (both developer and EOS Project) for report close-out. All "Red Flag" reports shall be highlighted at the GSFC flight assurance reviews (see par. 2.3).

8.14 ALERT INFORMATION

The developer shall review Alerts and SAFE-Alerts that document problems with parts, materials, processes, and safety as reported through the Government-Industry Data Exchange Program (GIDEP). Also, NASA may provide the developer other special notices (e.g. NASA TWX alerts) of general problems. The developer shall notify NASA of any Alerts or problem notices which have or may have an effect on the contract hardware. In accordance with Appendix C herein, the developer shall submit responses to these Alerts and problem notices, which inform NASA of the applicability of the problem to project hardware and any follow-up action proposed. Status summaries covering each applicable Alert received in a 30-day period shall be submitted as part of the Performance Assurance Status Report (1.6). The developer shall also respond to any specific NASA inquiry on the applicability of any part or materials problem to the contract hardware. [If the developer is not a member of GIDEP, NASA may provide the developer with selected Alerts and SAFE-Alerts, and the developer shall review them and notify NASA of problems potentially affecting the contract hardware.]

The developer shall prepare Alerts on problems that are within the scope of the Alert system. If the developer participates in GIDEP he shall submit a copy of the Alert to NASA when submitting it to GIDEP. If he does not participate in GIDEP he shall

GOVERNMENT-INDUSTRY DATA EXCHANGE PROGRAM <h1 style="margin: 0;">ALERT</h1> PLEASE TYPE ALL INFORMATION - SEE INSTRUCTIONS ON REVERSE		Form Approved OMB No 0704-0188
1. NOMENCLATURE (For Material Name and Safety Problem)		2. ALERT/DATE-ALERT NO. 3. DATE (Year/Month/Day)
4. MANUFACTURER AND ADDRESS	5. ITEM	
	6. PROCUREMENT SPECIFICATION	7. REFERENCE
	8. MANUFACTURER'S PART NUMBER	9. LOT/DATE CODE OR SERIAL NO.
10. SPECIAL REQUIREMENTS OR ENVIRONMENT (Requirements placed on or criteria environment to which part was exposed)		
11. PROBLEM SITUATION AND CAUSE (State form of problem and manufacturer's name and manufacturer's part number)		
12. ACTIONS TAKEN (State of actions taken to correct the problem situation and to prevent its recurrence)		
13. DATE MFR NOTIFIED Year/Month/Day	14. MANUFACTURER RESPONSE <input type="checkbox"/> CORRESPONDENCE ATTACHED <input type="checkbox"/> DID NOT REPLY	15. CONTACT POINT FOR INFORMATION (Name, Address, Phone)
16. ALERT COORDINATOR (Name, Address)		17. SIGNATURE OF ALERT COORDINATOR

DD Form 1938, JUN 86

Previous editions are obsolete.

Figure 8-2a ALERT Form

**INSTRUCTIONS FOR PREPARING DD FORM 1938,
"GOVERNMENT - INDUSTRY DATA EXCHANGE PROGRAM ALERT"**

1. **NOMENCLATURE** - Enter major subject category classification and function information obtained from the Government-Industry Data Exchange Program (GIDEP) Subject Thesaurus.
2. **ALERT/SAFE ALERT NO.** - Use originator's code assigned by GIDEP. Enter letter "A" for ALERTS or letter "S" indicating SAFE ALERT when subject or ALERT affects health or safety of personnel who may come in contact with defective part or unit if it is assembled into. The letter is followed by last two digits of year and then by consecutive sequence number of all ALERTS submitted by the originator for that year. An addendum is indicated by adding a change letter (A, B, or C, as required) to the sequence number. For example: XX-A-77-02A is ALERT number for addendum to second ALERT in 1977 by an originator with code XX.
3. **DATE** - This is date ALERT is released by ALERT Coordinator. Note coordination procedures in 13. Each addendum should have new release date.
4. **MANUFACTURER AND ADDRESS** - List actual manufacturer of item. Also enter Manufacturer's Federal Code Number (MFCN) from Federal Handbook H4-1 or H4-2. When possible, also enter Contract Administration Service Code Number (CASN) from DOD 4105 59-M supplied from source other than manufacturer and this is pertinent, also list the source here or in Block 10. If ALERT is against a category or application, do not identify manufacturer.
5. **NATIONAL STOCK NUMBER** - (Formerly Federal Stock Number.) List applicable number. If several numbers are applicable and space is not available, place asterisk after last number and continue entry in Block 10. As a minimum, enter Federal Supply Class.
6. **PROCUREMENT SPECIFICATION** - List applicable procurement specification and name of issuing organization. Include, in Block 10, nearest government or industry specification and any exceptions or special recognized government or industry specification requirements which were imposed.
7. **REFERENCE** - List any applicable documentation not included as part of this ALERT, e.g., previous ALERT number, TWX, or report number.
8. **MANUFACTURER'S PART NUMBER** - List manufacturer's catalog identification/part number of item. If different than procurement specification identification, list nearest similar manufacturer's identification and list differences in Block 11.
9. **LOT/DATE OR SERIAL NO.** - When problem is applicable to only certain lot/date code or serial numbered items, list appropriate code or number. Use year purchased if other information is not available. Blank space indicates "all."
10. **SPECIAL REQUIREMENTS OR ENVIRONMENT** - State any special requirements placed on item or any special or extreme environment to which it was subjected. This would include any exceptions or requirements other than imposed in applicable procurement specification listed in Block 6.
11. **PROBLEM SITUATION AND CAUSE** - State facts of problem and cause, including failure mode and mechanism.
12. **ACTIONS TAKEN** - State all actions taken to correct problem situation and to prevent further occurrences. This will include any actions taken by manufacturer, if known.
13. **DATE MANUFACTURER NOTIFIED** - Release of ALERT requires that a copy be sent to manufacturer identified in Block 4 and fifteen (15) working days be allowed for a reply. When available, attach a copy of the reply to the ALERT.
14. **MANUFACTURER RESPONSE** - Item manufacturer must be notified. When manufacturer correspondence is included, check CORRESPONDENCE ATTACHED entry. When manufacturer does not reply, check DID NOT REPLY entry. If ALERT is against a category or application and manufacturer is not identified, enter N/A in CORRESPONDENCE ATTACHED entry.
15. **CONTACT POINTS FOR INFORMATION** - Enter name, affiliation, and telephone number of persons to contact for further information. This may include designated personnel from ALERT originator's organization, or any other organization.
16. **ALERT COORDINATOR** - Enter name and affiliation of the ALERT Coordinator.
17. **SIGNATURE** - Signature of ALERT Coordinator.
18. **NOMENCLATURE** - Same as in Block 1.
19. **ALERT/SAFE-ALERT NO.** - Same as in Block 2.

prepare Alerts (DD Form 1938, Figure 8-2) and submit them and supporting data to NASA for appropriate action in accordance with Appendix C herein.

8.15 INSPECTIONS AND TESTS

The developer shall plan and conduct an inspection and test program which demonstrates that contract, drawing, and specification requirements are met. Inspections and tests shall be performed on products before they are installed in the next level of assembly. Inspection shall include a review of product records. Each inspection and test shall be traceable to the individual responsible. Quality assurance personnel shall approve all manufacturing documentation prior to its use.

8.15.1 PLANNING

The developer shall plan for inspections and tests and for a documentation system that substantiates their accomplishment. The planning function shall provide for:

- a. Orderly and timely inspection and tests at the earliest opportunity and through all phases.
- b. Coordination and sequencing of inspection and tests conducted at successive levels of assembly to ensure satisfactory articles and materials and to eliminate unnecessary testing.
- c. Availability of handling equipment and calibrated inspection and test equipment.
- d. Coordination of inspections and tests conducted by the designated Government Quality Representative.
- e. A documented listing of those inspection procedures utilizing sampling plans (paragraph 8.19), including the sampling rationale. This shall be maintained as a part of the inspection planning documentation and shall be available to NASA for review upon request.

8.15.2 INSPECTION AND IN-PROCESS TEST PROCEDURES

Inspection and in-process test activities shall be conducted in accordance with documented procedures physically located at the applicable inspection or test station. The degree of detail in the procedures shall be commensurate with the complexity of inspection or in-process test operations. Inspection procedures may be a part of the manufacturing control documentation. All procedures shall include, as applicable, the nomenclature of the article, characteristics to be inspected or tested, accept/reject criteria, and special consideration regarding measuring or test equipment, standards, safety, and environment.

8.15.3 INSPECTION ACTIVITY

As a minimum the inspections in the following paragraphs are to be performed.

8.15.3.1 In-Process Inspection. This task shall be performed at all levels of assembly in keeping with the following requirements:

a. The configuration, drawing requirements, and workmanship shall be verified prior to the next step of fabrication or integration; characteristics shall be verified that cannot be verified later without destructive disassembly.

b. In-process inspection shall be done in a clean environment in accordance with the Contamination Control Plan (see par. 9.2).

c. In-process inspection personnel shall be certified for the selected processes and inspections.

d. In-process verification below the component level shall include electrical interface tests (paragraph 3.3.1) of assemblies prior to being integrated into the next higher level of hardware.

8.15.3.2 Final Inspection. This task shall be performed at all levels of assembly:

a. Configuration, workmanship, and test results shall be verified before installation or use with the next higher level of assembly.

b. Verify that all nonconformances have been processed and all open items have been transcribed into the next level of inspection or fabrication documents.

c. Final inspection shall be done in a clean environment in accordance with the Contamination Control Plan.

d. Final inspection personnel shall be certified for the selected processes and inspections.

8.15.3.3 End-Item Inspection. This task shall be performed to:

a. Verify that configuration, test results, workmanship, and the Acceptance Data Package (see par. 8.23) is in compliance with the contract.

b. Verify that NASA has authorized the delivery of the end-item with such open nonconformances and unresolved tasks that may exist.

8.15.3.4 Surveillance Inspection. Stored and stocked parts, materials, and flight or spare hardware shall be periodically inspected and tested for proper storage environment and packaging to prevent deterioration or damage. The developer shall identify in the PAIP the hardware and the frequency of the inspection.

8.15.3.5 Printed Wiring Board Inspections and Tests. Printed wiring boards shall conform to the requirements of NHB 5300.4(3I), MIL-P-55110, or a NASA-approved developer specification, and shall be qualified by test and inspection results. Test coupons and test/inspection procedures shall be submitted to NASA for evaluation upon request. NASA RP 1161, "Evaluation of Multi-layer Printed Wiring Boards by Metallographic Techniques," shall be used for performance of these tests and for the interpretation of the test results.

8.15.4 QA ACTIVITIES DURING THE INTEGRATION AND TEST PHASE

Assurance personnel shall ensure that the subassemblies, assemblies, components, and contract end-items are integrated and tested in accordance with controlling documents. Articles undergoing test shall not be adjusted, modified, repaired, reworked, or replaced except as specified in established documents, or in accordance with MRB actions. The status, configuration, and integrity of the hardware must be maintained and documented. Integration and test activities shall be conducted in a clean area in accordance with the Contamination Control Plan.

Assurance personnel shall provide surveillance of all tests; the extent shall be defined in QA and test documents by quality assurance management. As a minimum the activities in the following paragraphs shall be performed.

8.15.4.1 Verification. Prior to testing, the assurance personnel shall verify:

- a. The presence of approved inspection and test documents.
- b. The identification of products.
- c. The configuration of products.
- d. That test equipment is within the calibration period for the duration of the test.
- e. Test setup and test configuration.

8.15.4.2 Test Documentation. During tests the assurance personnel shall:

- a. Ensure that tests are conducted in accordance with

approved specifications and procedures.

- b. Ensure accurate and complete recording of data and results.
- c. Document rework, repairs or modifications.
- d. Document nonconformances.

8.15.4.3 Post Test Assurance Activity. Subsequent to testing, the assurance personnel shall:

- a. Ensure proper disposition of articles.
- b. Verify that test results, reports, and nonconformance documents are accurate, complete, and traceable to the tested products. Any additional nonconformances shall be processed in accordance with 8.13.

8.15.5 RECORDS OF INSPECTIONS AND TESTS (COMPONENT LEVEL TO END-ITEM)

8.15.5.1 General Requirements. The developer shall prepare and maintain records, including logs, of all inspections and tests to show that all operations have been performed, the objectives met, and the end-item fully verified.

8.15.5.2 Scope. Records shall cover each component, subsystem, and system. As the hardware is integrated, records of lower-level assembly products shall be combined into those for the end-item as a means of compiling a continuous, chronological history of identified hardware, fabrication, assembly, inspection, and tests as well as other actions or data important to a complete assurance record, such as idle periods (storage), movement of the end-item, repairs, approvals, maintenance, configuration data, etc.

Assurance personnel shall verify that records are complete. The records shall be retained at the developer's facility for a minimum of five years after launch of the hardware or otherwise as prescribed by the contract.

8.16 CONFIGURATION VERIFICATION

Assurance personnel are required to verify that the as-built product complies with the currently approved as-designed configuration listing and is in accordance with approved configuration documents as required by the Configuration Management Plan and with paragraphs 8.3 and 8.4. The configuration shall be maintained and controlled throughout the program.

Configuration verification is required as a part of all inspections (see par. 8.15.3). A nonconformance report shall be initiated in accordance with par. 8.13 for any deviations of inspected as-built hardware from the current approved configuration. Any configuration nonconformances that are not corrected shall be documented on a Deviation/Waiver request form (see Figure 4-3) and processed in accordance with approved configuration management procedures

For End-Item Inspections (see par. 8.15.3.3), the developer shall also provide an as-built configuration verification report in accordance with the requirements of GSFC 420-02-02 for inclusion in the End-Item Data Package. This verification report, based on inspection of the as-built hardware and review of records of lower levels of assembly that are not visually verifiable at the time of end-item inspection, shall list all nonconformances of the as-built hardware and software from the latest approved configuration.

The as-designed configuration and updates, as well as the as-built configuration verification report, shall be provided in accordance with the Contract configuration management requirements and included in the Acceptance Data Package (see par. 8.23).

8.17 METROLOGY

8.17.1 GENERAL REQUIREMENTS

The developer shall establish and comply with a documented metrology system that ensures that measurement standards and equipment (including GSE) are selected and controlled to the degree necessary to meet drawing requirements and functional test requirements. The system shall be in accordance with provisions of MIL-STD-45662 (Appendix A).

8.17.2 INSTRUMENTS USED FOR MEASURING

Tools, gages, jigs, and fixtures which measure dimensions, contours, or locations affecting quality characteristics shall be checked for accuracy prior to use. Also, test equipment and instruments (including GSE) used in functional test of the hardware shall be calibrated to standards appropriate to their test uses and shall be checked for accuracy in accordance with appropriate procedures prior to use. Checks and recalibrations shall be made at predetermined intervals to ensure continued accuracy.

8.17.3 PRODUCT MEASUREMENT PROCESS

The sum of random and systematic errors in any article or material measurement process shall not exceed ten percent of the

tolerance or material characteristics being measured. Where state-of-the-art or other considerations make this provision impossible or impracticable the developer shall maintain a list of exceptions, and they shall be available for review upon request.

8.17.4 CALIBRATION MEASUREMENT PROCESS

The sum of random and systematic errors in any calibration measurement process shall not exceed 25 percent of the tolerance of the parameter being measured. Where state-of-the-art or other considerations make this provision impossible or impracticable the developer shall maintain a list of those exceptions and they shall be available for review upon request.

8.18 STAMP CONTROL SYSTEM

The developer shall establish and maintain a documented stamp control system which provides the following:

a. Stamps, decals, seals, and paints which are applied to flight hardware shall comply with the criteria of 6.2.4 and shall show that products have undergone source and receiving inspection, in-process fabrication and inspection, end-item fabrication, inspection and storage, and shipment.

b. Stamps shall be traceable to the certified individual responsible for their use, and records shall be maintained to identify the individual. Fabrication (manufacturing) and inspection stamps shall be of different design.

c. Stamps shall be applied to records to indicate the fabrication or inspection status of the products.

8.19 SAMPLING PLANS

Sampling plans may be used when inspections or tests are destructive, or when data, inherent characteristics, or the noncritical application of a product allows for a reduction in inspection or testing. Such plans shall not jeopardize quality, reliability, or design intent. MIL-STD-105 (Appendix A) shall be used for establishing the sampling plan requirements. The sampling plan shall provide an average quality level that is appropriate to the reliability requirements of the project. Sampling plans shall be identified in the applicable inspection procedures, and a listing of those inspection procedures utilizing sampling plans, including the sampling rationale, shall be maintained as a part of the inspection planning documentation (paragraph 8.15.1).

8.20 TRAINING AND CERTIFICATION FOR MANUFACTURING AND INSPECTION PERSONNEL

8.20.1 TRAINING

The developer shall use trained personnel for implementing the performance assurance program including interpretation of related accept/reject criteria, and processes control. Training programs shall be developed, documented, implemented, and maintained for personnel who may have an effect upon, or who are responsible for reliability and quality.

8.20.2 CERTIFICATION AND RECERTIFICATION OF PERSONNEL

a. Certification- Developer personnel who perform or inspect selected processes and operations such as soldering, module welding, potting, encapsulation and radiography shall be certified on the basis of evidence of competence that includes training and testing.

b. Recertification- Developer personnel shall be recertified if they fail to perform satisfactorily in the production of products or services, or because of changes in techniques or required skills, or by the interruption of work experience as established for the process or operation. Recertification shall require retesting of the individual to demonstrate proficiency. Persons failing the retest shall not perform the tasks until they receive additional training and proficiency has been demonstrated.

8.20.3 RECORDS

Records shall be maintained of the training, testing, certification, and recertification status of personnel.

8.21 HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

The developer shall prepare and implement procedures for the handling, storage, preservation, marking, labeling, packaging, packing, and shipping of all products. Procedures shall be submitted in accordance with Appendix C herein. The procedures shall implement the requirements of NHB 6000.1 (Appendix A) and the following paragraphs.

8.21.1 HANDLING

The protection of products during the life of the program shall be achieved through the use of handling equipment (including GSE) and techniques which have been certified before use. Evidence of initial and periodic proof-testing of handling equipment shall be maintained.

8.21.2 STORING, PRESERVATION, MARKING, LABELING PACKAGING, AND PACKING

Products shall be stored, preserved, marked, labeled, packaged, and packed to prevent loss of marking, deterioration, contamination, or damage during all phases of the program. Stored and stocked items shall be controlled in accordance with documented procedures and be subject to quality surveillance as stated in paragraph 8.15.3.4.

8.21.3 SHIPPING

For instruments that are sensitive to damage from mechanical shock or extreme temperature exposure, monitoring devices shall be included at appropriate locations within the shipping containers to provide evidence of any exposure to potentially damaging shipping stresses.

Prior to shipping, quality assurance personnel shall ensure that:

- a. Fabrication, inspection, and test operations have been completed and accepted.
- b. All products are identified and marked in accordance with requirements.
- c. The accompanying documentation (developer's shipping and property accountable form) has been reviewed for completeness, identification, and quality approvals.
- d. Evidence exists that preservation and packaging are in compliance with requirements.
- e. Packaging and marking of products, as a minimum comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identification at their destinations.
- f. The loading and transporting methods are in compliance with those designated in the shipping documents.
- g. Integrity seals are on shipping containers and externally observable shock or temperature monitors do not show excessive environmental exposure.
- h. In the event of unscheduled removal of a product from its container, the extent of reinspection and retest shall be as authorized by NASA or its representative.
- i. Special handling instructions for receiving activities, including observation and recording requirements for shipping-

environment monitors, are provided where appropriate.

The developer's quality assurance organization shall verify prior to shipment that the above requirements have been met. QA shall sign off appropriate shipping documents to provide evidence of this verification.

8.22 GOVERNMENT PROPERTY CONTROL

8.22.1 DEVELOPER'S RESPONSIBILITY

In accordance with the provisions of the contract, the developer shall be responsible for and account for all property supplied by the Government including Government property that may be in the possession or control of a supplier. The developer's responsibility shall include, but not be limited to, the following:

- a. Upon receipt, examine products to detect damage that may have occurred in transit.
- b. Inspection for quantity, completeness, proper type, size and grade as specified in the shipping documents.
- c. Provision for the protection, maintenance, calibration, periodic inspection, segregation, and controls necessary to prevent damage or deterioration during handling, storage, installation, or shipment.
- d. Maintenance of records which include:
 - (1) Identification of the property.
 - (2) Location of the property.
 - (3) Dates, types, and results of developer inspections, tests, and other significant events.
- e. Any functional tests shall be performed on the product only if such tests are directed by the NASA project office.

8.22.2 UNSUITABLE GOVERNMENT PROPERTY

The property shall be processed in accordance with Government procedures and 8.13. The property shall not be dispositioned, repaired, reworked, replaced, or in any way modified unless such action is authorized by the contract or by the Contracting Officer in writing.

8.23 GOVERNMENT ACCEPTANCE

Prior to acceptance by NASA, quality assurance personnel shall

ensure that deliverable contract end-items, including the Acceptance Data Package, are in accordance with contract requirements. A copy of the data package shall be submitted to NASA in accordance with Appendix C herein and a copy shall accompany each end-item.

SECTION 9

CONTAMINATION CONTROL REQUIREMENTS

9.1 APPLICABILITY AND DEFINITIONS

A contamination control program shall be conducted to meet the needs of the instrument and the EOS Project. The contamination control allowances for the instrument developed under this program shall be used to establish the contamination control requirements for the integration, test, and mission use of the instrument when integrated with the Observatory.

Contaminants are defined as those materials, either at a molecular or a particulate level, whose presence degrades mission performance. The source of these contaminants may be the Platform, the developer's instrument, other instruments in the payload, any material or equipment coming in contact with the instrument, the test facilities, and/or the environments to which the instrument is exposed.

9.2 CONTAMINATION CONTROL PLAN

The developer shall prepare and implement a Contamination Control Plan (CCP) that includes contamination allowances, methods for control, and verifications that the allowances have been met. At least one copy of all referenced analyses, procedures, standards, and specifications, with the exception of Government standards, shall be provided with the CCP. The plan shall be submitted in accordance with Appendix C herein.

9.2.1 CONTAMINATION ALLOWANCES

As a basis for contamination control activities, the developer shall establish contamination allowances for performance degradation of contamination-sensitive hardware such that, even when degraded by contamination within the stated allowance, the hardware will meet its mission objectives. The contamination allowances for the developer's instrument shall reflect the allowable contamination levels defined in par. 9.3, below. The following information related to contamination allowances shall be included in the CCP:

-- The sensitivity of the instrument to contamination, the contamination control concerns, and potential sources of contamination;

-- The science requirements and allowable performance degradation;

-- Contamination allowances for all sensitive surfaces. These allowances are derived from the allowable performance degradation, and shall be stated as surface cleanliness levels (molecular and particulate) in accordance with MIL-STD-1246 or equivalent, (see Tables 9-1 and 9-2). Allowable outgassing and particulate contamination levels shall also be defined for materials or subsystems near contamination-sensitive surfaces. All analyses performed to assess instrument sensitivity and to derive contamination allowances shall be documented.

9.2.2 CONTAMINATION CONTROL

The developer shall prescribe in the CCP the measures to be taken to ensure that the contamination allowances established under 9.2.1 are not exceeded. This shall include a description of the facilities, and a description of all procedures used after fabrication and during integration and test, interfacing with other subsystems or the Observatory, cleaning, bagging, transportation, etc. An operations flow chart shall be included.

It is required that the total amount of outgassed condensable volatile matter from the instrument stay within the outgassing and particulate contamination allowances in section 9.2.1, even though the construction materials used satisfy the unit outgassing criteria for TML and CVCM prescribed in section 6.2.4.

Instruments shall be designed so that gases vented during ascent and on-orbit will be directed away from contamination sensitive surfaces or areas of the developer's instrument and adjacent instruments.

The developer shall detail in the CCP the methods of verification (e.g. measurements, inspections, tests, and analyses) to be used during each phase of the hardware lifetime. For each method, the documented procedure and data recording requirements must be enumerated or referenced. The CCP shall include criteria for defining out-of-control conditions and planned methods of dealing with them.

9.2.3 BAKE-OUTS

Bake-outs of wiring harnesses and thermal blankets are required since past experience has shown these to be major contributors to the contamination level of hardware in test and flight. For highly contamination-sensitive instruments, bake-outs of critical subsystems before final instrument assembly may also be necessary. During these bake-outs, the outgassing must be measured to ensure compliance with the allowances in 9.2.1. The parameters (e.g. verification method, temperature, duration, pressure) of such bake-outs must be individualized, depending on the materials used, the fabrication environment, and the

Table 9-1
EQUIVALENT WAYS TO EXPRESS
PARTICULATE CONTAMINATION ON SURFACES

MIL-STD-1246B Level	# of particles/cm ² *	Percent Obscuration **
300	1	0.02
400	4	0.09
500	13	0.3
600	30	0.7
700	70	1.6
750	100	2.2
800	150	3.3
900	275	6.0

* This is number of particles visible on the surface when inspected with high intensity white light from a distance of 10 to 30 cm (6 to 12 inches). Only particles of size 50 microns or larger are assumed to be visible.

** This is the percentage of surface area obscured by particles.

Table 9-2
EQUIVALENT WAYS TO EXPRESS
MOLECULAR CONTAMINATION ON SURFACES

MIL-STD-1246B Level	Max. mass deposition ($\mu\text{g}/\text{cm}^2$)	Max. layer thickness (nm) *
A	1	10
B	2	20
C	3	30
D	4	40

* Assuming the molecular contamination has an average density of $1 \text{ g}/\text{cm}^3$.

established contamination allowance. The bake-out parameters for each hardware item shall be documented in individual bake-out specifications and referenced in the CCP.

9.2.4 THERMAL VACUUM TEST

The Contamination Control Plan shall include or reference the contamination controls to be exercised in preparing the thermal-vacuum chamber and the necessary fixtures and stimuli for system level tests. These shall include the operational procedures that will be followed to minimize the potential contamination hazard, from pumpdown through return to ambient conditions. Test phases that represent contamination hazards and the approaches to be taken to minimize these hazards shall be addressed. Pretest measurements, monitoring methods to be used during the test, and post-test measurements for verifying that contamination criteria have not been exceeded shall be prescribed. Contingency plans dealing with the possibility that contamination criteria are exceeded shall be included.

9.3 INSTRUMENT CROSS-CONTAMINATION

Since EOS will contain many instruments with widely varying contamination sensitivities in close proximity to each other, the instruments could contaminate each other, thus jeopardizing each others' performance. In order to minimize this, each instrument, regardless of its contamination sensitivity, must meet the following minimum cleanliness requirements.

The external surfaces of all instruments shall be at Level 600A or better (per MIL-STD-1246) upon delivery to the integration contractor. Surface cleanliness levels shall be verified upon delivery to the Observatory contractor.

At the last hot cycle of the instrument-level thermal-vacuum testing, all instruments shall outgas at a rate less than or equal to 1×10^{-7} grams/square centimeter/hour for 5 consecutive hours at the maximum instrument operating temperature, as measured by a temperature-controlled quartz crystal microbalance (TQCM) located within the test chamber and maintained at $-20 \text{ C.} \pm 2^\circ\text{C}$. The TQCM must have a representative view of the instrument.

SECTION 10

SOFTWARE ASSURANCE REQUIREMENTS

10.1 GENERAL REQUIREMENTS

The developer shall establish an organized program of software assurance that includes verification and validation, quality assurance, configuration management, and nonconformance reporting and corrective action. This software assurance program shall be coordinated with the hardware and system oriented assurance program established to meet the requirements of the rest of this document. The software assurance program shall encompass flight software and firmware, ground support equipment software, and any software purchased or developed under this contract that is related to flight mission operations. Specifically excluded from this requirement are science and data analysis software.

In preparing the software section of the PAIP, (par. 1.3) the developer shall describe the software management and assurance approach that will be followed in developing and verifying the software, and will address each of the following:

- a. A brief description of the software to be developed.
- b. Management structure and responsibilities of the organization(s) developing and assuring the software, and its (their) relationship to the hardware and flight systems development activities of the project.
- c. The software requirements development and control process, including the process for identification and control of interfaces.
- d. The software design and implementation process, describing the major steps that are to be followed in detailing the design and implementing it.
- e. The general assurance process for software development and its application to the specific software to be developed. If certain of the software items are deemed more critical than others and different management and assurance practices will be used, these shall be described.

10.1.1 DOCUMENTATION

The developer shall provide with the PAIP a list of the documentation to be produced for the software elements covered by this assurance requirement. This list shall be updated with the PAIP in accordance with Appendix C herein.

The effectivity relationship of the issuance of versions of this documentation to configuration management baselines required in section 10.4 shall be documented.

10.2 VERIFICATION AND VALIDATION

The developer shall plan and implement a verification and validation process to demonstrate that the software is correct and meets its requirements. It shall include testing, walkthroughs or inspections, and reviews.

10.2.1 SOFTWARE TEST PLAN

The developer shall develop and submit in accordance with appendix C a software test plan for each major software component covered by this assurance requirement. The plan shall show the requirement driven software acceptance tests and any hardware/software integration tests that will be done to demonstrate that the software component meets its requirements. The plan shall include the tests that will be used to demonstrate that each software requirement has been satisfied, the environment under which the test is to be conducted, the data required for the test, the expected results, test schedules, and any special operating conditions required. It is to be updated as requirements are updated and be included as part of each review required in section 10.2.5. This plan shall also describe any special test support tools (i.e., simulators, emulators, etc.) needed for the testing and any required support from other organizations to perform the testing.

After acceptance of any version of the software, any changes to the baselined version of the software shall require issuance of a new or revised test plan in accordance with the requirements of the Project configuration management system. If the software is updated, adequate regression testing is required and shall be so identified in the test plan.

10.2.2 SOFTWARE TEST PROCEDURES

The developer shall prepare software test procedures that implement the software test plans required in 10.2.1.

10.2.3 SOFTWARE TEST REPORTS

The developer shall prepare a software test report(s) that summarizes each of the software acceptance testing and/or retesting activities. The report shall show which of the planned tests were completed, conformance of the test results to the expected results, the number, type and criticality of the discrepancies found, the identification of components tested, and an analysis of any performance requirements that the items tested could affect. The actual test results shall either be attached

to the report(s) or maintained available. Test reports shall be provided in accordance with Appendix C herein.

10.2.4 SOFTWARE WALKTHROUGHS OR INSPECTIONS

The developer shall conduct some form of walkthroughs or inspections on requirements, detailed design and code. The team doing the walkthrough shall include individuals not responsible for the development of the design or code being reviewed and a software QA member. NASA personnel shall not normally participate in developer walkthroughs. However, in special cases, at the request of the NASA instrument manager, the developer shall make provision for inclusion of designated NASA personnel in specific, identified walkthroughs. The walkthrough process shall be devised with the intent of finding errors or omissions in the design or code. At the developer's option, the process may be used to enforce design and coding standards.

10.2.5 SOFTWARE REVIEWS

The software review process shall include both internal reviews and external reviews.

The developer shall support three external GSFC conducted software reviews in addition to the Flight Assurance Reviews described in section 2.0 of this document: (1) a Software Requirements Review (SWRR) (the requirements shall be baselined prior to the early design effort), (2) a PDR and (3) a CDR. The reviews shall address the following:

a. The Requirements Review shall address the definition of the software requirements relative to the system-level requirements for each software-hardware system within the instrument and the interfaces of these systems with the EOS Observatory and ground system. This review shall also formally define the interface boundaries between the software and hardware in each internal software-hardware system. This Review shall include a preliminary version of the Software Test Plan which describes the major tests to be performed to demonstrate that the requirements are satisfied.

b. The Preliminary Design Review shall present the software requirements, an architectural level design description, and a requirements driven test approach.

c. The Critical Design Review shall describe the software detailed design, including the data flow and the interfaces, and an implementation approach/plan.

d. At each review, any questions or issues relating to the potential impact of the software on system safety shall be addressed.

e. Software review material shall address questions of data security, including protection of software products from unauthorized access and modifications, as well as protection against loss from natural sources or operational anomalies.

For each external review, the developer shall meet the requirements given in section 2.2.

10.3 SOFTWARE QUALITY ASSURANCE

10.3.1 STANDARDS

The developer shall establish standards for software and project documentation, including the documentation of software designs and interface specifications. Unless otherwise approved by the Contracting Officer, the developer shall use the NASA software documentation standards contained in the "Information System Life-Cycle and Documentation Standards" (Appendix A).

The developer shall also set standards for code and for the internal, code level documentation.

10.3.2 ASSURANCE FUNCTION

The developer shall have an assurance function which verifies that the standards required by section 10.3.1 have been met. The assurance function shall also verify that the required test, configuration management, and nonconformance reporting procedures have been followed, and that walkthroughs are completed. The software assurance function shall be a part of the over-all Project performance assurance system established in accordance with this document.

10.4 SOFTWARE CONFIGURATION MANAGEMENT

The developer shall establish a software configuration management process to manage requirements, design, code, data, and documentation, and to track and report on the status of changes to them. The software configuration management system shall be a part of or shall be conducted in close coordination with the over-all Project configuration management system. This software configuration management process shall include, as a minimum, the following elements:

a. Identification of configuration items that will be baselined and maintained under configuration control. The developer shall establish at least three baselines, one after each of the formal software reviews required in section 10.2.5 and one after the acceptance test has been conducted and the software accepted for use.

b. A change classification and impact assessment process.

The process must result in Class 1 software changes being forwarded to GSFC for disposition. Class 1 software changes are defined as those which affect system requirements, software requirements, system safety, reliability, cost, schedule, and external interfaces.

c. A Configuration Control Board (CCB) that reviews and dispositions changes.

d. Version control and media labelling methods and procedures.

e. A media control process. The developer shall state the methods and facilities to be used to protect computer program physical media from unauthorized access or inadvertent damage or degradation.

The developer shall establish procedures that detail the steps to accomplish the CM process, including any needed forms and their processing.

10.5 SOFTWARE NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

The developer shall establish a process for the reporting, analysis, correction, and verifying effectiveness of correction of nonconformances discovered in the software and software documentation during the development of the software. After development and starting with the first use of a software item with the flight hardware, software nonconformances shall be reported and dispositioned through the malfunction or failure reporting system (section 8.13.2). Provision shall be made for transfer of nonconformance data from the development phase reporting activity, including software acceptance tests, to the malfunction reporting system on any nonconformances which, in the judgement of the cognizant development activity, may be of value in analyzing later potential problems. Also, data on any problems occurring in the operations testing of the software shall be entered in the malfunction reporting system.

The nonconformance reporting and corrective action process at all times shall interface with the software configuration management process such that change control is effected, and that reported nonconformances and change requests are so identified and processed. The developer shall develop and maintain a reporting process that shows the status and criticality of all nonconformances.

The developer shall document procedures that detail the steps to accomplish the nonconformance reporting and corrective action process. These shall be submitted for NASA review with the PAIP (par. 1.3).

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APPENDIX A - APPLICABLE DOCUMENTS

The revisions of the documents listed below that are current at the time of Contract award are applicable to these Requirements.

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
SECTION 1			
1.1	NHB 5300.4 (1A)	Reliability Program Requirements for Aeronautical and Space System Contractors	Note 1
1.1	NHB 5300.4 (1B)	Quality Program Provisions for Aeronautical and Space System Contractors	Note 1
1.1 5.1	NHB 5300.4 (1F)	Electrical, Electronic and Electromechanical (EEE) Parts Management and Control Requirements for NASA Space Flight Programs	Note 1
SECTION 2			
2.5	S-311-98	Guidelines for Conducting a Packaging Review	Note 7
SECTION 3			
3.1 3.2.1 3.5.2.2	GEVS-SE	General Environmental Verification Specification for STS and ELV Payload Systems, Subsystems and Components (TBD)	Note 7
3.1, 3.4.1, 3.4.5, 9.2.1	GIIS	EOS General Instrument Interface Specification	Note 7
3.5.2.1	MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.	Note 1 or 3
3.5.2.1	MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of	Note 1 or 3

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
3.5.2.1	MIL-STD-463	Military Standard Definitions and System of Units, Electromagnetic Interference and Electromagnetic Compatibility Technology.	Note 1 or 3
3.5.2.2	SEP-106	EOS Observatory EMI/EMC Control Plan	Note 7
SECTION 4			
4.1 6.2.4	WSMCR 127-1	Western Space and Missile Center, Range Safety Regulations	Note 1
4.1	MIL-STD-1574	System Safety Program for Space and Missile Systems	Note 1
SECTION 5			
5.1 5.3.1 7.3.3	GSFC PPL	GSFC Preferred Parts List	Note 7
5.1 5.3.1 7.3.3	MIL-STD-975	NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List	Note 1 or 3
5.3.2.3	MIL-STD-490	Specification Practices	Note 1 or 3
5.3.2.4	MIL-M-38510	General Specification for Microcircuits	Note 1 or 3
5.3.2.4	MIL-H-38534	General Specification for Hybrid Microcircuits	Note 1 or 3
5.3.6	S-311-70	GSFC Specification, for Destructive Physical Analysis of Electronic Parts	Note 7
SECTION 6			
6.2.1	None	GSFC Materials Tips for Spacecraft Applications	Note 7
Revision A		108	August 1991

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
6.2.1	TM 82275* (GSFC Mtr. No. 755-013)	Quality Features of Spacecraft Ball Bearing Systems	Note 5
6.2.1	TM 82276* (GSFC Mtr. No. 313-003)	An Evaluation of Liquid and Grease Lubricants for Spacecraft Applications	Note 5
6.2.1	None	Materials Selection Guide	Note 7
6.2.1	N-84-26751* (NASA RP-1124)	Outgassing Data for Selecting Spacecraft Materials	Note 5
6.2.1	NHB 8060.1	Flammability, Odor, and Outgassing Requirements and Test Procedures for Materials in Environments that Support Combustion	Note 1
6.2.1	MSFC-SPEC-522	Design Criteria for Controlling Stress Corrosion Cracking	Note 4
6.2.1	MSFC-HDBK 527, JSC 09604	Materials Selection List for Space Hardware Systems	Note 4
6.2.4	ASTM Method E 595	Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment	Note 6
6.2.4	ESMCR 127-1	Range Safety Manual (for ETR)	Note 7
SECTION 7			
7.2.2	GSFC-S-313-100	GSFC Fastener Integrity Requirements	Note 7
8.5.8			
7.3.1.1	GSFC S-302-89-01 (12/1/89)	Failure Modes and Effects Analysis Procedure for Unmanned Spacecraft and Instruments	Note 7
7.3.2	NPRD-3 (RADC publication)	Non-Electronic Parts Reliability Data	Note 1

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
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SECTION 8

8.3 8.5.1 8.13.2.2	GSFC 420- 02-02	EOS Configuration Management Plan	Note 7
8.5.8 8.9.d	MSFC-STD- 655	Standard Weld Filler Metal, Control of	Note 4
8.10.3	NHB 5300.4 (3A)	Requirements for Soldered Electrical Connections	Note 1
8.10.3	NHB 5300.4 (3G)	Requirements for Interconnect- ing Cables, Harnesses, and Wiring	Note 1
8.10.3	NHB 5300.4 (3H)	Requirements for Crimping and Wire Wrap	Note 1
8.10.3 8.15.3.5	NHB 5300.4 (3I)	Requirements for Printed Wiring Boards	Note 1
8.10.3	NHB 5300.4 (3J)	Requirements for Conformal Coating and Staking of Printed Wiring Boards and Electronic Assemblies	Note 1
8.10.3	NHB 5300.4 (3K)	Design Requirements for Rigid Printed Wiring Boards and Assemblies	Note 1
8.12	DOD-HDBK- 263	Electrostatic Discharge Control Handbook for Protec- tion of Electrical, Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	Note 3
8.12	DOD-STD- 1686	Electrostatic Discharge Control Program for Protection of Electrical, Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	Note 3
8.15.3.5	MIL-P- 55110	General Specification for Printed-Wiring Boards	Note 3

PARAGRAPH NO.	DOCUMENT NO.	TITLE	AVAILABLE FROM
8.15.3.5	NASA RP E161	Evaluation of Multilayer Printed Wiring Boards by Metallographic Techniques	Note 2
8.17.1	MIL-STD- 45662	Calibration System Requirements	Note 3
8.19	MIL-STD- 105	Sampling Procedures and Tables for Inspection by Attributes	Note 3
8.21	NHB 6000.1	Requirements for Packaging, Handling, and Transportation	Note 1
9.2.1	MIL-STD- 1246	Military Standard Product Clean- liness Levels and Contamination Control Program	Note 3
10.3.1		Information System Life-cycle and Documentation Standards	Note 2

NOTES (SOURCES):

1. Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.
2. NASA/Scientific and Technical Information Facility, P.O. Box 8757, BWI Airport, MD, 21240.
3. Department of the Navy, Naval Publications & Forms Center, 5801 Tabor Avenue, Philadelphia, PA, 19120.
4. NASA/Marshall Space Flight Center, Documentation, Code CW 22D, Huntsville, AL, 35812.
5. National Technical Information Service, Springfield, VA 22161.
6. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.
7. EOS Project Office, Code 420, Goddard Space Flight Center, Greenbelt, MD, 20771. Attention: EOS Librarian.

GSFC 420-05-01

APPENDIX B - ABBREVIATIONS, ACRONYMS, AND GLOSSARY

Abbreviations and Acronyms

ARAR	Accident Assessment Report
ASIC	Application Specific Integrated Circuit
ASTM	American Society for Testing and Materials
CAGE	Commercial and Government Entity
CCB	Configuration Control Board
CCP	Contamination Control Plan
CDR	Critical Design Review
CDRL	Contract Documentation Requirements List
CE	Conducted Emission
CIL	Critical Items List
CM	Configuration Management
CPT	Comprehensive Performance Test
CS	Conducted Susceptibility
CVCM	Collected Volatile Condensable Mass
DCR	Design Concept Review
DOD	Department of Defense
DPA	Destructive Physical Analysis
DRL	Document Requirements List
EEE	Electrical, Electronic, & Electromechanical
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOC	EOS Operations Center
EOS	Earth Observing System

ESD	Electrostatic Discharge
ESMCR	Eastern Space & Missile Center Regulation
FMEA	Failure Mode and Effects Analysis
FOR	Flight Operations Review
FRB	Failure Review Board
FRR	Flight Readiness Review
GEVS-SE	General Environmental Verification Specification for STS and ELV Payloads, Subsystems & Components
GFE	Government Furnished Equipment
GIA	Government Inspection Agency
GIDEP	Government Industry Data Exchange Program
GIIS	General Instrument Interface Specification for the EOS Observatory
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSI	Government Source Inspection
ICC	Instrument Control Center
ICF	Instrument Control Facility
ICD	Interface Control Document
IAC	Independent Assurance Contractor
JSC	Johnson Space Center
LOD	Letter of Delegation
MIL-HDBK	Military Handbook
MIL-STD	Military Standard
MOR	Mission Operations Review
MR	Malfunction Report
MRB	Material Review Board

MSFC	Marshall Space Flight Center
MUA	Materials Usage Agreement
MUH	Mission Unique Hardware
NASA	National Aeronautical and Space Administration
NASCOM	NASA Communications Network
NDE	Nondestructive Evaluation
NHB	NASA Handbook
NSPAR	Non-Standard Parts Approval Request
NSPL	NASA Standard Parts List
OHA	Operations Hazard Analysis
ORR	Operations Readiness Review
ORU	On-orbit Replaceable Unit
PAIP	Performance Assurance Implementation Plan
PAPL	Platform Approved Parts List
PAR	Performance Assurance Requirements
PCB	Parts Control Board
PCP	Parts Control Plan
PDA	Percent of Defectives Allowable
PIND	Particle Impact Noise Detection
PDR	Preliminary Design Review
PER	Pre-environmental Review
PMP	Payload Mounting Plate
PPL	Preferred Parts List
PSR	Pre-shipment Review
QA	Quality Assurance
RE	Radiated Emission

RH	Relative Humidity
RS	Radiated Susceptibility
SMAP	Software Management and Assurance Program
SOR	System Operations Review
SSF	Space Station Freedom
SSIP	System Safety Implementation Plan
STS	Space Transportation System
SWCDR	Software Critical Design Review
SWPDR	Software Preliminary Design Review
TML	Total Mass Loss
TO	Technical Officer
TQCM	Temperature Controlled Quartz Crystal Microbalance
UIID	Unique Instrument Interface Document
WSMC	Western Space & Missile Center
WSMCR	Western Space & Missile Center Regulation

APPENDIX B - ABBREVIATIONS, ACRONYMS, AND GLOSSARY (cont'd)

Glossary

Acceptance Tests: The process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen to detect deficiencies and normally to provide the basis for delivery of an item under terms of a contract.

Assembly: See Hardware: Hardware Levels of Assembly.

Audit: A review of the developer's (contractor's) or subcontractor's documentation or hardware to verify that it complies with project requirements.

Catastrophic Failure: A failure whose potential effect would result in fatality or serious injury to personnel or loss of the Observatory, the launch facility or vehicle or prevent mission success (loss of a primary mission objective).

Collected Volatile Condensable Material (CVCN): The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific constant temperature for a specified time.

Component: See Hardware: Hardware Levels of Assembly.

Configuration: The functional and physical characteristics of parts, assemblies, equipment of systems, or any combination of these which are capable of fulfilling the fit, form and functional requirements defined by performance specifications and engineering drawings.

Configuration Control: The systematic evaluation, coordination, and formal approval/disapproval of proposed changes and the implementation of all approved changes to the design and production of an item, the configuration of which has been formally approved by the contractor or by the purchaser, or both.

Configuration Management: The systematic control and evaluation of all changes to baseline documentation and subsequent changes to that documentation which define the original scope of effort to be accomplished (contract and reference documentation) and the systematic control, identification, status accounting and verification of all configuration items.

Critical Failure: A failure whose potential effect would result in a significant (as determined by the Project) degradation of a primary mission objective or loss of a secondary mission objective.

Critical Application: Critical applications are defined as part applications in circuits or assemblies whose failure, without regard to redundancy, would be critical or catastrophic to the mission.

Derating: The reduction of the rating of a device to improve reliability.

Design Specification: Generic designation for a specification which describes functional and physical requirements for an article, usually at the component level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects the end-item specifications serve all the purposes of design specifications for the contract end items. Design specifications provide the basis for technical and engineering management control.

Designated Representative: An individual (such as a NASA plant representative), firm (such as assessment contractor), Department of Defense (DOD) plant representative, or other Government representative designated and authorized by NASA to perform a specific function for NASA. As related to the developer's effort, this may include evaluation, assessment, design review participation, and review/approval of certain documents or actions.

Destructive Physical Analysis (DPA): An internal destructive examination of a finished part or device to assess design, workmanship, assembly, and any other processing associated with fabrication of the part.

Deviation: A specific written authorization granted prior to the manufacture of an item to depart from a particular or design requirement of a specification, drawing or other document for a specific number of units or a specific period of time.

Discrepancy: See Nonconformance.

Effectivity: The point (in configuration evolution) at which a change or action becomes applicable to the hardware or software.

Electromagnetic Compatibility: The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI): Electromagnetic energy which interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility: Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

End-to-End Tests: Tests performed on the integrated ground and flight system, including all elements of the payload, its control, communications, and data processing to demonstrate that the entire system is operating in a manner to fulfill all mission requirements and objectives.

Failure: See Nonconformance.

Failure Modes and Effects Analysis (FMEA): Study of a system and working interrelationships of its elements to determine ways in which failures can occur (failure modes), effects of each potential failure on the system element in which it occurs and on other system elements, and the probable overall consequences of each failure mode on the success of the system's mission. Criticalities are usually assigned by categories, each category being defined in terms of a specified degree of loss of mission objectives or degradation of crew safety.

Functional Tests: The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.

Hardware: Physical items of equipment. As used in this document, there are two major categories of hardware as follows:

1. **Nonflight Hardware:** Development hardware not intended to fly, hardware of flight design but found to be of unsuitable quality for flight use, or hardware intended for use on the ground (e.g., GSE).
2. **Flight Hardware:** Hardware to be used operationally in space. It includes flight instruments (experiments) and/or spacecraft hardware. It includes the following subsets:
 - a. **Qualification Hardware:** Hardware of a new design that is subjected to qualification levels and durations of environmental stresses in a design qualification test program; it is identical to the flight hardware, but is not suitable for flight use without acceptable refurbishment.
 - b. **Protoflight Hardware:** Flight hardware of a new design; it is subject to a design qualification test program employing qualification level environmental stresses for flight durations. It is suitable for flight use after test.
 - c. **Follow-On Hardware:** Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is

subject to a flight acceptance test program.

d. **Spare Hardware:** Hardware the design of which has been proven in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.

3. Hardware Levels of Assembly

Part: A hardware element that is not normally subject to further subdivision or disassembly without destruction of designed use.

Subassembly: A subdivision of an assembly. Examples are wire harness and loaded printed circuit boards.

Assembly: A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole. Examples are a power amplifier and a gyroscope.

Component: A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation. Examples are transmitter, gyro package, actuator, motor, battery. Examples in an instrument are power supply, travelling wave tube amplifier (TWTA), central processing unit (CPU), position encoder, sun sensor, star tracker.

Subsystem: A functional subdivision of a spacecraft or payload consisting of two or more components. Examples are attitude control, electrical power subsystems, or an analogous functional element in an instrument: e.g., subsystems for electrical power, instrument data processing, scanning, or pointing.

System: A functionally interrelated group of hardware and software items which collectively perform one or more defined overall task(s). The system is usually broken down into a number of subsystems, each of which performs a discrete portion of the overall system task(s). E.g., at the instrument level, the defined task is the instrument's flight mission, and the flight instrument is the system; at the EOS Observatory level, the defined task is the Observatory's flight mission, and the Observatory is the system, while a flight instrument on the Observatory is a subsystem.

Instrument: A system or subsystem consisting of sensors and associated hardware for making measurements or observations in space. The flying portion of a flight experiment.

Spacecraft: An integrated assemblage of subsystems designed to perform a specified mission in space. The EOS Platform is the basic EOS spacecraft.

Observatory: The complete flight segment of a space system consisting of the spacecraft bus (EOS platform, for EOS), mission unique flight equipment, and instrument payload.

Payload: An integrated assemblage of subsystems designed to perform a specified mission in space. Examples: an EOS flight instrument may be a payload on the EOS observatory; the EOS observatory is a payload on the Titan IV launch vehicle.

Inspection: The process of measuring, examining, gaging, or otherwise comparing an article or service with specified requirements.

Instrument: See Hardware: Hardware Levels of Assembly.

Margin: The amount by which hardware capability exceeds requirements.

Model. Generic term to describe a physical or mathematical simulation of an article of hardware, software, or part or all of a mission system. To be useful for purposes of this document, the term must be further identified as to the nature of the model and its purpose. Two examples are:

1. **Thermal Model.** Unless identified to the contrary by context, this term describes a hardware model. A Thermal Model is a unit of hardware thermally equivalent to a Flight Unit, but need not be capable of the optical, electrical functions or structural/mechanical survivability of a Flight Unit.

2. **Thermal Math Model:** This may also be called an "analytical thermal model" and is defined as an analytical model used to evaluate the thermal performance of an article of the flight hardware, such as the flight instrument. A reduced node version of this model is used to evaluate the instrument-spacecraft combination. These models shall be refined after comparison with thermal test data.

Monitor: To keep track of the progress of a performance assurance activity; the monitor need not be present at the scene during the entire course of the activity, but he will review resulting data or other associated documentation (see Witness).

Nonconformance: A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality assurance, nonconformances fall into two categories-- discrepancies and failures. A discrepancy is a departure from specification that

is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating. A failure is a departure from specification that is discovered in the functioning or operation of the hardware or software.

Observatory: See Hardware: Hardware Levels of Assembly.

Outgassing: The emanation of volatile materials under vacuum conditions resulting in a mass loss and/or material condensation on nearby surfaces.

Part: See Hardware: Hardware Levels of Assembly.

Payload: See Hardware: Hardware Levels of Assembly.

Performance Verification: Determination by test, analysis, or a combination of the two that the payload element can operate as intended in a particular mission; this includes being satisfied that the design of the payload or element has been qualified and that the particular item has been accepted as true to the design and ready for flight operations.

Platform: See Hardware: Hardware Levels of Assembly: Spacecraft.

Qualification: The process of demonstrating that a given design and manufacturing approach will produce hardware that will meet all performance specifications when subjected to defined conditions more severe than those expected to occur during its intended use.

Redundancy (of design): The use of more than one independent means of accomplishing a given function.

Repair: The article is to be modified by an established (customer approved, where required) standard repair procedure or specific repair instructions which are designed to make the article suitable for use, but which will result in a departure from the original specification.

Rework: Return for completion of operations (complete to drawing). The article is to be reprocessed to conform to the original specifications or drawings.

Similarity, Verification By: A procedure of comparing an item to a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design differences are insignificant, environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.

Single Point Failure: A single element of hardware the failure of which would result in loss of mission objectives or the

hardware, as defined for the specific application or project for which a single point failure analysis is performed.

Spacecraft: See Hardware: Hardware Levels of Assembly.

Subassembly: See Hardware: Hardware Levels of Assembly.

Subsystem: See Hardware: Hardware Levels of Assembly.

Temperature Cycle: A transition from some initial temperature condition to temperature stabilization at one extreme and then to temperature stabilization at the opposite extreme and returning to the initial temperature condition.

Temperature Stabilization: The condition that exists when the rate of change of temperatures has decreased to the point where the test item may be expected to remain within the specified test tolerance for the necessary duration or where further change is considered acceptable.

Thermal Balance Test: A test conducted to verify the adequacy of the thermal design and the capability of the thermal control system to maintain thermal conditions within established mission limits.

Thermal-Vacuum Test: A test to demonstrate the validity of the design in meeting functional goals. It also demonstrates the capability of the test item to operate satisfactorily in vacuum at temperatures based on those expected for the mission. The test can also uncover latent defects in design, parts, and workmanship.

Total Mass Loss (TML): Total mass of material outgassed from a specimen that is maintained at a specified constant temperature and operating pressure for a specified time.

Verification: See Performance Verification.

Vibroacoustics: An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration excitation.

Waiver: A written authorization to accept a configuration item or other designated item(s), which during production or after being submitted for inspection, are found to depart from specified requirements, but nevertheless are considered suitable for use "as is" or after rework by an approved method.

Witness: A personal, on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements. (see Monitor).

APPENDIX C - PERFORMANCE ASSURANCE DATA REQUIREMENTS LIST

The listing of developer deliverable documents, below, is to be considered a part of the contract DRL for each instrument. In the event of a conflict between Appendix C and the CDRL, Appendix C shall take precedence over the instrument CDRL for the documents required by this PAR.

REFERENCED PARAGRAPH	DESCRIPTION	TIME OF DELIVERY	NASA ACTION*
1.3	Performance Assurance Implementation Plan (PAIP)	a. With Proposal	I
		b. Update Prior to Contract Award	A
		c. Updates as generated	A
1.3.2	Developer's practices and procedures referenced in the PAIP	a. With Proposal	A
		b. Updates, as generated	A
1.4	Previously Designed, Fabricated or Flown Hardware Data	a. Preliminary	a. With Proposal I
		b. Final	b. At time of GSFC Flight Assurance CDR A
1.6	Performance Assurance Status Report	Monthly; can be part of Project Status Report	I
1.9 & 1.9.1	Description of Developer and Subcontractor Audit Programs.	a. With Proposal	I
		b. Updates with Update of PAIP	I

*A - NASA approves. The developer may proceed only after receiving the written approval of the Contracting Officer.

R - NASA reviews and may comment within 30 days; developer may continue work unless comment requires him to stop.

I - Information; the developer's work schedule is not normally affected.

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
1.9.2	Audit Reports	Available as generated	I
1.9.2	Audit Report Summaries	With PA Status Reports	I
SECTION 2			
2.2	Data for GSFC Flight Assurance Reviews:		
2.2.a	Copies for review team of material presented at review.	10 working days before review meeting	I
2.2.c	Responses to action items	As established by Review Team	A
2.5	Packaging Review data	Available on Request	I
	Summary Reports of Developer Reviews	With Monthly PA Status Reports	I
SECTION 3			
3.2.1 3.6.2	Verification Plan (Including test sequence (3.6.2) and matrix)		
	a. Preliminary	a. With Proposal	I
	b. Final	b. At time of GSFC Flight Assurance CDR	A
	c. Updates	c. As generated	A
3.2.2 3.5.2.2	Verification Specification (Including list of the tests and parameter limits)		
	a. Preliminary	a. With Proposal; may be combined with Verification Plan	I

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
	b. Final	b. At time of GSFC Flight Assurance CDR	A
	c. Updates	c. As generated	A
3.2.3	Verification Procedures	30 days before the particular test activity for instrument level	A
3.2.4	Procedure for Control of Unscheduled Activities During Integration and Verification Testing	At time of developer CDR	R
3.2.5	Verification Reports	30 days after completion of activity	I
3.4.3.1	Stress Analysis Report	Initial available (at developer's facility) at time of PDR	I
		Update available at time of CDR	I
		Further updates available as generated	I
SECTION 4			
4.4.1	Hazard Analyses:		
	a. Preliminary	a. At time of GSFC Flight Assurance PDR	R
	b. Final	b. At time of GSFC Flight Assurance CDR	R
	c. Updates	c. As generated	R
4.4.2	Operations Hazard Analyses	30 days before an activity or use of a facility	R

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
4.5	Hazard Control Veri- fication Reports	At time of GSFC Flight Assurance PER	R
4.8	Waiver Requests	As generated	A
4.9	Safety Compliance Data Package	Preliminary at PDR	R
		Final 30 days before instrument PSR	A
		Update 120 days before delivery of EOS Observatory to launch site	A
4.10	Launch Complex Safety Plan	Preliminary on delivery of instru- ment to EOS inte- gration contractor	R
		Final 120 days before delivery of EOS observatory to launch site	A
4.11	Non-Ionizing Radiation Source Usage Plan	GSFC Flight Assurance CDR	R
		Updates as generated	R
SECTION 5			
5.3.2.1	Nonstandard Parts Data Package		
	a. Parts to be pro- cured by developer	30 days before procurement	A
	b. Parts in stock at developer's facility	30 days before use	A
5.5.1	As-Designed Parts Lists (paper and computer readable formats)		
	a. Initial	90 days after contract award	I

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
	b. First Update	30 days before Instrument PDR	I
	c. Second Update	30 days before Instrument CDR	I
	d. Additional Updates	As generated	I
5.5.2	As-Built Parts Lists	With End-Item Acceptance Data Package (8.23)	A
SECTION 6			
6.2.7	Data supporting uncured out-of-date material use	30 days before use of materials	A
6.4.a	Data on Nonconventional Application of Materials	30 days before use of materials	A
6.4.b	Engineering Drawings of Materials Application	15 days after request	I
6.4.g, d,e,f	Materials List (Inorganic and Polymeric), Lubrication List, Process List		
	a. Preliminary	30 days before developer PDR	R
	b. Final	30 days before developer CDR	A
	c. Updates	As changes are made; between developer CDR and delivery	A
6.4.c	Material Usage Agree- ment/Stress Corrosion Evaluation Form	As generated	A
6.4.h	As-built Materials List	With End-Item Accep- tance Data Package (8.23)	A

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
SECTION 7			
7.3.1	Failure Modes and Effects Analyses and CIL		
	a. Preliminary	a. 30 days before developer PDR	R
	b. Final	b. 30 days before developer CDR	R
	c. Updates	c. With Class 1 changes	R
7.3.2	Reliability Assessments		
	a. Initial (parts count basis)	a. 30 days before developer PDR	I
	b. Complete Update (stress analysis basis)	b. 30 days before developer CDR	I
	c. Change Updates	c. With Class 1 changes	I
7.3.3	Parts and Devices Stress Analyses	Available on request	I
7.3.5	Trend Analyses		
	a. List of parameters to be monitored	a. At time of GSFC Flight Assurance CDR	I
	b. Trend Analysis Reports	b. At time of GSFC Flight Assurance PER and FRR, and within 10 days of detection of any trend	I
7.4	Limited-Life List		
	a. Preliminary	a. 30 days before developer PDR	R
	b. Final	b. 30 days before developer CDR	A

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
	c. Updates	c. As changes are made, between developer CDR and delivery	A
SECTION 8			
8.10.1	Fabrication & Assembly Flow Plan		
	a. Preliminary	a. 30 days before developer PDR	R
	b. Final	b. 30 days before developer CDR	R
8.13.1.3	MRB Decisions	As generated	I
8.13.1.3.c(1)	Standard Repair Procedures	As generated	A
8.13.1.3.c	Request for Waiver [Use DOD Form 1694, Request for Deviation or Waiver. (from DOD-STD-480)]	As generated	A
8.13.2.1	Malfunction/Failure Reporting		
	a. Notification	a. Orally within 24 hours	I
	b. Written Notification (Hard Copy & Computer-Readable Data of MR Form)	b. Within 3 working days	I
	c. Failure Analysis, Proposed Corrective Action	c. As developed	I
8.13.2.2	Malfunction/Failure Report Close-Out (Hard Copy & Computer-Readable Data of MR Form) plus supporting data.	Completion of required actions	A
8.14	Response to Alerts	10 working days	R

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
		after receipt of Alert	
8.14	Alerts	As generated	R
8.16	As-designed Configuration definition and updates	As generated	I
8.21	Procedures for Handling, etc.		
	a. Preliminary	a. 30 days before GSFC Flight Assurance CDR	I
	b. Final	b. 30 days before use	A
8.23	Acceptance Data Package for each End-Item com- prising:	At time of delivery of end- item	A
	a. As-Built Configuration Report in accordance with paragraph 8.16		
	b. Lists of parts used in the hardware. Prepared in accor- dance with paragraphs 5.5 and 8.4		
	c. Lists of Materials and Processes which were used in the hardware (6.4)		
	d. Test Log Book including total operating time and cycle records (8.15.5)		
	e. List of open items with reasons for items being open (8.21.3)		
	f. Safety Compliance Data Package		
	g. Listing and status of all identified Limited-Life Items (7.4)		

<u>REFERENCED PARAGRAPH</u>	<u>DESCRIPTION</u>	<u>TIME OF DELIVERY</u>	<u>NASA ACTION*</u>
	h. Critical Parameters Trend Data (7.3.5)		
	i. Results of the Final Comprehensive Performance Test		
SECTION 9			
9.2	Contamination Control Plan		
	a. Preliminary	a. With Proposal	I
	b. Interim	b. 30 days before PDR	R
	c. Final	c. 30 days before GSFC Flight Assurance CDR	A
	d. Updates	d. As generated	R
SECTION 10			
10.2.1	Software Test Plan		
	a. Preliminary	At time of SWRR	R
	b. Initial	At time of SWPDR	R
	c. First Update	At time of SWCDR	R
	d. Further Updates	As generated	R
10.3.3	Software Test Reports	As generated	I