ACE-CT-100-20

Caltech
Payload Management

Payload
Assurance Implementation Plan

for

The Advanced Composition Explorer Mission

California Institute of Technology

December 1, 1993

Signature Page

Caltech Payload Management

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1. GENERAL DESCRIPTION

1.1. Description of the Overall Quality System

Management of the science payload development for NASA's Advanced Composition Explorer (ACE) has been assigned to the California Institute of Technology (Caltech) under contract to the Goddard Space Flight Center (GSFC). Caltech is the home institution of Mission Principal Investigator Professor Edward C. Stone. Under terms of its Phase C/D contract with Goddard, the Caltech Payload Management Office (PMO) will plan and implement an organized Assurance and System Safety program which encompasses all science payload flight hardware and software development from inception through launch operations. Caltech will fulfill its responsibilities in such a way as to ensure that all flight hardware and flight software provided by U.S. domestic ACE Science Payload Hardware Developers (SPHDs) are developed in response to Project requirements set forth in the Performance Assurance Requirements for the Science Payload of the Advanced Compositions Explorer, GSFC-410-ACE-008, (referenced hereafter as the ACE Science Payload PAR).

Non-U.S. flight hardware developers will be kept informed of all ACE payload performance assurance considerations relevant to their development efforts. The Caltech Payload Management Office (PMO) will review their practices and make appropriate recommendations in keeping with the ACE Science Payload PAR. Assistance will be offered to participants funded by foreign governments in establishing appropriate practices if the Caltech PMO perceives there to be a deficiency. The ACE Project Office will be kept informed on all such matters. In the unlikely event that a assurance or systems safety issue with a foreign institution cannot be resolved, Caltech will refer the matter to the Project Office for resolution.

1.2. Payload Assurance Implementation Plan (PAIP)

The assurance program implementation described in this document responds to requirements set forth in the ACE Science Payload PAR. It addresses all sections of the ACE Science Payload PAR, and it is called the Payload Assurance Implementation Plan (PAIP). This PAIP applies to all U.S. government funded elements of the ACE science payload. With sign-off by the Project, it becomes a contractual document for Caltech and its subcontractors. If any inconsistencies occur between this Project-approved PAIP and the ACE Science Payload PAR during the performance period of the Caltech contract, the approved PAIP takes precedence. Funding limitations associated with commitments to NASA Headquarters dictate that the performance assurance provisions which the Goddard Space Flight Center can afford to implement for the ACE science payload be limited to those provisions described in this document, and in a subservient set of Instrument Assurance Implementations Plans (IAIPs). If the Goddard Space Flight Center should later issue a new or different set of Assurance and System Safety requirements in a subsequent revision to the ACE Science Payload PAR, this PAIP will not necessarily be changed unless the ACE Project Office directs the change, and appropriately funds its impact. If a change to the Project-approved PAIP is proposed on behalf of the science payload, Caltech will initiate a dialog with the Project Office to see whether or not it will be entertained and can be afforded. If so, the proposed change will be submitted for approval prior to implementation in accordance with the Caltech's contract.

Caltech has, and will continue to encourage all SPHDs to make maximum use of existing, proven institutional practices and implementation procedures that meet the requirements stated in the ACE Science Payload PAR. How these requirements are met at each participating institution is described in the individual IAIPs. In the ACE payload document tree, IAIPs are Caltech-approved documents in concert with this PAIP.

As specified in the implementation contract deliverables list, process specifications, manufacturing flow diagrams and test procedures used by the U.S. government funded investigators in developing or refurbishing their part of the ACE science payload are available for project review. The Caltech Science Payload Performance Assurance Manager (PAM) will periodically review SPHDs practices to ensure that the processes and procedures being used are in agreement with those described in the individual Caltech-approved IAIPs. The outcome of such reviews will be reflected in the PMO monthly Technical Status reports to the Project. The Project will be kept apprised of changes to the IAIPs, and will be consulted before Caltech grants approval in any case where there is a perceived special sensitivity, or a significant impact to cost, schedule or performance. Therefore, in keeping with the foregoing approach, the content of this PAIP is focused on describing how Caltech goes about ensuring that the ACE Science Payload PAR requirements have been satisfied, and what information to that effect Caltech provides to the Project.

1.3. Previously Designed, Fabricated, or Flown Hardware/Software

The ACE payload complement includes instrument hardware and software designed for other NASA and ESA missions. These hardware elements are either flight spares or design replicas. Caltech will evaluate the physical, functional and storage conditions of existing flight hardware destined for use as part of the ACE payload. The existence and availability of applicable performance assurance records and reports from each earlier project will be determined. The Caltech PMO will then work with individual SPHDs to determine the degree to which the instrument heritage and pedigree satisfy the ACE Science Payload PAR requirements, and the extent to which certain tasks need not be repeated. Functional changes to the instruments that are needed in order to satisfy ACE science or mission requirements will also be evaluated. Any rework or design changes required for meeting interface requirements, for overcoming performance deficiencies or component obsolescence, or for replacing limited-lifetime components, will be evaluated by the Caltech PMO to determine what materials, EEE components, work practices or retesting will be needed in order to meet the ACE Science Payload PAR. Once the extent of existing hardware compatibility is determined, and the needed changes are evaluated, Caltech will work with each supplier of inherited hardware on a status summary, and a plan of action for presentation to an Inheritance Review Board. Rationale will be provided for any waiver requests anticipated at that time. Backup documentation substantiating the Inheritance Review presentations will be retained at each SPHD's home institution where it will be available for review.

1.4. Assurance Status Reports

In their monthly Technical Status reports to Caltech, SPHDs are asked among other things to state matters of significance related to implementation of their instrument

Assurance program. Matters of significance include system safety issues, EEE parts concerns prompted by Alerts, and subcontract Assurance issues related to reviews.

1.5. Surveillance of the Hardware Developer

The ACE Science Payload PAR states that work activities, operations and documentation performed under contract by the SPHD, sub-hardware developers, or suppliers are subject to evaluation, review, and inspection by government-designated representatives from GSFC, the Government Inspection Agency (GIA), or an independent assurance developer (IAD). Sufficient and suitable work space is to be made available to the government-designated representative by the SPHD, sub-hardware developer or supplier when requested during site visits. For suppliers, paragraph 8.2.5 of the ACE Science Payload PAR indicates that any and all work by the suppliers is subject to inspection and test by the government at any time and place. The Project Office however exercises control over the whole process through its letter of delegation (LOD) which enables the surveillance in the first place.

Caltech's implementation plan insofar as this oversight requirement is concerned is to work with the Project to see to it that the government's legitimate concerns over SPHD, sub-hardware developer and supplier Assurance program issues are addressed in a timely fashion, and allayed in a reasonable manner with minimal impact to cost and schedule.

The Caltech PMO will act to allay and resolve any Assurance program concerns before it becomes necessary for independent action to be taken by a local government-designated representative acting under delegated authority from the Goddard Space Flight Center. In meeting its responsibility, the Caltech Payload Management Office will provide the local government-designated representative with requested assurance documents, safety documents and records for review, as well as a suitable work area within the Caltech facilities.

If in the judgment of the local government-designated representative there is a need for site visits, face-to-face meetings, special reviews, or in-process inspections of procedures and practices, then the approach that will be followed by the Caltech PMO will be to make arrangements for the requested site visit after suitable advance notice is given to the SPHD, sub-hardware developer or supplier. This would typically be two working days.

1.6. Reviews and Reports

During the course of payload development, the Caltech PMO may elect to conduct reviews of Assurance program procedures, processes, records and analyses being followed at the SPHDs, their sub-hardware developers or suppliers. The purpose will be to determine the effectiveness and suitability of the practices in use. The need for these reviews will depend upon:

a) The mission criticality of the flight hardware or flight software involved;
b) The performance history of any suppliers involved;
c) Whether or not there are known problems or Alerts related to work in progress; and
d) The potential impact of a review to the SPHD's experiment development schedule.

Through the use of site visits, the Caltech PMO will periodically update it's knowledge

of SPHD practices and will comment accordingly. In addition, the SPHDs themselves may consider conducting Assurance program reviews of their sub-hardware developers or suppliers.

1.7. Applicable Documents (Appendix A)

To the extent referenced herein, applicable portions of the documents listed in Appendix A form a part of this document.

1.8. Glossary (Appendix B)

Appendix B defines acronyms and terms as applied in this document.

1.9. Contract Deliverables

All required deliverables will be specified in the contract. Caltech will ensure that the contractual requirements are met.

1.10. Waiver Requests

Any departures from the Assurance program implementation described in this document will be processed in accordance with ACE-CIT-100-31, "Configuration Control Plan for the Advanced Composition Explorer (ACE) Science Payload." This Caltech science payload Configuration Management (CM) plan is consistent with the Project's Configuration Management procedures as described in Goddard document GSFC-410-ACE-004 entitled "Advanced Composition Explorer Configuration Management Procedure". The Caltech CM plan also satisfies the configuration verification requirements stated in Section 8.3 and 8.13 of the ACE Science Payload PAR.

Examples of the need for Waiver Requests are given in subsequent sections of this document. Typically, a Waiver Request is generated whenever there is a compelling technical reason for not meeting a Project requirement. In addition, SPHDs may chose to initiate a Waiver Request under special circumstances whereby the cost or schedule impact meeting a Project requirement has for what ever reason, become prohibitive. As with all Waiver Requests, ones based on such programmatic considerations require processing in accordance with the ACE Science Payload CM Plan.

2. Assurance Reviews

2.1. General

The Caltech PMO, in conjunction with GSFC ACE Project Office, will Co-Chair a series of comprehensive, Project-level reviews, including design reviews. The subject of these reviews will be the deliverable flight and ground hardware, software and operations. Caltech will ensure such reviews are supported by the SPHDs.

Each review called out in this section will be scheduled by Caltech in conjunction with the GSFC ACE Project Office. Typically, informal discussions will be held with the SPHDs beforehand by Caltech representatives to ensure that they are ready, and to lay plans for the preparation of suitable presentation material prior to the formal reviews.

2.2. Flight Assurance Reviews

2.2.1. Existing Flight Spare Instruments

Inheritance Reviews will be scheduled for existing instruments. Such reviews will include a brief discussion of the instrument's history and pedigree, any limited lifetime items, ground support equipment and provisions for instrument storage and handing. In addition, these reviews will consist of the following:

a) Presentations and backup documentation that show the extent to which the instrument meets the performance and environmental requirements of the ACE Mission. In areas where there may be some question, plans will be presented for confirming that the Project and Mission requirements are met;
b) Discussion of any new design/redesign of the instrument software or hardware that may be necessary either for adapting it to the ACE mission, or for assuring that Mission and Project performance and environmental requirements are met;
c) The plans for revalidation of the instrument against the ACE mission requirements if it involves any new designs or a redesign;
d) A preliminary Failure Modes and Effects Analysis (FMEA) of the proposed interface to the ACE spacecraft. Any paths intended to be redundant will be analyzed to verify their isolation. As the interface agreement between the spacecraft developer and the SPHD, the existing instrument's Specific Instrument Interface Specification (SIIS) will be baselined and signed off before the Inheritance Review so as to allow time for a preliminary FMEA to be carried out. A final FMEA will be accomplished prior to spacecraft CDR; and
e) A discussion of the degree to which any new designs used in the existing instrument conforms to the requirements of paragraph 2.2.2 of the ACE Science Payload PAR. Any areas of non-conformance by the present design to these requirements will be accompanied by either a discussion of the plans for meeting the requirements, or by the rationale that will be given to justify the SPHD's request for a waiver.

2.2.2. Other Science Payload Instruments

2.2.2.1. Previously Designed Instruments

Owing to the amount of time and costs associated with each formal design review, instruments which rely extensively on existing designs, (e.g. the SWIMS instrument) will be evaluated by Caltech on a case-by-case basis to determine their system-level review requirements. In such cases, Caltech may plan to combine or restructure the review program, and focus only on those designs that must be changed in order to adapt it to the spacecraft, overcome component obsolescence, or to meet Mission requirements. Caltech will submit their evaluation to GSFC for concurrence, accompanied by recommendations for a suitable set of review topics. Once the review agenda is agreed to, and the SPHD is ready, the review(s) will be scheduled. For instance, Caltech and the GSFC Project Office may agree that it makes sense to combine the PDR and CDR into one formal review early-on, perhaps followed by a delta CDR later. Even though consolidated, all such reviews will address the requirements of paragraph 2.2.2 of the ACE Science Payload PAR.

2.2.2.2. New Designs

For each subsystem-level review specified for new Science Instruments and conducted by Caltech/GSFC, Caltech will ensure that the SPHD:

a) Develops and organizes material for presentation to the Review Team, and provides copies of the visual aids and supporting material in accordance with the contract Deliverable List; and
b) Support splinter meetings resulting from the major review as needed; and

A written report will then be jointly prepared by the Caltech and GSFC. It will make recommendations and list action items resulting from the review. The SPHD whose new design was reviewed will be given a reasonable time in which to respond, (e.g. 30 days). The SPHD response will then describe the disposition of action items, or a plan for closeout of those items.

2.3. Review Program

Caltech will structure a formal review program for those SPHDs designing new instruments. This program will consist of a Preliminary Design Review (PDR), a Critical Design Review (CDR), and a Pre-Shipment Review (PSR). Typically, the Caltech PMO will expect SPHDs to include discussion of the following in their PDR and CDR:

a) The results of electrical, electronic and electromechanical (EEE) parts stress analyses; and
b) The packaging approach that is to be used including:

1. The placement, mounting, and interconnection techniques used for EEE parts placed on circuit boards or substrates, and
2. The structural support and thermal accommodation of circuit boards, substrates and interconnections

In addition to the foregoing, the Caltech PMO may elect to call for an informal Pre-Environmental Review (PER) if the SPHD himself does not already have one scheduled.

For flight spare instruments from other missions, or ones using existing designs from other missions, the Caltech PMO will establish an appropriate set of formal reviews. As a minimum, this will consist of an Inheritance Review that includes a combined PDR/CDR for any design modifications being planned. For the existing instruments, there will also be a Pre-Ship Review. Although, depending on the extent of any modifications, and with the concurrence of the Project Office, it may not require the full participation of the GSFC Flight Assurance Review Team. It could therefore be informal.

Besides supporting the three formal reviews (PDR, CDR and PSR) for the newly designed instruments, the Caltech PMO will support all formal Observatory-level reviews as well. Where necessary and appropriate, Caltech will also arrange for SPHD support at the Observatory-level reviews. Furthermore, the Caltech PMO plans to provide at least informal support to the Project for its Mission Operations Review (MOR), Flight Operations Review (FOR), and Flight Readiness Review.

2.4. System Safety

Caltech will ensure that system safety is addressed at each formal review.

2.5. Hardware Developer Reviews

At the discretion of the Caltech PMO and/or each individual SPHD, internal peer reviews will be used to complement the formal review process.

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3. Verification Requirements

3.1. General

Caltech will organize and develop a verification program for the Science Payload. Each instrument will be evaluated to determine the proper set of tests and analyses needed to meet the ACE Mission requirements. Caltech will work with the individual SPHDs to customize their instrument verification plans, to ensure that adequate facilities are available for performing the tests, to provide appropriate support where required, to monitor test activities, and to assess the outcome.

3.2. Verification Documentation

3.2.1. Verification Matrix

A verification matrix has been developed for the ACE Science Payload. It identifies the applicable set of tests and analyses which, when carried to completion, will ensure that each science payload element meets specified mission requirements. Individual SPHDs participated in the development of the matrix which was submitted as part of Caltech's payload implementation proposal. Once Project Office concurrence is attained, it will be a Caltech PMO responsibility to keep the Payload Verification Matrix current. It will always be available at Caltech for review by the Project. In addition, this matrix or an appropriate subset of it, will be statused at the reviews identified in Section 2.

Standing behind the overall Payload Verification Matrix submitted with the Phase C/D proposal is a set of individual Instrument Verification Matrices. These are where specific test levels will be referenced, and the successful test completion's tracked. These 1-page verification matrices for each individual instrument will back up the main Payload Verification Matrix, and it will be updated in concert with updates to the individual matrices. Project Office concurrence will be attained for the individual Instrument Verification Matrices prior to their initial use. However, in keeping with Caltech's Configuration Management Plan, these lower-tier documents come under Caltech configuration control after they are approved. Therefore, Change Requests (CRs) to entries or references in the individual Instrument Verification Matrices will be processed for approval or disapproval by Caltech, with information copies available to the Project Office at the next regular update of verification status.

3.2.2. Verification Plan

The approach planned for demonstrating that science payload elements comply with the electrical functional, structural, mechanical, electromagnetic compatibility, vacuum, thermal and humidity requirements stated in Sections 3.3 through 3.6 of the ACE Science Payload PAR, is described in general terms in each instrument's Experiment Implementation Plan (EIP). Specifics of the approach to be followed at participating institutions is further described in the individual Instrument Assurance Implementation Plans (IAIPs). The IAIPs address the methodology employed for controlling and documenting activities that are not part of an approved procedure,

and for maintaining configuration control at such times. System safety considerations are also acknowledged in the IAIPs, especially for non-standard or unplanned operations. In the event of unplanned test operations which cause the validity of a verification to be questioned, Caltech will work with the SPHD to determine whether or not a retest is required.

3.2.3. Verification Specification

Caltech will work with the individual SPHDs to ensure that the quantitative environmental parameters under which hardware elements must meet their performance requirements are well understood before verification tests and/or analyses are carried out.

In working with individual SPHDs on planning their environmental test program, Caltech will ensure that specific environmental test parameters, (e.g. temperature/humidity, pressure, etc.), associated with the verification testing of a flight payload element will be as specified in JHU/APL 7345-9007, "Advanced Composition Explorer (ACE) Spacecraft, Environmental Specification." This is an APL document that contains Caltech contributions in the sections that pertain to test levels and conditions appropriate to components of an individual instrument. Prior to payload element testing, Caltech will concur with the ACE Spacecraft Environmental Specification. This document is often referenced by specific entries in the individual Instrument Verification Matrices. The individual Instrument Verification Matrices will be used to note any necessary tailoring of the requirements to take into account payload peculiarities, or possible interactions with the spacecraft and launch vehicle.

3.2.4. Verification Procedures

Each of the test activities specified in the verification matrix will have an associated procedure. If needed, Caltech will assist the SPHDs in the preparation of these procedures. The procedures will describe the test article configuration, and the planned sequence to be followed. Such procedures will be available for review at the SPHDs facilities.

Specifics of the test procedures will vary depending upon the SPHD and the complexity of the test being performed. Caltech will work with the individual SPHDs to ensure that the test parameters, pass-fail criteria, test environment, test set-up, contamination controls, safety considerations, and data collection, are identified in the test procedures.

3.2.5. Verification Reports

After completion of each test activity called for in an individual Instrument Verification Matrix, pertinent information will be recorded in order to either:

a) Document at the time of delivery that the appropriate tests have been run, and that the unit has passed successfully; or
b) To provide a basis for processing any waiver requests that are deemed necessary.

3.2.6. Verification Tests (PAR Sec. 3.3-3.7)

The individual Instrument Verification Matrices identify the various tests and analyses to be performed for specific elements of the ACE Science Payload. Each SPHD is responsible for the accomplishment of the required tests and analyses of their instrument. Caltech is responsible for ensuring that an appropriate verification program is followed for each instrument. In doing so, Caltech will ensure that all required testing is performed, that adequate data are collected, and that baselines are established for the assessment and comparison of test results. Since the Goddard Space Flight Center contract with Caltech calls for the Payload Management Office (PMO) to carry out day-to-day management of payload development activities, much of Caltech's efforts will be devoted to communicating with, and visiting, the various SPHD facilities to assure that the requirements are well understood and properly satisfied. When requested, Caltech will provide guidance and/or implementation assistance to the SPHDs in meeting the requirements. Through its direct involvement, Caltech will remain fully cognizant of the approach to, and the accomplishment of, payload verification activities at the SPHD's facilities.

Upon the completion of verification testing, and prior to the PSR, each element of the science payload will have accumulated a minimum of 240 hours of trouble free performance. This PAR requirement reflects the Project's acceptance of payload performance demonstrations as a substitute for formal analyses of the instrument design, except at the interfaces, where FMEAs are still required.

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4. System Safety

4.1. General

Caltech will ensure that the Safety programs of individual SPHDs are conducted to provide the identification and control of hazards to personnel, facilities, support equipment, and flight subsystems during all stages of development. Such Safety programs will meet the requirements of the following:

a) System Safety Implementation Plan for the ACE Project;
b) Eastern Test Range (ETR) ESMCR 127-1; and
c) Industrial and individual SPHD facilities.

Each facility will have at least one person who will be responsible for compliance with the Safety requirements. The individual SPHD Safety programs will be monitored on a periodic basis by Caltech.

4.2. System Descriptions

With Caltech's assistance, each of the SPHDs developing flight hardware systems based on new designs will generate an Instrument Functional Requirements Document (IFRD). Inherited instruments will provide Caltech with existing functional description documents from other programs. These IFRDs and functional descriptions will be to a depth sufficient to provide Caltech with the detailed subsystem descriptions needed for a preliminary safety assessment. The IFRDs and instrument description documents will then be provided to the GSFC Project Safety Manager (PSM), along with Caltech's preliminary safety assessment.

4.3. System Assessment Report

The process for accomplishing safety assessments is described in Caltech's Payload Safety Plan. In summary, Caltech will work with each SPHD early in the development phase to identify the ground operations hazards associated with their flight instrument(s), and with the associated ground support equipment as well as their interfaces. Efforts to minimize hazards will be taken by both Caltech and the SPHDs. Caltech will also aid in identifying the need for testing to determine whether a hazard exists in those cases where analysis alone is not considered sufficient for the detection of a hazard. Caltech will ensure that all analyses are updated in a timely manner during the design, fabrication and testing of the science payload. The results of analyses performed by the SPHDs will be submitted to Caltech. Caltech will review and then submit these results to the GSFC Project Safety Manager as a Safety Assessment Report in the form of a Safety Hazard Report.

4.4. Procedures

Caltech will ensure that suitable procedures are prepared and submitted to the GSFC PSM for all planned ground operations to be performed at either GSFC or the launch site. Launch site procedures will be reviewed by Caltech for compliance with ESMCR 127-1 prior to being submitted to GSFC. Any hazardous operations will be identified and highlighted, along with the planned control procedures.

4.5. Documentation of Noncompliance

When a particular safety requirement cannot be met, Caltech will submit a Class I waiver request to GSFC in accordance with procedures described in the ACE Science Payload Configuration Management plan (ACE-CIT-100-31). Such requests will be accompanied by a rationale for approval of the noncompliance. A Safety Assessment Report in the form of a Hazard Report will accompany the Caltech waiver request.

4.6. Support of the Safety Working Group Meetings

Caltech will provide technical support to the GSFC Project Safety Manager for Safety Working Groups, as requested. Caltech will provide this support either directly, or through a SPHD representative, whichever is required.

5. EEE Parts Control

5.1. General

Caltech will ensure that each of the SPHDs has an in-house Electrical, Electronic, and Electromechanical (EEE) parts acquisition and control program. Support will be provided as necessary by Caltech in establishing and maintaining these programs. The Caltech PMO is complementing SPHD programs has been given access to JPL's EEE Parts Engineering group of technical experts starting at the beginning of ACE payload development. Caltech will coordinate technical interchanges and advice that is needed by SPHDs from JPL specialists.

5.2. Electrical, Electronic, and Electromechanical Parts

5.2.1. Standard Parts

Standard parts will be used wherever possible in the design of new instruments, or for the required modifications to existing payload elements. Standard parts are defined as:

a) Grade 1 and 2 parts contained in the GSFC Preferred Parts List (PPL) and the NASA Standard Electrical, Electronic and Electromechanical (EEE) Parts List, MIL-STD-975 (NSPL);
b) Class B, JANTXV QPL parts or better;
c) Established Reliability parts (MIL-ER) parts, Failure Rate P minimum;
d) DESC certified MIL-STD-883C compliant parts or manufacturer certified MIL-STD-883 parts procured directly from the manufacturer with customer source inspection (CSI).

Each standard part purchased for use in the ACE science payload will be procured against the appropriate specification that has been designated for that part type. Caltech will ensure that utilization of standard parts is the norm for new designs.

In these designs only standard parts be used at interfaces to the spacecraft.

5.2.2. Nonstandard Parts

As part of the Caltech/JPL Parts Engineering evaluations, EEE parts not satisfying the paragraph 5.2.1 definition for standard parts will be designated as nonstandard. Every EEE part used in a flight payload element will be classified as either "standard" or "nonstandard".

Caltech will have the JPL Parts Engineering group review all SPHD EEE Parts Lists for concurrence with the preliminary standard/nonstandard part classification indicated by the SPHD. For nonstandard parts, whenever it becomes evident either as a result of the JPL Parts Engineering evaluations, or from other information sources, that it would be desirable for the SPHD to consider an alternative, Caltech will provide necessary information to the SPHD along with recommendations. If a nonstandard part must be used in an interface with the spacecraft, then the SPHD

must demonstrate via a FMEA that a single point instrument failure cannot propagate across the interface, causing loss of function in another subsystem. Except for part types that affect failure modes at the spacecraft interfaces, the SPHD, after having been given the recommendations of EEE Parts experts, is responsible for weighing other factors such as cost, schedule and performance risk, and making the final decision as to which part type to use within his instrument.

Caltech will have the JPL Parts group evaluate SPHD plans for screening nonstandard parts, and provide recommendations where appropriate.

A remotely-accessible electronic database will be established containing pertinent and sufficient information on the screening and planned utilization of a nonstandard parts so as to allow an independent assessment of their use in a given application. Backup hard copy information will be made available to the Project Office upon request. Additions or modifications to the database will be noted by calendar date so that recent changes will be self-evident. Goddard reviews of nonstandard part usage can therefore readily take up where the last one left off. The database will be organized in such a way as to allow a sorting by instrument acronym and component.

5.2.3. Derating

Derating guidelines in the Goddard Preferred Parts List (PPL) will be used by Caltech's Parts Engineering program. For institutionally-unique reasons, or perhaps based on their own historical experience, individual SPHDs may prefer to use existing, internal procedures that differ from the PPL derating guidelines. In such cases, Caltech, with help from the JPL Parts Engineering group, will review the proposed alternative and, when it is determined that appropriate derating criteria are being proposed, will provide a recommendation to GSFC for approval. Experience based upon the use of JPL derating criteria will be reflected in this recommendation. Alternative derating policies will require approval.

5.2.4. Radiation Hardness

As part of the review of individual SPHD Parts Lists by the JPL Parts Engineering group supporting Caltech, an assessment will be made of the suitability of the planned EEE parts usage for meeting radiation requirements of the ACE mission. Effects of the total dose of ionizing radiation as well as single event effects will be considered. The application of an individual piece part, its location on the spacecraft, and any planned spot shielding will be considered in this review. Appropriate recommendations will be provided to the individual SPHDs.

5.2.5. Screening Verification Tests

Standard parts selected by the SPHD to meet mission requirements and applicable instrument requirements are not required to undergo screening verification tests. Caltech's Parts Engineering support group at JPL will provide screening recommendations when receiving inspection results or Alerts concerning a part indicate that screening verifications are warranted. Through the use of site visits, the Caltech PMO will periodically review parts verification practices at SPHD institutions and comment accordingly.

5.2.6. Destructive Physical Analysis (DPA)

On the advice of JPL Parts Engineering, the Caltech PMO will recommend to the SPHD which nonstandard parts are to be subjected to DPA. When a DPA is carried out, it will be performed on each manufacturing lot or lot date code of nonstandard microcircuits, semiconductors, filters, ceramic capacitors, relays and crystal oscillators used in new builds of flight payload elements. DPAs will be performed in accordance GSFC Specification S-311-M-70, or JPL Specification ZPP-2078-GEN, or in accordance with the SPHD's own procedure if it is agreed-to by Caltech beforehand and approved by the Goddard Project Office.

If requested by the SPHD, and if deemed appropriate by the Caltech PMO, the JPL Parts Engineering support group will be prepared to carry out a limited number of DPAs on nonstandard part types being used by more than one group.

5.2.7. Electric Motors

Wherever an electric motor is envisaged for use in a flight payload element, SPHDs will be advised to use brushless motors. In the event that a design requires the use of a brush motor, a waiver request will be submitted to Caltech for review. If the review JPL specialists in spaceflight electric motors is favorable, it will be forwarded to the Goddard Project Office with a recommendation for approval.

5.3. Parts Identification List (PIL)

An EEE Parts Identification List (PIL) will be prepared by each SPHD and maintained in accordance with the SPHD's own configuration control system. Caltech will arrange for the JPL Parts Engineering group to perform a review of, and an Alert search on, parts listed in the science payload PILs. Caltech will also arrange for the JPL Parts group to maintain a remotely-accessible electronic database containing the latest PIL information obtained from each SPHD. Information in this database will include: part name, part number, manufacturer, manufacturer's generic part number, applicable manufacturing and test specifications, lot date code, an indication of the part's status (e.g. on-order, in-screening, ready-for-use), the quantities to be used, and their location at the instrument/component level. Entries will be updated in a timely manner, and they will be dated so that the database can be searched instrument-by-instrument, or component-by-component, to identify only those changes since the last review.

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6. Materials and Processes

6.1. General

Caltech will ensure that each of the SPHDs has an in-house program for tracking the pedigree of purchased flight materials, and for identifying, assessing and controlling processes used in the manufacture of flight hardware. Support will be provided as necessary by Caltech in establishing and maintaining these programs. SPHDs have been given access to JPL's Materials and Processes technical group of experts beginning at the start of payload development. Caltech will coordinate technical interchanges and advice that is needed by SPHDs from JPL specialists.

6.2. Materials Selections

Caltech will have the JPL Materials and Processes group to informally review materials utilization's planned by individual SPHDs. The basis for such reviews will be the requirements specified in ESMCR 127-1 (for flammability and toxic offgassing), in ASTME-595 (for vacuum outgassing), and in MSFC-SPEC-522 (for stress corrosion cracking). In addition, each review will determine whether or not the planned application can be considered a conventional use of the material or process. Materials and processes which satisfy the foregoing ESMCR, ASTME and MSFC requirements, and which are used in a conventional application, will be considered "compliant". Their usage will require no further review, although note will be made in the instrument Materials List of any known lifetime limitations.

Materials not compliant with the ESMCR, ASTME or MSFC requirements, but which are still used in a conventional application, will be reviewed in more detail by the JPL Materials and Processes group. Where appropriate, alternative materials or processes will be recommended to the SPHD. In the course of its informal materials and processes reviews early in the program, and later in preparation for the formal reviews, an Alert search will be performed on the latest Materials Lists obtained from each SPHD. Caltech will make a summary of each evaluated SPHD Materials List electronically available to GSFC for review. The SPHD Materials Lists maintained by the Caltech PMO will be in the form of an electronic database that can be separated by SPHD and by the type of material used (e.g. polymeric, inorganic, or lubricant).

Caltech will review SPHD procedures to ensure that polymeric materials having a limited shelf life are controlled and identified. For any material whose shelf-life has expired, the SPHD will prepare a waiver request. The request will then be reviewed by JPL Materials specialists and a response given within five (5) working days. Waiver request approval status will be summarized monthly as part of the Performance Assurance discussion in Caltech's Technical Progress report. For those cases where approval is given to use an out-of-date polymeric material in flight hardware, (including lubricants and paints), the piece part in which it is used should be added to the SPHDs Limited-Life Item List.

Fasteners will be procured and processed in accordance with GSFC S-313-100 or an equivalent specification from another NASA Center. Caltech will ensure that all mandatory testing of structural fasteners is completed prior to their use on flight

hardware. Caltech will accomplish this by either verifying that suitable test reports exist, or by having the items submitted to testing arranged for by Caltech. Material test reports for fastener lots will be submitted to GSFC for review.

6.3. Process Selection

Caltech's Materials and Processes Engineering support personnel from JPL will aid the SPHDs in selecting appropriate processes which do not adversely affect the properties of the materials that are to be used in the flight hardware. Later, an evaluation will be carried out, and an Alert search made, on the processes lists obtained from individual SPHDs. If, in the judgment of the JPL Materials specialist supporting Caltech, a given process is inadequate or inappropriate to the application, Caltech's evaluation of the process list will so indicate, and the SPHD will be notified. In these cases, Caltech/JPL will recommend an alternative to the SPHD. The SPHD is responsible for deciding which process to choose. The SPHD is also responsible for weighing other factors such as cost, schedule, and performance risk which could lead him to not follow the recommendations of the JPL specialist. In any case, because of the cost and schedule constrained nature of the ACE program, the SPHD must weigh all factors before deciding which process to use.

The process lists and their evaluation by JPL specialists will be separable by instrument and by SPHD. Caltech will make copies of the evaluated processes lists available to GSFC for review. Information on the detailed individual processes can also be made available to Goddard upon request.

7. Design Assurance and Reliability

7.1. General

Caltech will organize and implement a reliability program for the ACE Science Payload. This program will be designed to interact effectively with other program disciplines including systems engineering, hardware design, and product assurance. The program will address technical matters such as:

a) The use of redundancy in the designs;
b) Analysis of EEE component stress;
c) Single failure points that might affect system safety or mission success;
d) Suitability of the designs for meeting mission lifetime requirements;
e) The identification of, and plans for accommodating, limited-life items;
f) The identification of parameters for trend analysis monitoring; and
g) Review of the designs for testability and maintainability.

Caltech will work with individual SPHDs to address the foregoing matters while making maximum use of their institutional procedures and approach to flight system reliability. Details are described in the individual instrument IAIPs.

7.2. Design Assurance

Maximum use will be made of existing institutional engineering practices and procedures. As part of its close coordination with the SPHDs, Caltech will ensure that good engineering practices are being followed.

7.3. Reliability Analyses - FMEA

Caltech will aide those SPHDs requesting assistance in the preparation of an interface failure modes and effects analysis (FMEA). This effort will begin early in the design phase, and will be refined as the design proceeds. The FMEAs will be performed at the instrument interface level. Caltech will arrange for circuit reliability specialists at JPL to review the FMEAs for completeness, and to identify any single failure points within a payload element that could propagate across an interface to cause loss of function in another subsystem. Specific recommendations will be made to the SPHDs by Caltech to alter their design in order to eliminate any such possibility.

Caltech will arrange for a JPL circuit reliability specialist to review each FMEA submission not only for completeness of the analysis, but also to ensure that no single failure within a given flight payload element will prevent removal of power from that element, and that any redundant paths intended by the design are isolated or protected. The Caltech Payload Performance Assurance Manager will review the FMEA as well, and assign a severity category in accordance with the definitions given in Table 7.3.-1 which is taken from Section 7 of the Science Payload PAR. After completing the Caltech/JPL review of an FMEA, comments will be sent back to the SPHD along with any request for reconsideration of the design arising from the review. Once the SPHD and Caltech are satisfied with the FMEA and the associated interface circuit design, an information package will be prepared and forwarded to the ACE Project Office at

GSFC for independent review.

Table 7.3-1 Severity Categories

CATEGORY	SEVERITY	DEFINITION
1	Catastrophic	Failure modes that could result in serious injury or loss of life (ground personnel) or loss of launch vehicle.
1R		Failure modes of identical or equivalent redundant hardware items that, if all failed, could result in category 1 effects.
1S		Failure in a safety or hazard monitoring system that could cause the system to fail to detect a hazardous condition or fail to operate during such condition and leads to Severity Category 1 consequences.
2	Critical	Failure modes that could result in loss of one or more mission objectives as defined by the GSFC project office.
2R		Failure modes of identical or equivalent redundant hardware items that could result in Category 2 effects if all failed.
3	Significant	Failure modes that could cause degradation to mission objectives.
4	Minor	Failure modes that could result in insignificant or no loss to mission objectives.

7.4. Trend Analyses

Each SPHD will identify measurable parameters that reflect the performance stability of their instrument. Measurements will be made and test records kept during the development/refurbishment phase so that by the time of the Pre-Ship Review (PSR) an assessment can be made as to whether or not there is evidence of a potential stability or degradation problem within the instrument, and whether or not there is any reason for concern over its reliability.

7.5. Limited-Life Items

Each SPHD will identify all of the limited life items they are planning to use in their flight hardware. Items considered to have limited life include thermal control surfaces, electromechanical mechanisms, and selected structures. A list of such items will be submitted to the Caltech Science Payload Performance Assurance Manager (PAM) for review. For each item listed, the expected life, the required life, and the expected duty cycle (if applicable) will be identified, along with the rationale for selecting the item. The Caltech PAM, and the JPL specialists supporting Caltech, will review these lists. Any items deemed mission critical will be identified in this review. Mission critical items are ones whose failure would cause the loss of a mission objective. Caltech will work with the SPHDs to develop a plan to manage those limited-life items identified as mission critical. These will be tracked by Caltech and their status presented as a special topic at each formal review. Following the Caltech/JPL informal review of items on a limited life list, the accompanying rationale, and the proposed application, comments will be sent back to the SPHD along with any request for reconsideration of the planned

usage arising from the review. A waiver request will be generated for any flight hardware item whose expected life is less than its mission design life.

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8. Quality Assurance

8.1. General

Caltech will review and remain apprised of each SPHD's Quality Assurance (QA) capabilities and practices. As appropriate the Caltech PMO will arrange for assistance to those SPHDs needing additional support. This support can be provided either directly by Caltech, or by a designated representative of Caltech or GSFC. By offering to provide needed support, Caltech will ensure that each of the SPHDs is able to:

a) Demonstrate an organized approach to achieving the quality aspects of the program;
b) Determine and satisfy the quality requirements throughout the instrument's design, development, fabrication, processing, assembly, inspection, test, checkout, packaging, shipping, storage, maintenance, field use, flight preparations and flight operations;
c) Implement quality considerations in all operations of all products;
d) Detect existing or potential deficiencies, system incompatibilities, marginal quality, and trends or conditions which could result in less than satisfactory quality; and
e) Provide timely preventative and remedial action.

8.2. Organization

An organization chart for the development of the ACE science payload, including a description of Co-Investigator roles and responsibilities, appears in the Plan for Management of the Science Payload for the Advanced Composition Explorer (ACE) Mission, (ACE-CT-100-30). For quick reference, the organization chart is also shown in Figure 8.2-1. The accompanying Table, (Table 8.2-1) defines the instrument acronyms used in the Figure, and identifies the institutions and lead individuals responsible for the development of each payload element. Within each organization, there is an individual who has been delegated responsibility for directing and managing the Quality Assurance program there. Organization charts associated with each of the ACE instrument developments/refurbishments appear in the individual Experiment Implementation Plans, (ACE-CT-XXX-41).

8.3. Configuration Control and Verification

Caltech will ensure that all documents affecting flight hardware, flight software/firmware and GSE which interface with flight hardware are controlled in accordance with the Project-approved science payload configuration control plan (ACE-CT-100-31). Caltech will accomplish this by reviewing documentation during visits to the SPHD facilities, and through its membership on Configuration Control Boards (CCBs), as appropriate. All as-built documentation will be verified by Caltech prior to the submittal of each instrument's Acceptance Data Package.

Figure 8.2-1 Payload Organization Chart

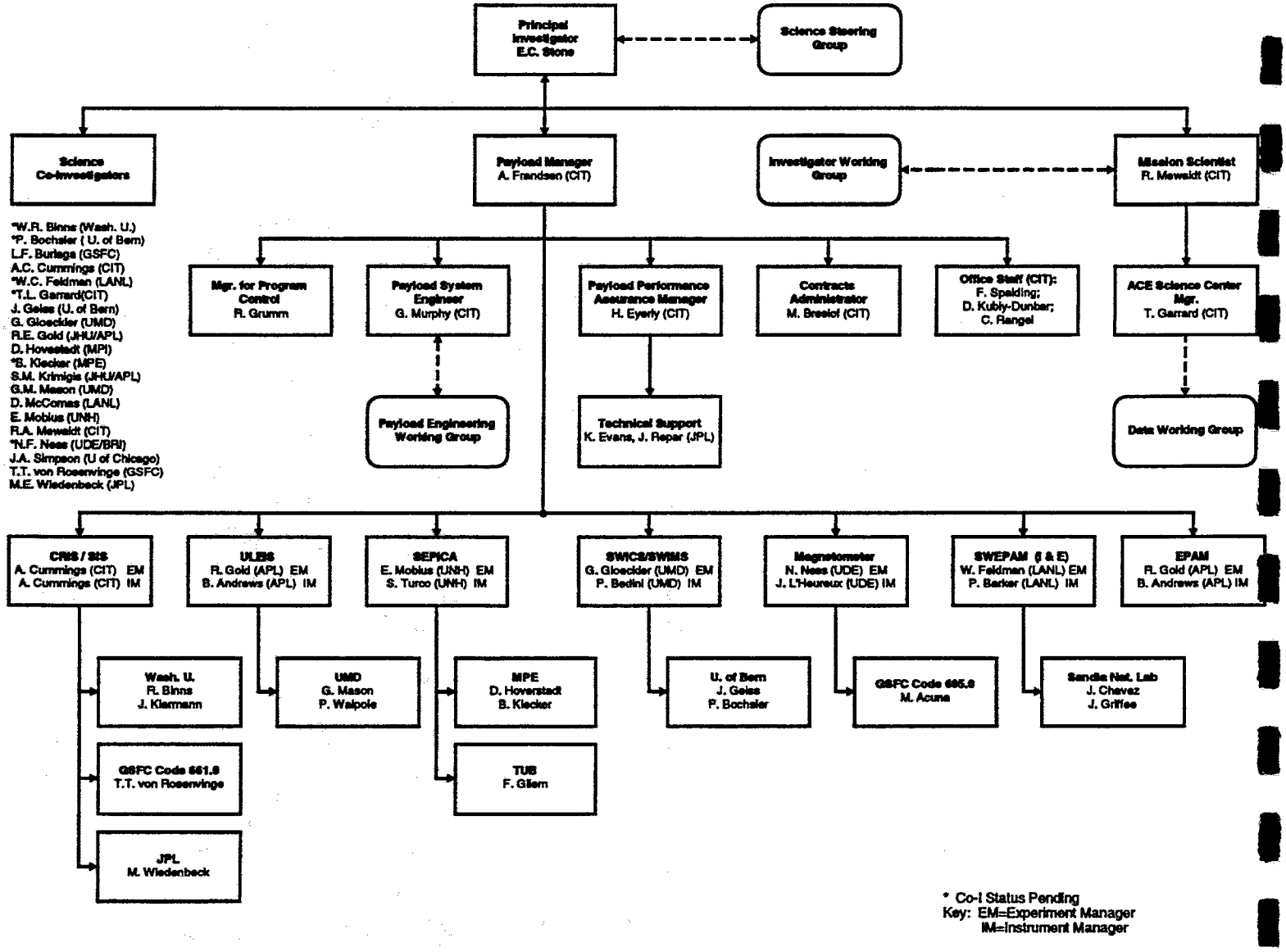

Table 8.2-1 Payload Development Responsibility

PAYLOAD ELEMENT ACRONYM	NAME	INSTITUTION AND RESPONSIBILITY	LEAD INDIVIDUALS
CRIS	Cosmic Ray Isotope Spectrometer	Caltech: Main instrument electronics assembly & test JPL: Stack detectors mapping, GSE and test support Washington U: SOFT Hodoscope GSFC Code 661.0: LiD stack detectors, mechanical design/fab & test support	A. Cummings, R. Mewaldt & E. C. Stone M. Wiedenbeck W. R. Binns T. von Rosenvinge
SIS	Solar Isotope Spectrometer	Caltech: Main instrument electronics assembly & test GSFC Code 661.0: Matrix detectors, mechanical design/fab & test support JPL: Stack detectors, GSE & test supp't	A. Cummings, R. Mewaldt & E. C. Stone T. von Rosenvinge M. Wiedenbeck
ULEIS	Ultra Low Energy Isotope Spectrometer	U. of Maryland: Telescope and analog electronics JHU/APL: Digital logic	G. Mason R. Gold & S.M. Krimigis
SEPICA	Solar Energetic Particle Ionic Charge Analyzer	Max-Planck Institute, Garching: CAMEX microcircuits & anti-coincidence detectors U. of New Hampshire: Main instrument hardware and solid state detectors	D. Hovestadt & B. Klecker E. Moebius
SWIMS	Solar Wind Ion Mass Spectrometer	U. of Maryland: Main instrument hardware U. of Bern: WAVE entrance system	G. Gloeckler P. Bochsler & J. Geiss
SWICS (Ulysses spare)	Solar Wind Ion Composition Spectrometer	U. of Maryland: Entire instrument U. of Bern: Test support	G. Gloeckler P. Bochsler & J. Geiss
MAG (WIND spare)	(Twin, Tri-Axial) Magnetometer	GSFC Code 695.0: Entire instrument UDE/BRI: Instr. Mgmt & test support	N. F. Ness, L. Burlaga & M. Acuna
SWEPAM (Ulysses spare)	Solar Wind Electron, Proton, and Alpha Monitor	Los Alamos National Laboratory: Entire instrument	D. McComas & W. Feldman
EPAM (Ulysses spare)	Electron, Proton and Alpha Monitor	The John Hopkins University Applied Physics Laboratory (JHU/APL): Entire instrument	R. Gold & S.M. Krimigis
S/S/S DPU	SWICS/SWIMS/ SEPICA Data Processing Unit (DPU)	Tech University of Braunsweig (TUB): Entire DPU & software	F. Gliem

8.4. Identification and Traceability

Caltech will ensure that every SPHD has in place a product identification system which allows for the tracking of all flight hardware. SPHD systems for product identification and traceability will begin at the subassembly level and continue through completion of the end product. Caltech will ensure that these systems are consistent with the approach described in the Project-approved science payload configuration control plan (ACE-CT-100-31). In doing this, Caltech will at the same time work with the individual SPHDs to make maximum use of their pre-existing, institutionally-unique and proven configuration control practices. Specifics of each SPHD's plan for product identification and traceability are described in the individual instrument IAIPs. These institutionally-tailored tracking systems described in the individual plans will be reviewed by Caltech for their ability to trace backwards to the originating subassembly, and forward to the location of a subassembly at any given level of process, assembly, or test.

8.5. Procurement

The SPHD Quality Assurance (QA) representative will participate in source selections and will review each procurement involving items that might become part of a flight item. QA inputs to the source selection will include such factors as supplier performance history, vendor ratings and inspection results. Receiving inspection data from previous orders and/or test results may also become factors influencing the QA recommendation on preferred sources. When an order is ready to be placed for an flight item, SPHD QA will first be given the procurement package for approval in order to ensure that the appropriate requirements and specifications are passed down to the supplier, and to indicate whether or not SPHD QA activity will be required at the supplier's plant.

The Caltech Science Payload Performance Assurance Manager (PAM) will review SPHD QA involvement in flight item procurements during one or more of his periodic site visits to each SPHD facility.

8.5.1. Source Inspection

Periodic site visits to SPHD facilities by the Caltech Science Payload PAM constitute a form of source inspection. Such visits are planned quarterly by Caltech in managing the development of new instruments. More frequent visits will be conducted as the situation warrants. Periodic visits by the Caltech PAM to all SPHD facilities will continue throughout the development and testing of flight hardware.

8.5.2. Government Procurement Reviews

All procurements for items destined to become part of a flight end-item deliverable, and for which there is no current plan to involve government source inspection (GSI), will have included, as a minimum, the following statement on the purchase order: "The Government has the right to inspect any or all of the work included in this order at the supplier's plant."

Procurements for items intended for use in deliverable flight end-items, and for

which it is planned to involve GSI, will have the following alternative statement on the purchase order: "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."

8.6. Receiving Inspection

Caltech will have a receiving inspection system for those items which are purchased as a common buy for several users, or for any one SPHD. For standard EEE parts, the system used by Caltech will be that of JPL. Receiving inspection will do the following:

a) Perform inspections to documented standards, document the inspection results;
b) Review inspection and test documentation for compliance with purchase specifications;
c) Check that products meet or exceed limited life requirements;
d) Verify source inspection acceptance when applicable;
e) Ensure proper packaging and handling for devices vulnerable to ESD damage;
f) Ensure proper shipping, storage, and handling of limited life items;
g) Ensure that items are properly identified with respect to inspection status;
h) Segregate nonconforming materials;
i) Ensure that appropriate ESD and contamination control practices are employed; and
j) Maintain receiving inspection and test records including copies of documents submitted by the supplier.

By working with individual SPHDs at the outset of the development phase, and through an inspection process later on, Caltech will ensure that the receiving inspection system employed by individual SPHDs includes the inspection activities and processes described in the foregoing paragraph.

8.6.1. Resubmission of Nonconforming Articles

Items returned to a supplier because of nonconformance to a requirement will be specifically marked by the supplier when resubmitted. The accompanying documentation will also indicate that the item(s) is (are) a resubmittal.

8.7. Control of Fabrication Activities

The Caltech Payload Management Office will not be fabricating any hardware. Instead, it will be managing SPHD activities where the fabrication of flight hardware will take place. The philosophy that will be followed will be to encourage each SPHD to use their standard practices in the unique fabrication of their hardware. Individual SPHDs are responsible for ensuring that process specifications and procedures have been evaluated technically and from the standpoint of system safety, that they meet the contractual requirements, and that controls are used on those processes for which uniform quality cannot be ensured by inspection alone. Caltech will arrange for

support to the SPHDs in those areas of fabrication where in-house expertise may need to be supplemented.

Each SPHD assembling a new instrument will generate a fabrication flow chart that includes the planned tests and mandatory inspection points. For the SPHD defined government inspection points, the cognizant government inspection agency (GIA) will be contacted a minimum of 48 hours prior to the need date to perform any inspection. Fabrication processing will not resume unless the article has passed the prescribed government inspection, or unless 24 hours has passed after the inspection need date and the cognizant GIA has not made itself available.

In the area of flight printed wiring boards (PWBs), Caltech will ensure that each SPHD submits flight PWB coupons for evaluation and approval directly to the Goddard Space Flight Center, or to a GSFC-approved independent test facility. Manufacturers will be notified that acceptance of their coupons will determine the acceptance of their PWBs by the SPHD. Caltech will work with each SPHD to procure the PWBs from those vendors who have established a history of producing high quality boards. Caltech will work with both GSFC and the SPHD to ensure that the whole process of PWB coupon evaluation is scheduled in advance and carried out in an expeditious manner so as to not unduly delay the manufacturing activities.

8.8. Contamination Control

Caltech will evaluate the facilities of each SPHD to ensure that they will support the requirements set by the Science Payload Contamination Control Plan.

8.9. Electrostatic Discharge Control

Caltech will work with each SPHD to ensure that an appropriate program for controlling electrostatic discharge (ESD) is in place for ESD-sensitive elements of the flight payload. Some instrument components are insensitive to ESD effects. An appropriate ESD control program includes provisions for work area protection, handling procedures, training, intra-plant protective covering, packaging for delivery, and quality assurance verification of conformance. Procedures meeting the applicable technical requirements of JPL D-1348A, "JPL Handbook for Electrostatic Discharge (ESD) Control" are recommended by Caltech to the SPHDs for satisfying the intent of DOD-HDBK-263 and DOD-STD-1686. The SPHD ESD control plans will be detailed in the individual IAIPs and provided to the GSFC Project Office for review as required by the contract. Caltech will periodically review SPHD facilities to ensure compliance with these ESD control procedures which are detailed in the individual IAIPs.

8.10. Non-Conformance Control

Caltech will ensure each SPHD has in place a system for the reporting, documenting, and controlling of nonconformances. Plans of each of the SPHDs will be reviewed by the Caltech Payload Performance Assurance Manager to ensure conformance with the use of established procedures for nonconformance control. SPHD plans which include provisions for the following, are described in the individual IAIPs:

a) Documentation of each nonconformance traceable to the specific part, material, or product on which the failure or discrepancy occurred;
b) Assignment of a unique and traceable document number for each discrepancy and

failure;
c) Description of the nonconformance and the required characteristic or design criteria;
d) Performance and documentation of analyses and examinations to determine the cause;
e) Assignment, implementation, and documentation of timely and effective remedial and preventive action;
f) Signatures of authorized personnel on the appropriate nonconformance documents; and
g) Closeout of nonconformance documentation after verifying that effective remedial and preventive actions have been taken.

8.10.1. Control, Disposition, and Reporting of Discrepancies

Caltech will ensure that SPHD plans for the documentation of discrepancies will start with the receipt of procured parts, materials, or other products, or the initiation of in-house manufacturing, whichever occurs first. Each IAIP will contain a form appropriate for the documentation of discrepancies.

Each discrepant product will be reviewed by SPHD quality assurance, and where appropriate by engineering personnel, and will be subject to one of the following dispositions as a result

a) Return for Rework or Completion of Operations - The product will be returned using established procedures and/or approved documents and operations. During and after rework, the product will be resubmitted to normal inspection and tests;
b) Scrap - The product will be scrapped in accordance SPHD procedures;
c) Return to Supplier - The SPHD will provide the supplier with nonconformance information, and assistance as necessary, to permit remedial and preventive action; or
d) Use "as-is" with the concurrence of local Quality Assurance.

Initial review dispositions will be recorded on nonconformance documentation and be available for review by the Caltech PAM and the government assurance representative.

Caltech will ensure that each of the SPHDs has identified the role and core membership of a Material Review Board (MRB). Membership will be comprised as a minimum with the following members:

a) SPHD quality assurance representative;
b) SPHD engineering representative; and
c) Government quality representative.

Participation by the government quality representative in SPHD MRBs will usually be by teleconference, supported by fax material. Any MRB delegations by SPHDs to their suppliers will be reviewed first by Caltech, and then submitted to the Goddard Project Office in accordance with the contract.

When the disposition as described a) - c) above is not appropriate, the discrepant product will be submitted to the MRB for final disposition. The MRB will have

authority for the following:

a) Repair - The MRB will approve repairs, using standard repair procedures. Normally, an MRB decision to repair an item will call for the use of standard procedures. Before any work is done using a non-standard repair procedure for work that has been authorized by an MRB decision, the procedure will be written out for review by the Caltech PAM, and for subsequent approval by the Goddard Project Office in accordance with the contract;
b) Scrap; and
c) Use-As-Is.

MRB decisions which may adversely affect safety, or preclude product conformance to documented requirements, or are contrary to the requirements of the contract, will have a change request or waiver request generated. Such requests will be generated using procedures described in the ACE Science Payload Configuration Control Plan (ACE-CIT-101-100).

All MRB decisions will be by the unanimous agreement of its membership. If an MRB cannot agree unanimously on a course of action, then the matter will be submitted to an MRB Resolution Board (MRBRB) for disposition in 5 working days or less. This board will consist of the Experiment Manager (i.e. Instrument Project Manager), the Caltech Science Payload Performance Assurance Manager (PAM), and the Science Payload System Engineer. In the unlikely event that the MRBRB cannot reach a consensus agreement on a suitable course of action, the matter will be referred to the Science Payload Manager who will seek guidance from the GSFC Contracting Officer's Technical Representative (COTR), and the GSFC Performance Assurance Manager for the ACE Project Office. If these three individuals cannot reach a consensus agreement on the course of action to be followed, then the matter will be referred to the ACE Project Manager for discussion with the ACE Mission Principal Investigator. At that point, Goddard Code 410.0, in consultation with Goddard Code 303.0, will resolve the matter.

GSFC may reopen the closeout of any MRB action or MRBRB decision within the 30 day period following receipt by GSFC of the MRB or MRBRB disposition.

8.10.2. Control, Reporting and Disposition of Failures

All malfunctions or failures affecting the function of flight equipment, or the function of ground support equipment (GSE) at the interface with flight equipment, or which could compromise mission objectives, will be documented by SPHDs. Malfunctions or failures affecting function will typically involve significant departures from the instrument design, performance, testing, or handling requirements. Formal reporting of failures will begin at the first application of power during formal acceptance testing at the component level, (i.e. whole boxes at one level below the complete instrument level), or at the first operation of a flight mechanical item.

SPHDs will investigate, analyze, and determine the cause of each failure. An assessment of the degree to which the causes are understood and the effectiveness of the proposed fixes will be made by the SPHDs. The Caltech PAM, working with the SPHD will then classify the MR as to the risk involved to system safety or payload performance, as well as the degree to which the cause of the

malfunction/failure is understood and the confidence that one can attribute to the SPHD's proposed fix. This risk classification will make use of the definitions shown in Table 8.10-1.

Caltech will ensure that each of the SPHDs has identified the role and core membership of a Failure Review Board (FRB). Membership will be comprised as a minimum with the following members:

a) SPHD quality assurance representative;
b) SPHD engineering representative; and
d) SPHD project manager.

The SPHD FRBs will closeout MRs within the SPHD indicated impact-risk categories indicated in the Impact-Risk matrix. Copies of the SPHD closedout MRs will be provided to the PMO for information.

Caltech has established the membership of the PMO FRB. Membership is comprised of following members:

a) Caltech PAM
b) Science Payload System Engineer; and
c) Experiment Manager (i.e. Instrument Project Manager).

The Caltech PMO will closeout MRs within the Caltech indicated impact-risk categories indicated in the Impact-Risk matrix. In the unlikely event that the PMO FRB cannot reach a consensus agreement on a suitable course of action, the matter will be referred to the Science Payload Manager for closeout.

The Caltech PMO Monthly Technical Status report will include information on the status of science payload MRs generated, still open, or closed out during the month. GSFC may reopen any MR within the 30 day period following receipt by GSFC of the MR closeout.

Table 8.10-1 MR Categories & Disposition Responsibility

Impact-Risk Matrix for Determining Disposition of Malfunction/Failure Reports

Impact	Risk Category I	II	III	IV
A	CALTECH	CALTECH	CALTECH	CALTECH
B	CALTECH	CALTECH	CALTECH	CALTECH
C	CALTECH	CALTECH	CALTECH	SPHD
D	SPHD	SPHD	SPHD	SPHD
E	SPHD	SPHD	SPHD	SPHD

Impact Assessment

Category	Possible Impact
A	Possible loss Observatory Mission.
B	Loss of one or more instruments.
C	Loss of one instrument.
D	Loss of instrument performance with resulting compromise to science return.
E	Degradation with little or no impact on performance.

Risk Assessment

Risk Category	Cause	Confidence in Fix
I	Unknown	Unknown
II	Known	Unknown
III	Unknown	Known
IV	Known	Known

8.11. Alert Information

Arrangements will be made by the GSFC Project Office for the Caltech PMO to routinely receive selected Alerts describing the problems encountered by others with parts, materials, processes and system safety. Using SPHD supplied lists that are stored in an electronic media, the PMO will compare SPHD parts, materials and processes with the Alerts received from GSFC. The PMO will then respond to these Alerts within 30 working days by notifying the GSFC Project Office, of the applicability (if any) of the Alert information to Project-funded end-item products. Information copies of selected Alerts will be provided to the SPHDs.

8.12. Control of Assembly and Inspection/Test Activities

Caltech will review the inspection and test systems used at SPHD facilities and, if necessary, make recommendations for changes needed to meet the requirements given in the ACE Science Payload PAR. If additional support is required, Caltech will coordinate with GSFC to provide whatever support is needed at an SPHD facility.

8.13. Configuration Verification

Caltech will review the fabrication documentation of flight hardware at the SPHD's facilities. Such reviews by the Caltech PAM are intended to verify that SPHD practices are sufficient to ensure that the as-built hardware complies with the as-designed configuration listings.

8.14. Metrology

It is the policy of the Caltech PMO that SPHDs should establish and implement a suitable metrology system for assuring that laboratory test equipment and measurement standards are selected and controlled to the degree necessary for meeting the requirements of applicable engineering drawings and project documents.

8.15. Stamp Control System

It is the policy of the Caltech PMO that SPHDs should establish and implement a suitable Stamp Control System. Such a system should have the characteristics described in the ACE Science Payload PAR.

8.16. Transportation

Caltech will ensure that all flight hardware uses transportation procedures generated in accordance with NHB 6000.1. Prior to the shipment of any end-item deliverable hardware, Caltech will review SPHD procedures to verify compliance with the requirements of the ACE Science Payload PAR, including the prescribed involvement of SPHD QA. The Caltech review will also verify conformance to the prevailing state and federal regulations, and ensure that the appropriate environmental considerations are included as well.

8.17. Government Property Control

Caltech will ensure that all government-furnished property is properly accounted for at the SPHD facilities. To the maximum extent possible, institutional property accounting procedures will be used, and annual reports to the government (SF 1018) will be generated in accordance with contract provisions.

Caltech will ensure that each SPHD inspects such products upon receipt, and notifies Caltech in the event of damage, malfunction, or a nonconformance making the item unsuitable for use. Goddard disposition is required before rework or replacement. Existing flight-spare hardware and associated support equipment GFE'ed to the SPHD and intended for refurbishment at his facility are exempt from this ACE Science Payload PAR requirement, and from the contractual requirement (clause H.6.c) to report nonconformances of government-furnished property to the GSFC Safety and Health Branch, Code 205.2.

8.18. Government Acceptance

Prior to acceptance by GSFC, the Caltech PMO will inspect the contract deliverable flight end-items, and review the flight article Acceptance Data Package (ADP). Pertinent engineering drawings, data and records related to non-flight end-item deliverables, (e.g. instrument Ground Support Equipment [GSE], ground cables, interface hardware or instrument structural and thermal math models), will be made available to the Project upon request. However, no separate ADP will be prepared for these non-flight end-items. Required flight cables will be included in the delivery of flight instrument end-item hardware. The flight article Acceptance Data Packages will contain:

a) A list of engineering drawings that reflect the as-built configuration;

b) An as-built parts list;
c) As-built materials and processes lists;
d) A Test Log book including total operating time and operating cycles;
e) A list of open items along with a rationale and the appropriate approvals;
f) A listing of, and the status of, all limited life items;
g) Copies of Trend data; and
h) Results of the final Comprehensive Performance Test.

For each flight article end-item delivered to the government, a copy of the Acceptance Data Package will be submitted by Caltech to the GSFC Project Office for approval. A copy of the ADP will also accompany each shipment.

9. Contamination Control

Caltech will establish an ACE Science Payload Contamination Control plan based upon the most contamination sensitive instrument or component on the science payload, or on the spacecraft, along with the specific cleanliness needs of individual payload elements. Each SPHD will be polled as to the sensitivity of their hardware. The data so gathered will be compared with information available from spacecraft subsystem designers, and with the concurrence of APL and GSFC, the cleanliness requirements will be set. The plan will be properly coordinated and iterated before being submitted to the Goddard Project Office for review in accordance with the contract.

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10. Software Assurance

The Caltech PMO will monitor development of all software generated for the science payload. This will include Caltech monitoring of SPHD software verification and validation activities. Preliminary verification and validation activities by the SPHD will involve the testing of software. As test plans are developed, they will be reviewed by Caltech, and once iterated with the SPHD, they will be made available to the Goddard Project Office for review. Caltech will review each of the SPHD's schedule for the verification and validation testing of software modules. Caltech will also review each SPHD's plans for, and approach to, regression testing on software that has been previously verified, and then subsequently changed.

The SPHD approach to software management is discussed in the individual Experiment Implementation Plans (EIPs). When requested, the Caltech PMO will assist SPHDs in generating a software configuration control plan for PMO's approval. Configuration control is covered in the individual Instrument Assurance Implementation Plans (IAIPs). In any case, the Caltech Science Payload Performance Assurance Manager (PAM) will review all SPHD software development plans to assure that the individual, in some cases institutionally-unique, approaches to software management and configuration control meet the requirements of the ACE Science Payload PAR, and are consistent with Caltech's Plan for Management of the Science Payload, (ACE-CT-100-30), Caltech's Payload Configuration Control Plan, (ACE-CT-100-31), and Caltech's S/W Implementation Plan (ACE-CT-100-32). Reviews may be performed subsequently by Caltech of SPHD software configuration management practices. All changes will be processed by Caltech as described in the ACE Science Payload Configuration Control Plan (ACE-CIT-100-31).

Caltech will take steps to ensure that software provided by the government, or the use of existing or purchased software by any SPHD, meets the appropriate functional, performance, and interface requirements as well as all applicable standards for coding, design, and documentation. If not a change request will be made and submitted to the appropriate party.

Software reviews will be held at the time of the formal Science Payload reviews. These reviews will be Co-chaired by a Caltech and GSFC review team as described in Section 2.

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APPENDIX A

Applicable Documents

Document Number	Document Identification
ACE-CT-100-24	Caltech Document: Verification Matrix & Data Base," Version: Final, Dated: May 20, 1993.
ACE-CIT-100-30	Caltech Document: "Payload Management Plan," Version: Draft, Date: TBD.
ACE-CIT-100-31	Caltech Document: "S/W Implementation Plan for the Advanced Composition Explorer (ACE) Science Payload System," Version: TBD, Dated: TBD.
ACE-CIT-100-32	Caltech Document: "Configuration Control Plan for the Advanced Composition Explorer (ACE) Science Payload System," Version: Preliminary, Dated: June 18, 1993.
ACE-CIT-1XX-40	SPHD Documents: "TBS Instrument Functional Requirements Document," Version: Planned, Date: TBD.
ACE-CIT-XXX-41	Caltech Document: "Experiment Implementation Plans," Version: Preliminary, Dated: June 18, 1993.
ASTM E 595	TBD Document: "Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment," Version: TBD, Dated: 1990.
DOD-HDBK-263A	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)," Version: A, Dated: February 22, 1991.
DOD-STD-1686A	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)," Version: A, Dated: august 8, 1988.
D-1348A	JPL Document: JPL Handbook for Electrostatic Discharge (ESD) Control," Version: Revision A, Dated: March 1993.
ESMCR 127-1	US Air Force Document: "Eastern Space and Missile Center, Range Safety," Version: Final, Dated: July 30, 1984.
GSFC-S-313-100	GSFC Document: "Goddard Space Flight Center Fastener Integrity Requirements," Version: A, Date: April, 1993

APPENDIX A

Applicable Documents (Continued)

Document Number	Document Identification
GSFC-410-ACE-004	GSFC Document: "Advanced Composition Explorer Configuration Management Procedure," Version: Change Request, Dated: November 3, 1993.
GSFC-410-ACE-008	GSFC Document: "Performance Assurance Requirements for the Science Payload of the Advanced Composition Explorer (ACE) Mission," Version: Final, Dated: April 1993.
GSFC-410-ACE-XXX	GSFC Document: System Safety Plan for the Advanced Composition Explorer, Version: TBS, Date: TBS.
JHU/APL 7345-9007	"Advanced Composition Explorer (ACE) Spacecraft, Environmental Specification." Version: Draft.
MIL-STD-883	Military Standard Document: "Test Methods and Procedures for Microelectronics," Version: Revision D, Dated: November 15, 1993.
MIL-STD-975	Military Standard Document: "NASA Standard Electrical, Electronic and Electromechanical (EEE) Parts List" Version: Revision H Notice 2, Dated: October 1 1983.
MSFC-SPEC-522	MSFC Document: "Design Criteria for Controlling Stress Corrosion Cracking," Version: Revision B, Dated: July 1987.
NHB 6000.1	NASA Document: "Requirements for Packaging, Handling, and Transportation," Version: Revision C, Dated: June 1976.
7345-90XX	APL Document: "Specific Interface Specifications (SIIS), Version: TBD, Dated: TBD.
PPL	GSFC Document: "GSFC Preferred Parts List."
S-311-M-70	GSFC Document: "Specification for Destructive Physical Analysis (DPA)," Version: Revision A, Dated: January 7, 1993.
S-313-100	GSFC Document: "Fastener Integrity Requirements," Version A, Dated April 20, 1993

APPENDIX A

Applicable Documents (Continued)

Document Number	Document Identification
ZPP-2078-GEN	JPL Specification: "General Specification for Destructive Physical Evaluation of Electronic Parts, Version: A. Dated January 4, 1991. Caltech Document: "Science Payload Predelivery Verification Matrix," Version: Preliminary, Dated: June 22, 1993.

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APPENDIX B

Glossary

Acronyms and Abbreviations	Meaning
ACE	Advanced Composition Explorer
ADP	Acceptance Data Package
APL	Applied Physics Laboratory
BRI	Bartol Research Institute
Caltech	California Institute of Technology
CAMEX	A Custom Microcircuit
CCB	Change Control Board
CDR	Critical Design Review
CIT	California Institute of Technology
CM	Configuration Management
COTR	Contracting Officer's Technical Representative
CR	Change Request
CRIS	Cosmic Ray Isotope Spectrometer
CSI	Customer Source Inspection
DESC	Defense Electronics Supply Center
DOD	Department of Defense
DPA	Destructive Physical Analysis
DPU	Data Processing Unit
ECR	Engineering Change Request
EEE	Electrical, Electronic and Electromechanical
EIP	Experiment Implementation Plan
EPAM	Electron, Proton and Alpha Monitor
ER	Established Reliability
ERD	Experiment Requirements Document
ESA	European Space Agency
ESD	Electrostatic Discharge
ETR	Eastern Test Range
FMEA	Failure Modes and Effects Analysis
FOR	Flight Operations Review
FRB	Failure Review Board
GFE	Government Furnished Equipment
GIA	Government Inspection Agency
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
GSI	Government Source Inspection
HDBK	Handbook
IAD	Independent Assurance Developer
IAIP	Instrument Assurance Implementation Plan
IDPP	Instrument Design and Data Package
IFRD	Instrument Functional Requirements Document
JAN	A diode and transistor reliability standard
JHU	Johns Hopkins University
JPL	Jet Propulsion Laboratory
LiD	Lithium Drifted Detector

APPENDIX B

Glossary (Continued)

Acronyms and Abbreviations	Meaning
LOD	Letter of Delegation
MAG	Magnetometer
MIL	Military
MOR	Mission Operations Review
MR	Malfunction Report
MRB	Material Review Board
MRBRB	Material Review Board Resolution Board
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
NSPL	NASA Standard Parts List
PAIP	Payload Assurance Implementation Plan
PAM	Caltech Performance Assurance Manager
PAR	Performance Assurance Requirements
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PIL	Parts Identification List
PMO	Caltech Payload Management Office
PPL	Preferred Parts List
PWB	Printed Wiring Board
PSM	GSFC Project Safety Manager
PSR	Preshipment Review
QA	Quality Assurance
QPL	Qualified Parts List
SEPICA	Solar Energetic Particle Ionic Charge Analyzer
SIS	Solar Isotope Spectrometer
SIIS	Specific Instrument Interface Specification
SOFT	Scintillating Optical Fiber Technology
SPEC	Specification
SPHD	Science Payload Hardware Developer
S/S/S DPU	SWICS/SWIMS/SEPICA DPU
STD	Standard
SWEPAM	Solar Wind Electron, Proton and Alpha Monitor
SWICS	Solar Wind Ion Composition Spectrometer
SWIMS	Solar Wind Ion Mass Spectrometer
TBD	To Be Determined
TBS	To Be Supplied
TUB	Technical University of Braunsweig
U.	University
UDE	University of Delaware
ULEIS	Ultra Low Energy Isotope Spectrometer
U.S.	United States of America
WIND	Solar Wind Project

APPENDIX B

Glossary (Continued)

Acronyms and Abbreviations	Meaning
WAVE	Wide Angle Variable Energy

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APPENDIX B

Glossary (Continued)

Term	Definition
Alert	A notice that informs users that a part, material or process may be defective or have uncertainties associated with it.
Class I	A change that requires Project approval prior to preceding with implementation activities.
Coupons	Non-functional test circuitry located at the edge of printed wiring boards.
Derating	The reduction of the application rating criteria on electronic devices vs part capabilities.
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.
Limited Life Items	Space flight hardware that may have failure-free life that is less than the required mission life, when considering cumulative ground operation, storage and space flight operation.
Limited Shelf Life	Items whose useful life may expire prior to their being incorporated into a hardware item.
Observatory	Devices which are designed to be placed into orbit about the earth or about another celestial body for the purposes of obtaining scientific data.
Phase C/D	The Phases of a project following the initial planning when detail design, fabrication and testing occur
Regression	A kind of software test which demonstrates that a change to properly functioning software does not adversely affect the software system.