STEREO
IMPACT

Performance Assurance Implementation Plan (PAIP)

STEREO-IMPACT-PAIP_F.doc
Version F – 2002-Oct-15

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Document Revision Record

Rev.	Date	Description of Change	Approved By
A	2000-July-27	Phase A Report Draft	-
B	2001-June-25	Inputs from Project	
C	2001-Oct-24	Inputs from Project New CESR SWEA PAIP Appendix	
D	2001-Nov-27	Response to inputs from Project	
E	2002-Apr-2	• Add GSFC soldering & PWB standards for Tycho • Add new "as good or better" wording to for CESR, Kiel, MPAe	
F	2002-Oct-15	Incorporate latest ESTEC PAIP (Appendix B.1)	

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1. GENERAL

1.1. *Basis and Scope of the Plan*

This document has been written in response to the Draft STEREO Safety, Reliability & Quality Assurance Requirements document (November 1999), as called out in the Phase A Statement of Work.

The STEREO IMPACT (In situ Measurements of Particles and CME Transients) investigation shall provide a suite of particle instruments for the NASA STEREO mission. The IMPACT project is an international effort of several universities, laboratories, and NASA. The Principal Investigator (PI) for IMPACT is Dr. Janet Luhmann at the University of California at Berkeley (UCB), and the IMPACT Project Manager (PM) is David Curtis, also at UCB. Note that the term PI in this document refers to Dr. Luhmann or a designated member of the IMPACT team under her authority. The allocation of hardware development responsibilities amongst the team is called out in the STEREO/IMPACT Phase A Report. This PAIP covers that part of the development effort performed at UCB and its subcontractors. Other NASA-funded institutions providing IMPACT flight hardware (Caltech, GSFC, UMd) shall conform to this PAIP. Non-NASA-funded institutions (foreign Co-Investigators) shall meet the Performance Assurance requirements called out by their funding agency.

1.1.1. CESR

The STEREO IMAR and this PAIP have been reviewed by the CESR TOULOUSE and are compatible with existing requirements and performance assurance procedures in place at CESR for the control of hardware and software built by CESR. These procedures and any oversight required are under the control of the French space agency (CNES). A short description of this plan is provided in Appendix B.3 of this document.

1.1.2. University of Keil

In developing its instrumentation, the University of Kiel will use quality assurance techniques that meet or exceed the requirements of the STEREO IMAR and this PAIP. See Appendix B.2 of this document.

1.1.3. MPAe

In developing its instrumentation, Max Planck Institute for Aeronomy at Lindau will use quality assurance techniques that meet or exceed the requirements of the STEREO IMAR and this PAIP.

1.1.4. ESTEC

In developing its instrumentation, ESTEC will use the quality assurance techniques as called out in Appendix B.1 of this document.

In this document, unless otherwise stated, the terms Project and GSFC refer to the STEREO Project office at GSFC, as represented by the STEREO Project office Instrument Manager for IMPACT.

1.2. *General Requirements*

The PI for the STEREO IMPACT instrument suite will establish an organized program which will demonstrate that the design meets the functional requirements, including margins, has been manufactured properly and that it will operate properly in association with other project components. This will be accomplished by conducting analyses, tests and inspections.

The performance assurance program will encompass flight equipment, critical GSE (*), Flight Software and spare flight equipment. This plan will be used by the PI and all Co-investigators who fabricate or test such equipment. This plan does not apply to ground support, mission operation, data analysis equipment or software except where specifically called out.

(*) Critical Ground Support Equipment (GSE) includes that parts of the IMPACT GSE that interfaces directly to the flight hardware in such a way that failure or incorrect operation could damage the flight hardware. The requirements of this PAIP only apply to such GSE as required to ensure the safety of the flight hardware.

1.3. *Use of Previously Designed, Fabricated, or Flown Hardware*

Any previously designed or fabricated section of the hardware used on IMPACT will be subject to the PA requirements of this PAIP.

1.4. *Flow-Down of PA Requirements*

The PI will ensure that all vendors and subcontractors who supply hardware for the IMPACT instrument suite will meet applicable PA/QA requirements.

1.5. *Surveillance*

The work activities, operations, and documentation performed by NASA funded IMPACT institutions and their suppliers are subject to evaluation, review, audit, and inspection by government-designated representatives from GSFC, the Government Inspection Agency (GIA), or an independent assurance contractor (IAC). GSFC will delegate in-plant responsibilities and authority to those agencies via a letter of delegation, or the GSFC contract with the IAC.

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

Work activities performed at CESR/Toulouse are evaluated regularly with internal inspections and on an as-needed basis by external (e.g. CNES) inspectors. Should NASA so desire, it may conduct

inspections of activities at CESR/Toulouse. Inasmuch as CESR activities are not funded by NASA, such oversight shall be of an advisory nature only.

1.6. *SR&QA Verification*

The PI will provide GSFC or their representative with any documents and records outlined in the PAIP upon request.

1.7. *Applicable Documents (Appendix A)*

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

2. ASSURANCE REVIEW REQUIREMENTS

2.1. *General Requirements*

The PI will support a series of system-level design reviews that are conducted by an independent review team. The reviews will cover all aspects of the flight hardware, critical ground support hardware, flight software, and operations.

In addition the PI will support informal subsystem-level engineering peer reviews as required by the Project. These peer reviews will be coordinated with Project and will include Project representatives and Project-designated reviewers. Resulting action items shall be tracked on the Project Action Item database, and the GSFC Instrument Manager shall concur with closeouts.

2.2. *GSFC Flight Assurance Review Requirements*

For each system-level review, the Project Manager will:

- Organize an oral presentation of materials from the instrument development team to the review team. Preliminary copies of the viewing material will be furnished to the review team one week before the review, with a final version furnished at the time of the review.
- Support splinter review meetings resulting from the major review.
- Produce written responses to recommendations and action items resulting from the review.

2.3. *Flight Assurance Review Program*

The PI will support the following instrument design reviews:

a. A Preliminary Design Review (PDR) which is to occur when the preliminary design is completed.
b. A Critical Design Review (CDR) which occurs before the bulk of the flight fabrication begins.
c. Pre-Environmental Review (PER) which occurs after the instrument suite is complete and before the full environmental tests are performed (in the event that some of the instrument is complete and ready to test before the entire suite is ready, the PER will be moved forward to occur before the first environmental tests).
d. A Pre-Shipment Review (PSR) which occurs prior to shipping the instrument suite to the spacecraft for integration.

In addition, the PI will support observatory level design reviews, including the Observatory PDR, CDR, MOR, PER, FOR, PSR, and FRR, as well as the subsystem Peer Reviews mentioned above.

3. PERFORMANCE VERIFICATION REQUIREMENTS

3.1. *General Requirements*

A Performance Verification program will be conducted to ensure that the flight hardware meets the mission requirements. The program consists of a series of functional demonstrations, calibrations, analyses, physical measurements, and environmental tests which simulate the environments encountered during handling and transportation, pre-launch, launch and flight. All flight hardware will comply with the requirements of this PAIP. In the event that spare instrumentation is used, it will be verified prior to flight.

The applicable environmental verification program is described in GEVS-SE, as modified by environmental test specifications provided by STEREO Project (APL STEREO Document 7381-9003) based on system-level information.

3.2. *Documentation Requirements*

The IMPACT Project Manager will be responsible for managing the collection and distribution of verification documentation. This documentation will include a Verification Matrix, Environmental Test matrix, Verification Procedures, and Verification Reports. Verification documentation shall be available on request, and shall be summarized at design reviews.

3.2.1. Verification Matrix

The Verification Matrix shall show the flow-down of science and mission requirements and the method of verification for each requirement.

3.2.2. Environmental Test Plan

The Environmental Test Plan shall summarize the environmental tests to be performed at each level of assembly. Test levels, cycles, and special provisions will be called out.

3.2.3. Verification Test Procedures

Verification Test Procedures will be developed for all tests conducted at the component level and above. Such procedures will be at least a lab notebook level of formality.

3.2.4. Verification Test Report

A test report will be generated for each test at the component level and above. This report will show the degree to which the test objectives were met, how well the data correspond to the expected results, and any other significant findings. They will include as-run procedures and test data. Such reports shall be at least a logbook level of formality.

3.3. *Demonstration of Failure-Free Operation*

At the time of delivery of flight hardware to spacecraft integration, it shall have demonstrated trouble-free operation for at least 100 hours without significant change to the hardware. A “Significant Change”

generally means any work on the item that calls into question the validity of the previous test results, such as a repair or part replacement.

3.4. *Comprehensive Performance Test*

A set of Comprehensive Performance Tests (CPT) shall be used before, in some cases during, and after environmental tests to verify the end-to-end performance and functionality of the instruments. These tests shall also be used at spacecraft integration and test as a validation of instrument functionality. Unfortunately, some instrument performance characteristics can only be verified in vacuum or at a special facility, but the CPT will be designed to verify as much as possible of the system, and provide a baseline against which to compare subsequent test results.

4. SAFETY

4.1. *General*

The PI shall plan and implement a system safety program that accomplishes the following:

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

b. Support Project plans to ensure the design meets the system safety requirements of EWR 127-1 "Range Safety Requirements Eastern and Western Range". for the Eastern launch site (KSC) and KHB 1710.2D, "Kennedy Space Center Safety Practices Handbook".

c. Support Project plans to ensure the design meets the baseline industrial safety requirements of the institution, EWR 127-1, as well as any special contractually imposed mission unique obligations.

4.2. *System Description and Safety Assessment Report*

The IMPACT Phase A Report includes a detailed description of the system down to the subsystem level. This document shall serve as a baseline for the STEREO Project Safety Manager (PSM). A preliminary assessment of the IMPACT instrument's compliance with the requirements of section 4.1 follows. The PI shall continue to identify, analyze, and minimize hazards throughout the development effort. All hazards affecting personnel, launch vehicle hardware, or the spacecraft shall be identified and brought to the attention of the PSM. A synopsis of the on-going safety analysis, consistent with the maturity of the subsystem design, shall be part of each subsystem presentation at peer level and system level independent design reviews.

4.2.1. Preliminary Safety Assessment

The only unusual identified hazards related to the IMPACT instrument suite development and test are:

a) High Voltage: The instrument contains a number of high voltage supplies, as high as 3400V. There shall be no exposed high voltage. The supplies shall be resistively current limited on the output. The instrument can be damaged by inadvertent operation of the supplies in air. This risk is mitigated by the use of red tag disable plugs and/or green tag enable plugs, multiple series commanding interlocks, plus appropriate hazardous procedure interlocks.

b) Radiation Sources: Low level radiation sources shall be used during the calibration and test of the instruments. These sources do not fly with the instrument, but will be used during instrument and spacecraft functional tests. These sources will be handled by qualified personnel using appropriate handling procedures.

c) Non-Explosive Actuators (NEA): The instruments shall contain in-flight deployable covers using non-explosive actuators. The IMPACT boom deployment is also planned to use

NEAs. None of these actuations are expected to present a personnel hazard. Enable or disable plugs will be used to prevent unintended actuation that might expose a detector to contamination or damage the boom by deployment in 1G.

4.3. *Procedure Approval*

The PI shall submit, in accordance with the contract schedule, all ground operations procedures to be used at GSFC facilities, other integration facility, or the launch site. All hazardous operations as well as the procedures to control them shall be identified and highlighted. All launch site procedures shall comply with the applicable launch site safety regulation.

4.4. *Safety Noncompliance Requests*

When a specific safety requirement cannot be met, the PI shall submit to the GSFC PSM an associated safety noncompliance request that identifies the hazard and shows the rationale for approval of a noncompliance, as defined in the applicable launch site safety regulation.

4.5. *Support for Safety Working Group Meetings*

The PI shall provide technical support to the STEREO Project Safety Manager for safety working group meetings, when necessary.

4.6. *Safety Data Package, Launch Site Safety Plan, and Orbital Debris Assesment*

The spacecraft contractor shall develop these documents. The PI shall provide input as required concerning the IMPACT instrument suite and its related ground activities that impact safety.

5. EEE PARTS REQUIREMENTS

5.1. *General Requirements*

UCB will conduct a parts control program covering the selection, procurement, and acceptance of EEE parts used on the STEREO IMPACT Instrument Suite. This section of the PAIP shall serve as the IMPACT Parts Control Plan.

The UCB Project Manager is responsible for implementation of the parts control program. Parts selection and screening plans will be done by various engineers working on the project, with final approval by the Parts Control Board (see 5.8). Parts testing, when required, will be performed by engineers assigned to the project, and/or outside vendors.

Note that non-NASA funded institutions providing hardware to the IMPACT instrument suite will use the parts control program mandated by their funding institution (see Appendix B). It is assumed that the parts quality level shall be similar to that imposed in this section on the NASA-funded institutions. At a minimum, sections 5.2.1 and 5.5 shall apply to all flight hardware.

5.2. *Parts Selection*

Parts will be selected and processed in accordance with GSFC Specification GSFC-311-INST-001 for Grade 2 quality level. Parts will be preferably selected from the following sources:

a) Parts listed in the GSFC Preferred Parts List (PPL), or the NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List (NSPL), MIL-STD-975. Where differences in requirements exist between the PPL and the NSPL, the PPL should take precedence. Parts should be procured in accordance with the appropriate specification designated for that part.

b) MIL-M-38510, Class B or better microcircuits procured from a Qualified Products List (QPL) supplier. Additional PIND testing is required for class B parts.

c) MIL-I-38535, Class Q or better microcircuits procured from a Qualified Manufacturers' List (QML) supplier. Additional PIND testing is required for class Q parts.

d) MIL-H-38534, Class H or better hybrid microcircuits procured from a Qualified Manufacturers' List (QML) supplier. Additional PIND testing is required for class H parts, plus precap visual or DPA.

e) Standard Military Drawing (SMD) microcircuits procured from an authorized supplier as listed in the SMD.

f) Microcircuits compliant with paragraph 1.2.1 of MIL-STD-883 and procured from manufacturers having QPL or QML status for parts of the same technology. Parts procured from manufacturers without QPL or QML status should be procured with lot specific or generic Group C Quality Conformance Inspection (QCI) data within one year of the lot date code of the parts being procured. MIL-STD-883 compliant microcircuits shall be subjected to PIND testing and DPA. Screening data shall be obtained with the parts.

g) Manufacturers' in-house high reliability processed parts provided all screening tests listed in Appendix C of the PPL have been satisfied. The high reliability process flow should be that formally documented by the manufacturer in cases where changes would require a revision to the flow documentation. Tests not included in the manufacturer's high reliability flow must be performed by the manufacturer, an independent test facility, or by the developer. Parts procured in this section should be procured with lot specific or generic Group C Quality Conformance Inspection (QCI) data within one year of the lot date code of the parts being procured. If not included in the manufacturer's high reliability test flow, the parts should be subjected to PIND testing and DPA. Screening data shall be obtained with the parts.

h) MIL-S-19500, JANTX, JANTXV and JANS semiconductors procured from a QPL listed supplier. It is preferred that semiconductors be procured to JANTXV level or better. Any semiconductor that has an internal cavity should be subjected to PIND.

i) Established Reliability (ER) passive components procured from a QPL listed supplier for the appropriate military specification. Only ER parts within the minimum and maximum value ranges specified in the PPL should be considered acceptable. 50V ceramic capacitors used in applications <10VDC may require steady state humidity low voltage testing per 311-Inst-001A; refer to PCB. CSR09 and CSR13 capacitors require surge current testing per 311-Inst-001A and PPL.

j) Parts procured to a GSFC S-311 specification from a GSFC approved source.

k) Relays procured to MIL-R-39016, MIL-R-83536, MIL-R-6106, or MIL-R-83536 procured to failure rate M or better.

5.2.1. EEE Parts Identification List

A list of all parts used in the IMPACT instrument suite flight hardware will be maintained in electronic format by each IMPACT institution providing such hardware. The list shall be submitted to STEREO Project and the PCB for approval prior to their application. This list will include, as applicable:

1) Generic part type
2) Control specification
3) Part number

4) Manufacturer
5) Lot # and/or lot date code
6) Where used
7) Total quantity used
8) Screening required, status
9) Project Approval Status

An as-built parts list shall also be maintained, typically in the form of as-built PWB loading documentation. Documentation shall include lot date code and, where applicable, serial number for each part is loaded on the board. Photographic documentation may also be used (see section 8.3). The as-built documentation shall also include lot/serial information on any replacement parts.

5.3. *Other Parts*

Other parts, not on any of the documents listed in section 5.2, and including Custom circuits (ASICs, MCMs etc.) will be purchased or screened in accordance with GSFC Specification GSFC-311-INST-001 for Grade 2 quality level. The Parts Control Board shall review and approve use of such parts and their application, procurement and screening plans/specifications.

For devices not covered under GSFC-311-INST-001, they shall be screened in accordance with the nearest applicable GSFC specification or military specification.

Devices with interval cavities shall be subject to PIND testing. Devices shall either have a pre-cap visual or a DPA performed.

Screening specifications shall fully identify the tests to be performed, the test conditions, failure criteria, and lot rejection criteria. For lot acceptance or rejection, the Percentage of Defectives Allowable (PDA) in a screened lot shall be in accordance with that required in the closest military part specification.

Part screening results, failed parts, parts subject to destructive tests, and non-flight parts subjected to non-destructive tests shall be archived and retained for the life of the mission, unless otherwise directed by the PCB.

5.3.1. Magnetic Devices

Transformers and inductors will be manufactured at UCB using magnetic components purchased from Magnetic, Inc. and Phillips, to commercial specifications, and MWS Heavy Armored Polythermaleze wire (HAPT), also purchased to commercial specifications. Parts and wire will be carefully visually inspected before and after winding. Units may be potted using approved materials at UCB. Correct operation of the completed units will be verified by electrical tests and measurements as follows:

- DC Winding resistance
- Winding Inductance
- Turns ratio or Voltage Ratio

- Polarity
- Dielectric Withstanding Voltage
- Induced Voltage
- Self Resonant Frequency
- Visual

Qualification shall be based on similarity; the same procedures and personnel will be used that have fabricated magnetics at UCB for several successful NASA missions.

Caltech magnetics shall be manufactured by John Gilbert, whose facility was source-inspected for ACE by JPL magnetic specialists.

5.3.2. Plastic Encapsulated Microcircuits (PEMs)

The use of PEMs shall be restricted to applications where no similar high reliability hermetically sealed device exists.

Each lot of PEMs shall be qualified by subjecting samples to Highly Accelerated Stress Testing (HAST) or Steady State Temperature Humidity Bias Life testing in order to qualify and assess overall package integrity of the lot.

All PEMs shall be subjected to screening to eliminate random early life failures, including temperature cycling, burn-in, electrical measurements and C-SAM (C-Mode Scanning Acoustic Microscopy.

The PCB shall approve the details of the qualification and screening procedures.

PEM may be susceptible to moisture intrusion, and shall be protected during shipping, storage, and assembly. The flight units shall be packaged in a Moisture Barrier Bag with desiccant and humidity indicator cards.

5.3.3. Units and Subassemblies

Function of units or assemblies that are purchased as "off the shelf" hardware items shall be analyzed for mission criticality. When loss of off the shelf units does not compromise mission success, on a case-by-case basis, these units may be considered exempt from the parts control requirements of this section, subject to approval of the program office and the parts control board. However, additional unit level testing such as thermal cycling or thermal vacuum testing, may be directed by the PCB or project in lieu of additional part level screening.

When failure of such units represents significant compromise to mission success, an analysis of the parts used within the units shall be performed. The parts shall be evaluated for screening compliance to GSFC 311-INST-001, established reliability level, and include a radiation analysis. Pending the results

of this investigation, units may be required to undergo modification for use of higher reliability parts, or Rad hard parts. All upgrade parts shall be subject to PCB approval.

Modifications such as additional shielding for radiation effectiveness or replacing radiation soft parts for Rad-Hard parts, may be recommended.

5.3.4. Field Programmable Devices

Field programmable devices such as PROMs that cannot be fully tested prior to programming shall be re-screened following programming, including burn-in and final electrical functional. Note that Actel FPGAs do not require re-screening beyond that performed by the programmer, per the manufacturer's recommendation:
http://www.actel.com/appnotes/ppbi_dc.pdf

5.3.5. PIND Testing

Parts from lots exceeding 25% PIND failure must be reviewed by the PCB for approval. This includes PIND testing for devices covered by section 5.2 also.

5.3.6. Destructive Physical Analyses (DPA)

DPA procedures, sample size and criteria shall be performed per GSFC specification S-311-M-70 (TBR), Destructive Physical Analysis. For small procurements, small lot sampling per 311-M-70 may be used. The PCB on a case-by-case basis shall consider variation to the DPA sample size requirements, due to quantity used in flight, application criticality, part complexity, availability or cost.

5.4. ***Derating***

All flight parts will be derated to the levels of PPL, Appendix B.

5.5. ***Radiation Tolerance***

All EEE parts shall be selected to meet their application design requirements in the predicted radiation environment, including TID and SEE.

Parts shall have a TID tolerance of 8 Krads or more, based on manufacturers data sheet, demonstrated technology hardness, or lot testing. Shielding or special packaging may be used to achieve the desired tolerance. 8 Krads assumes 75mils aluminum shielding or equivalent (a dose vs. depth curve will be provided in the APL Environmental Specifications document, 7381-9003)

Parts shall be SEL-immune to a LET of >80 MeV-cm^2/mg, or else shall be protected against damage by a protection circuit. Parts that may affect critical functions that could damage the instrument shall be SEU-immune, or else shall use a Triple-Modular-Redundancy scheme to avoid any single SEU causing a failure. Parts shall meet these criteria based on manufacturers data sheet, demonstrated technology hardness, or lot testing.

The rational/analysis/test data demonstrating the radiation tolerance of each part shall be documented.

5.6. *Alerts*

The instrument team will respond to GIDEP Alerts and NASA Advisories forwarded by STEREO Project (GSFC), and determine if any flight hardware or parts inventory is affected. In-coming EEE parts into the STEREO flight stock will be screened against the GIDEP database. Any parts for which there is an open Alert will either be removed from the flight stock and/or hardware or referred to the PCB.

5.7. *Parts Age Control*

Integrated Circuits and Semiconductors that have a lot date code or screening record older than 7 years at the time of installation into PWBs shall be subjected to a room temperature re-screen and sample DPA as necessary per PCB recommendation.

5.8. *Parts Control Board*

A Parts Control Board shall be set up to approve the screening and use of non-standard parts, re-testing due to age, failure history, GIDEP Alerts, or other reliability concerns, and other parts related issues called out above. The PCB shall include STEREO Project Parts Engineer and System Assurance Manager, in addition to an IMPACT subsystem lead engineer, QA, or parts engineer (depending on what system is involved) and the IMPACT Project Manager. Given the geographic distribution of the team, PCB actions will typically take place informally by phone or e-mail. Most PCB functions shall be performed by e-mail, but occasional telecons will be set up when there is a specific issue to discuss. Documentation shall consist of the e-mail exchange and the annotated PIL and related documents attached to such e-mail. The PIL shall be the summary of the agreements reached by the PCB, including approval, screening requirements, etc.

In the event that the PCB cannot reach consensus on a parts issue, the issue will be forwarded to the STEREO Project Manager for disposition.

6. MATERIALS AND PROCESSES CONTROL REQUIREMENTS

6.1. *Selection Requirements*

6.1.1. Compliant Materials

Compliant materials will be used in the fabrication of flight hardware to the extent practicable. In order to be compliant, a material must be used in a conventional application and meet these ELV criteria:

1. Hazardous materials requirements including flammability, toxicity, and compatibility as specified in EWR 127-1 (Sections 3.10 and 3.12).
2. Vacuum Outgassing requirements as defined in paragraph 6.1.6.
3. Stress corrosion cracking requirements as defined in 6.1.5.

6.1.2. Noncompliant Materials

A material that does not meet the requirements of section 6.1.1, or meets the requirements of section 6.1.1 but is used in an unconventional application shall be considered to be a noncompliant material. A Materials Usage Agreement (MUA) and/or a Stress Corrosion Evaluation Form be submitted to the GSFC STEREO Project for concurrence for all noncompliant materials.

No pure Tin shall be used due to Tin Whisker problem.

6.1.3. Conventional Applications

Conventional applications or usage of materials is the use of compliant materials in a manner for which there is extensive satisfactory aerospace heritage.

6.1.4. Nonconventional Applications

The proposed use of a compliant material for an application for which there is limited satisfactory aerospace usage shall be considered a nonconventional application. In that case, the material usage shall be verified for the desired application on the basis of test, similarity, analyses, inspection, existing data, or a combination of those methods. This information shall be provided to the GSFC Material Assurance Engineer during design reviews or other project meetings. The proposed use of a material in a nonconventional application requires that a MUA be submitted to the GSFC STEREO Project for concurrence.

6.1.5. Inorganic and Metallic Materials

A MUA and stress corrosion cracking evaluation form shall be submitted to Project for each material usage that does not comply with the MSFC-SPEC-522 stress corrosion cracking requirements.

6.1.6. Non-metallic Materials

Materials will be noncombustible or self-extinguishing as much as possible. The outgassing properties of organic materials will be considered in their selection. When tested to ASTM E-595, compliant

materials will have less than 1 percent total mass loss and less and 0.1 percent collected volatile condensable mass.

Solithane conformal coat materials shall be avoided, with Uralane being preferred.

6.1.7. Fasteners

Fasteners shall be selected and screened in accordance with 541-PG-8072.1.2.

6.1.8. Lubricants

No lubricants are expected to be used. Should lubricants be required, they will be included in the Materials list approved by Project.

6.1.9. Consideration in Process Selection

Manufacturing processes will be selected so as to minimize changes to the material's properties.

6.1.10.Shelf Life Controlled Items

Polymeric materials with an uncured limited shelf life will be identified with manufacturing data and storage conditions. Regular purchases of limited shelf life materials will be planned to assure that current date code materials are always available. Out of date materials will not be used on flight hardware.

Any other limited life material will be identified in the Limited Life Items list discussed in section 7.4.

6.1.11.Magnetics Compatibility

Materials shall be selected non-magnetic wherever possible. Use of any magnetic materials shall be reviewed with Project and the Magnetometer Co-Investigator to determine acceptability of use.

6.2. ***Documentation***

Documentation for materials and processes control will include:

a. Engineering Drawings for materials application
b. Materials and Processes List

The material list will be available to the Project.

6.3. ***GIDEP Alerts***

Materials selection and usage records sufficient to determine applicability of any Government Industry Data Exchange Program (GIDEP) alert shall be maintained. These records shall typically be kept in the form of material Certificates of Compliance in the shop traveler or QA records. Historical GIDEP Alert status shall be reviewed on receipt of materials, and new GIDEP alerts shall be checked against flight stock. Any material against which there is an open Alert shall be removed from flight stock or refereed to the MRB.

7. DESIGN ASSURANCE AND RELIABILITY

7.1. *Requirements*

The IMPACT instrument suite and associated test equipment will be designed to:

a. Function properly during the mission lifetime,
b. Minimize or eliminate human-induced failures,
c. Permit ease of assembly, test, fault-isolation, repair, and maintenance without compromising performance, reliability, or safety aspects.

7.2. *Implementation*

The Project Manager shall ensure that system-level design and trade studies include reliability considerations. Areas where significant improvement in reliability can be achieved at the cost of increased resource requirements shall be passed on to Project. At the subsystem level, lead subsystem engineers will be responsible for reliability issues concerning their subsystem, and shall bring to the attention of the Project Manager any reliability concerns outside the scope of their allocated resources.

7.3. *Failure Modes and Effects Analysis*

A formal FMEA shall be performed at the spacecraft interface level to identify failures that can propagate beyond the instrument. A less formal analysis shall be performed by the Project Manager, together with subsystem engineers, as part of the design process to identify likely failure modes and mitigation schemes.

The IMPACT team shall also provide design data to Project as required to aid in the development of Reliability Assessments (RBDs, PRAs, FMEA, and FTAs), and will analyze the results of the these analyses and consider with Project possible risk mitigation trades.

7.4. *Limited Life Items*

Limited life items shall be identified and avoided when possible. The Project Manager shall compile a list of limited life items with input by the subsystem engineers. This list shall be provided for approval to Project. Limited life items include all hardware that is subject to degradation due to age, operating time, or cycles, such that its expected useful life is less than twice the required life, when fabrication, test, storage, and mission operation are combined. The Project Manager shall maintain a record of total operating times for these items.

7.5. *Trending*

A set of measurable parameters that relate to performance stability shall be identified for each instrument. These parameters shall be measured and tracked as part of the standard functional testing starting at the instrument level. Recording of these parameters shall be part of the standard Comprehensive Performance Test (CPT). As part of the analysis of the results of each CPT, changes in

the trending parameters shall be analyzed. This process shall continue through spacecraft I&T and post-launch mission operations.

8. QUALITY ASSURANCE REQUIREMENTS

8.1. *Support of Design Reviews*

QA issues and the status of the QA program will be addressed in the reviews identified in section 2.3.

8.2. *Configuration Management*

Configuration management is described in the STEREO and IMPACT configuration management plans:

460-PG-1410.2.1B: STP Program Configuration management procedure
IMPACTCMPlan_B: STEREO IMPACT Configuration Management Plan.

It is the responsibility of the design engineer to verify that the as-built configuration (as described in the traveler) is correct (compared to as-designed) prior to integration of an item into the next level of assembly.

8.3. *Identification and Traceability*

Part numbers will be provided on each sub-assembly or PWB. If sub-assemblies or assemblies are not unique, serial numbers will be used to identify them.

Mechanical parts will be serialized when they are not fully interchangeable. Significant sub-assemblies (such as a sensor assembly) will be serialized for traceability.

Records will be maintained (sometimes in the form of photographs) to support a trace of any non-interchangeable part or material to the board or unit in which it was placed. Parts from a given manufacturer with the same lot-date-code and screening history are considered to be interchangeable. Similarly, any board or unit will be traceable backwards to the parts or materials from which it was built. Thus, if an ALERT were to identify a problem part, IMPACT could determine all places where the part exists in the instrument.

8.4. *Procurement Controls*

The following procurement controls shall be imposed on all flight unit parts and materials purchases.

8.4.1. Purchased Raw Materials

Purchase orders for raw materials will include a requirement for the results of physical and chemical tests, or a certificate of compliance. Exceptions shall be approved by the GSFC via a waiver request, based on evidence of the acceptability of the material for the intended use.

Suppliers of materials will be requested to make acceptance test results available.

8.4.2. Age Control and Limited-Life Products

Records will be kept on products having characteristics of degradation with use or age. Records will note date, when useful life was initiated, and date when life expires.

8.4.3. Inspection and Test Records

UCB will require where necessary that suppliers maintain inspection and test records. Records that are to be provided with the deliverable item will also be specified.

8.4.4. Purchase Order Review

All purchase orders for flight articles to verify the correctness of the purchase requirements and that all applicable QA requirements have been included.

8.4.5. Re-submission of Non-conforming Articles or Materials

If an article is deemed non-conforming by the contractor and returned to the supplier, the supplier will resubmit the article with evidence showing the article has been corrected, and with markings which clearly indicate that it is a "re-submitted part." Non-conforming items shall be handled by the process described in section 8.8.

8.5. ***Receiving Inspection***

Upon receipt, all purchased products will undergo an inspection that includes:

1) Verification that documentation meets the requirements of the Purchase Order.
2) Verification that parts marking and packaging is consistent with the requirements of the Purchase Order.
3) Verification of correct parts count.

Parts will be handled in accordance with the UCB Space Physics Research Group ESD control plan (or equivalent contractor's plan), then bagged, marked, and placed into bonded flight stores. Records shall be maintained for the life of the mission.

8.6. ***Fabrication Control***

8.6.1. Manufacturing Certification Log

A Certification Log will be established for each manufactured component which will travel with the item through fabrication and inspection. Operations will be done per referenced documents, or documented directly in the log book. Torque values, part serial numbers, etc. will be noted, and all entries will be signed and dated by the operator. Entries will include results of in process testing.

8.6.2. Workmanship

The following NASA workmanship standards shall be used in the fabrication of the IMPACT flight hardware:

Soldering - NASA STD-8739.3, NASA STD-8739.2
Cable, Harness, and Wiring Interconnections - NASA-STD-8739.4
Conformal Coating and Staking - NASA-STD-8739.1

8.6.2.1 Worker Certification

All flight segment soldering, wiring, and conformal coating/staking will be by technicians certified and trained as required.

8.6.3. Process Control

Appropriate controls will be implemented for processes for which uniform high quality cannot be ensured by inspection alone.

8.7. *ESD Control*

ESD control will be accomplished by the techniques and process controls described in the UCB Space Physics Group Electrostatic Discharge Control Plan, Revision B, dated May 1990.

8.8. *Non-conformance Control*

The PI will perform non-conformance control for failures and discrepancies. (A failure is a non-conformance discovered in testing, while a discrepancy is a non-conformance discovered at other times) The PI will track non-conformances with a Non-conformance Report that includes the following information:

1) A description of the non-conformance,
2) Analyses to determine the fundamental cause and any impacts to the rest of the flight instrument,
3) Remedial action to be taken,
4) Verification of the removal of the non-conformance, and
5) Disposition of the non-conforming item.

Status of all failures and discrepancies shall be included in the monthly Technical Report to Project.

8.8.1. Discrepancies

8.8.1.1 Documentation.

Documentation of discrepancies will begin with receipt of procured materials or fabrication.

8.8.1.2 Initial Review Dispositions.

Discrepant products will be reviewed by engineering personnel to decide if they should be (a) returned for rework, (b) scrapped, (c) returned to supplier, or (d) submitted for MRB action. Initial reviews will be documented as described above.

8.8.1.3 Material Review Board.

The PI will designate an MRB to review all non-conformances, chaired by the IMPACT Project Manager. Project shall designate a voting member of the IMPACT MRB.

The MRB will: determine dispositions, ensure remedial and preventive actions; verify implementation of all dispositions; and ensure accurate records are maintained. MRB dispositions will specify one of the following:

1) Repair: The MRB will approve repairs. Although standard repair procedures may be approved on a one-time basis, the MRB will track the number of standard repairs on a per unit basis to ensure that reliability or quality are not compromised by excessive repairs.
2) Use-as-is.
3) Waiver: To use or accept hardware at the spacecraft interfaces which does not meet contract requirements; this action will require GSFC Approval prior to implementation.

8.8.2. Failures

8.8.2.1 Reporting

A failure report will be written for failures that affect the function of the flight segment or could compromise mission objectives. Other issues shall be recorded in the traveler. Reporting will begin with the first functional test of the fully assembled component and will continue through the flight segment. All such shall be reported to the STEREO Project within one business day, with preliminary documentation provided within five business days. A sample Problem Report form is shown:

PR-040 ADP SAS ACS Data Incorrect

Assembly : IDPU	**SubAssembly :** ADP
Component : FSW	
Originator: D. Curtis	**Organization:** UCB
Phone : 510-642-5998	**Email :** dwc@ssl.berkeley.edu

Problem Occurred During (Check all that apply √)

Functional test	Qualification test	√ S/C Integration	Launch operations

Environment when problem occurred:

√ Ambient	Post Vibration	Shock	Acoustic
Vacuum	Thermal-Vacuum	EMI/EMC	

Problem Description

During testing of the ADP on the spacecraft, the SAS simulators were connected and operated to determine the ACS backup data sent from the IDPU to the spacecraft SEM. We expected to see a four second series of calculations, but saw a fixed pattern that repeated each .25 seconds.

Analyses Performed to Determine Cause

Removed the SAS Simulators and found that the programming PROM and Actels were not compatible. The units were, in fact, generating a pattern as described by the SAS ACS data.

.

Corrective Action/ Resolution

Load new version of ADP software 2-17-00. Verified correct SAS ACS data during IDPU level testing.

Distribution: Ron Jackson, Peter Harvey, David Curtis, Aliko

8.8.2.2 Failure Review Board.

The PI will designate an FRB to review each failure, chaired by the IMPACT Project Manager. Project shall designate a voting member of the IMPACT FRB.

The FRB will: determine dispositions, ensure remedial and preventive actions; verify implementation of all dispositions; and ensure accurate records are maintained. FRB dispositions will specify one of the following:

1) Repair: The FRB will approve repairs. Although standard repair procedures may be approved on a one-time basis, the FRB will track the number of standard repairs on a per unit basis to ensure that reliability or quality are not compromised by excessive repairs.
2) Use-as-is.
3) Waiver: To use or accept hardware at the spacecraft interface which does not meet contract requirements; this action will require GSFC Approval prior to implementation.

Failures shall be documented on the Problem Report form, which shall also document any diagnostic and analysis data, plus the final resolution. This form shall be signed-off by the FRB (including GSFC representative) for closure. Any level 1 failures shall be referred to the Project CCB for final disposition.

8.8.3. Alert Information

The PI will support the Alert program by determining the relevance of each Alert submitted to UCB. If action is required, the MRB will determine the approach to resolving the problem. Sections 5.6 and 6.3 discuss Alerts further.

8.9. *Inspections and Tests*

UCB will plan and implement an inspection and test program that will demonstrate that applicable requirements are met. Inspection and in process testing will be completed prior to installation into the next level of assembly

Verification of soldering to NASA STD-8739.3 and/or NASA STD-8739.2 (as applicable) will be done by NASA certified personnel other than the original operator.

The component responsible engineer will review the hardware and documentation package prior to certification of readiness for the next assembly process.

The responsible engineer will perform an end-item inspection on each component. It will be verified that the configuration is as specified in the released design documentation, that workmanship standards have been met, and that test results are acceptable.

8.9.1. Inspection and Test Records

Inspection and test records will be included in the manufacturing certification log for each deliverable component, to show that all manufacturing operations have been performed, the objectives met, and the end item fully verified.

8.9.2. Printed Wiring Boards Inspections and Tests

Printed wiring boards shall conform to the requirements of Mil-P-55110E, and shall be qualified by inspection and test results. PWB coupons shall be evaluated by GSFC or a GSFC approved laboratory for evaluation and approval prior to loading with flight parts.

8.10. *Metrology*

Verification of the accuracy of test equipment to the necessary levels during testing and calibration of the flight instrument will be done by a combination of calibration by outside vendors (traceable to NIST) and cross-checking of one unit against another. Equipment that has been calibrated shall have a label indicating the calibration date and how long that calibration is good for. The engineer making a measurement is responsible for ensuring that the calibration is current when a calibrated measurement is required. Any measurement that relates to the verification of performance, requirements, or calibration of the instrument should be made with calibrated equipment.

8.11. *Handling, Storage, Marking, Shipping, Preservation, Labeling, and Packaging*

8.11.1.Handling

No handling equipment is planned for the IMPACT project. In the event that a need for such equipment is identified, appropriate proof testing will be performed prior to use.

8.11.2.Shipping

Shipping of the flight units or components will be done with the appropriate accompanying documentation and handling instructions.

8.12. *Government Property Control*

UCB and its subcontractors shall be responsible for and will account for all property procured under the contract or provided by the government. The University property control system and standard government property transfer forms will be used to accomplish this.

8.13. *End Item Acceptance*

Prior to shipment of the IMPACT Instrument suite, the Acceptance Data Package (as called out in the IMPACT Statement of Work, item 6002) will be assembled by the Project Manager and reviewed by Project or its designee at the Pre-ship review.

8.14. *Ground Support Equipment*

That part of the Mechanical and Electrical Ground Support Equipment that directly interfaces with the flight hardware shall be of flight quality, and shall be subject to a subset of these Quality Assurance

standards, such as Metrology, Non-conformance Control, Workmanship, Configuration Management, and Contamination Control as required. The quality level of all GSE shall be sufficient to ensure that the flight hardware connected to it is not compromised, and the operations performed with the GSE are consistent, correct, and safe.

9. CONTAMINATION CONTROL

9.1. *Project Requirements*

The IMPACT Instrument suite shall be built to meet the Project contamination control requirements as specified in 7381-9040b. In addition, IMPACT instrument contamination concerns are addressed here.

9.2. *IMPACT Concerns*

The STEREO IMPACT instruments contain contamination sensitive detectors (Microchannel Plate detectors and Solid State Detectors). The detectors are sensitive to dust, water, and most aromatic hydrocarbons. Some analyzers contain high voltages (up to 3500V). In addition, some surfaces such as radiators shall be contamination sensitive.

9.3. *Control Plan*

The instrument shall be fabricated from low-outgassing materials as discussed in section 6.1.6 of this PAIP to minimize contamination of itself or other instruments.

For the detectors, rather than impose a requirement on surface contamination, we rely on proven procedures. Measuring contamination buildup is very difficult since many of these detectors are buried deep in the analyzers. The procedures used have proven to be adequate on numerous previous missions.

The detectors are stored, handled, and installed into the flight instruments in appropriately clean environments (typically class 100 clean benches or storage containers) by experienced technicians. Flight parts and GSE used in the vicinity of sensitive detectors shall be thoroughly cleaned prior to use. In some cases, bakeout of subassemblies shall occur prior to integration of temperature and contamination sensitive parts to avoid cross-contamination or excessively long bakeouts at low relatively temperature.

Once installed into the flight hardware, the detectors are sealed behind covers with positive flow of high grade dry Nitrogen to prevent contamination. In this configuration, good housekeeping cleanliness levels (or bagging) are adequate to maintain the cleanliness of the exterior of the instrument. Prior to delivery to spacecraft integration, the exterior of the instrument shall be cleaned to meet the spacecraft-level cleanliness requirements. A bakeout (as called out in 7381-9040b), will be included as part of the subassembly thermal vacuum tests

GSE used in the vicinity of flight detectors shall be class 100 clean room compatible, and shall be thoroughly cleaned prior to use. Once the detectors are sealed into the flight unit, only good housekeeping requirements are placed on the GSE until such time as the instrument is cleaned for integration into the spacecraft.

Following cleaning and bakeout of the instruments for integration with the spacecraft, the instrument and GSE that must be used near the instrument must be maintained at adequate cleanliness levels per the Project Contamination Control Plan. This will be achieved using clean rooms and/or bagging.

9.4. *IMPACT Requirements on Spacecraft I&T and Operations*

Nitrogen purge shall be maintained on a near-continuous basis throughout I&T, at least up to encapsulation. Occasional outages in the Nitrogen flow can be tolerated for a few hours.

For tests that require the removal of the aperture covers, exposing the detectors, the instrument should be bagged or otherwise maintained in a class 100,000 environment or better, and Nitrogen flow should be continuous. Such exposures should be limited in duration to a few hours total. Alternatively, longer duration at a better cleanliness level can be tolerated.

Some of the solid state detectors will be cold in space, and so present an enhanced contamination problem due to condensation (especially STE). In some cases, where the detectors are exposed and cold (STE), reclosable covers have been provided so that the detectors will not be exposed during thruster firings.

Some of the analyzers contain high voltages (up to 3500V). These supplies can only be turned on in a good vacuum to avoid arcing. This implies outgassing requirements, thermal vacuum test requirements, and possibly powering off some of the supplies for thruster firings. Normal spacecraft materials requirements plus a 24 hour outgassing interval before powering up the supplies should be sufficient.

10. SOFTWARE ASSURANCE

10.1. *General*

The Space Physics Group at the UCB Space Sciences Laboratory has had considerable experience in the development of real time processor-based systems for spaceflight use (including the first microprocessor system flown on a NASA satellite - ISEE-1) and computer-based ground support equipment. The group currently includes persons of considerable ability and experience in the software area. The group has developed approximately 25 such systems over the past 15 years, all of which have been delivered on schedule and have been completely successful.

It is our intent to use the same type of organization and development procedures and coding practices on IMPACT that has proven to be successful on past programs.

Flight Software is the instrument computer code that runs in the micro processor(s) which are a part of the flight experiment package. Only Flight Software is covered by this document. GSE software shall be developed using reasonable practices, and shall only be controlled to the extent that critical GSE used for acceptance tests at the system level shall be under configuration control starting at the beginning of system-level testing.

10.2. *Software Development*

IMPACT software development includes the following subsystems:

- IDPU flight processor (UCB)
- SEP common electronics flight processor(s) (Caltech/GSFC)
- Instrument Command and Display GSE software (UCB)
- Science Display GSE Software (Caltech, UCB, UNH)
- Subsystem-level test GSE software (various)
- Mission Operations Software (UCB)

Software will be by a small team of programmers (typically one per subsystem). Control is maintained by the programmer for a subsystem, who is responsible for maintaining the code and incorporating all changes at a single location throughout its lifecycle.

More details of the software development can be found in the IMPACT Software Development Plans.

10.3. *Documentation*

The instrument software will be documented at a minimum by the following:

Software Development Plan	Describes the flight software development plan as called out in the IMPACT contract deliverables list.
Software Requirements:	Describes the functional requirements on the software to a level sufficient for a programmer to implement.

Software Users Guide:	Describes the software at the interface level for the end user (scientists, operations personnel and ground software programmers).
Software History Log:	This log will include all PFRs (with dispositions), results of acceptance testing, and detailed descriptions of any modifications made by uplinked code after launch. This is the programmers log book.

The Software Development Plan and Software requirements may be combined. Separate plans and requirements may be developed for each separate subsystem, or they may be combined.

The subsystem programmer will be responsible for developing these documents and maintaining configuration control over them. This control will consist of reviewing and implementing any document changes, maintaining a revision code on all document updates, and distributing the documents for review to interested parties.

Software with a long life cycle (Flight software and some GSE software) shall also have sufficient design documentation to allow a new programmer to maintain and update the software if required.

10.4. *Software Design Reviews*

Software specific reviews (as negotiated with Project) include:

- Software Requirements Review (which shall also cover the preliminary software design). This shall be an internal review with Project participation.
- Software Design Review (part of the formal instrument CDR)
- Critical Software Code Walkthrough (this is an internal review with Project participation)

10.5. *Configuration Management*

Configuration control on the software will be performed by the subsystem programmer, and any change requests or bug reports will be communicated to him. Version numbers will be assigned and maintained by the subsystem programmer.

Prior to the beginning of acceptance testing, when the code is complete and ready to test, additional controls will be put in place. Any failures or change requests will be made to the subsystem programmer via the Problem/Failure Report system. The subsystem programmer will verify the problem and determine the cause. If the problem can be fixed without impacting the functionality of the rest of the code and does not have a serious schedule impact, he will proceed with the fix, and distribute a new revision of the code for further tests. Any instrument S/W modifications, no matter how seemingly minor, will be verified by a complete S/W acceptance test. Problems with greater impact will be submitted to a review board consisting of at least the subsystem programmer, the Instrument Project Manager, and the PI. The subsystem programmer shall maintain a logbook of all software PFRs.

When all PFRs have been dispositioned and the final version of the code has completed acceptance testing, the code will be committed to the flight PROMs and installed into the flight hardware. From this

point on, all change requests or problem resolution will be made via the FRB/MRB mechanism described in section 8 of this PAIP. If a change is approved, the subsystem programmer will implement the fix and issue a new release. The new release will be submitted to a full acceptance before again committing to PROM. No software will be used with flight hardware unless it in a known documented and verified state.

Any code to be uplinked after launch will be submitted to the same level of configuration control as was levied on the final version of the flight code, including detailed acceptance testing on breadboards prior to uplinking the code. Any significant code uplink will be accompanied by a change in the code version number which is included in the instrument housekeeping, so that ground data processing software can determine what version of the software is running.

At all stages of the software development, a system of backups will be maintained to ensure that the failure of a system or media will not destroy more than 1 day's work. In addition, a backup copy will be maintained off-site, updated periodically.

Appendix A - APPLICABLE DOCUMENTS

The following documents shall be applicable to this PAIP to the extent referenced herein.

Document No.	Title
GEVS-SE	General Environmental Verification Specification for STS & ELV Payloads, Subsystems, and Components, rev A, dated June 1996
EWR 127-1	Range Safety Requirements Eastern and Western Range
GSFC 311-INST-001	Instructions for EEE Parts Selection, Screening, and Qualification
GSFC PPL-21 Notice 1	Preferred parts list
MIL-STD-975 (NASA)	NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List
MSFC-SPEC-522B	Design Criteria for Controlling Stress Corrosion Cracking
ASTM E-595	Standard Test Method for Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from Outgassing in a Vacuum Environment (Re-approved 1999)
460-PG-1410.2.1B	STP Program Configuration management Procedure
IMPACTCMPlan_B	STEREO IMPACT Configuration Management Plan
7381-9040	STEREO Contamination Control Plan (APL document)
7381-9003	STEREO Environment Definition, Observatory, Component and Instrument Test Requirements Document
IMPACTEnvTestPlan	IMPACT Environmental Test Plan
541-PG-8072.1.2	Goddard Space Flight Center Fastener Integrity Requirements
NASA STD-8739.2	Requirements for Surface Mount Soldering
NASA STD-8739.3	Requirements for Soldered Electrical Connections
NASA STD-8739.4	Requirements for Interconnecting Cables, Harnesses, and Wiring
NASA STD-8739.1	Requirements for Conformal Coating and Staking of Printed Wiring Boards and Electronic Assemblies
NHB 5300.4 (3K)	Design Requirements for Rigid Printed Wiring Boards and Assemblies
NASA STD S-312-003 Rev B.	Design Requirements for Rigid Printed Wiring Boards and Assemblies
-	UCB Space Physics Group Electrostatic Discharge Control Plan, Revision B, dated May 1990.
MIL-P-55110 Rev E	General Specification for Printed Wiring Boards
IDPU_SDP_A	IMPACT IDPU Software Development Plan

Appendix B - Foreign Co-I Performance Assurance Plans

B.1 Product Assurance for SEPT Development at ESTEC

ESTEC document STEREO-ETKI-001.0 describes the Quality Assurance Plan to be used at ESTEC for STEREO IMPACT SEPT instrument development. That document is included in this appendix.

STEREO IMPACT/SEPT ELECTRONICS

PRODUCT ASSURANCE PLAN

Prepared by:

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DOCUMENT CHANGE LOG

Issue	Revision date	Pages deleted	Pages modified/ added	Comment	Changed by
1			All	First draft	BJ
	28 July 2002		All	Second draft. GSFC and UCB comments included	BJ

Table of Contents

1 INTRODUCTION

1.1 General

This Product Assurance Plan defines the policy, methods and procedures by which PA activities shall be carried out for the SEPT electronics activities at SCI-ST during FM/FS phase. The plan is based on requirements from ECSS and ESA/PSS standards (listed in applicable and reference documents). The specific requirements have been tailored to suit the specific SEPT electronics stringent demands for mass, power consumption, available budget and time constraints for the SEPT electronics project.

The H/W developed and supplied by RSSD consist of two densely packed PCBs, mainly populated with surface mounted components. The front-end charge amplifier is a full custom ASIC while the control of the instrument is performed by a FPGA. Delivery of fully assembled and tested PCBs will be to PI institute for further integration and environmental tests.

The detectors for SEPT and box/mechanisms are supplied by the PI institute while commanding and power is the responsibility of SEP central electronics.

1.2 Scope

This PA plan in its entirety is applicable to the FM and FS models of the SEPT/SEP/IMPACT electronics for the STEREO mission.

1.3 List of applicable documents

AD 1 ESA/PSS-01-301, iss. 2, April 1992.

1.4 List of reference documents

RD 1: ECSS-Q-70-08A

RD 2: ESA/PSS-01-738

RD 3: STERO IMPACT Performance assurance implementation plan, rev. E 2/4-2002

The ESA QPL and PPL are available at https://escies.org/public

The ESA/SCC documents are available at https://escies.org/public/scc/ref001/scc03.html

The ECSS documents may be available at http://www.ecss.nl

1.5 Abbreviations

AD	Applicable Document
ADP	Acceptance Data Package
ASIC	Application Specific Integrated Circuit
ATOX	Atomic oxygen
CMOS	Complementary Metal-Oxygen-Silicon
DPA	Destructive Physical Analysis
ECSS	European cooperation for space standardisation
ESA/PSS	European Space Agency Product Assurance and Safety Standards
ESD	Electrostatic Discharge
FISG	Flight Instrument Support Group
FM	Flight Model
FPGA	Field Programmable Gate Array
FS	Flight Spare model
H/W	Hardware
IMPACT	In-situ measurements of Particles and CME Transients
LET	Linear Energy Transfer
NCR	Non-conformance report
PA	Product Assurance
PCB	Printed circuit board
PI	Principle Investigator
PIND	Particle Impact Noise Detection
PPL	Preferred Parts List
QA	Quality Assurance
QPL	Qualified Parts List
RSSD	Research and Scientific Support Department
SCI-ST	Scientific Department, Payload and Technology Division
SEE	Single Event Effect
SEL	Single Event Latch-up
SEP	Solar Energy Package
SEPT	Solar Energy Particle Telescope
SET	Single Event Transients

TID	Total Ionising Dose
UCB	University of California at Berkeley
UV	Ultra Violet
PMP	Mechanical parts, Materials and Processes

2 PRODUCT ASSURANCE MANAGEMENT

2.1 Organisation of the Project Product Assurance

For the management of PA activities for this project, a nominated PA manager will be responsible. The PA manager will be supported in his activities by technical specialists from ESTEC Technical and Operations Directorate in the following areas:

- EEE parts selection, testing, inspection and failure analyses
- Materials selection and testing
- Mechanical parts selection and testing
- Metrology and interface verification
- Inspections

The PA manager is part of the project team and contacts directly the SEPT project manager for the conduct of the PA program. In case of conflict, the PA manager will report to SCI-ST Division Head. The PA manager will have sufficient authority for ensuring immediate attention to any situation that appears to bring into risk the achievement of the objectives and requirements of the project.

With the small technical team available within SCI-ST for this project, the PA responsibility will initially be handled by the Head of the Flight Instrument Support Group who also is responsible for component selection, procurement, inspections and processes.

PA supervision/control/inspection/documentation activities during all phases of the project shall not necessarily be performed by PA responsible but can also be performed by respective project team member (e.g. engineering, integration or test staff) if delegated by the PA responsible. The delegation of such activities is decided based on the criticality of the activity.

2.2 Right of access

PI or duly delegated representative(s) are permitted to witness or inspect any operation or document associated with this project and will be admitted to SCI-ST SEPT facilities or meetings after announcing attendance at least one week in advance.

2.3 PA reporting

The PA responsible will report to the SEPT project manager

- activities performed and planned
- problems and their status
- list of NCR's generated
- PA documents

3 QUALITY ASSURANCE

3.1 Documentation

All documents produced in this project will be clearly identified by unique reference, revision number and date. A master document list is maintained and kept under configuration control by the project manager.

3.2 Quality records

SCI-ST maintains a system of manufacturing, inspection and test control documentation sufficient to establish traceability, configuration and inspection status and to provide permanent record of events through to final acceptance, including closure of all non-conformance remedial actions. The quality records may be inspected by the PI at SCI-ST SEPT facilities.

A logbook covering details of all activities of the SEPT electronics will be established starting at acceptance testing of the SEPT electronics. The logbook shall be kept current by PA and operational personnel in charge. The logbook shall accompany the equipment and one copy shall be included in the ADP.

3.3 Traceability

Through quality records, full traceability will be guaranteed with regard to

- PCB revision and serial number
- Traceability of all parts to date code and lot code (where available)
- Serial numbers of parts under export license control
- FPGA program revision number and serial number

3.4 Metrology and Calibration

Only well maintained and calibrated test equipment will be used for acceptance testing and interface verification.

3.5 QA for design and verification

- Standard derating rules apply as per AD 1.
- A design review/manufacturing readiness review will be held prior to start of FM/FS manufacturing with PA responsible present.
- PA will review all certificates, incoming inspections, interface verification and acceptance test documentation.

3.6 QA for procurement

- PA responsible will verify orders, certificates, associated test data and incoming inspection for correctness.
- Any failed or non-conforming part identified will be placed in quarantine store and a NCR will be generated.
- Necessary tests not carried out by a supplier will be performed by project (e.g. radiation tests).
- Mechanical parts supplied by PI institute will not be tested; the incoming inspection is limited to verify the completeness of delivery and visual inspection to verify the integrity after transportation.

3.7 QA for manufacturing, assembly and integration

Prior to manufacturing, an internal SCI-ST project Manufacturing Readiness Review will be performed with PA responsible present.

- Hand soldering of electronic components to PCBs will be done according to workmanship standards in RD 1 and RD2. All soldering and visual inspection tasks are performed by personnel certified to RD1 and RD 2.
- Shop travellers will accompany each PCB during manufacturing.
- Passive parts are individually measured and values logged prior to soldering.
- Cleaning of assembled PCBs is performed in Iso-Propanol.
- Visual inspection is performed by PA prior to drying and coating.
- Coating (12-14 um Parylene-C) is done after drying cleaned, inspected and masked PCB for 12 hours at 60° C under <3 mtorr. This conformal coating will also serve as humidity barrier.
- Out-going visual inspection is performed by PA prior to packing and shipping.
- Assembly and integration into box of assembled PCBs is currently planned to be performed at PI institute and hence not covered by this PA plan.

3.8 QA for testing

PA will perform a cost effective test surveillance to assure correct testing, proper documentation, timely and adequate disposition in case of non-conformances, traceability and identification for qualification and acceptance tests. In particular, PA will be responsible for:

- Determine readiness and approve test documentation, test equipment and test object
- Check cleanliness of test facility
- Check calibration status of measuring equipment
- Check test schedule and manpower planning
- evaluation of test results (quick check)
- test witnessing (critical and most important event of test only)
- non-conformance reporting if applicable.

3.9 QA for acceptance and delivery

An acceptance test will be performed for each unit (two PCBs) before delivery to PI institute. Prior to the acceptance test, a test readiness review meeting will be held at ESTEC with PA presence.

PA shall witness the acceptance tests of all units; test witnessing tasks may be delegated to engineering staff.

Test procedure and associated equipment consisting of interface equipment, cabling, computer and associated test S/W shall be documented and held under configuration control.

3.10 Handling, storage, preservation, marking, labelling, packing and shipping control

PA will establish, in close co-operation with engineering and relevant service departments, requirements for proper handling, storage, preservation, marking, labelling, packing and shipping control. No dedicated procedure for handling and storage will be established.

- Handling of partially manufactured items will take place in FISG clean room or at assembly sub-contractor clean room facility.
- Handling critical to cleanliness will be done in Class 100 or better ESD protected flow bench.
- All handling will be done on ESD protected area with personnel wearing gloves and wrist strap.
- Storage of parts is in SCI-ST FISG high-rel component stock (ESD, temperature and humidity controlled clean room, typically class 30,000) or N2 flushed cabinets. The parts are kept in original packing until assembly. The FISG clean room has full electronic access control (access restricted to three SCI-ST staff) within the ESTEC access controlled perimeter. Parts under export license control are kept in locked storage in FISG clean room.
- All marking on FM/FS items will be of low out gassing, UV and ATOX resistent and large temperature range material.
- All packing will be done in FISG clean room in sealed ESD dissipative bags. Humidity absorbing Silica will not be used with coated items.

3.11 Non-conformance control

A non-conformance shall be a condition of any article or service in which one or more characteristics do not conform to requirements. NCR reporting will start at unit level testing of the FM/FS.

The SCI-ST SEPT project will establish and maintain a closed-loop non-conforming article and material control system for identification, documentation, review and control of non-conforming articles and materials during manufacturing and tests. The NCR system will be applied to all non-conforming articles like qualification H/W, deliverable flight H/W and S/W and acceptance test equipment (H/W and S/W).

The action to be undertaken with the non-conforming article depend on the nature of the non-conformance. The classification of non-conformances in this project will be:

- Major: non-conformances affecting the interfaces, decreasing the system performance, limiting the lifetime of the unit or major schedule impact.
- Minor: Any non-conformances without impacting areas as specified above.

The handling of non-conformances will follow the steps:

- Classification (SCI-ST SEPT PA responsible)
- Recommendation for disposition and corrective action (SCI-ST SEPT team)
- Approval of disposition and corrective action (SCI-ST SEPT project manager and PA responsible in case of Minor, PI in case of Major)
- Validation of corrective action (SCI-ST SEPT team)
- Close out (PA responsible)

Non-conformances affecting interfaces or performance will follow an approval/information matrix according to Appendix A.

An example of NCR form can be found in Appendix B.

4 DEPENDABILITY

- No dedicated FMECA will be generated for the units delivered by SCI-ST. IMPACT system level FMECA will be supported for electrical interfaces.

5 EEE PARTS

5.1 Introduction

The SEPT electronics has as a main component a full custom CMOS ASIC that perform the conversion from charge released in the solid state particle detectors to a digital output. The Particle Detection Front End (PDFE) ASIC has as one of the first ever single chip solutions integrated both analog and digital functionality for particle detection to reduce the necessary electronics volume significantly. The available mass and power for the SEPT instrument represent a several fold reduction to comparable instruments.

To realise the functionality required of the instrument, the design requires use of latest technology miniaturised parts where the packaging and qualification status not yet have matured into the high reliability market. Hence, to gain confidence in the overall reliability of the SEPT electronics, a review of complementary parts screening, testing approach and the manufacturing process have been required. We believe that the approach we will take for the SEPT electronics will minimise the development risks while building confidence of reliable in-orbit operation for the lifetime of the instrument.

5.2 Procurement policy, tasks and responsibilities

Parts procurement will be done by PA responsible in close collaboration with engineers in the SEPT SCI-ST team responsible for the design based on the specifications and quality levels as defined below. We will procure either directly from the manufacturer or local representative thereof or through parts procurement agent specialised in high reliability parts procurement.

Where parts are procured without recognised high reliability screening, a limited up-screening activity will also be ordered.

PIND testing on parts with a cavity will either be performed by manufacturer, laboratory performing up-screening or by ESTEC QA staff (standard PIND test equipment exist on ESTEC).

Parts without high-reliability screening will be procured with large amount of spares to allow testing on significant sample size. Additionally, a back-up part with identical or better performance and functionality will be procured to reduce development risk. Traceability will be to manufacturer original bulk package.

The PDFE ASIC procurement will be specially monitored by PA responsible and will involve the designing institute (IMEC, Belgium), Si wafer manufacturing plant (0.7 um Analog CMOS process, Alcatel, Belgium), packaging and test (TBD). A separate procurement document will be generated.

Analyses (e.g. DPA, failure analyses) will be performed by ESTEC QA department on parts on request by PA responsible.

Radiation testing (TID, SEE) will be performed on parts with unknown susceptibility to radiation induced degradation. Facility used will be ESTEC Co-60 source, ESTEC Cf-254 sources and/or Louvain la Neuf (B) Heavy ion particle accelerator.

PA responsible will review ESA alerts for relevant alerts to SEPT electronics.

A SEPT Electronics Parts Control Board will be established consisting of

- IMPACT Technical Manager (Chairman)
- IMPACT Parts Engineer at UCB
- SEPT Electronics Project Manager
- SEPT Electronics PA
- STEREO Parts Engineer at NASA/GSFC

The Parts Control Board will identify and review critical SEPT components and associated parts screening and qualification requirements. Any proposed changes to parts requirements as specified in RD3 shall be reviewed by the board. The board will convene in a telephone conference on request by the Lead Parts Engineer at UCB.

Decisions by the Parts Control Board shall be reached in consensus and documented. In cases where no consensus can be reached, the issue will be forwarded to SEPT PI for further disposition with IMPACT Project Manager and STEREO project.

5.3 Component quality

The SEPT electronics procurement will strive to reach a verified high and balanced quality for all parts used (see table below).

5.4 Component and manufacturer selection

Where available, components will be selected from ESA or NASA QPL or PPL. However, several components are not available that meet packaging density requirements for the SEPT electronics and the front-end ASIC (given) is not on any QPL or PPL. Hence, our approach is in order or preference to select according to table below. In addition, fully assembled sample PCBs will be subjected to extended thermal cycling (TBD procedure) to verify unit reliability.

Family	First choice	Second choice	Third choice
Integrated circuits	SCC 9000, level C MIL-I-38535, classes Q or 883 class B (PIND if package cavity)	Hermetic package, -55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, PIND if package cavity, hermeticity	Non-hermetic package, large volume major manufacturer, extended temperature range, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test
Transistors, diodes	SCC 5000, level C MIL-S-19500, JANTXV	Hermetic package, -55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, PIND, hermeticity	Non-hermetic package, large volume major manufacturer, extended temperature range, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test
Ceramic chip capacitors	SCC 3001, level C MIL-C-55681, level R	-55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, hermeticity	Extended temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test
Tantalum capacitors	SCC 3011, level C MIL-PRF-55365, level R (Optional surge current test will be included if not performed in standard flow by Manufacturer)	-55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, hermeticity, Surge	Extended temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, surge current test.

		current test	
Resistors (RM)	MIL-R-55342, level R	-55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, hermeticity	Extended temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test
Connectors	ESA/SCC level B MIL-PRF-83513	-55° to +125° C temperature range, large volume major manufacturer, max traceability	Extended temperature range, large volume major manufacturer, max traceability
Crystals	SCC 3501 level C MIL-PRF-3098H	Hermetic package, -55° to +125° C temperature range, large volume major manufacturer, max traceability, 100% 168 h burn-in at max temperature, 100% electrical test at min and max temperature, 20 pcs 1000 h/max temp life test, PIND, hermeticity	N/A
PDFE ASIC	Hermetic CQFP package, pre-cap inspection, 100% 168 h burn-in at +125 °C, 100 % electrical test at min and max temperature, 10 pcs 1000h/max temperature life test, PIND, hermeticity.		

All active parts shall be selected to withstand at least 8 kRad (expected mission total dose of SEPT electronics including radiation design margin of two).

All active parts shall be selected to be immune to SEL for a LET > 80 MeV/mg.cm2 or protected by verified current limiting circuit. Linear circuits (e.g. voltage regulators, voltage references, operational amplifiers) shall be filtered/buffered for low SET sensitivity.

5.5 Inspections

All parts are visually inspected at up-screening activities and before assembly for e.g. bent leads, cracks, chip-outs under 20x magnification.

Parts failing inspection will be transferred to quarantine store.

5.6 Declared components list

A declared components list (DCL) will be produced and kept under configuration control. The form can be found in Appendix C.

6 MATERIAL, MECHANICAL PARTS AND PROCESSES

6.1 Introduction

This section specifies the PMP program for the selection and control of mechanical parts, materials and processes for the SEPT electronics H/W. PA responsible will prepare PMP lists that will be kept under configuration control and will be kept compatible with latest valid configuration. The procurement control will be performed by review and purchase orders.

6.2 Materials

Materials will be selected based on following criteria:

- past performance on similar projects
- non-flammable/non-combustible
- Stress corrosion
- Chemical cleanliness
- Radiation resistance
- Out-gassing (TML<1%, CVCM<0.1%)
- Ageing
- Avoiding hazardous material

The Polyimide PCB will be procured from ESA qualified source (ESA PSS-01-710) and ordered to ESA CNES-QFT-SP 0117 and ESA CNES-QFT-SP 0119 specification. One test coupon will be delivered to UCB for further submittal for analysis funded by the STEREO project.

A Declared Materials List will be produced and kept under configuration control. An example can be found in Appendix D.

6.3 Mechanical parts

None for the SEPT electronics.

6.4 Processes

Processes used (e.g. soldering, cleaning and coating) will be adequately controlled by implementing procedures. These procedures will be approved by PA responsible prior to implementation for flight standard hardware production.

A Declared Processes list will be produced and kept under configuration control. An example can be found in Appendix E.

7 SOFTWARE

Not applicable, no flight S/W delivered.

8 CLEANLINESS AND CONTAMINATION CONTROL

RD3 para 9 apply.

9 APPENDICES

9.1 Appendix A, Approval/information matrix

Considering that the SEPT electronics:

- are delivered as part of the SEPT instrument without exchange of funding (RSSD internal research budget)
- have no electrical interface to S/C exist (only to SEP DPU and PSU)
- have neither mechanical nor thermal interface to S/C (integrated in SEPT box, SEPT PI responsibility)
- have no operations interface to S/C (through SEPT PI and IMPACT)
- scientific performance of SEPT is the responsibility of the SEPT PI

Class 1 changes definition and approval/information scheme for changes generated by SEPT electronics are reflected in table below:

Change	GSFC approval	GSFC info	UCB approval	UCB info	SEPT PI approval	SEPT PI info	SEPT electronics project manager approval	Comment
Cost							X	RSSD internal funding
Safety								N/A. No safety critical items in SEPT electronics
Memory (SEPT internal)						X	X	
Memory (IMPACT DPU)				X	X		X	Provided to PI to SEP DPU MM requirements
Purchases							X	RSSD internal funding
Facilities (SEPT electronics specific)						X	X	
Telemetry (SEPT specific)								N/A, ECR generated by SEPT PI
Interface (electrical)			X		X		X	
Interfaces (Thermal, mechanical)					X		X	
Other procurements							X	RSSD internal funding
Component Contracts							X	RSSD internal funding
Civil service manpower							X	RSSD internal funding
Qualification/Acceptance				X	X		X	SEPT electronics only prior to integration in SEPT.
Support service contract task							X	RSSD internal funding
Parts				X	X		X	Communicated in SEPT electronics controlled document (DCL) for inclusion in SEPT package.
Power					X		X	Provided to PI as

								input to total SEPT budget
Operations					X		X	Provided to PI for total SEPT operations
Materials				X	X		X	Communicated in controlled document (DML) for inclusion in SEPT package
Reliability					X		X	
Performance					X		X	
Mass properties					X		X	Provided to PI as input to total SEPT budget
Integration and test				X	X		X	Provided to PI for inclusion in SEPT package.
Transport operations						X	X	Transport from RSSD to PI for integration.
Launch site operations								N/A
Science Operations Centre								N/A
Mission Operations Centre								N/A
Procurement							X	RSSD internal funding.
Schedule				X	X		X	Provided to PI for total SEPT schedule

EXAMPLE

Non-Conformance Report

Title:		
Model: ☐ **EQM** ☐ **FM** ☐ **FS**	**Category:** ☐ **Minor** ☐ **Major** (To be filled out by SEPT PA responsible)	**Identifier:** **SEPT-RSSD-NCR-** (To be filled out by SEPT project manager)
Subsystem: ☐ **sub unit 1** ☐ **sub unit 2** ☐ **sub unit 3** ☐ **sub unit 4** ☐ **sub unit 5**	**Stage:** ☐ **Incoming inspection** ☐ **Mechanical integration** ☐ **Electrical integration** ☐ **Test** ☐ **Other**	

Affected item: Part number and serial number:		
Description:		
Originator:	**Place and Date:**	**Signature:**

APPENDIX A, Example of NCR form

EXAMPLE

Non-Conformance Report

Cause identification, corrective actions, due dates: *Corrective actions:* *Due date:*	
Close-out status:	**Approval** (Signature and date):

Appendix C, Example Declared Components List

Instrument/equipment: **Example** Circuits: **Example circuit, As built**					Prepared by: Date: Iss.:					
Item no.	Component / part number	Function; Application	Qty.	Industrial/ Commercial equivalent	Generic and detailed specification number or SMD	Manufacturer	Screening level	Radiation level [rad]	Datecode/ order	
1	HZ 2807 TF, 1.38kg/km, OD: 0.72 mm	+/- 5V supply wire	2 x 1m	AWG28	004-93301-287	Habia	ESA/SCC 3901	>10 Mrad (polyimide jacket)	2000/209151	
2	Coax 42 Ohm, 2.8 kg/km, OD: 1.1mm	Analog output wire	1m	-	004-93391-327	Habia	ESA/SCC 3902	>10 Mrad Tefzel jacket)	2000/209705	
3	Q1	Input JFET	1	2N4416	2N4416CSM-JQR-A	Semelab	JAN-TXV	>100K	9940	
4	Q2-Q4	NPN	3	2N2484	2N2484CSM-JQR-A	Semelab	JAN-TXV	>100K	9940	
5	R1, R6	1M	2		M55342K06B1F00S	SOTA	MIL-R-55342	N/A	9722J	

Declared Material List (DML)

Unit	Sub-Unit	Add. Info's	Ref.: / Issue: / Date: / Prepared by:
Example	Example subunit	As-built DML	Rev.: - / Page 1

Nr.	Qty	Commercial identification, date/lot code	Chem. Nature/ Type of Prod.	Manufacturer; procurement spec./standard	Processing Parameter	Application	Use Location	Env. Code R A T (1)	Outgassing or SCC-res., Data & Ref.	Size-Code (2)	Remarks
1	50 g	Torray M55J.6k.50 B	Carbon fibre	Torray Industries, JP (Soficar SA)		Helix and hoop layer fibre, cap	Boom	IL V T2-4		A3 W2	
2	0.5 g	CV-1152	Silicone conformal coating	NUSIL	RT cure	Humidity barrier CFRP-Al	Boom bracket	IS V T2-3		W0	
3	50g	Aluminium 6061-T651			Iridite surface treatment		Boom bracket, BM 2 accelerometer	IS V T2-3		W2	

Appendix D, Example Declared Materials List

Notes: (1) R (Radiation/UV/ATOX): I=Interplanetary inside, IS=Interplanetary outside shadow, IL=Interplanetary outside light
A (Ambiance): V=Vacuum, H=Hermetic, T(Temperature): 1=0-100K, 2=101-200K, 3=201-300K, 4=301-400K
(2) Size codes: A=Area [cm2], V=Volume [cm3], W=Mass [g], 0=0<1, 1=1<10, 2=10<100, 3=100<1000

Declared Processes List (DPL)

Unit	**Sub-Unit**	**Add. Info's**	**Ref.:**
Example	**Example subunit**	**As-built DPL**	**Issue:** **Rev.: -** **Date:** **Page** **Prepared by:**

Nr.	Process identification	Specification Issue/rev.	Process description	Use and location	Manufacturer name	Associated items in materials list	**Criticality of the process**	Justification for Approval
1	Composite manufacturing and adhesive bonding of SPEDE booms	Manufacturing data SPEDE booms 4-7 (ref. 20014-R02, S0101)	Filament winding of CFRP booms and adhesive bonding to mounting bracket. . During winding the resin is heated to 40^{o}C to reduce voids (<2%). Fibre volume fraction 0.6. Curing as specified while rotating the booms.	Externally mounted SMART-1/SPEDE booms	Advanced Lightweight Engineering, Delft, NL	1,2,4,5	Critical	N/A

Appendix E, Example Declared Processes List

Notes: (1) R (Radiation/UV/ATOX): I=Interplanetary inside, IS=Interplanetary outside shadow, IL=Interplanetary outside light
A (Ambiance): V=Vacuum, H=Hermetic, T(Temperature): 1=0-100K, 2=101-200K, 3=201-300K, 4=301-400K
(2) Size codes: A=Area [cm2], V=Volume [cm3], W=Mass [g], 0=0<1, 1=1<10, 2=10<100, 3=100<1000

B.2 Performance Assurance for SEPT Development at Keil

Performance Assurance Implementation Plan (PAIP)

for the STEREO IMPACT SEPT Sensors

1. This Appendix to the STEREO / IMPACT Product Assurance Plan shall cover the product assurance procedures and requirements for the SEPT sensor heads provided by the University of Kiel, Germany. The SEPT sensor heads will be integrated with the SEPT electronics provided by the Space Science Department of ESA, which will provide a separate product assurance plan statement.

2. Heritage

The SEPT sensors are based on sensors, instruments, and experiments built and managed by the University of Kiel Team for the international space science project ULYSSES (COSPIN / KET), SOHO (COSTEP Experiment), and CHANDRA (Radiation Monitor). No major problems were encountered during these projects in complying with the product assurance requirements both from the project offices and from the experiment management.

3. Product assurance statement from the University of Kiel IMPACT-SEPT Team.

The University of Kiel STEREO / IMPACT / SEPT Team will comply with all applicable requirements and procedures described in the STEREO / IMPACT Product Assurance Plan (PAIP), Revision D, November 26 2001. Procedures developed in previous projects will be used or updated to assure safety, quality, and reliability of parts, components, and items. The required documentation will be provided to support design, fabrication, and test control, reviews and acceptance/qualification. This will specifically include parts and material lists, thermal and structural analysis, contamination control, and configuration management.

4. Product Assurance Requirements imposed by the German Funding Agency DLR

No specific product assurance requirements are so far imposed by the German Funding Agency DLR nor have been imposed in previous projects. The application for funding sent to DLR provides for compliance with the product assurance implementation plan for the STEREO / IMPACT instrument suite The compliance with the above plan, however, is based upon the financial support and conditions imposed by DLR once the grants for STEREO / IMPACT / SEPT are provided.

B.3 Performance Assurance for SWEA Development at CESR

Document SWEA-AP-0044-CESR, dated 04/10/00 attached, with minor modifications on 2001-Oct-23 and 2002-Apr-2.

SWEA

PERFORMANCE ASSURANCE PLAN

Prepared by	F. COTIN	04/10/00	
Approved by	F. COTIN	04/10/00	

DOCUMENTATION CHANGE RECORD

Issue	Revision	Date	Modified Pages	Observations
Original	0	04/10/00		Creation of Doc ument
	0.1	10/23/01	8,	Minor Mods per C. Aoustin
	0.2	04/02/02	11	Mods per C. Aoustin ; meet or exceed PAIP requirements

TABLE OF CONTENTS

1 - INTRODUCTION

The CESR/Toulouse team has a long history of successful space flight instrumentation, with experiments on GIOTTO, MOM, MGS, Wind, Cluster and Cassini. This team has collaborated for most of these missions with the SSL Berkeley. The sharing of hardware and management responsibilities was very similar to what is being implemented on STEREO.

1-1 SCOPE

This document defines the performance assurance program to be used at CESR in the development of the SWEA (Solar Wind Electrostatic Analyzer) for the STEREO IMPACT INSTRUMENT SUITE. This plan is intended to :

- ensure that the SWEA will be compliant with its specifications and will have the applicable quality level.
- ensure that the SWEA will not have any detrimental effect on the IMPACT instrument or other elements of the STEREO spacecraft.

This plan is written in response to the draft STEREO Safety, Reliability and Quality Assurance requirements document (November 1999). It is intended to be in compliance with the principal features of the PAIP for the STEREO IMPACT INSTRUMENT SUITE (2000 - JUL.13). This plan is based on the CNES Management Instructions and on the ECSS and ESA PSS documents. The tailoring of these documents have been made taking into account that SWEA is a class 3 project in the CNES projects classification system and is developed by a small team in a University setting.

1-2 FIELD OF APPLICATION

This plan applies to the SWEA development items identified in the following table to the extent indicated. No delivered GSE items are currently planned.

PA REQUIREMENTS OF SWEA ASSURANCE PLAN	INSTRUMENT MODELS AND GSE

	MODELS	EM	FM (TWO UNITS)	SPARE SUBSYSTEMS	GSE
2	PRODUCT ASSURANCE	P (1)	A	A	P (2)
3	RELIABILITY AND SAFETY ASSURANCE	A	A	A	P (2)
4	QUALITY ASSURANCE				
4.1	DESIGN	A	A	A	N
4.2	PROCUREMENTS AND SUBCONTRACTS	P (3)	A	A	P (4)
4.3	MANUFACTURING	P (5)	A	A	P (4)
4.4	ASSEMBLY, INTEGRATION AND TESTS	P (5)	A	A	P (4)
4.5	GROUND SUPPORT EQUIPMENT	N	N	N	A
4.6	CLEANLINESS	A	A	A	P (4)
4.7	MARKING OF HARDWARE	A	A	A	P
4.8	HANDLING, STORAGE PACKAGING	A	A	A	P
4.9	DELIVERY DOCUMENTATION	P (5)	A	A	P
5	EEE COMPONENT	P (3)	A	A	N
6	MATERIALS, MECHANICAL, PROCESSES	P (6)	A	A	N

A : Applicable - P : partially - N : non applicable.
(1) Non-conformance reporting applicable on model starting of verification testing
(2) Applicable to element directly interfacing with flight hardware when an impact on the flight hardware is possible
(3) Selection of procurement sources is applicable
(4) Applicable for components coming into direct contact with flight hardware
(5) Applicable to all activities related to design verification.
(6) Process control applicable to EEE processes

1-3 APPLICABLE AND REFERENCE DOCUMENTS

This paragraph lists the documents which have been used to establish this PA plan or which contain useful supplementary information (i.e. recommended, not mandatory, methods).

AD 1.1A ECSS-Q-OOA Policy and Principles
AD 1.1B CNES DTS/AQ/QP 98-083 Guide pour les Projets Scientifiques

AD 2	ECSS-Q-20A Space Product Assurance, Quality Assurance
AD 3.1A	ECSS-Q-40A Safety.
AD 4.3B	ECSS-Q-70-08 A The Manual Soldering of High Reliability Electrical Connections
AD 4.3C	PSS-01-738 High Reliability Soldering for surface mount and mixed technology PCB's
AD 4.3D	PSS-01-726 The Crimping of High Reliability Electrical Connections
AD 4.6	PSS-01-201 Contamination and Cleanliness Control
AD 4.8	PSS-01-202 Preservation, Storage, Handling and Transportation of ESA Spacecraft and Associated Equipment
AD 4.10	PAIP for the STEREO IMPACT INSTRUMENT SUITE
AD 5.1	ECSS-Q-60A Electrical Electronic and Electromechanical Components
AD 5.3A	ESA SCC-QPL ESA/SCC Qualified Part List
AD 5.3B	CNES - QFT - IN - 500 CNES Preferred Part List
AD 5.3C	MIL-STD-975 NASA Standard EEE Part list
AD 5.4	NASA document 311 - INST - 001 Rev.A
AD 5.5	PSS-01-301 Derating Requirements and Application rules for Electronic Components
AD 5.8	MIL - HDBK - 263 Electrostatic Discharge Control for EEE parts
AD 6.1	ECSS-Q-70A Materials, Mechanical Parts and Processes
AD 6.2	PSS-01-701 Data for selection of space materials
AD 6.2A	PSS-01-736 Material Selection for Controlling Stress-corrosion Cracking
AD 6.2B	MSFC-HDBK-527 Material Selection List for Space Hardware Systems
AD 6-3A	MSFC-SPEC 522B Design Criteria for Handling Stress-corrosion Cracking
AD 6.3B	PSS-01-702 A Thermal Cycling Test for Screening of Space Materials and Processes
AD 6.3 F	NASA R.P. 1112 Outgassing Data for Selecting Spacecraft Materials
AD 6.5A	CNES-QFT-SP-0117 Qualification specification for multilayers regid printed circuit
AD 6.5B	CNES - QFT - SP - 0118 Qualification specification for flexible printed circuit

1-4 ACRONYMS

AD	Applicable Document
AIT	Assembly Integration and Tests
CIL	Critical Item List
CNES	Centre National d'Etudes Spatiales
ECSS	European Cooperation for Space Standardization
EEE	Electrical, Electronic, Electromechanical
EIDP	End Item Data Package
ESA	European Space Agency
ESD	Electro-Static Decharge
IMPACT	In-situ Measurements of Particles and CME Transients
MMP	Materials, Mechanical parts, Processes
MRB	Material Review Board
NC	Non Conformance

NEA	Non Explosive Actuator
PA	Product Assurance
PAIP	Performance Assurance Implementation Plan
PAM	Product Assurance Manager
PM	Project Manager
PSS	Product Specifications for Space
RFA	Request For Approval.
SSL	Space Science Laboratory
STEREO	Solar Terrestrial Relations Observatory
SWEA	Solar Wind Electrostatic Anlyzer
UCB	University of California, Berkeley
WCA	Worst Case Analysis

2 - PRODUCT ASSURANCE

2-1 PRODUCT ASSURANCE ORGANIZATION

Product assurance is organized within the project level and is therefore the responsability of the Project Manager, F. Cotin up to October 2001 and then C. Aoustin. He is assisted by J.L. Médale who has responsability for electronics and EEE parts and J. Rouzaud who is responsible for MMP quality assurance. Because of limited scope of the SWEA developement the part-time PA tasks are assigned to existing project engineering and management staff. In addition, the SWEA team will seek assistance of the CNES PA team as necessary.

2-2 INSTITUTE AND SUBCONTRACTORS PA PLAN

No major contracts are planned. However, Project Manager will assure that all vendors and subcontractors who supply hardware for SWEA will meet applicable PA/QA requirements. If radiation hardness testing are necessary, they will be performed at ONERA-DERST facilities in TOULOUSE **or HIREX Engineering, 117 rue de la Providence 31500 Toulouse** with assistance of a PA Parts engineer of CNES on request.
Printed circuits board fabrication will be done in accordance with flight quality standards.

2-3 RIGHT OF ACCESS

For the purpose of product assurance and technical co-ordination, UCB-SSL and STEREO Project Managements will have access, by appointment to SWEA related in house facilities documentation and records.

2-4 REVIEWS

Formal project reviews will be attended by lead Co-I and Project Manager and the relevant PA documentation will be prepared.
In addition, the PM will support instrument subsystem peer reviews as required.

2-5 QUALITY AUDITS

Work performed under our contract is subject to the audit activities of CNES. Audits may be financial or technical in nature. Within the SWEA project, the PA Manager (PAM) has the responsability for assuring that personnel involved with fabrication, inspection and assembly of flight hardware are following approved procedures and are in compliance with this plan.

2-6 DOCUMENTATION APPROVAL AND VERIFICATION

Internal approval shall be required and external approval by SSL solicited for critical documentation. Such documentation includes : interface and performances, specifications, qualification and test documentation.

2-7 RISK MANAGEMENT - CRITICAL ITEM LIST

Enhanced visibility for items which offer a significant development risk is provided through the establishment and maintenance of a Critical Item List (CIL).
The CIL will be maintained and coordinated with SSL PA Manager.
The CIL will include the following informations :

- ✓ identification of the critical item
- ✓ company or institute responsable for it
- ✓ type of criticality
- ✓ the degree of criticality (minor or major)
- ✓ thes risk reduction actions with associated planning
- ✓ the critical item status
- ✓ the associated documents references.

2-8 NON-CONFORMANCES MANAGEMENT

The SWEA team will incorporate a "closed loop" system for identificaiton, reporting, analysis, review, corrective action and prevention involving failures and discrepancies of flight hardware.

2-8-1 MATERIAL REVIEW BOARD ACTIONS AND REPORTING

An internal Material Review Board chaired by the PAM will determine classifications and dispositions.
Non cormances and action against, will be documented on serialized reporting forms and major non conformances reported to SSL within 2 working days. Non conformance reports will be available for review upon request.

2-8-2 NON CONFORMANCE LIST

An NCR list will be established and maintained. This list will provide the following categories of information :

- ✓ NCR number
- ✓ Item identification
- ✓ Responsible entity

- ✓ Title with description
- ✓ Analyses to determine the fundamental cause and any impacts to the rest of the flight instrument
- ✓ Classification
- ✓ Remedial action taken
- ✓ Verification of the removal of the non-conformance
- ✓ NCR Status.

2-8-3 ALERTS

All Alerts forwarded to the SWEA project office will be evaluated to assure that the problem is relevant or not on the SWEA. If action is required, the MRB will determine the approach to resolving the problem and will inform SSL in a timely manner.

2-9 CONFIGURATION CONTROL

Configuration control of SWEA flight hardware will be established and maintained to assure that :

- ✓ the definition of the products and changes made to them ar known at all times,
- ✓ the modifications and consequences have been identified and analyzed in a complete and detail manner by all concerned disciplines and entities,
- ✓ only those modifications approved by a designated authority are made to the affected products services or documentation.

2.10 TRACEABILITY

Measures for systematically identifying and documenting the products their componants and their historical record will be implemented for the SWEA. For hardware, this identificaiton will include batch number or item number as recorded on the traveler documentation. The travelers or logbooks will identify all operations performed on the products. A SWEA logbook will be delivered with each flight item as part of the delivery data package.

2-11 PROGRESS REPORT

Reporting on the progress and status of the PA program will be included in the regular monthly project reporting.

3 - RELIABILITY AND SAFETY ASSURANCE

The goal of Reliability and Safety Management is to ensure technical mission success, the preservation of human life and equipment, and to minimize personnel and equipment hazards and environmental impact.

3-1 RELIABILITY ASSURANCE

The SWEA will be designed such that no SWEA failure will propagate into the spacecraft or instrument subsystems. To meet this objective, a functional analysis and a EEE part derating analysis will be performed. No quantitative reliability analysis is planned.

3-1-1 WORST CASE ANALYSIS

A WCA will be performed only for critical electronic circuits (High Voltage Power Supplies) in order to demonstrate by test or analysis that end of life performances are insured.

3-2 SAFETY

3-2-1 GENERAL

In cooperation with UCB, the PM will identify and control hazards to personnel facilities, support equipment and the flight system during all stages of project development.

3-2-2 SYSTEM DESCRIPTION AND SAFETY ASSESSMENT

The only unusual identified hazards related to the SWEA instrument development and test are : High Voltage and Non Explosive Actuators (NEA). The instrument contains a number of high voltages supplies as high as 3400 V. There shall be no exposed high voltage. The supplies shall be resistively current limited on the output.
The instrument can be damaged by inadvertent operation of the supplies in air. Enable/Disable plugs will be need to prevent damage. Instrument shall contain an internal in-flight deployable cover using non-explosive actuator. As non exposed this actuator do not present a personnel hazard. Enable/Disable plugs will be used to prevent unintended actuation that might expose a detector to contamination.

3-2-3 SAFETY DATA PACKAGE

The PM shall provide input as required concerning the SWEA instrument and its related ground activities that impact safety.

4 - QUALITY ASSURANCE

In developing its instrumentation, CESR will use quality assurance techniques that meet or exceed the requirements of the STEREO IMAR and this PAIP.

4-1 DESIGN

4-1-1 TECHNICAL SPECIFICATIONS

The design of the SWEA shall proceed from mutual agreement between CESR and the IMPACT PI's on technical specifications documented by CESR and SSL. Functional analysis will be performed to clarify needs and avoid overspecification.

4-1-2 DESIGN VERIFICATION

Design verification matrice will be established for the SWEA. It includes the list of requirements of the technical specification and how compliance with them is verified. The matrice and results will be presented at each SWEA major review. Development risks may also be reduced through the use of informal validation testing on non-flight hardware.

4-1-3 QUALIFICATION

The flight SWEA and its components will be qualified for the STEREO mission according to the SWEA verification matrix. Qualification test results and lists such as the EEE components list, materials list, process list and mechanical parts list will be submitted to SSL and STEREO Project for approval. In order to minimize risks, evaluation tests may be performed prior to tests on some items.

4-2 PROCUREMENTS AND SUBCONTRACTS

4-2-1 SELECTION OF PROCUREMENT SOURCES

The SWEA team will select suppliers and contractors which have a demonstrated capability of supplying the item or service with the required properties and quality level. In the case of uncertainties regarding this capability, an evaluation audit will be performed.

4-2-2 PROCUREMENT DOCUMENTS

The SWEA PA manager will assure that procurement documents will include appropriate quality, reliability and safety requirements. For raw materials exceptions shall be approved by the project manager based on the evidence of acceptability of the material for intended use. Records will be kept on products having characteristics of degradation with use or age. Records will note date, when useful life was initiated and date when life expires.

4-2-3 INCOMING INSPECTIONS

All incoming flight articles will be subjected to two incoming inspections. First a receiving inspection is performed for any indication of external damage to shipping and packaging materials. Second a detailed inspection is performed by SWEA project personnel to verify the received documentation and product are as specified.

4-3 MANUFACTURING

4-3-1 MANUFACTURING DOCUMENTATION

All SWEA flight hardware manufacturing operations will be documented. Fabrication and assembly will be controlled and performed through the use of Manufacturing/Assembly Travelers (MAT). A manufacturing flow plan may be used as a supplement to the MAT's to identify inspection points.

The MAT includes the following information :

- ✓ Name and identification of the article,
- ✓ Applicable parts and materials list identification,
- ✓ Manufacturing drawings to be used,
- ✓ Listing of the activity to be completed and any special instructions,
- ✓ Identification or procedures or processes to be used,
- ✓ Necessary tools and fixtures,
- ✓ Workmanship standards,
- ✓ Cautions and verifications for handling or life limited or age controlled items,
- ✓ Instructions and entries supporting traceability,
- ✓ Entries for date and initials or stamps for personnel performing the activity or inspecting the results.

4-3-2 WORKMANSHIP

The following workmanship standards shall be used in the fabrication of the SWEA flight hardware:

Cable, Harness and Wiring Interconnection : ECSS - Q - 7008
Soldering : PSS-01-738
Crimping : PSS-01-726

4-4 ASSEMBLY INTEGRATION AND TEST (AIT)

The PAM will verify that the assembly, integration and tests are performed in accordance with approved procedures.
The tests at subassembly or instrument level are prepared conducted and the results analysed using the following documents :

- ✓ tests specifications
- ✓ tests procedures
- ✓ test minute
- ✓ test report.

4-5 GROUND SUPPORT EQUIPMENT (GSE)

The design of GSE equipment and accessories provided for use with the flight SWEA or other flight elements shall be such that they cannot induce a failure or degradation of quality of a flight item even in the event of GSE item failure.

4-6 CLEANLINESS - CONTAMINATION CONTROL

The SWEA instrument contain contamination sensitive detectors (Microchannel Plate detectors). The detectors are sensitive to dust, water, and most aromatic hydrocarbons. In addition, some surfaces such as radiators shall be contamination sensitive.

The detectors are stored, handled and installed into the flight instruments in appropriately clean environments by experienced technicians using systems that have been used successfully on numerous previous instruments. Once installed into the flight hardware, the

detectors are sealed behind covers with positive flow of high grade dry Nitrogen to prevent contamination. In this configuration, good housekeeping cleanliness levels are adequate to maintain the cleanliness of the exterior of the instrument. Prior to delivery to spacecraft integration, the exterior of the instrument shall be cleaned to meet the spacecraft-level cleanliness requirements.

Nitrogen purge shall be maintained on a near-continuous basis throughout I&T, at least up to encapsulation. Occasional outages in the Nitrogen flow can be tolerated for a few hours.

For tests that require the removal of the aperture covers, exposing the detectors, the instrument should be bagged or otherwise maintained in a class 100.000 environment or better, and Nitrogen flow should be continuous. Such exposures should be limited in duration to a few hours total. Alternatively, longer duration at a better cleanliness level can be tolerated.

The instrument shall be fabricated from low-outgassing materials to minimize contamination of itself or other instruments.

4-7 MARKING OF FLIGHT HARDWARE

Each piece of hardware shall bear an identification mark identifying the production series or batch. Once assigned, a serial number must be non-modifiable and must not be reassigned elsewhere. For equipment, subassemblies and instrument, the mark shall include as a minimum. :

- ✓ the item name (or acronym)
- ✓ the serial number
- ✓ the model type and number.

4-8 HANDLING, STORAGE, PACKAGING AND TRANSPORTATION

4-8-1 HANDLING

No handling equipment is planned for SWEA. In the event, that a need for such equipment is identified appropriate proof testing will be performed prior to use.

4-8-2 PACKAGING AND TRANSPORTATION

When the instruments are to be transported, they will be placed in air-tight bags, or air-tight transit containers, which will act as a moisture barrier.

All packaged or bagged items will be clearly marked or labeled to identify the item and specify the environment and conditions required when the package is opened.

Transport containers will be used to protect the equipment and its packaging in transit. Containers will be fitted with shock absorbers, lifting attachments, as necessary to facilitate transportation and prevent damage.

Shipping of the flight units or components will be done with the appropriate accompanying documentation, handling instructions, packaging and transportation procedures.

4-8-3 STORAGE

Procedures will be established for storage or removal from storage in order to guarantee personnel safety and maintain product quality and integrity. During storage instruments will be flushed with dry nitrogen.

4-9 SWEA DELIVERY DOCUMENTATION

The SWEA models will be delivered with an End Item Data Package which will include documentation items listed herunder :

EIDP shall include :
- ✓ shipping documents,
- ✓ packaging, storing, transport, handling and installation procedures,
- ✓ certificate of conformance,
- ✓ copy of all NCR,
- ✓ as-built configuration list,
- ✓ copie of the major drawings,
- ✓ test reports,
- ✓ qualification status list,
- ✓ calibration data record,
- ✓ user manual,
- ✓ log-book.

5 - EEE COMPONENTS

5-1 ORGANIZATION

CESR will conduct a part control program covering the selection, procurement and acceptance of EEE parts used on the SWEA instrument.

The CESR Project Manager is responsible for implementation of the parts control program. Part testing, when required will be performed by engineers assigned to the project and/or outside vendors.

The SWEA team has appointed a EEE components representative, Jean-Louis Médale who will support the PAM with EEE components activities and interact with SSL and CNES EEE component representatives.

5-2 LIST MANAGEMENT

The EEE components representative, shall coordinate and prepare as a minimum, the following lists :

A Preliminary Components List (PCL) will be prepared for PDR
An Authorized Components List (ACL) will be prepared for CDR
The Final Components List will be preparad for the QR
Each list will be presented at the corresponding review for approval.

5-3 PARTS SELECTION

Parts and related manufacturers will be selected as much as possible from the following sources :

- ✓ ESA-SCC Qualified Part List level C or B
- ✓ CNES/QFT/IN.500 Part 1 and ESA PPL (PSS-01-603) Part 1
- ✓ CNES/QFT/IN.500 Part 2 and ESA PPL (PSS-01-603) Part 2
- ✓ Parts approved for European Space Programs
- ✓ MIL-STD-975
- ✓ MIL-M-38510 Class B procured for a Qualified Manufacturers List (QML) supplier
- ✓ MIL-I-38535 Class Q procured for a Qualified Manufacturers List (QML) supplier
- ✓ MIL-H-38534 Class H
- ✓ Standard Military Drawing (SMD) microcircuits procured from an authorized supplier as listed in the QML
- ✓ Microcircuits compliant with paragraph 1.2.1 of MIL-STD-883 and procured from manufacturers having QML status. MIL-STD-883 compliant microcircuits should be subjected to PIND testing in accordance with section 5.5.
- ✓ MIL-S-19500, JANTX, JANTXV and JANS semiconductors procured for a QML supplier.
- ✓ Established Reliability (ER) level R ou S passive components procured from a QML supplier.

5-4 OTHER PARTS

Other parts, not on any of the documents listed in section 5.3 will be purchased or screened in accordance with GSFC specification GSFC-311-INST-001 for grade 3 quality level.

5-4-1 MAGNETICS DEVICES

Transformers will be manufactured at CESR using magnetic components purchased from Magnetic Inc and Philipps, to commercial specifications. Parts and wires will be carefully visually inspected before and after winding. Unit may be potted using approved materials at CESR. Correct operation of the completed units will be verified by electrical tests and measurements in special test beds.

5-5 DERATING

During the design of the circuits and the identification of the parts the derating factors are incorporated into the design and the values of the parts to be used. If it is necessary to use derating factors with less margin than listed in the following : CNES/QFT/IN-0500 appendix 2 or PSS-01-301, Derating Requirements and Application rules for Electronic Components, a request will be presented to the SSL and STEREO project offices.

5-6 RADIATION

All EEE parts shall be selected to meet their application design requirements in the predicted radiation environment, including TID and SEE.

Parts shall have a TID tolerance of 8 Krads or more based on manufacturer data sheet, demonstrated technology hardness or lot testing.

Shielding or special packaging may be used to achieve the desired tolerance.
Parts shall be SEL immune to a LET of > 80 or else shall be protected against damage by a protection circuit.

5-7 PROCUREMENT

Any procurement will include requirements on the following :
- ✓ quality level,
- ✓ rocurement specifications,
- ✓ lot homogeneity,
- ✓ lot acceptance testing,
- ✓ documentation and traceability
- ✓ packaging
- ✓ radiation tolerance.

5-7-1 QUALITY LEVEL

Quality level 3 has been specified by NASA for this project. This quality level is defined in NASA document 311-INST-001 Rev.A, Instructions for EEE Parts Selection, Screening, and Qualification. A higher grade part will be used if there is no cost penalty, or no Grade 3 part is available.

5-8 RECEIVING INSPECTION

As a minimum, the SWEA team will perform an inspection on delivered parts with regard to :
- ✓ the conformance with the order (number of parts, package, marking, ...)
- ✓ documentation (if any),
- ✓ the outside appearance.

Parts will be handled in accordance with ESD control plan and placed into bonded flight stores.

5-9 USE PHASE

This phase covers the following operations carried out at the procurement agent's and user's premises :
- ✓ storage and documentation,
- ✓ removal from storage,
- ✓ handling, transport and assembly.

5-9-1 STORAGE AND DOCUMENTATION

SWEA flight hardware will be protected from environmental damage, labeled, inventoried and segregated from non-flight hardware. Provision for tracking and controlling life-limited parts shall be included.

5-9-2 REMOVAL FROM STORAGE

Access to flight stores will be controlled and checkout from stock under inventory documentation control.

5-9-3 HANDLING, TRANSPORT AND ASSEMBLY

The SWEA team will be responsible for providing adequate environmental conditions during the handling, transport and assembly of parts.

6 - MATERIALS, MECHANICAL PARTS AND PROCESSES

6-1 INTRODUCTION

Materials, mechanical parts selection, and processes will be controlled starting with initial design and will continue throughout the developement of the SWEA. Listing of materials, mechanical parts and processes used in qualificaiton and flight hardware will be prepared (Declared Material List, Declared Mechanical Part List, Declared Process List), updated as changes occur or additions are made. The MMP representative will prepare and update the list and provide a point of contact for SSL and STEREO PROJECT.

6-2 MATERIALS AND PROCESSES SELECTION

Materials to be used will preferably be selected from the following documents :

ESA-PSS-01-701
ESA-PSS-01-736
MFSC-HDBK-527

Materials and processes shall be selected not only on basic application requirements but also on vacuum and magnetics properties and previous experience in space flight missions. No unique or exotic materials parts or processes are planned in SWEA hardware. In the event that an MMP non compliant item becomes identified, approval will be requested using the CNES Request For Approval (RFA).

6-3 MATERIALS CONTROL

CESR will give special attention to problem areas such as radiation effects, stress-corrosion cracking, galvanic corrosion, hydrogen embrittlement, lubrication, contamination of detectors and composite materials.

6-3-1 INORGANIC AND METALLIC MATERIALS

Materials will be chosen for resistance to stress corrosion in compliance with Table 1 of ESA-PSS-01-736. Table 1 of MFSC-SPEC-522B or MSFC-HDBK-527, classified as "A".

6-3-2 ORGANIC MATERIALS

Organic materials chosen for the SWEA will meet the criteria of TML < 1.00%, CVCM < 0.10%. Such materials will be specified to meet ESA-PSS-01-702 or be listed as passing such criteria in NASA Reference Publication 1122 - Outgassing Data for Selecting Spacecraft Materials.

6-4 MECHANICAL PARTS CONTROL

Mechanical parts will be preferentially chosen from those successfully used for an identical application in other space programs similar with respect to environmental constraints and life span. The SWEA team will support the IMPACT MMP representative in determining that the materials used in the selected parts meet STEREO mission requirements.

6-5 PROCESSES CONTROL

Processes chosen will be selected from those already validated and used on previous similar missions. The SWEA team will support the IMPACT MMP representative in determining that the processes used meet STEREO mission requirements. Printed circuit boards will be processed in accordance with CNES-QFT-SP-0117 and CNES-QFT-SP-0118 inspection criteria.