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Stanford University

Gravity Probe B Relativity Mission

SCIENCE MISSION QUALITY PLAN

Contract No: NAS8 - 39225

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A	4/01/97	531	All		Re-written.
B	3/23/99	968	All		Re-written
C	10/20/99	1041	All		Re-written
D	12/19/00	1237	3 6 7 8 8 11 11 11 13 22 23 27 29 30 38 44	3.5 Ref. List 1.2.8 1.2.46 1.2.47 2.2.1 2.2.2 2.3 3.5 6.4.1 6.4.2 8.3 8.5 8.6.2 Appendix A Appendix G	Add TRR paragraph 3.5. Change PA-01 to SCPA-01. Remove LMMS spec. Add 1.2.46 to list. Add 1.2.47 to list. Add section “f”. Add “Cyro training”. Add reference to P0616. Add “Test Readiness Review”. Remove ref to LMMS doc. Replace with SU P0476. Add reference to P0855. Add definition of “Other”. Delete LM MRB. Insert document for clarity. Insert document for clarity.

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Reference Documents

DR SCPA-01 Rev B (LMMS/ P086904)	"Gravity Probe B Relativity Mission, System Effectiveness Plan"
DR 802 PA-05 (LMMS)	Acceptance Data Package
DR 802 IT-02 (LMMS)	Transportation and Handling Plan
SU P0630	Software Quality Assurance Plan
T001	Science Mission Objectives
T002	12 Fundamental Science Requirements
T003	System Designed Performance Requirements

1. INTRODUCTION

1.1 General Scope

The purpose of this plan is to define the methods and procedures used by Stanford University to provide an effective and economical system of assuring product quality for the development of spaceflight instrumentation for the **Science Mission** phase and operational phase of the Relativity Mission Program per NASA contract number NAS8-39225.

The methods and procedures used are in conformance with the intent of NHB 5300.4 (1B). The numbers in parentheses in the Table of Contents show the correlation of this plan with the requirements of NHB 5300.4 (1B).

Quality Assurance activities performed at LMMS are described in separate documentation, DR PA-01 Rev A (LMMS/ P086904) "Gravity Probe B Relativity Mission, System Effectiveness Plan".

1.2 Applicable Documents

1.2.1 NASA NHB 5300.4 (1B), Quality Program Provisions for Aeronautical and Space System Contractors
1.2.2 NASA NHB 5300.4 (1C), Inspection System Provisions for Aeronautical and Space System Materials, Parts, Components and Services (applicable to SU subcontractors)
1.2.3 F-225791, Surface Mount
1.2.4 MIL-I-45208A, Inspection System Requirements
1.2.5 MIL-C-45662, Calibration System Requirements
1.2.6 MIL-P-55110, Printed Wiring Boards.
1.2.7 MIL-STD-1686A, Electrostatic Discharge Control Program.
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1.2.9 MIL 461D, Electromagnetic Compatibility.
1.2.10 MPS 623-050,
1.2.11 LAC 0170, Surface Wipe Cleaning
1.2.12 MPS 623-050Q, Cleaning Inspection
1.2.13 FED-STD 209, Environmental Control
1.2.14 MPS 623-057, LAC3012, 3851 Cleaning/ Flux removal
1.2.15 MPS 623-057Q, Cleaning Inspection
1.2.16 NASA NHB 5300.4 (3A-2), Requirements for Solder Electrical Connections
1.2.17 NASA NHB 5300.4 (3H), Requirements for Crimping & Wire Wrap
1.2.18 NASA NHB 5300.4 (3G), Requirements for Interconnecting Cables, Harnesses & Wiring
1.2.19 LMMS (FAA), Board Component Filleting and Staking
1.2.20 LMMS (FBB), Conformal Coating
1.2.21 F-225793, Inspection
1.2.22 GP-B SPEC #5833727, Repair and Modification of PWBs
1.2.23 NHB 6000.1D, Requirements for Packaging, Handling and Transportation
1.2.24 MIL-STD-883, Test Methods and Procedures for Microelectronics

1.2.25 MIL-STD-975, Standard Parts List for Flight and Mission Essential Ground Support Equipment
1.2.26 MIL-STD-506C
1.2.27 LAC 3210, 3211, 3251, 3252, Conformal Coating
1.2.28 NASA NHB 5300.4 (3K), Design Requirements for Rigid Printed Wiring Boards and Assemblies
1.2.29 NASA NHB 5300.4 (3I), Requirements for Printed Wiring Boards
1.2.30 MIL-STD-781, Verification and Test
1.2.31 SU P0400, Operations Manual for QA Inspection and Flight Stores
1.2.32 SU P0403, Payload Transportation and Handling Plan
1.2.33 SU P0406, Travel Sheet & As-Built Procedure Guidelines
1.2.34 SU P0034, Clean Room Access Policy
1.2.35 SU P0035, General Conduct Rules within GP-B Clean Rooms
1.2.36 SU P0036, Approved and Restricted Materials and Actions
1.2.37 SU P0038, Clean Room Policy Review Procedure
1.2.38 SU P0039, Procedure for Monitoring Airborne Particulate
1.2.39 SU P0040, Clean Room Janitorial Procedure
1.2.40 SU P0043, Chemical Safety Program for HEPL Room 128, 129, 130 & 132
1.2.41 SU P0147, Gravity Probe B Relativity Mission Contamination Control Plan, Master
1.2.42 SU P0057, Magnetic Control Plan
1.2.43 SU P0080, Cryogenic Magnetic Screening Procedure
1.2.44 SU P0098, Science Mission Configuration Management Plan
1.2.45 MSFC-P15.1-C01, Packaging, Handling, and Moving Critical Hardware
1.2.46 SU P0476, EOS/ESD Risk Mitigation Procedure
1.2.47 SU P0855, Discrepancy Reporting
1.2.48 SU P0616, Stanford University Data Archiving Procedure

1.3 Acronyms and Abbreviations

ADP	Acceptance Data Package
ANSI	American National Standards Institute
CCB	Configuration Control Board
DWG	Drawing
DR	Discrepancy Report
ECO	Engineering Change Order
EMI	Electromagnetic Interference
ESD	Electro Static Discharge
GFE	Government-Furnished Equipment
GFP	Government Furnished Property
GP-B	Gravity Probe-B
GSE	Ground Support Equipment.
GSFC	Goddard Space Flight Center.
HEPL	Hansen Experimental Physics Laboratory
ICD	Interface Control Document

ID	Identification Number
LDC	Lot Date Code
LMMS	Lockheed Martin Missiles and Space Corp
LMSC	Lockheed Missiles and Space Corp
MILSTD	Military Standard
MRB	Material Review Board
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NRE	Non Recurring Engineering
NSPAR	Non Standard Part Approval Request
ONR	Office of Naval Research
PAPMR	Product Assurance Program Management Representative
PCB	Program Control Board or Printed Circuit Board.
PDT	Product Development Team
P/N	Part Number
PO	Purchase Order
PPL	Preferred Parts List
PWA	Printed Wiring Assembly
PWB	Printed Wiring Board
QE	Quality Engineer
QPL	Qualified Parts List
RDE	Responsible Design Engineer
RE	Responsible Engineer
Rep.	Representative
Rev.	Revision
SEM	System Effectiveness Manager
SM	Science Mission
S/N	Serial Number
SU	Stanford University

1.4 Action and Prerogatives of the Customer (1B102)

The operations and work of Stanford University and its suppliers and subcontractors are subject to the evaluation, review, audit, survey and inspection by the customer and its designated quality representatives.

1.5 Quality Program Documents (1B103)

The internal procedures, instructions, lists and standards required to implement this quality assurance plan are contained in P0098 Science Mission Configuration Management Plan, P0400 Operations Manual for QA Inspection and Flight Stores, P0406 Travel Sheet & As-Built Procedure Guidelines, P0034 Clean Room Access Policy, P0035 General Conduct Rules within GP-B Clean Rooms, P0036 Approved and Restricted Materials and Actions, P0038 Clean Room Policy Review Procedure, P0039 Procedure for Monitoring Airborne Particulate, P0040 Clean Room Janitorial Procedure,

P0043 Chemical Safety Program for HEPL Room 128, 129, 130 & 132, P0057 Magnetic Control Plan, P0080 Cryogenic Magnetic Screening Procedure and P0147 Gravity Probe B Relativity Mission Contamination Control Plan, Master.

2. Quality Program, Management and Planning

2.1 Organization and Responsibilities (1B201)

The Stanford University GP-B Program Manager is responsible for the quality of all GP-B products and services.

Stanford University will designate one individual, the System Effectiveness Manager (SEM) to be responsible for the implementation and direction of the quality assurance program. This individual will report directly to the Program Manager and have the support of the upper management levels as shown in Appendix A. His/her responsibilities will include the development of reliability, quality assurance, safety and configuration control related documentation to control, verify, and record the design, fabrication, testing, and operational requirements of the program hardware and software. The System Effectiveness Manager will make functional assignments to implement each element of the quality assurance program, as required. In cases where the Quality Requirements are conveyed via contract with outside organizations, selected quality assurance, safety, configuration management, and reliability services may be provided by outside service organizations as delegated by the System Effectiveness Manager.

2.2 Training (1B202)

The SEM will maintain a program for training of GP-B personnel performing or inspecting special operations that have a significant effect upon quality or reliability. Certification will be based upon formal training and/or on-the-job training coordinated by the SEM or his/her delegate.

2.2.1 Certification of Personnel

a. Personnel performing crimp and soldering operations per NHB 5300.4(3A-2) will be certified via a NASA certified program. Re-certification will be performed via the same manner.
b. Personnel using the Class 10 and Class 1000 clean rooms will be certified per SU procedures. The process will include viewing video training tapes and reviewing SU procedures under the direction of the Clean Room Manager. Re-certification will be performed via a written test.
c. Either LMMS or SU QA will certify all personnel working with electronics for ESD control. SU process will be to view ESD training tapes under the direction of the SU SEM.
d. All SU personnel who will be operating the Mission Operational Control Computers during the Relativity Mission will be formally trained and certified prior to any access.
e. All GP-B SU hands-on personnel shall attend SU Quality Management System training to become familiar with the requirements of this Plan.
f. Personnel performing cyrogenic operations will be certified via a Stanford University training program. The process will be to view a Gas Handling training video under the direction of the Cyrogenic Team Lead.

2.2.2 Records

In order to assure mission success, the SEM shall maintain a certification file containing all formal certifications and documenting all certification actions. This information will be available for customer review. Records of personnel training for training not directly associated with formal certification shall also be maintained. Certification records are defined as Clean Room training and certification, Cyro training and certification, ESD training and certification, and NASA training and certification for solder and crimp activities per contract requirements.

2.3 Quality Information (1B203)

All pertinent documentation (drawings, procedures, travel sheets, plans, inspection, test and analysis, etc.) resulting from the design, procurement, fabrication, test, inspection, and usage of articles and materials procured and produced for space-flight articles will be archived for no less that five years after launch. This requirement also applies to SU vendors/sub-contractors. Reference SU P0616, Stanford University Data Archiving Procedure.

2.4 Quality Status Reporting (1B204)

At SU's Monthly Review, the SEM will present the Monthly System Effectiveness Report. The Report will include as a minimum: Engineering Changes, Discrepancy Report Summary, NASA ALERT Summary, Reviews, Quality Audits, Corrective Action Requests, and Safety Assurance Activities.

A copy of the Monthly Review presentation material will be forwarded to MSFC and ONR each month. Major Quality Problems at LMMS are also reported at the Stanford University Monthly Review. A copy of the LMMS Monthly Review presentation materials will also be forwarded to MSFC each month. Electronic copies of all SU Monthly Review presentations are stored on the GP-B server.

2.5 Quality Programs (1B205)

2.5.1 Stanford University Audits

Formal Audits will be conducted to verify the implementation of this plan. The Audits will be scheduled and performed a minimum of once a year by the SEM or his/her delegate and will be coordinated with the appropriate department representative. Audit results will be recorded including Corrective Action required, person responsible for completing these actions and date of completion. Copies of all audit results will be submitted to the Program Manager or his/her designee, and Chief System Engineer and the customer's delegated QA representative if applicable. Sample of Audit Result Summary is shown in Appendix B.

The Work Area List and the Responsible Engineer for each area is shown in Appendix C. An example of an Audit Schedule is shown in Appendix D. The Work Area List and the Schedule will be generated and updated by the SEM periodically based on activities performed in each area and the

results of last Audit.

2.5.2 Vendor/Subcontractor Audits

The SEM or his/her delegate reserves the right to audit suppliers . This requirement is primarily directed to suppliers not currently on the approved vendor list; i.e. sole source contractors. Prior to commencement of work a SU Quality Representative will review the supplier's facility, procurement process, fabricating procedures/processes and the quality program. The SEM will review the SOW and participate in all supplier reviews. In cases where the supplier is local the SEM reserves the right to perform process audits of work being performed at the supplier facilities in lieu of conducting annual audits.

SU primarily contracts with suppliers from the Preferred Parts List defined in paragraph 5.1.1.3, item 1. In lieu of performing SU audits of these suppliers, SU reserves the right to accept the system which is in place that audits of these suppliers; i.e. LMMS and Goddard.

2.6 The GP-B Configuration & Test Database

SU will develop and utilize a database that will be used to store Quality, Configuration and Test Data. The Database will include the following elements:

a. Document Tree
b. Requirements and Specs
c. Science Documents
d. Procedure Documents
e. Program Changes (PCB)
f. Drawings
g. ECOs
h. Discrepancy Reports
i. Calibration
j. Approved Vendor List

2.7 Software Quality Assurance

SU will develop and utilize a separate Software Quality Assurance Plan, P0630, for flight support software developed by SU. This documentation will include software acquisition, development, specifications, configuration management, engineering and quality assurance standards or techniques.

3. Design and Development Controls

3.1 Technical Documents (1B300)

3.1.1 Document Preparation

All phases of the program activity shall be documented via released specifications, drawings, and procedures. These documents shall be used to define the design and quality requirements and to

control all fabrication, inspection, and test activities. The documents shall define all characteristics and criteria required to meet the design intent and shall provide appropriate tolerances. The document release process shall be in accordance with the P0098, Science Mission Configuration Management Plan.

3.1.2 Document Review

All technical documents, i.e. drawings, procedures, ECOs and PCBs, will be reviewed and approved by Quality Assurance personnel during the course of the release and re-release processes in accordance with the P0098, Science Mission Configuration Management Plan.

3.2 Quality Support to Design Review (1B301)

The SEM or his/her delegate will participate in Design Reviews to ensure that quality issues are considered in all phases of manufacture and test.

3.3 Configuration Management (1B302)

It is the responsibility of Quality Assurance to ensure only released documentation or approved redline drawings are used during procurement, fabrication, inspection, and test of the deliverable end item. The control and release of documentation will be in accordance with the P0098, Science Mission Configuration Management Plan.

3.4 Deviations/Waivers

A Deviation request shall be forwarded to the Program Manager at MSFC for approval/disapproval when it is expected that contract requirements cannot be met. Discrepant hardware (already documented on a DR) which violates contract requirements shall be accepted/rejected by MSFC via a waiver submitted to MSFC for that purpose; the waiver shall be referenced on the DR and must be approved prior to DR closure. Deviations and Waivers shall be generated using MSFC Form 847, Deviation/Waiver Approval Request (DAR).

3.5 Test Readiness Review

Prior to a system level verification the REE will generate a Test Readiness Review package for approval by the review committee. The committee will consist of System Engineering (the chairman), the REE (co-chairman), Quality, the customer, and any other parties deemed necessary by the chairman.

Specific subjects and tasks covered by the TRR are as follows:

Test Requirements and Specifications: Identify and review the current revision of the baseline test requirements and specifications. Assess the proposed test program and methods for compliance with the Verification Requirements Compliance Matrix (VRCM), program objectives, intent, and philosophy. Assure that all prerequisite test and pretest analysis has been successfully completed or acceptable waivers/deviations exist.

- **Test Documentation:** Determine the status of the test documentation and test related preparation activities such as facility activation and test and checkout procedures. Assess the procedures against the approved test requirements. Assure that test documentation has been reviewed and approved.
- **Facility:** The requirements, which the test facility must meet, will be reviewed and it must be shown that the facility has been configured and certified to meet these requirements.
- **Test Article Configuration:** The as-built versus the design configuration of the test article will be reviewed by assessing all deviations and waivers.
- **Test Equipment:** Assure that all equipment utilized in performing the test meets requirements and is ready to support the test.
- **Test Team Certification:** Personnel training and certification shall be reviewed. Adequate staffing levels shall be assured.
- **Hazard Analysis:** The approved hazard analysis and resulting open item shall be summarized.
- **Measurement Program:** The measurement list shall be reviewed to determine its adequacy. Redline measurements shall be assessed to assure safe conduct and valid test data.
- **Open Work:** Open work items shall be reviewed to assure satisfactory completion prior to test.

The committee will:

- Evaluate the state of readiness of test hardware/software, support equipment, test facility, test requirements specification and procedures, and test operations.
- Provide authority to commence test and identify specific constraints to start tests as appropriate.
- Assign action items to appropriate organizations. Designate as “constraint to test” or “no constraint to test”.
- Document results of the TRR including authorization to proceed and approval by the chairman and co-chairman.

4. Identification and Data Retrieval (1B400)

Parts, materials, and assemblies shall be identified and shall maintain this identity either on the fabricated article or on the accompanying documentation. The identification number shall be easily traced to procurement documentation, fabrication and assembly records, and/or test and inspection records. The controls established will assure only conforming articles and materials are used. Nonconforming articles and materials will be removed from work areas, stored separately, and identified as being nonconforming. The system shall also provide for locating parts and materials.

4.1 Identification Methods (1B401)

A unique part number will identify each article. The number will consist of the letters SUGPB-, followed by the Part Number (component number), followed by the Revision, followed by Serial Number or Lot Date Code. The Lot Date Code is the date of Receiving. Example of Identification number: SUGPB-25451-201 Rev. A 97-02-14. The requirement for Identification and the method will appear in the drawing. When a Serial Number is required, the RE will keep a list of assigned Serial Numbers. Since there are never multiple deliveries of the same Part on the same date, Lot

Date Numbers do not require a control List. For most of GP-B parts, marking the part itself is not allowed and identification is required to be on the bag or on the accompanying paperwork. Parts for which identification on the part itself is required, the location of the ID number will also appear in the drawing.

4.2 Documentation (1B402)

Method and location of part or type number and detailed identification on article and/or its packaging shall be indicated on applicable drawings, procedures, and travel sheets.

4.3 Identification Control (1B403)

Quality Assurance shall ensure serial numbers are assigned in a consecutive manner and that all deliverable items are properly identified throughout their life cycle. All space-flight articles removed from bonded stores shall be recorded on a form uniquely associated with the next higher assembly. This will permit both backward and forward tracing to determine the usage of like materials when required. Quality Assurance will be able to determine the description, storage location, quantity, and intended use of all parts, components, and subsystems in the GP-B project.

4.4 Identification List (1B404)

An End Item Configuration List (Identification List) shall be prepared by the SEM showing the drawing number, revision letter, and corresponding serial number or lot date code for every part, subassembly, and assembly in the Gravity Probe B deliverable end item. Quality Assurance shall ensure this requirement is flowed down to all vendors.

4.5 Retrieval of Records (1B405)

The SEM shall ensure that article and material procurement, fabrication, processing, inspection, and test records are related to the articles and materials specified in the Identification List. It shall be organized so that these records and the related articles and materials may be located and retrieved in the event verification of, or removal of articles or materials become necessary. Per SU GP-B requirements, hard copies of all procurement, fabrication (e.g. travel sheet) and testing data of Flight Hardware will be stored in limited access area for five years after launch.

The SU Associate responsible for the Document Control Center will receive original, approved documents from the last person to approve the document. Electronic copies shall be forwarded to upon approval of hard copies; this affects S-Docs and P-Docs. SU Document Control will archive all original controlled documents in a location separate of the Document Control Center. This area will have limited access. The Document Control Center will retain copies and email a list of document numbers as original documents are archived.

The following are controlled Documents are stored by the Document Control Central:
Released drawings
Released S-Docs
Released P-Docs

Approved Acceptance Data Packages
Approved ECOs
Approved PCBs
Approved ECCBs

The SU Bonded Stores will develop a part folder for each flight item received. Procurement, SU Receiving or the Responsible Engineer will deliver documents to the SU Associate responsible for Bonded Stores. The folder will consist of the following and be archived in a manner consistent with Controlled Documents upon completion of this project:

Copy of procurement documentation
Certificates of Conformance if required
Part drawing
Specifications if required
Copy of Travel Sheet
Copy of As-Built or As-Tested P-Docs for lower level assemblies

SU Purchasing will maintain files of purchase orders as they apply to parts and processes procurement. Upon completion of this project, all purchasing documentation will be archived in a manner consistent with Controlled Documents.
The Document Control Center will retain copies and a list of all archived original documents.

5. Procurement Control (1B500)

SU will be responsible for the adequacy and quality of all purchased articles and materials. The policy of the management of the program is to incorporate all the Sub-Contractors and Vendors as Partners for Success, and as part of the Quality Team. To achieve this goal, Stanford will involve sub-contractors in the design stage, will make visits to vendors' facilities with Engineering, Quality, Purchasing and Management before issuing PO and during fabrication, when possible. **It must be noted that LMMS will be procuring the majority of the EEE parts due to the fact that LMMS is responsible for delivering completed electronic systems to SU for this project.** There are three types of subcontractors for this program:

a. Major Subcontractors
Subcontractors who are developing, designing and fabricating sub-systems for GP-B, for example, LMMS. The Quality Plans of these subcontractors shall meet the intent of the requirements of NHB 5300.4 (1B), and will be reviewed and approved by SU's SEM.

b. Minor subcontractors/Build to Print Vendors
Mainly machine shops, will meet MIL-I-45208A or NHB 5300.4 (1C). The Quality/Inspection Plans of these vendors will be reviewed by SU's SEM.

c. Off the shelf vendors
Suppliers from an Approved Vendor List will be used to procure off the shelf items such as nuts, fasteners, washers, etc.

5.1 Evaluation and Selection of Contractor Procurement Sources (1B501)

The designated SU Quality Assurance representative will participate in the selection of sources for the program and will ensure articles and materials are chosen from vendors that are on the SU List of Approved Vendors. SU will maintain and update this List of Approved Vendors. The data will be in the GP-B Configuration & Test Database under the "Hardware" category. The selection of a vendor to be added to the List of Approved Vendors will be based on one or more of the following:

a. Records documenting the vendor's previous and continuous supply of quality articles, materials, or services of the type being procured.
b. A Pre-Award Survey of the vendor, either in situ or by letter.
c. Records documenting the acceptability of the vendor from the LMMS DAS, *Directory of Approved Suppliers,* for similar items.
d. In the case of commercial or off-the-shelf items with no previous quality history, a vendor may be added to the List of Approved Vendors, but a note must be included to ensure that a thorough inspection of the article or material is mandatory at Stanford or its designated inspection organization.

5.1.1 Parts Selection

5.1.1.1 Definitions

Standard parts: Off the shelf electrical and electromechanical parts that are manufactured per the manufacturer specifications.

Non-Standard parts: Electrical and electromechanical parts that are manufactured per Stanford's design.

5.1.1.2 Parts List

A Parts List will be prepared for each sub-system. The list will include standard parts (as they appear in the Drawing Tree) and non-standard parts.

5.1.1.3 Standard Parts Selection at Stanford or its Sub-Contractors Except LMMS

1. Parts shall be chosen from one of the following Preferred Parts List (PPL):

    - MIL-STD-975 PPL
    - Goddard Space Flight Center PPL (PPL-21)
    - LMMS PPL

Parts that are not in these three PPL's shall be considered a Non-Standard part and shall require an NSPAR (Non Standard Part Approval Request). Stanford will use LMMS Parts Engineering for evaluation, up-screening, DPA and the preparation of NSPAR.

2. All electronic parts shall meet the intent of Class B/Grade 2.

3. No electrical test data/data summary sheet shall be required for standard parts (parts that appear in the above mentioned PPL).

4. The minimum data requirement for all part types will include:
   - Certificate of Conformance, COC.
   - Positive evidence of the suppliers QA buy-off. (COC signed by QA is acceptable)

5. Printed Circuit Boards will be purchased from a MIL-P-55110 source.

5.1.1.4 Standard Parts Selection at LMMS

1. All parts shall be chosen from one of the following Preferred Parts List (PPL).

   - MIL-STD-975 PPL
   - Goddard PPL (PPL-21)
   - LMMS PPL

If, for whatever reason, LMMS is unable to use one of these three PPL's then the part shall be considered a Non-Standard part and shall require an NSPAR- Non Standard Part Approval Request.

All parts, which have been procured to date, as well as what is yet to be procured shall be evaluated by LMMS Parts Engineering to determine the need for up-screening.

2. All parts shall be selected by LMMS Parts Engineering to meet Class B/Grade 2.

3. An evaluation shall be performed by LMMS Parts Engineering to determine whether DPA will be performed. Criteria for determination will be supplier and part history. A review of what has been procured to date, as well as what is yet to be procured will be performed. Where Single Lot Date Code (LDC) requirements can be imposed, without penalty to cost and lead time, it shall be done. Where multiple LDC's were procured, determination as to course of action shall be determined by LMMS Parts Engineering and GP-B SEM (or his/her designee).

4. No electrical test data/data summary sheet shall be required for any of the parts unless:
   - LMMS Parts Engineering determines that data is required.
   - LMMS Parts Engineering requires DPA.
   - Part failure(s) occur during testing.

5. There will be a minimum data requirement for all part types:
   - Certificate of Conformance, C of C.
   - Positive evidence of the suppliers QA buy-off.

Printed Circuit Boards will be purchased from a MIL-P-55110 source.

5.2 Procurement Documents (1B502)

5.2.1 Documentation associated with Purchase Order

The designated Quality Assurance representative will review every Purchase Order for Flight hardware and will "determine the relevant quality provisions". He/she will complete and sign the supplemental purchase order form, see Appendix E. The Quality Assurance representative will also verify that attached to the Purchase Order are all the applicable documentation such as a Travel Sheet (prepared per procedure P0406 and signed by the RE and Quality Engineer), Material certification and material magnetic screening report (when material is supplied by Stanford). Non-Flight procurements will be reviewed by the Controller or his/her designee.

Copies of all procurement documentation will be forwarded to Bonded Stores for receiving inspection verification and to become part of the part history file. Upon completion of this project, all Receiving Inspection documentation will be archived in a manner consistent with Controlled Documents.

5.2.2 Data Package

Data package for purchased part will include the applicable documents from the following list:

a. Completed and signed Travel Sheet for all fabricated piece parts and assemblies.
b. Drawings, Procedures and/or Specifications for all Flight Items
c. Material Request form for items supplied by SU.
d. For all of the mechanical Flight Parts, material that meets the magnetic requirements is supplied by Stanford. This form includes details such as Material Lot Number, Magnetic Test Number, Quantity issued and more.
e. Material Certifications: Certificate of Test and Magnetic Test Report for all Flight Items.
e. f. Special Processes Certificates per drawing requirements, such as: Plating, Etching, Cleaning.
g. g. Vendor's completed Inspection Report and Vendor's Shipping paper
h. Magnetic Screening Report of the final part when magnetic are specified on drawing or SOW.
i. D-Log/Discrepancy Report, when item is found to be discrepant.

5.3 Quality Assurance Personnel at Source (1B503)

SU may assign quality personnel at sub-contractors or suppliers' facilities. Due to the interaction process described in paragraph 5.2.1 and the cost/effectiveness analysis, SU will not utilize this right on a regular basis.

5.4 Government Source Inspection (1B504)

The SEM will coordinate procurements of space flight deliverable end-items with NASA or their delegated QA representative (ONR) to determine the level of Government Source Inspection to be imposed. The customer's delegated QA representative will be notified of all pending procurements and will be part of the review process for all Statements of Work (SOW) issued to the supplier.

5.5 Receiving Inspection System (1B505)

The SEM will control and implement a Receiving Inspection/Bonded Stores System. All Flight and Non-flight GP-B procured parts will go through Receiving Inspection/Bonded Stores. Parts, which are deemed to be flight hardware, will be identified with a green, flight hardware sticker. The Receiving Inspection/Bonded Stores Area will be controlled by the Operation Manual for QA Inspection and Flight Stores, P0400. This area will receive and process items received from sub-contractors.

5.6 Receiving Records (1B506)

Receiving Inspection records will be maintained for articles and materials in accordance with the Operation Manual for QA Inspection and Flight Stores, P0400. At a minimum, these records will include the following:

a. A copy of purchase order.
b. The date of receipt, accomplishment of applicable inspections and tests.
c. Part number with LDC or serial number assigned.
d. Supplier documents received; and disposition of items (this applies to outside vendors only).

Items not accepted shall be identified, held and separated pending disposition. Upon completion of this project, all Receiving Inspection documentation will be archived in a manner consistent with Controlled Documents.

6. Fabrication Controls

6.1 Fabrication Operations (1B600)

Stanford will control manufacturing, including assembly operations, to the extent necessary to ensure that characteristics and design criteria specified in technical documentation are achieved in fabricated articles. Detailed fabrication documents shall be generated and utilized by personnel conducting manufacturing operations.

The fabrication documentation for Flight Hardware will include:

a. Released drawings under change control as the basis for beginning fabrication.

TRAVEL SHEETS USED TO DOCUMENT FABRICATION AND ASSEMBLY OPERATIONS AND THEIR INSPECTIONS AND TESTS AND ALSO TO LIST ANY

SPECIAL INSTRUCTIONS REQUIRED DURING THE MANUFACTURE AND TEST OF THE ARTICLE. ALL TRAVEL SHEETS WILL BE REVIEWED AND APPROVED BY QA TO ENSURE THAT THE PROPER

b. conditions exist for fabrication of an article.
c. Approved Procedures to detail processes.
d. Discrepancy Log Sheet and any Discrepancy Reports on the article.

6.1.1 Travel Sheets

At the initiation of the manufacturing or assembly process a Travel Sheet will be prepared in accordance with procedure P0406, Travel Sheet & As-Built Procedure Guidelines. The Travel Sheet will accompany the part or assembly along all the manufacturing processes at SU and sub-contractors. A Travel Sheet may be prepared for a single part or for a Lot. They will include:

a. List of operations required to be performed, by who, (Stanford, Vendor).
b. Reference to drawings and/ or specifications.
c. Date of completion.
d. Initials of the person who completed the operation.
e. Round Stamp-off of QA Inspector or Quality Engineer, as appropriate.
f. Reference to D-Log and Discrepancy Report when applicable.
g. Buy-off Section for the QE and RE.

The RE and the designated Quality Engineer prior to use will sign the original form. The RE and the Quality Engineer will also sign the final buy-off. See Appendix F for example of Travel Sheet. For operations performed by a vendor, the vendor may be required to prepare an internal, more detailed travel sheet for these operations.

6.1.2 Data Package for Contract Items

The content of the Data Package, ADP, for Contract End Items, CEI, is described in document DR802 PA 05, LMMS Acceptance Data Package.

6.1.3 Material Kit List

The kitting list for the Science Instrumentation Assembly will be prepared by the Responsible Integration Engineer.

6.1.4 As-Built Configuration

The configuration of the Parts and Sub-Assemblies that were actually used in the Assemblies integrated at Stanford, including:

a. Part Number
b. Part Title
c. Serial Number or Lot-Date-Code
d. Revision of the part that was integrated

e. Current Revision, and rationale if the two revisions are not identical.

6.2 Article and Material Controls (1B601)

Quality Assurance shall ensure that only conforming articles are released and used for flight. Those articles with similar characteristics that are not required for the specific operation involved are to be removed from the work operation area. Quality Assurance shall assure that all purchase orders for limited shelf life material require vendors to identify their product with its manufacture date on the purchased material.

6.3 Cleanliness Control (1B602)

Quality Assurance shall verify all cleaning operations and cleanliness inspections identified in technical documentation are met. Fabrication, assembly, inspection, and test areas shall be controlled in accordance with documented cleanliness requirements as called out in drawings, procedures, and P0147, Gravity Probe B Relativity Mission Contamination Control Plan, Master. Quality Assurance shall verify compliance to all cleanliness requirements and maintain a method for maintaining and measuring conformance to these requirements. Evidence of facility certification and personnel training shall be documented and on file for government review upon request. Only Certified personnel shall be allowed to come into the clean rooms.

Procedures shall be developed for controlling, and monitoring of the clean rooms and for certification of the personnel. These include:

a. P0034, Clean Room Access Policy
b. P0035, General Conduct Rules within Clean Rooms
c. P0036, Approved and Restricted Materials and Actions
d. P0038, Clean Room Policy Review Procedure
e. P0039, Procedure for Monitoring Airborne Particulate
f. P0040, Clean Room Janitorial Procedure
g. P0043, Chemical Safety Program for Clean Rooms

6.4 Process Controls (1B603)

Stanford will implement controls (including operator certification where applicable) for those processes where uniform, acceptable quality cannot be assured by inspection of articles alone. Process procedures shall be prepared for these processes. Procedures shall include detailed performance and control provisions. Stanford process documentation will be imposed on suppliers as applicable.

Equipment used for special processes shall be manufactured, maintained and certified by SU released drawings and/or procedures. Document Control will retain control of the drawings/procedures. Certification records shall be maintained and equipment shall be re-certified periodically as required.

6.4.1 ESD Control

Work performed in the electronic laboratory will be Electrostatic Discharge protected per the requirements of the Stanford University "EOS/ESD Risk Mitigation" procedure, P0476, which satisfies the requirements of **MIL-STD-1686A**. All operators involved in the assembly, rework, repair or testing of electro static components and/or assemblies shall be ESD certified by an outside source such as AMES. The benches will be equipped with a grounded work surface and personnel ground strap. Static generators will be eliminated at least 3 feet from the periphery of the work bench. All packaging of electronic components and assemblies will use ESD protective materials and envelopes.

6.4.2 Electronic Assemblies Development Control

SU Procedures used for the assembly and test of Electronic Assemblies at Stanford, by Stanford personnel, will reference specifications from the following list as applicable:

ESD	SU P0476, EOS/ESD Risk Mitigation Procedure
EMC	MIL 461D Electromagnetic Compatibility
CLEANING	LAC 0170 Surface Wipe Cleaning MPS 623-050
	INSPECTION MPS 623-050Q
	FED-STD 209 Environmental Control
	LAC3012 , 3851 Cleaning/ flux removal MPS623-057
	INSPECTION MPS 623-057Q
CERTIFICATIONS	NHB 5300.4(3A-2) soldering
	NHB 5300.4 (3H) crimping & wire wrap
	NHB 5300.4 (3G) cable harness
	INSPECTION NHB 5300.4(3A-2), (1B), (3H) (F-225793)
REPAIR AND MODIFICATION OF PWB"S	GP-B SPEC #5833727
HANDLING	NHB 6000.1C
MATERIAL & PROCESSES	MIL-STD-506C
SOLDERING	NHB 5300.4(3A-2)
BOARD ASSEMBLY	NHB 5300.4 (3A-2), (3G), (3H), (3K), (3I),(F-225792)
VERIFICATION AND TEST	MIL-STD-781

6.4.3 Magnetic Control

Many parts and systems of the Science Mission experiment are extremely sensitive to magnetic properties. To achieve the stringent requirements, two governing documents were written to control and monitor this issue: - Magnetic Control Plan, P0057 that covers Design, Testing, Documentation, Fabrication and Assembly requirements per each magnetic zone - Cryogenic Magnetic Screening Procedure, P0080 that describes the screening procedures and parameters.

6.5 Workmanship Standards (1B604)

Workmanship will be in accordance with good aerospace standards, per specifications stated on drawings and in procedures, the standards in the applicable document's list and elsewhere in this document.

7. Inspections and Tests

7.1 General (1B700)

Stanford will plan and conduct inspection and test programs that demonstrate that contract, drawing, and specification requirements are met. This system will provide maximum assurance that the quality inherent in the design is maintained. T002 and T003 requirements will be stated in the form of a Verification Requirements Compliance Matrix (VRCM) and in which the method of verification will be identified along with it's applicable document number. The VRCM is a controlled document that is presented in the Acceptance Data Package and maintained by Document Control.

7.2 Inspection and Test Planning (1B701)

Stanford shall provide the necessary planning functions for the accomplishment of inspections and tests as defined in the documentation system, which substantiated their accomplishment. The planning function shall provide for:

a. Orderly and timely inspection and testing at the earliest opportunity and through all phases.
b. Coordination and sequencing of inspection and testing conducted at successive levels of assembly to ensure satisfactory articles and materials and to minimize unnecessary testing.
c. Economical and effective use of equipment, facilities and personnel.
d. Availability of calibrated inspection and test equipment.
e. Coordination of inspections and tests with the designated Government Quality Assurance Representative

7.2.1 Test Plan

A list of sub-assemblies and tests to be performed at SU will be prepared. This list will include: Test name, Test Objective, Test Flow, Facility where the Test will be performed, and Responsible Engineer of each Test. The list will be prepared as part of the Test Readiness Review

7.3 Inspection and Test Procedures (1B703)

Procedures will be prepared for each test and inspection operation. The procedures shall be prepared to provide assurance that the item is capable of meeting contract requirements per the VRCM and that the required quality and workmanship are present. Procedures shall be approved and baselined prior to use. Changes will be approved using Engineering Change process per P0098, Science Mission Configuration Management Plan.

Each procedure shall identify the items to be inspected or tested, characteristics and design criteria to be inspected or tested and clear accept/reject criteria. The procedure shall also identify the test configuration and the test equipment required. In addition, each procedure shall specify the environmental conditions to be maintained, government mandatory inspection points (if required), QA witnessing during test, calibration requirements, special precautions and safety requirements, and instructions for recording and reporting nonconformance or anomalous occurrences. The procedures shall contain sufficient detail to preclude incorrect set up or operation, insure proper parts, materials

and equipment are utilized, and minimize the potential for error.

7.4 End-Item Inspection and Test (1B704)

Inspections and tests will be completed on the deliverable end products prior to submittal to the customer for final acceptance and shipping. The SEM will assure that the non-conformances that can be closed out prior to final testing and acceptance of the deliverable end item have indeed been closed. If a non-conformance can not be close prior to final acceptance it will be presented to the Government Representative via a Form DD250. Stanford can proceed to the next level integration and/or testing if the Government (MSFC) Representative or their (ONR) Quality Representative authorized it.

7.5 Inspection and Test Performance (1B705)

Quality Assurance shall ensure articles are inspected and tested in accordance with applicable technical documents and that articles undergoing test are not modified except in accordance with proper nonconformance disposition. Inspection and test phases will include receiving, in process, and final.

7.6 Inspection and Test Records and Data (1B706)

Inspection and test records and data shall be generated in accordance with SU internal procedures. The released procedures shall be maintained in the SU Configuration and Test Database. Hard copies of released procedures shall be on file in the Document Control Center. Those procedures used during the inspection/test processes which become 'As-Built' Procedures will be archived per paragraph 4.5.

7.7 Quality Assurance Actions (1B707)

It is the responsibility of the System Effectiveness Manager or his/her delegate to verify the following elements of all test activities are in place and used:

Prior to testing:

a. Verify that the applicable Travel Sheet and test documents are released and available.
b. Ensure that requirements for selection and control of articles have been implemented and that Test Readiness Review constraints have been resolved.
c. Verify that articles are identified.
d. Verify configuration of articles.
f. Verify that configuration of GSE is consistent with articles under test.
g. Verify that test equipment is calibrated and will remain within calibration for the length of the test period.
h. Verify that ONR has been notified of upcoming testing of Flight Hardware as required by the test procedure.

During testing:

a. Verify the use of the applicable Travel Sheet and Test Procedure.
b. Verify that Test Results are recorded.
c. Verify that rework, repair or modification during the test are documented.
d. Verify Discrepancy Report is written when applicable.

After testing:

a. Ensure proper disposition of articles.
b. Report any additional nonconformance and participate in their disposition.
c. Ensure that remedial and preventative action has been accomplished relative to non-conformances.
d. Verify that test results and reports are accurate, complete, and traceable to the tested articles.
e. Concur with redlining that was done during testing. (see definition below)
Redlining: Minor change, such as a change to methods, parameters, data collections, etc, to the procedure that was done during test and approved by the RE and Quality Representative.

8. Non-conforming Article and Material Control

8.1 General (1B800)

Articles and materials that do not conform to applicable drawings, specifications or other requirements will be identified as nonconforming, tagged, segregated, and dispositioned by the Material Review Board (MRB). Large articles that cannot be moved to a segregated, controlled area will be clearly marked. A copy of the DR will be attached to the discrepant material or for items that are in cleanroom areas, the material will be identified with the DR number.

8.2 Definitions

Non-conformance:
The failure of a characteristic to conform to the requirements specified in the contract, drawing, specifications, or other approved product description.

Critical Non-conformance
A critical non-conformance is one that analysis indicates is likely to create or increase a hazard to human safety, or to result in failure of a system or major product to perform a required mission.

Major Non-conformance

A major non-conformance is one that analysis indicates is not critical but is likely to result in failure of an end item to perform a required mission.

Minor Nonconformance
A minor non-conformance is one that analysis indicates is significant to product quality but is not likely to impair the mission performance of the part or item.

Test Anomaly
Any deviation of test result from the expected value, failures, and other unplanned occurrences.

Suspect Condition

A condition in which there appears to be a non-conformance or a condition that exists for which there are no perimeters defined. These conditions warrant further investigation.

8.3 Non-conformance Documentation (1B801)

Non-Conformances will be documented in Discrepancy Reports, (DR) or Discrepancy Logs, D-Logs. See Appendix G for an example of a DR and Appendix H for an example of a D-Log. The person who discovered the discrepancy shall report discrepancies. A Discrepancy Report in the GP-B Configuration & Test Database shall be opened within 24 hours of the discovery. When opening a Discrepancy Report in the database (Reference P0855, Discrepancy Reporting), the following fields shall be filled:

a. Date of event
b. DR Date = the date of report
c. Description = the symptoms of the discrepancy.

DR Number is given automatically by the database. The Status will be by default "Draft".
Later, all other relevant fields, i.e.

a. Component Number
b. Title
c. Serial Number
d. Discovered during
e. Cause (analysis), shall be filled.

The System Effectiveness Manager or his/her designee will fill the "Severity" field and the "Sign Off list", and will report the DRs in the Monthly Review. After reporting, he will check the "reported" field for each reported DR. For Major and Critical DRs the SEM will fill the date that the DR was reported to MSFC. When all the relevant fields are filled, the Status will be changed to "Ready for review" which mean that the DR is ready for final review and approval. Each reviewer using his or her password will do the approval in the database. The appropriate Payload Manager or his/her designee will be the last to sign for SU. The ONR representative will be the last to sign, and he has authority to change the Status to "Closed". If the discrepancy was discovered while using Stanford's procedure, the DR number will be recorded at the relevant paragraph of the procedure or the Travel Sheet Comments.

Discrepancy Logs will be generated for those discrepancies that can be corrected by simple rework to specification. D-Logs will be noted in Procedures and on Travel Sheets and must be closed in order to close parent documentation. The hard copies of the D-Logs will be attached to the Travel Sheets.

<u>Discrepancy that are not required to be reported:</u>

- Discrepancy of hardware due to normal fabrication yields.
- Discrepancy of Non-Flight hardware, provided that the discrepancy has no effect whatsoever on flight design or test.
- Discrepancy or anomaly due to test equipment that was discovered during a test that is not Qualification or Acceptance Test. To remove any doubts, **any** discrepancy discovered during Acceptance Test must be reported.

The DR will include:

- Unique identifiable report number.
- Date of occurrence.
- Date of report.
- Phase in which the nonconformance happened: Fabrication, Qualification Test, Acceptance Test.
- Identification of nonconforming article: Component/Assembly Number, Title, Revision, Serial Number or Lot Date Code.
- Description of the nonconformance.
- Analysis of the root cause.
- Effect on Service.
- Discrepancy Severity: Minor, Major, Critical.
- Disposition: Rework, Repair, Use As Is, Scrap, QA Hold and Other.
- Disposition Note for recording rationale for disposition and explanation for "Other"
- Repair Procedure, when the disposition is Repair.
- Corrective Action, when applicable.
- Corrective Action Due Date.
- Status: Draft, Ready for review, Closed, or Withdrawn.
- Status Note: For recording actions authorized by the MRB, status of analysis and repair actions. If Status is Open, reason for this status.
- Approval of MRB members.
- NASA Notification for Major and Critical DRs

8.4 Remedial and Preventative Action (1B802)

Each nonconformance will be reviewed and analyzed, as appropriate, to determine the cause of the nonconformance. SU will initiate corrective action to prevent recurrence of the nonconformance, including the correction of technical documents via ECO. In addition, vendors will be notified of non-conformances and the need for remedial or preventative actions.

8.5 Initial Review Dispositions (1B803)

Some non-conformances can be documented on a Discrepancy Log (D-log). If the Quality Engineer determines that the nonconformance cannot be reworked to specification, the non-conformance will be moved to a Discrepancy Report (DR) and dispositioned through the Material Review Board.
In cases where the QE is not present during the occurrence of an anomaly and the anomaly is minor in nature, the RE has authority to take necessary actions to analyze and rectify the problem at SU

risk as long as he documents the steps in the D-Log. The QE will review this information prior to hardware buyoff and can require additional steps or re-tests if deemed necessary.

All other discrepancies will be recorded using a DR, this includes suspect conditions.

Definitions of Dispositions

Rework
Operation(s) that will bring a non-conforming item to be in full conformance with all specifications without any traces. Results in fully conforming article.

Repair
Operation(s) that will bring the item to be usable but with traces.

Use As Is
A disposition of material with one or more nonconformance determined to be usable for its intended purpose in its existing condition. Also considered if documentation changes are needed.

Scrap
Dispose of material when rework or repair is impractical and there is no recourse to the supplier. Scrapped material shall be identified and controlled to preclude accidental use. Note that due to the procurement of small quantities of items, this material may be used for engineering investigations, mock-ups, etc.

QA Hold
A disposition of material to be held with a final disposition to be made at a later date.

Other
A disposition of "other" will be used preliminarily for discrepancies that are found to be GSE related. All others must have rationale entered into the DR form.

8.6 Material Review Board (1B804)

8.6.1 Material Review Board

Material Review Board (MRB) will determine the disposition and closure of a Non-conformance. The MRB shall be comprised of a Quality Engineer, the appropriate Payload Manager or his/her designee, the Responsible Engineer, the Delegated Government Representative, and any functional expert as requested by the MRB. The government representative shall approve all SU members. Decisions, including interim actions shall be documented on the Discrepancy Report (DR).
The MRB is responsible for determining disposition of submitted articles, ensuring that appropriate remedial and preventive action are included in the DR, and maintaining Board records. It is the responsibility of the MRB to investigate the necessity and feasibility of remedial and preventive actions to eliminate the main cause of the nonconformance and prevent recurrence. When corrective action is recommended, the MRB will assign responsibility for the follow-up activity.

Subcontractor's discrepancies, which require SU's approval, will be reviewed by the Responsible

Engineer. The RE will review the criticality. Minor DRs will be disposition by the RE or the QE. Major DR- Stanford will open SU DR and which will be disposition by the MRB.
All Discrepancy data will be recorded in the GP-B Configuration & Test Database. The data will include all the fields mentioned in paragraph 8.3 plus a field to indicate reporting a specific DR in the Monthly Review and a field to record date of immediate reporting to MSFC for Major and Critical Nonconformance.

8.6.2 Dispositions

MRB Dispositions can be Use-As-Is, Repair, Rework, scrap, QA Hold or Other. QA Hold is a temporary disposition until final disposition is made. "Other" is used when multiple dispositions are necessary like some parts are Use-As-Is and some Scrap. Details will be given in the Disposition Note field. Explanation for the decision will be recorded in the Discrepancy Report. A unanimous decision is required. The MRB has authority to deem a Discrepancy Report as Not Required. In this case the DR Status field will be changed to "Withdrawn". When interim authority is granted by the MRB, a note will be made in the Status Note field. Deviations/Waivers will be processed per paragraph 3.4.

Approval Authorities for MRB Disposition:

Table No. 1: Authorities for disposition of Non-conformances at SU ~~and LMMS~~.

Disposition: Nonconformance type	Use-As-Is or Repair	Scrap, Rework, QA Hold
Critical	MSFC approval is required.	MSFC approval is required if there is effect on cost or schedule.
Major	SU's MRB including the Program Manager. ONR rep. is mandatory member of the MRB	SU's MRB including the Program Manager and ONR representative.
Minor	SU's MRB chaired by the System Effectiveness Manager. ONR rep. is mandatory member of the MRB	SU MRB chaired by the System Effectiveness Manager
~~Critical at LMMS (RDD & SSD)~~	~~DCMC, SU and MSFC approval are required.~~	~~DCMC approval required. SU and MSFC approval required if there is effect on cost or schedule.~~
~~Major at LMMS (RDD & SSD)~~	~~DCMC and SU approval are required.~~	~~DCMC and SU approval are required.~~
~~Minor at LMMS (RDD & SSD)~~	~~DCMC approval is required.~~	~~DCMC approval is required.~~

8.7 Written Requests for NASA Contracting Officer Approval (1B805)

Critical Non-conformances that have been dispositioned as Use-As-Is or Repair shall be submitted to

the MSFC Contracting Officer for MSFC approval. Further processing of articles and materials shall be withheld until MSFC approval is obtained.

8.8 Supplier Material Review Board (1B806)

SU will delegate MRB authority to various suppliers. The terms of the delegation shall be stated in the contract.

9. Metrology Controls (1B900)

SU will provide and maintain suitable inspection, measuring, and test equipment of the range, accuracy, and type to ensure conformance of articles to contract requirements. Whenever standard measuring equipment is used for quantitative verification of a requirement per the Verification Requirement Compliance Matrix, VRCM, the equipment will be identified and calibrated per MIL-STD-45662.

9.1 Acceptance (1B901)

SU shall ensure that all measurement standards and equipment used for quantitative verification of a requirement per the Verification Requirement Compliance Matrix, VRCM, are inspected and/or tested to verify conformance with requirements. This process will also generate and maintain the required documentation and records.

9.2 Evaluation (1B902)

SU shall perform evaluation on all special standards and measurement equipment and shall generate and maintain the released P-Docs and S-Docs of the evaluation. The items shall be evaluated under their intended operation conditions to verify that:

a. The standards and equipment measure the desired characteristic to the required accuracy and provide the desired indications or records when used in the intended measurement process.
b. The standards and equipment are compatible with the configuration of related hardware and environment.
c. The operating instructions are correct and complete.

9.3 Article or Material Measurement Processes (1B903)

SU will ensure that all random and systematic errors in any article or material measurement process shall not exceed 10% of the tolerance of the article or material characteristic being measured. In situations where, for various reasons, this tolerance threshold cannot be maintained, SU shall request an exception from MSFC.

9.4 Calibration Measurement Processes (1B904)

SU will ensure that all random and systematic errors in any calibration measurement process shall not exceed 25% of the tolerance of the parameter being measured. In situations where, for various reasons, this tolerance threshold cannot be maintained, SU shall request an exception from MSFC.

9.5 Calibration Controls (1B905)

9.5.1 Calibration Laboratories

SU GP-B program will utilize LMMS or other certified outside facilities for calibration of the above mentioned measurement equipment.

9.5.2 Handling

All measurement equipment will be handled, stored and transported in a manner to protect it from damage and preserve accuracy.

9.5.3 Traceability

The above mentioned measurement standards and equipment for GP-B flight hardware shall be traceable to standards maintained by the National Institute of Standards and Technology or their values shall be derived from a controlled measurement process utilizing a fundamental constant of nature.

9.5.4 Responsibility

Each SU-GP-B employee performing Inspection or Test is responsible for:

a. Using only identified and calibrated measurement equipment with accuracy and precision required for the inspection or test.
b. Assuring that equipment that has exceeded its calibration due date or has suffered potential damage will be removed from use and QA notified so this equipment is sent out for calibration.
c. The QA department is responsible for monitoring, auditing and for the proper implementation of this plan.

9.5.5 Calibration Records

The following data will be kept in the GP-B Configuration & Test Database (reference paragraph 2.6) and maintained by the QA department:

a. Equipment Description.
b. Equipment Serial Number.
c. Equipment Stanford Registration Number when applicable.
d. Equipment Location.

e. Person Responsible for the Equipment.
f. Last Calibration Date.
g. Calibration Interval.
h. Next Calibration Date.
i. Comments if applicable.

The calibration service provider will maintain detailed records of the calibration of measurement equipment and provide SU with a Certificate of Conformance. SU may audit the service provider for the following records, which are designed to maintain the complete history of calibration and include:

a. Equipment Identification.
b. Identification of standard, equipment and calibration procedure used.
c. Evidence of traceability to standards maintained by NIST.
d. Calibration intervals.
e. Dates and results of each calibration.
f. Due date of next calibration.
g. Individuals performing calibration.
h. Degree of nonconformance (if any are detected).

9.5.6 Non-Standard Test Equipment

Non-Standard Test Equipment, for example the Magnetic Screening Facility, will have written calibration procedures. These procedures will be documented in the form of released P-Docs which will be available from the Document Control Center. It is the responsibility of the operator of the test equipment to perform the calibration per the procedure at the intervals specified in the calibration procedure.

9.5.7 Identification and Labeling

SU procedures will require that measurement
standards and test equipment mentioned in paragraph 9.1 are identified and labeled, tagged or coded to indicate calibration status including date for next calibration.

9.5.8 Calibration Intervals

SU will establish calibration intervals for all measurement and test equipment. The intervals will be recorded in the GP-B Configuration and Test Database. The intervals will be based on the recommendation of the manufacturer of the measurement equipment, the common practice for the specific type of equipment and/or the history of the calibration results. When a test takes longer than the calibration interval, and change of measuring equipment might effect the test, a DR will be generated for the MRB to approve continuation of the test and perform calibration immediately after the completion of the test. The test procedures and DR will remain open until calibration has been completed. The final disposition will be determined by the MRB.

9.5.9 Recall System

SU will develop and implement a recall system to ensure that measuring and test equipment used on GP-B flight hardware has been calibrated. Calibration intervals of test and measuring equipment must be considered in planning for GP-B fabrication, assembly and test operations. In the event equipment is found on the floor to be past its calibration date this equipment is to be removed from the floor and held. The RE will be contacted for dispositioning of the status of this equipment with the results being that the equipment is sent out for calibration or identified as non-calibrated as define below. In the event the calibration expires on equipment in use this will be noted in the appropriate documentation and the equipment will be sent out for calibration upon completion of the process per paragraph 9.5.8. The corresponding documentation will be held open until this equipment has returned and found to be acceptable. Equipment that is not used on flight hardware will be identified by QA as being for 'Indication Purposes Only' or 'Not to be Used on Flight Hardware'.

9.6 Environmental Requirements (1B906)

SU requires that environmental conditions as stated in various calibration and operations procedures must be maintained during measuring and testing of flight and flight-like hardware.

9.7 Remedial and Preventive Action (1B907)

SU procedures require that remedial and preventive actions be taken on non-conforming measurement standards and equipment and on articles and materials measured by non-conforming standards or equipment.

10. Stamp Controls

10.1 Stamp Control System (1B1000)

Certified Personnel performing inspection or test functions will have a personal stamp. The SEM or his/her representative will issue stamps. QA stamps will be issued to individuals performing inspection or verification functions and RE stamps for those performing the operations. A record of the serial number will be kept to identify the bearer. Stamps are personal as they represent the person's signature and warranty and shall not be loaned. Those employees who have been issued stamps will be periodically audited by QA for control of their stamps.

If an employee has lost his/her stamp it shall be reported to the SEM immediately. The SEM will issue a letter to all program personnel, stating the effective date of invalidating the lost stamp and requesting their return it if found.

A stamp that was returned by an individual who leaves the program or doesn't need it any more, will not be re-issued for at least 6 months.
It is the responsibility of each stamp owner to control the storage and use of their stamp. Damaged or worn stamps will be returned to the SEM for proper disposal. Stamps that have not been issued will be stored in a locked cabinet controlled by the SEM or his/her designee.

10.2 Stamp Restriction (1B1001)

Two types of stamps will be used:

- Quality Assurance and Inspection Stamp, will be round. These stamps will be issued to inspectors and Quality Assurance personnel. See Appendix I for Inspection Stamps Log.
- Responsible Engineer Stamp, will be square and will be issued to engineers responsible for assemblies and systems.

Stamps issued by SU will not contain the designation “NASA” or any organization other than SU.

11. Handling, Storage, Preservation, Marking, Labeling, Packaging, Packing and Shipping

11.1 Handling and Storage (1B1100)

Handling, moving and transportation will be in accordance with MSFC-P15.1-C01 and NHB 6000.1 and the SU P0403, Payload Transportation and Handling Plan. Handling and storage methods will be selected to ensure that no damage will be caused to the articles. Whenever a nonstandard method is required, specific procedures will be written. The specific procedures will be called in the drawings and will be subject to configuration control. All flight hardware will be marked by the vendors as "Flight Part". The Science Mission Dewar, Probe C, Quartz Block, Telescope, Science Instrument Assembly, and the Integrated Payload have been deemed to be program critical items (PCH) and require extra precautions with regards to handling, reference P0403. This will be required and will be documented in the purchase order or contract. HEPL Receiving will not open packages marked as Flight Hardware and, after recording the receiving data, will forward the packages and accompanying documentation to GP-B Receiving. Limited life materials, such as bonding materials, will be dated upon receipt with expiration date and stored in accordance with the manufacturer's recommendations.

GP-B Bonded Stores will include the following limited access areas:

a. Holding area for inspection of parts and material that have been received and not processed.
b. Segregated Hold area for non-conforming items.
c. Accepted Items.
d. Ready For, for items that passed the in-process inspection and are ready for the next operation.

Items will be identified including P/N, S/N or LDC, Rev. and Status (Accepted, Scrapped etc.)
The documentation of each item, including Inspection/Tests result of each item will be kept with the stored item unless it's impractical due to the storage area limitation (clean rooms).
When parts are issued for integration, it is the responsibility of the Bonded Stores personnel to issue only Approved Flight Items. When limited life material is issued, the Bonded Stores personnel shall verify that the expiration date is clearly marked. It is the responsibility of the Integration Engineer of each Assembly to verify the use of Approved Parts, and when applicable that limited life material has not expired.

11.2 Preservation, Marking and Labeling, Packaging and Packing (1B1101)

GP-B flight hardware will be maintained in properly controlled environments during operations at SU and SU subcontractors. Marking and labeling, packaging and packing shall be in accordance with MSFC-P15.1-C01 and NHB 6000.1.

11.3 Shipping (1B1102)

Shipping will be in compliance with the SU transportation and handling plans, MSFC-P15.1-C01 and NHB 6000.1.

12. Sampling Plans, Statistical Planning and Analysis

12.1 Sampling Plans (1B1200)

Sampling will be considered in the following cases:

a. When inspection involves destructive testing.
b. Inspection of standard, non-critical parts.
c. Incoming inspection which is a repeat of the vendor inspection.

In these cases specific instructions approved by the RE will be included in the inspection or test procedures.

The Responsible Engineer will determine the Sampling Plan. ANSI/ASQC Z1.4 will be used as a guide in establishing sampling requirements.

12.2 Statistical Planning and Analysis (1B1201)

The use of statistical Planning and Analysis is not planned for this project due to the limited number of items being produced.

13. Government Property Control

Government property is controlled in accordance with SU Administrative Guide Memo-74, which complies with the requirements of FAR part 45 as to identification and record keeping.

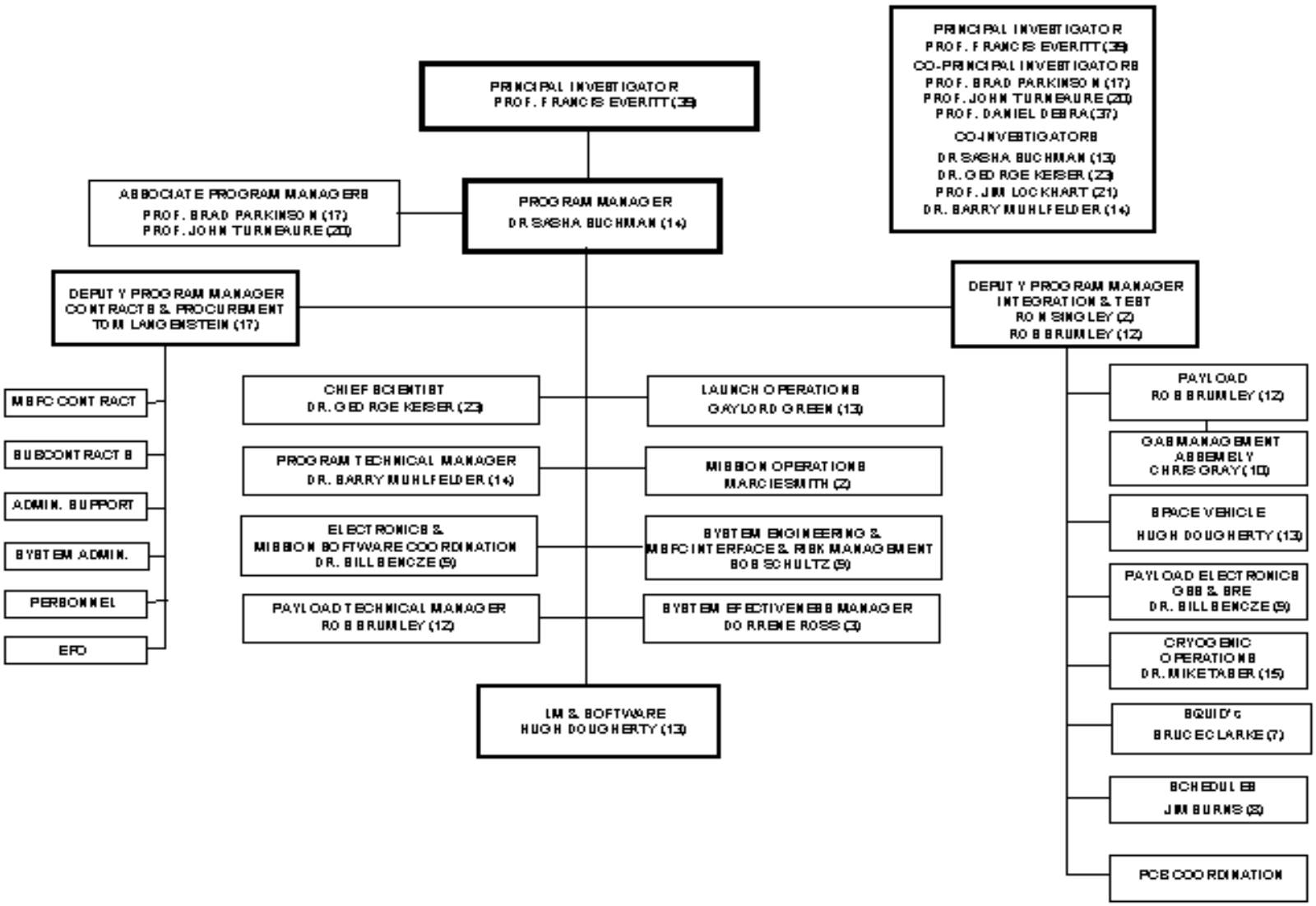
13.1 Contractor's Responsibility (1B1300)

Government Property supplied to SU will be examined upon receipt to detect damage that might occur during transit. Delivered property will also be inspected for identification, quantity and completeness as specified in shipment documents. Functional testing will also be performed as appropriate.

NASA will be notified of any discrepancy. The MRB will determine the acceptability for use or recommend repair procedures. If rework or repair is required (other then minor touch-ups) SU will contract the appropriate authority for authorization prior to repair.

GFP will be maintained and stored at the designated GP-B area, the equipment will be identified as GFP. When changes to the equipment are required due to program requirements, a change order will be issued via CCB. This will require NASA approval prior to change.

Appendix A: Stanford University Organizational Chart



Appendix B: Example of Audit Results Summary

Work area: SQUID fabrication + Readout loop.
Audit Date: 1/23/98 RE: B. Muhlfelder Auditor: Ben Taller

#	Applicability	Subject	Question	Relevant paragraph in QA Plan, P0108	Status	Closing Actions, Date, Responsible
0	All	Audit	Are all corrective actions from previous Audit closed.	2.5	See each paragraph for closing status.	
1		Documentation				
1.1	Fab	Drawings	All Parts and Assembly drawings released and updated.	4.2, 3.11	SQUID Top Assy Dwg had not been released.	The drawing will be release prior to the beginning of the assembly of the SQUID. Resp: B. Muhlfelder
1.2	Fab	Travel Sheets	All Parts and Assemblies have Travel Sheets. For completed parts, travel sheets are signed for all operations.	7.1.1	OK	
1.3	Fab	Kit List	All Assemblies and kits have Kit List	7.1.3	Not in the DB. See paragraph 11	
1.4	Fab	Procedures	All Procedures released and updated (when applicable).	4.3, 7.5	The following procedures need to be released or revised: P0110, P0117, P0119, P0120, P0160, P0161, P0165, P0169, P0171, P0324. The following procedures might need to be released or revised: P0118, P0033, P0380.	Procedures will be released or revised prior to their use. Resp: B. Muhlfelder
1.5	Fab	Configuration	Drawings, procedures have Release form and if revised ECO, signed and in the Database.	4.2, P0098	OK.	
1.6	Tst	Test Procedures	All tests are performed per Released/updated Test Procedures. Procedures data in GP-B database.	6.2	See 1.4	See 1.4

Appendix C: Example of Work List Areas

#	Work Area	Relevant issues, item # in QA questionnaire	RE
1	Design	1.1	M. Sullivan
2	Documentation center	1.5	M. Sato
3	SQUID + Readout loop deposition, 3 work areas.	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	B. Muhlfelder
4	Sphere fabrication (Frane)	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 9, 10.	M. Keiser
5	Sphere coating	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	D. Gill
6	Gyro Assy (P. Bayer)	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	R. Brumley
7	Gyro Room Testing (C. Gray)	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	R. Brumley
8	Gyro Cryogenic Testing (Yueming)	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	R. Brumley
9	Telescope Integration	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	L. Huff, J. Gwo
10	Telescope Testing- Artificial Star	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	S. Wang
11	DPA assembly	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	M. Sullivan
12	DMA assembly	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	M. Sullivan
13	TRE Testing	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	P. Ehrensberger
14	SIA Integration clean room	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	D. Bardas
15	FIST	1.2, 1.6, 2, 3, 5, 6.1, 7.2, 9, 10.	M. Taber
16	Purchasing	4	T. Langenstein
17	Receiving	2, 8.	D. Ross
18	Gyroscope Suspension System	1.2, 1.3, 1.4, 2, 3, 5, 6.2, 7.1, 7.2, 9, 10.	B. Bencze

Appendix D: Example of Audit Schedule

GP-B Audits 1999 schedule

#	Work Area	RE	Next Audit
1	Documentation center	M. Sato	Second Quarter
2	Purchasing	C. Kaye	Second Quarter
3	SIA Integration clean room	D. Bardas	Second Quarter
4	FIST	M. Taber	Third Quarter
5	Receiving	G. Brauer	Third Quarter
6	GSS	B. Bencze	Third Quarter
7	GPS	A. Ndili	Third Quarter

Subcontractors audits

#	Subcontractor	Date
1	LMMS	Fourth Quarter

External audits

#	Audit type	Date
1	MSFC annual Audit	N/A

Appendix E: Example of Supplemental Purchase Order

STANFORD UNIVERSITY GRAVITY PROBE B, RELATIVITY MISSION

SPECIAL REQUIREMENT FOR FLIGHT PART ORDER

P.O.# _____ Vendor: _____

X 1. Prior to using any other supplier source, vendor is to notify Stanford Buyer of this supplier , including name, address and telephone number . This must be done before completing flight part order.

X 2. In conjunction with Travel Sheets provided by Stanford, vendor is to follow instructions that are specific to machine shop; sign and return the travelers with delivery of parts.

3. Materials provided by Stanford will include material COC and/or COT.
a) Excess materials must be returned with delivery of parts and clearly identified.
b) Show P.O.# for work and enclose copy of material COT or COC with material.

4. Standard/Off-Shelf Parts, vendor is to include COC on parts and Lot No.

X 5. Analysis, Inspection and Test Reports shall remain on file for no less than 5 years after completion of order.

X 6. Mark packaging/shipping container "FLIGHT PARTS" (for fabrications identified as such), e.g. use dark ink marker to write bold lettering on packing list or outside of package.

X 7. Unless specifically addressed in travel sheet or drawing packaging, shipping shall be per normal supplier system.

8. The Contractor shall be notified of any articles having limited life or drift with age. Vendor shall provide records indicating life used prior to delivery and remaining life characteristics.

X 9. Contractor QE shall be immediately notified of any discrepancy that will effect form fit or function or seriously impact schedule.

X 10. Government Source Inspection (GSI):
The Government has the right to inspect any or all of the work included in this order at the supplier's plant.

X 11. Vendor will provide written signoff evidence, that Quality Assurance has reviewed, completed and approved all requirements needed to satisfy order.

12. Vendor will submit a Certificate of Conformance to confirm compliance with all specifications requested in this order.

QA Approval_____ Stamp_____

cc: Phil Unterreiner
Grace Brauer
RE_____

Appendix F: Example of Travel Sheet

PART NAME:				**SERIAL NUMBER OR LDC:**			
DRAWING NUMBER:				**REVISION:**			
#	OPERATION	**SPECIFICATION NO. & REV.**	**PERFORMED BY: (Signature required)**	DATE **COMPLETED**	INSPECTION & APPROVAL **(QA Stamp)**	BUY OFF (RE Stamp)	**REMARKS and DISCREPANCIES (REF. RELATED DOCS.)**
1	Pull flight parts from bonded stores.				I		
2							
3							
4							
5	QE Final Buy Off				**Q**	**X**	
6	RE Final Buy Off				**X**	**RE**	
RESPONSIBLE ENGINEER:			**SIGNATURE:**			**DATE:**	
QUALITY ASSURANCE:			**SIGNATURE:**			**DATE:**	

NOTE:
(X) = No approval is needed in that block **(I)** = QA inspection only (Representative from bonded stores) **(Q)** = Program QE

DISCREPANCY REPORT No. *096* 11/10/97

Nomenclature: ***Fiberoptic Switch, UV Charge Control***
Part No. ***25656-101*** Rev. - Serial No. ***FOS-10***
Date of Event: ***10/20/97*** Reported By: ***W Rowe*** Disposition: ***Scrap***
Severity: ***Minor*** Status: ***Closed***

Description:

A batch of 13 SM candidate fiberoptic switches underwent acceptance level vibration testing. The 13 switches were mounted to two rails and the rails/switches assembly was shaken as a unit. Post test inspection showed that one of the optical fibers on one of the switches (s/n above) was sheared off at the switch case.

Cause:

Given the location and type of failure, the mass of the fiber and the vibration amplitude it is believed that this failure was not caused by vibration. The cause of failure was most likely improper handling when the rails/switches assembly was mounted to the vibration table. It is believed that this particular fiber was over-stressed and cracked when it was moved aside to access one of the vibration table mounting bolts. Note that no failures of this type were observed during vibration testing of the flight-like engineering units where a different mounting scheme and 3dB higher vibration levels were used. For the engineering units, the fibers did not need to be moved during mounting.

Effect on Service:

Not usable as flight part. Could possibly repair for lab use or use as is in the lab as an on/off rather than a 1x2 switch.

Recommended Corrective Action:

1. Modify handling procedures to insure that fibers are not over-stressed.
2. Develop packaging for storage and shipping.
3. Hold meeting with Sasha Buchman to discuss resolution.

Repair Procedure:

none

NASA Notification

Disposition Notes

The Switch can not be repaired for flight use. however, it can serve in lab operations as an ON/OFF switch.

Appendix H: Example of Discrepancy Log

DISCREPANCY LOG SHEET

PART NAME:			**DRAWING No:**		**LOT OR SERIAL No:**		
No:	Description **of Discrepancy**	Disposition/ Correction	**Date Accepted**	**Rework**	Transfer to **DR No:**	QE Approval	RE Approval

Appendix I: Example of Inspection and Tests Stamps Log

	Inspection and Tests Stamps Log				
Stamp Number	**Name**	**Assy/System**	Phone	Date	Comments
INSP 1	Ben Taller	Quality Assurance	56403	6/21/96	System Effectiveness Manager
INSP 2	Roger Shile	SQUID carrier	52975	8/15/97	Left GP-B, Stamp returned
INSP 3	Marge Bogan	SQUID Assy's and parts	55742	3/7/96	Stamp returned on 12/8/98
INSP 4	Ming Luo	SQUID Assy's and parts	34014, 37250	10/7/97	
INSP 5	John Stamets	Incoming parts and Caging Assy	34803		
INSP 6	Dave Smith	Incoming - PARTS	34790	6/1/96	Left GP-B
INSP 7	Chris Gray	Gyro Assy	58683	8/20/97	
INSP 8	Barry Muhlfelder	SQUID Assy's and parts	54125		Inspection authority cancelled, 1/98 (Stamp lost)
INSP 9	Dale Gill	SQUID Assy's and parts	52216		
INSP 10	Paul Bayer	Gyro Assy	32047		
INSP 11	Yueming Xiao	Gyro Assy	33361	9/9/97	Left GP-B
INSP 12	Howard Demroff	DPA, DMA	56431	8/21/97	
INSP 13	John Goebel	DPA, DMA	54063		
INSP 14	Mike Taber	FIST operation	54136	9/3/97	
INSP 15	Dave Murray	FIST operation	58632		
INSP 16	Dave Hipkins	Gyro Testing	56753	9/10/97	
INSP 17	John Mester	Magnetic Testing	34227	11/11/97	
INSP 18	Grace Brauer	QA store + Magnetic Testing	34790, 51484	11/11/97	

Appendix I: Example of Inspection and Tests Stamps Log, continued

	Inspection and Tests Stamps Log				
Stamp Number	**Name**	**Assy/System**	Phone	Date	Comments
INSP 19	Paul Klima	Gyro	30177	6/30/98	Left GP-B
INSP 20	Art Nakashima	QA witnessing	354-5692	4/29/98	Left GP-B, Stamp returned 3/99
INSP 21	Ken Bower	Telescope Testing	34049	8/15/97	
INSP 22	Suwen Wang	Telescope Testing	56380	8/15/97	
INSP 23	Bruce Clarke	Gyro Testing	55999	10/3/97	
INSP 24	Yoshimi Ohshima	Gyro Testing	59168	10/3/97	
INSP 25	Rob Brumley	Gyro Testing	52221	1/19/98	Stamp returned on 7/23/98, Rob became RE.
INSP 26	Phil Unterreiner	Quality Assurance	33264	4/1/98	
INSP 27					
INSP 28	Russ Leese	Quality Assurance	33264	2/23/99	
INSP 29	Richard Junnila	Quality Assurance	32118	3/2/99	
INSP 30					