W. W. Hansen Experimental Physics Laboratory

STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305 - 4085

Gravity Probe B Relativity Mission

Payload Magnetometer Test Readiness Review Completion Certificate

GP-B P0262

Dec 15, 1998

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Prepared by: Sei Chun **Date**
Systems Engineer

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Approved by: Ernest Iufer **Date**
Contractor

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Approved by: Jim Lockhart **Date**
PL Magnetometer Integrated Product Team Leader

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Approved by: Ben Taller **Date**
Quality Assurance

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Approved by: Bob Schultz **Date**
Chief Systems Engineer

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Approved by: S. Buchman **Date**
Hardware Manager

Payload Magnetometer Test Readiness Review

Date & Time: Dec 15, 1998, 9:00 to 11:00 A.M.
Location: GP-B conference room

Purpose:
To ensure that the flight hardware, test facility, test equipment, and test procedures are ready for testing, data acquisition and reduction.

Scope:
The Payload Magnetometer Test Readiness Review (TRR) will encompass all four flight payload magnetometers.

Agenda:
- Requirements Traceability Status
- Procedure Status
- As-built vs. as-designed
- Test Personnel Status
- Test Resources Status
- Test Support Software Status

Review Team:

Sasha Buchman	Hardware Manager
Bob Schultz	Chief Systems Engineer
Lim Mar	Payload Electronics Team Leader
Jim Lockhart	SRE Integrated Product Team Leader
Ernie Iufer	Contractor
Ben Taller	Quality Assurance
Sei Chun	Systems Engineer

TRR check list:

- Confirm that all specifications and interface control documents are approved and have proper traceability.
- Confirm that the requirement verification matrix has accounted for all of the specification requirements
- Confirm that test procedures approved.
- Confirm that the as-built vs. as-designed is documented.
- Confirm that sufficient and detailed resources are allocated to the test effort.
- Confirm that test support software has been released

Attachments:
A. Test Flow diagram
B. Requirements Verification Matrix
C. Document Status Checklist (Acceptance Test procedures)
D. Test Personnel Status Checklist
E. Action Items Closure List

A. MAGNETOMETER Test Flow

MAGNETOMETER Acceptance Test

Pre-Environment Full Functional Test	Functional Test Procedure for Fully Assembled Forward Flight Unit
Random Vibration Test	MAGNETOMETER Proto-Qual Random Vibration Test Procedure
Pyroshock Test	MAGNETOMETER Proto-Qual Pyroshock Test Procedure
T/V Test	MAGNETOMETER Proto-Qual Thermal/Vacuum Test Procedure
Post-Environment Full Functional Test	Full Functional Test Procedure for Payload Magnetometer

B. Payload Magnetometer Verification Matrix

Payload Magnetometer Requirements in PLSE-12

#	Title	Requirement	Mtd	Verification Plan	REE
3.2.2.6	Science Magnetometers	The Science Payload shall provide 4 three-axis fluxgate magnetometers on the forward cone of the dewar, located axially near the top of the lead bag, and radially approximately 90° apart, to measure the local external field. The alignment of each magnetometer relative to the spacecraft truss shall have maximum error in knowledge <= 0.5 degree, rotation and <= 1.75 mm, translation, for X, Y, and Z axes. *Reference PCBs #50B and 180. Alignment accuracy taken from SMS 247, "Vehicle Alignment Requirements", dated 1 April 97.Reference PCB #324*	I	Magnetometer Full Functional Procedure	Iufer
3.2.2.6.1	Science Magnetometers Power Consumption	The electronics for the Science Magnetometers are located in the ECU. The power for these electronics is counted in the ECU power budget. *Reference PCB# 253A*	I	Magnetometer Full Functional Procedure	Iufer

Payload Magnetometer Specification (S0356)

Para	Title	Requirement Text and *Comment*	Ver Mtd	Verification Plan	REE
3.	Requirements		N/A		
3.1	Description	The Payload Magnetometers interface with the ECU to receive operating and feedback currents, and to provide three axis magnetic field data. The payload magnetometer signals consist voltages proportional to the magnetic field strength at the sensor position along three independent axes (X, Y, and Z). Four functionally equivalent payload magnetometer units will be mounted on the dewar near Station 199 and will be connected to the forward ECU.	N/A		
3.2	Payload Magnetometer Specifications		N/A		
3.2.1	Interfaces		N/A		
3.2.1.1	Mechanical Interfaces	The unit shall meet the mechanical interface defined in the Payload Magnetometer Mounting Drawing # A900-1130APS and EM-SMS334.	I	Inspect per drawing	Taller

Para	Title	Requirement Text and *Comment*	**Ver Mtd**	**Verification Plan**	**REE**
3.2.1.2	Electrical Interfaces	Each unit will have a single non-magnetic, chassis mounted, male 15 pin D connector on its side surface. The connectors will be on the right side of two units and the left side of two units. The pin assignments are as follows:	I	Inspect per drawing	Taller
3.2.2	Environments		N/A		
3.2.2.1	Natural & Man-made External EM Environment	The unit shall meet the EMI requirements in P0149 Paragraph 3.	A	Magnetometer EMI test procedure	Lockhart
3.2.2.1.1	EM Pulse Shielding	The unit design shall meet performance requirement after exposure to EMI pulses up to 50 V/M in the 1-10 GHz range.	A	Magnetometer EMI test procedure	Lockhart
3.2.2.1.2	Conducted Emissions into Probe	No spurious signal in the frequency range of 1 MHz to 1 GHz on any conductor which connects to the probe shall be larger than 50 microvolts RMS (measured prior to tophat filtering)	A	Magnetometer EMI test procedure	Lockhart
3.2.2.2	Corpuscular Radiation Environment	The unit will operate in the ambient radiation environment of all parts of the GB-B orbit except the South Atlantic Anomaly (SAA). The unit will recover from passage through the SAA and will again operate by the time of the next GI-to-GV transition after an SAA passage.	N/A		
3.2.2.2.1	Proton and Electron Instantaneous Flux Disturbances	The unit design shall be sufficient to reject disturbance due to Proton and Electron Instantaneous Fluxes shown in P0149 to level specified in roll and annual stability specs in its mounted configuration on the payload.	A	EM (TBS)	Lockhart
3.2.2.2.2	Galactic Cosmic Ray Flux Disturbances	The unit design shall be sufficient to reject disturbance due to Galactic Cosmic Ray Fluxes shown in P0149 to level specified in roll and annual stability specs in its mounted configuration on the payload.	A	EM (TBS)	Lockhart
3.2.2.2.3	Mission Integrated Proton Fluence Disturbances	The unit design shall meet performance requirements after exposure to Mission Integrated Proton Fluence shown in P0149 attenuated by shielding due to its mounted configuration and shall meet annual stability specs.	A	EM (TBS)	Lockhart
3.2.2.2.4	Solar Flare X-Ray Instantaneous Flux	The unit shall meet performance requirements when Solar Flare X-Ray Instantaneous Flux is less than 0.001 W/m^2.	A	EM (TBS)	Lockhart
3.2.2.3	Vibration Testing Levels	The unit shall be subjected to the Figure 1 environment in each of 3 axes, 1 minute /axis. Test tolerance shall be as listed in Table 1.	T	Vibration Test Procedure	Iufer

Para	Title	Requirement Text and *Comment*	**Ver Mtd**	**Verification Plan**	**REE**
3.2.2.4	Pyroshock Testing Level	The Payload Magnetometer shall be capable of performance as specified herein after exposure to the protoqual pyroshock environment, which consist of a half sine pulse having duration of 0.50 milliseconds and a half sine pulse zero-to-peak amplitude of 1500 g.	T	Pyroshock Test Procedure	lufer
3.2.2.5	Thermal Environment		N/A		
3.2.2.5.1	Magnetometer Baseplate Operational Temperature Range	The unit shall meet performance requirements at the operating temperature range from 200 to 320 K.	T	T/V test Procedure	lufer
3.2.2.5.2	Survival Test Temperature Range	The unit shall meet performance requirements after exposure to the survival test temperature range from 200 to 325 K.	T	T/V test Procedure	lufer
3.2.3	Electrical Performance.		N/A		
3.2.3.1	Full Scale Measurement Range	The payload magnetometer shall have a full scale range of +/- 1.0 +/-0.1 Gauss.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.2	Field to Voltage Scale Factor	The magnetic field to output voltage scale factor shall be 4.0 +/- 0.25 Volts/Gauss.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.3	Scale Factor Stability	The scale factor shall change by no more than 0.02% per Kelvin of temperature change.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.4	Noise Level	The payload magnetometer noise level shall be less than 1.0 x 10^{-4} Gauss RMS in a 1.0 Hz bandwidth.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.5	Linearity	The deviation from linearity of the voltage output versus magnetic field transfer function shall be less than 0.2 %.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.6	Initial Zero Offset	The initial zero offset shall be less than 4.0 mG.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.7	Zero drift	The zero drift shall be less than 0.1 mG per degree Kelvin of temperature change.	T	Magnetometer Full Functional Procedure	lufer
3.2.3.8	Frequency Response	The transfer function shall not vary by more than 20% for signal frequencies over the range from DC to 0.1 Hz and shall be measured to a precision of 0.1 % at DC, 0.05 Hz, 0.1 Hz, 0.25 Hz, and 0.35 Hz.	T	Magnetometer Full Functional Procedure	lufer
3.2.4	Payload Magnetometer Mechanical Specifications		N/A		

Para	Title	Requirement Text and *Comment*	**Ver Mtd**	**Verification Plan**	**REE**
3.2.4.1	Sensor Box Maximum Dimensions	The unit dimension shall be less than 4"L X 3" W X 3.5" H	I	Inspect per Magnetometer Assembly Drawing	Taller
3.2.4.2	Mass/Unit	The unit mass shall be less than or equal to 0.20 Kg	I	Review vendor data	Taller
3.2.4.3	Power, Max per Unit	The power consumption per unit and associated electronics, averaged over any orbit shall be less than or equal to 0.5 Watts. This power is furnished by the ECU and is included in the ECU power budget.	T	Magnetometer Full Functional Procedure	lufer

C. Payload Magnetometer Requirements Verification Documents Checklist

MAGNETOMETER Test Procedures

Author	Title
Ernie Iufer	Full Functional Test Procedure for Payload Magnetometer
Ernie Iufer	Abbreviated Functional Test Procedure for Payload Magnetometer
Ernie Iufer	MAGNETOMETER Proto-Qual Pyroshock Test Procedure
Ernie Iufer	MAGNETOMETER Proto-Qual Random Vibration Test Procedure
Ernie Iufer	MAGNETOMETER Proto-Qual Thermal/Vacuum Test Procedure

Additional Documents

	Date	Author	Title
PLSE-12	10/27/98	A. Nakashima	Payload Specification
S0356	10/29/98	J. Lockhart	MAGNETOMETER Specification
P086822	7/25/97	C. Chivatero	Spacecraft Contamination Control Plan

D. Payload Magnetometer Test Personnel Status Checklist

Test Director / QA

The test director is Ernie Iufer (Backup: Jim Lockhart).

The QA personnel is Ben Taller (Back-up: Phil Unterreiner).

E. Action Item Closure Status

Note: Action items 4, 9 and 12 are not required to be completed to sign-off the TRR. The other actions are required to be closed prior to TRR sign-off.

Action Items	Assignee	Orig:	ECD	Closure Information
1. Complete the verification plan of the VRCM.	Chun, Iufer Lockhart	John Turneaure	Closed	VRCM updated with all verification plans.
2. Confirm the PL magnetometer alignment plan and update alignment requirements 3.2.4.4 to be consistent with PLSE-12 3.2.2.6.	Lockhart / Shaul, Iufer	John Turneaure	Closed	The PL magnetometer alignment plan was reviewed, and Para 3.2.4.4 was deleted since it was same requirement as PLSE-12 para 3.2.2.6.
3. Release a magnetometer Interface Control Drawing. Have John Thatcher review, approve and sign the ECU interface.	Ernie Iufer	Bob Schultz	Closed	Op orders and installation drawings to install sensors are in review. The cable drawing 8A01548 and 8A01549 are released. These two documents are sufficient for Payload magnetometer interface definition to ECU and dewar.
(4.) Verify that the installation drawings and op orders have the connectors to the magnetometer and the hardware mounted to the dewar rings properly staked to avoid loosening by vibration.	Marc Campell	Gaylord Green	Open	
5. Investigate shock testing the payload magnetometer at NASA/Ames. Work with Ken Shaul on shock level.	Gaylord Green	Sasha Buchman	Closed	The investigation completed, and the shock level was finalized.
6.Verify requirements 3.2.2.5.1 and 3.2.2.5.2 survival and operating temperature ranges. Review the thermal installation plan.	Gaylord Green / Kevin Burns	John Turneaure	Closed	The magnetometer is not under a thermal blanket. There is no apparent advantage making a blanket for the boxes. The cold seasonal temperature is 200 K for a survival and operating temperatures. The thermal mass of the dewar will preclude large roll changes. (Response by Gaylord Green)
7. Release the payload magnetometer specification. Include red-lines from the TRR meeting. Investigate if it proper to release the specification as an s-doc.	Sei Chun		Closed	The PL magnetometer spec is released as S0356.
8. Review reqs. 3.2.3.1 thru 3.2.3.8 on specification tolerances and update if necessary.	Lockhart Iufer		Closed	The review was completed and updated.
(9.) Provide information to Ken Shaul to request mounting screws so LMMS can provide them for installation at Stanford. The dewar will be provided to LMMS with the PL magnetometers installed.	Ernie Iufer	Ernie Iufer	Closed	The information was provided to Ken.
10. Release test procedures in Ernie Iufer's release system. Ben Taller's approval signature is required on all procedures.	Ernie Iufer		Closed	The test procedures are released with QA approval signature.
11. Include the PL magnetometer test flow in both the traveler and in the TRR presentation package.	Ernie Iufer		Closed	The traveler includes test flow and TRR completion certificate has the test flow.

Action Items	Assignee	Orig:	ECD	Closure Information
(12.) Write the payload magnetometer installation op order and installation drawing for mounting the magnetometers on the dewar at Stanford.	Marc Campell		Open	
13. Provide the payload magnetometer calibration plan by forming a working group to update the calibration plan with minimal impact to ECU flight electronics. The working group is chaired by Jim Lockhart and includes Lim Mar, Lou Yamanishi, John Thatcher and Ernie Iufer. If necessary, relax the specification to reflect the updated calibration process.	Jim Lockhart		Closed	Payload magnetometer sensor test approach was written by Jim Lockhart.
14. Each qualification test procedure should include a 24 hour notice to ONR that testing is about to begin.	Ernie Iufer	Ben Taller	Closed	All procedures include a 24 hour notice.
15. Complete the remaining parts of the TRR package: a) as-built vs. as-designed, b) test personnel status, c) test resources status, d) test support software status.	Ernie Iufer	Bob Schultz	Closed	Since PL Magnetometer is a subcontracted item these sections are not required.