GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

P0862 REV -

DEWAR LIFETIME AND THERMAL DATA ACQUISITION

03 August 2001

Approvals:

Program Responsibility	Signature	Date
Prepared by: R. Brumley		
B. Muhlfelder Program Technical Manager		
R. Whelan Systems Engineering		
D. Ross GP-B Quality Assurance		
R. Brumley Payload Technical Manager		

NOTES:
Level of QA required during performance of this procedure:
___Stanford QA Representative
___Government QA Representative

All redlines must be approved by QA

Revision Record:

Rev	Rev Date	ECO #	Summary Description
-	08/03/2001		

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning

Table of Contents

A Scope

This procedure is use to acquire data related to the verification of some of the thermal requirements contained in PLSE-12 and T003. The actual operations used to perform this task are contained in other procedures (P0544 P0540 and P0871). This procedure is a place to record the data in support of various requirements and record the configuration under which the data was taken, therefore aiding in the requirements traceability process.

B Requirements Verification

B.1 Requirements Cross Reference

ID #	Req't. Source	Req't. Number	Requirement (Title and Description)	Ver. Method	Req't. Owner
177	2. T003	12.8	Thermal Requirements - The probe has a thermal design consistent with the Dewar lifetime requirement (Section 13). During on-orbit operation when the heat power in the QBS meets the requirements in 3.7.2.4.7 of PLSE-12, the probe thermal design shall (a) provide a temperature of the QBS fingers of <= 3.0K with the capability of being maintained with a stability of 1.0 mK rms in a 100 mHz bandwidth and with a stability of 0.2 mK in a 3 mHz bandwidth centered on roll frequency, and it shall (b) provide a temperature at the SQUID bracket attachment point of <= 3.0 K.	A,T	Muhlfelder, Murray Meriwether
	3. PLSE-12	3.2.1.10	Orbital Life - The Science Payload shall have an orbital operating lifetime of >= 16.5 months after initiation of launch. The lifetime includes operations such as spinup, flux flushing, and low temperature bakeout. The 16.5 mo requirement is reduced on a pro-rata basis for any increased helium flow rate required by the spacecraft helium thrusters for attitude control, translation control, or orbit trim.	A,T	Taber
174	3. PLSE-12	3.2.1.4	Thermal Requirements - The Science Payload shall be capable of meeting the SIA thermal requirements specified in 3.4, 11.1, and 12.8 of T003. --T003 12.8 Thermal Requirements - see below	I,A,T PCB 473	Muhlfelder, Murray, Burns, Meriwether
283	3. PLSE-12	3.7.2.5.1.1	Support Flange Temperature - The temperature of the Quartz Block Support (QBS) fingers shall meet the requirement specified in 12.8 of T003. From 12.8 of T003 (Thermal Requirements): The probe has a thermal design consistent with the Dewar lifetime requirement (Section 13). During on-orbit operation when the heat power in the QBS meets the requirements in 3.7.2.5.7 of PLSE-12, the probe thermal design shall (a) provide a temperature of the QBS fingers of <= 3.0K	A,T	Taber, Murray, Muhlfelder, Burns

			with the capability of being maintained with a stability of 1.0 mK rms in a 100 mHz bandwidth and with a stability of 0.2 mK in a 3 mHz bandwidth centered on roll frequency, and it shall (b) provide a temperature at the SQUID bracket attachment point of <= 3.0 K.		
175	3. PLSE-12	3.7.2.5.1.2	Support Flange Temperature Stability -The temperature stability of the QBS fingers shall meet the requirement specified in 12.8 of T003. From 12.8 of T003 (Thermal Requirements): The probe has a thermal design consistent with the Dewar lifetime requirement (Section 13). During on-orbit operation when the heat power in the QBS meets the requirements in 3.7.2.5.7 of PLSE-12, the probe thermal design shall (a) provide a temperature of the QBS fingers of <= 3.0K with the capability of being maintained with a stability of 1.0 mK rms in a 100 mHz bandwidth and with a stability of 0.2 mK in a 3 mHz bandwidth centered on roll frequency, and it shall (b) provide a temperature at the SQUID bracket attachment point of <= 3.0 K.	A,T	Muhlfelder, Murray, Meriwether
287	3. PLSE-12	3.7.2.5.3	Support Flange Thermal Resistance - The thermal resistance of the SIA/support flange during "normal operation" shall be such that the temperature of the QB flange does not exceed that of the QBS fingers by more than 50 mK. PCB 457	A,T	Taber, Murray
289	3. PLSE-12	3.7.5.5.1	Temperature at Station 200 – The dewar Station 200 shall be maintained below 1.85 K with a heat load from the probe of <= 65 mW, and the bath temperature <= 1.8 K.	A,T	Taber, Murray, Burns

B.2 Expected Data for verification per requirement

- All of these requirements require additional analysis for the final buyoff. Therefore the data collected in this procedure will not have an obvious path to a pass/fail on the requirement. This procedure gives guidelines on how and under what conditions to take the data.
- For each data set, the RE shall review the data, make an attachment plot which supports the requirement, and affix it to the end of this procedure. This plot shall be reviewed and signed by the RE, QA, and Systems Engineering as being data which supports the requirements (since analysis is required to achieve the actual verification, the signature is NOT saying the requirement has been achieved, only that it properly supports the requirement).

C **Configuration Requirements**

Probe C is installed in the dewar and being pumped on by the Leakage Gas Management pumping system.

D **Hardware Required**

D.1 Flight hardware required

Description	No. Req'd
Probe C in Flight Dewar	1

D.2 Commercial test equipment

(Complete table per actual hardware used)

Manufacturer	Model	Serial Number	Calibr. Exp. Date

D.3 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
Probe C Leakage Gas Management System	N/A	N/A	N/A	N/A
Facility Data Acquisition System	N/A	N/A	N/A	N/A
Dewar Data Acquisition System	N/A	N/A	N/A	N/A

D.4 Tools

Description	No. Req'd

D.5 Expendables

Description	Quantity

E **Software Required**

No software is required.

F **Procedures Required**

No other procedures are required.

G **Equipment Pretest Requirements**

No equipment pretests required.

H Personnel Requirements

This test to be conducted only by the following certified personnel:

- Mike Taber
- Robert Brumley
- Dave Meriwether
- Denys VanRenen
- Barry Muhlfelder
- Bruce Clarke
- William Bencze

Only the following certified personnel may operate the Facility and Dewar Data Acquisition Systems:

- Dave Murray
- Jim Maddocks
- Mike Taber

I Safety Requirements

General

It is important to be cognizant at all times of the position of the probe. Be extremely careful not to accidentally bump into the probe. If any connector does not connect smoothly and securely, do not try to force it. Instead, remove the connector and inspect it to find the reason for the difficulty. Great care must be taken at all times during the performance of this procedure.

Electrostatic Discharge

Grounded wrist straps shall be worn at all times when mating to or demating from an electrical connector on Probe C.

Personnel Safety

All operations shall take place according to Stanford University safety guidelines. Any person observing a situation that they deem unsafe shall report the fact immediately to the test director. The Quality Assurance representative shall be responsible for monitoring that all activities are performed in a safe manner.

Mating and demating of flight hardware electrical connectors

- Connection and disconnection shall be performed only when the equipment involved is in a powered-down state.
- Connector savers are to be used unless otherwise specified.
- Connectors shall be inspected for contamination and for bent, damaged, or recessed pins prior to mating.
- Grounded wrist straps are to be worn prior to removal of connector caps or covers and during mating/demating operations.

- ESD-protective caps or covers are to be immediately installed after demating of connectors.
- Update all applicable mate/demate log when mating to or demating from any probe connector.

J General Instructions

- Redlines can be initiated by D. Meriwether, B. Muhlfelder, R. Brumley, M. Taber, and D. Murray, and must be approved by QA.
- Any nonconformance or test anomaly should be reported by a Discrepancy Report. Refer to the Quality Plan, P0108, for guidance. Do not alter or break test configuration if a test failure occurs; notify quality assurance.
- Only the following persons have the authority to exit/terminate this test or perform a retest: Rob Brumley, Chris Gray, Ken Bower, Bruce Clarke, Sasha Buchman, and QA personnel

K References and Applicable Documents

Op. Order No._____

Date Initiated_____

Time Initiated_____

L OPERATIONS

NOTIFY ONR AND QA PRIOR TO THE START OF THIS PROCEDURE

L1 Pre-Test Checklist

Start Date: _____

Start Time: _____

L2 Science-Mission Heat Loads / Requirements Verification Data

L.2.1 Configure the payload such that 8.5 mW of power is being coupled into the quartz block. This can be accomplished in several ways:

(1) Use of the ECU analog closed-loop controller set to a set point such that 8.5 mW is being coupled into the resistor.

(2) Use of an open-loop ECU heater set to some value (e.g. 6.5 mW to model the heat being added by the SRE SQUID bracket control and the TRE), and the analog AC controller set to 2 mW.

(3) Use of the ECU analog AC controller (supplying a nominal 2 mW of heat) coupled with a combination of open-loop heat sources, such as (a) the TRE (nominally 6 mW), (b) the SQUID bracket controller (nominally 0.50 mW), and open-loop ECU heaters (if either the TRE or SRE isn't available).

Other configurations may also be acceptable, as long as there is a new 8.5 mW being coupled into the quartz block.

Record details of configuration below:

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Relevant Data Files:

Record file names for relevant data contained in this procedure:

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Additional Notes:

REQUIREMENT:

177	2. T003	12.8	Thermal Requirements - The probe has a thermal design consistent with the Dewar lifetime requirement (Section 13). During on-orbit operation when the heat power in the QBS meets the requirements in 3.7.2.4.7 of PLSE-12, the probe thermal design shall (a) provide a temperature of the QBS fingers of <= 3.0K with the capability of being maintained with a stability of 1.0 mK rms in a 100 mHz bandwidth and with a stability of 0.2 mK in a 3 mHz bandwidth centered on roll frequency, and it shall (b) provide a temperature at the SQUID bracket attachment point of <= 3.0 K.	A,T	Muhlfelder, Murray Meriwether

REQUIRED DATA:

Measurement of QBS thermometer while it is less than 3.0 K sampled as often as possible for at least 2 hours. Ideally, the data would also include an SRE measurement of the SQUID bracket control (controller off), but this is not required.

REQUIREMENT:

	3. PLSE-12	3.2.1.10	Orbital Life - The Science Payload shall have an orbital operating lifetime of >= 16.5 months after initiation of launch. The lifetime includes operations such as spinup, flux flushing, and low temperature bakeout. The 16.5 mo requirement is reduced on a pro-rata basis for any increased helium flow rate required by the spacecraft helium thrusters for attitude control, translation control, or orbit trim.	A,T	Taber

REQUIRED DATA:

Measurement of the Helium flow rate from the Dewar using the GSE DAS system. This data should be supplied to Kevin Burns (along with other supporting plots for this section) in support of his analysis.

REQUIREMENT:

174	3. PLSE-12	3.2.1.4	Thermal Requirements - The Science Payload shall be capable of meeting the SIA thermal requirements specified in 3.4, 11.1, and 12.8 of T003. --T003 12.8 Thermal Requirements - see below	I,A,T PCB 473	Muhlfelder, Murray, Burns, Meriwether

REQUIRED DATA:

None. This is just a cross reference to other requirements. Only T003 12.8 is relevant to this procedure, and that data has been specified above.

REQUIREMENT:

283	3. PLSE-12	3.7.2.5.1.1	Support Flange Temperature - The temperature of the Quartz Block Support (QBS) fingers shall meet the requirement specified in 12.8 of T003. From 12.8 of T003 (Thermal Requirements): The probe has a thermal design consistent with the Dewar lifetime requirement (Section 13). During on-orbit operation when the heat power in the QBS meets the requirements in 3.7.2.5.7 of PLSE-12, the probe thermal design shall (a) provide a temperature of the QBS fingers of <= 3.0K with the capability of being maintained with a stability of 1.0 mK rms in a 100 mHz bandwidth and with a stability of 0.2 mK in a 3 mHz bandwidth centered on roll frequency, and it shall (b) provide a temperature at the SQUID bracket attachment point of <= 3.0 K.	A,T	Taber, Murray, Muhlfelder, Burns

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REQUIREMENT:

287	3. PLSE-12	3.7.2.5.3	Support Flange Thermal Resistance - The thermal resistance of the SIA/support flange during "normal operation" shall be such that the temperature of the QB flange does not exceed that of the QBS fingers by more than 50 mK. PCB 457	A,T	Taber, Murray

REQUIRED DATA:

Measurement of QBS finger thermometer (T010P or T011P) and QB flange (T011P) for at least 15 minutes. Attach plots.

REQUIREMENT:

289	3. PLSE-12	3.7.5.5.1	Temperature at Station 200 – The dewar Station 200 shall be maintained below 1.85 K with a heat load from the probe of <= 65 mW, and the bath temperature <= 1.8 K.	A,T	Taber, Murray, Burns

REQUIRED DATA:

Measurement of Station 200 temperature using the DAS. Append plots.

INCLUDE ADDITIONAL DATA PLOTS HERE

L3 ADDITIONAL ENGINEERING INFORMATION

In order to better understand the thermal performance of the system, at the discretion of M. Taber and B. Muhlfelder, additional data may be taken under different heat loads. This data may include:

(1) Addition of open-loop heat through the SRE, ECU, or TRE

(2) Use of the analog AC ECU QBS temperature controller

(3) Use of the FDAS system to confirm thermal measurements

(4) "Sanity check" calibrations of power going down ECU cables

At no time may the quartz block be taken above 8 Kelvin, and the lead bag must stay less than 6 Kelvin. Within those parameters (and with the expression permission of B. Muhlfelder, M. Taber, and QA), additional measurements may be made.

Append written notes and plots to this procedure.

Archive Data Files:

Signoff:

Test Director (Mike Taber): _____

Quality Assurance (Dorrene Ross): _____

Systems Engineering (R. Whelan): _____