GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

CONFIGURE PAYLOAD FOR CRYO OPS FOLLOWING TRANSPORT

P0793 Rev A
ECO 1356
2/8/02

Prepared by: J. Maddocks
Revised by: M. Taber
Approvals:

Program Responsibility	Signature	Date
D. Murray Cryo. Test Director		
M. Taber Payload Test Director		
Harv Moscowitz LM Safety		
D. Ross GP-B Quality Assurance		
R. Brumley Payload Technical Manager		

Revision Record:

Rev	Rev Date	ECO #	Summary Description
A	28/02	1356	1) Changed GHe changeout reference from P0801 to P0881; 2) Reordered procedure to make transition from TM&A to DAS later to reflect current sequencing; 3) Changed from use of MT vent line to temporary plastic line during tilt-up operation; 4) Updated fiqures.

Acronyms and Abbreviations:

Acronym / Abbreviation	**Meaning**
GSE	Ground Support Equipment
GT	Guard Tank
LM	Lockheed Martin
MT	Main Tank
NBP	Normal boiling point
PPMS	Probe Pressure Measurement System
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar
S/V	Space Vehicle (Payload integrated with Spacecraft)

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A Scope

This procedure effects the preparation of the SMD for cryo operations following transport to a new location.

B Requirements Verification:

N/A

C Configuration Requirements

The integrated Payload is installed in the Spacecraft and/or the shipping fixture. The Payload is in the horizontal orientation (as needed for shipment) and is transferred (by LM procedure) to the Tilt Dolly in order to be tilted back to the vertical orientation. The Payload configuration is as obtained following completion of the procedure used to prepare for transport (example, P0885). The Main Tank is less than 50% full of NBP liquid helium, and the Guard Tank is empty of liquid and is maintained at positive pressure relative to atmospheric by an external source of helium gas.

D Hardware Required

D.1 Flight hardware required

Description	No. Req'd
GP-B Payload or Space Vehicle	1

D.2 Commercial test equipment: N/A

D.3 Mechanical/Electrical special test equipment: N/A

D.4 GSE / hardware:

Note: Items in parentheses are for reference, their use being described in a called procedure.

Description	No. Req'd
~15 ft of 3/8" plastic tubing with KF 40 fitting on one end and shutoff valve on the other (Fig. 3)	1

D.5 Tools

Description	No. Req'd

D.6 Expendables

Description	Quantity

E Software Required:

N/A

F Procedures Required

P0773, *Certify Electrical Module, Gas Module, and DAS*
P0790, *Disconnect TM&A from SMD*
P0791 *Connect Electrical GSE to SMD*
P0774, *SMD Functional Test (Abbreviated)*
P0674, *Connect Main Tank Vent Lines to Gas Module – Main Tank at NBP*

P0676, *Connect Guard Tank Vent Line to Gas Module*
P0881, *Verify Helium Cylinder Content/Connect Helium Supply Line*

G **Equipment Pretest Requirements**:

N/A

H **Personnel Requirements**

H.1 **Personnel Responsibilities**

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The person performing the operations (Test Director or Test Engineer) is to sign the "Completed by" sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the "Witnessed by" sign-off. ***The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 "GP-B Maintenance and Testing at all Facilities." Checklists will be used as directed by P0875***

H.2 **Personnel Qualifications**

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the SMD operations. Test Engineers must have SMD Cryogenic operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

H.3 **Qualified Personnel**

The names of those actually performing this procedure are to be initialed and the name of the person acting as Test Director should be circled.

Test Director	***Test Engineer***
Mike Taber	Tom Welsh
Dave Murray	Dave Hipkins
Ned Calder	Bruce Clarke
	Ned Calder

I **Safety**

I.1 **Potential Hazards**

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware. Examples include: positioning Dewar in tilt stand; integrating probe with airlock; positioning airlock on Dewar; removing airlock from Dewar; removing probe from Dewar; and positioning support equipment such as pressurized gas cylinders and supply dewars.

A number of undesired events may be associated with these operations. For example, personnel or equipment can be struck when hardware is being moved (e.g. by forklift or crane load). Personnel are subject to entrapment while positioning hardware, such as hands or feet caught between objects as hardware is moved into place. Suspended hardware may be dropped. Personnel can be caught between objects such as forklifts and walls or loads and building support columns.

In addition, liquid helium used in the SMD represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the

cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C discusses the safety design, operating requirements and the hazard analysis of the SMD.

I.2 Mitigation of Hazards

I.2.1 Lifting hazards

There are no lifting operations in this procedure

I.2.2 Cryogenic Hazards

The LM Building may have an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent line deflectors are installed over the four burst disks on the SMD vacuum shell.

Only authorized and trained LM and SU personnel are allowed In the LM facilities without escort. All personnel working at a height 30 inches or more off the floor are required to have an LM-approved Emergency Breathing Apparatus (EEBA) within easy reach. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact LM safety.

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing and full-face shields are to be worn whenever the possibility of splashing cryogens exists.

I.2.3 Other Hazards

When appropriate, tools or other items used with the potential to damage the SMD or Probe shall be tethered.

I.3 Mishap Notification

I.3.1 Injury

In case of any injury obtain medical treatment as follows
LM **Call 117**

I.3.2 Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229.

J Quality Assurance

J.1 QA Notification

The NASA representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

J.2 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the PTD or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the PTD or QA Representative, experiment functionality may be affected.

J.3 Discrepancies

A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.

J.4 All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

J.5 Redlines can be initiated by Mike Taber and must be approved by QA.

J.6 A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108.

J.7 Work done inside the HEPA filter downflow unit should with proper clean room garb consistent with Class 1000 conditions.

K References and Applicable Documents:

N/A

Op. Order No._____
Date Initiated_____
Time Initiated_____

L Operations

(**Note:** Operations listed in brackets are performed by LM personnel using LM Op Orders.)

L.1 Verify Appropriate QA Notification

- o Verify SU QA program office notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- o Verify NASA representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

L.2 Prepare to unload from transporter.

L.2.1 Remove Auxiliary Helium Pressurization System from transporter, per procedure P0881, *Verify Helium Cylinder Content/Connect Helium Supply Line,* immediately reconnecting helium gas supply (on a movable cart) to Guard Tank.

L.2.2 Rearrange TM&A cabling as necessary.

L.3 [After removal from the MPT, S/V is transported to tilt dolly.] Stanford personnel move Auxiliary Helium Pressurization System together with Payload to keep Guard Tank pressurized.

L.4 [Remove protective cover from Payload / Space Vehicle.]

L.5 Verify Initial Configuration

L.5.1 SMD mounted in tilt-dolly, in horizontal orientation, with sunshade installed.

L.5.2 Guard Tank vent short line installed and pressure regulated through GTV-Va (1.5 to 3 psig) via Auxiliary Helium Pressurization System (CPR-1).

L.5.3 Main Tank vent capped with 0.3 psid relief per Figure 2.

L.5.4 Fill cap assembly installed at SV-13.

L.6 Preparation for uprighting S/V:

L.6.1 Connect the temporary plastic line (Fig. 3) to MTVC-V. This will provide a contingency vent path while the S/V is being tilted to vertical to provide additional cooling, if needed.

L.6.2 Open VC-V and MTVC-V to purge the plastic line.

L.6.3 Close VC-V, leaving MTVC-V open.

L.6.4 Before proceeding with the next step, verify the MT relief valve is venting or that STG is reading at least 14 torr above atmospheric pressure and record:_____torr diff.

L.7 [Using Tilt Dolly, upright S/V.]

Note: Stanford personnel to monitor temperatures at Station 200 and top of Lead Bag while uprighting SMD. Record data in Table 1. If the Lead Bag temperature rises above 6 K, open VC-V to produce controlled blowdown of Main Tank pressure. When Lead Bag temperature stabilizes below 6 K, close VC-V. Continue to monitor temperatures. If venting Main Tank gas does not have the desired effect of lowering the Lead Bag temperature, return to horizontal orientation.

- Payload successfully brought to vertical orientation. Record date/time:_____
- Payload returned to horizontal orientation due to high temperature at top of Lead Bag. End procedure here. Record date/time:_____

L.8 Monitor temperatures to verify Station 200 and Lead Bag temperatures are stable or stabilizing.

L.9 Verify Electrical Module, Gas Module, and DAS certified per procedure P0773, *Certify Electrical Module, Gas Module, and DAS*. Record date, time and operation number _____ / Op. No._____.

L.10 When the S/V is in position for connection to the DAS, disconnect the TM&A : perform procedure P0790, *Disconnect TM&A from SMD*. Record date, time and operation number _____ / Op. No._____.

L.11 Connect Electrical GSE – perform procedure P0791, *Connect Electrical GSE to SMD*,. Record date, time and operation number _____ / Op. No._____.

L.12 Perform abbreviated SMD functional test, procedure P0774, *SMD Functional Test (Abbreviated)*, Record date, time and operation number _____ / Op. No._____.

L.13 Perform P0674, *Connect Main Tank Vent Lines to Gas Module – Main Tank at NBP.* Record date, time and operation number _____ / Op. No._____.

L.14 Connect Guard Tank vent line to Gas Module per procedure P0676, *Connect Guard Tank Vent Line to Gas Module*. Record date, time and operation number _____ / Op. No._____.

Operation completed. Completed by: _____

QA witness: _____

Date: _____

Time: _____

QA Program Engineer_____**Date**_____

Payload Test Director_____**Date**_____

Table 1

Date/ Time	SMD Angle (degrees)	Sta 200 Temp T[1] (K)	Top of Pb Bag temp T[28] (K)	Change in T[28]/min (K/min)	MT Pressure STG (torr diff)	MT Liquid Level (LLS-A) %

Figure 1 (Note: SMD valve references in the text have an “S” prefix.)

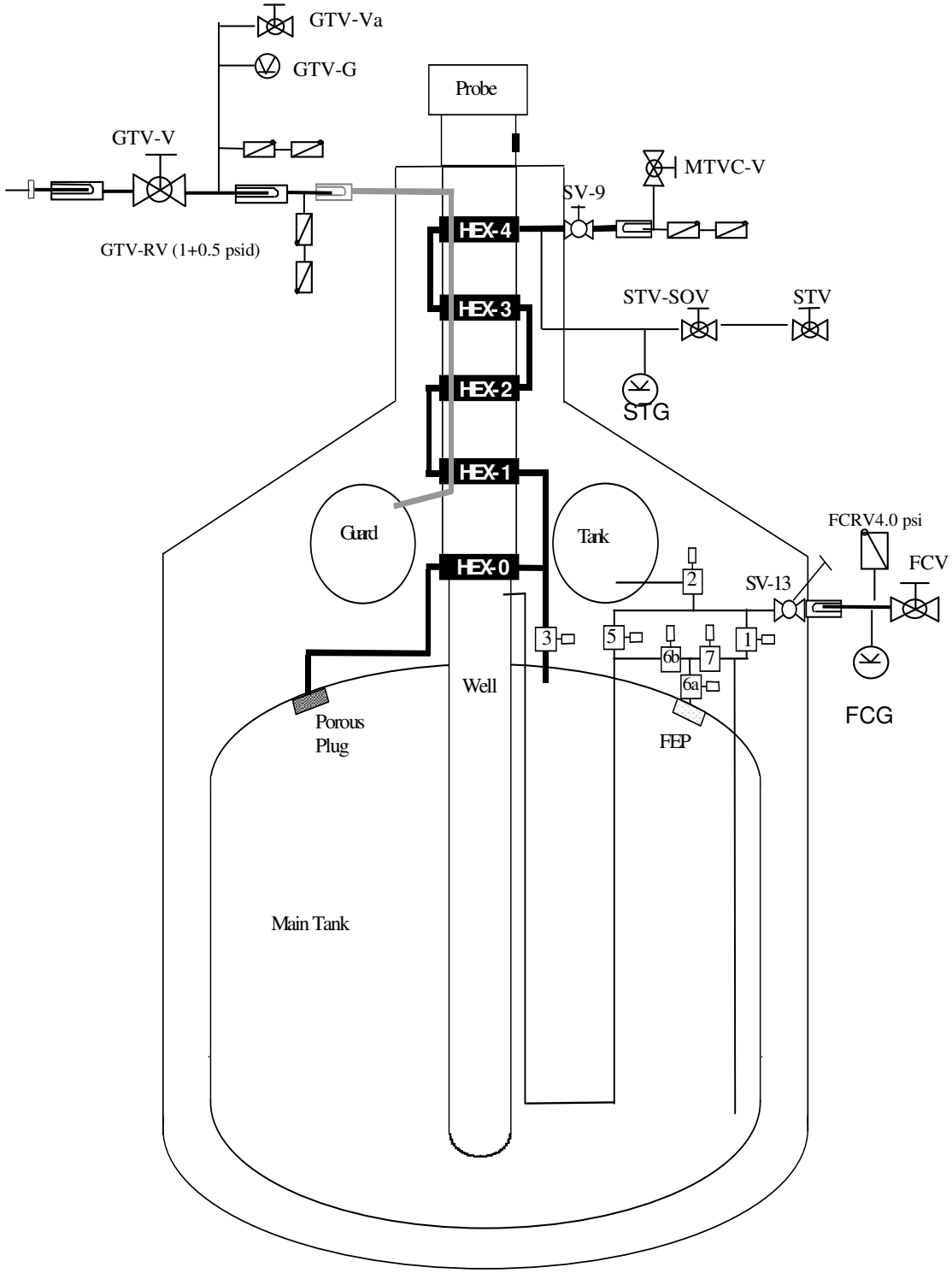

Figure 2 Main Tank vent cap for use during transportation.

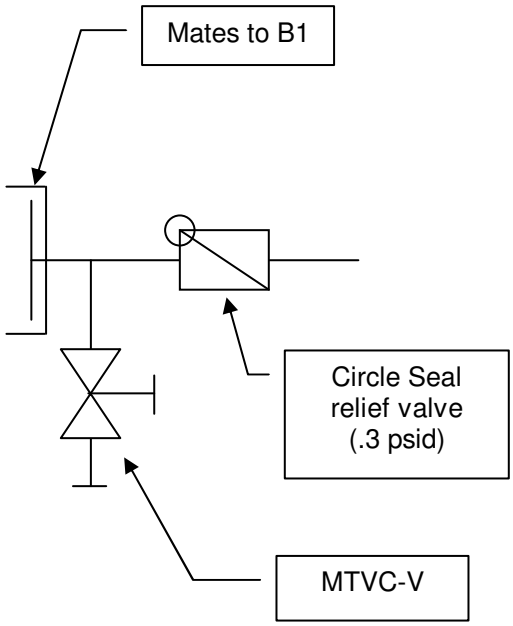

Figure 3 Main Tank vent line for use during uprighting after transportation.