GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

CONFIGURE PAYLOAD FOR TRANSPORT TO B159

2/4/02

Prepared by: M. Taber

Approvals:

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

Revision Record:

Rev	Rev Date	ECO #	Summary Description
-			

Acronyms and Abbreviations:

Acronym / Abbreviation	**Meaning**
DAS	SMD Data Acquisition System
FDAS	Facility Data Acquisition System (used to monitor the Probe)
GSE	Ground Support Equipment
GT	Guard Tank
LGS	Leakage Gas System
MT	Main Tank
NBP	Normal boiling point
PPMS	Probe Pressure Measurement System
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar

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A Scope

This procedure effects the preparation of the Payload (Probe-C integrated with the SMD) for shipment while integrated with the Spacecraft.

B Requirements Verification:

N/A

C Configuration Requirements

C.1 General

The Payload is integrated with the Spacecraft and and oriented with the +Z axis vertical.

C.2 Main Tank

Liquid in the Main Tank must be at its normal boiling point (NBP)

C.3 Guard Tank

The Guard Tank is either empty of liquid and being maintained at a pressure slightly above atmospheric by an external source of helium gas, or is at least 15% full of liquid helium.

C.4 Fill Bayonet

The Fill Bayonet (B3, see Fig. 1) has a standard GSE Fill Cap Assembly installed.

C.5 Well

The Well must be evacuated.

C.6 SMD Vacuum Shell

The Vacuum Shell pressure must be less than 5×10^{-5} torr. Document No. P0213, *Connect Vacuum Module to SMD*, contains the procedure for connecting to and pumping on the SMD vacuum shell.

D Hardware Required

D.1 Flight hardware required

Description	No. Req'd
65113-1C34292 Probe-C / Science Mission Dewar Assembly integrated in the Spacecraft	1

D.2 Commercial test equipment: N/A

Manufacturer	Model	Serial Number	Calibr. Exp. Date

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
Thruster vent manifold (see Fig. 2)	1
Main Tank vent cap GSE (bayonet cap with 0.3 psid Circle Seal relief valve; see Fig. 3)	1
(Utility Turbopump System, UTS)	1

D.5 Tools

Description	No. Req'd

D.6 Expendables

Description	Quantity

E **Software Required**:

N/A

F **Procedures Required**

(Note: All the following should be available; however, depending on circumstances, not all will be needed.):

P0212, *Empty the Guard Tank*
P0213, *SMD Connection of High Vacuum Module*
P0214, *Stop Pumping SMD Vacuum Shell / Disconnect Vacuum Module*
P0442, *Main Tank Fill with Guard Tank Precool – Main Tank at NBP*
P0595, *Reduce Level in MT (Liquid at NBP)*
P0613, *Repump Well with Probe Installed*
P0648, *Main Tank Fill After Uprighting – Guard Tank Initially Empty*
P0675, *Disconnect MT Vent Line from Gas Module – MT at NBP*
P0677, *Disconnect GT Vent Line from GM*
P0788, *Disconnect Electrical GSE from SMD*
P0789, *Connect TM&A to SMD*
P0797, *Pressurize the Guard Tank*
P0799, *Prepare and Verify Probe Configuration for Shipment*

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.
3. 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.

K **References and Applicable Documents:**

N/A

Op. Order No._____
Date Initiated_____
Time Initiated_____

L Operations

L.1 Verify Appropriate QA Notification

- Verify SU QA program office notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA representative notified.

  Record: Individual notified _____,

  Date/time _____/_____..

L.2 Check pressure in the SMD vacuum jacket:

L.2.1 Turn on the Ion Pump and record time / date:_____

L.2.2 Initiate [Monitor Data] on the DAS using channel no. 99.

L.2.3 Wait until the pressure stabilizes and record vacuum jacket pressure (IP):_____torr.

L.2.4 Exit [Monitor Data] and collect data with [Set Data Interval] (use existing data interval).

L.2.5 After the data cycle is complete, turn off the Ion Pump.

L.3 If the pressure measured by the Ion Pump is > 5×10^{-5} torr, or the Test Director determines that it is necessary, pump on the on SMD vacuum jacket using P0213, *Connect Vacuum Module / Pump on SMD Vacuum Shell*. Record the Op No.:_____.

L.4 Record the liquid levels in the Main Tank and Guard Tank:

Main Tank:_____%

Guard Tank:_____%

L.5 If the Main Tank is <40% full, fill Main Tank to 50 –52%:

- Guard Tank empty: Perform P0648, *Main Tank Fill After Uprighting – Guard Tank Initially Empty*. Record Op. No.:_____.
- Guard Tank >15% full: Perform P0442, *Main Tank Fill with Guard Tank Precool – Main Tank at NBP*. Record Op. No.:_____

Note: Guard Tank should not be filled more than necessary by this procedure.

L.6 Prepare the Guard Tank for transport:

- Guard Tank not more than 15% full: Perform P0797, *Pressurize Guard Tank*. Record Op. No.:_____
- Guard Tank >15% full: Perform P0212, *Empty the Guard Tank*, leaving Guard Tank in a regged up condition. Record Op. No.:_____.

L.7 If Main Tank is >52% full, perform P0595, *Reduce Level in MT (Liquid at NBP)* to achieve 50 – 52%. Record Op. No.:_____.

L.8 If the Well has not been pumped on since the last MT/GT transfer or since any other operation known to introduce He gas into the Well, perform P0613, *Repump the Well with the Probe Installed*, skipping G.6 (Close out procedure leaving Well Vent Manifold Installed at VTH). The Well should be pumped for at least 12 hours, preferably 24.

L.9 If the Well does not need to be pumped but the Well Vent Manifold is still installed, perform P0613, skipping sections G.4 through G.6, to remove the Well Vent Manifold.
Record Op. No.:_____.

L.10 Verify that the Well Relief Valve (RV2, 5833420-101) is capped per 5833500.

L.11 Verify that the Well Orbit Vent (pyrovalve) Assembly (PV3, 5833903-101, Rev. A) is mounted on the SMD. Tape the caps securely in place.

L.12 Prepare Guard Tank vent line for transport:

L.12.1 If the Guard Tank vent line is connected to the Gas Module, perform P0677, *Disconnect Guard Tank Vent Line from Gas Module*. This will leave the short GT vent line installed along with GTV-V and the Guard Tank Vent Cap Assemblies. Record Op. No. of the last performance of P0677 (or of this performance if it is needed):_____.

L.12.2 Provide temporary support for the GTV-V assembly.

L.13 Prepare Main Tank Vent (B1):

L.13.1 Perform P0675, *Disconnect Main Tank Vent Line From Gas Module – Main Tank at NBP*, with the following exceptions and options:

L.13.1.1 Record P0675 Op. No.:_____.;

L.13.1.2 At G.6.2 of the procedure, select the option of disconnecting at the bayonet B1 (at SV-9);

L.13.1.3 Install th e Main Tank vent cap specified in D.4 (Fig. 3) at SV-9 instead of the MTVC specified in P0675;

L.13.1.4 Skip the GT/MT manifold option at G.6.8.

L.13.1.5 Record the initial MT pressure as by the Thruster Vent Endevco (CN 49):_____torr. Date/time:_____

L.13.2 Observe the SMD temperatures (particularly at STA 200 and at the top of the lead bag) and pressures (particularly the GT pressure) until the MT is venting through the MT vent cap relief valve at ~0.3 psid. Record the venting MT pressure as measured by the Thruster Vent Endevco (CN 49):_____torr. Date/time:_____

L.14 Perform Procedure P0799, *Prepare and Verify Probe Configuration for Shipment to Acoustic Test*. Record Op. No.:_____.

L.15 Visually inspect the Probe Cross Flange and Top Hat regions as well as the SMD Top Plate region to ensure that no transport preparation issues involving the forward part of the Payload were overlooked.

L.16 Install / verify installed 90-deg. elbows with plastic dust covers on burst disks BD5A&B and BD7A&B. The elbows should be pointed in the forward direction.

L.17 Inspect the vacuum jacket pyrovalve (PV1) to verify that all openings are covered with dust caps. Tape the dust caps securely in place.

L.18 Inspect the SMD fill bayonet (B3) to verify that the standard fill cap assembly (ref., e.g., Figure 3 of P0442) is installed. Disconnect the pumping line, if connected, and install a KF cap where the pumping line connects.

L.19 If the Vacuum Module pumping line is connected to the SMD vacuum shell pumpout port (PO), perform P0214, *Stop Pumping SMD Vacuum Shell / Disconnect Vacuum Module*. Record Op. No.:_____.

L.20 Inspect the Ion Pump (IP) to verify that the high voltage cable has been removed and that the shield and magnet are securely installed.

L.21 Perform P0788, *Disconnect Electrical GSE from SMD*. Record Op. No.:_____.

L.22 Perform P0789, *Connect TM&A to SMD*. Record Op. No.:_____.

Operation completed. Completed by: _____

QA witness: _____

Date: _____

Time: _____

QA Program Engineer_____**Date**_____

Payload Test Director_____**Date**_____

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

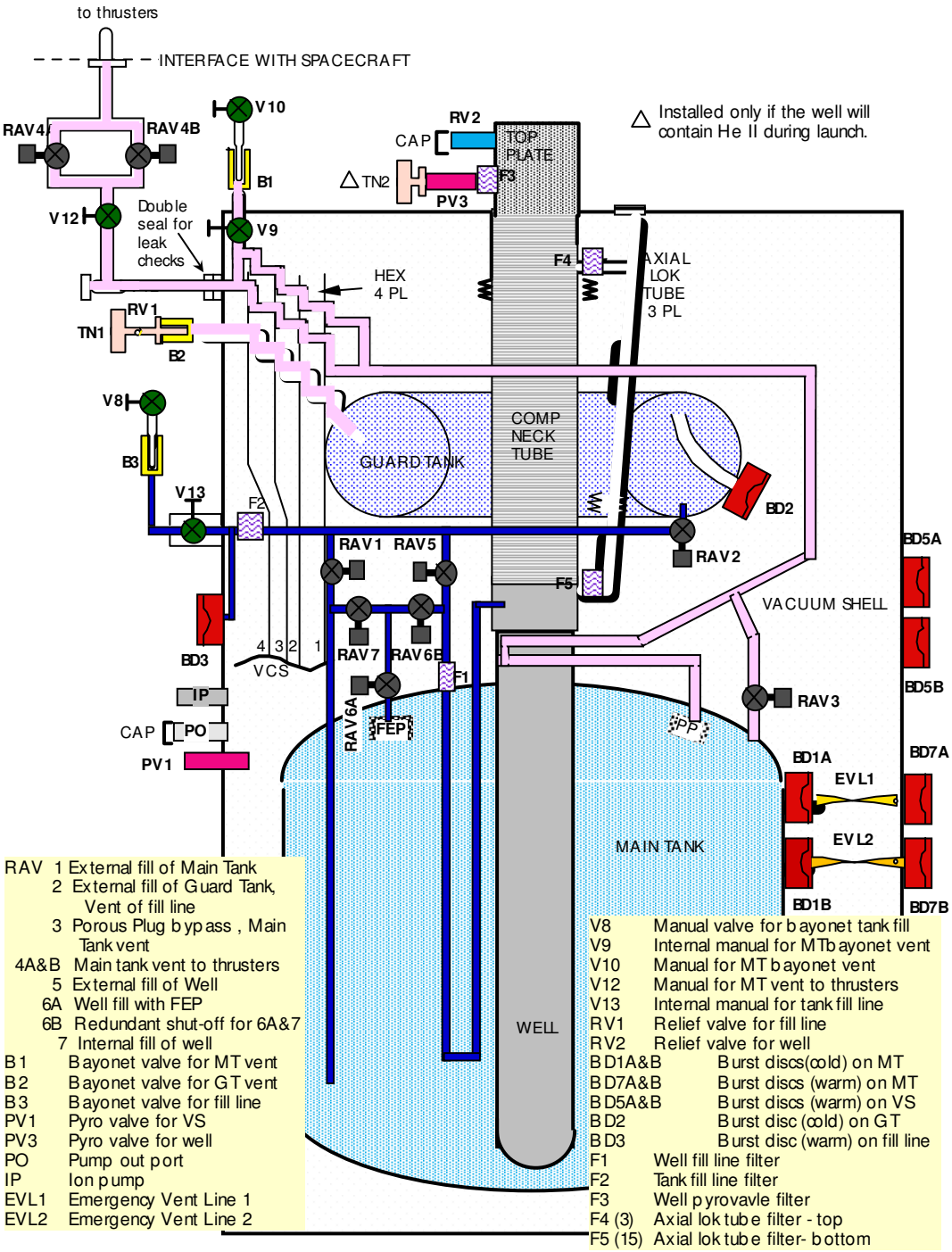

Figure 2. Cap assembly for Main Tank Thruster Vent.

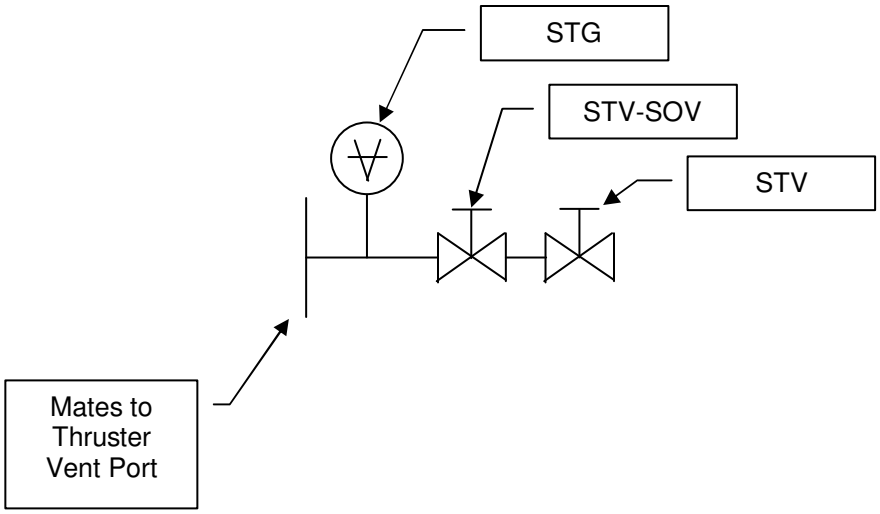

Figure 3. Cap assembly for Main Tank Vent Bayonet, B1.