GRAVITY PROBE-B
PAYLOAD TESTING
PROCEDURE

CERTIFY VACUUM MODULE AFTER TRANSPORT

P0786a

ECO 1297

August 10, 2001

Originator
J. Maddocks

Approvals:

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	1297	Added minor redlines Changed expected values of pressure in Section G.1.11 Changed numbering format and updated Sections A through F.	8/10/99

Table of Contents

List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
ATC	Advanced Technology Center
APR-x	Pressure regulator x of Gas Module
AV-x	Valve x of Gas Module auxiliary section
CG-x	Gauge x of portable helium pressurization source
CPR-x	Pressure regulator x of portable helium pressurization source
CV-x	Valve x of portable helium pressurization source
CN [xx]	Data acquisition channel number
DAS	Data Acquisition System
EFM	Exhaust gas Flow Meter
EG-x	Gauge x of Gas Module exhaust section
EH-x	Vent line heat exchanger in Gas Module
EM	Electrical Module
ERV-x	Relief valve of Gas Module exhaust section
EV-x	Valve number x of Gas Module exhaust section
FCV	Fill Cap Valve
FIST	Full Integrated System Test
GHe	Gaseous Helium
GM	Gas Module
GP-B	Gravity Probe-B
GSE	Ground Support Equipment
GT	Guard Tank
GTVC	Guard Tank Vent Cap
GTVC-G	Guard Tank Vent Cap pressure gauge
GTVC-RV	Guard Tank Vent Cap relief valve
GTVC-V	Guard Tank Vent Cap valve
GTV-G	Guard Tank vent pressure gauge
GTV-RV	Guard Tank vent relief valve
GTV-V	Guard Tank vent valve
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
LHV-x	Liquid Helium Supply Dewar valves
LLS	Liquid level sensor
LM	Lockheed Martin Co.
MT	Main Tank
MTVC	Main Tank Vent Cap
MTVC-G	Main Tank Vent Cap pressure gauge
MTVC-RV	Main Tank Vent Cap relief valve
MTVC-V	Main Tank Vent Cap valve
NBP	Normal boiling point
ONR	Office of Naval Research
PFCG	Fill Cap assembly pressure Gauge
PFM	Pump equipment Flow Meter
PG-x	Gauge x of Pump equipment
PM	Pump Module
psi	pounds per square inch
psig	pounds per square inch gauge
PTD	Payload Test Director
PV-x	Valve x of the Pump equipment
QA	Quality Assurance
RAV-x	Remote Actuated Valve-x
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar
STV	SMD Thruster vent Valve
SU	Stanford University
SV-x	SMD Valve number x
TG-x	Gauge x of Utility Turbo System
TV-x	Valve x of Utility Turbo System
UTS	Utility Turbo System
Vac	Vacuum
VCP-x	Vent cap pressure gauge
VCRV-x	Vent cap relief valve
VCV-x	Vent cap valve
VDC	Volts Direct Current
VF-x	Liquid helium Fill line valve
VG-x	Gauge x of Vacuum Module
VM	Vacuum Module
VV-x	Valve x of Vacuum Module
VW-x	Valve x of Dewar Adapter

A. SCOPE

This procedure describes the steps necessary start up the Vacuum Module after transportation, and check all gauges, pneumatic valves, and pumps for proper operation.

B. SAFETY

B.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.

B.2. Mitigation of Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

There are no cryogenic operations in this procedure.

B.2.3. Injuries

In case of any injury obtain medical treatment as follows
LMMS **Call 117;** Stanford University **Call 9-911**

C. QUALITY ASSURANCE

C.1. QA Notification

The ONR 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.

C.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.

C.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 to be dealt with in one of three ways.

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. Red-lines to procedures are included in this category.
2. If the discrepancy is minor, but affects procedure functionality, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and QA representative.
3. All critical and major discrepancies shall be documented in Discrepancy Reports.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The Test Director is the designated signer for the “witnessed by” sign-off located at the end of each procedure. The person in charge of the operation (Test Director or Test Engineer) is to sign the “completed by” sign-off.

D.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.

D.3. Qualified Personnel

Test Director	***Test Engineer***
Mike Taber	Tom Welsh
Dave Murray	Chris Gray
Jim Maddocks	Bruce Clarke
Dave Frank	Ned Calder

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not include any equipment sensitive to electrostatic discharge.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

None required

E.3.3. Additional Test Equipment

Item	Description	Manufacturer
1	Helium leak detector	Varian

E.3.4. Additional Hardware

None required

E.3.5. Tools

None required

E.3.6. Expendables

Description	Quantity	Mfr./Part No.
Liquid nitrogen	AR	N/A
99.99% pure helium gas	AR	N/A

E.4. Instrument Pretest Requirements

N/A

E.5. Configuration Requirements

N/A

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/Success Criteria

N/A

E.8. Payload Constraints and Restrictions

N/A

E.9. Configuration Requirements

N/A

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	*Instrumentation Installation*

F.2. Supporting documentation

Document No.	*Title*
SU/GP-B P0108	*Quality Plan*

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0778	*Disconnect Electrical GSE from Payload*

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Establish Initial Condition of Vacuum Module

G.1.1. Visually inspect module. Record damage: _____

_____

G.1.2. Ensure all access ports are capped.

1. Primary pump-out port
2. Utility pump-out port (at VV-10)
3. Access port 1
4. Leak Detector port

G.1.3. Ensure over-ride switch is in off position (switch down).

G.1.4. Ensure all manual valves VV-3, VV-5, VV-7, and VV-10 are closed.

Note: It is necessary to remove the right-hand panel to access VV-5.

G.1.5. Connect pressurized air for pneumatic valve operation.

G.1.6. Connect exhaust hose to pump exhaust.

G.1.7. Plug in and turn on Vacuum Module.

G.1.8. Record status of pneumatic valves per indicator lights.

Valve	*Light on (Open)*	*Light off (Closed)*	*Expected Status*
VV-1			Closed
VV-2			Closed
VV-4			Closed
VV-6			Closed

G.1.9. Turn on pressure gauges VG-2, VG-3, VG-4, and VG-5.

Caution
Do Not turn on ionization gauge VG-1 as the pressure in this section of the Vacuum Module is approximately 1 torr.

G.1.10. Verify that Vacuum Module was shut down according to procedure P0778, *Disconnect Electrical GSE from Payload*.

Record Operation Number _____ and date _____.

Note: if Vacuum Module not shut down according to P0778 the expected values in the following step may not be obtained.

G.1.11. Record pressures and compare to expected values. If pressures are significantly higher than expected, a leak may be indicated. In any case, continue with the remainder of the procedure.

Actual Reading	*Expected Reading*
VG-2 _____ torr	< 200 torr
VG-3 _____ torr	< 10 torr
VG-4 _____ torr	< 10 torr
VG-5 _____ torr	< 10 torr

G.1.12. Turn override switch on (switch up) and push reset button.

G.1.13. Verify closure of VV-4 and normal operation of rotary vane pump (VP-2) as follows:

1. Record pressure VG-2 _____ torr.
2. Record pressure VG-5 _____ torr.
3. Turn on vane pump. Verify proper rotation
4. Record condition of Indicator light “VP-2”
   ____ on ____ off.
5. When pressure at VG-2 < 25 mtorr, record VG-2: _____ torr.
6. Verify decrease in pressure VG-2 (to verify pump operating).
7. Record pressure VG-5 _____ torr.
8. Verify pressure at VG-5 unchanged (to verify VV-4 closed).
9. When satisfied vane pump is operating normally (VG-2 < 25 mtorr) and VV-4 closed (VG-5 unchanged), proceed to next step.

G.1.14. Verify closure of VV-1 and VV-6 and normal operation of VV-4 as follows:

1. Record pressure VG-5 _____ torr.
2. Record pressure VG-3 _____ torr.
3. Open VV-4.
4. Record condition of Indicator light “VV-4”
   ____ on (open) ____ off (closed).
5. When pressure at VG-5 < 25 mtorr, record VG-5: _____ torr.

6. Verify decrease in pressure VG-5 (to verify VV-4 open).
7. Record pressure VG-3 _____ torr.
8. Verify pressure at VG-3 unchanged (to verify VV-1 and VV-6 closed).
9. When satisfied VV-4 opened normally, close VV-4.
10. Record condition of Indicator light “VV-4”
    ____ on (open) ____ off (closed).
11. When satisfied VV-4 operates normally proceed to next step.

G.1.15. Verify normal operation of VV-2.

1. Record pressure VG-5 _____ torr.
2. Open VV-2.
3. Record condition of Indicator light “VV-2”
    ____ on (open) ____ off (closed).
4. When pressure VG-5 stabilizes, record VG-5 _____ torr.
5. Verify increase in pressure VG-5 (to verify VV-2 opened)
6. When satisfied VV-2 opened normally, close VV-2.
7. Record condition of Indicator light “VV-2”
    ____ on (open) ____ off (closed).
8. When satisfied VV-2 operates normally proceed to next step.

G.1.16. Verify normal operation of VV-1.

1. Open VV-4.
2. When VG-5 < 25 mtorr, Record pressure VG-5 _____ torr.
3. Close VV-4
4. Open VV-1.
5. Record condition of Indicator light “VV-1”
    ____ on (open) ____ off (closed).
6. When pressure at VG-5 stabilizes, record VG-5: _____ torr.
7. Verify increase in pressure VG-5 (to verify VV-1 opened).
8. When satisfied VV-1 opened normally, close VV-1.
9. Record condition of Indicator light “VV-1”
    ____ on (open) ____ off (closed).
10. When satisfied VV-1 operates normally proceed to next step.

G.1.17. Verify normal operation of VV-6.

1. Record pressures:
2. VG-3 _____ torr.
3. VG-4 _____ torr.
4. Open VV-4 and VV-6.
5. Record condition of Indicator light “VV-6”
   ____ on (open) ____ off (closed).
6. Slowly open valve VV-3 to evacuate the high-vacuum pumping manifold up to the capped-off pump inlet.
7. When pressure at VG-3 stabilizes, record VG-3: _____ torr.
8. When pressure at VG-4 stabilizes, record VG-4: _____ torr.
9. Verify decrease in pressures VG-3 and VG-4 (to verify VV-6 opened).
10. When satisfied VV-6 opened normally, close VV-6.
11. Record condition of Indicator light “VV-6.”
    ____ on (open) ____ off (closed).
12. When satisfied VV-6 operates normally, close VV-3 and proceed to next step.

G.1.18. Verify normal operation of turbo pump.

1. Verify open/open VV-4.
2. Verify Vacuum Module over-ride switch is on (up position).
3. Open VV-2.
4. When pressure at VG-5 < 50 mtorr, Record VG-5 _____ torr.
5. Open VV-6.
6. Slowly open VV-3 and evacuate to ensure pressure at VG-3 < 1 torr. Record VG-3 _____ torr.
7. Open gate valve VV-1 (switch up).
8. Turn on Turbo pump.
9. Verify that turbo comes up to normal operating speed.
10. Turn on ionization gauge VG-1 when the pressure at VG-5 is < 1.0 x 10-3 torr.
11. Continue evacuation up to capped-off pump-out port until the pressure at VG-1 is < 5.0 x 10-6 torr then record:
    a. Time of day:_____
    b. VG-1 pressure:_____ torr.

12. When satisfied that turbo is operating normally, proceed to next step.

G.2. **Leak Test Vacuum Module**

G.2.1. Calibrate leak detector

1. Standard leak value _____sccs He
2. Leak detector reading _____sccs He

G.2.2. Connect the leak detector to the leak check access port of the vacuum module.

G.2.3. Leak test the system up to closed valve VV-7.

G.2.4. Turn the leak detector's vent disable switch to the disabled position.

G.2.5. Slowly open leak detector access valve VV-7. Monitor the system pressure as read on gauge VG-1 as this valve is opened.

G.2.6. While monitoring VG-1 to ensure it does not rise above 1 x 10-5 torr, close valve VV-4.

G.2.7. Leak test all internal pumping lines and connections.

G.2.8. Record Leak detector readings:

1. Initial background:_____sccs He
2. Final reading:_____sccs He

G.2.9. Verify no leaks > 1.0×10^{-7} sccs are present.

G.2.10. Open valve VV-4.

G.2.11. Close valve VV-7.

G.2.12. Turn off the ionization gauge (VG-1).

G.2.13. Close VV-2, VV-3, and VV-6.

G.2.14. Turn the leak detector's vent disable switch to the off position.

G.2.15. Record pressure VG-2 _____ torr.

G.2.16. While monitoring the pressure at gauge VG-2 to ensure that valve VV-7 is closed, vent the leak detector to air.

Record pressure VG-2 _____ torr

G.2.17. Disconnect the leak detector from the vacuum module's leak check access port.

G.3. **Place System in Final Configuration**

G.3.1. Ensure VV-7 closed.

G.3.2. Close gate valve VV-1.

G.3.3. Turn off the turbo pump as follows:

1. Turn on Vacuum module over-ride switch (down).

2. Power off turbo pump and verify that VV-4 closes (indicator light goes off).
3. Open manual valve VV-5 slowly to decelerate the turbo pump.
4. When turbo deceleration is complete, close VV-5.
5. Switch Vacuum Module override to on (up) and verify that VV-4 opens by observing a decrease in pressure VG-5.

G.3.4. Purge and install gaseous helium supply line to leak detector port of Vacuum Module.

G.3.5. Close VV-4.

G.3.6. Open VV-1.

G.3.7. Backfill Vacuum Module with gaseous helium to 770 +/- 5 torr as read on gauge VG-4 by slowly opening valve VV-7.

G.3.8. Once VG-4 is greater then 770 torr, close VV-7 and record the following:

1. VG-4 pressure: _____ torr
2. Time of day: _____

G.3.9. Disconnect helium pressurization line from leak detector port.

G.3.10. Cap leak detector access port at valve VV-7.

G.3.11. Close gate valve VV-1.

G.3.12. Verify closed VV-4.

G.3.13. Turn system override switch off (down).

G.3.14. **(Option)** Shut down pump VP-2.

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

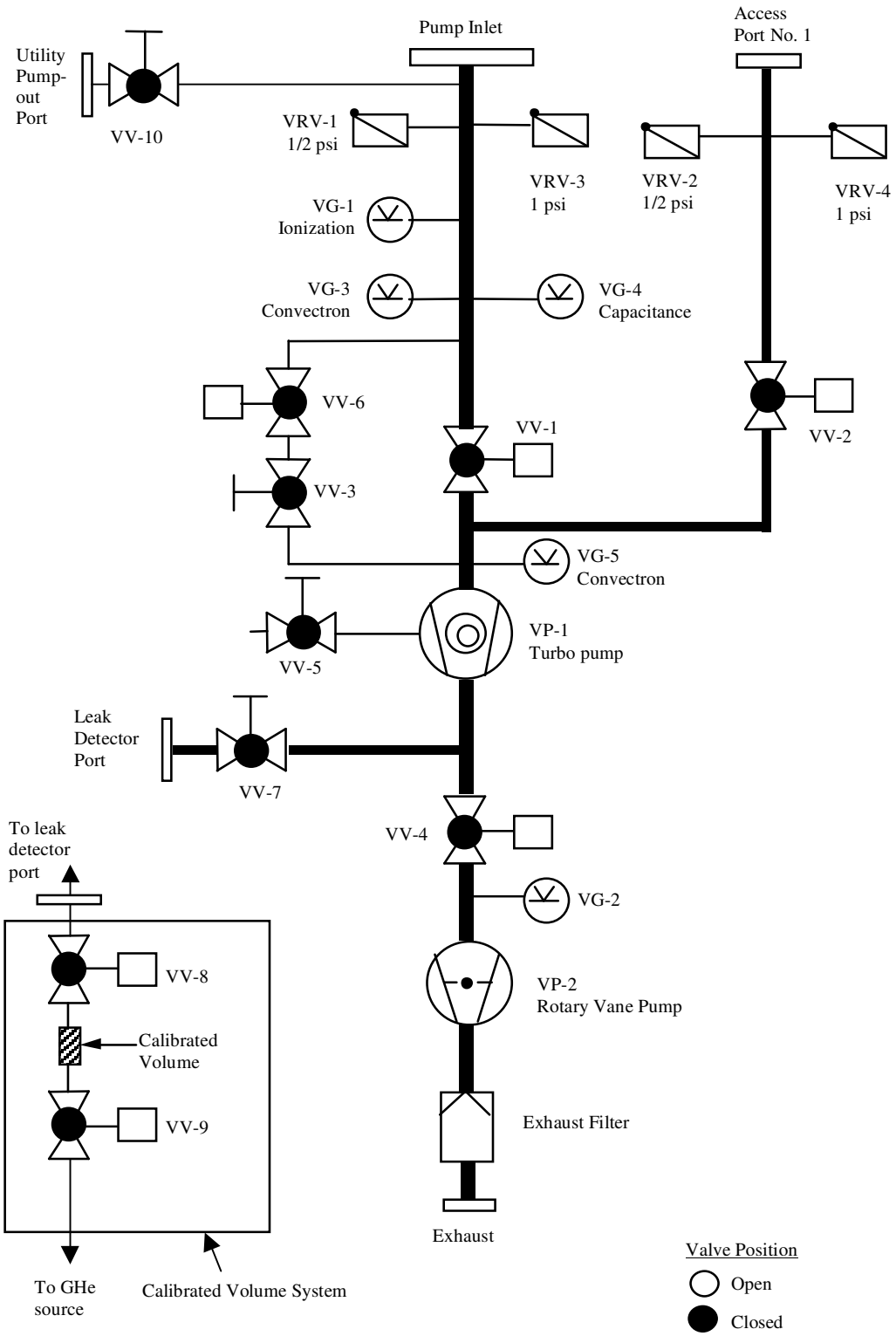

Figure 1. Schematic representation of Vacuum Module plumbing.