GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

STOP PUMPING ON SMD VACUUM SHELL / DISCONNECT VACUUM MODULE

To be performed in Vandenberg Air Force Base building 1610

This document contains non-hazardous operations

P1016

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section	MT	Main Tank
AMI	American Magnetics Inc.	MTVC	Main Tank Vent Cap
AP-1	Vane Pump in Gas module	MTVC-G	Main Tank Vent Cap pressure gauge
APR-x	Pressure regulator x of Gas Module	MTVC-RV	Main Tank Vent Cap relief valve
AV-x	Valve x of Gas Module auxiliary section	MTVC-V	Main Tank Vent Cap valve
CG-x	Gauge x of portable helium pressurization source	NBP	Normal boiling point
CPR-x	Pressure regulator x of portable helium pressurization source	ONR	Office of Naval Research
CV-x	Valve x of portable helium pressurization source	PFCG	Fill Cap assembly pressure Gauge
CN [xx]	Data acquisition channel number	PFM	Pump equipment Flow Meter
DAS	Data Acquisition System	PG-x	Gauge x of Pump equipment
EFM-x	Exhaust gas Flow Meters	PM	Pump Module
EG-x	Gauge x of Gas Module exhaust section	psi	pounds per square inch
EH-x	Vent line heat exchanger in GM	psig	pounds per square inch gauge
EM	Electrical Module	PTD	Payload Test Director
ERV-x	Relief valve of Gas Module exhaust section	PV-x	Valve x of the Pump equipment
EV-x	Valve number x of Gas Module exhaust section	QA	Quality Assurance
FCV	Fill Cap Valve	RAV-x	Remote Actuated Valve-x
FIST	Full Integrated System Test	RGA	Residual Gas Analyzer
GHe	Gaseous Helium	RGA-LV	RGA leak valve (needle valve)
GM	Gas Module	RGA-SOV	RGA shut off valve
GP-B	Gravity Probe-B	SMD	Science Mission Dewar
GSE	Ground Support Equipment	STV	SMD Thruster vent Valve
GT	Guard Tank	SU	Stanford University
GTVC	Guard Tank Vent Cap	SV-x	SMD Valve number x
GTVC-G	Guard Tank Vent Cap pressure gauge	TG-x	Gauge x of Utility Turbo System
GTVC-RV	Guard Tank Vent Cap relief valve	TV-x	Valve x of Utility Turbo System
GTV-G	Guard Tank vent pressure gauge	UTS	Utility Turbo System
GTV-RV	Guard Tank vent relief valve	Vac	Vacuum
GTV-V	Guard Tank vent valve	VCP-x	Vent cap pressure gauge
GTV-Va	Guard Tank Vent line valve for independent pressure regulation	VCRV-x	Vent cap relief valve
HEX-x	SMD heat exchanger x	VCV-x	Vent cap valve
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)	VDC	Volts Direct Current
LHe	Liquid Helium	VF-x	Liquid helium Fill line valve
LHSD	Liquid Helium Supply Dewar	VG-x	Gauge x of Vacuum Module
LHV-x	Liquid Helium Supply Dewar valves	VM	Vacuum Module
LLS	Liquid level sensor	VV-x	Valve x of Vacuum Module
LM	Lockheed Martin Co.	VW-x	Valve x of Dewar Adapter

LIST OF SPECIFIC HEADING DEFINITIONS

Each type of alert message will precede the procedural step to which it applies

1. NOTE: Used to indicate an operating procedure of such importance that it must be emphasized
2. CAUTION: Used to identify hazards to equipment
3. WARNING: Used to identify hazards to personnel

A. SCOPE

This procedure describes the steps necessary to discontinue pumping on the vacuum space of the Science Mission Dewar and disconnect the Vacuum Module. There are three possible initial configurations:

Initial Configuration 1 – Actively pumping on SMD vacuum.

Initial Configuration 2 – Actively pumping up to closed SV-14.

Initial Configuration 3 – Pumping line connected at both ends and pumped out.

There are likewise three final configurations:

Final Configuration 1 – Actively pumping up to closed SV-14.

Final Configuration 2 – Pumping line connected at both ends and pumped out.

Final Configuration 3 – Pumping line disconnected at one or both ends.

The steps include:

Close SMD vacuum-shell valve SV-14, if open

Turn off turbo pump, if running

Perform leak back test for SV-14 closure, if not continuing to pump up to closed SV-14

Disconnect pumping line from SMD and/or Vacuum Module if desired.

B. SAFETY

B.1. Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware.

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 and the Missile System Prelaunch Safety Package discuss 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

In VAFB building 1610, the GP-B cryogenic team provides 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 lines

are installed over the four burst disks to direct any flow to an outside area.

Only authorized and trained personnel are allowed in VAFB facilities without escort. All personnel working on platforms at a height 30 inches or more off the floor are required to have an approved air tank (emergency breathing apparatus) within easy reach. Note that tank need not be kept available when working from ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA safety.

This procedure does not involve cryogenic operations.

B.2.3. Other Hazards

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

B.3. **Mishap Notification**

B.3.1. Injury

In case of any injury or illness requiring emergency medical treatment **DIAL 911**.

B.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 and Stanford University GP-B P0879. Additionally, VAFB NASA Safety and 30th Space Wing Safety will be notified as required.

B.3.3. Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. QA Notification

The NASA program and the NASA safety 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

C.3. **Authority to red-line (make minor changes during execution) this procedure is given solely to the TD 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 TD or QA Representative, experiment functionality may be affected.**

C.4. **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.

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 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

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. Required Personnel

The following personnel are essential to the accomplishment of this procedure:

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

When working on the space vehicle, proper ESD protection is required. All wrist straps will be checked on an appropriate calibrated checker prior to use.

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

The Ground Support Equipment includes the Gas Module, the Electrical Module. The Gas Module provides the capability to configure vent paths, read pressures and flow rates, and pump and backfill vent lines. The Pump Module provides greater pumping capacity than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module. The Electrical Module contains the instruments listed in Table 1, and provides remote control of valves in the Gas Module, Pump Module, and SMD.

E.3.3. Computers and Software:

The Data Acquisition System (DAS) is required for this procedure. The DAS reads and displays pressures, temperatures, and flow rates and monitors critical parameters. No additional computers or software are required.

E.3.4. Additional Test Equipment

None

E.3.5. Additional Hardware

Description	***Manufacturer***	***Mfr./Part No.***
Standard Volume System	NA	N/A
Protective cover for SV-14	NA	NA

E.3.6. Tools

None

E.3.7. Expendables

Warning alcohol is a skin irritant, potentially toxic if skin absorbed, and flammable. All hazardous waste will be placed into approved waste containers.

Description	***Quantity***	***Mfr./Part No.***
Vacuum Grease	NA	Dow Corning High Vacuum or Apiezon
Isopropyl Alcohol	NA	NA
99.999% pure gaseous helium	AR	N/A

E.4. Instrument Pretest Requirements

The GSE instruments required to perform this procedure are listed in Table 1, together with their serial numbers, where available. Instruments that are required to have current calibrations are indicated in the Cal-Required column. Instruments that do not require calibration are those not used to verify performance requirements and are not connected to flight instrumentation. The status column is to be filled in with the due date of the instrument calibration sticker and verified to be in calibration by QE or QE designee. Serial numbers are to be updated as appropriate.

Table 1. Required Instrumentation and Calibration Status

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
1	DAS	Power Supply, H-P 6627A	A1, A2, A3, A4	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	B1, B2, B3, B4	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A245539	No	-
4	DAS	Digital Multimeter H-P 3458A	-	2823A15047	Yes	
5	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-1a, -1b	2827	No	-
6	EM	Vacuum Gauge Controller Granville-Phillips Model 316	AG-2a, -2b	2826	No	-
7	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-3	2828	No	-
8	EM	MKS PDR-C-2C	EG-2, FCG	92022108A	No	-
9	EM	Flow meter – Matheson 8170	EFM-1	96186	No	-
10	EM	Flow meter totalizer Matheson 8124	EFM-1	96174	No	-
11	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Main Tank	96-409-11	No	-
12	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Guard Tank	96-409-10	No	-
13	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Well	96-409-9	No	-
14	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Axial Lock	96-409-12	No	-
15	EM	Pressure Controller – MKS 152F-92	EV-7a, -7b	96203410A	No	-
16	EM	Power Supply HP 6038A	H08D Tank Heater	96023407A	Yes	
17	EM	Power Supply HP 6038A	H09D Tank Heater	3511A-13332	Yes	
18	EM	Power Supply HP 6038A	RAV Power Supply	3329A-12486	Yes	
19	EM	Vac Ion Pump power supply Varian 929-0910, Minivac	SIP	5004N	No	-
20	EM	Flow meter totalizer Veeder-Root	PFM-1	576013-716	No	-

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
21	GM	Pressure Gauge, Heise	AG-1	CC-122077	No	-
22	GM	Pressure Gauge, Marshall Town	AG-3	N/A	No	-
23	GM	Main Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	Eh-1	C-19950	No	-
24	GM	Guard Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	EH-2	C-09920	No	-
25	VM	Vacuum Gauge readout, Granville-Phillips 316	VG-3 VG-4	2878	No	-
26	VM	Vacuum Gauge readout, Granville-Phillips 360	VG-1, VG-2 VG-5	96021521	No	-

E.5. Configuration Requirements

E.5.1. Main Tank

Liquid in the Main Tank may be at its normal boiling point (NBP) or subatmospheric.

E.5.2. Guard Tank

The Guard-Tank may contain liquid, or be depleted.

E.5.3. Well

The Well must be evacuated.

E.5.4. SMD Vacuum Shell

The SMD vacuum shell pressure, as read at the Vac-ion pump (IP), must be $\leq 5 \times 10^{-5}$ torr.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
    a. Top of lead bag temperature (CN 175) set at T ≤ 6. K.
    b. Top of lead bag temperature set (CN 178) at T ≤ 6.0 K.
    c. Relative Guard Tank Pressure (CN 46) set at □P ≥ 0.3 torr.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet must be installed.
2. GSE cabling must be connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).
3. The Vacuum shell pump out port at SV-14 is connected to the Vacuum Module (P/N 5833816) via a 2-in valve operator and pumping line. The Vacuum Module is actively pumping the vacuum shell (SV-14 and VV-1 are both open), pumping up to closed SV-14 (SV-14 closed, VV-1 open), or shut down with the pumping line

evacuated (SV-14 closed, VV-1 closed).

E.6. Optional Non-flight Configurations

The following modifications or non-flight arrangement of the basic SMD configuration may also be in place. They are incidental to the performance of this procedure and not required.

1. The Main Tank Vent Line may be connected to the Gas Module, or it may be disconnected either at the Bayonet at the end of the short line or the Bayonet at SV-9.
2. The Guard Tank Vent Line may be connected to the Gas Module.
3. The Fill Cap Assembly may be installed at SV-13.

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	Instrumentation Installation

F.2. Supporting documentation

Document No.	*Title*
LMMC-5835031	GP-B Magnetic Control Plan
GPB-100153C	SMD Safety Compliance Assessment
LM/P479945	Missile System Prelaunch Safety Package
SU/GP-B P0141	FIST Emergency Procedures
LMSC-P088357	Science Mission Dewar Critical Design Review
SU/GP-B P0108	Quality Plan
LMMS GPB-100333	Science Mission Dewar Failure Effects and Causes Analysis
SU/GP-B P059	GP-B Contamination Control Plan
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

- Record calibration due dates in Table 1 (Section E.4)
- Persons actually performing this procedure should list their names in Sec D.3
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of emergency shower

G.2. Verify Purity of All Sources of Helium Gas

G.2.1. Record serial number on helium bottle/s.

1. _____ 2._____ 3. _____
4. _____ 5 _____ 6. _____

Verify helium bottle/s have been tested for purity and record Op. Number.
Op. Number:_____

QA Witness:_____

G.3. Verify Configuration Requirements

G.3.1. Verify DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – ensure CN [175] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _____K
2. ***Top of lead bag temperature*** – ensure CN [178] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _____K

3. ***Relative Guard Tank Pressure*** – ensure CN [46] on DAS alarm list and set to alarm at $\Delta P \geq 0.3$ torr. Record set point. _____torr

G.3.2. Verify liquid-level alarms set, as appropriate, and record set points.

1. ***Main Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _____%
2. ***Guard Tank*** – ensure liquid level alarm set ≥ 20% (if liquid in GT). Record set point. _____%

G.3.3. Verify DAS watchdog timer and alarm enabled.

G.3.4. Verify vacuum line connected between (SV-14) and Vacuum Module.

G.3.5. Verify ion-pump magnet installed.

G.3.6. Verify SMD vacuum pressure ≤ 5×10^{-5} torr:

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] for CN 99.
3. When value is steady, record pressure (IP) _____ torr. If pressure is above 5×10^{-5} torr, turn off Vac-ion pump and perform procedure P1015 to pump out SMD vacuum shell.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.3.7. Enter comment into DAS “Begin disconnect of Vacuum Module.”

G.3.8. Record and verify one of following initial configurations:

- ***Initial Configuration 1*** – Actively pumping on SMD vacuum.
  1. Ensure valves VV-2, VV-3, VV-5, VV-6, VV-7, and VV-10 closed.
  2. Verify pumps VP-1 and VP-2 on.
  3. Verify SV-14, VV-1 and VV-4 open.
  4. Verify Vacuum Module pressure (VG-1) < 1 x 10^{-5} torr and record:
     a. VG-1 pressure _____ torr.
     b. VG-2 pressure _____ torr.

- ***Initial Configuration 2*** – Actively pumping up to closed SV-14.
  5. Ensure valves VV-2, VV-3, VV-5, VV-6, VV-7, and VV-10 closed.
  6. Verify pumps VP-1 and VP-2 on. (VP-1 may be in standby mode.)
  7. Verify VV-1 and VV-4 open.
  8. Verify SV-14 closed.
  9. Verify Vacuum Module pressure (VG-1) < 1 x 10^{-5} torr and record:
     a. VG-1 pressure _____ torr.
     b. VG-2 pressure _____ torr.

- ***Initial Configuration 3*** – Pumping line connected and pumped out.
  10. Verify that leak back test of SV-14 closure was performed at time of closure. Record operation number_____ and date _____.
  11. Verify turbo pump VP-1 off.
  12. Verify SV-14, VV-1, and VV-4 closed.
  13. Ensure valves VV-2, VV-3, VV-5, VV-6, VV-7, and VV-10 closed.
  14. Record Vacuum Module pressure (VG-4) _____ torr.
  15. Turn on rotary vane pump (VP-2).
  16. Turn Vacuum Module override switch on (up)
  17. Open VV-4 and pump up to VV-1. When pressure at VG-2 reaches 10 to 20 mtorr, close VV-4.
  18. Open VV-1.

G.3.9. Verify EV-9 actuator control valve in appropriate position:

- Main Tank at NBP – EV-9 actuator control in "NBP" position.
- Main Tank subatmospheric – EV-9 actuator control in "Subatm" position.

G.3.10. Record Intended Final Configuration

- ***Final Configuration 1*** – Actively pumping up to closed SV-14.
- ***Final Configuration 2*** – Pumping line connected at both ends and pumped out.
- ***Final Configuration 3*** – Pumping line disconnected at one or both ends.

Section complete: QA Witness_____

G.4. **Close SV-14.**

- SV-14 already closed (Initial configurations 2, 3). Skip this section.
- SV-14 not already closed (Initial configuration 1). Perform this section.

G.4.1. Input comment to DAS "Close SV-14 to stop pumping on vac. jacket".

G.4.2. Remove the handle restrainer on the vacuum operator stem.

G.4.3. While monitoring VG-1, ***Close*** SV-14 (high vacuum valve) using the operator by slowly pushing the handle and attached valve insert into the valve body. When the operator encounters resistance, make sure the valve insert becomes fully seated by continuing to firmly push the operator as far as it will go.

G.4.4. ***(Only if not going to remove pumping line)*** Attach the operator's closed position handle lock.

G.4.5. ***(Only if going to remove pumping line)*** Unscrew the handle from the insert assembly by turning it counter clockwise approximately 4-5 turns. Watch the backward progress of the operator handle and continue unscrewing until it is clear that no further backward motion is occurring. Gently retract the operator handle fully. Install the handle restrainer.

Section complete: QA Witness_____

G.5. **Stop Pumping and Leak Check SV-14 Closure**

- Final configuration 1 – actively pumping up to closed SV-14 – is the desired final configuration. Skip this section.
- Turbo pump already off (Initial configuration 3). Skip this section.
- Final Configurations 2 or 3: Vacuum Module is to be shut down. Perform this section

G.5.1. Close gate valve VV-1.

G.5.2. Turn off the turbo pump as follows:

1. Verify that the module override is **off (down)**.
2. Power off turbo pump and ensure that VV-4 closes.
3. Open manual valve VV-5 slowly to decelerate the turbo pump.
4. When turbo deceleration is complete (all four speed indicator lights are off), close VV-5.

G.5.3. Connect VV-8 of the standard volume system to vacuum module's leak detector access port (see Figure 2).

G.5.4. Close valves VV-8 and VV-9 on the standard volume system.

G.5.5. Adjust helium pressurization system to 1.0 +/- 0.5 psig and purge supply line for one minute.

G.5.6. While the supply line is still purging, connect to valve VV-9 of the standard volume system.

NOTE:
In the following steps gas is evacuated from the standard volume using the rotary vane pump in the vacuum module. Open valve VV-7 slowly in the evacuation process and do not allow the vane pump pressure as measured by gauge VG-2 to exceed 1.0 torr.

G.5.7. Switch Vacuum Module override to **on (up)** and verify that VV-4 opens by observing a decrease in pressure VG-5.

G.5.8. Open valve VV-8.

G.5.9. Slowly open valve VV-7 and evacuate the standard volume until the pressure at VG-2 < 25 mtorr. Record the following:

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

G.5.10. Close valves VV-7 and VV-8.

G.5.11. Open valve VV-9 and pressurize the standard volume to 1.0 +/- 0.5 psig.

G.5.12. Close valve VV-9.

G.5.13. Open valve VV-8.

G.5.14. Slowly open valve VV-7 and evacuate the standard volume until the pressure at VG-2 < 25 microns. Record the following:

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

G.5.15. Close valves VV-7 and VV-8.

G.5.16. Open valve VV-9 and pressurize the standard volume to 1.0 +/- 0.5 psig.

G.5.17. Close valve VV-9.

G.5.18. Close valve VV-4.

G.5.19. Record pressure VG-5: _____torr:

G.5.20. Open VV-8 and VV-7 to let gas in standard volume into Vacuum Module.

G.5.21. Close valve VV-7 and VV-8.

NOTE:
In the following steps the small quantity of helium gas is admitted into the vacuum pumping system's hi-vacuum manifold to ensure that the hi-vacuum valve SV-14 has closed. If the valve has not closed and the gas leaks into the dewar's insulation space, the quantity of gas is small enough so as to not cause a rapid pressurization of the dewar.

G.5.22. Turn on Vac-ion pump, and record time of day: _____.

G.5.23. Wait 5 minutes and record the following pressures:

1. Vac-ion pump (IP):_____ torr
2. VG-5 pressure:_____ torr
3. VG-1 pressure:_____ torr

G.5.24. Input comment to DAS " Starting leak-back test of SV-14".

G.5.25. Turn off ion gauge VG-1.

G.5.26. Open gate valve VV-1 and record time: _____

G.5.27. After 5 minutes from opening gate valve VV-1 record the following pressures:

1. Vac-ion pump (IP):_____ torr
2. VG-5 pressure:_____ torr

G.5.28. Turn off Vac-ion pump.

NOTE:
In the following, VG-5 should be > 20 mtorr and the dewar vacuum space pressure as read by the Vac Ion pump shall not have changed; otherwise valve SV-14 has not closed and corrective steps must be taken immediately. Failure of this test should be D-Logged. Additional pressure measurements should be made after 5 minutes to verify the results. If it is certain that SV-14 has not closed, procedure P1015 should be initiated to restart pumping up to "closed" SV-14.

G.5.29. After 25 minutes from opening gate valve VV-1, turn on the Vac-ion pump and record time of day.

G.5.30. Wait five minutes then record the following pressures:

1. Vac-ion pump (IP):_____ torr
2. VG-5 pressure:_____ torr

G.5.31. Verify that the Vac-ion pressure has not increased from previous reading.

G.5.32. ***(Only if not removing pumping line)*** Turn off the Vac-ion pump and record time of day: _____.

Section complete: QA Witness_____

G.6. **Place System in Final Configuration**

Establish ***one*** of following configurations as recorded in paragraph G.3.10.

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o ***Final configuration 1*** – actively pumping up to closed SV-14 – is the desired final configuration. Continue with Section G.7.

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o ***Final Configuration 2*** – Pumping line connected at both ends and pumped out – is the desired final configuration. Perform the following steps.

G.6.1. Open VV-4 and pump for no more than 1 minute.

G.6.2. Close VV-4.

G.6.3. Close VV-1.

Comment: All valves should be closed, vane pump VP-2 running.

G.6.4. Turn Vacuum Module override switch to **off (down)** position.

G.6.5. Disconnect helium pressurization line from standard volume system.

G.6.6. Remove standard volume system from vacuum-module leak detector access port and place in clean-room compatible bag.

G.6.7. Cap leak detector access port at valve VV-7.

G.6.8. **(Option)** Shut down pump VP-2.

G.6.9. Continue with section G.7.

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o ***Final Configuration 3*** – Pumping line disconnected at one or both ends – is the desired final configuration. Perform the following steps

G.6.10. Ensure gaseous helium supply attached to leak detector port or standard volume at leak detector port of Vacuum Module.

G.6.11. Ensure VV-7 closed.

G.6.12. If standard volume installed, open valves VV-8 and VV-9.

G.6.13. Turn on/verify on Vac-ion pump.

G.6.14. Release the brakes on the Vacuum Module so that as the vacuum hose is let up to atmospheric pressure the module can move as the hose expands.

NOTE:
In the following step, control the rate of pressurization to < 100 torr / min. Monitor Vac-ion pressure throughout pressurization process.

G.6.15. Backfill the hi-vacuum hose with gaseous helium to 770 +/- 5 torr as read on gauge VG-4 by slowly opening valve VV-7.

G.6.16. Once VG-4 is greater then 770 torr, close VV-7 and record the following:

1. Vac-ion Pump (IP): _____ torr
2. VG-4 pressure: _____ torr

3. Time of day: _____

G.6.17. Close VV-8 and VV-9, if standard volume attached.

G.6.18. Turn off Vac-ion pump.

G.6.19. **(Option)** Disconnect High-vacuum pumping line from SV-14 operator at PO.

1. Remove KF-50 hose from hi-vacuum operator.
2. Install blank off plate on free end of hi-vacuum hose.
3. Remove operator by carefully unscrewing it from the dewar flange.
4. Place hi-vacuum operator in clean-room compatible bag.
5. Install PO protective cap by screwing in place.

G.6.20. **(Option)** Disconnect high-vacuum pumping line from Vacuum Module.

1. Disconnect vacuum line at ISO-100 inlet to Vacuum Module.
2. Strain relieve vacuum line to a position that allows independent operation of Vacuum Module.
3. Install blank off plates on free end of hi-vacuum hose and inlet to Vacuum Module.

G.6.21. Disconnect helium pressurization line from leak detector port/standard volume system.

G.6.22. Remove/verify removed standard volume system from vacuum-module leak detector access port. Place in clean-room compatible bag.

G.6.23. Cap leak detector access port at valve VV-7.

G.6.24. Close/verify closed Gate valve VV-1.

G.6.25. Close/verify closed VV-4.

G.6.26. Turn system override switch **off (down)**.

G.6.27. **(Option)** Shut down pump VP-2.

G.6.28. Continue with Section G.7.

Section complete: QA Witness_____

G.7. **Configure DAS**

G.7.1. Input comment to DAS “End disconnect of Vacuum Module”.

G.7.2. Set DAS data cycle interval to 15 minutes.

G.7.3. Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for the top of the lead bag are unchanged
- Thermal conditions substantially changed, temperature alarm points reset as follows:

a. Top of Lead Bag set point [CN 175] _____ K (≤ 6.0K)

b. Top of Lead Bag set point [CN 178] _____ K (≤ 6.0 K)

c. *Relative Guard Tank Pressure* CN [46] _____ torr (≥ 0.3 torr diff.)

G.7.4. Ensure liquid level sensor alarms enabled, as appropriate, and record set points if changed.

1. Main Tank Level Set Point _____%
2. Guard Tank Level Set Point _____%
3.

G.7.5. Ensure DAS watchdog timer and alarm enabled.

Section complete: QA Witness_____

H. **PROCEDURE COMPLETION**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

I.

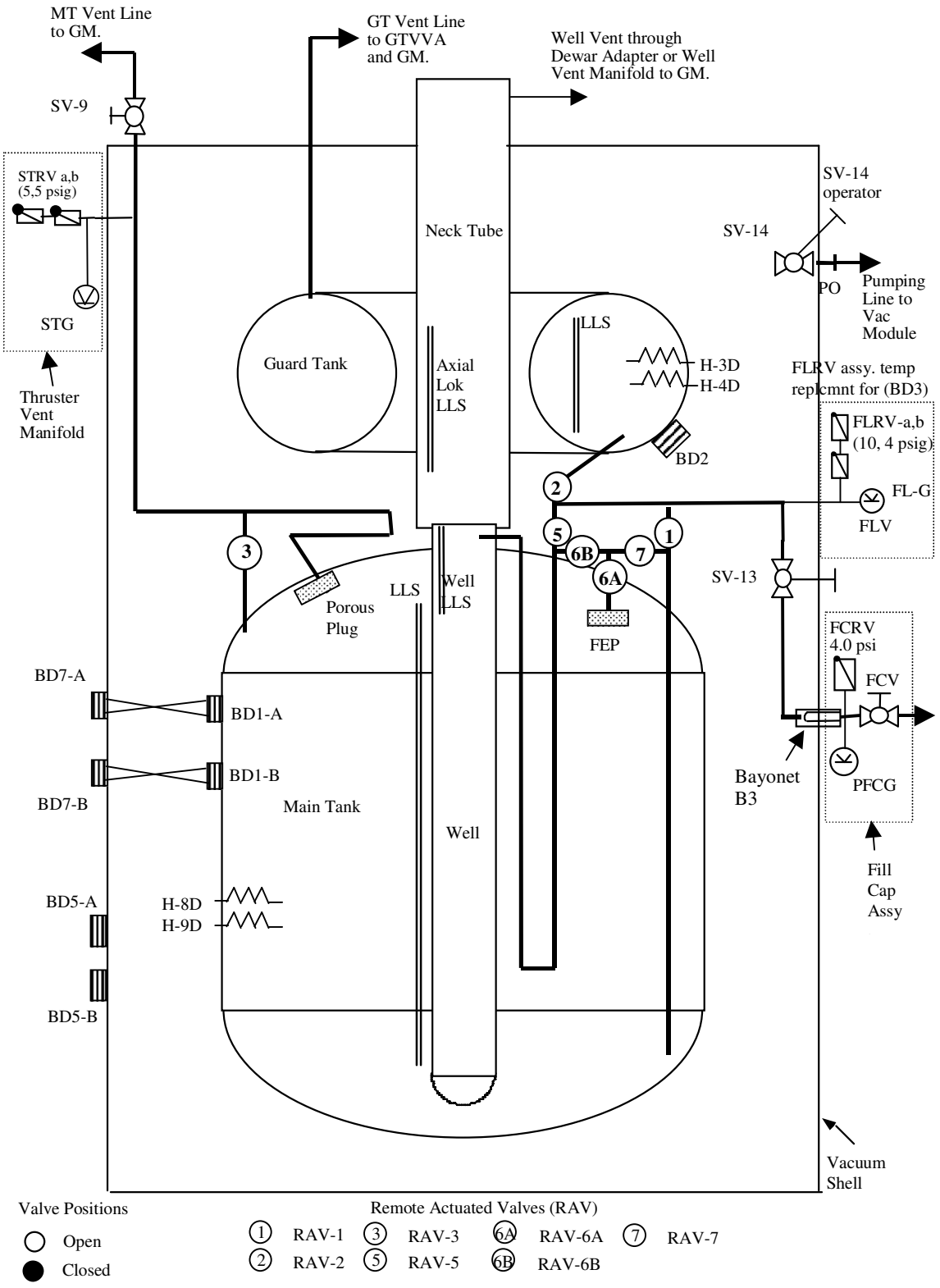

Figure 1. Schematic of Science Mission Dewar plumbing.

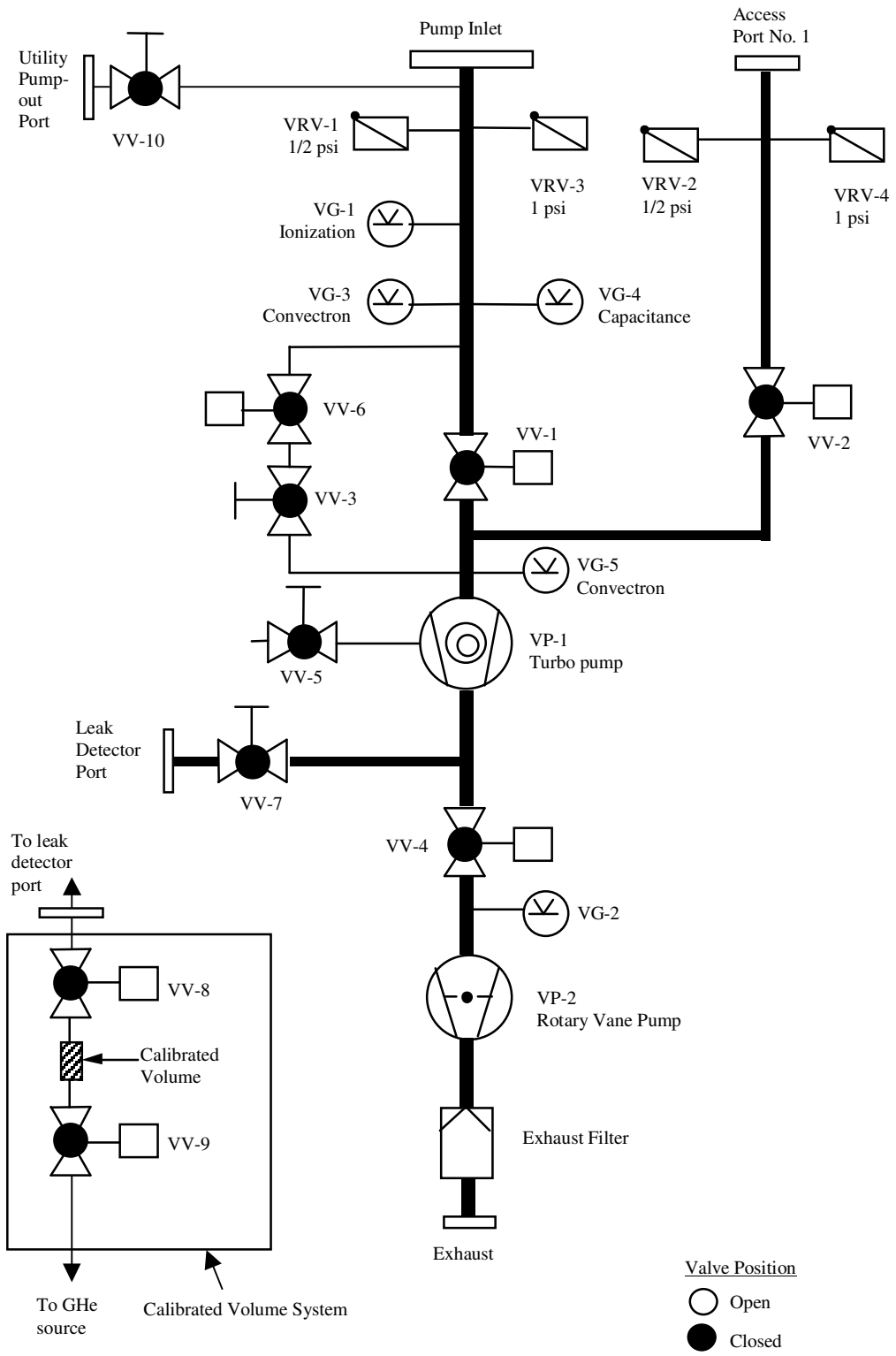

Figure 2. Schematic representation of Vacuum Module plumbing

APPENDIX 1 POST OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member is certified for the task being performed and knows their responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Verify/perform pre-task engineering/safety high-bay walk-down. Verify noted discrepancies have been corrected.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

J. APPENDIX 2 PRE OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify all steps in the procedure were successfully completed.		
	2. Verify all anomalies discovered during testing are properly documented.		
	3. Ensure management has been notified of all major or minor discrepancies.		
	4. Ensure that all steps that were not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	6. Verify all RAV valve operations have been entered in log book		
	7. Verify the as-run copy of procedure has been filed in the appropriate binder		
	Team Lead Signature: _____		

K. APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES

Condition	Circumstance	Response
Power Failure	Anytime	Close SV-14 and wait for power restoration
Liquid nitrogen spill	Anytime	Clear area until all spilled liquid has evaporated
Temperature limits (CN 40 or 41) exceeded	Any time	Close EV-17 (if open) and open EV-9. Crack open SV-9 to allow MT to vent. Adjust SV-9 as necessary to restore temperature(s) below alarm limits. Open EV-6 and EV-18 if higher flow rate is needed.
Burst disk rupture (MT/GT)	Any time	Evacuate room
Pressure in Main Tank exceeds limit	Anytime	Open either SV-9 or EV-9 to blow down Main Tank
Oxygen Monitor Alarm	Anytime	Evacuate room