GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

STOP PUMPING ON SMD VACUUM SHELL / DISCONNECT VACUUM MODULE

P0214c

ECO 1293

August 9, 2001

Revised by	Checked by
________________________Date________	________________________Date________
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Approvals:

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	734	Update procedure based on experience of performing operations	1/27/98
B	1091	Changed title to reflect procedure contents more accurately. Change title to: *Stop Pumping on SMD Vacuum Shell / Disconnect Vacuum Module*. Section A – Revised scope to reflect content of procedure more accurately. Section B – Divided into two sections, addressing safety issues (new Section B) and test personnel (new Section D). Reorganized safety paragraphs into: hazards, mitigation, injuries. Content of both new sections essentially unchanged. Added Quality Assurance Section (new Section C) Section C, D, and E – Consolidated all requirements into new Section E entitled Requirements. Added Configuration requirements, GSE/SMD interface requirements, alarm setup requirements, vacuum requirements, and non-flight hardware requirements. Added sections to verify QA notification, verify initial configuration, ensure DAS and liquid-level alarms properly set. Changed to include 3 initial and 3 final configurations corresponding the those configurations in P0213b *Connect Vacuum Module / Pump On SMD Vacuum Shell.*	
C	1293	Add redlines (move G.4.2.5 to G.4.7 and clarify wording) Update list of qualified personnel and include other minor changes..	8/8/01

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 to cease 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

Leak test 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. 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

The FIST OPS laboratory has an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Prior to beginning this procedure in any facility other than the FIST OPS Lab, the presence of a similar oxygen monitor must be verified by safety and operations personnel. 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, and oxygen collection pans are on the floor beneath them.

The following requirements apply to personnel involved 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.

The FIST Emergency Procedures document, SU/GP-B P0141, discusses emergency procedures. These documents should be reviewed for applicability at any facility where the hardware is operated.

B.2.3. Other Hazards

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

B.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 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 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

The Ground Support Equipment includes the Gas Module, the Pump Module, the Electrical Module, and the Vacuum 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 (see the *Electrical Module Manual* for details), and provides remote control of valves in the Gas Module, Pump Module, and SMD. The Vacuum Module contains a turbo pump, backed by a vane pump, and provides the capability to pump out the SMD vacuum shell.

This procedure calls for use of hardware located in the Vacuum Module (Figure 2) and the Electrical Module (Table 1).

E.3.3. Computers and Software:

The Data Acquisition System (DAS) and data acquisition software are 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

Description
Helium leak detector
Helium leak detector calibrated leak; cal. due date:

E.3.5. Additional Hardware

Description	***Manufacture r***	***Mfr./Part No.***
Calibrated Volume System	LMMS	N/A
Protective cover for SV-14		

E.3.6. Tools

No additional tools are required.

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
99.99% 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***	***User 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	User 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. The actuator control valve for EV-9 (located on the Gas Module, this valve switches the state that EV-9 defaults to, should a power failure occur) should be placed in the “NBP.” or “Subatm” position, as appropriate.

E.5.2. Guard Tank

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

E.5.3. Well

The Well may contain liquid or 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. Station 200 temperature (CN 01) set at $T \leq 6.5$ K.
   b. Top of lead bag temperature set (CN 28) at $T \leq 6.0$ K.
   c. Relative Guard Tank Pressure (CN 46) set at □P ≥ 0.3 torr.
2. The Facility Main Alarm System must be armed.

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 SMD is installed in its transportation and test fixture.
2. A relief valve is installed in place of the SMD internal fill-line burst disk.
3. A foreign object and debris shield may cover the upper cone of the SMD. If it is not present, any object that could cause damage to the SMD, if dropped, must be tethered.
4. The Airlock Support Plate may be installed on the SMD. This plate supports the Airlock that is used to keep air out of the Well during probe installation and removal. It is left in place while the Probe is removed.
5. A Dewar Adapter, Shutter, and Shutter Cover are mounted to the Well of the SMD when the Probe is removed
6. 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.
7. The Guard 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.
8. When the Well contains liquid, it vents through the Gas Module unless Well operations are being performed (e.g., Probe insertion). Venting through the Gas module is accomplished via a pumping line attached to the Dewar Adapter interface flange at the Airlock Support Plate (Probe not installed), or via a pumping line attached to the Well vent manifold installed at the Well pump-out port (Probe installed).
9. The thruster vent port may be flanged to a shut-off valve.
10. The Fill Cap Assembly may be installed at SV-13.

E.7. Verification/Success Criteria

N/A

E.8. Payload Constraints and Restrictions

N/A

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*
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*

F.3. Additional Procedures

No additional procedures are indicated.

Operation Number:____________
Date Initiated:____________
Time Initiated:____________

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- Verify SU QA notified.
  Record: Individual notified __________________,
  Date/time ________/________.
- Verify ONR representative notified.
  Record: Individual notified __________________,
  Date/time ________/________.

G.2. Verify Configuration Requirements

G.2.1. Ensure Facility Main Alarm System enabled.

G.2.2. Verify proper sealing of Well. Record closure (cover plate, Hole cutter, Probe etc.).______________________________________

G.2.3. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.4. Verify that gas connected to helium pressurization system is helium.

G.2.5. Verify DAS alarm system enabled and record set points.

1. ***Station 200 temperature*** – ensure CN [01] on DAS alarm list and set to alarm at T ≤ 6.5 K. Record set point. _________K
2. ***Top of lead bag temperature*** – ensure CN [28] 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 ΔP ≥ 0.3 torr. Record set point. _________tor r

G.2.6. Verify liquid-level alarms set, as appropriate, and record set points.

1. ***Main Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _________%
2. ***Well*** – ensure liquid-level alarm set ≥ 20% (if liquid in Well). Record set point. _________%
3. ***Guard Tank*** – ensure liquid level alarm set ≥ 10% (if liquid in GT). Record set point.

_________%

G.2.7. Verify DAS watchdog timer and alarm enabled.

G.2.8. Verify vacuum line connected between (SV-14) and Vacuum Module.

G.2.9. Verify ion-pump magnet installed.

G.2.10. Verify SMD vacuum pressure ≤ 5 x 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 x 10^{-5} torr, turn off Vac-ion pump and perform procedure P0213 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.2.11. Enter comment into DAS "Begin disconnect of Vacuum Module."

G.2.12. Record and verify one of following initial configurations:

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o ***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.

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o ***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.

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o ***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).

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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.2.13. 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.2.14. 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.

G.3. **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.3.1. Input comment to DAS “Close SV-14 to stop pumping on vac. jacket”.

G.3.2. Remove the handle restrainer on the vacuum operator stem.

G.3.3. 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.3.4. ***(Only if not going to remove pumping line)*** Attach the operator’s closed position handle lock.

G.3.5. ***(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.

G.4. **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 configuration 1 – actively pumping up to closed SV-14 – is ***not*** the desired final configuration and Vacuum Module is actively pumping. Perform this section

G.4.1. Close gate valve VV-1.

G.4.2. 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, close VV-5.

G.4.3. Connect calibrated volume system to vacuum module's leak detector access port (see Figure 2).

G.4.4. Close valves VV-8 and VV-9 on the calibrated volume system.

G.4.5. Adjust helium pressurization system to 1.0 +/- 0.5 psig and purge supply line for one minute.

G.4.6. While the supply line is still purging, connect to valve VV-9 of the calibrated volume system.

NOTE:
In the following steps gas is evacuated from the calibrated 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.4.7. Switch Vacuum Module override to **on (up)** and verify that VV-4 opens by observing a decrease in pressure VG-5.

G.4.8. Open valve VV-8.

G.4.9. Slowly open valve VV-7 and evacuate the calibrated volume until the pressure at VG-2 < 25 mtorr. Record the following:

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

G.4.10. Close valves VV-7 and VV-8.

G.4.11. Open valve VV-9 and pressurize the calibrated volume to 1.0 +/- 0.5 psig.

G.4.12. Close valve VV-9.

G.4.13. Open valve VV-8.

G.4.14. Slowly open valve VV-7 and evacuate the calibrated volume until the pressure at VG-2 < 25 microns. Record the following:

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

G.4.15. Close valves VV-7 and VV-8.

G.4.16. Open valve VV-9 and pressurize the calibrated volume to 1.0 +/- 0.5 psig.

G.4.17. Close valve VV-9.

G.4.18. Close valve VV-4.

G.4.19. Record pressure VG-5: ________torr:

G.4.20. Open VV-8 and VV-7 to let gas into in calibrated volume into Vacuum

Module.

G.4.21. 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.4.22. Turn on Vac-ion pump, and record time of day: _____.

G.4.23. 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.4.24. Input comment to DAS " Starting leak-back test of SV-14".

G.4.25. Turn off ion gauge VG-1.

G.4.26. Open gate valve VV-1 and record time: ___________

G.4.27. 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.4.28. Turn off Vac-ion pump.

NOTE:
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. If it is certain that SV-14 has not closed, procedure P0213 should be initiated to restart pumping up to "closed" SV-14. Otherwise, additional pressure measurements should be made after 5 minutes to verify the results.

G.4.29. After 25 minutes from opening gate valve VV-1, turn on the Vac-ion pump and record time of day.

G.4.30. Wait five minutes then record the following pressures:
1. Vac-ion pump (IP):_________ torr
2. VG-5 pressure:_________ torr

G.4.31. Verify that the Vac-ion pressure has not increased from previous reading.

G.4.32. ***(Only if not removing pumping line)*** Turn off the Vac-ion pump and record time of day: _________.

G.5. **Place System in Final Configuration**

Establish ***one*** of following configurations as recorded in paragraph G.2.10.

- ***Final configuration 1*** – actively pumping up to closed SV-14 – is the desired final configuration. Continue with Section G.6.

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

G.5.1. Open VV-4 and pump for no more than 1 minute.

G.5.2. Close VV-4.

G.5.3. Close VV-1.

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

G.5.4. Turn Vacuum Module override switch to **off (down)** position.

G.5.5. Disconnect helium pressurization line from calibrated volume system.

G.5.6. Remove calibrated volume system from vacuum-module leak detector access port and place in clean-room compatible bag.

G.5.7. Cap leak detector access port at valve VV-7.

G.5.8. **(Option)** Shut down pump VP-2.

G.5.9. Continue with section G.6.

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

G.5.10. Ensure gaseous helium supply attached to leak detector port or calibrated volume at leak detector port of Vacuum Module.

G.5.11. Ensure VV-7 closed.

G.5.12. If calibrated volume installed, open valves VV-8 and VV-9.

G.5.13. Turn on/verify on Vac-ion pump.

G.5.14. 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.

G.5.15. Backfill the hi-vacuum hose with gaseous helium to 770 +/- 5 torr as read on gauge VG-4 by slowly opening valve VV-7.

NOTE: Control the rate of pressurization to < 100 torr / min. Monitor Vac-ion pressure throughout pressurization process.

G.5.16. 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.5.17. Close VV-8 and VV-9, if calibrated volume attached.

G.5.18. Turn off Vac-ion pump.

G.5.19. **(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 (SV-14) protective cap by screwing in place.

G.5.20. **(Option)** Disconnect high-vacuum pumping line from Vacuum Module.

1. Disconnect vacuum line at ISO-100 elbow of 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.5.21. Disconnect helium pressurization line from leak detector port/calibrated volume system.

G.5.22. Remove/verify removed calibrated volume system from vacuum-module leak detector access port. Place in clean-room compatible bag.

G.5.23. Cap leak detector access port at valve VV-7.

G.5.24. Close/verify closed Gate valve VV-1.

G.5.25. Close/verify closed VV-4.

G.5.26. Turn system override switch **off (down)**. **Note:** no valves should trip. If a valve does trip it indicates an error in execution or in the procedure. In either case it should be D-logged and QA notified.

G.5.27. **(Option)** Shut down pump VP-2.

G.5.28. Continue with Section G.6.

G.6. Configure DAS

G.6.1. Input comment to DAS "End disconnect of Vacuum Module".

G.6.2. Set DAS data cycle interval to 15 minutes.

G.6.3. Ensure DAS alarm enabled and record set points if changed

- o Thermal conditions substantially unchanged, alarm set points for Station 200 and lead bag unchanged
- o Thermal conditions substantially changed, temperature alarm points reset as follows:

  a. Station 200 set point [CN 1] _________ K (≤ 6.5 K)

  b. Top of Lead Bag set point [CN 28] _________ K (≤ 6.0 K)

G.6.4. Ensure liquid level sensor alarms enabled, as appropriate, and record set points if changed.

1. Main Tank Level Set Point ___________%
2. Well Level Set Point ___________%
3. Guard Tank Level Set Point ___________%

G.6.5. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.6.6. Ensure DAS watchdog timer and alarm enabled.

G.6.7. Ensure Facility Main Alarm System enabled.

H. PROCEDURE COMPLETION

Completed by:_________________

Witnessed by:_________________

Date: ___________

Time:___________

Quality Manager___________________________________Date_________________

Payload Test Director______________________________Date_________________

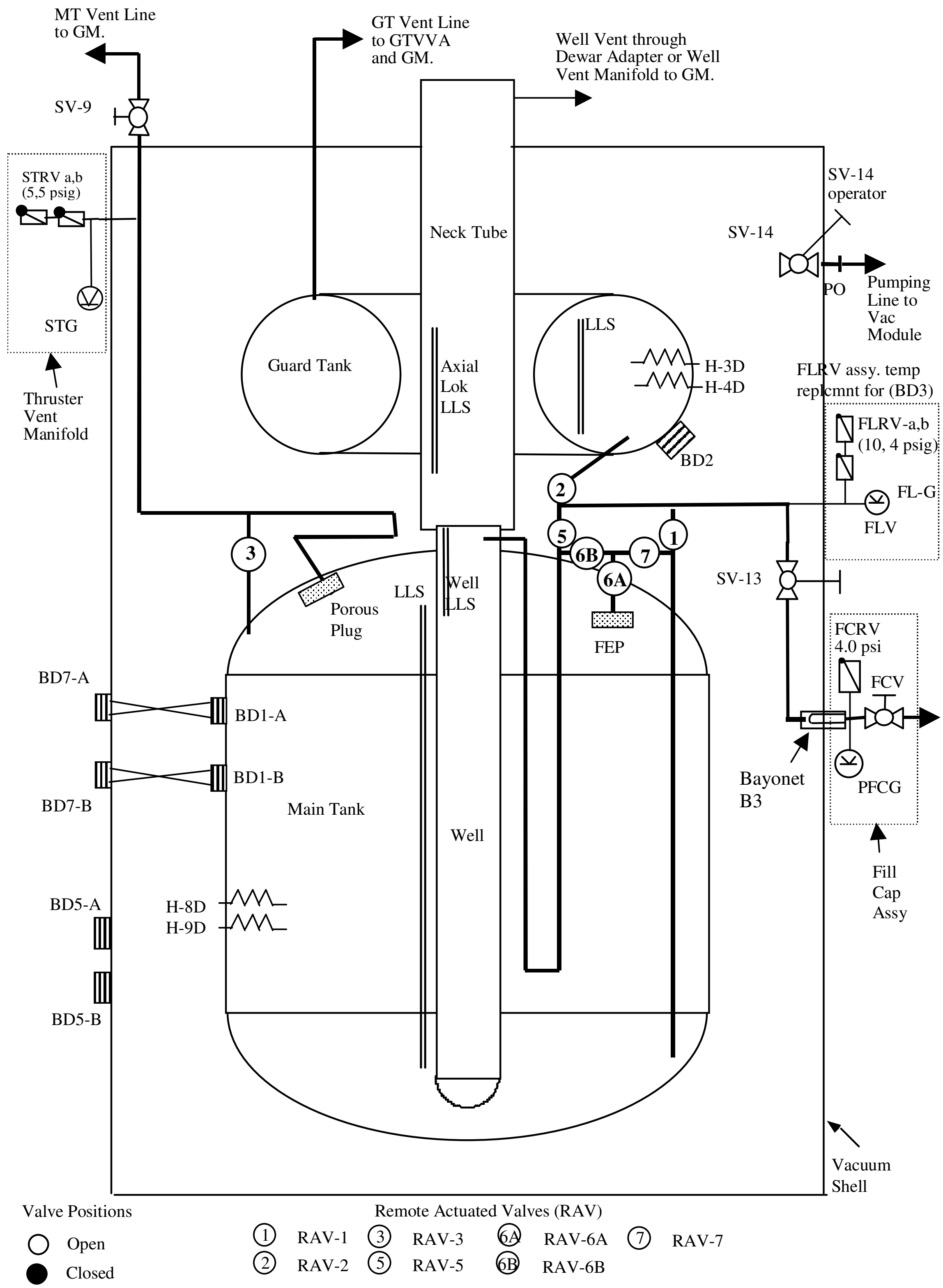

Figure 1. Schematic of Science Mission Dewar plumbing.

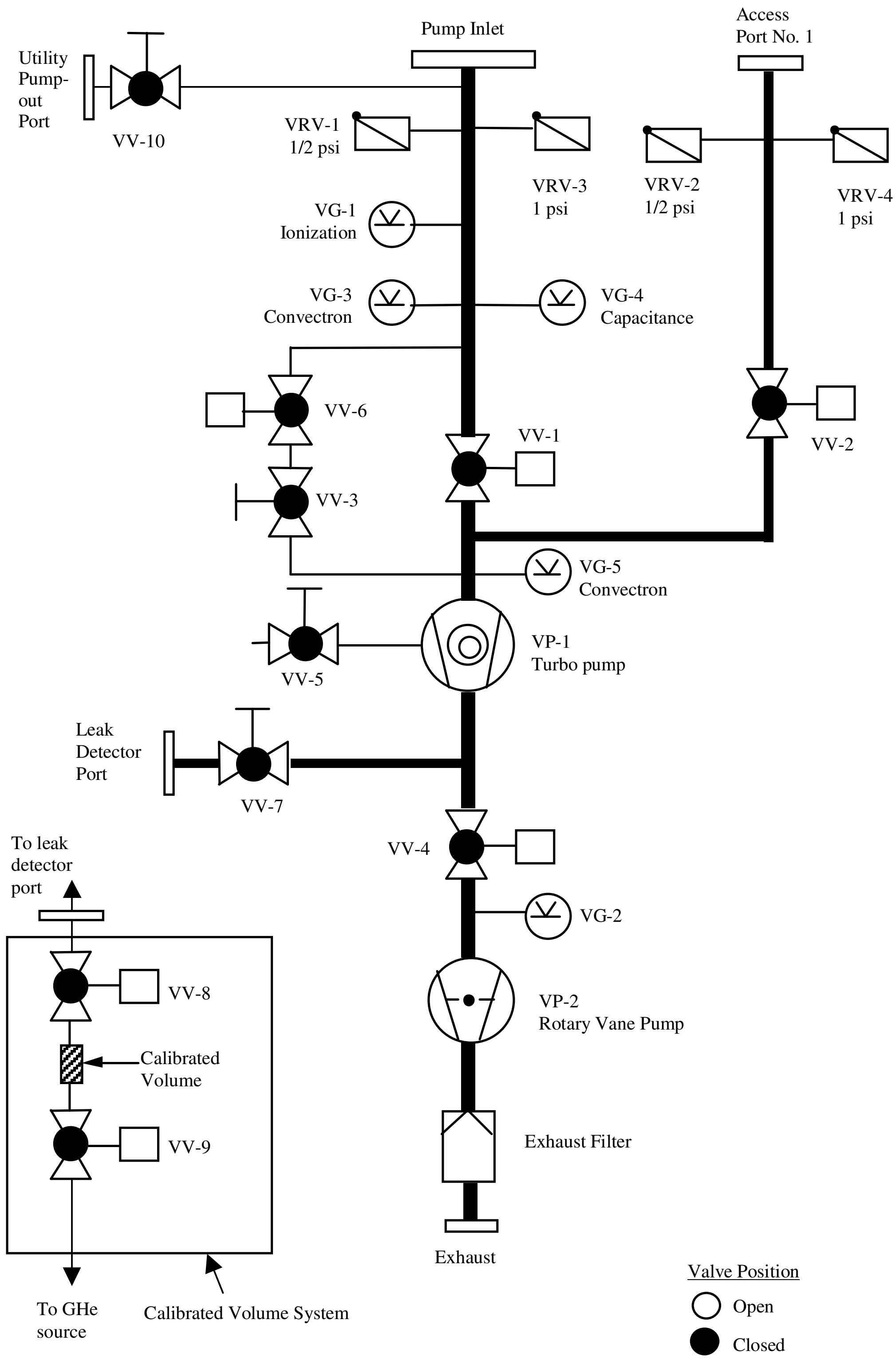

Figure 2. Schematic representation of Vacuum Module plumbing