GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

CONNECT VACUUM MODULE / PUMP ON SMD VACUUM SHELL

To be performed in Vandenberg Air Force Base building 1610

WARNING: This document contains hazardous operations

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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 connect the Vacuum Module to the vacuum space of the Science Mission Dewar and begin pumping. There are three possible initial configurations:

Initial Configuration 1 – Pumping line disconnected at one or both ends.

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

Initial Configuration 3 – Actively pumping up to closed SV-14.

There are likewise three final configurations. The first two are equivalent to initial configurations 2 and 3. The three final configurations are

Final Configuration 1 – Pumping line connected at both ends and pumped out.

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

Final Configuration 3 – Actively pumping on SMD vacuum.

The steps include:

Connect high-vacuum pumping line to Vacuum Module and SMD (if disconnected)

Pump out high-vacuum pumping line and leak check (if not already pumping)

Pump up to closed SV-14.

Open SV-14 and pump on SMD vacuum shell.

The hazardous operation contained in this procedure is the handling of cryogenic nitrogen to service the leak detector.

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 Project LM/P479945 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, there may be an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. In addition, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Building 1605 has been designated as a fall-back area in case of building evacuation. 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 and VAFB 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, non-absorbent shoes, rubber gloves (if required) and full-face shields with goggles/glasses are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

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

B.3. **Mishap Notification**

B.3.1. Fire/Injury

B.3.2. In the event of fire or illness/injury 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

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. Within hazardous portions of this procedure, all steps shall be worked in sequence. Out of sequence work or redlines shall be approved by NASA Safety prior to their performance.

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
NASA Safety Rep	1	SFAO or ANALEX

REQUIREMENTS

E.1. **Electrostatic Discharge Requirements**

Test engineers, when working on the vehicle, shall properly ground themselves. All wrist straps will be checked using 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) 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
Varian Leak Detector S/N #_____ Cal Due Date:_____
Torque Wrench, 1-1/4-in socket, 60 +/- 5 in-lb Cal Due Date:_____S/N_____

E.3.5. Personnel Protective Equipment

1. Cryogenic safety gloves and apron
2. Face Shield
3. Goggles/Glasses
4. Non-absorbent shoes
5. Rubber gloves (if ethonal is to be used.

E.3.6. Additional Hardware

Description	*Manufacturer*	*Mfr./Part No.*
Vacuum valve operator - 2-in	LMMS	5833808-105
Vacuum valve operator handle restrainer	N/A	N/A
4 liter thermos	N/A	N/A

E.3.7. Tools

No additional tools are required.

E.3.8. Expendables

Description	*Quantity*	*Mfr./Part No.*
99.999% pure gaseous helium	AR	N/A
Liquid nitrogen	AR	N/A
Vacuum grease	AR	Dow Cornings High Vacuum or Apiezon N

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,	3452A01956	Yes	

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
			B4			
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	-
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 is evacuated.

E.5.4. SMD Vacuum Shell

There is no requirement for the vacuum shell pressure.

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 set (CN 40 and CN 41) at $T \leq 6.0$ K.
    b. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet must be installed.
2. The thruster vent port is flanged to a relief valve assembly when the flight thruster manifold assembly is not installed.
3. Valve SV-14 at the Vacuum shell pump out port is closed. The pumping line between the Vacuum Module and SV-14 may or may not be connected. If it is disconnected, the Vacuum Module pumps are off. If it is connected, the Vacuum Module pumps may be actively pumping up to the closed SV-14.

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. 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. Verify Appropriate QA Notification

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

- Verify NASA safety representative notified and concurrence has been given to proceed.

  Record: Individual notified _____

  Date/Time:_____,

- Record calibration due dates in Table 1 (Sections. E.3.4, 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. Ensure DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – ensure CN [40] 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 [41] 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. _____torr

G.3.2. Ensure 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 ≥ 10% if liquid in GT. Record set point. _____%

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

G.3.4. Ensure ion-pump magnet installed.

G.3.5. Input comment to DAS "Begin Vacuum Module Connect"

G.3.6. Set DAS data cycle time to 5 minutes.

G.3.7. Record and verify initial configuration of high-vacuum pumping line.

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o ***Initial Configuration 1*** – Pumping line disconnected at one or both ends.

1. Ensure turbo pump off.
2. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7, and VV-10 closed.

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o ***Initial Configuration 2*** – Pumping line connected at both ends and pumped out (VG-3 ≤ 10 torr).

3. Verify turbo pump (VP-1) off
4. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7, and VV-10 closed..
5. Verify pressure in pumping line (VG-3) < 10 torr _____ torr.

Note: If high-vacuum pumping line is connected and VG-3 ≥ 10 torr, *do not* skip leak-check (Section G.7).

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o ***Initial Configuration 3*** – Actively pumping up to closed SV-14.

6. Verify turbo pump (VP-1) and vane pump (VP-2) on
7. Verify/switch turbo pump to normal speed operation (Standby light is

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off).

8. Verify VV-1 and VV-4 open.
9. Ensure VV-2, VV-3, VV-5, VV-6, VV-7, and VV-10 closed.
10. Verify pumping-line pressure (VG-1) $\leq 5x10^{-6}$ torr _____ torr.

G.3.8. Record intended final configuration

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

G.4. **Connect High-Vacuum Pumping Line to Vacuum Module**

- Skip if already connected
- Not connected, perform these steps:

Note:
All O-rings are to be inspected for damage, cleaned and lightly grease with Dow Corning High Vacuum Grease

G.4.1. Install/verify installed ISO reducer flange on inlet to Vacuum Module.

G.4.2. Install/verify installed 90-degree ISO-100 elbow.

G.4.3. Position high-vacuum pumping line such that it is well supported and strain relieved between Dewar and Vacuum Module.

G.4.4. Install high-vacuum pumping line to inlet of elbow.

G.5. **Connect SV-14 operator to SMD Pump Out Port at SV-14**

- Already connected, skip this section.
- Not connected, perform these steps:

G.5.1. Remove closure cap from SMD Pump Out (PO) port .

G.5.2. Remove o-ring from groove in flange on PO and clean groove with alcohol.

G.5.3. Inspect the o-ring and lightly grease with Braycote Micronic 601; install o-ring in groove.

G.5.4. Inspect SV-14 operator shaft and wipe with clean lint free cloth if necessary. Grease the shaft with Braycote Micronic 601 grease.

G.5.5. Clean operator's dewar interface flange with alcohol.

G.5.6. Clean operator's vacuum line interface flange with alcohol.

G.5.7. Withdraw operator handle and install handle-withdrawn restrainer.

G.5.8. Carefully thread operator in place on valve SV-14. Hand tighten so that the output flange is lined up with the flex hose at the end of the high-vacuum pumping line.

G.6. **Connect High-Vacuum Pumping Line to Dewar**

- Already connected, skip this section.
- Not connected, perform these steps:

G.6.1. Clean the flex hose flange at the end of the high-vacuum pumping line with alcohol.

G.6.2. Ensure centering ring used to connect high-vacuum pumping line with operator is clean.

G.6.3. Connect high-vacuum pumping line to operator. Strain relieve line so it does not place undue pressure on connection at operator.

CAUTION
In the following step the operator's shaft is engaged into SV-14 plug. Use <u>extreme</u> caution in performing this step. Engage the shaft only. Do not open the high-vacuum valve as it would result in a sudden pressurization of the dewar's insulation space. Failure to comply may result in equipment damage.

G.6.4. Remove handle-withdrawn restrainer.

G.6.5. Carefully engage SV-14 plug with the operator by screwing the handle into the plug clockwise until a very light resistance is felt indicating that the fully engaged handle is bottomed. After bottoming back off the handle 1/8 turn counter clockwise.

G.6.6. Install operator's closed position restrainer over handle.

G.7. **Evacuate Pumping Line up to Closed Valve SV-14.**

- Already pumping up to closed SV-14, skip this section.
- Not evacuated, perform these steps:

G.7.1. Begin recording data in Table 1.

G.7.2. Establish Initial Configuration of SMD and GSE

1. Ensure turbo molecular pump (VP-1) is off.
2. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7 and VV-10 are closed.
3. Verify on/turn on the rotary vane pump (VP-2 light on) and record pressure VG-2: _____ torr.
4. Turn Vacuum Module over-ride switch to **on** position (switch in up position).
5. Equilibrate pressures across VV-1 by opening valves VV-6 and VV-3 and record:
   a. VG-3 pressure _____ torr
   b. VG-5 pressure _____ torr

Note:

If pump module contained helium gas from last operations, these convectron gauges may be off scale.

G.7.3. Close VV-3 and VV-6.

G.7.4. Release the brakes on the vacuum module and ensure that the wheels will allow the module to move (up to 12 inches) during the compression of the pumping line during evacuation.

G.7.5. Open VV-4 (lighted switch) and pump up to closed valves VV-1 and VV-3 until pressures at VG-2 and VG-5 ≤ 50 mtorr.

G.7.6. Record pressures:

1. VG-2 pressure _____ torr
2. VG-5 pressure _____ torr

G.7.7. Open valve VV-6 (switch up) and slowly open valve VV-3 and evacuate the high-vacuum pumping line.

Note:
Control the evacuation rate at < 100 torr/min by throttling through valve VV-3.

G.7.8. When the pressure at VG-2 reaches 1 torr, perform the following:

1. Record Time of day:_____
2. Record VG-2 pressure:_____ torr
3. Record VG-3 pressure:_____ torr
4. Close valves VV-6 and VV-3.
5. Open VV-1 (switch up).
6. Turn on Turbo pump.

G.7.9. Turn on the ionization gauge VG-1 when the pressure at VG-5 is < 1.0 x 10-3 torr.

G.7.10. Continue the evacuation of the high-vacuum pumping line up to closed valve SV-14 until the pressure at VG-1 is < 5.0 x 10-6 torr then record:

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

WARNING

The following is a hazardous operation. While filling the nitrogen trap in the leak detector, wear cryogenic safety apron, gloves, face shield with goggles/glasses, and non-absorbent shoes. Failure to comply may result in personal injury.

G.8. Leak Test High-Vacuum System up to Closed Valve SV-14

- Pressure VG-3, as recorded in G.2.9-5, is ≤ 10 torr skip this section.
- Already pumping with turbo up to closed SV-14, skip this section
- Otherwise, perform these steps:
- Request NASA Safety make PA announcement that a hazardous operation is about to begin.
- Ensure area operation light is turned to Amber.
- Establish a controlled area or two feet.
- Ensure all nonessential personnel are clear of the area.

G.8.1. Calibrate the leak detector

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

NOTE

All Hazardous operations are now complete. Request NASA Safety make PA announcement. Ensure area operation light is returned to green. Disband controlled area.

G.8.2. Connect the leak detector to the leak check access port of the vacuum module.

G.8.3. Leak test the system up to closed valve VV-7.

G.8.4. Turn the leak detector's vent disable switch to the disabled position.

G.8.5. Slowly open leak detector access valve VV-7. Monitor the system pressure as read on gauge VG-1 as this valve is opened.

G.8.6. While monitoring VG-1 to ensure it does not rise above 1 x 10-5 torr, close valve VV-4.

G.8.7. Leak test the high-vacuum pumping line and connections from the vacuum module to the connections at SMD Pump Out port.

G.8.8. Record Leak detector readings:

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

G.8.9. Verify no leaks > 1.0 x 10-8 sccs are present.

G.8.10. Open valve VV-4 and close valve VV-7.

G.8.11. Turn off the ionization gauge (VG-1).

G.8.12. Close gate valve VV-1.

G.8.13. Turn the leak detector's vent disable switch to the off position.

G.8.14. 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.8.15. Disconnect the leak detector from the vacuum module's leak check access port.

G.8.16. Install a KF cap on the leak check access port.

G.8.17. Ensure Vacuum Module over-ride switch in off position (switch down).

G.9. **Place System in Final Configuration**

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

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o ***Final Configuration 1 –*** Pumping line connected at both ends and pumped out.

G.9.1. Turn off Turbo pump as follows:

1. Verify that Vacuum Module override switch is **off**.
2. Power off Turbo pump and ensure VV-4 closes.
3. Open manual valve VV-5 slowly to decelerate Turbo pump.
4. When Turbo deceleration is complete, close VV-5.
5. Briefly switch Vacuum Module override to **on** and verify that VV-4 opens by observing a decrease in pressure at VG-5.

G.9.2. Close/verify closed VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7 and VV-10.

G.9.3. Ensure Vacuum Module override switch is off.

G.9.4. (Option) Shut down pump VP-2.

G.9.5. Input comment to DAS "End connect and pump out of SMD high-vacuum pumping line – Vacuum Module shut down."

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o ***Final Configuration 2 –*** Actively pumping up to closed SV-14.

G.9.6. Open VV-1 to resume pumping up to closed SV-14.

G.9.7. Turn on ionization gauge and record pressure at VG-1.

1. VG-1 pressure _____ torr
2. Date / Time _____

G.9.8. Turn Vacuum Module over-ride switch to off position.

G.9.9. Place Turbo in Standby Mode (Standby light is on).

G.9.10. Input comment to DAS "End connect of Vacuum Module – pumping up to closed SV-14."

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o ***Final Configuration 3 –*** Actively pumping on SMD vacuum.

G.9.11. Verify already pumping up to closed SV-14 as follows:

1. Verify VP-1 and VP-2 on.
2. Open VV-1 to resume pumping up to closed SV-14.
3. Verify on/turn on ionization gauge (VG-1).
4. Verify pressure in high-vacuum pumping line $< 5 \times 10^{-6}$ torr.

Record VG-1 _____ torr.

G.9.12. Input comment to DAS “Begin pumping on SMD with Vacuum Module”.

G.9.13. Record pressure in SMD vacuum space:

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.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.

G.9.14. Record pressure in high vacuum pumping line (VG-1) _____ torr

G.9.15. Remove the operator’s closed position handle lock.

CAUTION
Do not proceed until VG-1 pressure is < 5.0 x 10-6 torr. Failure to comply may result in equipment damage.

CAUTION
In the following operation do not turn the handle as it is pulled out. A turning motion could result in a disengagement of the plug. The plug would then be floating free in the body of the operator and prove very difficult to retrieve. Failure to comply may result in equipment damage

G.9.16. Open SV-14 by gently pulling out the valve plug with the operator handle.

G.9.17. Record the following just as the valve is opened:

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

G.9.18. Install the operator-withdrawn handle restrainer.

G.9.19. Wait fifteen minutes and record the following:

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

G.9.20. Ensure that the vacuum module’s over-ride switch is in the off position.

G.9.21. Turn off Vac-ion pump and record time of day: _____.

G.9.22. Input comment to DAS “End connect of Vacuum Module – pumping on

SMD Vacuum."

G.10. **Establish Final Alarm Configuration**

G.10.1. Set DAS data cycle interval to 15 minutes.

G.10.2. Ensure DAS alarm enabled and record set points if changed

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

a. Top of Lead Bag set point [CN 40] _____ K (≤ 6.5 K)

b. Top of Lead Bag set point [CN 41] _____ K (≤ 6.0 K)

G.10.3. 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 _____%

G.10.4. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.10.5. Ensure DAS watchdog timer and alarm enabled.

G.10.6. (Option) Continue data recording in Table 1 until such time as SV-14 is closed.

H. **PROCEDURE COMPLETION**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Table 1 SMD Vacuum Shell Re-pump Data

Date Time	VG-2	VG-1	Vac-ion Pump	GT Temp. CN [24]		Comment
	torr	torr	torr	K		-

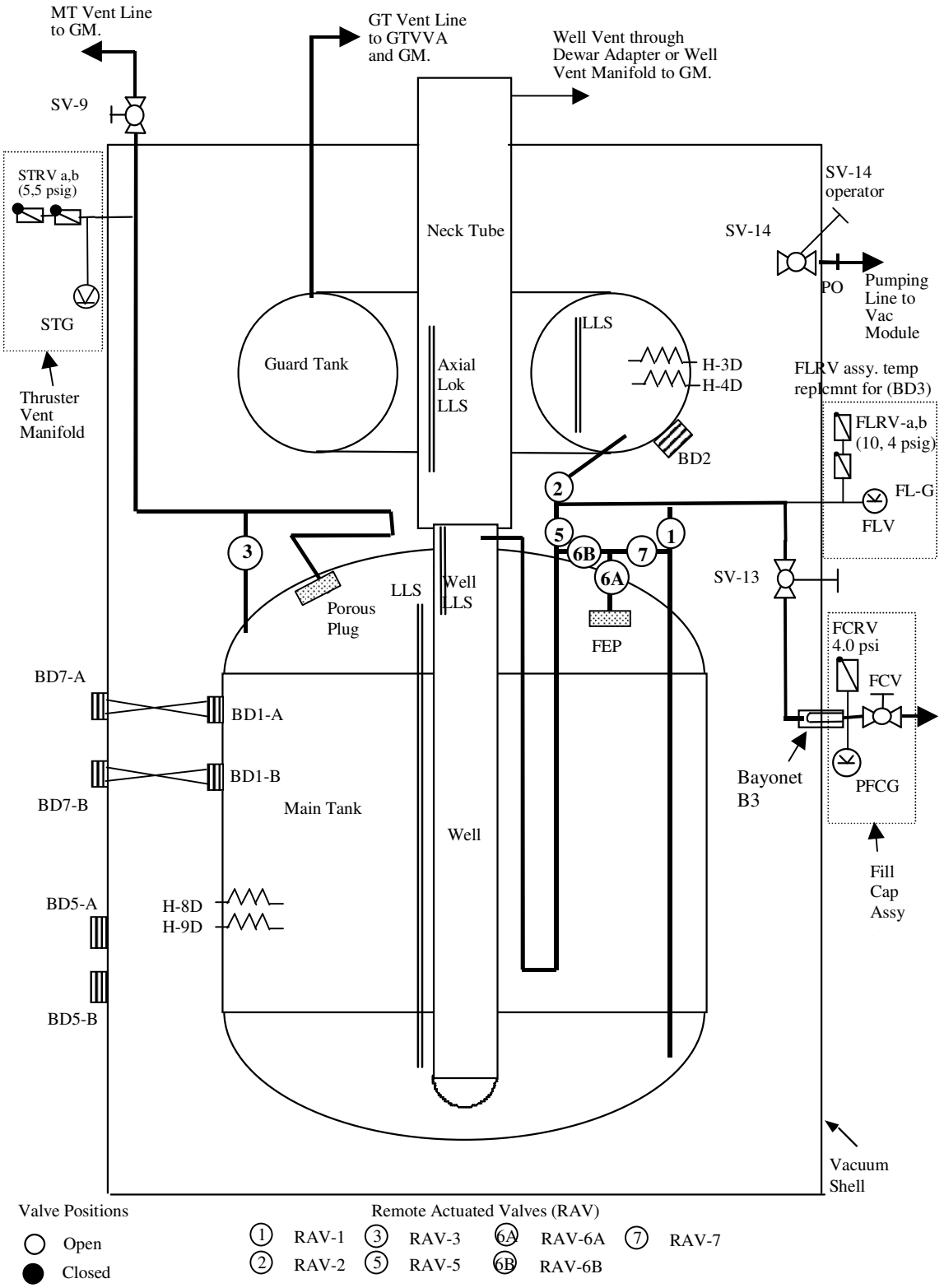

Figure 1. Schematic of Science Mission Dewar plumbing.

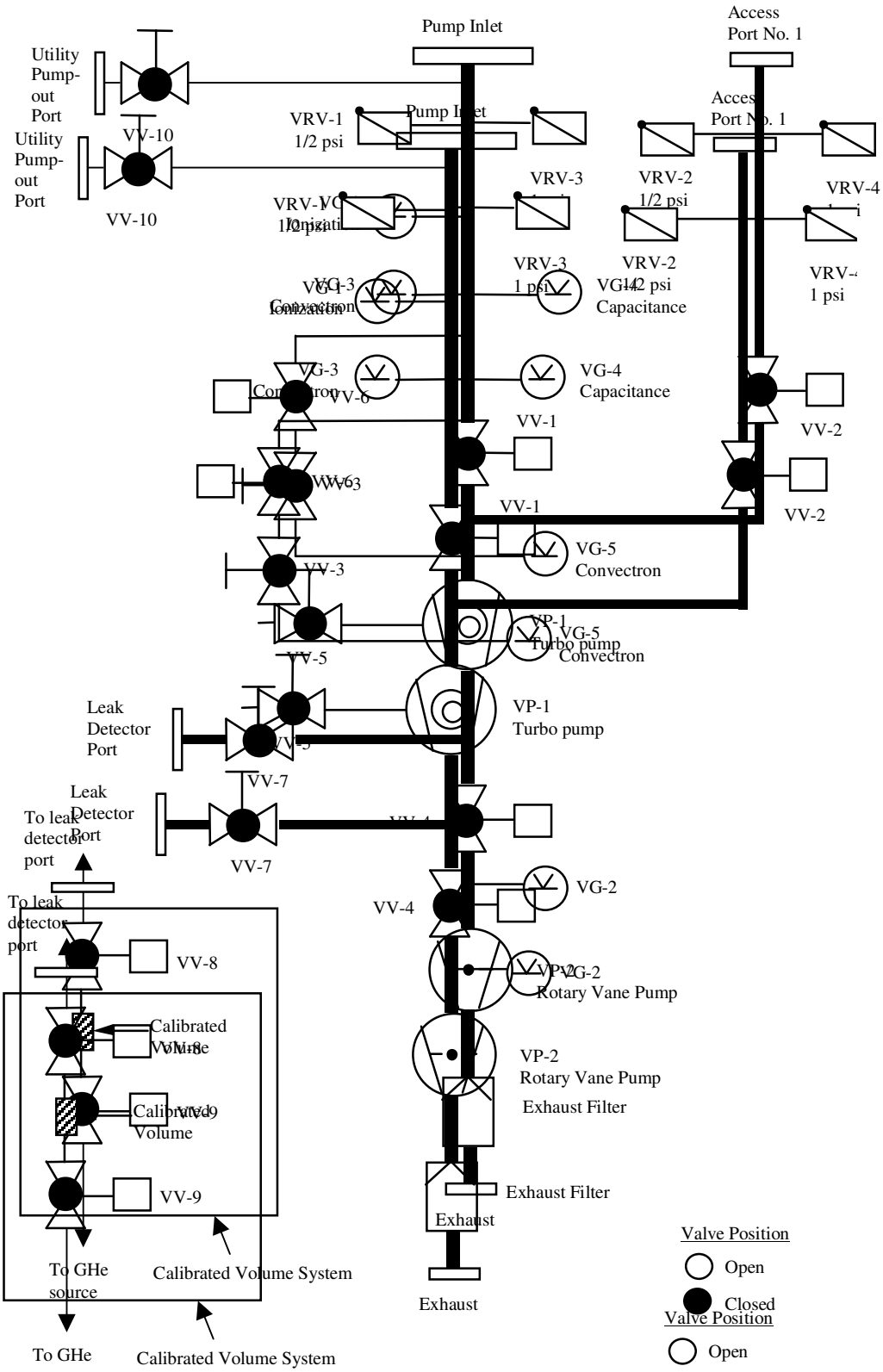

Figure 2. Schematic representation of Vacuum Module plumbing.

APPENDIX 1 PRE 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 POST 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
Temperature limits (CN 29 or 28) 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
Oxygen Meter Alarm	Any time	Evacuate room
Liquid Nitrogen Spill	Any time	Clear area until all liquid has evaporated.