GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

TILT SMD TO HORIZONTAL POSITION
(-x or –y Axis Up)

P0524B
ECO 1257

August 8, 2001

Prepared by

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	1095	Section A, updated scope to include case that Main Tank is subatmospheric. Added Quality Assurance Section (new Section C) Section C, D, and E – Consolidated all requirements into new Section E entitled Requirements. Added Configuration requirements to include minimum GT and Well liquid levels, GSE/SMD interface requirements, alarm setup requirements, vacuum requirements, and non-flight hardware requirements. Section G.1 Added section to verify notification of QA. Section G.2 – Added steps to verify configuration requirements and alarm setup. Section G.3 – Updated section to verify Gas Module in Standard Configuration. G.4. – Updated section to verify SMD in standard configuration. Added section to verify DAS and Main Facility alarms set at conclusion of procedure.	6/23/00
B	1257	Include minor redlines, add sections E.7 (Verification /Success Criteria) and E.8 (Payload Constraints and Restrictions)and update plumbing diagrams. Update DAS setup to include using fast scan mode. Change maximum allowable fill level for –x up rotation to 70%.	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 tilt the Science Mission Dewar from a vertical orientation to one of two horizontal orientations: –x axis up, or –y axis up. The steps include:

Verify SMD free to rotate

Verify appropriate Main Tank liquid level

Install tilt motor control on SMD test stand

Rotate in 10 degree increments until horizontal.

Liquid in the Main Tank can be NBP or subatmospheric, but must be at the appropriate level (see Table 2, Section G). The Guard Tank must be depleted, and the Well evacuated.

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 refers to or calls for use of hardware located in the Gas Module (Figure 1), Pump Module (Figure 2), Vacuum Module (Figure 3) and 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

No additional test equipment is required.

E.3.5. Additional Hardware

Item	Description	Manufacturer	Model
1	Thruster Vent Line Assembly	LMMS	N/A
3	1” Vacuum Line	N/A	N/A

E.3.6. Tools

	Description
1	Protractor bubble level
2	Torque Wrench – 1-1/4-in socket, 60 in-lb

E.3.7. Expendables

Description	Quantity	Mfr./Part No.
Alcohol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Braycote Micronic 601
Tie wraps - large size	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.

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	-	2936A24553 9	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. The actuator control valve for EV-9 switches the state that EV-9 defaults to, should a power failure occur. For this procedure it should be placed in the "NBP." position if the MT is at NBP or the "Subatm. He" position if the MT is subatmospheric

E.5.2. Guard Tank

The Guard Tank must be depleted. Procedure P0212 contains the appropriate steps.

E.5.3. Well

The Well must be evacuated.

E.5.4. SMD Vacuum Shell

There is no requirement on 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. 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 $\Delta P \geq 0.3$ torr.
2. The Facility Main Alarm System must be armed.

E.5.6. GSE and Non-flight Hardware

1. The SMD is installed in its transportation and test fixture.
2. The ion-pump magnet is installed.
3. 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). All other, unnecessary cabling must be removed.
4. The high-vacuum pumping line used for pumping out the SMD vacuum shell must be disconnected from SV-14. Procedure P0214, *Stop Pumping on the SMD Vacuum Shell / Disconnect Vacuum Module*, contains the appropriate steps for removing this line.
5. The thruster vent port is flanged to a relief assembly.
6. The 8-inch leakage-gas pumping line and spin-up gas supply lines must be removed from the probe.
7. The HEPA unit and scaffolding must be removed.

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. A relief valve is installed in place of the SMD fill-line burst disk.
2. 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 payload, if dropped, must be tethered.
3. 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.
4. The Guard Tank Vent Line may be connected to the Gas Module, or it may be disconnected at GTV-V.
5. 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**

Document No.	***Title***
SU/GP-B P0213	*Connect Vacuum Module / Pump on SMD Vacuum Shell*
SU/GP-B P0214	*Stop Pumping on SMD Vacuum Shell / Disconnect Vacuum Module*
SU/GP-B P0212	*Depletion of Guard Tank*
SU/GP-B P0595	*Reduce Liquid Level in Main Tank*
SU/GP-B P0618	*(PTP) Remove Probe Spinup Gas/Vac. Lines (+Z axis up)*

SU/GP-B P0594	*(PTP) SMD Lift and Rotate 90°*

Operation Number:___________

Date Initiated: ___________

Time Initiated:___________

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- o Verify SU QA notified.

  Record: Individual notified __________________,

  Date/time ________/________.

- o Verify ONR representative notified.

  Record: Individual notified __________________,

  Date/time ________/________.

G.2. Specify Direction of Rotation

Specify SMD axis that will be vertical upon completion of this tilting operation

- o -x
- o -y

G.3. Verify Configuration Requirements

G.3.1. Ensure Facility Main Alarm System enabled.

G.3.2. Verify SMD appropriately rotated about z axis to allow desired axis to be up when horizontal. If not, perform procedure P0594 as required. Record Operation No._________.

G.3.3. Verify all unnecessary electrical cables removed.

1. Record all GSE cables that will remain connected_______________

   ____

2. Ensure enough slack in remaining cables to allow full 90° tilt.
3. Verify all other GSE cables removed. (If unnecessary cables still connected to probe, dewar, or electronics, have qualified personnel perform appropriate procedures to remove).

G.3.4. Ensure DAS alarm system enabled and record set points.

1. ***Station 200 temperature*** – ensure CN [01] on DAS alarm list and set to alarm at $T \leq 6.5$ K.
   Record set point. __________K
2. ***Top of lead bag temperature*** – ensure CN [28] on DAS alarm list and set to alarm at $T \leq 6.0$ 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.3.5. Verify DAS watchdog alarm enabled.

G.3.6. Verify ion-pump magnet installed.

G.3.7. Verify 8” leakage gas pumping line and spin-up gas supply lines are removed from probe. If not, have qualified personnel perform procedure P0618 and record Operation No. _________.

G.3.8. Ensure HEPA unit removed.

G.3.9. Ensure scaffolding removed.

G.3.10. Ensure floor panels and turnbuckle struts removed.

G.3.11. Verify high-vacuum pumping line disconnected from SMD vacuum shell at SV-14. If not, perform P0214, and record Op. Order No ___________.

G.3.12. Verify appropriate vent lines disconnected from SMD.

1. Verify Well disconnected
2. Main Tank to be disconnected________(yes/no).

   If necessary, perform procedure P0673, or P0675, to disconnect Main Tank vent line and record Operation No. _________.
3. Guard Tank to be disconnected _________(yes/no).

   If necessary, perform procedure P0677 to disconnect Guard Tank vent line and record Operation No. _________.

G.3.13. Verify appropriate Main Tank liquid level.

1. Record liquid level in Main Tank ________%
2. Table 1 specifies maximum LHe levels for the two possible orientations when tilted. Minimum levels are not specified and depend on operational requirements. If the liquid level is not currently satisfactory, perform the appropriate fill or depletion procedure and record in Table 2.

Table 2

Orientation when tilted	***Maximum fill level when vertical***	***Level adjustment procedure performed***	***Operation No.***
-y up	48%		
-x up	70%		

3. If tilting is to proceed with liquid in Main Tank at NBP and liquid level is greater than maximum indicated in Table 2, perform Procedure P0595 *Reduce Liquid Level in Main Tank (Liquid at NBP)* and record Operation No.__________
4. If tilting is to proceed with liquid in Main Tank at subatmospheric

condition and liquid level is greater than maximum indicated in Table 2, perform Procedure P0719 *Reduce Liquid Level in Main Tank (Liquid Subatmospheric)* using Section G.7 to maintain current temperature. Record Operation No._________

G.3.14. Verify Guard Tank Depleted

1. Guard Tank depleted ______ (yes/no)
2. If Guard Tank not depleted, perform procedure P0212, “Guard Tank Depletion” and record Operation No.________.

G.3.15. Verify Guard Tank Pressure independently regulated at pressure greater than atmospheric pressure:

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o Guard Tank vent line is connected to Gas Module.

1. Verify pressurization source is helium and is connected through APR-2 to EV-23.
2. Verify EV-23 open.
3. Record pressure (EG-1a) ________ torr.

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o Guard Tank vent line is disconnected from Gas Module.

4. Verify pressurization source is helium and is connected through APR-3 to APR-3V and GTV-Va.
5. Verify open APR-3V and GTV-Va.
6. Record pressure (GTV-G) ________ torr (relative to atm.).

G.3.16. Record Guard Tank temperature CN [24] ________K

G.3.17. Record Vacuum Shell Pressure.

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.
5. When data cycle is complete, turn off Vac-ion pump.

G.4. **Record Initial Condition of SMD:**

G.4.1. Verify SV-9 open.

G.4.2. Record Main Tank pressure:

1. NBP – vent line connected (EG-3) ________ torr
2. NBP – vent cap installed (MTVC-G) ________ torr (relative to atm.)
3. Subatmospheric – vent line connected (EG-2) ________ torr
4. Subatmospheric – vent cap installed (VCP-1)_______ torr.

G.4.3. Record Fill Cap Assembly pressure and verify that it reads > 0.0 psig.
Fill Cap Assembly (PFCG): _______ torr.

G.4.4. Using the RAV log book verify that the dewar's internal valves are in the following positions. If not, investigate to ensure previous RAV operations properly recorded. If necessary, note resolution in D-log.

1. ***Open***:RAV-3, and RAV-6B.
2. ***Closed***:RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.

G.5. **Establish Main Tank Vent Configuration**

G.5.1. Establish **one** of the following vent configurations for the Main Tank.

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o Main Tank liquid at NBP – vent line connected to Gas module.

G.5.2. Verify SV-9 open.

G.5.3. Verify EV-9 open.

G.5.4. Verify Actuator Control Valve for EV-9 set to "NBP" position.

G.5.5. Record flow rate PFM-1 ________ Ll/hr

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o Main Tank liquid at NBP – vent line disconnected from Gas Module

G.5.6. Verify SV-9 open.

G.5.7. Verify MTVC-Va open (if installed).

G.5.8. Verify Actuator Control Valve for EV-9 set to "NBP" position.

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o Main Tank subatmospheric – vent line connected to Gas Module

G.5.9. Record method of pumping on Main Tank.

o Pumping with AP-1 (EV-17 and AV-6 open)

o Pumping with PP-1/2 (EV-4, EV-17, EV-21 open)

G.5.10. Verify closed EV-9, EV-15, and EV-16.

G.5.11. Close EV-17.

G.5.12. Close SV-9.

G.5.13. Verify Actuator Control Valve for EV-9 set to "Subatm. He" position.

G.5.14. Monitor pressure in Main Tank vent line (EG-3) throughout tilt procedure and record on attached data sheets.

G.6. **Set up DAS**

Note: refer to instructions for configuration definition and operation of DAS keyboard/mouse.

G.6.1. Verify DAS in configuration 4m.

G.6.2. Set DAS to fast scan mode using [other menus], [data config], [fast scan]

G.6.3. Set Main Tank liquid level sensor readout to 1 minute sample intervals.

G.6.4. Select appropriate level sensor

1. Set Main Tank liquid level sensor readout to LLS-A (switch up) if tilting to –x up
2. Set Main Tank liquid level sensor readout to LLS-B (switch down) if tilting to –y up

G.6.5. Start special data collection using CN [01] CN [20], CN [24],CN [28], CN [101] and CN [145] and 1 minute sampling intervals.

G.6.6. Enter comment to DAS, “Begin Tilting SMD.”

G.7. **Install tilt motor control**

Install tilt motor control onto the dewar test stand and connect electrical cables.

G.8. **Tilt SMD to Horizontal Orientation.**

CAUTION
If the vent lines are still attached great care must be taken to ensure that the vent lines can move freely as the SMD is rotated. Rotate slowly, and continuously verify that undue stress in not being applied to the vent lines.

G.8.1. Verify that a qualified test director or test engineer is present to monitor critical SMD temperatures and pressures.

G.8.2. Verify no obstructions to rotation above or below deck.

G.8.3. Using the protractor bubble level to measure tilt, proceed to rotate the SMD, monitoring the pressure at EG-1 (if vent line connected) or vent-line cap (VCP-1) as the rotation takes place.

G.8.4. Rotate in 10° steps. Continuously monitor and record Main Tank temperature and pressure, Guard Tank pressure, Well pressure, lead bag temperature and Main Tank liquid level on attached data sheet. Enter comment into DAS after every rotation

G.8.5. Continue the rotation until the SMD is within 10° of horizontal

G.8.6. Continue rotating final 10°, in 2° increments, to horizontal position.

G.8.7. When tilting complete, enter comment to DAS, “Tilting of SMD complete.”

G.8.8. Install SMD turnbuckle struts.

G.9. **Establish Final Configuration**

- Main Tank liquid at NBP – vent line connected to Gas module.

G.9.1. Verify SV-9 open.

G.9.2. Verify EV-9 open.

G.9.3. Record flow rate PFM-1 ________ Ll/hr

- Main Tank liquid at NBP – vent line disconnected from Gas Module

G.9.4. Verify SV-9 open.

- If Main Tank subatmospheric – vent line connected to Gas Module

G.9.5. Verify closed/close EV-9, EV-15, EV-16.

G.9.6. Verify that the pressure read by EG-3 has not increased by more than 2 torr since the closure of EV-9 and EV-17 in A.5.7.

G.9.7. Open EV-17

G.9.8. Open SV-9 to resume pumping.

G.9.9. Set Main Tank liquid level sampling interval to 10 minutes.

G.9.10. Ensure that power to Vac-Ion pump is off.

G.9.11. (OPTION) Reconnect high-vacuum pumping line to SMD. Complete procedure P0213, to connect high-vacuum pumping line to SMD at SV-14. Record Op. Order # __________.

G.9.12. Stop special data collection using [other menus], [special data], [stop sp. data].

G.9.13. Set DAS to normal scan mode using [other menus], [data config], [normal scan].

G.9.14. Set DAS to 15 minute data cycles using [Set Data Interval].

G.9.15. Ensure DAS alarm enabled and record set points if changed

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

a. Station 200 set point CN [01] ________ K ($\leq$ 6.5 K)

b. Top of Lead Bag set point CN [28] ________ K ($\leq$ 6.0 K)

G.9.16. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.9.17. Ensure DAS watchdog timer and alarm enabled.

G.9.18. Ensure Facility Main Alarm System enabled.

H. PROCEDURE COMPLETION

Completed by:______________________

Witnessed by:______________________

Date: __________

Time:__________

Quality Manager__________________________________Date_________________

Payload Test Director______________________________Date_________________

Data Sheet

Time	Tilt Angle degrees	MT Temp CN [09] K	MT Pressure (EG-2) or (EG-3) torr	GT Pressure (GTV-G) torr diff	Well Pressure (PW-2) torr	Lead Bag Temp CN [28] K	MT Liquid Level %

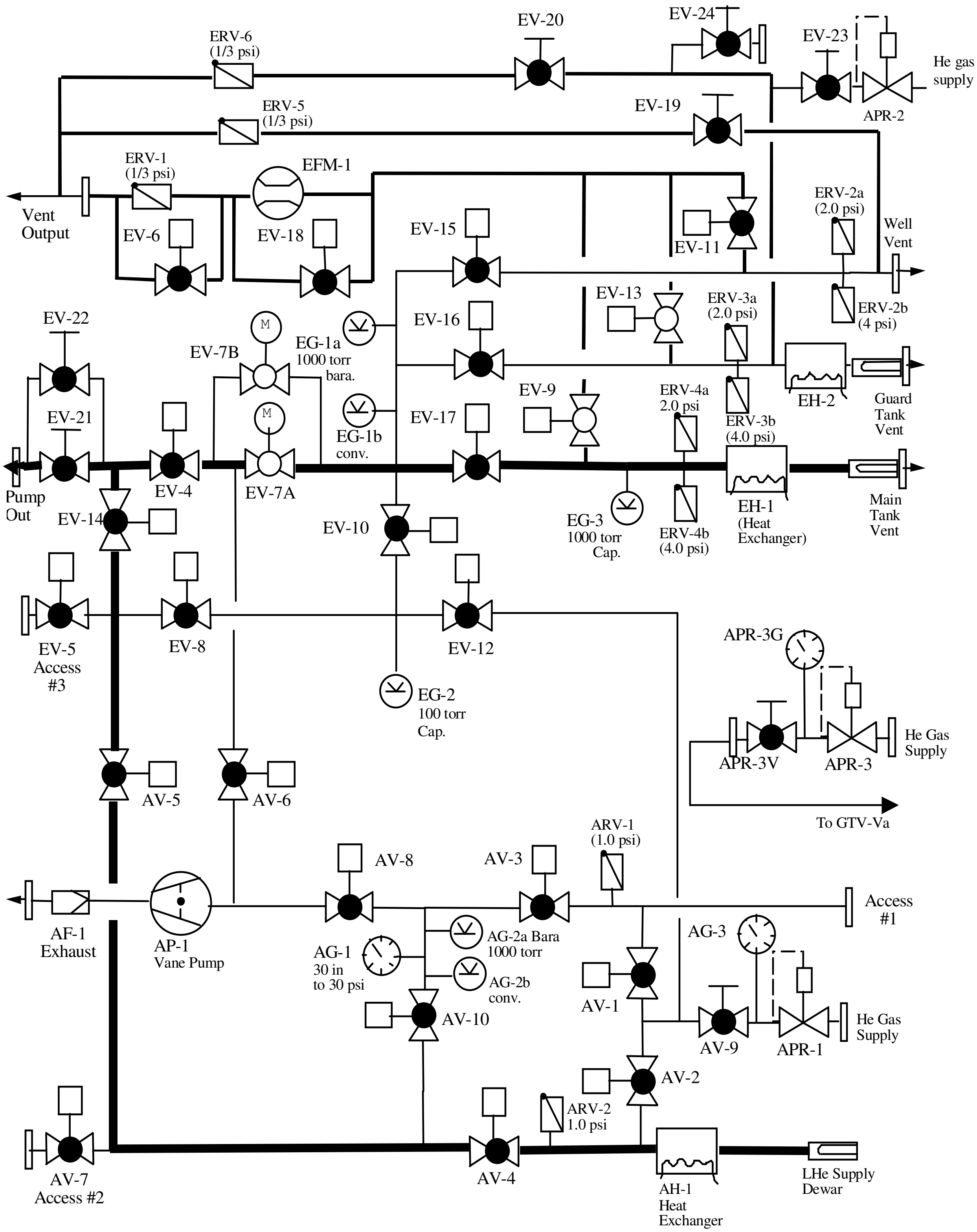

Figure 1. Schematic of Gas Module Plumbing.

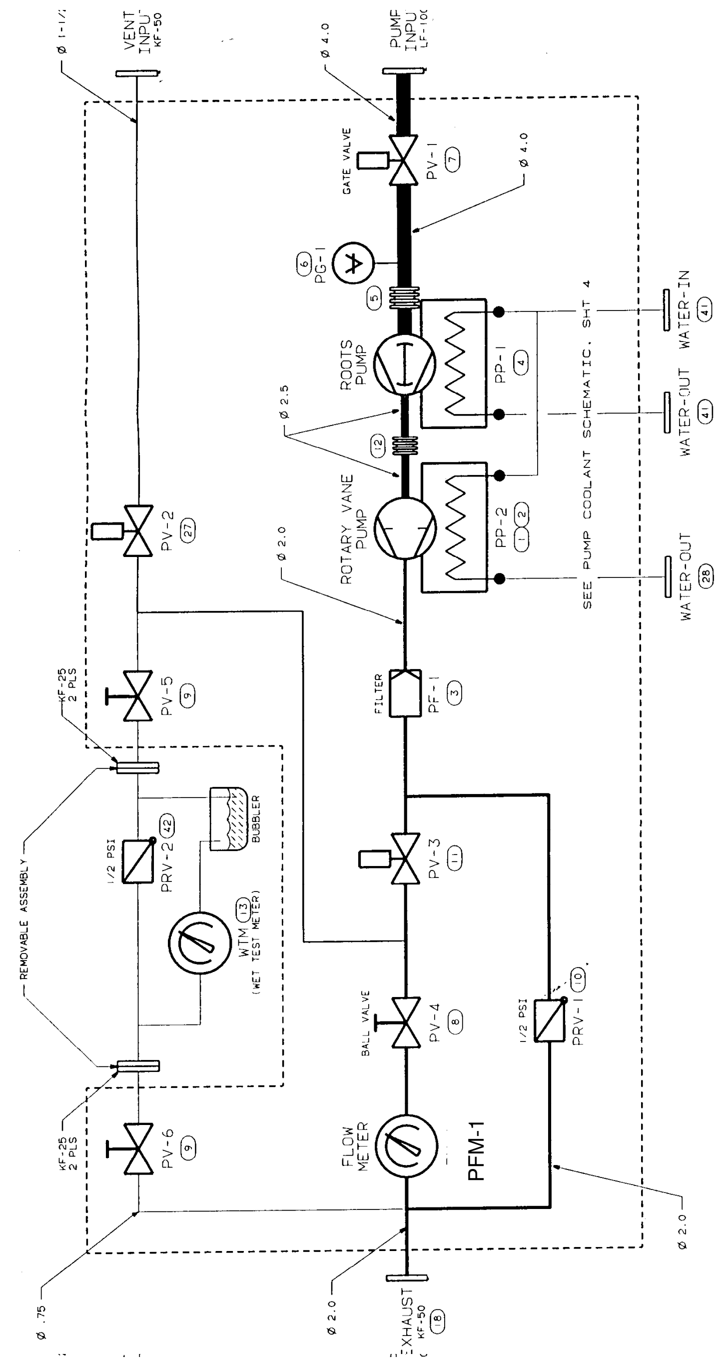

Figure 2. Schematic of Pump Module plumbing.

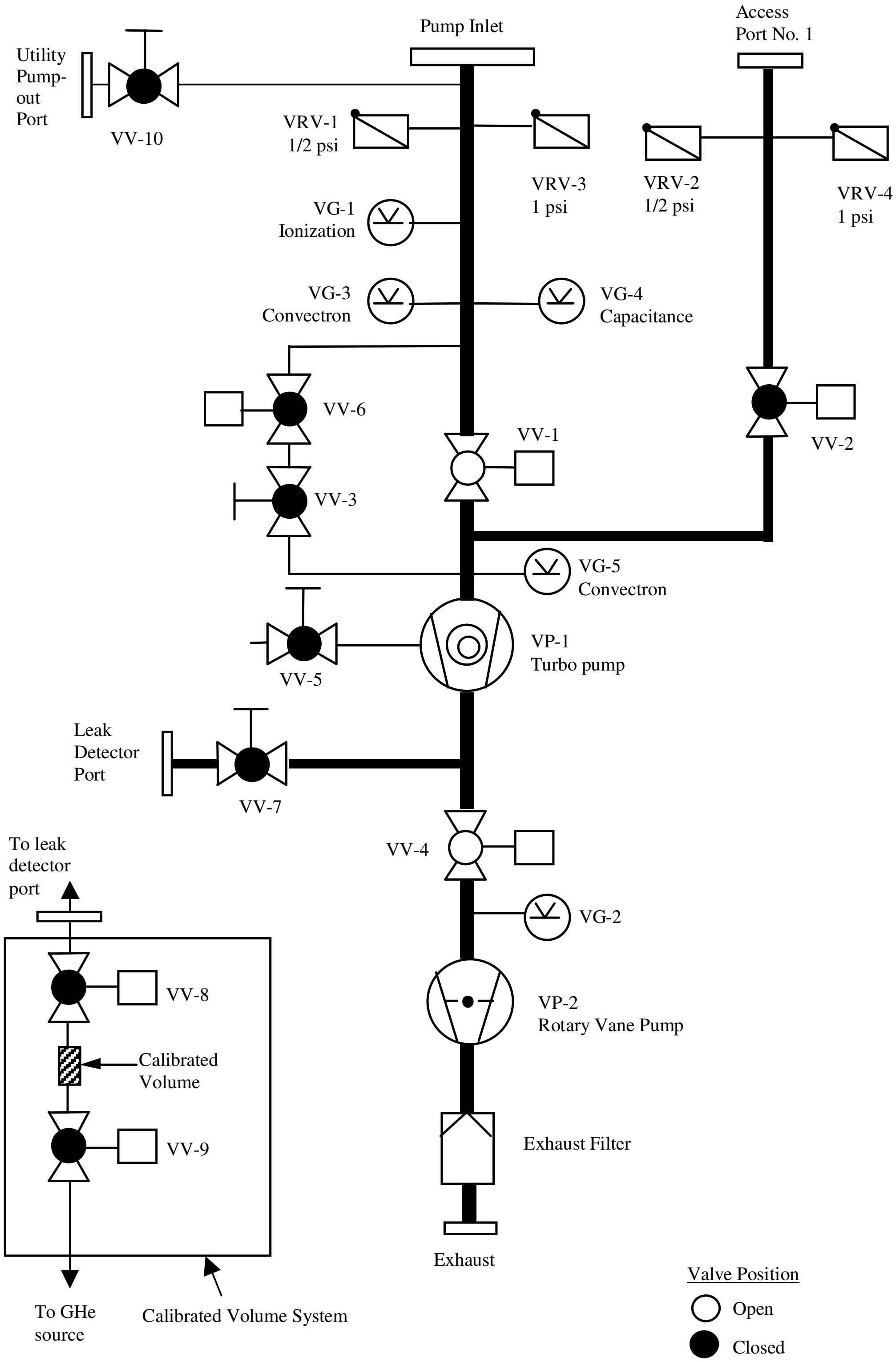

Figure 3. Schematic representation of Vacuum Module plumbing.

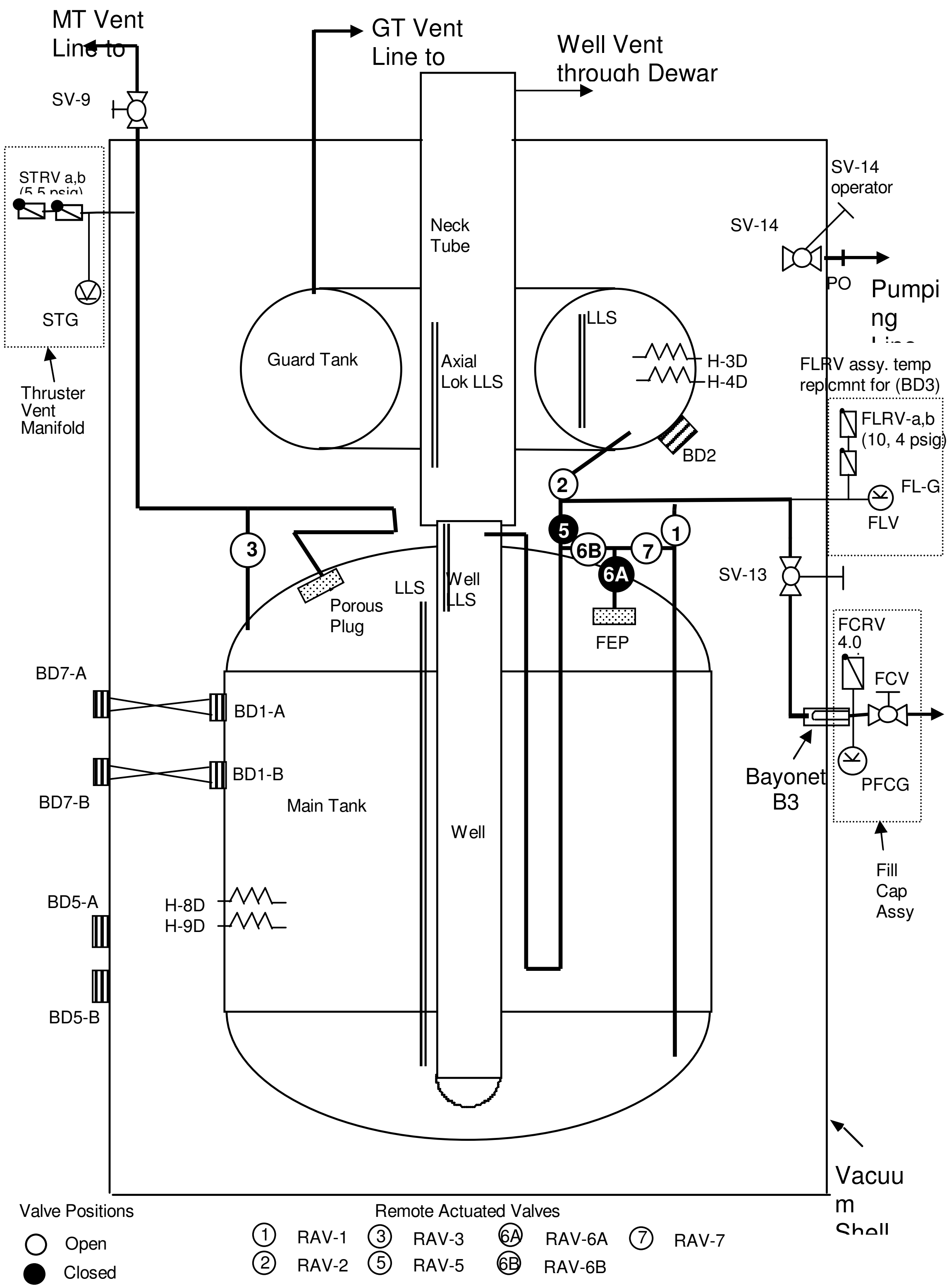

Figure 4. Schematic of Science Mission Dewar plumbing.

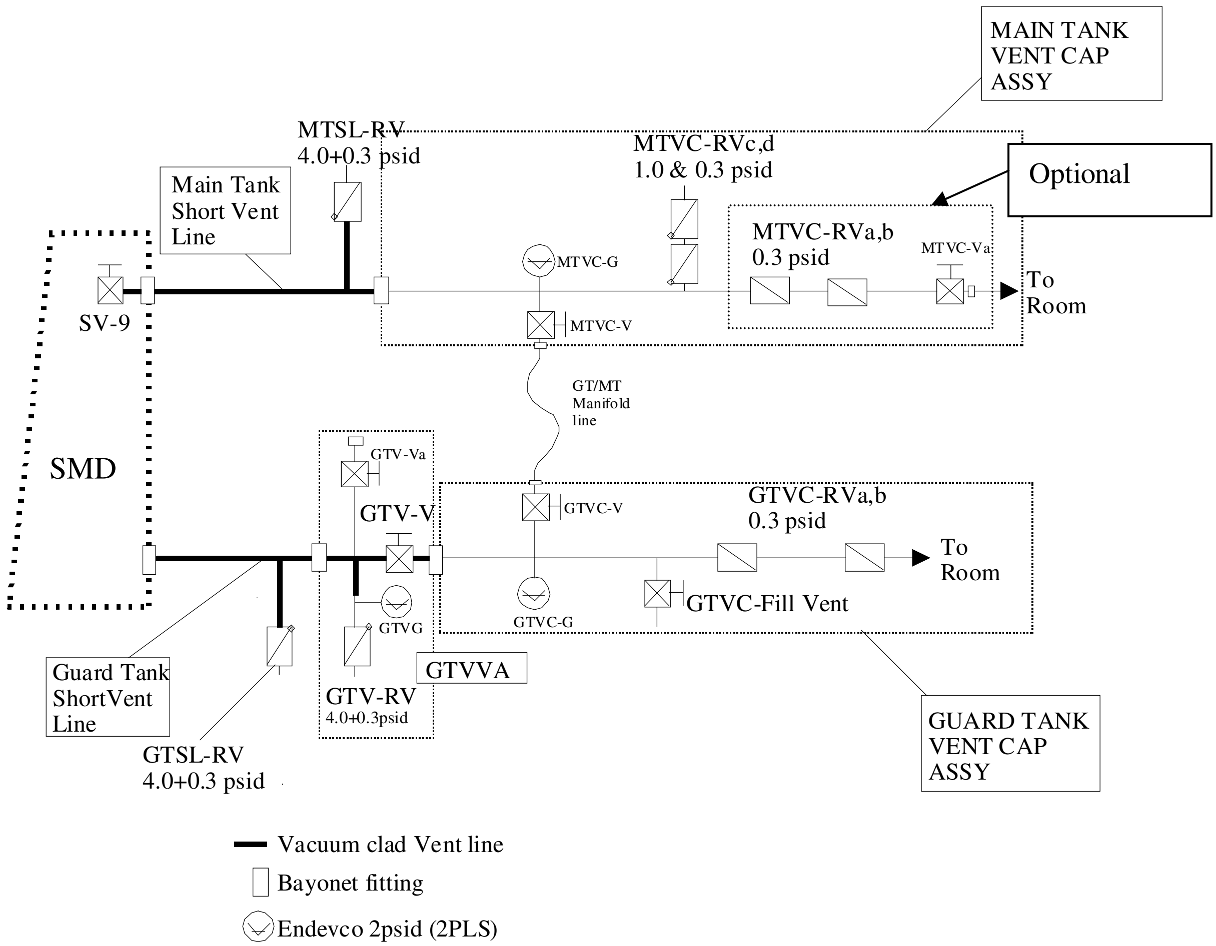

Figure 5. Schematic representation of Guard Tank Vent Valve Assembly (GTVVA) and Main Tank and Guard Tank vent cap assemblies. Common manifold capability is provided by the GT/MT manifold line.

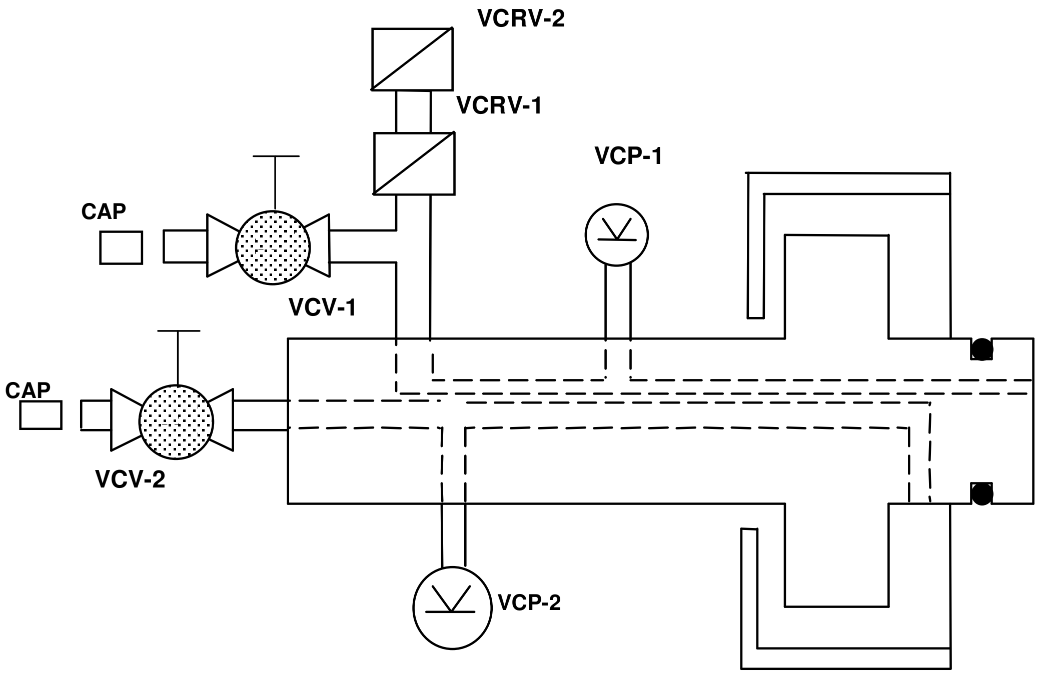

Figure 6. Main Tank Vent Cap Assembly for subatmospheric applications.