GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Upright SMD
(Rotate from Horizontal to Vertical Orientation)

P0633c
ECO 1291

August 8 2001

Prepared by

________________________Date_______
Jim Maddocks
Cryogenic Test

Checked by

________________________Date_______
Dave Murray
Cryogenic Test

Approvals:

________________________Date_______
Dorrene Ross
Quality Assurance

________________________Date_______
Harvey Moskowitz
LMMS Safety

________________________Date_______
Robert Brumley
Payload Technical Manager

________________________Date_______
Mike Taber
Payload Test Director

REVISION RECORD

REVISION	***ECO***	***PAGES***	***DATE***
A	1045	Changes made to include procedure for filling Well in the event that low liquid level in Main Tank results in high temperature at top of lead bag after or during rotation to vertical.	12-1-99
B	1157	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.	
C	1291	Changed response to temperature spike at top of lead bag to venting gas from Main Tank instead of adding liquid to the Well. Included minor redlines and miscellaneous updates.	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 rotate the Science Mission Dewar from a horizontal position, with either the -x or -y direction up, to a vertical position, with the +z direction up. It requires that the Main Tank be at NBP. The steps include:

Verify SMD free to rotate

Install tilt motor control on SMD test stand

Rotate in 10 degree increments until vertical.

Note that the Guard Tank is depleted. The procedure can be accomplished with the vent lines connected to the Gas Module or disconnected with vent caps installed.

If the liquid level in the Main Tank is less than 30% after uprighting, a transfer of liquid to the Main Tank will be necessary immediately following return to the vertical orientation. The Guard Tank, currently empty, is filled to 15% by transferring liquid from the Main Tank. The internal fill line is then precooled with liquid from the Guard Tank. Since the Main Tank heaters are located below the center of the dewar, but not at the bottom, it is likely that using these heaters will deposit heat in the vapor rather than the liquid. To avoid the possibility of raising the temperature of the vapor, and hence the temperature at the top of the lead bag, the pressure required to transfer liquid from the Main Tank to the Guard Tank is built up before rotation. This is done by allowing the Main Tank pressure to increase to 1.5 psig before continuing with the process of uprighting.

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.

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 or calls out procedures that make use of hardware located in the Gas module (Figure 1) Pump Module (Figure 2) Vacuum Module (Figure 3) 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

No additional test equipment is required

E.3.5. Additional Hardware

Description	***Quantity***	***Mfr./Part No.***
Thruster Vent Line Assembly (Figure 4)	1	LMMS

E.3.6. Tools

Description
1-1/4-in socket, 60 in-lb
Protractor bubble level

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
Liquid helium	1000 L	N/A
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. 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	-

No.	Location	Description	User Name	Serial No.	Cal Required	Status Cal due date
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 must be at its normal boiling point (NBP). 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.” position

E.5.2. Guard Tank

The Guard Tank is depleted. Its pressure is independently regulated through either of GTV-Va or EV-23, using a source of 99.99% pure helium gas.

E.5.3. Well

The Well is evacuated.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure should be less than 1 x 10^{-4} torr. however, in this procedure priority is given to uprighting the SMD. Pumping on the vacuum shell, if indicated, should be deferred to the end of the procedure. Document No. P0213, contains the procedure for connecting to and pumping on the SMD vacuum shell.

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 must be 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 cables must be removed.
4. The Main Tank Vent Line is connected to the Gas Module, or is disconnected and a vent cap is installed (Figure 5).
5. The Guard Tank Vent Line is connected to the Gas Module, or is disconnected at GTV-V. In the latter case a vent cap (Figure 5) may be installed.
6. The high-vacuum pumping line used for pumping on the SMD vacuum shell must be disconnected from the operator at SV-14. Procedure P0214 contains the steps for accomplishing this.
7. The Thruster Vent is flanged to a relief manifold (Figure 4).
8. The Fill Cap Assembly is installed at SV-13 This is also required for Main Tank fill operations.
9. The 8-inch Leakage Gas System (LGS) pumping line, as well as, the spin-up supply and exhaust lines must be disconnected from the probe. Procedure P0647 contains the steps for accomplishing this.
10. The flooring panels around the SMD and the support turnbuckles must be removed to allow for rotation of the SMD test fixture.

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 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 paylaod, if dropped, must be tethered.
2. A relief valve or flight like burst disk may be installed in place of the SMD internal fill-line burst disk. This is necessary for fill operations and is required here because Procedure P0648, Main Tank Fill After Uprighting SMD – Guard Tank Initially Depleted, is called as an option in this procedure.
3. The Well manifold assembly may be installed at valve VTH (Figure 6).

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 P0674	*Connect Main Tank Vent Line To Gas Module – Main Tank at NBP*
SU/GP-B P0675	*Disconnect Main Tank Vent Line From Gas Module – Main Tank at NBP*
SU/GP-B P0677	*Disconnect Guard Tank Vent Line From Gas Module*
SU/GP-B P0214	*Stop Pumping on the SMD Vacuum Shell / Disconnect Vacuum Module*
SU/GP-B P0647	*(PTP) Remove Probe Spinup Gas/Vac. Lines (-X,-Y axis up)*
SU/GP-B-P0648	*Main Tank Fill After Uprighting SMD – Guard Tank Initially Depleted*

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. Verify Configuration Requirements

G.2.1. Ensure Facility Main Alarm System enabled.

G.2.2. Ensure GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.3. 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.2.4. Ensure DAS watchdog timer and alarm enabled.

G.2.5. Verify liquid in Main Tank is at NBP ($4.2 < T < 4.3$). Record temperature at bottom of tank, CN [09] ________ K. If not perform procedure P0216 *Pressurize Main Tank from Subatmospheric to NBP* and record operation number ________.

G.2.6. Ensure Actuator Control for EV-9 is in “NBP” position.

G.2.7. Verify ion-pump magnet installed.

G.2.8. Verify Probe plumbing removed.

1. Verify 8” LGS pumping line removed
2. Verify spin-up supply lines disconnected

3. Verify spin-up gas exhaust lines removed
4. If any Probe plumbing **not** removed, perform procedure P0647 and record Op. Order No. ________.

G.2.9. Verify all unnecessary electrical cables removed.

1. Record all GSE cables that are to remain connected during rotation_
____
2. Verify enough slack in remaining connected cables to fully rotate to vertical.
3. Verify all other GSE cables removed. (If unnecessary cables still connected to the payload, have qualified personnel perform appropriate procedure to remove).

G.2.10. Remove/verify removed HEPA unit.

G.2.11. Remove/verify removed all flooring panels.

1. Disconnect power to outlets under floor.
2. Unbolt and remove floor panels and support struts.

G.2.12. Disconnect/verify disconnected SMD support turnbuckle/strut.

G.2.13. Verify pumping line disconnected from SMD vacuum shell.

1. Vacuum line is disconnected from SMD vacuum shell _____________(yes/no).
2. If **No**, perform procedure P0214 to disconnect, and record Operation No.________

G.2.14. Verify 500 or 1000 liters of liquid helium is on hand.

G.2.15. Verify protractor bubble level on hand

G.3. **Establish initial Condition of SMD:**

G.3.1. Specify SMD axis currently vertical

o -x

o -y

G.3.2. Record pressure in dewar vacuum shell

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

G.3.3. Record Guard Tank Pressure at GTV-G________torr diff.

G.3.4. Record Guard Tank temperature, CN [24] ________K

G.3.5. Verify SV-9 open.

G.3.6. Record Main Tank pressure

1. EG-3, if vent line connected ________ torr
2. MTVC-G, if vent line disconnected ________ psig / torr

G.3.7. Record Main Tank Temperatures

1. Bottom of tank, CN [09] ________ K
2. Station 200, CN [01] ________ K
3. Top of the lead bag CN [28] ________ K
4. Top of tank, CN [20] ________ K

G.3.8. Verify SV-13 and FCV closed.

G.3.9. Record Fill Cap Assembly pressure and verify that it reads > 0.0 psig.
Fill Cap Assembly (PFCG):_______ torr.

G.3.10. Record flow at PFM-1 CN[44] ________ LL/hr (scale B).

G.3.11. 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.4. **Establish Gas Module Configuration**

G.4.1. Verify appropriate vent lines disconnected from SMD.

1. Verify Well disconnected

   NOTE: The Main and Guard Tank vent lines may remain connected if desired.
2. Main Tank to be disconnected during uprighting _______ (yes/no).

   If necessary, perform procedure P0675, to disconnect Main Tank vent line and record Operation No. ________.
3. Guard Tank to be disconnected during uprighting _______ (yes/no).

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

G.4.2. Verify valve states are as indicated in following Table. Record configuration in left-hand column, then verify corresponding valve states.

Verify Initial Valve States		
	Verify Open	***Verify Closed***
1. Main Tank vent		
o Connected to GM	EV-9	EV-17
o Disconnected from GM – vent cap installed	MTVC-Va	EV-9, EV-17, MTVC-V
2. Guard Tank vent		
o Connected to GM – Depleted and pressure regulated at EV-23 (Ensure source of He gas connected to APR-2).	EV-16, EV-23 GTV-V	EV-13, EV-20 GTV-Va
o Not connected to GM – Depleted and pressure regulated at GTV-Va (Ensure source of He gas connected to APR-3).	GTV-Va	EV-13, EV-16, EV-20, EV-23 GTV-V, GTVC-V GTVC-Fill Vent
3. Remaining EV valves	EV-7a/b	EV-4, EV-5, EV-6, EV-8, EV-10, EV-11, EV-12, EV-14, EV-15, EV-18, EV-19, EV-21/22
4. AV valves		All

G.5. **Set Up SMD in Non-Vented Configuration**

CAUTION!

If the liquid level in the Main Tank is less than 30% after uprighting, a transfer of liquid to the Main Tank will be necessary immediately following return to the vertical orientation. The Guard Tank, currently empty, is filled to 15% by transferring liquid from the Main Tank. The internal fill line is then precooled with liquid from the Guard Tank. Since the Main Tank heaters are located below the center of the dewar, but not at the bottom, it is likely that using these heaters will deposit heat in the vapor rather than the liquid. To avoid the possibility of raising the temperature of the vapor, and hence the temperature at the top of the lead bag, the pressure required to transfer liquid from the Main Tank to the Guard Tank is built up before rotation. This is done by allowing the Main Tank pressure to increase to 1.5 psig before continuing with the process of uprighting.

G.5.1. Verify Thruster Vent relief valve combination ≥ 1.5 pisg.

G.5.2. If Main Tank vent line connected to Gas Module, close EV-9. The Main Tank is now venting through ERV-4a in the Gas Module.

G.5.3. If Main Tank vent line disconnected:

1. Verify Main Tank vent cap configured as shown in Figure 5. (**Note:** MTVC-Va and relief valves MTVC-RVa,b are optional.)
2. Verify relief valve combination on vent cap provides Main Tank relief ≥ 1.5 psig. Record relief pressure ________ psig.
3. Close MTVC-Va if installed. The Main Tank is now venting through relief valves MTVC-RVc,d.

G.6. **Set up DAS**

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

G.6.1. Verify/place DAS in configuration 4m.

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

G.6.3. Start special data collection using the pre-selected channels, except substitute CN [101] (LLS Main Tank) for CN [42] (fill valve V-13), and set to 30 sec. sample rate.

G.6.4. Set data collection interval to 5 min.

G.6.5. Select appropriate Main Tank liquid level sensor

- LLS-A (-x up)
- LLS-B (-y up).

G.6.6. Set Main Tank liquid level sensor readout to 1 minute sample intervals.

G.6.7. Ensure printer is displaying special Data Cycle data.

G.6.8. Enter angular position into DAS after each incremental change. (Enter data manually via F7 and insert in special data collection)

G.7. **Verify SMD Free To Rotate**

G.7.1. Verify no obstructions to rotation below deck.

G.7.2. Verify no obstructions to rotation above deck.

G.8. **Install Tilt Motor Control**

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

G.9. **Upright SMD.**

G.9.1. Verify pressure in Main Tank at least 835 torr (75 torr diff)

1. Record pressure EG-3 ________ torr, if MT vent line connected.
2. Record pressure MTVC-G ________ torr diff, if MT vent line disconnected.

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.

WARNING!

If the temperature at the top of the lead bag (CN [28]) rises at a rate greater than 0.140 K per minute (2.1 K over the estimated 15 minutes required to fully upright), be prepared to vent the Main Tank for a brief period. This has proven to be effective in lowering the temperature at the top of the lead bag and Station 200, and is accomplished by opening EV-9 or MTVC-V. The Main Tank should be vented if the temperature at the top of the lead bag rises to 6.0 K.

G.9.2. Verify qualified test director/engineer on hand and dedicated to monitoring critical SMD temperatures and pressures.

G.9.3. Enter comment to DAS, "Begin uprighting SMD."

G.9.4. Using the protractor bubble level to measure tilt, proceed to rotate the SMD in 10° increments.

G.9.5. Continuously monitor the Main Tank pressure at EG-3 (if vent line connected) or the vent-line cap (MTVC-G) as rotation takes place

G.9.6. Monitor Lead Bag temperature rate of rise (CN [28]) and continue monitoring throughout rotation. Record data in Data Sheets.

G.9.7. If Lead Bag temperature approaches 6.0 K briefly vent Main Tank as follows.

- Main Tank connected to Gas Module
  - a. Open EV-9
  - b. When the temperature at the top of the lead bag, CN [28], drops to a safe level, close EV-9 and continue with rotation.
- Main Tank vent cap installed – open MTVC-V
  - c. Open MTVC-V
  - d. When the temperature at the top of the lead bag, CN [28], drops to a safe level, close MTVC-V and continue with rotation.

G.9.8. Enter angular position into DAS after each incremental change. (Enter data manually via F7 and insert in special data collection)

G.9.9. When SMD vertical, Enter comment to DAS, "Finish uprighting SMD."

G.10. **Record Main Tank Liquid Level and Adjust as Appropriate**

G.10.1. Record liquid helium level:

Main Tank level (LL-1D or LL-2D): _________ %

G.10.2. If liquid level in Main Tank is less than 30% transfer LHe to Main Tank as follows:

1. Verify closed EV-9.
2. If Main Tank vent line disconnected, connect vent line per Procedure P0674 and record Operation Number ________. **Note**: complete procedure P0674 only through paragraph G.6.5. **Do not** reestablish Main Tank venting by opening EV-9.

Warning
Closely monitor lead bag temperature (CN [28]) throughout connection of Main Tank vent line. If the temperature reaches 6.0 K, briefly vent the Main Tank.

3. Transfer liquid to Main Tank using Procedure P0648 and record Operation Number ________. Continue to closely monitor lead bag temperature (CN [28]) throughout startup of transfer.

WARNING
If, during the Main Tank fill process, the lead bag temperature at CN [28] or CN [29] exceeds 6.0 K, briefly vent the Main Tank.

G.11. **Establish Final Configuration**

G.11.1. Open/verify open SV-9.

G.11.2. If Main Tank vent line connected, open/verify open EV-9.

G.11.3. If Main Tank vent line disconnected, open/verify open MTVC-Va .

G.11.4. Verify valve states are as indicated in following Table. Record configuration in left-hand column, then verify corresponding valve states.

Verify Final Valve States		
	Verify Open	***Verify Closed***
1. Main Tank vent		
o Connected to GM	EV-9	EV-17
o Not connected to GM	MTVC-Va	EV-9, EV-17
2. Guard Tank with liquid		
o Connected to GM	EV-13, EV-16, GTV-V	EV-20, EV-23 GTV-Va
o Not connected to GM	GTV-V	EV-13, EV-16, EV-20, EV-23 GTV-Va, GTVC-V GTVC-Fill Vent
3. Guard Tank depleted		
o Connected to GM – Depleted and pressure regulated at EV-23 (ensure source of He gas connected to APR-2)	EV-16, EV-23 GTV-V	EV-13, EV-20 GTV-Va
o Not connected to GM – Depleted and pressure regulated at GTV-Va (ensure source of He gas connected to APR-3)	GTV-Va	EV-13, EV-16, EV-20, EV-23 GTV-V, GTVC-V GTVC-Fill Vent
4. Well Vent		
o Well evacuated		EV-19, VW-3, VTH
o Well not evacuated	EV-19, VW-3, VTH	
5. Remaining EV valves	EV-7a/b	EV-4, EV-5, EV-6, EV-8, EV-10, EV-11, EV-12, EV-14, EV-15, EV-18, EV-21/22
6. AV valves		All

G.11.5. Stop special data collection by using [Other Menus] + [Special Data Col] + [Stop Col Data].

G.11.6. Set data collection interval to 15 minutes.

G.11.7. Set DAS to normal scan mode using [other menus], [data config], [Normal scan]

G.11.8. Set Main Tank liquid level sensor to 10 min. interval.

G.11.9. Ensure Guard Tank level sensor is off if Guard Tank depleted.

G.11.10. Ensure that power to Vac-Ion pump is off.

G.11.11. 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. Station 200 set point [CN 1] ________ K (≤ 6.5 K)
  b. Top of Lead Bag set point [CN 28] ________ K (≤ 6.0 K)

G.11.12. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.11.13. Ensure DAS watchdog timer and alarm enabled.

G.11.14. Ensure Facility Main Alarm System enabled.

H. PROCEDURE COMPLETION

Completed by:________________

Witnessed by:________________

Date: __________

Time:__________

Quality Manager___________________________________Date_________________

Payload Test Director______________________________Date_________________

Data Sheet

Date/ Time	SMD Angle (degrees)	Sta 200 Temp T[1] (K)	Top of Pb Bag temp T[28] (K)	Change in T[28]/min (K/min)	MT Pressure EG-3/MTVC-G (torr/torrdiff)

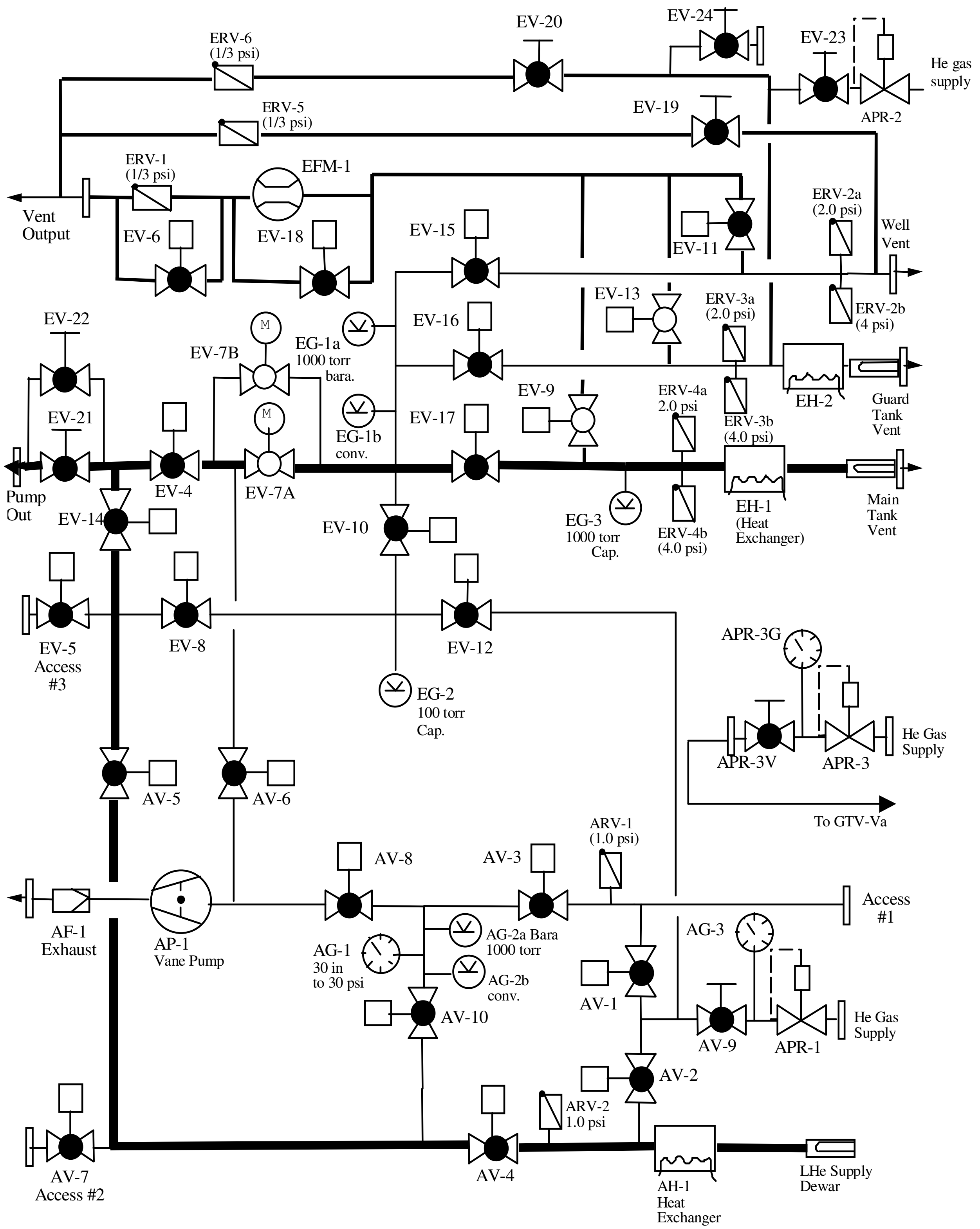

Figure 1. Schematic of Gas Module Plumbing.

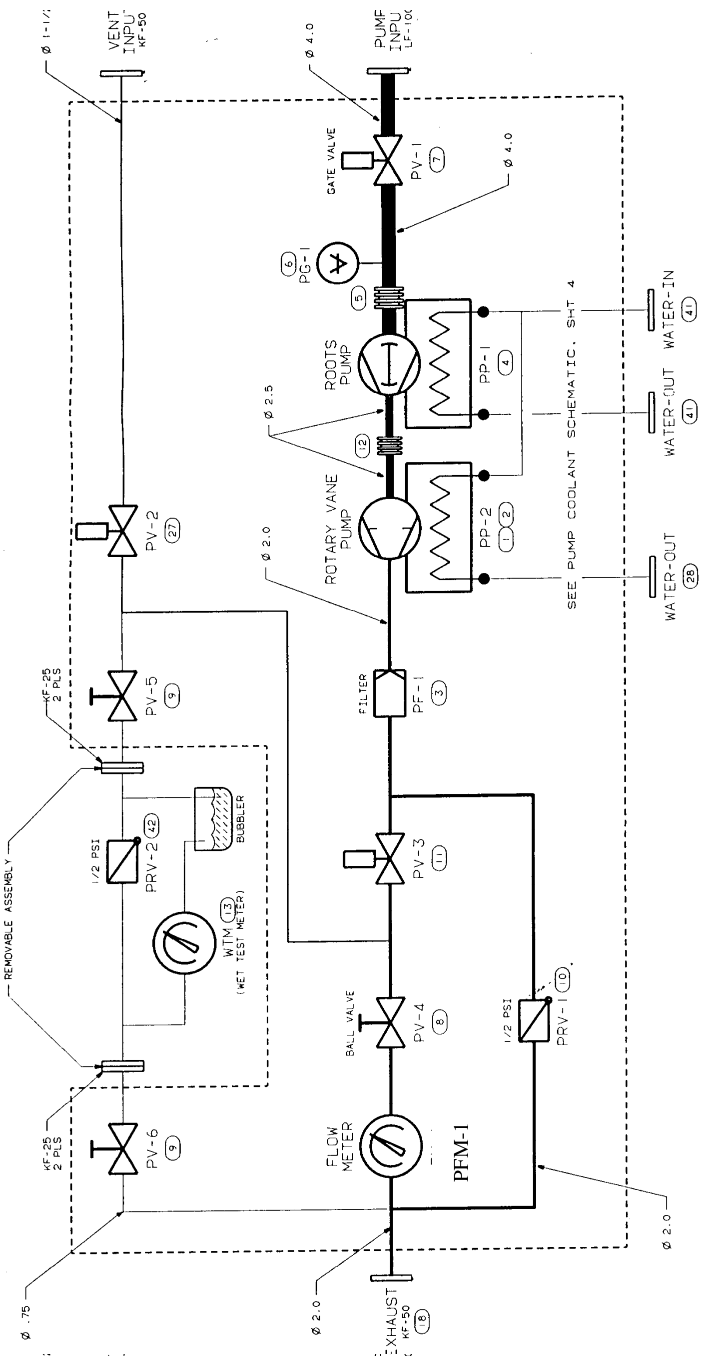

Figure 2. Schematic of Pump Module plumbing.

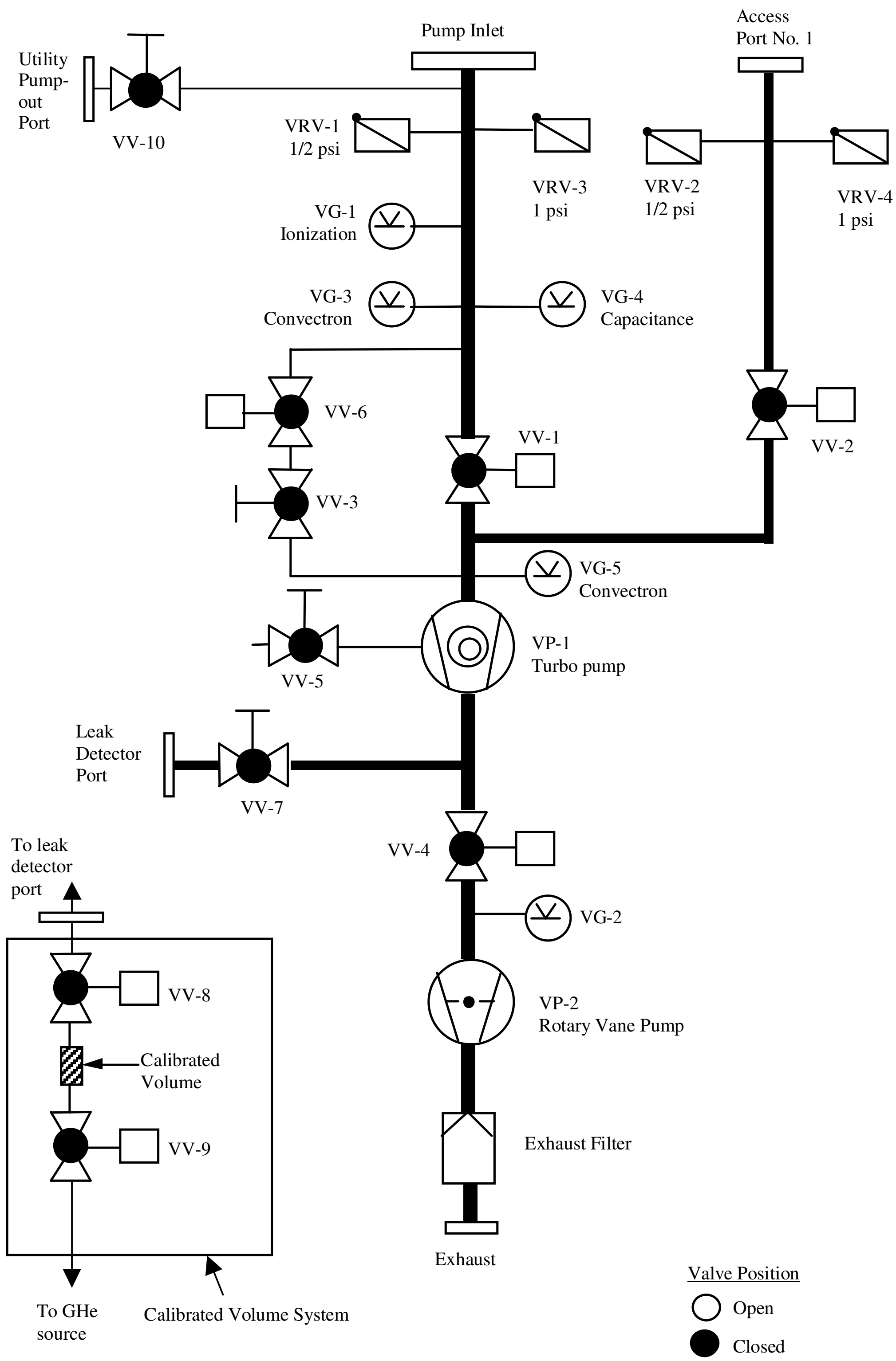

Figure 3. Schematic representation of Vacuum Module plumbing

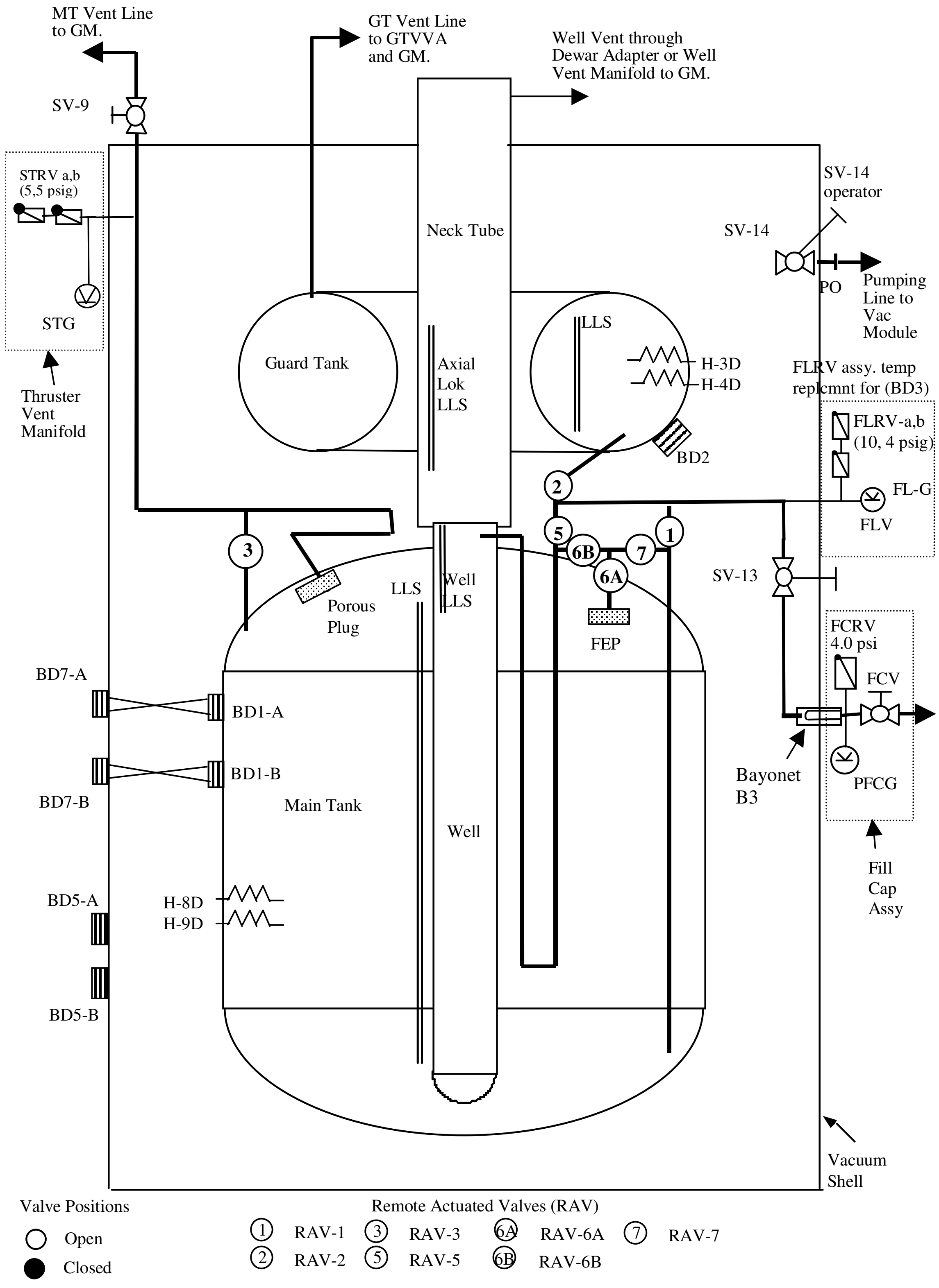

Figure 3. Schematic of Science Mission Dewar plumbing.

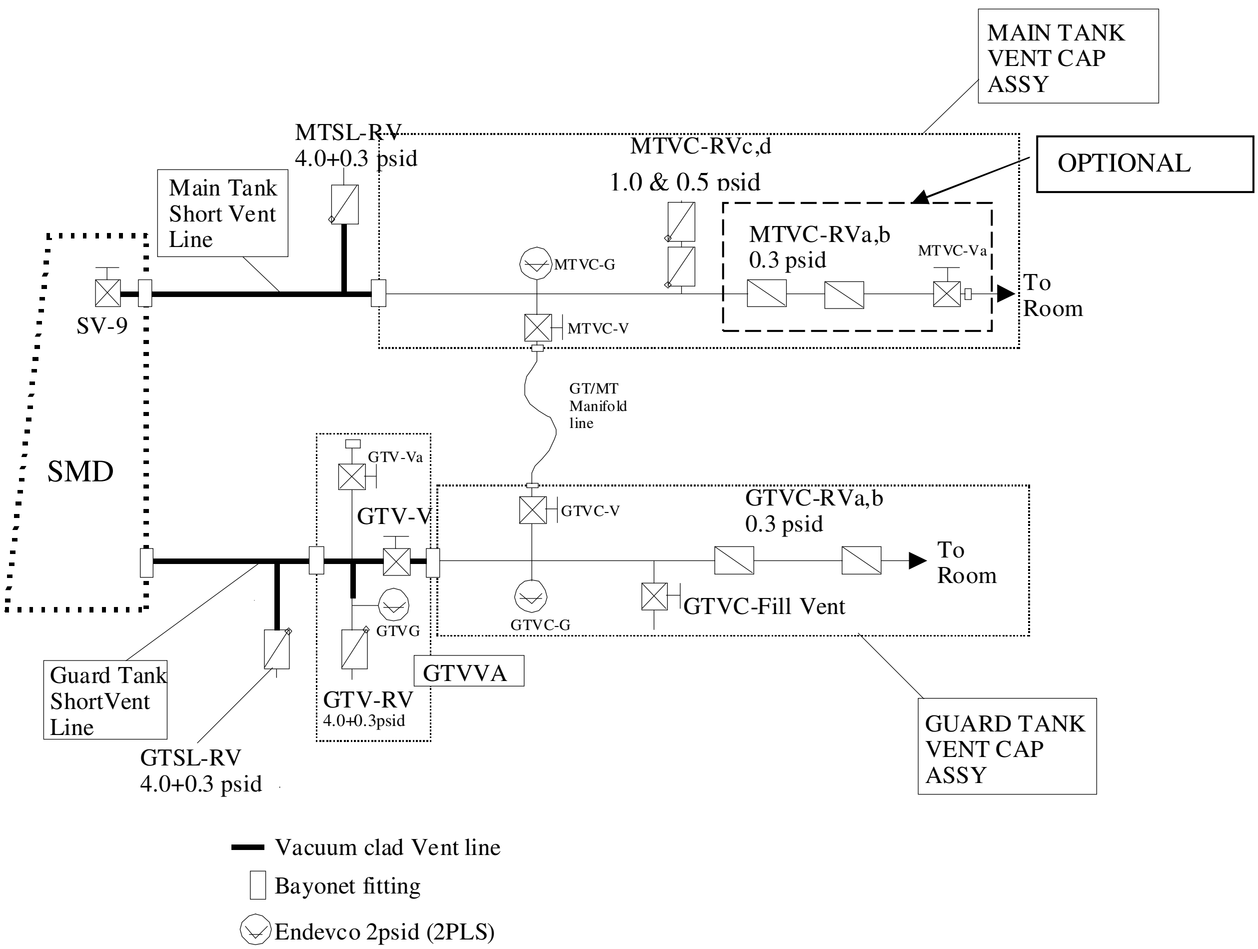

Figure 5. Schematic representation of Guard Tank Vent Valve Assembly (GTVVA) and Main Tank and Guard Tank vent cap assemblies. Common manifold capability is provided by the GT/MT manifold line.

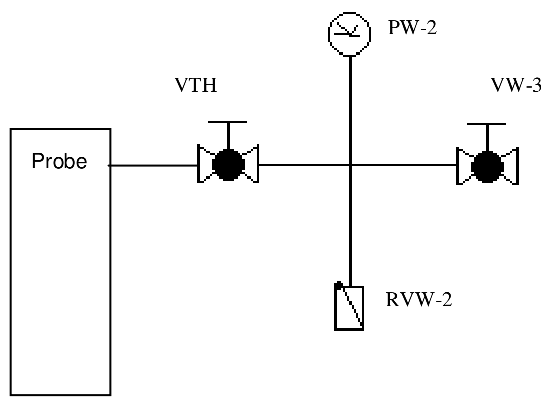

Figure 6 **Well Vent Manifold**