GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

MAIN TANK SUBATMOSPHERIC FILL FROM NBP SUPPLY DEWAR – GUARD TANK PRECOOL

P0798 Rev-

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REVISION CHANGES

REVISION	***ECO***	***PAGES***	***DATE***
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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
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
HX-x	Vent line heat exchanger in Gas Module
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
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 perform an external fill of the SMD Main Tank, while it is subatmospheric, using NBP liquid helium from a Liquid Helium Supply Dewar (LHSD). Precooling the SMD fill-line is performed using a reverse transfer from the Guard Tank. The steps include:

Pre-cool SMD internal fill line from Guard Tank

Pre-cool external transfer line from storage dewar

Fill Guard Tank

Fill Main Tank

Terminate transfer.

Note that when the Main Tank is subatmospheric, the Guard Tank liquid level must be maintained at a value greater than 15%. This guarantees that it contains enough liquid to precool the internal transfer line, a necessary step for Main Tank fill operations.

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. In addition, temperature and pressure alarms, provided by the DAS, warn of potential over or under-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.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 Hardware 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	

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not include any equipment sensitive to electrostatic discharge.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. **Hardware/Software Requirements**

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

The Ground Support Equipment includes the Gas Module, the Pump Module, the Electrical Module, and the Vacuum Module. The Gas Module provides the capability to configure vent paths, read pressures and flow rates, and pump and backfill vent lines. The Pump Module provides greater pumping capacity than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module. The Electrical Module contains the instruments listed in Table 1 (see the *Electrical Module Manual* for details), and provides remote control of valves in the Gas Module, Pump Module, and SMD. The Vacuum Module contains a turbo pump, backed by a vane pump and provides the capability to pump out the SMD vacuum shell.

This procedure calls for use of hardware located in the Gas Module (Figure 1), the Pump Module (Figure 2), the 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

Item	***Description***	***Manuf.***	***Model***
1	Filter Line assembly	LMMS	5833827
2	Liquid He Transfer Line	LMMS	5833804
3	Liquid He LHSD stinger	LMMS	5833803
4	AMI Level Sensor Readout for LHSD	AMI	110
5	GHe supply fittings to LHSD	N/A	N/A
6	Bayonet Cap with Nupro Valve	LMMS	N/A

E.3.6. Tools

Description
Torque Wrench
1-1/4-in socket, 60 in-lb

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
Ethyl Alcohol	AR	N/A

99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Braycote Micronic 601
500 Liter Dewars Liquid Helium	AR	SU or commercial
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	-	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	-	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, PFCG	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	RAV Power	3329A-12486	Yes	

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		HP 6038A	Supply			
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	-	C-19950	No	-
24	GM	Guard Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	-	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

The Main Tank liquid is subatmospheric. The actuator control valve for EV-9 switches the state that EV-9 defaults to, should a power failure occur. It should be placed in the “Subatm He.” position, for this procedure, ensuring that EV-9 remains closed in the event of power failure.

E.5.2. Guard Tank

The Guard Tank must contain liquid, and the level must be ≥ 15%. If the level is less than 15%, the Main Tank must be brought to NBP conditions and an internal transfer to the Guard Tank performed.

E.5.3. Well

The Well must be evacuated

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure must be less than 1 x 10-4 torr. 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. A relief valve or a flight-like burst disk is installed in place of the SMD fill-line burst disk.
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).
4. The Main Tank vent line must be connected to the Gas Module with a vacuum insulated line (P/N 5833806). Procedures P0674, and P0672 contain the procedures for connecting Main Tank vent lines.
5. The Guard Tank vent line must be connected to the Gas Module with a vacuum insulated line (P/N 5833813). Procedure No. P0676 contains the steps for connecting the Guard Tank vent line.
6. The Fill Cap Assembly must be installed at SV-13 (See Figure 4)
7. The thruster vent port may be flanged to a relief valve assembly if the flight thruster manifold assembly is not installed. (See Figure 4).
8. The heaters on the SMD top plate, SV-9, and Main Tank vent bayonet must be installed and operational.
9. The actuator control valve for EV-9 must be set to the subatmospheric position, “Subatm He.”.

E.6. **Optional Non-flight Configurations**

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

1. The SMD is installed in its transportation and test fixture.
2. A foreign object and debris shield covers the upper cone of the SMD and is required whenever work is being performed above the SMD such that hard objects could be dropped and impact the SMD or Probe.
3. The Airlock Support Plate may be installed on the SMD. This plate supports the Airlock that is used to keep air out of the Well during probe installation and removal. It is left in place while the Probe is removed.
4. A Dewar Adapter, Shutter, and Shutter Cover are mounted to the Well of the SMD when the Probe is removed
5. The Well Vent Manifold may be installed.
6. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve operator and pumping line, with the valve in either the closed position or in the open position. The Vacuum Module pump may be off, actively pumping the pumping line up to a closed SV-14, or actively pumping the vacuum shell.

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 P0672	*Connect Main Tank Vent Line to Gas Module – Main Tank Subatmospheric*
SU/GP-B P0676	*Connect Guard Tank Vent Line to Gas Module*
SU/GP-B P0213	*Connect Vacuum Module / Pump on SMD Vacuum Shell*
SU/GP-B P021	*Stop Pumping on SMD Vacuum Shell / Disconnect Vacuum Module*
SU/GP-B P0211	*Internal Guard Tank Fill – Vent Lines Connected*
SU/GP-B P0216	*Pressurize Main Tank from Subatmospheric to NBP*

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify ONR representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

G.2. Verify Configuration Requirements

G.2.1. Ensure Facility Main Alarm System enabled.

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

G.2.3. Verify Well evacuated

1. Record date of last Well Pump (Procedure P0613) _____.
2. Record Op. Number of last Well Pump _____.
3. Verify from Log of Operations that Well has not been pressurized since last date of pumping.

G.2.4. Verify heaters on SMD are operational:

- Top plate
- SV-9
- Main Tank vent bayonet

G.2.5. Verify relief valve or flight-like burst disk installed in place of the SMD fill-line burst disk.

G.2.6. Verify Fill Cap Assembly installed at SV-13.

G.2.7. Verify ion pump magnet installed.

G.2.8. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.9. Verify Main Tank vent line connected to Gas Module. If not, perform procedure P0674, *Connect Main Tank Vent Line to Gas Module – Main Tank at NBP,* to connect Main Tank vent.

G.2.10. Verify Guard Tank vent line connected to Gas Module. If not, perform

procedure P0676, Connect Guard Tank Vent Line to Gas Module, to connect Guard Tank vent.

G.2.11. Verify Main Tank is subatmospheric, as indicated by Main Tank temperature (< 4.2 K) and pressure (< 760 torr).

1. Record Main Tank bottom temperature CN [09]. _____ K.
2. Record Main Tank pressure (EG-2 / EG-3) _____ torr.

G.2.12. Record initial liquid helium levels.

1. ***Main Tank*** _____%
2. ***Guard Tank*** – Verify level ≥ 15% to precool internal transfer line. If necessary, warm Main Tank to NBP using procedure P0216 and perform procedure P0211, *Internal Main Tank to Guard Tank Transfer*, to raise level. _____%

G.2.13. Verify liquid-level alarms enabled and record set points.

1. ***Main Tank*** – verify liquid-level alarm set ≥ 20%. Record set point. _____ %
2. ***Guard Tank*** – verify liquid-level alarm set ≥ 20%. Record set point. _____ %

G.2.14. Verify DAS alarm system enabled and record set points.

1. ***Station 200 temperature*** – verify CN [01] on DAS alarm list and set to alarm at T ≤ 6.5 K. Record set point. _____K
2. ***Top of lead bag temperature*** – verify CN [28] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _____K
3. ***Relative Guard Tank Pressure*** – verify CN [46] on DAS alarm list and set to alarm at ΔP ≥ 0.3 torr. Record set point. _____tor r

G.2.15. Verify DAS watchdog timer and alarm enabled.

G.2.16. Verify Vacuum Shell Pressure < 1 x 10-4 torr.

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] for CN 99.
3. When value is steady, record pressure (IP) _____ torr. If pressure is above 1x10-4 torr, turn off Vac-ion pump and perform procedure P0213, Connection of High Vacuum Pumping Module, to connect Vacuum Module and pump out SMD vacuum shell.

4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

Note: Vac-ion pump should be turned on/off periodically during this transfer and reading recorded on Data Sheet.

G.3. **Verify SMD in Standard Configuration**

G.3.1. 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.3.2. Verify that SMD external valves are in the following positions.

1. ***Open***: SV-9.
2. ***Closed***: SV-13 and FCV.

G.4. **Establish Initial Condition of GSE**

G.4.1. Verify actuator control valve for EV-9 is turned to “Subatm He” position.

G.4.2. Verify valve states are as indicated in following Table. Record configuration by checking appropriate box, then verify corresponding valve states.

- o Main Tank pumped by Gas Module (AP-1)
  1. Verify open EV-7a/b, EV-10, EV-13, EV-17.
  2. Verify all other EV valves closed.
  3. Verify AP-1 on.
  4. Verify AV-6 open.
  5. Verify all other AV valves closed.
  6. Verify open PV-2 and PV-4.
  7. Verify closed PV-1, PV-3, PV-5 and PV-6.

- o Main Tank pumped by Pump Module (PP-1/2)
  8. Verify open EV-4, EV-7a/b, EV-10, EV-13, EV-17, EV-21/22.
  9. Verify all other EV valves closed.
  10. Verify all AV valves closed.
  11. Verify PP-1/2 on.
  12. Verify open PV-1, PV-2, PV-4.
  13. Close/verify closed PV-3, PV-5 and PV-6.

Note: This procedure uses pre-cooling from the Guard Tank and the Guard Tank level should be > 15%. If not, be aware that precooling may not reach the criterion specified below.

G.4.3. Record pressures:

1. Guard Tank (GTV-G, CN [46]) _____ torr gauge
2. Main Tank (EG-2) _____ torr

Note: Verify EV-8 and EV-12 are closed and EV-10 is open for proper reading of EG-2.

G.4.4. Record Fill Cap Assembly pressure and verify that it reads > 0.0 psig.

Fill Cap Assy (PFCG): _____ psig/torr

G.4.5. Record EV-7a valve position:_____ %

G.4.6. Record EV-7b valve position:_____ %

G.4.7. Turn on Main and Guard Tank Heat Exchangers EH-1/2.

G.4.8. Verify Actuator Control valve EACV-9 is in “subatmospheric” position.

G.5. Transfer Pumping of Main Tank to Pump Module

Note: This operation is to be performed if Main Tank is being pumped by Gas Module pump AP-1 and Pump Module is turned off. It is assumed that the plumbing between the Pump Module the Gas Module has been successfully leaked checked.

- Main Tank is pumped by AP-1, perform this section
- Main Tank is pumped by Pump Module, skip this section

G.5.1. Verify open PV-2 and PV-4.

G.5.2. Verify closed PV-1, PV-3, PV-5, and PV-6.

G.5.3. Start Pump Module:

1. Turn on/verify on water cooling of pump module.
2. Check oil level in Vane Pump (PP-2), record time _____ and initial _____. If oil level is low, add new oil to PP-2 per specification in Pump Module Manual.
3. Verify closed EV-4, EV-14, and EV-21/22.
4. Turn on rotary vane pump PP-2.
5. Open PV-1.
6. Once pressure PG-1 has come to equilibrium (, 1 torr), turn on roots pump PP-1 and verify PG-1 < 15 mtorr.

   Record PG-1 _____ mtorr

G.5.4. Transfer pumping of Main Tank to Pump Module

1. Verify closed AV-8, or if AV-8 is open, verify closed AV-3, -10.
2. Open EV-21 and EV-4.
3. Close AV-6.
4. Record time of day : _____

G.5.5. Verify current valve configuration

Open	EV-4, EV-10, EV-17, EV-13, EV-21/22, EV-7b(partial) PV-1, PV-2, PV-4, RAV-3, RAV-6b
Closed	All other EV, PV, and RAV valves All AV valves SV-13 and FCV

G.6. **Set Up Data Acquisition**

Note: refer to Operating Instructions for configuration definitions and mechanics of DAS keyboard/mouse operations.

G.6.1. Set DAS to configuration choice 4b.

G.6.2. Start “Special Data Cycle” by using [Other Menus] + [Special Data Col]. Set up the special data collection to include channel numbers 9, 1, 28, 42, 24, 46

G.6.3. Adjust roll over of Special Data Cycle to .25 to 0.5 minutes.

G.6.4. Set the Main Tank Liquid Level Sensors (LL-1D or LL-2D) to 1 minute sampling interval, and the Guard Tank Liquid Level Sensors (LL-5D or LL-6D) to 5 minute interval.

G.7. **Check Initial Pressure in Fill Line:**

G.7.1. Install a pumping line between valve FCV on the Fill Cap Assembly and the Access Port # 1 of the Gas Module.

G.7.2. Verify valve FCV is closed.

G.7.3. Turn on/verify on AP-1.

G.7.4. Open AV-8.

G.7.5. Open AV-3.

G.7.6. Open valve FCV and evacuate to 20 mtorr as measured at AG-2.

G.7.7. Close AV-8 and FCV.

G.7.8. Once the pressure in the Fill Cap Assy. as measured at PFCG has stabilized, record:

Pumping line pressure (PFCG): _____ torr.

G.7.9. Open valve SV-13 and bring the Fill Cap Assembly up to the pressure in the SMD Fill line and record:

(PFCG): _____ torr.

G.8. **Raise pressure in Fill Line:**

G.8.1. Record the pressure in Guard Tank at GTV-G (CN [46]) _____torr (relative to atm.).

G.8.2. Open RAV-2 to bring the Fill Line up to Guard Tank pressure as follows and record:

1. Verify all RAV selection switches are in the OFF position.
2. Turn on/verify on RAV power supply and adjust current limit to 1.85 amps.
3. Adjust power supply to 28 VDC.
4. Power up RAV controller No. 2.

5. Position Controller No. 2 selection switch to RAV-2.
6. Record initial switch status: Open: θ θ Closed: θ θ
7. Activate controller No. 2 to open RAV-2 and record:
   a. Rrun time: _____ seconds
   b. Current draw: _____ amp
   c. Time of day: _____
8. Record final switch status: Open: θ θ Closed: θ θ
9. Record operation in RAV log book.

G.8.3. Verify that the Fill Cap Assembly pressure rises to the Dewar Guard Tank pressure (approximately 770 torr).

Record Fill line pressure (PFCG): _____ torr.

G.8.4. Close SV-13 and torque to 60 in-lbs ± 5 in-lbs.

G.8.5. Verify closure of SV-13.

1. Open AV-8.
2. Open FCV and evacuate to < 25 mtorr as measured at AG-2b: now pumping with AP-1 up to SV-13.
3. Close FCV.
4. Close AV-8.
5. Open AV-1.
6. Open AV-9 until pressure reaches 0.5 psig as read on gauge AG-1 and then close AV-9.
7. Close AV-1.
8. Record:
   a. PFCG pressure:_____ torr
   b. Time of day:_____
9. Verify closure of SV-13 by observing the pressure in the Fill Cap Assembly PFCG until satisfied that no gas is leaking into the Dewar Fill line. After 10 minutes record:
   a. PFCG pressure:_____ torr
   b. Time of day:_____
10. Open AV-1
11. Open FCV.
12. Open AV-9 until pressure reaches 0.5 psig as read on gauge AG-1 and then close AV-9.
13. Close AV-1.

14. Remove the pumping line from the fill cap assembly.

G.8.6. Verify current valve configuration

Open	EV-4, EV-10, EV-17, EV-13, EV-21/22, EV-7a/b, AV-3 PV-1, PV-2, and PV-4, RAV-2, RAV-3, RAV-6b
Closed	All other EV, PV, and RAV valves All AV valves SV-13

G.9. **Install Stinger in LHSD**

Note: Use appropriate stinger extension for the LHSD being used. Inspect and clean all O-rings and mating surfaces including those in the LHSD Quick Disconnect stack as necessary.

G.9.1. Use the crane with load cell attached to suspend LHSD just off floor or use platform scale for weighing

G.9.2. Weigh the LHSD (without LLS readout) and record:

1. Total weight: _____ lbs.
2. Enter tare weight: _____ lbs (on tag)
3. Enter net weight: _____ lbs (total-tare)

G.9.3. Install 1000 torr Baratron guage on LHSD ullage.

G.9.4. Reduce the pressure in the liquid helium supply to < 1.0 psig by opening the low pressure relief valve LHV-2.

G.9.5. Open valve VF-1 (Liquid withdrawal valve) on the stinger

G.9.6. Slowly insert the stinger into the LHSD while allowing it to be purged.

G.9.7. Close valve VF-1 just as cold gas is expelled from stinger.

G.9.8. Record LHSD data:

1. Date / time_____
2. Liquid level _____ %
3. LHSD serial number _____

G.10. **Install Fill Line Assembly**

G.10.1. Remove the Fill Cap Assembly.

Note
In the following steps the fill line is connected from the LHSD stinger at VF-1 to the SMD. Two transfer lines are available for use. One has an integrated filter and connects directly to bayonet B3 at the dewar. The other has a separate filter that is first installed at bayonet B3, after which the fill line is connected to the filter.

G.10.2. Install Filter Line Assembly (P/N 5833827) to Dewar Fill Bayonet B3 if used.

G.10.3. Install Fill Line Assembly as follows:

CAUTION
Be sure to provide adequate Fill Line support to avoid damaging Filter and Stinger.

1. Mate the Fill Line (P/N 5833804) with the LHSD Stinger at VF-1.
2. Mate VF-2 end of transfer line with Filter Line Assembly or B3 as appropriate.
3. Ensure VF-2 and relief valve stems pointed upwards.
4. Close/verify closed VF-3.

G.11. **Condition the Transfer Line/Filter/Stinger Assembly**

G.11.1. Configure Pumping Line:

1. Mate a 1-1/2-in flexible pumping line to Access #1 port of the Gas Module.
2. Mate other end to outlet of VF-2.

G.11.2. Evacuate Transfer Line:

1. Open valve VF-2.
2. Open/verify open AV-3.
3. Open AV-8.
4. Close AV-8 when pressure reaches less than 50 mtorr as read on gauge AG-2.

G.11.3. Backfill Transfer Line:

1. Open AV-1.
2. Open AV-9 until pressure reaches 0.5 psig as read on gauge AG-1 and then Close AV-9.
3. Close AV-1.

G.11.4. Evacuate Transfer Line (second time) and leak-back test of Transfer Line:

1. Open AV-8.
2. Close AV-8 when pressure reaches less than 20 mtorr as read on gauge AG-2.
3. Verify that pressure AG-2 does not rise by more than 25 mtorr per minute in a two minute period while recording:

Time (min)	_____	_____	_____	_____	_____
P(AG-2) (mtorr)	_____	_____	_____	_____	_____

Pass/Fail _____ mtorr/min _____

G.11.5. Backfill Transfer Line (second time):

1. Open AV-1.
2. Open AV-9 until pressure reaches 0.5 psig as read on gauge AG-1 and then close AV-9.
3. Close AV-1.
4. Close AV-3.
5. Close valve VF-2.

G.12. **Weigh LHSD and Record:**

G.12.1. Total weight: _____ lbs.

G.12.2. Enter net weight: _____ lbs. (from Par. G.6.2)

G.12.3. Tare wt. including stinger and transfer line _____ lbs [total-net])

G.12.4. Verify current valve configuration

Open	EV-4, EV-10, EV-17, EV-13, EV-21/22, EV-7b(partial) PV-1, PV-2, PV-4, RAV-2, RAV-3, RAV-6b
Closed	All other EV, PV, and RAV valves All AV valves SV-13

G.13. **Precool Internal Fill Line From Guard Tank:**

Note: This section starts the transfer by pre-cooling the SMD internal Fill Line by pushing liquid up from the Guard Tank.

G.13.1. Record the following instrumentation and time of day:

1. Time of day:_____.
2. Main Tank LLS_____ %
3. Guard Tank LLS_____ %
4. Main Tank vent pressure, (EG-2)_____ torr.
5. Main Tank temperature (CN [09])_____.K
6. Guard Tank temperature (CN [24]) _____ K.

G.13.2. Set up EV-7 control valves

1. Record EV-7a valve position: _____ % open.
2. Record EV-7b valve position: _____ % open.
3. Verify that EV-7 valves are on manual control.

G.13.3. Close Guard Tank atmospheric vent path EV-13.

G.13.4. Record time/date _____/_____.

G.13.5. Input comment to DAS “Start MT subatmospheric Fill with NBP LHSD.

G.13.6. Verify closed VF-3.

G.13.7. Open SV-13.

G.13.8. Open VF-2.

G.13.9. Record relative Guard Tank pressure (GTV-G, CN [46]) _____torr.

G.13.10. Turn on Guard Tank Heater (H-3D or H-4D)

1. Set power supply current limit to 0.07 amps.
2. Set heater to 50 VDC and record:

V: _____ vdc and I: _____ a

G.13.11. Open VF-3.

Note: Monitor Guard Tank pressure (GTV-G) and maintain it at approximately 800 torr (+40 torr relative to atm.) by adjusting the heater voltage.

G.14. **StartTransfer**

G.14.1. When a dense plume is evident from VF-3 and when Fill Valve (SV-13) temperature T-24D, CN [42], is < 75K,

G.14.2. Reduce Guard Tank heater voltage to 0.0 volts.

G.14.3. Close SV-13.

G.14.4. Immediately open VF-1.

G.14.5. **Note:** Have one person watching the Special Data Cycle output and prepare to call for shutting of SV-13 if temperatures or pressures indicate excessive heating or pressure surges.

G.14.6. When a dense plume is evident from VF-2, close VF-2 and immediately open SV-13.

G.14.7. Open EV-13.

G.14.8. Open EV-6 and EV-18.

G.14.9. Close VF-3 when it is warm enough.

G.14.10. Verify AV-1 closed.

G.14.11. Verify current valve configuration

Open	EV-4, EV-6, EV-10, EV-17, EV-18, EV-13, EV-21/22, EV-7b(partial) VF-1, VF-2 SV-13 PV-1, PV-2, PV-4, RAV-2, RAV-3, RAV-6b
Closed	All other EV, PV, and RAV valves. All AV valves

G.14.12. Verify Start of Guard Tank Transfer

1. Verify flow through PFM-1 (scale B) of 50 to 100 liquid liters/hour.

CAUTION
Do not exceed 100 LL/hr transfer rate as read on PFM-1(Scale B) to avoid exceeding the capacity of the heat exchanger (EH-2) in the Gas Module.

a. Record PFM1 (Scale B) reading _____

b. Record Start Time _____

G.14.13. Record LHe level of LHSD:_____ % and weight _____ lb.

G.14.14. Input comment to DAS “Start External Fill of GT”.

G.14.15. Record all fill data on the attached data sheets every 15 minutes.

G.14.16. Adjust LHSD pressure as required:

1. Close pressurization valve at the LHSD and adjust the gas supply pressure regulator to the desired pressure not to exceed 8 psig.
2. Reopen pressurization valve at the LHSD.

G.14.17. When Guard Tank is at desired level, record Guard Tank level:

Guard Tank Level (LL-5D or LL-6D): _____ %

G.14.18. Proceed to the next section immediately.

G.15. **Switch from Guard Tank to Main Tank Fill:**

G.15.1. Quickly reduce ullage pressure in LHSD to atmospheric pressure via LHV-3 and LHV-4.

G.15.2. Closed LHV-3.

CAUTION
In the following step, there is a possibility that a temperature spike might occur in the Main Tank ullage. Be prepared to close SV-13 if the temperature at the top of the lead bag CN [28] or CN [29] reaches 6.3 K

G.15.3. Close RAV-2 by performing the following operations:

1. Verify that controller No. 2 is already powered up and that RAV selection switch is already set to RAV-2. If not, perform the following:
   a. Verify Controller No. 2 selection switch in OFF position.
   b. Power up controller No. 2.
   c. Position selection switch to RAV-2.
2. Record initial switch status: Open: θ θ Closed: θ θ
3. Activate controller No. 2 to close RAV-2 and record:
   a. run time: _____ seconds
   b. current draw: _____ amp
   c. time of day: _____
4. Record final switch status: Open: θ θ Closed: θ θ
5. Record operation in RAV log book.

G.15.4. Input comment in DAS “Switch from GT to MT”.

CAUTION
Watch temperatures of lead bag, CN [28], and STA 200, CN [01], carefully. Keep temperatures < 6K. Be prepared to close SV-13 immediately if temperatures approach 6 K.

G.15.5. Open RAV-1 by performing the following operations:

1. Verify that controller No. 1 is already powered up and that RAV selection switch is already set to RAV-1. If not, perform the following:
   a. Verify Controller No. 1 selection switch in OFF position.
   b. Power up controller No. 1.
   c. Position Controller No. 1 selection switch to RAV-1.
2. Record initial switch status: Open: θ θ Closed: θ θ
3. Activate controller No. 1 to open RAV-1and record:
   a. run time: _____ seconds
   b. current draw: _____ amp
   c. time of day: _____
4. Record final switch status: Open: θ θ Closed: θ θ
5. Record operation in RAV log book.

G.15.6. Open EV-7a fully.

G.15.7. Close EV-6 and EV-18 (GT is now protected from backflow).

G.15.8. Open PV-3.

G.15.9. Verify current valve configuration

Open	EV-4, EV-10, EV-17, EV-13, EV-21/22, EV-7a/b(fully) VF-1 SV-13 PV-1, PV-2, PV-3, PV-4, RAV-1, RAV-3, RAV-6b
Closed	All other EV, AV, and PV valves.

G.15.10. Verify Start of Transfer:

1. Verify flow through PFM-1 (scale B) of 50 to 100 liquid liters /hour. Record PFM-1:_____ LL/hr.

Note: Do not exceed 100 LL/hr transfer rate as read on PFM-1 (scale B) as this exceeds the capacity of the heat exchanger in the gas module. The flow rate is nominally controlled by maintaining the ullage pressure (LHG-1, -2) between 450 and 550 torr. It may also be trimmed to the desired value by adjusting the opening of EV-7a/b.

2. Record:
   a. Time of day: _____
   b. PFM1 (scale B) reading:_____ Ll/hr
   c. LHSD weight:_____ lbs

G.15.11. Maintain LHSD Pressure

During Main Tank fill, keep careful track of LHSD ullage pressure LHG-2

1. Allow it to drop subatmospheric.
2. Keep it between 450 to 550 torr using LHSD pressurization heater as required

G.15.12. Record all fill data on the attached data sheets every 15 minutes.

CAUTION
The Guard Tank may tend to subcool during this procedure. Maintain continuous monitoring of the Guard Tank pressure throughout the remainder of this procedure.

G.15.13. Monitor pressure in Guard Tank and maintain Guard Tank heater power to keep GTV-G > +5 torr relative to atmospheric pressure.

G.15.14. When the LHSD is near depletion or the Main Tank is full, proceed to next section.

G.16. **Terminate Transfer**

Note: A full Dewar or empty LHSD is indicated by a rapid drop in LHSD ullage pressure or (less prominently) a consistent increase in the flow rate at PFM-1.

G.16.1. Close VF-1.

G.16.2. Close SV-13 and torque to 60 in-lbs ± 5 in-lbs.

G.16.3. Open VF-2.

G.16.4. Open VF-3.

G.16.5. Record the following:

1. Date/time of day:_____ .
2. LHSD weight:lbs _____.
3. Main Tank level: _____%.
4. Flowrate PFM-1 (B): _____ Ll/hr.
5. Main Tank Temp (T-9D): _____ K.
6. Guard Tank Temp (T-15D) _____ K.
7. Main Tank exit pressure (EG-2): _____ torr.
8. Vacuum Module pressure (VG-1): _____ torr.

G.16.6. Continue to monitor and maintain positive Guard Tank pressure relative to atmosphere (Endevco at GTV-G, CN [46]) Record Data in Data Sheet. Adjust heater voltage as necessary, gradually reducing to avoid excessive (> 30 torr) pressure.

G.17. **Configure GSE**

G.17.1. Record:

1. Date/time of day: _____ .
2. EV-7a valve position: _____ %.
3. EV-7b valve position:_____%.

G.17.2. Verify open EV-4, EV-7a/b, EV-10, EV-13, EV-17, and EV-21/22.

G.17.3. Verify all other EV valves are closed.

G.17.4. Verify all AV valves closed.

G.18. **Verify Closure of SV-13**

G.18.1. Close/verify closed all AV valves.

G.18.2. Verify open VF-2.

G.18.3. Close VF-3.

G.18.4. Open AV-8 and AV-3.

G.18.5. When AG-2b is < 50 mtorr close AV-8.

G.18.6. Open AV-1.

G.18.7. Open AV-9 until pressure reaches 0.5 psig as read on gauge AG-1 and then close AV-9.

G.18.8. Perform leak-back test of SV-13.

1. Verify that pressure AG-2 does not fall by more than 1.0 torr per minute while recording pressures for 4 minutes:

Date/Time of Day: _____/_____

Time (min)	_____	_____	_____	_____	_____
P(AG-2) (mtorr)	_____	_____	_____	_____	_____

Pass/Fail _____ mtorr/min _____

G.18.9. In the case the leak-back test fails, perform the following:

1. Open AV-8 and evacuate the Transfer line.
2. Close AV-8 when pressure reaches less than 10 mtorr as read on gauge AG-2.

3. When SV-13 and Transfer line are judged to be warmed sufficiently (which may be a few hours) to pass a leak -back test, perform the following:
   a. Retorque SV-13 to 60 +/- 5 in-lbs.
   b. Open AV-8.
   c. Close AV-8 when pressure reaches less than 10 mtorr as read on gauge AG-2.
   d. Verify that pressure AG-2 does not rise by more than 50 mtorr in four minutes while recording:

Date/Time of Day: _____/_____

Time (min)	_____	_____	_____	_____	_____
P(AG-2) (mtorr)	_____	_____	_____	_____	_____

Pass/Fail _____ mtorr/min _____

G.19. **RemoveTransfer Line and Filter Assembly**

When satisfied that SV-13 is leak tight, remove the transfer line and filter assembly as follows:

G.19.1. Ensure AG-2 > 760 torr.

G.19.2. Close VF-2 and disconnect pumping line at VF-3.

G.19.3. Remove the Transfer/ Filter Lines from the Dewar fill bayonet B3.

G.19.4. Immediately install the Fill Cap Assembly at the Dewar fill bayonet B3.

G.19.5. Connect a pumping line between the Fill Cap Assembly at valve FCV and the Auxiliary Gas Section access port no. 1.

G.19.6. Open/verify open AV-3.

G.19.7. Close/verify closed all other AV valves.

G.19.8. Open AV-8.

G.19.9. Open/verify open valve FCV

G.19.10. Evacuate Fill Cap Assembly to <25 mtorr as measured at AG-2B.

G.19.11. Close FCV.

G.20. **Evacuate Internal Fill Line**

G.20.1. Record PFCG _____ torr.

G.20.2. Open SV-13.

G.20.3. Record PFCG _____ torr.

G.20.4. Close RAV-1:

1. Verify that RAV controller No.1 is already on and that RAV selection switch is already set to RAV-1. If not
   a. Verify Controller No. 1 selection switch in OFF position.
   b. Power up controller No. 1.
   c. Position Controller No. 1 selection switch to RAV-1.
2. Record initial switch status: Open: θ θ Closed: θ θ
3. Activate controller No.1 to close RAV-1 and record:
   a. run time: _____ seconds
   b. current draw: _____ amp
   c. time of day: _____
4. Record final switch status: Open: θ θ Closed: θ θ
5. Record operation in RAV log book.

G.20.5. Deactivating RAV system:

1. Turn all RAV selection switches to OFF.
2. Power off all controllers.
3. Turn off RAV power supply.

G.20.6. Open FCV and evacuate the Dewar fill line to < 25 mtorr as measured at AG-2b.

G.20.7. Input comment to DAS “RAV-1 closed and Fill Line pumped”.

G.20.8. Close SV-13 and torque to 60 +/- 5 in-lbs.

G.20.9. Close FCV.

G.20.10. Close AV-8.

G.20.11. Open AV-1.

G.20.12. Open AV-9 until pressure reaches 1.5 psig as read on gauge AG-1 and then close AV-9.

G.20.13. Close AV-1.

G.20.14. Monitor the pressure in the Fill Cap Assembly, FCA, for 15 minutes to be assured that no gas is leaking into the Fill Cap Assembly (i.e. it maintains vacuum) and record:

PFCG pressure: _____

Date/Time: _____

G.20.15. When Main Tank heat exchanger (EH-1) power demand is lower than 0.3 amps turn off heat exchanger and record time: _____

G.20.16. When Guard Tank heat exchanger (EH-2) power demand is lower than 0.3 amps turn off heat exchanger and record time: _____.

G.21. **Condition the LHSD**

G.21.1. Turn on electric pressure builder and bring the pressure LHG-2 to 800 torr (LP-1 to 1 psig). This should take about 10 minutes.

G.21.2. Turn off the electric pressure builder.

G.21.3. When LHG-2 reaches 1psig Open low pressure relief valve, LHV-2 on the LHSD.

G.21.4. Close LHV-1 and remove Baratron pressure gauge.

G.21.5. Remove stinger from LHSD.

G.21.6. Lower LHSD to floor or remove from platform scales.

G.21.7. Verify closed all valves on the LHSD except for the primary (low pressure) relief valve LHV-2 which is left open.

G.21.8. Verify pressure in LHSD is > 1 atm and remove the Stinger from the LHSD.

G.21.9. Verify closed all LHV valves except primary (1 psig) relief.

G.22. **Place Data Acquisition System in Standard Configuration**

G.22.1. Input comment to DAS “Complete NBP/Subamospheric fill of MT”.

G.22.2. Set DAS data cycle interval to 15 minutes.

G.22.3. Set Main Tank and Guard Tank Liquid Level sampling interval to 10 minutes.

G.22.4. Confirm that the liquid level sensors are set at a sampling rate of 10 minutes or turned off.

G.22.5. Confirm that Vac-ion pump is off.

G.22.6. Stop Special Data Cycle by using [Other Menus] + [Special Data Col] + [Stop Data Col].

G.22.7. 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 1] _____ K (≤ 6.5 K)

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

G.22.8. Ensure DAS watchdog timer and alarm enabled.

G.22.9. Ensure liquid level sensor alarms enabled on Main Tank and Guard Tank, and record set points if changed.

1. ***Main Tank*** – verify liquid-level alarm set ≥ 20%. Record set point. _____ %

2. ***Guard Tank*** – verify liquid-level alarm set ≥ 20%. Record set point. _____ %

CAUTION

The Guard Tank may tend to subcool following the completion of this procedure. Establish continuous monitoring of the Guard Tank pressure by placing it on the DAS alarm list.

G.22.10. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.22.11. Ensure Facility Main Alarm System enabled.

G.23. **Final Closure of SV-13 and Conditioning the Dewar Fill Cap Assembly**

Once SV-13 has warmed sufficiently to try final closure perform the following steps. **Note**: The time required to warm up until the valve seals correctly may be a few hours.

G.23.1. Verify that the Fill Cap Assembly is still evacuated and record:

PFCG pressure: _____

Date/Time: _____

G.23.2. Retorque SV-13 to 60 +/- 5 in-lbs.

G.23.3. Open AV-8 and open/verify open AV-3.

G.23.4. Open FCV and evacuate to < 25 mtorr as measured at AG-2b.

G.23.5. Close AV-8.

G.23.6. Open AV-1.

G.23.7. Open AV-9 until pressure reaches 1.5 psig as read on gauge AG-1 and then close AV-9.

G.23.8. Close AV-1.

G.23.9. Close FCV and record:

PFCG pressure:_____

Date/Time:_____/_____

G.23.10. Open AV-8 and evacuate to < 25 mtorr as measured at AG-2b.

G.23.11. Close AV-8.

G.23.12. Verify closure of SV-13 and FCV by observing the pressure in the Fill Cap Assembly ,PFA until satisfied that no gas is leaking into the Dewar Fill line or pump line. After 30 minutes record:

PFCG pressure:_____

Date/Time:_____/_____

Note: If PFCG drops by more than 0.5 torr in 30 minutes, repeat steps G.25.2 through G.25.12.

G.23.13. Open AV-1.

G.23.14. Open AV-9 until pressure reaches 0 psig as read on gauge AG-1 and then close AV-9.

G.23.15. Close AV-1.

G.23.16. Close AV-3.

G.23.17. Remove the pumping line from the Fill Cap Assembly.

G.23.18. Install a KF-25 blank-off cap on valve FCV.

G.24. **(Option) Returning Pumping of SMD to Gas Module Pump**

G.24.1. Continue adjusting valves EV-7a/b until desired Main Tank temperature is reached. Record data on attached data sheets.

G.24.2. Once temperatures and pressures have stabilized, and the Main Tank temperature, CN [09] is at the desired level, record the following

1. Date/time of day:_____/_____
2. Main Tank level:_____ %
3. Flowrate PFM-1 (CN110):_____ Ll/hr
4. Tank Temp (T09D):_____ K
5. Main Tank exit pressure (EG-2):_____ torr
6. Vac-ion pump(IP):_____ torr
7. Vacuum Module pressure (VG-1):_____ torr

G.24.3. Record EV-7a valve position:_____ %

G.24.4. Record EV-7b valve position:_____ %

G.24.5. Verify closed all AV valves.

G.24.6. Verify on/turn on AP-1.

G.24.7. Open AV-8.

G.24.8. When AG-2b < 50 mtorr proceed.

G.24.9. Comment to DAS: “Complete Subatmopheric/NBP MT fill.”

G.24.10. Open AV-6.

G.24.11. Close EV-4.

G.24.12. Verify Main and Guard Tank heat exchangers (EH-1/2) off.

G.24.13. Shut down pump module

1. Close EV-21/-22.
2. Close PV-1.
3. Power down PP-1 and PP-2.
4. Close PV-3.

G.24.14. Put/verfiy DAS on 15 minute data cycle.

G.24.15. Gas Module valve configuration:

a. ***Open:*** EV-10, EV-17, EV-13 and AV-6, and AV-8.

b. ***Closed:*** All other Gas Module valves.

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Data Sheet

DATE / TIME	Main Tank Press EG-2	Vac Press VG-1/ VIP	GT Press GTV-G CN [46]	Pump Press PG-1	Flow Rate PFM-1 (B)	MT Vent Bayonet/ Bayonet Nut	SV-9 Valve/ Top Plate	Top-Plate Cyl(2)	GM Hex GT/MT	Main Tank Temp CN [09]	Sta. 200 Temp CN [01]	Guard Tank Temp CN [24]	Hex-4 Temp CH [08]	LHSD Press CN [83]	LHSD LLS/ Wt	MT/GT LLS	GT Heater Power	Extern. Gas Sup. ea shift	Comments
	Torr	torr	torr	torr	LL/Hr	^{0}C/^{0}C	^{0}C/^{0}C	^{0}C/^{0}C	^{0}C/^{0}C	K	K	K	K	torr	%/lb	%	W	psi	

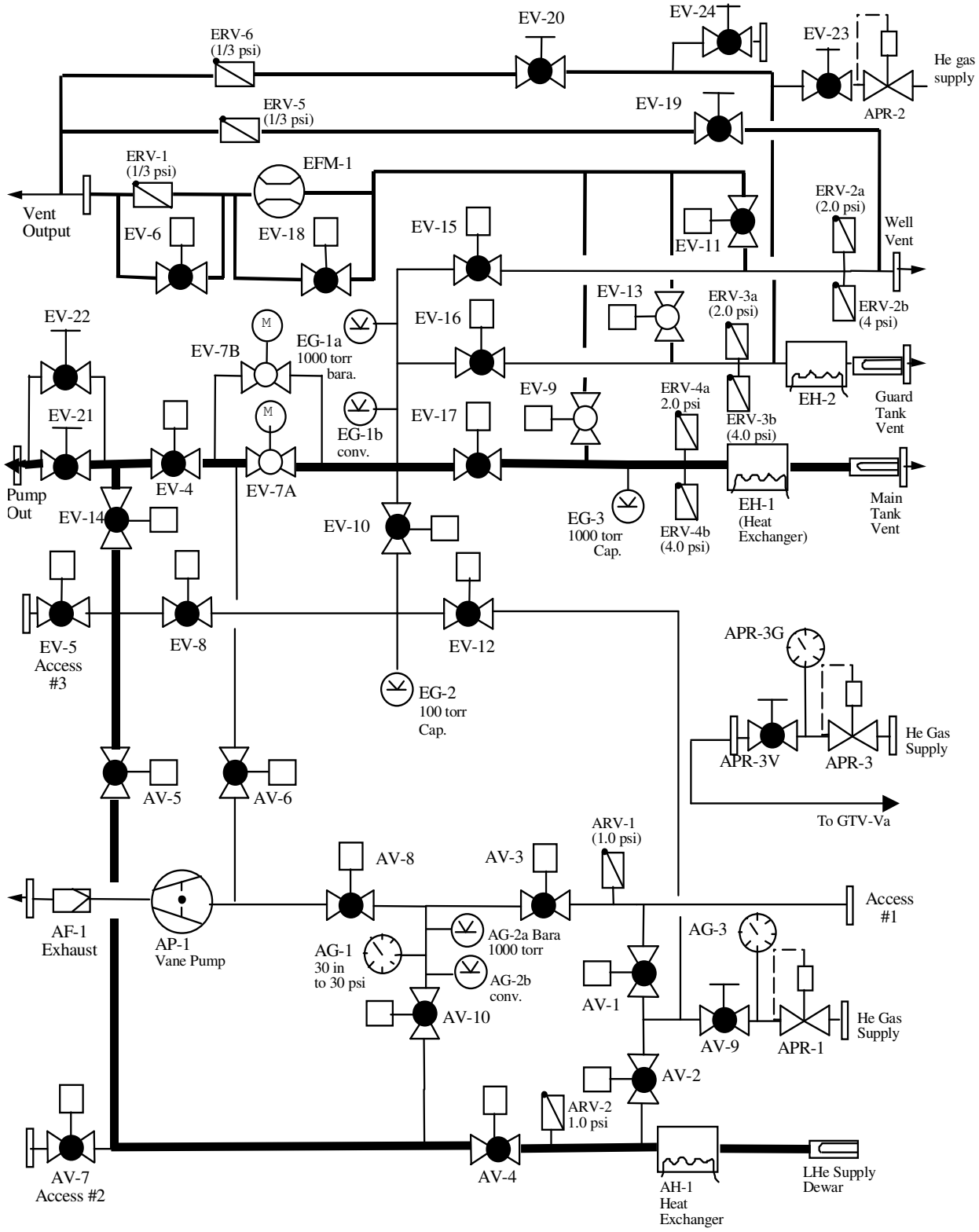

Figure 1. Schematic of Gas Module Plumbing.

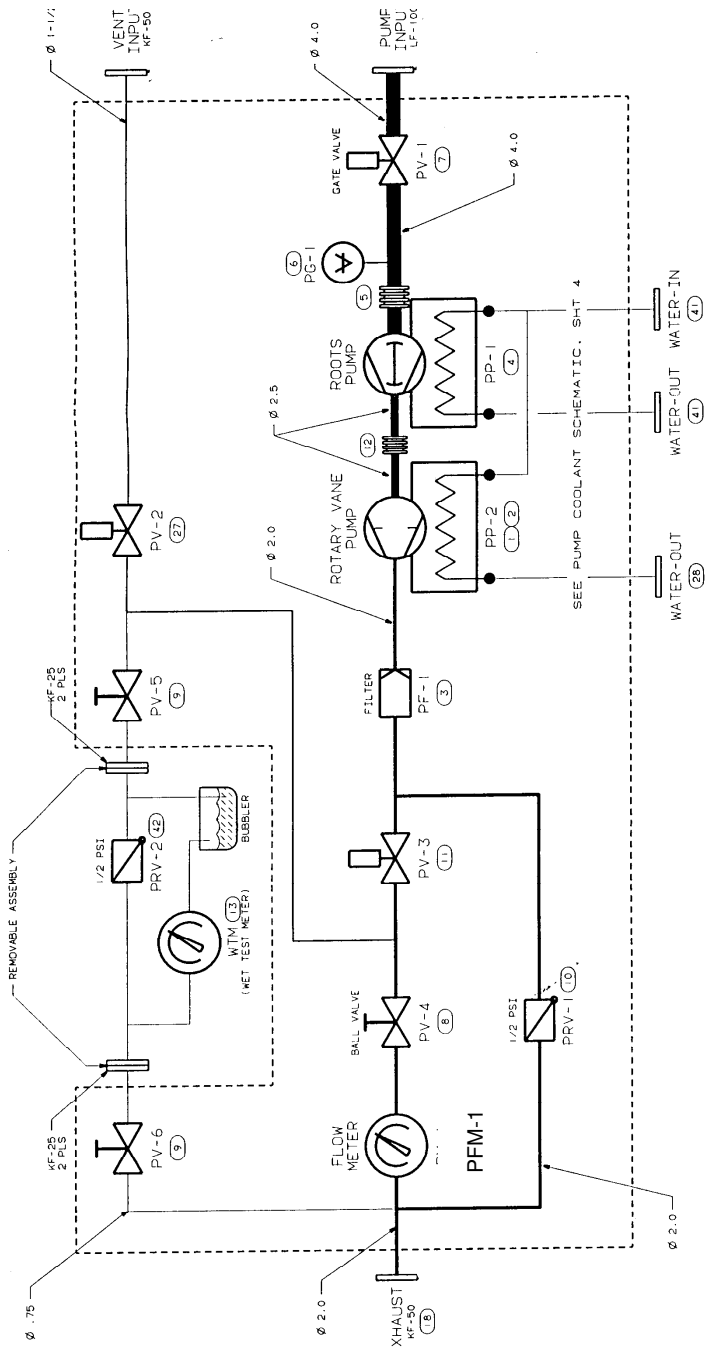

Figure 2. Schematic of Pump Module plumbing.

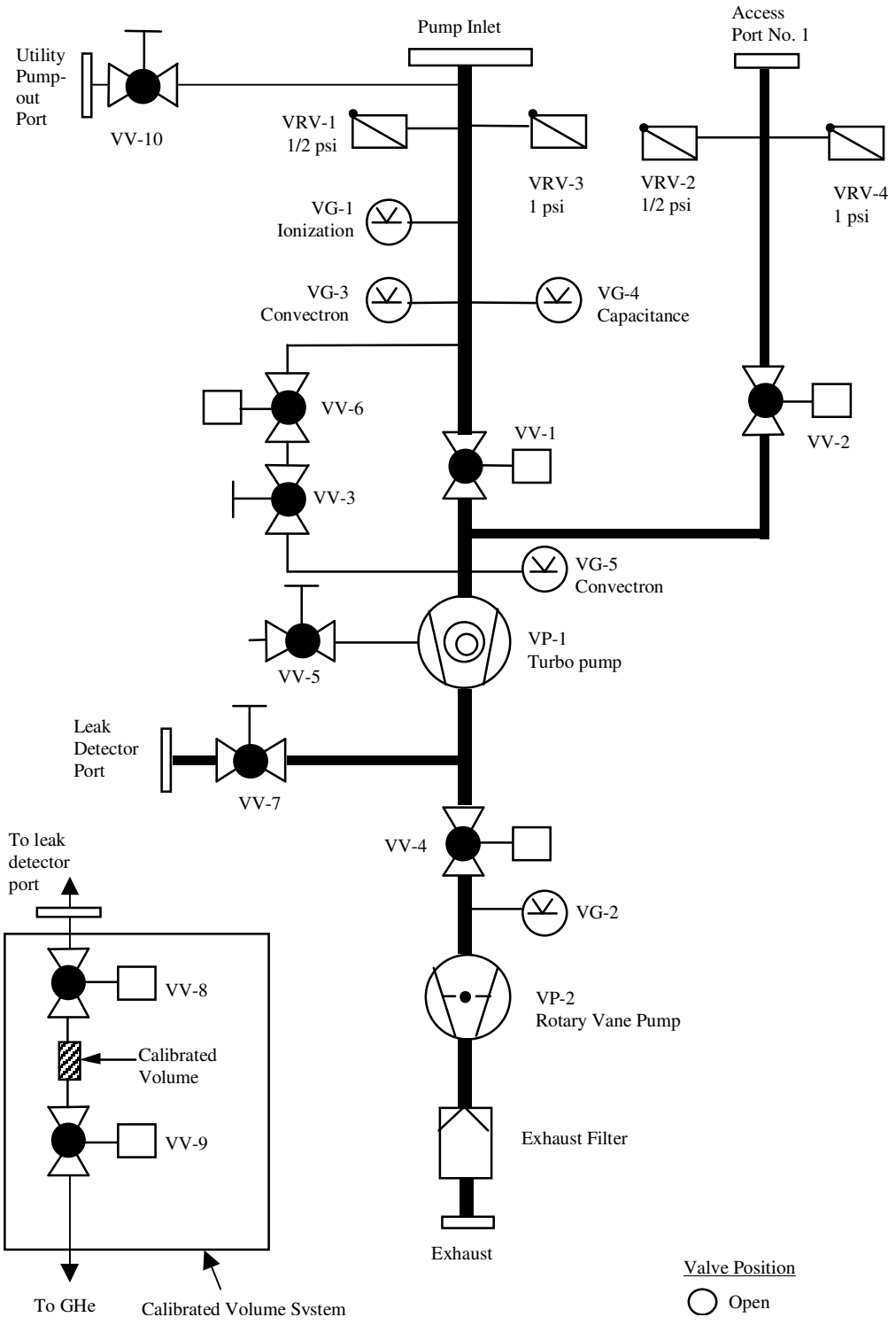

Figure 3. Schematic representation of Vacuum Module plumbing.

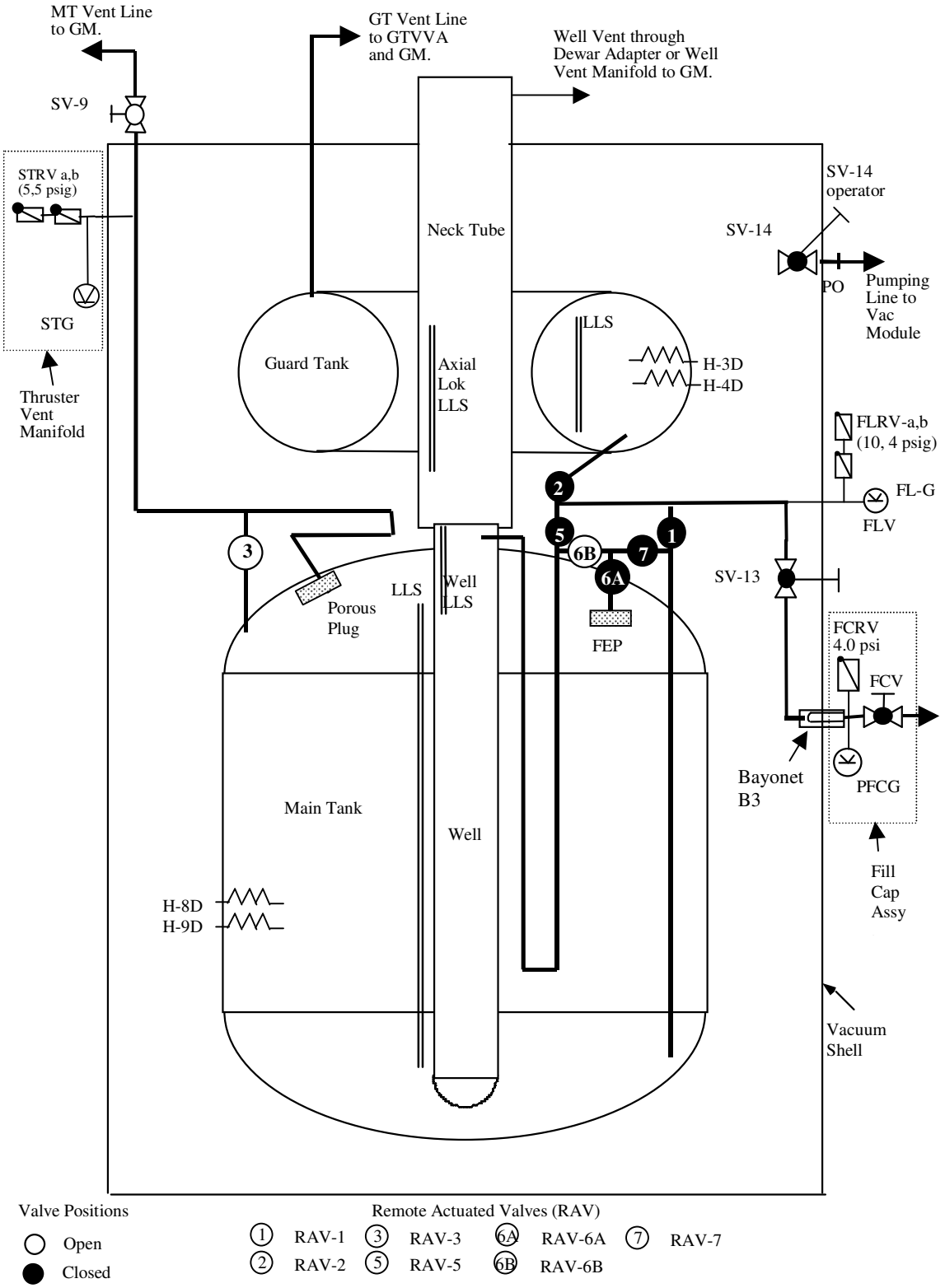

Figure 4. Schematic of Science Mission Dewar plumbing.

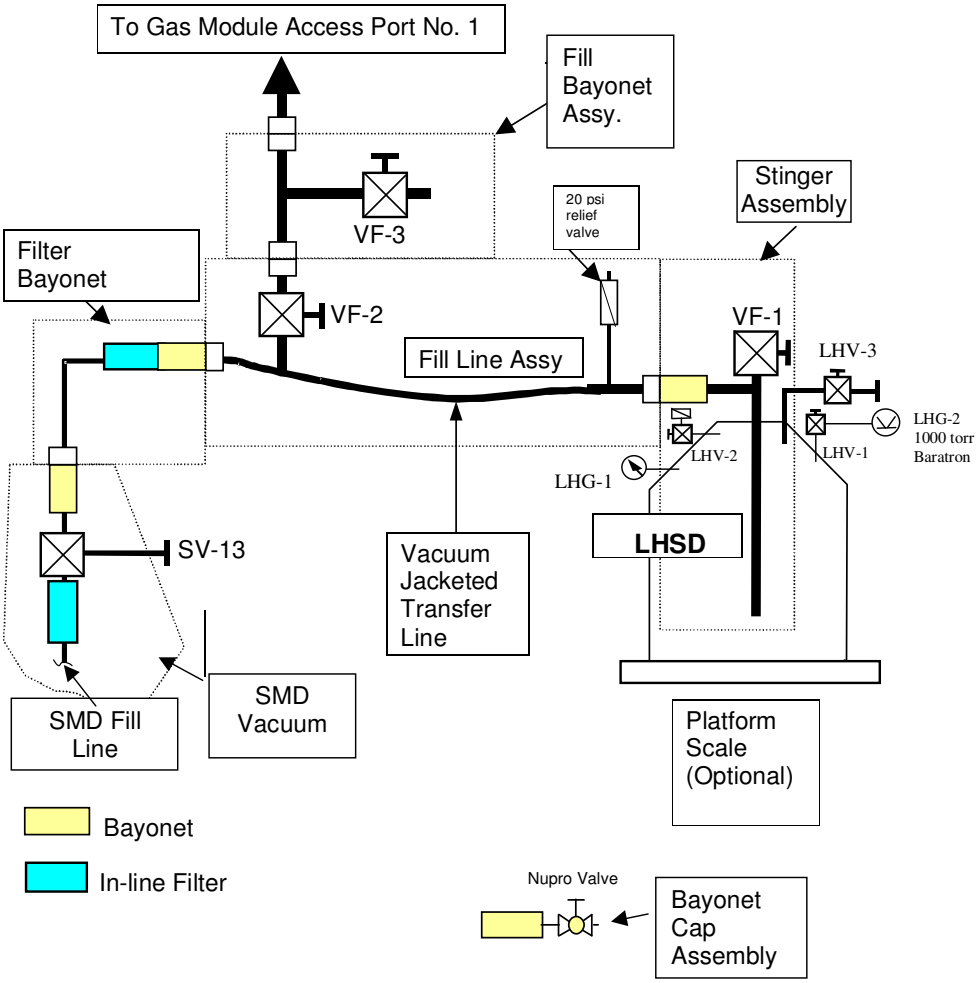

Figure 5 Schematic representation of LHSD and Transfer Line Plumbing

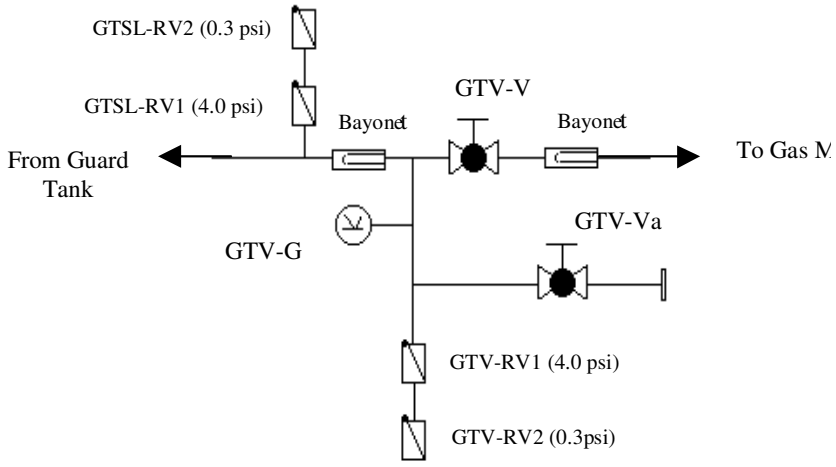

Figure 6. Guard Tank Vent Valve Assembly (GTVVA)