GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Prepare Main Tank for Launch

P0831 REV. A

ECO 1294

July 8, 2001

Prepared by

_____Date_____
Ned Calder
Cryogenic Test

Checked by

_____Date_____
Jim Maddocks
Cryogenic Test

Approvals:

_____Date_____
Dorrene Ross
Quality Assurance

_____Date_____
Harv Moskowitz
LM Safety

_____Date_____
Rich Whelan
Systems Engineering

_____Date_____
Mike Taber
Payload Test Director

_____Date_____
Robert Brumley
Payload Technical Manager

Revision Record

Rev	***ECO***	***Pages***	***Date***
a	1294	Added minor redlines Added Scope Modified section G.5 to include steps to either verify or start the Vacuum Module pumping up to SV-14 in Standby Mode Replaced sections G.11 and G.12 (subatmospheric LHSD to subatmospheric Main Tank fill operations per P0217) with NBP LHSD to subatmospheric Main Tank fill operations (P0798). Added two optional NBP to subatmospheric transfers (sects G.13 and G.14). Removed all expected values for Main Tank temperature and pumping times as they were based on estimates made before the practice fill of May 2001.	8/9/01

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
STG	SMD Thruster vent pressure gauge
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 prepare the Main Tank of the SMD for launch. These steps include:

Fill Main Tank to capacity at NBP. Requires execution of P0442 *Main Tank Fill With Guard Tank Precool – Main Tank at NBP*. Repeat until MT liquid level ≥95.Begin Pumping on Main Tank

Begin sequence of transfers – NBP LHe to Subatmospheric Main Tank. Requires execution of P0798 *Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool*. Continue pumping on Main Tank throughout sequence.

Continue pumping and transferring NBP LHe to subatmospheric Main Tank as directed by PTD until desired temperature and appropriate fill level are reached.

The well must be evacuated for this procedure.

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.

A.1.1. 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.

A.2. Qualified Personnel

Test Director	***Test Engineer***
Mike Taber	Tom Welsh
Dave Murray	Chris Gray
Jim Maddocks	Bruce Clarke
Dave Frank	Ned Calder

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

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

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

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

This procedure calls for use of hardware located in the 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

No additional hardware is required

E.3.6. Tools

No tools are required for this operation.

E.3.7. Expendables

No expendables are required for this operation.

E.4. Instrument Pretest Requirements

The GSE instruments required to perform this procedure are listed in Table 1, together with their serial numbers, where available. Instruments that are required to have current calibrations are indicated in the Cal-Required column. Instruments that do not require calibration are those not used to verify performance requirements and are not connected to flight instrumentation. The status column is to be filled in with the due date of the instrument calibration sticker and verified to be in calibration by QE or QE designee. Serial numbers are to be updated as appropriate.

Table 1. Required Instrumentation and Calibration Status

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
1	DAS	Power Supply, H-P 6627A	- A1, A2, A3, A4	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	B1, B2, B3, B4-	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A245539	No	-
4	DAS	Digital Multimeter H-P 3458A	-	2823A15047	Yes	
5	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-1a, -1b	2827	No	-
6	EM	Vacuum Gauge Controller Granville-Phillips Model 316	AG-2a, -2b	2826	No	-
7	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-3	2828	No	-
8	EM	MKS PDR-C-2C	EG-2, FCG	92022108A	No	-
9	EM	Flow meter – Matheson 8170	EFM-1	96186	No	-
10	EM	Flow meter totalizer Matheson 8124	EFM-1	96174	No	-
11	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Main Tank	96-409-11	No	-
12	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Guard Tank	96-409-10	No	-
13	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Well	96-409-9	No	-
14	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Axial Lock	96-409-12	No	-
15	EM	Pressure Controller – MKS 152F-92	EV-7a, -7b	96203410A	No	-
16	EM	Power Supply HP 6038A	H08D Tank Heater	96023407A	Yes	
17	EM	Power Supply HP 6038A	H09D Tank Heater	3511A-13332	Yes	
18	EM	Power Supply HP 6038A	RAV Power Supply	3329A-12486	Yes	
19	EM	Vac Ion Pump power supply Varian 929-0910, Minivac	SIP	5004N	No	-
20	EM	Flow meter totalizer	PFM-1	576013-716	No	-

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		Veeder-Root				
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

The Main Tank liquid must be at NBP with the liquid level ≥ 50%. 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, at the beginning of this procedure, ensuring that EV-9 remains open in the event of power failure. Before pumping on the Main Tank commences, it must be switched to the "Subatm He" position.

E.5.2. Guard Tank

The Guard Tank must contain liquid, and the level must be ≥ 15%.

E.5.3. Well

The Well must be evacuated.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure must be less than 1×10^{-4} torr. Procedure P0213, contains the steps 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 ≤ 6.5 K.
   b. Top of lead bag temperature set (CN 28) at T ≤ 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 ion-pump magnet is installed.
2. GSE cabling must be connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).
3. The 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.
4. 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.
5. The high-vacuum pumping line must be connected between the SMD at SV-14 and the inlet port of the Vacuum Module and be pumping up to a closed valve SV-14. Procedure No. P0213 contains the procedure for connecting to and pumping on the SMD vacuum shell.
6. A relief valve assembly (FLRV-a,b) or flight-like burst disk is installed in place of the flight SMD fill-line burst disk (BD3).
7. The Fill Cap Assembly must be installed at SV-13.
8. The thruster vent port is flanged to a relief valve/pressure sensor assembly.
9. The heaters on the SMD top plate, SV-9, and Main Tank vent bayonet must be installed and operational.
10. The Pump Module must be connected to the Gas module at EV-21.

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 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.
3. The Well Vent Manifold may be installed.

E.7. **Verification/Success Criteria**

This procedure demonstrates, in conjunction with rate of rise measurements (procedure P0515), that the specifications or requirements listed in the following table have been met. PLSE-12 paragraph 3.2.1.9, referred to in 3.7.5.7.1.1, specifies that the temperature at 95% fill should be sufficiently low that it will remain lesss than or equal to 1.85 K for 90 days. Whether or not this will be true depends on the heat rate measured in P0515.

Paragraph No.(PLSE-12)	***Specification/Requirement Title***	***Criterion***
3.7.5.7.1	Filling of the Main Tank	Fill Main Tank to 95% from LHSD with SMD vertical.
3.7.5.7.1.1	Conditioning and Top-off of the Main Tank	Condition Main Tank from NBP helium to He II and top-up to 95% full. He bath temperature to be consistent with 3.2.1.9.
3.7.5.7.2	Filling of the Guard Tank	Fill Guard Tank to 95% with NBP helium with SMD vertical.

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 P0676	*Connect Guard Tank Vent Line to Gas Module*
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 P0211	*Internal Guard Tank Fill – Vent Lines Connected*
SU/GP-B P0669	*Internal Guard Tank Fill – Vent Lines Disconnected*
SU/GP-B P0442	*Main Tank Fill With Guard Tank Precool – Main Tank at NBP*
SU/GP-B P0648	*NBP Main Tank Fill – Guard Tank Initially Depleted*
SU/GP-B P0798	*Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool*

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 Preliminary SMD and GSE Preparations Complete

G.2.1. Verify sufficient liquid helium on hand.

G.2.2. Verify that Probe is installed and Well has previously been pumped and leak checked per Procedure P0140 or P0613. Record most recent Op. No./Date _____/_____.

G.2.3. Record Guard Tank liquid level _____ %

Ensure level ≥ 15 %. If necessary, perform appropriate procedure to raise level (See note) and record:

Date _____ Procedure No. _____ and Op. No. _____

Note: Use procedure P0648 *NBP Main Tank Fill – Guard Tank Initially Depleted*, if the Guard Tank is depleted and the Main Tank level is < 50% (see below). Use procedure P0211, *Internal Guard Tank Fill – Vent Lines Connected* or P0669 *Internal Guard Tank Fill – Vent Lines Not Disconnected* , as appropriate, if the Main Tank level is acceptable.

G.2.4. Record Main Tank liquid level _____ %

Ensure level ≥ 50 %. If necessary, perform procedure P0648 *NBP Main Tank Fill – Guard Tank Initially Depleted* or P0442, *Main Tank Fill with Guard Tank Precool – Main Tank at NBP*, to raise level (see previous note) and record:

Date _____ Procedure No. _____ and Op. No. _____

Note: In Section G.4 the Main Tank is filled to capacity (≥ 95%). Given full dewars and average (based on previous experience) transfer efficiencies, a total of 1200 liters can be transferred to the Main Tank from four 500 L dewars or two 1000 L dewars. Thus, filling the Main Tank at this juncture to a level ≥ 50 % will minimize the number of fill ops required to reach the 95% liquid level, especially if the dewars are

expected to be less than full, or if it is desired that the Main Tank be greater than 95% full.

G.2.5. Verify transfer line and stinger vacuum shields have been pumped out within the previous month.

Record Date _____.

G.2.6. Ensure Gas Module has been leak checked since last transported.

Record Date _____ and Operation number _____.

G.3. **Verify Configuration Requirements**

G.3.1. Verify ion-pump magnet installed.

G.3.2. Ensure GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.3.3. Ensure 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.

Record Date _____ and Operation number _____.

G.3.4. Ensure 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.

Record Date _____ and Operation number _____.

G.3.5. Ensure Fill Cap Assembly installed at SV-13

G.3.6. Verify actuator control valve for EV-9, located on Gas Module, set to “NBP” position.

G.3.7. Verify Pump Module connected to Gas Module at EV-21/22.

G.4. **Fill Main Tank to Capacity (NBP)**

G.4.1. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.4.2. Perform procedure P0442, *Main Tank Fill With Guard Tank Precool – Main Tank at NBP.* Repeat until MT liquid level ≥ 95.

Note: on last fill operation bring Guard Tank liquid level to ≥ 90 %.

Record:

1. Date _____ Op. No. _____. Final MT level _____ %.
2. Date _____ Op. No. _____. Final MT level _____ %.
3. Date _____ Op. No. _____. Final MT level _____ %.
4. Date _____ Op. No. _____. Final MT level _____ %.

G.4.3. When Main Tank > 95 %, record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – Verify Guard Tank level ≥ 90 % _____%

G.4.4. Proceed to next section.

G.5. **Prepare to Pump on Main Tank**

G.5.1. Verify Vacuum Module configuration.

o Vacuum Module not pumping on high-vacuum pumping line up to closed SV-14

Perform procedure P0214 to connect and pump up to SV-14.

Record Op No _____.

o Vacuum Module already pumping on high-vacuum pumping line up to closed SV-14

1. Verify high-vacuum pumping line connected to SMD and Vacuum Module.
2. Verify SV-14 closed
3. Verify turbo pump on and in Standby Mode (Standby light is on)
4. Turn on ionization gauge and verify pressure in high-vacuum pumping line (VG-1) < $5x10^{-5}$ torr.

   Record pressure (VG-1) _____Torr.

   Record Date/Time _____/_____.
5. Verify Vacuum Module override switch in off position

Note – This configuration allows the user to pump on the vacuum shell immediately if this becomes necessary at any time during the procedure. To pump on the vacuum shell in this configuration the user should open valve SV-14 and take the turbo out of Standby Mode

G.5.2. 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.5.3. Ensure DAS watchdog timer and alarm enabled.

G.5.4. Ensure liquid-level alarms enabled and record set points.

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

G.5.5. Ensure Facility Main Alarm System enabled.

G.5.6. Ensure Top-plate heaters on SMD are connected and on.

G.5.7. Establish Initial Valve Configuration

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.
   a. ***Open:*** RAV-3, and RAV-6B.
   b. ***Closed***: RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.
2. Ensure that SMD external valves are in the following positions.
   a. ***Open***: SV-9.
   b. ***Closed***: SV-13 and FCV.
3. Verify all other valve states as indicated in following Table. Record configuration in left-hand column, then verify corresponding states.

Verify Initial Valve States		
	Verify Open	***Verify Closed***
o Main Tank connected to GM	EV-9	EV-17
o Guard Tank connected to GM – liquid level ≥ 15%	EV-16, EV-13 GTV-V	EV-20, EV-23, EV-24 GTV-Va
o Well evacuated – Pumping with UTS	VTH, VW-3 if installed	
o Well evacuated – valved off		EV-19, VTH, and VW-3 if installed
o 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
o AV valves		All

4. Turn on Main Tank, vent-line heat exchanger (EH-1) in Gas Module.
5. Position "Actuator Control EV-9" on Gas Module to "Subatm He."

G.5.8. Record Initial Conditions

1. Record initial SMD vacuum shell pressure as follows:
   a. Turn on Vac-ion pump and record date/time _____/_____
   b. Use DAS [Monitor Data] for CN 99.
   c. When value is steady, record pressure (IP) _____ torr.
   d. Verify Vacuum Shell Pressure < 1 x 10^{-4} torr. If not, turn off Vac-ion pump and perform procedure P0213, *Pump SMD Vacuum Space with Vacuum Module*, to pump out SMD vacuum shell. Record Op No. _____.
   e. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
   f. When data cycle is complete, turn off Vac-ion pump.
2. Record initial pressures:
   a. Guard Tank (EG-1a) _____ torr.
   b. Guard Tank relative to atm. (GTV-G) _____ torr.
   c. Main Tank (EG-3) _____ torr.
   d. Vacuum Module Pressure (VG-1): _____ torr.
3. Record initial temperatures
   a. Main Tank bottom (CN [09]) _____ K.
   b. Main Tank top (CN [20]) _____ K.
   c. Guard Tank (CN [24]) _____ K.
   d. Station 200 (CN [01]) _____ K.
   e. Top of lead bag (CN [28]) _____ K.

G.5.9. Establish Configuration of Pump Module (First Pump-down)

1. Verify open PV-2 and PV-4.
2. Verify closed PV-1, PV-3, PV-5, and PV-6.
3. Verify on/Turn on water cooling of pump module.
4. Turn on rotary vane pump PP-2 and blower PP-1.
5. Open PV-1.
6. Once pressure PG-1 in steady state record (PG-1): _____ torr.
7. Open PV-3.

G.5.10. Set up Data Acquisition System

Note: Refer to Operating Instructions for mechanics of DAS keyboard/mouse operations.

1. Verify DAS set to configuration 4m
2. Set the Main Tank liquid-level sampling interval to 1 minute.
3. Set the Guard Tank liquid-level sampling interval to 1 minute.

G.6. **Begin Pumping on Main Tank**

CAUTION

For the pumping operation, a heater has been placed on the Main Tank vent bayonet. Monitor (record on attached data sheets) the temperature of this bayonet to ensure that the heater can maintain the o-ring above 0° C in order to prevent leakage. The heater, however, cannot heat its zone above 52° C or it will automatically shut off. If the temperature of the o-ring drops below 0° C, immediately slow pumping by partially closing EV-21/22.

G.6.1. Close EV-9 and EV-16 and record:

Record Date _____ Time _____.

G.6.2. Ensure EV-21/22 closed.

G.6.3. Open EV-4 and EV-17.

G.6.4. Input comment to DAS “Start Main Tank Pump-down”.

G.6.5. Slowly open EV-22 to begin pumping on Main Tank.

G.6.6. Manually adjust EV-22 to control cool-down rate. Flow rate should not exceed 100 liquid liters per hour, as read on PFM-1 (scale B).

Record PFM-1 _____ LL/hr.

G.6.7. Open EV-10; EG-2 will now read approximate Main Tank pressure for pressures below 100 torr.

Note: In the past, the high flow rate produced by initial pump-down of the Main Tank has caused substantial migration of oil from the rotary vane pump, PP-2, into the mist separator which can result in damage to the pump. An automatic oil return unit has been added to PP-2 to eliminate this problem. However, as a precaution, the proper operation of this assembly should be monitored throughout the initial pump-down phase.

CAUTION

Pumping on the Main Tank will cause the Guard Tank to subcool. Monitor and maintain positive pressure in the Guard Tank (relative to atmospheric pressure) for the duration of the Main Tank pump-down. Positive pressure is maintained by adding heat as described in the following steps. Monitor pressure at GTV-G and record on attached data sheets.

G.6.8. Add heat to Guard Tank to maintain positive pressure:

1. Close EV-13.
2. Turn on power supply for Guard-Tank heater (H-3D or H-4D)
3. Set power supply current limit to 0.07 amps.
4. Set voltage limit to 50 VDC and record:
   V _____Vdc and I _____A.
5. Adjust heater voltage as necessary to maintain Guard Tank pressure (GTV-G). in the range 15 torr < ΔP < 30 torr.
6. Monitor and maintain positive Guard Tank pressure throughout the pump-down. Record data on attached data sheets.

G.6.9. When Main Tank pressure (EG-2) stalls and EV-22 is fully open switch control of pumping rate to EV-7a/b as follows:

1. Close EV-7a/b
2. Open EV-21
3. Record Date _____ and Time _____.

G.6.10. Resume pumping by slowly opening EV-7a/b to maintain desired maximum pumping rate of ≈ 100 LL/hr as read at PFM-1 (scale B).

G.6.11. When EV-7a/b fully open and flow rate remains below 100 LL/hr:

Record Date _____ and Time_____.

G.6.12. Continue to monitor and maintain positive pressure in Guard Tank, adjusting Guard Tank heater voltage as required.

G.6.13. When heater power required to maintain positive pressure in the Guard Tank is zero:

1. Reduce Guard Tank heater voltage to zero.
2. Open Ev-12 to vent Guard Tank.

Verify valve configurations

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

Verify Final Valve States		
	Verify Open	***Verify Closed***
o Main Tank connected to GM		EV-9,
o Guard Tank connected to GM – liquid level ≥ 15%	EV-13 GTV-V	EV-20, EV-23, EV-24 GTV-Va, EV-16,
o Well evacuated – Pumping with UTS	VTH, VW-3 if installed,	
o Well evacuated – valved off		EV-19, VTH, and VW-3 if installed
o Remaining EV valves	EV-4, EV-17, EV-21/22, EV-7a/b, EV-10	EV-5, EV-6,EV-8, EV-10, EV-11, EV-12,EV-14, EV-15, EV-18,
o AV valves		All

G.6.14. Set Up Data Acquisition

1. Set Main Tank liquid level sensor to 10 minute sampling interval.
2. Set Guard Tank liquid level sensor to 10 minute sampling interval.
3. Set Data interval to 15 min.

G.6.15. Continue pumping on Main Tank with pump module for 12 – 14 hours. When Main Tank liquid level ≤ 75% proceed to next section.

G.7. **Transfer NBP LHe to Subatmospheric Main Tank – I**

G.7.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.7.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.7.3. Perform procedure P0798, *Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool.* Bring Guard Tank liquid level to 100%

G.7.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.7.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.7.6. Continue pumping on Main Tank with pump module for 12-14 hours. When Main Tank liquid level ≤ 80% proceed to next section.

G.8. **Transfer NBP LHe to Subatmospheric Main Tank – II**

G.8.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.8.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.8.3. Perform procedure P0798, *Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool.* Bring Guard Tank liquid level to 100%

G.8.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.8.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (GTV-G) _____ torr.

G.8.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.9. Transfer NBP LHe to Subatmospheric Main Tank – III

G.9.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.9.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.9.3. Perform procedure P0798, *Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool.* Bring Guard Tank liquid level to 100%

G.9.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.9.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.9.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.10. Transfer NBP LHe to Subatmospheric Main Tank – IV

G.10.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.10.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.10.3. Perform procedure P0798, *Main Tank Subatmospheric Fill from NBP Supply Dewar – GT Precool.* Bring Guard Tank liquid level to 100%

G.10.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.10.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.10.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.11. **Transfer NBP LHe to Subatmospheric Main Tank V**

G.11.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.11.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.11.3. Perform procedure P0798, *Main Tank Subatmospheric Fill. From NBP Supply Dewar – GT Precool*

G.11.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.11.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (EG-1a) _____ torr.

G.11.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.12. **Transfer NBP LHe to Subatmospheric Main Tank – VI**

G.12.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure GTV-G) _____ torr.

G.12.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.12.3. Perform procedure P0798, *SMD Main Tank Subatmospheric Fill From NBP Supply Dewar – GT Precool*

G.12.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.12.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (GTV-G) _____ torr.

G.12.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.13. **(OPTION) Transfer NBP LHe to Subatmospheric Main Tank – VII**

G.13.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure GTV-G) _____ torr.

G.13.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.13.3. Perform procedure P0798, *SMD Main Tank Subatmospheric Fill From NBP Supply Dewar – GT Precool*

G.13.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.13.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (GTV-G) _____ torr.

G.13.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.14. **(OPTION) Transfer NBP LHe to Subatmospheric Main Tank – VIII**

G.14.1. Record initial conditions:

1. Record Date _____ and Time _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure GTV-G) _____ torr.

G.14.2. Record liquid helium levels.

1. ***Main Tank*** – _____%
2. ***Guard Tank*** – _____%

G.14.3. Perform procedure P0798, *SMD Main Tank Subatmospheric Fill From NBP Supply Dewar – GT Precool*

G.14.4. When transfer complete, record:

1. Date _____ and Time_____
2. Op. No. _____
3. Final MT level _____ %.

G.14.5. Record final fill conditions:

1. Time of day _____.
2. Main Tank bottom temp. CN [09] _____ K.
3. Main Tank top temperature CN [20] _____ K.
4. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
5. Guard Tank temperature CN [24] _____ K.
6. Guard Tank pressure (GTV-G) _____ torr.

G.14.6. Continue pumping on Main Tank with pump module until desired temperature or liquid level is reached. Proceed as directed by PTD.

G.15. **Switch Pumping to Gas Module (AP-1)**

G.15.1. When EG-2 reaches desired pressure, turn on AP-1

G.15.2. Open AV-6.

G.15.3. Close EV-4 and EV-21/22.

G.15.4. Close PV-1.

G.15.5. Turn off Pumps PP-1, and PP-2.

G.15.6. (Option)Turn off coolant water in Pump Module.

G.15.7. Continue monitoring Dewar instrumentation to verify that temperatures have stabilized.

G.16. **Establish Final Configuration**

G.16.1. Verify EV-7a/b, EV-10, EV-13, and EV-17 open.

G.16.2. Record positions of EV-7a _____ % and EV-7b _____ %.

G.16.3. Verify all other EV-valves closed

G.16.4. Verify AV-6 open.

G.16.5. Ensure all other AV valves closed.

G.16.6. Input comment to DAS “End of Main Tank Top-Off”.

G.16.7. Set the DAS data cycle to 15 minutes.

G.16.8. Set the Main Tank liquid level sampling interval to 10 minutes.

G.16.9. Set the Guard Tank liquid level sampling interval to 10 minutes.

G.16.10. 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.16.11. Ensure liquid level sensor alarms enabled and record set points if changed.

1. Main Tank Level Set Point _____%
2. Guard Tank Level 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.16.12. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.16.13. Ensure DAS watchdog timer and alarm enabled.

G.16.14. Continue to monitor Guard Tank pressure until HEX-1 temperature CN [05] reaches steady state. Be prepared to add heat as necessary.

G.16.15. Once HEX-1 temperature reaches steady value, turn off Guard Tank heater power supply.

G.16.16. Record the following:

G.16.17. Date: _____

1. Time of day: _____
2. Vacuum Module Pressure (VG-1): _____ torr
3. Main Tank pressure (EG-2)
   a. Dynamic (EV-4 open)_____ torr.
   b. Static (EV-4 briefly closed) _____ torr.
4. Guard Tank pressure relative to atm (GTV-G) _____ torr.

G.16.18. (Option) Disconnect Vacuum Module. Perform Procedure P0214, and record Operation No. _____.

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Data Sheet 1

Date/ Time	Comments	Main Tank LHe level (%)	Main Tank pressure EG-2/ EG-3 (Torr)	Vacuum pressure VG-1 (torr)	GM pressure PG-1/PG-2 (torr)	Flowrate PFM-1 (ll/hr)
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	

Data Sheet 2

Date/ Time	GT pressure GTV_G (torr)	GT Heater Voltage (V)	EV-7a setting (%)	EV-7b setting (%)	MT bottom T-9D [09] (K)	Sta. 200 CN [01] (K)	GT bottom CN [24] (K)	HX-4 T-8D CN [08] (K)	Gas Mod Hx MT (^{o}C)	MT Vent Bayonet/ Bay Nut (^{o}C/ ^{o}C)	Valve SV9/ Top Plate (^{o}C/ ^{o}C))	SV-9 Knob (^{o}C)

Data Sheet 1

Date/ Time	Comments	Main Tank LHe level (%)	Main Tank pressure EG-2/EG-3 (Torr)	Vacuum pressure VG-1 (torr)	GM pressure PG-1/PG-2 (torr)	Flowrate PFM-1 (ll/hr)
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	
					/	

Data Sheet 2

Date/ Time	GT pressure GTV_G (torr)	GT Heater Voltage (V)	EV-7a setting (%)	EV-7b setting (%)	MT bottom T-9D [09] (K)	Sta. 200 CN [01] (K)	GT bottom CN [24] (K)	HX-4 T-8D CN [08] (K)	Gas Mod Hx MT (^{o}C)	MT Vent Bayonet/ Bay Nut (^{o}C/ ^{o}C)	Valve SV9/ Top Plate (^{o}C/ ^{o}C))	SV-9 Knob (^{o}C)

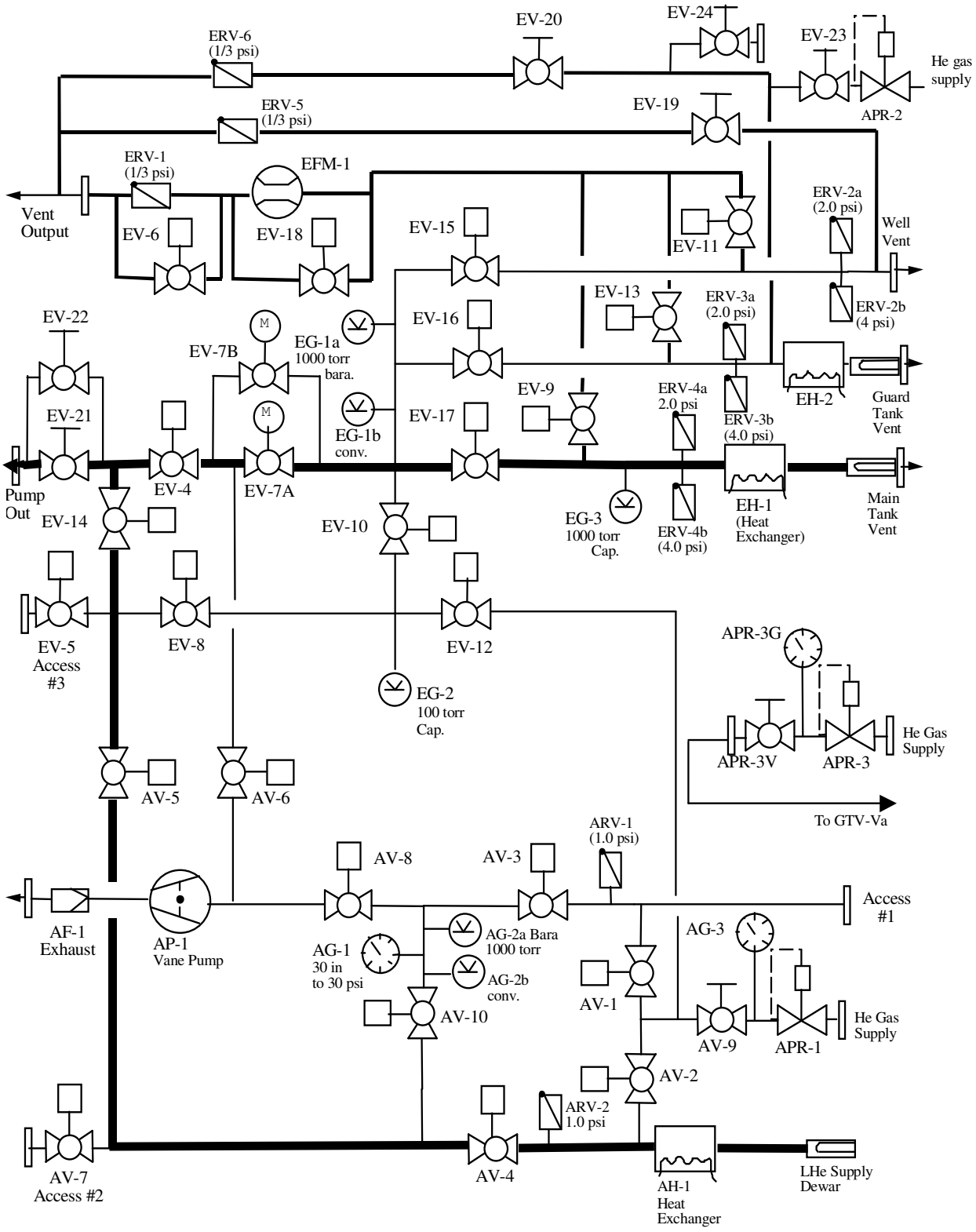

Figure 1. Schematic of Gas Module Plumbing.

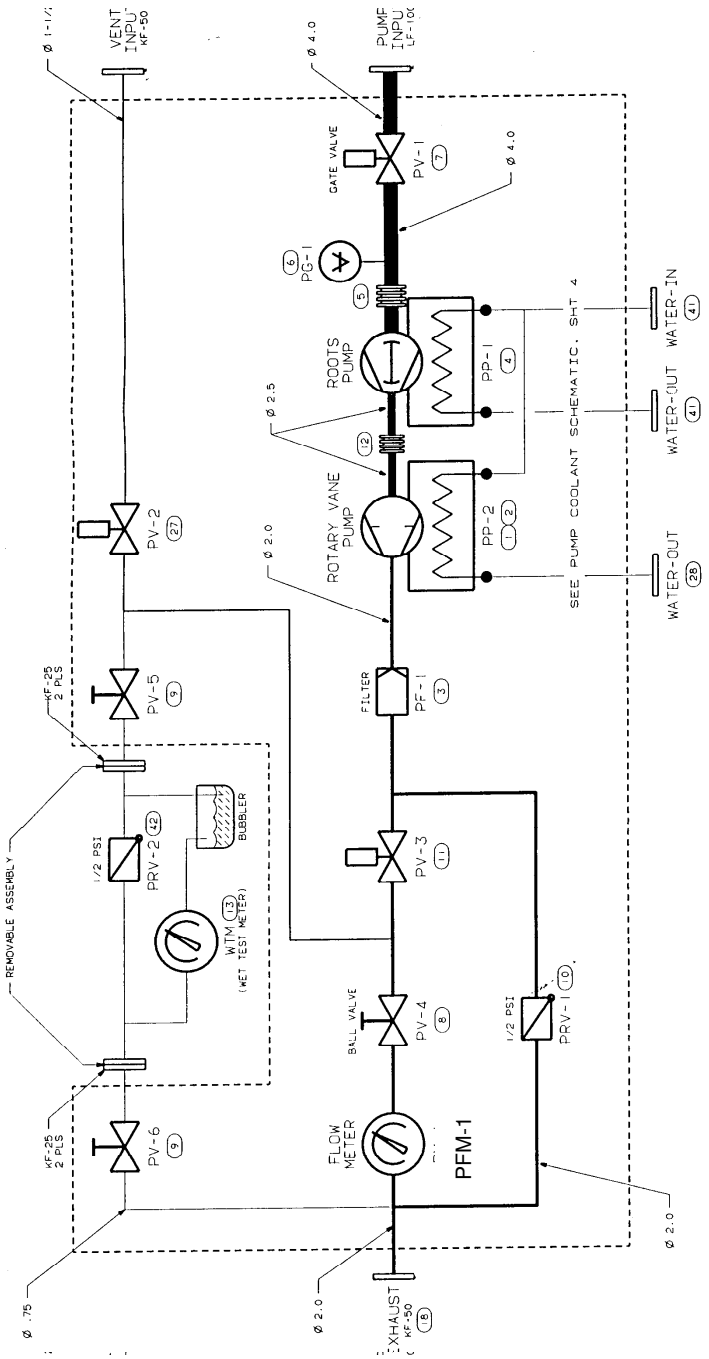

Figure 2. Schematic diagram of Pump Module plumbing.

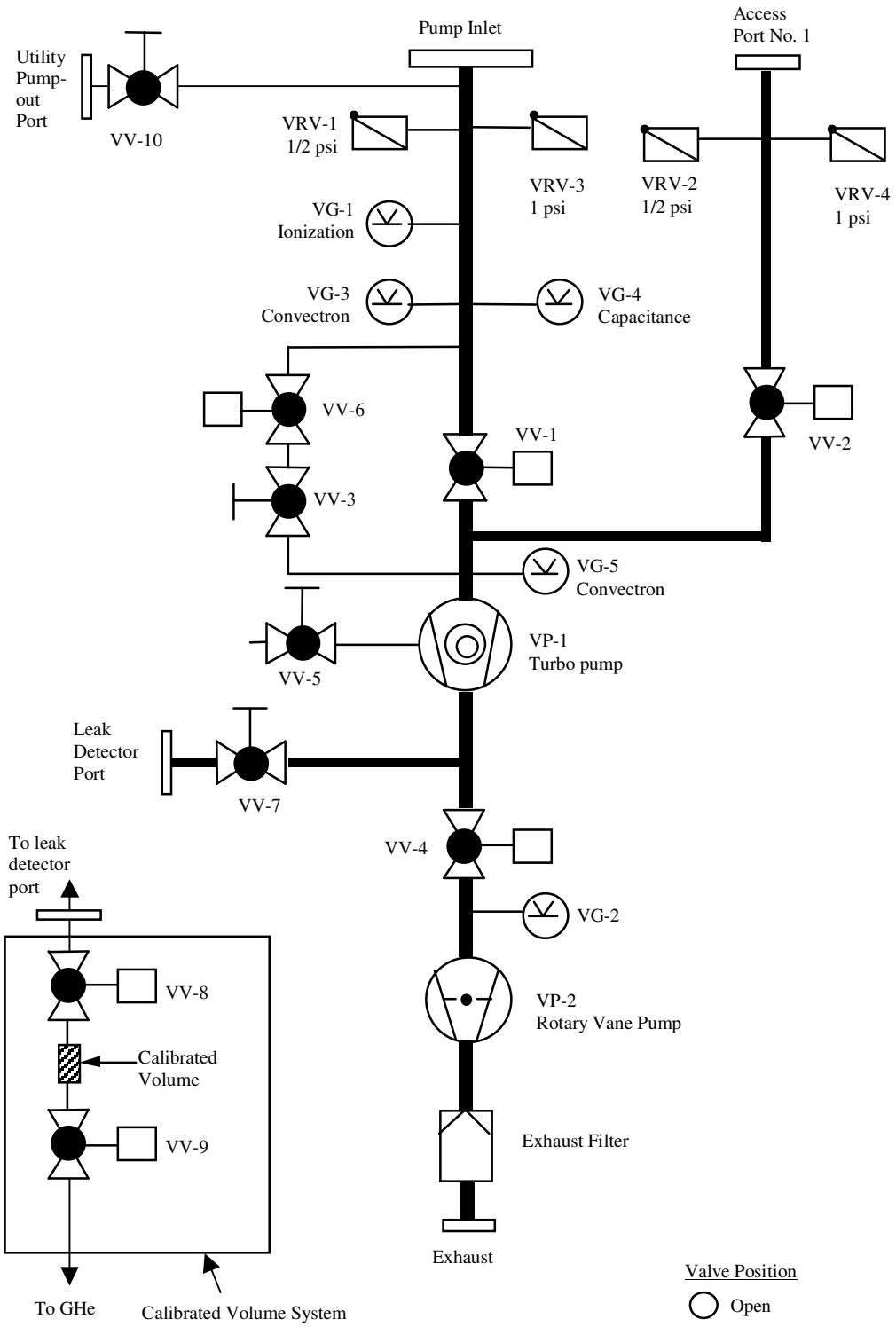

Figure 3. Schematic representation of Vacuum Module plumbing.

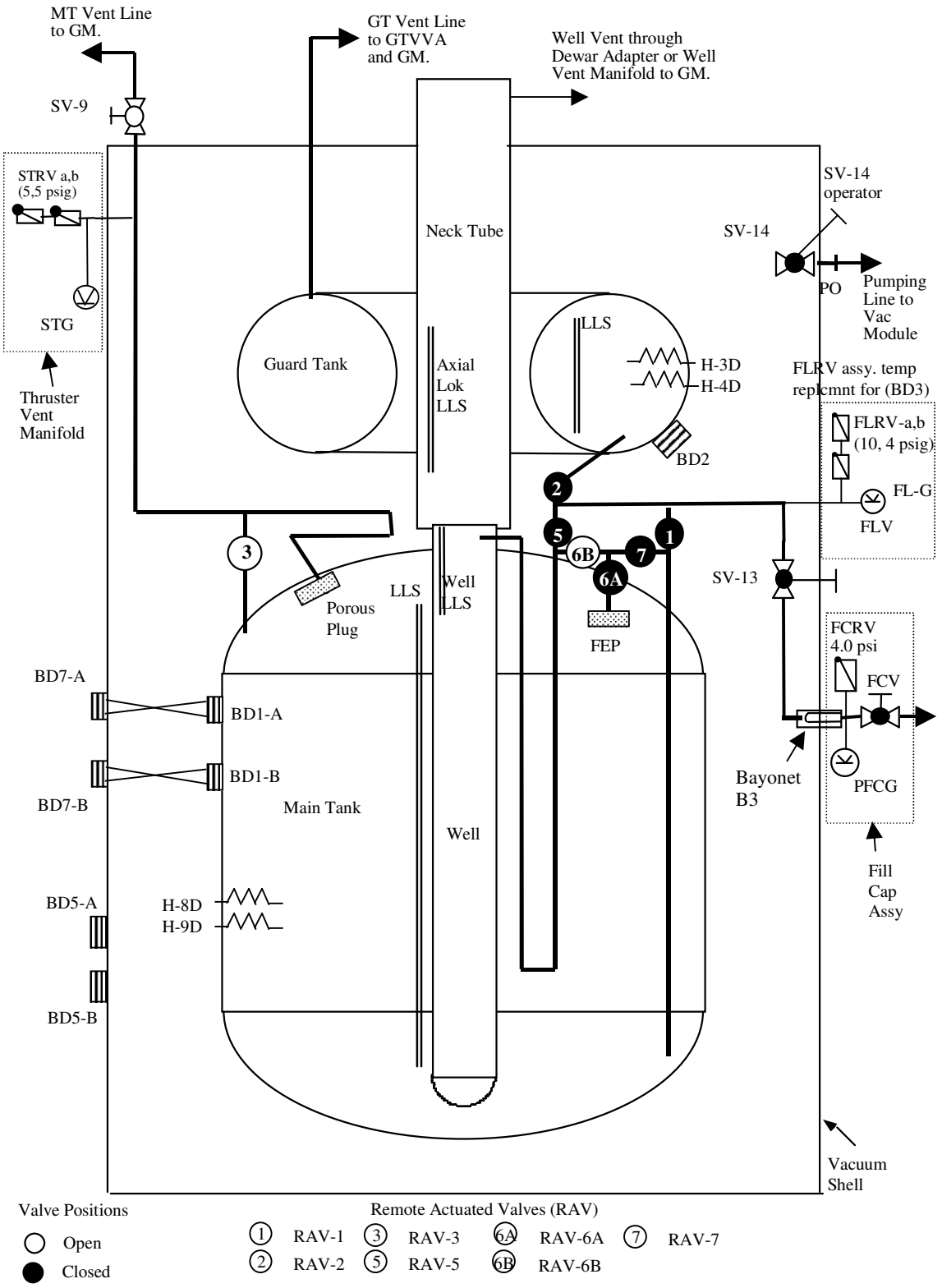

Figure 4. Schematic of Science Mission Dewar plumbing.

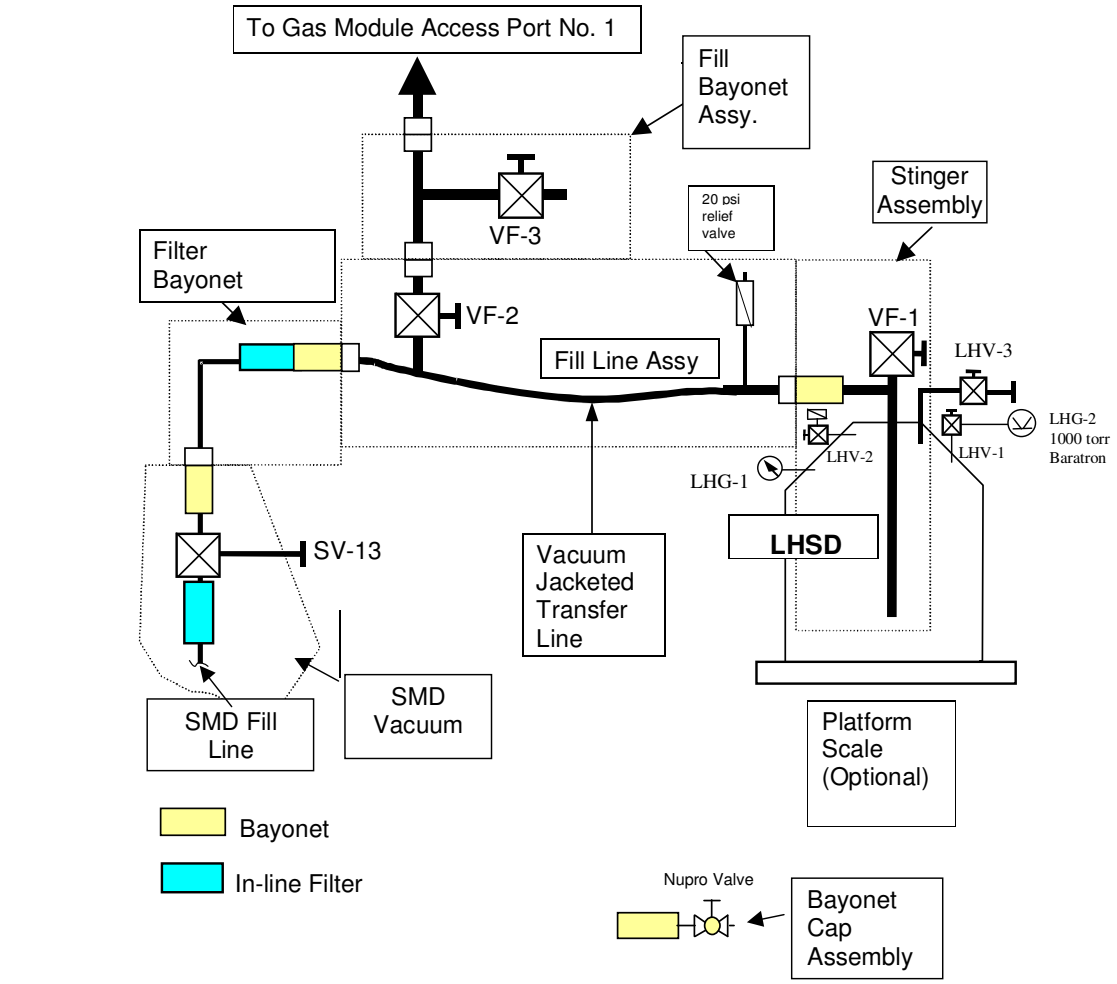

Figure 5 Schematic representation of LHSD and Transfer Line Plumbing

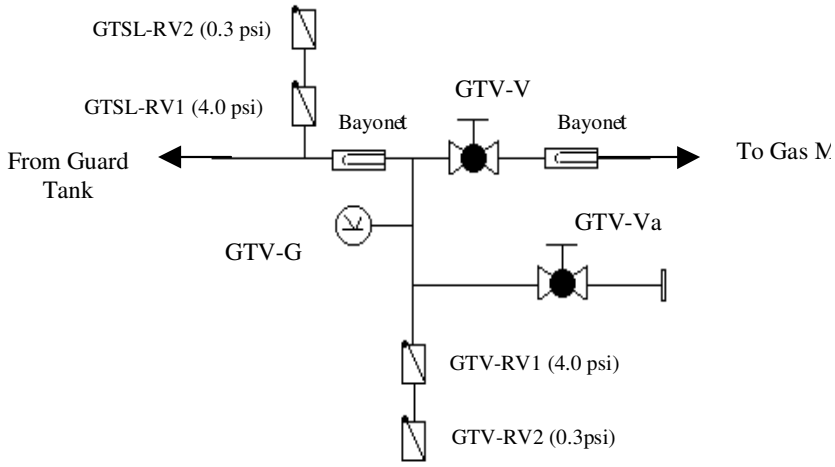

Figure 6. Guard Tank Vent Valve Assembly (GTVVA)