Operations No. ___________

GRAVITY PROBE B PROCEDURE FOR SCIENCE MISSION DEWAR

(PTP) Calibration of SMD Flow Meter

P0841 Rev -

May 22, 2001

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Revision Record

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-	-		May 25, 2001

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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 effects the calibration of the SMD flow meter using the cryogenic GSE. This is accomplished by operating the flow meter at various input heater power levels and for various rates of helium flow out of the main tank (see Fig. 4). The flow rates are changed by adjustment of the control valves, EV-7a/-7b.

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
LM **Call 117;** Stanford University **Call 9-911**

C. QUALITY ASSURANCE

C.1. QA Notification

The ONR representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

C.2. Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the PTD or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the PTD or QA Representative, experiment functionality may be affected.

C.3. Discrepancies

A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.

3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The Test Director is the designated signer for the “witnessed by” sign-off located at the end of each procedure. The person in charge of the operation (Test Director or Test Engineer) is to sign the “completed by” sign-off.

D.2. Personnel Qualifications

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the SMD operations. Test Engineers must have SMD Cryogenic operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

D.3. Qualified Personnel

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not involve operations with 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

Liquid helium for Guard Tank fillings is 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.	Loca-Tion	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 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 must start at SFHe temperatures of 1.7 to 1.8 K or less and be filled to a liquid level ≥ 90%. The actuator control valve for the Gas Module valve, EV-9, should be in the "Subatm He" position.

E.5.2 Guard Tank

The Guard Tank must contain liquid, and the level must be ≥ 20%.

E.5.3 Well

The Well may be connected to the UTS via the Well manifold and can be pumped to vacuum conditions

E.5.4 SMD Vacuum Shell

The Vacuum Shell pressure must be less than 5 x 10^{-5} torr. Procedure P0213 contains the steps for connecting to and pumping on the SMD vacuum shell and should be used it the pressure criterion is not met.

E.5.5 Alarm System

E.5.5.1 The DAS alarm system must be enabled and contain the following alarm set-points:

a. Station 200 temperature (CN 01) set at T ≤ 2.2 K.

b. Top of lead bag temperature set (CN 28) at T ≤ 2.2 K.

c. Relative Guard Tank Pressure (CN 46) set at ΔP ≥ 0.3 torr.

E.5.5.2 The Facility Main Alarm System must be armed.

E.5.6 GSE and Non-flight Hardware

E.5.6.1 The ion-pump magnet is installed.

E.5.6.2 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).

E.5.6.3 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.

E.5.6.4 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.

E.5.6.5 A relief valve assembly (FLRV) or flight-like burst disk is installed in place of the flight SMD fill-line burst disk (BD3).

E.5.6.6 The Fill Cap Assembly must be installed at SV-13.

E.5.6.7 The thruster vent port is flanged to a relief valve/pressure sensor assembly.

E.5.6.8 The heaters on the SMD top plate, SV-9, and Main Tank vent bayonet must be installed and operational.

E.5.6.9 The Pump Module must be connected to the Gas module at EV-21/22.

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 and is required whenever work is being performed above the SMD such that hard objects could be dropped and impact the SMD or Probe.

E.6.1 The high-vacuum pumping line may be connected between the SMD at SV-14 and the inlet port of the Vacuum Module and may 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.

E.7. Verification/Success Criteria

This procedure demonstrates the prelaunch hold time of the Main Tank and Guard Tank.

Paragraph No.(PLSE-12)	Specification/Requirement Title	Criterion
3.7.5.11.2	**Helium flow meter**	**A flow meter shall be provided for measuring the helium flow rate to the spacecraft thrusters while in orbit, to within +/- 5% of its true value.**

E.8. Payload Constraints and Restrictions

E.8.1 No Payload operations, which result in substantial heat dissipation in the Probe/SMD, e.g., temperature control operations, may be performed during this procedure.

E.8.2 Vacuum integrity of Probe must be maintained <5 E-6 torr level.

E.8.3 The Well vacuum must be at a low enough value such that main tank flow rate remains below approximately 3 slpm.

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
LMMC F277277v4.2	Science Payload Specification CDRL/PLSE-12

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 P0613	Repump Well with Probe Installed
SU/GP-B P0207B	External Guard Tank Fill

Operation Number: ____________
Date Initiated: ____________
Time Initiated: ____________

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- o Verify SU QA notified.
  Record: Individual notified __________________,
  Date/time ________/________.
- o Verify ONR representative notified.
  Record: Individual notified __________________,
  Date/time ________/________.

G.2. Verify Preliminary SMD and GSE Preparations Complete

G.2.1 Record Guard Tank liquid level ________ %, temperature [CN24] _______ K.

Ensure level ≥ 20 %. If necessary, perform procedure P0209B, "External Guard Tank Fill" to raise level and record:

Date ________ Procedure No. ________ and Op. No. ________

Liquid level ________ %

G.2.2 Record Main Tank liquid level ________ %, temperature [CN24] _______ K.

G.2.3 Verify relief assembly (FLRV) or flight-like burst disk installed on SMD fill line.

G.3. Verify Configuration Requirements

G.3.1 Verify ion-pump magnet installed.

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

G.3.3 Verify Main Tank vent line connected to Gas Module.

G.3.4 Verify Guard Tank vent line connected to Gas Module.

G.3.5 Verify actuator control valve for EV-9, located on Gas Module, set to "Subatm He" position.

G.3.6 Verify Pump Module connected to Gas Module at EV-21/22.

G.3.7 Verify Well pressure:

G.3.7.1 π Well is not being pumped:

Record for last performance of P0209, "Repump Well with Probe Installed", Operations No. __________,
Date performed _______, and measured PW-2 ______ torr.

G.3.7.2 π Well is being pumped:

Record PW-2 ______ torr.

G.3.8 Ensure DAS alarm system enabled and record set points.

G.3.8.1 **Station 200 temperature** – ensure CN [01] on DAS alarm list and set to alarm at T ≤ 6.5 K. Record set point. _________K

G.3.8.2 **Top of lead bag temperature** – ensure CN [28] on DAS alarm list and set to alarm at T ≤ 6.0 K. Record set point. _________K

G.3.8.3 **Relative Guard Tank Pressure** – ensure CN [46] on DAS alarm list and set to alarm at ΔP ≥ 0.3 torr. Record set point. ________torr

G.3.9 Ensure DAS watchdog timer and alarm enabled.

G.3.10 Ensure liquid-level alarms enabled and record set points.

G.3.10.1 **Main Tank** – ensure liquid-level alarm set ≥ 20%. Record set point. ______%

G.3.10.2 Guard Tank – ensure liquid-level alarm set ≥ 20%. Record set point. ______%

G.3.10.3 Ensure Facility Main Alarm System enabled.

G.3.11 Ensure Top-plate heaters on SMD are connected and on.

G.3.12 Valve configuration:

Open: EV-13, -17;	All other EVs closed
AV-6	All the AVs closed
PV-2, PV-4	All other PVs closed

AP-1 on, PP-1 and PP-2 off

Optional:

Open: VTH, All other TVs and VW-3 closed

G.3.13 If Well is open at VTH , record PW-2 _________ torr.

G.4. Record Initial Conditions

G.4.1 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 < 5 x 10^{-6} 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.

G.4.2 Record data in Table 2.

G.5. Set up Data Acquisition System

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

G.5.1 Set DAS to fast scan using [other menus] [data config] [fast scan].

G.5.2 Configure the DAS for the “Flow Meter Test” configuration under the [Data Configs] of the DAS program.

G.5.3 Set the Main Tank and Guard Tank liquid-level sensors to “off” and 10 minutes sampling intervals respectively.

G.5.4 Manually sample Main Tank level sensor for channel “A” and “B” and record: LLS “A” ____ %; LLS “B” ____ %; LLS average ____ %.

G.5.5 Verify plotter is set up to display the main tank temperatures and temperature rate of change and the flow meter temperatures and heater power.

G.5.6 Record the DAS software and version in use:

____

G.5.7 Record the DAS data file in use:

G.5.8 ________________________________

G.5.9 Connect/verify connected the A3 power supply output to the H5AD heater input using the three pin audio cables supplied with the DAS.

G.5.10 Set up special data cycle collection to record: CN05, CN01, CN28, CN 26 , CN27, CN69

G.6. Data Recording

G.6.1 In the following operations, record the data in Table 2.

G.6.2 Use [Get Data] of DAS to collect an initial hard copy of the data and attach to this procedure.

G.6.3 Adjust special data cycle interval to 0.5 min or less.

G.7. Verify RAV Configuration

G.7.1 Using RAV log book, verify:

Open: RAV-6B

Closed: RAV –1, -2, -5, -6A, -7

G.7.2 θ RAV-3 is closed; proceed with G.7.4

G.7.3 θ RAV-3 is open; close RAV-3 (flight configuration) as follows:

G.7.3.1 **Verify all** RAV selection switches are in the OFF position.

G.7.3.2 Turn on RAV power supply and adjust current limit to 1.85 amps.

G.7.3.3 Adjust power supply to 28 VDC.

G.7.3.4 Power up RAV controller No. 3.

G.7.3.5 Position selection switch to RAV-3.

G.7.3.6 Record initial switch status: Open: θ θ Closed: θ θ

G.7.3.7 Activate controller No. 1 and record:

a) run time: ______ seconds
b) current draw: ______ amp
c) Time of day: ______ .

G.7.3.8 Record final switch status: Open: θ θ Closed: θ θ

G.7.3.9 Turn RAV-3 selection switch to OFF.

G.7.3.10 Power off controller No 3.

G.7.3.11 Turn off RAV power supply.

G.7.4 Record operation in RAV log book

G.8. Flow Rate No. 1

G.8.1 Start with existing flow rate, WTM average readings:

G.8.1.1 Using long term plot, verify equilibrium conditions of temperature and flow exist.

G.8.1.2 Date/Time _________/_________

G.8.1.3 CN121 ___ slpm; CN122 ___ mg/s;

G.8.1.4 Flow Meter CN27 ____ K; Main Tank, bot CN09 ___ K; Top LB CN28 _______ K; S200 CN01 __________ K.

G.8.1.5 Execute DAS [GET DATA]

G.8.1.6 Record data in Table 2.

G.8.2 Flow Rate No. 1 / Heater Setting No. 1 - 35 mW

G.8.2.1 Adjust power supply A3 to give approximately 35 mW (R= 834 ohms) and record: _______ volt; _______ mW.

NOTE: The wattage used here is calculated by the DAS using the DMM voltage readings at the voltage leads of the heater and at the 0.1% resistor shunt in the current leads.

G.8.2.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.8.2.3 Record data in Table 2.

G.8.3 Flow Rate No. 1 / Heater Setting No. 2 - 50 mW

G.8.3.1 Adjust power supply A3 to give approximately 50 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.8.3.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.8.3.3 Record data in Table 2.

G.8.4 Flow Rate No. 1 / Heater Setting No. 3 - 100 mW

G.8.4.1 Adjust power supply A3 to give approximately 100 mW and record: _______ volt; _______ mW.

G.8.4.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.8.4.3 Record data in Table 2.

G.8.5 Flow Rate No. 1 / Heater Setting No. 4 - 0.0 mW

G.8.5.1 Adjust power supply A3 to 0.0 volts and record: ____0.0 volt; _______ mW.

G.8.5.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.8.5.3 Record data in Table 2.

G.9. **Flow Rate No. 2**

G.9.1 Increase flow by adjusting the position of EV-7a/-7b.

G.9.1.1 Using long term plot, verify equilibrium conditions of temperature and flow exist.

Note: The flow range of interest is 4 to 16 mg/s. Assuming flow rate No. 1 was in the neighborhood of 4 mg/s, the target flow rate here is in the neighborhood of 8 mg/s

G.9.1.2 Date/Time _________/_________

G.9.1.3 CN121 ___ slpm; CN122 ___ mg/s;

G.9.1.4 Flow Meter CN27 ____ K; Main Tank, bot CN09 ___ K;
Top LB CN28 _______ K; S200 CN01 __________ K.

G.9.1.5 Execute DAS [GET DATA]

G.9.1.6 Record data in Table 2.

G.9.2 Flow Rate No. 2 / Heater Setting No. 1 - 35 mW

G.9.2.1 Adjust power supply A3 to give approximately 35 mW (R= 834 ohms) and record: _______ volt; _______ mW.

NOTE: The wattage used here is calculated by the DAS using the DMM voltage readings at the voltage leads of the heater and at the 0.1% resistor shunt in the current leads.

G.9.2.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.9.2.3 Record data in Table 2.

G.9.3 Flow Rate No. 2 / Heater Setting No. 2 - 50 mW

G.9.3.1 Adjust power supply A3 to give approximately 50 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.9.3.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.9.3.3 Record data in Table 2.

G.9.4 Flow Rate No. 2 / Heater Setting No. 3 - 100 mW

G.9.4.1 Adjust power supply A3 to give approximately 100 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.9.4.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.9.4.3 Record data in Table 2.

G.9.5 Flow Rate No. 2 / Heater Setting No. 4 – 0.0 mW

G.9.5.1 Adjust power supply A3 to 0.0 volts and record: ____0.0 volt; _______ mW.

G.9.5.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.9.5.3 Record data in Table 2.

G.10. **Flow Rate No. 3**

G.10.1 Change flow rate

G.10.1.1 Increase flow by adjusting the position of EV-7a/-7b.

G.10.1.2 Using long term plot, verify equilibrium conditions of temperature and flow exist.

Note: The flow range of interest is 4 to 16 mg/s. Assuming flow rate No. 1 was in the neighborhood of 4 mg/s, the target flow rate here is in the of 12-16 mg/s

G.10.1.3 Date/Time _________/_________

G.10.1.4 CN121 ___ slpm; CN122 ___ mg/s;

G.10.1.5 Flow Meter CN27 ____ K; Main Tank, bot CN09 ___ K;
Top LB CN28 _______ K; S200 CN01 __________ K.

G.10.1.6 Execute DAS [GET DATA]

G.10.1.7 Record data in Table 2.

G.10.2 Flow Rate No. 3 / Heater Setting No. 1 - 35 mW (R= 834 ohms)

G.10.2.1 Adjust power supply A3 to give approximately 35 mW and record: _______ volt; _______ mW.

NOTE: The wattage used here is calculated by the DAS using the DMM voltage readings at the voltage leads of the heater and at the 0.1% resistor shunt in the current leads.

G.10.2.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.10.2.3 Record data in Table 2.

G.10.3 Flow Rate No. 3 / Heater Setting No. 2 - 50 mW

G.10.3.1 Adjust power supply A3 to give approximately 50 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.10.3.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.10.3.3 Record data in Table 2.

G.10.4 Flow Rate No. 3 / Heater Setting No. 3 - 100 mW

G.10.4.1 Adjust power supply A3 to give approximately 100 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.10.4.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.10.4.3 Record data in Table 2.

G.10.5 Flow Rate No. 3 / Heater Setting No. 4 – 0.0 mW

G.10.5.1 Adjust power supply A3 to 0.0 volts and record: ____0.0 volt; _______ mW.

G.10.5.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.10.5.3 Record data in Table 2.

G.11. **Flow Rate No. 4 (zero flow)**

G.11.1 Change flow rate

G.11.1.1 Close AV-6: Main Tank flow goes to zero.

G.11.1.2 Using long term plot, verify equilibrium conditions of temperature and flow exist.

G.11.1.3 Date/Time _________/_________

G.11.1.4 CN121 ___ slpm; CN122 ___ mg/s;

G.11.1.5 Flow Meter CN27 ____ K; Main Tank, bot CN09 ___ K; Top LB CN28 _______ K; S200 CN01 __________ K.

G.11.1.6 Execute DAS [GET DATA]

G.11.1.7 Record data in Table 2.

G.11.2 Flow Rate No. 4 / Heater Setting No. 1 - 35 mW

G.11.2.1 Adjust power supply A3 to give approximately 35 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.11.2.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.11.2.3 Record data in Table 2.

G.11.3 Flow Rate No. 4 / Heater Setting No. 2 - 50 mW (R= 834 ohms)

G.11.3.1 Adjust power supply A3 to give approximately 50 mW and record: _______ volt; _______ mW.

G.11.3.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.11.3.3 Record data in Table 2.

G.11.4 Flow Rate No. 4 / Heater Setting No. 3 - 100 mW

G.11.4.1 Adjust power supply A3 to give approximately 100 mW (R= 834 ohms) and record: _______ volt; _______ mW.

G.11.4.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]

b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.11.4.3 Record data in Table 2.

G.11.5 Flow Rate No. 4 / Heater Setting No. 4 – 0.0 mW

G.11.5.1 Adjust power supply A3 to 0.0 volts and record:
____0.0 volt; _______ mW.

G.11.5.2 When temperature equilibrium at T18D (CN26) is reached:

a. Do a [Get Data]
b. Record WTM flow rate: _____ slpm; ______ mg/sec

Time ________

G.11.5.3 Record data in Table 2.

G.11.6 **Open AV-6**

G.11.7 Adjust EB-7a/-7b as required for temperature stability.

G.12. Establish Final Configuration

G.12.1 Record Date/Time _______ / _______ .

G.12.2 Input comment to DAS "End of Flow Meter Test"

G.12.3 Verify valve configuration:

Open: EV-13, -17;	All other EVs closed
AV-6	All other AVs closed
PV-2, PV-4	All other PVs closed

AP-1 on, PP-1 and PP-2 off

Optional (if VTH is open)

Open: VTH	VW-3 closed.

G.12.4 If VTH of Well is open record PW-2 _________ torr.

G.12.5 Adjust RAV Configuration

G.12.5.1 Using RAV log book, verify:

Open: RAV-6B

Closed: RAV –1, -2, -5, -6A, -7

G.12.6 θ RAV-3 to remain closed; proceed with G.7.4

G.12.7 θ RAV-3 is to be opened as follows:

G.12.7.1 **Verify all** RAV selection switches are in the OFF position.

G.12.7.2 Turn on RAV power supply and adjust current limit to 1.85 amps.

G.12.7.3 Adjust power supply to 28 VDC.

G.12.7.4 Power up RAV controller No. 3.

G.12.7.5 Position selection switch to RAV-3.

G.12.7.6 Record initial switch status: Open: θ θ Closed: θ θ

G.12.7.7 Activate controller No. 1 and record:

a) run time: _______ seconds
b) current draw:_______ amp
c) Time of day: _______ .

G.12.7.8 Record final switch status: Open: θ θ Closed: θ θ

G.12.7.9 Turn RAV-3 selection switch to OFF.

G.12.7.10 Power off controller No 3.

G.12.7.11 Turn off RAV power supply.

G.12.8 Final RAV configuration:

G.12.8.1 θ RAV-3 is closed.

G.12.8.2 θ RAV-3 is open.

G.12.8.3 And:

Open: RAV-6B

Closed: RAV –1, -2, -5, -6A, -7

G.12.9 Verify/set the DAS data cycle to 15 minutes.

G.12.10 Stop Special Data collection using [other menus] [special data], [stop special data].

G.12.11 Set DAS to normal scan using [other menus], [data config], [normal scan].

G.12.12 Verify all operating liquid level sensors have sampling intervals of 10 minutes.

G.12.13 Ensure DAS alarm enabled and record set points if changed

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

a. Station 200 set point [CN 1] _________ K (≤ 2.2 K)

b. Top of Lead Bag set point [CN 28] _________ K (≤ 2.2 K)

c. Guard Tank, GTVG _________ torr (>0.3 torr)

G.12.14 Ensure DAS watchdog timer and alarm enabled.

G.12.15 Options:

- π Continue pumping Well under control of P0613B.
- π Close out pumping Well, perform final sections of P0613B.
- π Continue with Well manifold: VTH open VW-3 closed.
- π Continue with Well locked up: VTH closed; VW-3 closed.

H. PROCEDURE COMPLETION

Completed by:______________________

Witnessed by:______________________

Date: __________

Time:__________

Quality Manager____**Date**________

Payload Test Director_______________________________________**Date**________

Table 2a Flow Meter Data

Date/ Time	Comments	Main Tank LHe level CN101 %	T.V+Atm CN140 torr	Main Tank Press EG-2 CN114 torr	Thruster Vent CN49 torr	EV-7a/7b Position %/%	Vac Ion Pump press CN99 torr	GT press GTV_G CN46 torr	Flow rate PFM-1 CN110 Ll/hr
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Table 2b Flow Meter Data

Date/ Time	Flow Meter/a T18D [CN 26] K	Flow Meter/b T18D [CN 27] K	Top of Lead bag [CN 28] K	Main Tank Top [CN 20] K	MT Bottom T09D [CN09] K	GT Bottom [CN 24] K	HEX-1 T04D [CN 04] K	Slope of MT Bot [CN 141] K	Calc(Tave) Slope [CN28] K				

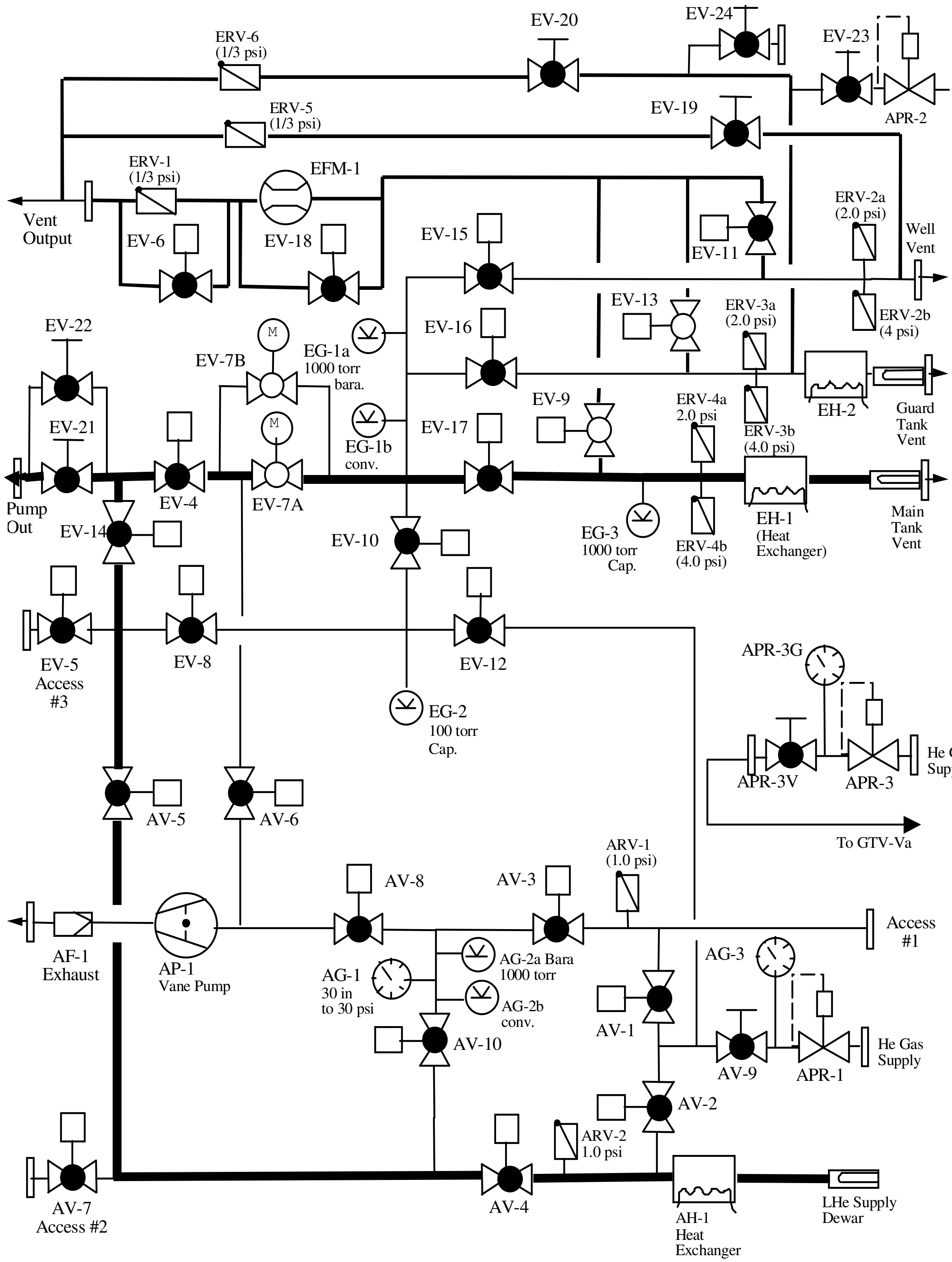

Figure 1. Schematic of Gas Module Plumbing.

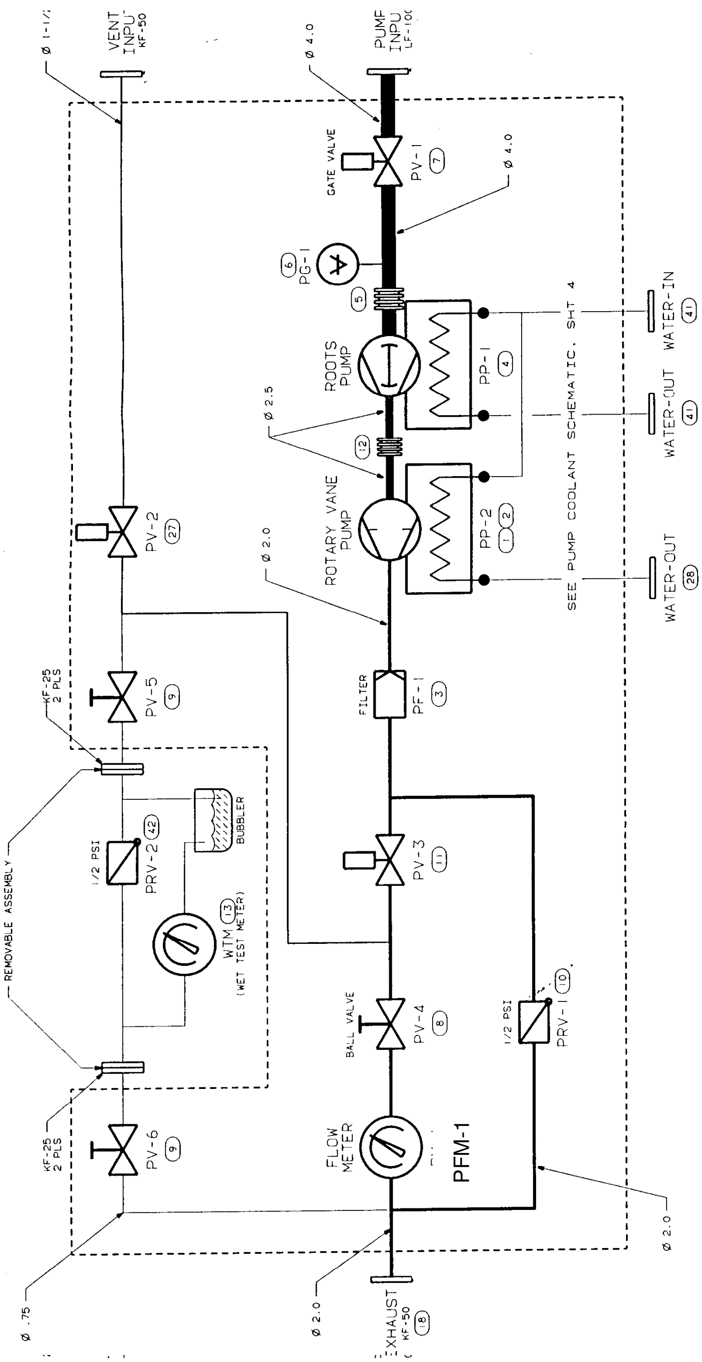

Figure 2. Schematic of Pump Module plumbing.

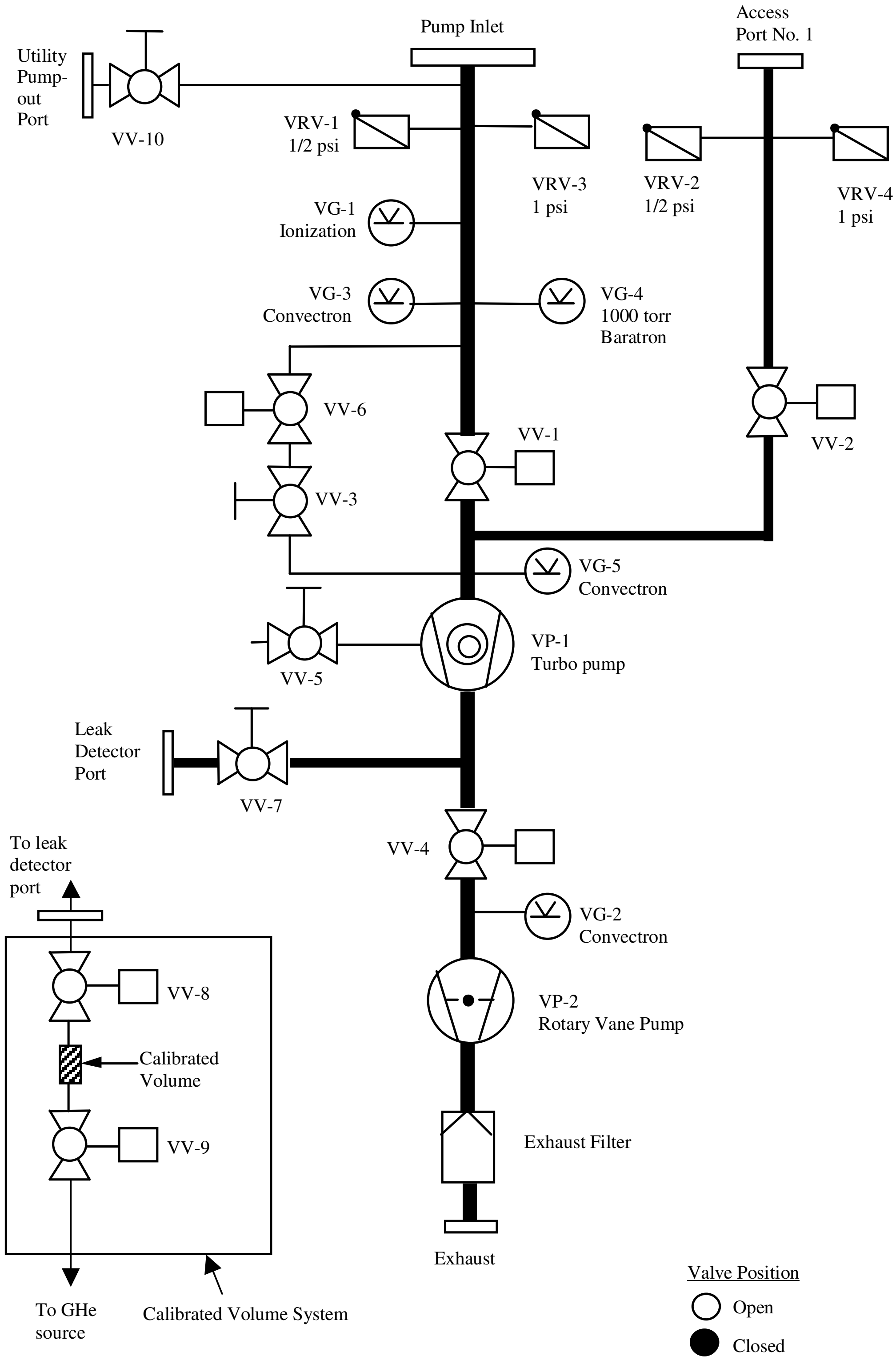

Figure 3 Schematic diagram of Vacuum Module

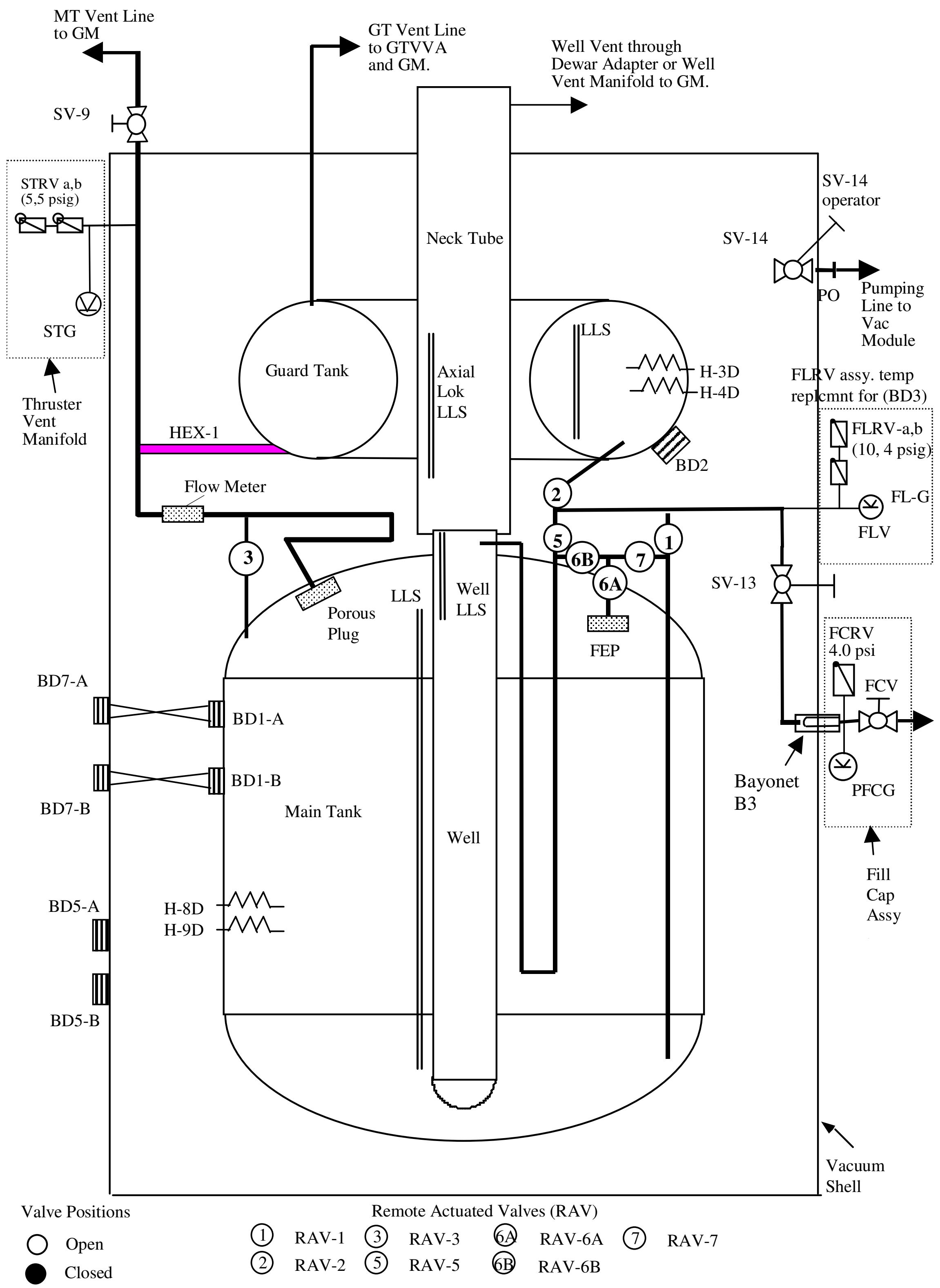

Figure 4. Schematic of Science Mission Dewar plumbing.