GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

EMPTY THE GUARD TANK

P0212B
ECO 1090

July 18, 2000

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Revision Record

REVISION	ECO	PAGES	DATE
A	772	Updated Equipment Pretest Requirements, section E. Revision incorporates the new Guard Tank vent path through EV-20 (by-pass mode), section G.2.1.1. Added section G.5 for checking final configuration. Expand alarm setting G.6.7, G.6.8, and G.6.9. Update figure 1. Added data record requirement, G.4.5 and Data Sheet 1	4/30/98
B	1090	Changed title to *Empty the Guard Tank*. Section A – Revised scope to include pumping on the SMD vacuum shell during Guard Tank depletion and to regulate GT pressure with independent source of He gas following depletion. Section B – Divided into two sections, addressing safety issues (new Section B) and test personnel (new Section D). Reorganized safety paragraphs into: hazards, mitigation, injuries. Content of both new sections essentially unchanged. Added Quality Assurance Section (new Section C) Section C, D, and E – Consolidated all requirements into new Section E entitled Requirements. Added Configuration requirements, GSE/SMD interface requirements, alarm setup requirements, vacuum requirements, and non-flight hardware requirements. Section G.1 Added section to verify notification of QA. Section G.2 – Added steps to verify configuration requirements and alarm setup. Added GT to level alarm list (setpoint = 10%) Section G.3 – Added section to verify Gas Module in Standard Configuration. Added caution to monitor and maintain positive pressure Guard Tank pressure at end of procedure by regulating pressure with independent source of helium gas.	

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
Aux	Auxiliary
AV-x	Valve x of Gas Module auxiliary section
Bot	Bottom
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
Liq	Liquid
LL	Liquid level
LLS	Liquid level sensor
LMMS	Lockheed Martin Missiles and Space
LMSC	Lockheed Missiles and Space 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 required to empty the Guard Tank. The steps include:

Pump on SMD Vacuum Shell with Vacuum Module

Ensure Guard Tank venting in parallel (i.e., bypass mode) with the Main Tank

Turn on Guard Tank heater

Boil liquid away

Turn off Guard Tank heater

Establish independent regulation of Guard Tank pressure.

The procedure can be performed when the Main Tank is at NBP or when it is subatmospheric. In either case, the Main Tank may be connected to or disconnected from the Gas Module. The Well may contain liquid or be evacuated.

B. SAFETY

B.1. Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware. Examples include: positioning Dewar in tilt stand; integrating probe with airlock; positioning airlock on Dewar; removing airlock from Dewar; removing probe from Dewar; and positioning support equipment such as pressurized gas cylinders and supply dewars.

A number of undesired events may be associated with these operations. For example, personnel or equipment can be struck when hardware is being moved (e.g. by forklift or crane load). Personnel are subject to entrapment while positioning hardware, such as hands or feet caught between objects as hardware is moved into place. Suspended hardware may be dropped. Personnel can be caught between objects such as forklifts and walls or loads and building support columns.

In addition, liquid helium used in the SMD represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C discusses the safety design, operating requirements and the hazard analysis of the SMD.

B.2. Mitigation of Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

The FIST OPS laboratory has an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent line deflectors are installed over the four burst disks on the SMD vacuum shell, and oxygen collection pans are on the floor beneath them.

The following requirements apply to personnel involved in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing and full-face shields are to be worn whenever the possibility of splashing cryogens exists.

The FIST Emergency Procedures document, SU/GP-B P0141, discusses emergency procedures. These documents should be reviewed for applicability at any facility where the hardware is operated.

B.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.

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, and provides remote control of valves in the Gas Module, Pump Module, and SMD. The Vacuum Module contains a turbo pump, backed by a vane pump, and provides the capability to pump out the SMD vacuum shell.

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

E.3.3. Computers and Software:

The Data Acquisition System (DAS) and data acquisition software are required for this procedure. The DAS reads and displays pressures, temperatures, and flow rates and monitors critical parameters. No additional computers or software are required.

E.3.4. Additional Test Equipment

No Additional test equipment is required

E.3.5. Additional Hardware

No additional hardware is required.

E.3.6. Tools

No tools are required.

E.3.7. Expendables

No expendables are required.

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, 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	LLS Main	96-409-11	No	-

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		American Magnetics, Inc. 136	Tank			
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

Liquid in the Main Tank may be at its normal boiling point (NBP) or subatmospheric.

E.5.2. Guard Tank

There is no requirement on the Guard-Tank liquid level.

E.5.3. Well

The Well may contain liquid or be evacuated. If it contains liquid, the level Must be > 20%.

E.5.4. SMD Vacuum Shell

The Vacuum Shell must be actively pumped during this procedure. The ion pump (IP) pressure should be less than 5×10^{-5} torr at all times.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
   a. Station 200 temperature (CN 01) set at $T \leq 6.5$ K.
   b. Top of lead bag temperature set (CN 28) at $T \leq 6.0$ K.
   c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.
2. The Facility Main Alarm System must be armed.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet must be 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 Guard Tank vent line must be connected to the Gas Module with a vacuum insulated line (P/N 5833813). Document No. P0676, Connect Guard Tank Vent Line to Gas Module, contains the procedures for connecting the Guard Tank vent line.
4. The high vacuum pumping line must be connected to the Vacuum shell pump out port at SV-14 and to the Vacuum Module The Vacuum Module pumps must be actively pumping the vacuum shell. Procedure P0213 describes the steps for connecting to and pumping on the SMD vacuum shell.

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

The following non-flight modifications of the basic SMD and optional GSE configurations are incidental to the performance of this procedure. Any combination represents an acceptable configuration.

1. The SMD is installed in its transportation and test fixture.
2. A relief valve is installed in place of the SMD fill-line burst disk.
3. A foreign object and debris shield covers the upper cone of the SMD.
4. 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.
5. A Dewar Adapter, Shutter, and Shutter Cover are mounted to the Well of the SMD when the Probe is removed
6. The Main Tank vent line may be connected to the Gas Module, or it may be disconnected and terminated at a Vent Cap.
7. The Well often contains liquid. When it does, it vents through the Gas Module unless Well operations are being performed (e.g., Probe or magnetometer insertion). Venting through the Gas module is accomplished via a pumping line attached to the Dewar Adapter interface flange at the Airlock Support Plate (Probe not installed), or via a pumping line attached to

the Well vent manifold installed at the Well pump-out port (Probe installed). When performing Well operations.

8. The thruster vent port is flanged to a shut-off valve.
9. The Fill Cap Assembly is installed at SV-13.

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 P0210	*Internal Main Tank to Well Transfer*
SU/GP-B P0213	*Connect Vacuum Module / Pump on SMD Vacuum Shell*
SU/GP-B P0676	*Connect Guard Tank Vent Line to Gas Module*

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 _____/_____.

CAUTION
Be aware that if the Main Tank is subatmospheric, it will be necessary to warm it up to NBP before the Guard Tank can be refilled.

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 DAS alarm system enabled and record set points.

1. ***Station 200 temperature*** – verify CN [01] on DAS alarm list and set to alarm at $T \leq 6.5$ K.
   Record set point. _____K
2. ***Top of lead bag temperature*** – verify CN [28] on DAS alarm list and set to alarm at $T \leq 6.0$ K.
   Record set point. _____K
3. ***Relative Guard Tank Pressure*** – verify CN [46] on DAS alarm list and set to alarm at $\Delta P \geq 0.3$ torr.
   Record set point. _____torr

G.2.4. Ensure liquid-level alarms enabled and record set points.

1. ***Main Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _____ %
2. ***Well*** – If there is liquid in the Well, ensure liquid-level alarm set ≥ 20%, . Record set point. _____ %

G.2.5. Verify the Vacuum Module is connected to the SMD vacuum shell pump- out port at SV-14 and is actively pumping on the vacuum shell. If not, perform Procedure P0213 Connect Vacuum Module / Pump on SMD Vacuum Shell, and record Operation Number _____..

G.2.6. Verify ion-pump magnet installed.

G.2.7. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.8. Verify Guard Tank vent line connected to Gas Module. If not, perform procedure P0676, Connect Guard Tank Vent Line to Gas Module, and record operation number _____.

G.3. Record Initial Configuration

G.3.1. Record SMD vacuum shell pressure as follows:

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

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] for CN 99.
3. When value is steady, record pressure (IP) _____ torr.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.3.2. Set GSE valves as indicated in following Table. Record configuration in left-hand column, then place or ensure corresponding valve states as indicated.

Configure Initial Valve States		
	Verify Open	***Verify Closed***
1. Main Tank vent connected to GM		
o Liquid at NBP	EV-7a/b, EV-9, EV-16 PV-2, PV-4 SV-9	EV-4, EV-5, EV-6, EV-8, EV-10, EV-11, EV-12, EV-14, EV-15, EV-17, EV-18, EV-21/22 All AV valves PV-1, PV-3, PV-5, PV-6
o Liquid subatmospheric: Pumping w/ AP-1	EV-7a/b, EV-10, EV-17, AV-6 PV-2, PV-4 SV-9	EV-4, EV-5, EV-6, EV-8, EV-9, EV-11, EV-12, EV-14, EV-15, EV-16, EV-18, EV-19, EV-21/22 All AV valves except AV-6 PV-1, PV-3, PV-5, PV-6
o Liquid subatmospheric Pumping w/ PP-1/PP-2	EV-4, EV-7a/b, EV-10, EV-17, EV-21/22, PV-1, PV-2, PV-3, PV-4 SV-9	EV-5, EV-6, EV-8, EV-9, EV-11, EV-12, EV-14, EV-15, EV-16, EV-18 EV-19 All AV valves PV-5, PV-6
2. Main Tank ***not*** connected to GM		
o Liquid at NBP	EV-7a/b, EV-16 SV-9, MTVC-Va PV-2, PV-4	EV-4, EV-5, EV-6, EV-8, EV-9, EV-10, EV-11, EV-12, EV-14, EV-15, EV-17, EV-18, EV-21/22 All AV valves PV-1, PV-3, PV-5, PV-6 MTVC-V
o Liquid subatmospheric	EV-7a/b, PV-2, PV-4	EV-4, EV-5, EV-6, EV-8, EV-9, EV-10, EV-11, EV-12, EV-14, EV-15, EV-16, EV-17, EV-18, EV-19, EV-21/22 All AV valves PV-1, PV-3, PV-5, PV-6 SV-9, VCV-1, VCV-2
3. Guard Tank vent connected to GM		
o With liquid in common manifold	EV-13, GTV-V	EV-20, EV-23, GTV-Va
o With liquid in bypass	EV-20, GTV-V	EV-13, EV-23, GTV-Va

G.3.3. Only if liquid in Well, verify EV-19 open.

G.3.4. Record Main Tank temperature CN [09] _____ K.

G.3.5. If liquid in Well record pressure (PW-1/PW-2) _____ oz/in2/ torr.

G.3.6. Record liquid helium levels as appropriate

1. ***Main Tank*** _____%
2. ***Well*** – If liquid in Well verify level > 20%. If not perform procedure P0210 and record Operation No. _____. _____%
3. ***Guard Tank*** _____%
4. ***Axial Lock*** _____%

G.4. **Verify Set-Up to Regulate Guard Tank Pressure**

CAUTION
Following the completion of this procedure, the Guard Tank pressure may sink below atmospheric pressure. To minimize the chance of plugging the vent line, the Guard Tank pressure must be independently regulated and maintained at a value greater than atmospheric pressure.

G.4.1. Verify EV-23 closed

G.4.2. Verify He gas supply connected from APR-2 to EV-23, ____yes ____no.

G.4.3. If yes, adjust APR-2 to regulate at 1.0 psig and skip to G.5

G.4.4. If no, connect He gas supply from APR-2 to EV-23 as follows:

1. Connect/verify connected pressurizing line to EV-23.
2. Back off/verify backed off APR-2 (pressure at APR-2 should read 0.0 psig).
3. Disconnect copper line from APR-2.
4. Start slow purge through APR-2.
5. Open EV-23 just enough to allow slow purge.
6. Connect line from EV-23 to APR-2 while purging through both valves.
7. Close EV-23.
8. Adjust APR-2 to regulate at 1.0 psig.

G.5. **Set up Data Acquisition**

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

G.5.1. Set the Guard Tank liquid level sampling interval to 1 minute.

G.5.2. Change DAS configuration to “config 4o” using [other menus] +[data config] + [change config], then select item “16” and choose “enter” following query.

G.5.3. Initiate special data collection: [other menu] + [special data col] + [use pre-selected] + [init. collection], then choose enter following query “Enter, L, I, N, or S.”.

G.5.4. Input comment to DAS “Start Depletion of Guard Tank”.

G.6. **Deplete Guard Tank**

Caution
This procedure calls for heating the Guard Tank. Under no circumstances is this to be done while the Guard Tank vent is manifolded with the Main Tank vent.

G.6.1. Place Guard Tank in bypass mode

1. Close/verify closed EV-13
2. Open/verify open EV-20

G.6.2. Verify Guard Tank heaters H-3D and H-4D connected to power supply A outputs #1 and #2.:

1. Verify A1 connected to H-3D in DAS patch panel.
2. Verify A2 connected to H-4D in DAS patch panel.

G.6.3. Turn on Guard Tank Heater H-3D, using power supply A output #1:

1. Set power supply current limit to 0.07 amp.
2. Set voltage of heater H-3D to 50 Vdc and record:
   a. Time of Day: _____
   b. V: _____ Vdc and I: _____ a

G.6.4. **(Optional)** Turn on Guard Tank Heater H-4D, using power supply A output #2:

1. Set power supply current limit to 0.07 amp.
2. Set voltage of heater H-4D to 50 Vdc and record:
   a. Time of Day: _____
   b. V: _____ Vdc and I: _____ a

G.6.5. Turn on Guard Tank vent-line heat exchanger (EH-2).

G.6.6. Record data in attached Data Sheet every 10 minutes. Rising CN [24]

will indicate Guard Tank is depleted.

G.6.7. When Guard Tank liquid level sensors read zero:

1. Record time of day:_____
2. Record Guard Tank temp. (T-15D):_____ K
3. Turn off Guard Tank liquid Level Sensor.

G.6.8. When Guard Tank temperature CN [24] rises above 4.5K record:

1. Time of day:_____
2. Guard Tank temp. CN [24]:_____ K
3. Guard Tank pressure (GTV-G) _____ torr (relative to atm.).
4. Vacuum Module pressure (VG-1):_____ torr.

G.6.9. Close EV-20.

G.7. **Regulate Guard Tank Pressure**

G.7.1. Continue to heat Guard Tank, closely monitoring temperature and pressure. Record data in Table 1.

Table 1

Time	GTV-G Endevco CN [46] (torr diff)	GT Temp. CN [24] (K)	GT Temp CN [08] (K)	Comments

G.7.2. When Guard Tank pressure reaches 50 torr above atmospheric pressure (i.e., GTV-G reads 50 torr.) open EV-23.

G.7.3. Turn off power supply to Guard Tank heater(s).

G.7.4. Turn off Guard Tank vent-line heat exchanger (EH-2).

G.8. **Establish Final Configuration of Dewar and GSE**

G.8.1. Verify EV-23 open.

G.8.2. Verify closed EV-13 and EV-20.

G.8.3. Only if Main Tank at NBP, ensure that EV-15, -17 are closed and open EV-16.

G.8.4. Record the final liquid levels as appropriate:

1. ***Main Tank*** level (LL-1D or LL-2D) _____ %
2. ***Well*** level (LL-3D or LL-4D) _____ %
3. ***Axial Lock*** level (LL-7D or LL-8D) _____ %

G.8.5. Record the following pressures:

1. Main Tank pressure
   a. Main Tank at NBP (EG-3) _____ torr.
   b. Main Tank subatmospheric (EG-2) _____ torr.
2. Vacuum Module pressure (VG-1): _____ torr

G.9. **Configure DAS and Liquid Level Sensor Sampling Interval**

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

G.9.1. Input comment to DAS “End Depletion of Guard Tank”.

G.9.2. Set the DAS data cycle to 15 minutes.

G.9.3. End special data collection.

G.9.4. Change DAS configuration to “config 4m” using [other menus] +[data config] + [change config], then choose “enter” following query.

G.9.5. Confirm that Guard Tank liquid level sensor is off.

G.9.6. Confirm that power to Vac-Ion pump is off.

G.9.7. Ensure that Guard Tank vent-line heat exchanger is off.

G.9.8. Ensure that Guard Tank heaters are off.

G.9.9. Verify 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.9.10. Verify liquid level sensor alarms enabled on Main Tank and Well, if appropriate, and record set points if changed.

1. ***Main Tank*** Level Set Point_____
2. ***Well*** Level Set Point_____

CAUTION

Monitor and maintain positive pressure in the Guard Tank. Following the completion of this procedure, the Guard Tank pressure may sink below atmospheric pressure. To avoid this, the Guard Tank pressure is independently regulated and must be continuously monitored. Verify that the Guard Tank pressure is on the DAS alarm list and set to alarm at 0.3 torr differential.

G.9.11. Verify Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.9.12. Continue to pump on SMD vacuum shell for 24 hours, recording data in attached Data Sheet.

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Data Sheet

Date Time	Sta. 200 T-1D [1] (K)	Lead bag top T-20D [28] (K)	G.T. bottom T-15D [24] (K)	HX-4 T-08D[8] (K)	M.T. bottom T-9D [9] (K)	Vac-Ion Pump (torr)	Gas Module HX (^{o}C)	Guard Tank Liquid He LL-5, -6D (%)	Dewar Adapter (^{o}C)

Data Sheet

Date Time	Sta. 200 T-1D [1] (K)	Lead bag top T-20D [28] (K)	G.T. bottom T-15D [24] (K)	HX-4 T-08D[8] (K)	M.T. bottom T-9D [9] (K)	Vac-Ion Pump (torr)	Gas Module HX (^{o}C)	Guard Tank Liquid He LL-5, -6D (%)	Dewar Adapter (^{o}C)

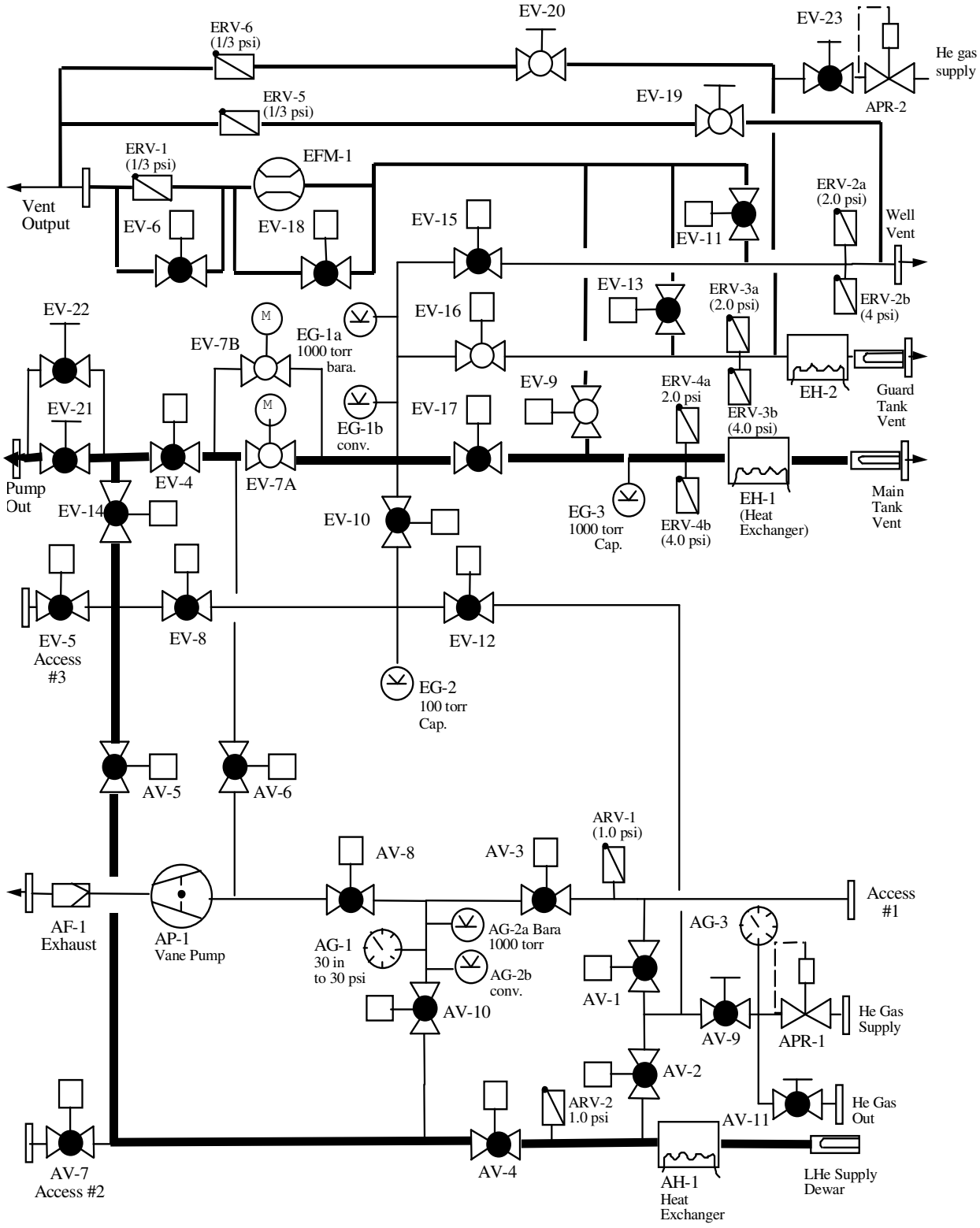

Figure1. Schematic of Gas Module Plumbing. The valve configuration corresponds to the standard bypass configuration with the Main Tank (at NBP), Guard Tank, and Well each venting independently.

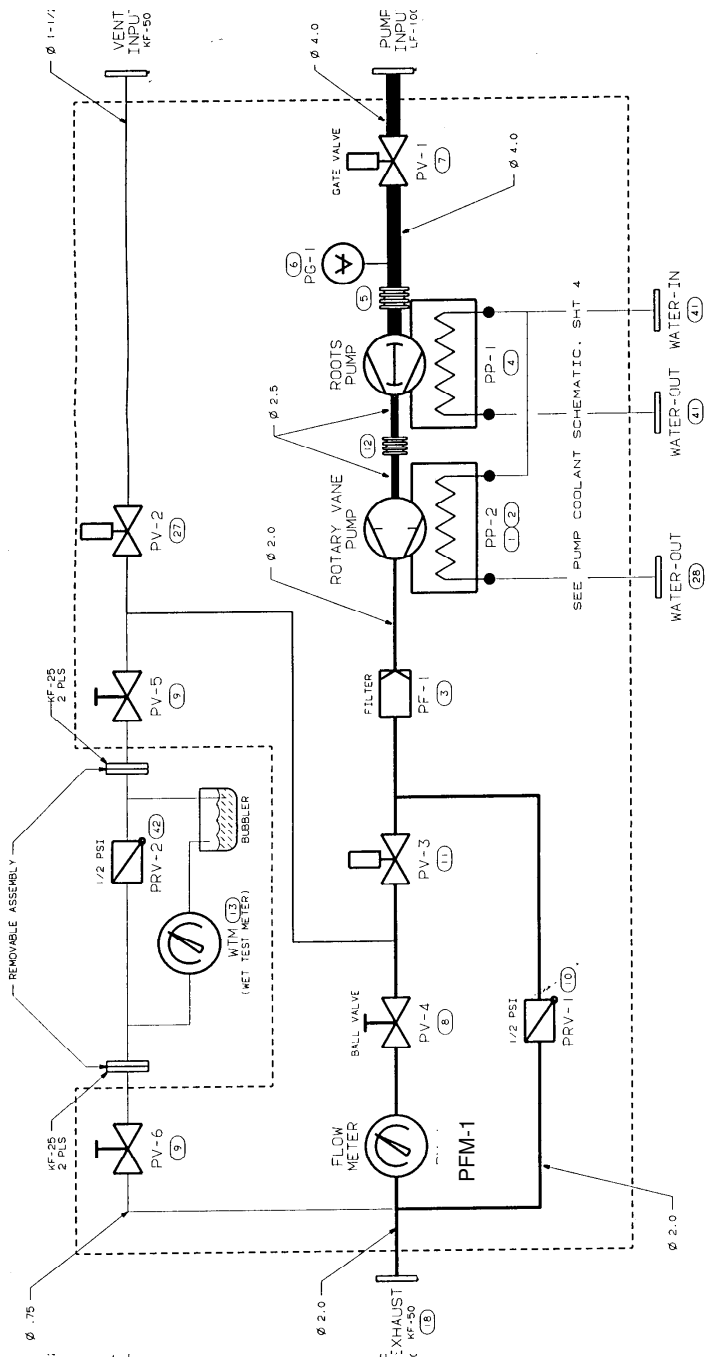

Figure 2. Schematic of Pump Module plumbing.

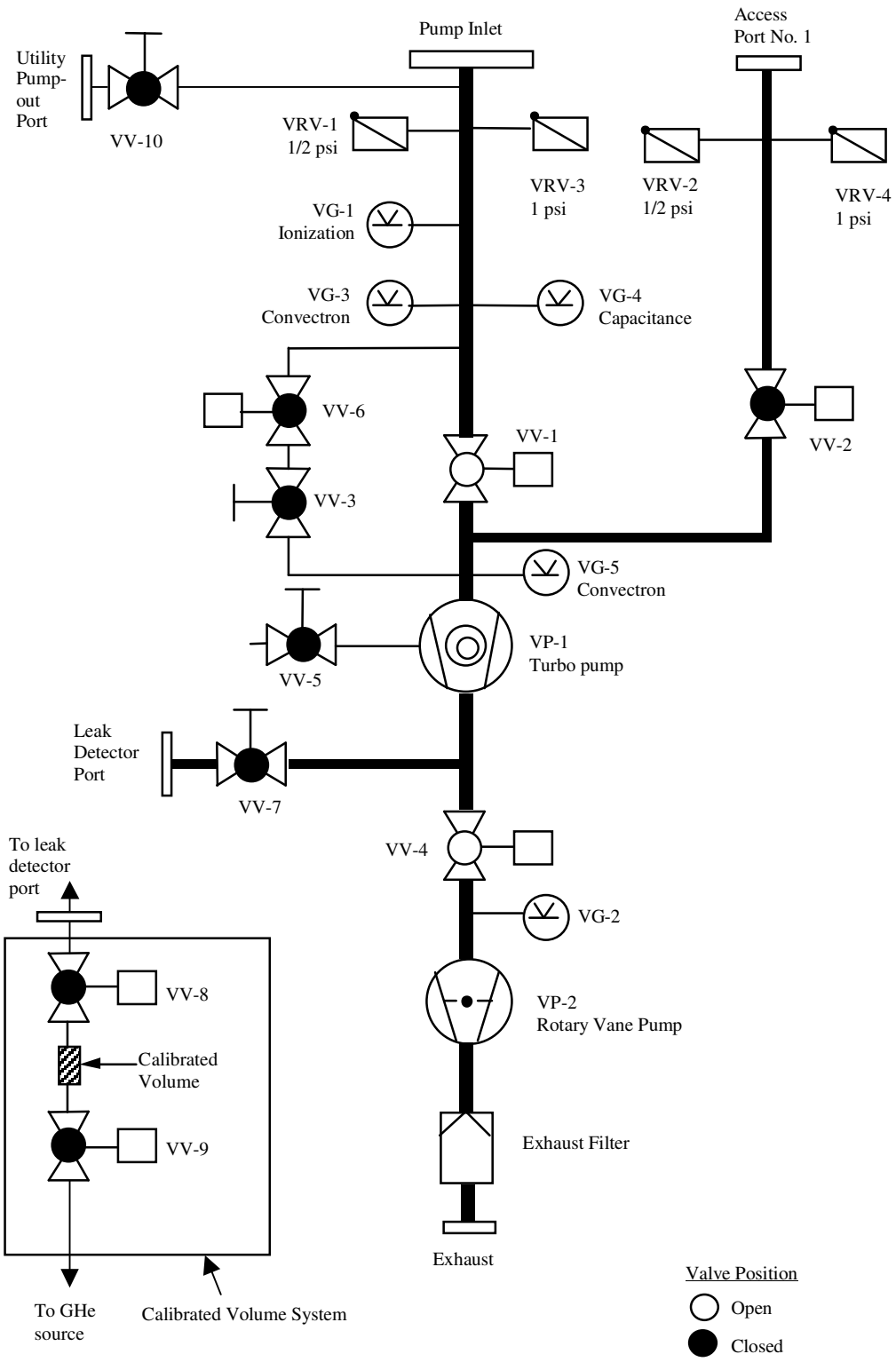

Figure 3. Schematic representation of Vacuum Module plumbing.

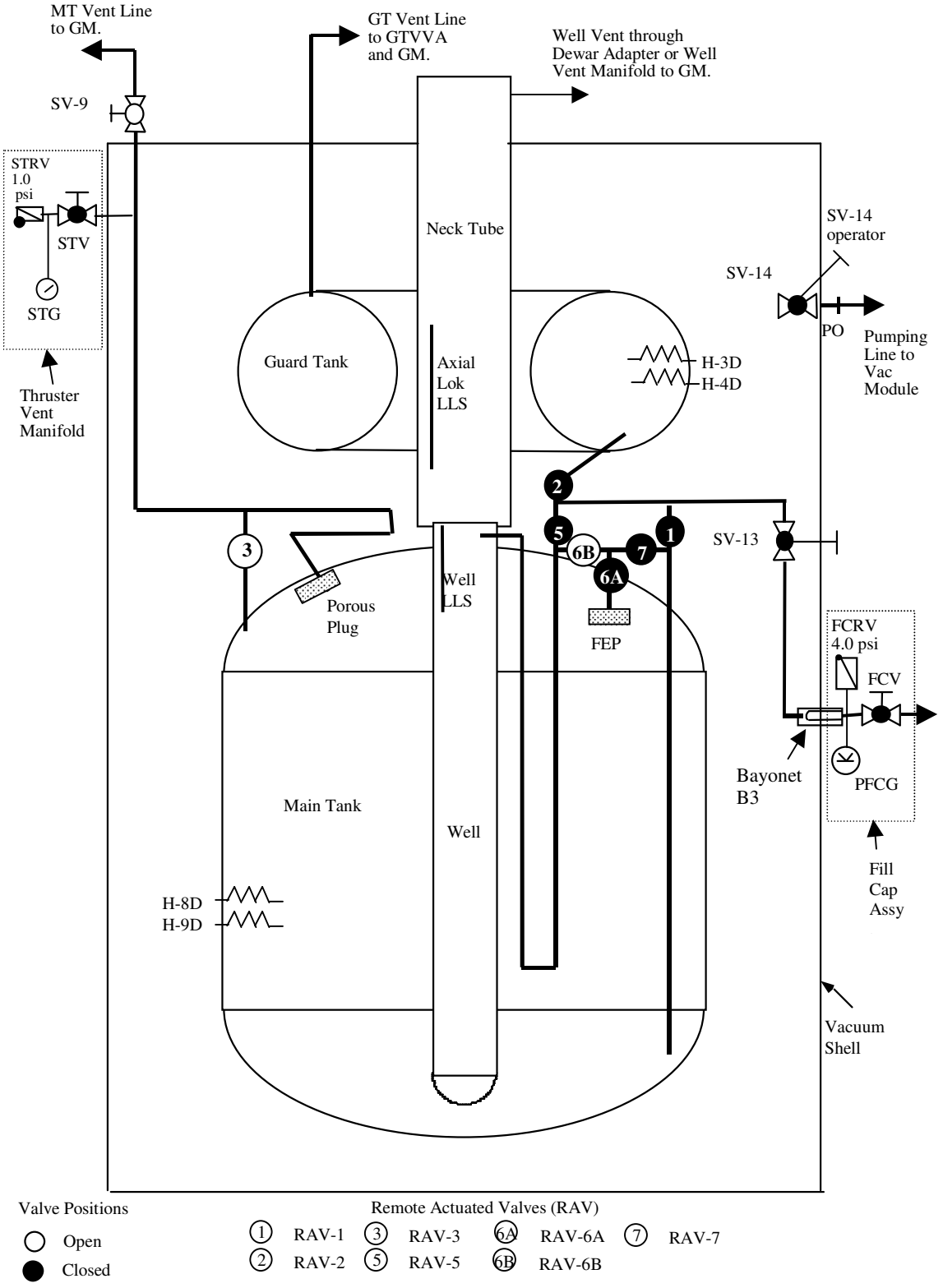

Figure 4. Schematic of Science Mission Dewar plumbing.

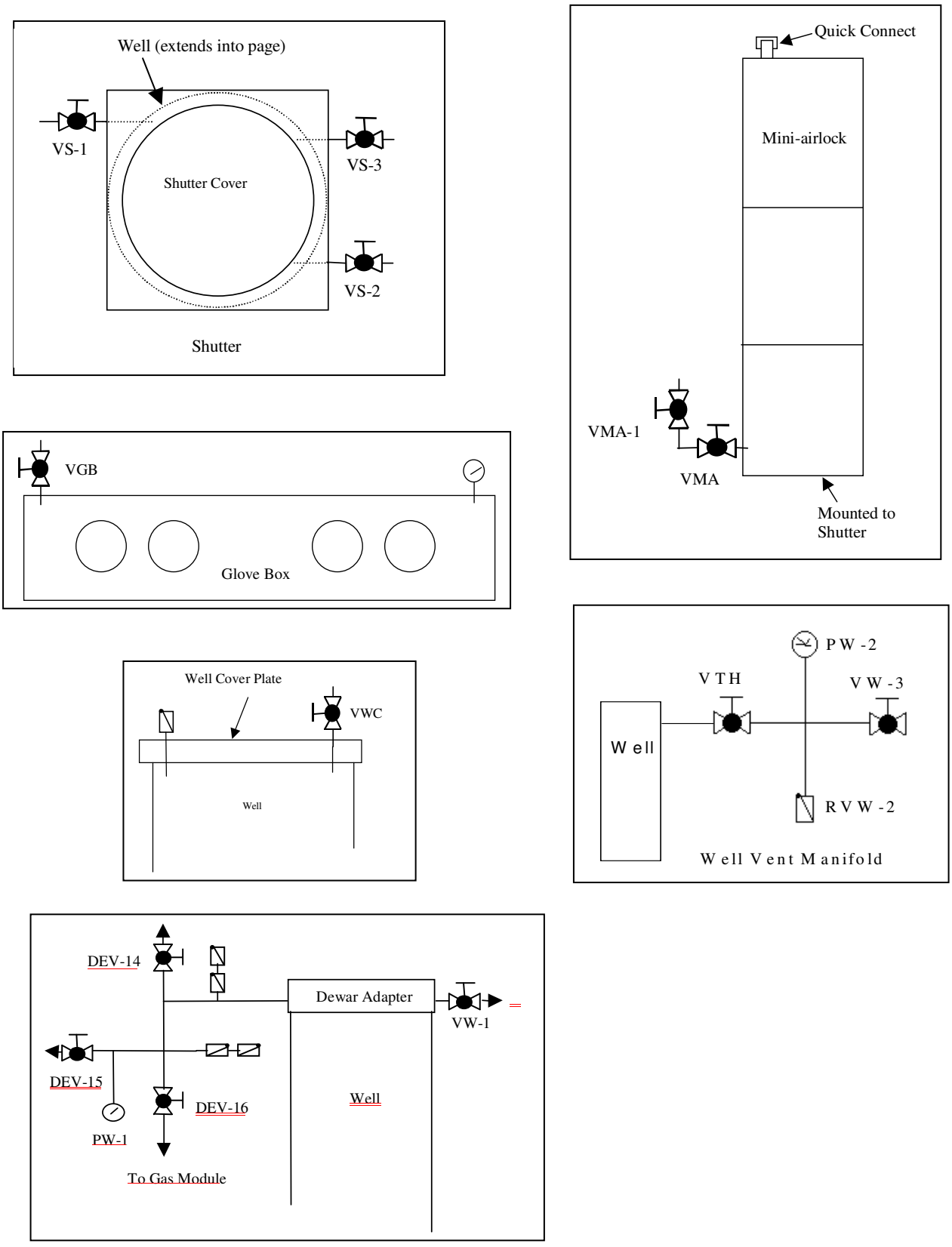

Figure 5. Well closures, manifolds, and associated plumbing.

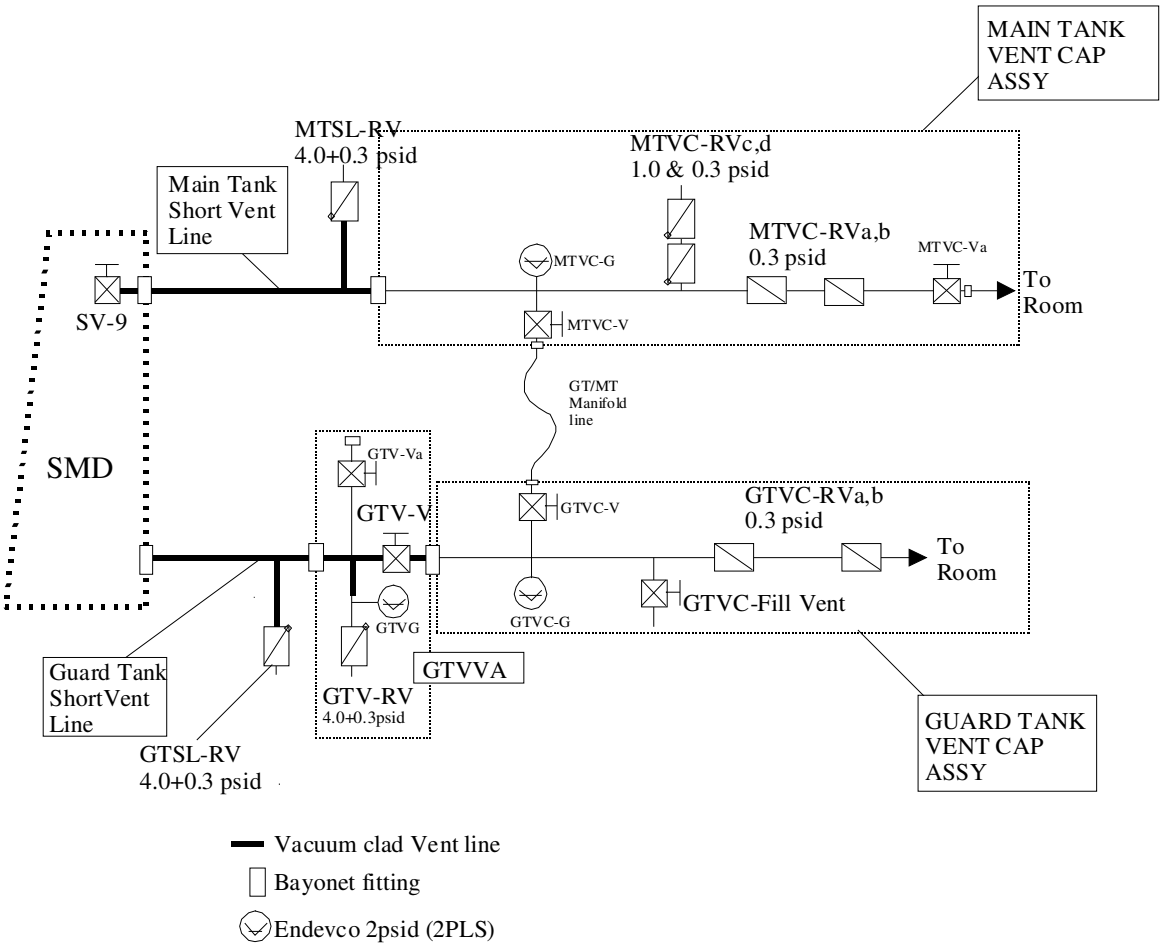

Figure 6. Schematic representation of Guard Tank Vent Valve Assembly (GTVVA) and Main Tank vent cap assembly for NBP applications.

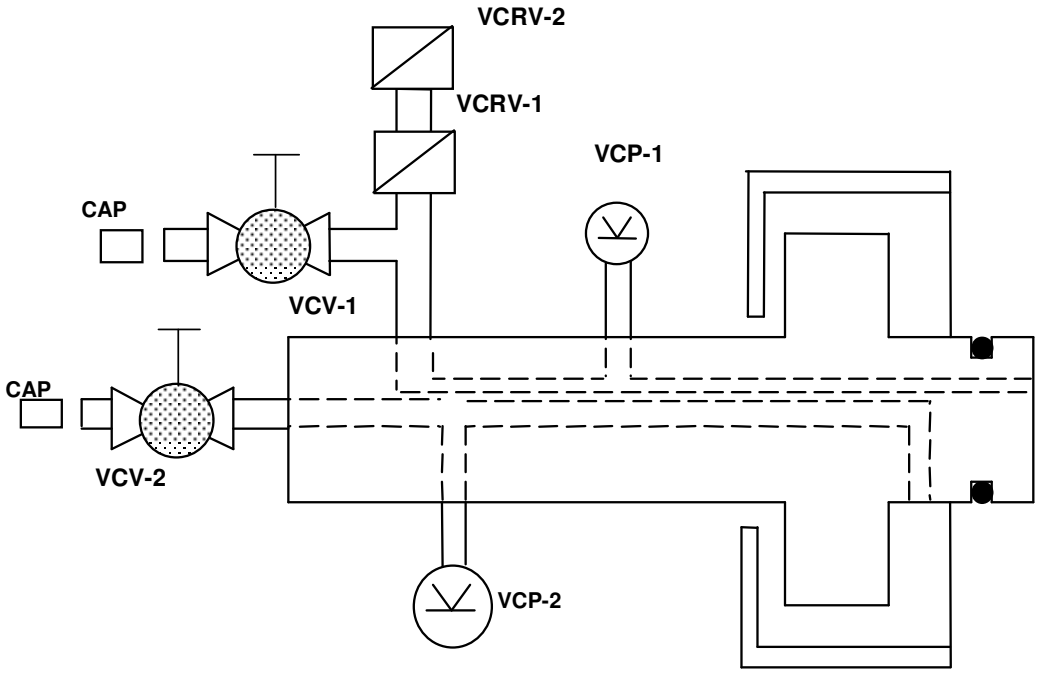

Figure 7. Main Tank Vent Cap Assembly for subatmospheric applications.