GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

GUARD TANK LIQUID LEVEL REDUCTION

To be performed at Vandenberg Air Force Base building 1610

THIS DOCUMENT CONTAINS NON HAZARDOUS OPERATIONS

P1030

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Revision Record

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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
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

LIST OF SPECIFIC HEADING DEFINITIONS

Each type of alert message will precede the procedural step to which it applies

1. NOTE: Used to indicate an operating procedure of such importance that it must be emphasized
2. CAUTION: Used to identify hazards to equipment
3. WARNING: Used to identify hazards to personnel

A. SCOPE

This procedure describes the steps required to reduce the liquid level in the Guard Tank. The steps include:

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

Turn on Guard Tank heater/s

Reduce level

Turn off Guard Tank heater/s

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.

B. SAFETY

B.1. Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware.

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 and the Missile System Prelaunch Safety Package discuss 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

In VAFB building 1610, the GP-B cryogenic team provides 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 lines are installed over the four burst disks to direct any flow to an outside area.

Only authorized and trained personnel are allowed in VAFB facilities without escort. All personnel working on platforms at a height 30 inches or more off the floor are required to have an approved air tank (emergency breathing apparatus) within easy reach. Note that tank need not be kept available when working from ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA and VAFB safety.

The following additional requirements apply to all personnel involved directly 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, non-absorbent shoes, goggles/glasses, and full-face shields are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

All tools or other items used with the potential to damage the space vehicle shall be tethered.

B.3. **Mishap Notification**

B.3.1. Injury

In case of any injury or illness requiring emergency medical treatment **DIAL 911.**

B.3.2. Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229 and Stanford University GP-B P0879. Additionally, VAFB NASA Safety and 30th Space Wing Safety will be notified as required.

B.3.3. Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Appendix 3.

C. **QUALITY ASSURANCE**

C.1. **QA Notification**

The NASA program 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 TD 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 TD 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 person performing the operations (Test Director or Test Engineer) is to sign the “Completed by” sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the “Witnessed by” sign-off. The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 “GP-B Maintenance and Testing at all Facilities.” Checklists will be used as directed by P0875

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. Required Personnel

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

When working on the space vehicle, a proper ESD ground strap is required. Prior to use all ESD wrist straps will be checked using a calibrated wrist strap checker.

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 Electrical 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.

E.3.3. Computers and Software:

The Data Acquisition System (DAS) is 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

E.3.5. Additional Hardware

E.3.6. Tools

Description
Varian Leak Detector S/N #_____ Cal Due Date:_____
Torque Wrench, 1-1/4-in socket, 60 +/- 5 in-lb Cal Due Date:_____S/N_____

E.3.7. Protective Clothing

1. N/A

E.3.8. Expendables

WARNING

Ethanol is highly flammable and vapor/air mixtures are Explosive.

Exposure hazards include: Inhalation (headache/fatigue),

skin (dryness, eyes (redness/pain/burning)

Description	*Quantity*	*Mfr./Part No.*
Ethanol	AR	N/A
99.999% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Dow Corning High Vacuum or Apiezon N

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*	*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 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	H09D Tank	3511A-13332	Yes	

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		HP 6038A	Heater			
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 is evacuated

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. Top of lead bag temperature set (CN 175 and 178) at $T \leq 6.0$ K.
    b. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.
2. The watchdog timer must be enabled.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet must be installed.
2. 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.
3.

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. The Main Tank vent line may be connected to the Gas Module, or it may be disconnected and terminated at a Vent Cap.
3. 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
LM/P479945	Missile System Prelaunch Safety Package
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
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements

KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3. Additional Procedures

Document No.	**Title**
SU/GP-B P0879	Accident/Incident/Mishap Notification Process

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.
  Record: Individual notified _____,
  Date/time _____/_____.
- Verify NASA program representative notified.
  Record: Individual notified _____,
  Date/time _____/_____.

- Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- Persons actually performing this procedure should list their names in Sec D.3.
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of emergency shower.

Section Complete QA Witness:_____

Note:
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. Verify DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – verify CN [175 and 178] on DAS alarm list and set to alarm at $T \leq 6.0$ K. Record set point. _____K
2. ***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.2.2. Ensure liquid-level alarms enabled and record set points.

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

G.2.3. Verify Guard Tank vent line connected to Gas Module. If not, perform procedure P1008, 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:

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. Record Main Tank temperature CN [171] _____ K.

G.3.4. Record liquid helium levels as appropriate

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

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. Failure to comply may result in hardware damage.

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 not, 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**

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. Failure to comply may result in hardware damage

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 [170]:_____ K
3. Guard Tank pressure (GTV-G) _____ torr (relative to atm.).
4.

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) _____ %

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**

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. Top of Lead Bag set point [CN175] _____ K (≤ 6.0 K)

b. Top of Lead Bag set point [CN 78] _____ K (≤ 6.0 K)

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

1. ***Main Tank*** 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. Failure to comply may result in hardware damage

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

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

G.9.13. V
erify completion of post operations checklist

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)

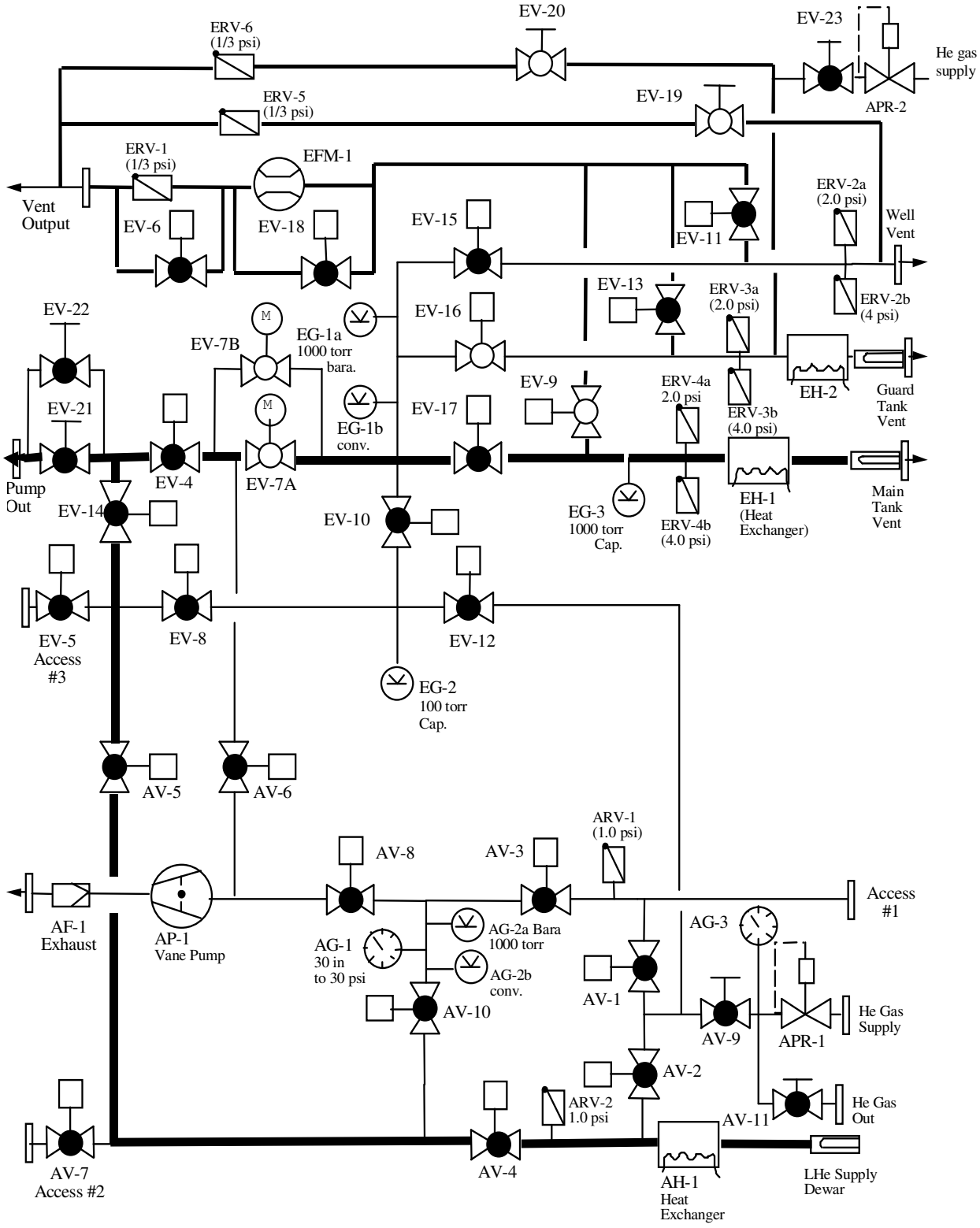

Figure1. Schematic of Gas Module Plumbing. The valve configuration corresponds to the standard bypass configuration with the Main Tank (at NBP), Guard Tank, and Well each venting independently.

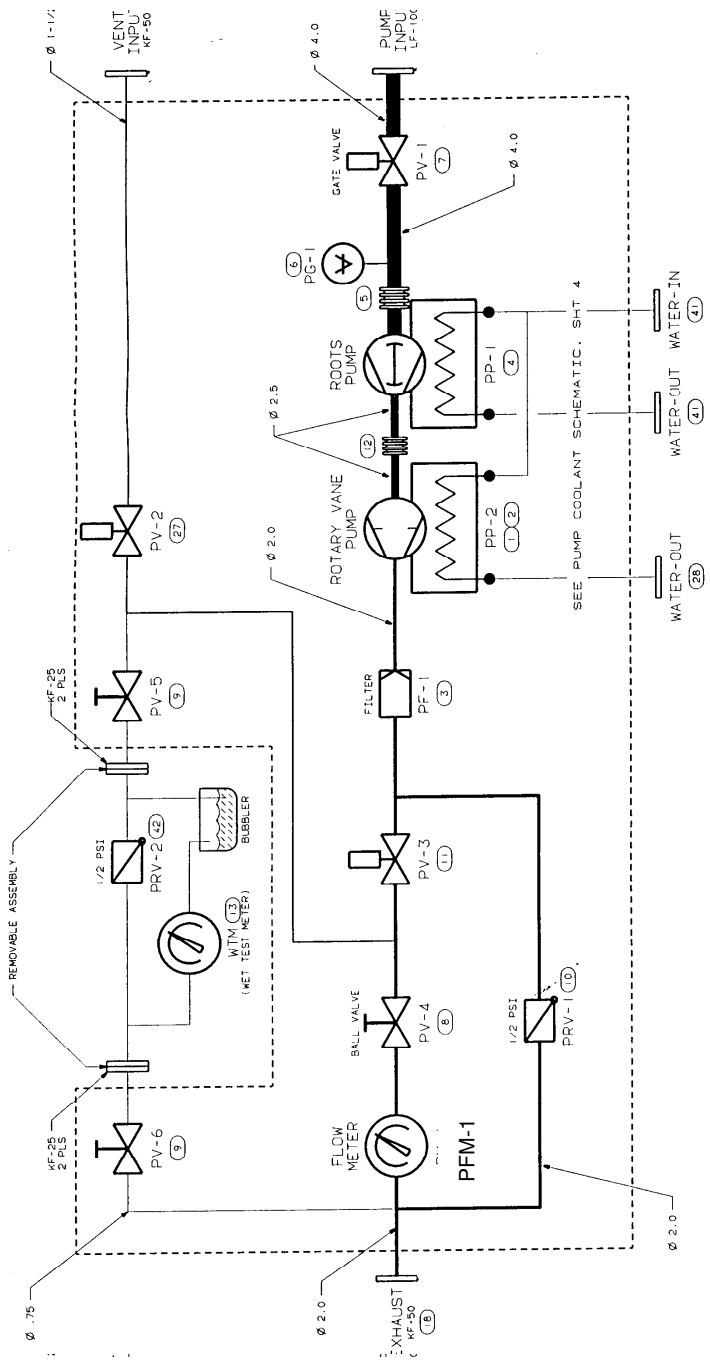

Figure 2. Schematic of Pump Module plumbing.

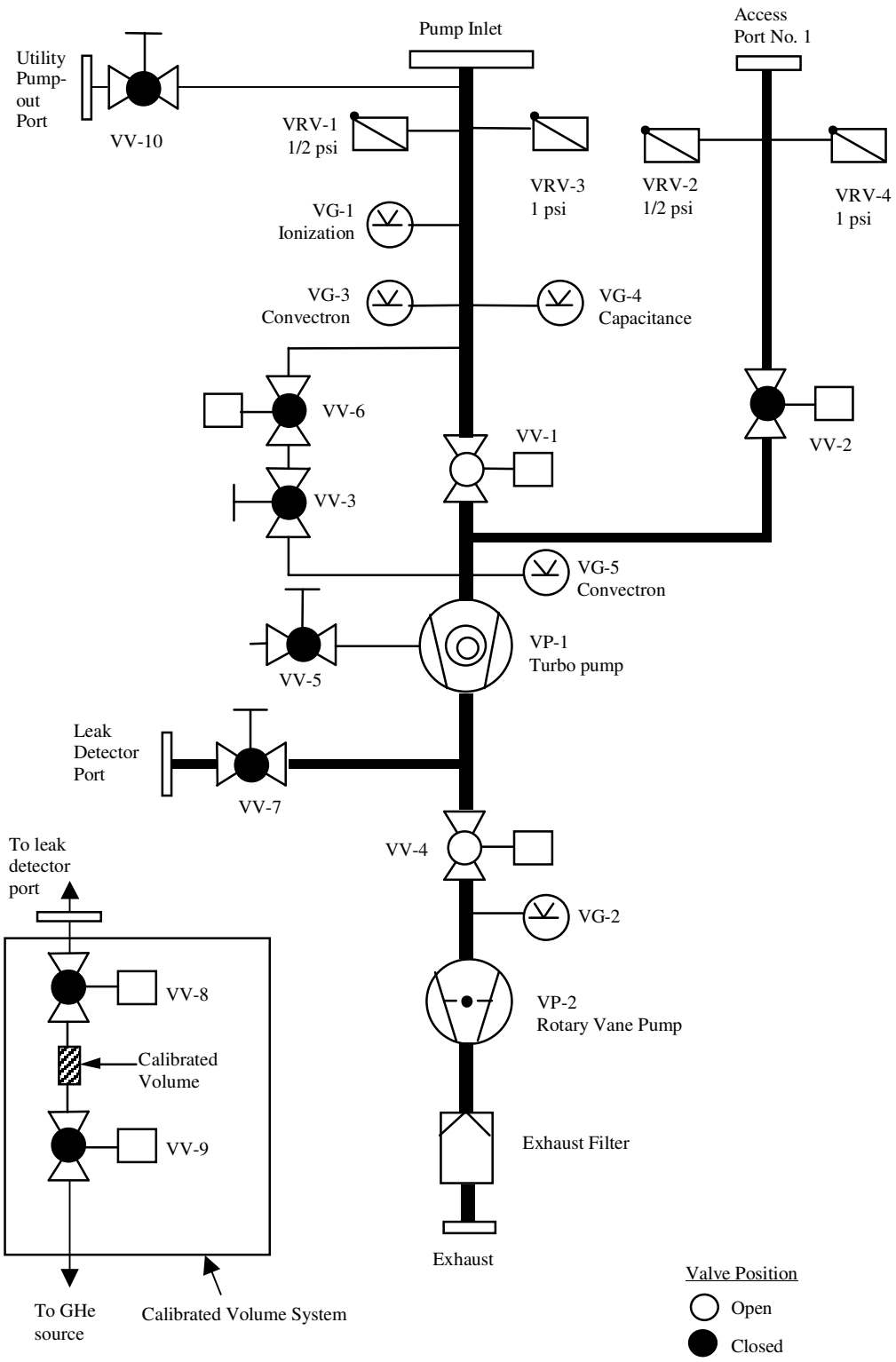

Figure 3. Schematic representation of Vacuum Module plumbing.

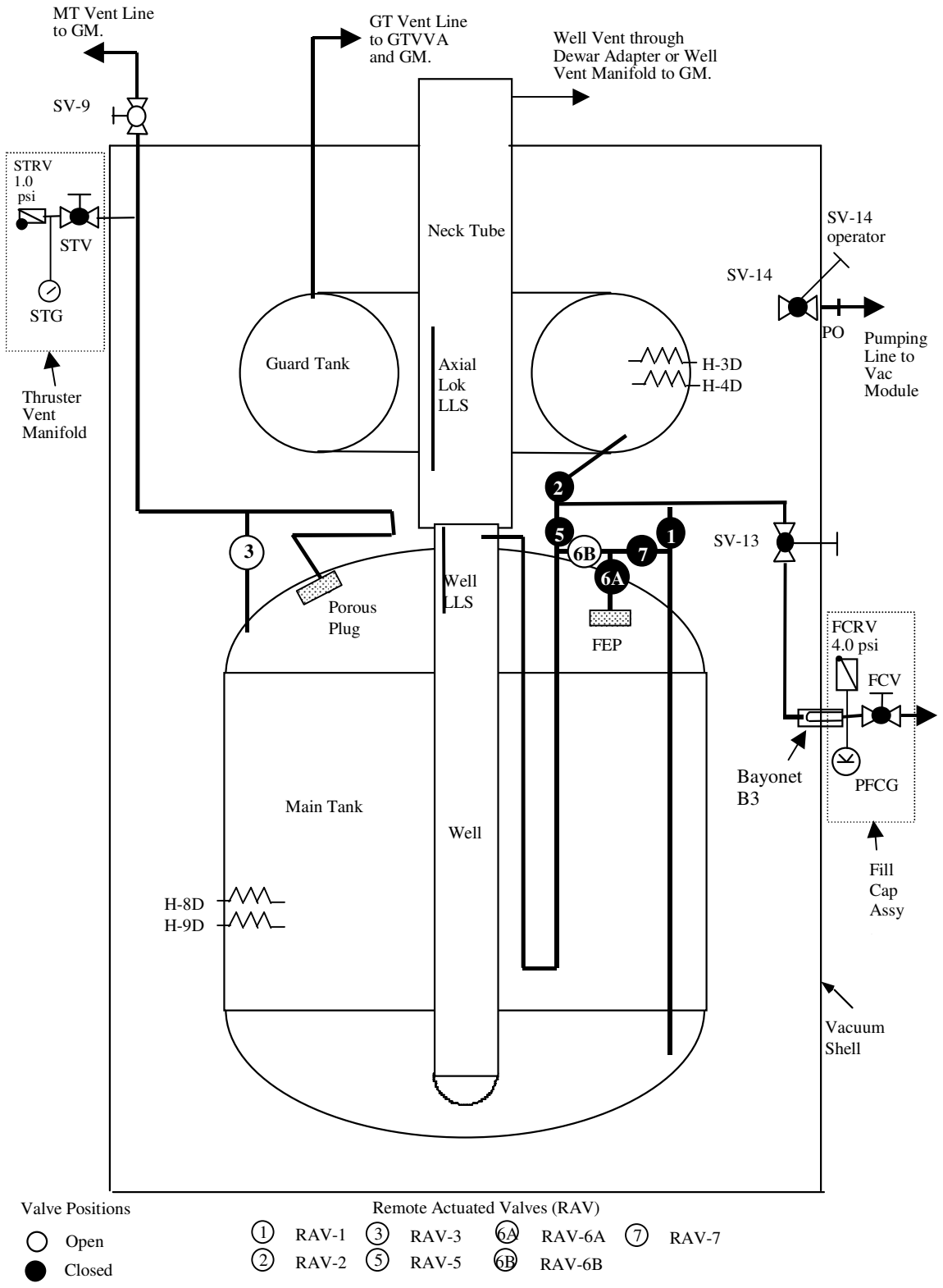

Figure 4. Schematic of Science Mission Dewar plumbing.

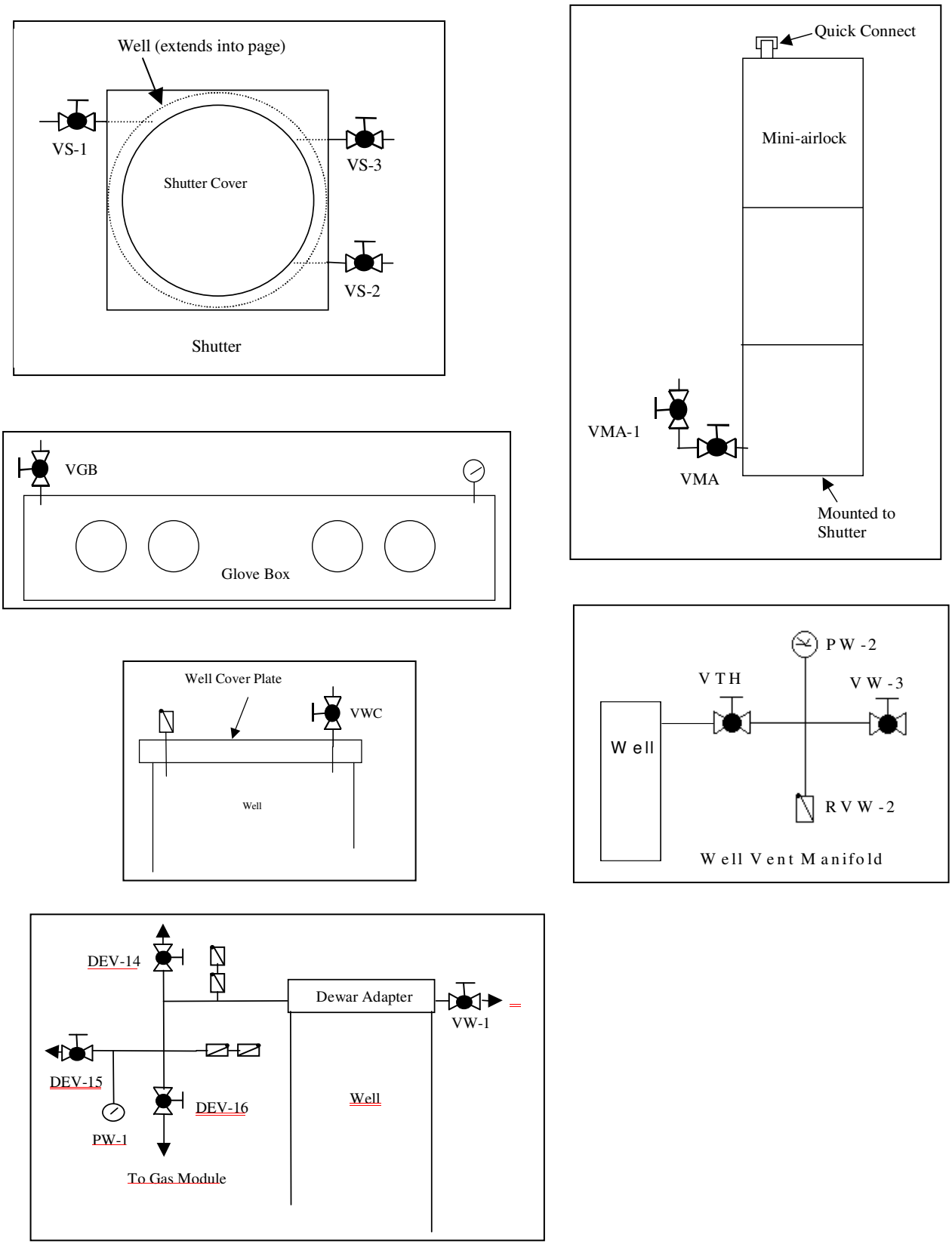

Figure 5. Well closures, manifolds, and associated plumbing.

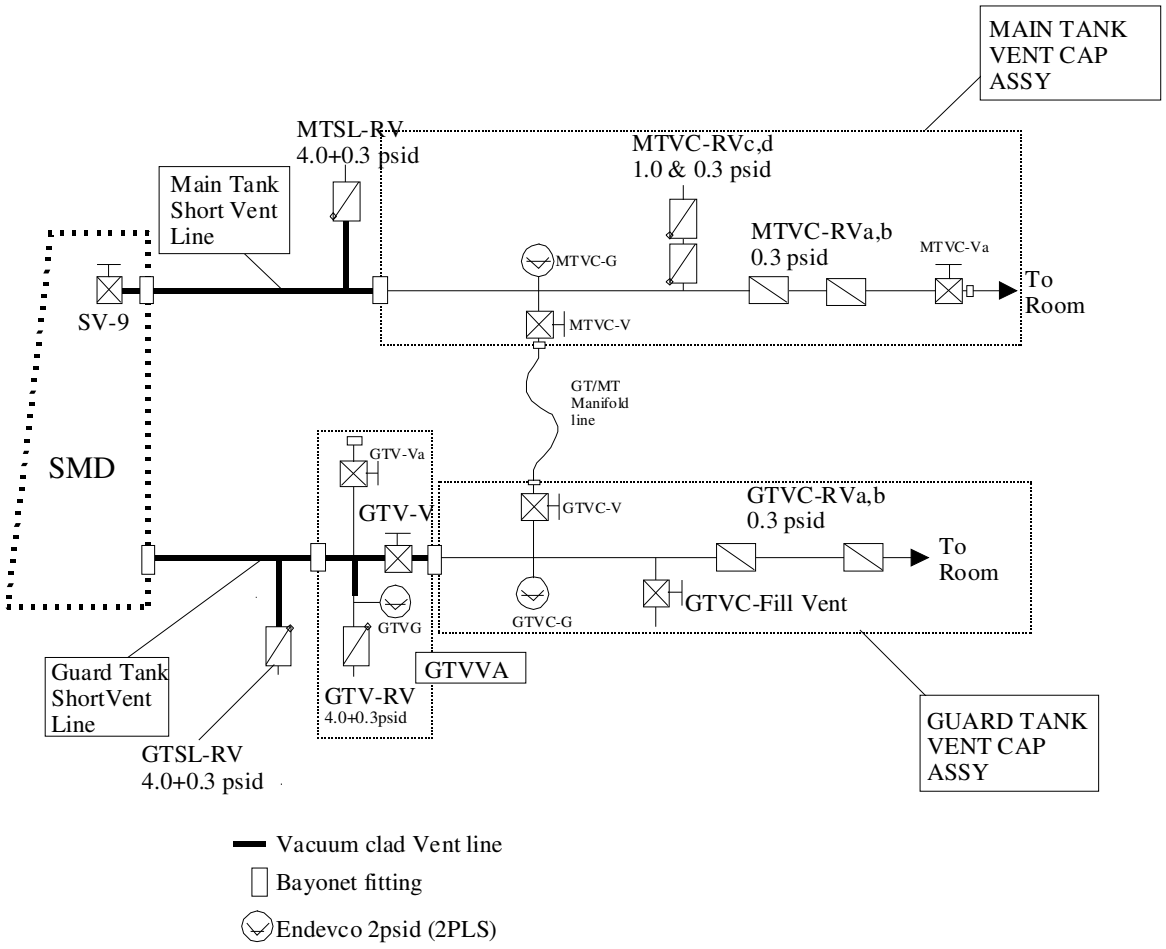

Figure 6. Schematic representation of Guard Tank Vent Valve Assembly (GTVVA) and Main Tank vent cap assembly for NBP applications.

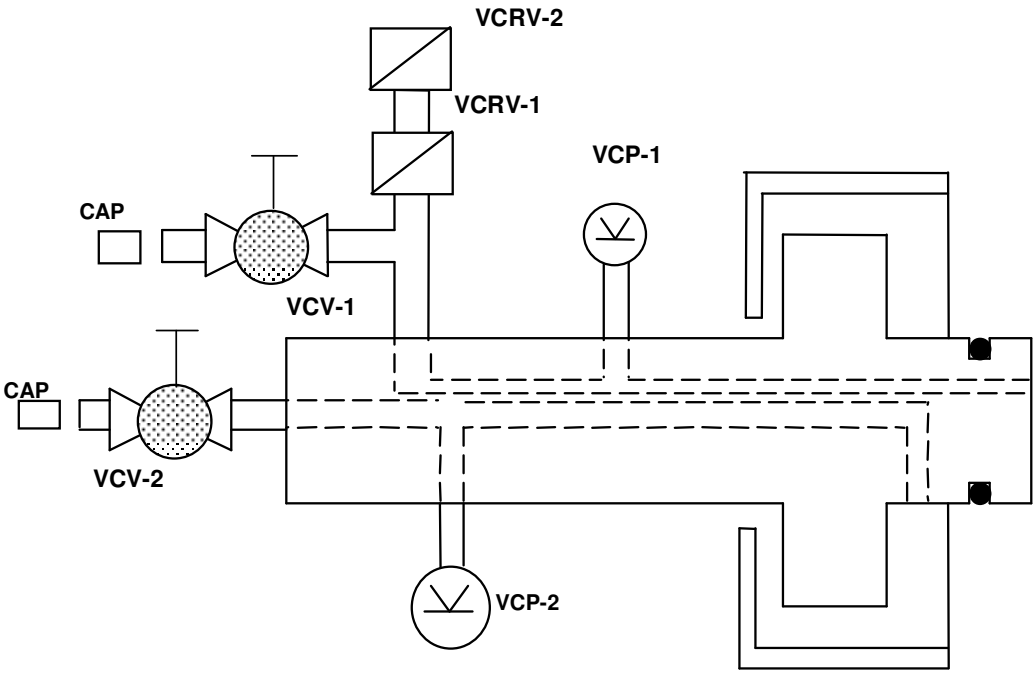

Figure 7. Main Tank Vent Cap Assembly for subatmospheric applications.

H. APPENDIX 1 PRE OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member is certified and know their individual responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Verify/perform an Engineering and Safety pretest high-bay walk down. Ensure all discrepancies are corrected prior to start of operations.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

I. APPENDIX 2 POST OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify all steps in the procedure were successfully completed.		
	2. Verify all anomalies discovered during testing are properly documented.		
	3. Ensure management has been notified of all major or minor discrepancies.		
	4. Ensure that all steps that were not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	6. Verify all RAV valve operations have been entered in log book		
	7. Verify the as-run copy of procedure has been filed in the appropriate binder		
	Team Lead Signature: _____		

J. APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES

Condition	Circumstance	Response
Power Failure	Anytime	Wait for power restoration, than proceed with operation
Liquid nitrogen spill	Anytime	Clear area until all spilled liquid has evaporated
Temperature limits (CN 29 or 28) exceeded	Anytime	Close EV-17 (if open) and open EV-9. Crack open SV-9 to allow MT to vent. Adjust SV-9 as necessary to restore temperature(s) below alarm limits. Open EV-6 and EV-18 if higher flow rate is needed.
Burst disk rupture (MT/GT)	Anytime	Evacuate room
Pressure in Main Tank exceeds limit	Anytime	Open Main Tank Vent Valve
Oxygen Monitor Alarm	Anytime	Evacuate room