GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

CONNECT MAIN TANK VENT LINE TO GAS MODULE – MAIN TANK SUBATMOSPHERIC

P0672 Rev-

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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 remove the Main Tank Vent Cap and connect the Main Tank vent line to the Gas Module, while liquid in the Main Tank is subatmospheric. The steps include:

Close and leak check Main Tank vent valve (SV-9)

Remove Vent Cap

Install and leak check vent line

Reestablish pumping on Main Tank (optional) with Pump Module or Gas Module.

The Guard Tank may contain liquid or be depleted; it may be connected to or disconnected from the Gas Module. The Well is 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. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

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

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

D. TEST PERSONNEL

D.1. Personnel Responsibilities

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

D.2. Personnel Qualifications

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

D.3. Qualified Personnel

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

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

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

The Ground Support Equipment includes the Gas Module, the Pump Module, the Electrical Module, and the Vacuum Module. The Gas Module provides the capability to configure vent paths, read pressures and flow rates, and pump and backfill vent lines. The Pump Module provides greater pumping capacity than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module. The Electrical Module contains the instruments listed in Table 1, 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), Pump Module (Figure 2), 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

Description
Utility Turbo System (UTS) (see Figure 3)
Helium leak detector
Helium leak detector calibrated leak; cal. due date:

E.3.5. Additional Hardware

No additional hardware is required.

E.3.6. Tools

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

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
Alcohol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Braycote Micronic 601
500 Liter Dewars Liquid Helium	AR	SU or commercial
Tie wraps - large size	AR	N/A

E.4. Instrument Pretest Requirements

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

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	

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

Liquid in the Main Tank is subatmospheric.

The Main Tank vent line consists of two parts: a short line attached to the dewar, and a long line that connects the short line to the Gas Module. The vent line can be disconnected at the dewar or at the bayonet joining the long and short lines. For tilting purposes, it is usually disconnected at the end of the short line.

E.5.2. Guard Tank

The Guard-Tank may contain liquid, or be depleted. There is no required liquid level. When the Guard Tank is depleted, its pressure must be independently regulated from a source of 99.99% pure helium gas.

Whenever independently regulated, the Guard Tank pressure must be continuously monitored and maintained at a positive value relative to the atmosphere. Monitoring is accomplished by placing the relative pressure (GTV-G), as read at the Guard Tank Vent Valve Assembly, on the DAS alarm list. The pressure is kept positive by maintaining liquid in the tank or supplying a source of He gas for independent regulation.

E.5.3. Well

The Well is evacuated

E.5.4. SMD Vacuum Shell

There is no requirement for the vacuum shell pressure.

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. 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.5.7. The Thruster Vent Manifold is installed at the Thruster vent port.

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 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 ion-pump magnet is installed.
5. 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.
6. A Dewar Adapter, Shutter, and Shutter Cover are mounted to the Well of the SMD when the Probe is removed
7. The Guard Tank may be connected to the Gas module via a vacuum insulated or line, or be disconnected at GTVVA with a Vent Cap installed.
8. The Well may be connected to or disconnected from the Gas Module.
9. The Well vent manifold may be installed and valved off.
10. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve operator and pumping line, with the valve in either the open or closed position. The Vacuum Module pump may be; off, actively pumping the pumping line up to a closed SV-14, or actively pumping the vacuum shell.
11. The Fill Cap Assembly is installed at SV-13 (See Figure 3)

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

No additional procedures are indicated.

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify ONR representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

G.2. Verify Configuration Requirements

G.2.1. Ensure Facility Main Alarm System enabled.

G.2.2. Ensure interlock override switch is off (blinking light off) to prevent accidental opening of EV-15 and EV-16.

G.2.3. Verify liquid in Main Tank subatmospheric and record:

1. Temperature at bottom of Main Tank CN [09] _____K.
2. Main Tank Pressure (VCP-1) _____ torr

G.2.4. Ensure DAS alarm system enabled and record set points.

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

G.2.5. Ensure liquid-level alarms enabled and record set points.

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

G.2.6. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.7. Verify Thruster Vent Manifold installed and vent valve STV closed.

G.3. **Establish Gas Module Configuration and Record Initial Conditions**

G.3.1. Record Guard Tank pressure relative to atm. (GTV-G) _____ torr.

G.3.2. Record Guard Tank configuration:

- o Guard Tank contains liquid and is not connected to Gas Module.
  1. Ensure GTV-V open.
  2. Close/verify closed all EV valves.

- o Guard Tank is depleted and not connected to Gas Module.
  1. Ensure GTV-V closed.
  2. Ensure Guard Tank pressure regulated by APR-2 at GTV-Va.
  3. Close/verify closed all EV valves.

- o Guard Tank contains liquid, is connected to Gas module, and venting through EV-13.
  1. Ensure GTV-V open.
  2. Ensure EV-13 open.
  3. Ensure all other EV valves closed.

- o Guard Tank contains liquid, is connected to Gas module, and venting through EV-20.
  1. Ensure GTV-V open.
  2. Ensure EV-20 open.
  3. Ensure all other EV valves closed.

- o Guard Tank depleted and connected to Gas Module.
  1. Ensure GTV-V open.
  2. Ensure Guard Tank pressure regulated by APR-2 at EV-23.
  3. Ensure EV-23 open.
  4. Close/verify closed all other EV-valves.

G.3.3. Close/verify closed all AV valves.

G.3.4. Record status of Main Tank Vent Cap

1. Tank pressure (VCP-1):_____ torr
2. Seal pressure (VCP-2):_____ psig

G.4. Close and Leak Check Main Tank Vent Valve

CAUTION
During the period of Main Tank vent closure the temperatures at station 200 and the top of the lead bag are to be continuously monitored.

G.4.1. Close SV-9 to 60 in-lbs and record date/time : _____/_____ .

G.4.2. Install a pumping line between the Main Tank Vent Cap Assembly at valve VCV-1 and the Auxiliary Gas Section access port no. 1.

G.4.3. Turn on/verify on pump AP-1.

G.4.4. Open AV-3 and AV-8.

G.4.5. Open VCV-1 and evacuate to <25 mtorr measured at AG-2b.

G.4.6. Close AV-8.

G.4.7. Open AV-1.

G.4.8. Open AV-9 until pressure at AG-1 reaches 0.0 psig, and close AV-9.

G.4.9. Close VCV-1.

G.4.10. Verify that pressure VCP-1 does not change by more than 1 torr in 20 minutes while recording in 4 min. intervals

Time (min)	0	4	8	12	16	20
VCP-1 (torr)						

G.4.11. Pass/Fail: _____ torr/ 20 min: _____.

G.4.12. If leak-back test fails, retorque SV-9 to 60 in-lbs and repeat test.

1. Verify that pressure VCP-1 does not change by more than 1 torr in 20 minutes while recording each minute:

Time (min)	0	4	8	12	16	20
VCP-1 (torr)						

2. Pass/Fail: _____ torr/ 20 min: _____.

G.4.13. Close/verify closed all AV valves.

G.4.14. Remove pumping line from Main Tank Vent Cap Assembly.

G.5. **Connect Main Tank Vent Line**

G.5.1. Remove Vent Cap – record location:

- Bayonet at SV-9.
- Bayonet at end of short line opposite SV-9.

G.5.2. Remove o-ring from bayonet receptacle and inspect for defects or damage. Replace if any found and record in o-ring log.

G.5.3. Clean o-ring and lightly coat with Braycote before installation.

G.5.4. Install Main Tank vent line between Gas Module (at inlet to Main Tank heat exchanger) and location of Vent Cap removal. Install bags around new joint(s).

G.6. **Leak Check Main Tank Vent Line**

G.6.1. Turn on and verify calibration of leak detector. Record

1. calibrated leak value _____ sccs
2. measured leak value _____ sccs

G.6.2. Connect leak detector to the UTS at access port (LD).

G.6.3. Ensure EV-5 closed.

G.6.4. Install UTS/Leak detector to Access port #3 of Gas Module and start the UTS pumping up to closed EV-5, as follows:

1. Place valve interlock switch in “over-ride” position.
2. Turn on vane pump and converter (Note: converter switch provides power to turbopump controller and pirani and cold-cathode vacuum-gauge display.
3. Push the red “reset” button to activate the interlock over-ride circuit. (the yellow-orange indicator light will come on).
4. Turn “foreline” switch on, to open TV-2, and verify that the switch is illuminated.
5. Push the “Sensor” button on the vacuum gauge display to read the foreline pressure (TG-4). This is the pirani gauge. The “Pir” annunciator will appear in upper left corner of the display).
6. Open TV-4.
7. When foreline pressure (TG-4) < 1 torr, push “Start” button on turbo controller.
8. When the ”Normalbetrieb” light illuminates on turbo controller, indicating turbopump is up to speed, close TV-4 and open gate valve TV-1.
9. Switch the valve interlock switch to the “protected” position.
10. Push the “Sensor” button on the vacuum gauge readout so that the “Hi-Vac” annunciator shows, and push the “Emis” button to turn on the cold cathode gauge (TG-1).

11. Record the pumping line pressure (TG-1) _____ torr.

G.6.5. Open EV-4, EV-14, and EV-17.

G.6.6. Record settings of EV-7a _____ and EV-7b_____ and open fully.

G.6.7. Evacuate Main Tank vent plumbing with Gas Module

1. Open AV-6 and AV-8.
2. Once pressure is < 25 mtorr as measured at AG-2b, close AV-6 and AV-8.

G.6.8. Open EV-5 and evacuate with UTS/leak detector, as follows:

1. Verify that leak detector is operational and pumping up to closed valve TV-3.
2. Open TV-3 and close the foreline valve (TV-2)
3. Pump until background level is < $1x10^{-5}$ scc/s.

G.6.9. Purge bagged joints with GHe for 2 minutes and record:

1. O-ring location: _____

Time (min)	0	1/2	1	1 1/2	2
LD (ssc/s)					

2. Pass/Fail: _____ (Pass= **no** increase from initial background)

3. O-ring location: _____

Time (min)	0	1/2	1	1 1/2	2
LD (ssc/s)					

4. Pass/Fail: _____ (Pass= **no** increase from initial background)

5. O-ring location: _____

Time (min)	0	1/2	1	1 1/2	2
LD (ssc/s)					

6. Pass/Fail: _____ (Pass= **no** increase from initial background)

G.6.10. Close EV-4, EV-5, and EV-14 and remove UTS/Leak Detector if not going to use for more operations.

G.7. **Reestablish Initial Gas Module Configuration**

G.7.1. Place Gas Module valves in initial configuration:

Note: before reestablishing Main Tank venting place the Gas Module valves in the same states they were in to start with (i.e., the states established in Paragraph G.3.3. Those states are repeated below.

- Guard Tank contains liquid and is not connected to Gas Module.
  3. Ensure GTV-V open.
  4. Close/verify closed all EV valves.

- Guard Tank is depleted and not connected to Gas Module.
  4. Ensure GTV-V closed.
  5. Ensure Guard Tank pressure regulated by APR-2 at GTV-Va.
  6. Close/verify closed all EV valves.

- Guard Tank contains liquid, is connected to Gas module, and venting through EV-13.
  4. Ensure GTV-V open.
  5. Ensure EV-13 open.
  6. Ensure all other EV valves closed.

- Guard Tank contains liquid, is connected to Gas module, and venting through EV-20.
  4. Ensure GTV-V open.
  5. Ensure EV-20 open.
  6. Ensure all other EV valves closed.

- Guard Tank depleted and connected to Gas Module.
  5. Ensure GTV-V open.
  6. Ensure Guard Tank pressure regulated by APR-2 at EV-23.
  7. Ensure EV-23 open.
  8. Close/verify closed all other EV-valves.

G.7.2. Close/verify closed all AV valves.

G.8. **Resume Pumping on Main Tank**

G.8.1. Record desired Main Tank configuration

- Pump on Main Tank with Pump Module (PP-1/PP-2), perform Section G.8.2.

- Pump on Main Tank with Gas Module (AP-1) perform Section G.8.3.

G.8.2. **(Option)** Establish Pumping on Main Tank With Pump Module

Note: This operation assumes that the plumbing between the Pump Module and the Gas Module has been successfully leak checked.

1. Ensure PV-1, PV-2, and PV-4 open.
2. Ensure PV-3, PV-5, and PV-6 closed.
3. Initiate Pump Module:
   a. Turn on water cooling of pump module.
   b. Ensure EV-4 EV-21/22, EV-14 , EV-5, EV-8, and EV-12 closed.
   c. Turn on rotary vane pump PP-2 and Blower PP-1.
   d. Once pressure at PG-1 has come to equilibrium –

      Record pressure(PG-1) _____ torr.
4. Ensure EV-9, EV-15, and EV-16 closed.
5. Open EV-4 and EV-21.
6. Open EV-10 and EV-17.
7. Set EV-7 valves on manual control and adjust to full closure.
8. Record the following:
   a. Date/time of day _____/_____
   b. Main Tank Temp (T-9D):_____ K
   c. Guard Tank Temp (T-15D)_____ K
   d. Vacuum Module pressure (VG-1) if connected:_____ torr
9. Enter comment in DAS “Begin pumping on Main Tank with Pump Module.”
10. Open SV-9.
11. Adjust EV-7 valves to value previously recorded in Section G.6.6.
12. Open PV-3.
13. Once conditions have stabilized, record the following:
    a. Date/time of day:_____/_____
    b. Main Tank level:_____ %
    c. Flowrate (PFM-1, scale B):_____ Ll/hr
    d. Flow meter (PFM-1, scale C):_____ Ll x 60
    e. Main Tank Temp (T-9D):_____ K
    f. Guard Tank Temp (T-15D)_____ K
    g. Main Tank exit pressure (EG-2):_____ torr
    h. Vacuum Module pressure (VG-1) if connected:_____ torr
    i. Record EV-7a valve position:_____ %
    j. Record EV-7b valve position:_____ %

14. Skip to Paragraph G.9.

G.8.3. **(Option)** Establish Pumping on Main Tank With Gas Module

1. Ensure EV-9, EV-15 and EV-16 closed.
2. Turn on/verify on AP-1.
3. Set EV-7 valves on manual control and adjust to full closure.
4. Open EV-10 and EV-17.
5. Open AV-6.
6. Record the following:
   a. Date/time of day _____/_____
   b. Main Tank Temp (T-9D) _____ K
   c. Guard Tank Temp (T-15D) _____ K
   d. Vacuum Module pressure (VG-1) if connected _____ torr
7. Enter comment in DAS “Begin pumping on Main Tank with AP-1.”
8. Open SV-9.
9. Adjust EV-7 valves to value previously recorded in Section G.6.6.
10. Once conditions have stabilized, record the following:
    a. Date/time of day _____/_____
    b. Main Tank level _____ %
    c. Main Tank Temp (T-9D) _____ K
    d. Guard Tank Temp (T-15D) _____ K
    e. Main Tank exit pressure (EG-2) _____ torr
    f. Vacuum Module pressure (VG-1) if connected _____ torr
    g. Record EV-7a valve position _____ %
    h. Record EV-7b valve position _____ %

G.8.4. Continue with Paragraph G.9.

G.9. **Establish Final Alarm Configuration**

G.9.1. Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for Station 200 and lead bag are unchanged and set to alarm.
- Thermal conditions substantially changed, temperature alarm points reset as follows:
  a. Station 200 set point [CN 1] _____ K (≤ 6.5 K)
  b. Top of Lead Bag set point [CN 28] _____ K (≤ 6.0 K)

G.9.2. Ensure liquid level sensor alarms enabled, as appropriate, and record set points if changed.

1. Main Tank Level Set Point _____%
2. Guard Tank Set Point _____%

G.9.3. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.9.4. Ensure Facility Main Alarm System enabled..

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

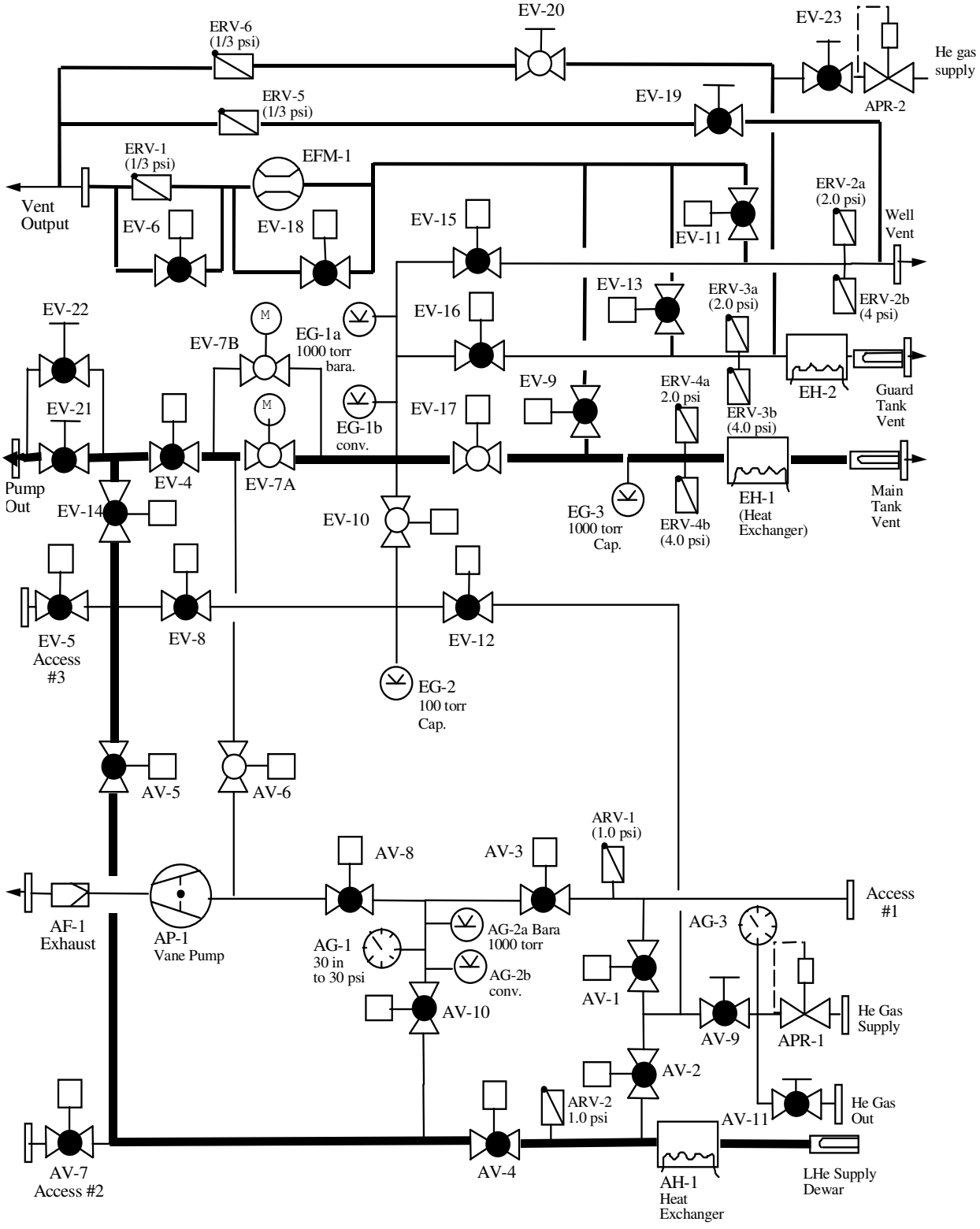

Figure 1. Schematic of Gas Module plumbing. Valve configuration corresponds to likely final configuration – Main Tank bath being pumped by AP-1 and the Guard Tank, with liquid, venting through EV-20.

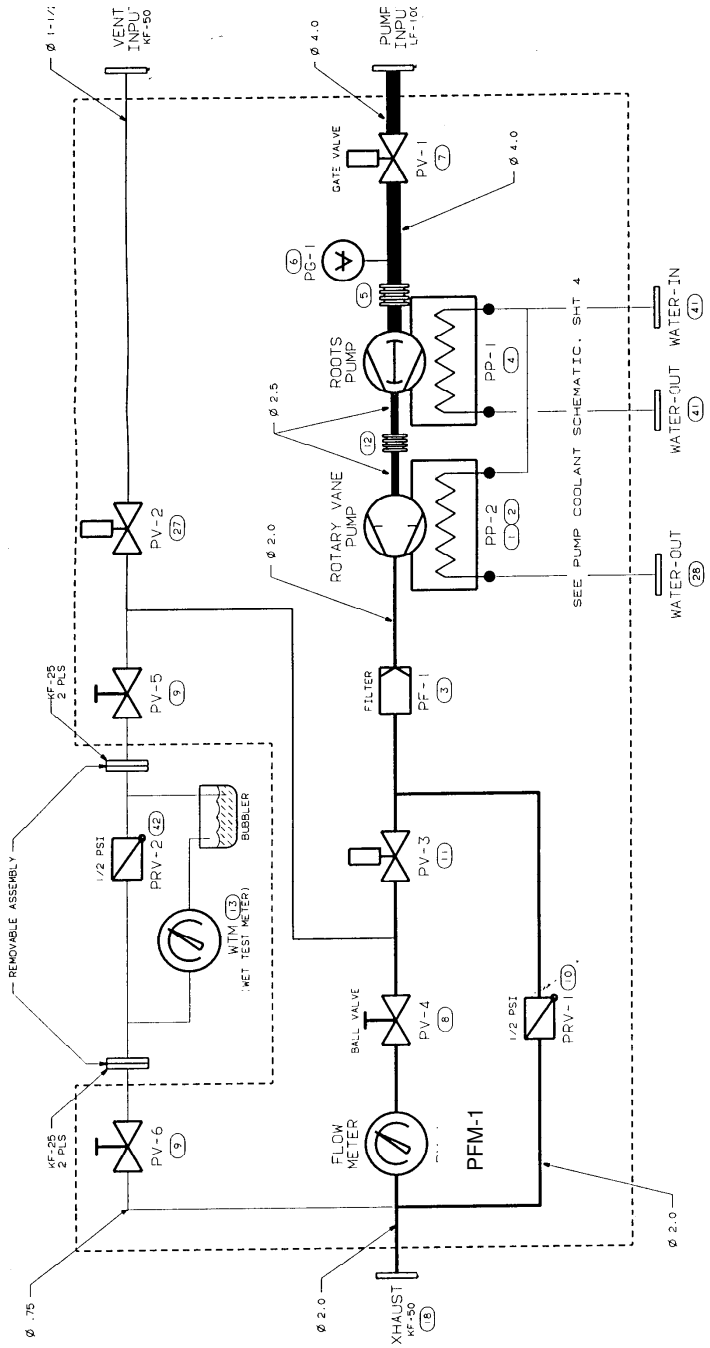

Figure 2. Schematic of Pump Module plumbing.

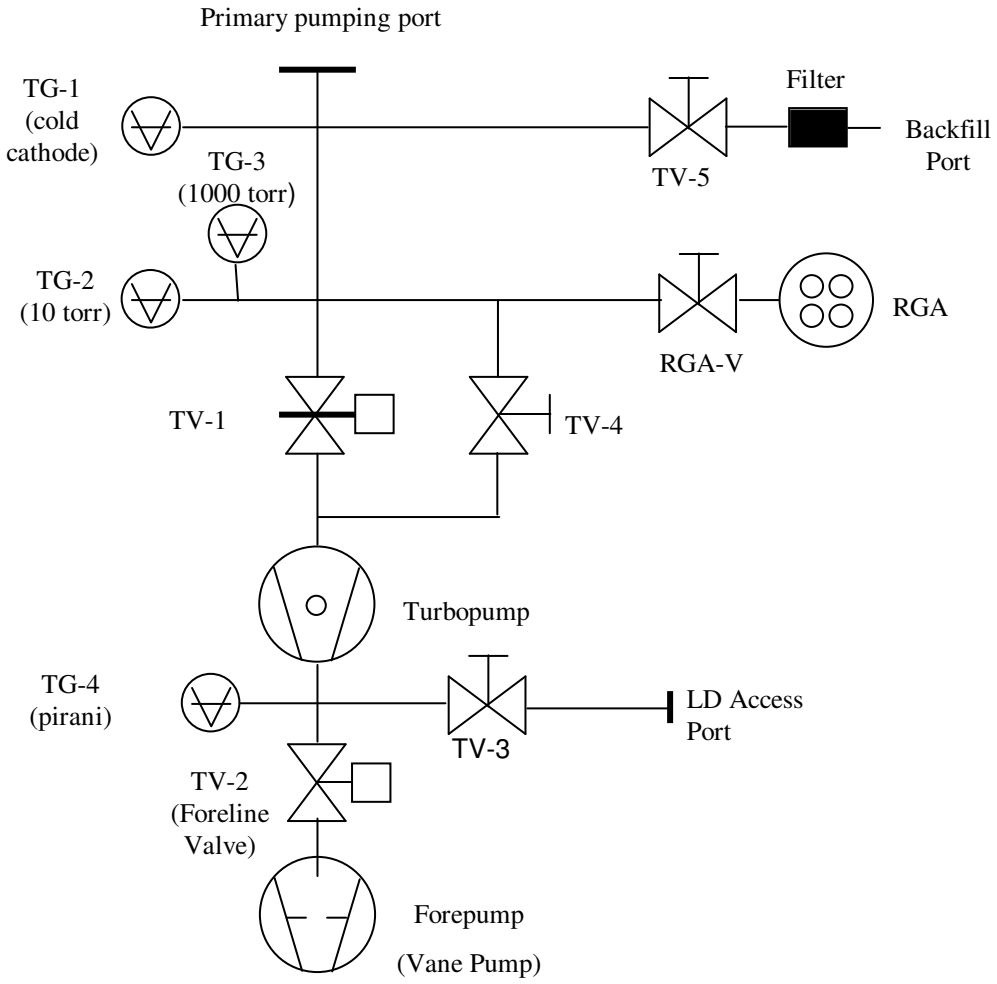

Figure 3. Schematic diagram of Utility Pumping System (UTS)

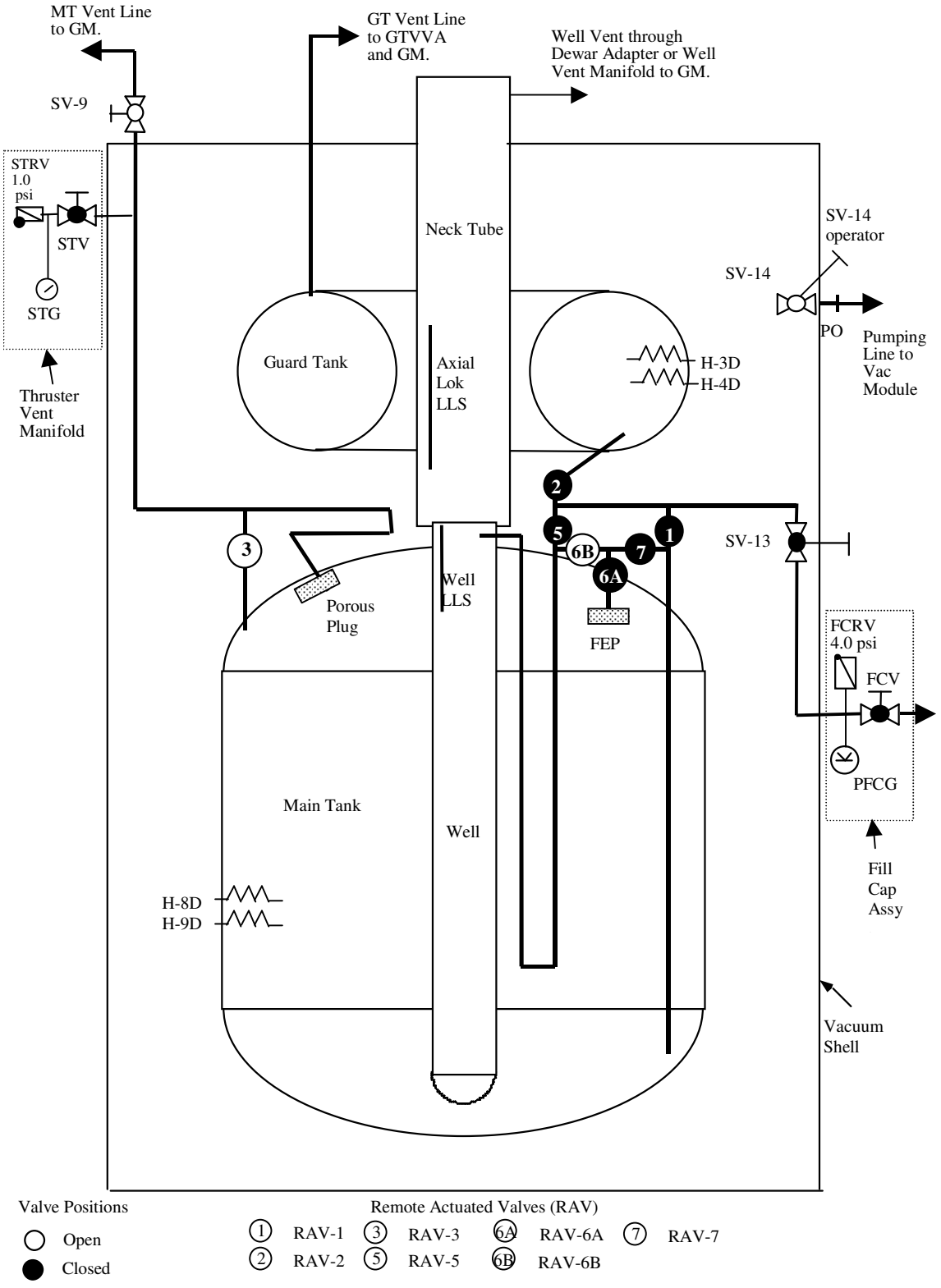

Figure 4. Schematic of Science Mission Dewar plumbing.

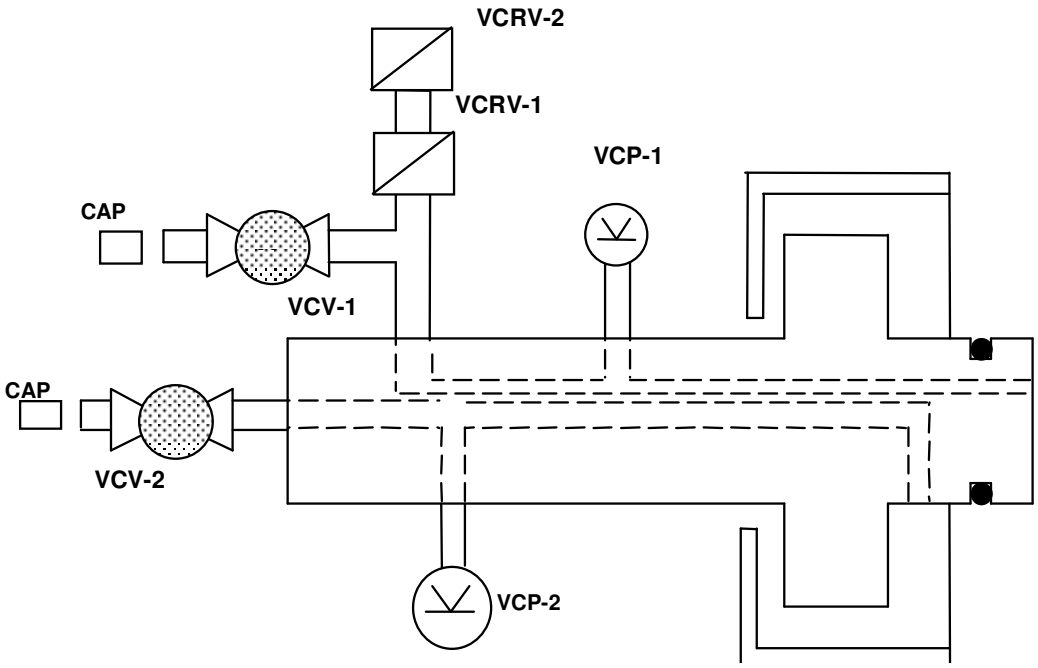

Figure 5. Main Tank Vent Cap Assembly for subatmospheric applications.