GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

CHECK GUARD TANK VENT LINE IMPEDANCE AND ELIMINATE BLOCKAGE

P0874 Rev A
ECO 1347

January 7, 2002

Revised by:

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REVISION RECORD

REVISION	*ECO*	*DESCRIPTION*	*DATE*
A		1) Changed title: Was: “Check Guard Tank Vent Line Impedance”. 2) Incorporated redlines from Op. No. 1804 in all sections. 3) Incorporated pre- and post-op checklist and other requirements of P0875, “GP-B Maintenance and Testing at all Facilities”. 4) Changed heading of section G.8: Was: “Test Purity of Helium Gas”. Deleted purity checking aspect of this section since gas content checking is now done in a separate procedure. 5) In section G.10, added steps to zero PFCG and EG-1a and to cross check their calibrations. 6) In section G.12, eliminated option to abort procedure if pressure difference between the GT vent and the fill exceeds 30 torr. 7) In section G.13, eliminated option to abort procedure if flow through GT is less than 0.1 slpm. 8) In section G.15, updated success criterion based on most recent operational experience. 9) Updated Fig. 2 to be consistent with the current Gas Module configuration.	12/21/01

Table of Contents

List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section	MT	Main Tank
AMI	American Magnetics Inc.	MTVC	Main Tank Vent Cap
AP-1	Vane Pump in Gas module	MTVC-G	Main Tank Vent Cap pressure gauge
APR-x	Pressure regulator x of Gas Module	MTVC-RV	Main Tank Vent Cap relief valve
AV-x	Valve x of Gas Module auxiliary section	MTVC-V	Main Tank Vent Cap valve
CG-x	Gauge x of portable helium pressurization source	NBP	Normal boiling point
CPR-x	Pressure regulator x of portable helium pressurization source	ONR	Office of Naval Research
CV-x	Valve x of portable helium pressurization source	PFCG	Fill Cap assembly pressure Gauge
CN [xx]	Data acquisition channel number	PFM	Pump equipment Flow Meter
DAS	Data Acquisition System	PG-x	Gauge x of Pump equipment
EFM-x	Exhaust gas Flow Meters	PM	Pump Module
EG-x	Gauge x of Gas Module exhaust section	psi	pounds per square inch
EH-x	Vent line heat exchanger in GM	psig	pounds per square inch gauge
EM	Electrical Module	PTD	Payload Test Director
ERV-x	Relief valve of Gas Module exhaust section	PV-x	Valve x of the Pump equipment
EV-x	Valve number x of Gas Module exhaust section	QA	Quality Assurance
FCV	Fill Cap Valve	RAV-x	Remote Actuated Valve-x
FIST	Full Integrated System Test	RGA	Residual Gas Analyzer
GHe	Gaseous Helium	RGA-LV	RGA leak valve (needle valve)
GM	Gas Module	RGA-SOV	RGA shut off valve
GP-B	Gravity Probe-B	SMD	Science Mission Dewar
GSE	Ground Support Equipment	STV	SMD Thruster vent Valve
GT	Guard Tank	SU	Stanford University
GTVC	Guard Tank Vent Cap	SV-x	SMD Valve number x
GTVC-G	Guard Tank Vent Cap pressure gauge	TG-x	Gauge x of Utility Turbo System
GTVC-RV	Guard Tank Vent Cap relief valve	TV-x	Valve x of Utility Turbo System
GTV-G	Guard Tank vent pressure gauge	UTS	Utility Turbo System
GTV-RV	Guard Tank vent relief valve	Vac	Vacuum
GTV-V	Guard Tank vent valve	VCP-x	Vent cap pressure gauge
GTV-Va	Guard Tank Vent line valve for independent pressure regulation	VCRV-x	Vent cap relief valve
HEX-x	SMD heat exchanger x	VCV-x	Vent cap valve
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)	VDC	Volts Direct Current
LHe	Liquid Helium	VF-x	Liquid helium Fill line valve
LHSD	Liquid Helium Supply Dewar	VG-x	Gauge x of Vacuum Module
LHV-x	Liquid Helium Supply Dewar valves	VM	Vacuum Module
LLS	Liquid level sensor	VV-x	Valve x of Vacuum Module
LM	Lockheed Martin Co.	VW-x	Valve x of Dewar Adapter

A. SCOPE

This procedure describes the steps necessary to check the flow impedance of the Guard Tank vent line The procedure is intended for use while the SMD is in the horizontal orientation with the -x axis up. The RGA on the UTS is used to monitor the vent gas from the Guard Tank for atmospheric gases. A baseline pressure drop for a fixed flow rate of Guard Tank vent gas has previously been established. The objectives of this procedure are twofold:

1. Establish flow conditions similar to those in the baseline (i.e., similar pressure drop and flow rate), and compare the observed flow rate to the baseline rate.
2. Attempt to purge the vent system of solidified atmospheric gases.

The steps include:

1. Connect UTS to Gas Module at EV-5 and RGA-SOV (see Figure 1).
2. Connect Vacuum Module to Gas module at EV-21.
3. Leak check all new plumbing (i.e., Vacuum Module and UTS connections).
4. Verify purity of the helium purge gas connected to APR-1.
5. Connect purge line from Access #1 on the Gas module to the Fill Cap Assembly at SV-13 and leak check plumbing.
6. Close off Main Tank venting at SV-9 and initiate flow through Guard Tank to Vacuum Module via SV-13, RAV-2, EV-21 and VV-10.
7. Set upstream pressure to the baseline value by adjusting pressure at the Fill Cap Assembly (PFCG) using AV-9.
8. Adjust flow rate (EFM-3) to baseline value by throttling the valve VV-3 in the Vacuum Module.
9. Record pressures (EG-1a and PFCG) and flow rate (EFM-3) and compare to baseline values.
10. Monitor and record partial pressures of of N_2, O_2, He, and H_2O at RGA (connected at RGA-LV).

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 high bay, LM Building 205, 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.

Only authorized and trained LM and SU personnel are allowed In the high-bay without escort. All personnel working at a height 30 inches or more off the floor are required to have an LM approved air tank within easy reach. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact LM 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 and full-face shields are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

When appropriate, tools or other items used with the potential to damage the SMD or Probe shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury obtain medical treatment as follows
LM **Call 117**

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 EMSYS229 and SU GP-B P0879,
Accident/Incident/Mishap Notification Process.

B.3.3. Contingency Response

Contingency responses to possible equipment troubles or irregularities (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. QA Notification

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

C.2. Red-line Authority

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

C.3. Discrepancies

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

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.
3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The 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. Qualified Personnel

The names of those actually performing this procedure are to be initialed and the name of the person acting as Test Director should be circled.

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

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

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

The Ground Support Equipment includes the Gas Module, the Pump Module, the Electrical Module, The Utility Turbo System (UTS) and the Vacuum Module. The Gas Module provides the capability to configure vent paths, read pressures and flow rates, and pump and backfill vent lines. The Pump Module provides greater pumping capacity than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module. The

Electrical Module contains the instruments listed in Table 1(see the *Electrical Module Manual* for details), and provides remote control of valves in the Gas Module, Pump Module, and SMD. The UTS contains a turbo pump, backed by a vane pump, together with an RGA. It is a general-purpose system used for miscellaneous pumping tasks, leak detection, and gas analysis. The Vacuum Module also contains a turbo pump backed by a vane pump and provides the capability to pump out the SMD vacuum shell.

This procedure uses hardware located in the Gas Module (Figure 2), the Vacuum Module (Figure 3) The UTS (Figure 4) and the Electrical Module (Table 1).

E.3.3. Computers and Software:

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

E.3.4. Additional Test Equipment

Description
RGA located on Utility Turbo System (UTS) see Figure 4
Dwyer flow meter (10 slpm air full scale)

E.3.5. Additional Hardware

Description
Stainless steel flex line and appropriate fitting to connect UTS to Gas Module at EV-5 and RGA-SOV
Stainless steel flex line to connect Vacuum Module to Gas Module at EV-21.

E.3.6. Tools

Description
Torque Wrench, 1-1/4-in socket, 60 in-lb.
Adjustable Wrench (adjustable to1-1/4 in).

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
Ethanol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Braycote Micronic 601

E.4. Instrument Pretest Requirements

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

Table 1. Required Instrumentation and Calibration Status

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
1	DAS	Power Supply, H-P 6627A	A1, A2, A3, A4	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	B1, B2, B3, B4	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A24553 9	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	EH-1	C-19950	No	-
24	GM	Guard Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	EH-2	C-09920	No	-
25	VM	Vacuum Gauge readout, Granville-Phillips 316	VG-3 VG-4	2878	No	-
26	VM	Vacuum Gauge readout,	VG-1, VG-2	96021521	No	-

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
		Granville-Phillips 360	VG-5			

E.5. Configuration Requirements

E.5.1. Main Tank

Liquid in the Main Tank must be at its normal boiling point (NBP). The SMD is horizontal with the –x axis up.

E.5.2. Guard Tank

The Guard Tank is depleted and regulated to a pressure > 0.3 torr above atmosphere.

E.5.3. Well

The Well is evacuated.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure should be less than 1×10^{-4} torr. Document No. P0213 contains the procedure for connecting to and pumping on the SMD vacuum shell.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
    a. Station 200 temperature (CN 01) set at $T \leq 6.5$ 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 DAS watchdog timer and alarm are enabled.

E.5.6. GSE and Non-flight Hardware

1. The SMD is installed in the transportation tilt dolly.
2. A relief valve or flight-like burst disk is installed in place of the SMD fill-line burst disk.
3. The ion-pump magnet must be installed.
4. 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).
5. The Main Tank vent line is disconnected with a vent cap installed.
6. The Guard Tank vent line is connected through the Guard Tank Vent Valve Assembly to the Gas Module with a vacuum insulated line. Document No. P0676, Connect Guard Tank Vent Line to Gas Module, contains the procedures for connecting the Guard Tank vent line.
7. The thruster vent port must be flanged to a shut-off manifold with the

shut-off valve(s) closed (Figures 1 and 5).

8. The Fill Cap Assembly must be installed at SV-13 (Figure 5)

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/ Success Criteria

N/A

E.8. Payload Constraints and Restrictions

N/A

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	***Title***
LMMS-5833394	*Instrumentation Installation*

F.2. Supporting documentation

Document No.	***Title***
LMMC-5835031	*GP-B Magnetic Control Plan*
SU/GP-B P0108	*Quality Plan*
EMSYS229	*Accident/Incident/Mishap Notification Process*
GPB-100153C	*SMD Safety Compliance Assessment*
LMSC-P088357	*Science Mission Dewar Critical Design Review*
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 P0213	*Connect Vacuum Module/ Pump on SMD Vacuum Shell*
SU/GP-B P0676	*Connect Guard Tank Vent Line to Gas Module*
SU/GP-B P0773	*Certification of Electrical Module, Gas Module and DAS*
SU/GP-B P0786	*Certify Vacuum Module after Transport*
SU/GP-B P0787	*Certify UTS after Transport*
SU/GP-B P0875	*GP-B Maintenance and Testing at all Facilities*
SU/GP-B P0879	*Accident/Incident/Mishap Notification Process*

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Record calibration due dates in Table 1 (Page 6).
- Verify that persons actually performing this procedure have initialed their names in Sec. D.3 and the name of the Test Director is circled.
- Complete pre-operations review. (Meeting of all personnel involved in performing procedure to review primary steps and emergency procedures. See appendix 1.)

G.2. Verify Configuration Requirements

G.2.1. Turn on Leak Detector and allow to warm-up for approximately 1/2 hour. Record time of day _____. During this warm-up time, complete sections G.2 through G.4.

G.2.2. Note baseline flow impedance data from Operation Number 1804.

1. Downstream pressure EG-1A: 704 torr.
2. Upstream pressure PFCG: 730 torr.
3. At flow rate EFM-3: 4.5 slpm.

G.2.3. Verify SMD is installed in the transportation tilt dolly.

G.2.4. Verify SMD is horizontal with –x axis up.

G.2.5. Verify thruster vent port is flanged to a shut-off manifold with the shut-off valve STV closed.

G.2.6. Verify that a relief valve or flight burst disk is installed. Record which is installed:_____

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

G.2.8. Verify Fill Cap Assembly installed at SV-13.

G.2.9. Ensure ion-pump magnet installed.

G.2.10. Record Vacuum Shell Pressure.

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] to monitor CN 99 (Vac Ion Pump pressure).
3. When value is steady, record pressure (IP) _____ torr. If pressure is above $1x10^{-4}$ torr, perform procedure P0213, *Connect Vacuum Module / Pump on SMD Vacuum Shell*, to connect Vacuum Module and pump out SMD vacuum shell. Record Date _____ and operation Number _____.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 15 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.2.11. Verify Guard Tank vent line connected through Guard Tank Vent Valve Assembly to Gas Module. If not, perform procedure P0676, *Connect Guard Tank Vent Line to Gas Module,* to connect Guard Tank vent. Record Date_____ and Op. No. _____.

G.2.12. Verify vacuum integrity of external Guard Tank vent line.

- External vent line leak checked within the past six months or following transportation if it has been moved within the past six months. Record Date _____, Op. No. _____ and Leak Rate _____.
- External vent line not leak checked – perform abbreviated vent line connect (Procedure P0676) for leak check and record Operation No. _____.

G.2.13. Verify Main Tank vent line disconnected from Gas Module and vent cap installed.

G.2.14. Visually verify gas cylinders connected to Gas Module at APR-1, APR-2 and APR-3 contain helium. Cylinders must have blue tags with the notation “GP-B Program Specific Gas: Helium” and the vendor label must indicate Grade 5.0 (5-9’s) or higher.

Visual confirmation of helium gas _____ QA.

G.2.15. Record serial number(s) of GHe cylinders._____

_____

G.2.16. Verify DAS alarm system enabled and record set points.

1. ***Station 200 temperature*** – verify [CN 01] on DAS alarm list and that the alarm set point is ≤ 6.5 K. Record set point. _____K
2. ***Top of lead bag temperature*** – verify [CN 28] on DAS alarm list and that the alarm set point is ≤ 6.0 K. Record set point. _____K
3. ***Main Tank pressure*** – verify [CN 49] on DAS alarm list. Set alarm set point to 150 torr diff.

Record set point. ____torr diff

G.2.17. Ensure DAS watchdog timer and alarm enabled.

Record time: _____. Section G.2 complete _____ QA.

G.3. **Verify Gas-Module Configuration and Record Initial Conditions**

G.3.1. Verify Actuator Control for EV-9 is set to “NBP” position.

G.3.2. Verify valve states as indicated in following Table. Record configuration in left-hand column, then verify corresponding valve states.

Verify Initial Valve States		
	Verify Open	***Verify Closed***
1. Main Tank vent		
o Disconnected from GM with vent cap installed.		EV-9, EV-17, MTVC-V
2. Guard Tank vent		
o Connected to GM – Depleted and pressure regulated through APR-2 at EV-23 (Note: visually verified source of He gas at APR-2 in G.2.14.)	EV-16, EV-23 GTV-V	EV-13, EV-20, EV-24 GTV-Va
3. Well Vent		
o Well evacuated		EV-19
4. Remaining EV valves	EV-7a and/or EV-7b.	EV-4, EV-5, EV-6, EV-8, EV-10, EV-11, EV-12, EV-14, EV-15, EV-18, EV-21/22, RGA-LV, RGA-SOV
5. AV valves		All

G.3.3. Record initial temperatures

1. Station 200 CN [01] _____ K.
2. Top of Lead Bag CN [28] _____ K.
3. Temperature at bottom of Main Tank CN [9] _____K.
4. Guard Tank temperature CN [24] _____ K.
5. HEX-1 temperature CN [05] _____ K.

G.3.4. Record initial pressures.

1. Guard Tank (GTV-G) CN [46]:_____ torr (relative to atm.).
2. Guard Tank EG-1a _____ torr.
3. Main Tank (STG) CN [49]:_____ torr diff. (Endevco on Thruster Vent Manifold).

Record time: _____. Section G.3 complete _____ QA.

G.4. **Verify SMD in Standard Configuration**

G.4.1. Using the RAV log book verify that the dewar's internal valves are in the following positions. If not, investigate to ensure previous RAV operations properly recorded. If necessary, note resolution in D-log.

1. ***Open***: RAV-3, and RAV-6B.
2. ***Closed***: RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.

G.4.2. Verify SV-9 open.

G.4.3. Verify SV-13, and FCV, STV, and STV-SOV closed.

G.4.4. Valve Configuration

Open:	Closed:
EV-7a and/or -7b, EV-16, EV-23	All other Evs closed
	All AVs
SV-9, GTV-V	SV-13, FCV
	All TVs
	All VVs
	All RGAs

Record time: _____. Section G.4 complete _____ QA.

G.5. **Connect Vacuum Module and UTS to Gas Module**

Note: in this section and the following section the Vacuum Module and UTS are connected to the Gas Module as indicated in Figure 1. The plumbing internal to the Vacuum Module, UTS, and Gas Module is verified to be leak tight by verifying that a leak check has been performed within the previous six months. The Vacuum Module pumps are isolated from the Gas Module at VV-10, and the Vacuum Module and UTS connections to the Gas Module are leak checked (through EV-5, EV-14, and EV-21) using a helium leak detector connected to the exhaust of the UTS turbopump.

G.5.1. Verify Gas Module leak checked within the past six months or following transportation or alteration if it has been moved or altered within the past six months. Record Date _____ and Operation Number _____. If not perform procedure P0773, *Certification of Electrical Module, Gas Module and DAS*, and record Date _____ and Operation Number _____.

G.5.2. Verify Vacuum Module leak checked within the past six months or following transportation or alteration if it has been moved or altered within the past six months. Record Date _____ and Operation Number _____. If not perform procedure P0786, *Certify Vacuum Module after Transport*, and record Date _____ and Operation Number _____.

G.5.3. Connect Vacuum Module utility pump-out port at VV-10 to Gas Module at EV-21/22 using 1½ or 2 inch flex line.

G.5.4. Release the brakes on the vacuum module and ensure that the wheels will allow the module to move.

G.5.5. Verify UTS leak checked within the past six months or following transportation or alteration if it has been moved or altered within the past month. Record Date _____ and Operation Number _____. If not, perform procedure P0787, *Certify UTS after Transport*, and record Date_____ and Operation Number _____.

G.5.6. Connect UTS to Gas Module at Access #3 (EV-5 and RGA-SOV) as indicated in Figure 1.

Record time: _____. Section G.5 complete _____ QA.

G.6. **Leak Check Vacuum Module and UTS Connections to Gas Module**

G.6.1. Close/verify closed VV-10.

G.6.2. Ensure blank-off installed at ISO-100 pump inlet of Vacuum Module.

G.6.3. Ensure RGA-LV is closed – do not over tighten. Valve will be sealed when the turns counter is at 10.

G.6.4. Start the UTS pumping up to closed EV-5 and closed RGA-SOV as follows:

1. Close/verify closed TV-1, TV-2, TV-3, TV-4, TV-5, TV –6, and RGA-V.
2. Place valve interlock switch in “over-ride” position.
3. Turn on vane pump and converter (Note: converter switch provides power to turbopump controller and pirani and cold-cathode vacuum-gauge display.)
4. Push the red “reset” button to activate the interlock over-ride circuit. (the neon indicator light will come on).
5. Turn “foreline” switch on, which opens TV-2, and verify that the switch is illuminated.
6. 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.)
7. Slowly open TV-4.
8. When TG-4 is approximately 1 torr, open EV-5, EV-14, EV-21, and RGA-SOV.
9. When foreline pressure (TG-4) < 1 torr, push “Start” button on turbo controller.
10. When the ”Normalbetrieb” light illuminates on turbo controller, indicating turbopump is up to speed:
    a. Open gate valve TV-1
    b. Close TV-4.

Note: The UTS turbopump is now pumping up to closed valves VV-10 in the Vacuum Module and closed valves EV-4, EV-8, AV-5, and RGA-LV in the Gas Module.

11. Switch the valve interlock switch to the "protected" position.
12. 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).
13. Record the pumping line pressure (TG-1) _____ torr. Do not leave TG-1 on until it reads on the 10^{-4} scale or lower.

G.6.5. Calibrate Leak Detector and record:

1. Calibrated leak value _____ sccs; cal exp. Date _____.
2. Measured leak value _____ sccs.

_____ QA.

G.6.6. Connect leak detector to the UTS at Leak Detector Access Port and put Leak Detector in test mode.

G.6.7. Put Leak Detector lockout switch to "Vent Disable".

G.6.8. Leak check up to TV-3.

G.6.9. Record: Background _____ sccs, Leak rate_____sccs.

_____ QA.

G.6.10. Verify TG-1 < $4x10^{-5}$, and record:TG-1 _____ torr

G.6.11. Transfer UTS turbo backing from vane pump to Leak detector by slowly opening TV-3 then closing TV-2.

Note: in the following leak check procedure, a successful leak check is indicated by the fact that the leak detector is stable and there is no increase in the leak rate from the initial background. The initial background shall be no greater than 5 x 10^{-5} sccs. The Leak Detector shall be stable to $\pm$ $2x10^{-6}$ sccs.

G.6.12. Leak check all external and reassembled vacuum seals in plumbing including plumbing between VV-10 and EV-21, and plumbing between UTS primary pumping port and EV-5 and RGA-SOV.

G.6.13. Record: Initial Background _____ sccs

G.6.14. Record: Final Background _____ sccs.

_____ QA.

G.6.15. If the leak check is not successful, proceed as follows:

1. Open TV-2.
2. Close TV-3. The Leak Detector is now valved off from the UTS.
3. Close TV-1 and TV-2.

4. Turn off the vane pump and turbopump.
5. Open TV-6 until turbo decelerates, then close TV-6.
6. Connect helium gas source to TV-5 on UTS while purging. Open TV-5 and vent plumbing to atmospheric pressure, then close TV-5.
7. Fix leak.
8. Repeat steps G.6.1 through G.6.13.

G.6.16. When leak check complete, transfer turbo backing from Leak Detector to UTS vane pump as follows:

1. Open TV-2.
2. Close TV-3.

G.6.17. Close EV-5, EV-14, EV-21, and RGA-SOV.

G.6.18. Valve Configuration

Open:	Closed:
EV-7a and/or -7b, EV-16, EV-23	All other Evs closed
	All AVs
SV-9, GTV-V	SV-13, FCV
TV-1, TV-2	All other TVs
	All VVs
	All RGAs

Record time: _____. Section G.6 complete _____ QA.

G.7. **Start Up Vacuum Module**

G.7.1. Verify ISO-100 pump inlet and access port #1 on Vacuum Module are capped.

G.7.2. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7 and VV-10 are closed.

G.7.3. Turn on the rotary vane pump (VP-2 light on) and record pressure VG-2: _____ torr.

G.7.4. Turn Vacuum Module over-ride switch to **on** position (switch up).

G.7.5. Open VV-4, VV-1, and VV-6 (lighted switches) and pump up to closed valve VV-10.

G.7.6. Attach Wet Test Meter to exhaust of Vacuum Module pump (VP-2).

G.7.7. Record zero offset, if any, of Wet Test Meter (let run for at least two minutes before recording) _____ slpm.

G.7.8. When VG-3 < 10 mtorr:

1. Open VV-10 and EV-21.
2. Close VV-1.

Note: Guard Tank can now be pumped by opening EV-4, in Gas Module, and throttle valve VV-3, in Vacuum Module.

G.7.9. Ensure output of Wet Test Meter connected to DAS and operating properly.

G.7.10. Valve Configuration

Open:	Closed:
EV-7a and/or -7b, EV-16, EV-21 EV-23	All other Evs closed
	All AVs
SV-9, GTV-V	SV-13, FCV
TV-1, TV-2	All other TVs
VV-4, VV-6, VV-10	All other VVs
	All RGAs

Record time: _____. Section G.7 complete _____ QA.

G.8. **Set Up and Verify RGA Operation**

G.8.1. Set up RGA on UTS as follows:

1. Slowly open RGA-V on UTS.
2. Verify TG-1 pressure is $<5x10^{-5}$ torr
3. Turn on RGA on UTS.
4. Set up RGA in selected peak mode specifying gases H_2, He, H_2O, N_2, O_2, and CO_2.
5. Record name of data file _____.

G.8.2. Ensure RGA-LV closed. Do not over-tighten.

G.8.3. Open RGA-SOV.

G.8.4. Record RGA background partial pressures in following Table.

	H_2	He	N_2	O_2	H_2O	CO_2
Partial Pressure						

_____ QA.

G.8.5. Set AG-3 to ~1 psig by adjusting APR-1.

G.8.6. Verify Access #1 on Gas Module capped off.

G.8.7. Open AV-1 and AV-3.

G.8.8. Open AV-9, EV-12, EV-8, and EV-14. Helium gas is now up to VV-3.

G.8.9. Open VV-3 to pump on Gas Module and adjust to maintain VG-4 at approximately 700 torr.

G.8.10. Maintain AG-2a at 760 torr by adjusting AV-9.

G.8.11. Verify Wet Test Meter performing properly and record flow rate CN [121] _____ slpm

G.8.12. Slowly open RGA-LV maintaining He partial pressure between $5x10^{-5}$ and $1x10^{-4}$ at RGA.

G.8.13. Record partial pressures in following Table.

	H_2	He	N_2	O_2	H_2O	CO_2
Partial Pressure						

G.8.14. Shut down Ghe flow as follows:

1. Close RGA-LV. (Do not over-tighten.)
2. Close VV-3.
3. Close AV-9, AV-3, and AV-1.
4. Close EV-12, EV-8, and EV-14.

G.8.15. Valve Configuration

Open:	Closed:
EV-7a and/or -7b, EV-16, EV-21 EV-23	All other Evs closed
	All AVs
SV-9, GTV-V	SV-13, FCV
TV-1, TV-2	All other TVs
VV-4, VV-6, VV-10	All other VVs
RGA-V, RGA-SOV	All other RGAs

Record time: _____. Section G.8 complete _____ QA.

G.9. **Connect Purge Line to SV-13 and Leak Check**

G.9.1. Verify SV-13 closed.

G.9.2. Record pressure at Fill Cap Assembly and verify > 760 torr. (PFCG) _____.

G.9.3. Remove Fill Cap assembly and Access-1 exit and change out O-rings to helium-unsaturated O-rings.

G.9.4. Reinstall Fill Cap Assembly.

G.9.5. Verify FCV closed.

G.9.6. Install/verify installed 1.5 or 2-in diameter flex pumping line from FCV of Fill Cap Assembly to Leak Detector: use fresh helium-unsaturated O-rings .

Note: in the following leak check procedure, a successful leak check is indicated by the fact that the leak detector is stable and there is no increase in the leak rate from the initial background. The initial

background shall be no greater than 5 x 10^{-5} sccs. The Leak Detector shall be stable to $\pm$ 2x10^{-6} sccs.

G.9.7. Perform leak check on all joints and components up to FCV.
Record:

Initial Background _____ sccs

Final background _____ sccs.

_____ QA.

G.9.8. Place Leak Detector in "Hold" mode.

G.9.9. Open FCV and leak check Fill Cap Assembly:
Record:

Initial Background _____ sccs

Final background _____ sccs.

_____ QA.

G.9.10. When leak check successfully completed:

1. Zero PFCG.
2. Close FCV.
3. Vent Leak Detector.

Record time: _____. Section G.9 complete _____ QA.

G.10. **Connect Purge Line From SV-13 to Gas Module and Leak Check**

G.10.1. Disconnect flex line from Leak Detector and connect to Gas Module Access-1.

G.10.2. Turn on pump AP-1.

G.10.3. Open AV-8 and AV-3: now pumping up to FCV.

G.10.4. When AG-2b < 50 mtorr, open FCV: now pumping up to SV-13.

G.10.5. When AG-2b < 20 mtorr close AV-8 and perform leak-up test for 20 minutes.

Time (min)	0	4	8	12	16	20
AG-2b (torr)						

G.10.6. Verify leak back data is less than 20 mtorr rise in last 12 minutes.

_____ QA.

G.10.7. Cross Check PFCG / EG-1a and Equalize GT Fill Line and Vent Line Pressures:

1. Close EV-16.
2. Open AV-6 and pump until EG-1b < 100 mtorr.
3. Zero EG-1a.
4. Close AV-6.
5. Ensure AV-9 and EV-10 are closed.
6. Open AV-8, AV-1, and EV-12.
7. When AG-2a < 100 mtorr, close AV-8, AV-3.
8. Open EV-10.
9. Slowly open AV-9 until EG-1a reaches the pressure recorded at G.3.4 and close AV-9.
10. Open EV-16 to equalize fill line and vent line pressures. (Wait at least 5 minutes to be sure.)
11. After pressures have stabilized, record:
    a. EG-1a: _____torr
    b. PFCG: _____torr

_____ QA.

G.10.8. Close AV-1, EV-10, EV-12.

G.10.9. Valve Configuration

Open:	Closed:
EV-7a and/or -7b, EV-16, EV-21 EV-23	All other Evs closed
No AVs	All AVs
SV-9, GTV-V, FCV	SV-13
TV-1, TV-2	All other TVs
VV-4, VV-6, VV-10	All other VVs
RGA-V, RGA-SOV	All other RGAs

Record time: _____. Section G.10 complete _____ QA.

G.11. **Set Up Data Acquisition System**

Note: refer to DAS operating instructions for information on configurations and mechanics of keyboard/mouse operation.

G.11.1. Verify DAS set to configuration 4Q.

G.11.2. Set up DAS on 12-hr plot to record temperatures and pressures.

G.11.3. Set DAS to fast scan mode using [other menus], [data config], [fast scan]

G.11.4. Start “Special Data Cycle” by using [Other Menus] + [Special Data Col] + [Use Pre-Selected] + [Init. Collectn] + [Enter] Use channels [01], [28], [40], [24], [05], and [49]. Record filename: _____

G.11.5. Ensure printer is displaying special Data Cycle data.

G.11.6. Prepare to enter flow data from EFM-3 at the DAS keyboard.

G.11.7. Set data cycle to 15 minutes.

Record time: _____. Section G.11 complete _____ QA.

G.12. **Measure Guard Tank Pressure and Prepare to Introduce Purge Gas**

G.12.1. Enter comment to DAS “Prep to purge GT”.

G.12.2. Backfill internal fill line and record pressures:

1. Open SV-13 (this backfills the internal fill line and prevents any gross flow of gas into or out of the Guard Tank when RAV-2 is opened).
2. Close FCV.
3. Record:
    a. Pressure at PFCG _____ torr
    b. Guard Tank vent line pressure EG-1a _____ torr
    c. Date/Time _____/_____.

G.12.3. Open RAV-2 as follows to measure Guard Tank Pressure at PFCG:

1. Verify all RAV selection switches are in the OFF position.
2. Turn on RAV power supply and adjust current limit to 1.8 ± 0.05 A.
3. Adjust power supply to 28 ± 0.01 VDC.
4. Power up RAV controller No. 2.
5. Position selection switch to RAV-2.
6. Record initial switch status: Open: θ θ Closed: θ θ.
7. Activate controller No. 2 to open RAV-2 and record:
    a. Run time _____ seconds
    b. Current draw _____ amp
    c. Time of day _____
8. Record final switch status: Open: θ θ Closed: θ θ.

    Note: in the event that RAV-2 fails to operate refer to Appendix at end of procedure.

9. When convenient, record operation in RAV log book.

G.12.4. Record pressures and time:

1. Guard Tank pressure PFCG _____ torr
2. Guard Tank vent line pressure EG-1a _____ torr.
3. Date/Time _____/_____.

Record time: _____. Section G.12 complete _____ QA.

G.13. **Flow Helium Gas Through RAV-2 and Guard Tank**

G.13.1. Record initial Main Tank pressure CN [49] _____ torr diff.

G.13.2. Record Pressures:

1. Vacuum Module VG-4 _____ torr.
2. Gas Module EG-1a _____ torr.
3. Guard Tank GTV-G _____ torr.

G.13.3. Begin data recording on Data Sheet.

G.13.4. Set AG-3 to ~2 psig by adjusting APR-1.

G.13.5. Close EV-23. (Removes GT independent pressure regulation).

CAUTION

In the following step the Main Tank vent valve SV-9 is closed to keep the vent gas from cooling the neck tube heat exchangers. Maintain a close watch on the Main Tank pressure CN [49]. If at any time during the remainder of the procedure the pressure at CN [49] rises to 150 torr diff, adjust open SV-9 and MTVC-V as necessary to reduce pressure and abort as detailed below.

Monitor temperatures at top of lead bag CN [28] [29] [40] and [41]. If temperature reaches 6.5 K immediately

- **turn off all heaters**
- **adjust open SV-9 (and MTVC-V if necessary)**
- **close out procedure per G.15.11.**

In the following steps ensure that a dedicated test director or test engineer is assigned to monitor temperatures and pressures, including data plots and trends.

G.13.6. Close SV-9.

G.13.7. Open AV-1, AV-3, and AV-9.

G.13.8. Open FCV.

G.13.9. Open EV-4.

G.13.10. Open VV-3 to start flow through Guard Tank.

G.13.11. Adjust VV-3 and AV-9 to maintain 730 ± 10 torr pressure at PFCG and 3.5 slpm at EFM-3.

Note: Gauge is calibrated for air. For purposes of comparison to the baseline value, do not convert to helium.

G.13.12. Enter comment into the DAS: “Start GHe flow through GT”.

G.13.13. Valve Configuration

Open:	Closed:
EV-4, EV-7a/-7b, EV-16, EV-21	All other Evs closed
AV-1, AV-9	All other AVs
SV-13, GTV-V, FCV	SV-9
TV-1, TV-2	All other TVs
VV-3, VV-4, VV-6, VV-10	All other VVs
RGA-V, RGA-SOV	All other RGAs
RAV-2	

Record time: _____. Section G.13 complete _____ QA.

G.14. **Record Initial Vent Flow**

G.14.1. When pressure and flow rate are steady, record the following data and compare to baseline values recorded in G.2.2.

1. Downstream pressure EG-1a _____. torr.
2. Upstream pressure PFCG _____ torr.
3. Flow rate EFM-3 (high flow) / WTM (low flow): _____ slpm. (Indicate which meter.)

G.14.2. Record temperatures

1. HEX-1 CN [05] _____ K.
2. HEX-2 CN [06] _____ K.
3. Guard Tank CN [24] _____ K.

G.14.3. Record partial pressure of nitrogen (from RGA) _____ torr. (This establishes a baseline for nitrogen partial pressure)

G.14.4. Enter flow rate EFM-3 in DAS and record data in Data Sheet.

Record time: _____. Section G.14 complete _____ QA.

G.15. **Heat Guard Tank**

G.15.1. Verify lead bag temperatures and Main Tank pressure alarmed.

G.15.2. Continue flow adjusting APR-1, AV-9 and VV-3 to achieve maximum flow possible, while maintaining PFCG near atmospheric pressure and EG-1a > 1 torr (this ensures viscous flow conditions throughout entire flow loop).

G.15.3. Record data at 10-minute intervals and watch DAS plot to observe Guard Tank flow. **Note**: for a fixed upstream pressure (PFCG) and fixed flow rate (EFM-3), if EG-1a goes up with time, the implication is that the vent line plug is diminishing.

G.15.4. Slowly open RGA-LV to obtain a He partial pressure at RGA between $5x10^{-5}$ and $1x10^{-4}$ torr. During the monitoring process adjust RGA-LV as

necessary to maintain a constant partial pressure of helium at the RGA.

G.15.5. Record RGA file name _____.

G.15.6. Continue the flow of warm gas, heating as necessary and safe, to achieve a temperature at HEX-1 > 50 K.

Note: Option 1 and Option 2 below are to be performed at the discretion of the test director, based on trending of the Main Tank pressure and lead bag temperatures. The Main Tank pressure (STG is a differential gauge read at CN [49]) should not be allowed to go higher than 150 torr differential. The lead bag temperature must be kept below a maximum of 7.2 K. Initiate corrective action as indicated in CAUTION if any of the lead bag temperatures approach 6.5 K.

G.15.7. Before proceeding, record:

1. Downstream pressure EG-1a _____. torr.
2. Upstream pressure PFCG _____ torr.
3. Flow rate EFM-3 / WTM _____ slpm. (Indicate which meter.)

G.15.8. **(Option 1)** Heat Guard Tank heater H-3D.

1. Turn on power supply for Guard-Tank heater (H-3D)
2. Set power supply current limit to 0.07 amps.
3. Set voltage to 10 VDC and record: (**Note**: Each power supply channel is capable of 50 V maximum).
   V _____Vdc and I _____A and time of day _____.
4. Increase heater voltage as necessary to raise temperature at HEX-1 > 50 K.

G.15.9. **(Option 2)** Add additional heat to Guard Tank heater H-4D.

1. Turn on power supply for Guard-Tank heater (H-4D).
2. Configure power supply for 150 V limit. This requires linking 3 output channels in series.
3. Set power supply current limit to 0.2 amps.
4. Set initial voltage to 10 VDC and record:
   V _____Vdc and I _____A and Time of day _____.
5. Increase heater voltage as necessary to raise temperature at HEX-1 to 50 K.

G.15.10. Continue flow of gas until one of the following results is obtained.

- **Temperature at top of lead bag or Main Tank pressure out of bounds – vent line still partially blocked.** Abort procedure and continue as follows:

  1. Turn off Guard Tank heaters.
  2. Adjust open SV-9 to begin slowly venting Main Tank.
  3. Close VV-3 and VV-10.
  4. Close RGA-LV.
  5. Verify APR-2 set to regulate at 2 psig.
  6. Open EV-23 (this backfills Gas Module and keeps GT vent line under positive pressure).
  7. Allow pressure at EG-1a to rise to 760 torr.
  8. Close EV-21 and EV-4 (GT now pressurized through APR-1).
  9. Verify valve configuration.

Open	Closed
EV-7a/-7b, EV-16, EV-23	All other EVs closed
AV-1, AV-9	All other AVs
SV-9, SV-13, GTV-V, FCV	
TV-1, TV-2	All other TVs
VV-4, VV-6	All other VVs
RGA-V, RGA-SOV	
RAV-2	

  10. Skip to Section G.17 and complete procedure.

- **Vent line successfully unblocked:**

  Note: Success is defined by a flow conditions similar to those recorded at G.2.2, **and** a stable partial pressure of N_2, as read at the RGA, less than 2 times the original value (recorded at G.14.3). Use the results recorded at G.10.8 to correct for any calibration difference between PFCG and EG-1a.

11. Record pressures and flow rate.
    a. Partial pressure of nitrogen (from RGA) _____ torr.
    b. Downstream pressure EG-1a _____. torr.
    c. Upstream pressure PFCG _____ torr.
    d. Flow rate EFM-3 _____ slpm.
12. Turn off Guard Tank heaters.
13. Adjust open SV-9 to begin slowly venting Main Tank.
14. Close VV-3, and VV-10. Close RGA-LV.
15. When EG-1a greater then 760 torr, close EV-21 and EV-4.
16. Close AV-9 and AV-1.
17. Close RAV-2 as follows:
    a. Verify controller #2 powered up and controller #2 RAV selection switch set to RAV-2. If not, perform the following steps:
       i. Ensure controller #2 selection switch in off position
       ii. Power up controller #2.
       iii. Position controller #2 selection switch to RAV-2.
    b. Record initial switch status: Open: θ θ Closed: θ θ.
    c. Activate controller No. 2 to close RAV-2 and record:
       i. run time: _____ seconds
       ii. current draw: _____ amp
       iii. time of day: _____
    d. Record final switch status: Open: θ θ Closed: θ θ.

       Note: in the event that RAV-2 fails to operate refer to Appendix at end of procedure.

    e. When convenient, record operation in RAV log book.
18. Position controller No. 2 selection switch to off.
19. Power down RAV controller No. 2
20. Power-off RAV power supply.
21. Open EV-23 to provide independent regulation of Guard Tank pressure.
22. Continue opening SV-9 slowly while monitoring Guard Tank pressure (GTV-G) to ensure it remains positive relative to atmospheric pressure. Record data in attached Data Sheet.

23. Valve Configuration.

Open:	Closed:
EV-7a/-7b, EV-16, EV-23	All other Evs closed
	All AVs
SV-9, SV-13, GTV-V, FCV	
TV-1, TV-2	All other TVs
VV-4, VV-6	All other VVs
RGA-V, RGA-SOV	RGA-LV
	RAV-2

24. Complete procedure by performing Sections G.16 and G.17.

Record time: _____. Section G.15 complete _____ QA.

G.16. **Condition SMD Fill Line:**

G.16.1. Verify AP-1 on.

G.16.2. Open AV-3 and AV-8 and pump SMD fill line via Access-1/SV-13.

G.16.3. Evacuate the Dewar fill line to < 25 mtorr as measured at AG-2b.

G.16.4. Close SV-13 and torque to 60 +/- 5 in-lbs.

G.16.5. Close FCV.

G.16.6. Close AV-8.

G.16.7. Open AV-1.

G.16.8. Open AV-9 until pressure reaches 1.5 psig as read on gauge AG-1 and then close AV-9.

G.16.9. Close AV-1 and AV-3.

G.16.10. Record:
Pressure at PFCG :_____ and time of day: _____

G.16.11. Monitor pressure in Fill Cap Assembly (PFCG) for 15 minutes to be assured that no gas is leaking into the Fill Cap Assembly (i.e. it maintains vacuum). After 15 minutes record:
Pressure at PFCG :_____ and time of day: _____

G.16.12. Open FCV to bring Fill Cap Assembly up to atmospheric pressure and record PFCG _____ torr.
Close FCV.

G.16.13. Continue to monitor the Guard Tank pressure.

G.16.14. Valve configuration.

Open:	Closed:
EV-7a/-7b, EV-16, EV-23	All other Evs closed
	All AVs
SV-9, GTV-V	SV-13, FCV
TV-1, TV-2	All other TVs
VV-4, VV-6	All other VVs
RGA-V, RGA-SOV	RGA-LV

Record time: _____. Section G.16 complete _____ QA.

G.17. **Establish Final Configuration**

G.17.1. Shut down UTS.

1. Close RGA-SOV on Gas Module and RGA-V on UTS.
2. Close TV-1 and TV-2.
3. Turn off fore pump and turbo pump.
4. Open TV-6 to spin down turbo.
5. Close TV-6.

G.17.2. Condition and shut down Vacuum Module as follows.

1. Close VV-4 and VV-6.
2. Verify all other VV valves closed.
3. Turn Vacuum Module over-ride switch to **off** position (switch down).
4. Turn off vane pump VP-2.

G.17.3. Visually verify gas cylinders connected to Gas Module at APR-1, APR-2 and APR-3 contain helium. (Note: RGA verification performed in Section G.8.)

G.17.4. Verify gas cylinders connected to APR-2 Record serial number(s) of GHe cylinders._____

_____

G.17.5. Record Main Tank pressure (STG): _____ torr:

G.17.6. Ensure all RAV operations recorded in log book.

G.17.7. Input comment to DAS “Completed check of GT vent line impedance”.

G.17.8. Stop Special Data Cycle by using [Other Menus] + [Special Data Col] + [Stop Data Col].

Note: refer to DAS operating instructions for information on configurations and mechanics of keyboard/mouse operation.

G.17.9. Record Vacuum Shell Pressure.

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 15 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.17.10. Set DAS to normal scan mode using [other menus], [data config], [normal scan]

G.17.11. 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:
  1. Station 200 set point [CN 1] _____ K (≤ 6.5 K)
  2. Top of Lead Bag set point [CN 28] _____ K (≤ 6.0 K)

CAUTION

The Guard Tank may tend to subcool following the completion of this procedure. Establish continuous monitoring of the Guard Tank pressure by placing it on the DAS alarm list.

G.17.12. Continue monitoring Guard Tank pressure until Main Tank flow rate and Guard tank pressure stabilize.

G.17.13. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr diff.

G.17.14. Ensure DAS watchdog timer and alarm enabled.

G.17.15. Ensure that Vac-ion pump is off.

Record time: _____. Section G.17 complete _____ QA.

H. **PROCEDURE COMPLETION**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

DATA SHEET 1

Date/ Time	$T_{Pb\ bag}$ CN[28] (K)	$T_{Pb\ bag}$ CN[29] (K)	$T_{Pb\ bag}$ CN[40] (K)	$T_{Pb\ bag}$ CN[41] (K)	STG CN[49] (torr)	T_{GT} CN[24] (K)	$T_{s\text{-}200}$ CN[01] (K)	$T_{HEX\text{-}1}$ CN[05] (K)	$T_{HEX\text{-}4}$ CN[28] (K)	Ion Pump CN[99] (torr)	GT heaters H3D/H4D (watt)	Comments

DATA SHEET 2

Date/ Time	EFM-3 (slpm air)	Wet Test Meter CN[121] (slpm)	PFCG (torr)	EG-1a (torr)	VG-4 (torr)	TG-1 (torr)	N2 Partial Pressure (torr)	O2 Partial Pressure (torr)	He Partial Pressure (torr)	H2O Partial Pressure (torr)	Comments

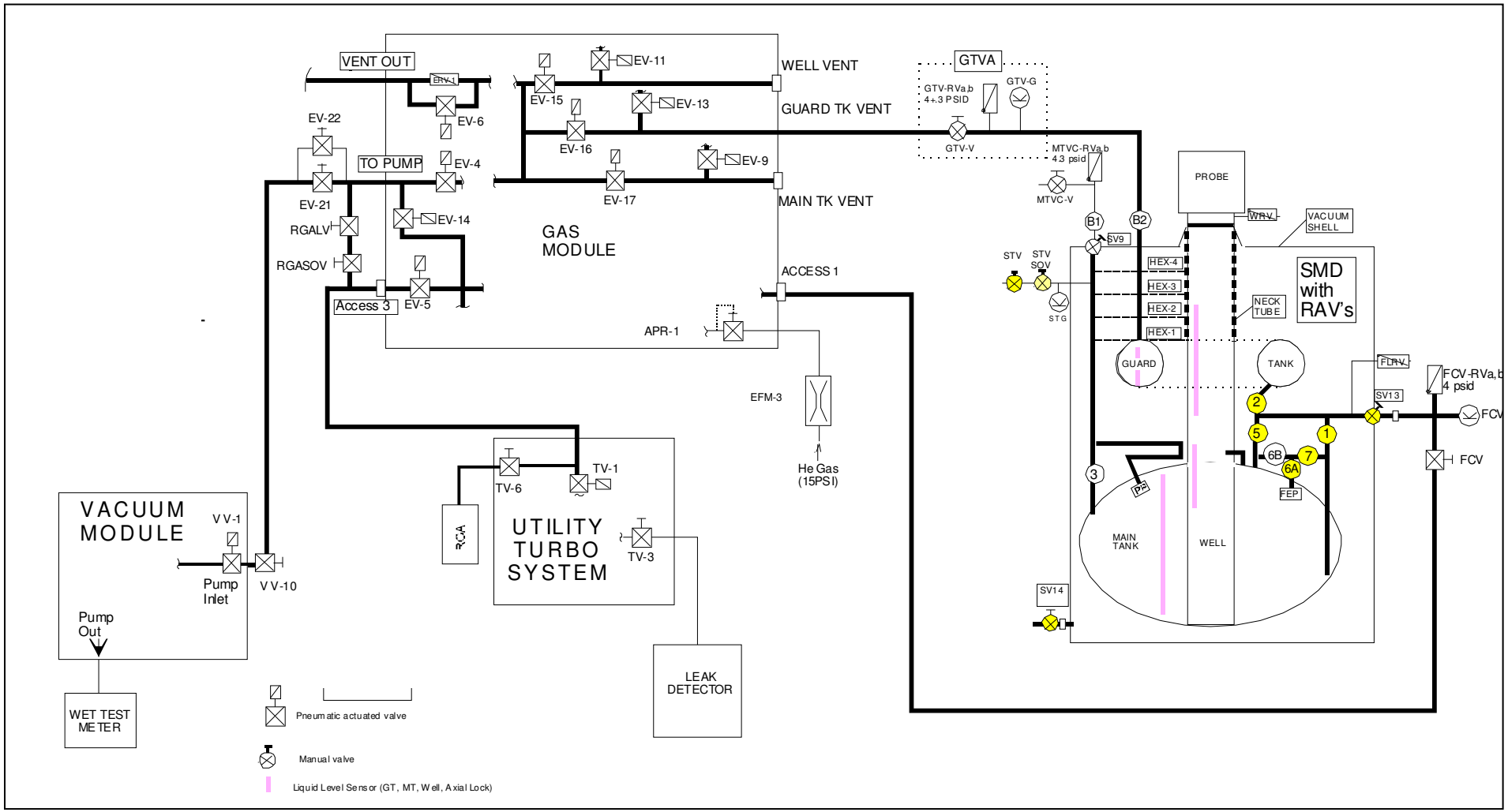

Figure 1. Block diagram showing interfaces between Utility Pumping System (UTS), Vacuum Module Gas Module, and SMD.

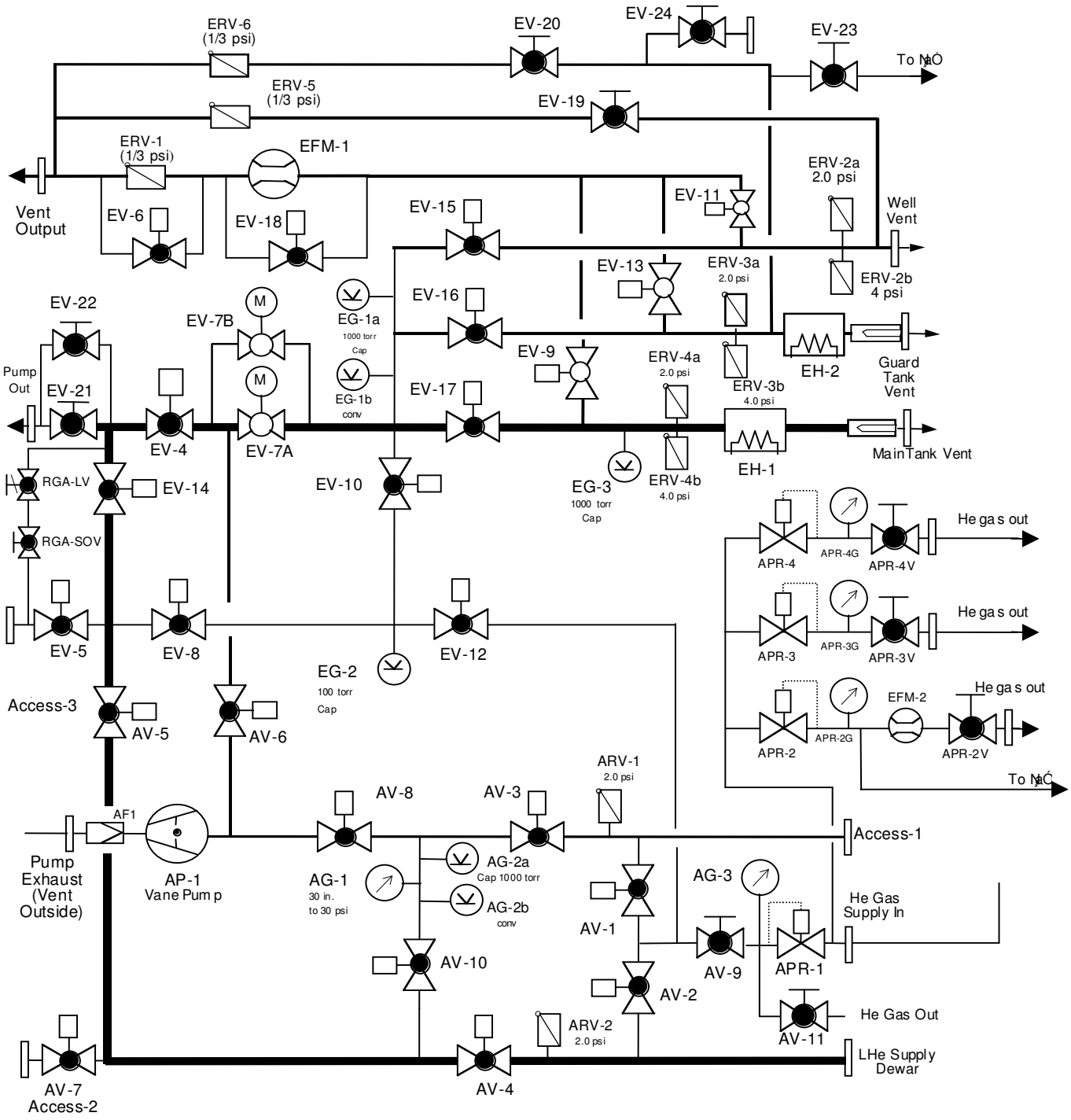

Figure 2. Schematic of Gas Module including the flowmeter EFM-3.

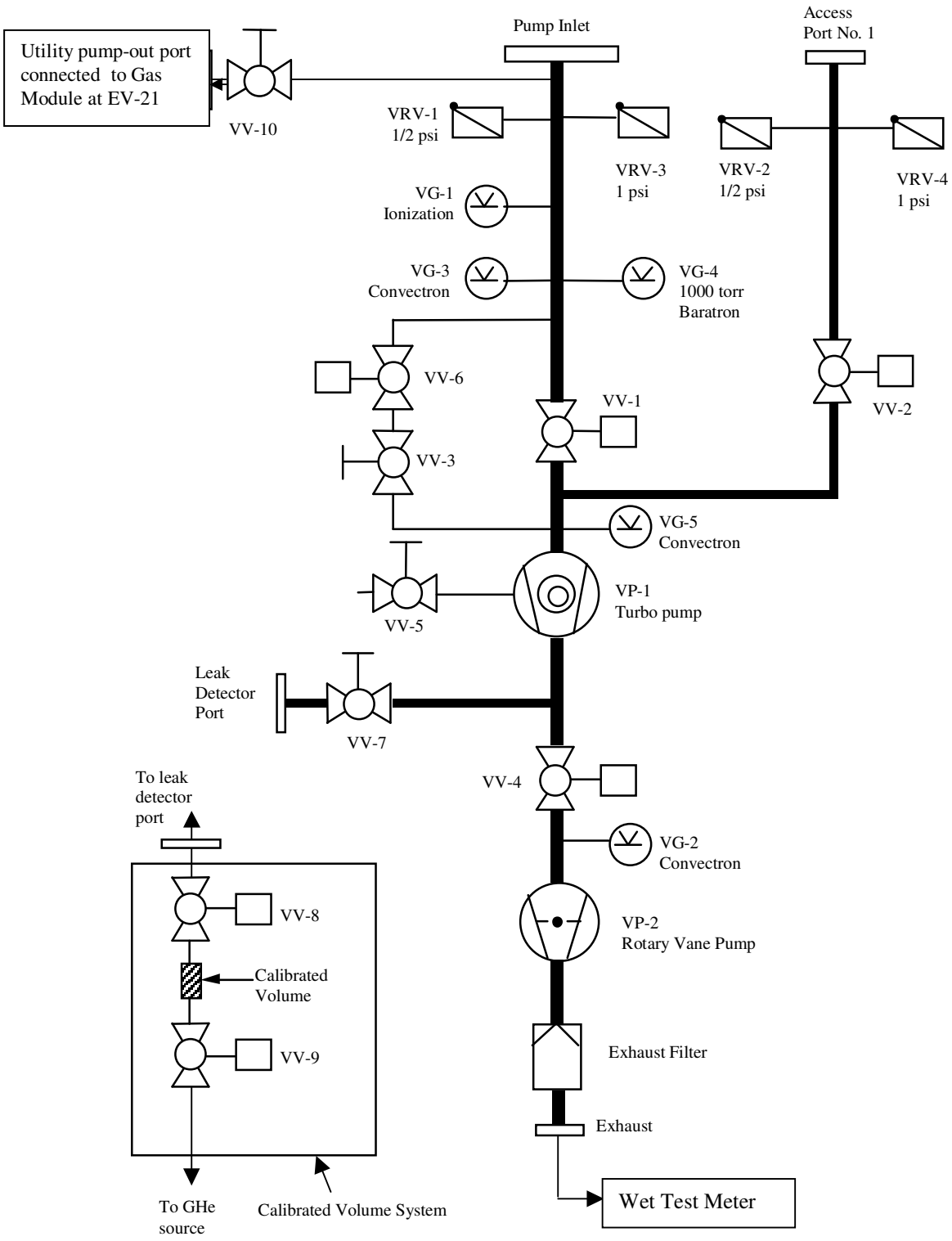

Figure 3 Schematic diagram of Vacuum Module indicating interface with Gas Module at EV-21.

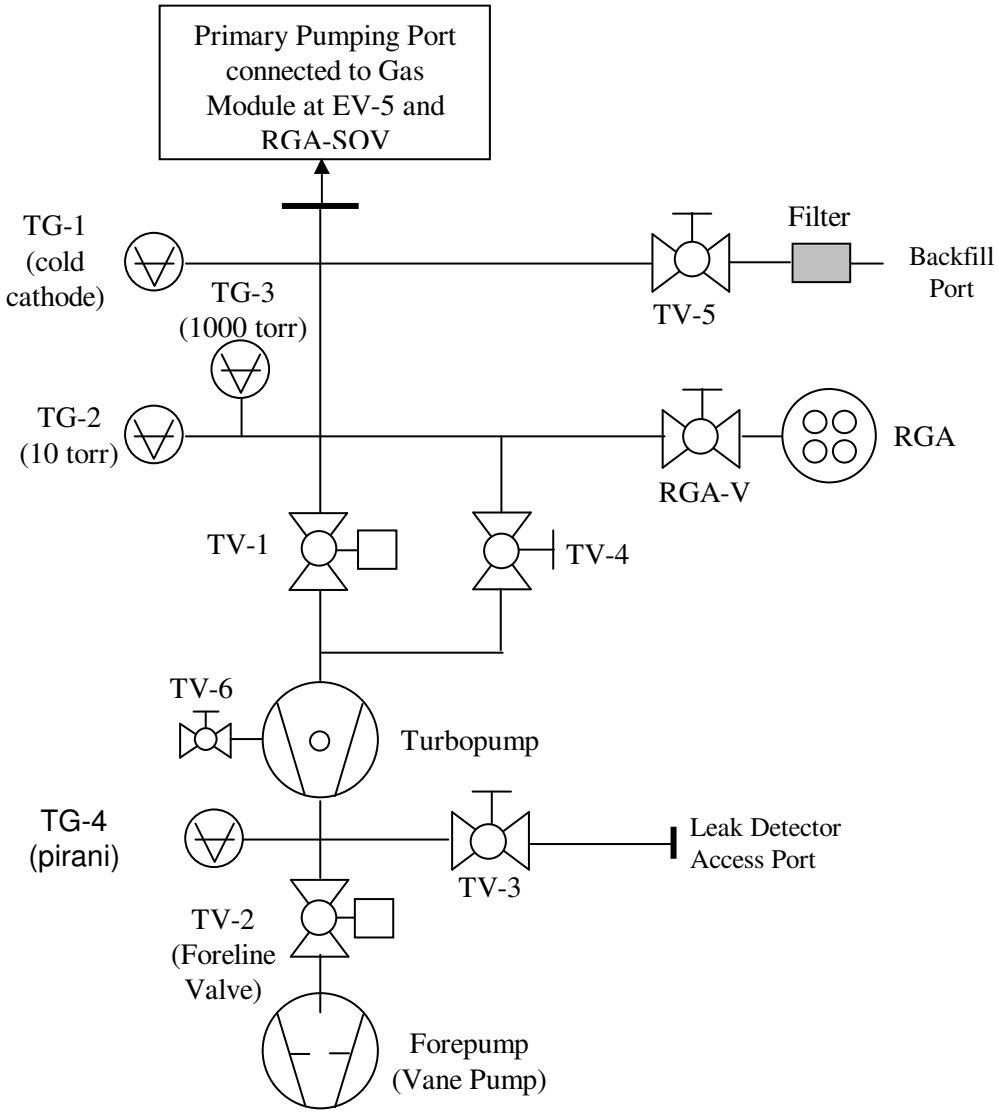

Figure 4. Schematic diagram of Utility Turbo System (UTS) showing interfaces with Gas Module.

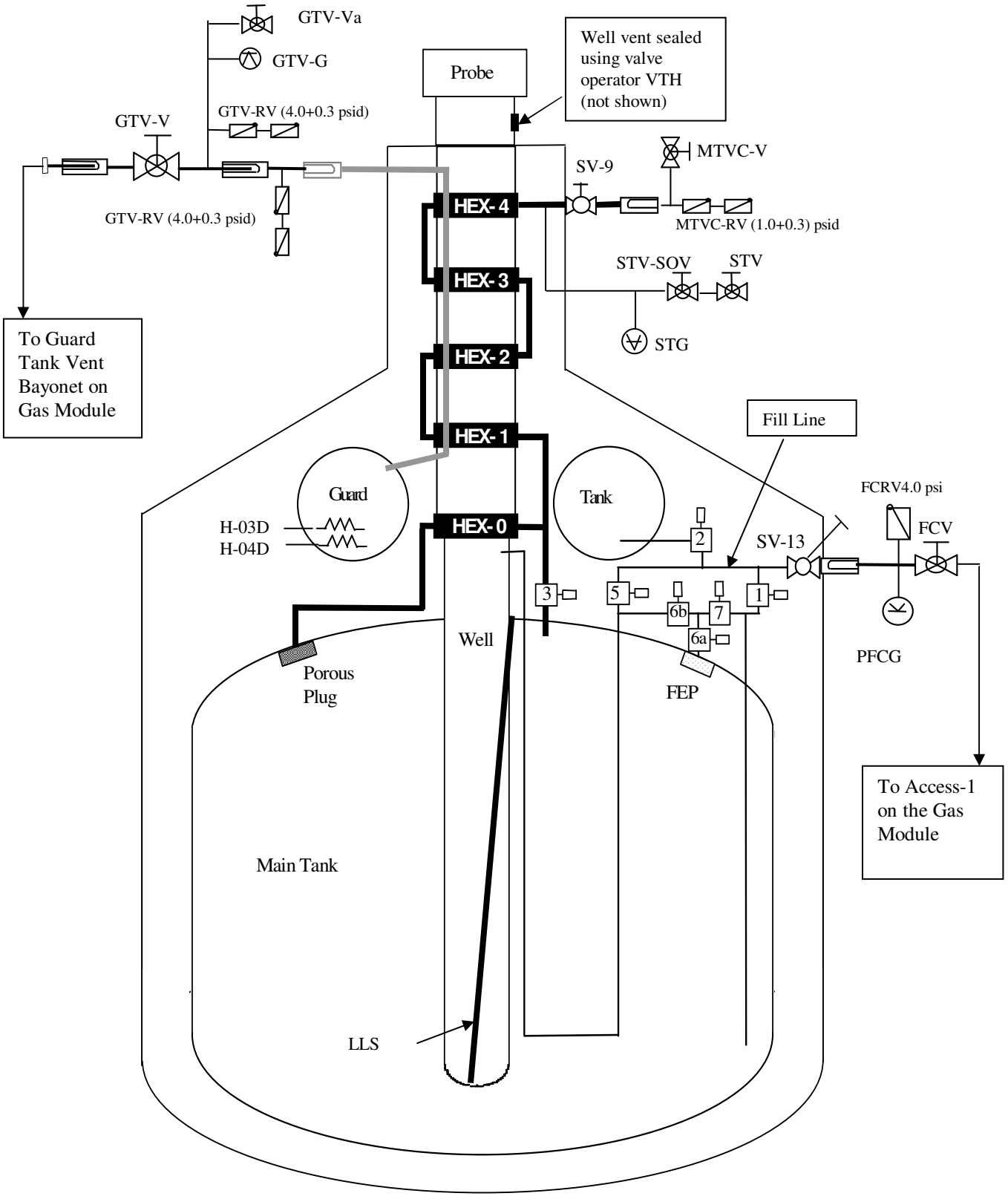

Figure 5 Schematic representation of SMD showing interfaces with Gas module.

Appendix 2

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 knows 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. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

Appendix 2

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: _____		

Appendix 3 – Contingency Responses

Condition	Circumstance	Response
Power Failure	Before Sec. G.12	Wait for power restoration
	Sec. G.12 or later	Safe mode: Open/verify open EV-23, bleed down main tank through SV-9
Failure of RAV-2 to open	On valve operation	Re-attempt to open; if lights do not immediately indicate that the valve is open, abort procedure and declare discrepancy.
Failure of RAV-2 to close	On valve operation	Re-attempt to close; if lights do not immediately indicate that the valve is closed, close SV-13 and establish safe mode (above)
Failure of APR-1 (full open)	Sec, G.8 or later.	Down regulate regulator at helium supply to achieve 1 - 2 psig at AG-3.
Burst disk rupture (MT/GT)	Any time	Evacuate room