

GRAVITY PROBE B PROCEDURE FOR SCIENCE MISSION DEWAR

DISCONNECT MAIN TANK VENT LINE FROM GAS MODULE – MAIN TANK AT NBP

THIS DOCUMENT CONTAINS THE USE OF HAZARDOUS MATERIALS

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PO675B

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Revision Record

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A	1342	Added Hazardous Materials comment to title Page. Added QA inspection points Added minor redlines Added step to verify purity of helium gas Modified sections B.2.2. and B.3.1 to reflect new location of SMD in Lockheed Martin building 205 Added sections B.2.3 "Other Hazards", B.3.2 "Hardware Mishap", B.3.3 "Contingency Response". Updated Qualified Personnel List Added EM SYS229 Added Appendix Contingency Responses Added pre/post checklist tables Updated Figures	10/8/01
B	1332	Updated Scope Updated Figures Modified sections B.2.2. and B.3.1 to reflect location of SMV in all Lockheed Martin buildings Updated monitored channels and data to reflect installation of the flight ECU Add minor redlines	1/23/02

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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
ATC	Advanced Technology Center	MTVC-G	Main Tank Vent Cap pressure gauge
Aux	Auxiliary	MTVC-RV	Main Tank Vent Cap relief valve
AV-x	Valve x of Gas Module auxiliary section	MTVC-V	Main Tank Vent Cap valve
Bot	Bottom	NBP	Normal boiling point
CN [xx]	Data acquisition channel number	ONR	Office of Naval Research
DAS	Data Acquisition System	PFCG	Fill Cap assembly pressure Gauge
EFM	Exhaust gas Flow Meter	PFM	Pump equipment Flow Meter
EG-x	Gauge x of Gas Module exhaust section	PG-x	Gauge x of Pump equipment
EM	Electrical Module	PM	Pump Module
ERV-x	Relief valve of Gas Module exhaust section	psi	pounds per square inch
EV-x	Valve number x of Gas Module exhaust section	psig	pounds per square inch gauge
FCV	Fill Cap Valve	PTD	Payload Test Director
FIST	Full Integrated System Test	PV-x	Valve x of the Pump equipment
GHe	Gaseous Helium	QA	Quality Assurance
GM	Gas Module	RAV-x	Remote Actuated Valve-x
GP-B	Gravity Probe-B	RGA	Residual Gas Analyzer
GSE	Ground Support Equipment	SMD	Science Mission Dewar
GT	Guard Tank	STV	SMD Thruster vent Valve
GTVC	Guard Tank Vent Cap	SU	Stanford University
GTVC-G	Guard Tank Vent Cap pressure gauge	SV-x	SMD Valve number x
GTVC-RV	Guard Tank Vent Cap relief valve	TG-x	Gauge x of Utility Turbo System
GTVC-V	Guard Tank Vent Cap 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
HX-x	Vent line heat exchanger in Gas Module	VCRV-x	Vent cap relief valve
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)	VCV-x	Vent cap valve
LHe	Liquid Helium	VDC	Volts Direct Current
LHSD	Liquid Helium Supply Dewar	VF-x	Liquid helium Fill line valve
Liq	Liquid	VG-x	Gauge x of Vacuum Module
LL	Liquid level	VM	Vacuum Module
LLS	Liquid level sensor	VV-x	Valve x of Vacuum Module
LMMS	Lockheed Martin Missiles and Space	VW-x	Valve x of Dewar Adapter
LMSC	Lockheed Missiles and Space Co.		

A. SCOPE

This procedure provides the steps necessary to disconnect the Main Tank vent line from the Gas Module and install the Main Tank Vent Cap assembly, when the Main Tank liquid is at NBP. The steps include:

- Set up Main Tank in slightly pressurized mode to ensure adequate pressure for purging
- Leak check Main Tank Vent Cap
- Close SMD vent valve
- Remove vent line
- Install vent cap and leak check
- Open SMD vent valve

The procedure is applicable when the Guard Tank contains liquid or when it is depleted. In either case the Guard 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. 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 LM facilities may have 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 LM facilities 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 cryogenics 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 cryogenics 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 EM SYS229.

B.3.3. Contingency Response

Responses to contingencies (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 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. ***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.

<i>Test Director</i>	<i>Test Engineer</i>
Mike Taber	Tom Welsh
Dave Murray	Ned Calder
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, and the Vacuum Module. The Gas Module (Figure 1) 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 and Electrical Modules.

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

<i>Description</i>

Helium leak detector: Calibrated. Leak: _____ Cal Due Date: _____

E.3.5. Additional Hardware

<i>Description</i>
Main Tank vent cap assembly – See Figure 2

E.3.6. Tools

<i>Description</i>
Torque Wrench, 1-1/4-in socket/open end, 60 in-lb +/- 5 in-lbs Cal Due Date: _____ S/N: _____

E.3.7. Expendables

<i>Description</i>	<i>Quantity</i>	<i>Mfr./Part No.</i>
Ethanol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Apeizon N Dow Corning High Vacuum Grease

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

<i>No.</i>	<i>Location</i>	<i>Description</i>	<i>User Name</i>	<i>Serial No.</i>	<i>Cal Required</i>	<i>Status Cal due date</i>
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	-

No.	Location	Description	User Name	Serial No.	Cal Required	Status Cal due date
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 must be at its normal boiling point (NBP).

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. If it is to be disconnected at the dewar, the glovebox support plate and Airlock support-plate ring must be removed.

E.5.2. Guard Tank

The Guard-Tank may contain liquid, or be depleted. When it contains liquid, it may be venting in either the bypass or common manifold mode. When the Guard Tank is depleted, its pressure must be independently regulated from a source of 99.999% pure helium gas, and its pressure must be continuously monitored and maintained at a positive pressure relative to atmospheric. Monitoring is accomplished by placing the relative pressure, as read at the Guard Tank Vent Valve Assembly (GTV-G), 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 always evacuated.

E.5.4. Vacuum Shell

The Vacuum Shell pressure shall be less than 5×10^{-5} torr.

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 28 and CN29) at $T \leq 6.0$ K.
 - b. Relative Guard Tank Pressure (CN 46) set at $P \geq 0.3$ torr.

E.5.6. GSE

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).
2. The Main Tank Vent Cap (Figure 5).

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 internal 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. When the Well contains liquid, it vents through the Gas Module unless Well operations are being performed (e.g., Probe insertion). Venting through the Gas module is accomplished via a pumping line attached to the Dewar Adapter interface flange at the Airlock Support Plate (Probe not installed), or via a pumping line attached to the Well vent manifold installed at the Well pump-out port (Probe installed).
8. The Vacuum shell pump out port at SV-6 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve and pumping line, with the valve in either the closed position or in the open position with the Vacuum Module actively pumping the vacuum shell.
9. The thruster vent port is flanged to a shut-off valve.
10. The Fill Cap Assembly is installed at SV-13.

F. REFERENCE DOCUMENTS

F.1. Drawings

<i>Drawing No.</i>	<i>Title</i>
LMMS-5833394	Instrumentation Installation

F.2. Supporting documentation

<i>Document No.</i>	<i>Title</i>
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
EM SYS229	Accident/Mishap/Incident Notification Process
SU/GP-B P059	<i>GP-B Contamination Control Plan</i>

F.3. Additional Procedures

<i>Document No.</i>	<i>Title</i>
SU/GP-B P0674	<i>Connect Main Tank Vent Line to Gas Module – Main Tank at NBP</i>
SU/GP-B P0676	<i>Connect Guard Tank Vent Line to Gas Module</i>
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P0213	<i>Connect Vacuum Module to SMD</i>
SU/GP-B P0875	<i>GP-B Maintenance and Testing at all Facilities</i>

Operation Number: _____

Date Initiated: _____

Time Initiated: _____

G. OPERATIONS

G.1. Pre-Operations Verifications

- o Verify SU QA notified.
Record: Individual notified _____,
Date/time ____/____.
- o Verify NASA representative notified.
Record: Individual notified _____,
Date/time ____/____.
- o Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- o Persons actually performing this procedure should initial their names in Sec D.3 and the name of the Test Director should be circled.
- o Verify completion of the Pre-Operations Checklist (Appendix 1).
- o Verify Main Tank Vent Line connected-if Main Tank Vent Line is not connected terminate procedure.

QA Witness: _____

G.2. Verify Purity of All Sources of Helium Gas

G.2.1. Record serial number on helium bottle/s.

1. _____ 2. _____ 3. _____
4. _____ 5. _____ 6. _____

G.2.2. Verify helium bottle/s have been tested for purity and record Op. Number.

Op. Number: _____
Record Step Number: _____

QA Witness: _____

G.3. **Leak Check Main Tank Vent Cap.**

- G.3.1. Record calibrated leak: _____ scc/s
- G.3.2. Record measured leak: _____ scc/s
- G.3.3. Connect Leak Detector to MTVC-V.
- G.3.4. Cap all other access ports.
- G.3.5. Bag the entire Main Tank Vent Cap Assembly.
- G.3.6. Open MTVC-V.
- G.3.7. Record Leak detector background: _____ scc/s
- G.3.8. Verify background less than 5×10^{-7} scc/s.
- G.3.9. Record leak rate after one minute exposure: _____ scc/s
- G.3.10. Verify no rise detected during this test.

QA Witness: _____

G.4. **Verify Configuration Requirements**

- G.4.1. Verify proper sealing of Well. Record closure (cover plate, Hole cutter, Probe etc.).
- G.4.2. Verify liquid in Main Tank at NBP ($4.2 < T < 4.3$) and record temperature at bottom of tank CN [9] _____ K.
- G.4.3. Ensure DAS alarm system enabled and record set points.

1. **Top of lead bag temperature** – ensure CN [28] and CN[29] on DAS alarm list with alarm limit at $T \leq 6.0$ K.
Record set point.

_____ K

2. **Relative Guard Tank Pressure** – ensure CN [46] on DAS alarm list with alarm limit at $\Delta P \geq 0.3$ torr.
Record set point.

_____ torr

G.4.4. Ensure liquid-level alarms enabled, as appropriate, and record set points.

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

%

2. **Guard Tank** – ensure liquid-level alarm set $\geq 20\%$.
Record set point. _____

%

G.4.5. Ensure GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

QA Witness: _____

G.5. **Record Initial Configuration and Conditions**

G.5.1. Record Guard Tank Configuration.

- o Guard Tank contains liquid and is connected to Gas Module.
- o Venting in bypass mode (EV-20 open and EV-13 closed).
- o Venting in common manifold mode (EV-13 open and EV-20 closed).
- o Guard Tank contains liquid and is disconnected from Gas Module.
- o Guard Tank is depleted and is connected to Gas Module.
- o Guard Tank is depleted and is disconnected from Gas Module.

G.5.2. Record initial liquid helium levels as appropriate.

1. Main Tank (LL-1D or LL-2D) _____ %

2. Guard Tank (LL-5D or LL-6D) _____ %

G.5.3. Record initial pressures, as appropriate.

1. Main Tank (EG-3): _____ torr.

2. Guard Tank (EG-1a) _____ torr.

3. Guard Tank (GTV-G, relative to atm.) _____ torr.

QA Witness: _____

G.6. **Set Up Main Tank in Non-vented, Slightly Pressurized Mode**

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.6.1. Close EV-9 and record:

1. Date/time : _____/_____.
2. Main Tank Pressure (EG-3): _____ torr
3. Input comment to DAS, "Close EV-9"

G.6.2. Monitor Main Tank pressure at EG-3 for 3 minutes. Record data in Table 1.

Table 1

Time	Pressure EG-3 (Torr)	Lead Bag temp [28] (K)

G.6.3. If Main Tank pressure (EG-3) remains constant or rises at a rate less than 1.5 torr per minute, build pressure in Main Tank as follows:

1. Turn on Tank Heater (H-8D or H-9D) power supply and adjust current limit to 1.25 amps.
2. Increase heater voltage slowly to 15 V maximum to build pressure in Main Tank.
3. Monitor Main Tank pressure at EG-3 and record data in Table 2.

Table 2

Time	Heater Voltage (V)	Pressure EG-3 (Torr)	Lead Bag temp [28] (K)	GT temp [24] (K)

G.6.4. When Main Tank pressure (EG-3) reaches 780 torr,

1. Turn off Main Tank heater, if on.
2. Record time of day: _____
3. Record Main Tank Pressure (EG-3): _____ torr

QA Witness: _____

G.7. Disconnect Main Tank Bayonet and Install Vent Cap

G.7.1. Close Main Tank Vent valve SV-9 and torque to 60 in-lbs.

Record Tool Cal Due Date: _____. Record Tool Serial Number: _____

QA Witness: _____

- G.7.2. Remove vent line from Main Tank exhaust at one of the following locations (see Figure 2):
 - o Bayonet (at SV-9) **or**
 - o Bayonet at end of short vent line opposite from SV-9.
- G.7.3. Cover open end of vent line.
- G.7.4. Inspect o-ring on appropriate bayonet receptacle; clean and lightly lubricate with Braycote.
- G.7.5. Install Vent Cap with MTVC-V open.
- G.7.6. Leak check bayonet seal at Vent Cap:
 - 1. Turn on leak detector
 - 2. Check calibration
 - a. Standard leak rate _____ sccs
 - b. Calibrated leak rate _____ sccs
 - 3. Connect leak detector to Vent Cap at MTVC-V.
 - 4. Record background leak rate _____ sccs
 - 5. Leak check all joints up to SV-9
 - 6. Verify all joints leak tight in gross leak mode:
 - a. Record highest leak rate _____ sccs
 - b. Verify highest leak rate less than $5 \cdot 10^{-6}$ sccs
 - 7. Close MTVC-V
 - 8. Remove leak detector
- G.7.7. Open SV-9 to establish Main Tank venting.

QA Witness: _____

G.8. Establish Final Configuration

- G.8.1. Close/verify closed EV-9 and EV-17.
- G.8.2. **(Option)** Remove Main Tank vent line from inlet to heat exchanger at Gas Module, install blankoff, and cover open end of vent line.
- G.8.3. Record Main Tank pressure STG _____ torr.
- G.8.4. Ensure DAS alarm enabled and record set points if changed
 - o Thermal conditions substantially unchanged, alarm set point for the lead bag is unchanged and set to alarm.
 - o Thermal conditions substantially changed, temperature alarm points reset as follows:
 - a. Top of Lead Bag set point [CN 28 _____ K (≤ 6.0 K) and CN29]
- G.8.5. 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.8.6. Ensure Guard Tank pressure on DAS alarm list and set to alarm at > 0.3 torr above atmospheric pressure.
- G.8.7. Verify Completion of Post Operations Checklist.

QA Witness: _____

Completed by: _____

Witnessed by: _____

Date: _____

Time: _____

Quality Manager _____ Date _____

Payload Test Director _____ Date _____

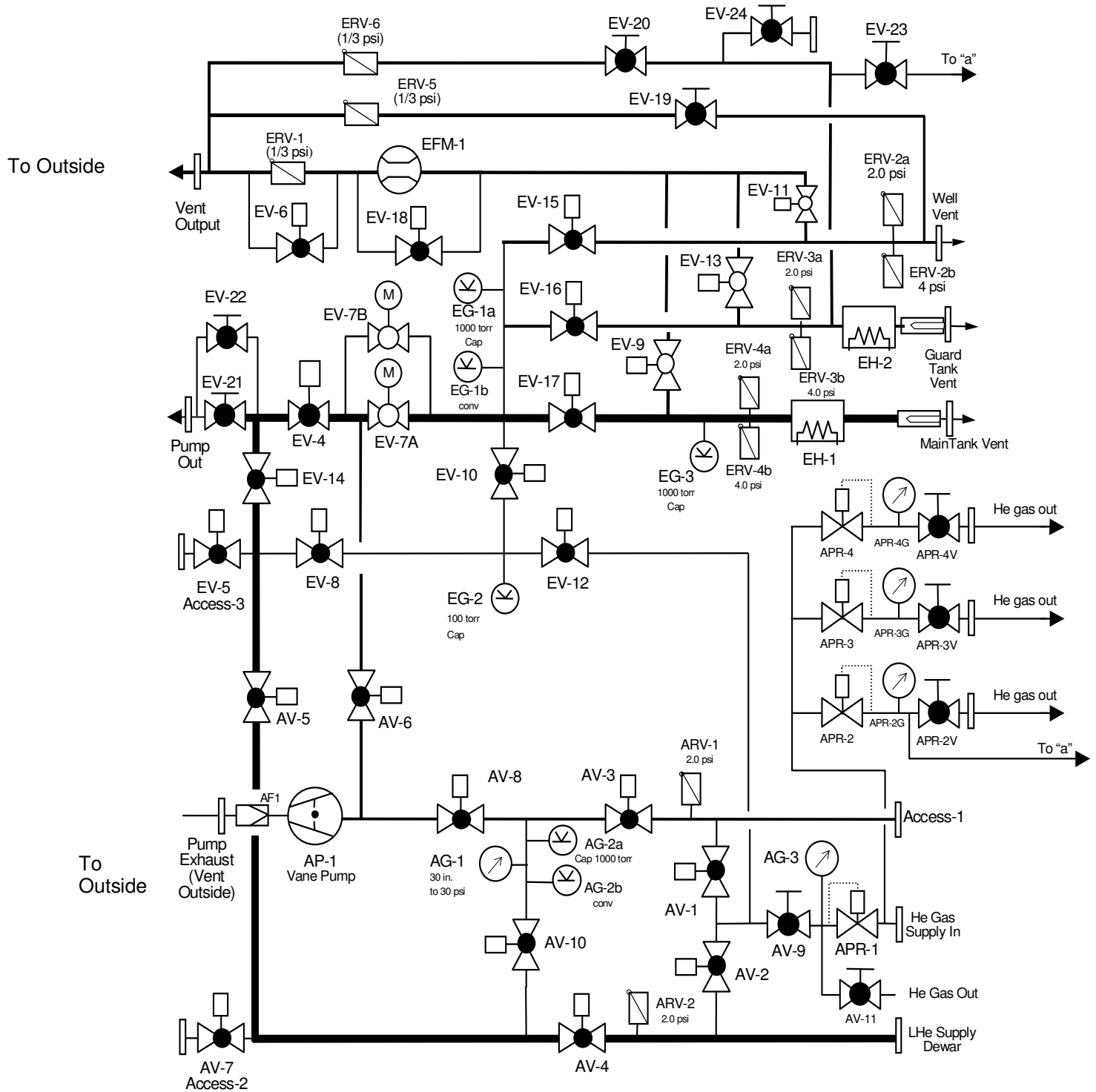
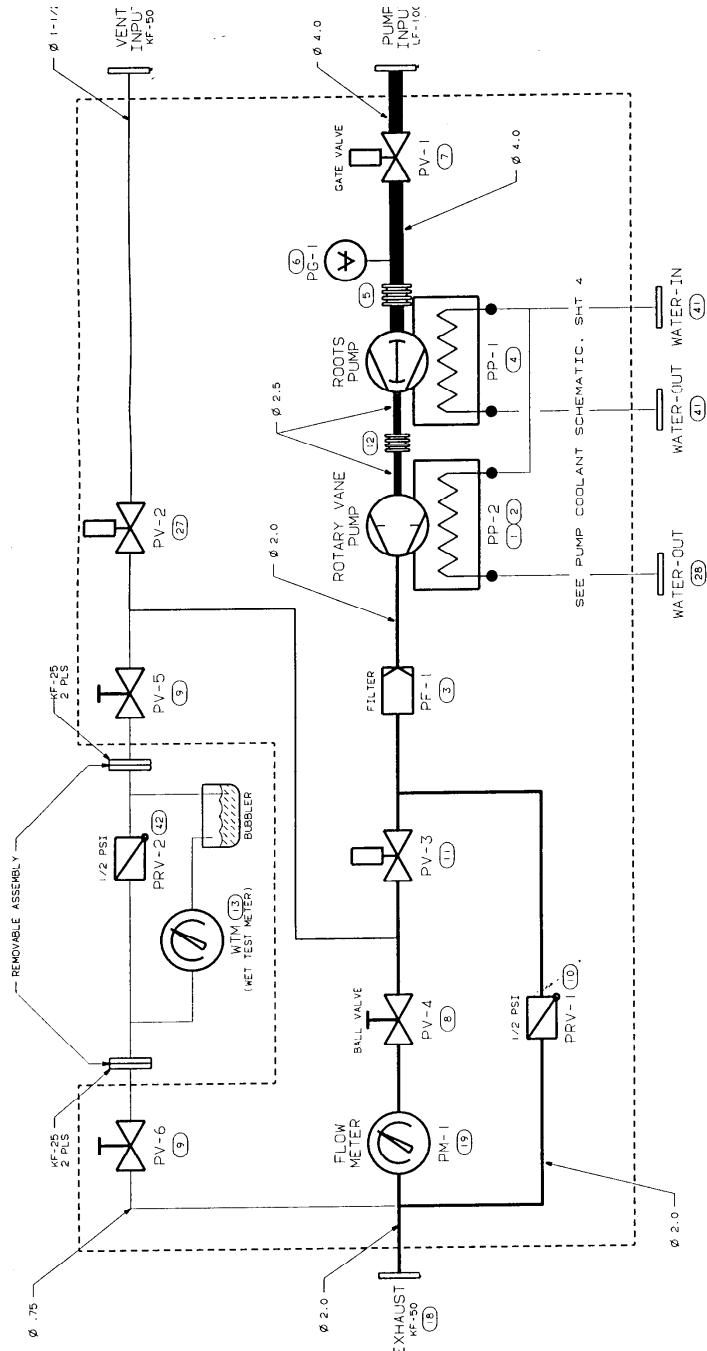


Figure 1. Gas Module

Figure 2-Schematic diagram of the Pump Module



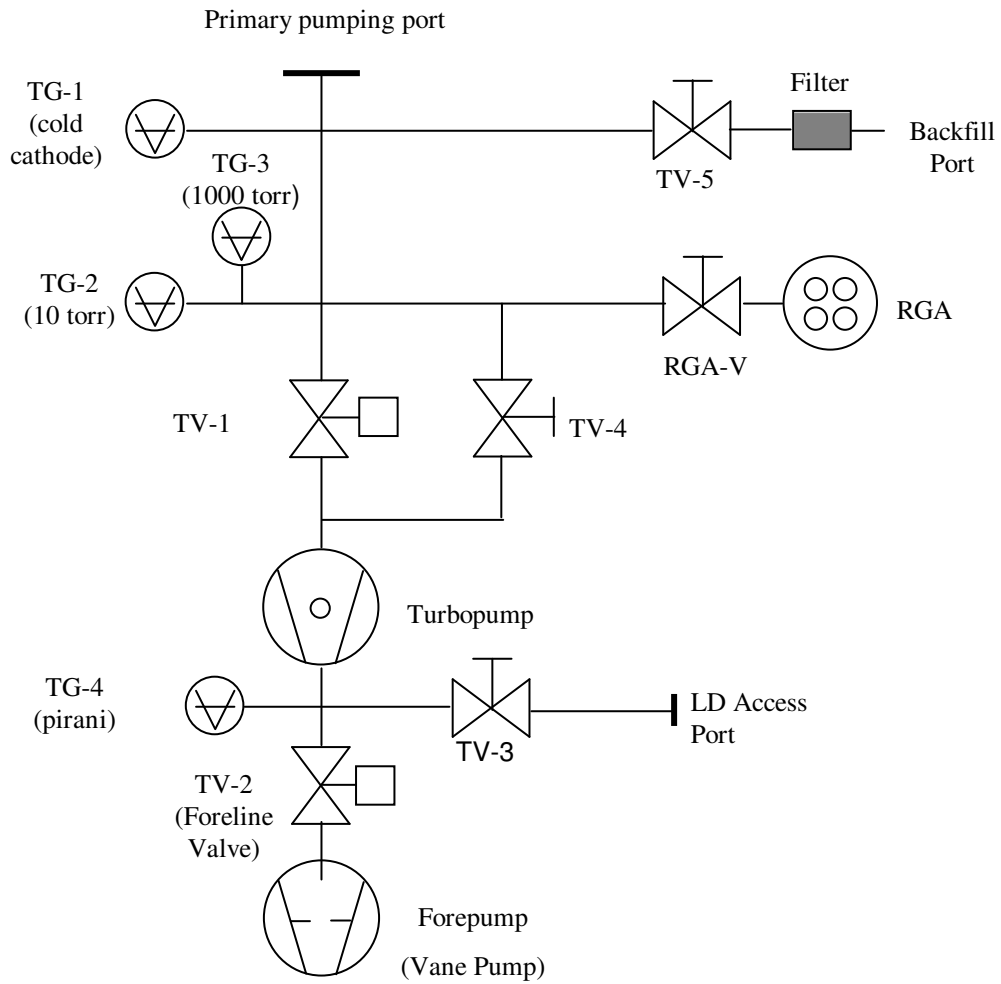


Figure 3. Schematic diagram of Utility Pumping System (UTS)

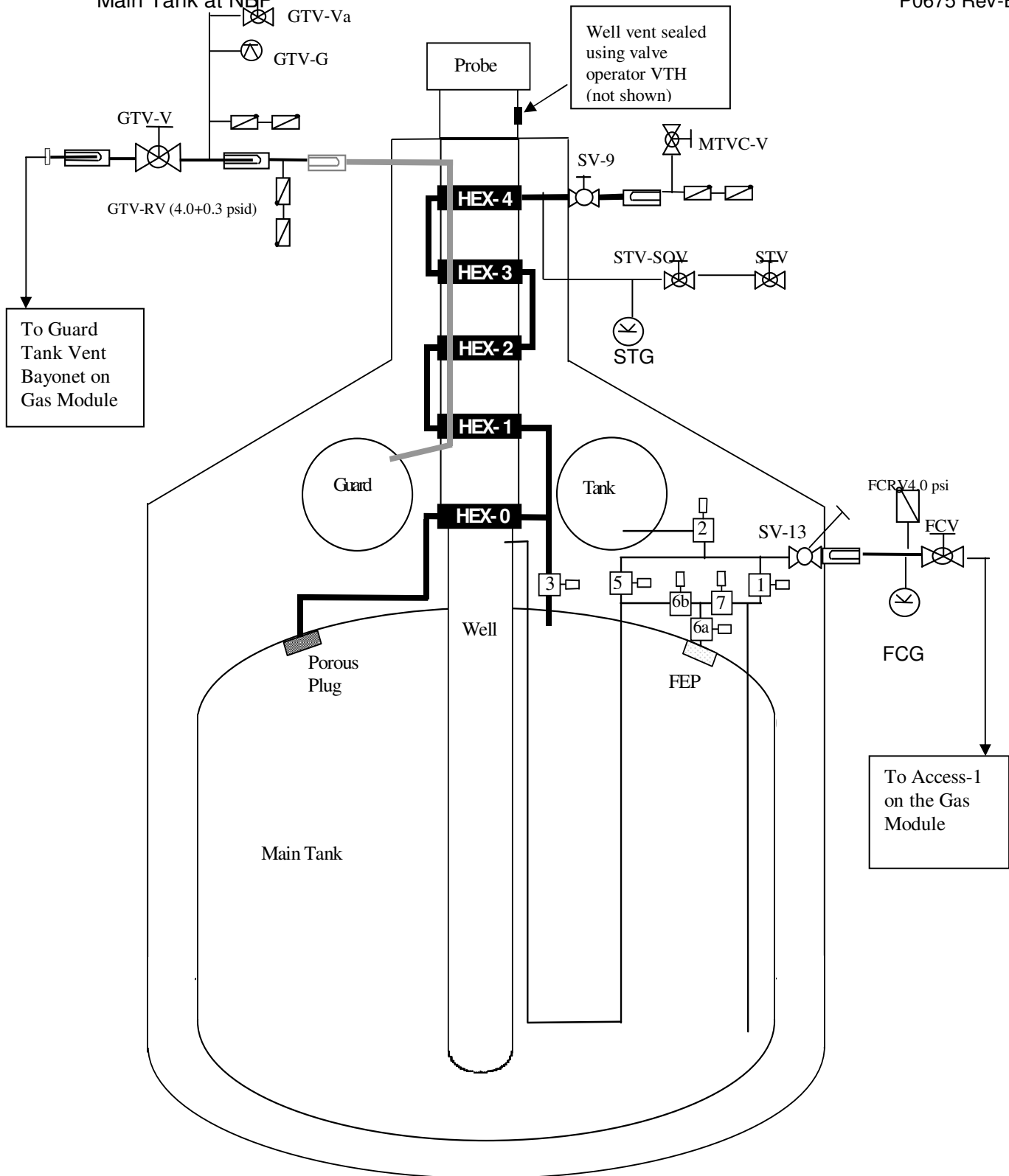


Figure 4 Schematic representation of SMD showing interfaces with Gas module.

Figure 5- Possible Main Tank and Guard Tank Vent Configurations

*note-dashed arrows indicated an option

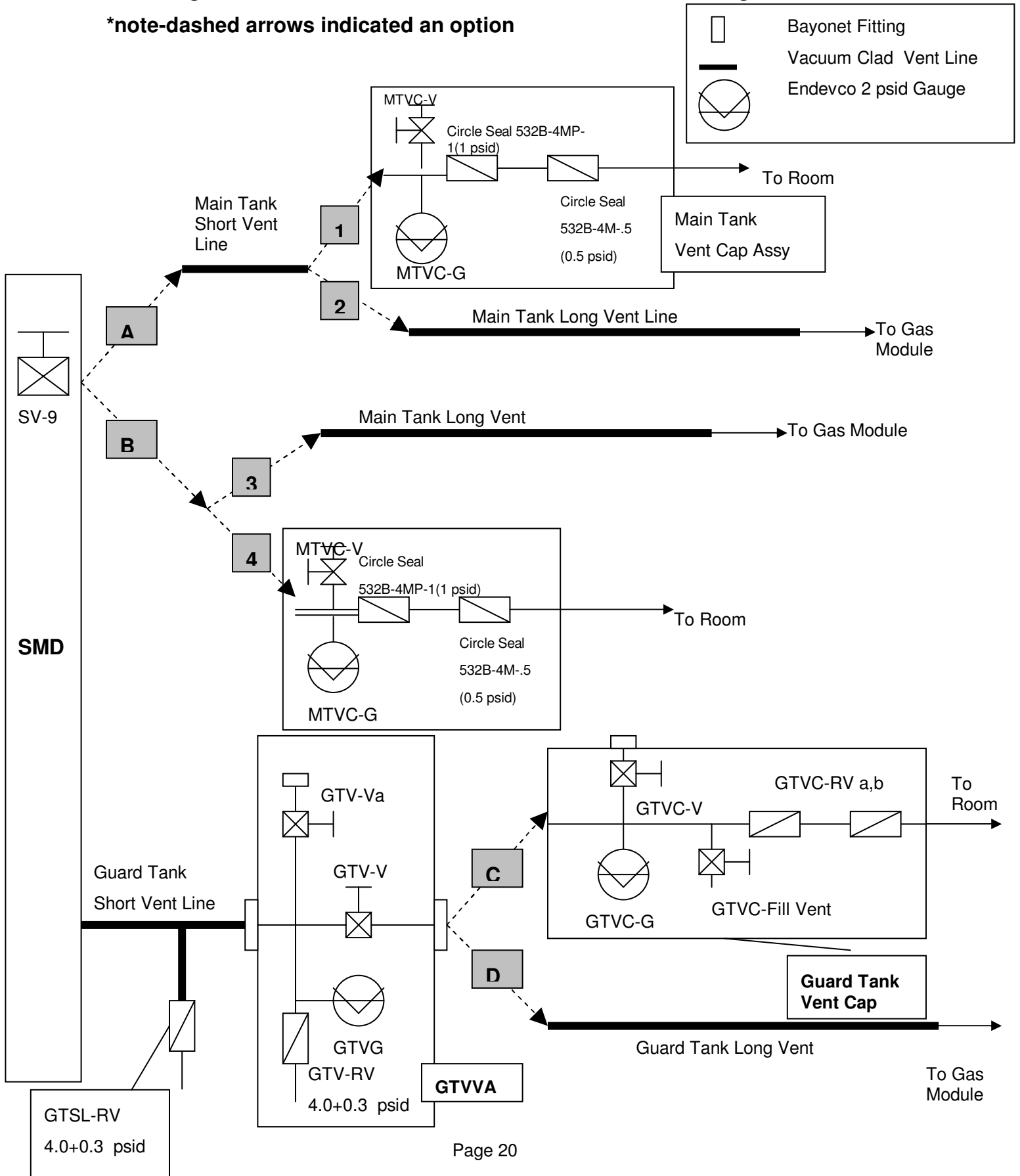
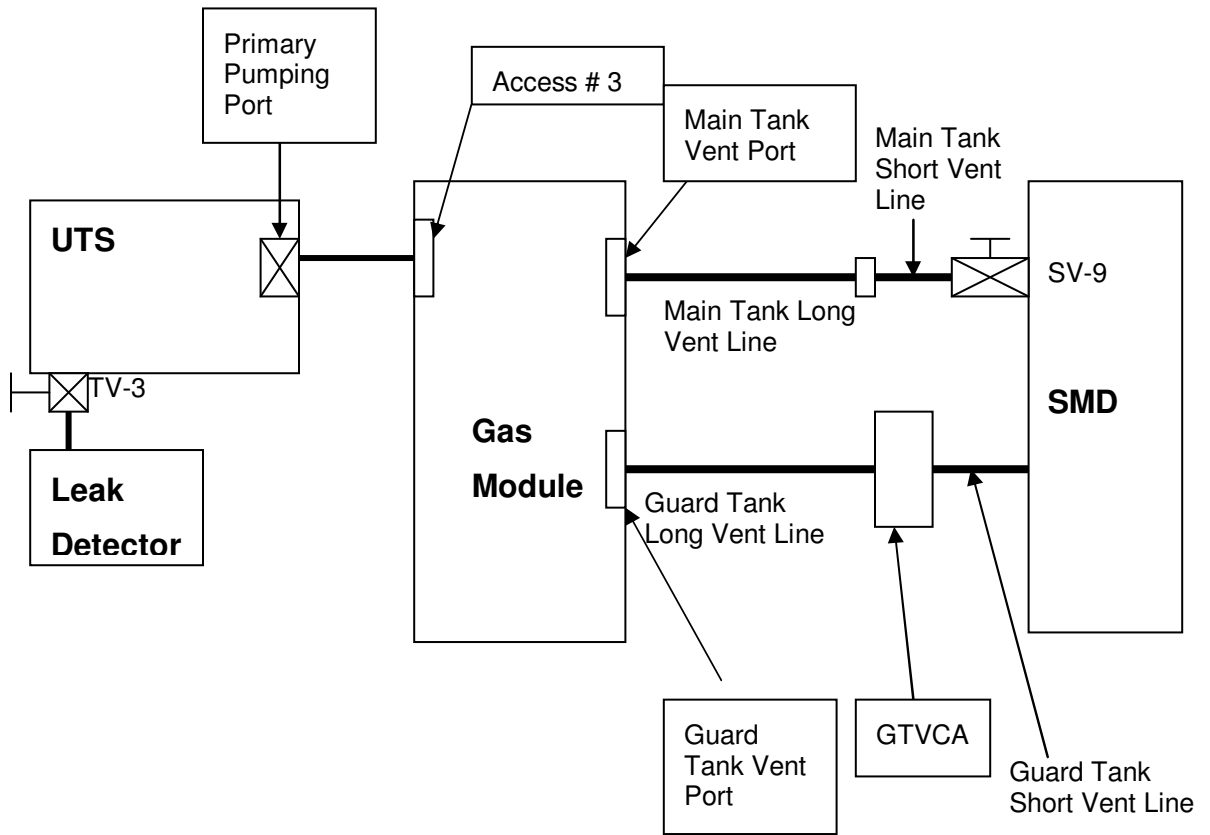


Figure 6: Block Diagram of GSE and SMD-See individual diagrams for more detail



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 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 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.		
	Team Lead Signature: _____		

Appendix 3– Contingency Responses

Condition	Circumstance	Response
Temperature limits (CN 1 or 28) exceeded	Any time	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)	Any time	Evacuate room
Main Tank or Guard Tank liquid level falls below alarm limit	Any time	Configure Dewar and Fill as appropriate