GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

CONNECT MAIN TANK VENT LINE TO GAS MODULE – MAIN TANK AT NBP

THIS DOCUMENT CONTAINS THE USE OF HAZARDOUS MATERIALS

P0674 Rev B

ECO #1331

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	1309	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 EMSYS229 Removed option with Well not evacuated Added Appendix Contingency Responses Added pre/post checklist tables Updated Figures	
B	1331	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 Added steps to bake out Gas Module	1/23/02

Table of Contents

List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
AP-1	Vane Pump in Gas module
APR-x	Pressure regulator x of Gas Module
AV-x	Valve x of Gas Module auxiliary section
CG-x	Gauge x of portable helium pressurization source
CPR-x	Pressure regulator x of portable helium pressurization source
CV-x	Valve x of portable helium pressurization source
CN [xx]	Data acquisition channel number
DAS	Data Acquisition System
EFM-x	Exhaust gas Flow Meters
EG-x	Gauge x of Gas Module exhaust section
EH-x	Vent line heat exchanger in GM
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
GTV-G	Guard Tank vent pressure gauge
GTV-RV	Guard Tank vent relief valve
GTV-V	Guard Tank vent valve
GTV-Va	Guard Tank Vent line valve for independent pressure regulation
HEX-x	SMD heat exchanger x
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
LHV-x	Liquid Helium Supply Dewar valves
LLS	Liquid level sensor
LM	Lockheed Martin 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
RGA-LV	RGA leak valve (needle valve)
RGA-SOV	RGA shut off valve
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 at its normal boiling point. The steps include:

Close Main Tank vent valve (SV-9)

Remove Vent Cap

Install and leak check vent line

Reestablish Main Tank venting.

The Guard Tank may contain liquid or be depleted; it 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 Building 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 the 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 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 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.

Test Director	*Test Engineer*
Mike Taber Dave Murray Ned Calder	Tom Welsh 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

E.3.5. Additional Hardware

Main Tank Vent Cap Assembly

Main Tank Vent Line

E.3.6. Tools

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

E.3.7. Expendables

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

E.4. Instrument Pretest Requirements

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

Table 1. Required Instrumentation and Calibration Status

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
1	DAS	Power Supply, H-P 6627A	-	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	-	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A245539	No	-
4	DAS	Digital Multimeter H-P 3458A	-	2823A15047	Yes	
5	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-1a, -1b	2827	No	-
6	EM	Vacuum Gauge Controller Granville-Phillips Model 316	AG-2a, -2b	2826	No	-
7	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-3	2828	No	-
8	EM	MKS PDR-C-2C	EG-2, FCG	92022108A	No	-
9	EM	Flow meter – Matheson 8170	EFM-1	96186	No	-
10	EM	Flow meter totalizer Matheson 8124	EFM-1	96174	No	-
11	EM	Liquid Helium Level Controller 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	LLS Well	96-409-9	No	-

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

E.5.2. Guard Tank

The Guard Tank may contain liquid or be depleted.

E.5.3. Well

The Well must be evacuated.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure must be less than 5x 10-5 torr. Document No. P0213, *Connect Vacuum Module to SMD*, 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. 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 $\Delta P \geq 0.3$ torr.

E.5.6. GSE and Non-flight Hardware

1. The flight burst disk is installed at the SMD Fill Line.
2. The ion-pump magnet is installed.
3. 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).
4. The Fill Cap Assembly must be installed at SV-13 (See Figure 3)
5. Dewar Adapter heaters on SMD must be installed and operational.

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 SMV may be installed in its transportation and test fixture.
2. A foreign object and debris shield covers the upper cone of the SMD.

3. The Vacuum shell pump out port at SV-14 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. The Vacuum Module pump may be; off, actively pumping the pumping line up to a closed SV-6, or actively pumping the vacuum shell.

4. The thruster vent port is flanged to a shut-off valve.

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*
EM SYS229	Accident/Mishap/Incident Notification Process

F.3. Additional Procedures

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

Operation Number:_____
Date Initiated:_____
Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- 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 (Sections. E.3.4, E.4)
- Persons actually performing this procedure should initial their names in Sec D.3 and the name of the Test Director should be circled.
- Verify completion of the pre-operations checklist (Appendix 1).

G.1.1. Record Condition of Main Tank

- Main Tank at NBP
- Main Tank Subatmospheric-If the Main Tank is subatmospheric abort this procedure and perform procedure P0672, Connect Main Tank Vent Line-MT Subatmospheric.

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. _____

Verify helium bottle/s have been tested for purity and record Op. Number.
Op. Number:_____
Record Step Number:_____

QA Witness:_____

G.3. Verify Configuration Requirements

G.3.1. Ensure watchdog timer enabled.

G.3.2. Verify proper sealing of Well. Record closure (cover plate, Hole cutter, Probe etc.)._____

G.3.3. Verify liquid in Main Tank at NBP (4.2<T<4.3) and record temperature at

bottom of tank CN [9] _____K.

G.3.4. Ensure DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – ensure CN [28 and 29] on DAS alarm list and alarm set at ≤ 6.0 K. Record set point. _____K
2. ***Relative Guard Tank pressure*** – ensure CN [46] on DAS alarm list and alarm set at ≥ 0.3 torr. Record set point. _____torr

G.3.5. 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 ≥ 10% (if liquid in GT). Record set point. _____%

G.3.6. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.3.7. Verify Thruster Vent Manifold installed to provide relief and pressure reading of Main Tank during vent closure.

Section G.3 completed. QA Witness:_____

G.4. **Establish Gas Module Configuration and Record Initial Conditions**

G.4.1. Record Main Tank Vent Configuration referring to Figure 5:_____(i.e. A2)

G.4.2. Record Guard Tank Vent Configuration referring to Figure 5:_____

G.4.3. Record condition of Guard Tank (one of the following) and ensure corresponding valve configuration:

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

- o B. Guard Tank is depleted and Guard Tank vent line is not connected to Gas Module.
  1. Ensure GTV-V closed
  2. Ensure GT pressure regulated(1-2 psi) by APR-2 at GTV-Va.
  3. Ensure GTV-Va open.
  4. Close/verify closed all other EV valves
  5. Ensure all AV valves closed

- o C. Guard Tank contains liquid, is connected to Gas module, and venting through EV-13.
  1. Ensure GTV-V open
  2. Ensure EV-13 and EV-16 open.
  3. Close/verify closed all other EV-valves.
  4. Ensure all AV valves closed

- o D. Guard Tank contains liquid, is connected to Gas module, and venting through EV-20.
  1. Ensure GTV-V open
  2. Ensure EV-20 and EV-16 open.
  3. Close/verify closed all other EV-valves.
  4. Ensure all AV valves closed

- o E. Guard Tank depleted and connected to Gas Module.
  1. Ensure GTV-V open
  2. Ensure GT pressure regulated(1-2 psi) by APR-2 at EV-23.
  3. Ensure EV-23 and EV-16 open
  4. Close/verify closed all other EV-valves.
  5. Ensure all AV valves closed

G.4.4. Record Guard Tank pressure. (GTV-G) _____ torr (relative to atm.).

G.4.5. Record Main Tank pressure (STG) _____ torr (relative to atm.)

Section G.4 completed. QA Witness:_____

G.5. **Remove Main Tank Vent Cap and Install Vent Line**

G.5.1. Close/verify closed MTVC-V and GTVC-V.

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. In addition, the Main Tank pressure should also be monitored since closing SV-9 leaves the Main Tank unable to vent.

G.5.2. Close Main Tank vent valve (SV-9) and torque to 60 in-lbs.

G.5.3. Record date/time _____/_____.

G.5.4. Remove Vent Cap – record location:

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

G.5.5. Remove o-ring from bayonet receptacle and inspect for defects or damage. Replace if any found; record results in o-ring log.

G.5.6. Install Main Tank Vent line between Gas Module (at inlet to Main Tank heat exchanger) and location at which Vent Cap was removed. Install bags around the new joint(s).

G.5.7. Verify configuration is identical to Figure 2.

Section G.5 completed. QA Witness:_____

G.6. **Leak Check 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. Close, EV-16, if open.

G.6.6. Open EV-4, EV-14, and EV-17.

G.6.7. Open fully EV-7a and EV-7b..

G.6.8. Evacuate Main Tank vent plumbing with Gas Module

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

G.6.9. Bake out Gas Module

1. Open EV-5, now pumping up to closed GTV-V with UTS

   Record TG-1:_____torr

   Record Time:_____

2. Turn on Main Tank heat exchanger and set to 50C
3. Bake out heat exchanger until TG-1 < 5*10^-6 torr

   Record TG-1:_____torr

   Record Time:_____

4. Turn off Main Tank heat exchanger
5. When TG-1 pressure stablizes proceed to section G.6.10

   Record TG-1:_____torr

   Record Time:_____

G.6.10. Leak check all plumbing and connections

1. Verify that leak detector is operational and pumping up to closed valve TV-3.
2. Leak check all plumbing and connections between leak detector and TV-3
3. Open TV-3 and close the foreline valve (TV-2)
4. Pump until background level is on $1x10^{-5}$ scc/s range.

G.6.11. 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.6.12. Close EV-4, EV-5, and EV-14.

G.6.13. Remove UTS/leak detector (if not going to use for more operations), as

follows:

1. Close valve TV-3 and open foreline Valve (TV-2)
2. While monitoring the pressure on the cold cathode gauge (TG-1), vent and disconnect the leak detector
3. Close UTS gate valve (TV-1).
4. Turn turbo pump off.
5. Close foreline valve (TV-2) and turn off vane pump.
6. Install GHe to UTS valve TV-5 upstream of gate valve, open TV-5 and backfill to 760 torr, as read at TG-3.
7. Close TV-5
8. Disconnect UTS from access port 3 at EV-5.

G.6.14. Backfill Gas Module to one atmosphere.

1. Ensure that a cap is installed at Access #1.
2. Ensure that AP-1 is on.
3. Open AV-8 and AV-3.
4. Once pressure is < 25 mtorr as measured at AG-2b, close AV-8.
5. Open EV-10, EV-12, and AV-1.
6. Open AV-9 and pressurize to 0.0 psig as read at gauge AG-1 and close AV-9.
7. Close EV-10, EV-12, EV-17, EV-7a/b, AV-1, and AV-3.

Section G.6 completed. QA Witness:_____

G.7. **Establish Final Configuration**

G.7.1. Record the time of day _____.

G.7.2. Record Main Tank Temp (T-9D):_____ K

G.7.3. Record Guard Tank Temp (T-15D) _____ K

G.7.4. 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.

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

- o B. Guard Tank is depleted and not connected to Gas Module.
  1. Ensure GTV-V closed
  2. Ensure GT pressure regulated (1-2 psi) by APR-2 at GTV-Va.
  3. Ensure GTV-Va open.
  4. Close/verify closed all other EV valves
  5. Ensure all AV valves closed

- o C. Guard Tank contains liquid, is connected to Gas module, and venting through EV-13.
  1. Ensure GTV-V open
  2. Ensure EV-13.
  3. Open EV-16.
  4. Close/verify closed all other EV-valves.
  5. Ensure all AV valves closed

- o D. Guard Tank contains liquid, is connected to Gas module, and venting through EV-20.
  1. Ensure GTV-V open
  2. Ensure EV-20.
  3. Open EV-16.
  4. Close/verify closed all other EV-valves.
  5. Ensure all AV valves closed

- o E. Guard Tank depleted and connected to Gas Module.
  1. Ensure GTV-V open
  2. Ensure GT pressure regulated (1-2 psi) by APR-2 at EV-23.
  3. Ensure EV-23.
  4. Open EV-16.
  5. Close/verify closed all other EV-valves.
  6. Ensure all AV valves closed

G.7.5. Reestablish Main Tank venting through Gas Module.

1. Open SV-9.
2. In all cases except case C of Sec. G.7.4, once EG-3 is above 770 torr, open EV-9. For case C, wait until EG-3 is within 5 torr of EG-1a, then open EV-9. Since the pressure in the manifold downstream of EV-9 is relieved at 0.3 psig, this prevents a large slug of hot gas from entering the Main Tank on opening EV-9.
3. Enter comment in DAS "MT now venting through EV-9."

G.7.6. Once conditions have stabilized, record the following:

1. Date/time of day _____/_____.
2. Main Tank liquid level: _____ %.
3. Flowrate EFM-1 _____.
4. Main Tank Temp (T-9D) CN [09] _____ K.
5. Guard Tank Temp (T-15D) CN [24] _____ K.
6. Main Tank exit pressure (EG-3) _____ torr.

G.7.7. Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for the lead bag is unchanged and set to alarm.
- Thermal conditions substantially changed, temperature alarm points reset as follows:

  a. Top of Lead Bag set point [CN 28 and 29] _____ K (≤ 6.0 K)

G.7.8. 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.7.9. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

G.7.10. Ensure watchdog timer is operating.

G.7.11. Verify performance of post-operations checklist (Appendix 2)

Section G7 completed. QA Witness:_____

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

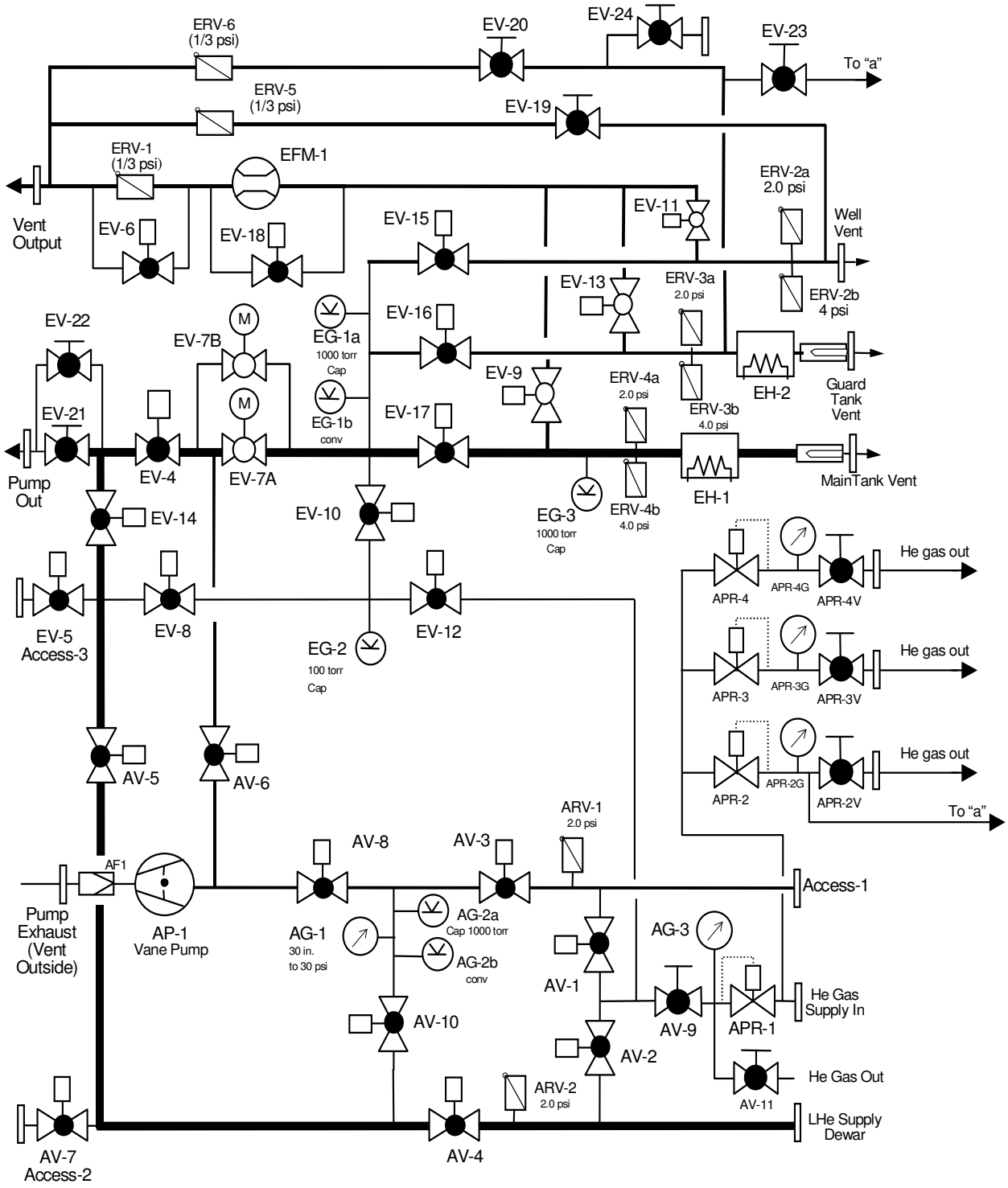


Figure 1. Gas Module

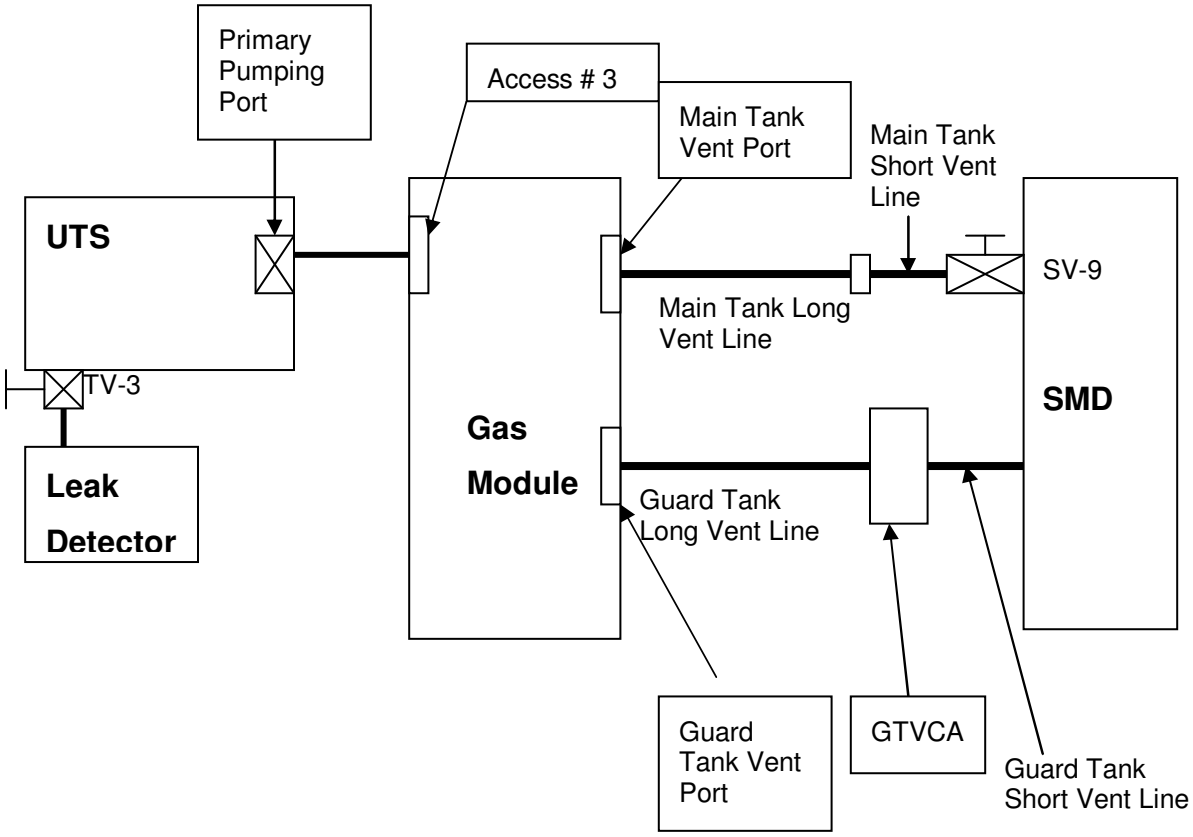


Figure 2: Overview of final configuration and connections.

See individual diagrams for more detail

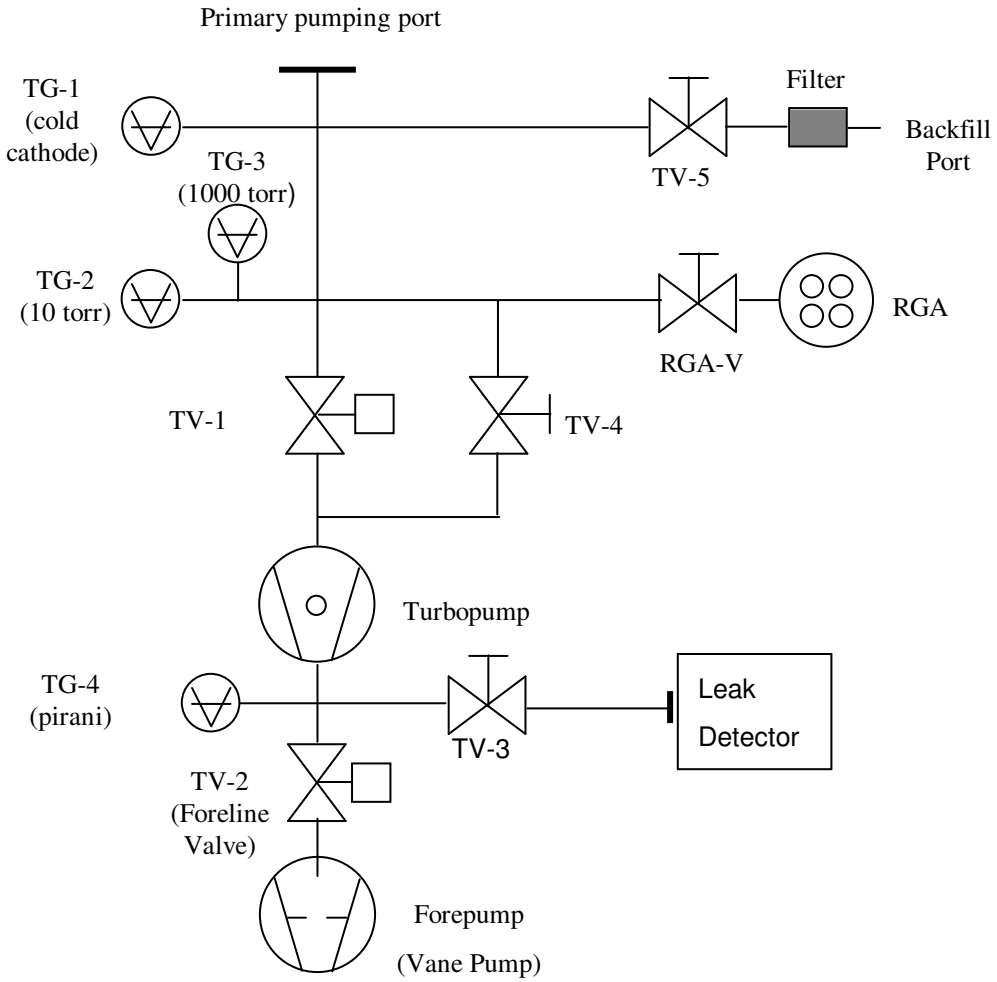


Figure 3. Schematic diagram of Utility Pumping System (UTS)

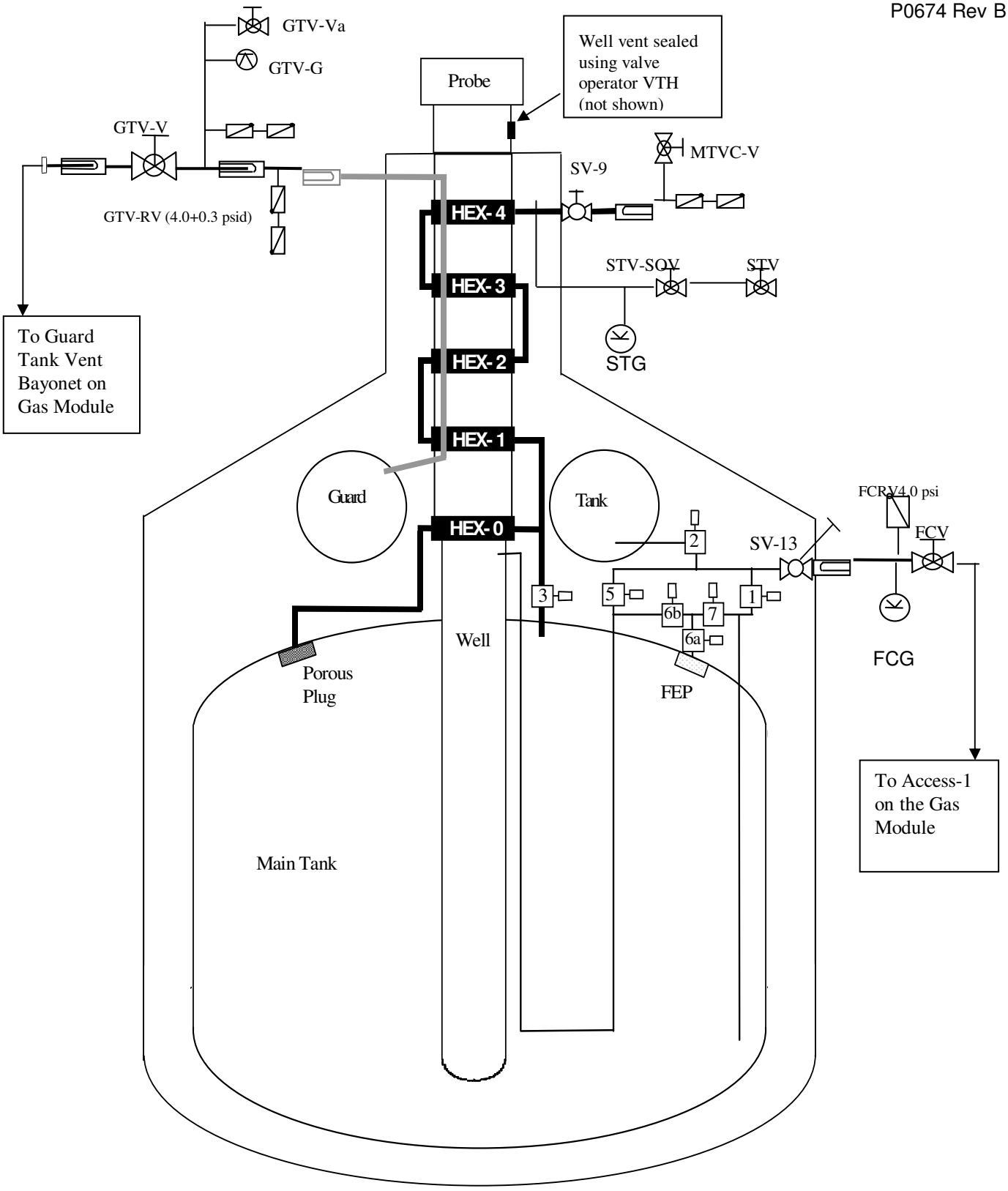
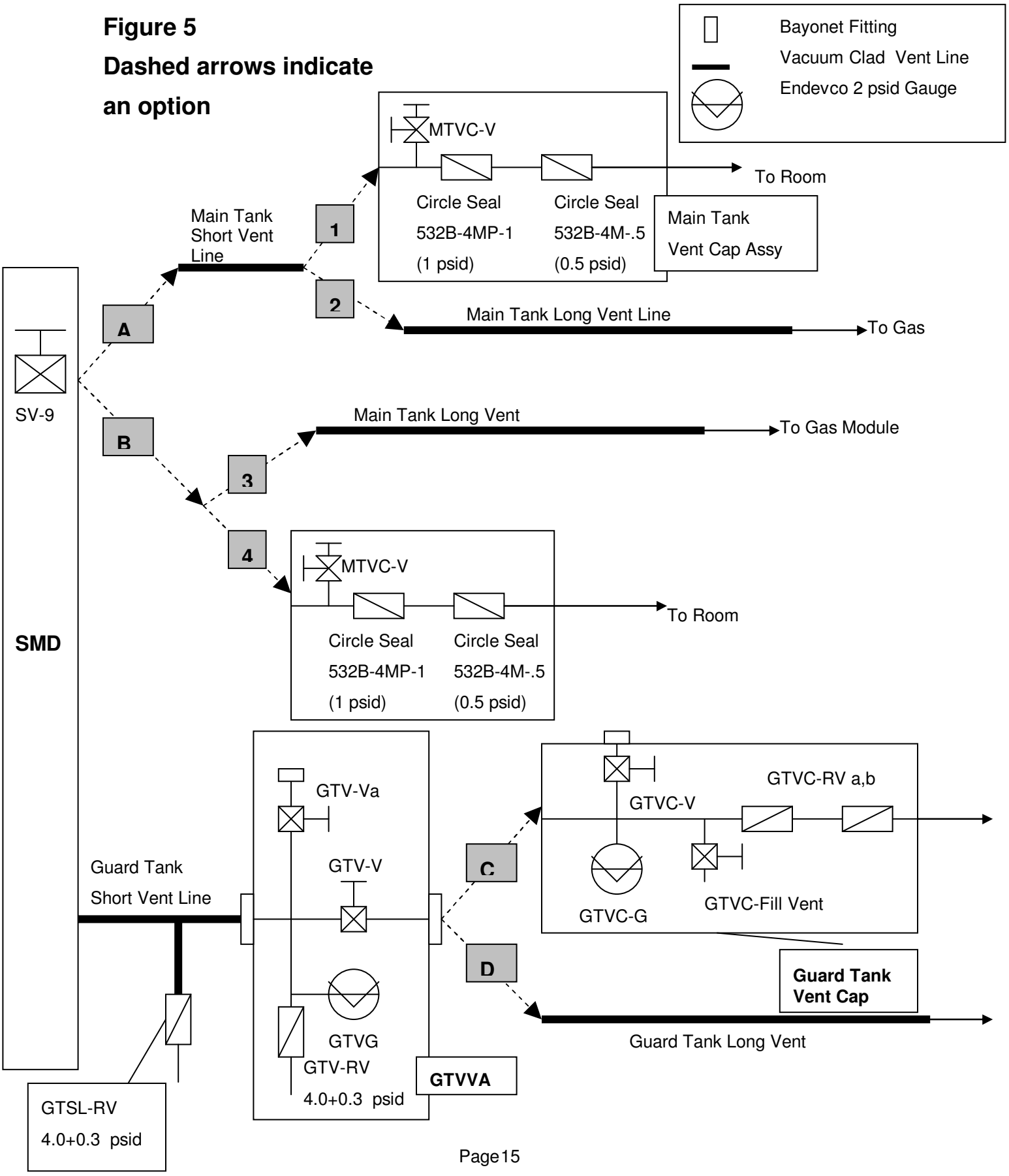


Figure 4 Schematic representation of SMD showing interfaces with Gas module.

Figure 5
Dashed arrows indicate an option



Appendix 1

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.5.2 (closure of SV-9)	Wait for power restoration, and resume procedure
	After Sec. G.5.2 and before G.7.5 (open SV-9) and for a outage duration of <12 hours	Wait for power restoration, and resume procedure after restarting UTS and leak detector as necessary.
	After Sec. G.5.2 and before G.7.5 (open SV-9) and after power is out for >12 hours	Open SV-9 to allow MT to vent. EV-17 will be closed and EV-9 will be open during power failure.
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
Pressure in Main Tank exceeds limit	After Sec. G.5.2 and before G.5.6	Reinstall Vent Cap and then open SV-9.
	After Sec. G.5.6 and before G.7.5	Verify closed EV-17, open EV-9 1. If in configuration A,B,D, or E, slowly open SV-9. 2. If in configuration C, open EV-20 and close EV-13, then open SV-9