GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Measure Guard Tank Vent Line Impedance

To be performed at Vandenberg Air Force Base building 1610/MST

This document contains non-hazardous operation

P1038

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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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

LIST OF SPECIFIC HEADING DEFINITIONS

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

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

A. SCOPE

This procedure describes the steps to perform an evaluation of the flow impedance of the SMD internal Guard Tank vent line. This process does not produce a quantitative result but is intended to serve as a qualitative evaluation of the condition of the Guard Tank vent line that can be used to detect an incipient plugging of the vent line.

B. SAFETY

B.1. Potential Hazards

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

Liquid helium used in the SMD represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C and the Missile System Prelaunch Safety Package LM/P479945 discuss the safety design, operating requirements and the hazard analysis of the SMD.

B.2. Mitigation of Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

In VAFB building 1610/MST, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent lines are installed over the four burst disks to direct any flow to an outside area.

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

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing, non-absorbent shoes and full-face shields with goggles/glasses 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 space vehicle shall be tethered.

B.3. **Mishap Notification**

B.3.1. Injury

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

B.3.2. Hardware Mishap

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

B.3.3. Contingency Response

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

C. **QUALITY ASSURANCE**

C.1. **QA Notification**

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

C.2. **Red-line Authority**

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

C.3. **Discrepancies**

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

1. If the discrepancy has minimal effect on procedure

functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.

2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.

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

D. TEST PERSONNEL

D.1. Personnel Responsibilities

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

D.2. Personnel Qualifications

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

D.3. Required Personnel

The following personnel are essential to the accomplishment of this procedure:

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

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

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

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

E.3.3. Computers and Software:

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

E.3.4. Additional Test Equipment

1. No additional test equipment is required

E.3.5. Additional Hardware

1. N/A

E.3.6. Tools

Description
NA

E.3.7. Expendables

WARNING

Ethanol is highly flammable and vapor/air mixtures are Explosive. Exposure hazards include: Inhalation (headache/fatigue), skin (dryness, eyes (redness/pain/burning)

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

E.4. Instrument Pretest Requirements

The GSE instruments required to perform this procedure are listed in Table 1, together with their serial numbers, where available. Instruments that are required to have current calibrations are indicated in the Cal-Required column. Instruments that do not require calibration are those not used to verify

performance requirements and are not connected to flight instrumentation. The status column is to be filled in with the due date of the instrument calibration sticker and verified to be in calibration by QE or QE designee.

Table 1. Required Instrumentation and Calibration Status

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
1	DAS	Power Supply, H-P 6627A	-	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	-	3452A01956	Yes	
3	DAS	Data Acquisition/Control Unit H-P 3497A	-	2936A245539	No	-
4	DAS	Digital Multimeter H-P 3458A	-	2823A15047	Yes	
5	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-1a, -1b	2827	No	-
6	EM	Vacuum Gauge Controller Granville-Phillips Model 316	AG-2a, -2b	2826	No	-
7	EM	Vacuum Gauge Controller Granville-Phillips Model 316	EG-3	2828	No	-
8	EM	MKS PDR-C-2C	EG-2, FCG	92022108A	No	-
9	EM	Flow meter – Matheson 8170	EFM-1	96186	No	-
10	EM	Flow meter totalizer Matheson 8124	EFM-1	96174	No	-
11	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Main Tank	96-409-11	No	-
12	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Guard Tank	96-409-10	No	-
13	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Well	96-409-9	No	-
14	EM	Liquid Helium Level Controller American Magnetics, Inc. 136	LLS Axial Lock	96-409-12	No	-
15	EM	Pressure Controller – MKS 152F-92	EV-7a, -7b	96203410A	No	-
16	EM	Power Supply HP 6038A	H08D Tank Heater	96023407A	Yes	
17	EM	Power Supply 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	-

No.	*Location*	*Description*	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
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. P1015, *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 175 and CN178) 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 ion-pump magnet is installed.
2. 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).
3. The Fill Cap Assembly must be installed at SV-13 (See Figure 3)
4. 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. 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.

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	Instrumentation Installation

F.2. Supporting documentation

Document No.	*Title*
LMMC-5835031	GP-B Magnetic Control Plan
GPB-100153C	SMD Safety Compliance Assessment
LM/P479945	Missile System Prelaunch Safety Package
SU/GP-B P0141	FIST Emergency Procedures
LMSC-P088357	Science Mission Dewar Critical Design Review
SU/GP-B P0108	Quality Plan
LMMS GPB-100333	Science Mission Dewar Failure Effects and Causes Analysis
SU/GP-B P059	GP-B Contamination Control Plan
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P1015	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 program representative notified.

  Record: Individual notified _____,

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

Section G.1 Complete Quality_____

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:_____

Section G.2 Complete QA Witness:_____

G.3. Verify Configuration Requirements

G.3.1. Ensure DAS Watch Dog Alarm enabled.

G.3.2. Ensure that Top Plate heaters on SMD are operational.

G.3.3. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.3.4. Record MT pressure (EG-3 and/ or STG) ____ torr ____ torr diff.

G.3.5. Verify DAS and, as appropriate, liquid level alarms enabled and record set points.

1. Main Tank level (“A” or “B”):

Record set point _____%

2. Guard Tank Level (“A” or “B”):

   Record set point _____%

3. Station 200 temperature – verify [CN 01] on DAS alarm list and alarm setpoint at T ≤ 6.5 K.

   Record set point _____K

4. Top of lead bag temperature – verify [CN 28] on DAS alarm list and and alarm setpoint at T ≤ 6.0 K.

   Record set point _____K

5. Relative Guard Tank Pressure – verify [CN46] on DAS alarm list and and alarm setpoint at P ≥ 0.3 torr.

   Record set point _____torr

G.3.6. Verify Main Tank vent line connected to Gas Module. If not perform procedure P1007, Connect Main Tank Vent Line to Gas Module.

If P1007 used, enter Op Order Number_____ .

G.3.7. Verify Guard Tank vent line connected to Gas Module. If not, perform procedure P1008, Connect Guard Tank Vent Line to Gas Module , to connect Guard Tank vent.

If P1008 used, enter Op Order Number_____ .

G.3.8. Verify Fill Cap Assembly installed at SV-13.

G.3.9. Ensure ion-pump magnet installed.

G.3.10. 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. If pressure is above $5x10^{-5}$ torr, perform procedure P1015, Connect of Vacuum Module / Pump on SMD Vacuum Shell, to connect Vacuum Module and pump out SMD vacuum shell.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.3.11. If Guard Tank is not supplied with gaseous helium via APR-2 and EV-23, perform the following steps:

1. Adjust APR-2 to 1.5 psig
2. Close EV-13 (manifolded vent) or EV-20 (bypass vent)..
3. Open EV-23.
4. Verify flow meter, EFM-2 responds, showing inflow to Guard Tank.

Section G.3 Complete Quality _____

G.4. **Verify Gas-Module and SMD Configuration and Record Initial Conditions**

G.4.1. 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		
Connected to GM	EV-9	EV-17
2. Guard Tank vent		
Connected to GM; depleted of LHe and Pressure regulated at EV-23 (verify source of He gas at APR-2)	EV-16, EV-23 GTV-V, APR-2	EV-13, EV-20, EV-24 GTV-Va
3. Remaining EV valves	EV-7a/b	EV-4, EV-5, EV-6, EV-8, EV-10, EV-11, EV-12, EV-14, EV-15, EV-18, EV-19, EV-21/22
4. AV valves		All

G.4.2. 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 09] _____K.

G.4.3. Record pressures.

1. Guard Tank (GTV-G) [CN46]:_____ torr (relative to atm.).
2. Main Tank (STG) [CN49]:_____ torr diff.. (Endevco on Thruster Vent Manifold)

G.4.4. Record liquid level in Main Tank _____ %.

G.4.5. Record Fill Cap Assembly pressure and verify that it reads >760 torr. If not, enter in D-log and consult Payload Test Director.
Fill Cap Assembly (PFCG): _____ torr.

G.4.6. Record status of Well pump-out:

- VTH closed and Well manifold not installed.
- Well manifold installed, record valve positions and pressure:

  VTH ____ , VW-3 _____ , PW-1 _____ torr.

G.4.7. Verify SMD internal valving is in Standard Configuration

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.
    a. Open: RAV-3, and RAV-6B.
    b. Closed: RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.
2. Verify SV-9 open.

Section G.4 Complete. Quality_____

G.5. Set Up Data Acquisition System

G.5.1. Set up WTM (Wet Test Meter) to measure flow from EV-24, verify data is being acquired at DAS.

G.5.2. Verify DAS set to configuration 4M.

G.5.3. Set DAS to fast scan mode using [other menus], [data config], [fast scan]

G.5.4. Record directory and data file name _____ .

G.5.5. Start "Special Data Cycle" by using:

1. [Other Menus] + [Special Data Col] + [Input IDs]
2. Input CNs: 1, 5, 25, 8, 46, 120 for scan list.
3. And [Init. Collectn] + [Enter] (=use default file).

G.5.6. Record directory and special data file name _____ .

G.5.7. Set Main Tank Liquid Level Sensor sampling interval to 1 min.

G.5.8. Ensure printer is displaying special Data Cycle data.

G.5.9. Place normal Data Cycles to 5 minute intervals.

G.5.10. Valve configuration:

	Open	Closed
EV valves	EV-7a/-b, EV-9, EV-23, EV-16	All other
AV valves	APR-2	All other
Dewar valves	GTV-V, SV-9	GTV-Va, SV-13, ST-Va/Vb
RAV valves	RAV-3, RAV-6B	All other

Section G.5 complete. Quality_____

G.6. Set up for flow test

G.6.1. Verify DAS is cycling at 5 minute intervals.

G.6.2. Set up Guard Tank pressure.

1. Begin data entry every 15 minute in Table 1.

Note:

In the following it is important to minimize perturbing internal temperatures as a good equilibrium temperature condition is important for high quality data.

2. Adjust APR-2 to slowly adjust pressure at GTVG (CN46) to between 100 torr to 140 torr (140 torr is maximum reading at CN46). Use EFM-2 reading to maintain low helium in flow rate.
3. When the pressure is attained and the flow is low, proceed with the next steps.

Note:

The quality of the evaluation results are a strong function of establishment of good equilibrium temperature distribution in the Guard Tank-HEX1 through HEX4 regions.

G.6.3. Comment on condition of temperature equilibrium of Guard Tank, Main Tank and HEXs: _____

_____

_____

Section G.6 Complete. Quality _____

G.7. Flow gas out of Guard Tank.

G.7.1. Comment to DAS, “Begin flow out of Guard Tank”.

G.7.2. Close EV-23: Guard Tank is now closed off; pressure relief is now at ERV-2a/-2b.

G.7.3. Verify DAS is set to fast scan mode using [other menus], [data config], [fast scan]

G.7.4. Suspend alarm cycles.

G.7.5. Place special Data Cycle cycle time to </= 0.25 minutes

G.7.6. At the conclusion of a normal data cycle, suspend normal data cycles.

G.7.7. At a point between special data cycles, perform the following steps and record exact time (from DAS clock) at which EV-24 is opened.

1. Open EV-24

Record time _____ .

G.7.8. Once the flow as indicated at CN120 has reached a relative constant value, initiate normal data cycles at 5 minute intervals.

G.7.9. Continue recording data in Table 1 every <=15 minutes.

Section G.7 Complete. Quality _____

G.8. Completion of Guard Tank flow.

G.8.1. When:

1. the flow rate as measured by WTM is ~/< 1 slpm

Or,

2. the pressure at GTVG is <15 torr

proceed with the following steps to shut down the test.

G.8.2. Verify APR-2 is adjusted to ~ 1.5 psig.

G.8.3. Close EV-24.

G.8.4. Open EV-23.

G.8.5. Stop data entries to Table 1.

Section G.8 Complete. Quality _____

G.9. Configuring Dewar and GSE

G.9.1. Verify Gas Module valving as follows:

	Open	Closed
EV valves	EV-7a/-b, EV-16, EV-9, EV-23	All other
AV valves	APR-2	All other
Dewar valves	GTV-V, SV-9	GTV-Va, ST-Va/Vb, SV-13, FCV
RAV valves	RAV-3, RAV-6B	All other

Section G.9 Complete. Quality _____

G.10. Setting up Data Acquisition

G.10.1. Input comment to DAS “Completed Guard Tank Vent Line Impedance Measurement”.

G.10.2. Set DAS to configuration choice 4M.

G.10.3. Stop Special Data Cycle by using [Other Menus] + [Special Data Col] + [Stop Data Col].

G.10.4. 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.10.5. Set DAS to normal scan mode using [other menus], [data config], [normal scan]

G.10.6. Set DAS data cycle interval to 15 minutes.

G.10.7. Set Main Tank Liquid Level sampling interval to 10 minutes.

G.10.8. Confirm that the liquid level sensors are set at a sampling rate of 10 minutes or turned off.

G.10.9. Confirm that Vac-ion pump is off.

G.10.10. Enable/verify enabled the alarms on the Main Tank and Well Liquid Level Sensors.

G.10.11. Verify enabled the DAS alarm and record the set points:

a) CN ____, Level _____

b) CN ____, Level _____

c) CN ____, Level _____

d) Main Tank Level: _____ %

e) Well Level: _____ %

G.10.12. Ensure DAS watchdog timer and alarm enabled.

Section G.10 Complete. Quality _____

G.11. **Data Documentation**

G.11.1. Attach to this procedure an Excel plot of the special data cycle output.

G.11.2. Record time elapsed to reach a flow of 1 slpm or a pressure of 15 torr-diff at GTVG _____ .
Flow rate CN121 _____ slpm
Pressure GTVG CN46 _____ torr

G.11.3. From the Excel spreadsheet calculate the integrated flow out of the Guard Tank and enter _____ liters.

G.11.4. Verify performance of post-operations checklist (Appendix 2)

Section G.11 Completed. QA Witness:_____

H. **PROCEDURE COMPLETION**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

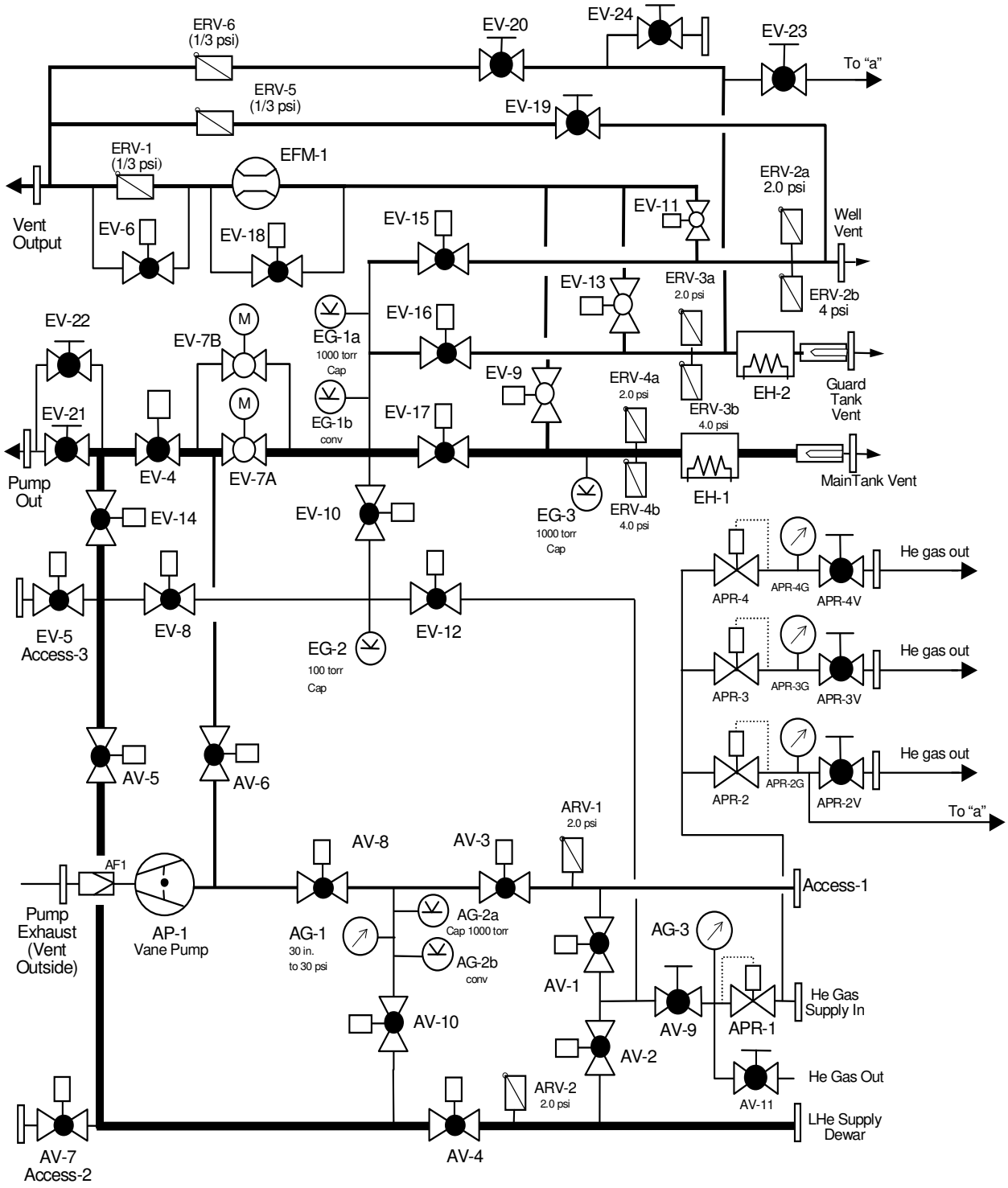


Figure 1. Gas Module

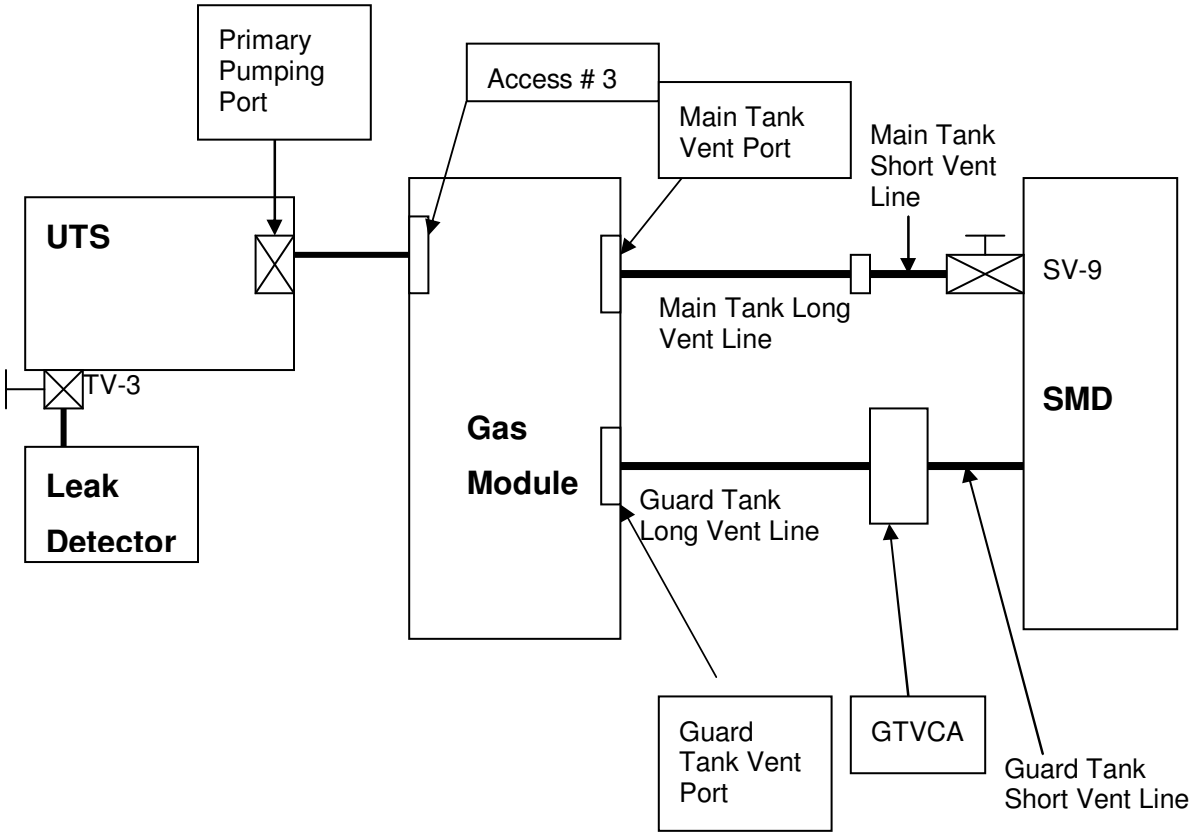


Figure 2: Overview of final configuration and connections.

See individual diagrams for more detail

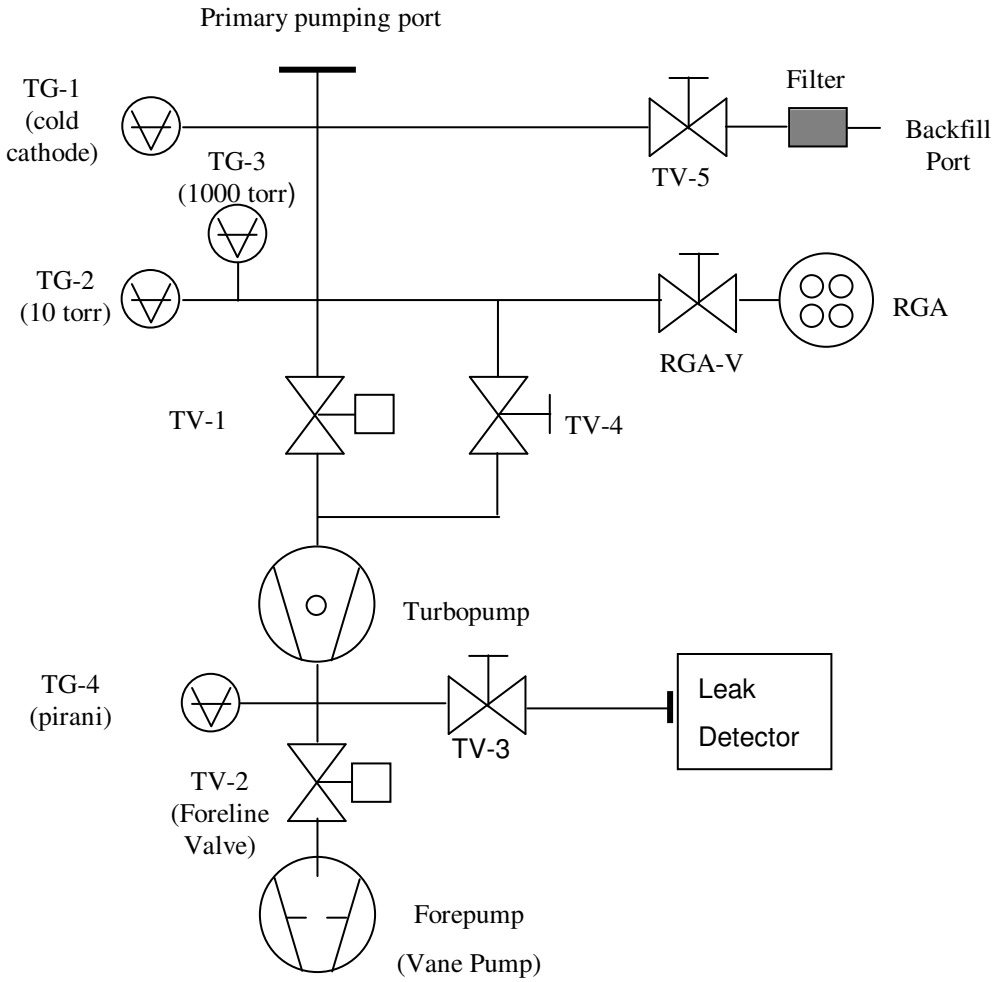


Figure 3. Schematic diagram of Utility Pumping System (UTS)

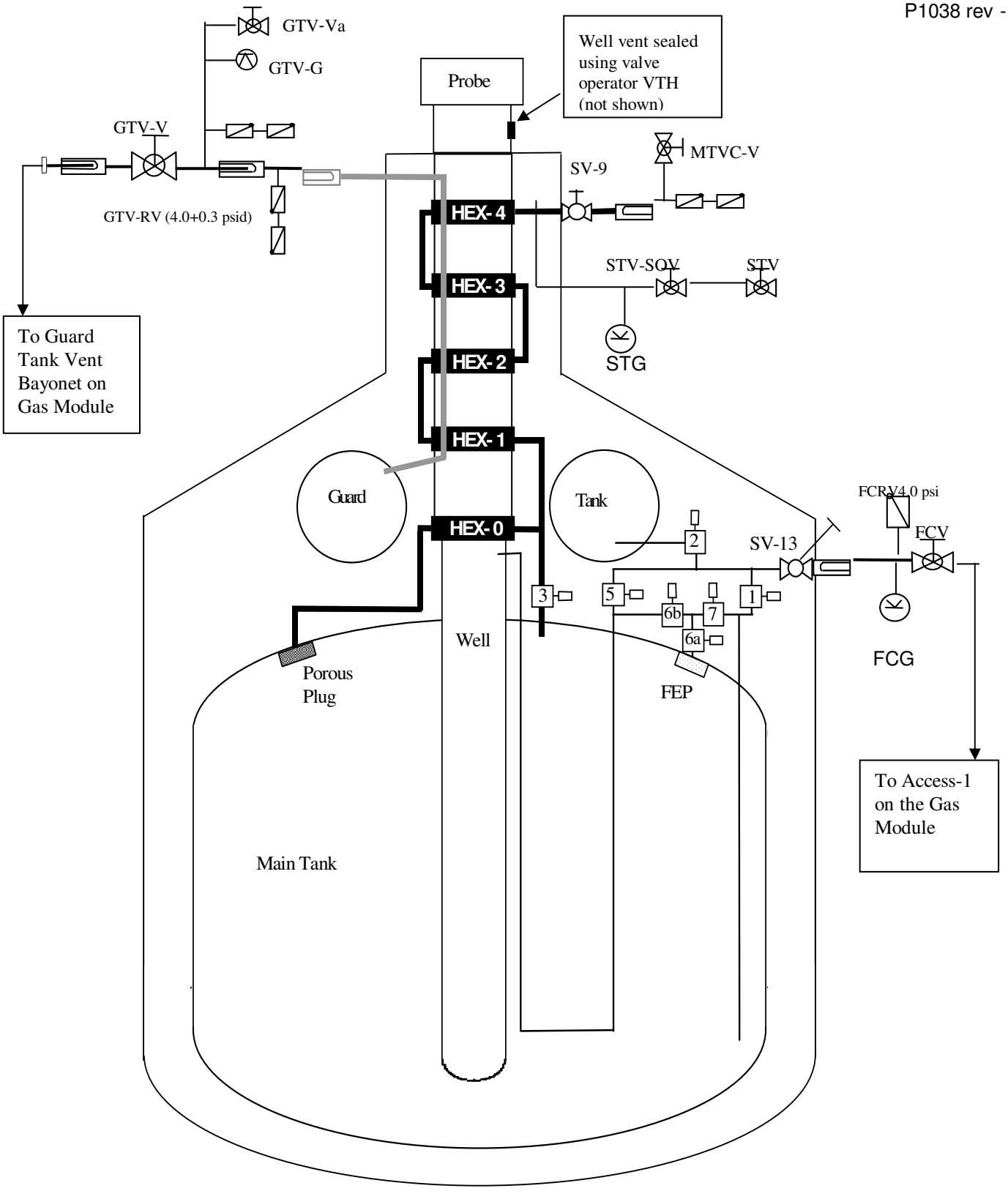
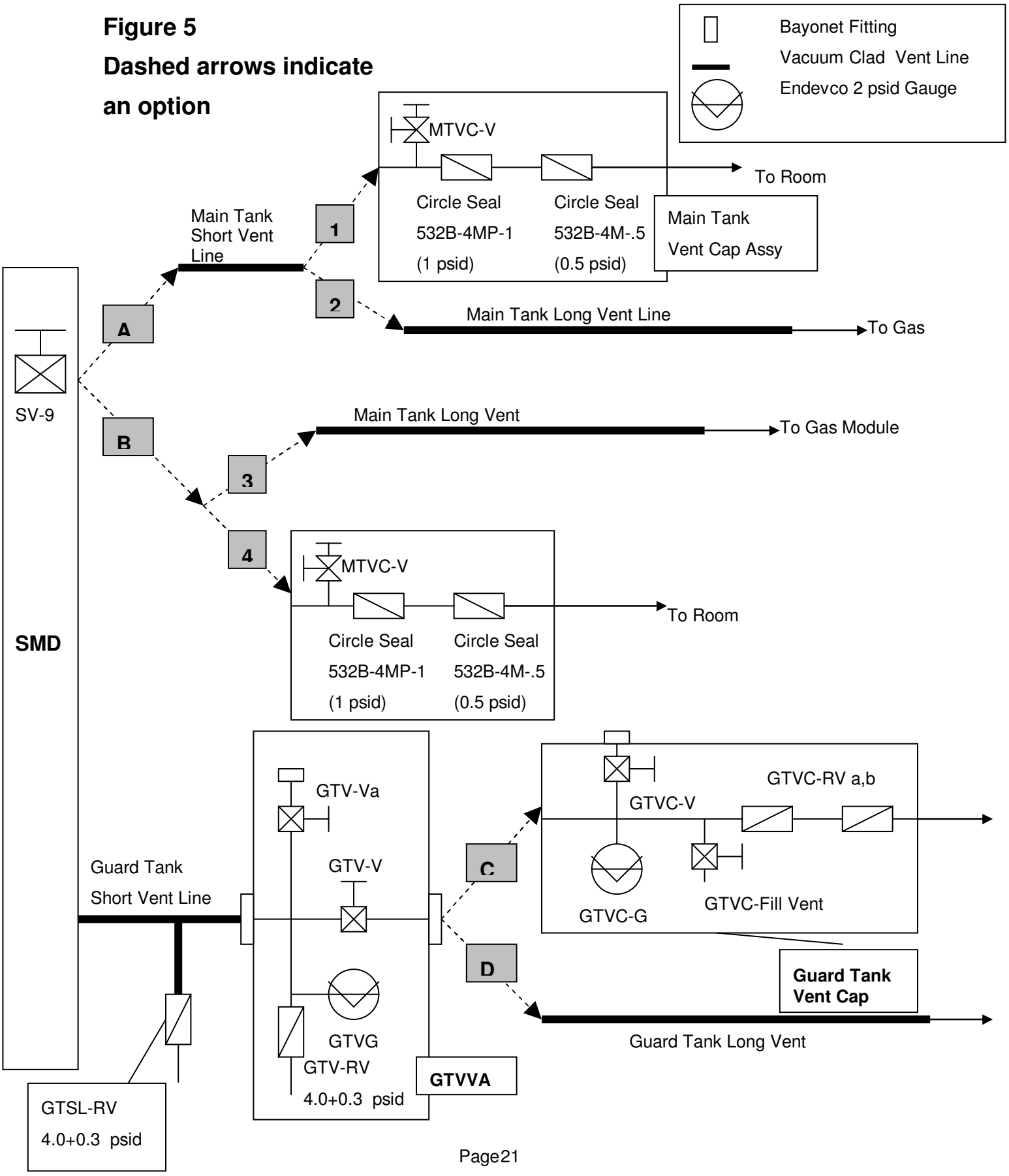


Figure 4 Schematic representation of SMD showing interfaces with Gas module.

Figure 5

Dashed arrows indicate an option



I. APPENDIX 1 PRE OPERATIONS CHECKLIST

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

J. APPENDIX 2 POST OPERATIONS CHECKLIST

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

K. APPENDIX 3– CONTINGENCY/EMERGENCY 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.
Liquid nitrogen spill	Anytime	Clear area until all spilled liquid has evaporated
Temperature limits (CN 29 or 28) exceeded	Anytime	Close EV-17 (if open) and open EV-9. Crack open SV-9 to allow MT to vent. Adjust SV-9 as necessary to restore temperature(s) below alarm limits. Open EV-6 and EV-18 if higher flow rate is needed.
Burst disk rupture (MT/GT)	Anytime	Evacuate room
Pressure in Main Tank exceeds limit	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
Oxygen Monitor Alarm	Anytime	Evacuate room