

GRAVITY PROBE B PROCEDURE FOR SCIENCE MISSION DEWAR

DISCONNECT GUARD TANK VENT LINE FROM GAS MODULE

To be performed at Vandenberg Air Force Base building 1610

WARNING: THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

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P1009

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REVISION RECORD

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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.		

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 provides the necessary steps to disconnect the Guard Tank vent line from the Gas Module and install a Vent Cap. The steps include:

- Close off vent line at Guard Tank Vent Valve (GTV-V)
- Leak check Guard Tank Vent Cap
- Disconnect Guard Tank long vent line
- Install vent cap at GTV-V
- Leak Check Guard Tank Vent Cap
- Open Guard Tank vent valve if not depleted.

The procedure is applicable when the Guard Tank contains liquid, as well as, when it is depleted. The Main Tank vent line may be connected to the Gas Module or disconnected from the Gas Module. The Main Tank liquid may be at normal boiling point or subatmospheric.

The hazardous operation contained in this procedure is the handling of cryogenic nitrogen to service the leak detector.

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/P0479945 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, there may be an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. In addition, 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 line deflectors 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 safety. The fall back area will be building 1605

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, non-absorbent shoes and full-face shields with goggles/glasses are to be worn whenever the possibility of splashing cryogenics exists. (if ethanol is to be used rubber gloves are required

B.2.3. Other Hazards

All 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 the event of fire or illness/injury 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 EMSYS229 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 (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. QA Notification

The NASA program and NASA safety 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 PTM or QA Representative, experiment functionality may be affected. Within hazardous portions of this procedure, all steps shall be worked in sequence. Out-of-sequence work or redlines shall be approved by NASA Safety prior to their performance.

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 PTM 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:

<u>FUNCTIONAL TITLE</u>	<u>NUMBER</u>	<u>AFFILIATION</u>
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford
NASA Safety Rep	1	SFAO or ANALEX

E. REQUIREMENTS**E.1. Electrostatic Discharge Requirements**

When working on the space vehicle, proper ESD protection is required. The wrist-strap will be checked using an appropriate calibrated checker prior to use.

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:

E.3.4. The Data Acquisition System (DAS) and data acquisition software are required for this procedure. The DAS reads and displays pressures, temperatures, and flow rates and monitors critical parameters. No additional computers or software are required.

E.3.4. Additional Test Equipment

<i>Description</i>
Helium leak detector S/N or Model #: _____ Cal Leak Due Date: _____

E.3.5. Additional Hardware

<i>Description</i>
Guard Tank Vent Cap – See Figure 2
4 liter thermos

E.3.6. Tools

No special tools are required.

E.3.7. Personnel Protective Equipment

1. Cryogenic safety gloves and apron
2. Face shield
3. Goggles/glasses
4. Non-absorbent shoes
5. Rubber Gloves if ethanol is to be used

E.3.8. Expendables

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

<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	Aperizon 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

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	-

No.	Location	Description	Name	Serial No.	Cal Required	Status Cal due date
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.6. Configuration Requirements

E.6.1. Main Tank

Liquid in the Main Tank may be at its normal boiling point (NBP) or subatmospheric. When subatmospheric, the initial configuration of the Gas Module may be such that the bath is being actively pumped or is set up in a non-vented mode.

E.6.2. Guard Tank

The Guard-Tank may contain liquid, or be depleted.

The Guard Tank liquid boils away at a rate of approximately 15% per day. If the vent line is to be disconnected for a period of less than 7 days, the liquid level should be topped off before disconnection (see document no. SU/GP-B-P1029 *Internal Guard Tank Fill – Vent Lines Connected*). Note: to perform an internal fill of the Guard Tank while the vent line is disconnected requires that the Main Tank be at NBP and that the Main Tank vent line also be disconnected with a vent cap installed (see document no. SU/GP-B-P1026, *Internal Guard Tank Fill – Vent Lines Disconnected*). Otherwise, the Guard Tank must be reconnected to the Gas Module, or depleted (see document no. SU/GP-B-P1030, *Guard Tank Depletion*).

When the Guard Tank is depleted, its pressure must be independently regulated from a source of 99.99% pure helium gas and its pressure must be continuously monitored and maintained at a positive value relative to that of the atmosphere. Monitoring is accomplished by placing the relative pressure, as read at the Guard Tank Vent Valve Assembly (GTV-G), on the DAS alarm list.

E.6.3. Well

The Well is evacuated.

E.6.4. Vacuum Shell

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

E.6.5. 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 CN 29) at $T \leq 6.0$ K.
 - b. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq .3$ torr.

E.6.6. GSE and Non-flight Hardware

1. GSE cabling must be connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).
2. Guard Tank Vent Cap (Figure 2).

E.7. **Optional Non-flight Configurations**

The following modifications or non-flight arrangement of the basic SMD configuration may also be in place in various contingencies. They are incidental to the performance of this procedure and not required.

1. The SMD is installed in its transportation and test fixture.
2. The ion-pump magnet is installed.
3. The Main Tank Vent Line may be connected to the Gas Module, or it may be disconnected either at the Bayonet at the end of the short line or the Bayonet at SV-9.
4. 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.
5. 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
LM/P479945	Missile System Prelaunch Safety Package
SU/GP-B-P0141	FIST Emergency Procedures
LMSC-P088357	Science Mission Dewar Critical Design Review

EM SYS229	Accident/Incident/Mishap Notification Process
SU/GP-B P059	GP-B Contamination Control Plan
EWR 127-1	Eastern and Western Range Safety Requirements
SU/GP-B-P0108	Quality Plan
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3. **Additional Procedures**

<i>Document No.</i>	<i>Title</i>
SU/GP-B-P1029	Internal Guard Tank Fill – Vent Lines Connected
SU/GP-B-P1026	Internal Guard Tank Fill – Vent Lines Disconnected
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities
SU/GP-B-P1030	Guard Tank Depletion
SU/GP-B P0879	Accident/Incident/Mishap Notification Process

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 Safety representative notified.
Record: Individual notified _____,
- o Verify NASA program representative notified.
Record: Individual notified _____,
- o Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- o Persons actually performing this procedure should sign their names in Sec D.3 Verify completion of the pre-operations checklist (Appendix 1).
- o Verify Guard Tank Vent Line connected to Gas Module- if not terminate procedure
- o Verify proper operation of the GP-B Cryogenic Group oxygen monitor
- o Verify availability and functioning of emergency shower

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. No.

Operation. Number: _____

QA Witness: _____

WARNING

Hazardous operations are about to begin. When filling the nitrogen trap in the leak detector, wear cryogenic safety apron, gloves, face shield with goggles/glasses, and non-absorbent shoes. Failure to comply may result in personal injury.

G.3. Leak Check Guard Tank Vent Cap.

- G.3.1. Request NASA Safety make PA announcement that a hazardous task is about to begin
- G.3.2. Ensure the operation light is turned to Amber
- G.3.3. Establish a six foot controlled area
- G.3.4. Ensure all nonessential personnel are clear of area.
- G.3.5. Attach Leak Detector at GTVC-V
- G.3.6. Bag the entire assembly.
- G.3.7. Ensure all other access ports are capped off.
- G.3.8. Record Leak Detector background rate: _____ scc/s
- G.3.9. Ensure background on the 10^{-7} scc/s range.
- G.3.10. Spray helium into bagged assembly for two minutes.
- G.3.11. Record leak rate after two minutes: _____ scc/s.
- G.3.12. Verify that no rise is detected.
- G.3.13. Close GTVC-V.
- G.3.14. Disconnect Leak Detector at GTVC-V.

NOTE

The hazardous operation is now complete.

- G.3.15. Request NASA safety return operational light to green.
- G.3.16. Remove controlled area requirements and request NASA safety concurrence to open building 1610 for normal operations.
- G.3.17. Request PA announcement that hazardous operations are complete.
- G.3.18.

G.4. Verify Configuration Requirements

- G.4.1. 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 and set to alarm at $T \leq 6.0$ K. Record set point. _____K
 2. **Relative Guard Tank Pressure** – ensure CN [46] on DAS alarm list and set to alarm at $\Delta P \geq 0.3$ torr. Record set point. _____torr
- G.4.2. Ensure liquid-level alarms set, as appropriate, and record set points.
1. **Main Tank** – ensure liquid-level alarm set. Record set point. _____%
 2. **Guard Tank** – ensure liquid level alarm set (if liquid in GT). Record set point. _____%
- G.4.3. Ensure appropriate GSE cabling connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).

Section Complete QA Witness: _____

G.5. Record Initial Configuration and Conditions

G.5.1. Record Main Tank Configuration.

- o MT.A- Main Tank at NBP – vent line connected to Gas Module:
- o MT.B- Main Tank at NBP – vent line disconnected from Gas Module:
- o MT.C- Main Tank subatmospheric- vent line disconnected from Gas Module.
- o MT.D. Main Tank subatmospheric and being pumped by AP-1-verify that AP-1 is running.

G.5.2. :

G.5.2. Record Guard Tank Configuration

- o GT.A-Guard Tank contains liquid and is venting in Bypass mode
- o GT.B- Guard Tank is depleted and regulated by APR-3 through GTV-Va.
- o GT.C- Guard Tank is depleted and regulated by APR-2 through EV-23.
- o GT.D-Guard Tank contains liquid and is venting in common manifold mode.

G.5.3. Verify valves are in the proper configuration as given by the following table.

Configuration	EV Valve States		AV Valve States		Other Valves	
	Open	Closed	Open	Closed	Open	Closed
MT.A/GT.A	EV-9, EV-16, EV-20	All other EV valves	None	All AV valves	SV-9, GTV-V, V,	MTVC-V, GTV-Va
MT.A/GT.B	EV-9, EV-16, APR-3V	All other EV valves	None	All AV valves	SV-9, GTV-Va	MTVC-V, GTV-V
MT.A/GT.C	EV-9, EV-16, EV-23	All other EV valves	None	All AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.A/GT.D	EV-9, EV-13, EV-16	All other EV valves	None	All AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.B/GT.A	EV-16, EV-20	All other EV valves	None	All AV valves	SV-9, GTV-V, V,	MTVC-V, GTV-Va
MT.B/GT.B	EV-16, APR-3V	All other EV valves	None	All AV valves	SV-9, GTV-Va	MTVC-V, GTV-V
MT.B/GT.C	EV-16, EV-23	All other EV	None	All AV	SV-9, GTV-V	MTVC-V,

Configuration	EV Valve States		AV Valve States		Other Valves	
	Open	Closed	Open	Closed	Open	Closed
		valves		valves		GTV-Va
MT.B/GT.D	EV-16, EV-13	All other EV valves	None	All AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.C/GT.A	EV-16, EV-20,	All other EV valves	None	All AV valves	SV-9, GTV-V,	MTVC-V, GTV-Va
MT.C/GT.B	EV-16, APR-3V	All other EV valves	None	All AV valves	SV-9, GTV-Va	MTVC-V, GTV-V
MT.C/GT.C	EV-16, EV-23	All other EV valves	None	All AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.C/GT.D	EV-16, EV-13	All other EV valves	None	All AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.D/GT.A	EV-7a/b, EV-17, EV-20	All other EV valves	AV-6,	All AV valves	SV-9, GTV-V,	MTVC-V, GTV-Va
MT.D/GT.B	EV-7a/b, EV-17, APR-3V	All other EV valves	AV-6	All other AV valves	SV-9, GTV-Va	MTVC-V, GTV-V
MT.D/GT.C	EV-7a/b, EV-17, EV-23	All other EV valves	AV-6	All other AV valves	SV-9, GTV-V	MTVC-V, GTV-Va
MT.D/GT.D	EV-7a/b, EV-13, EV-17	All other EV valves	AV-6	All other AV valves	SV-9, GTV-V	MTVC-V, GTV-Va

G.5.4. Record initial liquid helium levels as appropriate.

1. Main Tank (LL-1D or LL-2D) _____ %
2. Guard Tank (LL-5D or LL-6D) _____ %

G.5.5. Record initial pressures, as appropriate.

1. Main Tank – Subatmospheric (EG-2/STG): _____ torr.
2. Main Tank – NBP (EG-3/STG): _____ torr.
3. Guard Tank – with liquid (EG-1a) _____ torr.
4. Guard Tank – depleted (GTV-G) _____ torr.

G.5.6. Branch to appropriate section of procedure

1. If in configuration GT.A or GT.D proceed to section G.6
2. If in configuration GT.B or GT.C proceed to section G.7

Section Complete QA Witness: _____

G.6. Disconnect Vent Line – Liquid in Guard Tank

- G.6.1. Close/verify closed EV-13 and EV-20.
- G.6.2. Verify Guard Tank pressure positive relative to atmospheric pressure.
Record relative pressure (GTV-G) _____ torr.
- G.6.3. Close GTV-V.
- G.6.4. Remove long vent line from GTV-V.
- G.6.5. Inspect, clean, and lubricate (Apiezon "N") Vent-Cap o-ring.
- G.6.6. Install Guard Tank Vent Cap at GTV-V.
- G.6.7. Leak Check Guard Tank Vent Cap.
1. Attach Leak Detector at GTVC-V.
 2. Bag the entire assembly, including connection to between GTV and Guard Tank Vent Cap assembly.
 3. Ensure all other access ports are capped off.
 4. Record Leak Detector background rate: _____ scc/s
 5. Ensure background on the 10^{-7} scc/s range.
 6. Spray helium into bagged assembly for two minutes.
 7. Record leak rate after two minutes: _____ scc/s.
 8. Verify that no rise is detected.
 9. Close GTVC-V.
 10. Disconnect Leak Detector at GTVC-V.

QA Witness: _____

- G.6.8. Open GTV-V.
- G.6.9. Record Guard Tank pressure (GTV-G, relative to atm.) _____ torr.
- G.6.10. **(Option)** Remove Guard Tank vent line from inlet to Gas Module heat exchanger and install blankoff.
- o Guard Tank Vent Line disconnected from Gas Module
 - o Guard Tank Vent Line not disconnected from Gas Module
- G.6.11. Cover open ends of vent line.
- G.6.12. Proceed to Section G.8.

Section Complete QA Witness: _____

G.7. Disconnect Vent Line – Guard Tank Depleted

G.7.1. Record method of Guard Tank pressure regulation:

- o If in configuration GT.B skip to Section G.7.2.

 - o If in configuration GT.C; perform the following:
 1. Close/ Verify closed EV-23
 2. Crack open GTV-Va and adjust for He gas outflow.
 3. Attach GHe supply line (while purging) from APR-2V to access port at GTV-Va.
 4. Open GTV-Va fully.
 5. Perform Section G.7.2
-

G.7.2. Ensure Guard Tank pressure positive relative to atmospheric pressure.
Record relative pressure (GTV-G) _____ torr.

G.7.3. Close GTV-V.

G.7.4. Remove long vent line from GTV-V.

G.7.5. Inspect, clean, and lubricate (use Braycote 601 or aperizon "N") Vent-Cap o-ring.

G.7.6. Install Guard Tank Vent Cap at GTV-V.

G.7.7. Leak Check Guard Tank Vent Cap.

1. Attach Leak Detector at GTVC-V
2. Bag the entire assembly, including connection to between GTV and Guard Tank Vent Cap assembly.
3. Ensure all other access ports are capped off.
4. Record Leak Detector background rate: _____ scc/s
5. Ensure background on the 10^{-7} scc/s range.
6. Spray helium into bagged assembly for two minutes.
7. Record leak rate after two minutes: _____ scc/s.
8. Verify that no rise is detected.
9. Close GTVC-V.
10. Disconnect Leak Detector at GTVC-V.

QA Witness: _____

- G.7.8. Open GTVC-V.
- G.7.9. Crack open GTV-V, observe flow and purge Vent Cap for one minute.
- G.7.10. Close GTVC-V.
- G.7.11. Close GTV-V
- G.7.12. **(Option)** Remove Guard Tank Vent line from inlet to Gas Module heat exchanger and install blankoff.
 - o Guard Tank Vent Line disconnected from Gas Module
 - o Guard Tank Vent Line not disconnected from Gas Module
- G.7.13. Cover open ends of vent line.
- G.7.14. Proceed to Section G.8.

Section Complete QA

Witness: _____

G.8. Establish Final Configuration

- G.8.1. Close/verify closed EV-13, EV-16, EV-20, EV-23 and EV-24.
- G.8.2. Ensure DAS alarm enabled and record set points if changed
 - o Thermal conditions substantially unchanged, alarm set point for the lead bag is unchanged
 - o Thermal conditions substantially changed, temperature alarm points reset as follows:
 - a. Top of Lead Bag set point _____ K (≤ 6.0 K)
[CN 28 and CN 29]
- G.8.3. Ensure liquid level sensor alarms enabled, as appropriate, and record set points if changed.
 - 1. Main Tank Level Set Point _____%
 - 2. Guard Tank Level Set Point _____%
- G.8.4. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.
- G.8.5. Verify completion of Post-Operations Checklist. (Appendix 2)

Section Complete QA Witness: _____

H. **PROCEDURE COMPLETION**

Completed by: _____

Witnessed by: _____

Date: _____

Time: _____

Quality Manager _____ **Date** _____

Payload Test Director _____ **Date** _____

Figure 1: Gas Module

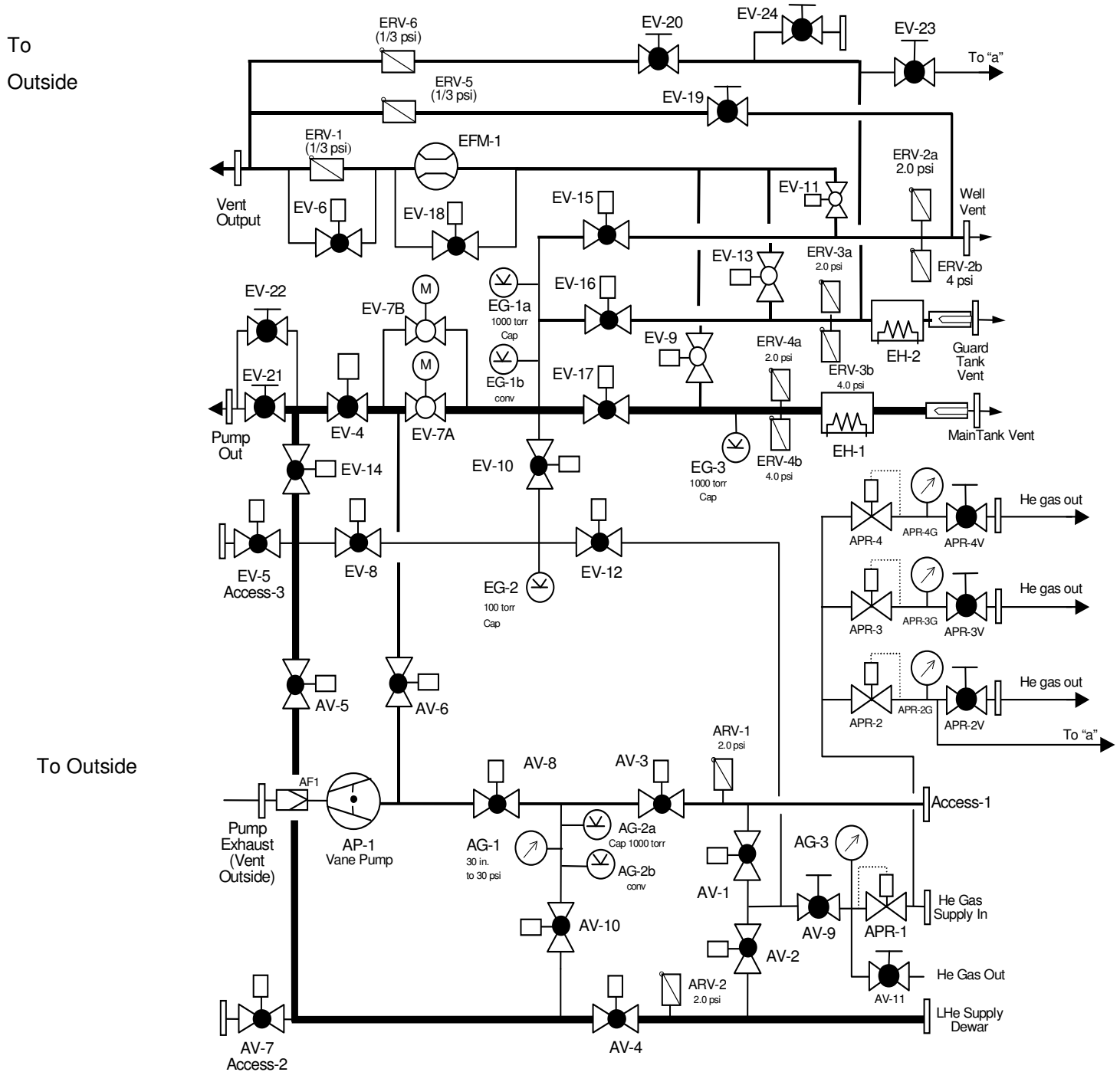
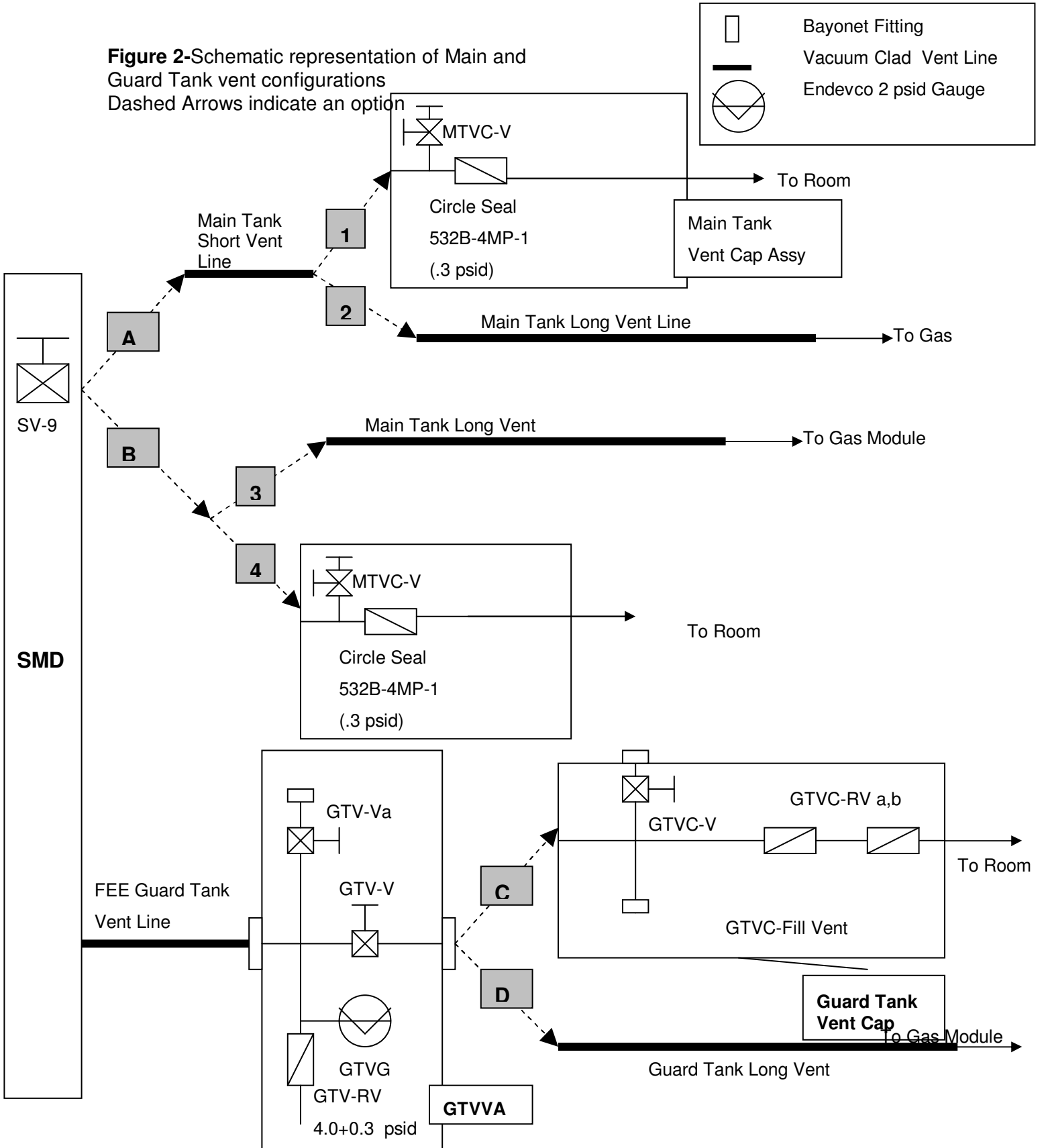
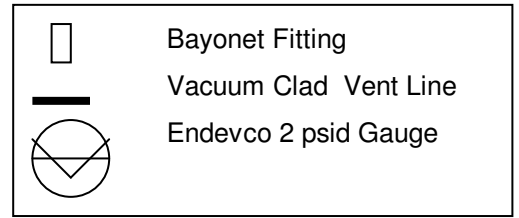


Figure 2-Schematic representation of Main and Guard Tank vent configurations
Dashed Arrows indicate an option



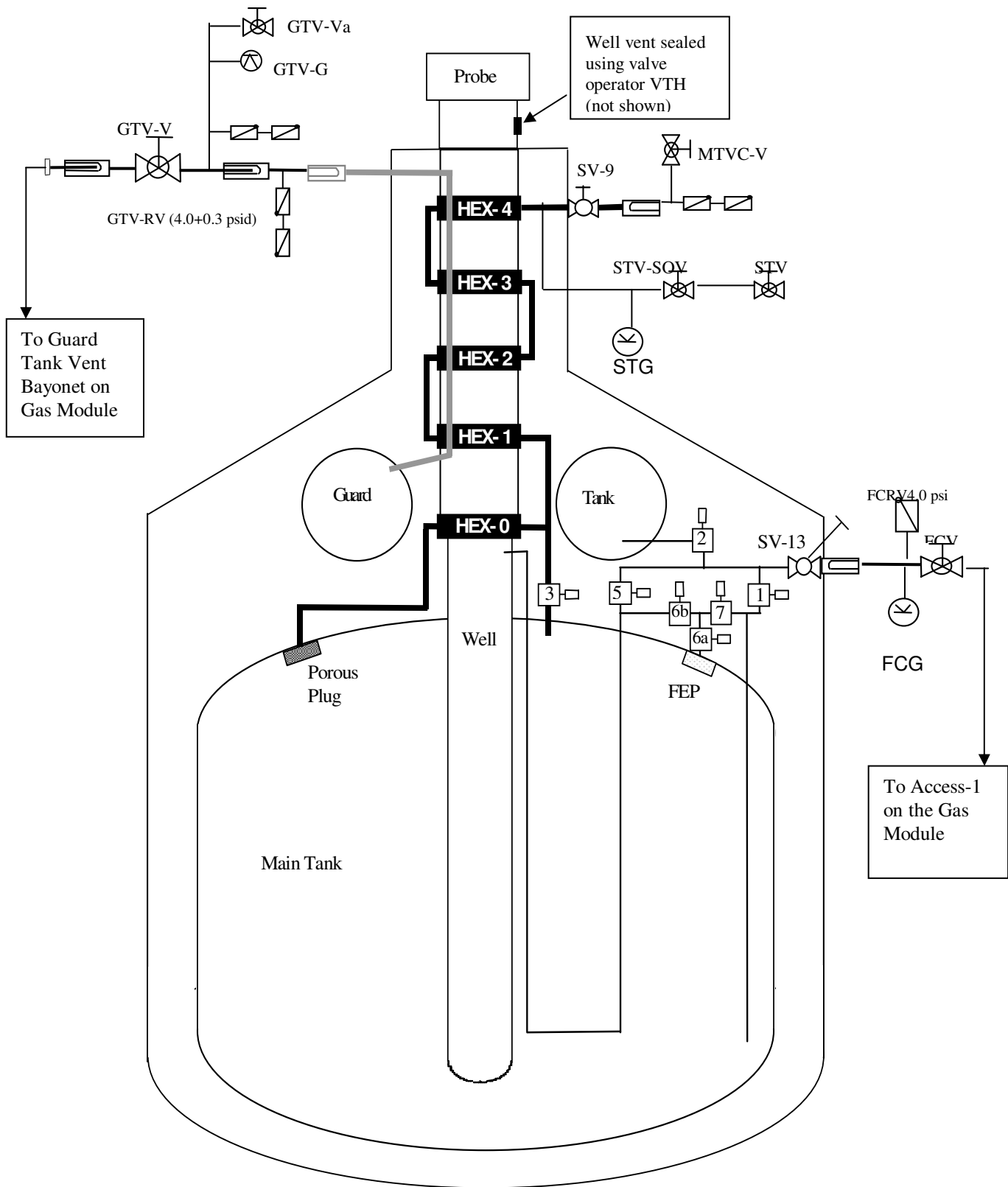
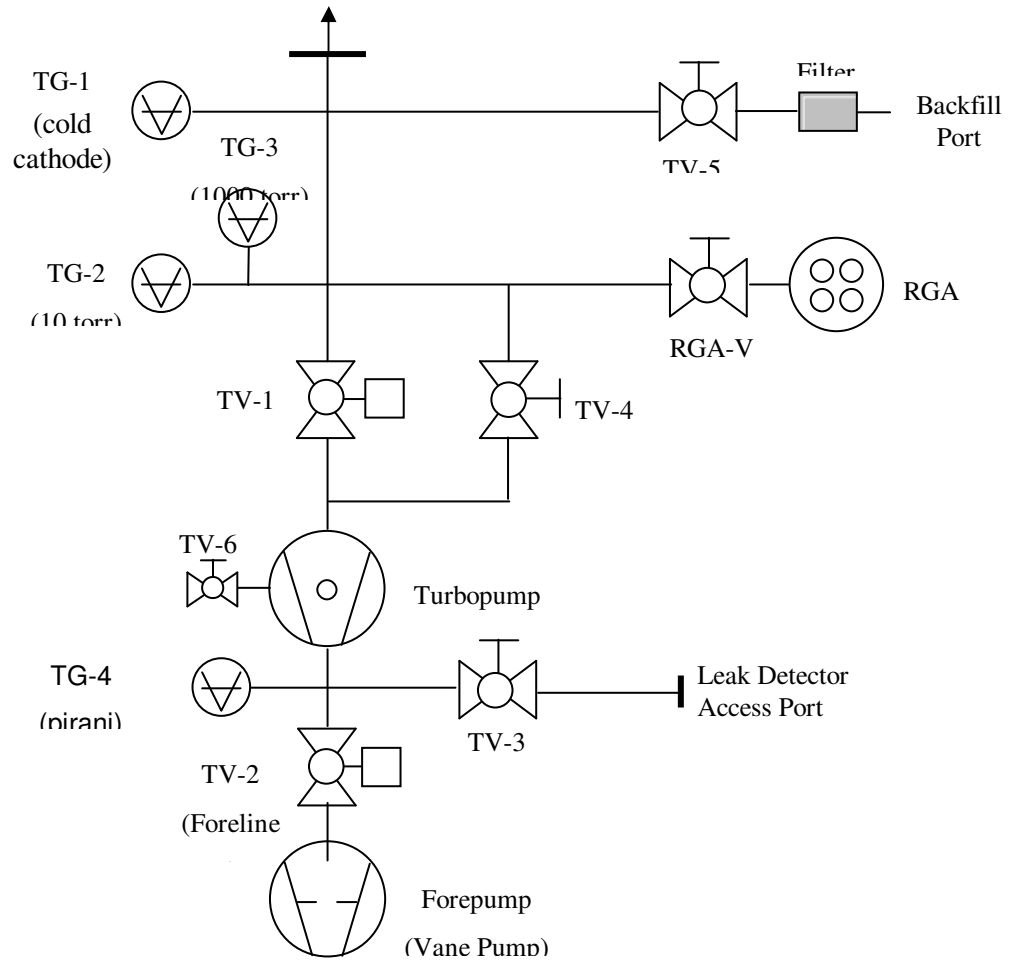


Figure 3 Schematic representation of SMD showing interfaces with Gas module.

I. **FIGURE 4: UTILITY TURBO PUMPING SYSTEM**



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 is certified for the task being performed and knows their 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 pre-task engineering/safety high bay walk down. Verify noted discrepancies are corrected.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		

	Team Lead Signature: _____		
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J. **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: _____		

K. **APPENDIX 3– EMERGENCY/CONTINGENCY RESPONSES**

Condition	Circumstance	Response
Temperature limits (CN 29 or 28) exceeded	While MT is at NBP	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
Oxygen Meter Alarm	Any time	Evacuate room
Liquid Nitrogen Spill	Any time	Clear area until all spilled liquid has evaporated