GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Internal Guard Tank Fill – Vent Lines Disconnected

P0669 Rev. A

January 25, 2000

ECO# 1350

Revised by

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REVISION RECORD

REV	ECO	PAGES	DATE
A	1350	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 Removed references to filling the well Removed requirement for continously pumping on the vacuum shell 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 Removed options and references to manifolding the Main Tank and Guard Tank vent caps together	1/25/02

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List of Abbreviations and Acronyms

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

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A. SCOPE

This procedure describes the steps necessary to transfer normal boiling point liquid helium from the Main Tank to the Guard Tank of the Science Mission Dewar, while the Main and Guard Tanks are both disconnected from the Gas Module. The steps include;

Raise Main Tank Pressure- Close SV-9 and use Main Tank heaters

Raise internal fill line pressure to Main Tank pressure – open RAV-1.

Decrease Guard Tank pressure – open Guard Tank vent valve on Vent Cap.

Initiate transfer – open RAV-2.

Terminate transfer – close RAV-1 and RAV-2.

The Main Tank liquid must be at normal boiling point. All RAV-2 operations are to be performed by the LM personnel and the ECU

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 "Emergency Escape Breathing Apparatus" (EEBA) 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

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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.

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

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

E.3.6. Tools

Description

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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 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	-

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No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
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 CN 29) 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

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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.

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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*

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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 and section E.3.6.
- Verify that persons actually performing this procedure have initialed their names in Sec. D.3 and the name of the Test Director is circled.
- Complete pre-operations review.
- Verify LM personnel prepared to open RAV-2 when neccessary

QA Witness:_____

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

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

G.3.2. Ensure Dewar Adapter heaters are operational and record:

1. HP power supply: V: _____ Vdc, I: _____ A
2. Top Plate temperature: _____ oC

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.

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G.3.4. Ensure ion-pump magnet installed.

G.3.5. Ensure Vacuum Shell Pressure < 5 x 10-5 torr.

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. If pressure is above 5x10-5 torr, turn off Vac-ion pump and perform procedure P0213 to pump out SMD vacuum shell with Vacuum Module. Record operation number _____.
5. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
6. When data cycle is complete, turn off Vac-ion pump.

CAUTION
This procedure necessitates closure of the Main Tank vent. During the period of closure the temperatures at the top of the lead bag are to be continuously monitored. Ensure that these temperatures are on the DAS alarm list and appropriately alarmed.

G.3.6. Ensure DAS alarm system enabled and record set points.

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

G.3.7. 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%. Record set point. _____ %

G.3.8. Verify flight burst disk installed on SMD internal fill-line.

G.3.9. Ensure GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.3.10. Ensure Main Tank Vent Cap installed. If not, perform procedure P0675, *Disconnect Main Tank Vent Line From Gas Module – Main Tank at NBP*, and record operation number _____.

G.3.11. Ensure Guard Tank Vent Cap installed. If not, perform procedure P0677,

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Disconnect of Guard Tank Vent Line From Gas Module, and record operation number _____.

G.3.12. Ensure Fill Cap Assembly installed at SV-13.

\QA Witness:_____

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

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

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

G.4.2. Verify that SMD external valves are in the following positions.

1. ***Open***:SV-9.
2. ***Closed***:SV-13, STV and FCV.

QA Witness:_____

G.5. **Establish Vent Line Configuration and Record Initial Conditions**

G.5.1. Record pressures, relative to atmospheric

1. Guard Tank pressure (GTV-G, CN [46]) _____ torr.
2. Main Tank pressure (STG, CN [49]) _____ torr .

G.5.2. Establish Guard Tank vent configuration:

- Liquid in Guard Tank
  1. Verify GTV-V open
  2. Verify GTV-Va closed

- Guard Tank depleted with pressure independently regulated at GTV-Va.
  1. Verify GTV-Va open and connected to APR-2V
  2. Verify APR-2 set to 2 psig
  3. Verify EV-23 closed

G.5.3. Record liquid helium levels:

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

QA Witness:_____

G.6. **Check Initial pressure in Fill Line**

G.6.1. Turn on pump AP-1

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G.6.2. Install a pumping line between valve FCV on the Fill Cap Assembly and the Access Port #1 of the Auxiliary gas section.

G.6.3. Open AV-8.

G.6.4. Open AV-3.

G.6.5. Open valve FCV and evacuate to 20 mtorr as measured at AG-2.

G.6.6. Close AV-8 and FCV.

G.6.7. Once the pressure in the Fill Cap Assembly (PFCG) has stabilized, record Fill Cap Assembly pressure (PFCG): _____ torr.

G.6.8. Open valve SV-13 and bring the Fill Cap Assembly up to the pressure in the SMD fill line and record fill line pressure (PFCG): _____ torr.

QA Witness:_____

G.7. **Set up Data Acquisition**

G.7.1. Set Main Tank sampling interval to 1 minute.

G.7.2. Set Guard Tank sampling interval to 1 minutes.

Note: Refer to Operating Instructions for mechanics of DAS keyboard/mouse operations.

G.7.3. Set DAS data cycle time to 5 minutes or less: use [Set D.C. Interval].

G.7.4. Set up special data collection

QA Witness:_____

CAUTION
When RAV-1 is closed, the temperature of the Lead Bag and the Main Tank pressure may increase quickly. The test director should monitor the special data continuously. In addition, RAV-2 should be opened as soon as the pressure differential between the Main Tank and the Guard Tank is sufficient to transfer liquid.

G.8. **Raise Pressure in Fill Line by opening RAV-1 and close SV-9**

G.8.1. Ensure LM personnel on standby and ready to open RAV-2

G.8.2. Close SV-9

G.8.3. Enter comment in DAS, "Closed Main Tank Vent Valve- SV-9"

G.8.4. **Ensure all** RAV controller selection switches in OFF position.

G.8.5. Turn on RAV power supply and adjust current limit to 1.85 amps.

G.8.6. Adjust power supply to 28 VDC.

G.8.7. Power up controller #1.

G.8.8. Position controller #1 selection switch to RAV-1.

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G.8.9. Record initial switch status: Open: θ θ Closed: θ θ

G.8.10. Activate controller #1 to open RAV-1 and record:

1. Run time: _____ seconds
2. Current draw: _____ amp
3. Time of day: _____

G.8.11. Record final switch status: Open: θ θ Closed: θ θ

G.8.12. When convenient, record operation in RAV log book.

NOTE: Do not power off controller.

G.8.13. Verify that the Fill Cap Assembly pressure (PFCG) rises to pressure > 760 torr.

Record fill line pressure (PFCG): _____ torr.

QA Witness:_____

G.9. **Prepare to Transfer**

G.9.1. Prepare to open RAV-2

G.9.2. Request LM personnel install arming plug for RAV-2

G.9.3. Request LM SV Operations open RAV-2.

G.9.4. Verify RAV-2 is open by observing initial increase flow at EFM-3 and then decay and a decrease in pressure at FCG.

G.9.5. Record FCG _____torr, GTV-G_____torr

G.9.6. Open GTVC-Fill Vent valve to reduce pressure in Guard Tank and record time: _____.

G.9.7. When Guard Tank pressure stabilizes, record pressure relative to atmospheric, GTV-G _____torr.

G.9.8. Record relative MT pressure desired for sustaining transfer _____ torr. **Note:** typically 30 torr greater than Guard Tank pressure GTV-G is sufficient.

G.9.9. Record desired final Guard Tank level: _____ %.

G.9.10. Input comment to DAS “Start Internal transfer to Guard Tank”.

QA Witness:_____

G.10. **Initiate Transfer**

G.10.1. Turn on Tank Heater (H-8D or H-9D) power supply and adjust current limit to 1.25 amps.

G.10.2. Adjust power supply to 15 VDC and record:

Voltage: _____ Vdc and Current: _____ A

G.10.3. Open RAV-2 to initiate transfer as follows:

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1. Activate controller #2 to open RAV-2 and record:
    a. Run time:_____ seconds
    b. Current draw:_____ amp
    c. Time of day: _____
2. Record final switch status: Open: θ θ Closed: θ θ
3. When convenient, record operation in RAV log book.

Note: Do not put RAV controller selection switches to OFF or power off RAV Controller.

G.10.4. Record pressures:

1. STG _____ torr (relative to atm.)
2. GTV-G _____ torr (relative to atm.)

G.10.5. Adjust Main Tank heater voltage – as necessary, to a maximum of 35 V – to maintain desired transfer pressure. Record data in the following table.

Time	MT Pressure STG (torr)	GT Pressure GTVC-G (torr)	MT Heater Voltage (V)	MT LLS (%)	GT LLS (%)	Comments

QA Witness:_____

G.11. **Terminate Transfer to Guard Tank**

G.11.1. When the Guard Tank level reaches the value chosen in Paragraph G.7.4 Turn off Main Tank heater

G.11.2. Prepare to close RAV-2

G.11.3. Record pressures

1. FCG _____torr

-

2. GTVC-G _____torr

G.11.4. Request LM SV Operations close RAV-2.

G.11.5. Request LM personnel remove arming plug for RAV-2

G.11.6. Record pressures

1. Record FCG _____torr
2. Record GTVC-G_____torr
3. When convenient, record operation in RAV log book.

G.11.7. Record Guard Tank Pressure (GTVC-G/GTV-G):_____ torr (relative to atm.).

G.11.8. Record Main Tank pressure (STG):_____ torr (relative to atm.).

G.11.9. Close GTVC Fill Vent valve.

G.11.10. Open SV-9

G.11.11. Once conditions have stabilized, record final transfer conditions:

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

QA Witness:_____

G.12. **Condition Dewar Fill Line and Fill Cap Assembly.**

G.12.1. Ensure pumping line installed between Fill Cap Assembly at valve FCV and Auxiliary Gas Section access port no. 1.

G.12.2. Ensure FCV closed.

G.12.3. Close/verify closed AV-1 and AV-9.

G.12.4. Ensure pump AP-1 on.

G.12.5. Open AV-8 and AV-3 and evacuate pumping line to <25 mtorr measured at AG-2b.

G.12.6. Close RAV-1 as follows :

Note:
Relief of the Dewar fill line will be through the relief valve in the Fill Cap Assembly until the next operation.

1. Verify controller #1 already powered up and controller #1 selection switch set to RAV-1. If not, perform the following steps:
   a. Ensure controller #1 selection switch in off position
   b. Power up controller #1.
   c. Position controller #1 selection switch to RAV-1.
2. Record initial switch status: Open: θ θ Closed: θ θ
3. Activate controller #1 to close RAV-1 and record:

-

a. Run time:_____ seconds
b. Current draw:_____ amp
c. Time of day:_____

4. Record final switch status: Open: θ θ Closed: θ θ
5. Turn controller #1 selection switch to OFF.
6. Power off controller #1.
7. Turn off RAV power supply.
8. When convenient, record operation in log book.

G.12.7. Open FCV and evacuate Dewar fill line to < 25 mtorr as measured at AG-2b, and record AG-2b: _____ torr

G.12.8. Close SV-13 and torque to 60 +/- 5 in-lbs.

G.12.9. Close AV-8.

G.12.10. Open AV-1.

G.12.11. Open AV-9 until pressure reaches 1.5 psig at AG-1, then close AV-9.

G.12.12. Close AV-1 and AV-3.

G.12.13. Close FCV.

G.12.14. Turn off pump AP-1.

G.12.15. Remove pumping line from Fill Cap Assembly.

G.12.16. Install KF-25 blank-off cap on valve FCV and record:

1. PFCG pressure: _____
2. Time of day: _____

G.12.17. Verify closure of SV-13 by observing the pressure in the Fill Cap Assembly (PFCG) until satisfied that no gas is leaking into the Dewar Fill line. After 30 minutes record:

Time of day:_____

PFCG pressure:_____

Note: If PFCG drops by more than 0.5 torr in 30 minutes, retorque SV-13 and repeat steps G.11.8 through G.11.16.

QA Witness:_____

G.13. Configure the DAS and Liquid Level Sensors

G.13.1. Input comment to DAS “End of Internal transfer to Guard Tank”.

G.13.2. Set the DAS data cycle to 15 minutes.

G.13.3. Set all the liquid level sampling intervals to 10 minutes.

G.13.4. Ensure DAS alarm enabled and record set points if changed

-

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

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

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

G.13.5. Ensure liquid level sensor alarms enabled and record set points if changed.

1. Main Tank Level Set Point _____%
2. Guard Tank Level Set Point _____%

CAUTION

Monitor and maintain positive pressure in the Guard Tank. The Guard Tank may tend to subcool following the completion of this procedure. Ensure Guard Tank pressure on DAS alarm list.

G.13.6. Ensure Guard Tank pressure on DAS alarm list and set to alarm at > 0.3 torr differential.

-

QA Witness:_____

G.14. **Verify Final Configuration**

G.14.1. Ensure GTVC-V closed

G.14.2. Ensure SV-9 open

G.14.3. Ensure all EV valves closed.

G.14.4. Ensure all AV valves closed

G.14.5. Ensure that all liquid level sensors are set at a sampling rate of 10 minutes.

G.14.6. Ensure that power to Vac-Ion pump is off.

G.14.7. Ensure all RAV operations(open and close) recorded in log book

1. RAV-1
2. RAV-2

G.14.8. Record Main Tank liquid usage:

1. Start level: _____ %, Finish level : _____%.
2. Amount transferred: _____ liters (use 1 % = 24 l)

H. **PROCEDURE SIGN OFF**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

-

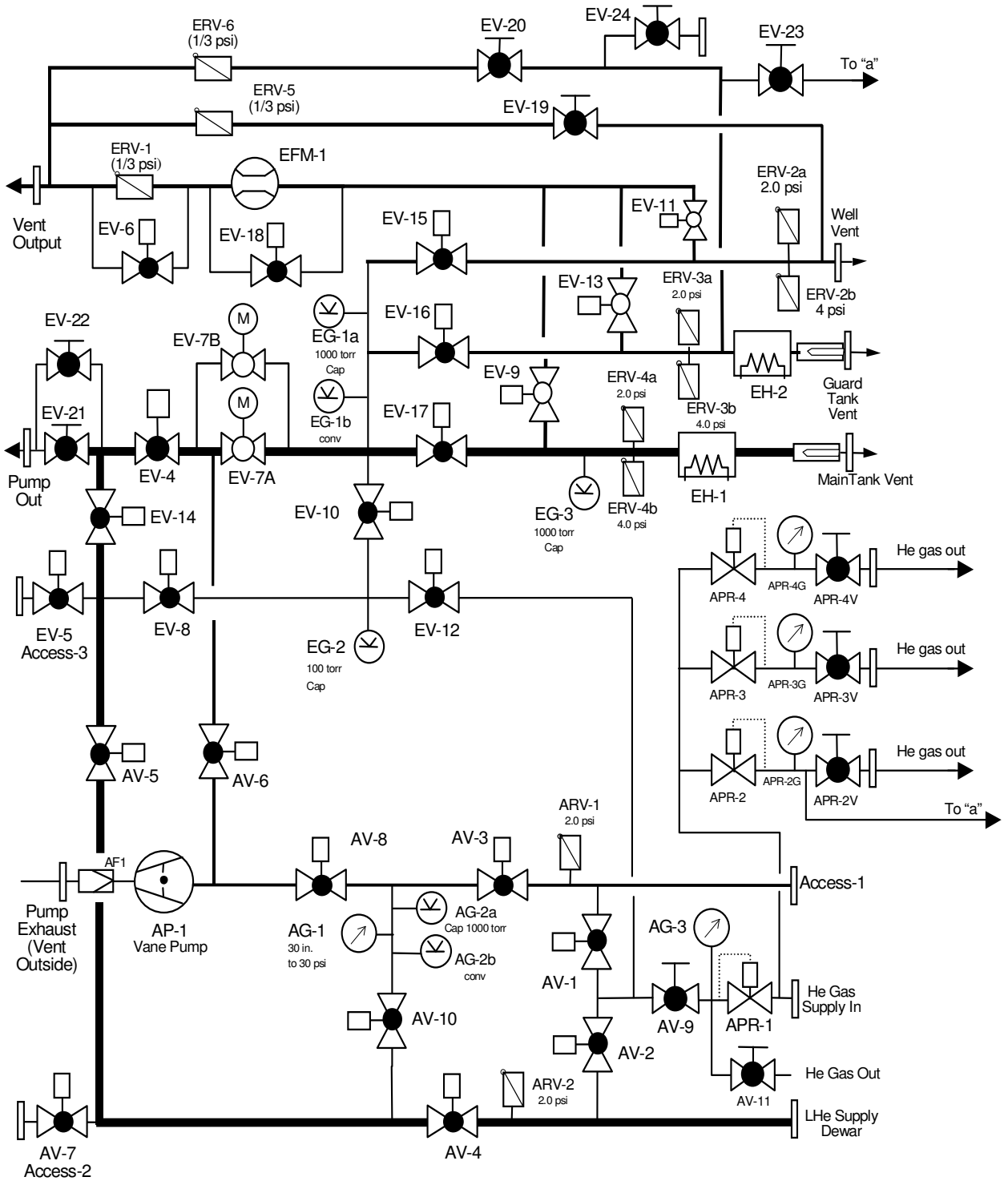

Figure 1: Gas Module

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F

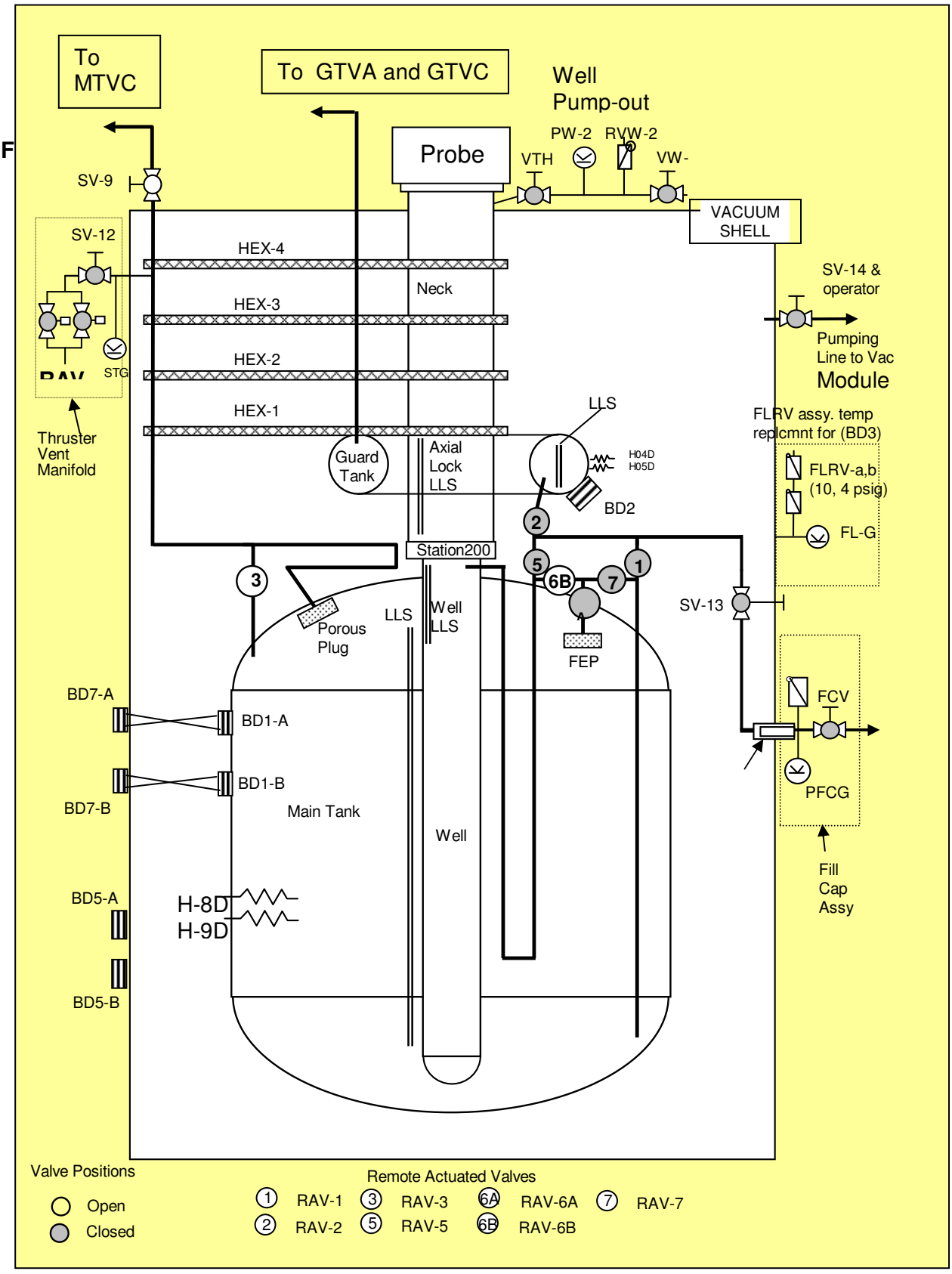
To MTVC
To GTVA and GTVC
Well Pump-out
Probe
PW-2
RVW-2
VTH
VW-
VACUUM SHELL
SV-9
SV-12
HEX-4
HEX-3
HEX-2
HEX-1
Neck
SV-14 & operator
Pumping Line to Vac Module
STG
Thruster Vent Manifold
LLS
FLRV assy. temp replcmnt for (BD3)
Guard Tank
Axial Lock LLS
H04D
H05D
BD2
FLRV-a,b (10, 4 psig)
FL-G
Station200
Porous Plug
Well LLS
SV-13
FEP
FCV
PFCG
BD7-A
BD1-A
BD1-B
BD7-B
Main Tank
Well
Fill Cap Assy
BD5-A
H-8D
H-9D
BD5-B
Valve Positions
Open
Closed
Remote Actuated Valves
RAV-1
RAV-2
RAV-3
RAV-5
RAV-6A
RAV-6B
RAV-7

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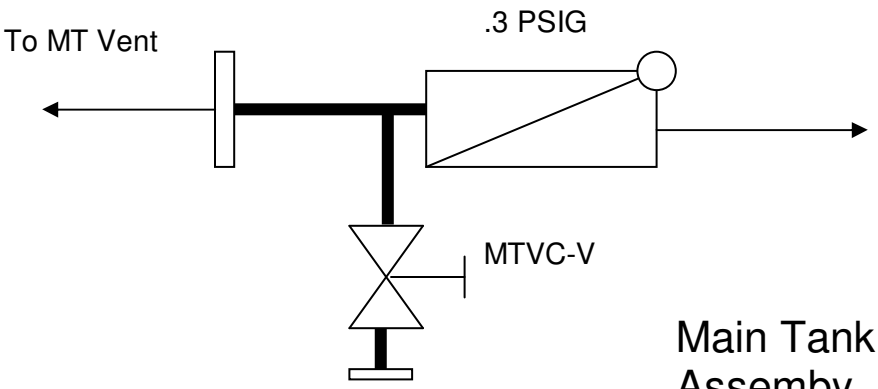
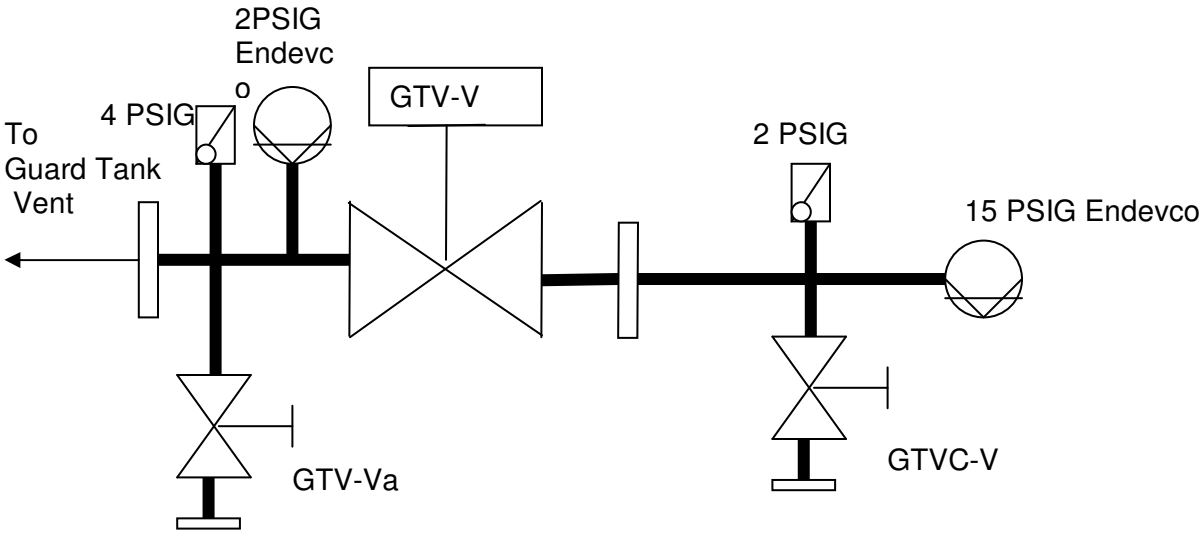
Figure 3: MT Vent Cap, GTVA GT Vent Cap



Main Tank Vent Cap Assemby



Guard Tank Vent Valve Assemby and Guard Tank Vent Cap Assembly

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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: _____		

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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: _____		

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Appendix 3– Contingency Responses

	Condition	Circumstance	Response
1	Temperature limits (CN 1 or 28) exceeded	Main tank is not venting	ALLOW MAIN TANK TO VENT If SV-9 is closed: **Close EV-17 (if open) and verify EV-9 open, 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.** If SV-9 open and EV-9 closed: **Open EV-9 for short periods (~15 sec) and allow increased flow from Main tank; in addition, Open EV-6 and EV-18 if higher flow rate is needed.** If SV-9 and EV-9 open **Open EV-6 and EV-18 for higher flow** **If problem persists see item 3**
2		Main tank is venting	PROMOTE INCREASE IN MAIN TANK VENTING Power up heater at H08D or H0-9D and starting at 15 vdc input increase power until increased flow has cooled the problem area
3	Burst disk rupture (MT/GT)	Any time	Evacuate room