GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

INSTALLATION OF
FEE GUARD TANK VENT LINE
AND LEAK CHECK

P0894 Rev-

April 10, 2002

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REVISION RECORD

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LIST OF ABBREVIATIONS AND ACRONYMS

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

A. Scope

This procedure describes the steps to effect the removal and replacement of the Guard Tank Short Vent Line with the FEE Guard Tank Vent Line. This process assumes a dry Guard Tank and the SV in a horizontal orientation. The installation steps for installing the FEE Guard Tank Vent Line are given in a LM Operations Order No. INT-251 and will be carried out by LM personnel.

B. Safety

B.1. Potential Hazards

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

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 proximity to the SV without escort. All personnel working at a height 30 inches or more off the floor are required to have a LM approved air tank within easy reach. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact LM safety.

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

B.2.3. Other Hazards

When appropriate, tools or other items used with the potential to damage the SMD or Probe shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury obtain medical treatment by immediately calling 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

Contingency responses to possible equipment troubles or irregularities (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, QA 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 Test Director or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgment of the test director 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.

C.3.1. 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.

C.3.2. 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 Test Director and approved by the QA representative.

C.3.3. 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. However, during the startup of the transfer (Sec. G.14), there are to be a minimum of two qualified persons (Sec. D.3) in attendance. 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. Qualified Personnel

The names of those actually performing this procedure are to be initialed and the name of the person acting as Test Director should be circled.

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

E. Requirements

E.1. Electrostatic Discharge Requirements

All work on the SV requires the use of grounding wrist straps attached to grounding points on the SV per LM requirement.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

Leak Detector

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 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(see the Electrical Module Manual for details), 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 uses hardware located in the Gas Module (Figure 1), the Pump Module and the Electrical Module (Table 1). However, the Pump Module may be omitted if a stand-alone gas meter (a substitute for PFM-1) is connected at the Gas Module Vent Output. The primary helium vent and all vane pump exhausts must be connected to an outside vent.

E.3.3. Computers and Software:

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

Description	Manufacturer	Model
AMI Level Sensor Readout for LHSD	AMI	110

E.3.5. Additional Hardware

Description	Manufacturer	Model
SMD Vent Bayonet O-rings	Parker	2-027
SMD Bayonet fit check tool	SU	N/A
Apiezon	MI Products Ltd	Model N
No. 5 rubber stopper with .5 psid relief valve	N/A	N/A

E.3.6. Tools

Description	Serial No.	Cal Due
Strap wrench 2-in.	N/A	N/A

E.3.7. Expendables

Description	Quantity	Mfr./Part No.
Ethyl alcohol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Tie wraps – large size	AR	N/A

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. Serial numbers are to be updated as appropriate.

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	A1, A2, A3, A4	3452A01975	Yes	
2	DAS	Power Supply, H-P 6627A	B1, B2, B3, B4	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	

No.	Location	Description	User Name	Serial No.	Cal Required	Status Cal due date
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	EH-1	C-19950	No	-
24	GM	Guard Tank Heat Exchanger: a) Thermocouple, b) Current meter, c) Temperature set point controller	EH-2	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	-
27	Leak Detector	Standard leak internal to leak detector	N/A	-	N/A	Yes

E.5. Configuration Requirements

E.5.1. Main Tank

Liquid in the Main Tank must be at its normal boiling point (NBP), 4.2 K. The SMD is horizontal with the -X axis up. The actuator control valve for EV-9 switches the state that EV-9 defaults to, should a power failure occur. It should be in the “NBP.” position, for this procedure, ensuring that EV-9 remains open in the event of power failure.

E.5.2. Guard Tank

The Guard Tank is depleted of liquid helium and regulated to a pressure > 0.3 torr above atmosphere.

E.5.3. Well

The Well is evacuated and the Well pump-out at VTH may be in one of the following configurations:

1) closed with the VTH operator removed;

2) have the Well manifold connected to a closed VTH; or

3) have an open VTH with a pumpout valve, VW-3, and convectron, PW-2, making up the Well manifold.

E.5.4. SMD Vacuum Shell

The Vacuum Shell pressure should be less than 1×10^{-4} torr.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
    a. Top of lead bag temperature set (CN 28) at $T \leq 6.0$ K.
    b. Top of lead bag temperature set (CN 29) at $T \leq 6.0$ K.
    c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.
2. The watchdog alarm must be armed.

E.5.6. GSE and Non-flight Hardware

1. A relief valve or flight-like burst disk may be installed in place of the SMD fill-line burst disk.
2. The ion-pump magnet must be installed.
3. GSE cabling must be connected between the SMD and the Electrical Module (P/N 5833812) and between the SMD and the Data Acquisition System (P/N 5833811).
4. The Main Tank is venting to the room via the Main Tank vent cap assembly.
5. The Guard Tank is pressurized at the GTVA via the GTV-Va valve and then to the GM helium source at APR-2V.
6. The thruster vent port must be plumbed to an Endevco pressure transducer, STG.
7. The Fill Cap Assembly must be installed at SV-13 (Figure 3)
8. Top Plate heaters must be installed on SMD and be operational.

E.6. Optional Non-flight Configurations

The following non-flight modifications of the basic SMD and optional GSE configurations are incidental to the performance of this procedure. Any combination represents an acceptable configuration.

1. The SV is installed in: the SMD transportation and test fixture or in the space vehicle assembly fixture; or the space vehicle tilt dolly.
2. A foreign object and debris shield may cover the upper cone of the SMD. If it is not present, any object that could cause damage to the payload, if dropped, must be tethered.
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 valve operator 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-14, or actively pumping the vacuum shell
4. If the Vacuum shell operator is not installed, then the vacuum shell valve is closed and capped off.

E.7. Verification/ Success Criteria

N/A

E.8. Payload Constraints and Restrictions

N/A

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
EM SYS229	Accident/Mishap/Incident Notification Process
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

F.3. Additional Procedures

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

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. Operations

G.1. Perform Preparatory Operations

G.1.1. Verify SU QA notified.

Record: Individual notified _____,

Date/time _____/_____.

G.1.2. Verify NASA representative notified.

Record: Individual notified _____,

G.1.3. Verify LM SV Operations representative (Frank Mendoza, Norm Bennett) notified of approximate time for RAV-2 operations.

Record: Individual notified _____,

Date/time _____/_____.

G.1.4. Record calibration due dates in Table 1 (Sec. E.4).

G.1.5. Verify that persons actually performing this procedure have initialed their names in Sec. D.3 and the name of the Test Director is circled.

G.1.6. Verify Pre-ops meeting with operations group has been conducted.

G.1.7. Verify Purity of All Sources of Helium Gas

Record serial number on helium bottle/s.

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

G.1.8. Verify helium bottle/s have been tested for purity and record Op. Number. Op. Number:_____

Date/time _____/_____.

Quality _____

G.2. Verify Configuration Requirements

G.2.1. Ensure DAS Watch Dog Alarm enabled.

G.2.2. Ensure that Top Plate heaters on SMD are operational.

G.2.3. Verify GSE cabling connected between SMD and Electrical Module and between SMD and Data Acquisition System.

G.2.4. Record MT pressure (STG) ____ torr.

G.2.5. Verify DAS and liquid level alarms enabled and record set points.

1. Main Tank level ("A" or "B"): Record set point _____%
2. Top of lead bag temperature/a – verify [CN 28] on DAS alarm list and set to alarm at $T \leq 6.5$ K. Record set point _____K
3. Top of lead bag temperature/b – verify [CN 29] on DAS alarm list and set to alarm at $T \leq 6.5$ K. Record set point _____K
4. Relative Guard Tank Pressure – verify [CN46] on DAS alarm list and set to alarm at $\Delta P \geq 0.3$ torr. Record set point _____torr
5. Relative Main Tank Pressure – verify [CN49] on DAS alarm list and set to alarm at $\Delta P \geq 4.0$ torr. Record set point _____to

G.2.6. Verify orientation of SMD/SV: is horizontal with –X up.

G.2.7. Verify Main Tank is venting to the room via the Main Tank Vent Cap Assembly (MTVCA) relief valve.

G.2.8. Verify Guard Tank is pressurize with helium gas via regulator from APR2-V at GTV-Va with GTV-V closed.

G.2.9. Verify EFM-3 flow meter is mounted and measuring Gas Module helium input flow.

G.2.10. Verify connected/connect the DAS Endevco read out to GTV-G and verify read out and DAS receive appropriate indicated values.

G.2.11. Ensure ion-pump magnet and signal cable installed.

G.2.12. 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 1×10^{-4} torr, perform procedure P0213, 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 10 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.2.13. Verify Actuator Control for EV-9 set to "NBP" position.

Section G.2 Complete Quality _____

G.3. **Verify Gas-Module Configuration and Record Initial Conditions**

G.3.1. 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/Active	Verify Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to regulated helium supply at GM and empty of liquid helium	APR-2, APR-2V, GTV-Va	GTV-V
Remaining EV valves	EV-7a/b	EV-4, EV-5, EV-6, EV-8, EV-9, EV-10, EV-11, EV-12, EV-13, EV-14, EV-15, EV-16 EV-17, EV-18, EV-19, EV-20, EV-21/22, EV-23, EV-24
AV valves		All

G.3.2. Record initial temperatures

1. Top of Lead Bag CN [28] _____ K.
2. Top of Lead Bag CN [29] _____ K.
3. Temperature at bottom of Main Tank CN 09] _____K.

G.3.3. Record pressures.

1. Guard Tank (GTV-G) CN[46]:_____ torr (relative to atm.).
2. Main Tank (STG) CN[49]:_____ torr. (Endevco on Thruster Vent Manifold)

G.3.4. Record calculated liquid level in Main Tank _____ %.

G.3.5. Verify Main Tank liquid level is below 55% to ensure Main Tank fill line is in the vapor and it is OK to open and close RAV-1. (Note: The calculated liquid level at which the liquid is just below the Main Tank inlet is 61%, 55 % is used for conservativism)

Note: The Main Tank will be used as a source of cold vapor to backfill the GT near the end of this procedure.

~~G.3.6. and OK to open and close RAV-1.~~

G.3.7. 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 (FCG): _____ torr.

G.3.8. 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.

Section G.3 complete. Quality_____

G.4. Verify SMD Valves in Standard Configuration

G.4.1. Using the RAV log book verify that the dewar 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 SV-13, and FCV closed.

Section G.4 complete. Quality_____

G.5. Set Up Purge Gas via SMD Fill Line

G.5.1. Install a pumping line between valve FCV on the Fill Cap Assembly and the Access Port #1 of the Auxiliary gas section.

G.5.2. Turn on pump AP-1.

G.5.3. Open AV-8 and AV-3.

G.5.4. Open valve FCV and evacuate to 20 mtorr as measured at AG-2.

G.5.5. Close AV-8.

G.5.6. Open AV-1 and adjust AV-9 to give 1 psig at AG-1.

G.5.7. Close AV-1

G.5.8. Open AV-8 and evacuate to 20 mtorr. as measured at AG-2.

G.5.9. Close AV-8 and FCV.

G.5.10. Once the pressure in the Fill Cap Assembly has stabilized, record

Fill Cap Assembly pressure (FCG): _____ torr.

G.5.11. Open valve SV-13 to bring Fill Cap Assembly up to SMD Fill line pressure and record

Fill line pressure (FCG): _____ torr.

Section G.5 complete. Quality_____

G.6. **Adjust Guard Tank Pressure**

G.6.1. Record Guard Tank pressure:
GTV-G _____ torr (relative to atm.)

G.6.2. Adjust/verify adjusted guard tank pressure to atmospheric + 20 to 30 torr as indicated by GTV-G adjusting APR-2 and using GTV-V to bleed off excess pressure as needed.

G.6.3. Record Guard Tank pressure:
GTV-G _____ torr (relative to atm.).

G.6.4. Close GTV-Va.

Section G.6 complete. Quality_____

G.7. **Raise Pressure in Fill Line to Guard Tank Pressure**

G.7.1. Open FCV.

CAUTION

In the following, watch the special data output to protect against producing over temperature (>6.5K) at the Lead Bag sensors, CNs 28 and 29. Stopping or slowing the input of helium gas will prevent excessive heating in this area.

G.7.2. Open AV-1.

G.7.3. Gradually build the pressure at FCG to be 20 torr above GTV-V+Atm

G.7.4. Close AV-9.

Record:
Atmospheric pressure (CN84) _____ torr.
Guard Tank pressure (GTV-G) _____ (relative to atm.)
Record Fill line pressure (FCG) _____ torr.

Section G.7 complete. Quality_____

G.8. **Open RAV-2**

G.8.1. Request LM personnel install arming plug for RAV-2

G.8.2. Request LM SV Operations open RAV-2.

G.8.3. Verify RAV-2 is open by observing initial increase flow at EFM-3 and then decay and a decrease in pressure at FCG.

G.8.4. Record FCG _____torr, GTV-G _____torr

G.8.5. Record initial (maximum) flow on RAV-2 activation _____slpm record flow at 5 mins. from start _____.slpm

Section G.8 complete. Quality_____

G.9. **Set Up Data Acquisition System**

Note: Refer to DAS operating instructions for information on configurations and mechanics of keyboard/mouse operation.

G.9.1. Verify DAS set to configuration 4Y.

G.9.2. Set DAS to fast scan mode using [other menus], [data config], [fast scan]

G.9.3. Record directory and data file name _____.

G.9.4. Start “Special Data Cycle” by using [Other Menus] + [Special Data Col].

G.9.5. Enter CNs: 28, 29, 24, 46 (GTV-G) and 49 (ST-G, Thruster Vent) and 114 (EG-1a).

G.9.6. [Init. Collectn]

G.9.7. [Enter] use default file name.

G.9.8. Record directory and special data file name _____.

G.9.9. Ensure printer is displaying special Data Cycle data.

Section G.9 complete. Quality_____

G.10. **Prepare FEE Guard Tank Vent Line (FGTVL)**

G.10.1. Record the bayonet female fit check gap measurements made in LM operations order No. INT-251 for the inboard FEE Guard Tank Vent Line.

1. Maximum gap _____
2. Minimum gap _____

G.10.2. Record the bayonet male fit check gap measurements made in LM operations order No. INT-251 for the outboard end of the FEE Guard Tank Vent Line.

1. Maximum gap _____
2. Minimum gap _____

G.10.3. Prepare a new bayonet O-ring (Parker Viton 2-027) with a thin layer of Apiezon N vacuum grease.

G.10.4. Install the O-ring into the outlet bayonet O-ring groove of the FGTVL.

Section G.10 complete. Quality_____

G.10.5. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to regulated helium supply at GM and empty of liquid helium	APR-2,	GTV-V, GTV-Va
Remaining EV valves	EV-7a/b	All other EVs
Fill line purge	AV-1, AV-3, AV-9, APR-1 FCV, SV-13	All other AV valves
RAVs	RAV-2, RAV-3, RAV-6B	All other RAVs\\\\\\

G.11. **Remove GT short vent line**

G.11.1. Prepare a No. 5 rubber stopper with a 1 psid relief valve (1/8-in NPT size)

CAUTION

In the following steps the Guard Tank pressure indicated by FCG must be monitored closely to prevent subatmospheric conditions in the Guard Tank which could result in air contamination and plugging of the internal Guard Tank venting. Corrective action is to increase the flow rate by adjusting APR-1/AV-9 to higher pressures.

G.11.2. Verify GT pressure at GTV-G is 20 to 30 torr (relative to atm.) adjust AV-9/APR-1 as required.
NOTE: This will require approximately 785 to 795 torr at FCG.

G.11.3. Remove GTSVL from SMD GT vent port (B2) and **Immediately** install No. 5 stopper/relief valve.

G.11.4. Remove O-ring from SMD bayonet and clean O-ring groove with clean room wipes and ethyl/isopropyl alcohol.

G.11.5. Remove stopper assembly and:

Immediately insert the male bayonet gauge fit check and using feeler gauges measure gap and record:

Maximum gap _____ Minimum gap _____

G.11.6. Remove tool and reinstall stopper.

G.11.7. Prepare a new bayonet O-ring (Viton 2-027) with a thin layer of Apiezon N vacuum grease.

G.11.8. Install the O-ring into the SMD Guard Tank vent bayonet O-ring.

G.11.9. Remove the Guard Tank Vent Assembly from the GTSVL and install onto the bayonet outlet for FGTVL. Remove the GTVCA from the GTVA. Keep helium purge hose on closed GTV-Va and signal cable on GTV-G.

G.11.10. Open/verify open GTV-V.

Section G.11 complete. Quality_____

G.12. **Install FGTVL**

CAUTION

In the following steps the GT must not be allowed to depressurize to atmospheric pressure or air condensate may form in and plug the internal Guard Tank vent line. If pressure becomes low, as evidenced by low flow at EFM-3, increase flow from APR-1 or plug all vent paths and allow GT to re-pressurize.

CAUTION

Watch the special data collection output to warn of excessive lead bag temperatures caused by high purge flow rates. Corrective action is to slow the flow rate by adjusting APR-1 to lower pressures.

G.12.1. Perform LM operations order No. INT 251 “Install Guard Tank Vent Line …” up to the point of removing B2 rubber stopper.

G.12.2. Open AV-9 and adjust APR-1 to obtain Atm. + 15 torr at FCG.

G.12.3. Prepare to adjust APR-1 to maintain a low flow, 2-4 slpm as indicated by EFM-3, into the fill line.

G.12.4. Continue with the LM operation.

G.12.5. When the operation is completed verify FGTVL has been purged by Guard Tank outflow and the valve GTV-V is closed with vent path supplied by GTV-RV and GTV-Va is closed.

Section G.12 complete. Quality_____

G.13. **Close RAV-2**

G.13.1. Record initial flow into fill line
EFM-3(initial) _____slpm.

G.13.2. Record pressures

1. FCG _____torr
2. EG-1a _____torr

G.13.3. Request LM personnel remove arming plug for RAV-2

G.13.4. Request LM SV Operations close RAV-2.

G.13.5. Record pressures

1. Record FCG _____torr
2. Record EG-1a _____torr

G.13.6. Record final fill line flow
EFM-3(initial) _____slpm.

G.13.7. Verify closure by decrease in flow rate at EFM-3; record
EFM-3(max) _____slpm.

G.13.8. Request LM personnel remove arming plug for RAV-2

G.13.9. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to regulated helium supply at GM and empty of liquid helium	GTV-RV	GTV-V, GTV-Va
Remaining EV valves	EV-7a/b	All other EV valves
Fill line purge	AV-1, AV-3, AV-9, APR-1, FCV, SV-13	All other AV valves
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.13 complete. Quality_____

G.14. **Pump Fill Line**

G.14.1. Verify AP-1 is on.

G.14.2. Close AV-1 and AV-9

G.14.3. Open AV-8

G.14.4. When AG-2b < 20 mtorr,

1. Record AG-2b _____ torr.
2. Close SV-13, torquing to 60 in-lb.
3. Close AV-8.

G.14.5. Backfill with helium gas via AV-1 and AV-9 to 1.5 psig as indicated by AG-1, ending with AV-9 closed.

G.14.6. Close FCV.

G.14.7. Close AV-1.

G.14.8. Open AV-8: pump line to vacuum.

G.14.9. When AG-2b < 20 mtorr, close AV-8 and AV-3.

G.14.10. Record FCG pressure for 30 minutes:

G.14.11. Date:_____.

G.14.12. Time _____ _____ _____ _____

G.14.13. FCG (torr) _____ _____ _____ _____

G.14.14. Verify no leakage at SV-13 into fill line.

G.14.15. Turn AP-1 off.

G.15. **Final Configuration**

G.15.1. Verify all AVs closed and AP-1 off.

G.15.2. FCV and SV-13 closed.

G.15.3. Input comment to DAS “GT fill line closed off”.

G.15.4. Stop DAS Special Data Cycle.

G.15.5. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to regulated helium supply at GM and empty of liquid helium	GTV-RV	GTV-V, GTV-Va
Remaining EV valves	EV-7a/b	All other EV valves
Fill line purge		All fill line valves
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.14 & 15 complete. Quality_____

G.16. **Preparing Equipment for Leak Detection**

G.16.1. Verify SV is horizontal, Main Tank is venting to room via SV-9 and Main Tank Vent Cap Assembly relief valve, MTVC-RV

G.16.2. Connect GTVA to GM using procedure "Connect Guard Tank Vent to Gas Module, P0676, Record Op number _____. **Note:** Stop the procedure at the completion of para. G.6.11, **the point at which the UTS is pumping up to a closed GTV-V and with the Guard Tank pressurized at GTV-Va from the Gas Module.**

G.16.3. Ensure 'pump exhaust' of Gas Module is vented to outside of facility.

G.16.4. Close verify/closed SLAV.

G.16.5. Adjust APR-2 to ensure GTV-G is greater than 100 torr.

G.16.6. Install Neon Standard Leak at GTV-Va opening GTV-Va to allow purging of NSL flex hose before making plumbing connection.

G.16.7. Leave GTV-VA open.

G.16.8. Verify the configuration of the Vacuum Module, Gas Module, UTS, RGA, Neon Standard Leak and SMD is as shown in Figures 1 with valve configuration as given below.

G.16.9. Verify configuration is as given in Fig. 1b and valves as given below.

G.16.10. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to GM at "Guard Tank Vent" and pumped by the UTS up to GTV-V	TV-1, TV-2, EV-5, EV-14, EV-4, EV-7A/B, **EV-16**	GTV-V
Remaining EV valves		All other EV valves
Neon leak valves	GTV-Va	RGA-SOV, RGA-LV, NSL-V
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.16 complete. Quality_____

G.17. **Pump Guard Tank with AP-1**

G.17.1. Put Gas Module control panel into INTLK DEFEAT.

G.17.2. Turn on/verify on AP-1.

G.17.3. Close EV-5.

G.17.4. Verify RGA-LV closed.

G.17.5. Open RGA-SOV slowly.

G.17.6. Open RGA-V slowly.

G.17.7. Open AV-6: AP-1 now pumping up to closed GTV-V.

G.17.8. Open GTV-V gradually, keeping pressure at EG-1a to less than 20 torr.

G.17.9. Enter comment to DAS: “Begin pumping Guard Tank”.

G.17.10. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to GM at “Guard Tank Vent” and pumped by the AP-1	AV-6, EV-14, EV-4, EV-7A/B**, EV-16,** GTV-V	
Remaining EV valves		All other EV valves
RGA & Neon leak valves	TV-1, TV-2, RGA-SOV, RGA-V, GTV-Va	RGA-LV, NSL-V
RAVs	RAV-3, RAV-6B	All other RAVs

NOTE:

The UTS turbo is now pumping up to RGA-LV, EV-21, -22, EV-4, EV-8 and AV-5.

AP-1 is pumping Guard Tank through a partially open GTV-V

Section G.17 complete. Quality_____

G.18. **Configure for Neon Leak Detection**

G.18.1. Enter comment to DAS " Start neon cal 50 torr".

G.18.2. Power-on RGA.

G.18.3. Verify RGA-SOV is open.

G.18.4. Adjust RGA-LV to maintain TG-1 between 1E-5 to 8E-5 torr.

G.18.5. Set up RGA in leak detect mode for mass 20.

G.18.6. Start data recording in Table 1.

G.18.7. Bag/verify bagged, connections at GTVA/GTLVL, FGTVL/GTVA and FGTVL/B2 bayonet.

G.18.8. Install/verify installed regulator on Neon supply Bottle.

G.18.9. When GTV-G is approximately 50 torr proceed with the following steps

G.18.10. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to GM at "Guard Tank Vent" and pumped by the UTS	AV-6, EV-14, EV-4, EV-7A/B, EV-16, GTV-V	
Remaining EV valves		All other EV valves
RGA & Neon leak valves	TV-1, TV-2, RGA-V, RGA-SOV, RGA-LV	GTV-Va, NSL-V
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.18 complete. Quality_____

G.19. **Leak Check at 50 Torr**

G.19.1. Leak Check GTVA/GTLVL Bayonet at 50 Torr: Date/Time _____

1. Record data in Table 2.
2. Open/verify open RGA-SOV.
3. Adjust RGA-LV to maintain TG-1 to 5 +/- $1x10^{-5}$
4. Verify RGA is in leak check mode for mass 20.
5. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
6. Introduce neon gas into bagged GTV bayonet for 2 mins.
7. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
8. Comments: _____

G.19.2. Leak Check FGTVL/GTVA bayonet at 50 Torr
Date/Time _____.

1. Open/verify open RGA-SOV.
2. Adjust RGA-LV to maintain TG-1 to 5 +/- $1x10^{-5}$
3. Verify RGA is in leak check mode for mass 20.
4. Record steady state data in Table 2 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
5. Introduce neon gas into bagged FGTVL/GTVA bayonet for 2 mins.
6. Record reading _____ amps.
7. Comments: _____

G.19.3. Leak Check FGTVL/B2 bayonet at 50 Torr
Date/Time _____.

1. Adjust RGA-LV to maintain TG-1 to 5 +/- $1x10^{-5}$
2. Introduce neon gas into bagged FGTVL/B2 bayonet for 2 mins.
3. Record steady state data in Table 2 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
4. Comments: _____
5. Enter comment to DAS “End 50 Torr Leak Test”.

Section G.19 complete. Quality_____

G.20. **Pumping Guard Tank to Vacuum and Leak Check**

G.20.1. Pumping Guard Tank with Turbo:

G.20.2. When EG-1a is between 1 and 10 torr, and GTV-V is fully open:

1. Power off RGA and TG-1.
2. Close RGA-LV and RGA-SOV.
3. Close AV-6.

G.20.3. Open EV-5: now pumping Guard Tank with UTS turbo.

G.20.4. When TG-3 < 1 torr power on TG-1.

G.20.5. Power on TG-1.

G.20.6. Record: TG-1 _____ torr, VG-4 _____ torr Date/Time _____

G.20.7. When TG-1 is less than 8E-5 proceed.

G.20.8. Record TG-1 _____ torr. Date/Time _____

G.20.9. Power on RGA and place in leak check mode for mass 20.

Calibrate RGA at Low Pressure

Note: The neon standard leak has a value of 1.5×10^{-6} sccs Ne.

G.20.10. Open NSL-V.

G.20.11. Record steady state data in Table 1 and below:
Record TG-1 _____ torr, I_{RGA} _____ amp.

G.20.12. Close NSL-V

G.20.13. Record steady state data in Table 1 and below:
Record TG-1 _____ torr, I_{RGA} _____ amp.

G.20.14. Open NSL-V.

G.20.15. Record steady state data in Table 1 and below:
Record TG-1 _____ torr, I_{RGA} _____ amp.

G.20.16. Close NSL-V

G.20.17. Record steady state data in Table 1 and below:
Record TG-1 _____ torr, I_{RGA} _____ amp.

G.20.18. When time allows calculate RGA sensitivity, 1.5×10^{-6} sccs/change in amps, _____sccs/amp.

Section G.20 complete. Quality_____

G.21. **Leak Check at low pressure**

NOTE:

Maximum Leak rate shall be less than $1X10^{-6}$ sccs Neon

G.21.1. Leak Check GTVA/GTLVL Bayonet Date/Time _____

1. Open/verify open RGA-SOV.
2. Adjust RGA-LV to maintain TG-1 on same value as used for low pressure calibration above.
3. Verify RGA is in leak check mode for mass 20.
4. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
5. Introduce neon gas into bagged GTV bayonet for 2 mins.
6. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
7. Calculate leak rate using RGA sensitivity determined above _____sccs Ne.
8. Calculate leak rate: _____ sccs Ne
9. Verify leak rate is less than $1x10^{-6}$ sccs Ne.
10. Comments: _____

G.21.2. Leak Check FGTVL/GTVA bayonet Date/Time _____.

1. Verify RGA is in leak check mode for mass 20.
2. Record steady state data in Table 2 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
3. Introduce neon gas into bagged FGTVL/GTVA bayonet for 2 mins.
4. Record reading _____ amps.
5. Calculate leak rate: _____ sccs Ne
6. Verify leak rate is less than $1x10^{-6}$
7. Comments: _____

G.21.3. Leak Check FGTVL/B2 bayonet

Date/Time _____.

1. Adjust RGA-LV to maintain TG-1 on same value as used for low pressure calibration above.
2. Introduce neon gas into bagged FGTVL/B2 bayonet for 2 mins.
3. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, I_{RGA} _____ amp.
4. Calculate leak rate: _____ sccs Ne
5. Verify leak rate is less than $1x10^{-6}$ sccs.
6. Comments: _____

G.21.4. Enter comment to DAS "End low pressure Ne Leak Test".

G.21.5. Spray Ne around the GTLVL/HEX bayonet and adjacent GM joints up to EV-13 and EV-16.

G.21.6. Record steady state data in Table 1 and below:
Record TG-1 _____ torr, I_{RGA} _____ amp.

G.21.7. Enter comment to DAS "Complete low pressure leak checks".

G.21.8. Turn off RGA.

G.21.9. Close/verify closed RGA-SOV, RGA-V.

G.21.10. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent Connected to GM at "Guard Tank Vent" and pumped by the UTS	TV-1, TV-2, EV-5, EV-14, EV-4, EV-7A/B, EV-16, GTV-V	
Remaining EV valves		All other EV valves
RGA & Neon leak valves		GTV-Va, NSL-V, RGA-SOV, RGA-LV, RGA-V
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.21 complete. Quality_____

G.22. **Helium Leak Check**

G.22.1. Put RGA in spectrum mode to monitor He, H_2O, O_2, N_2 and CO_2

G.22.2. Continue pumping with UTS until the leak detector shows a background of less than $1X10^{-5}$ sccs He.

G.22.3. Maintain data entries in Table 1.

G.22.4. Remove leak detector from UTS, cap the pumping port, put leak detector in test mode and record:
Std leak size _____sccs
Std leak signal _____sccs
Std leak S/N _____.
Std leak call due date _____.

G.22.5. Verify agreement to within 5%.

G.22.6. Connect leak detector to TV-3.

G.22.7. Leak check all plumbing up to closed TV-3.

G.22.8. Perform periodic leak detector hookups to determine the leak detector background using:

1. Activate leak detector using leak detector instructions
2. Close TV-2 open TV-3.
3. Record background in Table 1.

G.22.9. When background is less than $1X10^{-5}$ proceed.

G.22.10. Record leak detector background _____sccs He

G.22.11. Leak Check GTVA/GTLVL Bayonet

Date/Time _____

1. Verify leak detector backing UTS turbo pump.
2. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He background _____ sccs He
3. Introduce helium gas into bagged GTVA bayonet for 2 mins.
4. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He leak rate _____ sccs He
5. Verify helium leak rate is less than $1x10^{-6}$ sccs.
   Comments: _____

G.22.12. Leak Check FGTVL/GTVA bayonet Date/Time _____.

1. Verify leak detector backing UTS turbo pump.
2. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He background _____ sccs He
3. Introduce helium gas into bagged FGTVL/GTVA bayonet for 2 mins.
4. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He leak rate _____ sccs He
5. Verify helium leak rate is less than $1x10^{-6}$ sccs.
   Comments: _____

G.22.13. Leak Check FGTVL/B2 bayonet Date/Time _____.

1. Verify leak detector backing UTS turbo pump.
2. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He background _____ sccs He
3. Introduce helium gas into bagged FGTVL/B2 bayonet for 2 mins.
4. Record steady state data in Table 1 and below:
   Record TG-1 _____ torr, He leak rate _____ sccs He
5. Verify helium leak rate is less than $1x10^{-6}$ sccs
   Comments: _____

G.22.14. Enter comment to DAS “End helium leak test”.

G.22.15. Spray He around the GTLVL/HEX bayonet and adjacent GM joints up to EV-13 and EV-16.

G.22.16. Verify helium leak rate is less than $1x10^{-6}$

G.22.17. Remove leak detector from UTS, cap the pumping port, put leak detector in test mode and record:
Std leak size _____sccs
Std leak signal _____sccs

G.22.18. Verify agreement to within 5%.

G.22.19. Shut down leak detector

G.22.20. Power down RGA and close RGA-V, Date/Time _____.

Section G.21 complete. Quality_____

G.23. **Re-pressurize Guard Tank with Helium Gas from Main Tank**

Date/Time_____

G.23.1. Record: EG1b _____ torr.

G.23.2. Close EV-5, EV-14, and EV-4.

G.23.3. Close TV-1 and shut down UTS.

G.23.4. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent	EV-16, GTV-V	
Remaining EV valves	EV-7A/B	All other EV valves
RGA & Neon leak valves		GTV-Va, NSL-V, RGA-SOV, RGA-LV, RGA-V
RAVs	RAV-3, RAV-6B	All other RAVs

Section G.23 complete. Quality_____

G.24. **Prepare Fill Line**

G.24.1. Turn on pump AP-1.

G.24.2. Open AV-8 and AV-3.

G.24.3. Open valve FCV and evacuate to 20 mtorr as measured at AG-2.

G.24.4. Close AV-8.

G.24.5. Open AV-1 and adjust AV-9 to give 1 psig at AG-1.

G.24.6. Close AV-1

G.24.7. Open AV-8 and evacuate to 20 mtorr. as measured at AG-2.

G.24.8. Close AV-8 and FCV.

G.24.9. Once the pressure in the Fill Cap Assembly has stabilized, record

Fill Cap Assembly pressure (FCG): _____ torr.

G.24.10. Open valve SV-13 to bring Fill Cap Assembly up to SMD Fill line pressure and record

Fill line pressure (FCG): _____ torr.

Section G.24 complete. Quality_____

G.25. **Open RAV-1**

G.25.1. Enter comment to DAS “Start repress of GT”. Date/Time _____.

G.25.2. Verify all selector switches are off.

G.25.3. Power up RAV power supply to 28 volt at 1.9 a.

G.25.4. Power up RAV controller No. 1.

G.25.5. Position selection switch to RAV-1.

G.25.6. Record initial switch status: Open: θ θ Closed: θ θ

G.25.7. Activate controller No. 1 and record:

1. run time: _____ seconds
2. current draw: _____ amp
3. time of day: _____ hrs

G.25.8. Record final switch status: Open: θ θ Closed: θ θ

G.25.9. Record operation in RAV log book.

G.25.10. Record FCG _____torr

G.25.11. Record EG-1a _____torr

Section G.25 complete. Quality_____

G.26. **Open RAV-2**

G.26.1. Verify closed FCV.

G.26.2. Request LM personnel install arming plug for RAV-2

G.26.3. Request LM SV Operations open RAV-2.

G.26.4. Record FCG _____torr

G.26.5. Record EG-1a _____torr

G.26.6. Verify RAV-2 is open by near coincident with SV open command of rise of Guard Tank pressure to the Main Tank pressure (FCG).

G.26.7. Record FCG _____torr

G.26.8. Record EG-1a _____torr

Section G.26 complete. Quality_____

G.27. **Close RAV-2**

G.27.1. Request LM SV Operations close RAV-2.

G.27.2. Request LM personnel remove arming plug for RAV-2

G.27.3. Verify by pressure rise in FCG that RAV-2 is closed.

G.27.4. Record:

1. FCG ___torr
2. EG-1a _____torr

G.27.5. Verify APR-2 is adjusted to ~.5 psig .

G.27.6. Verify open EV-23 to regulate pressure to Guard Tank.

G.27.7. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent	EV-16, EV-23, APR-2, GTV-V	GTV-Va
Remaining EV valves	EV-7A/B	All other EV valves
Fill line		FCG, SV-13, AV-1, AV-9
RAVs	RAV-1, RAV-3, RAV-6B	All other RAVs

Section G.27 complete. Quality_____

G.28. **Close RAV-1 and Pump Fill Line**

G.28.1. Verify FCV and all AVs closed.

G.28.2. Open AV-3 and AV-8.

G.28.3. Open FCV.

G.28.4. When FCG < 20 mtorr, close FCV.

G.28.5. Open SV-13, record PFCG _____ .

G.28.6. Close RAV-1.

1. Record initial switch status: Open: θ θ Closed: θ θ
2. Activate controller No. 1 and record:
   a. run time: _____ seconds
   b. current draw: _____ amp
   c. time of day: _____

   Immediately:
3. Verify SV-13 open
4. Record FCG _____ torr
5. Open FCV: now pumping fill line with AP-1.
6. Record final switch status: Open: θ θ Closed: θ θ
7. Record operation in RAV log book.
8. Position selection switch to off.
9. Power down RAV controller No. 1.
10. Power off RAV power supply.

G.28.7. Record FCG _____ torr, EG-1a _____ torr.

G.28.8. Pump Fill Line

1. When AG-2b < 20 mtorr,
2. Record AG-2b _____ torr.
3. Close SV-13, torquing to 60 in-lb.
4. Close AV-8.

G.28.9. Backfill with helium gas via AV-1 and AV-9 to 1.5 psig as indicated by AG-1

G.28.10. Close FCV.

G.28.11. Close AV-1.

G.28.12. Open AV-8: pump line to vacuum.

G.28.13. When AG-2b < 20 mtorr

1. Close AV-8
2. Close AV-3.

G.28.14. Record FCG pressure for 30 minutes:

G.28.15. Date:

G.28.16. Time _____ _____ _____ _____

G.28.17. FCG (torr) _____ _____ _____ _____

G.28.18. Verify no leakage at SV-13 into fill line.

Section G.28 complete. Quality_____

G.29. **Final Configuration**

G.29.1. Valve configuration:

	Open/Active	Closed
Main Tank vent Not Connected to GM	SV-9, MTVC-RV	
Guard Tank vent	EV-16, EV-23, APR-2, GTV-V	GTV-Va
Remaining EV valves	EV-7A/B	All other EV valves
Fill line		FCV, SV-13, AV-1, AV-9
RAVs	RAV-1, RAV-3, RAV-6B	All other RAVs

G.29.2. Input comment to DAS “GT leak check completed”.

G.29.3. Stop DAS Special Data Cycle.

G.29.4. Remove pumping line between Access 1 and FCV.

Section G.29 complete. Quality_____

G.30. **Configuration of Dewar and GSE**

G.30.1. Record the Main Tank liquid level (LL-1D or LL-2D): _____ %

G.30.2. Record the following pressures:

1. Main Tank pressure (EG-3): _____ torr
2. Guard Tank pressure (EG-1a/GTVG): _____ torr

Section G.30 complete. Quality_____

G.31. **Setting up Data Acquisition**

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

G.31.1. Set DAS to configuration choice 4Y.

G.31.2. Stop Special Data Cycle by using [Other Menus] + [Special Data Col] + [Stop Data Col].

G.31.3. 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.31.4. Set DAS data cycle interval to 15 minutes.

G.31.5. Set Main Tank Liquid Level sampling interval to 10 minutes.

G.31.6. Confirm that the liquid level sensors are set at a sampling rate of 10 minutes or turned off.

G.31.7. Confirm that Vac-ion pump is off.

G.31.8. Enable/verify enabled the alarms on the Main Tank and Well Liquid Level Sensors.

G.31.9. Verify enabled the DAS alarm and record the set points:

a) CN ____, Level _____

b) CN ____, Level _____

c) CN ____, Level _____

d) Main Tank Level: _____ %

e) Guard Tank Level:_____ %

G.31.10. Ensure DAS watchdog timer and alarm enabled.

Section G.31 complete _____.

H. **Procedure Completion**

Completed by:_____

Witnessed by: _____

Date: _____

Time: _____

Quality Manager:_____Date _____

Payload Test Director:_____Date _____

Table 1 Neon leak Data

Date/Time	Neon Amp	EG-1a Torr	TG-1 torr	EG-1a torr	FCG Torr-diff		Comments

Figure 1a. Schematic of Gas Module Plumbing at Start of FEE Guard Tank Vent Line Install

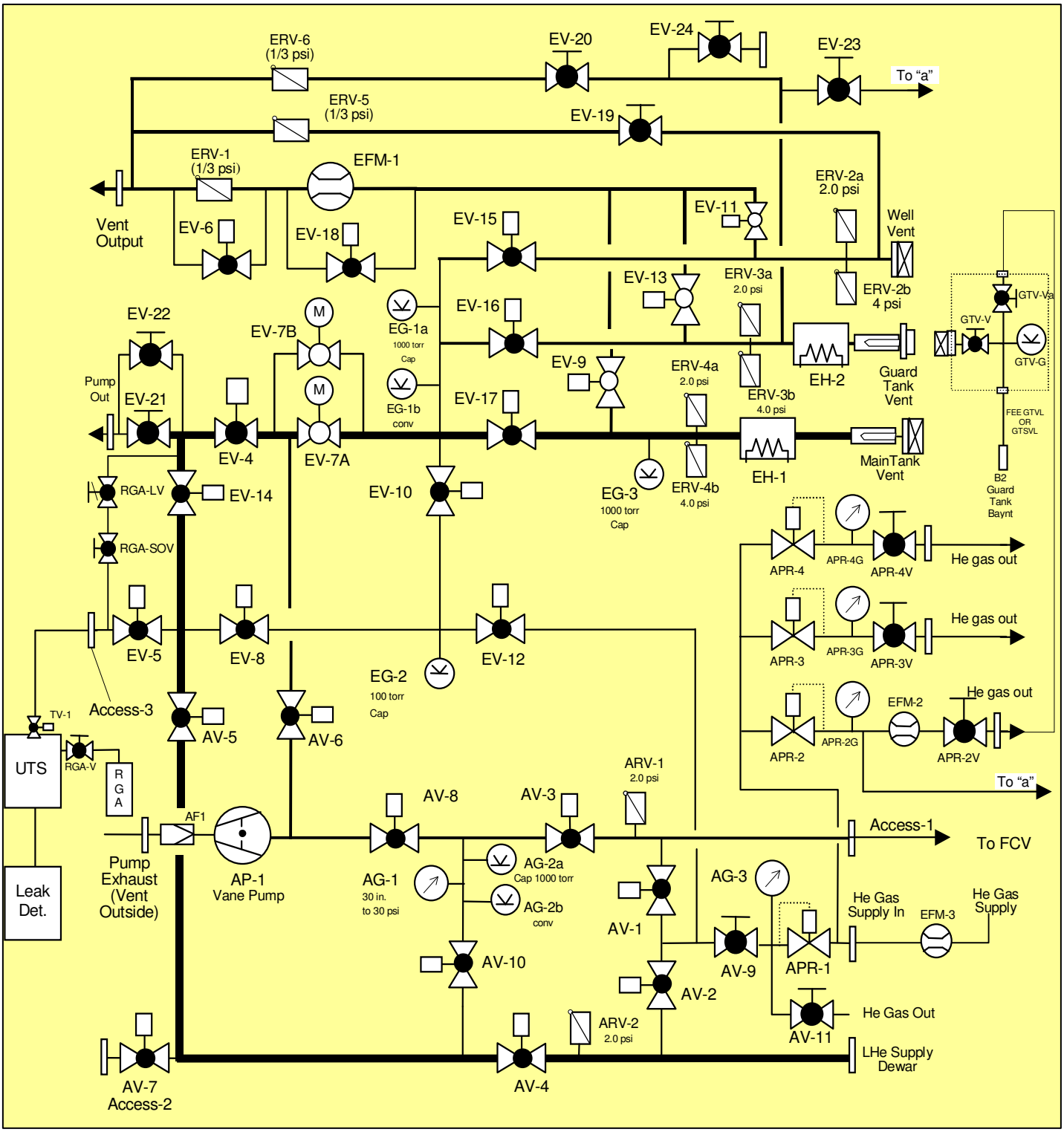


Figure 1b. **Schematic of Gas Module Plumbing for Neon Leak Detection of Guard Tank Vent**

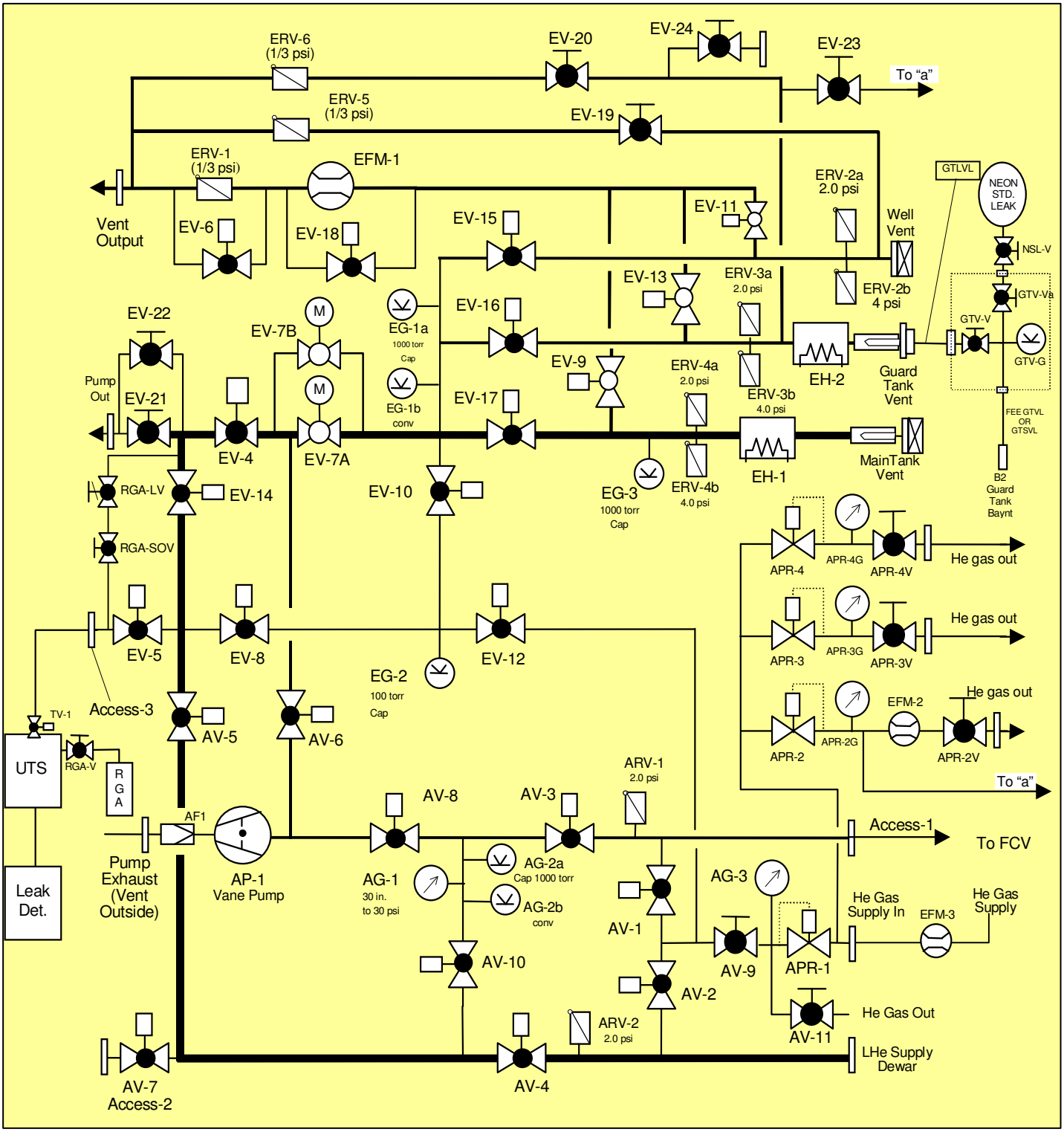


Figure 2 Gas Module and Vent lines connected to SMD

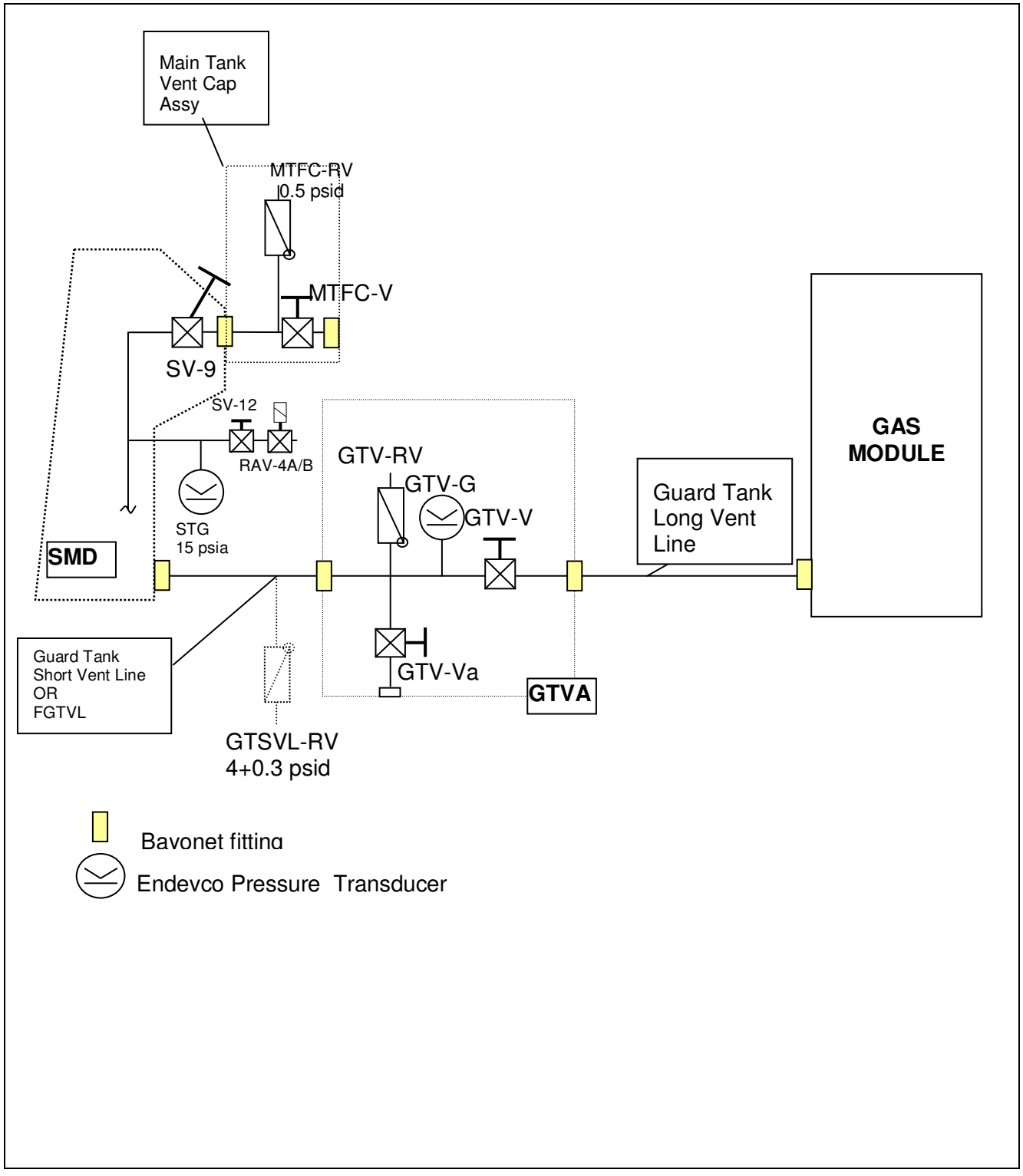
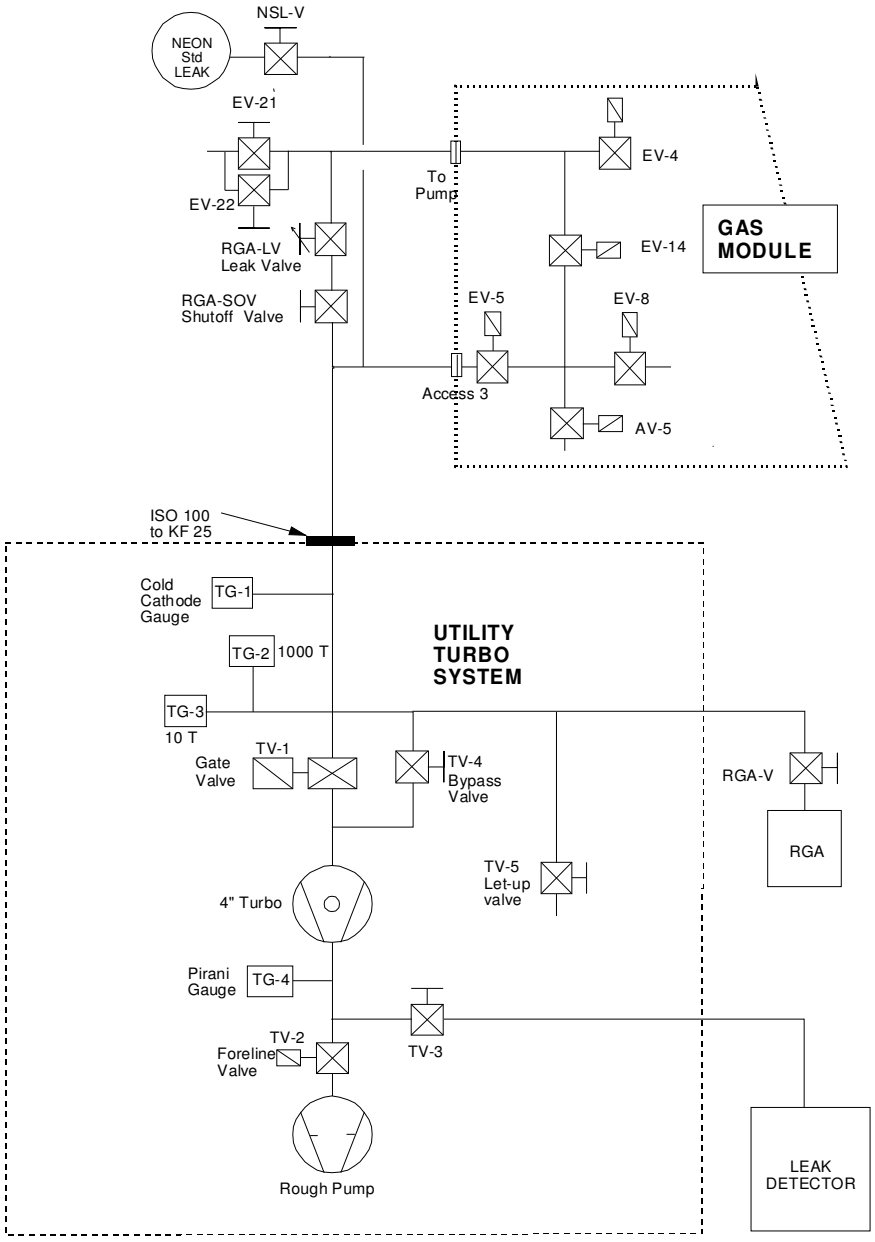


Figure 2 Utility Pump System with RGA for Neon leak detection



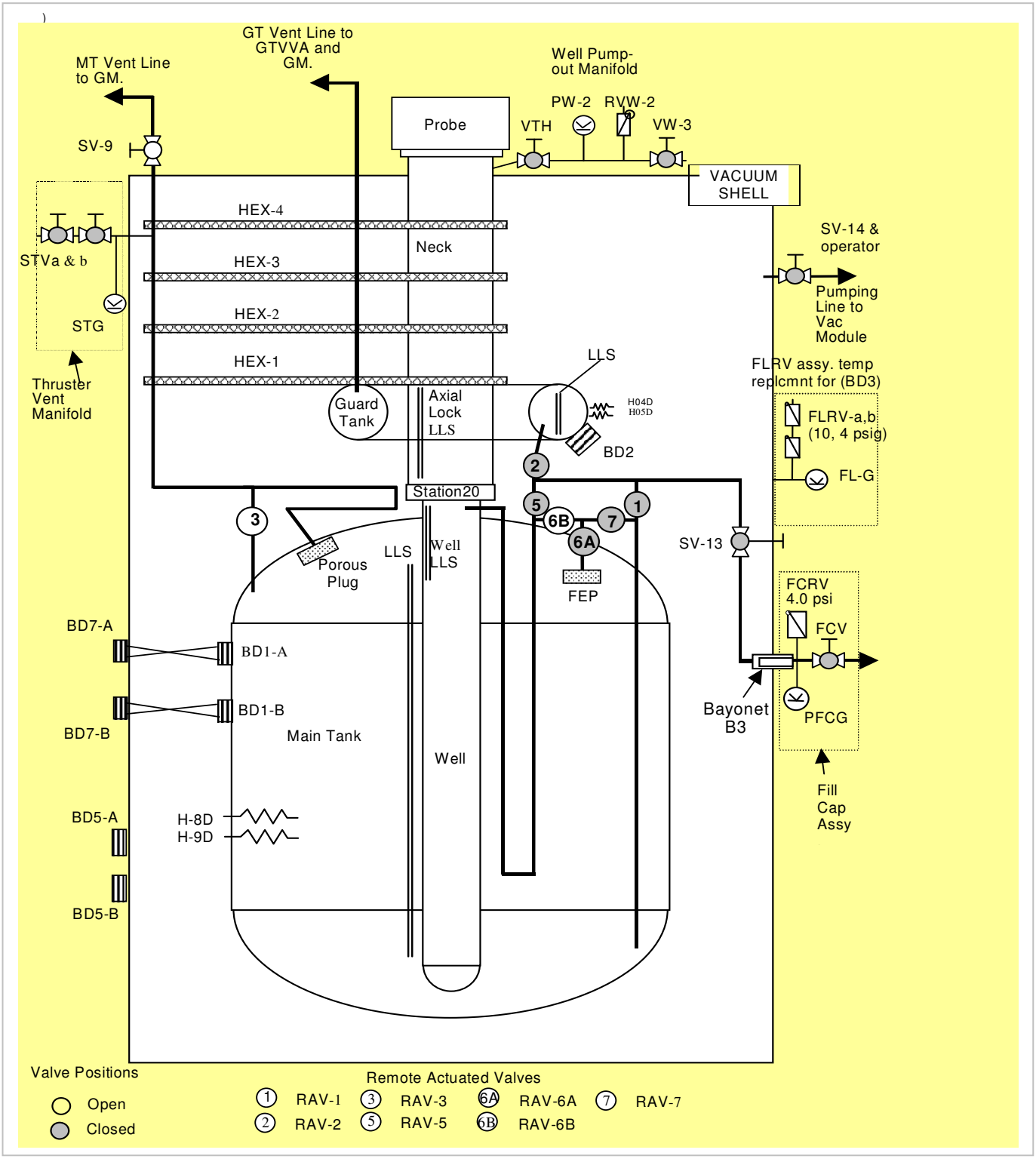


Figure 3. Schematic of Science Mission Dewar plumbing

Appendix 1

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member knows their individual responsibilities.		
	7. CONFIRM THAT EACH TEST TEAM MEMBER CLEARLY UNDERSTANDS THAT HE/SHE HAS THE AUTHORITY TO STOP THE TEST IF AN ITEM IN THE PROCEDURE IS NOT CLEAR.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. NOTIFY MANAGEMENT OF ALL DISCREPANCY REPORTS OR D-LOG ITEMS IDENTIFIED DURING PROCEDURE PERFORMANCE. IN THE EVENT AN INCIDENT OR MAJOR DISCREPANCY OCCURS DURING PROCEDURE PERFORMANCE MANAGEMENT WILL BE NOTIFIED IMMEDIATELY.		
	10. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

Appendix 2

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

Appendix 3– Contingency Responses

	Condition	Circumstance	Response
1	Power Failure		
		Any time	Wait for power restoration Note: the DAS computer will continue to function for several hours, however no data will be collected DAS computer still operating: Reset GM valving per the last configuration in procedure and resume procedure DAS computer not operating: Reboot computer and launch DRP_SMD and select auto startup option Reset GM valving per the last configuration in procedure and resume procedure
2	Temperature limits (CN 28 or 29) exceeded	ANY TIME	Lower inflow of helium gas to Guard Tank OR, INCREASE MAIN TANK VENTING Open MTVC-V momentarily or if problem persists see 3 below
3		ANY TIME	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
4	Burst disk rupture (MT/GT)	ANY TIME	Evacuate room