

GRAVITY PROBE B PROCEDURE FOR SCIENCE MISSION DEWAR

Repump Well with Probe Installed

THIS PROCEDURE CONTAINS HAZARDOUS OPERATIONS

P0613D
ECO 1395

December 3, 2002

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REVISION RECORD

REV	ECO	PAGES	DATE
A	1159	<p>Change title to <i>Repump Well with Probe Installed</i>.</p> <p>Section A – Updated scope to accurately reflect content.</p> <p>Section B – Divided into two sections, addressing safety issues (new Section B) and test personnel (new Section D). Reorganized safety paragraphs into: hazards, mitigation, injuries. Content of both new sections essentially unchanged.</p> <p>Added Quality Assurance Section (new Section C)</p> <p>Section C, D, and E – Consolidated all requirements into new Section E entitled Requirements. Added Configuration requirements, GSE/SMD interface requirements, alarm setup requirements, vacuum requirements, and non-flight hardware requirements.</p> <p>Section G.1 Added section to verify notification of QA.</p> <p>Section G.2 – Added steps to verify configuration requirements and alarm setup. Added GT to level alarm list (setpoint = 10%)</p> <p>Section G.7 – added section to verify DAS and Main Facility alarms enabled.</p>	7-14-00
B	1239	<p>Change to reflect change in normal operating status of Well vent valve VTH. VTH is normally closed with 2 to 5 torr helium gas captured between VTH and VW-3.</p> <p>Include steps for installation and removal of Well Vent Manifold at VTH (see Figure 3).</p>	1-3-01
C	1353	<p>Update to reflect operation at LM rather than SU;</p> <p>Update per P0875;</p> <p>Replaced references to CN [1] (STA 200 temperature) with references to CN [29] (top of lead bag temperature, redundant to CN [28]);</p> <p>Added pre- and post-operation checklists (Appendices 1, 2);</p> <p>Added contingency responses (Appendix 3).</p>	
D	1395	<p>Incorporate Minor Redlines</p> <p>Update to reflect installation of flight plumbing</p>	11/11/02

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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.		

A. SCOPE

This document provides the necessary steps to pump on the Well with the UTS. The steps include:

- Install the Well Vent Manifold (Figure 1)
- Connect pumping line between UTS and Well at VW-3
- Pump up to closed VW-2
- Leak check pumping line
- Open VW-2 and pump on Well
- Close VW-2, perform leak-back test of closure,
- Remove the Well Vent Manifold (optional)

The procedure may also be used to install or remove the Well Vent Manifold at VW-2, by skipping the appropriate sections.

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 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 requirements apply to personnel involved 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 and full-face shields are to be worn whenever the possibility of splashing cryogenics 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 Test Director or his designate and shall be approved by the QA Representative. Additionally, approval by the Hardware Manager shall be required, if in the judgement 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.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.
3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

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

D.2. Personnel Qualifications

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

D.3. 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.

<i>Test Director</i>	<i>Test Engineer</i>
Mike Taber	Tom Welsh
Dave Murray	
Ned Calder	

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

Proper ESD protection is required when working around the SV.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

<i>Description</i>
Varian Leak Detector Model # _____ Cal Due Date: _____

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, 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 Electrical Module (Table 1).

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

<i>Description</i>
Utility Turbo System (UTS)

E.3.5. Additional Hardware

<i>Description</i>
Stainless steel flex line to connect UTS to Well at VW-3
Well vent manifold

E.3.6. Tools

<i>Description</i>
Torque Wrench, Cal Due Date: _____ S/N _____

E.3.7. Expendables

<i>Description</i>	<i>Quantity</i>	<i>Mfr./Part No.</i>
Alcohol	AR	N/A
99.99% pure gaseous helium	AR	N/A

Vacuum Grease	AR	Dow Corning High Vacuum or Apiezon N
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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	-
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	-

No.	Location	Description	User Name	Serial No.	Cal Required	Status Cal due date
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 may be either subatmospheric or at NBP.

E.5.2. Guard Tank

The Guard Tank may contain liquid or be depleted.

E.5.3. Well

The Well should be nominally evacuated. (This procedure is intended for repumping and not for initial evacuation.)

E.5.4. SMD Vacuum Shell

There is no requirement on the vacuum shell pressure.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
 - a. Top of lead bag temperature set (CN 175) at $T \leq 6.0$ K.
 - b. Top of lead bag temperature set (CN 178) at $T \leq 6.0$ K.
 - c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 30$ torr.
2. The Watch Dog alarm must be armed.

E.5.6. 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).

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 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 disconnected with a vent cap installed.
4. The Guard Tank vent line may be connected to the Gas Module or disconnected with a vent cap installed.
5. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in 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.
6. The thruster vent port is flanged to a shut-off valve.
7. The Fill Cap Assembly is installed at SV-13 (See Figure 1)

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	Title
LMMS-5833394	<i>Instrumentation Installation</i>

F.2. Supporting documentation

Document No.	Title
LMMC-5835031	<i>GP-B Magnetic Control Plan</i>
GPB-100153C	<i>SMD Safety Compliance Assessment</i>
SU/GP-B P0141	<i>FIST Emergency Procedures</i>
LMSC-P088357	<i>Science Mission Dewar Critical Design Review</i>
SU/GP-B P0108	<i>Quality Plan</i>
LMMS GPB-100333	<i>Science Mission Dewar Failure Effects and Causes Analysis</i>
EM SYS229	<i>Accident/Mishap/Incident Notification Process</i>
SU/GP-B P059	<i>GP-B Contamination Control Plan</i>

F.3. Additional Procedures

Document No.	Title
SU/GP-B P0140	<i>Prepare Probe C for Testing</i>

Operation Number: _____

Date Initiated: _____

Time Initiated: _____

G. OPERATIONS

G.1. Verify Preparations

G.1.1. Verify SU QA notified.

Record: Individual notified _____,

Date/time _____ / _____.

G.1.2. Verify NASA representative notified.

Record: Individual notified _____,

Date/time _____ / _____.

G.1.3. 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.1.4. Verify completion of pre-operations checklist

Section Complete Quality _____

G.2. Verify Configuration Requirements

G.2.1. Ensure Watch Dog Timer enabled.

G.2.2. Verify DAS alarm system enabled and record set points.

1. **Top of lead bag temperature** – verify CN [175] on DAS alarm list and set to alarm at $T \leq 6.0$ K. Record set point. _____ K
2. **Top of lead bag temperature** – verify CN [178] on DAS alarm list and set to alarm at $T \leq 6.0$ K. Record set point. _____ K
3. **Relative Guard Tank Pressure** – verify CN [46] on DAS alarm list and set to alarm at $\Delta P \geq 10$ torr. Record set point. _____ torr

G.2.3. Verify liquid-level alarms set, as appropriate, and record set points.

1. **Main Tank** – verify liquid-level alarm set $\geq 20\%$. Record set point. _____ %
2. **Guard Tank** – If appropriate, verify liquid level alarm set $\geq 20\%$ (if liquid in GT). Record set point. _____ %

G.2.4. Verify VTH open and handle restrainer installed.

G.2.5. Ensure VW-1 open

G.2.6. Ensure VW-2 Closed

G.2.7. Install/verify installed Well Vent Manifold:

- o Manifold removed:
 1. Install manifold at VW-2 per configuration in Figure 1.
 2. Connect PW-2 to Convectron readout controller.
- o Manifold currently installed and configured per Figure 1.

Section Complete Quality _____

G.3. **Connect Pumping Line and Leak Check Up to VW-1**

G.3.1. Turn on and verify calibration of leak detector. Record

1. Calibrated leak value _____ sccs; cal exp.
Date: _____
2. Measured leak value _____ sccs

Quality _____

G.3.2. Connect leak detector to the UTS at access port (LD).

G.3.3. Open/verify open VW-3

G.3.4. Connect UTS primary pumping port to Well manifold assembly at VW-3 and start the UTS pumping up to closed VW-2 as follows:

1. Close/verify closed TV-1, -2, -3, -4, -5 and RGA-V.
2. Place valve interlock switch in "over-ride" position.
3. Turn on vane pump and converter (Note: converter switch provides power to turbopump controller and the vacuum-gauge display.)
4. Push the red "reset" button to activate the interlock over-ride circuit. (the neon indicator light will come on).
5. Turn "foreline" switch on, to open TV-2, and verify that the switch is illuminated.
6. Push the "Sensor" button on the vacuum gauge display to read the foreline pressure (TG-4). (This is the pirani gauge. The "Pir" annunciator will appear in upper left corner of the display.)
7. Slowly open TV-4.
8. When foreline pressure (TG-4) < 1 torr, push "Start" button on turbo controller.
9. When the "Normalbetrieb" light illuminates on turbo controller, indicating turbopump is up to speed, open gate valve TV-1 and close TV-4.
10. Switch the valve interlock switch to the "protected" position.
11. Push the "Sensor" button on the vacuum gauge readout so that the "Hi-Vac" annunciator shows, and push the "Emis" button to turn on the cold cathode gauge (TG-1).
12. Record the pumping line pressure (TG-1) _____ torr.

G.3.5. Close TV-2 and open TV-3.

G.3.6. Leak check all joints between VW-2 and Leak Detector.

Note:

No leaks greater than 1×10^{-7} sccs are allowed.

1. Record background _____ sccs.
2. Record Leak Rate _____ sccs.
3. Record TG-1 _____ torr.

G.3.7. When finished with leak check, open TV-2 and close TV-3.

Section Complete Quality _____

G.4. Pump On Well

- o Skip this section, only using procedure for purposes of installing or removing Well Vent Manifold.
- o Perform this section to pump on Well.

Note:

Step G.4.1 provides the option of filling the cold trap on the UTS with LN₂.
This is done primarily to achieve a lower base pressure and, only as a secondary concern, to prevent back-streaming of any fore pump oil into the Well.

G.4.1. **Option:** Add LN₂ to UTS cold trap.

G.4.2. Close VW-3.

G.4.3. Record PW-2: _____ torr

G.4.4. Open VW-2.

G.4.5. Record PW-2: _____ torr.

G.4.6. Record VW-2 operation in Well Valves Log Book

G.4.7. Proceed as follows

o PW-2 < 1 torr

1. Open VW-3, now pumping on Well with turbo.
2. Record Date/Time _____/_____.

o PW-2 > 1 torr

1. Close TV-1 and stop turbo pump
2. When turbo is fully stopped, open TV-4 and VW-3. Now pumping on Well with forepump.
3. When TG-4 < 1 torr, turn on turbo.
4. When "normalbetrieb" light comes on open TV-1 and close TV-4. Now pumping on Well with turbo.
5. Record Date/Time _____/_____.

G.4.8. Remove Leak Detector from UTS as follows:

1. Verify UTS interlock switch in "protected" position.
2. Verify TV-3 closed and TV-2 open.
3. While monitoring the pressure on the cold cathode gauge (TG-1), vent and disconnect the leak detector
4. Disconnect Leak Detector from UTS and cap TV-3.

G.4.9. Start Data collection in Table 2.

Table 2

Date/Time	TG-1 (torr)	TG-4 (torr)	PW-2 (torr)	Comments

G.4.10. **(Option)** Set Up RGA

1. When TG-1 is $< 1 \times 10^{-5}$ torr slowly open RGA-V.
2. Set up RGA software (Transpector Ware)
3. Record Transpector Ware File Name _____.
4. When data collection is complete, shutdown RGA and close RGA-V.

Section Complete Quality _____

G.5. Terminate Well Pump Down

G.5.1. Record Time _____ and Date _____.

G.5.2. Record pressures:

1. PW-2 _____ torr,
2. TG-1 _____ torr,
3. TG-4 _____ torr.

CAUTION:
In the following operation, it is important to ensure that VW-2 is properly closed.

G.5.3. Close VW-2 and torque to 72-84 in-lbs (6-7 ft-lbs)

Quality _____

G.5.4. Record VW-2 operation in Well Valves Log Book

G.5.5. Close TV-1 and shut off TG-1.

G.5.6. Install a purged Helium source, set to approximately 1 psig, at TV-5.

G.5.7. Open TV-5 until ~100 torr is read on PW-2. Note: The real pressure is about 6.5 torr. The sensitivity of a Convectron to He is enhanced above 1 torr.)

G.5.8. Close TV-5.

G.5.9. Perform Leak Back Test of VW-2 Closure

1. Close VW-3
2. Record PW-2: _____ torr
3. Slowly open TV-4 to evacuate UTS plumbing
4. Close TV-4 when TG-2 < 25 mtorr
5. Monitor TG-2 and PW-2 for 30 minutes to verify successful closure of VW-2 and VW-3.

Time						
TG-2 (torr)						
PW-2 (torr)						

Note:

A pressure drop < 10 torr at PW-2 during the last 20 minutes indicates successful closure of VW-2.

Section Complete Quality _____

G.6. (Option) Close out procedure leaving Well Vent Manifold Installed at VW-2

- G.6.1. Ensure closed TV-4, following successful closure of VW-2, capturing 6-7 torr helium gas between VW-2 and VW-3.
- G.6.2. Remove UTS as follows:
 1. Turn turbo pump off.
 2. Close foreline valve (TV-2) and turn off vane pump.
 3. Open TV-5 and backfill to 760 torr, as read at TG-3.
 4. Remove pumping line from VW-3 and UTS.
 5. Cap port at VW-3.

Section Complete Quality _____

G.7. (Option) Close out procedure by removing Well Vent Manifold from VTH

- G.7.1. Open VW-3
- G.7.2. Open/Verify open TV-4 until TG-2 reads ~0.00 torr
- G.7.3. Close TV-4
- G.7.4. Remove Helium source from TV-5
- G.7.5. Open TV-5 until 760 torr (air) is read on TG-3.
- G.7.6. Close TV-5.
- G.7.7. Close VW-3.
- G.7.8. Monitor PW-2 for 30 minutes to verify successful closure of VW-2

Time						
PW-2 (torr)						

Note: a pressure drop < 1 torr at PW-2 during the last 20 minutes indicates successful closure of VW-2.

- G.7.9. Following successful closure of VW-2, remove UTS as follows:
 1. Turn turbo pump off.
 2. Close foreline valve (TV-2) and turn off vane pump.
 3. Remove pumping line from VW-3 and UTS.
- G.7.10. Remove Well Vent Manifold from VW-2
- G.7.11. Cap port at VW-2

Section Complete Quality _____

G.8. Establish Final Configuration

G.8.1. Ensure DAS alarm enabled and record set points if changed

- o Thermal conditions substantially unchanged, alarm set points for lead bag unchanged
- o Thermal conditions substantially changed, temperature alarm points reset as follows:
 - a. Top of Lead Bag set point [CN 175] _____ K (≤ 6.0 K)
 - b. Top of Lead Bag set point [CN 178] _____ K (≤ 6.0 K)

G.8.2. 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.8.3. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 10 torr differential.

G.8.4. Ensure Watch Dog Timer is armed.

G.8.5. Perform Post-Operations Checklist (Appendix 2)

Section Complete Quality _____

Completed by: _____

Witnessed by: _____

Date: _____

Time: _____

Quality Manager _____ Date _____

Payload Test Director _____ Date _____

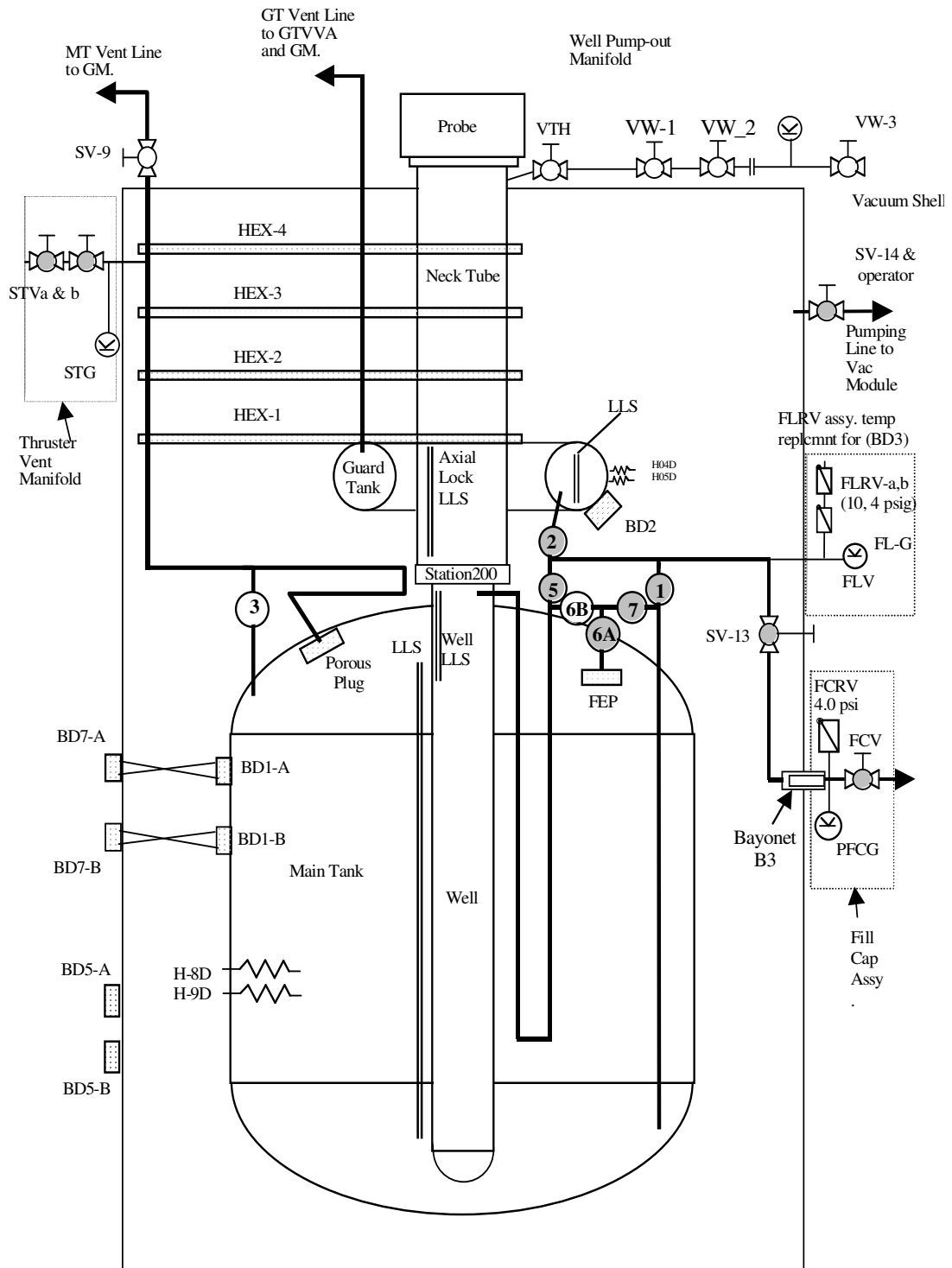


Figure 1. Schematic of Science Mission Dewar plumbing.

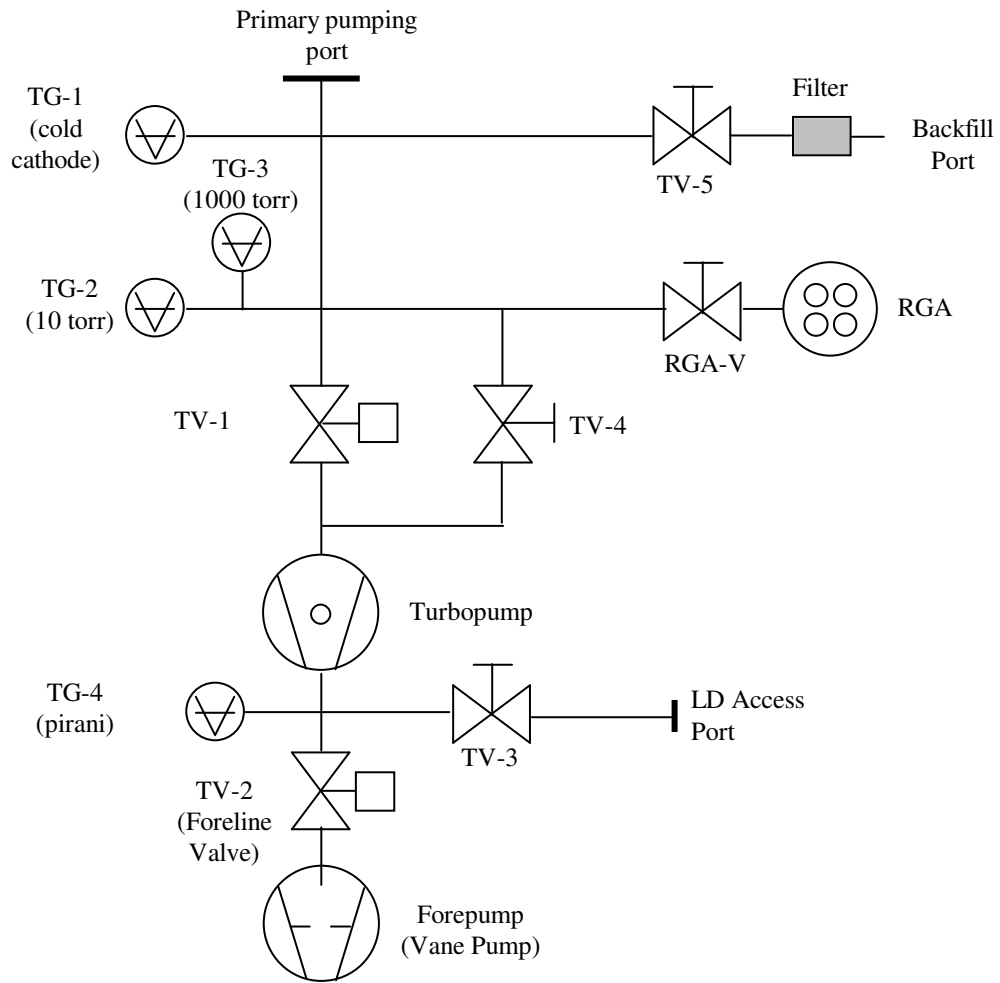


Figure 2. Schematic diagram of Utility Pumping System (UTS)

Figure 3. Well manifold assembly

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	Sections G.1, G.2	Wait for power resumption and continue with procedure.
		G.3 – G.4	Close VW-3 (if open) and all open valves on the UTS. Wait for power restoration. Note: TV-1 and TV-2 will automatically close upon loss of power. They will not reopen nor will the turbo restart when the power is restored. After power restoration, restart procedure at the beginning of G.3. If the leak check has already been completed, it need not be repeated.
		After G.4	Wait for power restoration and continue with procedure.
2	Failure of leak-back test	At G.5.8	<ol style="list-style-type: none"> 1) Verify that VTH is fully seated. 2) If the pressure drop was <30 mtorr, wait another 20 minutes to see if the trend continues. 3) If the pressure drop exceeded 30 mtorr or the trend continues, slowly open TV-4 to evacuate the pumping line. When TG-2 reads < 1 torr, open TV-1 and close TV-4. Turn on TG-1 and when it reads < 0.1 mtorr, reopen VTH. When the pressure at TG-1 returns to the value recorded in G.5.2, repeat the procedure

			starting at G.5.
3	Failure of leak-back test	At G.7.3	<ol style="list-style-type: none"> 1) Verify that VTH is fully seated. 2) Wait another 20 minutes to see if the trend continues. 3) If the trend continues, place the interlock in the override position and stop turbopump. Very slowly open TV-4 to evacuate the pumping line. When TG-2 reads < 1 torr, restart turbopump, open TV-1, and close TV-4. Turn on TG-1 and when it reads < 0.1 mtorr, take interlock out of override and reopen VTH. When the pressure at TG-1 returns to the value recorded in G.5.2, repeat the procedure starting at G.5.
4	Burst disk rupture (MT/GT)	Any time	Evacuate room