# GRAVITY PROBE B
# PROCEDURE FOR
# SCIENCE MISSION DEWAR

## Repump Well with UTS

**To be performed in Vandenberg Air Force Base building 1610 and VAFB MST**

**WARNING: This document contains hazardous operations**

P1017A
ECO 1440
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# VAFB Safety

**REVISION RECORD**

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|---|---|---|---|
| A | 1440 | -Add changes to reflect installation of Flight Well plumbing and valves | 8/28/03 |

**Table of Contents**

## List of Abbreviations and Acronyms

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

## LIST OF SPECIFIC HEADING DEFINITIONS

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

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

## A. SCOPE

After successful completion of P0140 the well will occasionally need to be repumped. This document provides the necessary steps to accomplish this task. Those steps include:

Connect pumping line between UTS and Well at VW-3

Leak check pumping line

Open VW-3 and pump on Well

Close VW-3, perform leak-back test of closure, Close VW-3, and remove pumping line.

Remove the Well Vent Manifold (optional)

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

## B. SAFETY

### B.1. Potential Hazards

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

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

The SMD Safety Compliance Assessment, document GPB-100153C 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

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

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

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or

impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing, non-absorbent shoes and full-face shields are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

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

### B.3. Mishap Notification

B.3.1. Injury

In case of any injury obtain medical treatment as follows
VAFB **Call 911**

B.3.2. Hardware Mishap

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

B.3.3. Contingency Response

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

## C. QUALITY ASSURANCE

### C.1. QA Notification

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

### C.2. Red-line Authority

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

### C.3. Discrepancies

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

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

2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.
3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

## D. TEST PERSONNEL

### D.1. Personnel Responsibilities

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

### D.2. Personnel Qualifications

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

### D.3. Required Personnel

This procedure requires at the minimum, one test director, and one SU QA representative.

List below those personnel involved with the procedure

| ***Test Director*** | ***Test Engineer*** | ***Safety Engineer*** |
|---|---|---|
| 1. | 1.<br>2.<br>3.<br>4. | 1. |

## E. REQUIREMENTS

### E.1. Electrostatic Discharge Requirements

When working on the space vehicle, proper ESD protection is required.

### E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

### E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

| ***Description*** |
|---|

| ***Description*** |
|---|
| Varian Leak Detector<br>S/N #_____<br>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

| ***Description*** |
|---|
| Utility Turbo System (UTS) |

E.3.5. Additional Hardware

| ***Description*** |
|---|
| Stainless steel flex line to connect UTS to Well |
| 4 liter LN2 thermos |

E.3.6. Tools

| ***Description*** |
|---|
| Torque Wrench, 1-1/4-in socket, 60 +/- 5 in-lb<br>Cal Due Date:_____S/N_____ |

E.3.7. Protective Clothing

1. Cryogenic safety gloves and apron
2. Face Shield
3. Non-absorbent shoes

E.3.8. 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 | - |
| 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:<br>a) Thermocouple, b) Current meter, c) Temperature set point controller | - | C-19950 | No | - |
| 24 | GM | Guard Tank Heat Exchanger:<br>a) Thermocouple, b) Current meter, c) Temperature set point controller | - | C-09920 | No | - |
| 25 | VM | Vacuum Gauge readout, Granville-Phillips 316 | VG-3<br>VG-4 | 2878 | No | - |
| 26 | VM | Vacuum Gauge readout, Granville-Phillips 360 | VG-1, VG-2<br>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

There are no configuration requirements for the Well.

E.5.4. SMD Vacuum Shell

The vacuum shell pressure shall be <5*10E-5 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 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 $\Delta P \geq 0.3$ 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.

## 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 |
| EWR 127-1, 31 March 1995, Eastern and Western Range Safety Requirements | Hazardous and Safety Critical Procedures |

### F.3. Additional Procedures

| ***Document No.*** | ***Title*** |
|---|---|
| SU/GP-B P0879 | Accident/Incident/Mishap Notification Process |
| SU/GP-B P0875 | *GP-B Maintenance and Testing at all Facilities* |

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

## G. OPERATIONS

### G.1. Verify Preparations

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

- Verify NASA safety representative notified and concurrence has been given to proceed.

  Record: Individual notified _____

  Date/Time:_____,

- Record calibration due dates in Table 1

- Persons actually performing this procedure should list their names in Sec D.3.

- Verify completion of the pre-operations checklist (Appendix 1).

- Verify proper operation of GP-B Cryogenic Team oxygen monitor

Section Complete Quality _____

### G.2. Verify Configuration Requirements

G.2.1. 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 ≤ 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 ≤ 6.0 K. Record set point. _____K
3. ***Relative Guard Tank Pressure*** – verify CN [46] on DAS alarm list and set to alarm at ΔP ≥ 10 torr. Record set point. _____torr

G.2.2. Verify liquid-level alarms set, as appropriate, and record set points.

1. ***Main Tank*** – verify liquid-level alarm set ≥20%. Record set point. _____%

2. ***Guard Tank*** – If appropriate, verify liquid level alarm set ≥ 20% (if liquid in GT). Record set point. _____%

G.2.3. Verify VTH open and handle restrainer installed.

G.2.4. Record State of VW-1 and VW-2

1. VW-1:_____
2. VW-2:_____

G.2.5. Install/verify installed Well Vent Manifold:

- Manifold removed:
  1. Install manifold at VW-2 per configuration in Figure 1.
  2. Connect PW-2 to Convectron readout controller.
- Manifold currently installed and configured per Figure 1.
  1. Ensure VW-3 and VW-4 closed

Section Complete Quality _____

## G.3. Connect Pumping Line and Leak Check Up

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. Verify state of VW-3 and VW-4

1. If manifold already installed, leave VW-3 and VW-4 closed
2. If manifold not installed, ensure open VW-3 and VW-4

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

**Note:**

No leaks greater than 1 x $10^{-7}$ 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

- Skip this section, only using procedure for purposes of installing or removing Well Vent Manifold.
- 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. 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.4.2. **Option:** Add $LN_2$ to UTS cold trap.

G.4.3. Record VW-2 operations in Well Valves Log Book

G.4.4. Proceed as follows

- o Manifold initially installed

1. Record PW-2:_____
2. Record Date/Time _____/_____.
3. Slowly open VW-4 ensuring TG-1 < 5*10-4 torr
4. Slowly open VW-3 ensuring TG-1 < 5*10-4 torr

- o Manifold initially not installed

1. Ensure TG-1<5*10-5 torr
2. Close VW-3 and VW-4
3. Record PW-2:_____
4. Open VW-2
5. Record PW-2:_____
6. Record Date/Time:_____/_____
7. Slowly open VW-4 ensuring TG-1 < 5*10-4 torr
8. Slowly open VW-3 ensuring TG-1 < 5*10-4 torr

G.4.5. Enter comment to DAS, " Now pumping Well with UTS"

G.4.6. Start Data collection in Table 2.

**Table 2**

| Date/Time | TG-1 (torr) | TG-4 (torr) | PW-2 (torr) | Comments |
|---|---|---|---|---|
| | | | | |
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G.4.7. **(Option)** Set Up RGA

1. When TG-1 is < 1 x$10^{-5}$ 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.6. (Option): Close VW-2**

G.6.1. Close VW-2 and torque to 72-84 in-lbs (6-7 ft-lbs)

Quality _____

G.6.2. Record VW-2 operation in Well Valves Log Book

G.6.3. Close TV-1 and shut off TG-1.

G.6.4. Install a purged Helium source, set to approximately 1 psig, at TV-5.

G.6.5. 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.6.6. Close TV-5.

G.6.7. 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.7. (Option) Close out procedure leaving Well Vent Manifold Installed at VW-2**

G.7.1. Close VW-3

G.7.2. Close TV-1 and shut off TG-1.

G.7.3. Install a purged Helium source, set to approximately 1 psig, at TV-5.

G.7.4. Open TV-5 until ~9 torr is read on TG-2.

G.7.5. Close TV-5.

G.7.6. Perform Leak Back Test of VW-3

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

**Note:**

A pressure drop < 20 mtorr at TG-2 during the last 20 minutes indicates successful closure of VW-3.

G.7.7. Close VW-4 leaving ~9 torr trapped between VW-3 and VW-4

G.7.8. Install cap at VW-4

Section Complete Quality _____

**G.8. (Option) Close out procedure by removing Well Vent Manifold from VW-2**

G.8.1. Ensure step G.6 complete

G.8.2. Open VW-3

G.8.3. Open/Verify open TV-4 until TG-2 reads ~0.00 torr

G.8.4. Close TV-4

G.8.5. Remove Helium source from TV-5

G.8.6. Open TV-5 until 760 torr (air) is read on TG-3.

G.8.7. Close TV-5.

G.8.8. Close VW-3.

G.8.9. 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.8.10. 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.8.11. Remove Well Vent Manifold from VW-2

G.8.12. Cap port at VW-2

Section Complete Quality _____

**G.9. Establish Final Configuration**

G.9.1. Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for lead bag unchanged
- 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.9.2. 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.9.3. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 10 torr differential.

G.9.4. Ensure Watch Dog Timer is armed.

G.9.5. Perform Post-Operations Checklist (Appendix 2)

Section Complete Quality _____

**Completed by:**_____

**Witnessed by:**_____

**Date:** _____

**Time:**_____

**Quality Manager**_____**Date**_____

**Payload Test Director**_____**Date**_

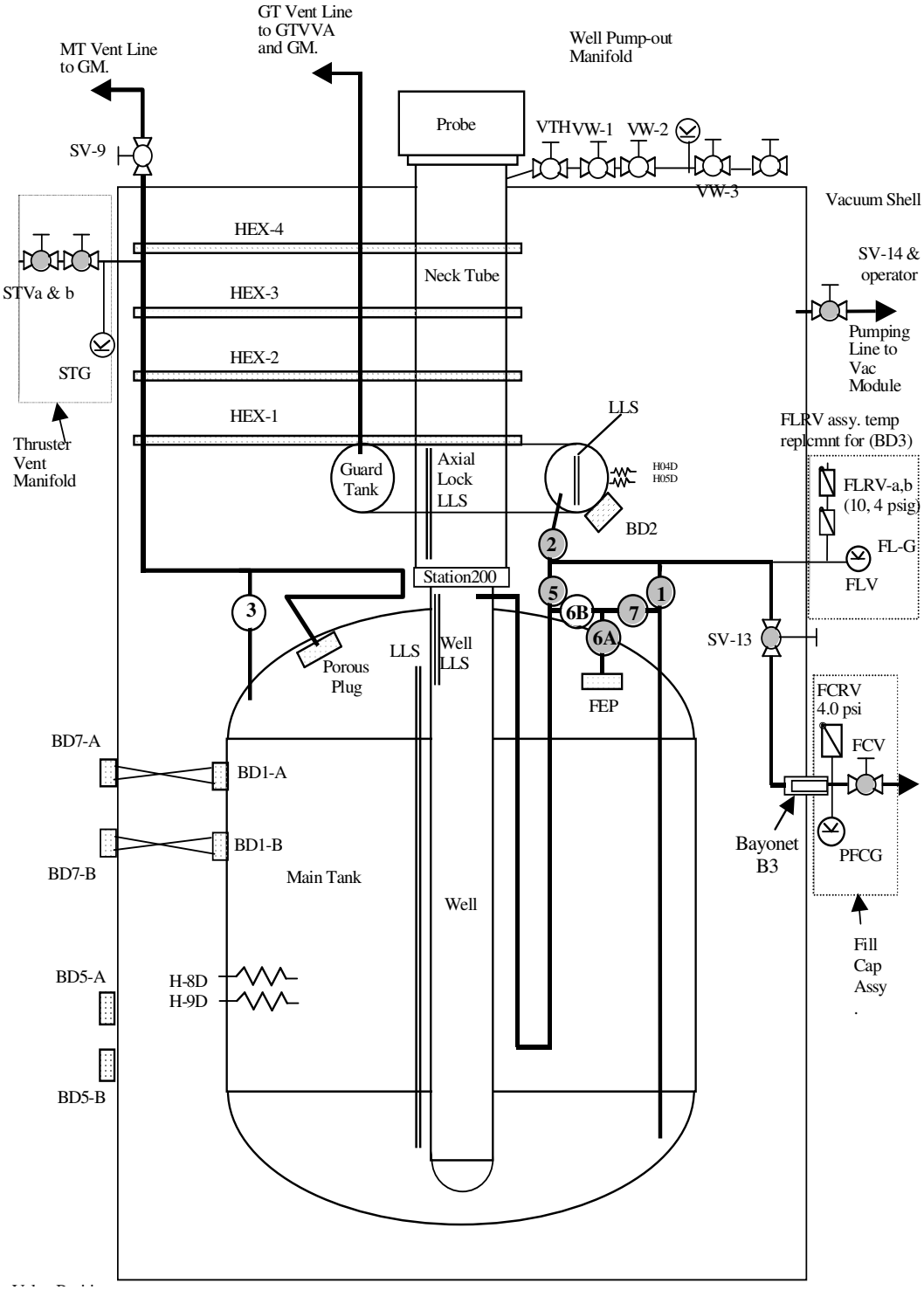


**Figure 1.** Schematic of Science Mission Dewar plumbing.

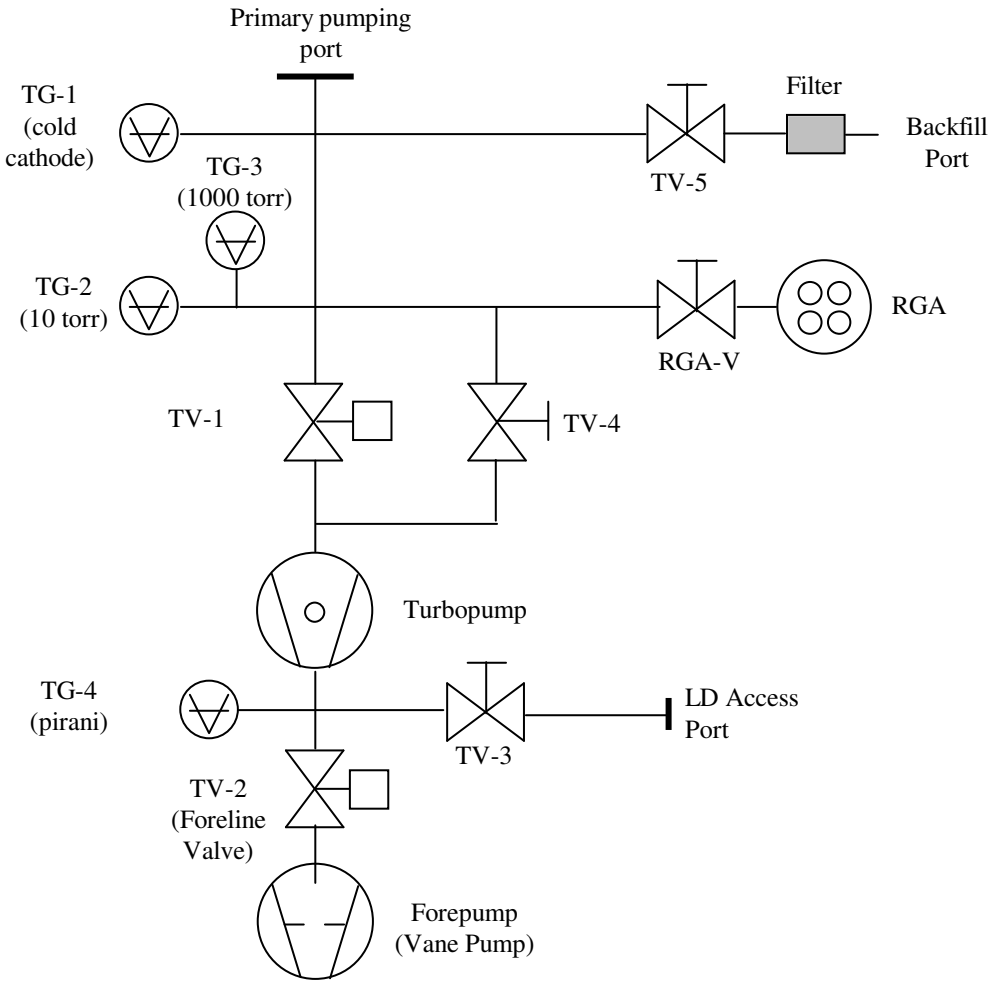


**Figure 2**. Schematic diagram of Utility Pumping System (UTS)

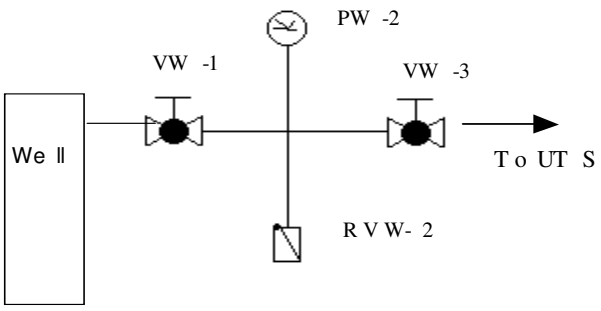


**Figure 3**. Well manifold assembly

## H. APPENDIX 1- PRE OPERATIONS CHECKLIST

| DATE | CHECKLIST ITEM | COMPLETED | REMARKS |
|---|---|---|---|
| | 1. Verify the test procedure being used is the latest revision. | | |
| | 2. Verify all critical items in the test are identified and discussed with the test team. | | |
| | 3. Verify all required materials and tools are available in the test area. | | |
| | 4. Verify all hazardous materials involved in the test are identified to the test team. | | |
| | 5. Verify all hazardous steps to be performed are identified to the test team. | | |
| | 6. Verify each team member 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: _____ | | |

## I. APPENDIX 2 POST OPERATIONS CHECKLIST

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

## J. 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 | 1) Verify that VTH is fully seated.<br>2) If the pressure drop was <30 mtorr, wait another 20 minutes to see if the trend continues.<br>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 | 1) Verify that VTH is fully seated.<br>2) Wait another 20 minutes to see if the trend continues.<br>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 |