GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

CONNECT VACUUM MODULE / PUMP ON SMD VACUUM SHELL

P0213 REV. D
ECO 1403

March 13, 2003

Revised by	Checked by
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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	733	Update procedure based on experience of performing operations	1/27/98
B	1092	Changed title to reflect procedure contents more accurately. Change title to: *Connect Vacuum Module / Pump on SMD Vacuum Shell*. Section A – Revised scope to reflect content of procedure more accurately. 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. Added Quality Assurance Section (new Section C) 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. Added sections to verify QA notification, verify initial configuration, ensure DAS and liquid-level alarms properly set. Added capability to begin from three possible initial configurations and end in one of three final configurations.	5/30/00
C	1295	Added data sheet (Table 1) and minor redlines.	8/9/01
D	1403	Added optional section to perform leak check of all dewar seals Updated figures Add pre/post checklists	3/14/03

Table of Contents

List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
ATC	Advanced Technology Center
APR-x	Pressure regulator x of Gas Module
AV-x	Valve x of Gas Module auxiliary section
CG-x	Gauge x of portable helium pressurization source
CPR-x	Pressure regulator x of portable helium pressurization source
CV-x	Valve x of portable helium pressurization source
CN [xx]	Data acquisition channel number
DAS	Data Acquisition System
EFM	Exhaust gas Flow Meter
EG-x	Gauge x of Gas Module exhaust section
EM	Electrical Module
ERV-x	Relief valve of Gas Module exhaust section
EV-x	Valve number x of Gas Module exhaust section
FCV	Fill Cap Valve
FIST	Full Integrated System Test
GHe	Gaseous Helium
GM	Gas Module
GP-B	Gravity Probe-B
GSE	Ground Support Equipment
GT	Guard Tank
GTVC	Guard Tank Vent Cap
GTVC-G	Guard Tank Vent Cap pressure gauge
GTVC-RV	Guard Tank Vent Cap relief valve
GTVC-V	Guard Tank Vent Cap valve
GTV-G	Guard Tank vent pressure gauge
GTV-RV	Guard Tank vent relief valve
GTV-V	Guard Tank vent valve
HX-x	Vent line heat exchanger in Gas Module
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
LLS	Liquid level sensor
LM	Lockheed Martin Co.
MT	Main Tank

MTVC	Main Tank Vent Cap
MTVC-G	Main Tank Vent Cap pressure gauge
MTVC-RV	Main Tank Vent Cap relief valve
MTVC-V	Main Tank Vent Cap valve
NBP	Normal boiling point
ONR	Office of Naval Research
PFCG	Fill Cap assembly pressure Gauge
PFM	Pump equipment Flow Meter
PG-x	Gauge x of Pump equipment
PM	Pump Module
psi	pounds per square inch
psig	pounds per square inch gauge
PTD	Payload Test Director
PV-x	Valve x of the Pump equipment
QA	Quality Assurance
RAV-x	Remote Actuated Valve-x
RGA	Residual Gas Analyzer
SMD	Science Mission Dewar
STV	SMD Thruster vent Valve
SU	Stanford University
SV-x	SMD Valve number x
TG-x	Gauge x of Utility Turbo System
TV-x	Valve x of Utility Turbo System
UTS	Utility Turbo System
Vac	Vacuum
VCP-x	Vent cap pressure gauge
VCRV-x	Vent cap relief valve
VCV-x	Vent cap valve
VDC	Volts Direct Current
VF-x	Liquid helium Fill line valve
VG-x	Gauge x of Vacuum Module
VM	Vacuum Module
VV-x	Valve x of Vacuum Module
VW-x	Valve x of Dewar Adapter

A. SCOPE

This procedure describes the steps necessary to connect the Vacuum Module to the vacuum space of the Science Mission Dewar and begin pumping. There are three possible initial configurations:

Initial Configuration 1 – Pumping line disconnected at one or both ends.

Initial Configuration 2 – Pumping line connected at both ends and pumped out.

Initial Configuration 3 – Actively pumping up to closed SV-14.

There are likewise three final configurations. The first two are equivalent to initial configurations 2 and 3. The three final configurations are

Final Configuration 1 – Pumping line connected at both ends and pumped out.

Final Configuration 2 – Actively pumping up to closed SV-14.

Final Configuration 3 – Actively pumping on SMD vacuum.

The steps include:

Connect high-vacuum pumping line to Vacuum Module and SMD (if disconnected)

Pump out high-vacuum pumping line and leak check (if not already pumping)

Pump up to closed SV-14.

Open SV-14 and pump on SMD vacuum shell.

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 FIST OPS laboratory has an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Prior to beginning this procedure in any facility other than the FIST OPS Lab, the presence of a similar oxygen monitor must be verified by safety and operations personnel. 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, and oxygen collection pans are on the floor beneath them.

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 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.

The FIST Emergency Procedures document, SU/GP-B P0141, discusses emergency procedures. These documents should be reviewed for applicability at any facility where the hardware is operated.

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. **Injuries**

In case of any injury obtain medical treatment as follows
LMMS **Call 117;** Stanford University **Call 9-911**

C. **QUALITY ASSURANCE**

C.1. **QA Notification**

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

C.2. **Red-line Authority**

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

C.3. Discrepancies

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

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

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The Test Director is the designated signer for the “witnessed by” sign-off located at the end of each procedure. The person in charge of the operation (Test Director or Test Engineer) is to sign the “completed by” sign-off.

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

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

REQUIREMENTS

D.4. **Electrostatic Discharge Requirements**

This procedure does not include any equipment sensitive to electrostatic discharge.

D.5. **Lifting Operation Requirements**

There are no lifting operations in this procedure

D.6. **Hardware/Software Requirements**

D.6.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

D.6.2. 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 calls for use of hardware located in the Vacuum Module (Figure 2) and the Electrical Module (Table 1).

D.6.3. 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.

D.6.4. Additional Test Equipment

Description	***Manufacturer***	***Model***
Leak Detector	Varian	960
Standard Leak	Varian	F3264302
High vacuum pumping line kit	LMMS	5833808-101

D.6.5. Additional Hardware

Description	***Manufacturer***	***Mfr./Part No.***
Vacuum valve operator - 2-in	LMMS	5833808-105
Vacuum valve operator handle restrainer		

D.6.6. Tools

No additional tools are required.

D.6.7. Expendables

Description	Quantity	Mfr./Part No.
99.99% pure gaseous helium	AR	N/A
Liquid nitrogen	AR	N/A
Vacuum grease	AR	Braycote Micronic 601

D.7. 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	
17	EM	Power Supply	H09D Tank	3511A-13332	Yes	

No.	Location	Description	User Name	Serial No.	Cal Required	Status Cal due date
		HP 6038A	Heater			
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	-

D.8. Configuration Requirements

D.8.1. Main Tank

Liquid in the Main Tank may be at its normal boiling point (NBP) or subatmospheric.

D.8.2. Guard Tank

The Guard-Tank may contain liquid or be depleted.

D.8.3. Well

The Well may contain liquid or be evacuated.

D.8.4. SMD Vacuum Shell

There is no requirement for the vacuum shell pressure.

D.8.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
    a. Station 200 temperature (CN 01) set at $T \leq 6.5$ K.
    b. Top of lead bag temperature set (CN 28) at $T \leq 6.0$ K.
    c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 0.3$ torr.
2. The Facility Main Alarm System must be armed.

D.8.6. GSE and Non-flight Hardware

1. A relief valve assembly or flight-like burst disk is 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 thruster vent port is flanged to a relief valve assembly when the flight thruster manifold assembly is not installed.
5. Valve SV-14 at the Vacuum shell pump out port is closed. The pumping line between the Vacuum Module and SV-14 may or may not be connected. If it is disconnected, the Vacuum Module pumps are off. If it is connected, the Vacuum Module pumps may be actively pumping up to the closed SV-14.

D.9. **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. 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 Airlock Support Plate may be installed on the SMD. This plate supports the Airlock that is used to keep air out of the Well during probe installation and removal. It is left in place while the Probe is removed.
4. A Dewar Adapter, Shutter, and Shutter Cover are mounted to the Well of the SMD when the Probe is removed
5. The Main Tank Vent Line may be connected to the Gas Module, or it may be disconnected either at the Bayonet at the end of the short line or the Bayonet at SV-9.
6. The Guard Tank Vent Line may be connected to the Gas Module, or it may be disconnected either at the Bayonet at the end of the short line or the Bayonet at SV-9.
7. When the Well contains liquid, it vents through the Gas Module unless Well operations are being performed (e.g., Probe insertion). Venting through the Gas module is accomplished via a pumping line attached to the Dewar Adapter interface flange at the Airlock Support Plate (Probe not installed), or via a pumping line attached to the Well vent manifold installed at the Well pump-out port (Probe installed).
8. The Fill Cap Assembly may be installed at SV-13.

E. REFERENCE DOCUMENTS

E.1. Drawings

Drawing No.	***Title***
LMMS-5833394	*Instrumentation Installation*

E.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*

E.3. Additional Procedures

No additional procedures are indicated.

Operation Number:____________

Date Initiated:____________

Time Initiated:____________

F. OPERATIONS

F.1. Verify Appropriate QA Notification

- o Verify SU QA notified.

  Record: Individual notified __________________,

  Date/time ________/________.

- o Verify NASA representative notified.

  Record: Individual notified __________________,

  Date/time ________/________.

- o Verify Completion of Pre operations checklist

F.2. Verify Configuration Requirements

F.2.1. Ensure DAS alarm system enabled and record set points.

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

F.2.2. Ensure liquid-level alarms set, as appropriate, and record set points.

1. ***Main Tank*** – ensure liquid-level alarm set ≥ 20%. Record set point. _____%
2. ***Guard Tank*** – ensure liquid level alarm set ≥ 10% if liquid in GT. Record set point. _____%

F.2.3. Ensure DAS watchdog timer and alarm enabled.

F.2.4. Ensure ion-pump magnet installed.

F.2.5. Input comment to DAS “Begin Vacuum Module Connect”

F.2.6. Set DAS data cycle time to 5 minutes.

F.2.7. Record and verify initial configuration of high-vacuum pumping line.

- o ***Initial Configuration 1*** – Pumping line disconnected at one or both ends.

1. Ensure turbo pump off.
2. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7, VV-10 and VV-11

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closed.

o **_Initial Configuration 2_** – Pumping line connected at both ends and pumped out (VG-3 ≤ 10 torr).

3. Verify turbo pump (VP-1) off
4. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7, VV-10and VV-11 closed..
5. Verify pressure in pumping line (VG-3) < 10 torr ________ torr.

   Note: If high-vacuum pumping line is connected and VG-3 ≥ 10 torr, *do not* skip leak-check (Section G.7).

o **_Initial Configuration 3_** – Actively pumping up to closed SV-14.

6. Verify turbo pump (VP-1) and vane pump (VP-2) on
7. Verify/switch turbo pump to normal speed operation (Standby light is off).
8. Verify VV-1 and VV-4 open.
9. Ensure VV-2, VV-3, VV-5, VV-6, VV-7, VV-10 and VV-11 closed.
10. Verify pumping-line pressure (VG-1) ≤ $5x10^{-6}$ torr ________ torr.

F.2.8. Record intended final configuration

o **_Final Configuration 1_** – Pumping line connected at both ends and pumped out.

o **_Final Configuration 2_** – Actively pumping up to closed SV-14

o **_Final Configuration 3_** – Actively pumping on SMD vacuum

F.3. **Connect High-Vacuum Pumping Line to Vacuum Module**

o Skip if already connected

o Not connected, perform these steps:

F.3.1. Install/verify installed ISO reducer flange on inlet to Vacuum Module.

F.3.2. Install/verify installed 90-degree ISO-100 elbow.

F.3.3. Position high-vacuum pumping line such that it is well supported and strain relieved between Dewar and Vacuum Module.

F.3.4. Install high-vacuum pumping line to inlet of elbow.

F.4. **Connect SV-14 operator to SMD Pump Out Port at SV-14**

o Already connected, skip this section.

o Not connected, perform these steps:

F.4.1. Remove closure cap from SMD Pump Out (PO) port .

F.4.2. Remove o-ring from groove in flange on PO and clean groove with alcohol.

F.4.3. Inspect the o-ring and lightly grease with Braycote Micronic 601; install o-ring in groove.

F.4.4. Inspect SV-14 operator shaft and wipe with clean lint free cloth if necessary. Grease the shaft with Braycote Micronic 601 grease.

F.4.5. Clean operator's dewar interface flange with alcohol.

F.4.6. Clean operator's vacuum line interface flange with alcohol.

F.4.7. Withdraw operator handle and install handle-withdrawn restrainer.

F.4.8. Carefully thread operator in place on valve SV-14. Hand tighten so that the output flange is lined up with the flex hose at the end of the high-vacuum pumping line.

F.5. **Connect High-Vacuum Pumping Line to Dewar**

o Already connected, skip this section.

o Not connected, perform these steps:

F.5.1. Clean the flex hose flange at the end of the high-vacuum pumping line with alcohol.

F.5.2. Ensure centering ring used to connect high-vacuum pumping line with operator is clean.

F.5.3. Connect high-vacuum pumping line to operator. Strain relieve line so it does not place undue pressure on connection at operator.

CAUTION
In the following step the operator's shaft is engaged into SV-14 plug. Use extreme caution in performing this step. Engage the shaft only. Do not open the high-vacuum valve as it would result in a sudden pressurization of the dewar's insulation space.

F.5.4. Remove handle-withdrawn restrainer.

F.5.5. Carefully engage SV-14 plug with the operator by screwing the handle into the plug clockwise until a very light resistance is felt indicating that the fully engaged handle is bottomed. After bottoming back off the handle 1/8 turn counter clockwise.

F.5.6. Install operator's closed position restrainer over handle.

F.6. **Evacuate Pumping Line up to Closed Valve SV-14.**

o Already pumping up to closed SV-14, skip this section.

o Not evacuated, perform these steps:

F.6.1. Begin recording data in Table 1.

F.6.2. Establish Initial Configuration of SMD and GSE

1. Ensure turbo molecular pump (VP-1) is off.
2. Ensure VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7 and VV-10 are closed.
3. Verify on/turn on the rotary vane pump (VP-2 light on) and record pressure VG-2: ______ torr.
4. Turn Vacuum Module over-ride switch to **on** position (switch in up position).
5. Equilibrate pressures across VV-1 by opening valves VV-6 and VV-3 and record:

   a. VG-3 pressure ________ torr

   b. VG-5 pressure ________ torr

   Note: If pump module contained helium gas from last operations, these convectron gauges may be off scale.

F.6.3. Close VV-3 and VV-6.

F.6.4. Release the brakes on the vacuum module and ensure that the wheels will allow the module to move (up to 12 inches) during the compression of the pumping line during evacuation.

F.6.5. Open VV-4 (lighted switch) and pump up to closed valves VV-1 and VV-3 until pressures at VG-2 and VG-5 $\leq$ 50 mtorr.

F.6.6. Record pressures:

1. VG-2 pressure ________ torr
2. VG-5 pressure ________ torr

F.6.7. Open valve VV-6 (switch up) and slowly open valve VV-3 and evacuate the high-vacuum pumping line.

Note: Control the evacuation rate at < 100 torr/min by throttling through valve VV-3.

F.6.8. When the pressure at VG-2 reaches 1 torr, perform the following:

1. Record Time of day:_______
2. Record VG-2 pressure:_______ torr
3. Record VG-3 pressure:_______ torr
4. Close valves VV-6 and VV-3.
5. Open VV-1 (switch up).
6. Turn on Turbo pump.

F.6.9. Turn on the ionization gauge VG-1 when the pressure at VG-5 is < 1.0 x 10-3 torr.

F.6.10. Continue the evacuation of the high-vacuum pumping line up to closed valve SV-14 until the pressure at VG-1 is < 5.0 x 10-6 torr then record:

1. Time of day:_______
2. VG-1 pressure:________ torr

F.7. Leak Test High-Vacuum System up to Closed Valve SV-14

- o Pressure VG-3, as recorded in G.2.9-5, is ≤ 10 torr skip this section.
- o Already pumping with turbo up to closed SV-14, skip this section
- o Otherwise, perform these steps:

F.7.1. Calibrate the leak detector

1. Standard leak value ___________sccs He
2. Leak detector reading __________sccs He

F.7.2. Connect the leak detector to the leak check access port of the vacuum module.

F.7.3. Leak test the system up to closed valve VV-7.

F.7.4. Turn the leak detector's vent disable switch to the disabled position.

F.7.5. Slowly open leak detector access valve VV-7. Monitor the system pressure as read on gauge VG-1 as this valve is opened.

F.7.6. While monitoring VG-1 to ensure it does not rise above 1 x 10-5 torr, close valve VV-4.

F.7.7. Leak test the high-vacuum pumping line and connections from the vacuum module to the connections at SMD Pump Out port.

F.7.8. Record Leak detector readings:

1. Initial background:___________sccs He
2. Final reading:___________sccs He

F.7.9. Verify no leaks > 1.0 x 10-8 sccs are present.

F.7.10. Open valve VV-4 and close valve VV-7.

F.7.11. Turn off the ionization gauge (VG-1).

F.7.12. Close gate valve VV-1.

F.7.13. Turn the leak detector's vent disable switch to the off position.

F.7.14. While monitoring the pressure at gauge VG-2 to ensure that valve VV-7 is closed, vent the leak detector to air.

Record pressure VG-2 _______ torr

F.7.15. Disconnect the leak detector from the vacuum module's leak check access port.

F.7.16. Install a KF cap on the leak check access port.

F.7.17. Ensure Vacuum Module over-ride switch in off position (switch down).

F.8. **Place System in Final Configuration**

Establish ***one*** of following configurations as recorded in paragraph G.2.10.

- ***Final Configuration 1 –*** Pumping line connected at both ends and pumped out.

F.8.1. Turn off Turbo pump as follows:

1. Verify that Vacuum Module override switch is **off**.
2. Power off Turbo pump and ensure VV-4 closes.
3. Open manual valve VV-5 slowly to decelerate Turbo pump.
4. When Turbo deceleration is complete, close VV-5.
5. Briefly switch Vacuum Module override to **on** and verify that VV-4 opens by observing a decrease in pressure at VG-5.

F.8.2. Close/verify closed VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7 and VV-10.

F.8.3. Ensure Vacuum Module override switch is off.

F.8.4. (Option) Shut down pump VP-2.

F.8.5. Input comment to DAS "End connect and pump out of SMD high-vacuum pumping line – Vacuum Module shut down."

- ***Final Configuration 2 –*** Actively pumping up to closed SV-14.

F.8.6. Open VV-1 to resume pumping up to closed SV-14.

F.8.7. Turn on ionization gauge and record pressure at VG-1.

1. VG-1 pressure _________ torr
2. Date / Time ____________

F.8.8. Turn Vacuum Module over-ride switch to off position.

F.8.9. Place Turbo in Standby Mode (Standby light is on).

F.8.10. Input comment to DAS "End connect of Vacuum Module – pumping up to closed SV-14."

- ***Final Configuration 3 –*** Actively pumping on SMD vacuum.

F.8.11. Verify already pumping up to closed SV-14 as follows:

1. Verify VP-1 and VP-2 on.
2. Open VV-1 to resume pumping up to closed SV-14.
3. Verify on/turn on ionization gauge (VG-1).
4. Verify pressure in high-vacuum pumping line < 5×10^{-6} torr.

   Record VG-1 ________ torr.

F.8.12. Input comment to DAS "Begin pumping on SMD with Vacuum Module".

Note: Refer to DAS instructions for keyboard/mouse operation.

F.8.13. Record pressure in SMD vacuum space:

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 5 min.

F.8.14. Record pressure in high vacuum pumping line (VG-1) ________ torr

F.8.15. Remove the operator's closed position handle lock.

CAUTION
Do not proceed until VG-1 pressure is < 5.0 x 10-6 torr

CAUTION
In the following operation do not turn the handle as it is pulled out. A turning motion could result in a disengagement of the plug. The plug would then be floating free in the body of the operator and prove very difficult to retrieve.

F.8.16. Open SV-14 by gently pulling out the valve plug with the operator handle.

F.8.17. Record the following just as the valve is opened:

1. Time of day:________
2. Vac-ion pump (IP)________ torr
3. VG-1 pressure:________ torr

F.8.18. Install the operator-withdrawn handle restrainer.

F.8.19. Wait fifteen minutes and record the following:

1. Time of day:________
2. Vac-ion pump (IP)________ torr
3. VG-1 pressure:________ torr

F.8.20. Ensure that the vacuum module's over-ride switch is in the off position.

F.8.21. Turn off Vac-ion pump and record time of day: __________.

F.8.22. Input comment to DAS "End connect of Vacuum Module – pumping on SMD Vacuum."

F.9. **Optional: Leak Check Dewar Seals**

F.9.1. Ensure VV-7 closed

F.9.2. Reconnect leak detector to access port at VV-7

F.9.3. Start leak detector

F.9.4. Ensure VG-1 < 1 *E-4 torr

F.9.5. Ensure Vent Disable switch in on position

F.9.6. Record Initial background :________sccs

F.9.7. Open VV-7 and close VV-4

F.9.8. Record background:___________sccs

F.9.9. Flood each of the seals listed below with helium for one minute and verify that no response is observed on the 10^{-7} sccs range. If a response is seen, a bag leak check of sufficient duration to reach steady state value should be performed to verify that the total leak does not exceed 5 x 10^{-6} sccs. Record below:

Location	Date/time	Background (sccs)	Leak after 1 min. (sccs)	Saturation leak (optional)
BD5B*				
BD7B*				
BD7A*				
BD5A*				
Ion Pump				
Main tank bayonet				
Guard tank bayonet				
+Y ARP post				
-Y ARP post				

*Note: The “A” units are on the right side of the +X axis (in the +Y direction). The Main Tank burst disks (BD7A/B) are adjacent to the +X axis.

F.9.10. Open VV-4 and close VV-7

F.9.11. Remove leak detector and cap port at VV-7

F.10. **Establish Final Alarm Configuration**

F.10.1. Set DAS data cycle interval to 15 minutes.

F.10.2. Ensure DAS alarm enabled and record set points if changed

- o Thermal conditions substantially unchanged, alarm set points for Station 200 and lead bag unchanged

- o Thermal conditions substantially changed, temperature alarm points reset as follows:

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

F.10.3. Ensure liquid level sensor alarms enabled, as appropriate, and record set points if changed.

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

F.10.4. Ensure Guard Tank pressure on DAS alarm list and set to alarm at 0.3 torr differential.

F.10.5. Ensure DAS watchdog timer and alarm enabled.

F.10.6. (Option) Continue data recording in Table 1 until such time as SV-14 is closed.

F.10.7. Verify completion of post operations checklist

Completed by:______________________

Witnessed by:______________________

Date: __________

Time:__________

Quality Manager____Date_________________

Payload Test Director____________________________________Date_________________

Table 1 SMD Vacuum Shell Re-pump Data

Date Time	VG-2	VG-1	Vac-ion Pump	GT Temp. CN [24]		Comment
	torr	torr	torr	K		-

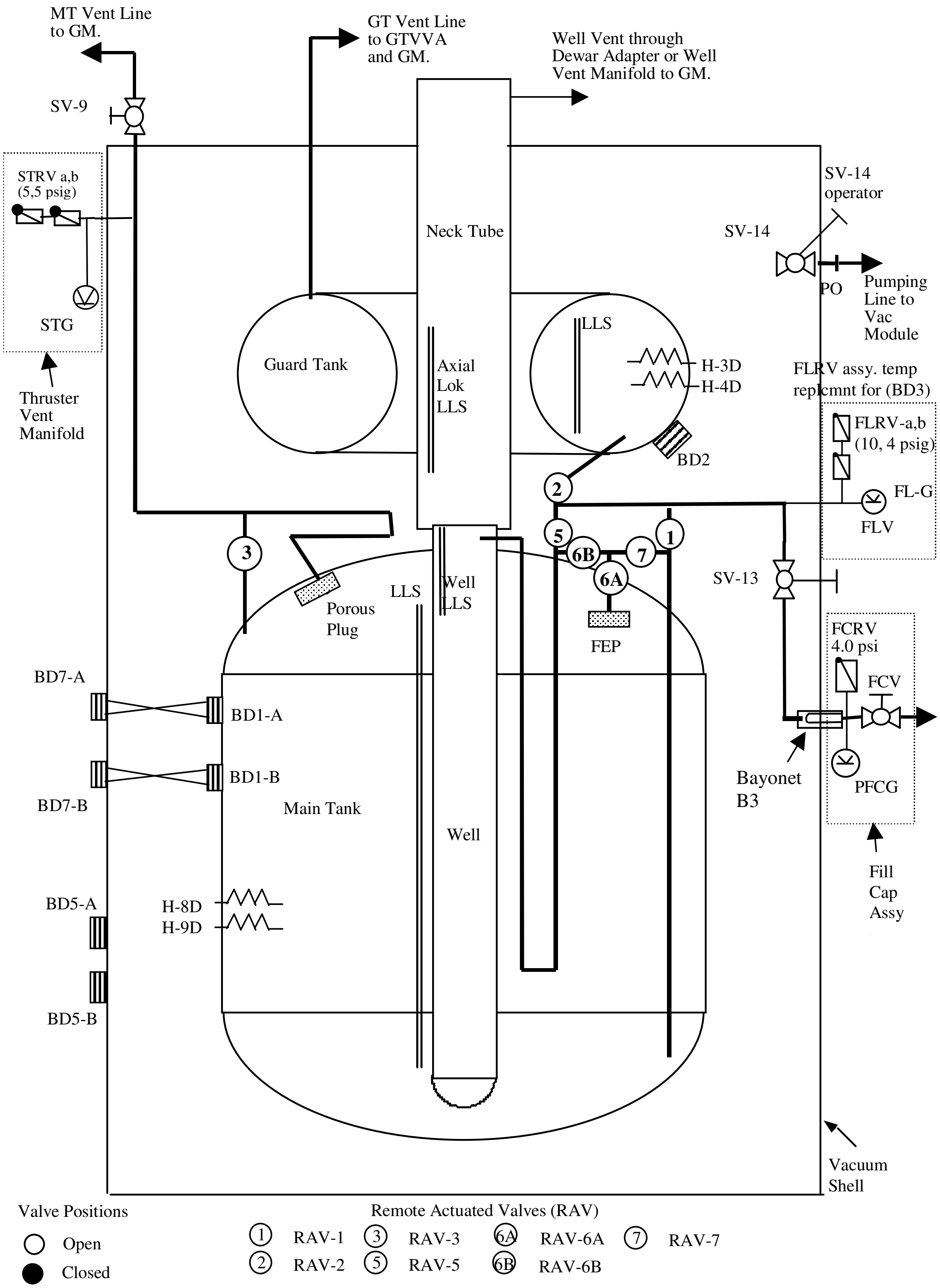
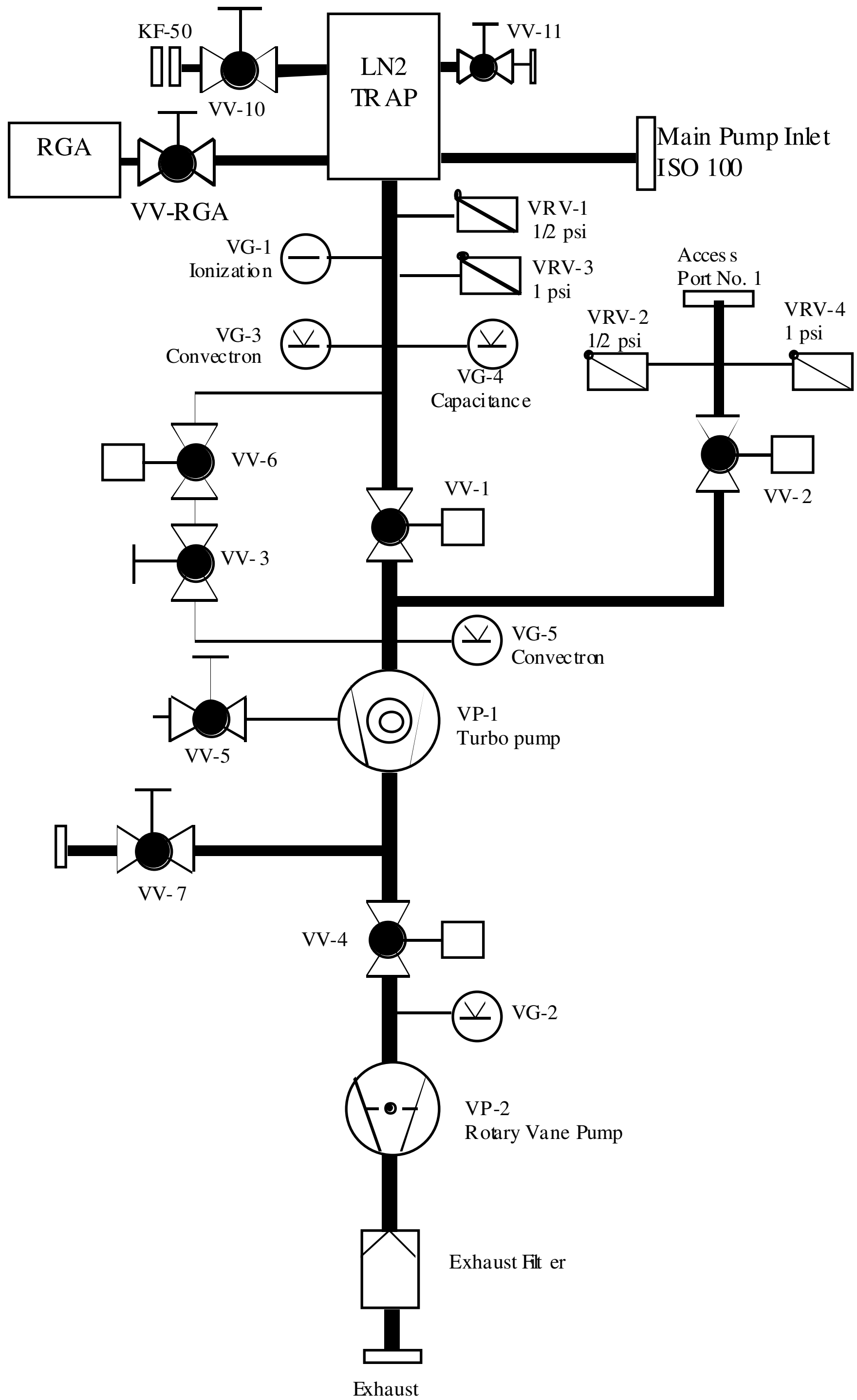


Figure 1. Schematic of Science Mission Dewar plumbing.


KF-50
VV-10
LN2
TRAP
VV-11
RGA
VV-RGA
Main Pump Inlet
ISO 100
VRV-1
1/2 psi
VG-1
Ionization
VRV-3
1 psi
Access
Port No. 1
VRV-2
1/2 psi
VRV-4
1 psi
VG-3
Convectron
VG-4
Capacitance
VV-6
VV-1
VV-2
VV-3
VG-5
Convectron
VP-1
Turbo pump
VV-5
VV-7
VV-4
VG-2
VP-2
Rotary Vane Pump
Exhaust Filter
Exhaust

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 is certified for the task being performed and knows their responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Perform a pretest Engineering and Safety high-bay walk down. Ensure all discrepancies are corrected prior to start of operations.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: ______________________		

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.		
	1. 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: ______________________		