GRAVITY PROBE B
PROCEDURE

Prepare Payload Ground Support Equipment for Transport

P0792a
ECO 1296
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Prepared by

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REVISION RECORD

REVISION	ECO	PAGES	DATE
A	1296	Added steps to pump out UTS before crating (Section G.6) Included minor updates.	8/10/01

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
EH-x	Vent line heat exchanger in Gas Module
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
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)
LHe	Liquid Helium
LHSD	Liquid Helium Supply Dewar
LHV-x	Liquid Helium Supply Dewar valves
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 document provides the necessary steps and lists to assure the GSE, and it's related tools and equipment are prepared for shipment.

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

There are no cryogenic operations in this procedure.

B.2.3. 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 to be dealt with in one of three ways.

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. Red-lines to procedures are included in this category.
2. If the discrepancy is minor, but affects procedure functionality, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and QA representative.
3. All critical and major discrepancies shall be documented in Discrepancy Reports.

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*
Mike Taber	Tom Welsh
Dave Murray	Chris Gray
Jim Maddocks	Bruce Clarke
Dave Frank	Ned Calder

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

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

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

No commercial test equipment is required for this operation.

E.3.2. Ground Support Equipment

The Ground Support Equipment includes the Gas Module, the Pump Module, the Electrical Module, the Vacuum Module and the Utility Pumping System (UTS). 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 data acquisition instrumentation and provides remote control of valves in the Gas Module, Pump Module, and SMD (see the *Electrical Module Manual* for details). The Vacuum Module contains a turbo pump, backed by a vane pump, and provides the capability to pump out the SMD vacuum shell. The UTS provides utility pumping capability using a turbo pump.

This procedure prepares the Gas Module, Pump Module , Vacuum Module, Electrical Module, and UTS (Figure 1) for transportation.

E.3.3. Additional Test Equipment

No additional test equipment is required.

E.3.4. Additional Hardware

Item	Description	Manufacturer	Model
1	Wooden crates	All Pak	Various
2	Wooden Covers	All PAk	Various

E.3.5. Tools

	Description
1	Phillips screw driver
2	Side cutting pliers

E.3.6. Expendables

Description	Quantity	Mfr./Part No.
Alcohol	AR	N/A
99.99% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Braycote Micronic 601
Tie wraps - large size	AR	N/A

E.4. **Instrument Pretest Requirements**

N/A

E.5. **Configuration Requirements**

E.5.1. Verify P0778 has been preformed.

E.5.2. Verify all cables have been properly marked.

E.6. **Optional Non-flight Configurations**

N/A

E.7. **Verification/Success Criteria**

N/A

E.8. **Payload Constraints and Restrictions**

N/A

E.9. **Configuration Requirements**

F. REFERENCE DOCUMENTS

F.1. Drawings

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

F.2. Supporting documentation

Document No.	*Title*
SU/GP-B P0108	*Quality Plan*

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0778	*Disconnect Electrical GSE from Payload*
SU/GP-B P0797	*Regulate Guard Tank Pressure*

Operation Number:_____
Date Initiated: _____
Time Initiated:_____

G. OPERATIONS

G.1. Verify Appropriate QA Notification

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify ONR representative notified.

  Record: Individual notified _____,

  Date/time _____/_____.

G.2. Prepare Gas Module(PN 5833813)

G.2.1. Verify that “Disconnect Electrical GSE from SMD” P0778 has been completed. Record Op. Number _____. and Date _____.

G.2.2. Verify Guard Tank pressurization transferred to Auxiliary Helium Pressurization Unit per P0797 Record Operation Number _____ and Date _____.

G.2.3. Verify all manual valves are closed.

G.2.4. Verify removed 4-foot, 4” Pump-Module pumping line, otherwise remove:

1. Remove line from Pump Outlet on GM and cap port.
2. Remove line from Pump Module inlet (under flooring).
3. Cap pumping line and stow in transport locker.

G.2.5. Verify removed “Pump Exhaust” hose and cap port with aluminum foil.

G.2.6. Verify removed helium vent line.

G.2.7. Verify removed line from “Vent Output” port on GM and cap port.

G.2.8. Remove other end of stainless line from plastic piping.

G.2.9. Cap both ends of line and stow in transport locker.

G.2.10. Verify removed/remove any pumping lines connected to Access port 1, Access port 3, and the Well vent port.

G.2.11. Remove/verify removed both Main and Guard Tank vent lines from GM.

G.2.12. Verify all plumbing is capped.

G.2.13. Verify 2 ea Circuit Breakers marked “ Main C/B 30 amp” and “ Pump C/B 15amps” are powered down.

G.2.14. Verify all electrical connections are removed or stowed onboard GM: WD-23, WD-24, PW-2, GM Genius Block, Power cable208Vac, and 3ph 30A.

G.2.15. Verify removed gaseous helium supply line from “Helium gas inlet”.

G.2.16. Verify removed gas line from “ Purge and Valve Activation Gas Inlet”

G.2.17. Install all panels on GM. Verify all screws are tight on panels that were previously installed.

G.2.18. Install shipping panels with straps. Ratchet mechanisms should be on top.

G.3. **Prepare Vacuum Module (PN 5833816)**

G.3.1. Verify unit is powered down and 30amp Main power breaker is off.

G.3.2. Disconnect power from wall and stow cable on unit.

G.3.3. Verify all manual valves are closed.

G.3.4. Remove any external plumbing and stow in transport locker.

G.3.5. Verify all vacuum ports are capped.

G.3.6. Remove Nitrogen Pressurization Supply line.

G.3.7. Close/verify closed water in/out valves.

G.3.8. Remove/verify removed water supply lines.

G.3.9. Remove/verify removed pump exhaust line.

G.3.10. Ensure all data connections removed.

G.3.11. Install all panels and verify existing panels are screwed securely to vacuum module.

G.3.12. Install shipping panels and attach with straps ensuring ratchets remain on top of unit.

G.4. **Prepare Electrical Module (PN 5833812)**

G.4.1. Verify Vacuum Module has been pumped out per procedure P0778. Record Operation Number _____ and Date _____.

G.4.2. Verify all units in EM are powered down.

G.4.3. Verify 30 amp breaker on side panel is off.

G.4.4. Disconnect power cable from receptacle and stow cable to transport locker.

G.4.5. While verifying all cables are properly marked remove and stow cables. Refer to Cable Table 1.

G.4.6. Remove Endevco read-out box to transport locker.

G.4.7. Check all units inside of EM for security during transport.

G.4.8. Check all cabling inside EM for stress relief during transport.

G.4.9. Secure all panels and doors.

G.4.10. Install packing covers and attach using straps ensuring ratchets are located on top of EM.

G.5. **Prepare Data Acquisition System (PN 5833812)**

G.5.1. Verify all units are powered down.

G.5.2. Verify breaker at top of unit is off.

G.5.3. Unplug both 110Vac lines and stow.

G.5.4. Verify all units are mounted securely into DAS.

G.5.5. Verify all cabling is marked and remove or stow in DAS. Refer to Cable Table 1.

G.5.6. Disconnect UPS from DAS and stow for shipment.

G.5.7. Close/verify back door closed securely

G.5.8. Pack DAS into it's transport container and secure door.

G.6. **Prepare Utility Turbo Pump System**

G.6.1. Verify UTS pumps are shut down and the two circuit breakers on the front panel are off.

G.6.2. Verify TV-3, TV-4, TV-5, TV-6, and RGA-V closed.

G.6.3. Verify TV-1 and TV-2 are closed (Gate valve and foreline valve)

G.6.4. Verify pumping ports are capped:

1. Primary pumping port (TV-1).
2. Leak Detector port (at TV-3).

G.6.5. Turn on roughing pump TV-2.

G.6.6. Place interlock switch in "override" position.

G.6.7. Push the reset button to activate the override circuit.

G.6.8. Open TV-2.

G.6.9. Open TV-1.

G.6.10. Pump for approximately ½ hour until pressure at TG-2 < 25 mtorr.

G.6.11. Close TV-2.

G.6.12. Monitor TG-2 for ½ hour to verify the pressure does not rise above 1 torr. (If pressure does rise above 1 torr, check to be sure all manual valves are fully closed and all pumping port caps are properly installed, then repeat steps G.6.8 through G.6.12.)

G.6.13. Close TV-1.

G.6.14. Turn off roughing pump.

G.6.15. Turn off both circuit breakers on front panel.

G.6.16. Disconnect power cord and stow in bottom of cart.

G.6.17. Remove RGA electronics from RGA sensor and stow in transport container. Verify RGA power supply is stowed with electronics.

G.6.18. Verify all units are secured to pump cart.

G.6.19. Release pressure from compressor tank and close valve.

G.6.20. Install UTS into transport container and secure door.

G.7. **Prepare Leak Detector (2ea Varian units)**

G.7.1. Verify LD is turned off and all 4 circuit breakers are off.

G.7.2. Disconnect power cord and securely stow on back of unit.

G.7.3. Verify pumping port plug is installed and secure.

G.7.4. Verify cold trap installed.

G.7.5. Verify calibration date on Standard leak: _____ . The calibration date must exceed the duration of the deployment.

G.7.6. Install LD in it's shipping container and secure door.

G.8. **Prepare Pump Module (Option: Vandenberg AFB only)**

G.8.1. Verify unit's pumps are powered down and both 60amp and 20 amp breakers are off.

G.8.2. Disconnect power from wall and stow cables on unit.

G.8.3. Verify all manual valves are closed.

G.8.4. Remove any external plumbing and stow in transport locker.

G.8.5. Verify all vacuum ports are capped.

G.8.6. Remove Nitrogen Pressurization Supply line.

G.8.7. Close/verify closed water in/out valves.

G.8.8. Remove/verify removed water supply lines.

G.8.9. Install all panels and verify existing panels are screwed securely to vacuum module.

G.8.10. Install shipping panels and attach with straps ensuring ratchets remain on top of unit.

G.9. **List of Support Equipment to be Packed.**

Verify all equipment is accounted for and stowed in transport containers.

Name	Part Number	Qty
Leak detector adapter	KF-25	1ea
Leak detector adapter	KF-40	1ea
Helium Probe	0981-K0167-301	1ea
Helium Probe extension		1ea
¼ " nylon hose	50'	3ea
Vacuum pump exhaust hose	20'	4ea
Helium exhaust hose	80' and 20'	1ea
RGA electronics/power supply	TSP TH100/911-038-P1	1ea
Stinger	5833803-101	2ea
Endevco read out	Model 136	2ea
Main Tank Vent line (long)	5833805-101	2ea
Main tank Vent line (short)	5833805-102	1ea
Guard Tank Vent line (long)	5833805-101	2ea
Liquid Helium Transfer line	5833804-101	2ea
Liquid Helium Transfer elbow	5833827-101	1ea
Vacuum Shell Pump line 10'	5833808-101	1ea
4" ISO elbow	5833808-76-1610	1ea
4" to 6" adapter	5833808-76-2510	1ea
Nitrogen supply line		2ea
Nitrogen manifold		1ea
Helium manifold		1ea
Fill Line Vacuum Hose		2ea
KF-40 Hoses	Various	
KF-25 Hoses	Various	
GT Regulator		1

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Cable Table 1.

Cable No.	Dewar/Probe Connection	Connection No	GSE Connection	Connection No.	Ft.	Comments
W-D1	Dewar P800	P1	DAS	J1/JB1	60	TM&A/Cryo-Ops/Test/Accelerometer
W-D2	Dewar P801	P2	DAS	J2/JB2	60	TM&A/Cryo-Ops/Test
W-D3	Dewar P802	P3	DAS	J3/JB3	60	Cryo-Ops/Test
W-D4	Dewar P803	P4	EM	J4/JE4	60	Cryo-Ops/Test
W-D5	Dewar P804	P5	EM	J5/JE5	60	Cryo-Ops/Test
Heater	Dewar Tophat	Tophat Htr	Htr Control	Htr1	10	Cryo-Ops
GT	GTV-VA	GTVV 1	Endevco	End 1	30	TM&A/Cryo-Ops/Test
TV	Thruster Vent	TV 1	Endevco	End 2	30	TM&A/Cryo-Ops/Test
ION	Ion Pump	IP 1	EM Minivac	MV 1	25	Cryo-Ops
W-D24	GM	TS-24	EM	J24/JE24	50	Cryo-Ops
W-D23	GM	TS-23	EM	J23	50	Cryo-Ops
W-D20	DAS	P20	EM	J20	20	Cryo-Ops/Test
W-D21	DAS	P21	EM	J21/JE21	20	Cryo-Ops/Test
W-D22	DAS	P22/JB22	EM	J22/JE22	20	Cryo-Ops/Test
Printer	DAS	Comp/Zip	Printer	Parallel	10	Cryo-Ops/Test
Plotter	DAS	HP3497A	Plotter	Parallel	20	Cryo-Ops/Test
IEEE	DAS	Computer	EM	H08D	20	Cryo-Ops/Test

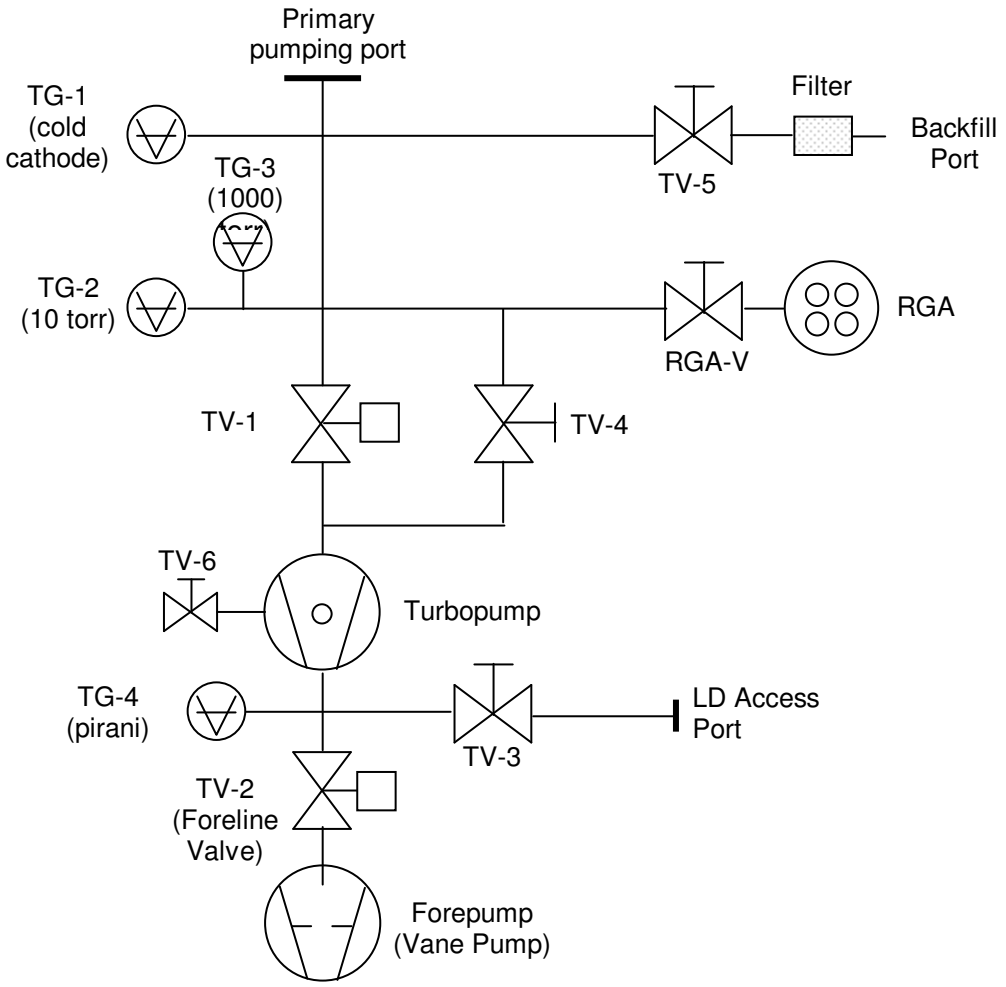

Figure 1. Schematic diagram of Utility Pumping System (UTS)