GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Reduce Liquid Level in Main Tank- Liquid at NBP

To be performed at Vandenberg Air Force Base building 1610

This document contains non-hazardous operations

P1033
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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
ATC	Advanced Technology Center
Aux	Auxiliary
AV-x	Valve x of Gas Module auxiliary section
Bot	Bottom
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
Liq	Liquid
LL	Liquid level
LLS	Liquid level sensor
LMMS	Lockheed Martin Missiles and Space
LMSC	Lockheed Missiles and Space 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

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

This procedure describes the steps necessary to reduce the NBP liquid helium level in the Main Tank of the Science Mission Dewar. The steps include:

Turn on Main Tank heater

Reduce liquid level

Turn off Main Tank heater

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, and the Missile System Prelaunch Safety Package, LM/P479945 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 outside 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 to building 1605 and contact NASA 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 with goggles/glasses are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

All 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 or illness requiring emergency medical treatment **DIAL 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 Space Wing 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

The following personnel are essential to the accomplishment of this procedure:

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

When working on the space vehicle, proper ESD protection is required. Prior to use all ESD wrist straps will be checked using a calibrated checker.

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 Electrical 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.

E.3.3. Computers and Software:

The Data Acquisition System (DAS) is 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: NA

E.3.5. Additional Hardware: NA

E.3.6. Tools: NA

E.3.7. Disposal of hazardous waste (if any) will be into approved waste containers.

E.3.8. Expendables

Warning alcohol is a skin irritant, potentially toxic if skin absorbed, and flammable. All hazardous waste will be placed into approved waste containers.

Description	***Quantity***	***Mfr./Part No.***
Alcohol	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*	*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	-
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-09920	No	-

No.	*Location*	*Description* c) Temperature set point controller	*Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
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 must be at its normal boiling point (NBP)

E.5.2. Guard Tank
The Guard Tank may contain liquid or be depleted.

E.5.3. Well
The Well must be evacuated.

E.5.4. SMD Vacuum Shell
The Vacuum Shell pressure must be less than 5x 10-5 torr. Document No. P1015, *Connect Vacuum Module to SMD*, contains the procedure for connecting to and pumping on the SMD vacuum shell.

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 40 and CN 41) at $T \leq 6.0$ K.

    b. Relative Guard Tank Pressure (CN 46) set at $P \geq 0.3$ torr.

E.5.6. GSE and Non-flight Hardware

1. The ion-pump magnet is installed.
2. The Fill Cap Assembly must be installed at SV-13 (See Figure 3)
3. Dewar Adapter heaters on SMD must be installed and operational.

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 SMV may be installed in its transportation and test fixture.

2. The Vacuum shell pump out port at SV-14 may be connected to the Vacuum Module (P/N 5833816) via a 2-in valve and 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-6, 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
LM/P479945	Missile System Prelaunch Safety Package
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	Eastern and Western Range Safety Requirements
KHB 1710.2 rev E	Kennedy Space Center Safety Practices Handbook

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P1015	Connect Vacuum Module to SMD
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities

Operation Number:_____

Time Initiated:_____

Date Initiated:_____

G. OPERATIONS

G.1. Pre Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

  _____

  Date/Time:_____,

- Record calibration due dates in Table 1 (Sections. E.3.4, E.4)
- 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
- Verify availability and functioning of an emergency shower.

QA Witness:_____

G.2. Verify Purity of All Sources of Helium Supply

G.2.1. Record serial number on helium bottle/s.

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

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

QA Witness:_____

G.3. Verify Configuration Requirements

G.3.1. Verify Dewar Top Plate heaters are operational.

G.3.2. Verify Main Tank Vent Bayonet heaters are operational.

G.3.3. Verify ion-pump magnet installed.

G.3.4. Verify Vacuum Shell Pressure < 5 x 10^{-5} torr.

1. Turn on Vac-ion pump and record time of day _____
2. Use DAS [Monitor Data] for CN 99.
3. When value is steady, record pressure (IP) _____ torr. If pressure is above 5x10^{-5} torr, turn off Vac-ion pump and perform procedure P1015 to connect Vacuum Module and pump out SMD vacuum shell.
4. Exit [Monitor Data] and collect data with [Set Data Interval] to 5 min.
5. When data cycle is complete, turn off Vac-ion pump.

G.3.5. Verify DAS alarm system enabled and record set points.

1. ***Top of lead bag temperature*** – verify CN [40] 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 [41] 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 ≥ 0.3 torr.
   Record set point. _____torr

G.3.6. Verify liquid-level alarms enabled 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 there is liquid in the Guard Tank.
   Record set point. _____ %

G.3.7. Verify Main Tank vent line connected to Gas Module. If not perform procedure P1006, *Connect Main Tank Vent Line to Gas Module – Main Tank at NBP*, to connect Main Tank vent.

G.3.8. Record liquid helium levels:

1. ***Main Tank*** _____%
2. ***Guard Tank*** – If liquid in GT, verify level ≥ 15%. If necessary, perform procedure P1029, *Internal Main Tank to Guard Tank Transfer*, to raise level or regulate Guard Tank pressure per procedure P1014. _____%

   Record Opt #:_____

QA Witness:_____

G.4. **Establish GSE Valve Configuration and Record Pressures**

G.4.1. Set GSE valves as indicated in following Table. Record configuration in left-hand column, then place or ensure corresponding valve states as indicated.

Configure Initial Valve States		
	Open	***Close***
1. Main Tank vent	EV-9	EV-17
2. Guard Tank vent		
o With liquid – place in common manifold mode:	EV-16, EV-13, GTV-V	EV-20, EV-23
o Depleted and pressure regulated at EV-23	EV-16, EV-23, GTV-V	EV-13, EV-20
o Depleted and pressure regulated at GTV-Va	GTV-Va	EV-13, EV-16, EV-20, EV-23, GTV-V
3. Remaining EV valves	EV-7a/b	EV-4, EV-21/22, EV-14, EV-5, EV-8, EV-12, EV-10, EV-6, EV-18
4. AV valves		All

G.4.2. If Guard Tank depleted:

1. Verify source of 99.999% pure helium gas available at APR-2.
2. Verify Guard Tank Properly pressurized
   - o Guard Tank Vent Line Connected
     a. Ensure EV-23 open and APR-2 set to 2 psig
   - o Guard Tank Vent Line Disconnected
     b. Verify EV-23 closed
     c. Verify GTV-Va open
     d. Verify line connected between GTV-Va and APR-2V
     e. Verify APR-2V open and APR-2 set to 2psig

QA Witness:_____

G.5. **Establish Initial Condition of SMD**

G.5.1. Using the RAV log book verify that the dewar's internal valves are in the following positions. If not, investigate to ensure previous RAV operations properly recorded. If necessary, note resolution in D-log.

1. ***Open***: RAV-3, and RAV-6B.
2. ***Closed***: RAV-1, RAV-2, RAV-5, RAV-6A, and RAV-7.

G.5.2. Verify that SMD external valves are in the following positions.

1. ***Open***: SV-9.
2. ***Closed***: SV-13, STV and FCV.

G.5.3. Record appropriate Guard Tank pressure:

1. GT with liquid (EG-1a): _____ torr,
2. GT depleted (GTV-G) _____ torr (relative to atm).

G.5.4. Record Main Tank pressure (EG-3) _____ torr.

QA Witness:_____

G.6. **Set Up Data Acquisition**

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

G.6.1. Set the main Tank liquid level sampling interval to 1 minute.

G.6.2. Input comment to DAS “Start reduction of Main Tank liquid level”.

QA Witness:_____

G.7. **Reduce Main Tank Liquid Level**

G.7.1. Ensure Main Tank Vent from Gas Module directed out of facility

G.7.2. Specify desired final helium level in Main Tank: _____%

Note:

Heaters H09D and H08D are designed for 1.3 A and 52 VDC (40 ohms) per the SMD CDR [Ref. 4]. Heater power supplies should be operated in the voltage limited mode.

The set points for H09D of 50 VDC and 1.3 A results in 62.5 W of heat being deposited in the Main Tank, with the power supply in the voltage limited mode. At 4.2 K (latent heat = 20.6 J/g, density = .125 g/cc) use this requires 27.5 hrs to boil off the entire 2400 liters of Helium, or 2.75 hours to reduce the liquid level by 10%.

The boiloff rate should be limited to approximately 100 liters per hour to avoid exceeding the vent-line heat exchanger capacity. This is equivalent to approximately 70 W of total power from both heaters combined. The set points for H08D are chosen to maintain a combined heater power < 70 W.

G.7.3. Turn on Main Tank Heater H09D:

1. Set power supply current limit to 1.3 amp.
2. Set voltage of heater H09D to 50 Vdc and record:
   a. Time of Day: _____

b. V: _____ Vdc and I: _____ a

G.7.4. Turn on Main Tank vent-line heat exchanger in Gas Module.

G.7.5. Open EV-6 and EV-18 to reduce back pressure on Main Tank.

G.7.6. **(Option)** Turn on Main Tank Heater H08D

1. Set power supply current limit to 0.5 amp.
2. Set voltage of heater H08D to ≤ 14 Vdc and record:
   a. Time of Day: _____
   b. V: _____ Vdc and I: _____ A

G.7.7. Record data in attached Data Sheet every 10 minutes.

CAUTION
Monitor and maintain positive Guard Tank pressure. If the Guard Tank pressure drops below atmospheric perform the following option (G.7.7). Failure to comply may result in equipment damage

G.7.8. **(Option)** Add heat to Guard Tank to maintain positive pressure:

1. Close/verify closed EV-13.
2. Turn on power supply for Guard-Tank heater (H-3D or H-4D)
3. Set power supply current limit to 0.07 amps.
4. Set voltage limit to 50 VDC and record:
   V _____Vdc and I _____A.
5. Adjust heater voltage as necessary to maintain Guard Tank pressure (GTV-G). in the range 15 torr < ΔP < 30 torr.
6. Monitor and maintain positive Guard Tank pressure throughout the pump-down. Record data on attached data sheets.

G.7.9. When Main Tank liquid level sensor reads desired level record:

1. Time of day:_____
2. Main Tank bottom temperature CN [09] _____ K
3. Lead Bag CN[28] _____ K

G.7.10. C
lose EV-6 and EV-18

G.7.11. T
urn off power supply to Main Tank heater(s).

G.7.12. T
urn off power supply to Guard Tank heater(s).

G.7.13. T
urn off Main Tank vent-line heat exchanger (EH-1).

QA Witness:_____

G.8. **Establish Final Configuration**

G.8.1. Input comment to DAS “End of Main Tank liquid level reduction”.

G.8.2. Set the DAS data cycle to 15 minutes.

G.8.3. Ensure that power to Vac-Ion pump is off.

G.8.4. Ensure that Main Tank vent-line heat exchanger (EH-1) is off.

G.8.5. Ensure Main Tank heaters are powered off (H-8D and H-9D).

G.8.6. Ensure Guard Tank heaters are powered off (H-3D, H-4D)

G.8.7. Verify GSE valves set as indicated in following Table. Record configuration in left-hand column, then ensure corresponding valve states are as indicated.

Configure Final Valve States		
	Open	***Close***
Main Tank vent	EV-9	EV-17
Guard Tank vent		
o With liquid – place in common manifold mode:	EV-16, EV-13, GTV-V	EV-20, EV-23
o Depleted and pressure regulated at EV-23	EV-16, EV-23, GTV-V	EV-13, EV-20
o Depleted and pressure regulated at GTV-Va	GTV-Va	EV-13, EV-16, EV-20, EV-23, GTV-V
Remaining EV valves	EV-7a/b	EV-4, EV-21/22, EV-14, EV-5, EV-8, EV-12, EV-10, EV-6, EV-18
AV valves		All

G.8.8.

Ensure DAS alarm enabled and record set points if changed

- Thermal conditions substantially unchanged, alarm set points for the lead bag are unchanged and set to alarm.
- Thermal conditions substantially changed, temperature alarm points reset as follows:
  a. Top of Lead set Point bag CN [40] _____ K (≤ 6.0 K)
  b. Top of Lead Bag set point CN [41] _____ K (≤ 6.0 K)

G.8.9. Ensure liquid level sensor alarms enabled on Main Tank and Guard Tank and record set points if changed.

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

CAUTION
The Guard Tank may tend to subcool following the completion of this procedure. Establish continuous monitoring of the Guard Tank pressure by placing it on the DAS alarm list. Maintain positive pressure in the Guard Tank by regulating pressure as necessary. Failure to comply may result in equipment damage.

G.8.10. E
nsure Guard Tank pressure on DAS alarm list and set to alarm at > 0.3 torr differential.

G.8.11. I
f Guard Tank liquid level <15%, verify Guard Tank properly pressurized

- Guard Tank Vent Line Connected
  a. Ensure EV-23 open and APR-2 set to 2 psig
- Guard Tank Vent Line Disconnected
  b. Verify EV-23 closed
  c. Verify GTV-Va open
  d. Verify line connected between GTV-Va and APR-2V
  e. Verify APR-2V open and APR-2 set to 2psig

G.8.12. C
Continue to monitor and record data on data sheet for 60 minutes to ensure that system stabilizes.

G.8.13. V
erify Completetion of Post Operations checklist

QA Witness:_____

H. **PROCEDURE SIGN OFF**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

Data Sheet 1

									SMD External Temp. Control		
Date Time	M.T. bottom T-9D [9] (K)	Lead bag top T-20D [28] (K)	HX-1 T-03D [5] (K)	G.T. bottom T-15D [24] (K)	M.T. Pressure EG-3 [114] (torr)	G.T. Pressure EG-1 [112] (torr)	Main Tank Liquid level LL-1D [101] (%)	Main Tank Flow rate PFM-1 [110] LL/hr	M.T. Vent Bayonet /O-ring (^{o}C/ ^{o}C)	Valve SV-9 /Top Plate (^{o}C/ ^{o}C)	SV-9 Knob/ Dewar Adapter (^{o}C/ ^{o}C)

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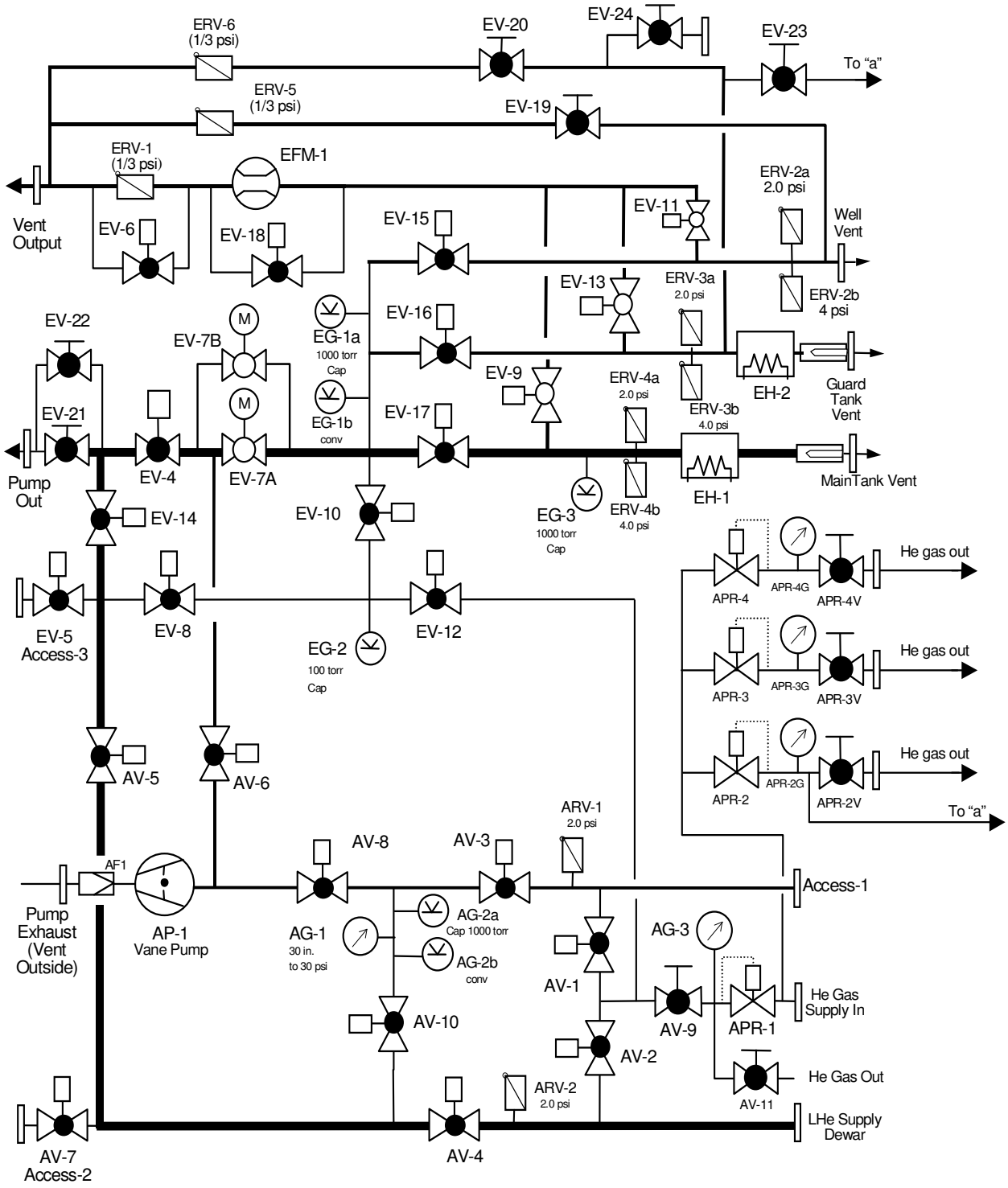
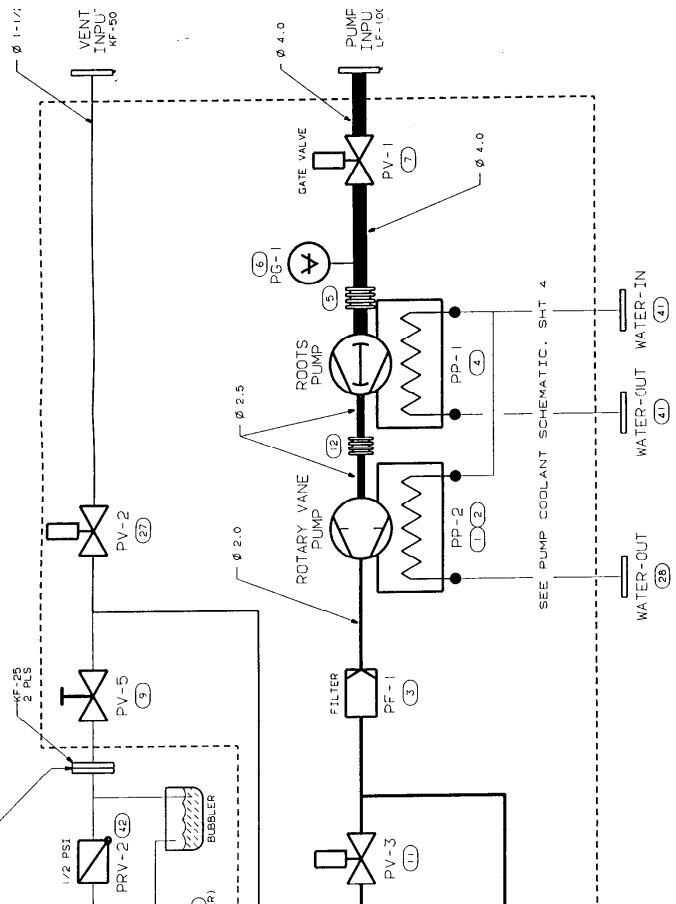

ERV-6
(1/3 psi)
EV-20
EV-24
EV-23
To "a"
ERV-5
(1/3 psi)
EV-19
ERV-1
(1/3 psi)
EFM-1
ERV-2a
2.0 psi
Vent
Output
EV-6
EV-18
EV-15
EV-11
Well
Vent
EV-13
ERV-3a
2.0 psi
ERV-2b
4 psi
EV-22
EV-7B
M
EG-1a
1000 torr
Cap
EV-16
EV-9
ERV-4a
2.0 psi
EH-2
Guard
Tank
Vent
EV-21
M
EG-1b
conv
EV-17
ERV-3b
4.0 psi
Pump
Out
EV-4
EV-7A
MainTank Vent
EH-1
EV-14
EV-10
EG-3
1000 torr
Cap
ERV-4b
4.0 psi
He gas out
APR-4
APR-4G
APR-4V
EV-5
Access-3
EV-8
EG-2
100 torr
Cap
EV-12
He gas out
APR-3
APR-3G
APR-3V
AV-5
AV-6
He gas out
APR-2
APR-2G
APR-2V
To "a"
ARV-1
2.0 psi
AV-8
AV-3
AF1
Access-1
Pump
Exhaust
(Vent
Outside)
AP-1
Vane Pump
AG-1
30 in.
to 30 psi
AG-2a
Cap 1000 torr
AG-2b
conv
AG-3
AV-1
AV-9
APR-1
He Gas
Supply In
AV-10
AV-2
He Gas Out
AV-11
ARV-2
2.0 psi
LHe Supply
Dewar
AV-7
Access-2
AV-4


VENT INPUT KF-50
PUMP INPUT
Ø 4.0
GATE VALVE
PV-1
7
Ø 4.0
6
PG-1
5
ROOTS PUMP
PP-1
4
Ø 2.5
12
ROTARY VANE PUMP
PP-2
2
Ø 2.0
SEE PUMP COOLANT SCHEMATIC, SHT 4
WATER-IN
41
WATER-OUT
41
WATER-OUT
28
PV-2
27
KF-25
2 PLS
PV-5
9
FILTER
PF-1
3
PV-3
11
BUBBLER
PRV-2
42

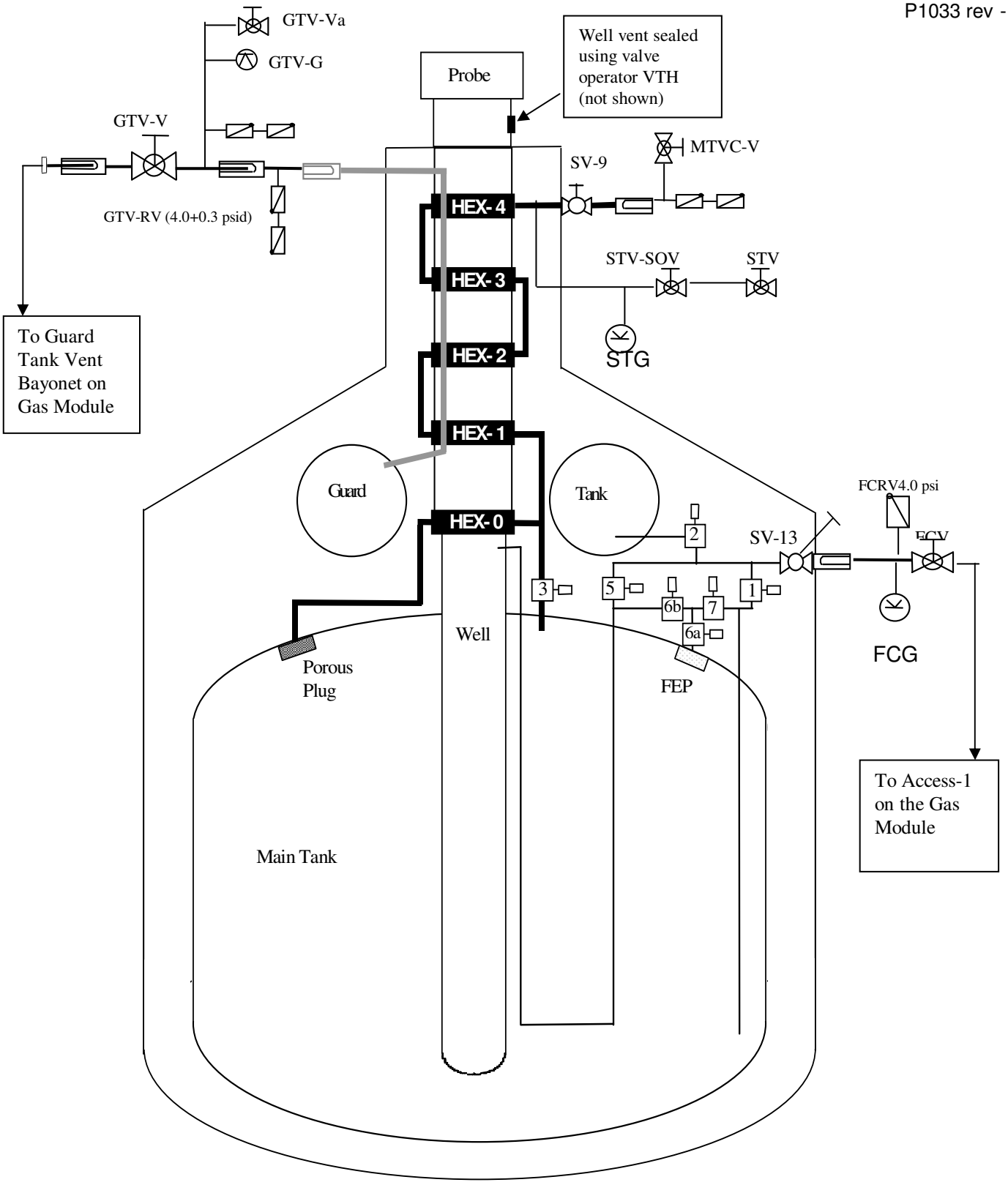


Figure 3 Schematic representation of SMD showing interfaces with Gas module.

I. 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. Verify/perform an 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: _____		

J. 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: _____		

K. APPENDIX 3– CONTINGENCY RESPONSES

	Condition	Circumstance	Response
1	Power Failure	If before section G.7 If after section G.7	Terminate Procedure Wait for power restoration
2	Burst disk rupture (MT/GT)	Any time	Evacuate room
3	Oxygen Monitor Alarm	Any time	Evacuate room