GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Prepare Payload for Mass/CG Measurements and Condition Payload During Spin Balance Test

THIS DOCUMENT CONTAINS THE USE OF HAZARDOUS MATERIALS

P0975 Rev. -

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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

A. SCOPE

This procedure describes the steps necessary to first prepare the Payload for mass and center of gravity measurements. In addition it outlines the steps necessary to prepare and condition the Payload for the spin balance test.

B. SAFETY

B.1. Potential Hazards

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

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

An oxygen deficiency monitor provided by Stanford University, that alarms when the oxygen level is reduced to 19.5% may be utilized. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent line deflectors are installed over the four burst disks on the SMD vacuum shell.

Only authorized and trained LM and SU personnel are allowed In the high-bay without escort. All personnel working at a height 30 inches or more off the floor are required to have an LM approved air tank within easy reach. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact LM safety.

The following 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 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 SMD or Probe shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury obtain medical treatment as follows
LM **Call 117**

B.3.2. Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229.

B.3.3. Contingency Response

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

C. QUALITY ASSURANCE

C.1. QA Notification

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

C.2. Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the 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 judgment 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 person in charge of the operation (Test Director or Test Engineer) is to sign the "completed by" sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the "Witnessed by" sign-off. ***The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 "GP-B Maintenance and Testing at all Facilities." Checklists will be used as directed by P0875.***

D.2. Personnel Qualifications

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

D.3. Qualified Personnel

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

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

Any person who comes in contact with the SV must use a grounding wrist strap that has been tested that day. Appropriate attachment points are positioned around the SV.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Commercial Test Equipment

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, 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 Gas Module and 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. Test Equipment

Description
Helium leak detector
Helium leak detector calibrated leak; Calibrated leak S/N#:_____ Cal. due date:

E.3.5. Additional Hardware

1. Main Tank Vent Cap Bracket.
2. Modified Guard Tank Vent Cap Assembly

E.3.6. Tools

Adjustable Torque Wrench 60-80 in-lbs.

E.3.7. Expendables

Description	***Quantity***	***Mfr./Part No.***
Isopropyl alcohol	AR	N/A
99.999% pure gaseous helium	AR	N/A
Vacuum Grease	AR	Apeizon N or Dow Corning High Vacuum Grease

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) Temperature set point controller	-	C-09920	No	-

No.	*Location*	*Description*	*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 will be at NBP. The liquid level will be adjusted as necessary during the spin balance test per test requirements. The level adjustments are addressed in this document.

E.5.2. Guard Tank

The Guard-Tank must be depleted.

E.5.3. Well

The Well is evacuated.

E.5.4. SMD Vacuum Shell

This procedure places no requirement on the vacuum shell pressure.

E.5.5. Alarm System

1. The DAS alarm system must be enabled and contain the following alarm set-points:
    a. Top of lead bag temperature (CN 40) set at $T \leq 6.0$ K.
    b. Top of lead bag temperature set (CN 41) at $T \leq 6.0$ K.
    c. Relative Guard Tank Pressure (CN 46) set at $\Delta P \geq 10$ torr.

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. N/A

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 Criticality Analysis*
SU/GP-B P059	*GP-B Contamination Control Plan*
EM SYS229	*Accident/Mishap/Incident Notification Process*
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities
SU/GP-B P0879	Accident/ Incident/Mishap Notification Process
OO-SPN-001	*Master Spin Balance Procedure* (and Operations Orders referenced therein)

F.3. **Additional Procedures**

No additional procedures are indicated.

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA 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 initial their names in Sec D.3 and the name of the Test Director should be circled.
- Verify completion of the Pre-Operations Checklist (Appendix 1).

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

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

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

Verify helium bottle/s have been tested for purity and record Op. Number.

Op. Number:_____

QA Witness:_____

G.3. **Prep Payload for Mass and CG Measurements**

G.3.1. Request LM team install cable P802 to SMD top plate connector

G.3.2. Perform procedure P0669, “Internal Guard Tank Fill, Vent Lines Disconnected”

G.3.3. Perform procedure P0916, “Install FEE Guard Tank Vent Line” to install Modified Guard Tank Vent Valve Assembly (MGTVVA, see figure 2) with the following notes/blue lines

1. The procedure will only be used to install the Modified Guard Tank Vent Valve, since the FEE Guard Tank vent line is already installed and leak checked
2. Use 1.5” pumping line instead of the Guard Tank vent line with the appropriate adapters such that it still connects with the Guard Tank Heat Exchanger in the Gas Module
3. A neon leak check as written in the procedure is not possible due to the configuration of the Modified Guard Tank Vent Cap. If it is desired to perform a neon leak check, connect calibrate leak to Well Vent access port on Gas Module. Open EV-15 to expose RGA to neon standard leak.

G.3.4. Perform Procedure P0675, “Disconnect Main Tank Vent Line from Gas Module,” to install Main Tank Vent Cap with the following notes/blue lines

1. It will be necessary to remove the current vent cap and install a new vent cap with it’s associated bracket.
2. A bracket supplied by LM is needed to preserve the orientation of Main Tank vent cap whenever it is installed.

G.3.5. Remove Vac Ion Pump (VIP) magnet and shield

1. Turn on Vac Ion Pump and record date/time:_____/_____
2. Monitor CN99 and after VIP has stabilized, record VIP:_____torr
3. Roll data system over and when complete turn off VIP
4. Remove cable from VIP
5. Remove Ion Pump Magnet and protective cover

G.3.6. Remove burst disk deflectors and covers

G.3.7. Remove Al foil from Probe Burst Disk covers

G.3.8. Remove any GSE connector covers in the FEE

G.3.9. Install GSE plug in Fill Line relief assembly

G.3.10. Install Flight Fill cap Assembly

1. Verify SV-13 closed
2. Remove Fill Cap Assembly
3. Install Flight Fill Cap per drawing 65113-5833500 Rev C. Make sure

the orientation of the valve stem is as depicted.

4. Ensure Flight Fill Cap Valve (FFCV) Open
5. Connect pumping line to FFCV
6. Evacuate plumbing to less than 25 mtorr
7. Backfill to ~830 torr with He gas.
8. Monitor TG-3 for 30 minutes and verify no decrease in pressure.
9. Close FFCV
10. Remove pumping line and install GSE Swagelok cap on Flight Fill Cap

G.3.11. Secure Well Pump out Plumbing

1. Remove Well Vent cap, clamp and centering ring
2. Close VW-1 and torque to 72-84 in-lbs (6-7 ft-lbs)
    a. Record torque wrench cal due date:_____
    b. Record torque wrench s/n#:_____
    c. Record valve closure in Well Pump out logbook.

Note:

The following steps, recording the Main Tank liquid level, disconnecting cables and installing arming plugs, should be performed as close to the mass and CG measurement as possible.

G.3.12. Record Main Tank Liquid:_____

1. Record Date/Time:_____/_____

G.3.13. Configure cables:

1. Pause the DAS
2. Remove Cables 804, 803 and 800 from the bottom of the FEE
3. Request LM team to install P803A Shorting Plug
4. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
5. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
6. Ensure Guard Tank Pressure >100 torr and remove Guard Tank Endevco Cable

G.3.14. Close MGTVVA-V and remove Guard Tank Pressurization line

G.3.15. Install VCR plug in MGTVVA-V

Note:

The vehicle will now be lifted vertically for mass and CG measurements. After the SV has returned to the tilt dolly and before being tilted horizontal the following steps must be performed

G.3.16. Reconnect GSE cables 800, 803, Thruster Vent Endevco, and Guard Tank Endevco

G.3.17. Ensure Guard Tank pressure >50 torr

G.3.18. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line

Note:
The Main Tank liquid level in the following step should be recorded just prior to rotating horizontal.

G.3.19. Record Main Tank Liquid:_____

1. Record Date/Time:_____/_____

Note:
The SV will now be rotated horizontal. Following completion of the rotation the following steps must be performed.

G.3.20. Configure cables:

1. Pause the DAS
2. Remove Cables 803 and 800 from the bottom of the FEE
3. Request LM team to install P803A Shorting Plug
4. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
5. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
6. Remove Guard Tank Endevco Cable

G.3.21. Close MGTVVA-V and remove Guard Tank Pressurization line

G.3.22. Install VCR plug in MGTVVA-V

Note:
The vehicle will now be lifted in the horizontal orientation for mass and CG measurements. After the SV has returned to the tilt dolly, the following steps must be performed.

G.3.23. Reconnect GSE cables 800, 803, Thruster Vent Endevco and Guard Tank Endevco

G.3.24. Ensure Guard Tank pressure >50 torr

G.3.25. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line

G.3.26. Install Vac Ion Pump Magnet and protective cover

G.3.27. Remove GSE plug from fill line relief valve

G.3.28. Install GSE Fill Cap

1. Remove Flight Fill Cap

2. Install GSE Fill Cap.
3. Open FCV
4. Connect pumping line and evacuate to <25 mtorr
5. Backfill Fill Cap with helium to 1.5 psig
6. Close FCV
7. Monitor PFCG for 30 minutes and verify no decrease in pressure

G.4. **Prepare Payload for Spin Balance Test**

G.4.1. Perform procedure P0674, “Connect Main Tank Vent Line to Gas Module”

G.4.2. Perform procedure P0676, “Connect Guard Tank Vent Line to Gas Module” with the following notes/blue lines

1. Instead of using the Guard Tank vent line, use a 1.5” pumping line with the appropriate adapters so that the pumping lines connects with the Guard Tank heat exchanger in the Gas Module.
2. Also, the Guard Tank pressure must monitored closely and maintained above atmospheric using the Guard Tank heaters if necessary since there are no means to externally maintain pressure in the Guard Tank while MGTVVA-V is closed

Note:
It is desired to fill the Main Tank to a sufficient level such that the Main Tank liquid level will be at 95% on the first spin balance cycle (approximately 2/13/03)

G.4.3. Perform procedure P0648, “NBP Main Tank Fill- Guard Tank Initially Depleted.”

G.4.4. Perform procedure P0442, “NBP Main Tank Fill with Guard Tank Pre-cool.”

G.4.5. Perform procedure P0675, “Disconnect Main Tank Vent Line from Gas Module.”

1. Ensure Bracket and orientation of Main Tank Vent Cap is preserved from Mass/CG measurements.

G.4.6. Perform procedure P0677, “Disconnect Guard Tank Vent Line from Gas Module.” With the following blue lines/notes

1. No vent cap will be installed at the completion of this procedure.
2. Blue lines will be necessary for the new location of the pressurization source at the end of MGTVC-V

G.4.7. Remove Vac Ion Pump (VIP)

1. Turn on Vac Ion Pump and record date/time:_____/_____
2. After VIP has stabilized, record VIP pressure:_____torr
3. Roll data system over and when complete turn off VIP

4. Remove cable from VIP
5. Remove Ion Pump Magnet and protective cover

G.4.8. Install GSE plug in Fill Line relief assembly

G.4.9. Install Flight Fill cap Assembly

1. Verify SV-13 closed
2. Remove Fill Cap Assembly
3. Install Flight Fill Cap per drawing 65113-5833500 Rev C. Make sure the orientation of the valve stem is as depicted.
4. Ensure Flight Fill Cap Valve (FFCV) Open
5. Connect pumping line to FFCV
6. Evacuate plumbing to less than 25 mtorr
7. Back fill Flight Fill Cap to ~830 torr with He gas
8. Monitor TG-3 for 30 minutes and verify no decrease in pressure
9. Close FFCV
10. Remove pumping line and install GSE swagelok cap on Flight Fill Cap

G.4.10. Perform Procedure P0775, “Certification TM&A”

G.4.11. Perform Procedure P0789 “Connect TM&A to SMD”

1. Note: This will be used for moving the SV to B156 low bay.

Note:
The SV will now be moved along with all the necessary GSE into the B156 Low Bay. At this point the SV will be lifted on and off the spin balance table for alignment checks. Cables may need to be temporarily disconnected in order to accommodate various lifts and rotations

Section Complete QA Witness:_____

Note:
The SV will now be placed on the spin balance table for the remainder of the Spin Balance test.
The Spin Balance test consists of three tests at correspondingly three different Main Tank liquid levels. For each level there will be a minimum of three spins for 20 minutes. Before each spin the Main Tank liquid level will be recorded before all monitoring cables are disconnected from the vehicle.

G.5. **Configure Payload During Spin Balance Test @ 95%**

G.5.1. Spin Balance at 95 percent Spin #1

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.

2. Record Guard Tank Pressure:_____
3. Record Main Tank Pressure:_____
4. Record Top of Lead Bag CN40:_____
5. Configure cables:
    a. Pause the DAS
    b. Remove Cables 804, 803 and 800 from the bottom of the FEE
    c. Request LM team to install P803A Shorting Plug
    d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
    e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
    f. Remove Guard Tank Endevco Cable
6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 95% spin cycle #1.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure > 50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____torr above atmosphere
13. Record Main Tank Pressure:_____torr above atmosphere
14. Record Top of Lead Bag CN40:_____Kelvin

G.5.2. Spin Balance at 95 percent Spin #2

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:
    a. Pause the DAS

b. Remove Cables 804, 803 and 800 from the bottom of the FEE

c. Request LM team to install P803A Shorting Plug

d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE

e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug

f. Remove Guard Tank Endevco Cable

6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 95% Spin cycle #2.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure > 50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____

    a. Record Date and Time:_____/_____.

12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.5.3. Spin Balance at 95 percent Spin #3

1. Record Main Tank Liquid level:_____

    a. Record Date and Time:_____/_____.

2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:

    a. Pause the DAS

    b. Remove Cables 804, 803 and 800 from the bottom of the FEE

    c. Request LM team to install P803A Shorting Plug

    d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE

    e. Remove Thruster Vent Endevco cable and request LM

team install Shorting Plug

f. Remove Guard Tank Endevco Cable

6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 95% spin cycle #3.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.6. **Main Tank Liquid Level Reduction to 66%**

G.6.1. Perform Procedure P0674, “Connect Main Tank Vent Line to Gas Module.”

G.6.2. Perform Procedure P0595, “Reduce Liquid Level in Main Tank.”

1. The Main Tank liquid level should be reduced to 66%

G.6.3. Perform Procedure P0675, “Disconnect Main Tank Vent Line from Gas Module.”

G.7. **Configure Payload During Spin Balance Test @ 68%**

G.7.1. Spin Balance at 68% spin #1

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:
    a. Pause the DAS
    b. Remove Cables 804, 803 and 800 from the bottom of the FEE

c. Request LM team to install P803A Shorting Plug

d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE

e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug

f. Remove Guard Tank Endevco Cable

6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 66% spin cycle #1.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____

    a. Record Date and Time:_____/_____.

12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.7.2. Spin Balance at 68% spin #2

1. Record Main Tank Liquid level:_____

    a. Record Date and Time:_____/_____.

2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:

    a. Pause the DAS

    b. Remove Cables 804, 803 and 800 from the bottom of the FEE

    c. Request LM team to install P803A Shorting Plug

    d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE

    e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug

    f. Remove Guard Tank Endevco Cable

6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 66% spin cycle #2.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.7.3. Spin Balance at 68% spin #3

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Remove Cables 804, 803 and 800 from the bottom of the FEE
    a. Request LM team to install P803A Shorting Plug
    b. Request LM team to install umbilical cable to 804a and 800a connectors on the bottom of the FEE
    c. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
    d. Remove Guard Tank Endevco Cable
6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 66% spin cycle #3.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect

Guard Tank Pressurization line

11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.8. **Main Tank Liquid Level Reduction to 44%**

G.8.1. Perform Procedure P0674, "Connect Main Tank Vent Line to Gas Module."

G.8.2. Perform Procedure P0595, "Reduce Liquid Level in Main Tank."

1. The Main Tank liquid level should be reduced to 44%

G.8.3. Perform Procedure P0675, "Disconnect Main Tank Vent Line from Gas Module."

G.9. **Configure Payload During Spin Balance Test @ 44%**

G.9.1. Spin Balance at 44% spin #1

1. Record Main Tank Liquid level:_____
   a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:
   a. Pause the DAS
   b. Remove Cables 804, 803 and 800 from the bottom of the FEE
   c. Request LM team to install P803A Shorting Plug
   d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
   e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
   f. Remove Guard Tank Endevco Cable
6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 44% spin cycle #1.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.9.2. Spin Balance at 44% percent Spin #2

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:
    a. Pause the DAS
    b. Remove Cables 804, 803 and 800 from the bottom of the FEE
    c. Request LM team to install P803A Shorting Plug
    d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
    e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
    f. Remove Guard Tank Endevco Cable
6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 44% spin cycle #2.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____

a. Record Date and Time:_____/_____.

12. Record Guard Tank Pressure:_____torr
13. Record Main Tank Pressure:_____torr
14. Record Top of Lead Bag CN40:_____Kelvin

G.9.3. Spin Balance at 44% percent Spin #3

1. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
2. Record Guard Tank Pressure:_____torr
3. Record Main Tank Pressure:_____torr
4. Record Top of Lead Bag CN40:_____Kelvin
5. Configure cables:
    a. Pause the DAS
    b. Remove Cables 804, 803 and 800 from the bottom of the FEE
    c. Request LM team to install P803A Shorting Plug
    d. Request LM team to install flight umbilical cable to 804a and 800a connectors on the bottom of the FEE
    e. Remove Thruster Vent Endevco cable and request LM team install Shorting Plug
    f. Remove Guard Tank Endevco Cable
6. Close MGTVVA-V and remove Guard Tank Pressurization line
7. Install VCR plug in MGTVVA-V

Note:
The following activities are to be performed after completion of the 44% spin cycle #3.

8. Reconnect GSE cables 800, 803, Main Tank Endevco and Guard Tank Endevco
9. Ensure Guard Tank pressure >50 torr
10. Open MGTVVA-V and while purging from both directions reconnect Guard Tank Pressurization line
11. Record Main Tank Liquid level:_____
    a. Record Date and Time:_____/_____.
12. Record Guard Tank Pressure:_____
13. Record Main Tank Pressure:_____
14. Record Top of Lead Bag CN40:_____

Note:

After ballasting operations, the SV will now be moved back to B156 high bay along with all support GSE

G.10. **Procedure Completion**

G.10.1. Ensure completion of post operations checklist

Section Complete QA Witness:_____

Section H.

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____Date_____

Payload Test Director_____Date_____

Gas Module

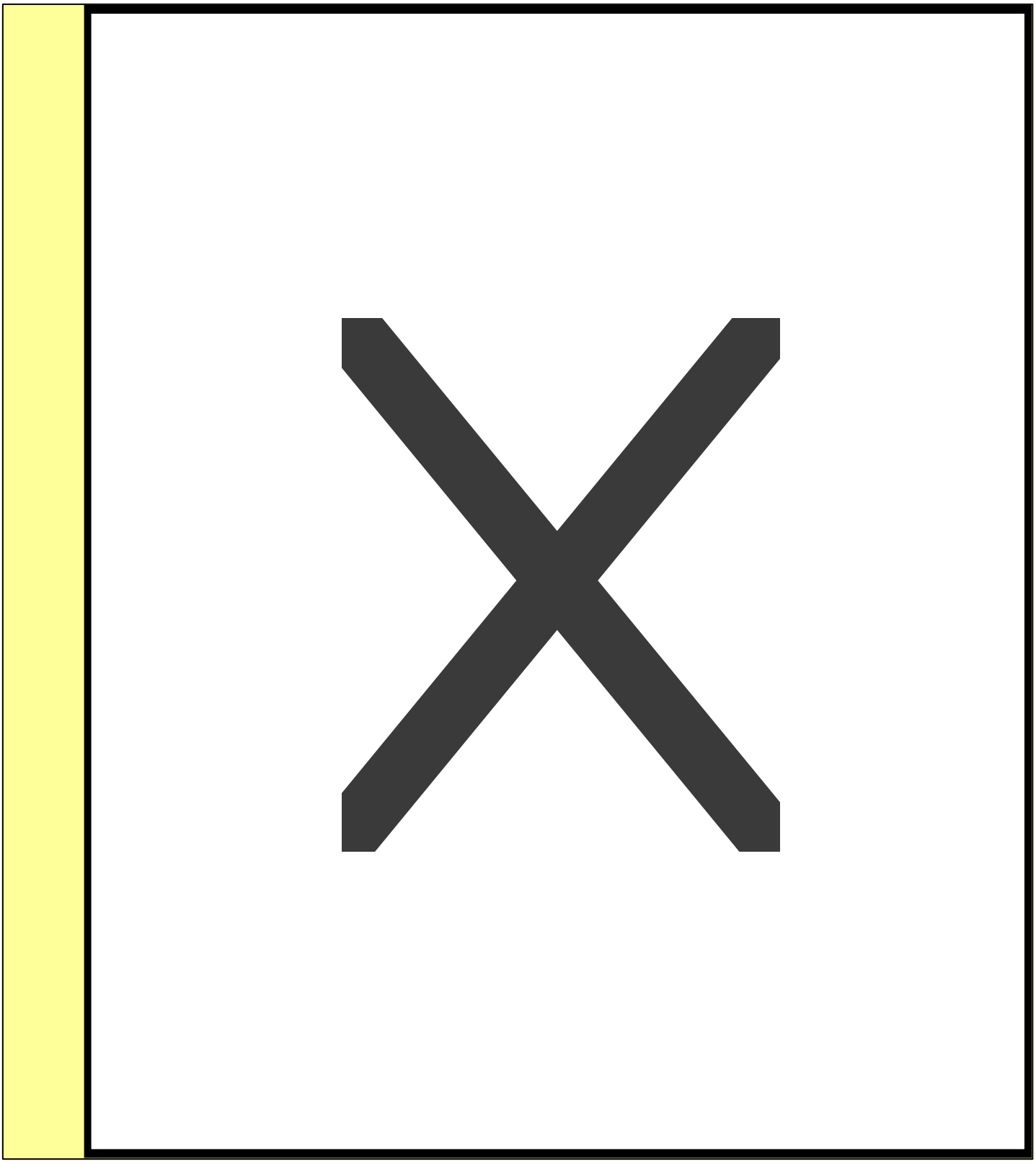
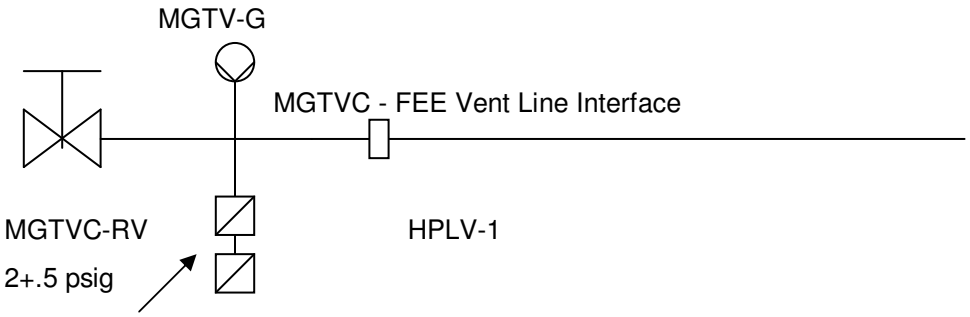
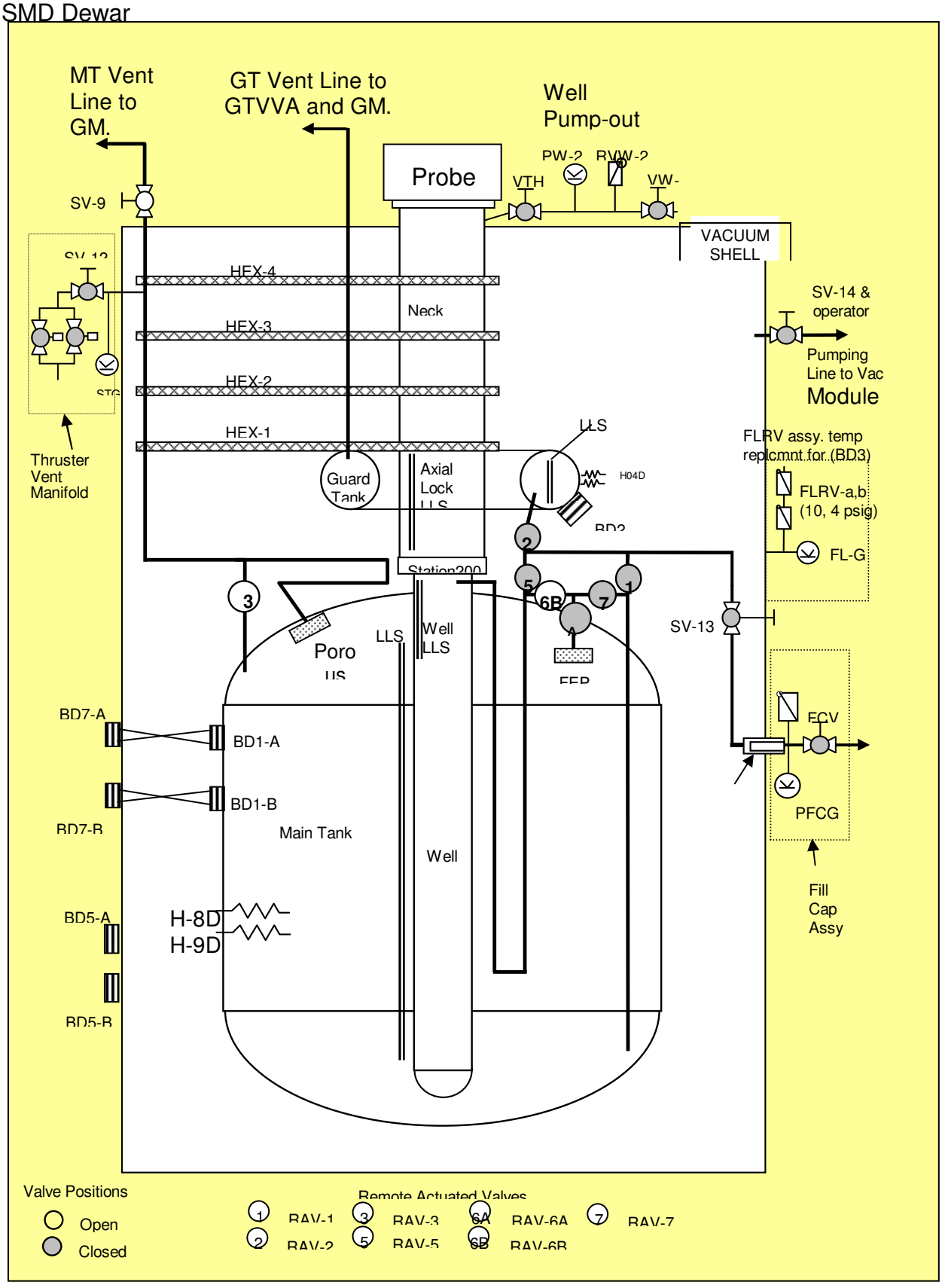


Figure 2: Modified Guard Tank Vent Cap



SMD Dewar


MT Vent Line to GM.
GT Vent Line to GTVVA and GM.
Well Pump-out
Probe
PW-2
RVW-2
VTH
VW-
SV-9
VACUUM SHELL
HEX-4
HEX-3
HEX-2
HEX-1
Neck
SV-14 & operator
Pumping Line to Vac Module
Thruster Vent Manifold
Guard Tank
Axial Lock
LLS
H04D
BD2
FLRV assy. temp replcmnt for (BD3)
FLRV-a,b (10, 4 psig)
FL-G
Station200
Poro
Well LLS
SV-13
FCV
PFCG
Fill Cap Assy
BD7-A
BD1-A
BD1-B
BD7-B
Main Tank
Well
BD5-A
H-8D
H-9D
BD5-B
Valve Positions
Open
Closed
Remote Actuated Valves
RAV-1
RAV-2
RAV-3
RAV-5
RAV-6A
RAV-6B
RAV-7

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: _____		

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.		
	Team Lead Signature: _____		

Appendix 3– **Contingency Responses**

Condition	Circumstance	Response
Temperature limits (CN 1 or 28) exceeded	Any time	Open EV-9 to Vent Main Tank
Burst disk rupture (MT/GT)	Any time	Evacuate room