GRAVITY PROBE B
PROCEDURE FOR
SCIENCE MISSION DEWAR

Guard Tank Recycle on MST

To be performed at Vandenberg Air Force Base SLC-2W

THIS DOCUMENT DOES NOT CONTAIN HAZARDOUS OPERATIONS

P1042 Rev A

ECO No. 1472

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Revision Record

Rev	***ECO***	***Description***	***Date***
A	1472	Updated alarm set point specification Added use of aprons to catch loose debris and prevent impingement of condensation on the SV or LV. Start pumping on well at start of procedure (was optional), and discontinue at the end. Add warning restricting the use of a heat gun on the MST Provide for multiple guard tank fill operations if there is a delay in the launch schedule	1/30/04

Table of Contents

List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section
AMI	American Magnetics Inc.
APR-x	Pressure regulator x of Gas Module
AV-x	Valve x of Gas Module auxiliary section
CGSE	Cryogenic GSE
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
EEB	Electrical Equipment Building
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.
LV	Launch Vehicle
MST	Mobile Service Tower (of SLC-2W)
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
PAF	Payload Adapter Flange
PFCG	Fill Cap ass'y pressure Gauge
PFM	Pump equipment Flow Meter
PG-x	Gauge x of Pump equipment
PM	Pump Module
PRT	Platinum resistance thermometer
psi	pounds per square inch
psig	pounds per square inch gauge
PV-x	Valve x of the Pump equipment
QA	Quality Assurance
RAV-x	Remote Actuated Valve-x
RGA	Residual Gas Analyzer
SLC-2W	Space Launch Complex 2W (Vandenberg AFB)
SMD	Science Mission Dewar
STG	SMD Thruster vent pressure gauge
SU	Stanford University
SV	Space Vehicle
SV-x	SMD Valve number x
TD	Test Director
TG-x	Gauge x of Utility Turbo System
TN	Thrust Nullifier

List of Abbreviations and Acronyms (cont'd)

TV-x	Valve x of Utility Turbo System
UTS	Utility Turbopump 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 Well pumping line

LIST OF SPECIFIC HEADING DEFINITIONS

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

Note:
Used to indicate an operating procedure of such importance that it must be emphasized.

CAUTION:
Used to identify hazards to equipment.

WARNING:
Used to identify hazards to personnel.

A. SCOPE

This procedure describes the steps necessary to refill the guard tank after one or more launch aborts. The steps include:

Gain access to burst disks and connect facility vent lines

Perform P1017, *Repump Well with UTS*

Remove thrust nullifier and install guard tank vent valve assembly

Connect guard tank vent to Gas Module

Remove fill line relief valve plug

Gain access to fill cap and replace with GSE fill cap assembly

Perform P1028, *External Guard Tank Fill- Main Tank Subatmospheric* (skip installation of GSE fill cap at completion). If launch is delayed, repeat fill operations as necessary.

Remove GSE fill cap and install flight fill cap

Disconnect guard tank vent line

Remove guard tank vent valve assembly and install guard tank thrust nullifier

Install fill line relief valve plug

Complete P1017 and close redundant well isolation valve

Disconnect emergency vent lines for launch

Note that this procedure is classified as non-hazardous. That classification does not necessarily apply, however, to other procedures that are called by this procedure.

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) discuss 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

A rupture of the main tank burst disk(s) will be obvious due to the plume of cold gas. Emergency vent lines are installed over the burst disks on the SMD vacuum shell to eliminate the possibility of direct plume impingement on personnel. The emergency vent lines direct flow to an outside area. Orderly evacuation shall be performed in the event one or more of these burst disks rupture. An oxygen deficiency monitor (provided by GP-B) that alarms when the oxygen level is reduced to 19.5% will be utilized as an added precaution. Temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions.

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 a ladder. In the unlikely event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA and VAFB safety. The following additional requirements apply to all personnel involved directly in cryogenic operations: Insulated gloves when handling equipment that has been cooled to cryogenic temperatures. A protective apron, gloves impervious to liquid cryogens, impermeable shoes, and full-face shields with goggles/glasses are to be worn whenever the possibility of splashing or impingement of high velocity cryogens exists.

B.2.3. Other Hazards

Tools or other items with the potential to damage the SV or launch vehicle if dropped shall be tethered. Aprons or other means of catching or deflecting small parts, condensation, etc. shall be used to shield the flight hardware.

B.3. **Mishap Notification**

B.3.1. Injury

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

B.3.2. Hardware Mishap

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

B.3.3. Contingency Response

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

C. **QUALITY ASSURANCE**

C.1. **QA Notification**

The NASA program 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 judgment of the TD or QA Representative, mission 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.

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.

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 TD and approved by the QA representative.

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. However, procedures called by this procedure may have additional requirements. 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**

List below those personnel involved with the procedure

Functional Title	Number	Affiliation
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

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 (GM), the Pump Module (PM), the Electrical Module (EM), the Vacuum Module (VM), and the Utility Turbopump 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 (when needed for pumping on the Main Tank) than the Gas Module, together with additional flow metering capabilities. The vent output of the Gas Module flows through the Pump Module when it is in use. 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. The UTS is a smaller version of the Vacuum Module.

This procedure calls for use of hardware located in the Gas Module (Figure 2), and the Electrical Module (Table 1). Additionally, the SMD External Temperature Control Module, (located in the EEB), the Power Distribution Unit are needed. The UTS is needed to pump on the well). (The Vacuum Module can be used as a backup.) The Pump Module is not needed.

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. It also

provides power to operate heaters associated with the Guard Tank and its vent. No additional computers or software are required.

E.3.4. Spacecraft Support

With connector J802 connected to flight electronics, operation of RAV2 and RAV6B must be commanded through the spacecraft instead of the RAV controller in the Electrical Module.

E.3.5. Additional Test Equipment

Description	***Manufacturer***	***Model***
O_2 Monitor and Alarm	Alpha-Omega Instruments	1000
Handheld digital multimeter	Fluke	85 or similar
AMI Level Sensor Readout for LHSD*	American Magnetics, Inc.	110

*(Ref.) Required by called procedure.

E.3.6. Additional Hardware

Description	***Manufacturer***	***Model***
Filter Line assembly*	LMMS	5833827
Liquid He Transfer Line*	LMMS	5833804
Liquid He Stinger*	LMMS	5833803
GHe supply fittings to LHSD*	N/A	N/A
Bayonet Cap with Nupro Valve*	LMMS	N/A
(2x) 500 Liter Dewars, Liquid Helium*	Cryofab	CMSH-500
(2x) 4 liter LN2 flask*	Taylor-Wharton	4 LD
#5 rubber stopper (tetherable)	–	–

*(Ref.) Required by called procedure.

E.3.7. Flight Hardware

Space Vehicle in launch-ready condition.

E.3.8. Protective Clothing

(Ref.) The following is required for use in called procedure P1028, *External Guard Tank Fill- Main Tank Subatmospheric*

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

E.3.9. Tools

Description	***Manufacturer***	***Model***
Torque wrench	Sturtevant Richmont or sim.	50 in-lb
Torque wrench	Sturtevant Richmont or sim	150 in-lb

E.3.10. Expendables

(Ref.) The following is required for use in called procedure P1028, *External Guard Tank Fill- Main Tank Subatmospheric* in addition to other minor items listed in that procedure.

Description	***Quantity***	***Mfr./Part No.***
Liquid helium	2x 500 liters.	N/A
Compressed helium gas	2x "T" bottles	N/A
Liquid Nitrogen	160 liter cylinder	N/A

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. 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	-

No.	*Location*	*Description*	*User Name*	*Serial No.*	*Cal Required*	*Status Cal due date*
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	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	-

E.5. **Configuration Requirements**

E.5.1. Space Vehicle

The SV must be mounted vertical (+Z up) on the launch vehicle. The fairing doors needed to access the rupture disks, fill port, and thrust nullifier must be removed.

E.5.2. Main Tank

The Main Tank liquid must be subatmospheric (~1.7 – 1.9 K) with the liquid level ≥ 95%. The Main Tank vent is isolated by closure of SV-9 and the installation of the Main Tank flight cap as obtained by the completion of P1002, *Configure SMD for Transport to SLC-2W* (Fig. 1). No access to the main tank is needed or possible in this procedure.

E.5.3. Guard Tank

The Guard Tank is filled with NBP liquid He and should be maintained above a minimum level of 20%. Venting of the Guard Tank is through the flight Guard Tank vent line and flight Guard Tank thrust nullifier (Fig. 1). The design of the thrust nullifier is intended to maintain the guard tank pressure above atmospheric while in a 1 G environment.

E.5.4. Well

The Well must be evacuated.

E.5.5. SMD Vacuum Shell

The Vacuum Shell pressure must be less than 5 x 10^{-5} torr. Procedure P1015, *Connect Vacuum Module to SMD*, contains the steps for connecting to and pumping on the SMD vacuum shell, if needed.

E.5.6. GSE and Non-flight Hardware

No non-flight hardware is installed at the beginning of this procedure.

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/Success Criteria

N/A

E.8. Payload Constraints and Restrictions

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*
LM/P479945	*Missile System Prelaunch Safety Package*
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*
LM EM SYS229	*Accident/Incident/Mishap Notification Process*
EWR 127-1, 31 March 1995, Eastern and Western Range Safety Requirements	*Hazardous and Safety Critical Procedures*
KHB 1710, rev D	*Kennedy Space Center Safety Practices Handbook*

F.3. Additional Procedures

Document No.	***Title***
SU/GP-B P1017	*Repump Well with UTS*
SU/GP-B P1028	*External Guard Tank Fill- Main Tank Subatmospheric (MST)*

Operation Number:_____

Date Initiated:_____

Time 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 _____/_____.
- ❑ Verify that the required personnel identified in Sec. D.3 are present.
- ❑ Verify performance of pre-operations checklist (Appendix 1).

Section G.1 complete _____ QA.

G.2. Verify Preliminary SMD and GSE Preparations Complete

G.2.1. Verify that the following items are available on the MST:

1. At least one 500 liter LHSD that is at least 30% full
2. Gas Module
3. Electrical Module
4. Vacuum Module
5. Utility Turbopump System
6. Power Distribution Unit
7. Leak detector with 4 liter LN_2 flask
8. 2x “T” bottles of GHe
9. Toolbox

G.2.2. Verify content of All Sources of Helium Gas

1. Record serial number on helium bottle/s.
   1. _____ 2._____
2. Verify helium bottle/s have been tested for content and record Op. Number.
   Op. Number:_____

_____ QA.

G.2.3. Verify that the DAS and the SMD External Temperature Control Module are operating nominally in the EEB.

G.2.4. Verify that all Gas Module Valves (EV, AV) are closed (except for EV-7A/B) and AP-1 is off.

G.2.5. Verify operation of the GP-B portable oxygen monitor.

G.2.6. Verify that the fairing doors, needed to access the burst disks, fill port, and thrust nullifier, have been removed.

Section G.2 complete _____ QA.

G.3. **Prepare for Guard Tank Maintenance**

G.3.1. Connect emergency vent lines from the SMD burst disks to a facility vent location.

G.3.2. Verify the Guard Tank contains NBP liquid He and liquid level is above a minimum level of 20%. Record GT liquid level: _____ %

G.3.3. Ensure DAS alarm system enabled and record set points.

1. ***Bottom of main tank temperature*** – ensure CN [48] on DAS alarm list and set to alarm (upper limit) at T ≤ 2.2 K. Record set point. _____K
2. ***Guard Tank* temperature** – ensure CN [170] on DAS alarm list and set to alarm (upper limit) at T ≤ 5.0 K. Record set point. _____K

G.3.4. Ensure DAS watchdog timer and alarm enabled.

G.3.5. (Optional) Vacuum status:

1. Using a tether on the magnet and a temporary apron to catch any loose hardware, install the ion pump magnet and connect the ion pump controller.
2. Verify that the vacuum shell pressure is less than 5×10^{-5} torr as follows:
    a. Turn on ion pump controller.
    b. Measure the recorder output voltage (pin 2 relative to pin 6).
    c. After the voltage has stabilized, record: _____ V.
    d. Convert voltage to torr by multiplying by 6.7×10^{-5} torr/volt and record: _____torr.
3. Turn off the ion pump controller.
4. Disconnect the ion pump cable.
5. Using a tether on the magnet and a temporary apron to catch any loose hardware, remove the ion pump magnet and stow.

G.3.6. Perform P1017, *Repump Well with UTS,* and record the Op. Order No.: _____ and date/time: _____/_____. Comment: Performing this procedure will require opening both staked valves VW-1 and VW-2. Active pumping should take place during fill operations and for approximately a day afterwards, whenever possible.

G.3.7. Replace the Guard Tank Passive (Thrust) Nullifier with GSE as follows:

1. Turn off power (in the EEB) operating the TN heater
2. Disconnect the heater and PRT leads.
3. Remove the TN and lightly install a tethered #5 rubber stopper in the female bayonet.
4. Inspect the o-ring on the female bayonet and replace with a flight o-ring, part number 02697-2-027V747-75, if necessary.
5. Open GTV-V, GTV-Vb, and GTV-Va on GTVVA.
6. Remove the rubber stopper and mount the GTVVA by engaging the bayonet nut and tightening. Be certain that the o-ring stays in its groove during this process.
7. Close GTV-V, GTV-Va, and GTV-Vb on GTVVA.
8. Connect the guard tank vent line between GTVVA and the GT heat exchanger on the Gas Module.
9. Verify that a purged source of He gas is connected to the GM at the He inlet port.
10. Turn on AP-1 and open AV-8, AV-6, EV-7A/B, EV-13, EV-16 to evacuate up to a closed GTV-V.
11. Verify that AG-2b drops to below 10 mtorr.
12. Close AV-8 and AV-6, and turn off AP-1.
13. Backfill the GT vent plumbing with He gas through EV-23 and APR-2 until EG-3a reads 1 atm. Close EV-23.
14. Open GTV-V to allow the Guard Tank to vent through the GM.
15. Connect GTV-G and verify operation.

G.3.8. Remove the fill line relief plug (P/N SS-4-PSC of drawing 8A03009).

G.3.9. Replace the flight fill cap assembly with the GSE version as follows:

1. Remove the flight fill cap, “Fill Valve Weldment Assembly”, (5833270-101)
2. Install the GSE fill cap assembly on the fill bayonet.
3. Connect the Fill Cap pressure gauge, PFCG, to its readout and verify operation.

G.3.10. Install plastic drapes underneath the fill bayonet and the guard tank vent valve assembly to prevent condensation from impinging on the SV/LV

Section G.3 complete _____ QA.

G.4. **Fill Guard Tank**

WARNING:
The use of an electric heat gun is prohibited on the MST except under the following conditions: 1) The LV second stage is not fueled; 2) There are no flammable materials in the area of use; 3) Use is approved by on-site NASA and Boeing safety.

G.4.1. If the next launch attempt is delayed, perform P1028, *External Guard Tank Fill – Main Tank Subatmospheric* as required. Record the date, time, and Op. Order No. for each occasion in the following table. Comment: Since no vent cap is installed, only GTV-V needs to be operated. If this is the last guard tank fill prior to a launch attempt, proceed with the next step.

Date	Time	Op. Order No.

G.4.2. When it is time to perform the final guard tank fill prior to the next launch opportunity, perform P1028, *External Guard Tank Fill - Main Tank Subatmospheric*, and record the Op. Order No.: _____ and date/time: _____/_____. Fill the guard tank to a level that would result in the guard tank being 50 +5/-0% full at the next launch opportunity. Record resulting guard tank fill level: _____ and date/time of completion: _____/_____.

Section G.4 complete _____ QA.

G.5. **Reconfigure for Launch**

G.5.1. Replace the GSE fill cap assembly with the flight fill cap as follows:

1. Record Fill Cap pressure (PFCG): _____torr, and record date / time:_____.
2. Remove the installed Fill Cap.
3. Install the flight fill cap, “Fill Valve Weldment Assembly” (5833270-101) per 65113-5833500C. Ensure that the valve stem is oriented in the direction shown in the drawing (in the +Y direction). Request LM

to safety wire the fill cap nut per MS 33540. Use safety glasses or face shield while clipping safety wire.

4. Install a pumping line between the Nupro valve on the Fill Cap Assembly and the Access Port #1 of the Auxiliary gas section. Provide strain relief as necessary.
5. Turn on pump AP-1.
6. Ensure EV-12 closed.
7. Open AV-8 and AV-3.
8. Open Nupro valve on the Fill Cap Assembly and evacuate to <25 mtorr as measured at AG-2B.
9. Close AV-8.
10. Open AV-1.
11. Open AV-9 until pressure reaches 1.5 psig as read on gauge AG-1 and then close AV-9.
12. Close AV-1.
13. Open AV-8 evacuate to <25 mtorr as measured at AG-2B.
14. Close AV-8.
15. Open AV-1.
16. Open AV-9 until pressure reaches 1.5 psig as read on gauge AG-1 and then close AV-9.
17. Close the Nupro valve on the fill cap and torque 25 ± 2 in-lb. Record S/N _____ and cal. due date: _____

_____ QA.

18. Close AV-1.
19. Close AV-3.
20. Turn off AP-1.
21. Disconnect the pumping line at the Nupro valve on the fill cap.
22. Install a Swagelok plug on the port at the Nupro valve on the fill cap.
23. Request LM to safety wire the Swagelok nut and Nupro valve per MS 33540. Use safety glasses or face shield while clipping safety wire.

_____ QA.

G.5.2. Assist LM in the installation of the Guard Tank Passive (Thrust) Nullifier as follows:

1. Disconnect GTV-G.
2. Close GTV-V and disconnect the GT vent line from GTVVA.

3. Remove GTVVA and lightly install a tethered #5 rubber stopper in the female bayonet.
4. Inspect the o-ring on the female bayonet and replace with a flight o-ring, part number 02697-2-027V747-75, if necessary.
5. Remove the rubber stopper and mount the Guard Tank Thrust Nullifier by engaging the bayonet nut and hand tightening. LM personnel will complete the mechanical installation.
6. Connect the heater and PRT leads and verify operation of the thrust nullifier heater.

G.5.3. Install the fill line relief plug (P/N SS-4-PSC of drawing 8A03009). LM will epoxy stake.

G.5.4. As late as possible, but at least 4 hours after completion of the guard tank fill operation, complete procedure P1017, *Repump Well with UTS,* (without installing the KF cap at VW-2) and record the date/time: _____/_____.

G.5.5. Secure Well pump out plumbing as follows:

1. Verify Well vent cap, clamp, and centering ring are removed.
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 serial number: _____
    c. Record valve closure in Well pump-out valve logbook.
3. Verify that VW-2 is closed and torqued to 72-84 in-lbs and that the valve closure has been recorded in the Well pump-out valve logbook.
4. Request LM stake both valves.

G.5.6. Verify installation of RAV arming plug P222 per LM op order.

G.5.7. Remove and stow the SMD emergency burst disk vent lines, centering rings, and clamps.

G.5.8. Remove plastic drapes installed underneath the fill bayonet and the guard tank vent valve assembly.

G.5.9. Perform a census of all tools used in this procedure and verify that they have been properly stowed.

G.5.10. Verify performance of the post-procedure checklist (Appendix 2)

Section G.5 complete _____ QA.

H. **PROCEDURE COMPLETION**

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Test Director_____**Date**_____

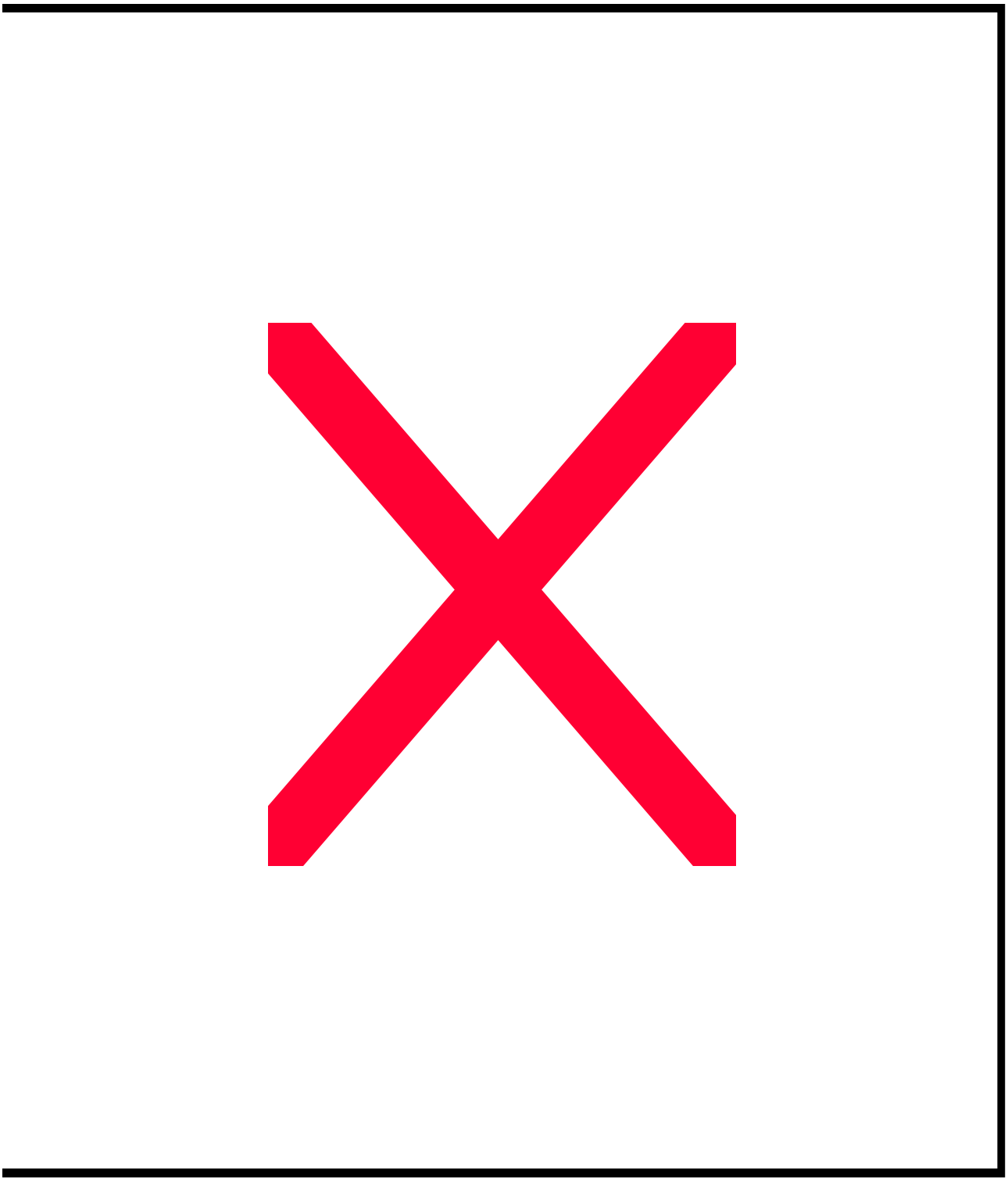


Figure 1. Schematic representation of SMD in launch-ready configuration (beginning and end of this procedure).

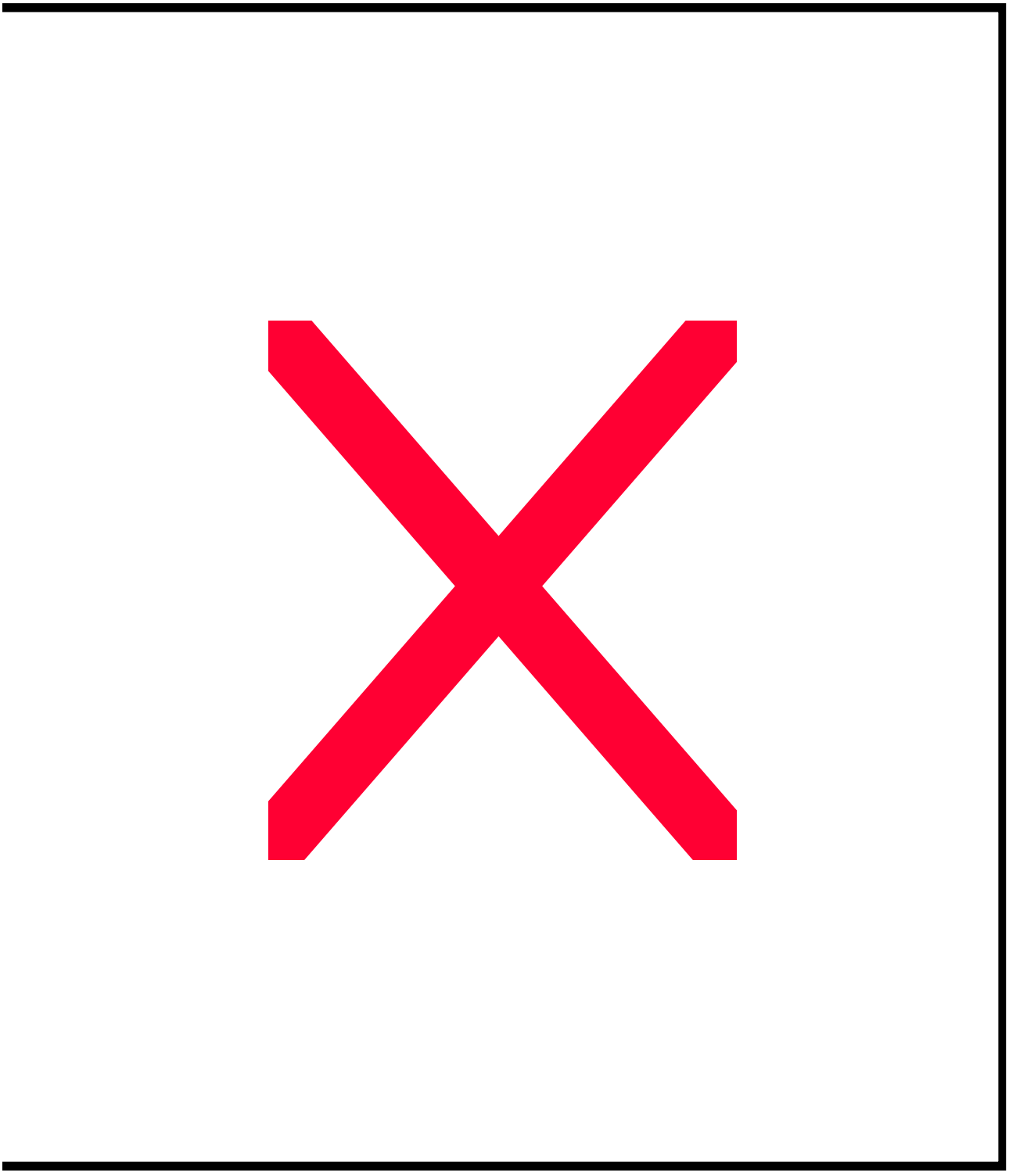
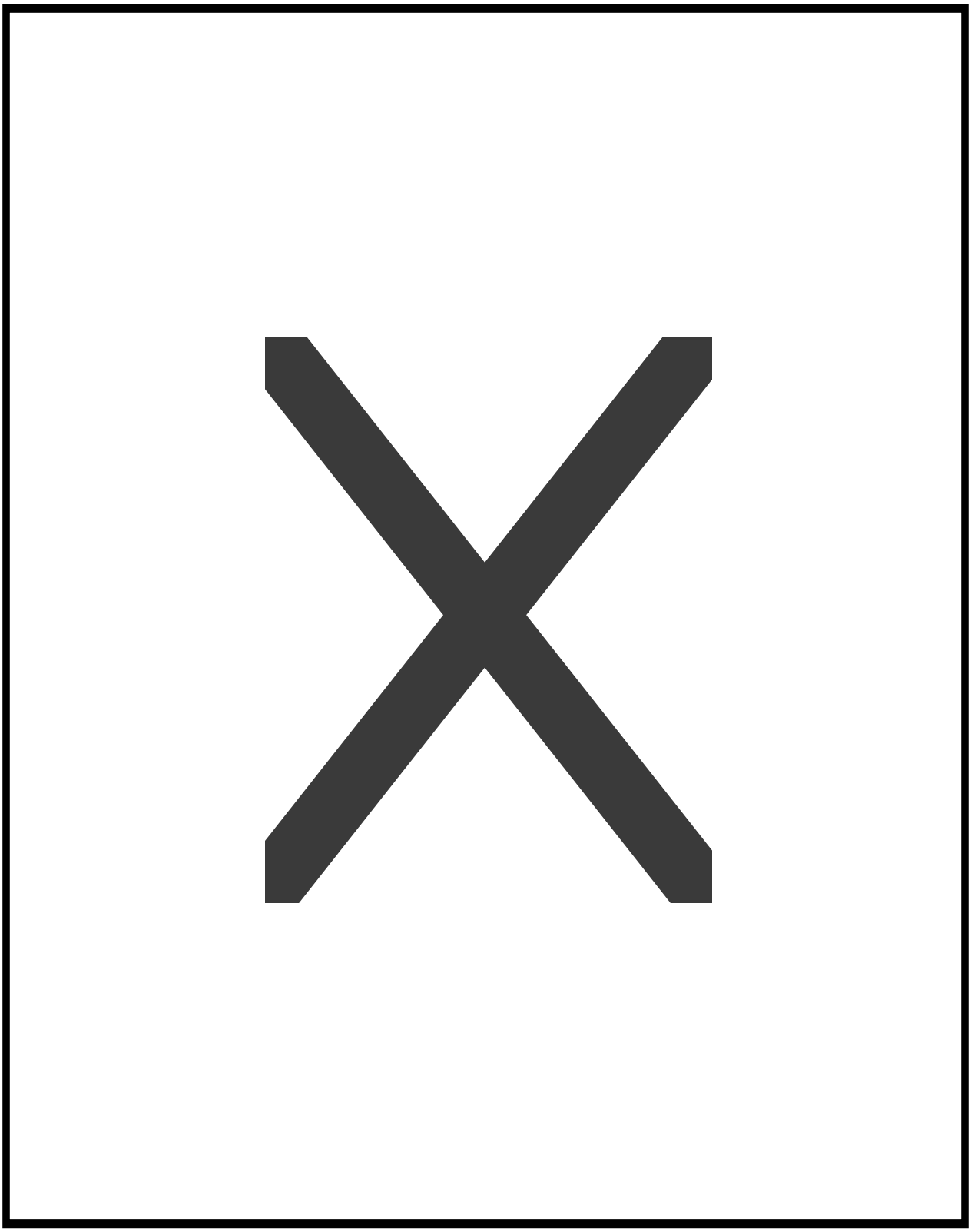


Figure 2. Schematic representation of SMD at beginning of Guard Tank fill procedure (G.4). (Note: Setup to pump on the Well is not shown.)



I. APPENDIX 1 – PRE-PROCEDURE 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. Perform an engineering and safety highbay walk around. 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-PROCEDURE 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	Any time	Wait for power restoration and restore valve status
2	Burst disk rupture (MT/GT)	Any time	Evacuate immediate vicinity
3	Oxygen depletion alarm	Any time	Evacuate immediate vicinity

Instrumentation available through the umbilical (reference only; not part of procedure):

Designator	Description	SMD Connector	DAS Channel No.
T-09D	Bottom Main Tank – SDT	P800	48
T-15D	Guard Tank/a - SDT	P800	170
T-24D	Fill Valve SV-13 – SDT	P800	177
T-20D	Top Lead Bag/a – GRT	P804	175
T-21D	Top Lead Bag/b – GRT	P804	178
H-03D	GT Heater/a	P804	150 (V) 151 (I)
H-04D	GT Heater/b	P804	152 (V) 153 (I)
LL-5D	GT Liquid Level/a (manually switched; primary)	P804	165 (analog)
LL-6D	GT Liquid Level/b (manually switched; secondary)	P804	165 (analog)
H-20D	GT Vent Heater	P1 of W604	–
T-26D	GT Vent/a – PRT	P1 of W604	–
T-27D	GT Vent/b – PRT	P1 of W604	–
H-20D	GT Thrust Null. Htr	P1 of W604	–
T-25D	GT Thrust Null. – PRT	P1 of W604	–