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W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

BLEED DOWN OF THE GMA HIGH PRESSURE AT VAFB

GP-B ENGINEERING PROCEDURE

To be performed at Vandenberg Air Force Base Building 1610

THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

P0968 Rev -

27 February, 2003

PREPARED	S. Buchholz, Technical Writer	Date
APPROVED	C. Gray, GMA Responsible Engineer	Date
APPROVED	Harv Moskowitz, LMSSC Safety Engineer	Date
APPROVED	NASA/KSC Safety	Date
APPROVED	D. Ross, Quality Assurance	Date

APPROVED _____ _____

R. Brumley, Hardware Manager Date

REVISION RECORD

Rev	Date	Comments
-	2/27/03	

TABLE OF CONTENTS

List of Abbreviations and Acronyms

D-Log	Discrepency Log
DR	Discrepency Report
ECU	Electronic Control Unit
ESD	Electro Static Discharge
GDS	Gas Delivery System
GMA	Gas Management Assembly
GP-B	Gravity Probe B
He	Helium
LM	Lockheed Martin
NASA	National Aeronautics and Space Administration
psi	pounds per square inch
psia	pounds per square inch absolute(=psig+14.7)
psig	pounds per square inch gauge
QA	Quality Assurance
SU	Stanford University
VAFB	Vandenberg Air Force Base

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

In general, this procedure is used to bleed excess pressure from the Gas Management Assembly (GMA). It starts by bleeding the pressure from the downstream portion of the system through the GMA Vent. Optionally, the supply tanks may be bled down as well. This procedure assumes that the areas of the GMA below the Gyroscope Valves (Zones 6 and 7 on Diagram 2) are at the correct pressure and therefore leaves them untouched. This procedure is a revision of P0942, which was used at LM and SU. The revision incorporates requirements for VAFB.

B SAFETY

B.1 General

The GMA is a gas pressure vessel. Under normal operations, the GMA requires no safety measures or equipment beyond those required for the use of a supply gas cylinder. Personnel Protective Equipment (PPE) will be worn during hazardous operations as required by location. When any of the systems are pressurized and connected to a vacuum system, be cautious not to vent high pressure through the pumping portions of the system. Only allow high pressure to vent through approved ports and make sure that these are open at time of venting. Note that the GMA is an extremely high value piece of space flight equipment. The GMA tanks located under the GMA pallet are also fracture critical items, so care must be taken not to damage them in any way.

B.2 Mishap Notification

B.2.1 Injury

In case of any injury or illness requiring medical treatment - Dial 911

B.2.2 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.2.3 Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Section **G.11.**

C QUALITY ASSURANCE

C.1 QA Notification

This test will be conducted on a formal basis to approved and released procedures. **The QA program office and NASA program and NASA Safety representative shall be notified 24 hours prior to the start of this procedure**. A Quality Assurance Representative, designated by D. Ross shall be present during the procedure and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Program Engineer, D. Ross or her designate, will certify 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 redline (make minor changes during execution) this procedure is given solely to the Test Director 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. Within hazardous portions of this procedure, all steps shall be worked in sequence. Out-of-sequence work or redlines shall be approved by NASA Safety prior to their performance.

C.3 Discrepancies

Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

D TEST PERSONNEL

D.1 Personnel Responsibilities

The Test Director shall be Chris Gray or an alternate that he shall designate. The person performing the operations (Test Director or Test Engineer) has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it.

D.2 Personnel Qualifications

The Test Director must have a detailed understanding of all procedures and experience in all of the GMA operations. The Test Director shall designate a Test Engineer as required.

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
NASA Safety Rep	1	SFAO or ANALEX

E REQUIREMENTS

E.1 Electrostatic Discharge Requirements

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

E.2 Lifting Operation Requirements

N/A

E.3 Hardware/Software Requirements

- ECU
- Appropriate software for controlling GMA on the spacecraft, this includes a null script which enables command-line control of the GMA.
- Flight GMA
- Vacuum system (Alcatel pump cart or equivalent)
- Plumbing lines, cleaned consistently with Class 100 practices
- Clean check valve
- Clean manual valves (2), one of which should be a multi-turn bellows valve
- CSTOL Scripts as required
- Plumbing gender changers, elbows, etc. as required, cleaned consistently with Class 100 practices
- Class 100 down flow hood, if required
- Hand held particle counter, if required

  Calibration Date: _____ S/N: _____ Model #: _____

E.4 Instrument Pretest Requirements

E.5 All GMA instrumentation used in taking data shall be "in calibration" at time of test.

E.5 Configuration Requirements

GMA work will be performed under Class 100 flow hood or in clean room. (class 1000 or better)

E.6 Optional Non-flight Configurations

N/A

E.7 Verification/ Success Criteria

N/A

E.8 Constraints and Restrictions

Normal clean room practices apply under down flow hood and in clean room.

F REFERENCE DOCUMENTS

F.1 Drawings

Drawing No.	Title
26273	GMA Schematic, GP-B Dwg

F.2 Supporting documentation

Document No.	Title
S0681	CSTOL Scripts for GMA Testing
SU/GP-B P0108	Quality Plan
SU/GP-B P059	GP-B Contamination Control Plan
LM/P479945	Missile System Prelaunch Safety Package
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 P0875	GP-B Maintenance and Testing at all Facilities
Various	ECU operations as applicable
P0962	GMA Sleep Procedure

G OPERATIONS

G.1 Verify Appropriate QA Notification

QA Notified:
NASA Program and Safety
Representative Notified:

_____	_____
Date & Time)	Date & Time)

G.2 Verify Configuration Requirements

Verify GMA is situated in a Class 1000 or better clean room or under a Class 100 or better flow hood. If GMA is under flow hood, verify the environment with a hand held particle counter. Counts under the hood shall average better than 10 per 0.1 cubic feet measured of size 0.5 micron or greater.

Quality _____

G.3 Setting up the GMA

Started on**:** _____

Note:
Mark off each step of this section as it is completed. This section is a non-hazardous operation.

G.3.1 Complete Pre-Test Checklist (Section **G.9**)

G.3.2 Verify the ECU is connected to the GMA and start up the ECU and appropriate software. Record script used here: _____

G.3.3 Connect plumbing to the GMA vent per Diagram 1.

G.3.4 With OM Vent 1 closed and OM Vent2 fully closed, start the vacuum system and evacuate the new plumbing.

G.3.5 Slowly open OM Vent1 and evacuate up to the GMA solenoid valves.

G.3.6 Close OM Vent1.

G.3.7 Use the ECU to close all GMA solenoid valves.

G.3.8 Read the GMA pressure transducers and fill in the table below.

Table 1, GMA pressures, PSIA:

	GP1	GP2	GP3	GP4	GP5	GP6
Expected	>299	300	300	'railed' (~36 psia)	'railed' (~36 psia)	'railed' (~19 psia)
Actual						

Quality_____

G.4 Bleed down of GMA Downstream Pressure

Started on: _____

Note: Mark off each step of this section as it is completed.

Warning:

Hazardous operations are about to begin, these operations involve working with medium-pressure helium. Use standard practices for handling of medium-pressure gas. (500 to 3000 psi per EWR 127-1).

G.4.1 Request the area operation light be changed to Amber.

G.4.2 Establish a 10 foot diameter controlled area.

G.4.3 Request a PA announcement that a hazardous task is about to begin.

G.4.4 Ensure all nonessential personnel are clear of controlled area

G.4.5 Verify that GMA solenoid valves OM Vent 1, OM Vent 2 and OM Vent 3 are all closed.

G.4.6 Open OM Vent 2 (check valve cutoff).

G.4.7 Open GMA solenoid valves V3, V4, V5, V6, V27 and V29.

G.4.8 Open OM Vent 3 a small amount to slowly bleed the pressure from the GMA.

G.4.9 When flow stops, close OM Vent 2.

G.4.10 Monitor GP2 and use OM Vent 1 to throttle pressure.

G.4.11 When the pressure at GP2 and GP3 reaches desired pressure (<330 psia) close OM Vent 1 and record pressure at GP3 here _____.

G.4.12 Open V1 and V2 then wait 1 minute then Close V1, V2, V3, V4, V5, V6, V27 and V29.

G.4.13 The Test Director or engineer will determine if GMA tank is to be vented as well. If not, skip to section G.6.

Quality _____

G.5 GMA Tank Bleed Down

Started on**:** _____

Note: Mark off each step of this section as it is completed.

G.5.1 Verify that sections G.3 and G.4 have been successfully completed.

G.5.2 Read the GMA pressure sensors and verify the following: GP2 and GP3 are greater than 270 psia; GP4 and GP5 are approximately 25 psia; and GP6 less than 25 psia (it might be railed).

G.5.3 Determine desired final GMA tank pressure and record it here _____(300 psia if preparing for shipping).

G.5.4 If GP1 reads below the pressure recorded in G.5.2 for GP2 and GP3, repeat section G4.

G.5.5 Open GMA solenoid valves V1, V2, V3, V4, V5, V6, V27, and V29.

G.5.6 Monitor pressure at GP1.

G.5.7 Open OM Vent 3 and OM Vent1/ 2 as required.

G.5.8 When pressure reaches desired level (300 psia if preparing for shipping) close OM Vent 3 and record final pressure at GP1 here _____. (This step may take several hours.)

Quality_____

G.6 GMA Final Configuration

Started on: _____

Note: Mark off each step of this section as it is completed.

G.6.1 Verify that sections G.4 and G.5 (if necessary) have been successfully performed and all GSE valves are closed.

G.6.2 Open solenoid valves V1, V2, V3, V4, V5, V6, V27, and V29.

G.6.3 Monitor pressure at GP6 until it stabilizes or rails (~ 19 psia).

G.6.4 Close solenoid valves V29, V27, V6, V5, V4, V3, V2, and V1.

G.6.5 Run GMA sleep procedure, P0962, if desired by the Test Director.

NOTE: THIS HAZARDOUS OPERATION IS NOW COMPLETE.

G.6.6 Request PA announcement that hazardous operations are now complete.

G.6.7 Ensure area warning light is returned to green.

G.6.8 Disband controlled area.

G.6.9 Disconnect the vacuum system and GSE from the GMA if desired by the Test Director.

G.6.10 Cap the GMA vents if exposed.

G.6.11 Shut down the ECU.

G.6.12 Compete Post-Test Checklist (Section **G.10**)

Quality _____

G.7 Diagrams

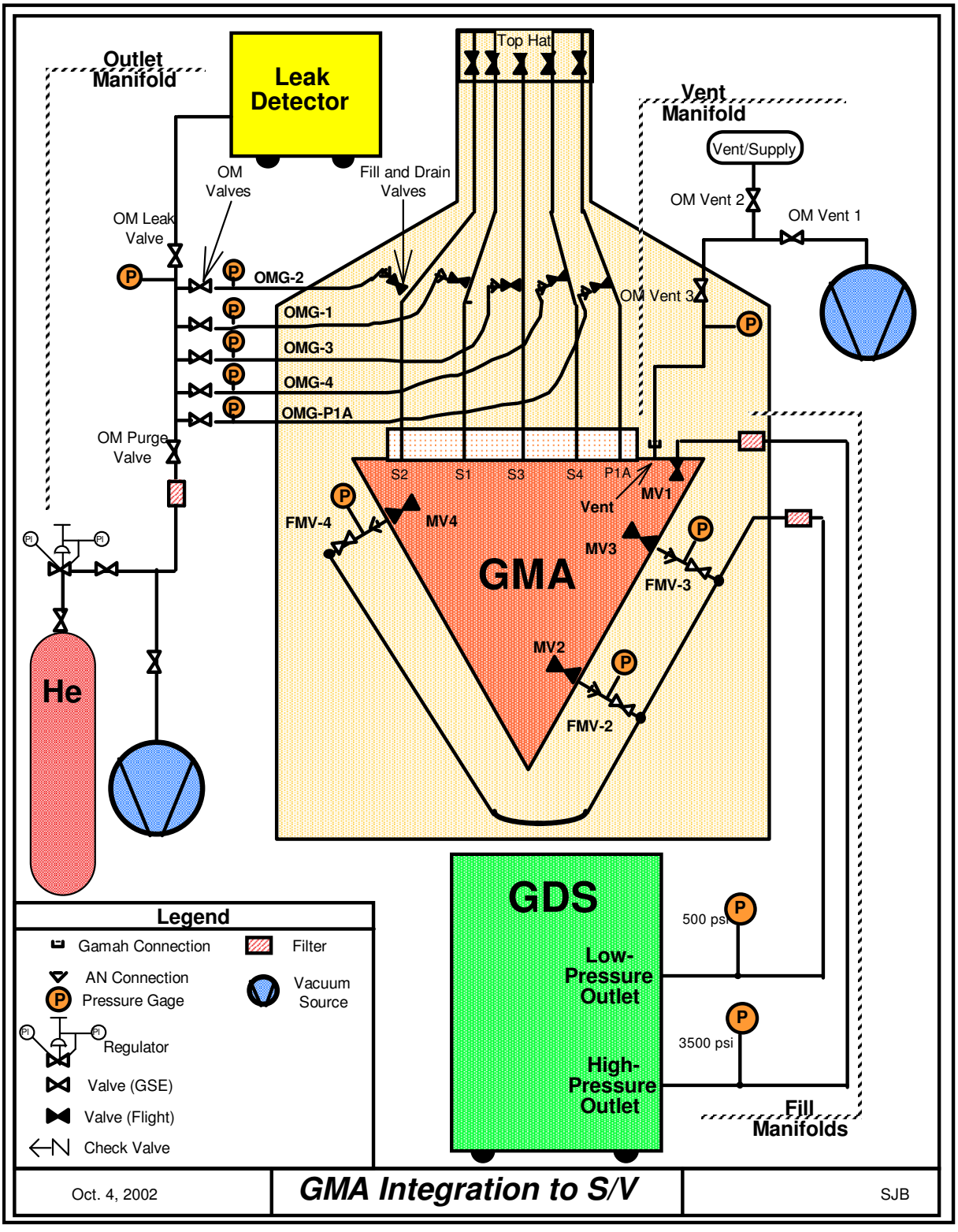
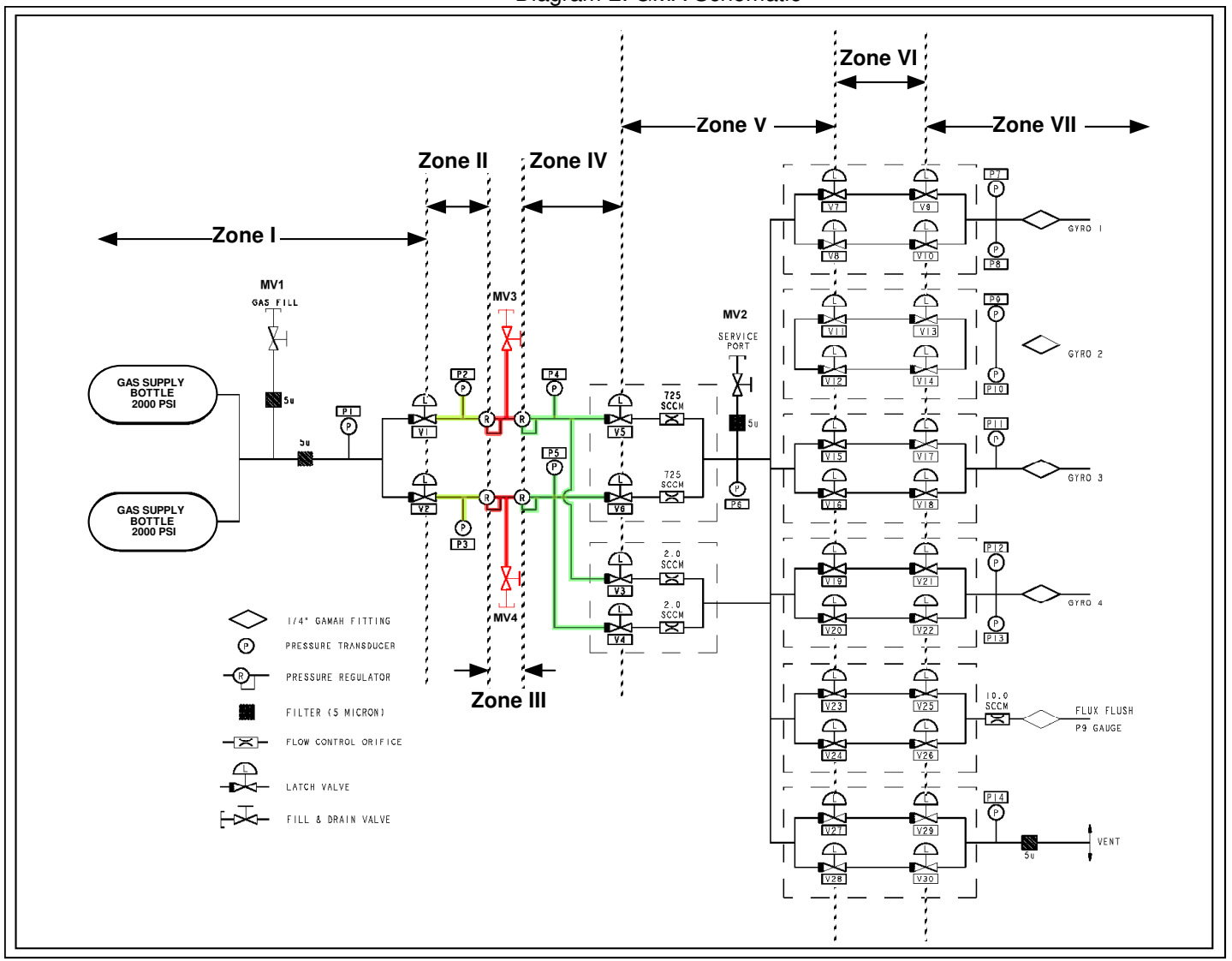

Outlet Manifold
Leak Detector
Top Hat
Vent Manifold
Vent/Supply
OM Vent 2
OM Vent 1
OM Valves
Fill and Drain Valves
OM Leak Valve
OMG-2
OMG-1
OMG-3
OMG-4
OMG-P1A
OM Vent 3
OM Purge Valve
S2
S1
S3
S4
P1A
MV1
Vent
FMV-4
MV4
MV3
GMA
FMV-3
MV2
FMV-2
He
GDS
500 psi
Low-Pressure Outlet
3500 psi
High-Pressure Outlet
Fill Manifolds
Legend
Gamah Connection
Filter
AN Connection
Vacuum Source
Pressure Gage
Regulator
Valve (GSE)
Valve (Flight)
Check Valve
Oct. 4, 2002
GMA Integration to S/V
SJB

Diagram 2: GMA Schematic



G.8 D-Logs

PART NAME:			DRAWING No:		LOT OR SERIAL No:		
					Transfer to	QE	RE
No:	Description of Discrepancy	Disposition/ Correction	Date Accepted	Rework	DR No:	Approval	Approval

G.9 Pre-Test 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. If helium is to be used verify that a blue "HELIUM" tag is around the neck of the helium cylinder.		
	6. Verify all hazardous steps to be performed are identified to the test team.		
	7. Verify each team member is certified for the task being performed and know their individual responsibilities.		
	8. 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.		
	9. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	10. 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.		
	11. Verify/Perform an Engineering and Safety high-bay walk down. Ensure all discrepancies are corrected prior to start of operations.		
	12.Confirm that each test team member understands that there will be a post-test team meeting.		
	TEAM LEAD SIGNATURE: _____		

G.10 Post-Test 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 not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	Team Lead Signature: _____		

G.11 Contingency/Emergency Responses

In the event of an emergency requiring shutdown and/or evacuation which does allow time for steps to be taken without endangering personnel, the following general steps should be taken, in order of priority (operator to determine sequence):

- Isolate the flight hardware wetted surfaces (fluid flow paths) from the exterior environment by closing GSE valves (GDS V-24, GDS V-25, OMPurge, and OMVent, or similar, as applicable to the state of assembly.)
- Use ECU to close all GMA solenoid valves.
- Record state of GMA and related flight volumes as known (valves open/closed, current pressures, ECU status, etc.).
- Shut down GSE as desired (leak detectors, vacuum sources, ECU control systems, GDS, etc.).

In the event of a power failure, the Test Director shall implement similar steps as applicable (see above emergency shutdown steps).

In the event that these steps have been taken (in part or whole), when it safe for personnel to return to the equipment:

- The Test Director shall perform an evaluation of the current state of the hardware.
- With concurrence of the GMA, Responsible Engineer and QA, the Test Director shall issue a d-log detailing the steps required to return the flight equipment to its prior state and to establish which step the procedure shall continue from. The test director may issue partial instructions (i.e. start up GSE) for the purpose of better evaluation of the flight hardware status.
- If the Test Director, Responsible Engineer, or QA believe it necessary, a discrepancy report may be issued for MRB review

H PROCEDURE SIGN OFF

The results obtained in the performance of this procedure are acceptable:

_____ date: _____
Test Director

Discrepancies if any:

Approved: _____ date: _____
C. Gray, GMA Responsible Engineer

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
D. Ross, QA