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

OPEN GAS INLET MANUAL (TOP HAT) VALVES

GP-B ENGINEERING PROCEDURE

To be performed at Vandenberg Air Force Base Building 1610

THIS DOCUMENT CONTAINS NON-HAZARDOUS OPERATIONS

P0977 Rev A

2 Oct, 2003

PREPARED	S. Buchholz, Prepared by	Date
APPROVED	K. Bower, GMA Engineer	Date
APPROVED	C. Gray, GMA REE	Date
APPROVED	Harv Moskowitz, LMSSC Safety Engineer	Date
APPROVED	D. Ross, Quality Assurance	Date
APPROVED	R. Brumley, Hardware Manager	Date

REVISION HISTORY

Rev	Date	Comments
-	5/23/03	
A	10/2/03	ECO #1445

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List of Abbreviations and Acronyms

D-Log	Discrepency Log
DR	Discrepency Report
ECU	Electronic Control Unit
ESD	Electro Static Discharge
FEE	Forward Equipment Enclosure
F&D	Fill and Drain Valves
GMA	Gas Management Assembly
GP-B	Gravity Probe B
GSE	Ground Service Equipment
He	Helium
LM	Lockheed Martin
MRB	Materials Review Board
NASA	National Aeronautics and Space Administration
POD	Not an acronym, its a cluster of computers
QA	Quality Assurance
c	
f	
m	
cfm	Standard Cubic Feet per Minute
SU	Stanford University
TD	Test Director
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

This procedure defines how to open the gas inlet manual (Top Hat) valves just prior to the FEE closure and Solar Panel integration. It will cover evacuating the probe supply lines through the Off-Pallet Fill and Drain valves, opening the Top Hat Valves and verification of minimal pressure rise once the valves are open. Removal of the required GSE is defined in P0974. The Top Hat valves isolate the GMA from the science probe. It is critical that the exposure time of any Helium leakage from the GMA to the probe is minimized. Therefore, this procedure will be run as late as possible in the program schedule. Upon completion of the operation, the Top Hat valves will be open and the space vehicle will be ready to close the FEE and integrate the Solar Panels. This is a non-hazardous procedure.

B SAFETY

B.1 General

The GMA is a gas pressure system. Under normal operations, the GMA requires no safety measures or equipment beyond those required for the use of a supply gas cylinderThe GMA and the Space Vehicle are high value space flight hardware and should be handled with great care. The GMA tanks (mounted underneath the GMA pallet) are fracture critical items. All of the GSE used in this procedure have pressure ratings considerably higher than the maximum expected operating pressures.

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.7**.

C QUALITY ASSURANCE

C.1 QA Notification

This operation will be conducted on a formal basis to approved and released procedures. **The QA program office 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.

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 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

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
ECU Controller (in POD or MOC)	1	Stanford

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

- GMA on Space Vehicle
- Flight ECU with POD access and approved software
- Outlet Manifold Hardware to connect to Space Vehicle Off Pallet F&D Valves.
- Varian Pump cart (or alternate vacuum source)
- Research Grade (certified 99.9999%) Helium Supply: one (>1000psig) bottle for purge gas supply.
- Leak detector
- Agilent Data logger
- Power Supply and Distribution box
- Cables for data Logger
- IBM Laptop computer & logging software
- Moog conical seal gaskets, for flight, as required (5+): part #C33934-004
- Torque wrenches as required
  #1) Make/model _____ S/N _____ Certificate expiration _____

#2) Make/model _____ S/N _____ Certificate expiration _____

#3) Make/model _____ S/N _____ Certificate expiration _____

E.4 Instrument Pretest Requirements

N/A

E.5 Configuration Requirements

- The GMA is physically mounted, plumbed, and electrically grounded on the Space Vehicle (per LMMS INT-334 and SU P0945).
- Outlet Manifold is connected to the off-pallet F&D Valves (per P0974).
- ECU operations are available and P9 gauge(s) working.
- Appropriate FEE skins off
- Final GMA Rate of Pressure Rise Test is complete (P0974)

E.6 Optional Non-flight Configurations

N/A

E.7 Verification/ Success Criteria

Top Hat valves are open and probe pressure < $2x10^{-3}$ torr.

E.8 Constraints and Restrictions

None

F REFERENCE DOCUMENTS

F.1 Drawings

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

F.2 Supporting Documentation

Document No.	Title
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
P0974	GMA Pressure Rate of Rise Procedure
Various	ECU operations as applicable

G OPERATIONS

G.1 Verify Appropriate QA Notification

QA Notified:

_____
(Date & Time)

G.2 Verify Configuration Requirements

- Assemble test team and complete Pre-Test Checklist in Section **G.6**.
- Appropriate Spacecraft FEE skins are off
- Verify Flight ECU is available and P9 gauge is operational. (If P9 is not operating at startup of P0977, activate P9A and P9B then wait 30 minutes for gauges to stabilize.)
- Record P9 pressure(s): _____
- Verify GMA valve configuration is in 'Ground Mode' (all valves closed)
- Verify the Outlet Manifold is connected to the Off-pallet Fill and Drain valves per **Figure 1**.

Section complete. **Quality** _____

G.3 Open Gas Inlet Manual Valves

Started on: _____

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

G.3.1 Verify OM Leak Valve, OMG Valves and the OM Purge valves on the Outlet Manifold are closed.

G.3.2 Start vacuum pump attached to the outlet manifold.

G.3.3 Open OM Purge Valve and the OMG valves.

G.3.4 Verify the Outlet manifold is under vacuum [$<1 \times 10^{-3}$ torr].

G.3.5 Open the five off-pallet F&D valves and log as required.

G.3.6 Verify the P9 gauge under vacuum [$< 1 \times 10^{-3}$ torr] and record pressure(s) _____.

G.3.7 Close all off-pallet F&D valves and torque (40±5 in.lbs. over running torque). Record running torque below.

Wrench used_____

F&DS2 running torque _____ QA _____

F&DS1 running torque _____ QA _____

F&DS3 running torque _____ QA _____

F&DS4 running torque _____ QA _____

F&DP1A running torque _____ QA _____

G.3.8 Using gloved hands, check the Off Pallet F&D Valve stems for radial deflection.

G.3.9 Retorque the Off Pallet F&D Valves to 40±5 in.-lbs.

If any stem deflection or rotation in the valve during retorquing is observed, repeat steps G.3.8 and G.3.9 (only for the necessary line(s)) until valves are secure.

G.3.10 Close the valve to the vacuum pump on the outlet manifold.

G.3.11 Set the pressure regulator to 50 psia (±10 psi)and open the inlet supply valve on the outlet manifold. Wait one hour and verify the P9 gauge remains under vacuum [< 1 $x10^{-3}$ torr] and record pressures A_____ B_____.

G.3.12 Close the inlet supply valve on the outlet manifold.

G.3.13 Crack open the valve to the vacuum pump and evacuate the outlet manifold.

G.3.14 Verify the Outlet Manifold is under vacuum [<1 $x10^{-3}$ torr] then turn off vacuum pump if desired.

G.3.15 Remove data logger and associated cables from the Outlet Manifold.

G.3.16 Set up a helium environment for installing the flight caps (i.e. glove bag).

G.3.17 Remove any Outlet Manifold GSE as desired.

G.3.18 Using gloved hands, check the Off Pallet F&D Valve stems for radial deflection.

G.3.19 Retorque the Off Pallet F&D Valves to 40±5 in.-lbs.

G.3.20 If any stem deflection or rotation in the valve during retorquing is observed, reinstall the GSE and repeat steps G.3.1 thru G.3.20 (only for the necessary line(s)) until valves are secure.

G.3.21 Install flight caps and conical seals (120±10 in.lbs.) on Off Pallet F&D Valves and log as required.

Wrench used_____

F&DS2 running torque _____ QA _____

F&DS1 running torque _____ QA _____

F&DS3 running torque _____ QA _____

F&DS4 running torque _____ QA _____

F&DP1A running torque _____ QA _____

G.3.22 Using gloved hands, check the Off Pallet F&D Valve stems for radial deflection.

G.3.23 Retorque the Off Pallet F&D Valves to 40±5 in.lbs.

G.3.24 If any stem deflection or rotation in the valve during retorquing is observed, reinstall the GSE and repeat steps G.3.1 thru G.3.24 (only for the necessary line(s)) until valves are secure.

Caution:
Opening the P1A valve could expose the probe to Helium gas. Monitor the P9 gauge to verify the pressure rise within the probe is kept to a minimum.

G.3.25 Open Top Hat Valve P1A and record the P9 gauge pressures. If the probe pressure rises to >2x10^{-3}, close P1A immediately and consult the test director, else continue.

A) _____ B) _____

G.3.26 Monitor the P9 gauge(s) for 10 minutes. If the probe pressure rises to >2x10^{-3}, close P1A immediately and consult the test director, else continue. Record the final P9 gauge pressures.

A)_____ B) _____

Note:
Opening valves S1 through S4 (steps G.3.27 to G.3.34) can be completed in non-sequential order if desired.

G.3.27 Open Top Hat Valve S1 and monitor the P9 gauge(s). Close S1 if the pressure rises to >2x10^{-3}.

G.3.28 Record the P9 gauge pressures: A)_____ B) _____

G.3.29 Open Top Hat Valve S2 and monitor the P9 gauge(s). Close S2 if the pressure rises to $>2x10^{-3}$.

G.3.30 Record the P9 gauge pressures: A)_____ B) _____

G.3.31 Open Top Hat Valve S3 and monitor the P9 gauge(s). Close S3 if the pressure rises to $>2x10^{-3}$.

G.3.32 Record the P9 gauge pressures: A)_____ B) _____

G.3.33 Open Top Hat Valve S4 and monitor the P9 gauge(s). Close S4 if the pressure rises to $>2x10^{-3}$.

G.3.34 Record the P9 gauge pressures: A)_____ B) _____

G.3.35 Remove each manual valve hex handle completely from the valve assembly and give to LMMS personnel to account for non-flight hardware removed before flight.

Warning:

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

G.3.36 Wipe off as much valve lubrication as possible from the removed manual valve hex handles. Use alcohol if desired.

G.3.37 Record the P9 gauge pressures: A)_____ B) _____

G.3.38 Wait ten minutes.

G.3.39 Record the P9 gauge pressures: A)_____ B) _____

Section complete. **Quality** _____

G.4 Completion

Started on: _____

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

G.4.1 Shut down ECU if desired.

G.4.2 Disconnect remaining GSE as desired per P0974.

G.4.3 Visually inspect exterior surface of flight hardware and remove contamination if required

G.4.4 Assemble test team and complete Post Test Checklist in Section **G.7.**

G.5 Drawings

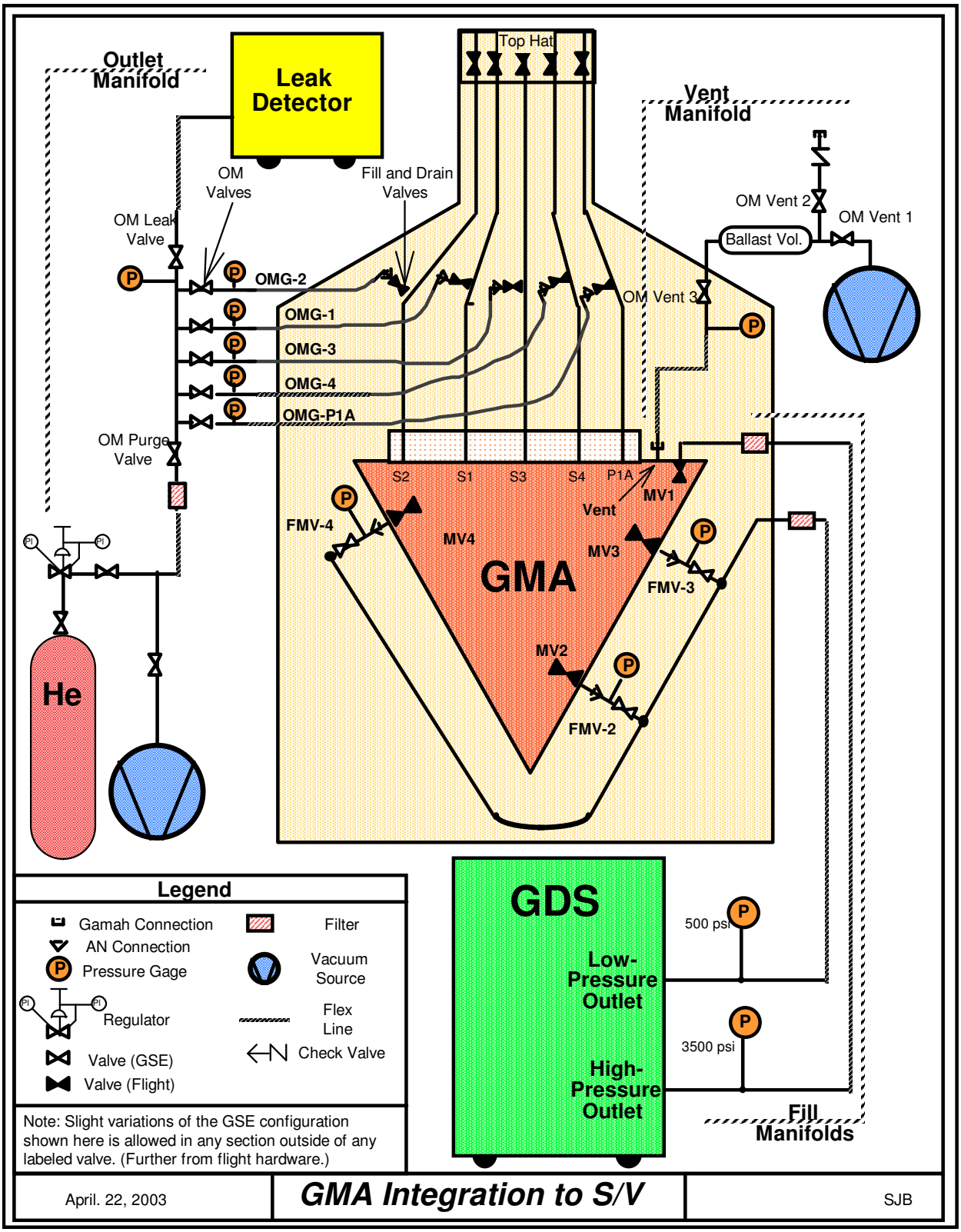
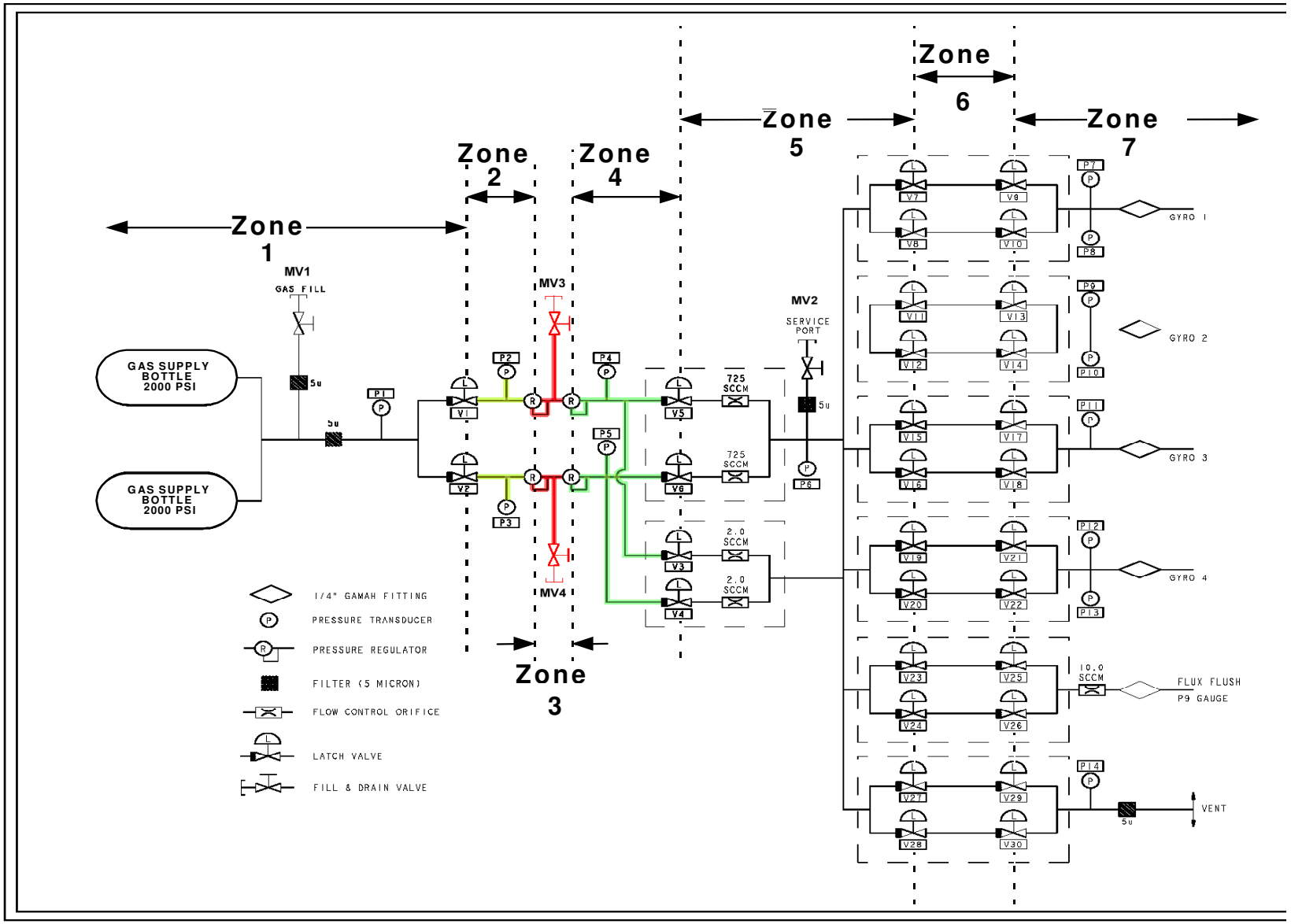


Figure 1



GMA Schematic - Figure 2

G.6 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 each team member is certified for the task being performed and know their individual responsibilities.		
	5. 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.		
	6. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	7. 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.		
	8. Verify/Perform an Engineering and Safety high-bay walk down. Ensure all discrepancies are corrected prior to start of operations.		
	9. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

G.7 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.8 Contingency/Emergency Responses

G.8.1 Emergency Shutdown/ Evacuation

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 (OM Valves, or similar, as applicable to the state of assembly.)
- Record state of all 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, etc.).

G.8.2 Power Failure

In the event of a power failure, the Test Director shall implement similar steps (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.
- 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