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STANFORD, CALIFORNIA 94305-4085

SCRUB LAUNCH RECOVERY PROCEDURE FOR THE GMA

GP-B ENGINEERING PROCEDURE

To be performed at Vandenberg Air Force Base
To be performed on the MST

THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

P0972 Rev A

13 October, 2003

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APPROVED	C. Gray, GMA REE	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 HISTORY

Rev	Date	Comments
-	5/14/03	
A	11/10/03	Added software scripts ‘gma_press_meas.prc’ and ‘gma_grd_mode.prc’

TABLE OF CONTENTS

List of Abbreviations and Acronyms

AVA	Access valve Assembly	NASA	National Aeronautics and Space Administration
D-Log	Discrepancy Log	POD	Not an acronym, its a cluster of computers
DR	Discrepancy Report	psi	pounds per square Inch
ESD	Electro Static Discharge	psia	pounds per square inch absolute (=psig+14.7)
GMA	Gas Mangement Assembly	psig	pounds per square inch gauge
GP-B	Gravity Probe B	QA	Quality Assurance
GSE	Ground Service Equipment	SU	Stanford University
He	Helium	S/V	Space Vehicle
LM	Lockheed Martin	VAFB	Vandenberg Air Force Base
MOC	Mission Operations Center	VSC	Vent Service Cart
MST	Mobile Service Tower		

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 return the GMA to a launch ready 'ground state' in the event of a scrubbed launch. It covers installation of GSE hardware to the GMA vent extension, servicing the GMA as required on the MST and then removal of GSE. All precautions will be made to insure that the GMA gas paths stay as clean as possible. This procedure will maintain regulator lockup and limit probe contamination.

This procedure is labeled hazardous because it includes operations over 150 psi (400 psi maximum) and uses pressure systems over 250 psi (GMA: 2000 psia maximum).

B SAFETY

B.1 General

The GMA is a self-contained gas delivery device and contains volumes under gas pressure (<2000 psia). During this procedure, the configuration of the GMA will be such that the primary gas tanks are protected from impact by the GMA pallet and therefore do not present a realistic safety concern. Personnel Protective Equipment (PPE) will be worn during hazardous operations as required by location.

The GMA and the Space Vehicle are high value space flight hardware and should be handled with great care. The manifold line connected to the GMA vent extension outlet may be exposed to pressures of up to 300 psia and therefore presents a minor safety concern. Purge operations typically run at around 5-20 psig, regulator bleed down releases very small volumes of <300 psig gas into large vented volumes. All of the GSE used in this procedure have pressure ratings considerably higher than the maximum expected operating pressures.

Care should be exercised during all connections to flight hardware to prevent contamination of wetted surfaces by particulates. Smocks, bonnets, and gloves (consistent with Class 10,000 practices) shall be worn whenever handling flight hardware. Full hoods, coveralls, bootcovers, and clean gloves (consistent with S/V class 100 practices) shall also be worn whenever working with flight wetted surfaces. The operator making any fluid connections shall do a visual inspection before making the connection.

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.10**.

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 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 judgment 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

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
Boeing TC/Safety	1	Boeing
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 mounted on Space Vehicle
- Flight ECU with POD/MOC access and 'launch_recovery.prc' , 'gma_press_meas.prc', 'gma_grd_mode.prc' script software
- Vent Service Cart (VSC), with supply tank > 500 psig
- Flex Line(s) to connect AVA to VSC (Service hoses, level 100A cleanliness)
- AVA - LM Part #8A03345GSE-101
- Leak Detector, Alcatel (or alternate), internally calibrated
  Model#_____
- Agilent Data logger to record AVA sensor
- Power Supply and Distribution box
- Cables for data Logger
- IBM Laptop computer & logging software
- VCR gaskets

E.4 Instrument Pretest Requirements

N/A

E.5 Configuration Requirements

- GMA is physically mounted and electrically grounded on the Space Vehicle (per LMMS INT-334 and SU P0945).
- ECU operations available

E.6 Optional Non-flight Configurations

N/A

E.7 Verification/ Success Criteria

GMA will be pressurized with all solenoid valves closed

E.8 Constraints and Restrictions

None

F REFERENCE DOCUMENTS

F.1 Drawings

Drawing No.	Title
26273	GMA Schematic, GP-B Dwg
SU-VSC-A001	Vent Service Cart
LM-8A03346GSE	Access Valve Assembly, Assembly Integration
LM-8A03340	GMA Pallet Vent Port Access Plumbing Assembly

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
Various	ECU operations as applicable
LM O/O MST-007	Preparation of the GMA Vent Access Assembly, Service (Non-Flight) Configuration
LM O/O MST-006	Preparation of the GMA Vent Access Assembly, Flight Configuration

G OPERATIONS

G.1 Verify Appropriate QA Notification

QA Notified

_____
(Date & Time)

Boeing Program and Safety Representative Notified:

_____
(Date & Time)

G.2 Setup of GMA and Space Vehicle

Started on: _____

Note: Mark off each step of procedure as it is completed.
All GMA solenoids will be operated using the ECU.

G.2.1 Assemble test team and complete Pre-Test Checklist (Section **G.8**)

G.2.2 Start 'Launch Recovery.PRC' script software to control the GMA solenoid valves. Make note of all problems in a Discrepancy Log.

G.2.3 Close all GMA valves.

G.2.4 Remove GMA fairing access panel per Boeing Launch Preparation Document (Boeing provided Support Crew).

G.2.5 Install hardware safety net between fairing and space vehicle.

G.2.6 Install the AVA per LM O/O MST-007.

G.2.7 Verify tethered VCR cap to Port #1 on the GMA Access Vent Port Nullifier is installed.

G.2.8 Connect data logger and related cables to the AVA then verify operation.

G.2.9 Verify all personnel involved in hazardous task are certified, equipped, briefed, and ready to proceed. Test Director or Safety_____.

Section complete. **Quality** _____

G.3 Install GMA Service Manifold

Started on: _____

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

G.3.1 Verify section **G.2** is complete.

G.3.2 Verify all VS, Access and GMA valves are closed.

G.3.3 Measure GMA system pressures and record values in Section **G.7** when possible.

G.3.4 Connect a service hose to the AVA Service Port with an additional service hose to the VSC as shown in **Figure 1**.

G.3.5 Join the service hoses.

G.3.6 Verify all GSE valves are closed.

G.3.7 Turn on leak detector and verify leak detector calibration with leakage standard.

Record Leak Standard Range: _____ Cal Date: _____

G.3.8 Connect leak detector to service port at GV-7 and start leak detector. Record leak detector sensitivity and leak check results _____.

G.3.9 Start vacuum pump on the VSC and begin evacuation.

G.3.10 Open GV-6, GV-3 and GV-4 then pump down to $<1x10^{-3}$ torr.

G.3.11 Close GV-6 and open GV-7.

G.3.12 Leak check all connections to GSE. GSE shall be tight to <1x10-7 sccs. Record leak check results _____.

G.3.13 Close GV-7 and open GV-6.

G.3.14 Open the Access Valve and evacuate the Vent line Extension.

G.3.15 Close GV-6 and open GV-7.

G.3.16 Check for gross leaks at AVA connections. Repair any found leaks then record leak check results _____.

G.3.17 Close GV-7

G.3.18 Evacuate (<1 torr), purge (with Helium), and evacuate Service Manifold to remove air residue.

G.3.19 Close GV-3, GV-4, GV-6 and the Access Valve. Turn off vacuum pump if desired.

Section complete. **Quality** _____

G.4 Service GMA

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 Verify Section **G.3** is complete.

G.4.2 Request the area operation light be changed to Amber.

G.4.3 Establish a10 foot diameter controlled area.

G.4.4 Request a PA announcement that a hazardous task is about to begin.

G.4.5 Ensure all nonessential personnel are clear of controlled area.

G.4.6 Request Boeing TC/ Safety concurrence to proceed with hazardous operations _____

G.4.7 Measure GMA system pressures and record values in Section **G.7** when possible.

G.4.8 The Test Director will make an estimate of the pressure in Zone V based upon elapsed time and the previous Rate of Rise Test data_____(< 300 psia).

G.4.9 Verify valves GV-6 and GV-7 are closed.

G.4.10 Open GV-2 and set VSC pressure regulator to the above pressure.

G.4.11 Open GV-3, GV-4 and the Access Valve then allow pressure to stabilize.

G.4.12 Close the Access Valve and record AVA sensor pressure_____.

G.4.13 Use “gma_press_meas.prc” script to open GMA valves V27 and V29 and/or V28 and V30.

G.4.14 Let the pressure equalize then measure GMA system pressures and the AVA sensor. Record values in Section **G.7** when possible.

G.4.15 Use “gma_press_meas.prc” script to open GMA valves V7 and V8.

G.4.16 Let the pressure equalize then measure GMA system pressures and the AVA sensor. Record values in Section **G.7** when possible.

G.4.17 Use “gma_press_meas.prc” script to open GMA valves V11 and V12.

G.4.18 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible.

G.4.19 Use “gma_press_meas.prc” script to open GMA valves V15 and V16.

G.4.20 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible. Note any significant pressure changes.

G.4.21 Use “gma_press_meas.prc” script to open GMA valves V23 and V24.

G.4.22 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible. Note any significant pressure changes.

G.4.23 If the VSC pressure differs from the AVA sensor by > 50 psi then vent excess pressure by cracking open GV-5. Slowly release pressure to obtain the correct pressure then close GV-5. Reset the VSC pressure regulator to match within 50 psi.

G.4.24 Open Access Valve.

G.4.25 Vent pressure by doing the following: Close GV-2 and GV-3 then crack open GV-5. Slowly release pressure to 10 psig. Close GV-5.

G.4.26 Turn on vacuum source and slowly open GV-6.

G.4.27 Evacuate to <5x10^-3 torr.

G.4.28 Use “gma_press_meas.prc” script to close GMA valves V7, V8, V11, V12, V15, V16, V23 and V24.

G.4.29 Close GV-6 then turn off vacuum pump if desired.

G.4.30 Measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible.

G.4.31 Set VSC pressure regulator to a minimum ($\leq$50 psia) and slowly open GV-3.

G.4.32 Slowly increase the regulator pressure to 300 psia ($\pm$30 psi, change rate<100 psi/ min).

G.4.33 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible.

G.4.34 Close the Access Valve.

G.4.35 Use “gma_grd_mode.prc” script to open GMA valves V3, V4, V5 and V6.

G.4.36 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.7** when possible.

G.4.37 Open Access Valve.

G.4.38 Let the pressure equalize and measure GMA system pressures and record values in Section **G.7** when possible.

G.4.39 Set GMA valves to “all valves closed” using the ‘gma_grd_mode.prc’.

G.4.40 Measure GMA system pressures and record values in Section **G.7** when possible.

G.4.41 Vent pressure by doing the following: Close GV-2 and crack open GV-5. Slowly release pressure to atmosphere. Close GV-5.

NOTE
THE HAZARDOUS OPERATION OF THIS SECTION IS NOW COMPLETE.

G.4.42 Request PA announcement that hazardous operations are now complete.

G.4.43 Ensure area warning light is returned to green.

G.4.44 Disband controlled area.

Section complete. **Quality** _____

G.5 Disconnect GMA Service Manifold

Started on: _____

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

G.5.1 Verify the Service Manifold is near atmospheric pressure and all GMA valves are closed.

G.5.2 Verify VSC valves GV-1, GV-2, GV-3, GV-4, GV-5, GV-6 and GV-7 are closed

G.5.3 Disconnect the flex line(s)connecting the Service Manifold from the space vehicle at the AVA Service Port. Cap hose ends.

G.5.4 Disconnect Data Logger and associated cables.

G.5.5 Disconnect VCR cap from Port #1 on the GMA Access Vent Port Nullifier and remove the VCR gasket (bag them).

G.5.6 Remove AVA per LM O/O MST-006 and bag it.

G.5.7 Close GMA access panel on the fairing per Boeing Launch Preparation Document (Boeing provided Support Crew).

G.5.8 Remove GSE from the MST as required.

G.5.9 Assemble test team and complete Post Test Checklist in Section **G.9**.

G.6 Drawings

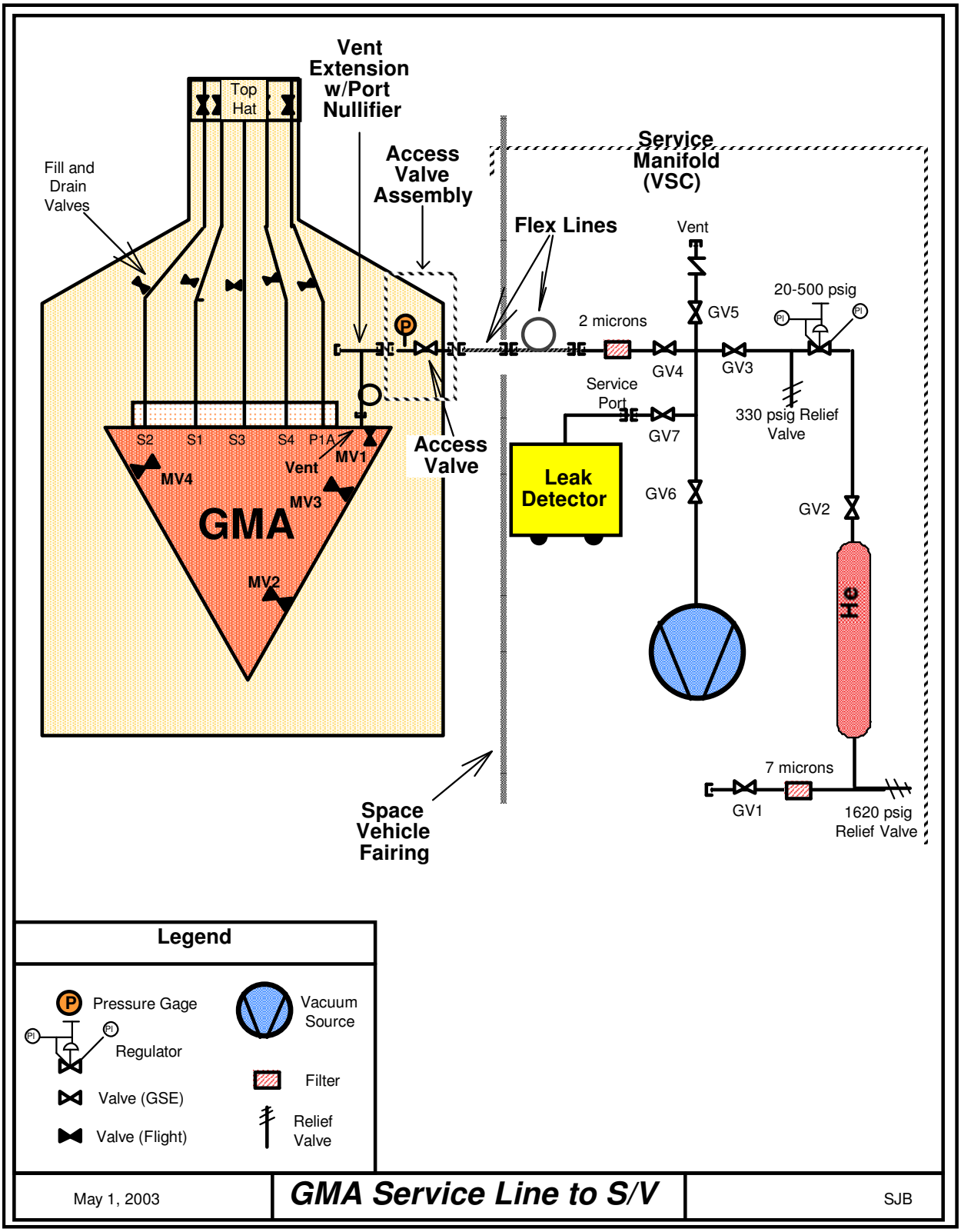
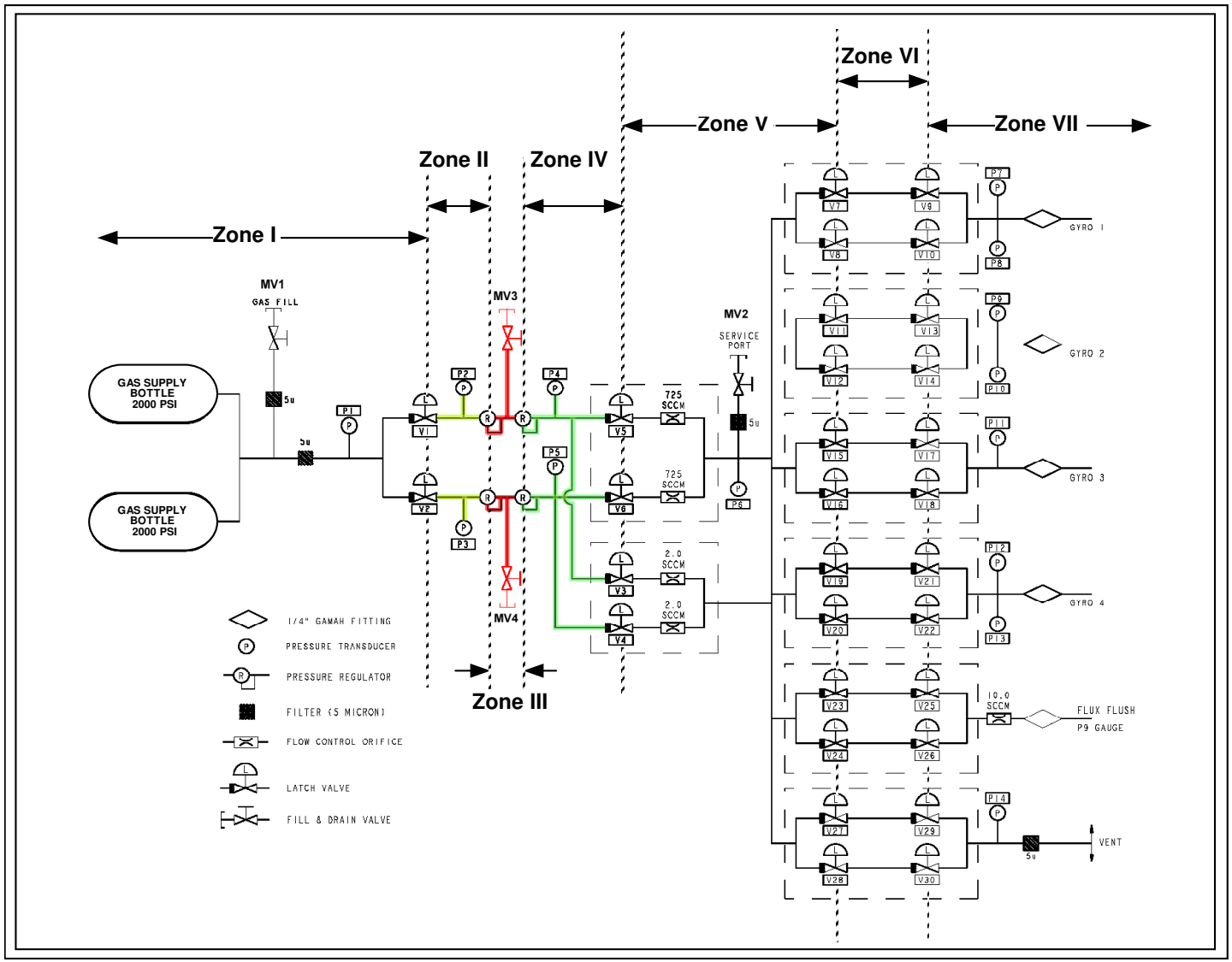


Figure 1



GMA Schematic

Figure 2

G.7 Pressure Sensor Log Table

			GMA Sensors Counts or psi														AVA Sensor
Sect: Step	Date	Time	GP1	GP2	GP3	GP4	GP5	GP6	GP7	GP8	GP9	GP10	GP11	GP12	GP13	GP14	500 psia

G.8 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. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member is certified for the task being performed and know 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. During a hazardous operation, the test will only be stopped when it is safe to do so.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly. During a hazardous operation, the test will only be stopped when it is safe to do so.		
	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: _____ _____		

G.9 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.10 Contingency/Emergency Responses

G.10.1 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 (all VSC valves and the Access Valve).
- 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, etc.).

G.10.2 Power Failure

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