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STANFORD, CALIFORNIA 94305-4085

GMA VENT EXTENSION SERVICE PROCEDURE

GP-B ENGINEERING PROCEDURE

To be performed at Vandenberg Air Force Base in Bldg 1610 and on the MST

THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

P0973 Rev –

23 May, 2003

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APPROVED	R. Brumley, Hardware Manager	Date

REVISION HISTORY

Rev	Date	Comments
-	5/23/03	

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	PPE	Personnel Protective Equipment
ECU	Electronic Control Unit	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	VCR	Vacuum Coupling RAD (Lawerence Livermore Radiation Laboratory)
MRB	Materials Review Board		
MST	Mobile Service Tower	VSC	Vent Service Cart

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 service the GMA through the Vent Extension Service Line. It covers installation of GSE hardware to the GMA vent extension line (with and without fairing installed) and servicing the GMA as required in Building 1610 and on the MST. This procedure will maintain regulator lock-up and limit probe contamination. Section **G.5** of this procedure will be run several times to mitigate GMA potential cryo contamination and maintain regulator lock-up before launch.

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 risk has been minimized. 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. 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.12**.

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 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 and 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 (1610 only)	SFAO or Analex
ECU Controller (in POD or MOC)	1	Stanford
Boeing TC/Safety	1 (MST only)	Boeing

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 approved software
- Vent Service Cart (VSC), with supply tank > 500 psig
- Flex Line(s) to connect AVA to VSC (Service hoses, level 100A cleanliness)
- AVA installed on S/V - 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 Zone V will be pressurized to a nominal 300 psia (±30 psi) to support regulator lock-up.

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 INT-362	Integration of the GMA Pallet Vent Port Access Line Assembly
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)

NASA Program and Safety or Boeing TC 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 the test team and complete Pre-Test Checklist (Section **G.10**)

G.2.2 Start 'Null' 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 Verify the AVA is installed per LM O/O INT-362.

G.2.5 Verify tethered VCR cap to Port #1 on the GMA Access Vent Port Nullifier is installed and fairing safety net is installed to catch any dropped hardware inside the S/V.

G.2.6 Connect data logger and related cables to the AVA then verify operation.

G.2.7 Verify all personnel involved in hazardous task are certified, equipped, briefed, and ready to proceed. Test Director or Safety_____

Section complete. **Quality** _____

G.3 Connect VSC to AVA in1610

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 VSC, Access and GMA valves are closed.

G.3.3 Measure GMA system pressures and record values in Section **G.9** when possible.

G.3.4 Connect a service hose to the AVA Service Port and another 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 Initial GMA Service

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 31 March 1995).

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 Measure GMA system pressures and record values in Section **G.9** when possible.

G.4.7 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.4.8 Verify valves GV-6 and GV-7 are closed.

G.4.9 Open GV-2 and set VSC pressure regulator to the above pressure.

G.4.10 Open GV-3, GV-4 and the Access Valve then allow pressure to stabilize.

G.4.11 Close the Access Valve and record AVA sensor pressure_____.

G.4.12 Open GMA valves V27 and V29 and/or V28 and V30.

G.4.13 Let the pressure equalize then measure GMA system pressures and the AVA sensor. Record values in Section **G.9** when possible.

G.4.14 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.4.15 Open Access Valve.

G.4.16 If the AVA sensor indicates that Zone V pressure is < 300 (±30), then slowly increase the regulator pressure to 300 psia (±30 psi, change rate<100 psi/min).

G.4.17 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.9** when possible.

G.4.18 Verify data logger is functioning correctly and recording the AVA sensor.

G.4.19 Close the Access valve.

NOTE
THE HAZARDOUS OPERATION OF THIS SECTION IS NOW COMPLETE.

G.4.20 Request PA announcement that hazardous operations are now complete.

G.4.21 Ensure area warning light is returned to green.

G.4.22 Disband controlled area.

Section complete. **Quality** _____

G.5 GMA Service Interval

Started on: _____

Note:
Mark off each step of this section as it is completed. This section of the procedure maybe run independent of the other sections once GMA service has been established.

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 31 March 1995).

G.5.1 Verify GMA Service has already been established.

G.5.2 Request the area operation light be changed to Amber.

G.5.3 Establish a10 foot diameter controlled area.

G.5.4 Request a PA announcement that a hazardous task is about to begin.

G.5.5 Ensure all nonessential personnel are clear of controlled area.

G.5.6 Measure GMA system pressures and record values in Section **G.9** when possible.

G.5.7 Record current AVA sensor reading_____(~ 300 psia)

G.5.8 Verify VSC pressure regulator is set to 300 psia ((±30 psi).

G.5.9 Crack open the Access Valve and let the pressure equalize.

G.5.10 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.9** when possible.

G.5.11 Verify data logger is functioning correctly and recording the AVA sensor.

G.5.12 Close the Access Valve.

NOTE
THE HAZARDOUS OPERATION OF THIS SECTION IS NOW COMPLETE.

G.5.13 Request PA announcement that hazardous operations are now complete.

G.5.14 Ensure area warning light is returned to green.

G.5.15 Disband controlled area.

Section complete. **Quality** _____

G.6 Disconnect VSC in 1610

Started on: _____

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

G.6.1 Measure GMA system pressures and the AVA sensor. Record values in Section **G.9** when possible.

G.6.2 Close GMA valves V27 and V29 and/or V28 and V30.

G.6.3 Close the Access Valve and lock with tethered carabiner

G.6.4 Vent pressure by doing the following: Close GV-2 and GV-3 then crack open GV-5. Slowly release pressure to between 1 to10 psig. Close GV-5.

G.6.5 Verify all GMA valves are closed (Ground Mode).

G.6.6 Verify VSC valves GV-1, GV-2, GV-3, GV-4, GV-5, GV-6 and GV-7 are closed

G.6.7 Disconnect the short service hose from the longer service hose.

G.6.8 Cap ends of both hoses.

G.6.9 Disconnect the data logger.

G.6.10 Secure service hose to the S/V.

G.6.11 Remove GSE as required.

Section complete. **Quality** _____

G.7 Re-Connect VSC to GMA on MST

Started on: _____

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

G.7.1 Measure GMA system pressures and the AVA sensor. Record values in Section **G.9** when possible.

G.7.2 Un-secure the short service hose from the S/V.

G.7.3 Position the VSC close enough to the S/V for ease of connecting.

G.7.4 Remove caps from the ends of the long and short service hoses and bag them.

G.7.5 Join the long and short service hoses.

G.7.6 Verify all GSE and GMA valves are closed.

G.7.7 Turn on leak detector and verify leak detector calibration with leakage standard.
Record Leak Standard Range: _____ Cal Date: _____

G.7.8 Connect leak detector to service port at GV-7 and start leak detector. Record leak detector sensitivity and leak check VSC results _____.

G.7.9 Start vacuum pump on the VSC and begin evacuation.

G.7.10 Open GV-6, GV-3 and GV-4 then pump down to $<1x10^{-3}$ torr.

G.7.11 Close GV-6 and open GV-7.

G.7.12 Leak check all connections and repair any found leaks. Leak check results _____.

G.7.13 Close GV-7.

G.7.14 Evacuate (<1 torr), purge (with Helium), and evacuate Service Manifold to remove air residue.

G.7.15 Close GV-3, GV-4 and GV-6. Turn off vacuum pump if desired.

G.7.16 Measure GMA system pressures and record values in Section **G.9** when possible.

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.7.17 Request the area operation light be changed to Amber.

G.7.18 Establish a10 foot diameter controlled area.

G.7.19 Request a PA announcement that a hazardous task is about to begin.

G.7.20 Ensure all nonessential personnel are clear of controlled area.

G.7.21 Record current AVA sensor reading_____(~ 300 psia)

G.7.22 Open GMA valves V27 and V29 and/or V28 and V30.

G.7.23 Let the pressure equalize then record current AVA sensor reading_____(~ 300 psia)

G.7.24 Open GV-2 and set VSC pressure regulator to the above pressure.

G.7.25 Open GV-3, GV-4 and the Access Valve then allow pressure to stabilize.

G.7.26 Record AVA sensor pressure_____.

G.7.27 Let the pressure equalize then measure GMA system pressures and the AVA sensor. Record values in Section **G.9** when possible.

G.7.28 If the AVA sensor indicates that Zone V pressure is < 300 ($\pm$30), then slowly increase the regulator pressure to 300 psia ($\pm$30 psi, change rate<100 psi/ min).

G.7.29 Let the pressure equalize then measure GMA system pressures and AVA sensor. Record values in Section **G.9** when possible.

G.7.30 Verify data logger is functioning correctly and recording the AVA sensor.

G.7.31 Close the Access valve.

NOTE THE HAZARDOUS OPERATION OF THIS SECTION IS NOW COMPLETE.

G.7.32 Request PA announcement that hazardous operations are now complete.

G.7.33 Ensure area warning light is returned to green.

G.7.34 Disband controlled area.

Section complete. **Quality** _____

G.8 Disconnect GMA Service GSE for Pre-Flight

Started on: _____

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

G.8.1 Measure GMA system pressures and the AVA sensor. Record values in Section **G.9** when possible.

G.8.2 Close GMA valves V27 and V29 and/or V28 and V30.

G.8.3 Verify the Access Valve is open.

G.8.4 Verify all GMA valves are closed.

G.8.5 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.8.6 Verify VSC valves GV-1, GV-2, GV-3, GV-4, GV-5, GV-6, GV-7 and the Access Valve are closed.

G.8.7 Disconnect Data Logger and associated cables.

G.8.8 Disconnect VCR cap from Port #1 on the GMA Access Vent Port Nullifier and remove the VCR gasket (bag them).

G.8.9 Disconnect the short and longer service hoses. Cap hoses ends.

G.8.10 Remove AVA per LM O/O MST-006 and bag it.

G.8.11 Verify fairing safety net is removed.

G.8.12 Remove GSE from the MST as required.

G.8.13 Assemble the test team and complete the Post Test Checklist in Section **G.11**.

G.9 Drawings

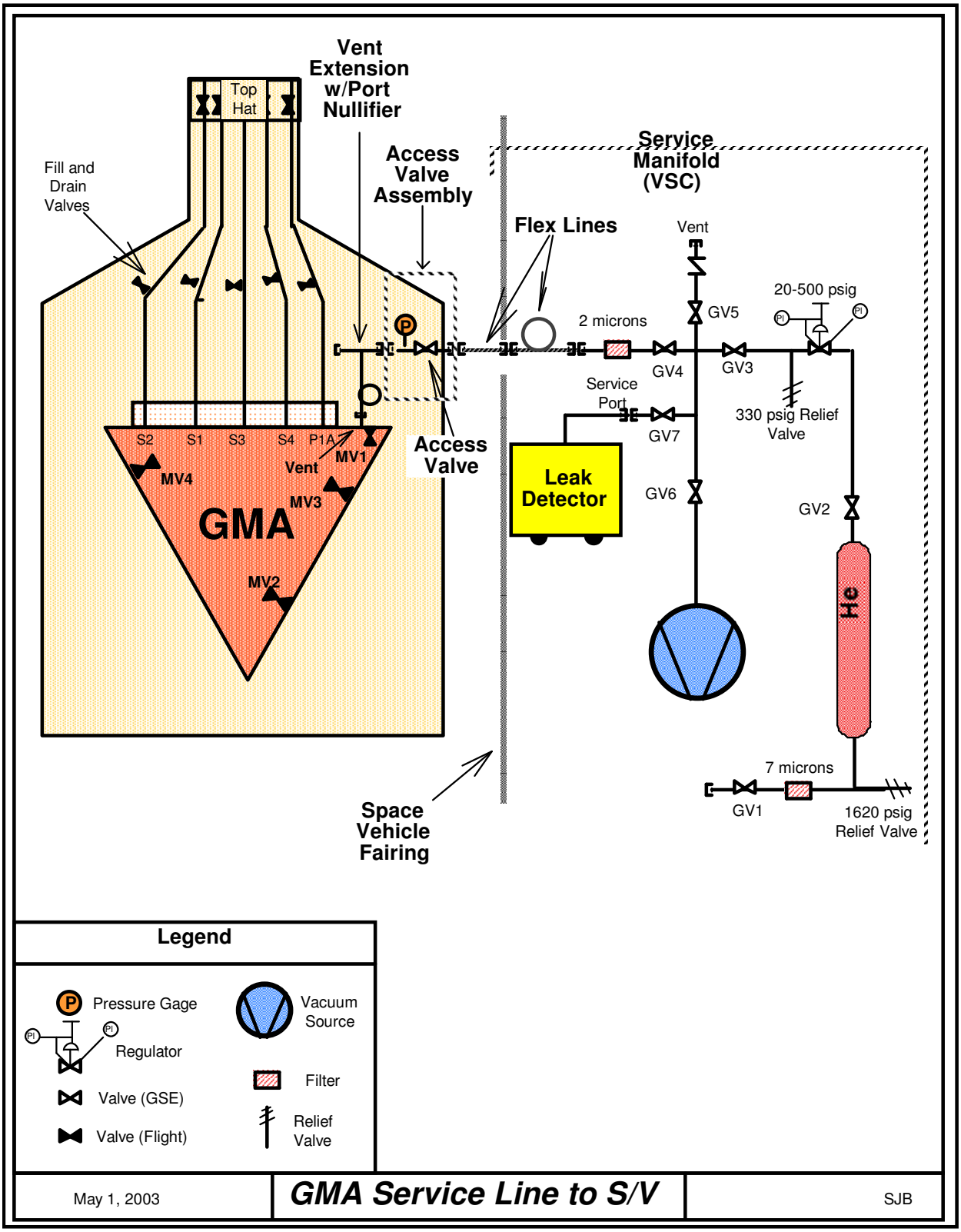
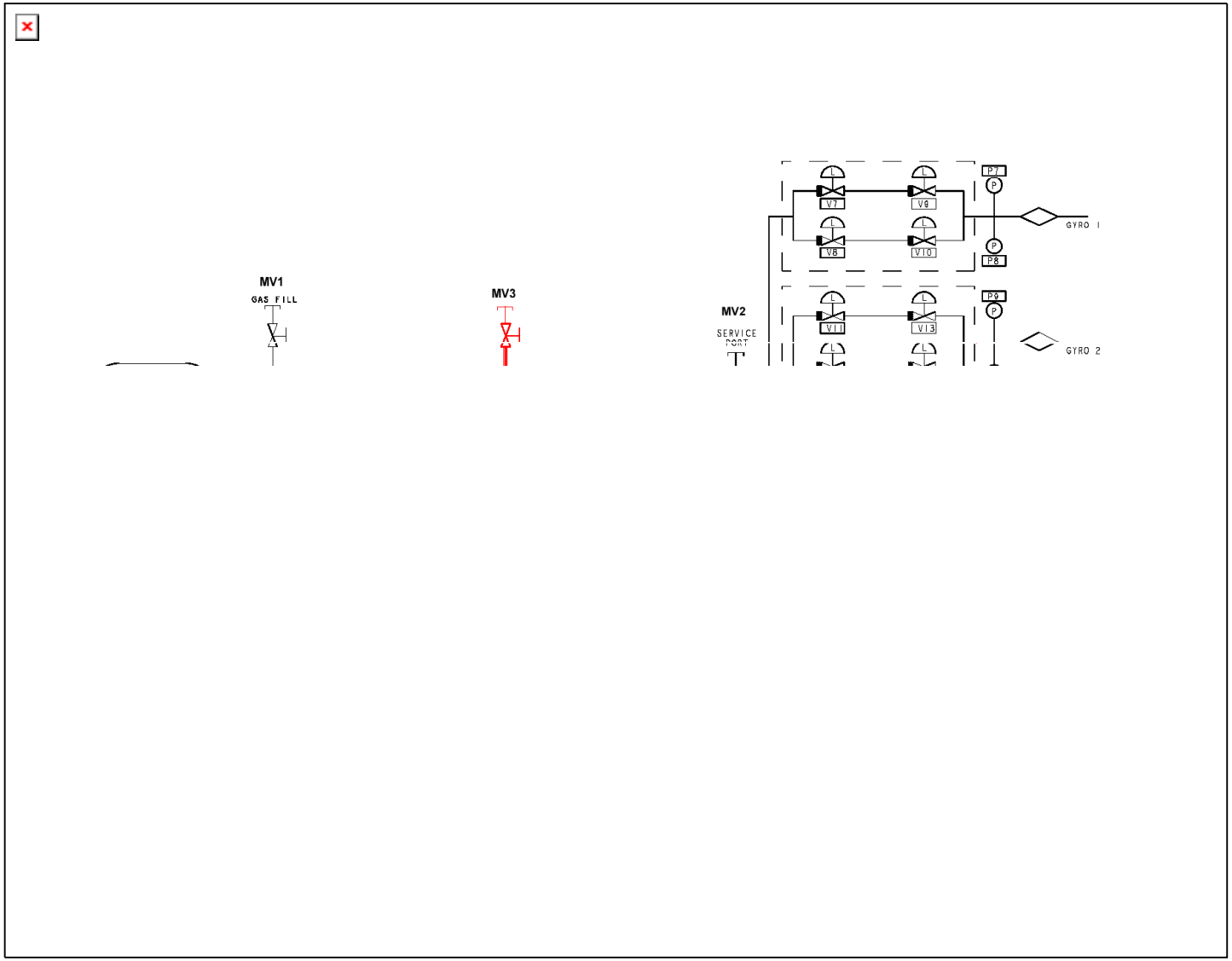


Figure 1



GMA Schematic

Figure 2

G.10 Pressure Sensor Log Table

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

G.11 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.12 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.13 Contingency/Emergency Responses

G.13.1 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.13.2 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