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STANFORD, CALIFORNIA 94305-4085

GMA RATE OF PRESSURE RISE TEST PROCEDURE AT VAFB

To be performed at Vandenberg Air Force Base
To be performed in Building 1610

THIS DOCUMENT CONTAINS HAZARDOUS OPERATIONS

P0974 Rev A

5 February, 2004

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REVISION HISTORY

Rev	Date	Comments
-	05/14/03	
A	12/10/03	ECO 1465. Updated to include redlines and include the use of Vent Service Cart.

List of Abbreviations and Acronyms

AP	Air Products
AVA	Access Valve Assembly (on GMA Vent)
BIP	Built in Purifier
CCW	Counter clockwise
CW	Clockwise
D-Log	Discrepency Log
DR	Discrepency Report
ECU	Electronic Control Unit
ESD	Electro Static Discharge
F&D	Fill and Drain
GDS	Gas Delivery System
GMA	Gas Management Assembly
GP-B	Gravity Probe B
He	Helium
LM	Lockheed Martin
lpm	Liters per Minute
MEOP	Maximum Expected Operating Pressure
PPE	Personnel Protective Equipment
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
ONR	Office of Naval Research
QA	Quality Assurance
scfm	Standard Cubic Feet per Minute
SU	Stanford University
S/V	Space Vehicle
VAFB	Vandenberg Air Force Base
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 test the individual zones of the Gas Management Assembly (GMA) for rate of pressure rise over time. GMA manifold pressures during launch activities (GMA valves at ground and launch configuration) will be verified. Upon completion of this operation, the data from these tests will define the leakage rates for the outlet valve quads, leakage rates for several volumes and an estimation of regulator lock-up minimum hold time in launch configuration. This procedure may not incorporate all testing of this nature. Therefore, more procedures may be issued to conduct additional tests. This procedure is a revision of P0970 and P0971, which were used at LM. The revision incorporates requirements for VAFB. 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, typically 300 psia ; GDS : 2640 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 have sufficient safety factors in place. 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 GMA tanks (mounted underneath the GMA pallet) are fracture critical items.

The manifold lines connected to the various GMA outlets may be exposed to pressures of up to 300 psia and therefore present 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. The Fill Manifold line connected to MV1 is intended to carry medium high pressures of up to 2200 psia, but its use is not called for in this operation and is not anticipated during any intersecting operations. All of the GSE used in this procedure have pressure ratings considerably higher than the maximum expected operating pressures.

The Gas Delivery System (GDS) has multiple gas pressure vessels. Under normal operations, the GDS requires no safety measures or equipment beyond those required for the use of a supply gas cylinder. The GDS is a high-pressure gas delivery system.

CAUTION

When any of the system is pressurized and connected to the vacuum system and/or leak detector, be cautious not to vent high pressure through the pumping portions of either system. Only allow high pressure to vent through approved ports (such as leak detector vent or CV-1) and make sure that these are open at time of venting.

The GDS is capable of locking out all critical valves as desired. The table below defines the pressure limits for each zone of the GDS.

GDS Operating Pressure Limitations (psig)

Zone	System MEOP	Vendor Rated MEOP	Relief Pressure	Proof Pressure	MAWP
Red (Supply)	2640	3500	3775	3960	3168
Orange (Hi-Press. Del.)	2000/2300	3000	2200/3300	3000	2400
Yellow (Lo-Press. Del.)	300	650	330	450	360
Green (Anal)	300	1000	330	450	360
Blue (Vac.)	<10	150	<10	N/A	N/A

Note: Observe caution with pressure units, psia and psig. (psia = psig+ 14.7)

Further information concerning the GDS can be found in the GDS schematic (on front panel), the GDS design manual (accompanying GDS), the GDS Operations Procedure (P0960), and the GDS Acceptance Test Procedure (P0917).

The pressurized manifold lines and hookups between the GDS and the GMA have a minimum rated MEOP of 2000 psig (3100 flex lines, 5100 rigid line, 3000 filters, 2000/7500 gauges, 8000 fittings) which is many times greater than the 300 psia maximum pressure to which they may be exposed and therefore have sufficient safety factors. Only qualified personnel under the supervision of the Test Director should work directly with this equipment.

WARNING

During the operation, some lines connecting equipment together represent trip/snag hazards. These hazards shall be minimized by careful routing, securing, and/or marking of such lines.

Some of the GSE used in this procedure is large and mobile and normal efforts should be used to ensure that equipment does not roll or fall during an earthquake, especially when connected to flight equipment. The GDS is equipped with wheel brakes, floor jacks, and tie down points.

WARNING

To ensure seismic safety, the GDS floor jacks will be engaged and /or the equipment tied down whenever the equipment is not being moved.

CAUTION

Avoid positioning the GDS closer than six feet from the Space Vehicle.

B.2. Heights

Some functions of this procedure may be completed with the use of ladders, platforms, and/or personnel lifts. The potential for falls from such equipment represents a safety concern. The use of these items shall be consistent with the normal practices of the Space Vehicle and the facility within which it is located and shall be subject to the authority and policies of facility safety personnel. Fall protection equipment shall be worn if a “cherry picker” type of personnel lift is used.

B.3. Contamination

Care should be exercised whenever venting any gas system to atmosphere to ensure that the internal volumes of the GMA and GSE plumbing lines are only exposed to appropriate environments. Improper venting of air into critical wetted areas can result in contamination requiring significant cleanup and verification.

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 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.4. Mishap Notification

B.4.1 Injury

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

B.4.2 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.4.3 Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Section G.14.

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 red-line (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 Ken Bower 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

- GMA on Space Vehicle
- Flight ECU with POD access and approved software
- HEPA down-flow hood installed over critical work area when applicable to specific sections.
- Research Grade (certified 99.9999%) Helium Supply: one (>1000psig) bottle for purge gas supply.
- Outlet Manifold Hardware to connect to Space Vehicle F&D Valves.
- Vent Manifold Hardware to connect to GMA vent port.
- Fill Manifold Hardware to connect to GMA F&D Valves.
- GSE mounting hardware for valves and manifolds as required.
- Leak detector, Alcatel (or alternate), internally calibrated
- Varian Pump cart (or alternate vacuum source)
- Agilent Data Logger
- Power Supply and Distribution box
- Cables for data Logger
- IBM Laptop computer & logging software
- 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 _____
- Moog conical seal gaskets, for flight, as required: part #C33934-004

E.4. Instrument Pretest Requirements

All GMA instrumentation used in taking data shall be “in calibration” at time of test.

E.5. Configuration Requirements

- The GMA is physically mounted, plumbed, and electrically grounded on the Space Vehicle (per LMMS INT-334 and SU P0945).
- The GMA Fill & Drain Valves are closed and capped (Unless the Fill Manifold is already installed).
- The GMA vent ports are capped (Unless the Vent Manifold is already installed).
- The off-pallet F&D Valves are closed, capped (Unless the Outlet Manifold is already installed).
- ECU operations are available.

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/ Success Criteria

Data will be acquired and a final launch configuration determined.

E.8. Constraints and Restrictions

N/A

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
Various	ECU operations as applicable

G. OPERATIONS

G.1. Verify Appropriate QA Notification

QA Notified

_____
(Date & Time)

NASA Program and Safety Representative Notified:

_____
(Date & Time)

G.2. Verify Work Environment for GSE Hookup (Optional)

Started on: _____

Note:
This is an optional section. If GSE is already installed it may be omitted. Mark off each step of this section as it is completed.

G.2.1 Assemble test team and complete Pre-Test Checklist in Section G.12.

G.2.2 Set up hand held particle counter near the caps of the Space Vehicle Off Pallet F&D Valves. Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

Samples @ F&D Valves : #1 ___ #2 ___ #3 ___ #4___ #5 ___.

Sample size: _____ Average particles per cubic foot: ____

G.2.3 Set up hand held particle counter near the mounting point of the outlet manifold (on the S/V tilt ring). Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

Samples @ tilt ring: #1 ___ #2 ___ #3 ___ #4___ #5 ___.

Sample size: _____ Average particles per cubic foot: ____

G.2.4 If any of the above particle count averages exceed 5, attempt to readjust the downflow hood arrangement and repeat the measurements as necessary. At the discretion of the Test Director with QA representative concurrence, the average count tolerance may be increased to a maximum of 100, provided that the counts of other measurable particle sizes do not exceed the standards of class 100 air (0.2 micron<750, 0.3 micron<300, 5.0 micron=0).

Section complete. **Quality** _____

G.2.5 Set up hand held particle counter near the outlet of GMA MV1. Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

Samples @ MV1 Valve: #1 ___ #2 ___ #3 ___ #4___ #5 ___.

Sample size: _____ Average particles per cubic foot: ____

G.2.6 Set up hand held particle counter near the outlet of GMA MV2. Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

Samples @ MV2: #1 ___ #2 ___ #3 ___ #4___ #5 ___.

Sample size: _____ Average particles per cubic foot: ____

G.2.7 If any of the above particle count averages exceed 5, attempt to readjust the downflow hood arrangement and repeat the measurements as necessary. At the discretion of the Test Director with QA representative concurrence, the average count tolerance may be increased to a maximum of 100, provided that the counts of other measurable particle sizes do not exceed the standards of class 100 air (0.2 micron<750, 0.3 micron<300, 5.0 micron=0).

Section complete. **Quality** _____

G.3. Install GSE Plumbing (Optional)

Started on: _____

Note:
This is an optional section. If GSE is already installed it may be omitted.
If necessary, steps G.3.15 – G.3.23 may be completed before steps G.3.1 – G.3.14. Mark off each step of this section as it is completed.

Outlet manifold hookup

G.3.1 Verify that all off-pallet F&D valves are closed (40+/-5 in.lbs.)

Wrench used_____

F&DS2 running torque _____ torque _____ QA _____

F&DS1 running torque _____ torque _____ QA _____

F&DS3 running torque _____ torque _____ QA _____

F&DS4 running torque _____ torque _____ QA _____

F&DP1A running torque _____ torque _____ QA _____

G.3.2 Verify that GMA V27, V28, V29, V30 are closed (use ECU to close them, or verify last state from prior operations).

method used/verification source_____

G.3.3 Install mounting clamps on tilt ring (adjust in future as desired).

Section complete. **Quality** _____

G.3.4 Install GSE as shown in Figure 2 to build Outlet Manifold. Utilize existing hardware remaining from prior operations as desired. Log F&D valve cap cycles as required.

G.3.5 Connect Outlet Manifold and the AVA Vent port to the VSC (see Figure 2).

G.3.6 Leak check Outlet Manifold and plumbing up to the AVA valve.

G.3.7 Evacuate (<1 torr), purge (with Helium), and evacuate Outlet Manifold and AVA plumbing to remove air residue.

G.3.8 Hook up data logger and record pressures:

G.3.9 OM-S1 _____ OM-S2 _____ OM-S3 _____ OM-S4 _____ OM-P1A_____ AVA_____

G.3.10 With Outlet Manifold under vacuum, open the five off-pallet F&D valves and log as required.

G.3.11 Open the AVA valve.

G.3.12 Record data logger pressures:

G.3.13 OM-S1 _____ OM-S2 _____ OM-S3 _____ OM-S4 _____ OM-P1A_____ AVA_____

G.3.14 Evacuate the Outlet Manifold and AVA plumbing, if necessary, (<1 torr), and close and secure all GSE valves in the Outlet Manifold and the AVA Valve.

Section complete. **Quality** _____

Fill Manifold Hookup

G.3.15 Verify that all on-pallet F&D valves are closed (40+/-5 in.lbs.)

Wrench used_____

MV1 running torque _____ torque _____ QA _____

MV2 running torque _____ torque _____ QA _____

MV3 running torque _____ torque _____ QA _____

MV4 running torque _____ torque _____ QA _____

G.3.16 Verify that GMA valves V1 and V2 are closed (use ECU to close them, or verify last state from prior operations).

method used/verification source_____

Section complete. **Quality** _____

G.3.17 Install GSE as shown in Figure 2 to build Fill Manifold. Utilize existing hardware remaining from prior operations as desired. Log F&D valve cap cycles as required.

G.3.18 Leak check Fill Manifold.

G.3.19 Evacuate (<1 torr), purge (with Helium), and evacuate Fill Manifold to remove air residue.

G.3.20 With Fill Manifold under vacuum (<1 torr), close and secure all GSE valves in the Fill Manifold.

G.3.21 Hook up data logger and record pressures:

MV-2 _____ MV-3 _____ MV-4 _____

G.3.22 Slowly open MV2, MV3, and MV4 if desired and log as required (do not open MV1).

G.3.23 Record data logger pressures:

MV-2 _____ MV-3 _____ MV-4 _____

Section complete. **Quality** _____

G.4. Setup of GMA

Started on: _____

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

G.2.8 Assemble test team and complete Pre-Test Checklist in Section G.12, if necessary.

G.4.22 Verify Fill, Outlet, and Vent manifolds are installed.

G.4.23 Verify ECU connected to the GMA and start ECU.

G.4.24 Start Null Script software to control the GMA solenoid valves. The Test Director will determine if the GMA valves will then be in “launch”, “sleep”, or “unchanged” configuration. Record configuration here: _____ (If “unchanged” Is the configuration chosen, attach a configuration description). Make note of all problems in a Discrepancy Log.

G.4.25 Close all GMA valves.

G.4.26 Connect remaining data logger related cables and verify operation.

G.4.27 Verify all personnel involved in hazardous task are certified, equipped, briefed, and ready to proceed. Test Director or Safety_____

G.4.28 Request the area operation light be changed to Amber

G.4.29 Establish a 10 foot diameter controlled area.

G.4.30 Request a PA announcement that a hazardous task is about to begin.

G.4.31 Ensure all nonessential personnel are clear of controlled area.

Section complete. **Quality** _____

G.5 GMA Rate of Pressure Rise Test

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 low-pressure gas. (0 to 500 psi per EWR 127-1).

G.5.1 Verify section G.4 is complete and that GSE is installed per Figure 2.

G.5.2 Measure GMA system pressures and record values in Section G.19 when possible.

G.5.3 Verify all GDS valves and regulators are closed, except the relief cutoff valves (V-21, V-23, RV-1 and RV-3, see Figure #1).

G.5.4 Verify all GSE valves are closed, including all VSC valves.

G.5.5 If GMA Zones II, III, IV and V (Figure #3) are all at a vacuum then go to step G.5.10.

G.5.6 If GMA Zones II, III, IV or V is > 50 psig then the pressure must be vented by doing the following: Enter ECU command to open GMA valves V3, V4, V5, V6, V27 and V29. Open AVA Valve, OM-Vent and VSC valves GV-4 and GV-5 and vent until GMA pressure is <50 psig. Close VSC valve GV-5.

G.5.7 Turn on VSC Turbo Pump and then open valve VSC valve GV-6 to evacuate to < 1 torr.

G.5.8 Close VSC valves GV-4 and GV-6. Close OM-Vent. Turn off Turbo Pump if desired.

G.5.9 Enter ECU command to close GMA valves V3, V4, V5, V6, V27 and V29.

(Fill Zone II)

G.5.10 Read all GMA pressure sensors and enter values in Section G.19 when possible.

G.5.11 Enter ECU command to open GMA valves V1 and V2.

G.5.12 Verify that GP1, GP2, GP3 all read about the same pressure.

G.5.13 Enter ECU command to close valves V1 and V2

G.5.14 Record all GMA pressure sensors and enter values in Section G.11 when possible.

G.5.15 On lines 1 and 2 of Section G.10 record completion of gas fill and final pressures in Zone II.

(Fill Zone III)

G.5.16 If the GDS is at a positive pressure (> 20 psig) then it must be vented through CV-1 by doing the following: Verify GDS valve V-6 is closed. Open GDS valves V-8, V-13 and V-26. Set PR-1 and PR-2 (CW to open) to minimum flows. Crack open GDS valve V-29 (CCW to open) and slowly release pressure. Close GDS valve V-29.

G.5.17 Start GDS vacuum pump, open GDS valves V-9, V-10, V-11, V-25 and V-26 (if not already open) and evacuate. If desired, evacuation may be by section and/or iterative.

G.5.18 Open valves FMV-2, FMV-3 and FMV -4.

G.5.19 Verify the GDS and supply manifold are under vacuum (< 5x10^-3 torr @ VT-1).

G.5.20 Close GDS valves V-8, V-9, V-10, V-11 and V-26.

G.5.21 Open one He supply bottle (bottle #_____), the corresponding GDS supply valve (V-1, V-2, V-3 or V-4) and V-6. Open GDS valve V-6 and set regulator PR-1 to 500 psig and crack open valve V-8 to allow the pressure to rise slowly.

G.5.22 Set regulator PR-2 to 50 psig (+ 10) and crack open valve V-26 and allow the pressure to rise slowly to 50 psig.

G.5.23 Slowly open GMA valves MV3 and MV4 (record each in valve cycle log sheet).

G.5.24 Increase PR-2 setting to 285 psig (300 psia) (+ 30) but limit increase to <100 psi/minute. Verify final pressure with the Mensor.

G.5.25 Close and lock GMA valves FMV-3 and FMV-4.

G.5.26 On lines 3 and 4 of Section G.10 record completion of gas fill and final pressures in Zone III. Record all GMA pressure sensors and enter values in Section H.2 when possible.

(Fill Zones IV & V)

G.5.27 Vent GDS pressure through CV-1 by doing the following: Close GDS valve V-6. Set PR-1 and PR-2 (CW to open) to minimum flows. Crack open valve V-29 (CCW to open) and slowly release pressure. Close GDS valve V-29.

G.5.28 Open GDS valves V-9, V-10 and V-11 and evacuate GDS

G.5.29 Verify the GDS and supply manifold are under vacuum (< 5x10^-3 torr @ VT-1) before pressurizing.

G.5.30 Verify that OM-Vent is closed.

G.5.31 Open AVA valve.

G.5.32 Close GDS valves V-8, V-9, V-10, V-11 and V-26.

G.5.33 Open GDS valve V-6 and set regulator PR-1 to 500 psig and crack open valve V-8 to allow the pressure to rise slowly.

G.5.34 Set regulator PR-2 to 50 psig and crack open valve V-26 and allow the pressure to rise slowly to 50 psig.

G.5.35 Open GMA valve MV2 (record in valve cycle log sheet).

G.5.36 Enter ECU command to open GMA valves V3, V4, V5, V6, V27, V28, V29 and V30.

G.5.37 Increase PR-2 setting to 285 psig (300 psia) (+ 30) but limit increase to <100 psi/minute. Verify final pressure with the Mensors.

G.5.38 Enter ECU command to close GMA valves V3, V4, V5, V6, V27, V28, V29 and V30 then close and lock FMV-2. On lines 5 to 7 of Section H.1 record completion of gas fill and final pressures in Zones IV and V and vent quad.

G.5.39 Vent pressure through CV-1 by doing the following: Close GDS valve V-6. Set PR-1 and PR-2 (CW to open) to minimum flows. Crack open valve V-29 (CCW to open) and slowly release pressure. Close GDS valve V-29.

G.5.40 Record all GMA pressure sensors and enter values in Section G.11.

G.5.41 On lines 8 and 9 of Section G.10 record completion of gas evacuation and final pressures in Zones IV and V.

(GMA Launch Operation rate of Rise Test)

G.5.42 Verify OM-Leak, all OM-Gx valves, OM-All, and OM-Vent are closed. Verify that OM-Purge and AVA valve are open.

G.5.43 Use ECU or log to verify that all GMA valves are closed.

G.5.44 Start VSC vacuum pump.

G.5.45 Open OM-All, the OM-Gx valves, and Fill and Drain valves S1, S2, S3, S4, and P1A (if necessary). Log as required.

G.5.46 Open VSC valves GV-4 and GV-6.

G.5.47 Evacuate until the Outlet manifold is under vacuum (< 1 torr].

G.5.48 Close VSC valve GV-6 and OM-All, OM-Gx Valves, and OM-Purge.

G.5.49 Open VSC valve GV-5.

G.5.50 Use OM-Vent to bleed vent quad to atmospheric pressure of helium. [15 psia (+ 5/-0)]

G.5.51 Close AVA Valve and VSC valves GV-5 and GV-4. Shutoff vacuum pump if desired.

G.5.52 Enter ECU command to open GMA valves V7, V8, V11, V12, V15, V16, V21, V22, V23, 24, V27, V28.

G.5.53 Record all GMA pressure sensors and enter values in Section G.11 when possible.

G.5.54 Start pressure rate of rise recording with the data logger. The Test Director will determine the length of time data will be recorded. (Minimum 24 hours elapse) Elapsed Time_____.

G.5.55 If desired, repeat elements of Section G.5 as required to obtain an acceptable launch configuration leak rate. Record activities in D-Log.

G.5.56 Record desired GMA Launch Configuration in Section G.7. Mark whether configuration is "Baseline" or "Revised."

(GMA Ground Operation Rate of Rise Test)

G.5.57 Verify OM-Leak, OM-Gx valves, OM-Vent, AVA valve, OM-All, and OM-Purge are closed.

G.5.58 Start VSC vacuum pump.

G.5.59 Open OM-Purge, OM-All, and the OM-Gx valves.

G.5.60 Verify that AVA Valve is still closed.

G.5.61 Open VSC valve GV-4 and GV6.

G.5.62 Evacuate until the Outlet manifold is under vacuum [< 1 torr].

G.5.63 Enter ECU command to close GMA valves V7, V8, V11, V12, V15, V16, V19, V20, V23, and V24.

G.5.64 Enter ECU command to open GMA valves V9, V10, V13, V14, V17, V18, V21, V22, V25, V26, V27, and V29.

G.5.65 Verify the GMA outlets are under vacuum (< 10^-3 torr @ vacuum source).

G.5.66 Use ECU to close GMA valves V9, V10, V13, V14, V17, V18, V21, V22, V25, and V26.

G.5.67 Close OM-Purge Valve and the OM-Gx valves.

G.5.68 Close VSC valves GV-6 and GV-4 and turn off vacuum pump if desired.

G.5.69 If the GMA regulator lockup pressure in Zones II, III, IV, or V is < 230 psia, then repeat the regulator lockup steps G.5.27 to G.5.40, else continue to next step.

G.5.70 Record all GMA pressure sensors and enter values in Section G.11 when possible.

G.5.71 Start pressure rate of rise recording with the data logger. The Test Director will determine the length of time data will be recorded. (Minimum 24 hours elapsed) Elapsed Time_____.

G.5.72 Conclude pressure rate of rise test with all GMA valves closed.

QUALITY_____

G.5.73 Close all GSE valves

G.5.74 Close all GMA valves.

NOTE:

THE HAZARDOUS OPERATION OF THIS SECTION IS NOW COMPLETE

G.5.75 Request PA announcement that hazardous operations are now complete.

G.5.76 Ensure area warning light is returned to green.

G.5.77 Disband controlled area.

Section complete. **Quality** _____

G.6. Remove GSE (Optional)

Started on: _____

Note:
Mark off each step of this section as it is completed.
This is an optional section of the procedure and may be omitted if desired.

G.6.1 Close all off-pallet F&D valves and torque (40+/-5 in.lbs.)

Wrench used_____

F&DS2 running torque _____ torque _____ QA _____

F&DS1 running torque _____ torque _____ QA _____

F&DS3 running torque _____ torque _____ QA _____

F&DS4 running torque _____ torque _____ QA _____

F&DP1A running torque _____ torque _____ QA _____

G.6.2 Remove data logger and associated cables.

G.6.3 Remove any Outlet Manifold GSE as desired.

G.6.4 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 _____ torque _____ QA _____

F&DS1 running torque _____ torque _____ QA _____

F&DS3 running torque _____ torque _____ QA _____

F&DS4 running torque _____ torque _____ QA _____

F&DP1A running torque _____ torque _____ QA _____

Section complete. **Quality** _____

G.6.5 Verify that all GMA F&D valves are closed (40+/-5 in.lbs.)

Wrench used_____

MV1 running torque _____ torque _____ QA _____

MV2 running torque _____ torque _____ QA _____

MV3 running torque _____ torque _____ QA _____

MV4 running torque _____ torque _____ QA _____

G.6.6 Remove any Fill Manifold GSE as desired.

G.6.7 Install flight caps and conical seals (120+/-10 in.lbs.) on GMA F&D valves and log as required.

Wrench used_____

MV1 cap running torque _____ torque_____ QA _____

MV2 cap running torque _____ torque_____ QA _____

MV3 cap running torque _____ torque_____ QA _____

MV4 cap running torque _____ torque_____ QA _____

Section complete. **Quality** _____

G.7 GMA Latch Valve Position

GMA launch configuration is: BASELINE or REVISED. (circle one).

GMA Responsible Engineer_____

QUALITY_____

If revised, mark desired configuration below:

Base Line Valve Configuration

Valve	N/C	N/O
V1	X	
V2	X	
V3	X	
V4	X	
V5	X	
V6	X	
V7		X
V8		X
V9	X	
V10	X	
V11		X
V12		X
V13	X	
V14	X	
V15		X
V16		X
V17	X	
V18	X	
V19	X	
V20	X	
V21		X
V22		X
V23		X
V24		X
V25	X	
V26	X	
V27		X
V28		X
V29	X	
V30	X	

Revised Valve Configuration

Valve	N/C	N/O
V1		
V2		
V3		
V4		
V5		
V6		
V7		
V8		
V9		
V10		
V11		
V12		
V13		
V14		
V15		
V16		
V17		
V18		
V19		
V20		
V21		
V22		
V23		
V24		
V25		
V26		
V27		
V28		
V29		
V30		

G.8 Completion

Started on: _____

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

G.8.1 If possible and desired, close all GMA valves.

G.8.2 If possible, use ECU to read all pressures/counts from GMA and log in pressure sensor log (at end of section G.19).

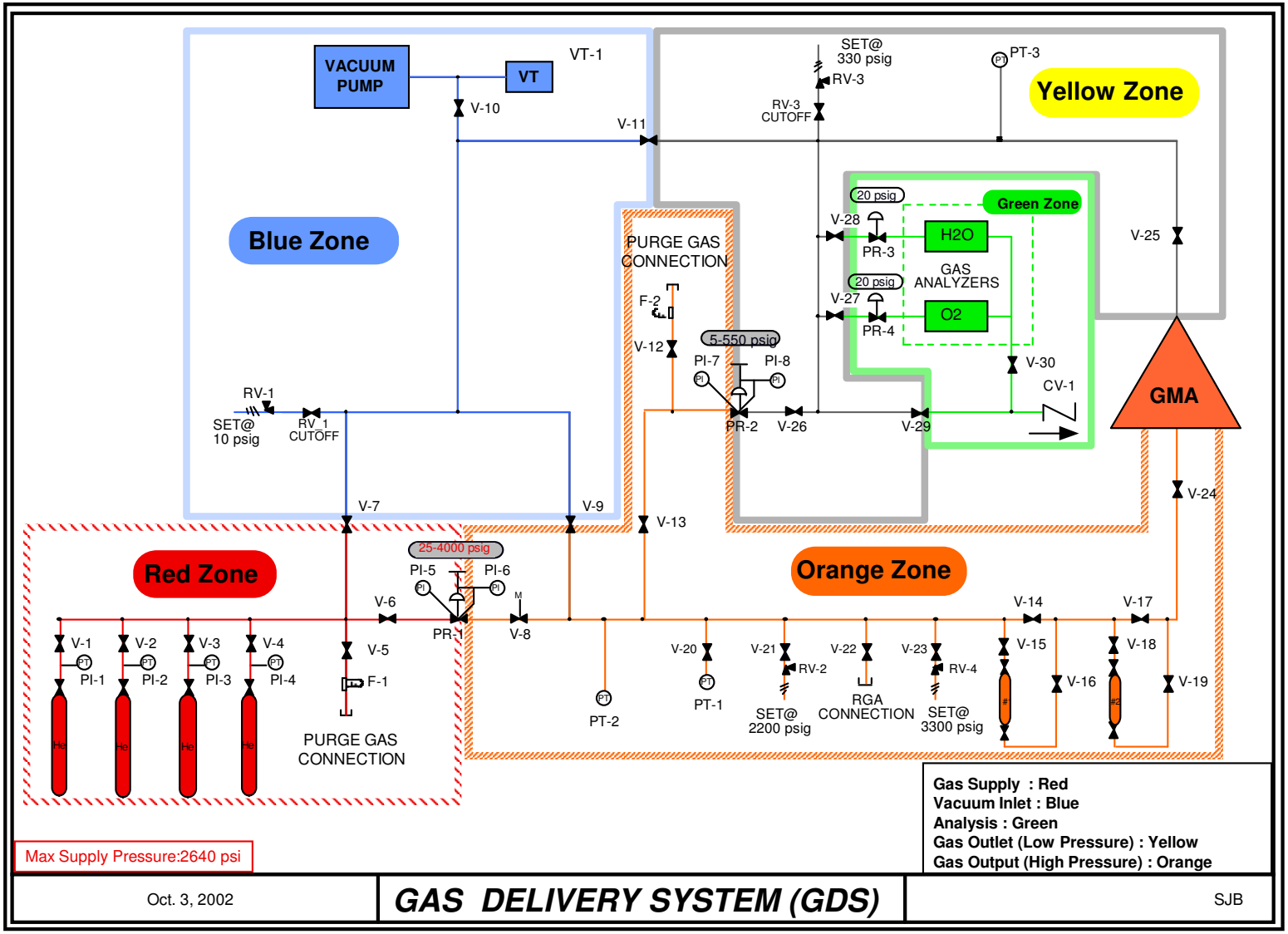
G.8.3 Shut down ECU if desired.

G.8.4 Disconnect remaining GSE as desired.

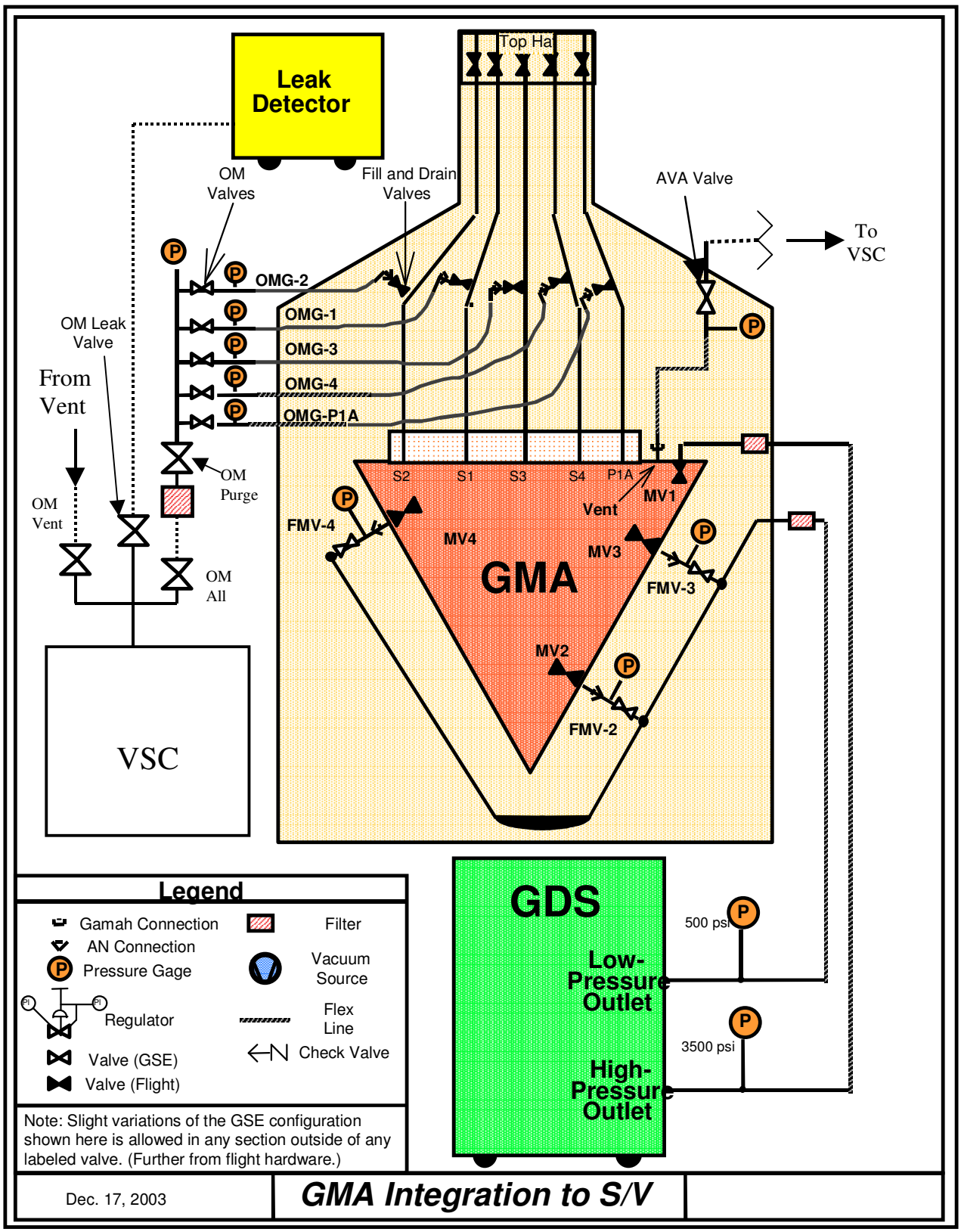
G.8.5 Visually inspect exterior surface of flight hardware and remove contamination if required

G.8.6 Assemble test and complete Post Test Checklist in Section G.22.

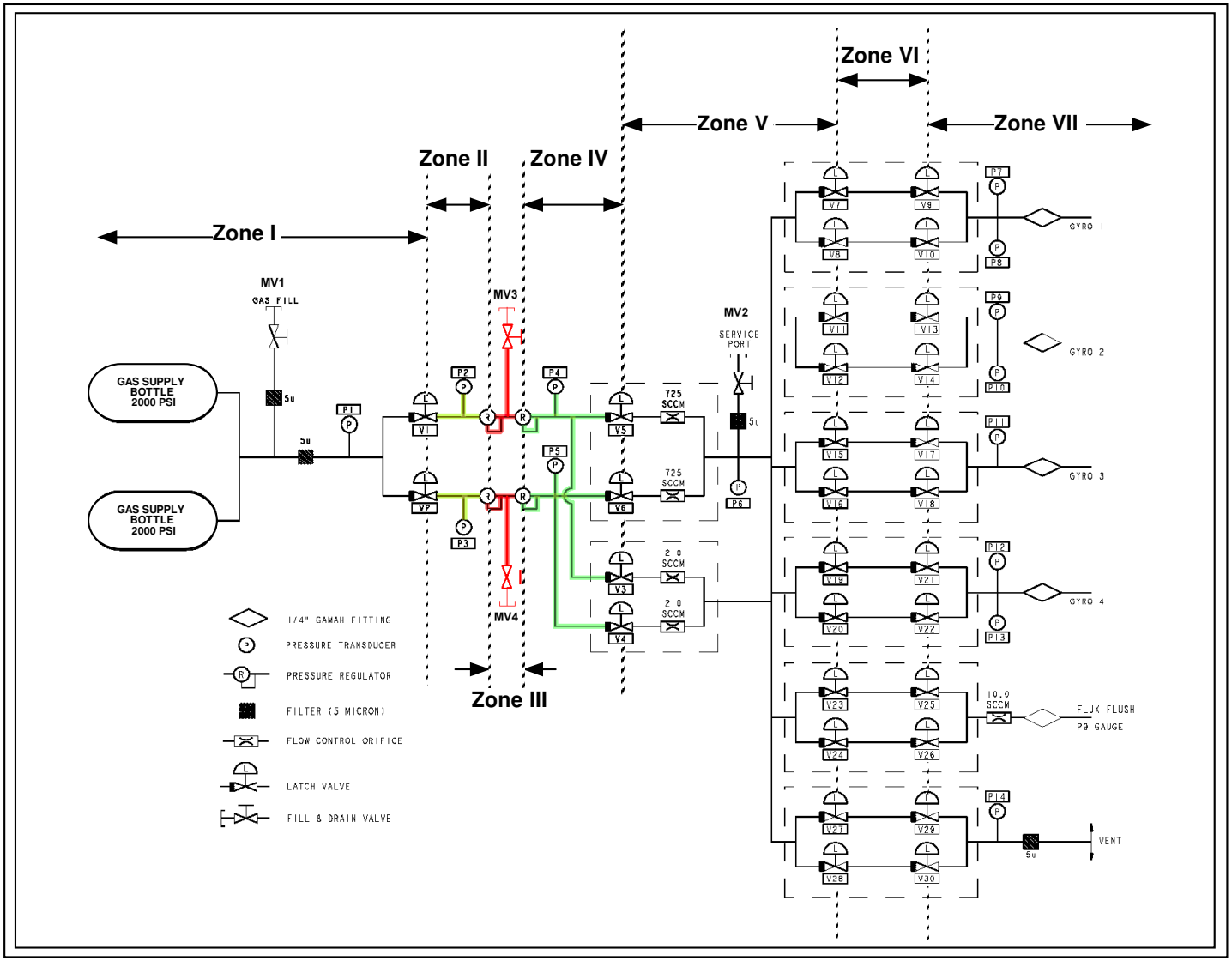
G.9 Diagrams



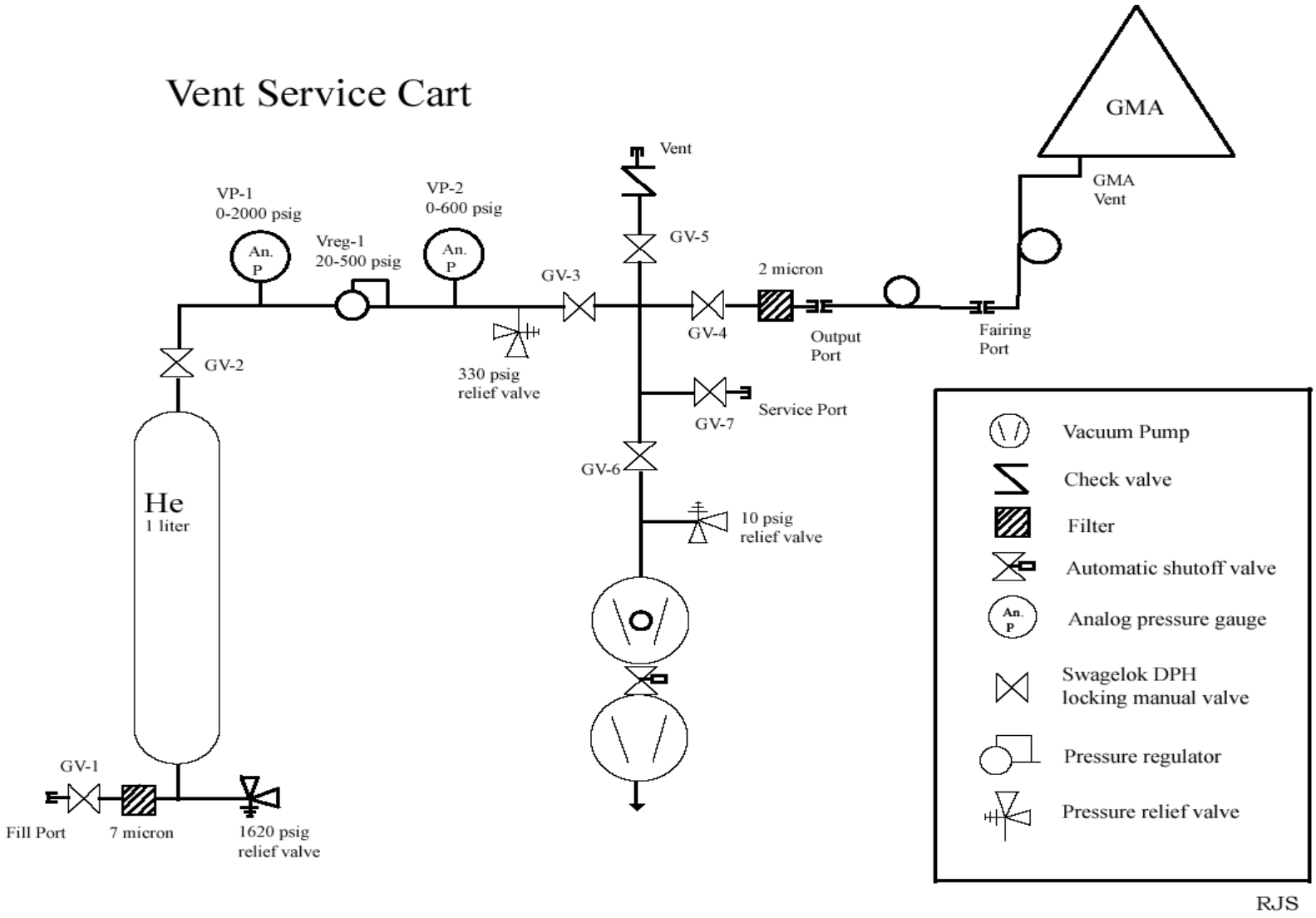
GDS Schematic - Figure 1



GMA on S/V - Figure 2



GMA Schematic - Figure 3



VSC Schematic - Figure 4

G.10 Procedure Completion Table

No.	Section	Task	Details	Final Pressure	Completed		QA Approval	Comments
					Date	Initial		
1	G.5	GDS fill of GMA between V1 and R1 (Zone II)	Pressure @300 psia (0/+50psi)					
2	G.5	GDS fill of GMA between V2 and R2 (Zone II)	Pressure @300 psia (0/+50psi)					
3	G.5	GDS fill of GMA between R1 regulators (Zone III)	Pressure @300 psia (0/+30psi)					
4	G.5	GDS fill of GMA between R2 regulators (Zone III)	Pressure @300 psia (0/+30psi)					
5	G.5	GDS fill of GMA between R1 andV3/V5(Zone IV)	Pressure @300 psia (0/+30psi)					
6	G.5	GDS fill of GMA between R2 andV4/V6(Zone IV)	Pressure @300 psia (0/+30psi)					
7	G.5	GDS fill of GMA between V3 to V6 andV9/V10, V13/ V14..etc (Zone V)	Pressure @300 psia (0/+30psi)					

G.11 Pressure Sensor Log Table

			GMA Sensors Counts														Manifold Mensors		GDS (psig)	
Sect: Step	Date	Time	GP1	GP2	GP3	GP4	GP5	GP6	GP7	GP8	GP9	GP10	GP11	GP12	GP13	GP14	500 psia	3500 psia	PT2	PT3

G.12 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. Verify/Perform an Engineering and Safety high-bay walk down. 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: _____		

G.13 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.14 Contingency/Emergency Responses

F.3.2 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 (GDS V-24, GDS V-25, OMVent, 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.).

F.3.3 Power Failure

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/GMA Engineer

Discrepancies if any:

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

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
D. Ross, QA