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GMA TO SPACE VEHICLE PLUMBING HOOKUP

P0945 Rev –

7 October, 2002

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TABLE OF CONTENTS

A SCOPE

This procedure defines how to connect the five plumbing "lower lines" on the GP-B Space Vehicle to the Gas Management Assembly (GMA). These connections are contamination critical and all will be made with *either* verified particle free flushes *or* full flushing from both directions.

This procedure also performs a leak check of the five existing GMA to Top Hat lines.

This procedure also equips the GMA and Space Vehicle with Ground Support Equipment (GSE) used in additional GMA testing.

B SAFETY

B.1 Flight equipment:

The GMA is a self-contained gas delivery device and contains volumes under gas pressure. During this procedure, the configuration of the GMA will be such that the contained gas pressures are a small fraction of the rated vessel pressures and therefore do not present a realistic safety concern.

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.

B.2 Ground Support Equipment (GSE)

The Gas Delivery System (GDS) has multiple gas pressure vessels. Under normal operations, 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. 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	Rated MEOP	Relief Pressure	Proof Pressure
Red	2640	3500	3775	3960
Orange	2000/2300	3000	2200/3300	3000
Yellow	300	650	330	450
Green	300	1000	330	450
Blue	<10	150	<10	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 (P0886), 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 do not present a realistic safety concern.

The vacuum/purge manifold lines connected to the GMA and Fill and Drain (F&D) Valves will not be exposed to high pressures and therefore do not present a realistic safety concern. (Purge operations typically run at around 5-20 psig.)

During the operation, some lines connecting equipment together will represent minor trip/snag hazards – these hazards shall be minimized by careful routing, securing, and/or marking of such lines. Only qualified personnel under the supervision of the Test Director should work directly with this equipment.

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. It is recommended that the floor jacks be engaged whenever the GDS is not being moved. Avoid positioning the GDS closer than six feet from the Space Vehicle, about ten feet would be ideal (plumbing lines longer than twelve feet are discouraged)..

B.3 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 moderate 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.

B.4 Contamination:

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

These operations are expected to occur within the B159 highbay, a Class 100,000 clean room, but may occur in any similar environment. 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. Face masks and clean gloves (consistent with Class 100 practices) shall also be worn whenever working with flight wetted surfaces. All fluid connections shall be visually inspected by the operator making the connection.

B.5 Terms used:

In some cases, different equipment used in this procedure will have similar names. For clarity, the following are defined generally:

- Fill Manifold – the GSE hardware connected to the Fill and Drain ports of the GMA
- Fill and Drain (or F&D) Valves – the five flight Fill and Drain valves mounted on the conical section of the Space Vehicle
- Fill and Drain (or F&D) Manifold – the GSE hardware connected to the F&D Valves
- Lower Lines – the five flight lines connecting the F&D valves to the GMA
- GMA Transition Bracket – the flight bracket affixed to the GMA which holds the connection between the GMA and the Lower Lines

- Top Hat Valves – the five flight valves mounted near the Top Hat of the Space Vehicle which control the flow between the GMA and the Probe

Within this procedure, flight valves will generally be designated without hyphens (i.e. GMA V1, GMA MV1, F&DS1) while GSE valves will be designated with hyphens (i.e. GDS V-1, OMG-1).

B.6 Emergencies

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.).

In the event of a power failure, the Test Director shall implement similar steps as applicable (Use care to ensure that equipment remains safe when power is restored.

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 RE 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, RE, or QA believe it necessary, a discrepancy report may be issued for MRB review.

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 ONR 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.

C.3 Discrepancies

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

D TEST PERSONNEL

The Test Director shall be Ken Bower or an alternate that he shall designate. The Test Director has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it. Additional personnel shall be assigned and supervised by the Test Director.

E REQUIREMENTS

E.1 Electrostatic Discharge Requirements

The Space Vehicle is defined as ESD sensitive. Appropriate ESD protection must be used when handling the space vehicle *or conductive equipment connected to it*.

E.2 Lifting Operation Requirements

N/A

E.3 Hardware/Software Requirements

- GMA physically mounted to Space Vehicle (per LMMS INT-334)
- HEPA downflow hood installed over critical work area
- ECU Flight Equivalent, Flight ECU, or Manual Latch Valve Control Box and related operational equipment (computers, cables, meters, etc.)
  (Note: The procedures will always call for an 'ECU command' to open GMA valves but it can be replaced by similar functions from any of the above equivalents.)
- "gma_null_setup.prc" script
- Interface cables from ECU to GMA
- GDS (Gas Delivery System), with design manual, ATP, and any additional certifying documentation.
- Research Grade (certified 99.9999%) Helium Supply: four bottles (minimum fill: two>2200psig, two>1000psig) on the GDS cart and one (>1000psig) for purge gas supply.
- F&D Manifold Hardware to connect Space Vehicle Fill and Drain valves to purge gas system
- Fill Manifold Hardware to connect GMA to GDS
- Mensor High Resolution Pressure Transducers attached to GDS manifolds:
  3500 psia digital pressure sensor
  Calibration Date: _____ S/N: _____ Model #: _____
  500 psia digital pressure sensor
  Calibration Date: _____ S/N: _____ Model #: _____
- Leak detector, Alcatel (or alternate), internally calibrated
- Hand held particle counter (sensitive to 0.5 microns or better)
  Calibration Date: _____ S/N: _____ Model #: _____

- Clean room bags and tape
- Various clean flex lines and fittings as required (Test Director to approve cleanliness of individual elements for specific uses)
- Alcatel Dry Pump / Turbo Pump Carts (or equivalent)
- “Space Tool” custom made Gamah torquing tool
- Torque wrench, 21 +/-1 in.-lb. capable
  #1) Make/model _____ S/N _____ Certificate expiration _____
- Gamah Gaskets S14004A, for flight, as required
- Additional torque wrenches as required
  #2) Make/model _____ S/N _____ Certificate expiration _____
  #3) Make/model _____ S/N _____ Certificate expiration _____
  #4) Make/model _____ S/N _____ Certificate expiration _____
- Moog conical seal gaskets, for flight, as required
- GMA bracket clamps and screws, for flight

E.4 Instrument Pretest Requirements

All test equipment used to verify test data is required to be “in calibration.”

E.5 Configuration Requirements

- The GMA is physically mounted and electrically grounded on the Space Vehicle.
- The GMA tanks (zones I-II) are pressurized to 300 psia (+/- 100 psi).
- The GMA is in “sleep” mode (all solenoid valves closed, zones III-VII <25 psia).
- The GMA Fill & Drain Valves are closed and capped.
- The GMA outlet ports are capped (connector savers optional).
- The Space Vehicle Lower Supply lines are installed and capped (“stubbies” optional). They may be temporarily dislocated at this time.
- The Space Vehicle is oriented such that the GMA and Fill & Drain Valves are accessible by personnel and capable of being enclosed within a downflow hood.
- The GMA has connector savers installed on the four electrical connectors.

E.6 Optional Non-flight Configurations

N/A

E.7 Verification/ Success Criteria

All connections shall be leak tight and properly torqued as set out in individual procedure sections.

E.8 Constraints and Restrictions

N/A

F REFERENCE DOCUMENTS

F.1 Drawings

- GMA Schematic, GP-B Dwg. Number 26273
- GMA Installation Dwg. Number 8A00982

F.2 Supporting documentation

GDS design manual, Operations procedure (P0886), and ATP (P0917)

F.3 Additional Procedures

ECU operations as applicable.

G OPERATIONS

G.1 Verify Appropriate QA Notification

QA Notified_____ ONR Notified_____
(Date & Time) (Date & Time)

G.2 Connect ECU to GMA

Started on: _____

G.2.1 Connect Flight Equivalent ECU to GMA using interface cables. Secure and route cables with care to prevent accidental disconnection or trip hazards.

G.2.2 Power up ECU, run “null script” and select “close all” starting condition.

G.2.3 Use ECU to read all pressures/counts from GMA and log in pressure sensor log (at end of section G).

Section G.2 complete. QA _____

Customer _____

G.3 Verify Work Environment

Started on: _____

G.3.1 Set up hand held particle counter near the caps of the Space Vehicle 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.

G.3.2 Samples @ F&D Valves : #1 ___ #2 ___ #3 ___ #4___ #5 ___.

G.3.3 Sample size: _____ Average particles per cubic foot: ____

G.3.4 Set up hand held particle counter near the GMA transition bracket. Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.3.5 Samples @ GMA transition bracket : #1 ___ #2 ___ #3 ___ #4___ #5 ___.

G.3.6 Sample size: _____ Average particles per cubic foot: ____

G.3.7 Set up hand held particle counter near the lowest point of the GMA (near MV2). Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.3.8 Samples @ MV-2 : #1 ___ #2 ___ #3 ___ #4___ #5 ___.

G.3.9 Sample size: _____ Average particles per cubic foot: ____

G.3.10 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 G.3 complete. QA _____

Customer _____

G.4 Setup of GDS

Started on: _____

Note: this section may require venting small quantities of Helium (<10L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.4.1 GDS RE to certify that GDS meets all ATP (SU P0917) requirements _____.

G.4.2 Verify that GDS pressure relief systems are installed and all associated cutoff valves are open (RV-1 cutoff, RV-3 cutoff, V-21, and V-23).

G.4.3 Verify GDS supply cylinders have sufficient Helium to complete required operations. (A minimum of two full Air Products (AP) BIP's 2640 psig cylinders are required to fill the GMA to ~2000psia. An entire cylinder may be required to perform a sequence of gas flow purges.). When any cylinder is supplying Helium to flight wetted surfaces, do not allow the cylinder to drop below 250 psig. For other uses (i.e. GSE purging, leak check spraying), do not allow the cylinder to drop below 100 psig.

G.4.4 Verify that all GDS valves (except those noted in G.4.1) and He supply valves are closed and all GDS ports are sealed. Open the GDS sample bottle valves. The sample bottle valves remain open at all times unless stated otherwise.

G.4.5 Verify that the GDS is at a positive pressure of Helium or vacuum.

G.4.6 Record PT-2_____ PT-3 _____ VT-1_____

G.4.7 Record the starting pressure of the Helium supply bottles:
#1 _____ #2 _____ #3_____ #4 _____

G.4.8 Evacuate GDS if desired.

Section G.4 complete. QA _____
Customer _____

G.5 Connect GDS to GMA via Fill Manifold

Started on: _____
Note G.6 and G.7 may be performed before G.5 if desired.
Note: this section will require venting moderate quantities of Helium (10L>1000L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.5.1 Open one He supply bottle (bottle #_____), the corresponding GDS supply valve (V-1, V-2, V-3 or V-4) and V-6. (refer to Fig. 2 as needed)

G.5.2 Open GDS valves V-13, V-14, V-17, and V-24. Set pressure regulator PR-1 to a low-pressure (<150 psig) then open valve V-8. Uncap high-pressure outlet. Set flow around 5-10 lpm (about 1/4 scfm – a flow easily sensed by a bare palm).

G.5.3 Connect high-pressure Fill Manifold hardware (3500 psi Mensor gauge, lines and fittings as required, filter, and high pressure leg of the Fill Manifold) to GDS high pressure outlet. (refer to Fig. 1 as needed)

G.5.4 Close GDS valve V-24 and open valve V-25. Set pressure regulator PR-2 to a low-pressure (<150 psig) then open valve V-26. Uncap low-pressure outlet. Set flow between 5-10 lpm (about 1/4 scfm).

G.5.5 Connect low pressure Fill Manifold hardware to GDS low -pressure outlet.

G.5.6 Close GDS valve V-25.

G.5.7 Open valve V-24. Fashion a clean room bag into an air trap with small openings at either end.

G.5.8 Affix the clean room bag to the high-pressure outlet of the Fill Manifold. Gas should slightly inflate the air trap.

G.5.9 Insert particle counter inlet loosely into other end of bag.

G.5.10 Allow gas to flow for at least 1 minute to purge line.

G.5.11 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.5.12 Samples @ MV1 connector: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.5.13 Remove particle counter and gas trap and do not shut off the gas flow.

G.5.14 Initial here to verify test pass for the high-pressure outlet of Fill Manifold _____.

G.5.15 Open GDS valve V-25 and repeat steps G.5.7 to G.5.12 for the low-pressure outlets of Fill Manifold.

G.5.16 Samples @ MV2 connector: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.5.17 Samples @ MV3 connector: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.5.18 Samples @ MV4 connector: #1 ___ #2 ___ #3 ___ #4___ #5 ___

Note: If there is insufficient flow, close valve cap outlet and V-24 during low-pressure outlet particle check.

G.5.19 Initial here to verify test pass for the three low-pressure outlets _____.

G.5.20 Verify that GMA MV1, MV2, MV3, and MV4 are closed (40 +/-5 in.lbs.).

G.5.21 Remove, identify, and secure (clean bag, label, and store) caps from GMA MV1, MV2, MV3, and MV4 as flight hardware and log as necessary.

G.5.22 Connect manifold to GMA using conical seals. Verify that positive flow is maintained during mating. (Open valve V-24 and uncap outlet if required)

G.5.23 Torque AN fittings on Fill Manifold (120 +/-10 in.lbs.) and log as required.

Wrench used_____

MV1 cap torque QA _____

MV2 cap torque QA _____

MV3 cap torque QA _____

MV4 cap torque QA _____

G.5.24 Provide strain relief to the Fill Manifold and associated lines by installing supporting bracketing, clamps, or ties as desired. Use care to route and secure plumbing lines to minimize hazard to personnel and equipment.

G.5.25 Vent pressure through CV-1 by doing the following: Close GDS supply valve (V-1, V-2, V-3 or V-4). Set PR-1 and PR-2 (CW to open) to minimum flows. Crack open valve V-29 (CCW to open) and slowly release pressure to a nominal 10 psig. Close valve V-29.

G.5.26 Connect leak detector to the GDS RGA connection. Ensure the leak detector has been tuned and calibrated. Calibration Date _____ Calibration Value _____

G.5.27 Start leak detector. Verify GDS pump running. Open GDS valves V-9, V-10, and V-11, wait for the GDS pump to evacuate the GDS (<5x10^-3 torr), close V-10, then open GDS valve V-22. Verify that all GDS pressure sensors read 0 psia once leak detector goes into test mode. Record background leak rate _____.

G.5.28 Using a small flow from the leak test supply bottle, spray helium around the GDS to GMA manifold hardware. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.5.29 Fix any leaks that are found and repeat step G.5.24 as necessary.

G.5.30 Close GDS valves V-9, V-11 and V-22. Shut down and disconnect leak detector if desired.

G.5.31 Initial here to verify test pass for the Fill Manifold hookup and leak check _____.

G.5.32 Use GDS to evacuate and purge Fill Manifold and lines as desired. (# of cycles TBD by Test Director – typically 3 evac/purge cycles and 1 overnight evac.)

Section G.5 complete. QA _____

Customer _____

G.6 Connect Fill and Drain (F&D) Valve Manifold

Started on: _____
Note: this section will require venting moderate quantities of Helium (10L>1000L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.6.1 Verify Top Hat Valves on Space Vehicle are closed.

G.6.2 Prepare an assembly as shown in Figure 1 (including vacuum and Helium sources) for the F&D Manifold purge port.

G.6.3 Prepare an assembly as shown in Figure 1 (including Leak Check device) for the F&D Manifold leak check port.

G.6.4 Assemble the lines prepared above with the F&D Manifold and manifold valves and secure in position near the F&D valves.

G.6.5 Establish a flow from the helium supply through the F&D Manifold sufficient for particle counting.

G.6.6 Fashion a clean room bag into an air trap with small openings at either end.

G.6.7 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.6.8 Insert particle counter inlet loosely into other end of bag.

G.6.9 Allow gas to flow for at least 1 minute to purge line.

G.6.10 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.6.11 Samples @ F&D Manifold: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.6.12 Remove particle counter and gas trap and do not shut off the gas flow.

G.6.13 Initial here to verify particle test pass for the high-pressure outlet of Fill Manifold _____.

G.6.14 Verify F&D Valves (F&DS2, F&DS1, F&DS3, F&DS4, and F&DP1A) are closed (40 +/-5 in.lbs.).

Wrench used_____

F&DS2 torque QA _____

F&DS1 torque QA _____

F&DS3 torque QA _____

F&DS4 torque QA _____

F&DP1A torque QA _____

G.6.15 Remove, identify, and secure (clean bag, label, and store) caps from F&DS2, F&DS1, F&DS3, F&DS4, and F&DP1A as flight hardware and log as necessary.

G.6.16 Connect F&D Manifold to F&D Valves using conical seals. Verify that positive flow is maintained during mating. (Adjust flow as required.)

G.6.17 Torque AN fittings on F&D Manifold (120 +/-10 in.lbs.) and log as required.

Wrench used_____

F&DS2 cap torque QA _____

F&DS1 cap torque QA _____

F&DS3 cap torque QA _____

F&DS4 cap torque QA _____

F&DP1A cap torque QA _____

G.6.18 Provide strain relief to the F&D Manifold and associated lines by installing supporting bracketing, clamps, or ties as desired. Use care to route and secure plumbing lines to minimize hazard to personnel and equipment.

G.6.19 Shut off Helium supply and evacuate F&D Manifold and lines with Vacuum source and/or Leak Detector.

G.6.20 Using a small flow from a supplemental external Helium supply, spray helium around the F&D Manifold hardware. Watch for leak rate spikes that would indicate leaks.

G.6.21 Fix any leaks that are found and repeat step G.6.19 as necessary.

G.6.22 Initial here to verify test pass for the F&D Manifold hookup and leak check _____.

G.6.23 Use Helium supply and vacuum source to evacuate and purge F&D Manifold and lines as desired. (# of cycles TBD by Test Director – typically 3 evac/purge cycles and 1 overnight evac.)

Section G.6 complete. QA _____

Customer _____

G.7 Leak Check existing GMA flight lines

Started on: _____

Note: this section may require venting small quantities of Helium (<10L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.7.1 Isolate Helium supply from F&D Manifold.

G.7.2 Close OM-Purge and start vacuum source connected to F&D Manifold

G.7.3 Close OM-Leak and start leak detector connected to F&D Manifold.

G.7.4 Open F&DS2 and log as required. Open OMG-2.

G.7.5 Crack open OM-Purge and bleed any pressure out through the vacuum source.

G.7.6 When OM-Purge is fully open and vacuum source has reached a stable pressure, close OM-Purge and open OM-Leak.

G.7.7 Allow Leak Detector to reach an acceptable background level and record: _____.

G.7.8 Using a small flow from a supplemental external Helium supply, spray helium around the Upper Line, F&D Assembly, and Lower Line. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.7.9 If any leaks are found in existing flight hardware, initiate a Discrepancy Report at the end of section G.7.

G.7.10 Close OMG-2 and OM-Leak

G.7.11 Initial here to verify leak test pass for the Gyro 2 Spinup Lines _____.

G.7.12 Open F&DS1 and log as required. Open OMG-1.

G.7.13 Crack open OM-Purge and bleed any pressure out through the vacuum source.

G.7.14 When OM-Purge is fully open and vacuum source has reached a stable pressure, close OM-Purge and open OM-Leak.

G.7.15 Allow Leak Detector to reach an acceptable background level and record: _____.

G.7.16 Using a small flow from a supplemental external Helium supply, spray helium around the Upper Line, F&D Assembly, and Lower Line. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.7.17 If any leaks are found in existing flight hardware, initiate a Discrepancy Report at the end of section G.7.

G.7.18 Close OMG-1.

G.7.19 Initial here to verify leak test pass for the Gyro 1 Spinup Lines _____.

G.7.20 Open F&DS3 and log as required. Open OMG-3.

G.7.21 Crack open OM-Purge and bleed any pressure out through the vacuum source.

G.7.22 When OM-Purge is fully open and vacuum source has reached a stable pressure, close OM-Purge and open OM-Leak.

G.7.23 Allow Leak Detector to reach an acceptable background level and record: _____.

G.7.24 Using a small flow from a supplemental external Helium supply, spray helium around the Upper Line, F&D Assembly, and Lower Line. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.7.25 If any leaks are found in existing flight hardware, initiate a Discrepancy Report at the end of section G.7.

G.7.26 Close OMG-3.

G.7.27 Initial here to verify leak test pass for the Gyro 3 Spinup Lines _____.

G.7.28 Open F&DS4 and log as required. Open OMG-4.

G.7.29 Crack open OM-Purge and bleed any pressure out through the vacuum source.

G.7.30 When OM-Purge is fully open and vacuum source has reached a stable pressure, close OM-Purge and open OM-Leak.

G.7.31 Allow Leak Detector to reach an acceptable background level and record: _____.

G.7.32 Using a small flow from a supplemental external Helium supply, spray helium around the Upper Line, F&D Assembly, and Lower Line. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.7.33 If any leaks are found in existing flight hardware, initiate a Discrepancy Report at the end of section G.7.

G.7.34 Close OMG-4.

G.7.35 Initial here to verify leak test pass for the Gyro 4 Spinup Lines _____.

G.7.36 Open F&DSP1A and log as required. Open OM-P1A.

G.7.37 Crack open OM-Purge and bleed any pressure out through the vacuum source.

G.7.38 When OM-Purge is fully open and vacuum source has reached a stable pressure, close OM-Purge and open OM-Leak.

G.7.39 Allow Leak Detector to reach an acceptable background level and record: _____.

G.7.40 Using a small flow from a supplemental external Helium supply, spray helium around the Upper Line, F&D Assembly, and Lower Line. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.7.41 If any leaks are found in existing flight hardware, initiate a Discrepancy Report at the end of section G.7.

G.7.42 Close OM-P1A.

G.7.43 Initial here to verify leak test pass for the P1A Lines _____.

G.7.44 Close OM-Leak and shut down leak detector if desired.

G.7.45 Close OM-Purge and shut down vacuum source if desired.

Section G.7 complete. QA _____

Customer _____

G.8 Connect GMA Vent to vacuum

Started on: _____

Note: this section may have performed already by another procedure.

Note: this section will require venting moderate quantities of Helium (10L>500L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.8.1 Prepare a vacuum source and lines and hardware as shown in Figure 1 (Vent Manifold) to provide vacuum to the GMA vent outlet.

G.8.2 Use GDS to establish 25 +/-5psia in the low pressure leg of the Fill Manifold.

G.8.3 Open GMA MV2 and log as required.

G.8.4 Use ECU to open GMA V27 and V29.

G.8.5 Uncap one port on the GMA vent. Use care to not strain the GMA vent line.

G.8.6 Connect Vent Manifold to GMA vent port. Use care to not strain the GMA vent line.

G.8.7 Use ECU to close GMA V29 and V27.

G.8.8 Use vacuum source to evacuate Vent Manifold and isolate. If any gross leak is indicated, identify and repair it. Shut down vacuum source if desired.

Section G.8 complete. QA _____

Customer _____

G.9 Connect GMA to F&D Lower Lines

Started on: _____

Note: this section will require venting moderate quantities of Helium (10L>1000L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.9.1 Remove screws and clamps from GMA transition bracket which secure the five GMA outlet connector savers. Identify and store these parts appropriately.

G.9.2 Verify GMA MV2 is open and GDS is supplying ~25 psia (as established in G.7).

G.9.3 Supply ~25psia of Helium to the purge port of the F&D manifold note: this flow may be adjusted as desired to supply an adequate purge.

G.9.4 Close OM-Leak. Open OM-Purge.

[Note Gyroscope 2 Spinup line connection begins here]

G.9.5 Open OMG-2 on F&D Manifold.

G.9.6 Use ECU to open GMA V11 and V13.

G.9.7 Use “Space Tool” to disconnect connector saver from GMA G2 outlet. Adjust flow from GDS through GMA as required to maintain a modest purging flow.

G.9.8 Remove GMA G2 outlet connector saver and the used Gamah gasket.

G.9.9 Use “Space Tool” to disconnect “stubby” cap from S2 Lower Line. Adjust flow from Helium supply through F&D Valves as required to maintain a modest flow.

G.9.10 Remove S2 Lower Line “stubby” cap and the used Gamah gasket.

G.9.11 Align S2 Lower Line with GMA G2 outlet on GMA transition bracket. If required to make alignment reasonably strain free, perform steps G.9.12 through G.9.25, otherwise continue to step G.9.26.

G.9.12 Loosen clamp securing S2 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.13 Use “Space Tool” to disconnect top of S2 lower line from bottom of S2 F&D Valve assembly if desired and remove used Gamah gasket.

G.9.14 Pivot S2 lower line and align with GMA G2 outlet on GMA transition bracket.

G.9.15 Install a fresh flight Gamah gasket into S2 lower line/F&D Valve assembly joint and assemble connection finger tight.

G.9.16 Use “Space Tool” to torque Gamah connection to 21 +/-1 in.lbs.

Wrench used_____

S2 lower line top torque QA _____

G.9.17 Fashion a clean room bag into an air trap with small openings at either end.

G.9.18 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.9.19 Insert particle counter inlet loosely into other end of bag.

G.9.20 Allow gas to flow for at least 1 minute to purge line.

G.9.21 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.9.22 Samples @ S2 Lower Line: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.9.23 Remove particle counter and gas trap and do not shut off the gas flow.

G.9.24 Initial here to verify particle test pass for the S2 Lower Line _____.

G.9.25 Tighten clamp securing S2 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H)..

G.9.26 Install a fresh flight Gamah gasket into S2 lower line/GMA G2 outlet assembly joint and assemble connection finger tight. Adjust flows as desired – both supplies should be less that 25psia.

G.9.27 Use "Space Tool" to torque G2 Gamah connection to 21 +/-1 in.lbs.

G2 outlet torque QA _____

G.9.28 Close OMG-2. Use ECU to close GMA V11 and V13.

[Note Gyroscope 1 Spinup line connection begins here]

G.9.29 Open OMG-1 on F&D Manifold.

G.9.30 Use ECU to open GMA V7 and V9.

G.9.31 Use "Space Tool" to disconnect connector saver from GMA G1 outlet. Adjust flow from GDS through GMA as required to maintain a modest purging flow.

G.9.32 Remove GMA G1 outlet connector saver and the used Gamah gasket.

G.9.33 Use "Space Tool" to disconnect "stubby" cap from S1 Lower Line. Adjust flow from Helium supply through F&D Valves as required to maintain a modest flow.

G.9.34 Remove S1 Lower Line "stubby" cap and the used Gamah gasket.

G.9.35 Align S1 Lower Line with GMA G1 outlet on GMA transition bracket. If required to make alignment reasonably strain free, perform steps G.9.36 through G.9.48, otherwise continue to step G.9.49.

G.9.36 Loosen clamp securing S1 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.37 Use "Space Tool" to disconnect top of S1 lower line from bottom of S1 F&D Valve assembly if desired and remove used Gamah gasket.

G.9.38 Pivot S1 lower line and align with GMA G1 outlet on GMA transition bracket.

G.9.39 Install a fresh flight Gamah gasket into S1 lower line/F&D Valve assembly joint and assemble connection finger tight.

G.9.40 Use "Space Tool" to torque Gamah connection to 21 +/-1 in.lbs.

G.9.41 Fashion a clean room bag into an air trap with small openings at either end.

G.9.42 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.9.43 Insert particle counter inlet loosely into other end of bag.

G.9.44 Allow gas to flow for at least 1 minute to purge line.

G.9.45 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.9.46 Samples @ S1 Lower Line: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.9.47 Remove particle counter and gas trap and do not shut off the gas flow.

G.9.48 Initial here to verify particle test pass for the S1 Lower Line _____.

G.9.49 Tighten clamp securing S1 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.50 Install a fresh flight Gamah gasket into S1 lower line/GMA G1 outlet assembly joint and assemble connection finger tight. Adjust flows as desired – both supplies should be less that 25psia.

G.9.51 Use “Space Tool” to torque G1 Gamah connection to 21 +/-1 in.lbs.

G1 outlet torque QA _____

G.9.52 Close OMG-1. Use ECU to close GMA V7 and V9.

[Note Gyroscope 3 Spinup line connection begins here]

G.9.53 Open OMG-3 on F&D Manifold.

G.9.54 Use ECU to open GMA V15 and V17.

G.9.55 Use “Space Tool” to disconnect connector saver from GMA G3 outlet. Adjust flow from GDS through GMA as required to maintain a modest purging flow.

G.9.56 Remove GMA G3 outlet connector saver and the used Gamah gasket.

G.9.57 Use “Space Tool” to disconnect “stubby” cap from S3 Lower Line. Adjust flow from Helium supply through F&D Valves as required to maintain a modest flow.

G.9.58 Remove S3 Lower Line “stubby” cap and the used Gamah gasket.

G.9.59 Align S3 Lower Line with GMA G3 outlet on GMA transition bracket. If required to make alignment reasonably strain free, perform steps G.9.60 through G.9.73, otherwise continue to step G.9.74.

G.9.60 Loosen clamp securing S3 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.61 Use “Space Tool” to disconnect top of S3 lower line from bottom of S3 F&D Valve assembly if desired and remove used Gamah gasket.

G.9.62 Pivot S3 lower line and align with GMA G3 outlet on GMA transition bracket.

G.9.63 Install a fresh flight Gamah gasket into S3 lower line/F&D Valve assembly joint and assemble connection finger tight.

G.9.64 Use “Space Tool” to torque Gamah connection to 21 +/-1 in.lbs.

S3 lower line top torque QA _____

G.9.65 Fashion a clean room bag into an air trap with small openings at either end.

G.9.66 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.9.67 Insert particle counter inlet loosely into other end of bag.

G.9.68 Allow gas to flow for at least 1 minute to purge line.

G.9.69 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.9.70 Samples @ S3 Lower Line: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.9.71 Remove particle counter and gas trap and do not shut off the gas flow.

G.9.72 Initial here to verify particle test pass for the S3 Lower Line _____.

G.9.73 Tighten clamp securing S3 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.74 Install a fresh flight Gamah gasket into S3 lower line/GMA G3 outlet assembly joint and assemble connection finger tight. Adjust flows as desired – both supplies should be less that 25psia.

G.9.75 Use “Space Tool” to torque G3 Gamah connection to 21 +/-1 in.lbs.

G3 outlet torque QA _____

G.9.76 Close OMG-3. Use ECU to close GMA V15 and V17.

[Note Gyroscope 4 Spinup line connection begins here]

G.9.77 Open OMG-4 on F&D Manifold.

G.9.78 Use ECU to open GMA V19 and V21.

G.9.79 Use “Space Tool” to disconnect connector saver from GMA G4 outlet. Adjust flow from GDS through GMA as required to maintain a modest purging flow.

G.9.80 Remove GMA G4 outlet connector saver and the used Gamah gasket.

G.9.81 Use “Space Tool” to disconnect “stubby” cap from S4 Lower Line. Adjust flow from Helium supply through F&D Valves as required to maintain a modest flow.

G.9.82 Remove S4 Lower Line “stubby” cap and the used Gamah gasket.

G.9.83 Align S4 Lower Line with GMA G4 outlet on GMA transition bracket. If required to make alignment reasonably strain free, perform steps G.9.84 through G.9.97, otherwise continue to step G.9.98.

G.9.84 Loosen clamp securing S4 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.85 Use “Space Tool” to disconnect top of S4 lower line from bottom of S4 F&D Valve assembly if desired and remove used Gamah gasket.

G.9.86 Pivot S4 lower line and align with GMA G4 outlet on GMA transition bracket.

G.9.87 Install a fresh flight Gamah gasket into S4 lower line/F&D Valve assembly joint and assemble connection finger tight.

G.9.88 Use “Space Tool” to torque Gamah connection to 21 +/-1 in.lbs.

S4 lower line top torque QA _____

G.9.89 Fashion a clean room bag into an air trap with small openings at either end.

G.9.90 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.9.91 Insert particle counter inlet loosely into other end of bag.

G.9.92 Allow gas to flow for at least 1 minute to purge line.

G.9.93 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.9.94 Samples @ S4 Lower Line: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.9.95 Remove particle counter and gas trap and do not shut off the gas flow.

G.9.96 Initial here to verify particle test pass for the S4 Lower Line _____.

G.9.97 Tighten clamp securing S4 lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.98 Install a fresh flight Gamah gasket into S4 lower line/GMA G4 outlet assembly joint and assemble connection finger tight. Adjust flows as desired – both supplies should be less that 25psia.

G.9.99 Use “Space Tool” to torque G4 Gamah connection to 21 +/-1 in.lbs.

G4 outlet torque QA _____

G.9.100 Close OMG-4. Use ECU to close GMA V19 and V21.

[Note Probe Flux Flush line connection begins here]

G.9.101 Open OM-P1A on F&D Manifold.

G.9.102 Use ECU to open GMA V23 and V25.

G.9.103 Use “Space Tool” to disconnect connector saver from GMA FF outlet. Adjust flow from GDS through GMA as required to maintain a modest purging flow.

G.9.104 Remove GMA FF outlet connector saver and the used Gamah gasket.

G.9.105 Use “Space Tool” to disconnect “stubby” cap from P1A Lower Line. Adjust flow from Helium supply through F&D Valves as required to maintain a modest flow.

G.9.106 Remove P1A Lower Line “stubby” cap and the used Gamah gasket.

G.9.107 Align P1A Lower Line with GMA FF outlet on GMA transition bracket. If required to make alignment reasonably strain free, perform steps G.9.108 through G.9.121, otherwise continue to step G.9.122.

G.9.108 Loosen clamp securing P1A lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.109 Use “Space Tool” to disconnect top of P1A lower line from bottom of P1A F&D Valve assembly if desired and remove used Gamah gasket.

G.9.110 Pivot P1A lower line and align with GMA FF outlet on GMA transition bracket.

G.9.111 Install a fresh flight Gamah gasket into P1A lower line/F&D Valve assembly joint and assemble connection finger tight.

G.9.112 Use "Space Tool" to torque Gamah connection to 21 +/-1 in.lbs.

P1A lower line top torque QA _____

G.9.113 Fashion a clean room bag into an air trap with small openings at either end.

G.9.114 Affix the clean room bag to the outlets of the F&D Manifold. Gas should slightly inflate the air trap.

G.9.115 Insert particle counter inlet loosely into other end of bag.

G.9.116 Allow gas to flow for at least 1 minute to purge line.

G.9.117 Take five one-minute samples. Average number of 0.5 micron or greater particles should be less than 5 per cubic foot.

G.9.118 Samples @ P1A Lower Line: #1 ___ #2 ___ #3 ___ #4___ #5 ___

G.9.119 Remove particle counter and gas trap and do not shut off the gas flow.

G.9.120 Initial here to verify particle test pass for the P1A Lower Line _____.

G.9.121 Tighten clamp securing P1A lower line to Space Vehicle mounting bracket if desired and log in Fastener Table (section H).

G.9.122 Install a fresh flight Gamah gasket into P1A lower line/GMA FF outlet assembly joint and assemble connection finger tight. Adjust flows as desired – both supplies should be less that 25psia.

G.9.123 Use "Space Tool" to torque FF Gamah connection to 21 +/-1 in.lbs.

FF outlet torque QA _____

G.9.124 Close OM-P1A. Use ECU to close GMA V23 and V25.

[Note leak checking of new connections begins here]

G.9.125 Use ECU to verify all GMA solenoid valves are closed.

G.9.126 Stop Helium supply and evacuate purge leg of F&D Manifold with vacuum source.

G.9.127 Verify closed OM-Leak and start Leak Detector. Open OM-Purge, OMG-2, OMG-1, OMG-3, OMG-4, OM-P1A.

G.9.128 Use ECU to open GMA V9, V10, V13, V14, V17, V18, V21, V22, V25, and V26.

G.9.129 Allow volumes to pump down sufficiently for leak detection or until stable

G.9.130 Use ECU to close GMA V9, V10, V13, V14, V17, V18, V21, V22, V25, and V26.

G.9.131 Close OM-Purge. Open OM-Leak. Allow Leak Detector to reach an acceptable background level and record: _____.

G.9.132 If unable to attain an adequate background rate, perform steps G.9.133 through G.9.141, otherwise go to G.9.142.

G.9.133 Close and torque GMA MV2 (40 +/- 5 in.lbs.) and log as required.

Wrench used_____

MV2 torque QA _____

G.9.134 Use the ECU to command the following GMA valves closed: V1, V2.

G.9.135 Close OM-Leak.

G.9.136 Start Vent vacuum source. When below 1 milli-torr, open OM-Vent.

G.9.137 Use the ECU to command the following valves open: V27, V28, V29, V30, V3, V4, V5, and V6.

G.9.138 Open OM-Purge.

G.9.139 Use the ECU to command the following valves open: V9, V10, V13, V14, V17, V18, V21, V22, V25, and V26

G.9.140 When pressures have stabilized in both vacuum sources, use the ECU to command all GMA valves closed.

G.9.141 Close OM-Vent and OM-Purge. Open OM-Leak. Allow Leak Detector to reach an acceptable background level and record: _____. Repeat steps G.9.134-G.9.141 if required.

G.9.142 Using a small flow from a supplemental external Helium supply, spray helium around the new Gamah connections. Watch for leak rate spikes (>2x10^7 sccs over background) that would indicate leaks.

G.9.143 Fix any leaks that are found and repeat step G.8.92 as necessary. Isolate and shut down Leak Detector if desired.

G.9.144 Initial here to verify test pass for the GMA to Space Vehicle hookup and leak check _____.

G.9.145 Close OMG-1, OMG-2, OMG-3, OMG-4, OM-P1A.

G.9.146 Install five clamps and screws securing lower lines to GMA transition bracket if desired and log in Fastener Table (section H).

Section G.9 complete. QA _____

Customer _____

G.10 Completion

Started on: _____

Note: this section may require venting small quantities of Helium (<10L) into the environment. This is not hazardous to personnel, but may pose a problem for Helium sensitive equipment in the same room. Notify the appropriate facility personnel if Helium venting is anticipated before starting this section. Notification _____.

G.10.1 Use ECU null script function to put GMA in “sleep” mode (all valves closed, zone I=II, zones III-VII ~20 psia).

G.10.2 Use ECU to read all pressures/counts from GMA and log in pressure sensor log (at end of section G).

G.10.3 Shut down ECU if desired.

G.10.4 Close and torque GMA MV2 (40 +/- 5 in.lbs.) and log as required if desired.

Wrench used_____

MV2 torque QA _____

G.10.5 Close and torque F&DS2 (40 +/- 5 in.lbs.) and log as required if desired.

F&DS2 torque QA _____

G.10.6 Close and torque F&DS1 (40 +/- 5 in.lbs.) and log as required if desired.

F&DS1 torque QA _____

G.10.7 Close and torque F&DS3 (40 +/- 5 in.lbs.) and log as required if desired.

F&DS3 torque QA _____

G.10.8 Close and torque F&DS4 (40 +/- 5 in.lbs.) and log as required if desired.

F&DS4 torque QA _____

G.10.9 Close and torque F&DP1A (40 +/- 5 in.lbs.) and log as required if desired.

F&DP1A torque QA _____

G.10.10 Close/verify closed all seven F&D Manifold valves (OMG-2, OMG-1, OMG-3, OMG-4, OMP-1A, OM-Purge, and OM-Leak).

G.10.11 Verify isolation of GMA Vent Manifold.

G.10.12 Disconnect GSE as desired.

G.10.13 Visually inspect exterior surface of flight hardware and remove contamination as desired.

Section G.10 complete. QA _____

Customer _____

G.11 Procedure Sign Off

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

_____ date: _____
Test Director/GMA Engineer

Discrepancies if any:

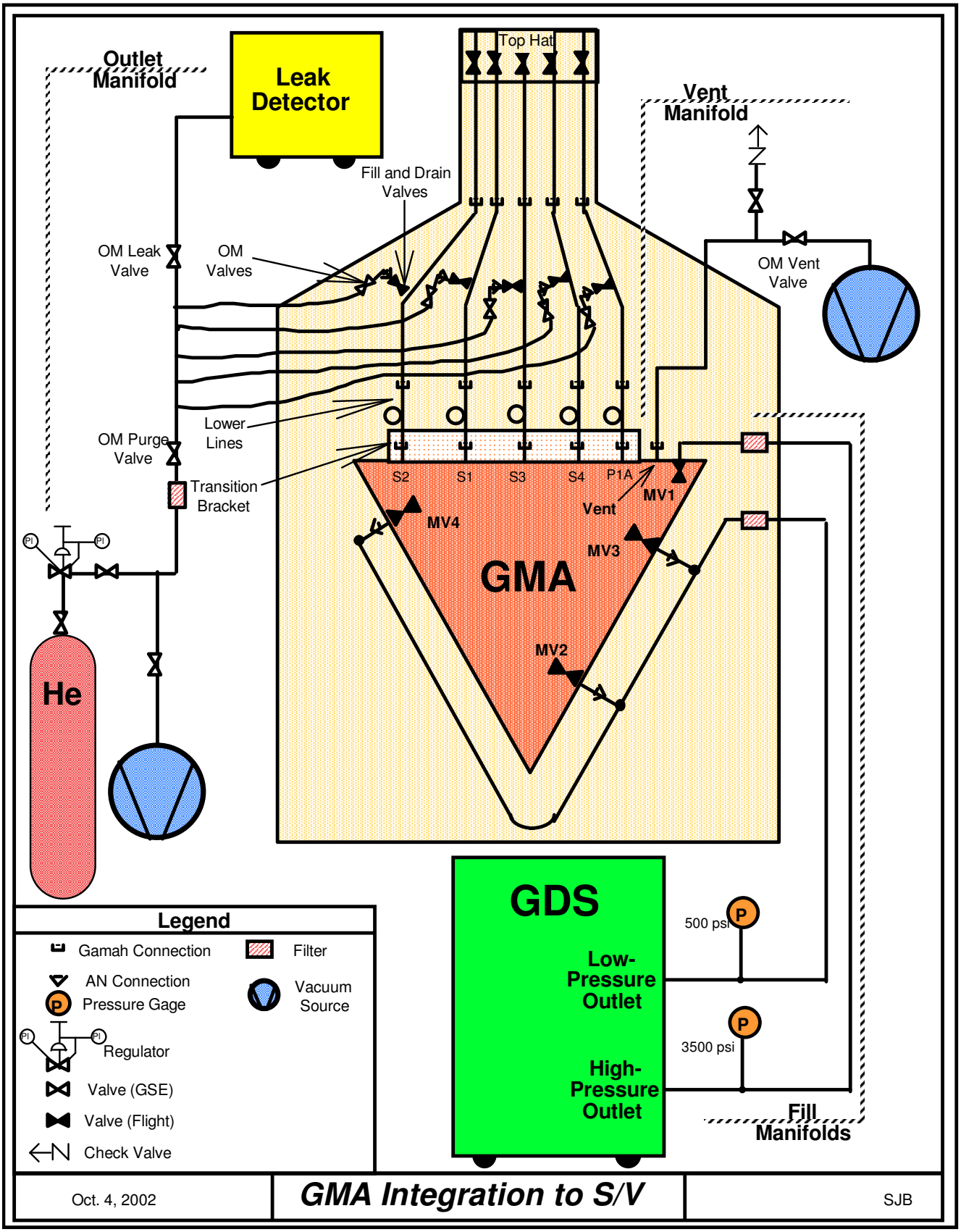
Approved: _____ date: _____
C. Gray, GMA REE

Approved: _____ date: _____
QA Representative

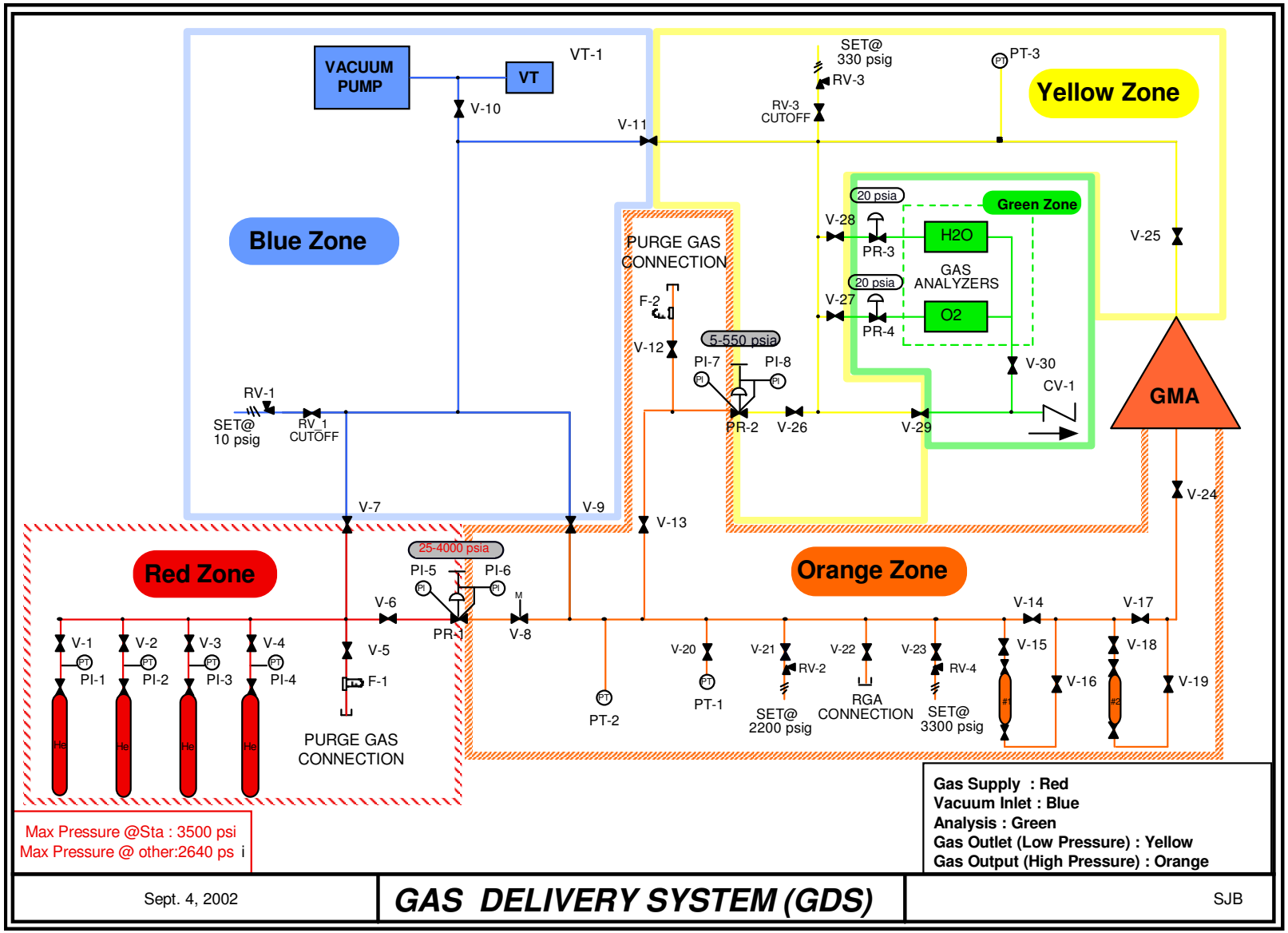
Approved: _____ date: _____
D. Ross, QA

H ILLUSTRATIONS AND TABLES

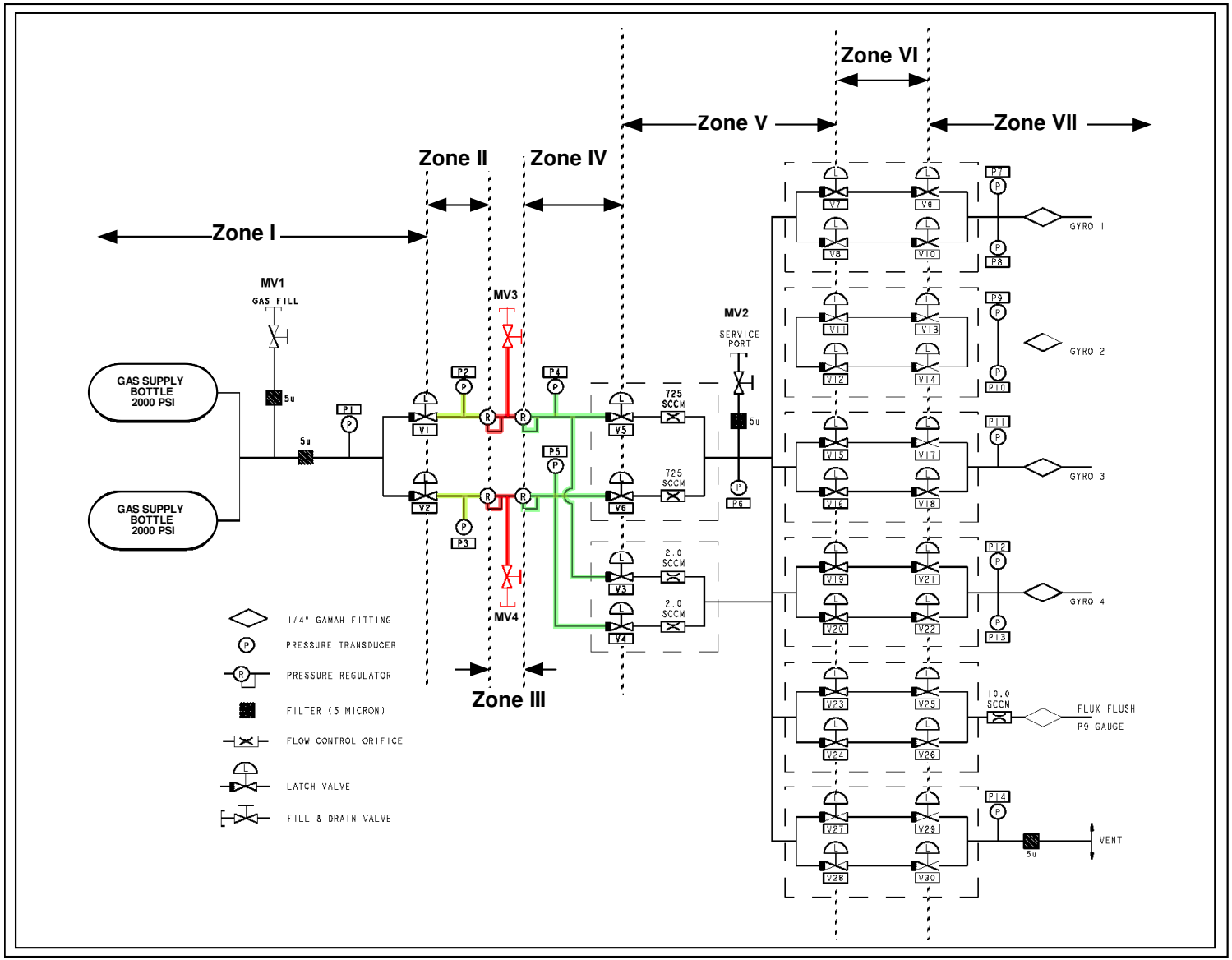
H.1 Figure 1 – GMA to Space Vehicle



H.2 Figure 2 – GDS Schematic



H.3 Figure 3 – GMA Schematic



H.4 Table 1 – Pressure Sensor Log

		GMA Sensors Counts														Manifold Mensors		GDS		
Sect: Step	Time	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	500 psi	3500 psi	PT1	PT2	PT3

H.5 Table 2 – Flight Fasteners to be Installed/Reinstalled:

Step #	Fastener location	Fastener Part Number	disposition	Torque, If applicable	QA Approval