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GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

GAS MOCK GMA ACCEPTANCE TEST PROCEDURE

GP-B ENGINEERING PROCEDURE

P0909 Rev –

4 March, 2002

PREPARED	R. Stephenson, GMA Engineer	Date
APPROVED	K. Bower, GMA Engineer	Date
APPROVED	C. Gray, GMA REE	Date
APPROVED	D. Ross, Quality Assurance	Date
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A. SCOPE

This procedure will test the acceptability of the Gas Flow Mock GMA (G-Mock) for use with flight and flight-like equipment. It will cover the setting and testing of the flows to the spinup lines along with valve verification, a proof test, a leak check, and a particle check. This will also test the interaction of the G-Mock with the ECU. Most of this procedure will be performed without the ECU, with the exception of sections G.6, and G.10. These are ECU specific tests. Sections G.3 through G.7 may be performed in any order. Section G.6 may be performed concurrently with Section G.5, or at any other time during the ATP. When not using the ECU, use strain gauge meters to read the pressure sensors. G-Mock will be connected to an Impedance Simulation Manifold (ISM) to simulate the pressure drop to a flight gyroscope (See Diagram 2). All gas connections to the G-Mock should be capped at all times when not connected. Make connections carefully to insure that the G-Mock gas path stays as clean as possible.

B. SAFETY

The G-Mock is a gas pressure vessel. Under normal operations, the G-Mock requires no safety measures or equipment beyond those required for the use of a supply gas cylinder. During high pressure operations (i.e. the proof test), the G-Mock should be treated as a pressurized delivery system. When any of the systems are 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) and make sure that these are open at time of venting.

C. QUALITY ASSURANCE

C.1 QA Notification

This assembly 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 of 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 Engineer 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 Engineer shall be Rick Stephenson or an alternate that he shall designate. The Engineer has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it.

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

N/A

E.2. Lifting Operation Requirements

N/A

E.3. Hardware/Software Requirements

ECU Flight Equivalent

Interface cables from ECU to GMA (Engineering)

G-Mock

G-Mock Outlet Manifold

Appropriate CSTOL calibrations for use with ECU

Leak detector

Clean Helium Supply (4.0 Grade or better)

High pressure inert gas supply for Proof Test, > 3000 psig

Minimum of 75 psi gas supply for valve actuation

Vacuum system

Impedance Simulation Manifold

- Baratron pressure gauge, 1000 torr range
- Baratron pressure gauge, 100 torr range
- Power supply readouts for above
- 5000 sccm MKS flow meter
- MKS 246 power supply for above
- 1000 sccm MKS flow meter
- MKS 246 power supply for above
- 10 sccm MKS flow meter
- MKS 246 power supply for above

Pre-cleaned plumbing lines, consistent with Class 100 practices

4000 psig digital pressure sensor

500 psig digital pressure sensor

Hand held particle counter

0.5 micron or better filter

Simple ball type flow meter, 1-5 lpm range.

PD691 strain gauge meter, manually calibrated.

G-Mock manual switch box (if available)

E.4. Instrument Pretest Requirements

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

E.5. Configuration Requirements

N/A

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/ Success Criteria

Individual quantities should be able to be within tolerances set out in individual procedure sections.

E.8. Constraints and Restrictions

N/A

F. REFERENCE DOCUMENTS

F.1. Drawings

G-Mock Drawing
GMA Schematic, Dwg. Number 26273

F.2. Supporting documentation

MKS Type 246C Power Supply/Readout Manual
MKS Baratron Type 622A/626A/627A/628A/629A Absolute Pressure Transducer Manual

F.3. Additional Procedures

P0912 Rev– CALIBRATING THE G-MOCK PRESSURE SENSORS AND THE ECU ENGINEERING UNIT

G. OPERATIONS

G.1. Verify Appropriate QA Notification

QA Notified_____ ONR Notified_____

G.2. Verify Configuration Requirements

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

Most of this procedure will be performed without the ECU, with the exception of sections G.6, and G10. These are ECU specific tests. Sections G.3 through G.7 may be performed in any order. Section G.6 may be performed concurrently with Section G.5, or at any other time during the ATP. When not using the ECU, use strain gauge meters to read the pressure sensors.

2.1 Before test, all G-Mock valves (manual and solenoid) should be closed and inlet and output gas connections should be capped.

2.2 Verify pressure relief systems are installed on high and low pressure side of G-Mock and that MMV3 is open (see Diagram 2).

2.3 Connect minimum 75 psig gas supply to the G-Mock pneumatic manifold.

2.4 Connect 500 psig sensor to Service Port of G-Mock using a VCR "T". Put a VCR plug on the other outlet of the VCR "T" and open MMV4.

2.5 Connect 4000 psig sensor to the Inlet Port of the G-Mock using a VCR "T. Put a VCR plug on the other outlet of the VCR "T".

2.6 Connect 0.5 micron or better filter to the G-Mock gas inlet and the Service Port.

G.3 Setup of ISM and G-Mock

Started on: _____

Note: Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves.

3.1 If not the beginning of ATP, simply verify that G-Mock is connected to the ISM and evacuated as per this section (Section G.3).

3.2 Connect the ISM to the vacuum system and the leak detector per Diagram 2. Baratron gauge and flow meters should be plugged in and turned on prior to test in order for them to warm up to operating temperature.

3.3 Verify that the G-Mock "Gyroscope" and "P1A" outlets are connected to the Outlet Manifold. Connect the lower portion of the Outlet Manifold to upper leg of the ISM using prepared lines.

3.4 Verify that the Vent outlet of the G-Mock is connected to the uppermost Outlet Manifold valve. Connect this valve to the lower leg of the ISM using prepared lines.

3.5 Open all of the Outlet Manifold manual valves (6).

3.6 Open all valves on the ISM. Close E2 and leak check the ISM, the Outlet Manifold, and all connections.

3.7 Unless they have previously been set, open G-Mock metering valves (full counterclockwise) and regulators (full clockwise) all the way (Finger tighten only. Excessive force or wrenches should never be used on regulators or metering valves).

3.8 Open all G-Mock solenoid valves. Open G-Mock manual valve MMV2.

3.9 Use leak detector to evacuate G-Mock, unless it is full of helium, in which case, close ISM manual valve E3 and open E2 and evacuate using the vacuum system.

3.10 Verify that G-Mock pressure sensors all read 0 psia (using strain gauge meter).

3.11 Close all solenoid valves and ISM manual valves. This is the starting configuration for most sections in this procedure.

G.4 G-Mock Leak test

Started on: _____

Note: Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves.

4.1 Verify that G-Mock is connected to the Outlet Manifold, which is connected to the ISM per section G.3. Verify that all solenoid valves and MMV1 are closed, along with all ISM valves. Verify that Outlet Manifold valves are all open. If ISM is unavailable, connect leak detector to the Vent Port of the Outlet Manifold, open the Vent Port Outlet Manifold Valve, close all other Outlet Manifold Valves, and continue with Section G.4, disregarding any reference to the ISM.

4.2 Open all ISM valves except E2.

4.3 Verify MMV2, MMV3, and MMV4 are open (see Diagram 2).

4.4 Open all G-Mock Solenoid valves.

4.5 Start leak detector. Verify that all G-Mock pressure sensors read 0 psia once leak detector goes into test mode.

4.6 Using a small flow, spray helium around every G-Mock connection, slowly working from the gas inlet towards the leak detector. Watch for leak rate spikes that would indicate leaks.

4.7 Fix any leaks that are found and repeat step 4.7 as necessary.

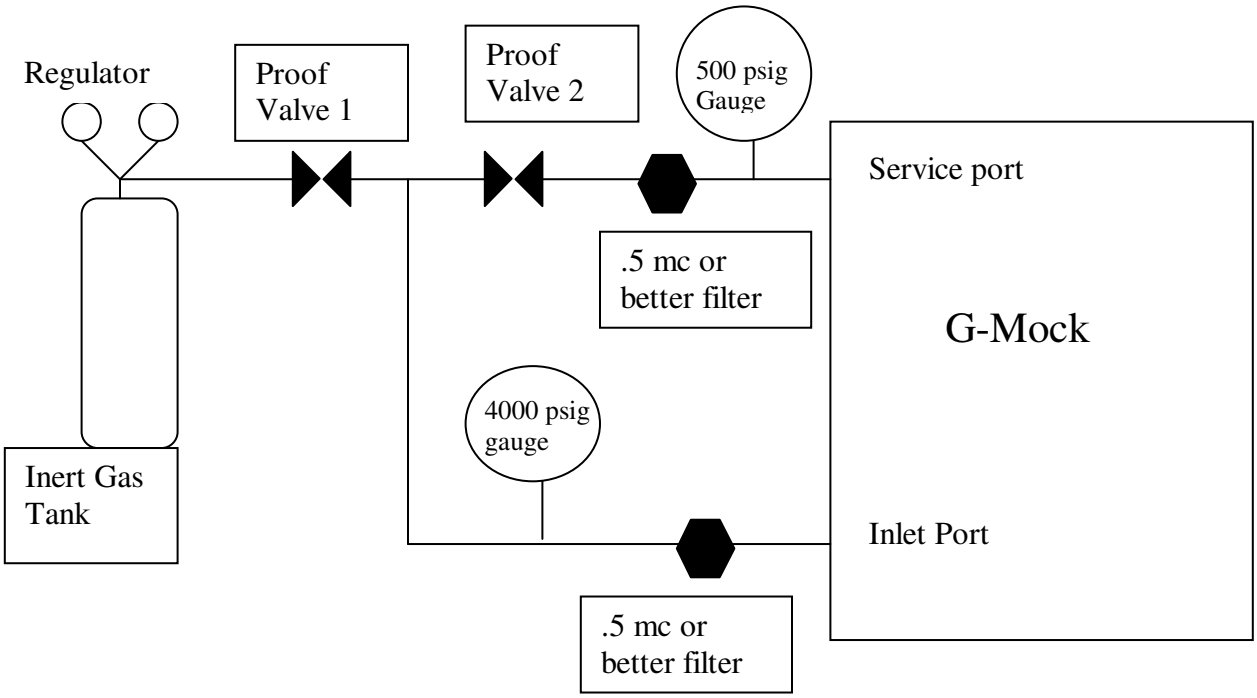
4.8 Close all solenoid and ISM valves. Shut down leak detector.

4.9 Record completion of leak test on line 1 of Section H.1

G.5 Proof Test

Started on: _____

Figure 5.1: Proof Test Gas Supply Setup:



Note: Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves. Optionally, the ECU may be used to control the G-Mock and take pressure sensor verification data.

5.1 Verify that all Outlet Manifold manual valves and all G-Mock solenoid valves are closed. Disconnect G-Mock from ISM if necessary. Verify that 0.5 micron or better filter is connected to G-Mock gas inlet. Connect leak detector to the Vent Port of the Outlet Manifold.

5.2 Close MMV1 (if necessary), MMV3 and MMV4. Verify that MMV2 is open.

5.3 Connect high pressure (>3000 psig) clean inert gas supply to both the G-Mock gas inlet, and the Service Port as per Figure 5.1. Also connect 4000 psig pressure sensor to the gas inlet per Figure 5.1. If performing Section G.6 concurrently, gas used should be Helium. Be sure to use lines that are rated at 3100 psig or greater. Use a 0.5 micron filter or better at the G-Mock Service Port.

5.4 Verify G-Mock metering valves are fully open (full counterclockwise).

5.5 Open both Proof valves (see Figure 5.1) and MMV1, MMV4, and all solenoid valves.

5.6 Set supply pressure to 90-100 psig. Be cautious not to go above 100 psig. Verify pressure using the pressure gauge at the Service Port. If necessary, this can be done incrementally per Section G.6 in order to test the pressure transducer calibration.

5.7 Close Proof Valve 2.

5.8 Increase supply pressure to 3000-3100 psig. If necessary, this can be done incrementally per Section G.6 in order to test the pressure transducer calibration.

5.9 Record pressure at GP1: _____ (should be 3000-3100 psig)

5.10 Record pressure at Service Port: _____ (should be 90-100 psig)

5.11 Allow G-Mock to soak at this pressure for 10 minutes.

5.12 Close Proof Valve 1 and open lower 5 Outlet Manifold manual valves (leaving Outlet Manifold Vent Valve closed in order to protect the leak detector) to vent G-Mock.

5.13 Once G-Mock pressure has reached atmospheric, start leak detector, close all Outlet Manifold Valves, open Outlet Manifold Vent Valve, and evacuate G-Mock. Wait for GP1 to reach 0 psia.

5.14 Close MMV1, and MMV4. Open MMV3.

5.15 Disconnect high pressure inert gas supply from G-Mock and replace VCR plug at Service Port "T".

5.16 Open MMV4, and close all G-Mock Solenoid valves.

5.17 Record completion of proof test on Lines 2 and 3 of Section H.1.

5.18 Verify that the pressure relief valves have factory certifications of the relief pressures and attach copies to this procedure.

5.19 Run Section G.4 "Leak Check" again.

5.20 Record successful completion of leak check on line 4 of Section H.1.

G.6 Verification of G-Mock Pressure Transducers With the ECU

Started on: _____

Note: This section can be performed concurrently with Section G.5, Proof Test, if the ECU is available at that time.
Tolerance on all G-Mock pressure sensors is 10% of full scale reading.
Mark off each step of this section as it is completed.

6.1 If test is being performed concurrently with Section G.5, skip to step 6.5.

6.2 Verify that all Outlet Manifold manual valves and all G-Mock solenoid valves are closed. Disconnect G-Mock from ISM if necessary. Verify that 0.5 micron or better filter is connected to G-Mock gas inlet. Connect leak detector to the Vent Port of the Outlet Manifold.

6.3 Close MMV1 (if necessary), MMV3 and MMV4. Verify that MMV2 is open.

6.4 Connect high pressure (>2000 psig) clean helium gas source to both the G-Mock gas inlet, and the Service Port as per G.11.2. Also connect 4000 psig pressure sensor to the gas inlet per Figure 5.1. Be sure to use lines that are rated at 3100 psig or greater. Use a 0.5 micron filter or better at the G-Mock Service Port.

6.5 Connect ECU to G-Mock using proper cables and initialize per ECU operator standard procedures.

6.6 Verify that P0912 Rev – has been completed, and calibration curves for the sensors have been loaded into the ECU.

6.7 Connect 1000 Torr Baratron gauge to the Outlet Manifold Gyro Port. Verify that it is warmed up and zeroed correctly per MKS Baratron Manual.

6.8 Verify Proof Valve 1 is closed, and set supply pressure to 5-20 psig, or as low as it can be set and still be open.

6.9 Verify that G-Mock regulators have been set per section G.8. If section G.8 has not yet been performed, open all G-Mock pressure regulators fully (full clockwise).

6.10 Verify that all G-Mock metering valves have been set per section G.9, or are fully open (full counterclockwise).

6.11 Open all G-Mock solenoid valves, MMV4, MMV1, and Proof Valve 2.

6.12 Open Outlet Manifold Gyro 4 Valve and Outlet Manifold Vent Valve and use leak detector to evacuate G-Mock.

6.13 Leak check the gas supply plumbing.

6.14 With leak detector in test mode, verify that Baratron gauge reads 0 psia.

6.15 Verify that all G-Mock pressure sensors read 0 psia (within tolerance).

6.16 Close Outlet Manifold Vent Valve.

6.17 Record on line 5 of Section H.1 that all G-Mock sensors are properly zeroed.

6.18 Very briefly crack open Proof Valve 1 to bring pressure in the G-Mock to 5-8. Verify this pressure with Baratron gauge.

6.19 Verify that GP7–GP14 all read the same as the Baratron gauge (within tolerance).

6.20 Record on line 6 of Section H.1 that GP7–GP14 are calibrated for the midrange.

6.21 Very briefly crack open Proof Valve 1 to bring the pressure in the G-Mock to 11.5–13.5 psia. Verify this pressure with Baratron gauge.

6.22 Verify that GP7–GP14 all read the same as the Baratron gauge (within tolerance).

6.23 Record on line 7 of Section H.1 that GP7–GP14 are calibrated for the high end of their range.

6.24 Close the Outlet Manifold Gyro 4 Valve and remove Baratron gauge.

6.25 Open Proof Valve 1 and raise the supply pressure to 8-12 psig (23–27 psia) on the Service Port gauge.

6.26 Verify the correct pressure readings on GP4 – GP6 (within tolerance).

6.27 Record on line 8 of Section H.1 that GP4 – GP6 are calibrated for the midrange.

6.28 Raise the supply pressure to 30–33 psig (45–48 psia) on the Service Port gauge.

6.29 Verify the correct pressure readings on GP4 and GP6 (within tolerance).

6.30 Record on line 9 of Section H.1 that GP4 and GP6 are calibrated for the high end of their range.

6.31 Close Proof Valve 2 and raise the supply pressure to 1250 psig (1215 psia) +- 20 psi.

6.32 Verify the correct pressure readings on GP1, GP2, and GP3 (within tolerance).

6.33 Record on line 10 of Section H.1 that GP1, GP2 and GP3 are calibrated for the midrange.

6.34 Raise the supply pressure to 1980 psig (1995 psia) +- 20 psi.

6.35 Verify the correct pressure readings on GP1, GP2, and GP3 (within tolerance).

6.36 Record on line 11 of Section H.1 that GP1, GP2 and GP3 are calibrated for their high range.

6.37 If performed concurrently with the Proof Test, take another data point on GP1 at 3000 psig.
Pressure: _____ GP1 Reading: _____

6.38 Record this measurement on line 12 of Section H.1.

6.39 Close Proof Valve 1 and open all Outlet Manifold Manual Valves except Vent Valve.

6.40 Open all G-Mock solenoid valves.

6.41 When pressure gets below 10 psig at 4000 psi gauge, close all Outlet Manifold Valves, MMV4 and MMV1. Open MMV3.

6.42 Open Outlet Manifold Vent Valve and use leak detector to evacuate G-Mock.

6.43 When pressure at GP1 reaches 0 psia, close all G-Mock solenoid valves and Outlet Manifold Vent Valve.

G.7 G-Mock Particle test

Started on: _____

Note: Pass level for particle test is < 5 particles of size 0.5 micron or greater per cubic foot.
Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves.

7.1 Verify that the G-Mock solenoids are closed, and the G-Mock is disconnected from the ISM. Verify that MMV1, MMV4, and all Outlet Manifold valves are closed and that MMV2 and MMV3 are open.

7.2 Verify that the G-Mock is situated in the Class 1000 (or better) clean room and has been allowed to rest there for at least 10 minutes to allow airborne particles to settle.

7.3 Connect a plastic ball flow controller in line with the clean inert gas supply.

7.4 Open supply bottle, raise pressure as needed and set flow to between 5-10 lpm (about 0.25 scfm).

7.5 Allow gas to flow for at least 5 minutes to purge line.

7.6 Install 0.5 micron or better filter on the output of the gas supply line (use the filter that is connected to the G-Mock inlet).

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

7.8 Affix to end of plumbing line. Gas should slightly inflate the air trap.

7.9 Allow gas to purge for one minute.

7.10 Insert particle counter inlet loosely into other end of bag.

7.11 Take five one-minute samples (1 cu. ft.). Average number of 0.5 micron or greater particles should be less than 5.

7.12 Shut off gas supply and connect this pluming to the G-Mock Inlet Port (see Diagram 2).

7.13 Set supply pressure and flow rate to the previous level from step 7.4.

7.14 Open all G-Mock regulators (full clockwise) and G-Mock metering valves (full counterclockwise) as far as they will go.

7.15 Open G-Mock manual valve MMV1.

7.16 Open V1, V3, V5, V27, V28, V29 and V30 to flow gas through the Vent port.

7.17 Allow gas to purge for at least 5 minutes.

7.18 Affix gas trap (made from clean room bag as before) to the correct port of the G-Mock and insert particle counter.

7.19 Take five samples each for one minute (1 cu. Ft.). Average count should be less than 5 particles per liter of size 0.5 micron or larger.

7.20 Remove particle counter and gas trap.

7.21 Initial here to verify test pass _____.

7.22 Close V1, V3, and V5 to close A-Side regulator leg.

7.23 Open V2, V4, and V6 in order to test B-Side regulator leg.

7.24 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.25 Close V27 – V30.

7.26 Open V23-V26 to flow gas through the P1A line.

7.27 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.28 Close V23-V26.

7.29 Open V7 – V10 to flow gas through the Gyro 1 line.

7.30 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.31 Close V7 – V10.

7.32 Open V11 – V14 to flow gas through the Gyro 2 line.

7.33 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.34 Close V11 – V14.

7.35 Open V15 – V18 to flow gas through the Gyro 3 line.

7.36 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.37 Close V15 – V18.

7.38 Open V19 – V22 to flow gas through the Gyro 4 line.

7.39 Repeat steps 7.18 – 7.21. Initial here to verify test pass _____.

7.40 Close V19 – V22.

7.41 Close all G-Mock solenoid valves. Close MMV1 and all Outlet Manifold Valves.

7.42 Record successful completion of the test on line 13 of Section H.1

G.8 Set/Check G-Mock Regulators

Started on: _____

Note: Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves.

8.1 If the regulators have not previously been set, skip steps 8.3 – 8.11.

8.2 Verify that the G-Mock solenoids and ISM manual valves are closed and MMV1 is closed, while MMV2, MMV3, and all Outlet Manifold valves are closed.

8.3 Connect the ISM to the G-Mock per Section G.3.

8.4 Connect helium supply to the inlet of the G-Mock per Diagram 1 and set the supply pressure to 100–200 psig. Use a 0.5 micron or better filter at the G-Mock gas inlet.

8.5 Start vacuum source and open E2, E1, B2, and all Outlet Manifold Valves.

8.6 Open V27, V29, V5, and V3 to evacuate A-side of G-Mock.

8.7 Close V27 and open V1. Verify that GP2 reads the supply pressure and GP4, GP6 and sensor at Service Port read 20-24 psia (5-9 psig).

8.8 Close V1, open V27, and allow G-Mock to evacuate. Verify 0 psia at GP2, GP4, and GP6.

8.9 Repeat steps 8.5 – 8.7 for B-side regulator leg. Close all G-Mock solenoid valves and ISM manual valves.

8.10 Regulators verified as set correctly: Date_____ Engineer: _____

8.11 Go to next section.

8.12 Connect the ISM to the G-Mock per section G.3.

8.13 Connect Helium supply to the G-Mock inlet and set supply pressure to 100-200 psig. Use a 0.5 micron or better filter at the G-Mock gas inlet.

8.14 Verify G-Mock metering valves are open all the way (Full counterclockwise) and G-Mock pressure regulators are open all the way (full clockwise).

8.15 With vacuum source running, open ISM valves E2, E1, B2, and all Outlet Manifold Valves. Verify that B1, F2, and F1 are closed. Open G-Mock valves V30–V27 and V6–V1 to evacuate G-Mock.

8.16 Close V1–V6 and V28–V30. Open MMV1.

8.17 Verify pressure is 100-200 psig at GP1. Close upstream pressure regulators (R1 and R2) all the way (turn counterclockwise until resistance drops significantly).

8.18 Open V1. Verify pressure rise at GP2.

8.19 Open V3 and V5. Slowly open A-Side upstream pressure regulator (R1) until pressure at Service Port gauge reaches 22–24 psia (7–9 psig).

8.20 Verify pressure at GP4 and GP6 is 22–24 psia.

8.21 Close V1 and open V29 to evacuate G-Mock. When pressure falls below 15 psia (0 psig) at Service Port, close V29.

8.22 Verify pressure at GP2, GP4, GP6, and GP1 (GP1 should be at supply pressure). Close A-Side downstream pressure regulator (R3) all the way (turn counterclockwise until resistance drops significantly).

8.23 Open V1 and slowly open A-side downstream regulator (R3) until the service port pressure sensor reads from 20 to 22 psia (5-7 psig).

8.24 Close V1 and open V29. Wait for G-Mock to be completely evacuated.

8.25 While waiting, record that A-Side regulators are set, on line 14 of Section H.1.

8.26 Verify pressure is 0 psia at GP2, GP4, and GP6. Close V3, V5, and V29.

8.27 Open V2. Verify pressure rise at GP3.

8.28 Open V4 and V6. Slowly open B-Side upstream pressure regulator (R2) until pressure at Service Port gauge reaches 22–24 psia (7–9 psig).

8.29 Verify pressure at GP5 and GP6 is 22–24 psia.

8.30 Close V2 and open V29 to evacuate G-Mock. When pressure falls below 15 psia (0 psig) at Service Port, close V29.

8.31 Verify pressure at GP3, GP5, GP6, and GP1 (GP1 should be at supply pressure). Close B-Side downstream pressure regulator (R4) all the way (turn counterclockwise until resistance drops significantly).

8.32 Open V2 and slowly open B-side downstream regulator (R4) until the service port pressure sensor reads from 20 to 22 psia (5-7 psig).

8.33 Close V2 and open V29. Wait for G-Mock to be completely evacuated.

8.34 While waiting, record that B-Side regulators are set, on line 15 of Section H.1.

8.35 Verify pressure is 0 psia at GP3, GP5, and GP6. Close V4, V6, V27, and V29.

8.36 With G-Mock evacuated up to V1 and V2, close all remaining solenoid valves and ISM manual valves.

G.9 Setting of G-Mock Metering Valves

Started on: _____

Note: Tolerance on 725 sccm flow rate is ±20%
Tolerance on 2 sccm flow rate is ±50%.
Tolerance on 40 Torr pressure reading is ±25%
Mark off each step of this section as it is completed.
Use Manual Switch Box to control solenoids if available. If not, control them using the manual buttons on the pilot valves.

9.1 Verify that metering valves have not yet been set. If lines 16–19 of section H.1 have already been signed, skip to Section G.10.

9.2 Verify that he G-Mock solenoids and ISM manual valves are closed, the G-Mock is connected to the ISM and evacuated, and that MMV1 is closed, while MMV2, MMV3, and all Outlet Manifold valves are open. Verify that a 0.5 micron or better filter is installed on the gas inlet.

9.3 Connect the Helium supply to the G-Mock, if necessary, per section Diagram 1.

9.4 Open all ISM valves except E3 and evacuate using vacuum supply.

9.5 Verify Baratron gauge at IP1 is warmed up and zeroed properly. It should have been powered for at least 2 hours prior to zeroing. Zeroing must take place at less than 0.01 Torr.

9.6 Verify that mass flow meters are warmed up. Set the Flow Meters per chapter four of the MKS 246C manual for full flow measurement of Helium.

9.7 Close Helium Valve 1 and open MMV1. Set supply pressure to 100–200 psig.

9.8 Open all G-Mock solenoid valves to evacuate G-Mock and supply line.

9.9 Close all G-Mock Solenoid Valves.

9.10 Close ISM manual valves F3, F4, B2, F1, and B1.

9.11 Open Helium Valve 1 and verify supply pressure at GP1 is 100–200 psig.

9.12 Verify ISM metering valves M1 and M2 are open (full counterclockwise).

9.13 Open V1 and verify 20-24 psia at GP4.

9.14 Open V7 and V9. Open V5 and wait for flow to stabilize on Flow Meters 2 and 3 (FM2 and FM3).

9.15 Close G-Mock metering valve MTR1 until the sum of the flows at FM2 and FM3 reaches 725 sccm.

9.16 Close ISM metering valve until pressure at IP1 (Baratron gauge) reads 40 Torr.

9.17 Adjust G-Mock Metering Valve until the sum of the flows at FM2 and FM3 reaches 725 sccm.

9.18 Adjust ISM metering valve M1 until pressure at IP1 reaches 40 Torr.

9.19 Repeat steps 9.16 and 9.17 until both conditions are met.

9.20 Close V7 and V9. Open V10 and V8.

9.21 Verify that the sum of the flows at FM2 and FM3 and IP1 pressure is within tolerance.

9.22 Close V8 and V10. Open V13 and V11 and verify the sum of the flows at FM2 and FM3 is within tolerance and adjust metering valves if necessary.

9.23 Repeat for valve pairs from V15 through V22. Note that a metering valve adjustment requires that all other valves must be rechecked until all are within tolerance. Attempt to adjust only the metering valve on the G-Mock, leaving metering valve M1 on the ISM set if possible.

9.24 Tape metering valve MTR1 in place and record completion on line 16 of Section H.1. Also tape ISM metering valves M1 and M2 in place.

9.25 Open V9 and V7. Close V5 and V1.

9.26 Open V2 and verify 20-24 psia at GP4.

9.27 Open V6 and wait for the sum of the flows at FM2 and FM3 to stabilize.

9.28 Close G-Mock metering valve MTR2 until flow stabilizes at 725 sccm.

9.29 Verify flow through all valve pairs as in 9.22 above, adjusting as necessary.

9.30 Close V6 and V2. Tape metering valve MTR2 in place and record completion on line 17 of Section H.1.

9.31 Close manual valves F2 and F5 on the ISM, and open F1.

9.32 Open V3 and V1. Verify pressures at GP2 and GP4. Open V9 and V7.

9.33 Close G-Mock metering valve MTR3 until FM1 reads 2 sccm. The Baratron gauge may not read 40 Torr during low flow.

9.34 Close V7 and V9. Open V8 and V10.

9.35 Verify that flow is within tolerance and repeat for valve pairs V11 – V26.

9.36 Tape G-Mock metering valve MTR3 in place and record completion on line 18 of Section H.1.

9.37 Close V1. Open V5, V7 and V9. Open B1 on the ISM. Verify pressure is 0 psia at GP2.

9.38 Close V5 and V3. Close B1 on the ISM. Open V2 and verify pressures at GP3 and GP5.

9.39 Open V4. Close G-Mock metering valve MTR4 until FM1 reads 2 sccm. The Baratron gauge may not read 40 Torr during low flow.

9.40 Close V7 and V9. Open V8 and V10.

9.41 Verify that flow is within tolerance and repeat for valve pairs V11 – V26.

9.42 Tape G-Mock metering valve MTR4 in place and record completion on line 19 of Section H.1.

9.43 Close MMV1. Open B1 and close F1 on the ISM. Open V6, V7, and V9 to evacuate the G-Mock.

9.44 Verify pressure at GP3 is 0 psia.

9.45 Close V2, V4, V6, V7, and V9. Close all ISM manual valves.

G.10 Verification of G-Mock Helium Flow Rates; Verification of Valve Function with ECU

Started on: _____

Note: Tolerance on 725 sccm flow rate is ±20% (this is read as the sum of FM2 and FM3)
Tolerance on 2 sccm flow rate is ±50% (this is read at FM1)
Tolerance on 40 Torr presssure reading is ±25% (this is read at IP1)
Mark off each step of this section as it is completed.

10.1 Verify that the G-Mock solenoids and ISM manual valves are closed, the G-Mock is connected to the ISM and evacuated, and that MMV1 are closed, while MMV2, MMV3, MMV4, and all Outlet Manifold valves are open. Verify that a 0.5 micron or better filter is installed on the gas inlet, as well as the Helium Supply per DIAGRAM 2 and that the supply pressure is set to 100–200 psig.

10.2 Verify that section G.8 of this procedure has successfully been completed.

10.3 Verify that section G.9 of this procedure has successfully been completed.

10.4 Connect the ECU to the G-Mock and initialize per ECU operator standard procedures.

10.5 Start vacuum source, and open manual valves F2, F5, and E2 on the ISM

10.6 Open V7, V9 and V5 and verify state with the ECU.

10.7 Open MMV1. Verify supply pressure at GP1 is 100-200 psig.

10.8 Open V1 and record the sum of the flows at FM2 and FM3 in Table 1(MTR1, Gyro 1 Upper). Verify valve state with the ECU.

10.9 Close V5 and verify flow at FM2 stops. Verify valve state with the ECU.

10.10 Open manual valve F1 on the ISM and close F2 and F5.

10.11 Open V3 and record flow at FM1 in Table 1 (MTR3, Gyro 1, upper). Verify valve state with the ECU.

10.12 Close V3 and verify flow at FM1 stops. Verify valve state with the ECU.

10.13 Close V1 and verify valve state with the ECU.

10.14 Record on line 20 of Section H.1 that all A-Side Regulator Leg solenoid valves and state switches are functional.

10.15 Open V4 and V2. record flow at FM1 in Table 1 (MTR4, Gyro 1 Upper). Verify valve state with the ECU.

10.16 Close V4 and verify flow at FM1 stops. Verify valve state with the ECU.

10.17 Open manual valves F2 and F5 on the ISM and close F1.

10.18 Open V6 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR4, Gyro 1 Upper). Verify valve state with the ECU.

10.19 Close V6 and verify flow at FM2 stops. Verify valve state with the ECU.

10.20 Close V2 and verify valve state with the ECU.

10.21 Record on line 21 of Section H.1 that all B-Side Regulator Leg solenoid valves and state switches are functional.

10.22 Close F5 on the ISM.

10.23 Open V2 and V6 and verify that flow starts at FM2. Stable flow need not be reached, simply verify that gas is flowing.

10.24 Close V9 and verify flow at FM2 stops. Verify valve state with the ECU.

10.25 Open V9 and verify flow starts at FM2. Close V7 and verify flow stops. Verify valve state with the ECU.

10.26 Close V9 and open V10 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 1 Lower). Verify valve state with the ECU.

10.27 Close V8 and verify flow stops. Close V10. Verify valve state with the ECU.

10.28 Open V11 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.29 Open V13 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 2 Upper). Verify valve state with the ECU.

10.30 Close V11 and verify flow at FM1 stops. Close V13. Verify valve state with the ECU.

10.31 Open V12 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.32 Open V14 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 2 Lower). Verify valve state with the ECU.

10.33 Close V12 and verify flow at FM1 stops. Close V14. Verify valve state with the ECU.

10.34 Open V15 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.35 Open V17 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 3 Upper). Verify valve state with the ECU.

10.36 Close V15 and verify flow at FM1 stops. Close V17. Verify valve state with the ECU.

10.37 Open V16 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.38 Open V18 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 3 Lower). Verify valve state with the ECU.

10.39 Close V16 and verify flow at FM1 stops. Close V18. Verify valve state with the ECU.

10.40 Open V19 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.41 Open V21 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 4 Upper). Verify valve state with the ECU.

10.42 Close V19 and verify flow at FM1 stops. Close V21. Verify valve state with the ECU.

10.43 Open V20 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.44 Open V22 and record the sum of the flows at FM2 and FM3 in Table 1 (MTR2, Gyro 4 Lower). Verify valve state with the ECU.

10.45 Close V20 and verify flow at FM1 stops. Close V22. Verify valve state with the ECU.

10.46 Close manual valves F2 and F5 on the ISM, and open F4 and E1.

10.47 Open V27 and pause to verify no flow starts at FM5. Verify valve state with the ECU.

10.48 Open V25 and verify that there is flow at FM5. A stable flow rate does not have to be reached, simply verify that there is gas flowing. The same holds true for the next four steps.

10.49 Verify valve state with the ECU.

10.50 Close V27 and verify flow at FM5 stops. Close V29. Verify valve state with the ECU.

10.51 Open V28 and pause to verify no flow starts at FM5. Verify valve state with the ECU.

10.52 Open V30 and verify that flow starts at FM5. Verify valve state with the ECU.

10.53 Close V28 and verify flow at FM5 stops. Close V26. Verify valve state with the ECU.

10.54 Record on line 23 of Section H.1 that flow through MTR2 has been verified through all applicable gas paths.

10.55 Close manual valves F4 and E3 on the ISM and open F1.

10.56 Close V6 and open V10, V8, and V4.

10.57 Record flow at FM1 (MTR4, Gyro 1, Lower).

10.58 Close V8 and V10.

10.59 Open V13 and V11 and record flow at FM1 (MTR4, Gyro 2, Upper).

10.60 Close V11 and V13.

10.61 Open V14 and V12 and record flow at FM1 (MTR4, Gyro 2, Lower).

10.62 Close V12 and V14.

10.63 Open V17 and V15 and record flow at FM1 (MTR4, Gyro 3, Upper).

10.64 Close V15 and V17.

10.65 Open V18 and V16 and record flow at FM1 (MTR4, Gyro 3, Lower).

10.66 Close V16 and V18.

10.67 Open V21 and V19 and record flow at FM1 (MTR4, Gyro 4, Upper).

10.68 Close V19 and V21.

10.69 Open V22 and V20 and record flow at FM1 (MTR4, Gyro 4, Lower).

10.70 Open V23 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.71 Open V25 and record flow at FM1 (MTR4, P1A , Upper). Verify valve state with the ECU.

10.72 Close V23 and verify flow at FM1 stops. Close V25. Verify valve state with the ECU.

10.73 Open V24 and pause to verify no flow starts at FM2. Verify valve state with the ECU.

10.74 Open V26 and record flow at FM1 (MTR4, P1A , Lower). Verify valve state with the ECU.

10.75 Close V24 and verify flow at FM1 stops. Close V26. Verify valve state with the ECU.

10.76 Close V2 and open V6 and V4.

10.77 Wait for pressure at GP3 to reach 0 psia.

10.78 Close V6, V20, and V22.

10.79 Record on line 24 of Section H.1 that flow through MTR4 has been verified through all applicable gas paths.

10.80 Record on line 22 of Section H.1 that all downstream solenoid valves and valve switches are functional.

10.81 Open V10, V8, V3, and V1.

10.82 Repeat steps 10.56 through 10.75 but record under MTR3.

10.83 Close V3.

10.84 Record on line 25 of Section H.1 that flow through MTR3 has been verified through all applicable gas paths.

10.85 Open V10, V8, and V5.

10.86 Repeat steps 10.56 through 10.69, but record the sum of the flows at FM2 and FM3 under MTR1.

10.87 Close MMV1 and wait for pressure at GP1 to reach 0 psia.

10.88 Close V1, V5, V20, and V22.

10.89 Record on line 26 of Section H.1 that flow through MTR1 has been verified through all applicable gas paths.

10.90 Close all Outlet Manifold Valves and ISM manual valves, and disconnect ISM.

Table 1: Gyro path flows

Metering Valve	Flow Path	Flow Rate	Pass/Fail
MTR1	Gyro 1 Upper		

MTR1	Gyro 1 Lower		
MTR1	Gyro 2 Upper		
MTR1	Gyro 2 Lower		
MTR1	Gyro 3 Upper		
MTR1	Gyro 3 Lower		
MTR1	Gyro 4 Upper		
MTR1	Gyro 4 Lower		
MTR3	Gyro 1 Upper		
MTR3	Gyro 1 Lower		
MTR3	Gyro 2 Upper		
MTR3	Gyro 2 Lower		
MTR3	Gyro 3 Upper		
MTR3	Gyro 3 Lower		
MTR3	Gyro 4 Upper		
MTR3	Gyro 4 Lower		
MTR3	P1A Upper		
MTR3	P1A Lower		
MTR2	Gyro 1 Upper		
MTR2	Gyro 1 Lower		
MTR2	Gyro 2 Upper		
MTR2	Gyro 2 Lower		
MTR2	Gyro 3 Upper		
MTR2	Gyro 3 Lower		
MTR2	Gyro 4 Upper		
MTR2	Gyro 4 Lower		
MTR4	Gyro 1 Upper		
MTR4	Gyro 1 Lower		
MTR4	Gyro 2 Upper		
MTR4	Gyro 2 Lower		
MTR4	Gyro 3 Upper		
MTR4	Gyro 3 Lower		
MTR4	Gyro 4 Upper		
MTR4	Gyro 4 Lower		

MTR4	P1A Upper		
MTR4	P1A Lower		

G.11 G-Mock Final Configuration

Started on: _____

Note: This section is to be performed at the end of the ATP. It back fills the G-Mock with helium to prevent contamination, removes all optional equipment, and puts it into a safe configuration. Mark off each step of this section as it is completed.

11.1 Verify that the G-Mock solenoids and ISM manual valves are closed, the G-Mock is connected to the ISM and evacuated, and that MMV1 are closed, while MMV2, MMV3, MMV4, and all Outlet Manifold valves are open. Verify that a 0.5 micron or better filter is installed on the gas inlet, as well as the Helium Supply per Diagram 1.

11.2 Set Helium supply pressure to 10 psig.

11.3 Open manual valves B2, E1, B1, and E2 on the ISM and start vacuum system.

11.4 Open all G-Mock solenoid valves. Close Helium Valve 1, and open MMV1 to evacuate the plumbing line as well.

11.5 Verify 0 psia at GP1, and wait 5 minutes.

11.6 Close all outlet manifold valves.

11.7 Open Helium Valve 1 to back fill G-Mock to 10 psig.

11.8 Verify pressure at the Service Port, and close MMV4.

11.9 Close Helium Valve 1, MMV1 and all solenoid valves.

11.10 Close all ISM manual valves, shut down vacuum system, and disconnect ISM from Outlet Manifold.

11.11 Disconnect Helium Supply from Inlet Port, leaving filter connected.

11.12 Disconnect the 500 psig pressure gauge and VCR "T" from the Service Port.

11.13 Sign off on line 27 of Section H.1 to verify that G-Mock is safed and back-filled with Helium to 10 psig.

G.12 Diagrams

Diagram 1 Helium Gas Setup

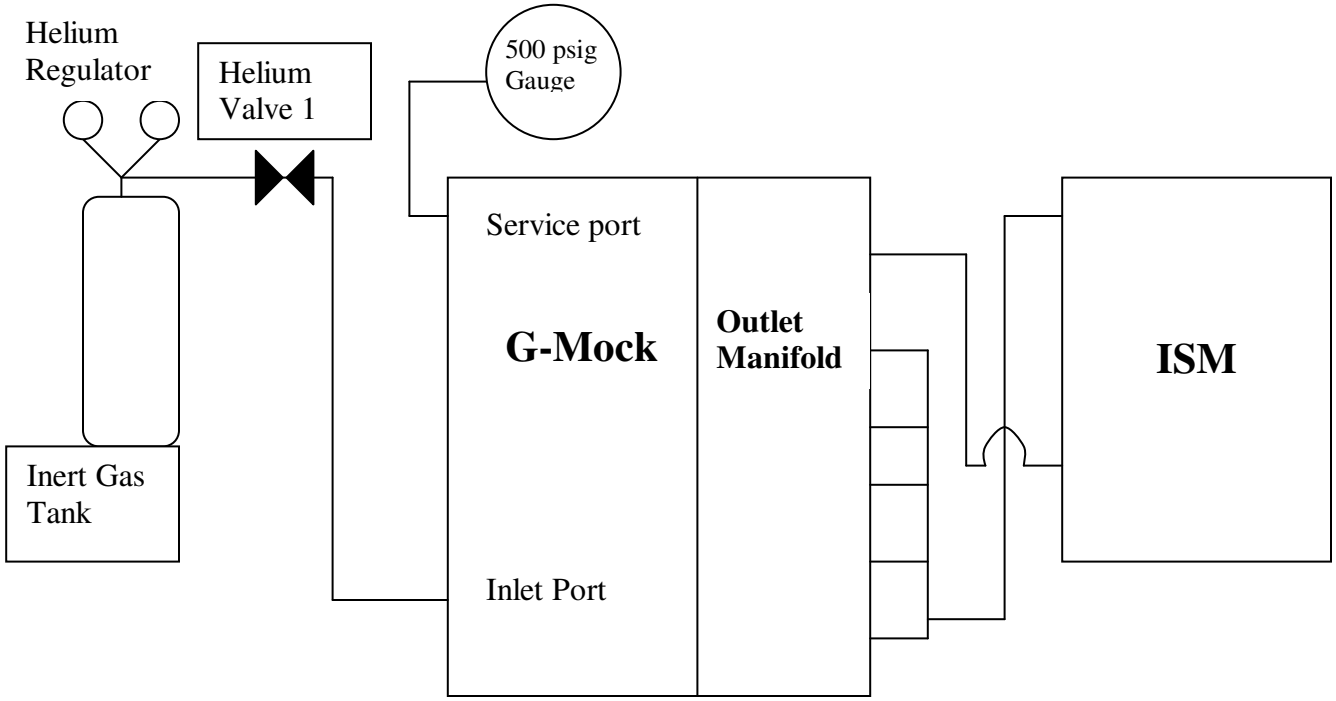
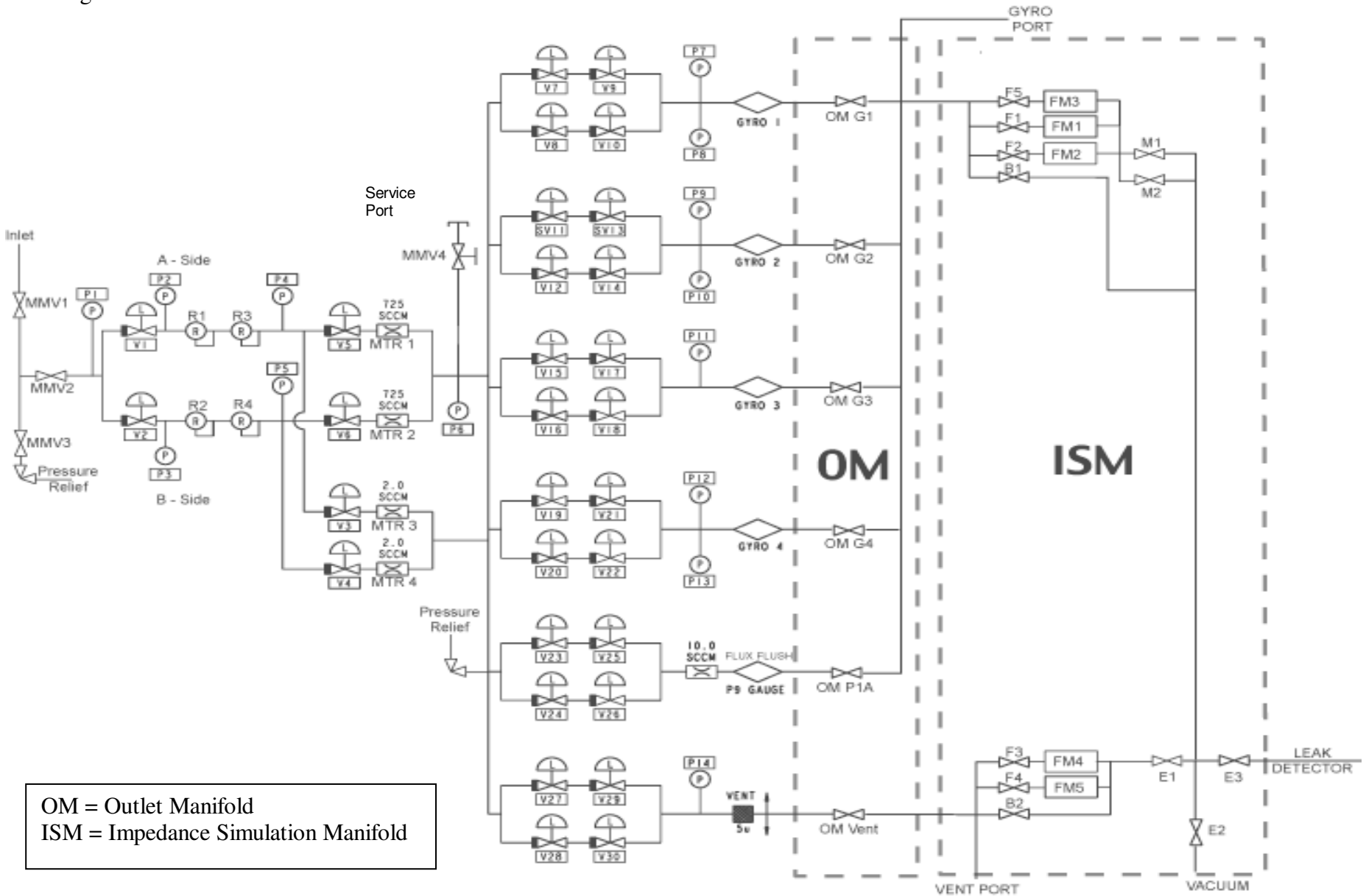


Diagram 2: G-Mock Schematic



OM = Outlet Manifold
ISM = Impedance Simulation Manifold

H. PROCEDURE COMPLETION

H.1 Table 2: Completion Table

	ATP				Completed		ECU Verified			
	section	Task	Details	Date	Initial	Value	Date	Initial	Value	Comments
1	G.4	G-Mock leak test passed	Better than 10-8 sccs external leak rate				X	X	X	
2	G.5	G-Mock high pressure side Proof test passed	To 3000 psi for 10 minutes, Up to regulators				X	X	X	
3	G.5	G-Mock low pressure side Proof tested passed	To 90 psi for 10 minutes, Downstream of regulators				X	X	X	
4	G.5	G-Mock leak test passed Post Proof test	Better than 10-8 sccs external leak rate				X	X	X	
5	G.6	All pressure transducers zeroed	0 +- 0.5 psi at vacuum	X	X	X				
6	G.6	GP7-GP14 midrange calibrated	5-8 psia	X	X	X				
7	G.6	GP7-GP14 high range calibrated	11.5-13.5 psia	X	X	X				
8	G.6	GP4-GP6 midrange calibrated	23-27 psia	X	X	X				
9	G.6	GP4-GP6 high range calibrated	45-48 psia	X	X	X				
10	G.6	GP1-GP3 midrange calibrated	1215 psia +- 20 psi	X	X	X				
11	G.6	GP1-GP3 high range calibrated	1995 psia +- 20 psi	X	X	X				
12	G.6	GP1 highest range calibrated	~3000 psig	X	X	X				Optional
13	G.7	G-Mock particle test passed	<5 particles/cu. Ft. of size <.5uc				X	X	X	
14	G.8	A-Side regulators set	Set to 20-24 psia				X	X	X	

15	G.8	B-Side Regulators set	Set to 20-24 psia				X	X	X	
16	G.9	Metering valve MTR1 set	725 sccm +- 20%				X	X	X	
17	G.9	Metering valve MTR2 set	725 sccm +- 20%				X	X	X	
18	G.9	Metering valve MTR3 set	2 sccm +- 50%				X	X	X	
19	G.9	Metering valve MTR4 set	2 sccm +- 50%				X	X	X	
20	G.10	All A-Side Regulator Leg solenoids and switches functional.	Using ECU	X	X	X				
21	G.10	All B-Side Regulator Leg solenoids and switches functional.	Using ECU	X	X	X				
22	G.10	All downstream solenoid valves and valve switches are functional	Using ECU	X	X	X				
23	G.10	Metering valve MTR4 verified	Flow through all legs is 2 sccm +- 50%	X	X	X				
24	G.10	Metering valve MTR2 verified	Flow through all legs is 725 sccm +- 20%	X	X	X				
25	G.10	Metering valve MTR1 verified	Flow through all legs is 725 sccm +- 20%	X	X	X				
26	G.10	Metering valve MTR3 verified	Flow through all legs is 2 sccm +- 50%	X	X	X				
27	G.10	G-Mock backfilled with Helium	To 10 psig				X	X	X	
28	G.11	G-Mock temperature controls functional	optional	X	X	X				

H.2 Procedure Sign Off

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

_____ date: _____
GMA Engineer

Discrepancies if any:

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

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
D. Ross, QA