GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

P0925 Rev -

GYRO SLOW SPIN TEST IN THE GAF USING THE GMA

September 17, 2002

Prepared by: *B. Clarke*

Approvals:

Program Responsibility	Signature	Date
C. Gray *GMA RE*		
B. Clarke *Gyro Testing RE*		
D. Ross *GP-B Quality Assurance*		
R. Brumley *Payload Technical Manager*		

NOTES:
Level of QA required during performance of this procedure:
Stanford QA Representative
Government QA Representative

All redlines must be approved by QA

Revision Record:

Revision	Date	ECO #	Summary description
-	9/12/2002	N/A	Original revision.

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning
ECU	Experiment control unit
FEU	Flight equivalent unit
GAF	Gyro Acceptance Facility
GCP	Gyro Commissioning Probe
GMA	Flight Gas management assembly
GMOCK	Functionally equivalent GMA

Table of Contents

A Scope

This procedure covers the spin-up of a gyroscope at low temperature in the Gyro Acceptance Facility (GAF) using the flight Gas Management Assembly (GMA) or the non-flight functionally equivalent GMA mock-up (G-MOCK). It is only intended for very low speed spins (below 2 Hz).

B Requirements Verification

B.1 Requirements Cross Reference: none

B.2 Expected Data for verification per requirement: none

C Configuration Requirements

The gyro commissioning probe with a gyro installed is in the low field dewar and being pumped on by the GAF leakage gas pumping system. The gyroscope has been levitated continuously for at least one hour and shows no evidence of charging or otherwise unstable suspension as determined by one of the qualified operators listed in section H of this procedure.

The GMA or G-MOCK has been connected to the GAF per P0923B and is configured such that it may be operated using the ECU FEU and associated test set.

D Hardware Required

D.1 Flight hardware required

Description	No. Req'd
GMA (or functionally equivalent non- flight G-MOCK)	1

D.2 Commercial test equipment

Manufacturer	Model	Serial Number	Calibr. Exp. Date
N/A			

D.3 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
Optical readout systems				
DDC Suspension system				
FFT Data system				
Leakage gas management system				
Gyro spinup gas management system				
ECU FEU				

D.4 Tools

Description	No. Req'd
N/A	

D.5 Expendables

Description	Quantity
N/A	

E Software Required

CSTOL script "gma_low_spinup.prc" Version 1.2 Date: 9/17/02

F Procedures Required

N/A

G Equipment Pretest Requirements

N/A

H Personnel Requirements

The following personnel have received extensive training in the testing of GP-B gyroscopes and are qualified to perform this procedure.

- David Hipkins
- Bruce Clarke
- Chris Gray
- Robert Brumley
- Dr. Sasha Buchman
- Dr. William Bencze

I Safety Requirements

I.1 General

It is important to be aware at all times of the position of the probe. Be extremely careful not to accidentally bump into the probe or any system connected to the probe. If any connector does not connect smoothly and securely, do not try to force it. Instead, remove the connector and inspect it to find the reason for the difficulty. Great care must be taken at all times during the performance of this procedure.

I.2 Electrostatic Discharge

Grounded wrist straps are to be worn at all times when mating or demating to an electrical connector on flight hardware.

I.3 Personnel Safety

All operations shall take place according to Stanford University safety guidelines. Any person observing a situation that they deem unsafe shall report the fact immediately to the test director.

The Quality Assurance representative shall be responsible for monitoring that all activities are performed in a safe manner.

I.4 Electrical mating and demating of flight hardware connectors

I.4.1 Connection and disconnection shall be performed only when the equipment involved is in a powered-down state unless the procedure specifically states otherwise.

I.4.2 Connector savers are to be used unless otherwise specified.

I.4.3 Connectors shall be inspected for contamination and for bent, damaged, or recessed pins prior to mating.

I.4.4 Grounded wrist straps are to be worn prior to removal of connector caps or covers and during mating/demating operations on flight hardware.

I.4.5 ESD-protective caps or covers are to be immediately installed after demating of connectors on flight hardware.

J General Instructions

J.1 QA Notification

This test 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.

J.2 Redline Authority

Redlines can be initiated by any of the qualified operators listed in section H and must be approved by QA.

J.3 Discrepancies

Any nonconformance or test anomaly should be reported by a Discrepancy Report. Refer to the Quality Plan, P0108, for guidance. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

J.4 Test Exit Authority

Only the following persons have the authority to exit/terminate this test or perform a retest:

Rob Brumley, Chris Gray, David Hipkins, Bruce Clarke, Sasha Buchman, William Bencze, and QA personnel.

J.5 Gyroscope Delevitation

A gyro delevitation at any point during this procedure does not in itself imply the GMA or G-MOCK has failed the test. However, if a gyroscope delevitates during the completion of this procedure, all work shall cease and the test configuration shall not be broken. Work may only continue under the guidance of the MRB. A Discrepancy Report shall be immediately opened recording the details of what happened. The immediate concern of the investigation should be to determine whether the GSE was at fault in the delevitation and how this GSE should be re-tested prior to resuming the test.

K References and Applicable Documents

Op. Order No._____
Date Initiated_____
Time Initiated_____

L OPERATIONS

The following sections detail how to spin the gyroscope.

L.1 Pre Spin-Up Checklist

Start Date: _____

Start Time: _____

Gyroscope S/N: _____

L.1.1	Verify the gyroscope is levitated and in the desired position Record Commanded Position [X Y Z]: _____	_____
L.1.2	Verify that the gyroscope is not charged >70 volts	_____
L.1.3	Verify that there is no oscillation in the position greater than 40 micro-inches.	_____
L.1.4	Verify that the gyroscope has been levitated for at least one hour	_____
L.1.5	Leakage Gas Pumping System is operating, pumping on the probe (**VAT** open) and the probe pressure (P_{PB} measured on ion gauge channel A) is < 5 x 10^{-5} torr	_____
L.1.6	Spinup Exhaust Pumping System is operating and the exhaust gas pressure (EGP) is <5 x 10^{-3} torr (this is used to evacuate the spinup manifold)	_____
L.1.7	Verify the probe exhaust (gold manual valve – **PEX1**) is open.	_____
L.1.8	Verify the probe exhaust by-pass valve (**PEX2**) is closed.	_____
L.1.9	Confirm manifold between the GCP spin-up inlet (SU2) and the Gyro Spinup management manifold up to valves **PV2** and **OMG1** (with **SU1** open and **DP1**, **FF1**, **FF2**, **FF3**, **FF4** closed) is connected and under vacuum.	_____
L.1.10	Confirm the helium spinup gas supplies on both the GAF and the GMA (G-MOCK) are Grade 6 He and have Conformance Certification available.	_____
L.1.11	Zero the Baratron gauges. Zero the flowmeters.	_____

L.2 Spin-up Manifold Evacuation

Note: *Refer to figures 1 and 2 for pumping and gas management system schematics.*

L.2.1 Check that **SEP-1**/**SEP-2** pumps are operating and the exhaust gas pressure (EGP on the GAF pumping system) is < 5 x 10^{-3} torr. The control panel for these pumps is located at the east wall of FIST OPS. If the pumps are not running pressing the momentary switches on the right side of the schematic on the panel can start them. Place the system in Interlock Defeat mode and verify yellow LED is blinking.

EGP = _____ mtorr

L.2.2 Close (or verify closed) manual valves **FF1, FF2, FF3, FF4, SU2 and SU3**.

L.2.3 Open manual valves **SU1** and **OMG1**.

L.2.4 Open pneumatic valves **PV2** and **PV4**.

L.2.5 Wait for the exhaust gas pressure (EGP) to stabilize to the pressure recorded in step L.2.1 +/- 0.1 mtorr.

L.3 Purge and Pump Out the Spin-up Manifold Using GAF Bypass Flow

L.3.1 Check to ensure the GAF spin-up gas supply bottle contains > 250psi helium. Open the valve on the gas bottle and on the regulator.

L.3.2 The regulator should be set to 20 –25 psig.

L.3.3 Open **PV1** (down position- 2000 sccm flow controller).

L.3.4 On the 2000 sccm flow controller, rotate the 10-turn pot counter-clockwise on until a flow of 725 sccm is displayed. Continue this purge for 10 minutes.

L.3.5 Dial the flow down to zero on the 2000 sccm flow controller and close PV1.

L.3.6 Wait for the exhaust gas pressure (EGP) to stabilize to the pressure recorded in step L.2.1 +/- 0.1 mtorr.

L.3.7 Open the manual valve **SU2** on the probe and note any exhaust pressure rise (EGP).

L.3.8 Close the pneumatic valves **PV2** and **PV4**.

L.3.9 Open the manual valves **BV2** and **OMVENT** (located on the GMA/G-MOCK OUTLET MANIFOLD).

L.4 Gyroscope Low Speed Spinup Using the GMA /G-MOCK

L.4.1 Start an FFT file on the Sun 386i. Suggested sampling rate 30 Hz, logging interval 300 seconds and estimated spin frequency 0.5 Hz.

Record File name: _____

Record any additional useful information concerning the spin speed readout in the lines below (e.g. type of readout used, if the SQUIDs are being used, what range and gain are they on, FFT sampling rate, logging interval, harmonic monitored, etc.).

_____

_____

_____

_____

_____

_____

_____

_____

_____

L.4.2 Start a new NLFF system data file by stopping and re-starting the NLFF3 data acquisition program. Set the logging interval to 20 seconds and write to both the local and network drives.

Record the NLFF filename: _____

L.4.3 Have the ECU operator to start the low speed spin-up script, "gma_low_spinup.prc". This script will perform the following. **Bold face type must be performed manually using the GAF pneumatic valves.**

1. Flow 725 sccm through the GMA/G-MOCK vent to the exhaust pump for 60 seconds.
2. Hard wait - enable. **Manually open the GAF pneumatic exhaust valve PV5 prior to sending the enable.**
3. Flow 2 sccm through the GMA/G-MOCK vent to the exhaust pump and through the gyro in parallel for 90 seconds.
4. Flow 2 sccm through the gyro only for 180 seconds.
5. Flow 2 sccm through the GMA/G-MOCK vent to the exhaust pump and through the gyro in parallel for 90 seconds.
6. Close all GMA/G-MOCK valves opened in steps 1-6. **Manually close the GAF**

pneumatic exhaust valve PV5 after the GMA/G-MOCK valve V9 closes. The ECU operator will keep the GAF operator advised of the GMA/G-MOCK valve states as the low speed spin-up script runs.

L.4.4 Monitor gyro spin speed on the Sun 386i.

L.5 Post–Spinup Procedure for Gyro 1

L.5.1 Close manual valves **SU1** and **SU2**.

L.5.2 Close manual valves **BV2, OMVENT** and **OMG1**.

L.5.3 Carefully open spin-up bypass valve **SU3** and exhaust bypass valve **PEX2**.

L.5.4 Adjust the logging interval on the NLFF data acquisition program to 300 seconds and write to both the local and network drives.

L.6 DATA SUMMARY

L.6.1 Monitor the gyro spindown for six hours minimum after performing L.5. A linear fit to the spindown data determines the gyro spindown rate. Record that rate here and attach a copy of the plotted spindown data to this procedure.

df/dt = _____

L.6.2 Archived FFT data file name and directory path: _____

L.6.3 Archived NLFF system data file name and directory path: _____

L.6.4 Location of data analysis (lab book, Matlab file, EM, etc.):

_____

_____

_____

Test completed.

Completed by: _____
Witnessed by: _____

Date:

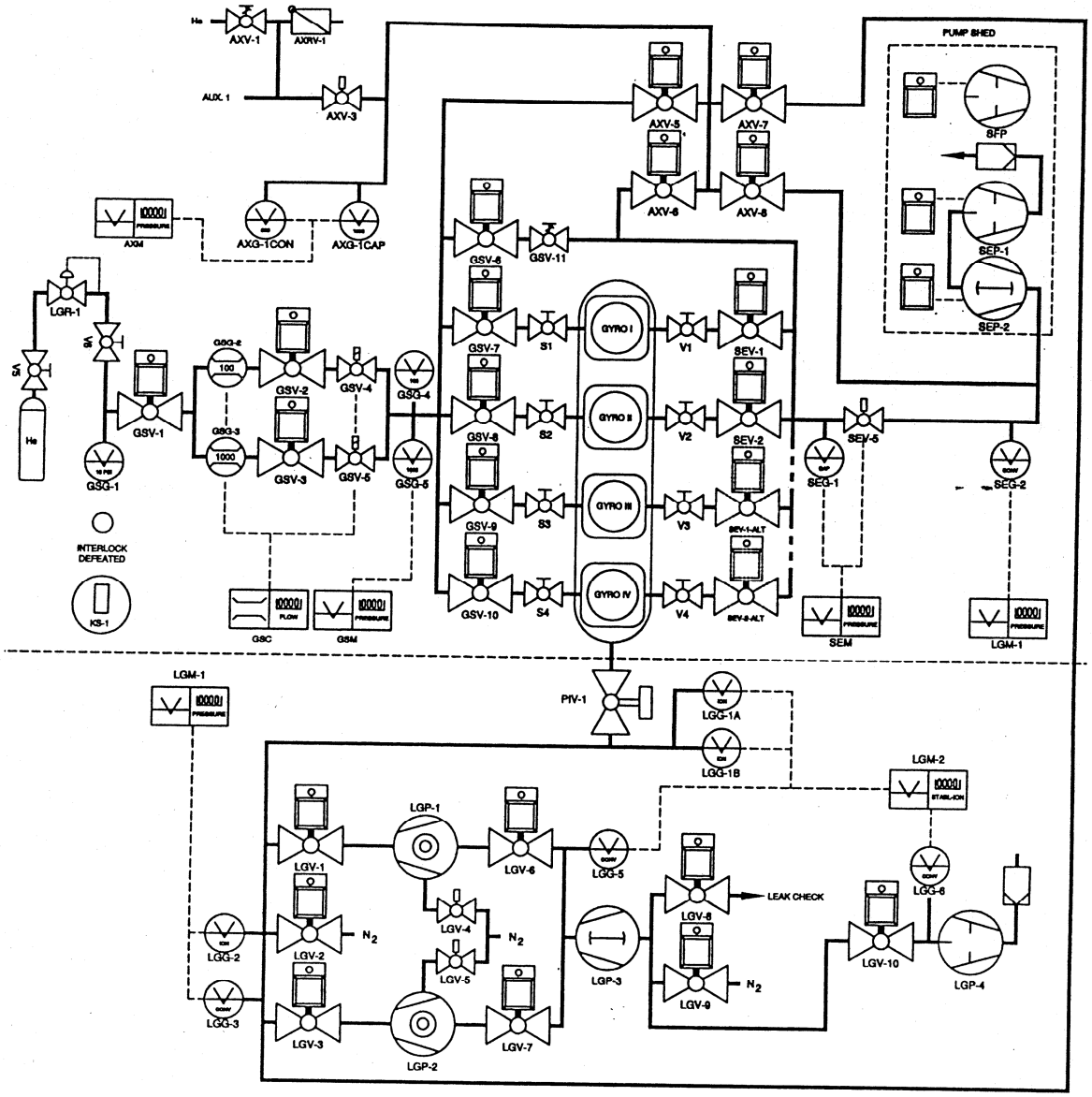

Figure 1: Gyro Gas Management System

This figure shows the location of the switches for the exhaust pumps SEP-1 and SEP-2. No other valve designations or labels in this figure are used in this procedure. Figure 2 – GMA Interface with the GAF is shown on the next page.

GMA Interfaced with Gyro Acceptance Facility

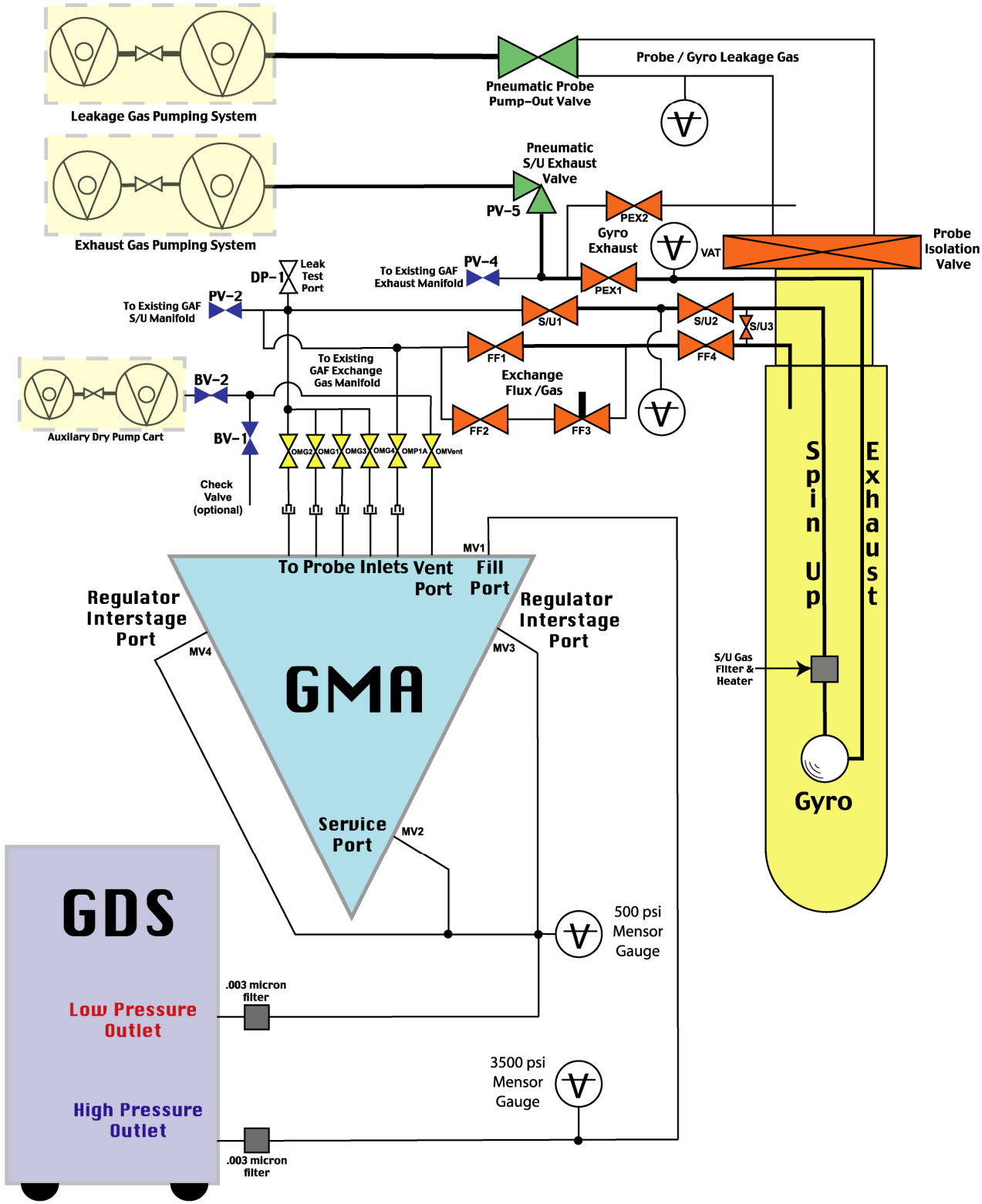

FIGURE 3 – GAF SPIN-UP GAS MANAGEMENT SYSTEM