STANFORD UNIVERSITY
W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

FLOW THROUGH TEST OF PROBE CAGING LINES

GP-B SCIENCE MISSION PROCEDURE

8 January, 1999

PREPARED _____ _____
H. Yengoyan, LMMS Engineer Date

APPROVED _____ _____
J. Stamets, Integration Engineer Date

APPROVED _____ _____
D. Bardas, Integration Manager Date

APPROVED _____ _____
B. Taller, Quality Assurance Date

APPROVED _____ _____
S. Buchman, Hardware Manager Date

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1 SCOPE

This document provides the procedure for checking the flow through of the four Caging Lines in Probe C. This procedure is to be completed prior to installing the SIA. It assumes that Probe C is mounted on the Precision Manipulator per P0205 in the HEPL Class 10 Cleanroom, and the Probe Vacuum Shell has been removed per P0376. Gaseous Nitrogen (GN_2) will be flowed through the caging lines from the Top Hat warm end to the cold end at the gyroscope locations.

1.1 Experimental Logic

The experiment outlined herein is intended as a gross flow through check at the system level, and does not formally verify any requirement for the probe.

1.2 Test Goals

The goal is to confirm gas flow through the caging lines and verify that the lines are not plugged or restricted. Also, this test will identify the location of the caging lines at the cold end of the probe to their respective Top Hat valves.

1.3 Acronyms

The following acronyms are used in this document

CG1–6	Caging lines 1 thru 6 respectively
ESD	Electrostatic Discharge
GN_2	Gaseous Nitrogen
HEPA	High Efficiency Particulate Air
HEPL	Hansen Experimental Physics Laboratory
ICD	Interface Control Document
l/m	Liters per minute
l/s	Liters per second
PC	Particle Counter
PM	Precision Manipulator
SCCM	Cubic centimeters per minute at standard temperature and pressure
SCFM	Cubic Feet per minute at standard temperature and pressure
SIA	Science Instrument Assembly

2 APPLICABLE DOCUMENTS

2.1 Plans and Procedures

P0059	GPB Contamination Control Plan
P0057	Stanford Magnetic Control Plan

2.2 Lockheed Plans and Procedures

5833741	Soldering Procedure for Caging and Spin-up Lines
5833161	Procedure for Leak Checking
1C34103	Probe ICD Drawing
1C34111	Phase 4C Installation

3 GENERAL REQUIREMENTS

3.1 Environmental Requirements

This procedure will be conducted in the Stanford Class 10 Cleanroom in the HEPL facility.

3.1.1 Room Cleanliness

The Class 10 clean room where this integration takes place shall be maintained at the cleanliness levels per Federal Stanford 209D. All personnel in the clean room shall wear certified Class 10 cloth garments.

3.1.2 Particulate Contamination

All parts and tools shall be cleaned at least to the cleanliness levels of the rooms where they are used for assembly or testing. In addition, all parts shall be maintained at Level 100 cleanliness per GP-B Contamination Control Plan (P0059). A portable particle counter shall be set up on a table downstream of the local work area, and monitored to ensure that particulate counts are consistent with the GP-B Contamination Control Plan P0059. Take all necessary precautions to keep tools and handling equipment free of particulate contamination.

To the maximum extent possible, personnel shall keep all parts of their bodies downstream of the probe, defined by the direction of HEPA airflow.

3.1.3 Magnetic Contamination

All parts and tools shall be cleaned using methods consistent with achieving Mil Spec Level 100 cleanliness. In addition, all parts shall be maintained at Level 100 cleanliness per GP-B Magnetic Control Plan, Science Mission (P0057). Take all necessary precautions to keep tools and handling equipment free of particulate contamination. Tool should be sprayed with Freon from a pressure can filtered to 0.2 µm prior to use, or when contaminated.

Only approved non-magnetic materials or tools are allowed to touch the cold end of the probe.

3.2 Integration and Test Personnel

3.2.1 Integration Test Director (ITD)

The test director for this procedure is John Stamets or his appointed replacement. This procedure also falls under the jurisdiction of the Integration Manager, Dr. Doron Bardas, who will review and sign off the procedure. The Integration Manager is also responsible in general for the coordination of all integration procedures, and will schedule appropriate time for the performance of this procedure.

3.2.2 Personnel

The following personnel are qualified to perform this procedure:

- Gary Reynolds
- John Stamets
- Haig Yengoyan
- Gideon Asher
- Dr. Doron Bardas

See section 3.4 for details on which Quality Assurance personnel are required to be notified and/or witness this procedure.

3.3 Safety

3.3.1 General

Safety Engineering is to be notified prior to the start of this procedure.

All participating personnel shall ensure they are aware of the specific and hardware safety concerns indicated in the safety requirements, cautions, and warnings in the procedure. Personnel working in the Class 10 Cleanroom must be cognizant of the base of the Precision Manipulator, and take special care to avoid tripping or bumping into it.

3.3.2 Maximum Number of People in Cleanroom

Under normal operating conditions, there shall be no more than 5 people in the Class 10 Cleanroom. This is to avoid violating legal make up air requirements, and to provide an efficient workspace. Exceptions must be for short periods only, and be approved by the Integration Manager.

3.3.3 Hardware Safety

Extreme care must be taken to avoid accidentally bumping the Probe or damaging connectors. Only flight-approved connectors can mate with Probe C connectors.

3.4 Quality Assurance

Integration shall be conducted on a formal basis to approved and released procedures. The QA program office shall be notified of the start of this procedure. A Quality Assurance Representative designated by B. Taller 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, B. Taller or P. Unterreiner, will certify his 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. Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

3.5 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate and shall be approved by the QA Representative. Additionally, approval by the Integration Manager and Hardware Manager shall be required, if in the judgment of the ITD or QA Representative, experiment functionality or probe integrity may be affected.

3.6 Procedure Computerization Special Requirements

Because of cleanliness requirements in the Class 10 room, and to conveniently record data directly into the procedure thus generating the "as-built" document, the procedure will be handled in a paperless fashion until completed. A Laptop computer containing an electronic version of this procedure will be operated by the ITD or QA Representative and data shall be recorded by typing directly into the electronic file.

Following completion of the procedure, a hard copy of the "as-built" procedure shall be printed ***and signed off by all the designated parties***. It shall then be filed, including an electronic copy into the data base.

The electronic editing of this document shall be as follows:

- Data will be inserted into the document using normal font, i.e. non-bold, non-italic
- "Signatures" shall be designated by **BLACK CAPITAL BOLD LETTERS**.
- "Redlines" shall be in ***RED BOLD ITALICS*** to make them distinguishable both on the Laptop screen and on the hard copy printout.
- If available, digital pictures shall be inserted into the document where appropriate.

4 REQUIRED EQUIPMENT

Flight Hardware

Hardware	Part Number
Probe-C Assembly, without sunshade or Vacuum Can	1C34115-102

Ground Support Equipment

Hardware	Part Number
Gary Reynolds' Flow Test Metering Device	N/A
Ultratorch	N/A

- **Note: No ESD protection is needed during this test. The SIA is <u>not</u> installed and no probe electronic components are involved.**

- Settings of pressure, flow, and time measurements should be within 10% of nominal.

- No software is involved in the measurements described in this procedure.

Note: Recent calibration of hardware used is <u>not required</u> due to the qualitative nature of the experiment and the fact that this is procedure does not verify any SM requirement.

- GN_2 Gas Supply with Built-in Regulator
- Pressure Gauge (0-25 psid)
- In-line high flow gas filter (0.1 µm)

Tools and Miscellaneous

- Allen wrenches, various

5 INITIAL SETUP AND TEST OF CAGING LINES

5.1 Initial Preparations

Record Start Time and Date: _____

5.1.1 The Probe should be horizontal on the Precision Manipulator at a height of approximately four feet, with the cold end toward the observation window.

5.1.2 Clear off a suitable table and situate it under the cold end of the probe. Make sure that it is clean. If necessary, wipe it down with an appropriate solvent. Clear adequate space on another table near the Top Hat end of the probe.

5.1.3 Using an Ultratorch, carefully remove all of the four Caging Line Caps from the Aft Caging Lines. Take care not to produce contamination by simultaneously vacuuming the area during disorder.

5.1.4 Attach a source of dry Nitrogen line sequentially to each of Caging Valves at the Top Hat while arranging to submerge each aft caging , using the LMMS supplied flexible extension tube with orifice used during tests at LMMS, into a small container of pure ethyl alcohol..

5.1.5 Pressurize the caging line to approximately 20 psid and count the bubbles per second produced at the aft end line in the alcohol. Record results in table below i.e. "10 bubbles per 20 seconds". Repeat the test for all Caging Valves (CG1 thru CG6) and respective Aft Caging Lines. It will be necessary to plug one end of each of the second aft caging line ports feeding gyros 3 and 4 using a cleaned gloved finger to test proper flow through the other leg. This will not be necessary for the other two aft lines because they don't split. After each line is tested, note its corresponding Top Hat label and Cold End identification Table 1. below. Also mark the corresponding CG numbers on the ICD 1C34103.
Note that one pair of redundant CG#'s from the Top Hat should correspond to the gyro 3/4 pair at the aft end. These are tentatively identified as CGA and CGB below and will be renamed after the test.

Table 1.

Top Hat Caging Valve #	1C34103 Cold End Identification (page 8)	Flow (bubbles per second)
CG1 (redundant to CG2)		
CG2 (redundant to CG1)		
CG3 (redundant to CG4)		
CG4 (redundant to CG3)		
CG5 (redundant to CG6)		
CG6 (redundant to CG5)		
CGA (redundant to CGB)		
CGB (redundant to CGA)		

5.1.6 Document the results on a diagram from 1C34103 and also on a photograph in this document.

PICTURE

Approval of Section 5

Approved: _____ date: _____
Integration Engineer

Discrepancies if any:

Approved: _____ date: _____
ITD

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
Integration Manager

!C34103 diagram

Aft End annotated Picture

6 PROCEDURE COMPLETION

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

Test Engineer _____ Date _____

ITD _____ Date _____

Discrepancies if any:

The information obtained under this assembly and test procedure is as represented and the documentation is complete and correct:

Integration Manager _____ Date _____

QA Representative _____ Date _____

Quality Assurance _____ Date _____

7 DATA BASE ENTRY

The following data shall be entered into the GP-B Data Base:

1) Name, number and revision of this procedure
2) An electronic copy of this document
3) A copy of the “as-built” procedure with data and pictures, when completed.