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

PROBE-C CAGING VALVE INSTALLATION

GP-B SCIENCE MISSION PROCEDURE

21 June, 1999

PREPARED _____ _____
G. Reynolds Date

APPROVED _____ _____
J. Janicki, Safety Engineering Date

APPROVED _____ _____
D. Bardas, Integration Manager Date

APPROVED _____ _____
D. Ross, Quality Assurance Date

APPROVED _____ _____
S. Buchman, Hardware Manager Date

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1 SCOPE

This document provides the procedure for installing the External Caging Line Valves onto the Probe. This procedure is to be completed prior to integrating the Probe into the Science Mission Dewar. It assumes that Probe C is mounted in the precision manipulator in the HEPL Class 10 Clean Room, and the Probe's Vacuum Shell has been installed.

1.1 Experimental Logic

The experiment outlined herein is intended as an installation procedure which will reinstall the caging line valves onto the Probe.

1.2 Test Goals

The goal is to install the external caging line valves after the bypass caging line repair has been performed on the Probe.

1.3 Acronyms

The following acronyms are used in this document

CG1–6	Caging lines 1 through 6 respectively
ESD	Electrostatic Discharge
GHe	Gaseous Helium
GN_2	Gaseous Nitrogen
HEPA	High Efficiency Particulate Air
HEPL	Hansen Experimental Physics Laboratory
ICD	Interface Control Document
LN_2	Liquid Nitrogen
l/m	Liters per minute
LMMS	Lockheed Martin Missiles and Space
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
STP	Standard Temperature and Pressure

2 APPLICABLE DOCUMENTS

2.1 Plans and Procedures

P0059 GPB Contamination Control Plan
P0057 Stanford Magnetic Control Plan
P0205 Mounting Probe on Precision Manipulator
P0376 Removing the Probe Vacuum Shell
P0388 Cleanliness Test Probe Exhaust Lines

2.2 Lockheed Plans and Procedures

5834588 Strongback Drawing
1C34103 Probe ICD Drawing
1C34111 Phase 4C Installation

3 GENERAL REQUIREMENTS

3.1 Environmental Requirements

This procedure will be conducted in the Stanford Class 1000 Clean Room in the HEPL facility with the Class 10 tent.

3.1.1 Room Cleanliness

The Class 10 clean room tent where this assembly takes place shall be maintained at the cleanliness levels per Federal Standard 209D. All personnel in the clean room tent shall wear certified Class 10 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 in the tent 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.

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 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 Robert Brumley, 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 LMMS and Stanford personnel are qualified to perform this procedure:

- Gary Reynolds
- Bruce Clarke
- Paul Ayres
- Chris Gray
- Robert Brumley
- 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 Clean Room must be cognizant of the base of the Genie stand, and take special care to avoid tripping or bumping into it.

3.3.2 Maximum Number of People in Clean Room

Under normal operating conditions, there shall be no more than 5 people in the Class 10 Clean Room. 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 and parts can mate with Probe C hardware.

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 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, 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. 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 (Optional)

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 CAPITAL 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

4.1.1 Flight Hardware

Pull the following items from the Class 10 Clean Room or Bonded Stores.

Hardware	Part Number
Probe-C Assembly, without sunshade	1C34115-102
10-32 x 1/2 Locking SHCS, Qty: 8	NAS1351N3LN8S
#10 Flat Washer, Qty: 16	NAS620C10L
10-32 x 7/16 100° CSK Screw, Qty: 12	MS24693-A271
GAMAH Seal, Qty: 6	S14004A
Caging Valve Assy, Qty: 6	1C34198-101
Blue Death Epoxy, Qty: A/R	1210 A w/ 9615-10
10-32 x 1/2 SHCS, Qty: 8	NAS1351C-3-8

4.1.2 Quality Assurance to verify that the above items are flight qualified.

Approved: _____ Date: _____
QA Representative

- **Note: No ESD protection is needed during this test. The SIA is not 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 set up of the Probe as described in this procedure.

Note: Recent calibration of hardware used is required due to the final installation of the hardware on the Probe.

- Torque Wrench 0-30 in-lbs.
- Class 10 clean room tent

Tools and Miscellaneous

- Allen wrenches, and various hand tools

5 INITIAL SETUP OF THE PROBE

5.1 Initial Preparations

Record Start Time and Date: _____

5.2 Cleaning Parts

5.2.1 Precision clean all hardware to Level 100 which will be installed on the Probe, and bake out for 8 hours at 150°F in a vacuum.

5.3 Install Large Valve Plate

5.3.1 Remove the yellow anodized valve plate and support plate from the Probe. Save the two plate for reinstallation. Discard all fasteners.

5.3.2 Install each of the six caging valves 1C34198-101 and seal finger tight to the Top Hat Gamah fittings labeled CG1 through CG6. Orient the handles towards the CNT.

5.3.3 Place the larger valve attach plate 1C34289-105 onto the back of the valve bodies, lining up the slotted holes with the valve mounting holes. Install finger tight two #10-32 countersink screws (FN 93) into each valve.

5.3.4 Place the large support plate 1C34289-101 onto the Top Hat as shown on Sheet 6 of the 1C34111 drawing. Position both support plates so all the holes line up.

5.3.5 Remove the large support plate and snugly tighten the countersunk screws and the Gamah fittings. Remove each valve one at a time to install a seal (FN94). Torque Gamah fittings per Note 33 of drawing 1C34111.

5.3.6 Perform a warm leak test on the Gamah fittings per the 5833161 Leak Test Procedure less thermal cycling. Attach the test line to each assembly; maximum allowable leak rate is 1.0×10^{-9} scc/sec of Helium @ STP. Record information in the tables below.

CG1 thru CG6 Gamah Fittings

Pretest STD Leak Rate_____
Temperature_____
Leak Test Results Start_____
Leak Test Results Finish _____
Leak Rate (Start-Finish) _____
Post Test STD Leak Rate_____
Temperature_____
Location of leak_____ P

WARNING

Do not inhale Epibond 1210A w/ 9615 epoxy vapor or mists. Doing so can result in nose or throat irritation. Prolonged or repeated exposure to epoxy could cause delayed and/or serious injury. This includes eye irritation and harmful if absorbed through the skin or ingested.

5.3.7 Stake the counter sink screws to the Probe using 1210A with 9615 epoxy per the 5835028 Epoxy Bonding Procedure. P

Mix a batch of 1210 A w/ 9615 per the Epoxy Bonding Procedure 5835028. Record epoxy data below.

Mix Time _____
PO # _____
Epoxy Mag Log # _____
Epoxy Expiration Date _____
Shore Hardness after 24 hrs _____ P
(Minimum shore of 1210A is 70)

De-gas epoxy for approximately 10 minutes or until foaming stops.

5.3.8 Stake the 10-32 counter sunk flat head screws to the valve plate per Note 40 with the exception of using 1210A with 9615 epoxy. P

5.3.9 Torque the countersink screws per Note 2. P

Torque Wrench Asset Number _____
Calibration Due Date _____
Final Torque Value _____ P

5.3.10 Inspection to witness torque. I

5.3.11 Reinstall the large support plate to the Top Hat with eight #10 screws and washers (FN 106 & 113) and to the support plate with eight #10 screws and washers (FN 100 & 113). Torque FN 106 and FN 100 screws per Note 2. P

Torque Wrench Asset Number _____
Calibration Due Date _____
Final Torque Value _____ P

5.3.12 Inspection to witness torque. I

PICTURE

Approval of Section 5

Approved: _____ date: _____
Integration Engineer

Discrepancies if any:

Approved: _____ date: _____
ITD

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
Integration Manager

PICTURE

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.