



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

# HELIUM LEAK TESTING OF PROBE CAGING LINES

## GP-B SCIENCE MISSION PROCEDURE

28 January, 1999

PREPARED \_\_\_\_\_  
H. Yengoyan Date

APPROVED \_\_\_\_\_  
J. Janicki, Safety Engineering 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 leak checking the Caging Lines on 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.

### **1.1 Experimental Logic**

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

### **1.2 Test Goals**

The goal is to confirm that the caging lines are leak tight. Also, this test checks the CG5 burst disk to provide information which will be used to compare to the information gathered by Lockheed prior to delivering the probe.

### 1.3 Acronyms

The following acronyms are used in this document

CG1-6	Caging lines 1 thru 6 respectively
ESD	Electrostatic Discharge
GHe	Gaseous Helium
GN <sub>2</sub>	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
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

### 2.2 Lockheed Plans and Procedures

5833161	Procedure for Leak Checking
1C34103	Probe ICD Drawing
1C34111	Probe C Phase IVC Installation
1C34198	External Caging Assy - External Plumbing

### 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 Standard 209D. All personnel in the clean room 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 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  $\mu\text{m}$  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 **???????**, 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
- Dan Welsh
- Bruce Clarke
- 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

<b>Safety Engineering is to be notified prior to the start of this procedure.</b>
-----------------------------------------------------------------------------------

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
Leak Detector	N/A
Plumbing from the Leak Detector to the Caging gama fittings.	N/A

- **Note: No ESD protection is needed during this test. The SIA is not installed and no probe electronic components are involved.**
- Settings of leak detector 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 not required due to the qualitative nature of the experiment and the fact that this is procedure does not verify any SM requirement.***

- Helium Gas Supply with Regulator
- Helium Leak Detector

### 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 Bag off the CG5 burst disk with cleanroom bagging and cleanroom tape to prevent helium from entering the burst disk.

5.1.2 Warm leak test the CG5 caging lines' mechanical and soldered connections. This might require bagging off the strong back so that it can be filled with helium gas in order to check the caging lines in the neck tube region. Attach the test line to the CG5 Caging Valve's gama fitting at the Top Hat. A clean gloved finger will be needed to press against the CG5 cold end caging line to hold a vacuum since the solder caps were removed. Record information in Table 1 below.

TABLE 1

Pre-test Calibrated Leak Rate	
Temperature	
CG5 Leak Test Results Start	
CG5 Leak Test Results Finish	
CG5 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

5.1.3 After the caging lines' mechanical and soldered connections are leak checked, unbag the burst disk and leak check it. Record the information in Table 1A below.

TABLE 1A

Temperature	
CG5 Burst Disk Leak Rate	

5.1.4 After leak checking the CG5 caging valve, remove the Burst Disk assembly and route to Inspection for shipping the part back to Hydrodyne for investigation and repair.

5.1.5 Warm leak test all the mechanical and soldered connections of all the caging lines from CG1 through CG6 (note that on CG5 you will connect the gama fitting strait to the Top Hat gama connection). This might require bagging off the strong back so that it can be filled with helium gas in order to check the caging lines in the neck tube region. A clean gloved finger will be needed to press against the respective cold end caging lines to hold a vacuum since the solder caps were removed. Attach the test line to each Caging Valve gama connection; maximum allowable leak rate is  $1 \times 10^{-9}$  cc/sec of Helium @ STP. Record information in Tables 2 through 7 below for each caging line.

TABLE 2

Pre-test Calibrated Leak Rate	
Temperature	
CG1 Leak Test Results Start	
CG1 Leak Test Results Finish	
CG1 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

TABLE 3

Pre-test Calibrated Leak Rate	
Temperature	
CG2 Leak Test Results Start	
CG2 Leak Test Results Finish	
CG2 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

TABLE 4

Pre-test Calibrated Leak Rate	
Temperature	
CG3 Leak Test Results Start	
CG3 Leak Test Results Finish	
CG3 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

TABLE 5

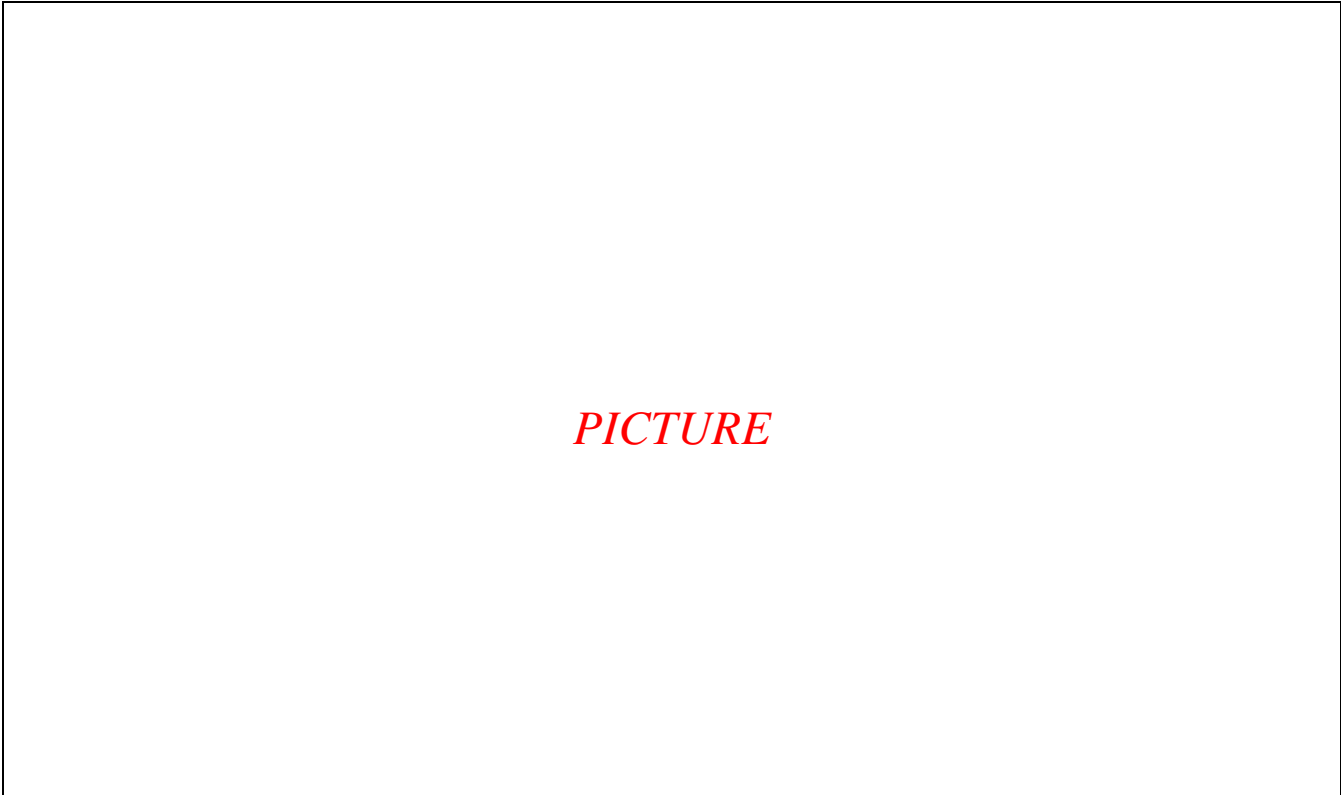
Pre-test Calibrated Leak Rate	
Temperature	
CG4 Leak Test Results Start	
CG4 Leak Test Results Finish	
CG4 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

TABLE 6

Pre-test Calibrated Leak Rate	
Temperature	
CG5 Leak Test Results Start	
CG5 Leak Test Results Finish	
CG5 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	

TABLE 7

Pre-test Calibrated Leak Rate	
Temperature	
CG6 Leak Test Results Start	
CG6 Leak Test Results Finish	
CG6 Leak Rate (Finish-Start)	
Post-test Calibrated Leak Rate	
Temperature	



**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.