W. W. Hansen Experimental Physics Laboratory

STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305 - 4085

Gravity Probe B Relativity Mission

CAGING ASSEMBLY

and

TEST READINESS REVIEW

COMPLETION CERTIFICATE

P0256 Rev. -
February 06, 1998

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Approved by: A. Nakashima **Date**
Systems Engineer

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Approved by: J. Stamets **Date**
REE Assembly and Test

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Approved by: M. Sullivan **Date**
REE Design

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Approved by: R. Schultz **Date**
Chief Systems Engineer

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Approved by: B. Taller **Date**
Quality Assurance

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Approved by: J. Turneaure **Date**
Hardware Manager

Caging Assembly and Test Readiness Review Minutes

The Caging Assembly and In-Process Test Readiness Review was held on 30 Jan 98. In attendance were:
Stanford: John Turneaure, John Stamets, Doron Bardas, Ben Taller
Lockheed Martin: Art Nakashima, Bob Schultz, Ken Hooper, Sei Chun
ONR: Ed Ingraham

Minutes and Actions are listed below

Action #1
Review cleaning procedures during the assembly sequence. Insert appropriate words in P0050.
Assignee: John S and Art N to review with John T. ECD: 2/3/98

Action #2
Complete and release Leak Test Procedure P0054
Assignee: John S and Art N. ECD: 2/6/98

Action #3
Remove reference to P0054 in Section 5.1. Refer to vendor procedure instead.
Assignee: John S and Art N. ECD: 2/3/98

Action #4
Determine if 160 psid is high enough for max pressure test of Diaphragm Assembly. Change P0050 to reflect decision.
Assignee: John S and Art N to review with John T. ECD: 2/3/98

Action #5
Indicate in P0050 places where ONR is to be notified of test 24 hrs in advance. (Sections 10.2, 13.2, 7.2)
Assignee: Art N. ECD: 2/3/98

Action #6
Indicate in personnel chart and P0050 that Art Nakashima will be QA rep.
Assignee: Art N. ECD: 2/3/98

When these actions are completed, Art to route updated package for approval signatures.

Submitted by A. Nakashima, 1/30/98

Readiness Review for Assembly and In-Process Tests of Science Mission Caging Assemblies

AGENDA

• Purpose of Review	A. Nakashima
• Procedures Status	A. Nakashima
• Requirements Verification	A. Nakashima
• QA Plan	A. Nakashima
• Test Resources Status	J. Stamets

–Flight Hardware
–Schedule
–GSE
–Personnel, Facilities

Purpose of Review

- Confirm Readiness for Assembly and In-Process Test of Science Mission Caging Assemblies
  - Test Procedures in place
  - Applicable Requirements to be Verified
  - Personnel and Facilities in place
  - Flight Parts Ready
  - GSE Ready
  - QA Plan
- What It Is Not
  - Integration and Testing of Caging System in SIA and Probe
  - Integration and Testing of Caging System in SMD
  - Spinup Plumbing Assemblies

Test Procedures Status

- P0050, Assembly and In-Process Tests of SM Caging Units - reviewed and approved
  - Assembly and Weld of Diaphragm Subassembly
  - Thermal Cycle, Leak Test, and Mag Test of Diaphragm Subassembly
  - Assembly and Braze of Tubing Assembly, Caging
  - Thermal Cycle, Leak Test, Epoxy Bond, and Mag Test of Tubing Assembly
  - Assembly and Weld of Diaphragm Assembly
  - Pressure Test, Thermal Cycle, and Leak Test of Diaphragm Assembly
  - Assembly of Actuator Assembly
  - Dimensional Measurements of Actuator Assembly
  - Match Machining of Housing and Rod to Actuator Assembly
  - Assembly of Housing/Actuator Assembly
  - Maximum Travel and Maximum Force Tests of Housing/Actuator Assembly
  - Dimensional Measurement of Protruding Rod Length
  - Assembly of Mechanism Assembly
  - Dimensional Measurement, Mag Test of Mechanism Assembly
  - Assembly of Caging Subassembly
  - Assembly of Tubing Assembly, Caging Jumper Line
  - Thermal Cycle, Leak Test, and Mag Test of Tubing Assembly, Caging Jumper Line
- Support Procedures
  - P0063, Thermal Cycle in LN2 - reviewed and approved
  - P0355, Epoxy Bond 2115 - reviewed and approved
  - P0356, Epoxy Bond 2143D - reviewed and approved
  - P0107, Caging Rod Polishing - reviewed and approved
  - P0054, Leak Test Procedure - reviewed and approved

CAGING ASSEMBLY VERIFICATION

Caging Assembly Requirements from the Science Payload Spec. (PLSE-12)

Section	Title	Text	Method	Verification Plan and Test Procedure
3.7.1.4.7	Caging Assembly	none		
3.7.1.4.7.1	Force Applied to Gyroscope by Caging Pin	The caging mechanism shall apply a force of 57.8 N +/- 4.4 N (13.0 lb +/- 1.0 lb).	T	Maximum force test of Housing/Actuator Assembly. Section 10.2.3 of P0050
3.7.1.4.7.2	Surface of Caging Pin	The surface of the caging pin in contact with the gyroscope shall have a surface finish and curvature compatible with applying the caging force to the gyroscope without affecting gyroscope performance requirements.	I	Final surface finish to have 0.25 µ smoothness. P0107, Caging Rod Polishing Procedure.
3.7.1.4.7.3	Actuation Pressure	The caging mechanism shall operate with a helium gas pressure in accordance with the requirement in section 3.7.2.4.3. *Section 3.7.2.4.3 spec: <= 1.72 Mpa.(250 psia)*	T	Diaphragm Assembly, Housing/Actuator Assembly pressurized to 160 psid. Sections 7.2 and 10.2, P0050
3.7.1.4.7.4	Volume of Caging Circuit	The volume of each caging circuit on the SIA side of the probe to SIA interface (up to two caging mechanisms per circuit) shall be in accord with the requirement in Section 3.7.2.4.4. *Section 3.7.2.4.4 spec: <= 1.0 cm^3.*	I	By design. Not applicable to this procedure.
3.7.1.4.7.5	Interface of Helium Gas Actuation Line with Probe	The demountable connection of the helium gas line to the probe shall be in accord with the SIA to Probe ICD, LMMS 1C34103.	I	By design. Not applicable to this procedure.
3.7.1.4.7.6	Leak Rate	When internally pressurized with helium at 0.10 MPa (15 psia), the helium leak rate shall be less than 1.0e-8 standard cm^3/s.	T	Weldments and Tubing leak tests. Sections 5.2, 6.2, 13.2 of P0050.
3.7.1.4.7.7	Position of Caging Pin with Zero Applied Pressure	The caging pin shall be withdrawn from the surface of the gyroscope housing (ID of spherical surface of uncoated housing) greater than or equal to 0.25 mm (0.010 inch) when a differential pressure of 0.00 MPa is applied to the mechanism.	I	By design, reqmt is satisfied if protruding length of rod from Housing ≤ 0.233 inch. Protruding rod length measured in Section 10.2.1, P0050.
3.7.1.4.7.8	Position of Caging Pin at 0.12 MegaPascal (17 PSID	The caging pin shall be withdrawn from the surface of the gyroscope housing (ID of spherical surface of uncoated housing) greater than or equal to 0.05 mm (0.002 inch) when a differential pressure is applied to the mechanism of 0.12 MPa (17 psid).	I, T	By design, reqmt is satisfied if diaphragm travel ≤ .008 inch at 17 psid. Diaphragm travel test in Section 7.2.8, P0050.

Quality Assurance Plan

- QA representative designated by B. Taller to witness requirements verification tests, and sign off completion of these tests. This person must be someone other than the engineer conducting the test (Art Nakashima)
- ONR will be notified of verification tests at least 24 hrs before test. He will be invited to witness. (Sections 7.2, 10.2, 13.2)

GSE Status

GSE	MODEL NO	CAL DUE DATE	STATUS
Caging Control Unit Pressure Transducer Rest of CCU	N/A	PT Calibration at SIMCO scheduled for 2/15/98	ready when PT calibrated
Gyro Caging Simulator Tube Dial Indicator Adapter Load Cell Adapter	N/A	N/A	ready
Mitutoyo Dial Indicator	IDC-112E	4/29/98	ready
Load Cell Force Meter	Omega DP41-V	Calibration at SIMCO scheduled for 2/15/98	ready when calibrated
Leak Detector	Varian Auto-test 960	3/3/98	new LD arriving in Feb
Adapter T-flange for Leak Detector	N/A	N/A	ready
Mitutoyo Test Stand	70040	N/A	ready
Aluminum Cylinder for Test Stand for holding Actuator Assembly	N/A	N/A	ready

Personnel, Facilities

- John Stamets, REE for assembly and test
- Art Nakashima, QA representative
- Directed Light, Inc does welds of Diaphragm Assembly
- Stanford's Manuel Ortega does brazing for Tube Assemblies
- Stanford's Joe Vrhel does polishing of Caging Rods
- Most assembly and test in Class 1000 HEPL Cleanroom

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REV. C

November 26, 1997

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CAGING TRR 1-30-98

All Parts are in house except the following parts listed.

22798-101 Caging Rod	**Due in on March 1998**
23384 Sleeve Solder	**Due in February 20, 1998**

22897 Retainer and 22804 Pusher are both in house but more are being manufactured because of need for spares. 6 each in house.

Brazing of the tube assys 22822 is scheduled for February 12, 1998 and welding of the Dia. assembly is scheduled for 25 February at directed light.

GSE calibration is scheduled for February 15 at Simco.

Operational testing and profiling per procedure is scheduled to take place from March 10 thru March 31st.

Final 22809 Mechanism assy is planned on April 6th to be followed by Magnetic screening of complete units.

Units ready to install into probe mid April depending on magnetics.