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Gravity Probe B Relativity Mission

Mechanisms ADP Review – Final Issue Close Out

(Mass Trim Mechanism, Attitude Reference Platform Launch Restraint Mechanism, Solar Array Release Mechanism, Solar Array Deployment Mechanism)

S0838, Rev. -

March 26, 2003

Close Out Certification

The Mechanisms data package* has been reviewed by Stanford University. MSFC and the IRT have been requested to identify any flight risks from any review to the Stanford University review chairman. The chairman, having assessed all inputs received as of the review date of 26 March 2003, finds the mechanism components reviewed acceptable for the GP-B flight mission contingent on the acceptable closure of the action items and acceptable system level testing.

* the following items were reviewed: Mass Trim Mechanism, Attitude Reference Platform Launch Restraint Mechanism, Solar Array Release Mechanism, Solar Array Deployment Mechanism

ADP Review Chairman:

Bill Bencze — 31 MAR 03 — Date

GP-B Program Manager:

Gaylord Green — 1 Apr 03 — Date

Concurrence:

Systems Engineering — 4/1/03 — Date

Concurrence:

Quality Assurance — 4/1/03 — Date

ITAR Assessment Performed Tom Langenstein — 3/31/03

ITAR Control Req'd? ☐ Yes ☒ No

Mechanisms ADP Data Review (telecon) and Issues Resolution Meeting Minutes:

Location: Lockheed Martin, Building 255 Room OA235, 1 pm, March 26, 2003
Minutes prepared by: Steve Young

References: None

Attendees:

MSFC ..... Charlie Dischinger, Carl Foster, Albert Froelich, Jerry Hahn, Phil McKnaught
SU: ..... Bill Bencze, Ken Bower, Rob Brumley, John Mester, Dorrene Ross, Steve Young
LM: ..... Rich Whelan, Sean McCully, Dennis St. Clair, Dave Steele, Mike Miranda

Background:

Acceptance Data Packages for all Spacecraft and Space Vehicle components were sent to Marshall Space Flight Center for review. MSFC responded with questions and issues raised by the ADPs. A series of Issue Resolution Meetings were scheduled to address those questions and achieve issue closure based on appropriate discussions, clarifications, or actions. The issue closure process began when several ATC component issues were addressed in January 2003. Meetings scheduled for March and April (2003) will address other subsystems and their components.

The March 26, 2003 meeting focused on spacecraft mechanisms, including the Mass Trim Mechanism (MTM), Attitude Reference Platform Launch Restraint Mechanism (ALRM), Solar Array Release Mechanism (SARM), and Solar Array Deployment Mechanism (SADM).

Overview / Summary:

The responses concerning the four components of the mechanism ADP were reviewed and discussed. All issues were closed pending some appropriate clarification or action. All issues reviewed and further discussion is included below. After this, there was some discussion regarding resolution of the responses to the Vatterfly Valve ADP. It was decided to revisit these issues during the Payload Component Acceptance Review.

Mechanism Questions / Issues from MSFC:

Subsystem	MSFC Reviewer	MSFC Findings/Issues	Stanford Findings/Issues	Finding Resolution
Mass Trim Mech	Saxon	None	Ken Bower (3/17/03) - no new issues identified. However, no review document (ADR, ADP, etc.) seems to exist for this mechanism. A thorough review would require evaluating ~2000 pages of vendor EIDPs & logbooks and/or considerable time with LMMS engineering personnel.	MTM Design Disclosure [1] submitted in lieu of EM. Component CDR (P086825) uploaded to ITAR (3/28/03). See clarification of tested range of motion issue [2]. CLOSED
Att. Ref. Platf. Laun. Restr. Mech	Saxon	Data appears to show the ALRM meets applicable specifications with the exception of a DR on outgassing and a note that SN001 CRES bolts nees to be reworked.	Ken Bower (3/17/03) - ALRM outgassing issue is acceptably resolved by DR# R73457 and EM SMS 404. SN001 issue (proto-qual, not flight) acceptable as is. What is notable, however, is that DR# R73457 is not shown in the log book DR list. Do other DR's not appear?	See response to outgassing and SN001 issue below [3] See reconditioning info below [4] DR# R73457 was incorrectly listed as DR# R74357 in the ADR and Flight Proto-Qual Assembly Log (P480491). CLOSED
Sol. Arr.Rel. Mech	Saxon	Package appears to be complete and thorough for verification at the component level. It is not apparent that the package conteins any data relating to function before or after system-level thermal vacuum or acoustinc testing. Such data may be included in a higher-level package and should include documentation of Shape Memory Rod reconditioning operations performed on vehicle.	Ken Bower (3/17/03) - no new issues identified.	Component Level package delivered for component level review. See reconditioning info below [4] CLOSED
Sol. Arr. Depl.. Mech	Saxon	Package appears to be complete and thorough for verification at the component level. It is not apparent that the package conteins any data relating to function before or after system-level thermal vacuum or acoustinc testing. Such data may be included in a higher-level package and should include disposition of the self-generated debris observed during array walk-out.	Ken Bower (3/17/03) - no new issues identified.	Component Level package delivered for component level review. Self-generated debris poses no risk at the SV level -- disposition is "use as is" per Vehicle Level DR# R19683 and R19677 CLOSED

Additional Notes:

(1) MTM Design, Build, Test, and Acceptance, Rich Whelan (3/27/03)

The MTM Design is fully disclosed in the MTM CDR document (P086825)
Lockheed Martin Gravity Probe B Spacecraft Team designed and built an MTM engineering unit, then built and tested a proto-qualification unit.
After proving out the processes for building and successfully testing this unit, the flight unit parts, build procedures, and test procedures were sent to LITTON Poly-Scientific Technology for build and test.

Description	LM GPB #	Part #	S/N	MSFC Hardcopy Shipment	Scanned	Who has it?	Action *
Protoqual		8A00168	S/N 001	#22	MSFC	MSFC	send to SU
Protoqual		8A00168	S/N 002	#22	MSFC	MSFC	send to SU
Protoqual		8A00168	S/N 003	#22	MSFC	MSFC	send to SU
End Item Data Package	P480113	8A00168	SN 002	#42	LM	MSFC, SU	none
End Item Data Package	P480114	8A00168	SN 003	#42	LM	MSFC, SU	none
End Item Data Package	P480115	8A00168	SN 004	#42	LM	MSFC, SU	none
End Item Data Package	P480116	8A00168	SN 005	#42	LM	MSFC, SU	none
End Item Data Package	P480117	8A00168	SN 006	#42	LM	MSFC, SU	none
End Item Data Package	P480118	8A00168	SN 007	#42	LM	MSFC, SU	none
End Item Data Package	P480119	8A00168	SN 008	#42	LM	MSFC, SU	none
CDR	P086825						send to SU

* Actions complete at time of sign-off

After completing the build and test, LITTON Poly-Scientific Technology provided a document package for each flight item consisting of:
Certificate of Conformance
Build Procedures
Test Procedures
VRICs

This content is specified on page 2 of each package.

The drawings had been previously provided to MSFC per their separate request, but are only now being provided to SU as part of the SC ADP.

(2) Clarification of MTM tested range of motion, Steve Young (3/26/03)

There is no risk assumed by testing the MTMs at less than full range-of-motion. The tests performed consisted of cycling the masses 0.1" in each direction and returning them to the centered position. While 0.1" is less than the maximum range-of-motion of the masses, the MTM motors were exercised through all positions during this manuever. Since the main MTM failure mode is non-starting, this test was adequate.

(3) Resolution of ALRM outgassing and SN001 issue, Sean McCully (2/17/03):

ALRM outgassing was written up on DR# R73457. SARMs were written up on DR# R73455 for the nylon backshell. The culprit item (nylon backshell) was the same in both cases, and the final disposition was the same - "use as is".

The SN001 ALRM is not a flight unit nor a flight spare. The SN001 ALRM is the proto-qual ALRM. A lein was placed on the hardware so that it could not be used as a flight spare without the proper refurbishment. There is no desire to refurbish this assembly to flight spare status.

(4) Response to Shape Memory Rod Reconditioning questions, Sean McCully (3/27/03):

1. Where and how was the conditioning effort documented at the component level?

The conditioning requirement is documented on the drawing as note 17 (ref 8A00227) and in the spec (P086928) at paragraph 3.2.1.1.3. The conditioning was simply a note in the operations order. The note was eventually simplified to "clamp" during life testing.

2. How often did this conditioning happen at the component level?

As an example, I counted 7 conditioning cycles during SN005 ATP (out of a total of 21 releases). These conditioning cycles were generally timed with a dual rod release, so that an additional heat cycle was not necessary. During life testing, the clamp was placed on the cooling rods on average every other release. This is documented in the as run procedure SARM 010 simply as a note "clamp". This was done not to improve contact with the toggle, but rather to maximize the mechanical cycle during these tests.

3. What is the process at the vehicle level?

ETP 192 documents the method for conditioning the solar array release mechanisms at the vehicle level. I anticipate running this conditioning ETP one more time. MEC 007 documents the last conditioning cycle for the ALRM.