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Gravity Probe B Relativity Mission

Mission Rehearsal (MR) Plan: Flight Days #1 and #2

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This document outlines the plan for Mission Rehearsal (a.k.a., MR), which will be the final full simulation/training exercise involving the entire Gravity Probe B (GP-B) Project, and will be conducted over a ~48-hour period during 29-31 Mar 2004. This plan discusses MR as follows:

- Section 1 – Outlines the goals and success criteria.
- Section 2 – Discusses the details of the exercise.
- Section 3 – Lists the basic assumptions and ground rules in effect.
- Section 4 – Discusses the plan for anomalies and contingencies.

1. Goals and Success Criteria

The major goals and associated success criteria for MR are shown in Table 1. The coarse schedule of activities for this exercise is as follows:

- 28 Mar: Day #0 – SV power-up from L-17^h mark.
- 29 Mar: Day #1 – MR officially begins at the L-4^h mark with the pre-launch countdown, which is followed by launch and the Flight Day #1 early on-orbit activities.
- 30 Mar: Day #2 – Flight Day #2 on-orbit activities.
- 31 Mar: Day #3 – Flight Day #2 closeout data analysis/review, and post-MR debriefing.

Table 1: Major goals and associated success criteria for MR.

Goal	Success Criteria
To demonstrate flight readiness for the entire Stanford-Lockheed-NASA (SU-LM-NASA) GP-B operations team.	♦ Conduct the simulation, on the Integrated Test Facility (ITF) simulator systems, in a flight-like environment. ♦ Conduct integrated operations involving mission operations, engineering, and management personnel in their respective roles. ♦ Follow the baseline day-in-the-life scenario: daily meetings, etc. ♦ Demonstrate console training of the entire GP-B flight team. ♦ Exercise the flight-like staffing scenario for the associated activities.
Successfully conduct the Flight Day #1 pre-launch and LEO activities.	♦ Conduct the SV power-up sequence according to the approved Launch Power-Up procedure and using the flight loads in EEPROM. ♦ Conduct the official pre-launch countdown from the launch-minus-four-hour (L-4^h) point using a realistic and detailed launch script that includes the required go/no-go polling and voice loop interactions with the MOC team and the external NASA elements (e.g., Vandenberg Air Force Base, VAFB). ♦ Conduct the Flight Day #1 launch and early orbit (LEO) operations including initial Space Vehicle (SV) deployment, signal acquisition, subsystem activation, attitude capture, and orbit determination/trim activities.

Goal	Success Criteria
Successfully conduct the Flight Day #2 LEO activities.	♦ Conduct the Flight Day #2 on-orbit activities including the remaining payload activation, initial Science Telescope (ST) shutter operations, spacecraft SafeMode (SM) initialization, and guide start capture via dwell scans.
If required, successfully exercise the anomaly response process.	♦ Exercise the interfaces between the Mission Director (MD), Flight Director (FD), and Anomaly Review Board/Team (ARB/ART) investigation personnel. ♦ Conduct anomaly response, as required, according to the approved Anomaly Response Plan (ARP).
Continue to successfully exercise and stress the newly introduced data processing (DP) capabilities.	♦ Verify limit checking for both realtime/framex and playback/VC data files, including Responsible Engineer (RE) acknowledgement of limit violations. ♦ Exercise timely posting of DP reports to the gpbops web site. ♦ Exercise timely production and distribution of the daily baseline plot sets covering the last 24 hours; hardcopy plots for internal REs should be complete by 8am while those for external personnel will be posted to the web by 10am.

In addition to these major goals, a number of other notable items will be worked during MR, although these are not critical to its overall success:

- RE checklists – Implement the use of subsystem checklists for use on console by the REs for facilitating shift handovers and reporting status information during realtime events.
- limit management – Continue to improve the realtime limit management process, particularly with respect to obtaining RE acknowledgement to limit alarms posted in TQSM.
- approved command templates and procedures – To exercise the approved command templates and associated flight/ground procedures for nominal and, as required, contingency operations.
- dlog process – Continue to exercise the flight-like discrepancy log (dlog) process for the reporting, disposition, and follow-up action on noted discrepancies in the GP-B flight and ground systems; in particular, make use of the new TQSM-based dlog generation tool.

2. Discussion

MR will be a ~48-hour simulation/training exercise conducted during 29-31 Mar 2004, and will involve the entire integrated Stanford, Lockheed, and NASA flight team. MR will focus on launch and the initial two days of on-orbit operations:

- **MR Day #0, Sun, 28 Mar** – Pre-launch activities will actually commence on the previous day at the L-17^{h} mark for the initial SV power-up activities, which will include loading the flight deployment sequence – with the actual flight launch dates, times, and SV separation vector – from EEPROM, ECU/GMA operations, and vehicle power-up and configuration according to the flight *Launch Power-Up* procedure (GNDR00 3.4.2.2).

- **MR/Flight Day #1, Mon, 29 Mar** – MR will then *officially* begin at the L-4^h mark with the commencement of the countdown activities, which the flight team will work through based on a "sim only" release of the approved *GP-B Launch Operations Go/No-Go Criteria* (S0878) document and associated checklists. Launch will then occur at 170912Z, which is the actual Greenwich Mean Time (GMT) slated for the real launch on 17 Apr; note that due to the switch from PST to PDT in early Apr this GMT time corresponds to 9:09:12am PST for MR vs. 10:09:12am PDT for the actual flight launch. After launch, the team will conduct the baseline flight day #1 activities – SV deployment and initial activation, attitude capture, and the orbit trim and shutter operations decision – by following the approved operations script for the associated flight command load sequences.
- **MR/Flight Day #2, Tue, 30 Mar** – This day will consist of all of the flight day #2 activities, including the remaining payload activation, initial ST shutter operations, spacecraft SM initialization, and guide start capture via dwell scans, again following the approved operations scripts.
- **MR Day #3, Wed, 31 Mar** – The on-console portion of MR will end at ~7am PST on this day, and will be immediately followed by a period of data review leading into an All-Hands meeting to close the loop on the Day #2 activities. A debriefing session will then follow to terminate the exercise.

MR will be run with the ITF as the "SV" data source, and will be conducted in realtime with the SV clock synchronized with GMT with a set day offset. All of the various GP-B teams – operations, management, engineering, etc. – will participate in MR according to their assignments as set forth in the *GP-B Launch and Activation Plan* (S0629). Each will work according to a flight-like schedule and in their flight-like areas, with full 24x7 console support in the MOC from most subsystems for the first 72 hours on-orbit.

Under the direction of the FD, the on-line realtime operations will be conducted in the MOC in a flight-like manner. Realtime controllers (RTs) will employ approved passplan checklists to accomplish the daily commanding, telemetry monitoring, and SSR data management activities. REs will provide console support for all significant subsystem activities. All SV anomalies will be worked according to the approved *GP-B On-Orbit Anomaly Response Plan* (ARP; S0897). All communications will be conducted over the combined intercom and SCAMA (Switching, Conferencing, and Monitoring Arrangement) voice loops. RTWorks "snaps" of engineering monitors will be collected during each realtime event, and will be provided to DP personnel for processing to produce out-of-limit (OOL) "alarm" reports that, along with other reports, will periodically be pushed to the established "gpbops" operational web interface (https://gpbops.stanford.edu/) for secure remote access via the Internet. The flight team will exercise the pre-launch, launch, and early-orbit activities using pre-approved operations scripts that specifically delineate tasks to be performed, associated polls, verification information, and the like. During the L-4^h countdown on Day #1, the actual NASA network elements – Space/Ground Networks (SN/GN) and associated Network Operations Managers (NOMs), Flight Dynamics Facility (FDF), and a small contingent

from VAFB – will participate; after launch all of these interfaces will be simulated by the Sim Team.

The basic routine off-line activities will consist of orbit determination, data processing and trending, subsystem performance analysis, and anomaly investigation and response. Overall status information will be conveyed at the daily local 10am All-Hands meeting, which will be attended by all MR participants, as available, and run by the MD; note that the initial All-Hands meeting on Day #1 will be held at ~L+8^{h}, which will allow sufficient time for the flight team to review the initial playback data and assess overall SV health and performance. Planning for the follow-on command sequences will be accomplished via the daily Mission Planning (MP) load review and signoff meetings at 11am and 4:30pm, respectively. The Timeline sequences employed will be baselined on the actual ones for flight with any changes to be implemented via Timeline Change Request (TCR). The team will also exercise a number of ParamGen interfaces in order to work the associated data, software, and personnel interfaces for modifying on-board databases.

The MP team will schedule SN/GN realtime events using the actual interfaces at NASA Goddard Space Flight Center (GSFC) and the White Sands Complex (WSC). The Sim Team will simulate the SN/GN "ground sites" for the scheduled realtime events during the sim, as well as the Standard Autonomous File Server (SAFS) function for the transfer of Solid State Recorder (SSR) playback dump data to the MOC. As mentioned above, the actual NASA network elements will participate in the pre-launch countdown sequence only.

All MR participants should document any problems, anomalies, areas of concern, suggestions for improvement, etc., as dlogs, which will be periodically collected for review and disposition. All items of interest to operations personnel should be noted in the on-line Telemetry Quality and Status Monitoring (TQSM) logbook software.

To support this exercise, the ITF will be configured as follows:

- SV-to-ground communications will be via the IONET; the simulated ground stations – i.e., the Front-End Processor (FEP) in the ITF – will use the appropriate desktop configurations to provide realistic realtime events.
- The Vehicle Environment Simulator (VES) will simulate the SV rolling at 0.1 RPM as per the baseline post-launch Timeline, and will be fully synchronized to allow for precision ATC pointing operations in "Mode 1A" as required. Inherent limitations in the VES may preclude its full and proper operation throughout the exercise; if so, the Sim Director will green-card the appropriate functions as necessary to carry out the MR objectives.
- To simulate in telemetry any proper external signals, the Sim Team will operate the various simulators to ensure the insertion and timing of the associated signals.
- The GPS receiver will be cabled to the rooftop antenna so as to receive signals from the actual orbiting GPS constellation – the WelNav GPS simulator will *not* be used in MR. The use of the rooftop antenna will ensure the reception of

accurate timing signals for analysis by the Science Team, something that the WelNav cannot do; the resulting static orbit solution from the rooftop antenna will be pre-green-carded as nominal by the Sim Director.

The following are the major deltas between this exercise and actual flight operations:

- The launch time for MR will be at 9:09:12 am PST, which is one hour earlier than the actual launch of 10:09:12 PDT on 17 Apr. This one-hour offset is a result of the change from PST to PDT that occurs in early Apr between MR and actual launch. The need for the ~9am PST launch is due to the use of the actual flight deployment load in EEPROM, which includes the 170912Z launch time.
- All external NASA network interfaces, except for the real SN/GN scheduling, will be simulated post-launch by the Sim Team; *all pre-launch network interfaces will be real.*
- Because the ITF simulators will be used in place of the actual SV, a number of ITF limitations will be in effect; the Sim Director will provide a list prior to the exercise. These limitations require minor modifications to the "flight" timeline for the ITF.

After completion of MR, all relevant on-line materials will be archived in the simulations area on the training page within the gpbops web site.

3. Assumptions and Ground Rules

The following assumptions and ground rules will be in effect for MR:

- The ITF systems will serve as the "SV" data source.
- The Sim Director will lead and direct the exercise according to this plan.
- All participants should conduct operations as they would in flight – *think flight, not sim* – work issues as you would in flight and don't call the Sim Director!
- The Sim Director will maintain a list at the FD console of officially green-carded items. *Only the Sim Director can add items to this list. Any anomaly that does not appear on this list should be treated and worked as if it were real.*
- All personnel working on the MOC systems must have received their NASA SOLAR security certifications.
- All persons working in the MOC will follow accepted MOC protocols as per the L&AP (S0629).
- All operations will be conducted under the three major flight operations documents:
  1. *GP-B Launch and Activation Plan* (S0629)
  2. *GP-B Flight Rules* (S0856)
  3. *GP-B On-Orbit Anomaly Response Plan* (S0897)
- The security word will *not* be used as per the plan for IOC.

- All participants will use the dlog system within TQSM to document problems, issues, areas for improvement, etc. All dlogs will be collected and dispositioned at least once each day.
- The FD will ensure the maintenance of a status board showing a variety of relevant information.
- Personnel not specifically on duty will be available by phone or pager.
- The Sim Team will be available to simulate any element required for the exercise, if and when the actual ones are not active participants; otherwise, contact the appropriate persons.

4. Anomalies and Contingencies

The purpose of MR is to perform one last "clean" simulation prior to launch, in which the flight team exercises all normal activities in as routine a fashion as possible. Therefore, throughout MR the Sim Team will *not* introduce any "planned" anomalies. However, should any "freebie" anomaly occur (e.g., due to simulator issues) the team should respond in accordance with the ARP, making use of the resources available in the Anomaly Room on the second floor of the GP-B building. As necessary, the Sim Director will step in to "green-card" out various anomalies in order to ensure that the simulation exercise achieves its goals. The ARB will summarize and track all anomalies at the daily All-Hands meeting.