Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 20, 2006

I. Black Brant Anomaly Report and Recovery Plan

Summary. The SRWG appreciates the synopsis of the anomaly committee's report on the Black Brant failure and applauds the fact that the cause of the failure appears to have been identified. The SRWG believes that the report should be made public. In particular, the SRWG was informed that the report includes a discussion concerning Principal Investigator's acceptance of risk and cognizance of new hardware which, among other things, is very germane to the SRWG. The SRWG requests an opportunity to review the document and offer comments. We are also concerned about the protracted schedule for the test flight to recover from the failure in time for the anticipated FY07 launch schedule.

Background. The SRWG appreciates the technical review and anomaly report synopsis presented to the committee by the anomaly board chair, Mr. Steve Nelson of Code 500. The review process appears to have been thorough and constructive. Most importantly, it appears as if the review panel has identified a clear set of causes for the failure. It also has proposed a clear recovery plan for fixing them. For this, the SRWG extends our appreciation and commendation.

The post-review process has been less satisfactory. As the official review document from this anomaly panel has still not been released, there has been very little feedback or other comments from users and others involved in the program. Indeed, the SRWG only learned the details of the igniter problem and fix through Mr. Nelson's Powerpoint presentation at the meeting. It is our understanding that the report has been at NASA HQ for over 6 months and that there are no plans to release the report publicly due to proprietary information regarding cost information that we understand is in the Appendix. Could not this information be excised and the rest of the report be released, as with previous Wallops sounding rocket anomaly reports? Issues such as risk evaluations, why the problem was not caught, and, in particular, what the PI's posture might be in agreeing to fly his/her scientific experiment on new hardware is highly germane to the SRWG, yet we have had little, if any, opportunity to review the report's findings and comment. Given the discussion of these topics in the findings and conclusions of the report (as we learned in Mr. Nelson's presentation), we believe that the report should be made available to members of the SRWG (without the proprietary cost information) for comment. We request that an update on the status of the availability of the report be provided at the next SRWG meeting.

The SRWG is also concerned about the return-to-flight schedule, which has slipped from November to May. By all means, the SRWG agrees that the test flight should not occur until the new igniter and all hardware are ready and have been thoroughly reviewed. Our concern rests with whether the test rocket will be completed in time for Wallops to purchase new motors to fulfill its launch obligations in 2007. The SRWG is fully cognizant that this test rocket is a priority for both the SRPO and NSROC, and to be sure the user community is also very eager for a successful test flight of the improved Brant vehicle with the re-engineered igniter system. We extend to everyone at Wallops our best wishes for a successful return to flight for the improved Black Brant system.

II. Alternative Sounding Rocket Motors

Summary: The SRWG is very encouraged by the innovative, proactive work that the Sounding Rocket Program Office (SRPO) has carried out with respect to identifying and testing alternative motors for future sounding rocket missions. We comment briefly on the update on the Terrier Patriot, ASAS, Oriole, ATACMS, and MLRS motors, as presented to us at the meeting. The SRWG renews its concerns regarding the need to find an alternative to the Nihka booster for which production at Bristol Aerospace has been discontinued.

Background: The SRWG is encouraged with the SRPO's progress in identifying alternative motor configurations to supplement and perhaps eventually replace currently available launch vehicle options. In particular, the possibility of the Terrier-Patriot combination as an alternative to the single stage Brant is very encouraging as a low cost option with increased launch reliability, since it would appear to be less sensitivity to winds due to the added boost stage. The SRWG eagerly awaits results of a first test launch, and suggests further modeling/simulation to determine its feasibility for carrying larger diameter (>16") payloads aloft.

News of the successful test of the ASAS and Oriole motors was a welcome development toward expanding Brant-class motor configurations. We hope that the costs of these vehicles will be low enough so that they might be affordable options for use in NASA's sounding rocket program. In a similar vein, the SRWG looks forward to news of tests with the ATACMS boosters that were discussed at the meeting.

The MLRS option presented as a low cost Mesospheric rocket was extremely encouraging. Further development and a test launch are eagerly awaited. We are also very interested in any news of the enhanced MLRS motor, particularly since this could enable some lower ionosphere/thermosphere missions that currently must use larger vehicles.

The discontinuation of the Nihka motor and the inability to identify a likely substitute continues to be a very disturbing prospect. As discussed in the SRWG Finding #2 from the meeting of June, 2003, the loss of an exo-atmospheric boost stage would be a significant loss to NASA's high altitude sounding rocket research capabilities. Indeed, an entire class of auroral physics investigations would be terminated should this capability vanish as now appears possible. The SRWG strongly believes that a recovery plan for replacing the Nihka should be a priority for the SRPO over the next few years.

III. Review of Vibration Specifications

Summary. The SRWG strongly endorses the NSROC plans to quantify and analyze the flight-level vibration specifications based on updated information and flight data pertaining to each vehicle currently in the sounding rocket stable. We would like to better understand the policy of performing sine-wave tests on re-flights of proven payloads and are concerned with their detrimental effects on sensitive, optical instrumentation.

Background. The SRWG strongly approves of the current NSROC efforts to quantify flight-level vibration specifications through a program of direct flight measurements and analysis. There is a fairly widespread impression among experimenters, whether justified or not, that the existing flight level test specifications are unrealistically high. This leads to many requests for waivers, not all of which may be well-advised. Although the ideal case would be to predict flight levels exactly and test to these, in reality, this is a complex problem and is difficult to achieve. On the other hand, given the fact that the current test levels are based on very old data with minimal analysis, a re-evaluation appears overdue

and welcomed. Over-testing adds expense and limits science capability while under-testing opens the door for preventable failures. Improved knowledge that enables more realistic testing is therefore a major benefit to the program whatever the results may be.

The ability to review actual flight vibration measurements for relevant payload/vehicle configurations will also help both the experimenter and project in making an informed risk/benefit evaluation during the instrument design process and when requesting a departure from standard tests. The SRWG suggests that the results of the vibration analysis be made available for experimenter review in some convenient format for each of the various vehicle configurations listed in the SR handbook. Ideally, vibration levels could be recommended for each mission during the Design Review process, once the dynamic pressures for the specific vehicle/payload configuration have been determined.

Finally, the SRWG seeks clarification concerning vibration testing proposed by Wallops management for astronomy and solar payloads at White Sands. Many of these payloads contain delicate optical components. During sine sweeps these typically show extremely high amplification factors (Q of 100 or more) that require notching of the input power when tested at the component level. Since these elements are typically deep within the integrated payload, monitoring of critical components is not possible at the integrated instrument level. Repeated testing of this type is likely to unnecessarily increase the risk of instrument failure by overstressing components within the instrument. In addition to seeking comments on the vibration requirements for these payloads, we also seek confirmation that for re-flights, only random vibration, and not sine sweeps, will be performed.

IV. Integration of Solar Payloads

Summary. The SRWG believes that solar payloads should be integrated at Wallops, rather than at White Sands, except for certain tests, such as those that involve the heliostat. This integration approach would be more efficient and appears to be cost effective as well.

Background. Traditionally, many solar payloads are integrated at White Sands Missile Range (WSMR) rather than at Wallops. Our understanding is that the reason for this is that various equipment such as heliostats reside at WSMR, some technical advisors are resident at WSMR, and some experiment teams can more efficiently travel to WSMR than Wallops.

Given the cost constraints on the program and the fact that much of the ACS hardware is now built and/or managed by NSROC at Wallops, it would appear sensible that all solar payloads should be integrated at Wallops, in line with other payloads that are designed, built, and tested as part of NASA's sounding rocket program. Certain tests, such as those with the heliostat could still be performed, insofar as possible, at WSMR, where this equipment resides and where the number of days with sunlight in a given year are higher than at Wallops.

V. Progress with ACS Systems and Attitude Knowledge Systems

Summary. The SRWG is concerned that the NSROC fine pointing attitude control systems (ACS) will not be as precise as ones previously procured from industry, and we urge that low-noise gyro platforms and other system improvements be undertaken to enable such precision fine pointing to be achieved. Regarding the replacement gyro that provides attitude knowledge typically used in geophysics payloads, we are concerned that the NSROC data reduction software and end-to-end testing has not been demonstrated with

quantifiable, acceptable resolution and accuracy in all three axes. The SRWG suggests that test plans and data for both the celestial ACS and the new, coarse gyro be shared with a group of users who would normally use the end products. This group, which may consist of representatives of the SRWG and/or other users, would provide independent verification of the new systems and offer assistance with the data interpretation and analysis.

Background.

Fine-pointing ACS for Astronomy payloads. The results of the new NSROC Celestial ACS (CACS) yield errors of ~ 3 arc seconds at best, substantially less accurate than the requirements of a number of upcoming astronomy missions which require accuracies on the order of 1 arc second. As stated in the NSROC presentation, the GLN-MAC must be augmented by a new gyro platform having sensitivity and noise characteristics superior to those of the LN200. The SRWG urges that NSROC follow their own suggestion of incorporating a sensitive, low-noise gyro platform into the CACS to improve its performance. Other improvements discussed at the meeting, such as improving the very fine thrust control, optimizing the controller to overcome measurement noise, and creating an air bearing test environment capable of simulating the star field to measure the fine-pointing performance, all appear to be sound and very important tasks, and we wish NSROC well in these endeavors. The SRWG offers the expertise of users, either within the SRWG or elsewhere in the community, to provide independent calculations and analysis where appropriate.

Coarse Gyro for Geophysics Payloads. Geophysics payloads have long used gyros to provide coarse (~ 1 degree resolution) payload attitude for a variety of missions. The workhorse gyro has been the MIDAS platform provided by Space Vector. The last of these platforms were flown in the Kwajalein Campaign of 2004. NSROC intends to replace these systems with the GLN-MAC. Although the GLN-MAC has been tested in flight, the SRWG has not seen a detailed analysis showing the accuracy of the payload knowledge in all three axes. Typically, this is accomplished with comparisons with on-board magnetometer and solar sensor data. The SRWG would also welcome an opportunity to review the NSROC software and analysis procedures for converting the raw data to attitude information with respect to a fiducial on the payload. Given the importance of this information for the success of numerous types of geophysical payloads, the experimenters who will be the first to use the new system are understandably nervous. Again, the SRWG offers to facilitate a users group to provide independent analysis to verify that the system is working as designed and to offer assistance with the data interpretation and analysis, where appropriate. This users group could also discuss definitions of standards and processing procedures in accordance with the attitude handbook that NSROC is preparing.

NASA Sounding Rocket Working Group

Dr. Robert F. Pfaff, Jr. (Chair)
NASA/Goddard Space Flight Center

Dr. Scott Bounds
University of Iowa

Dr. Tim Cook
Boston University

Dr. John Craven

University of Alaska

Dr. Ray Cruddace
Naval Research Laboratory

Dr. Lynette Gelinas
Cornell University

Dr. Jim Green
University of Colorado

Dr. Paul Kintner
Cornell University

Dr. Gerald Lehmacher
Clemson University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center