Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of February 24-25, 2011

Findings

1. Flight Termination System "Crisis"

Summary:

The SRWG remains seriously concerned about the lack of qualified Flight Termination Systems (FTS) available for launches at White Sands Missile Range. This situation has resulted in serious delays for a considerable number of payloads and is exacerbated because the "return to flight" schedule remains uncertain. The SRWG supports an aggressive development plan for moving to a long-term, viable, qualified, flight termination system for launch operations at WSMR. The SRWG welcomes updates on the detailed development and qualification schedule for both the "Hybrid II" and "Final design" FTS units.

Background:

Flight termination systems are required for Black Brant IX (BBIX) operations at the White Sands Missile Range (WSMR) as well as for some other launch configurations at other ranges. The "legacy" FTS, used until 2009, is no longer available and, we understand, would not be allowed by current WSMR range safety policies. Our understanding is that a recovery plan was agreed to between the SRPO, NSROC, and WSMR starting with a limited quantity of "Hybrid I" systems deployed in 2009. The stock of Hybrid I systems, however, was not large enough to meet the need for flights manifested in 2010, and the agreement did not allow additional "Hybrid I" systems to be manufactured. The plan was to deploy the next development unit ("Hybrid II") in January 2011 with 21 units to be procured, 3 of which would be used for qualification testing. The remaining 18 units were to be used for flights, bridging the gap until the "final" design is to be ready sometime in 2012. The "final" design is to be fully compatible with WSMR range safety rules and should provide viable, long-term FTS units for WSMR flight operations.

The present situation is that the launch manifest for WSMR has been necessarily suspended (following the last flight of the Hybrid I FTS on 36.275, Woods, which took place in March 2011). No flights will occur until the Hybrid II systems are ready, and this unit is delayed until it is qualified and accepted by WSMR range safety. This situation will then re-occur when the limited Hybrid II systems are depleted if, at that time, the "final" FTS systems are not yet available.

From the SRWG perspective, the current effort to provide a new, viable FTS includes many uncertain aspects. Definitive goals, milestones, and cost estimates required to establish a FTS acceptable to White Sands Range Safety were not presented at the SRWG meeting and we look forward to seeing these when they are available. The current uncertainty in both the cost and readiness date, leaves the SRWG with a low confidence level that sounding rocket flights will resume from WSMR before 2012, at the earliest. Such an extended delay is particularly detrimental for missions supporting calibration of on-orbit high priority satellite investigations.

Accordingly, the SRWG urges the SRPO to develop a cost effective, new FTS on a "fast track" schedule, perhaps including a team of highly experienced senior engineers and users (if necessary) to aid in getting the FTS back on-track. We especially hope that creative, low cost solutions will be explored, noting that certain "MIL Spec" requirements for FTS flight relays are more stringent than those required for a 15 minute sounding rocket flight.

The SRWG welcomes detailed insight and regular updates regarding the new FTS development activities, including cost, schedule, and qualification plans, including any contingency planning.

2. Black Brant Concerns

Summary

The SRWG remains very concerned about the status of the Black Brant vehicle, including reported problems with the "improved" MK1 vehicle, particularly those regarding evidence for unacceptable angles of the exit cone at burn out (non-symmetric throat erosion), spin up anomalies, combustion instabilities, and regressive pressure curves possibly caused by different blending/pre-blending procedures with the ammonium percolate. The SRWG strongly supports the aggressive test program led by the SRPO to identify and remedy these problems.

Background

The Black Brant has been the workhorse of the NASA sounding rocket program since the 1970s, with a track record of outstanding reliability. Unfortunately, material and vendor availability issues developed in the late 1990s. The most recent MK1 version of the Black Brant, an improved version for higher performance, has not been consistent. Of the last 33 MK1 flights, 6 have shown combustion instability or spin-up anomalies. The SRPO has investigated the cause of this behavior, and found regressive pressure curves, non-symmetric throat erosion, as well as evidence for possible issues with the composition and quality of the ammonium percolate solid fuel mixture. The SRPO has developed a procedure for widening the throat of the nozzle which has so far delivered good results.

The implications of Black Brant Mk1 reliability are serious and ripple through the NASA sounding rocket program. The vibration levels on some of the anomalous flights exceed the qualification envelope for the flight termination system used on all WSMR flights. We support the ongoing efforts of the SRPO to modify the nozzle, inspect recovered motors, and work to a resolution of these problems with the vendor. However because this behavior is intermittent, and given the nature of lot purchases, it will be some time before this problem can be fully resolved. Meanwhile, Black Brant X, XI and XII flights are currently under moratorium due to damage to the Brant exit cone and coning issues for the remaining stages.

The SRWG looks forward to the results of the test flight in April, 2011 from Poker Flat, which promise to help resolve the blended/pre-blended ammonium percolate (AP) issues. We strongly supports the aggressive test program led by the SRPO to identify and remedy the problems with the MK1 Black Brant vehicle.

Finally, the SRWG supports SRPO efforts to identify new sources of sounding rocket motors that would provide alternative launch vehicle choices in the future. At the February 2011 meeting, the SRWG learned that the SRPO has issued a request for tender of replacement motors from an alternate vendor. Such a switch to a new vehicle represents a major transition, due to the long experience base with Black Brants, the work horse of the sounding rocket program for decades, and the specific ignition, termination, and separation systems associated with a new

vehicle. The SRWG looks forward to further information on the possibility of phasing in a new vehicle with sufficient time for development and test flights that does not disrupt on-going sounding rocket flights.

3. NSROC II Welcome and Comments on Staff Levels, Mission Development Risk Posture

Summary

The SRWG welcomes NSROC II, represented by the Orbital Sciences Corporation (OSC), into the NASA sounding rocket "family" and looks forward to working together on many successful science missions over the coming years. Despite this enthusiastic, "pro-active" welcome, the SRWG is worried about the low experience level of the new team. We are also concerned about NSROC II's suggestions of adding more reviews, paperwork, and personnel onto payload teams, without a demonstration that such actions are directly linked to solving problems.

Background

The SRWG welcomes NSROC II, represented by the Orbital Sciences Corporation (OSC), into the NASA sounding rocket "family" and looks forward to working together on many successful science missions over the coming years. We very much appreciate OSC management's expressed willingness to work with PI's to maintain and improve NASA's highly successful sounding rocket program.

At the February, 2011 SRWG meeting, we learned that a large number of personnel remained with the former NSROC company, establishing a new office in the area to work on DoD target missions and hence were not captured by the new NSROC-II contractor. The average experience level of the new NSROC team is thus quite low, despite the significant experience of the OSC company with space-related tasks. This is a stated concern of the SRPO as well as the SRWG.

The SRWG is weighing and considering the new risk posture and appropriateness of proposed changes to the sounding rocket development process proposed by the new NSROC II management. We find that this new beginning is an appropriate time for the user community, the SRPO, NSROC II, and NASA HQ to discuss these matters.

At the February, 2011, meeting, the SRWG learned of new, proposed ideas by NSROC II involving both their risk posture and suggestions for improving the program. The SRWG would like to discuss with both the SRPO and NSROC II management the best way to improve what needs to be improved, while maintaining the best, working parts of the existing program. We are reluctant to see changes of the tried-and-true "recipe for success" of NASA's Sounding Rocket Program, which make it uniquely capable of flying low-cost, rapid-turnaround, important scientific missions for the nation.

Towards this end, the SRWG seeks clarification concerning the new emphasis on higher levels of documentation, new reviews, and the role of systems engineers now assigned to each mission. In the past, while a certain level of documentation and reviews have always been viewed as important and necessary, they have been used as important tools to improve missions, and not as a means to push the reliability of missions beyond the appropriate risk posture (typically 85% success rate). The role of a systems engineer has often been performed by mission managers, who have the best overall picture of mission requirements, interfaces with the experimenters, and schedule and budget. The addition of a separate systems engineer to each mission may result in improved reliability, but may also tend to unnecessarily slow down mission development or drive costs on both the NSROC and experiment side. We thus wonder if such an engineer might

be most appropriately assigned on a “case by case” basis, for example, for new or payloads with particularly challenging designs. Finally, the addition of more formal reviews, such as a Flight Readiness Review (in addition to the Mission Readiness Review) and a Lessons Learned Review may have value, but the need for such additional meetings (and the time to prepare for them) need to be demonstrated in practice with specific examples of risks that could have been mitigated.

4. Increased Constraints for Poker Flat Launches and Associated Costs

Summary

The SRWG is very concerned to learn of increasing difficulties associated with obtaining permits to operate sounding rockets within Poker Flat's designated flights zones. The cost (currently estimated at 1.2 million dollars) to perform a comprehensive Environmental Impact Study (EIS) is painful to accept but is recognized as necessary. Since increasing restrictions have unacceptably reduced Poker Flat's launch capability, we understand that alternative high latitude launch sites may be considered. The SRWG would like to be closely involved in any discussion or investigation of potential alternative launch sites.

Background

At the February 2011 SRWG meeting, the SRPO advised that US federal agencies with regulatory control over flight zones downrange from Poker Flat have been coming under increasing pressure from stakeholders concerned about the environmental impact of rocket operations. Particular concern appears to be focused on the notion that Poker is "littering" the down-range area by allowing spent hardware to remain unrecovered. Recent media attention has noticeably increased both the public and agency pressure on this issue.

The regulatory agencies have, however, expressed willingness to support ongoing operations at Poker provided firstly that a comprehensive Environmental Impact Study indicates that it is acceptable to do so, and secondly that Poker substantially increases efforts to mitigate those impacts that do occur. These actions are considered reasonable and likely inevitable, although associated costs will be substantial. The SRPO has begun the EIS effort, which is estimated to cost 1.2 million dollars.

Historically, Poker has had good success recovering payloads that were explicitly designed to be recovered -- although the costs are significant and success is not guaranteed. Recovery has proven far more difficult in cases (such as anomaly investigations) where the hardware was not specifically intended to be recovered. In either case, range personnel at Poker Flat have extensive experience in these activities stretching back over many years. This experience should be leveraged where possible as we move to a regime in which more hardware is recovered.

5. Update on NASA Sounding Rocket Launch Ranges for Astrophysical Flights

Summary:

The SRWG applauds the Sounding Rocket Program Office (SRPO) for its continuing efforts to return NASA standard launch operations to the Woomera Test Facility (WTF) in Australia, and the decision by NASA to consider proposals for flight opportunities there in the Fall of 2014 and Spring of 2016. The SRWG also applauds SRPO inquiries into the use of Kwajalein as an alternate launch site and the pursuit of reliable recovery options for payloads launched from Poker Flat.

Background:

The desire for increased scientific grasp through both higher apogee sounding rockets with recoverable payloads and increased sky coverage, as well as increased constraints posed by WSMR operations, has prompted renewed inquiries over the past year into the feasibility of using the sounding rocket launch ranges other than WSMR for Astrophysical payload launches. This finding summarizes the SRWG views of updates presented at the recent meeting.

Woomera Test Facility. The SRWG applauds the Sounding Rocket Program Office (SRPO) for its continuing efforts to return NASA launch operations to the Woomera Test Facility (WTF) in Australia, and the decision by NASA to consider proposals for flight opportunities there in the Fall of 2014 and Spring of 2016. We wish to underscore our interest in this range and urge that a full feasibility study and implementation plan be developed as soon as possible with a view of using the range for *standard launch operations* with permanent or quasi-permanent infrastructure. The Woomera range is unique for its full view of the southern sky, moreover, it provides access to higher apogees (increased science) with recoverable payloads and has the potential for less constrained launch operations as compared to WSMR. The less restrictive range operations may allow for high bandwidth telemetry, multiple launch windows, event triggered launches, and higher payload apogees.

Kwajalein's low latitude should result in low background for many of the astronomical detectors used in sounding rocket flights. Use of this range demands water recovery, presenting challenges to the payload both in location and flotation. We encourage the continuing research conducted by the SRPO on these technical challenges, which will applicable also to the *WFF* range.

Poker Flat: Launch of astrophysical payloads from the Poker Flat range will require a reasonably high payload recovery probability. The SRWG supports SRPO's current pursuit of a redundant method of payload tracking to compensate for the early LOS due to the elevated horizon at Poker Flat. The high latitude and restricted zenith angle, however, will prevent this site from being a viable option for some astrophysics missions.

6. New Techniques to Deploy Sub-Payloads

Summary

Proposals for missions involving multiple ejectable sub-payloads has been increasing, and that continued development of subsystems to support such missions will likely be required. It is recommended that as missions requiring sub-payload deployment are developed, NSROC use these missions to substantially increase the development and qualification of standard, deployable payload systems.

Background

A number of recent or newly-funded missions have included ejectable sub-payloads. Examples of such missions include Enstrophy, Cascades/Cascades-II, ROPA, Ampules, and ASSP. These missions all share a common theme -- the need to resolve the three dimensional spatial structure of the geophysical environment in the vicinity of the rocket trajectory. Furthermore, the SRWG notes that proposal for missions involving multiple ejectable sub-payloads has been increasing, and that continued development of subsystems to support such missions will likely be required.

Rather than have each new mission independently develop their own sub-payload form-factor, deployment system, power, telemetry, etc, it is recommended that NSROC use these missions to, over time, build up a set of re-usable standard subsystems. Furthermore, recent experience has shown that some systems developed as part of the Mesquito effort can already be adapted to support small sub-payloads. Having these capabilities available and documented will greatly assist future PIs who are considering new missions involving sub-payloads.

A common characteristic of multiple sub-payloads is considerable complexity associated with multiple replications of individual point-to-point wiring for each ejectable. This could be considerably relieved using networked communications between the parent vehicle/GSE and "smart" sub-payloads.

NASA Sounding Rocket Working Group

Dr. Robert Pfaff, Jr. (Chair and Project Scientist)
NASA/Goddard Space Flight Center

Dr. Scott Porter (Deputy Project Scientist)
NASA/Goddard Space Flight Center

Committee Members:

Dr. Scott Bailey
Virginia Polytechnic Institute and State University

Dr. James Bock
Jet Propulsion Laboratory

Dr. Mark Conde
University of Alaska

Dr. Massimiliano Galeazzi
University of Miami

Dr. Darrell Judge
University of Southern California

Dr. Mary Elizabeth Kaiser
Johns Hopkins University

Dr. Michael Kowalski
Naval Research Laboratory

Dr. Miguel Larsen
Clemson University

Dr. Kristina Lynch
Dartmouth College

Dr. Douglas Rowland
NASA/Goddard Space Flight Center