Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 20-21, 2016

Findings

1. Ensuring Critical Connections Are Made Correctly

Summary

In light of the recent vehicle failure of rocket 49.003 that resulted from an apparent swap of pyro event connectors and given that there have been several other connector swap incidents of varying consequence, the SRWG believes a review of the current processes with respect to industry best practices of avoiding swapped connectors is warranted. We urge that a low-impact solution be sought to provide increased assurance that vital connections are made correctly.

Background

With the recent vehicle failure of rocket 49.003 that resulted from an apparent swap of pyro event connectors and given that there have been several other connector swap incidents of varying consequence, the SRWG believes a review of the current processes with respect to industry best practices of avoiding swapped connectors is warranted. The consequences of swapped connectors can vary greatly, and often such errors are caught quickly and no harm is done. On the other end of the spectrum, however, the impact to both schedule and budget can be extreme if damage is done to the payload, vehicle, or instrument. It is recognized that industry understands the risks involved with the possibility of connector errors, and standard processes exist to lower the likelihood of such problems.

In industry, generally, the connector attachment processes involve extensive safe-to-mate procedures for all connectors and logging each mate/de-mate operation in a logbook. It is recognized that such actions may be efficacious in high-reliability situations such as are commonly encountered during satellite mission operations, but such a heavy-overhead system may not be tractable for an operation such as the sounding rocket enterprise where low cost and rapid operations are needed. Sounding rocket missions generally see a high number of mate/de-mate cycles, including many in the field during final integration at the launch site, and requiring that cumbersome processes be followed for these operations have the potential to drive cost and schedule. In other words, the SRWG understands that changes in these processes must be weighed against growing the cost of operations. That said, we urge that a low-impact solution be sought to provide increased assurance that vital connections are made correctly. For example, some of the low-impact solutions that could be explored to diminish the possibility of attaching incorrect connectors include:

- -- Use unique connector types
- -- Use keyed connectors
- -- Stagger harness segments strategically
- -- Use clear and unique connector numbering and marking for easy, visual confirmation of a correct mate

A small financial increase that greatly reduces or eliminates the possibility of a mistake is well worth the cost. This is particularly the case for vehicle pyro events, for which errors can be very costly. Because vehicle pyro events cannot be directly tested during sequence testing, the final, flight connections to the actual pyros are made post-sequence test, so that an error in the connection at this stage can result in mission failure. These final connections should be unmistakably clear and verifiable via safety, quality control and inspection photos. The SRWG understands that NSROC and the SRPO are already working toward a solution, and we believe that the process would benefit from a review of all connector design, selection, purchasing, usage and mating processes and procedures.

2. Mission Oversight Monitors

Summary

The SRWG is supportive of SRPO's initiative to become more involved in the management of missions. We recommend that the SRPO clarify the role of the proposed Mission Oversight Monitor (MOM) such that it emphasizes advocacy for the PI and their team.

Background

The SRPO has unveiled a new role that it has created to be executed by SRPO members during the new NSROC III contract. This role has been named Mission Oversight Monitor, or MOM for short. The role was created to increase the impact of the SRPO in management decisions and to involve the SRPO in each phase of a mission. This may allow for identification of potential issues and hurdles before they become critical issues that require decisions that must be made in short timeframes.

The SRPO envisions several duties for the MOM. First, the MOM will manage the project from the MIC to the RDM of each mission. This is a critical phase where the MOM will work with the NSROC MM to develop requirements, a mission schedule, and a mission timeline. From the RDM to DR and to MRR, the MOM will attend all meetings in an approval and "oversight" role. The MOM may also travel to the field for launch activities.

The SRWG desires clarification of these roles. First, the name Mission Oversight Monitor seems geared toward policing of a mission as opposed to assisting with the mission. A name that suggests advocacy for the scientists and the mission as a whole would be more appropriate. It was also stated that during the pre-MIC phase, the MOM will be assisting in the transfer of original proposal ideas to a MIC and ultimately requirements. It should be clear that some modifications from the proposal by the PI are allowable and expected, provided that they do not change the science thrust or scope of the mission. The MOM should not serve as a proposal referee but assist the PI in the definition of the MIC and requirements based on the most recent set of goals at the time of the MIC. The SRWG appreciates that the MOM will assist in minimizing requirement creep between the MIC and RDM.

Finally, the SRWG is concerned about the implementation and phasing-in of the MOMs. The personnel in the SRPO are already responsible for several roles and functions and we note that a number of retirements are imminent. Adequate budgetary and human resources should be identified for these efforts.

3. Serious Concerns Regarding Available Frequency Bands for Sounding Rocket Telemetry

Summary

Aware that S-band radio allocations for sounding rocket telemetry are threatened by growing demands for spectrum from commercial wireless services, the SRWG urges that steps be taken to ensure that the frequencies currently utilized by the program be preserved for scientific research under the auspices of the NASA Sounding Rocket Program. The SRWG also requests that the potential use of both X-band and C-band frequencies within NASA's rocket program be clarified, particularly as these frequencies enable the higher telemetry rates that are critical to an increasing number of missions in all science disciplines.

Background

The working group was advised that existing S-band radio allocations for sounding rocket telemetry are threatened by growing demands for spectrum from commercial wireless services. Consequently, there is a real chance that the entire band may be auctioned or otherwise made unavailable over the course of time in the U.S. and elsewhere. We note in related news that the EISCAT network of radars recently lost the protected status of its UHF frequencies, forcing the conversion of the mainland UHF radar to VHF and the attendant increase both in radar beamwidth and background noise level. The threats posed by the re-allocation of the radio spectrum in favor of commercial services is hence a real threat to scientific research.

Wallops engineers have been exploring conversion to X-band, a suitable choice for Wallops, Poker Flat, and Kwajalein, motivated by requests for ever-increasing telemetry rates. Using X-band for telemetry could be accomplished with readily available equipment and would afford a desirable increase in available bandwidth. Inquires along these lines to the National Telecommunications and Information Agency (NTIA) received a positive response. However, the SRWG learned at their January 2016 meeting that this effort has been met with resistance from NASA HQ headquarters for reasons that are unknown to the working group. This "pushback" appears to be related to X-band telemetry being reserved for cubesats but not for sounding rockets.

Another option for sounding rocket telemetry is C-band, the band already utilized by the US Department of Defense. Expanded bandwidth would also be afforded by the switch to C-band, although new telemetry systems would have to be acquired and developed.

The SRWG urges that the S-band telemetry remain intact for as long as possible, particularly since proven hardware exists for both the payloads and ground stations. We furthermore request the clarification of the situation with respect to the utilization of X-band for telemetry and the possible reclassification of this band for both cubesats and sounding rockets. In any case, a decision regarding the choice of X- or C-band for sounding rocket telemetry should be made expediently, even if its first application will be simply to provide higher rates for specific missions.

4. Evolving Situation with Black Brants

Summary

The SRWG remains concerned over the problem of combustion instability in the Black Brant motor that has had a significant impact to achieving mission success. We recognize that the SRPO is clearly "on top" of this problem, as evidenced by the efforts to remedy the problems using Black Brant Mk 4 that were presented at the recent SRWG meeting. We agree with the SRPO that development of the Peregrine alternative should be continued in parallel with efforts to improve the Black Brant motor.

Background

The SRWG remains concerned over the problem of combustion instability in the Black Brant motor. Although recent manifestations of this problem have not all resulted in mission failures, in many cases they have led to significant damage to instruments and compromise of scientific return. We recognize that the SRPO has taken appropriate measures to address this problem within available resources, as summarized at the January, 2016 SWRG meeting. Clearly, it will take some time to discover whether the Brant Mk 4 has solved the problem. In the meantime, SRPO is prudently pursuing development of the Peregrine alternative in parallel with the continued improvements with the Black Brant. The SRWG supports this approach and will continue to monitor the situation and provide feedback as appropriate.

5. Subsystem Development Activities

Summary

The SRWG was pleased to learn of the new developments of several subsystems presented by the NSROC engineering team, particularly in the area of Guidance, Navigation, and Control. Although impressed with much of the development work presented at the meeting, the SRWG has two (related) concerns: (1) we are concerned about the large number of developments (i.e., new variants) of key, well-working sub-systems that are the backbone of the program, and (2) we would like to better understand the motivation for many of the upgrades currently underway and their assigned priorities.

Background

The SRWG was pleased to learn of the new developments on several subsystems presented by the NSROC engineering team. Standard subsystems are the technical bedrock of the sounding rocket program and are crucial elements to assure that mission goals can be met reliably while keeping costs low and schedules manageable. Evolving these subsystems is important in that prudent evolution provides for a multitude of benefits, including mitigation of component obsolescence, improved performance, enhanced reliability, greater usability, reduced size/weight/power, and diminished cost. An added benefit of this type of development activity is that it provides good growth and motivation opportunities for the technical staff by presenting new and varied challenges. The SRWG is enthusiastic about such developments in general.

The presentations we received at the January, 2016 SRWG meeting made it clear that several subsystems are in the midst of substantial development cycles, and perhaps no subsystem area is evolving more than Guidance, Navigation, and Control (GNC). Although impressed with much of the development work presented at the meeting, the SRWG has two concerns:

(1) Since standard subsystems play a critical role in the overall success of the sounding rocket program, we urge that recognized "working subsystems" not be discarded until new subsystem developments are thoroughly tested and their benefits are both understood and welcomed by the user community. Furthermore, having a large number of variants of each sub-system can become a challenge to manage.

(2) We would like to better understand the motivation for many of the upgrades currently underway. In particular, the user community (represented by the SRWG) would like some input to the "big picture" planning, and how priorities are set. For example, despite poor performance on a number of missions (e.g., 36.285 and 36.297) we still do not have a suitable alternative to the Xybion aspect camera needed for telescope missions.

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. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. James Clemmons
Aerospace Corporation

Dr. Richard Collins
University of Alaska

Dr. Enectali Figueroa-Feliciano
Northwestern University

Dr. Kevin France
University of Colorado, Boulder

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Craig Kletzing
University of Iowa

Dr. Randall McEntaffer
University of Iowa

Dr. Marilia Samara
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 3-4, 2015

Findings

1. Support for continuation of the Peregrine motor development

Summary

The development of NASA's Peregrine motor remains an extremely important activity for the program to pursue to completion. The SRWG believes that NASA should fully fund the continued development of the Peregrine. Full and successful completion of a new, cost effective, motor design including manufacture and test will secure NASA's future as the premier space agency for the launch of suborbital experiments, and minimize the susceptibility to mission failure due to motor combustion instabilities that exist with other motors.

Background

The Peregrine motor was initiated through a collaboration of the Marshall Space Flight Center, the NASA Engineering and Safety Center (NESC), the Wallops Flight Facility, and NASA Headquarters. This motor was developed on the premise that it would match the performance expectations of the Black Brant, attach to the same interfaces as the Black Brant, and eventually be a government furnished design to vendors that could bid on the development and manufacture of the motor. This initiative was meant to have several positive effects for the government: training of new personnel in the design, engineering, test and verification of rocket motors; development of a stable motor with a design owned by the U.S. government; and the availability of a suitable, cost effective alternative of the Black Brant motor for future sounding rocket missions.

The Peregrine motor has faced some substantial challenges during development. Most of these challenges were associated with contractor planning and delivery. The final system was tested in a static fire test that unfortunately ejected the aft end enclosure in a destructive failure for the launch system. This aft end enclosure failure was a noted concern for the system, as an aft end design was adopted from another motor system instead of developing a new enclosure for the Peregrine. This decision was made in an attempt to save development and test funds.

Despite this setback, the Peregrine motor remains a sound concept and prudent course of action for NASA. It is the finding of the SRWG that NASA fully fund the continued development of the Peregrine. Full and successful completion of a new cost-effective motor design, manufacture and test will secure NASA's future as the premier space agency for the launch of suborbital experiments, and minimize the susceptibility to mission failure due to motor combustion instabilities. Within limited additional expense, NASA can resolve the issues associated with the Peregrine aft end enclosure and develop the next generation of small payload test vehicle launch systems.

2. Initiation of rocket campaigns at non-standard launch sites

Summary

Non-standard launch ranges and mobile "campaigns" continue to be a hallmark of the sounding rocket program, enabling unique, important scientific investigations to be carried out in a variety of locations and launch conditions for which the data can not be obtained by any other means. The SRWG recommends that the procedure to decide upon and solicit proposals at non-standard ranges be clarified such that a larger group of investigators may propose for such campaigns and that no proposals are submitted "prematurely" for remote locations that are not yet approved or deemed feasible.

Background

Remote or mobile campaigns which include sounding rocket launches at non-standard ranges represent a signature feature of the sounding rocket program, enabling important scientific investigations to be carried out that cannot readily be pursued from the program's standard launch sites, such as Wallops Island, Va., White Sands Missile Range, New Mexico, and Poker Flat, Alaska. Scientific motivations for such remote campaigns typically including specific geospace investigations at different latitudes (e.g., the magnetic equator or the high latitude cusp) where the upper atmosphere and available sources of energy may differ significantly, astrophysical observations of southern hemisphere targets, launches in conjunction with powerful ground-based assets such as NSF's Arecibo Observatory, and ranges that provide unique locations for celestial events (e.g., launches in the path of totality of solar eclipses).

During the 50+ year history of NASA's sounding rocket program, numerous remote campaigns have been carried out at sites all over the world, including, but not limited to, sites located in Peru, Australia, Puerto Rico, India, Brazil, Argentina, Spain, Michigan, Greenland, Hawaii, Antarctica, and numerous remote sites in Canada. These locations were selected on the basis of input from the science community who articulate science drivers and candidate investigations in discussions with both NASA HQ and the Wallops Flight Facility. This input typically takes the form of workshop reports and other informal means of communication. Eventually, campaigns that are deemed feasible are encouraged by both NASA HQ and the Wallops Sounding Rocket Program Office (SRPO) after which individual proposals are then tenured and evaluated via the standard peer review process.

It should be noted that the remote sites may have special logistical, financial, and political aspects, and, in some cases, a high degree of flexibility is required for remote campaigns to succeed. Indeed, despite the best planning, in some cases, launch dates might need to be adjusted to accommodate unforeseen circumstances. Furthermore, in some cases, a "Campaign Scientist", who is typically one of the selected P.I.'s, is designated as the point of contact to lead the effort to help articulate the importance of, and potential science return from, the remote site campaign.

Despite their popularity and scientific advantages, at present, there are no well-established procedures for the initiation of such remote campaigns within the framework of NASA's sounding rocket program. The SRWG notes that the community is not well-served when PIs have insufficient advance warning to respond to opportunities to participate in remote campaigns, particularly campaigns that may not be publicized in the NASA Announcements of Opportunity. Further, the development of individual science investigations predicated on the availability of a given remote location is a waste of resources should the remote location turn out not to be available and the submitted proposals end up being disqualified without a detailed review. Although some uncertainty is inevitable, the effectiveness of the program overall would benefit from clearer procedures and signaling regarding remote campaign planning and projections.

The SRWG suggests that both NASA HQ and Wallops publicize their most up-to-date plans for remote campaigns in advance of the ROSES AO deadlines. Candidate sites for launches during the upcoming 3-5 years may be provided for which proposals may be submitted. The plans would be considered tentative and non-binding and would be in keeping with the ROSES AO instructions. The chief goal is to optimize the community awareness and streamline its participation in remote campaigns, as well as to prevent the generation and receipt of implausible sounding rocket proposals.

3. Continued interest in very high telemetry rates

Summary

Very high telemetry rates continue to provide exceptional scientific advantages for a wide variety of sounding rocket investigations that are not routinely available on any other experimental space platform. In a continuation of previous findings on this subject, the SRWG reiterates its enthusiasm for both very high telemetry rates via X-band and the inclusion of high capacity data recorders on recoverable flights.

Background

As sounding rocket instruments increase in complexity and resolution, the rate of data collection grows proportionately. Consequently, the scientific return of the rocket program cannot grow without major increases in telemetry bandwidth and data storage. The SRWG has been monitoring developments that would address this critical need. In particular:

(1) A commercial high speed, high capacity data recorder was under test by the program until the sole unit was destroyed in a mission mishap. It is our understanding that the program lacks funding for a replacement unit. The SRWG understands the concern over high unit cost, and we recognize that program resources are thin. However, we urge the SRPO to resume the data recorder effort or pursue a lower cost alternative. We note that PIs commonly develop their own onboard data storage capability out of necessity, using science funding. Repeatedly reinventing the wheel is not a good use of NASA funds. Moreover, it is possible that the elements of a good technical solution are available from the community. We urge Wallops to discuss such possibilities with cognizant

experimentalists.

(2) The program has been pursuing the adoption of an X-Band science telemetry system. We see this approach as an excellent fit both to experimenter needs and to existing range infrastructure. However, we are concerned by initial indications that NASA officials may decline to allocate the necessary bandwidth for sounding rocket usage. The committee urges NASA to authorize the use of X-band TM for sounding rockets on a non-interference basis.

4. Water recovery of high altitude, telescope payloads

Summary

The SRWG continues to encourage in the strongest terms the development of technologies for the water recovery of telescope payloads launched to high altitudes (400 km or greater.) The SRWG recommends the establishment of a water based recovery sub-committee consisting with members drawn from the SRWG, SRPO, NSROC, and the broader rocket community, to assist in defining technology developments in this area.

Background

The SRWG continues to encourage the development of technologies for recovering high altitude (> 400 km apogee) telescope payloads launched over water. Development of capabilities for telescope payload recovery in and over water is a necessary precursor effort towards routine access to new science targets, longer observation times, and long, low altitude trajectories. There are no landlocked launch ranges that can support long duration, recoverable experiments. Furthermore, recovery technologies have not been adequately developed for ranges that launch over water and could potentially support these high altitude missions. Studies of new hardware such as a hermetic shutter door design and gas pressurization systems can provide immediate incremental developments that would be beneficial to missions in the near future. Ultimately, however, it would be preferable to have a recovery system that does not expose the experiment or payload critical subsystems (e.g., ACS, telemetry) to water at all. Towards this end, we also recommend the investigation of powered paragliders and high altitude lifting bodies that can be flown to an offshore platform, or even back to land, as alternatives to water recovery.

Developments in payload recovery in and over water will enable “game-changing” science opportunities for the astrophysics and solar sounding rocket communities. For astrophysics, these developments will provide not only increased observation time, but access to unique targets located in the southern hemisphere. Currently, NASA has no capability to routinely launch south of the equator which severely limits science potential. For solar experiments, water based recovery is necessary to support investigations from next generation launch vehicles that can supply more than 10 minutes of exo-atmospheric observation, enabling the study of transient behavior tied to the 5 minute solar oscillation cycle. We also note that whereas water recovery has been successfully used for geospace payloads with limited ranges, this discipline could also benefit from water recovery for higher altitude rockets and those with tailored, long range, low altitude trajectories.

We appreciate the detailed studies performed by NSROC examining the potential increase in observing time provided by BBXI and BXII launches of a typical astrophysics payload outfitted to survive water recovery. The information provided was detailed, useful and sobering. The increase in time above 150 km from 337 seconds on a BBIX to 420 seconds on a BBXI, and to 475 seconds on a BBXII was found to be incremental. As such, SRWG recommends a study be undertaken to identify an advanced vehicle option to enable the game-changing science opportunities in astrophysics and solar as mentioned above. A delivery system capable of providing a factor-of-two gain in exo-atmospheric exposure time currently offered by a BBIX will be transformative for astrophysics. Moreover, such a system will also capture the time domain science necessary for key advancements in solar and can be used for long, low trajectory missions in support of geospace science. We encourage SRPO and NSROC to consider new vehicles or combinations of existing vehicles to fulfill the community's science requirements for longer duration recoverable experiments.

In addition to BBXI and BBXII payload studies, we urge continued discussion of water recovery for BBIX payloads both to enable new astronomical targets and as a stepping stone to recovery of payloads launched on advanced vehicles. This is a very important point as recovery of BBIX payloads from launch ranges such as Kwajalein (latitude = 9° N) enables partial access to the southern skies. This opens up a huge selection of astronomical targets that are unavailable from the standard ranges of WSMR, WFF, and Poker Flat, all of which are at latitudes northward of 30° N. Included in the deep southern sky are the nearest neighbor galaxies to the Milky Way (the Magellanic Clouds) and the nearest exoplanetary system (orbiting α Cen B); access to the southern hemisphere not only increases the number of available astronomical targets, but includes unique objects that cannot be accessed from standard northern launch sites. The impetus for water recovery enabling southern launch opportunities has increased with the delay and uncertainty in the Australia campaign. Water recovery of BBIXs from Kwajalein (possibly as part of the planned 2017 campaign) would enable new science objectives while concurrently testing key technologies such as a new shutter door and on-board experiment pressurization for future water recovery, acting as a stepping stone to recovery of payloads launched on advanced vehicles. We note a new shutter door design should not compromise aperture open area and gas pressurization systems must operate at ultra-high purity (both the gas and the delivery system). We also note that it may be cost effective to test both the BBIX and other Black Brant configurations such as the XI or XII at a more capable, potentially lower cost, launch site such as PMRF (Kauai) on an as-needed basis.

Recovery in water does come with its risks, however, and the eventual goal would be to develop a system that does not expose the payload. Critical subsystems such as the ACS, telemetry, and guidance are costly to replace, while experimenters are reluctant to drop expensive instrumentation into the ocean. Development of controlled descent mechanisms could remove these risks. Powered, shaped parachutes allow for tailored flight paths of the descending payload so that it can be flown to an autonomous recovery vehicle, an offshore platform, into the snare of an airplane, or even onto land. These approaches offer the developmental advantage of incorporation into existing BBIX payload systems designed for land-based recovery, reducing developmental risk. Such systems could also serve as an alternative to helicopter recovery at WSMR.

To help consolidate these efforts, SRWG recommends the establishment of a water based recovery subcommittee consisting with members drawn from the SRWG, SRPO, NSROC, and the broader rocket community, to assist in defining technology developments in this area.

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. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. James Clemmons
Aerospace Corporation

Dr. Richard Collins
University of Alaska

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Kevin France
University of Colorado, Boulder

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Craig Kletzing
University of Iowa

Dr. Randall McEntaffer
University of Iowa

Dr. Marilia Samara
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 14/15, 2015

Findings

1. Technology Roadmap Progress and Next Steps

Summary

The SRWG applauds the revitalized New Technology Roadmap for sounding rockets and was pleased to be briefed on the ongoing and planned efforts along these lines. Infusion and development of new technologies into the program are important for its future and represent an appropriate and necessary investment of resources. The SRWG is interested in ensuring that these investments provide maximum benefit to the program, and suggests implementing methods by which a broader base of stakeholders would be involved in guiding the Roadmap. As a step in this direction, the SRWG endorses obtaining broader input by extending the SRWG meeting by adding a session to which the larger community would be invited to discuss new technology ideas.

Background

There is a strong consensus, both in the Sounding Rocket Program Office (SRPO) and the Sounding Rocket Working Group (SRWG), that the sounding rocket program should pursue highly innovative technologies that would enable major scientific advances across multiple disciplines. While we also applaud the flexibility that has allowed the program to address mission-driven technology, we mutually agree that a longterm plan and priorities are necessary to provide optimum benefit to all stakeholders. As a strategic implement, we applaud the technology development roadmap managed by the SRPO, which helps to frame a deeper interaction between SRPO and SRWG over technology priorities for the sounding rocket program. The working group looks forward to establishing a dedicated time for discussion of tech development priorities in subsequent meetings. We suggest in conjunction with our next meeting that we hold a technology development discussion with open community participation.

2. Water Recovery -- Next Steps

Summary

The Sounding Rocket Working Group continues to emphasize that establishing routine water recovery of telescope payloads should be a priority in the technology development area. Three major science advantages afforded by expanded water recovery capabilities for astrophysical payloads are: 1) longer flight times, 2) coverage of a wider swath of the celestial sky with access to southern hemisphere and equatorial targets, and 3) payload and data recovery with high telemetry. The SRWG will establish a sub-committee to work directly with Wallops on this issue.

Background

The Sounding Rocket Working Group continues to emphasize that establishing routine water recovery of telescope payloads should be a priority in the technology development area. Three major science advantages afforded by expanded water recovery capabilities for astrophysical payloads are: 1) longer flight times, 2) coverage of a wider swath of the celestial sky with access to southern hemisphere and equatorial targets, and 3) payload and data recovery with high telemetry. These are discussed below:

1) The ultimate limitation on the science production from most astrophysics rockets is the number of photons collected per flight. For most astrophysics rockets, the number of photons collected is directly proportional to the time above 150 km. The larger vehicles that can be launched from water sites (BB XI and BB XII vs. BB IX that can be accommodated at the White Sands Missile Range (WSMR)) can deliver up to ~twice the total exposure time of a ground-recoverable payload. This impacts both the quality of any given measurement, and more importantly, the types of investigations that can be undertaken from a rocket platform. This manifests in two ways: a) enough photons can be collected in a single flight to address a given science goal and b) the opportunity to observe several celestial targets in a given flight. Comparative observations open a fundamentally new science capability from a rocket platform.

2) One major limitation with all launches from WFF, WSMR, and Poker Flat (the available standard astronomical launch sites) is that they are at > +30˚ N latitude. From that location, one cannot observe crucial and unique celestial objects in the southern sky. For example, many astrophysics investigations would benefit from observations of the Magellanic Clouds, and these galaxies cannot be viewed from WSMR. By gaining access to the southern sky, the astrophysical community would gain access to a whole new set of potential science targets, greatly expanding the scope of the science investigations that could be carried out from a rocket platform.

From this perspective, Kwajalein (+9˚) would be advantageous because it would open up more of the southern sky to astrophysics observations. Kauai would also extend southern hemisphere coverage relative to WSMR and would enable longer-duration flights if water recovery were available. While Kauai (+22˚) is not as far south as Kwajalein or Peru, if there were other programmatic reasons to launch from this site (such as cost), then this opportunity should be investigated. High-altitude launches with water recovery from WFF would allow one to get more observing time (item #1), but does not offer any significant gains in sky coverage over WSMR. The committee also discussed the possibility of exploring joint astrophysics and space sciences missions out of Punta Lobos, Peru, (–12.5˚), which would open up most of the southern sky and for which water recovery was successfully carried out of NASA geospace payloads in 1983. All of these launch sites become available for expensive telescope payloads once water recovery has a sufficiently high probability of success.

The SRWG will respond to NSROC's request for input regarding the optimal water recovery site parameters and will convene a subcommittee to study this issue in collaboration with NSROC and the broader sounding rocket community.

3) As suborbital payloads fly larger format and higher data rate sensors, on board storage (for data rates greater than 50 Mbps) is becoming critical. The water recovery system would enable the recovery of the primary science data from missions launched out of any of the coastal sites. In addition, this would allow the science payloads themselves to be recovered. With an estimated water recovery cost of $275K per flight, it will often be financially advantageous to invest this money in the water recovery as opposed to re-building a payload that has been lost to a water landing.

The SRWG's initial recommendation would be for a high-altitude launch site with water-recovery in the north (e.g., WFF), one near the equator (e.g., Kwajalein, Peru, or Kauai), and one in the south (below ~-30˚ S). This would provide a fundamentally new science capability from sounding rockets. The subcommittee on water recovery will develop a series of crucial advantages for different disciplines within the sounding rocket community and produce a justification for the development of a key new capability for the NASA sounding rocket program.

3. Range Opportunities for New Missions

Summary

The SRWG appreciates the campaign operations planning presented/initiated by the SRPO and inclusion of tentatively planned launch sites in the Wallops report. Several questions have been raised, however, regarding how the process of ongoing range selection should work and how the available ranges to which one might propose are communicated to the community. The SRWG eagerly seeks ways to best advise the SRPO on science-driven reasons to consider new ranges as well as means to communicate which ranges are available to the community for new proposals each year.

Background

The SRWG appreciates the campaign operations planning presented/initiated by the SRPO and inclusion of tentatively planned launch sites in the Wallops report. Several questions have been raised, however, regarding how the process of ongoing range selection should work and how the available ranges to which one might propose are communicated to the community. These questions are outlined below. In general, the SRWG seeks ways to best advise the SRPO and contribute to the optimum prioritization for range availability in a given year. While the ROSES AO pertaining to sounding rockets typically includes language that allows the possibility of a number of launch sites, the steps that guide these decisions should be clarified.

1. How does the community provide input in the decision process to determine which range sites might be available in a given year and how are the final decisions made? How do campaign ideas become real campaigns?

2. What is the most effective way for the communication of availability (including large scale campaigns from a non-standard location) of that information between HQ and the science community? It would be beneficial to have a clearer picture of which range(s) might be supported each year and ensuring that the ROSES AO has timely and accurate material each year.

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. Matthew Beasley
Planetary Resources, Inc.

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. James Clemmons
Aerospace Corporation

Dr. Richard Collins
University of Alaska

(list continues on next page)

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Kevin France
University of Colorado, Boulder

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Craig Kletzing
University of Iowa

Dr. Marilia Samara
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of July 1, 2014

Findings

1. Proposed New PI Reporting Policy

Summary

The Sounding Rocket working Group (SRWG) was briefed on a proposal to initiate a standardized "Low Cost Access to Space Technical Reporting Policy" for sounding rockets, balloons, cubesats, ISS payloads, and suborbital reusable launch vehicles. The SRWG suggests an alternative, less burdensome process be applied to sounding rocket missions (outlined below), since in-depth project information is already provided to NASA HQ, required financial reporting is already monitored by the Grants office, and the Sounding Rocket Program Office already includes numerous reviews in its highly acclaimed management of the program at Wallops.

Background and Alternative Proposal

At the July, 2014 Sounding Rocket Working Group (SRWG) meeting, a presentation was made regarding a proposed "Low Cost Access to Space (LCAS) Technical Reporting Policy." Although it was stated that this policy is "not to add any onerous or costly reporting requirements", in fact, it could indeed encumber the P.I. by adding numerous plans, reports, and reviews to the already significant number of technical meetings and reviews at Wallops, including the Mission Initiation Conference, Requirements Definition Meeting, Design Review, and Mission Readiness Review, as well as his/her required, periodic reporting to the Grants office necessary to receive and disseminate funds to the science team(s). Additional, proposed new reviews outlined in the presentation to the SRWG include: Project Plan, Quad Chart, Interim Review, Confirmation Review, Annual Review (every 12 months) and a Final Review.

The SRWG understands the need for close communications between the HQ program scientist and the payload teams in assessing progress, milestone completions, scheduling, and payload manifests. However, we are concerned that adding more reviews and "long-form" information will further burden the payload teams and may not provide the concise and timely information that the Program Scientist needs. Rather, the SRWG believes that the review system already in place works exceedingly well, as has been underscored by numerous panels that have reviewed the program over the years. In order to provide information more readily to NASA HQ, we propose an alternative that would be less burdensome and, we believe, provide much easier access to the status of the mission from the P.I. perspective.

The SRWG notes that detailed or "long-form" payload information is already available to NASA HQ through material provided by the P.I. and payload team via: 1) the mission proposal, 2) the Mission Initiation Conference, 3) the Requirements Definition Meeting material, and 4) the Design Review. However, this material is not very condensed and could be difficult for the Program Scientist to parse for a quick status update across his/her portfolio. Thus we propose that each PI submit to the Program Scientist a summary package at the beginning of the mission, consisting of: 1) a single slide summarizing the payload science, instrument status, and condensed milestones, 2) a top level schedule including technology milestones, and 3) notes on any technical issues and tall poles. Such a "short-form" presentation provides a concise resource that the Program Scientist might use to consolidate payload information and status across their portfolio. We further propose that an update of this material be provided at the time of the Design Review. At that time (or at any other time, if necessary), if there is an indication from Wallops that a payload is having trouble meeting its technical and schedule milestones, then NASA HQ could, in turn, request subsequent in-depth, supporting material including additional reviews. In this manner, the burden to provide more detailed information is concentrated on only those payloads that are having difficulty and levies only a light burden on missions that are proceeding on-track.

2. Delays in funding Sounding Rocket Principal Investigators

Summary

The length of time taken to establish new grants to transfer funds from NASA HQ to the science P.I. institutions is considerably greater now, with the new centralized NASA grants system, compared to past procedures where P.I. funding was administered directly by Wallops Code 810. Although the length of time to establish the grants varies among institutions, several investigators have experienced lengthy delays impacting the start of project initiation and design activities with the NASA SRPO and NSROC. In turn, these delays can be detrimental to maintaining the expedient schedules which all agree are at the core of a successful sounding rocket program. Testimonials presented at the SRWG meeting illustrated how the new system requires seemingly inordinate amounts of information typically used for high dollar NASA contracts involving satellite flight programs and are not in keeping with the spirit or practice of low cost, quick turn-around, P.I.-led, sounding rocket projects.

Background

During the past several years, NASA has shifted the management of the distribution of sounding rocket P.I. funding to a centralized grants process administered at the NASA Shared Services Center (NSSC) at Stennis Space Center. Since NSSC began overseeing sounding rocket P.I. grants, investigators have been required to supply ever greater amounts of paperwork and engage in lengthy negotiations and question-and-answer periods with NSSC. Beginning new grants has been especially problematic, and delays in getting the grants established have led to pushing back at least one RDM (Requirements Definition Meeting) significantly. Delays have stretched into the summer, for new starts announced near the beginning of the year, while not changing any period-of-performance dates or report due dates. Thus the first year of performance can be as short as six months. Beyond the usual types of certifications, examples of the information now being required before a grant is put into place include:

• An itemization and basis of cost for all supplies and materials (quotes, bids, email quotes, invoices, catalog price pages, etc.) by year.
• Institutional government Rate Agreement as per the latest government audit report.
• Description of what will be shipped as well as shipping details -- to/from, via what method, and copy of the quote, bid, or old invoice.
• The purpose, departure/destination, mode of travel, number of travelers, number of days, per diem and any other pertinent expense such as registrations and rental cars for all domestic travel (each trip for each year).
• Miscellaneous supplies/materials amount breakout.

These negotiations seem more appropriate for complex government contracts having many deliverables and milestones than for simple grants which have reports as their only deliverables. In other words, a one-size-fits-all approach seems to be taken by NSSC despite the fact that much of the information required seems to be irrelevant to the grant as a funding vehicle for sounding rocket investigations. The SRWG is concerned that the process employed by NSSC will divert the attention of PIs and science teams, leading to a detrimental impact on science and schedules, as well as adding cost. Further, most sounding rocket investigations (particularly for Geospace) include co-investigators at other institutions who require substantial funding which now must be distributed by the P.I. institution on the same rapid schedules required to keep the program on track. (Previously, co-I science teams received their funding from Code 810 in grants separate from that of the Principal Investigator, not only expediting the funding, but eliminating possible overhead charges by the P.I. institution in their administration of co-investigator funding.)

The SRWG urges management to take a fresh look at the new procedures to send funding to rocket P.I.'s as well as co-I's at other institutions. We urge Wallops to either return to the previous process in which Code 810 administered the funding directly to the science teams or to establish new guidelines within the NSSC appropriate for sounding rocket investigations, ensuring the timely dissemination of funding to the P.I. teams, without undue paperwork and lengthy negotiations which are not in keeping with the spirit or practice of low cost, quick turn-around, P.I.-led, science investigations.

3. New Technology Roadmap

Summary

The SRWG appreciates the “higher fidelity” new technology roadmap presented by the SRPO including the division of projects within these categories: (a) science-driven, (b) SRPO/NSROC initiated, and (c) obsolescent-driven. With respect to the science-driven new technology projects, the SRWG seeks ways to best advise the SRPO and influence the prioritization of these activities undertaken by the SRPO. We also wish to find mechanisms to augment community involvement and make sure users are aware of new developments so that they may be used in future proposals.

Background

The New Technology Roadmap developed by the SRPO in conjunction with the SRWG is an excellent way to keep an eye on future needs and emerging capabilities that can benefit the sounding rocket community. We recognize that these ideas could be further delineated by their scope (some are “big ticket items” while others are modest or even small in comparison) and by whether the path to their successful development is anticipated to be relatively short and straightforward or, in some cases, lengthy and uncertain.

With respect to the science-driven new technology projects, the SRWG would like further insight into the decision process, and general resources needed, to pursue and achieve the various new technology goals. We recognize that some initiatives are led by specific, approved investigations, such as the rocket propelled sub-payload ejection mechanisms, for which NASA HQ provided specific technology development funding to one geospace P.I. team, and from which many groups have since benefited. Other initiatives, such as water recovery for high altitude telescope payloads, may require a more concentrated effort in both time and resources. Still other science-driven ideas such as the small mesospheric sounding rocket payload, have remained dormant and, in fact, are no longer listed on the roadmap.

In the past, the SRWG has provided sub-committees to assist the SRPO new technology group (e.g., for the sub-payload design work and on-board data storage development). We would like to continue in this role, but expand our involvement to advise and influence the prioritization of the science-driven new technology activities considered by the SRPO. We look forward to discussing how to best streamline the process and ensure user input to top level decisions related to these exciting new technology initiatives.

Finally, the SRWG seeks to find mechanisms to augment community involvement (outside the SRWG) in the new technology being developed by the SRPO at Wallops to allow an “on ramp” for new ideas and needs. In addition, we want to make sure that all users are aware of the successful new developments so that they may be used in future proposals.

4. Renewed Urgency for Water Recovery Systems

Summary

The sounding rocket astrophysics community remains very interested in having access to the southern hemisphere sky on a routine basis as well as establishing routine means to launch telescope payloads to higher altitudes than are permitted at the White Sands Missile Range. Over the past many years, the SRWG believed that routine southern hemisphere observations could be accomplished by a semi-permanent presence with annual launch activities in Woomera, Australia. However, we now understand that this is not realistic based on costs and restricted availability of the Woomera facility. The SRWG is encouraged that the Sounding Rocket Program Office is pursuing Kwajalein as a routine range and that water recovery of reusable payloads is a real possibility there. The SRWG urges that a concentrated effort to develop technology and operational plans to make water recovery of telescope payloads at Kwajalein and other ranges (such as Wallops) truly available. We strongly encourage the SRPO and NSROC to develop a water recovery strategy and test flight not just for BB IX missions, but for high altitude BB XI and BB XII missions as well.

Background

Many modern payloads, especially in Astrophysics and Solar Physics, are highly complex, expensive, and are usually flown multiple times. An example is the XQC payload that has flown 7 times. These payloads are recovered, often enhanced, and re-flown, dramatically increasing their scientific yield. However, until recently, recovery from BBIX vehicles was only really possible at WSMR. Recently, the SRPO and NSROC have developed new logistical scenarios that allow payload recovery at Poker, and new water flotation technology that allows for recovery from WFF. These are essential new developments that promise to allow new missions, new observing strategies, and hopefully lower range costs and logistics. Note that the advent of such water recovery systems will not displace the need to fly some payloads from WSMR particularly those requiring low particle backgrounds. However, having choices and options may reduce the pressure at WSMR (and their associated costs) and will provide critical access to the southern hemisphere sky on a routine basis. These are essential and necessary first steps in expanding range options for recovered payloads, and the SRWG heartily applauds this effort! However, we need to go further.

The SRWG believes that extensive water recovery efforts are needed to allow recovered BBIX launches from Kwajalein that would actually be a viable alternative to WSMR for low background missions while also providing some access to the southern hemisphere sky. In addition, the development of high-speed recovery systems for BBXI and BBXII would dramatically increase the science yield per launch and open up new science investigations not currently possible on a BBIX. The recent non-recoverable, end-of-life, flight of the CIBER astrophysics payload on a BBXII rocket from Wallops is a good example of this. The SRWG looks forward to sustained investment and development of recovery systems and recovery logistics that will open more ranges, and higher performance vehicles for recovered payloads. We strongly encourage the SRPO and NSROC to develop a roadmap, with development milestones, to make water recovery of high altitude rockets at Kwajalein and Wallops a reality.

5. Concern about new procedures to enforce workplace safety

Summary

The SRWG is supportive of NASA's and WFF's goals of increasing workplace safety and mission assurance. However, both the SRWG and several non-committee community members are concerned that restrictive regulations on basic experiment operations have the potential to cause increased costs, schedule delays, and potentially to degrade the performance of the primary science instruments. The SRWG suggests increased and earlier communication from WFF and range personnel on changing safety regulations, WFF common-sense oversight on restrictive policies that could damage the low-cost/increased-risk sounding rocket operating principle, and implementation of a waiver process that relies on judgment and legacy systems that worked incident-free on many previous occasions.

Background

The SRPO, SRWG, and members of the rocket community have recently experienced increased safety oversight and new regulations from both WFF and remote launch range personnel. Although we recognize that the ability to accept increased experimental risk in the Sounding Rocket Program is distinct from concerns about safety (which should never be compromised), there is growing concern that these safety restrictions are being applied arbitrarily, sometimes very late in the mission timelines (e.g., < 6 months prior to launch). Notable instances are those related to cryogenics, payload pressure systems (e.g., payload evacuation and 'return to air' procedures), and lab calibration systems.

Many sounding rocket experiments include evacuated payloads where the cycle of 'pump down' and 'return to air' is a common part of the integration and launch exercises. Recently, safety officers from WFF, WSMR, and WSTF have started requiring multiple relief valves for standard low-pressure (~20 psi) low-pressure activities such as these. Most pressure regulators have internal relief valves, but for reasons that were not clearly identified to the experimenters, these safety systems were insufficient and additional valves were required. It is not clear that it is the prerogative of safety officers to regulate how carefully an experiment team backfills its payload. Additionally, the suggested additional hardware would have cost the experiment team several thousand dollars.

There is some concern on the SRWG that this may be a growing problem that will add risks to science payloads (and therefore compromise mission science success) and schedule adherence. Most suggestions relating to returning payloads to air impose much longer exposures to ambient conditions. Many payloads employ sensors or optical coatings that have very strict environmental requirements: as much as an extra hour or two exposed to the high-humidity environment of WFF can significantly degrade instrument performance. The SRWG suggests increased and earlier communication from WFF and range personnel on changing safety regulations, WFF common-sense oversight on restrictive policies that could damage the low-cost/increased-risk sounding rocket operating principle, and implementation of a waiver process that relies on judgment and legacy systems that worked incident-free on many previous occasions.

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. Matthew Beasley
Planetary Resources, Inc.

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. James Clemmons
Aerospace Corporation

Dr. Richard Collins
University of Alaska

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Kevin France
University of Colorado, Boulder

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Craig Kletzing
University of Iowa

Dr. Marilia Samara
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 21, 2014

Findings

1. Sounding Rocket Data Policy

Summary

The SRWG is in agreement with NASA's stated goal of making all sounding rocket data available to the public. We caution, however, that the resources necessary to make that data available can be significant and that any new requirements on the science team must factor in the need for those resources. Requiring that only high level data products be made available greatly reduces the burden on the PI.

Background

It is appropriate that all observations obtained through NASA-funded projects be made available to the general public. While the main observations are normally published in the literature, digital copies of the data made available by internet to other researchers and interested parties can increase the scientific impact of those observations. The SRWG is, in general, supportive of this activity.

It is often the case that observations from instruments flown on sounding rockets, as with many other sensors, require very mission-specific algorithms and tools to interpret the observations. While the ultimate published data products generally represent a scientific quantities in common units, the low level data products may not. In addition, procedures to apply calibration data, account for different environmental conditions between flight and ground, account for background signals, or address numerous other possible effects on the observations require instrument-specific knowledge that is not easily documented such that the general public or other researchers can apply those procedures. Therefore, any requirement for the PI to provide low level data, must be accompanied by resources to produce that documentation and make the data available.

A more straightforward approach and less costly would be to require the PI to provide only high level data products. This approach greatly reduces the burden on the PI and yet should allow other researchers to reproduce any published analysis. There is still some cost, as time and labor are required to format the data, provide documentation, make it available, and to answer any questions, but the costs are significantly lower than for providing all levels of data products.

2. Towards a science-driven range development roadmap

Summary

The SRWG finds that a "range development roadmap" would be valuable in optimizing the science return of the rocket program. Showing how the rocket program would develop and extend range capability in response to science requirements over the next decade, such a roadmap could be developed by the SRPO in conjunction with input from the SRWG and the larger sounding rocket user community. With the development of new range opportunities, the SRWG finds it essential that the rocket community be informed of which ranges are available when calls for proposals are issued.

Background

One of the defining traits of the sounding rocket program is its ability to utilize multiple launch ranges around the world, adapting to evolving science targets by utilizing new launch ranges, and existing ranges in new ways. Such range utilization over the past decade has had some strong successes (development of Kwajalein as a sustainable option, initiation of the Woomera planning, telescope payloads from Poker and Wallops, tailored trajectories (e.g. HEX), 5 simultaneous launches (e.g., ATREX)). Continued progress in this area will keep the program engaged with the cutting-edge needs of the science community.

A list of potential science investigations that would drive a range development roadmap is put forth here as examples. This list is based on conversations at recent SRWG meetings, but should not be construed as a complete list of inputs from the science community.

a) Continue Woomera (Australia) development as a “sustainable” range with launches every 5-10 years instead of once every 20-30 years. [See Finding #3, below.]
b) Develop southward launch capability from Kwaj. Target is BB XI or larger vehicles. First southern Kwaj launch capability desired by 2017.
c) Develop "high and short" trajectory capability in auroral zone to enable rockets with high apogees (> 500 km) closer to the rocket range. Some combination of guidance, ACS-assisted dispersion reduction, flying FTS, etc., is expected to be required.
d) Develop high latitude, "non-standard" range with eastward or westward trajectories to enable auroral zone “skimming” capability – e.g., from Ft. Churchill, Canada.
e) Develop routine launch capability for medium scale payloads (single stage and two-stage Brants) from Peru, Brazil, and Puerto Rico, as well as for small payloads (150 km apogees of less) from these locations with a minimum of infrastructure needed to support these launches.

As part of the range roadmap, SRWG and the community would like to be involved in the discussion of which ranges are available in any given year, including planning across multiple years. Often, the community learns about the availability of a range only when the ROSES call for proposals is issued by NASA HQ. This is not optimal for the purposes of planning new experiments. Part of the range roadmap should be a nominal plan in which the availability of ranges in a given year is outlined.

3. Establishing Woomera as a "Routine" Rocket Range

Summary

The SRWG reiterates its strong support for establishing Woomera (Australia) as a rocket range where NASA sounding rocket missions may be carried out on a routine basis. Scientific experiments enabled by access to the southern hemisphere are very compelling for the astrophysics and geospace disciplines.

Background

The SRWG has expressed its support on numerous occasions for a permanent range in the Southern Hemisphere with land recovery, such as that provided by the Woomera rocket range in Australia. Access to such a rocket range would facilitate, in particular, astrophysics sounding rocket launches to provide coverage of the southern hemisphere sky -- for example, to provide viewing access of the Magellanic Clouds. We appreciate the continued efforts of the SRPO to re-establish its capabilities to launch and recover sounding rocket payloads from Woomera. Despite the new constraints communicated to us at the last meeting, such as those involving local mining operations and issues with high altitude vehicles, such as the Black Brant IX needed for most solar and astrophysics payloads, we urge the SRPO to maintain their dedication to working out these challenges, with the ultimate goal of facilitating routine sounding rocket launches at the Woomera range.

With respect to the fact that the area has significant mining in place, we acknowledge that a short launch season would be acceptable if Woomera launches were routine. In other words, there wouldn't be a great need to launch a large number of rockets in a short, two week window, as smaller groups would be able to go more often. In this manner, the rocket launch activities could develop a compatible schedule with that of the mining activities.

Finally, we note that the Southern Hemisphere is also a favorable location for geospace missions. Of particular interest are missions addressing science in the mesosphere/lower thermosphere and ionosphere. The unique geometry of the Earth's magnetic field in the Southern Hemisphere as well as features of orographic content and meteorological phenomena that are found only in this part of the world, provide for investigations that can only be performed by going to a Southern Hemisphere, mid-latitude site such as Woomera.

4. Revisiting the Technology Roadmap

Summary

The SRWG applauds the development of new technology in many areas that has been presented to the committee in recent meetings. At this juncture, we suggest that the technology roadmap be reviewed and updated, in light of both the recent technology developments but also the current science-driven new technology requests. The SRWG looks forward to providing input regarding user priorities on small, medium, and large technology efforts.

Background

At the SRWG meeting, the committee heard presentations on a number of technology development items. For example:

Sub-payload technology. Significant development effort is being directed to the specific sub-payload deployments for two upcoming missions, with this development likely to benefit future sub-payload deployments as well. In addition, higher telemetry bandwidths and the transmission of GPS information between sub-payloads are actively being developed. Indeed, much of this sub-payload technology will soon be verified by the series of upcoming Sub-TEC flights.

On board memory. Large digital memory is being developed, which, if verified as robust and chosen as a "standard" payload item, quite a bit of (often duplicated) effort could be removed from the experimenters' side. Reliance upon the storage of large amounts of flight data on these onboard units will increase the desires for successful location and recovery of the payloads.

Star tracker developments. The split skin and the side-deployed star tracker also seemed like useful capabilities to have in the array of available features.

We applaud the above developments and hope that they will be successfully deployed in the field. Several of these correspond to items identified in the previously distributed technology development roadmap. Other elements of that roadmap have yet to be addressed. The SRWG would welcome an opportunity to revisit and update the technology roadmap. Fully aware that some of the community's development requests require significant resources, we would nevertheless especially like to know where things stand regarding higher altitude flights and technology development for high altitude water recovery. We look forward to an opportunity to provide user-based priorities for small, medium, and large technology development efforts.

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. Matthew Beasley
Planetary Resources, Inc.

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Keith Gendreau
NASA/Goddard Space Flight Center

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Miguel Larsen
Clemson University

Dr. Kristina Lynch
Dartmouth College

Dr. Scott Robertson
University of Colorado, Boulder

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 11, 2013

Findings

1. Strong Concern Regarding Program Vitality (Letter sent to NASA HQ)

The SRWG wrote a letter to NASA Headquarters (Dr. V. Elsbernd, Director, Acting, Heliophysics Division) expressing our strong concern regarding the impact of the projected funding profile for NASA's sounding rocket program. A copy of this letter is included in the Appendix of these Findings.

2. Establishing Kwajalein and Woomera as "Routine" Rocket Ranges

Summary

The SRWG applauds Wallops for their very successful rocket campaign in Kwajalein carried out in Spring, 2013. We reiterate our strong support for establishing both Kwajalein and Woomera (Australia) as rocket ranges to which NASA sounding rocket missions may be carried out on a routine basis.

Background

NASA's recent sounding rocket campaign in Kwajalein in the Spring, 2013, involved four sounding rockets launched within a two-week window. The launches were a complete success and underscore the expert technical and management capabilities of the SRPO/NSROC team in executing these missions at a remote site. The need for a routine launch range at low latitudes to carry out NASA sounding rocket launches can not be overstated. Indeed, Geospace phenomena at low, middle, and high magnetic latitudes are each distinct, and a dedicated rocket launch range at low magnetic latitudes is an essential component of a system-wide Geospace Observatory with sounding rocket capabilities. A launch capability from Kwajalein is consequently imperative for the Low Cost Access to Space (LCAS) program. Not only does the Kwajalein range offer access to equatorial aeronomic and electrodynamic processes in the ionosphere/thermosphere/mesosphere system, it also conveys with it access to the Altair radar, the equivalent of an NSF class-1 facility. The potential for discovery science at Kwajalein is thus unusually high. Consequently, the SRWG urges the SRPO to maintain their vital infrastructure and capabilities at Kwajalein and treat launch opportunities at this site as those of a regular, established launch range.

Similarly, the SRWG has also expressed on several previous occasions its support for a permanent range in the Southern Hemisphere with land recovery, such as that provided by the Woomera rocket range in Australia. Such a rocket range would facilitate, in particular, astrophysics sounding rocket launches to provide coverage of the southern hemisphere sky -- for example, to provide viewing access of the Magellanic Clouds. We appreciate the continued efforts of the SRPO to re-establish its capabilities to launch and recover sounding rocket payloads from Woomera. Despite the new constraints communicated to us at the last meeting, such as those involving local mining operations, we urge the SRPO to maintain their dedication to working out these challenges, with the ultimate goal of facilitating routine sounding rocket launches at the Woomera range.

3. Success Criteria Guidelines and Examples

Summary

Minimum and comprehensive success criteria lie at the center of the relationship between the PI and the SRPO/NSROC, yet there are few established guidelines for formulating such criteria. Such guidelines would be particularly useful for new P.I.'s. The SRWG suggests that guidelines and examples of success criteria, to which the SPRO concurs, be made available to the user community.

Background

Minimum and comprehensive success criteria lie at the center of the relationship between the PI and NSROC. Few guidelines are supplied for formulating them, however, and the possibility of writing criteria that are difficult to interpret, satisfy, or even evaluate post flight, exists. Tying criteria to flight dispersion statistics, for example, is a flawed practice that implicitly guarantees failure for some number of missions. Criteria that do not reflect actual scientific requirements or that simply cannot be satisfied pose a dilemma for PIs and NSROC alike and could, in principle, lead to missed launch opportunities or even mission failures. The common practice of softening criteria post flight undermines the integrity of the process.

The SRWG finds that examples of well-formulated success criteria to be used as templates should be drafted and made available to sounding rocket investigators. The SRWG would be very willing to provide comments on such guidelines and provide examples from past missions that were deemed particularly useful and effective by both the P.I. and the SRPO.

4. Continued Development of Recovery Systems

Summary

The SRWG applauds the recent work by NSROC and SRPO on water recovery systems at Wallops and land recovery logistics at Poker. We strongly encourage the further development of recovery systems for all ranges and for the full “stable” of NASA’s launch vehicles including recovery systems for the high speed BBXI and BBXII vehicles.

Background

Many modern payloads, especially in Astrophysics and Solar Physics, are highly complex, expensive, and are usually flown multiple times. An example is the XQC payload which recently carried out its 7^{th} flight from WSMR. These payloads are recovered, often enhanced, and re-flown, dramatically increasing their scientific yield. However, until recently, recovery using the BBIX was only routinely possible at WSMR. Recently, SRPO and NSROC have developed new logistical scenarios that allow payload recovery at Poker, and new water flotation technology that allows for recovery of this type of payload from WFF. These are essential new developments and will allow new missions, new observing strategies, and hopefully lower range costs and logistics. This will not displace the need to fly payloads from WSMR since lower latitude launches are essential for some Astrophysics payloads, especially those requiring low particle backgrounds. However, having choices and options should significantly reduce the logjam at WSMR. These are essential and necessary first steps in expanding range options for recovered payloads, and the SRWG heartily applauds this effort.

The SRWG further recognizes the need to extend water recovery efforts to allow recovered BBIX launches from Kwajalein that would actually be a viable alternative to WSMR for low background missions. In addition, the development of recovery systems for the higher apogee and hence, high-speed re-entry BBXI and BBXII vehicles would dramatically increase the science yield per launch (due to the increased “hang time”) and open up new science investigations not currently possible on a BBIX. The recent non-recoverable, end-of-life, flight of the CIBER Astrophysics payload from Wallops is a good example of this. The SRWG looks forward to sustained investment and development of recovery systems and logistics that will both open more ranges, and enable the use of higher performance vehicles for recovered 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. Matthew Beasley
University of Colorado, Boulder

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Keith Gendreau
NASA/Goddard Space Flight Center

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Miguel Larsen
Clemson University

Dr. Kristina Lynch
Dartmouth College

Dr. Scott Robertson
University of Colorado, Boulder

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland
20771

17 June 2013

Victoria Elsbernd
Director (Acting), Heliophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001

This letter expresses the strong concern of NASA's Sounding Rocket Working Group (SRWG) regarding the impacts of the projected funding profile for NASA's sounding rocket program. If the current projection comes to fruition, the science productivity of the program will be greatly reduced and the viability of the program will be severely threatened. Further, such a budget will also undermine the experience-base and technology innovation required to accomplish many of SMD's research goals.

As revealed to the SRWG at its meeting of June 11, 2013, the current funding projection for NASA's sounding rocket program shows essentially constant levels through at least 2019 without any adjustment for inflation. Simply put, while the funding profile for sounding rockets is flat, the cost of launching sounding rockets is not and the current rate of launches cannot be sustained. Furthermore, increased safety and scheduling restrictions at launch ranges such as the White Sands Missile Range and the Poker Flat Research Range in Alaska as well as the increased costs of rocket motors, underscore the need to *augment* the buying power of the sounding rocket budget, rather than allow it to diminish beyond its ability to sustain the program.

The sounding rocket program has only recently returned to viable funding levels after over a decade of drastic, program-threatening funding deficiencies. In order to survive those periods, the program exhausted stocks of rocket motors and other expendable flight equipment such that there are presently no backups or spares that could be used for further cost savings. In addition, the loss of personnel due to these cutbacks has significantly reduced the experience base in the program. Thus, while the program was sufficiently rescued to remain afloat at the present time, its position has been weakened such that it does not have the ability to respond to further funding deficiencies without an immediate loss of productivity.

The SRWG has been informed that one of the first impacts of the restrained budget resources will be to end the use of non-US rocket ranges. This will end a key hallmark of the rocket program -- to launch rockets where the research requires the measurements -- whether it be in the earth's cusps in Spitzbergen, Norway, or observing the southern celestial sphere from Australia. Further, we are told that by FY19, even launches at Poker Flat, the US high latitude launch launch site for auroral studies, will be eliminated as a NASA launch site.

We are painfully aware of the limitations imposed by the current fiscal environment. However, numerous NASA scientific advisory groups and the National Research Council Decadal Survey for both Astrophysics and Heliophysics have concluded that NASA's Sounding Rocket Program should be strengthened and preserved, not allowed to decrease beyond viability. We thus believe that every effort should be made to provide adequate funding for the Sounding Rocket Program both at the present time and in the years ahead, so that it may continue to provide, rapid, low cost research platforms to meet the nation's scientific, technological, and educational needs.

Sincerely,

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:

Prof. Scott Bailey, Virginia Polytechnic Institute and State University
Dr. Matthew Beasley, Planetary Resources, Inc.
Dr. Jonathan Cirtain, NASA/Marshall Space Flight Center
Prof. Enectali Figueroa-Feliciano, Massachusetts Institute of Technology
Dr. Keith Gendreau, NASA/Goddard Space Flight Center
Prof. David Hysell, Cornell University
Prof. Charles Kankelborg, Montana State University
Prof. Miguel Larsen, Clemson University
Prof. Kristina Lynch, Dartmouth College
Prof. Scott Robertson, University of Colorado, Boulder

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of December 13, 2012

Findings

1. Support for the Schedule Adherence Policy Concept

Summary

The Sounding Rocket Working Group (SRWG) supports the concept of the Schedule Adherence Policy that has been introduced by the NASA Sounding Rocket Program Office (SRPO) to help keep projects on schedule. The SRWG looks forward to providing comments on the details of such a policy. In a general sense, we strongly support scheduling the MIC soon after the onset of a new program and having the Principal Investigator (P.I.) help establish a schedule in conjunction with the NSROC mission manager. The SRWG believes that clear lines of responsibility between the experimenter, NSROC, the SRPO, and NASA HQ, are essential to maintain this schedule.

Background

The SRWG supports the concept of a “Schedule Adherence Policy,” introduced by the SRPO, and the establishment of checkpoints throughout the project, as a means of keeping projects on schedule. The formalization of consequences for schedule delays is likely to reduce the risk of multiple, concurrent schedule slips that can be detrimental to the program and will mitigate the need for overtime and cost overruns. The SRWG looks forward to providing comments on the details of such a policy. A few initial comments are provided here.

Scheduling the MIC soon after the onset of the program is advantageous for all concerned. However, detailed schedules may be difficult to produce with high fidelity this early in a project, especially if the mission is a new or significantly modified payload. The SRWG is concerned about the level of schedule detail which might be required early in a mission and the timeframe for producing this schedule. New payload missions, compared to re-flights and payloads with significant flight heritage, will have different fidelity in their schedule at the time of the MIC.

The SRWG strongly believes that the P.I. and the mission manager should jointly evaluate the schedule to identify areas of higher risk and should implement the appropriate level of schedule margin. Frequent and open communication is needed between the P.I. and the mission manager to maintain the schedule. Decisions to move milestones should be discussed and agreed upon well in advance.

In a larger sense, the SRWG believes that clear lines of responsibility for schedule delays is essential, and we would like to see more transparency on how the responsibility is attributed between the experimenters, NSROC, the SRPO, and, for funding/program issues, NASA Headquarters.

2. Strong Support for the Development of the Peregrine Motor

Summary

The SRWG is highly supportive of development efforts related to the new Peregrine motor. Such a vehicle would provide an alternative to the existing Black Brant and would provide platform diversification. We also support continued use of the Oriole rocket and request statistical information on the performance of this vehicle.

Background

The SRWG is highly supportive of development efforts related to the Peregrine motor. We commend the SRPO for taking the initiative to develop this rocket. In view of ongoing problems with the Brant and associated single-point failure vulnerability, alternative motor development is necessary to safeguard the program, prevent additional backlog, and to maintain a healthy competitive environment. It is also consistent with the recent Heliophysics NRC Decadal Survey recommendation for platform diversification.

We are also pleased that the Oriole rocket is being flown more frequently, as this vehicle also provides an important alternative. With respect to the Oriole, the SRWG requests statistical information regarding flight performance to help us better evaluate how this vehicle can help fulfill the varied scientific needs of the community.

3. Astrophysical Flights at Poker Flat Research Range with Recovery

Summary

The Sounding Rocket Working Group whole-heartedly endorses the use of the Poker Flat Research Range for launches of astrophysical payloads and their subsequent recovery. We urge the Sounding Rocket Program Office to continue to pursue all avenues to facilitate such launches and recovery operations. For such missions that can achieve their science objectives at high latitudes, these launches present an alternative to the White Sands Missile Range that is highly advantageous for cost and schedule reasons.

Background

The Sounding Rocket Working Group applauds the use of the Poker Flat Research Range in Alaska as a launch site for astrophysical payloads. Efforts for the complete recovery of all payloads that correctly deploy the parachute are producing good results. The only remaining concern is the survivability of the payload on the ground during a several-day stay in the downrange wilderness in what might be arctic winter conditions.

The additional flexibility of an alternate, low cost range for payloads that can accommodate a high latitude launch will ease the difficulty of maintaining the desired rapid flight schedule. The Sounding Rocket Working Group whole-heartedly encourages the Sounding Rocket Program Office to facilitate such launch/recovery operations and to allow PIs to select the Poker Flat Research Range in exchange for timely launch opportunities.

4. Communication between P.I. teams and NSROC

Summary

The SRWG underscores the importance of good communication practices between the P.I. teams and NSROC. We also urge SRPO and NSROC to authorize mission managers to make decisions within the experimenter-mission team group, and underscore the science team's need be more actively involved in mission design decisions, including countdown and timeline choices.

Background

We applaud the NSROC response to the SRWG Finding from July, 2012 on communications between the PI team and NSROC. Setting a standard of expectation for payload team – experimenter team communications is important, while it is recognized that the level and frequency of these communications will vary from mission to mission and from month to month. A well-informed PI and an authoritative mission manager who are both up-to-date on each other's schedule and able to make decisions locally are critical to the success of improving our scheduling, and are historically important to successful missions.

In discussing recent examples of experimenter-mission communications, we find that current tendencies are leaning away from this historical model. We urge that mission managers be authorized to make decisions within the experimenter-mission team group, and that the science team be actively involved in mission design decisions, including countdown and timeline choices.

We hope that this communication model will encourage a return to this level of autonomy for mission managers.

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. Matthew Beasley
Planetary Resources, Inc.

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. Keith Gendreau
NASA/Goddard Space Flight Center

Dr. David Hysell
Cornell University

Dr. Mary Elizabeth Kaiser
Johns Hopkins University

Dr. Charles Kankelborg
Montana State University

Dr. Miguel Larsen
Clemson University

Dr. Kristina Lynch
Dartmouth College

Dr. Scott Robertson
University of Colorado, Boulder

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of July 18, 2012

Findings

1. "Benchmark" Reviews to Ensure Payload Readiness at White Sands

Summary

Experiment delays including major postponements/cancellations present significant scheduling, coordination, and cost implications for NASA HQ, the SRPO, and NSROC, particularly for launches from the White Sands Missile Range. The SRWG recommends that two benchmark reviews or "checks" -- at intervals of (for example) 180 days and 45 days prior to the scheduled launch date -- be instigated by Wallops with the P.I., NSROC, and the SRPO represented, to identify and help mitigate the unintended consequences and cost penalties relative to such unexpected delays.

Background

Experiment delays and, in some cases, major experiment postponements and even cancellations present significant scheduling and coordination concern for NASA HQ, the Sounding Rocket Project Office (SRPO), and the NASA Sounding Rocket Contract (NSROC). Departures from agreed-upon launch readiness dates, specifically for rockets scheduled for launches from the White Sands Missile Range (WSMR), have significant cost and labor implications, that in many cases are not fully appreciated by the Principal Investigator (P.I.) since these costs are not borne by the experiment teams. For example, non-refundable range fees at WSMR are now levied several weeks prior to the launch date, which are lost when a slip occurs after this time. Furthermore, delays of this nature impact the NSROC work flow and staff morale, as well as the SRPO and NASA HQ manifest planning.

As communicated to the experiment community at the recent SRWG meeting, delays that are identified well in advance are most easily accommodated while week-to-week slips are far more problematic. The SRWG, via this Finding, recommends that benchmark "status checks" or reviews be instigated, at intervals prior to the launch date with the P.I. team, NSROC, and the SRPO represented, in order to establish the experiment status and to determine whether such delays will indeed take place.

The SRWG recommends that two such interchange meetings be required prior to the shipment of the science payload and the NSROC-supplied subsystems to WSMR.

Although pre-integration and pre-ship reviews are already part of the normal operations flow at Wallops, these additional status/schedule review "benchmarks" should be instigated, particularly with respect to WSMR payloads. These "checks" will help reduce the unintended consequences and cost penalties relative to unexpected delays.

The SRWG therefore suggests:

-- At 90-180 days (interval is at the discretion of the SRPO at Wallops) prior to launch, a meeting or teleconference be instigated by the SRPO at Wallops whereby, the experiment team, NSROC, and the SRPO review the status of the subsystems and the experiment and demonstrate that the mission will meet its pre-determined launch date at WSMR. The PI must discuss the status of the experiment and identify any schedule drivers that may delay shipment.

-- At 45 days prior launch, a second meeting or teleconference be instigated by the SRPO at Wallops to show that the experiment, NSROC, and SRPO are all fully aware of the payload/experiment readiness for shipment to the range. In principal, this review would serve as a final "gate" through which the payload team must pass prior to the expenditure of range fees and travel costs by the SRPO and NSROC.

It is understood that the times corresponding to 90-180 days and 45 days are simply suggested benchmark intervals. We anticipate that Wallops (SRPO) will determine the most appropriate times for these status checks.

2. Improving Communications between the Experimenter and NSROC Teams

Summary

Improved, regular communications between the experiment and NSROC teams are recommended. One consequence of such interactions might be the reduction in design and fabrication errors that appear to be occurring at increasing rates. Suggestions for the nature and frequency of such communications are presented.

Background

At the recent SRWG meeting, the lack of optimal communications between experiment teams and NSROC was identified as a possible problem that has hindered efficiency and may have contributed to recent design and fabrication errors.

Although the best practices for open communications depend, to some extent, on the make-up and experience of the specific experiment and NSROC teams, as well as on the specific mission and its schedule, the SRWG recommends some general approaches that have, for some teams, provided tangible results.

For example, for highly complex Geospace missions, regular group telecons between the experiment team (including graduate students and new engineers) and the NSROC team have been shown to have particular value. Such telecons might be on a weekly basis up until the Design Review and also leading up to integration, and perhaps at a more relaxed rate (monthly?) at other times. The best practice (optimal use of team time) certainly will depend on the complexity level of the mission and the size of the team, as well as the level of new design in the mission.

In all cases, it is suggested that these telecons embrace wide-ranging, open discussions, as opposed to telecons specifically scheduled to address a particular problem. This allows the team to become familiar with each other and to discuss various aspects of design choices without the immediate need to solve a particular problem within the overall design (although such focused discussions are, of course, also necessary, as appropriate). Within the framework of such open discussions, the relative merits of different choices can be evaluated with all team members encouraged to contribute.

3. Technology Transfer -- Adopting Experiment Team Innovation

Summary

The SRWG encourages the SRPO and NSROC to continue to make new technologies available for sounding rocket scientific payloads. In some instances, a cost effective way to achieve this could be to incorporate and standardize technologies already developed by experiment teams. Specific examples are on-board digital recording systems that allow very high-speed data collection, and sub-payload deployment mechanisms. We encourage the SRPO to pursue such technology transfer in an effort to revitalize its technology roadmap for applications that are appropriate to those of user contributions.

Background

The SRWG encourages the SRPO and NSROC to continue to make new technologies available for sounding rocket payloads. In some instances, a cost effective way to achieve this could be to incorporate and standardize technologies already developed by experiment teams. The SRWG feels strongly that a close collaboration between experiment teams and the sounding rocket program could foster the transfer of technologies that would benefit the program as a whole. We encourage the SRPO to pursue such technology transfer in an effort to revitalize its technology roadmap for applications that are appropriate for user contributions. Such possibilities might include both off-the-shelf technologies as well as advanced solutions developed “in house” by the various clever experimenter teams.

Examples of technologies that could be improved and disseminated within the experiment teams include:

-- Systems that take advantage of state-of-the-art data transfer and data interface components.

-- Ground station interfaces which enable higher data rates as well as those which replace the aging GDP units.

-- Telemetry (TM) simulators that replicate on-board TM and ground station outputs. Such simulators would help ensure that experimenters can test their equipment thoroughly before formal integration. Many such systems have been developed by experiment teams, and could be generalized to support a wider audience. In some instances, this could result in dramatically increased capability and reduced cost for the program as a whole.

-- Other ideas: pump pull-away systems, cryogenic fill systems, on-board data storage solutions, sub-payload deployment mechanisms.

4. Continued Need for High Telemetry Rates and a Standard 20 Mb/sec system

Summary

The SRWG reiterates that state-of-the-art experiments continue to "push the envelope" by requiring higher telemetry (TM) data rates. Indeed, this is an important feature of the sounding rocket program that distinguishes it from satellite missions whose telemetry, by comparison, is considerably more limited. The SRWG urges the SRPO and NSROC to continue to work toward making a standard, 20 Mbit/s TM system available that maximizes the downlink capability of the existing S-band systems.

Background

A wide variety of science payloads, including solar, astrophysical, and geospace experiments, generate data at increasingly higher rates compared to previous instruments. For example, many celestial and solar missions are now generating data at rates that require on-board storage for comprehensive success. As noted by NSROC at the recent SRWG meeting, it is currently not feasible to implement X-band telemetry in the near-term to facilitate such high rate, full data downlinks. Although X-band systems might yield considerably higher rates in the long term, modestly higher data rates using available (S-band) technology would allow more capable state-of-the art instruments now and thus a vastly increased science yield.

For example, multiple 20 Mbit/sec transmitters are being implemented in a special arrangement for the Figueroa payload that uses S-band and which is scheduled for January 2013. This is a large step in the right direction. We note, however, that the 20 Mbit/s data systems are not being advertised as a new standard capability, which are of substantial interest for the experimenter community at large.

We urge the SRPO to adopt the 20 Mbit/s TM system as the standard system going forward. This is particularly important since the now very old WFF93 system is not being modernized. A standard, 20 Mbps can be accomplished by either adopting the PSL system, modernizing the WFF93, or designing a new system. It is also essential that any system, including the WFF93, include higher speed data interfaces such as LVDS, fiber, etc. TM simulators should be made available that would enable the experimenters to develop and test payload interfaces before delivery to WFF.

Finally, we note that whereas the 20 Mbit/s capability is an essential complement to on-board storage systems, it cannot be replaced by on-board data storage systems. For example, on-board recording requires payload recovery to be successful. Furthermore, payloads with real-time command links may require high-speed data in order to enable uplink decisions and allow proper control of the payload.

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. Matthew Beasley
University of Colorado, Boulder

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. Keith Gendreau
NASA/Goddard Space Flight Center

Dr. David Hysell
Cornell University

Dr. Mary Elizabeth Kaiser
Johns Hopkins University

Dr. Charles Kankelborg
Montana State University

Dr. Miguel Larsen
Clemson University

Dr. Kristina Lynch
Dartmouth College

Dr. Scott Robertson
University of Colorado, Boulder

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 26/27, 2012

Findings

1. Black Brant Motor Situation

Summary

The Sounding Rocket Working Group (SRWG) remains very concerned about the status of the Black Brant vehicle. The SRWG appreciates the great expenditure of effort of the Sounding Rocket Program Office (SRPO) in carrying out an aggressive test program, particularly with respect to increasing Black Brant motor stability via efforts to eliminate unacceptable angles of the exit cone at burn out (non-symmetric throat erosion), spin up anomalies, and combustion instabilities. The acquisition of three surplus Black Brant motors from the Navy in exchange for launch support services is applauded. We also commend the actions of the SRPO in advancing the "return to flight" of the BBXII/BBXI, as well as pursuing alternate high-altitude launch vehicles (e.g. the Talos-Terrier-Oriole and Terrier-Terrier-Oriole).

Background

Safety concerns resulting from recent issues with the stability of the Black Brant (BB) motors has resulted in a moratorium of the entire Black Brant fleet within the NASA Sounding Rocket Program while the cause of the instability was investigated and mitigated. Although the BBIX configuration has been approved for a return to flight, stability issues still linger. In fact, a limited moratorium remains on the BBX, BBXI, and BBXII rocket configurations due to safety concerns resulting from the increased impact dispersion of the Nihka motor due to Black Brant coning and concerns that the instability might have on payload loss/recovery.

The SRWG commends the SRPO on its aggressive test program to understand and help correct the Black Brant issues. Corrective actions led by the SRPO include: increasing the motor throat diameter, use of unblended ammonium perchlorate (AP), switching to a US vendor production of ammonium perchlorate, construction of a hybrid case design, analysis of the integral exit cone design, and aft enclosure modifications permitting thicker throat region insulation. While increasing the nozzle diameter and the use of unblended ammonium perchlorate have enabled the BB motor stability to be sufficient to obtain acceptable altitudes for the BBIX payloads, the BBX, BBXI, and BBXII payloads are still under moratorium pending the implementation and test of a suite of corrective actions. Upcoming BBXI and BBXII flights will employ new motors fabricated with US unblended AP. BBXII/XI payloads will be required to fly a thrust termination system on the Nihka stage until the motor throat retains sufficient insulation margin.

Although these corrective actions have permitted a much needed and appreciated return to flight, altitude performance has been negatively impacted. The BBIX now has a slight altitude performance loss (resulting in a science loss) due to the motor modifications implemented to resolve/mitigate the instability issue. Upcoming BBXII flights scheduled for early 2012 will require an FTS on the Nihka stage which will further adversely affect the altitude performance for these vehicles. The reduced performance of the BBXII negatively impacts auroral zone missions that require high altitudes to carry out their research. The SRWG encourages the SRPO to continue its pursuit of options to retain the performance capabilities realized by the BBIX – BBXII launch vehicles.

2. High-velocity Ejection Systems for Small Sub-Payloads

Summary

The SRWG recommends that the Sounding Rocket Program Office take responsibility for the technical development of a reliable, high-velocity ejection system for small sub-payloads. Not only is this role too large for an individual experimenter to assume, the technical capabilities should be available to the entire user community.

Background

There continues to be strong interest in sounding rocket missions that incorporate small, sub-payloads, particularly those that eject at high velocity. Proposals for projects that make use of this technique continue to be submitted to NASA HQ in each annual proposal round, yet review panels have shown a lack confidence in the reliability of the ejection systems and thus, these missions have not gone forward. The SRWG recommends that the Sounding Rocket Program Office (SRPO) take responsibility for the technical development of a reliable, high-velocity ejection system for small sub-payloads.

A specific example of the problem is that associated with the ejectable modules referred to as Ampules. The Ampules system was initially proposed by the University of Alaska and much of the early development was carried out at that institution. The SRPO provided assistance with the further development of the system for the initial test flights, but problems were largely left to the investigator to resolve. The responsibility for the development of a reliable, high velocity deployment system suitable for flight should ultimately rest with the SRPO, as is the case with other vehicle deployment systems such as nose cone and door deployment systems. The science that is being addressed by the ejectable sub-payload proposals is compelling, but the Working Group finds that a commitment by SRPO to develop a reliable system is required to make these compelling science proposals viable in the review process. Furthermore, if the SRPO retained "ownership" of the small payload ejectable system, it would then be available to the entire user community for future investigations.

3. Incorporating Larger Data Rates

Summary

The SRWG is pleased to learn that the new 20 Mbps telemetry system will be routinely available for flights at the end of this year. Despite this advance, the user community remains very interested in systems that could provide orders of magnitude higher telemetry. As an interim solution for recoverable payloads, such high rate telemetry may be available via high speed recorders.

Background

The SRWG is pleased to learn that the new 20 Mbps telemetry system will be routinely available for flights at the end of this year. This represents a factor of two improvement over the currently available 10 Mbps system. The SRWG notes that future scientific experiments will require orders of magnitude improvements in capability. These future experiments include, but are not limited to, imaging and spectroscopy science payloads. In general, technology development of science payloads is now yielding smaller, less power intensive, and much richer data production than years ago. This trend is increasing. It is imperative for sounding rockets to match this pace in order that a large number of its missions might remain relevant in the future.

The SRWG is pleased to learn of the possible availability of high speed recorders in the future, which will provide a new capability to fill this need for recovered payloads, at least in the interim. The SRWG seeks more details on the planned development and field testing of these recorders. Currently, experimenters are building data recorders into their own systems and would immediately benefit from a standardized data recorder module. The SRWG notes, however, that the high speed recorders do not replace the continued need for much higher capacity telemetry systems.

4. White Sands Missile Range -- Notes on the NASA Infrastructure Upgrade

Summary

We commend NASA for the welcome and long overdue improvements to the payload integration and testing facilities at White Sands Missile Range. A list of additional improvements is provided.

Background

We commend NASA for the welcome and long overdue improvements to the payload integration and testing facilities at White Sands Missile Range. The new laboratory space is clearly a major improvement over the existing high and low bays in the NASA Vehicle Assembly Building used for payload testing. The conference and office space on the second floor is particularly well thought out.

A survey of researchers using the facility has recently identified a few concerns that may offer additional improvements and which we list here: (1) The new laboratory space has open access, and clean garb and sticky mats are used intermittently at best, so the space will become dusty over time without regular cleaning. We recommend finding an operating procedure that will keep the new lab space clean. We understand that a regular cleaning service will be used, and regular schedules to service filters and sticky mats will be implemented, procedures which we wholeheartedly support. If that is insufficient, adding a vestibule double door with sticky mats, hanging clean anti-static smocks, and restricting access to the personnel doors may be necessary. (2) The floor of the new lab space is already cracked and coming up from spilled liquid nitrogen. The situation should be monitored and a more durable replacement surface should be considered. (3) Clean room tents have not been installed as of March 2012. A ready means to lift instrument sections while under the clean tent is needed. (4) As more payloads are integrated simultaneously and the N200 space is decommissioned, floor square footage will be at a premium. An accessible place to store unused experiment crates and equipment, such as an adjacent shed, will maximize floor space efficiency during peak periods and keep crates and miscellaneous packing materials out of the new lab space. (5) Finally, we are concerned about the policy being imposed that science payloads are ITAR restricted, as opposed to the NSROC components already covered by TAAs. This interpretation requires elaborate procedures to be set up with multiple science payloads in the VAB, imposing serious operational impediments. We note that a recent US State Department memo determined that science payloads are not inherently ITAR-controlled. Due to the adverse consequences, we suggest this policy be carefully reviewed to determine if it is justified.

5. Support for Infrastructure for Virtual Meetings

Summary

We urge the SRPO and NSROC to implement inexpensive, but effective, upgrades to their virtual meeting infrastructure.

Background

Government travel restrictions and the general expense of traveling to the Wallops Flight Facility (WFF) make it increasingly difficult to conduct short but critical project meetings at WFF. Unfortunately, the telecon, videocon, and collaborative meeting software (i.e. WebEX, EVO, etc...) at WFF are not sufficient to conduct modern virtual meetings. These deficiencies have recently resulted in less than optimal communications during critical meetings, including both project meetings and design reviews.

We urge the SRPO and NSROC to implement inexpensive, but effective, upgrades to their virtual meeting infrastructure. This should include telecon equipment (with extension microphones!) such that all participants in the room are within range, videocon equipment or software (EVO,http://evo.caltech.edu/evoGate/ that is free and widely used in the science community), and virtual meeting software (i.e. WebEX). These upgrades are inexpensive and will allow critical collaborative work to proceed in an environment where face-to-face meetings are increasingly impractical.

6. Dr. Mary Mellott – Appreciation

The Sounding Rocket Working Group expresses its sincere appreciation and deep gratitude to Dr. Mary Mellott, who guided and helped manage the program at NASA HQ so effectively over the past several years and who retired at the end of last year. Mary worked for a considerable number of years as both the Program Scientist for the Sounding Rocket Operations at NASA HQ and as the Discipline Scientist for Geospace within the Heliophysics Division at NASA HQ. The Sounding Rocket Working Group acknowledges in particular the contributions of Dr. Mellott during some particularly difficult years for the program -- times when program funding was extremely low at NASA HQ and the very future of the program was quite uncertain, and also during the period in which the program transitioned to the NASA Sounding Rocket Operations Contract at Wallops. The sounding rocket program that Mary Mellott helped nurture has enabled unique scientific achievements to be carried out in space, reflecting highly on both NASA and the United States. We acknowledge Mary's unwavering support for, and her untiring dedication to, NASA's Sounding Rocket Program.

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. Keith Gendreau
NASA/Goddard Space Flight Center

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. Scott Robertson
University of Colorado

Dr. Douglas Rowland
NASA/Goddard Space Flight Center

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

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 30/July 1, 2011

Findings

1. Black Brant Motor Situation

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 an aggressive test program led by the SRPO to identify and remedy these problems.

Background

The safety concerns resulting from recent issues with the stability performance of the Black Brant motors resulted in a moratorium on the entire Black Brant fleet while the cause of the instability was investigated and mitigated. Although the BBIX configuration has been approved for a return to flight, stability issues still linger. In fact, the moratorium remains on the BBX, BBXI, and BBXII rocket configurations due to safety concerns resulting from the increased impact dispersion of the Nihka motor due to the Black Brant coning and concerns that the instability has on payload loss/recovery. In addition, the BBIX now has a slight altitude performance loss (resulting in a science loss) due to the motor modifications implemented to resolve/mitigate the instability issue. Increasing the nozzle diameter and the use of unblended ammonium perchlorate (AP) have enabled the BB motor stability to be sufficient to obtain acceptable altitudes for the BBIX payloads. However, the inability to launch the BBX, BBXI, and BBXII rockets is a severe impact to auroral zone missions that require high altitudes to carry out their research objectives. The SRWG encourages the SRPO to continue its pursuit of options to retain the performance capabilities of these launch vehicles.

2. NSROC-II Personnel and Staffing Levels

Summary

The SRWG recognizes the efforts of NSROC-II under Orbital Sciences Corporation to both retain and recruit experienced personnel at all levels. However, the SRWG is concerned that the number of available technicians may be quite insufficient – in some cases, it our understanding that the technician workload is so high that project schedules and morale are suffering. The SRWG requests a briefing on available NSROC-II staffing at the technician and engineer levels including anticipated future plans and a general comparison to previous levels (i.e., under NSROC-I) if this information is available. We are eager to learn NSROC-II's assessment of the impact (if any) that staffing has had on recent mission schedules.

Background

One of the hallmarks of the NASA sounding rocket program since its inception has been an excellent working relation between the PI team and the Wallops payload team, which is comprised of NSROC personnel. Adequate staffing on both sides is required for a well-working and efficient teaming relationship.

Recent anecdotal experience suggests that the workflow on some missions has been impeded by understaffing of NSROC-II technician positions, requiring the available technicians to work six-day weeks for months at a time to meet the schedule. This has resulted in delays to integration particularly in cases where the same technician has too many tasks assigned to him and where he can not possibly handle them all simultaneously. Due to work rules, as well as issues of experience, engineers often cannot substitute for technicians "in a pinch" and thus schedules must be delayed until technicians are available. This situation may have existed under NSROC-I as well, although the SRWG is not aware of its severity.

The SRWG requests a briefing on available NSROC-II staffing at the technician and engineer levels including anticipated future plans and a general comparison to previous levels (i.e., under NSROC-I) if this information is available. We are eager to learn NSROC-II's assessment of the impact (if any) that staffing has had on recent mission schedules.

3. Poker Flat Environmental Impact Statement

Summary

The SRWG strongly supports the work, and appreciates the tremendous efforts, of the SR Program Office to ensure a fully functioning launch range at Poker Flat with all available launch corridors maintained. To meet this objective, we understand that an environmental impact statement must be completed for this launch range. The SRWG committee members stand ready to help with this impact statement, as appropriate, and in particular to provide any input needed regarding why certain launch azimuths and trajectories are required for scientific research purposes.

Background

The Poker Flat research range remains an unparalleled and unique facility to carry out scientific investigations of the earth's high latitude geospace environment. Indeed, the SWRG has written on this subject before and our view of the importance of this range to the research needs of NASA and the nation remains unchanged.

The SRWG has been informed that certain launch corridors and azimuths at the Poker Flat Research Range are in danger of being closed to sounding rocket use due to environmental concerns, as well as the influx of people who wish to use the land for other purposes, such as hunting. Although we respect these other interests, the SRWG believes that the existing launch corridors and available azimuths be maintained for use as regions where NASA sounding rocket missions might be safely carried out. As such, we fully support the SRPO efforts to work with the various agencies to maintain the launch capabilities at the Poker Flat range, including the writing of an environmental impact statement. We also urge the SRPO to work with the Geophysical Institute at the University of Alaska, Fairbanks, who owns and operates the Poker Flat Rocket Range, to ensure that this vital and unique national treasure be maintained for space research needs for the foreseeable future.

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. Keith Gendreau
NASA/Goddard Space Flight Center

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. Scott Robertson
University of Colorado

Dr. Douglas Rowland
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of February 4-5, 2010

Findings

1. High Altitude Rockets with Recoverable Payloads

Summary:

The SRWG requests that the SRPO study the capability of launching the Black Brant XI with payload recovery from White Sands Missile Range (WSMR) and the Black Brant XI and Black Brant XII vehicles with payload recovery from Wallops, Woomera Test Facility (WTF), and Kwajalein. The use and recovery of payloads launched to high altitudes on these vehicles will enable longer observing times for astrophysics and solar missions with telescopes that currently utilize rockets with lower apogees to facilitate their recovery and to remain within the confines of WSMR.

To facilitate the realization of these goals, the SRWG requests that the SRPO present at future SRWG meetings an analysis of how the following objectives might be achieved:

a.) A vehicle system capable of achieving the altitude performance of the current BB XI that would enable the 1-sigma impact dispersion to remain on range at WSMR.

b.) Preliminary status of the infrastructure, logistics, and technical modifications (e.g. payload modifications) necessary to support water recoveries.

c.) The capability of an alternate land range, with low energetic particle backgrounds at high altitudes, (e.g. WTF), to launch the BB XI and the BB XII with a recoverable payload.

Background:

The limited available observing time above 150 - 250 kilometers for sounding rocket payloads with recovery places extreme limits on the science goals that can be achieved and the new technologies that can be implemented by astrophysics and solar payloads that include telescopes and for which recovery is typically required.

Although the BB XI and BB XII high altitude launch vehicles are already well used by the Sounding Rocket Program at launch ranges such as Wallops, Poker Flat, and Andoya, these vehicles are currently not used by astrophysics/solar telescope payloads as their high apogees (~ 1000 km) preclude recovery with standard recovery systems. Furthermore, the small size of WSMR has deterred the launch of science payloads using the BB XI and XII vehicles as their downrange impact areas would be outside the range boundaries. Indeed, the small impact dispersion of the BB IX is achieved only with the help of the S-19 boost phase guidance system.

On the other hand, if recovery could be implemented for high altitude launches of the BBXI and BBXII vehicles, such a technical advance would significantly increase the available observing time above 150 km and, in particular, above 250 km, and hence advance the scientific return of these missions. We estimate that for launches from WFF (i.e. near sea-level), the gains in time above 250 km for the BB XII and XI relative to the BB IX are 164% and 114% respectively. The percentage gains in time over 150 km are 85% and 62% respectively.

If the gains in observing time promised by the BBXI and BB XII vehicles are to be realized, then a high altitude recovery system must be implemented, together with either: (1) a larger land range, (2) a means to stay within the WSMR range limits, or (3) sea recovery. We know that the SRPO has been investigating many of these options over the years, and we ask that a summary of the technical feasibility and cost-benefit analysis of these alternatives be presented.

Promising alternate ranges for launch of the BB XI and BB XII include WFF and two southern ranges: RTS (Kwajalein, Marshall Islands) and the WTF (Australia). The WTF can accommodate the impact range and dispersion of these vehicles, satisfy the requirement for low particle background at sounding rocket altitudes, allow payload recovery on land, and provide access to the region around the South Celestial Pole which is inaccessible from WSMR, a factor important to astrophysicists. It is therefore of great interest to the SRWG (see next finding).

Excepting the option for an alternate or modification to the Nihka stage currently used in the BBXII system, it should be emphasized that no new vehicle development is needed.

Additional background on using high altitude rockets to increase observing time for astrophysics and solar telescope payloads that require recovery is available in the SRWG sub-committee report: HARIASOT_SRWG_Sub-committee_Report.pdf.

2. Woomera Test Facility -- Towards Developing a New Standard Range for NASA Rocket Launches

Summary:

The SRWG applauds the Sounding Rocket Program Office (SRPO) for its recent inquiries into returning NASA launch operations to the Woomera Test Facility (WTF) in Australia. 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 view of the southern sky, the potential for high altitude, recoverable payloads, and the possibility for multiple launch windows and less constrained access to the radio spectrum.

Background:

The Woomera Test Facility (WTF) in Australia has been used by the NASA sounding rocket program since 1961 for both astrophysics and geospace missions. From the standpoint of astrophysical payloads, the WTF provides an astronomical view of the southern sky, which includes the Large Magellanic Cloud (LMC), the closest galaxy to our own, the center of our own galaxy, and the southern galactic bulge, to name a few important astrophysical targets not available for observation from the White Sands

Missile Range (WSMR) in New Mexico. In addition, the Woomera range offers unique capabilities for launching high altitude rockets, enabling extended observing time, and less restrictive range operations than WSMR. The less restrictive range operations may allow for high bandwidth telemetry and multiple launch windows, and thus event triggered launches.

Unfortunately the Woomera range has only been utilized by NASA in campaign mode, where large parts of the launch infrastructure have to be deployed at the range for each campaign. The last such campaign was over 20 years ago to observe the SN1987a supernova in the LMC in 1989. There have been no campaigns since then given the large financial barrier to mounting such an endeavor. Now that the SRPO is returning to long term financial stability, developing the capability for land recovered, high altitude (generally astrophysical) payloads in the southern hemisphere should be among the program's priorities.

3. The Mosquito Project

Summary:

The Mosquito rocket has the potential of providing a relatively inexpensive method of sampling the 80 to 100 km region of the atmosphere with numerous launches in a single campaign. This capability has been among the highest priorities on the SRPO "technology roadmap" and is currently under development at NSROC. The SRWG requests an update on the current status of its development.

Background:

The Earth's upper mesosphere region between 80-100 km is one of the most dynamic in the upper atmosphere. Ground based radars and lidars provide some important data within these regions, but it has long been recognized that *in situ* measurements are necessary to advance our understanding of many of the important parameters and mechanisms at work at these altitudes.

In response to this need, the development of a small, inexpensive vehicle to sample this region with repeated launchings in a short period (e.g., 6 launches in a 3 hour period) has been among the highest priorities on the SRPO technology roadmap. Accordingly, the Mosquito rocket has been under development at NSROC for some time to fulfill these goals. Indeed, the Mosquito rocket promises to allow multiple measurements on a given day (night) and perhaps over several days (nights).

We understand there have been some new challenges regarding the Mosquito development that may be require choices to be made by the science community to make this project a reality. As the SRWG is eager to see this project advance in a timely fashion, we request an update on the current status of this vehicle/payload system.

4. Land Use Developments at the Poker Flat Research Range

Summary:

The Poker Flat Research Range (PFRR) continues to be an extremely important location for Geospace sounding rockets that study the high latitude upper atmosphere and auroral physics phenomena. Recent land use developments have been brought to the SRWG's attention, including a new cabin downrange for recreational use by the public and right of way permits for Alaskan natives and oil prospecting. The SRWG seeks to understand these developments insofar as they affect launch window and range use planning. We anticipate that experts at the University of Alaska Fairbanks will be encouraged to help resolve these issues, where appropriate.

Background:

The Poker Flat Research Range (PFRR) continues to be an extremely important location for Geospace sounding rockets that study the high latitude upper atmosphere and auroral physics phenomena. This range is owned by the University of Alaska and operated by the Geophysical Institute at the University of Alaska Fairbanks (UAF) under contract to NASA. The UAF has a significant interest in maintaining its ability to conduct sounding rocket-based experiments from PFRR, and has a member of its faculty currently represented on the SRWG.

At the last SRWG meeting, we were informed that there is an existing cabin downrange that is available for recreational use at certain times of the year by members of the public. Use of this cabin may preclude rocket launches and indeed, during the auroral rocket campaign this past winter, its use was a factor in the launch window planning of the LaBelle rocket (and perhaps other rockets as well.) As the cabin may become a factor in planning rocket launches into scientific events, we request an update from the SRPO on the expected impact of this cabin on future launch activities.

Agencies and Alaska Native Corporations are changing their permitting practices, so there are new ways for gaining the necessary right-of-way permits for PFRR operations. Similarly, drilling teams in the Yukon Flats area to the east of the pipeline may require access that ultimately impedes the use of the PFRR for sounding rocket purposes. The SRWG is concerned that launch activities at the PFRR may be hindered as a result of these new practices. The SRWG has been made aware that the UAF Geophysical Institute includes individuals knowledgeable about working with the specific Native-American communities, and suggest that the UAF's GI might be approached to play a more active role in resolving these issues, where appropriate.

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. James Hecht
The Aerospace Corporation

Dr. Darrell Judge
University of Southern California

Dr. Mary Elizabeth Kaiser
Johns Hopkins University

Dr. Michael Kowalski
Naval Research Laboratory

Dr. Marc Lessard
University of New Hampshire

Dr. Douglas Rowland
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 10-11, 2010

Findings

1. Black Brant Instability Issue

Summary:

The Sounding Rocket Working Group (SRWG) supports the Sounding Rocket Program Office's (SRPO's) considered approach to the current issues regarding what appears to be instabilities in the Black Brant Mk1 motors. The SRWG believes that accepting loss in vehicle performance (i.e., returning to the previous Black Brant performance levels) is certainly acceptable if this is necessary to ensure motor reliability and hence substantially decrease risk. The SRWG looks forward to results from the continued analysis and simulations by the Wallops team as it seeks to understand the performance of the existing motors, including suggested modifications. We request updates from the SRPO so that the experimenter community might stay abreast of developments with the Black Brant vehicle and the outlook for future launches.

Background:

Two Black Brant missions in recent months have experienced unstable and excessive launch loads that have endangered the experiments and affected the overall performance of the vehicle. It is hypothesized that these instabilities result from a combination of effects, but may primarily be due to the relatively recent reduction in the nozzle diameter. It has been suggested that the nozzle diameters of existing motors be increased by an amount that is expected to remove the instabilities at the expense of some vehicle performance. The increased nozzle diameter, as well as other changes to the fuel composition, would then be incorporated into future motor purchases.

This development comes at a time when Black Brant motors are in limited supply and the launch queue is already pressured by the even more limited availability of thrust termination systems. The SRWG shares the SRPO's very serious concern surrounding this issue.

The anticipated performance of the Black Brant, after the modifications to the nozzle diameter, will be reduced, and is anticipated to be at or near the levels of the standard (previous) Black Brant vehicle. We strongly believe that this reduced level of performance is an acceptable trade for the benefit of increased reliability of the motor.

The SRWG requests regular updates from the SRPO regarding this issue until it is deemed solved, insofar as practical. These updates would ideally include any results learned from simulations or other studies, as well as results from any upcoming launches, including test flights.

2. Revisiting the Mesquito Project

Summary

The SRWG appreciates the technical difficulties encountered with development of the Mesquito vehicle and the uncertainty regarding the required time and resources that will be needed to bring this concept to fruition. At the request of the SRPO, the SRWG, drawing from our representatives familiar with this science area, provides some general comments (below) regarding the scientific motivation of developing this vehicle. We are prepared to carry out a more extensive review of the science motivation for developing this vehicle, in conjunction with more extended community input as well as with the NASA HQ discipline scientist.

-- The original performance characteristics of the Mesquito vehicle rest on solid scientific motivation and hence remain a valid science priority, provided it can be developed with viable resources and launched as a low-resource vehicle.

-- The 70-100 km region is vital to mesospheric science and thus a nominal "target" apogee of 100 km for reasonable science payloads remains a crucial requirement.

-- The multiple-flight capability is currently not available in present capability for mesospheric investigations, and it is our understanding that this can only be achieved with smaller, less complex vehicles.

-- We recommend that the SRPO consider simpler, non-instrumented versions (Level 0, such as passive falling sphere, or Level 1, for example fixed nosecone with fixed Langmuir probe, basic TM, no GPS), as detailed in our previous recommendations regarding this vehicle.

-- We urge NASA to preserve and investigate other small payload developments, such as the MET-P, based on the Super-Loki Dart, which could serve as interim solutions for less complex payloads (Level 1) and has multi-launch capability. We also are also concerned about, and request information about, the future of the Falling Sphere (Viper-Dart) capability as standard measurement technique in the mesosphere.

-- We note with enthusiasm that the development to date of the Mesquito avionics package (as part of a Level 3b payload), could be used for a variety of sub-payload applications for larger vehicle missions in addition to its intended use in the Mesquito.

-- The SRWG is very concerned about the cost of the Mesquito, both for development of the platform and the estimated costs of these rockets after the development work is completed, and request that these estimates be provided to us at a future SRWG meeting.

Background:

The Mesquito, also known as the MLRS (Multiple Launch Rocket System) development effort is driven by: (a) the scientific need for a low-cost, mesospheric sounding rocket that can be used in multiple launches in a single set of launches over a short interval, and (b) the availability of small surplus motors in this class.

The background for this vehicle has been documented in the SRWG Report: "New Mesospheric Payload -- Science-Driven Design Considerations" on the SRWG web site: (http://rscience.gsfc.nasa.gov/keydocs/New_Mesospheric_Payload.pdf).

The target region is the upper mesosphere and mesopause region (70-110 km), with interesting scientific objectives: meteor ablation, sporadic layers, meteoric dust; noctilucent cloud particles; wave breaking and highly variable turbulent regions; chemically active species and reaction products, such as O, O2*, OH*, NO; ionization layers due to photon and particle ionization; water cluster ion chemistry, most of which can studied only by in situ measurements.

The Mesquito has been envisioned as somewhat larger and more capable than traditional meteorological rockets (Viper, Super Loki) equipped with instrumentation and telemetry, but smaller and less disturbing to the plasma environment than payloads launched on single-stage Orions. The development and first test flights of the Mesquito system, including miniaturized avionics system tailored for a 4-inch diameter "Dart" payload, have revealed new difficulties towards realizing a working vehicle and payload. Accordingly, the SRPO has asked the SWRG to reiterate and/or reevaluate the science requirements in order to guide future resource allocations.

The SRWG maintains that certain characteristics need to be met to make this platform useful and cost-effective for mesospheric applications. A target apogee of 100 km should be maintained. The predicted payload volume (3.9" x 5'') and mass (5-7 lb) is acceptable and can accommodate basic instrumentation such as originally developed for meteorological rockets with dart payloads (MET-P). It is noted that the form factor is similar to a CubeSat, and some new instrumentation development paths for small nanosatellites could potentially be adapted for or tested on the Mesquito.

The SRWG is concerned about the complexity of the new vehicle (e.g., active motor separation issues) limiting the number of multiple launches (only 2-3 per 3 hours or requiring several launchers). This brings the Mesquito expectations closer to the Orion capabilities, which is a proven vehicle with much larger capacity.

The SRWG recommends that the SRPO consider simpler, non-instrumented versions (Level 0, such as passive falling sphere, or Level 1, such as fixed nosecone with a Langmuir probe, basic TM, no GPS), as detailed in previous recommendations regarding this vehicle. Furthermore, we urge NASA to preserve and investigate other small payloads, such as the MET-P, based on the Super-Loki Dart, which could serve as interim solutions for less complex payloads (Level 1) and has multi-launch capability. We are concerned about, and request information about, the future of the Falling Sphere (Viper-Dart) capability as a standard measurement technique in the mesosphere.

The SRWG is concerned about the preliminary cost estimates of a Mesquito mission (45% of a single-stage Orion mission). We request further information on how much integrated research effort has been used since 2006 to develop this platform as well as the estimate cost to complete the vehicle development.

Despite these concerns about the viability of the vehicle itself, the SRWG is excited about the parallel development of the avionics package, which in addition to the Mesquito, could be used for a variety of subpayload applications for packages deployed from larger vehicles. Multipoint sub-payload arrays are one of the strengths of the WFF/NSROC program and these miniaturized avionics can advance this effort. The 2Mbs PCM stack, while small in bandwidth, can be an attractive small component for small subpayloads. The 4" wraparound GPS/S band antenna provides a convenient small TM system and the GPS positioning is important for array science.

We look forward to continue dialogue with the SRPO regarding the development of miniaturized payloads for both the Mesquito and small payloads in general.

3. Woomera Test Facility -- Towards Developing a New Standard Range for NASA Rocket Launches particularly for Telescope Payloads that Require Land Recovery

NOTE: This finding is nearly identical to Finding #2 of the Feb. 2010 meeting except the emphasis is now on the use of the range for STANDARD operations.

Summary:

The SRWG applauds the Sounding Rocket Program Office (SRPO) for its recent inquiries into returning NASA launch operations to the Woomera Test Facility (WTF) in Australia. 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. This location is particularly appealing for land recovery of payloads that include telescopes, such as those which are primarily launched from White Sands Missile Range (WSMR). The Woomera range is unique for its view of the southern sky, and the potential for less constrained launch operations compared to WSMR. Furthermore, the Woomera range would also facilitate multiple launches, "triggered" launch windows on geophysical or solar events, less constrained access to radio spectrum, and higher apogees, compared to WSMR.

Background:

The Woomera Test Facility (WTF) in Australia has been used by the NASA sounding rocket program since 1961 for both astrophysics and geospace missions. From the standpoint of astrophysical payloads, the WTF provides an astronomical view of the southern sky, which includes the Large Magellanic Cloud (LMC), the closest galaxy to our own, the center of our own galaxy, and the southern galactic bulge, to name a few important astrophysical targets not available for observation from the White Sands Missile Range (WSMR) in New Mexico. In addition, the Woomera range appears to offer less restrictive range operations than WSMR. The less restrictive range operations may allow for high bandwidth telemetry, multiple launch windows, and geophysical and solar "event triggered" launches, as well as higher payload apogees.

Unfortunately, the Woomera range has only been utilized by NASA in campaign mode, where large parts of the launch infrastructure are deployed at the range for each campaign and then removed at the completion of the campaign. The last such campaign was over 20 years ago to observe the SN1987a supernova in the LMC in 1989. There have been no campaigns since that time, given the large financial barrier to mounting such an endeavor. Now that the SRPO is returning to long term financial stability, developing the capability for land recovered (generally astrophysical and solar) payloads in the southern hemisphere should be among the program's priorities.

4. Science Benefits from High Altitude Rockets to Increase Astrophysics and Solar Observing Time (HARIASOT)

Summary:

The SRWG summarizes the general, improved science capabilities for Astrophysics and Solar telescope payloads gained by increasing by extending the time spent above 150-250 km. These advantages open discovery space and generally represent a linear growth in science benefits with increased observing time. It is shown that most of these advantages do not scale as simply increases of the "signal-to-noise" ratio.

Background:

As an outcome of the February 4, 2010 SRWG meeting, the SRWG released a finding on the benefits of High Altitude Rockets to Increase Astrophysics and Solar Observing Time (HARIASOT) with the goal of extending the science achieved by the Sounding Rocket Program (SRP) by significantly increasing the available observing time above 250 km. This increased time was to be achieved through the use of existing rocket program launch vehicles, such as the Black Brant XI and XII (BBXI and BBXII), with payload recovery. A question was raised at the subsequent SRWG meeting concerning what tangible benefits might result from such increased observing time, since signal/noise ratios are improved only by the square root of the observing time.

The SRWG believes that significant improvements in the science capabilities of astrophysics and solar payloads would result from increases in the observing time above 150-250 km. These are summarized below:

(1) permitting observations that are otherwise background limited (faint sources);
(2) permitting observations with previously limited instruments (e.g. higher resolution spectroscopy, novel technologies) and hence previously unachievable;
(3) providing increased time to observe an increased number of targets (pointings) on a single flight;
(4) increasing the field of view (area) on nearby extended targets, such as the Sun. (Note that some Solar missions scan a slit across the sun to build a spatial-spectral picture. Increasing the observing time by a factor of two increases the FOV by a factor of two. Because the atmosphere of the Sun evolves on timescales of minutes, the scientifically useful FOV cannot be increased by combining two flights with adjacent FOVs.)
(5) increasing the signal-to-noise on observable targets to enable the detection of spatial or spectral structures, in particular, of structures previously background limited.

Only for the last motivational argument (5), do science benefits scale as signal-to-noise which scales as square root of the observing time. For all of the other science motivators, the figure of merit grows much more rapidly: opportunities 1 and 2 open discovery space whereas capabilities 3 and 4 represent a linear growth in science benefits with increased observing time.

We estimate that for launches of a 1000 pound payload from WFF at an elevation angle of 85 degrees, the gains in time above 250 km compared to the BB IX vehicle are 164 and 114 percent for the BB XII and XI, respectively. The percentage gains in time over 150 km are 85 and 62 percent, respectively.

Additional technical information regarding this finding is appended in the report entitled: "General Science Benefits of Increased Observing Time for Astrophysical and Solar Sounding Rockets'' provided by the SRWG Sub-Committee on High Altitude Rockets to Increase Astrophysics and Solar Observing Time.

If the gains in observing time promised by the BBXI and BB XII vehicles are to be realized, then a high altitude recovery system must be implemented, together with either: (1) a larger land range, (2) a means to stay within the WSMR range limits, or (3) sea recovery. SRPO has identified the use of the larger land range at the Woomera Test Facility (WTF) as the most attractive option to initially pursue at this time.

The SRWG fully supports the prioritization of these options as presented by SRPO and requests that a summary of the technical feasibility and cost-benefit analysis of the WTF be presented with consideration given to the increase in observing time, additional sky coverage achievable, rocket dispersion, payload recovery costs, and infrastructure costs.

5. Flight Termination Systems

Summary:

The SRWG was pleased to see the development plan for moving to a long-term, viable, qualified, flight termination system (FTS) for launch operations at WSMR. However, the SRWG remains concerned that the project stay on schedule, particularly with respect to the full deployment of the interim "Hybrid II" system in January, 2011. If the Hybrid II system is delayed, launch operations at WSMR could be suspended, delaying a significant number of payloads. Even if the Hybrid II system is on-time, this risk recurs if the stock of 18 Hybrid II systems is depleted before the "final design" FTS system is deployed in 2012. The SRWG would welcome additional information on the detailed development and qualification schedule leading to both the "Hybrid II" and "Final design" flight termination systems, including schedule risks, "tall poles", workarounds, and backup plans.

Background:

Flight termination systems are required for BBIX operations at White Sands Missile Range (WSMR) as well as other launch operations depending on the vehicle and range. The legacy system used until 2009 is no longer available, and furthermore, no longer allowed by WSMR range safety. 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 current plan is to deploy the next development unit ("Hybrid II") in January 2011 with 21 units to be procured, 3 of which will be used for qualification testing. The remaining 18 units will be used for flights, bridging the gap until the "final" design is ready sometime in 2012. The "final" design is to be fully compatible with WSMR range safety rules and should provide a viable, long term solution for WSMR flight operations. However, the manifest for WSMR will, effectively, be suspended when the final 4 Hybrid I units are deployed, currently by September 2010. No flights will then occur until the Hybrid II systems are ready. Delays to the Hybrid II schedule will continue to slip WSMR flights until it is qualified and accepted by WSMR range safety. This situation will recur if the 18 Hybrid II systems are depleted before the "final" FTS systems become available. Clearly, the user community is very concerned about the availability of useable FTS systems to facilitate launches from White Sands Missile Ranges.

The SRWG would welcome detailed insight into the development activities including schedule, qualification plans, negotiations with WSMR, risks, and any contingency planning. This would allow the SRWG to fully understand the path-forward to returning launch operations to WSMR.

6. PFISR Interference and Communications at the Poker Flat Research Range

Summary.

The SRWG reiterates the urgent need to develop a routine means to solve the problem of RF interference between the rockets and the Poker Flat Incoherent Scatter Radar (PFISR) and to develop workable procedures so that PFISR might operate routinely before, during, and after the sounding rocket launches.

The SRWG finds that the ability to listen to the Poker Flat countdown on a suitable website is invaluable for field operations and urges that this capability be maintained.

Background

As detailed in the SRWG Finding #4 of its July, 2008 meeting, the SRWG recognizes that the National Science Foundation (NSF) Poker Flat Incoherent Scatter Radar (PFISR) is a critical instrument that brings much needed context to auroral rockets launched from Poker Flat. Turning this radar off to avoid interference with the sounding rocket launches is both disruptive to routine PFISR operations and may significantly degrade the scientific return of the rocket/radar experiment.

The SRWG continues to be concerned that workable solutions are not in place to enable the Poker Flat Incoherent Scatter Radar (PFISR) to operate continuously and routinely during countdowns and sounding rocket launches. The Wallops telemetry groups and the PFISR operators have learned a great deal in recent years about the possible interferences between our systems and PFISR. Although we understand that mitigation techniques have been developed so PFISR may continue to operate, P.I. teams learn in the field that PFISR must be turned off during launch operations.

SRWG requests that the PFISR interference problem be clarified and that the necessary design and development procedures be followed so that all Poker missions (whether they are using PFISR observations or not) include avoidance of PFISR S-band interference frequencies (if at all possible) such that PFISR can operate continuously during all launch operations. Such actions should be verified at the Design Review and Mission Readiness Review of all Poker Flat launches.

On a separate note, the SRWG finds that the ability to listen to the audible countdown on the Poker Flat web site is extremely valuable for field operations and believes that this capability should be maintained as part of the Poker Flat operations.

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

APPENDIX

June 2010

Report of the SRWG Sub-Committee on High Altitude Rockets to Increase Astrophysics and Solar Observing Time

As an outcome of the February 4, 2010 SRWG meeting, the SRWG released a finding on the use of High Altitude Rockets to Increase Astrophysics and Solar Observing Time (HARIASOT) with the goal of extending the science achieved by the Sounding Rocket Program (SRP) by significantly increasing the available observing time above 250 km through the use of existing rocket program launch vehicles, the Black Brant XI and XII (BBXI and BBXII), with payload recovery.

Science capabilities would be increased by extending the time above 150-250 km by

(1) permitting execution of programs that would otherwise be background limited (faint sources);
(2) permitting the execution of previously instrument limited programs (e.g. higher resolution spectroscopy, novel technologies) and hence previously unachievable programs;
(3) providing time to observe an increased number of targets (pointings) on a single flight;
(4) increasing the field of view (area) on nearby extended targets, such as the Sun. Some solar missions scan a slit across the Sun to build a spatial-spectral picture. Increasing the observing time by a factor of two increases the FOV by a factor of two. Because the atmosphere of the Sun evolves on timescales of minutes, the scientifically useful FOV cannot be increased by combining two flights with adjacent FOVs.
(5) increasing the signal-to-noise on observable targets to enable the detection of spatial or spectral structures in the target, in particular, structures previously background limited.

Note that only for the last motivational argument (5), do science benefits scale as signal-to-noise, which scales as square root of the observing time. For all other science motivators, the figure of merit grows much more rapidly: opportunities 1 and 2 open discovery space, capabilities 3 and 4 represent a linear growth in science benefits with increased observing time.

From carpet plots generated by WFF (Mr. Brent Edwards), it was estimated that for launches of a 1000 pound payload from WFF (i.e. near sea-level) at an elevation angle of 85 degrees the **gains** in time above 250 km relative to the BB IX are 164 and 114 percent for the BB XII and XI. The percentage **gains** in time over 150 km are 85 and 62 percent respectively. Typical elevation angles from WSMR are higher and, as is the altitude of the site relative to WFF, each of these effects would yield a higher apogee.

If the gains in observing time promised by the BBXI and BB XII vehicles are to be realized, then a high altitude recovery system must be implemented, together with either: (1) a larger land range, (2) a means to stay within the WSMR range limits, or (3) sea recovery. SRPO has been investigating many of these options over the years, and the SRWG requested that a summary of the technical feasibility and cost-benefit analysis of these alternatives be presented with consideration given to the increase in observing time, additional sky coverage achievable, rocket dispersion, payload recovery costs, and infrastructure costs. The SRWG does not have the independent means to assess the full costs associated with options 1-3.

Costs: Excepting the option for an alternate or modification to the Nihka stage, it should be emphasized that **no new vehicle development is needed.** The use of refurbished military motors has been successful in holding down the costs of the BB XI and XII vehicles.

The SRWG concluded previously that use of the BBX was not cost effective due to the cost of the Nihka motor in combination with the modest apogee gain for this launch vehicle.

Use of existing, on-site, technical infrastructure and operations, such as the SRPO uses U.S. Army facilities for tracking, range control and recovery at WSMR, would significantly reduce the cost of an ongoing NASA sounding rocket program at Woomera Test Facility (WTF) in Australia.

Time gains: The increase in observing time that can be expected from use of the BB XI and XII are summarized in Table 1. Times above two fiducial altitudes are provided: an altitude of 150 km, which satisfies many astrophysical observations, and 250 km, a figure of merit for astrophysical observations at infrared wavelengths. The figure of merit for many solar EUV observations is time above 200 km. The greatest gains can be achieved for payloads (e.g. near-infrared) where OH and other high-altitude contaminants are a concern. Using Table 2, we estimate that for launches from WFF (i.e. near sea-level) the **gains** in time above 250 km relative to the BB IX are 164 and 114 percent for the BB XII and XI. The **percentage gains** in time over 150 km are 85 and 62 percent, respectively.

Table 1. The apogee altitude, impact range and times above 150 and 250 km for a 1000 lb payload launched by the BB IX, XI and XII from WFF, and by the BB IX launched from WSMR : Q.E. = 85°

Range	Vehicle	Apogee km	Range km	Time above 150 km sec	Time above 250 km sec
WFF	BB IX	294	169	321	194
WSMR	BB IX	312	122	379	232
WFF	BB XI	438	272	521	416
WFF	BB XII	528	433	595	513

Table 2. Approximate 1-sigma impact dispersions for the BB IX, XI and XII. Incorporation of a radex joint fitting to the Nihka motor is in progress and is hoped to reduce the dispersion of the BB XII configuration.

Vehicle	Launch Site	Launch Elevation Angle [degree]	Apogee km	Range km	EW 1-sigma Dispersion	NS 1-sigma Dispersion
BB IX	WSMR	85	312	122	8	8
BB IX	WFF	85	294	169		
BB XI	WFF	85	438	272	40	60
BB XII	WFF	85	528	433	120	130

Alternate ranges: SRPO has experience in launching sounding rockets from two southern ranges, Roi Namur in the Marshall Islands (Reagan Test Site (RTS): US Army) and the Woomera Test Facility (WTF) in Australia. The WTF is an attractive candidate site for launch of the BB IX, XI and XII vehicles. *The WTF can accommodate the impact range and dispersion of these vehicles, satisfy the requirement for low particle background at sounding rocket altitudes, allow payload recovery, and provide access to the region around the South Celestial Pole which is inaccessible from WSMR, a factor important to astrophysicists*. Providing the capability to use WTF as a routine launch site for the BB IX will enable the use of the BBXI and BBXII launch vehicles with no additional development costs known to the SRWG.

Table 3 Physical size of potential launch ranges for the BB IX, XI and XII vehicles.

Range	**EW Size [km]**	**NS Size [km]**	**Recovery**
WFF			water
WSMR	60	160	land
WSMR + North Extension	60	215	land
Roi Namur (RTS)			water
Woomera (WTF)	600	220	land

The WTF operates a launch range of about 127,000 sq. km, measuring ~ 600 × 220 km (Table 3). Comparison of the 1-sigma impact dispersions (Table 2) with range dimensions indicates that launches of the BB XI and the BB XII and payload recovery should be feasible. The growing technical infrastructure available at the range, the international scope of WTF operations, and the invitation to extend and negotiate the use of range facilities for new users are described in the documents ``Woomera Test Facility Capability Brief'' and ``Trial Activities at the Woomera Test Facility'' (available on request).

This report is an updated abbreviation of the October 17, 2009 report of the SRWG sub-committee on High Altitude Rockets to increase Astrophysics and Solar Observing Time located at http://rscience.gsfc.nasa.gov/keydocs.html.

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 18/19, 2009

1. Impending Loss of Critical Engineering Work Force

Summary

The Sounding Rocket Working Group is alarmed to find that 30 critical engineers and technicians will be terminated from the NASA Sounding Rocket Operations Contract on July 1, 2009. The program depends on these highly skilled individuals, many with decades of experience, not only for their knowledge of existing, highly specialized systems, but also for their ability to design, construct, and test sophisticated sounding rocket payloads at low cost. The loss of this unique and highly experienced body of engineers at the Wallops Flight Facility and at the White Sands Missile Range is likely to have serious and lasting repercussions to innovative space research and technological development for many years to come, placing the health and future of the nation's sounding rocket program at high risk. We urge the Sounding Rocket Program Office to use all means available, including those at the highest levels of NASA management, to avert this crisis and prevent any disruption of the sounding rocket engineering team.

Background

At its meeting on June 18, 2009, the Sounding Rocket Working Group (SRWG) was informed that Northrop Grumman (NG), the prime contractor for the NASA Sounding Rocket Operations Contract (NSROC), had announced earlier this month that it intends to terminate its teaming relationship with its subcontractor, Orbital Sciences Corporation (OSC), on June 30, 2009. In consequence, OSC personnel will no longer participate in any NSROC activities. The SRWG was informed that since both NG and OSC are intending to compete for the role of prime contractor in response to the upcoming NSROC II solicitation, the teaming relation would be terminated to allow each company to protect the confidentiality of their separate proposal strategies. Although the current 10-year NSROC contract ended on January 31, 2009, it has since been operating under an extension that applies until June 30, 2009. However, NASA intends to add an additional year to this extension period in order to allow sufficient time to negotiate and establish the new NSROC II contract. Indeed, release of NASA's Request for Proposal (RFP) for the NSROC II contract has been delayed until later this year, with an expected contract effective date of July 1, 2010.

The immediate consequence of terminating the OSC sub-contract is that the NSROC team will suddenly lose 30 highly skilled, experienced engineers and technicians, many who fill critical positions in the program, including the Chief Engineer and the supervisors and lead engineers of several technical departments, including Guidance, Navigation, and Control (GNC), Electrical Engineering (EE), and Mechanical Engineering (ME). The loss of personnel is most serious in the areas of GNC and EE, and will be felt at both the Wallops Flight Facility (WFF) and the White Sands Missile Range (WSMR).

NASA's sounding rocket program relies first and foremost on its cadre of highly skilled, highly experienced, and highly dedicated engineers. This relatively small engineering team represents a significant fraction of the NASA sounding rocket "corporate memory" which enables NASA to produce high quality, sophisticated payloads at extremely low cost. Indeed, various NASA review panels have identified the experienced workforce of engineering contractors as the prime reason for success of the NSROC I contract over the last 10 years.

Recovery from the loss of 30 key engineers will take many, many years, and will cost the program through reduced performance and by diversion of sorely-needed funding into training new personnel. The SRWG notes that the NSROC prime contractor has on numerous occasions emphasized the difficulty of finding skilled engineering staff, particularly given the remote locations of both the Wallops Flight Facility and the White Sands Missile Range. As a consequence, the program as a whole may be expected to slow considerably, with added risk to missions that must proceed with a high proportion of new and inexperienced staff. For example, there are currently five rockets scheduled for launch at WSMR in the next three months. These missions must now either be delayed, or else proceed, if it is indeed possible to do so at all, with serious risk due to the expected loss of key engineering expertise.

Cataclysmic turnover in this small and highly specialized workforce will be hugely and unpredictably disruptive to the program. The SRWG finds this situation alarming and serious, and urges that all available means be pursued to find a solution which averts this crisis.

2. Serious Concerns about "NSROC II" Contract Structure

Summary

We urge the Sounding Rocket Program Office (SRPO) to consider new approaches to the contract structure for NASA's sounding rocket program. The SRWG is seriously concerned that the new NSROC II contract structure does not represent an improvement to that of NSROC I. Rather, the new NSROC II contract structure could hinder innovative scientific experimentation while reducing the efficiencies and cost savings that are at the core of NASA's sounding rocket program. The SRWG suggests that the SRPO manage the NASA science missions in a more direct way, using a "services contract" as is currently used to provide contractor engineering services at the Goddard Space Flight Center. In this fashion, the sounding rocket program benefits from the advantages of both the pre-NSROC and NSROC periods, while achieving a more optimum means to meet the scientific and technological goals of the program.

Background

In February 1999, after years of discussion and planning, the NSROC model replaced the established civil-servant led program. Civil servants had previously managed the program and directed teams, comprised of mostly contractors, to design, build, test, and launch sounding rockets for NASA. The change was enacted primarily to enable private industry to assume a larger role in carrying out NASA's sounding rocket program. The NSROC structure was also intended to save costs, provide more transparent accounting, and to initiate a vigorous external market for suborbital missions. By attracting outside customers for launch services, it was hoped synergy and increased economies-of-scale could be achieved that would benefit NASA.

Although some of these new aspects of the program have been realized, many of the intended goals and benefits were not effectively demonstrated during the 10 years of the initial NSROC contract. On the contrary, the SRWG observes serious deficiencies that will be either be carried into, or exacerbated by, the NSROC II contract structure. The SRWG provided some of its concerns regarding NSROC II in its Findings from its January, 2008 meeting. However, several aspects of the new contract structure had not been fully developed at that time. Further, as the potential loss of large numbers of key, experienced engineers has been revealed to us at this meeting, the SRWG concerns for the NSROC II contract have only deepened. Our most serious concerns are discussed below:

-- The purely incentive fee structure of NSROC II **seriously interferes with a goal-based program such as the sounding rocket program**. The lack of "award fee" and gradations in fee structure in NSROC II will put even more pressure on the experiment team to restrict mission success criteria to requirements that can be easily be met by the NSROC II contractor. In other words, principal investigators can be expected to be asked to "water down" their minimum success criteria in order for contract obligations to be more easily met.

-- The fee structure of NSROC II **will not encourage investigations that require *pushing-the-envelope*,** even if past history shows there is a reasonable chance of attaining the required performance. Because the contractor has internal pressure to maximize their fee, they will have no incentive to agree to more ambitious requirements or, for that matter, any innovation whatsoever. We find this structure highly incompatible with the spirit and overarching goals of the Sounding Rocket Program that has been consistently heralded as an incubator for technical innovation and maximum science return.

-- The NSROC contract did not demonstrate that it saves substantial amounts of money for NASA. The SRWG sees even **less incentive under NSROC II for the contractor to aggressively seek efficiencies** and complete missions for less than their initial bids.

-- The new 5 year NSROC contract term (instead of 10 year) reduces program stability and efficiency, while producing considerable overhead. Further, the risk of losing a substantial fraction of key workforce each time the contract is re-competed, as discussed above in Finding #1, has the potential to **seriously disrupt the entire sounding rocket program** on a regular basis. (The anticipated loss of personnel on June 30, 2009, and the impending disruption to the program emphatically illustrate this point.) The sounding rocket program must be nimble and highly efficient to maintain a tempo of 20 or more missions a year, and even a small disruption can add risk, schedule delays, and loss of science return for multiple investigations.

The committee urges NASA to revisit the contractor-managed mission model and to compare this objectively with a government-led, and contractor-supported, "services contract" model such as is currently in widespread use at GSFC. Using government mission managers (or contractors under government supervision), coupled with a engineering service contract(s), such as the Multidisciplinary Engineering Development Services (MEDS), the Electrical Systems Engineering Services (ESES), and the Mechanical Systems Engineering Services (MSES) contracts at Goddard, would provide a much more efficient model for the sounding rocket program, promoting innovation and efficiencies, whose savings would be directly fed back to the program.

It is important to emphasize that many of the positive aspects of NSROC would be maintained under this new arrangement, such as the accountability and transparent reporting of time spent by personnel on individual projects. On the other hand, aspects of the program which were identified by the user community as serious problems with NSROC (see

Findings of the December, 2000 and January 2001 SRWG meetings) would be immediately resolved. These include, for example, problems regarding field operations where civil servant management is needed to resolve range issues that have direct impact on the NSROC contractor performance and fee. It also simplifies many other aspects of the program, such as the buying of hardware and the maintenance of inventory (rocket motors, for example). In this fashion, the sounding rocket program benefits from the advantages of both the pre-NSROC and NSROC periods, while maintaining the optimum arrangement to meet the scientific, technical, and educational aims of the program.

Given the extension of one year to the existing NSROC contract, we urge the SRPO to consider new approaches to the contractor support structure that are needed to ensure a healthy, efficient, and innovative Sounding Rocket Program for the foreseeable future.

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. James Hecht
The Aerospace Corporation

Dr. Darrell Judge
University of Southern California

Dr. Mary Elizabeth Kaiser
Johns Hopkins University

Dr. Michael Kowalski
Naval Research Laboratory

Dr. Marc Lessard
University of New Hampshire

Dr. Douglas Rowland
NASA/Goddard Space Flight Center

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of December 10-11, 2008

Findings

Findings are followed by two SRWG Sub-Committee reports:

"Comments on White Sands Upgrades"

"Comments on Poker Flat Science Instruments"

1. Sounding Rocket Project Office "Strategic Plan"

Summary.

The Sounding Rocket Working Group (SRWG) recognizes the value of planning long-term investments in a strategic manner. Beyond our input to the Sounding Rocket Technology Roadmap, the SRWG would also appreciate opportunities to participate, where appropriate, in developing the broader "Strategic Plan" with the Sounding Rocket Project Office (SRPO) and the NASA Sounding Rocket Operations Contractor (NSROC).

Background.

The SRWG was pleased to learn of the planned major upgrades for integration facilities for NASA payloads at the White Sands Missile Range (WSMR) and of the new ideas to improve operations and facilities at the Poker Flat Research Range (PFRR) that directly involve NASA sounding rocket missions.

These important improvements have been long overdue and appear to have been made possible by the reversal of a long-term trend toward smaller available resources. Indeed, it appears that the SRPO is regaining a position whereby it might upgrade, improve, and revitalize other aspects of the program as well. For this, the SRWG could not be happier.

As the SRWG recognizes the value of planning long-term investments in a strategic manner, we note that such a process ties individual investments to the higher-level objectives of the program in an explicit manner. In this way, investments have a maximal impact toward meeting, and exceeding, the mission performance expectations of the program, the majority of which are directly related to maximizing scientific pursuits.

Currently, the SRWG provides input to the SRPO "Technology Roadmap". As a partner with the SRPO and NSROC, the SRWG would also appreciate the opportunity to participate, where appropriate, in the process by which such broader strategic decisions are made.

2. White Sands Operations -- Scheduling Issues and Concerns

Summary.

The SRWG is concerned about scheduling issues at the White Sands Missile Range (WSMR). We believe that insisting that missions meet various milestones prior to scheduling launch activities will not minimize the number of mission “scrubs”, but may in fact hinder the ability of the SRPO and PI to maintain flexible launch scheduling, an important feature of the program. The SRWG urges NASA management to engage in a dialogue with WSMR regarding improving the scheduling process.

Background.

The SWRG is very concerned about the slide entitled “WSMR Operations Trends – Schedules” presented by the SRPO at the December, 2008 meeting. This slide stated that there is a trend for NASA missions not to make their launch windows and that this trend could be reduced in the future by a change in scheduling protocol. The stated motivation for the new procedure is to reverse the loss of credibility with the WSMR that may result from these launch scrubs as well as to save operations costs.

The SRWG acknowledges that there are many reasons for launch scrubs and, whereas many of these are valid, they are normal for the sounding rocket program. The scrubs themselves appear to be unrelated incidents and not the result of a systematic trend requiring changes in integration and scheduling protocol.

The SRWG agrees that WSMR launch date requests submitted at the four-week planning meeting should be made on the basis of a careful review of the mission status and remaining schedule risks in the program. However, the requirements for each investigation are so different that the committee does not believe that a single set of milestones for all WSMR payloads should be instigated as this could greatly reduce the flexibility needed by both Wallops and the PIs to schedule their launches. In particular, the proposed approach of only making a launch request *after* the conclusion of all integration activities imposes an undue burden on the science investigations and removes the launch date as an important schedule incentive to complete integration. We do not believe that this would have a significant effect on reducing the launch scrub rate.

On the other hand, the timing of the launch date request should by no means be arbitrary. It should follow a careful review by the PI and Mission Manager of all schedule risks, including an candid evaluation of schedule reserve (slack). The PI should be made aware of the penalty for an overambitious field campaign schedule resulting in a launch scrub. In this manner, the SRPO can then exercise due diligence in this matter without the reduction of overall science program efficiency that would accompany the proposed “one size fits all” policy.

Finally, the SRWG believes that the SRPO should take the lead in raising the awareness of WSMR range personnel of the unique nature and benefits of the NASA Sounding Rocket Program including the need to maintain flexible launch date scheduling.

3. Proposal to Shift Certain Poker Flat Range Operations to the Science Operations Center

Summary.

Suggestions are provided regarding the SRPO proposal to relocate certain operational personnel at Poker Flat to a new facility located at the Poker Flat Science Operations Center.

Background.

The SRWG discussed the proposal of the SRPO that certain operational personnel at Poker Flat be relocated to a new facility located at the Science Operations Center (SOC). In this regard, the SRWG provides the following suggestions:

-- The existing SOC does not appear to have adequate space that could be reallocated for this purpose. The proposal would thus appear to only be feasible if a dedicated extension was added to the existing SOC.

-- A serious concern exists regarding extra vehicular traffic to the SOC, in particular the impacts of light pollution.

-- If this change were to occur, additional bandwidth would be required to the SOC.

-- The experiment teams would appreciate it if the extension is configured to allow either close interaction or full isolation between science and operational personnel, according to the experiment teams' needs for a given mission.

4. Use of Black Brant X, XI, and XII vehicles for Astrophysics and Solar Missions

Summary.

The SRWG requests that the SRPO study the possible use of the Black Brant X, XI and/or XII for launching astrophysical/solar payloads, with a view to making this an option for future proposals to NASA HQ for pertinent sounding rocket missions.

Background.

The available observation time in space by sounding rocket payloads, particularly in the case of astrophysical and solar instruments, is a constraint whose impact on the scientific results has become more significant over the years as more challenging goals have been set. As a result, in recent years SRPO has proposed the development of a new two-stage high-altitude sounding rocket (HASR), based on use of the Orion 50XGL and 30 motors, yielding 2400 sec (40 min) of observation above 100 km. However development of this vehicle has still to be approved, while the scientific need for more observation time becomes increasingly significant.

The sounding rocket program now relies almost exclusively on the Black Brant IX for astrophysical and solar missions, yet its launch vehicle inventory includes the proven

Black Brant X, XI and XII, 3 and 4-stage vehicles, which fly higher and so far have been used predominantly for auroral physics and other geospace investigations. For example, the observation time for a 1000 lb payload launched from WFF increases by over 60% when the BB IX is replaced by the BBXII. Such gains promise substantial increases in the scientific return and yet do not require any vehicle development.

However, some new technical developments would be necessary. The promising launch ranges are WFF and WSMR for northern hemisphere, and Kwajalein (Reagan Test Site) and Woomera for southern hemisphere launches. Missions from Kwajalein and WFF would require further development of techniques for ocean recovery of payloads. Further, payloads would have to be able to withstand the increased re-entry dynamic loads and temperatures experienced if the BB X, XI and/or XII vehicles were used.

The SRWG requests that WFF study the possible use of the BB X, XI and/or XII for launching astrophysical/solar payloads, with a view to making this an option in future proposals to NASA HQ for sounding rocket missions. The following technical questions are anticipated:

(1) What are the range and launcher constraints upon use of these three Black Brant vehicles at WFF, WSMR, Kwajalein and Woomera?
(2) What are the technical implications and cost of developing ocean recovery techniques for launches from WFF and Kwajalein?
(3) What technical developments are required to accommodate the increased re-entry loads and temperatures associated with these three vehicles?

5. Request that Higher 20 Mbit T/M Rate Option Becomes "Standard"

Summary.

The SRWG applauds NSROC's recent work with high-rate telemetry systems including the 100+ Mbit directional antenna and the 20 Mbit augmentation to the WFF93 system. We highly encourage that the 20 Mbit augmentation to the WFF93 system be offered as a standard option to all future payloads and that NSROC and the SRPO continue to investigate methods of offering even higher data rates using both directional and omni transmitters.

Background.

Current and future payloads continue to grow in complexity and acquire ever increasing amounts of data during a rocket flight. It is becoming not uncommon for the scientific content of the mission to be constrained not just by mass and power envelopes but also by the available downlink rates on the sounding rocket platform. To enable the continued development of complex and scientifically rich payloads, we strongly encourage NSROC and the SRPO to enlarge the envelope of available downlink rates with a goal of achieving 100+ MBit per omnidirectional transmitter at all launch ranges. This includes investigating methods of offering high data-rates in the crowded and tightly controlled RF space at WSMR.

Further, we highly encourage that the 20 Mbit augmentation to the WFF93 system be offered as a standard option to all future payloads and that NSROC and the SRPO continue to investigate methods of offering even higher data rates using both directional and omni transmitters

6. NSROC communications

Summary.

The SRWG believes the NSROC mission close out reports are essential documents, yet are not routinely accessible to the experimenters. These should be readily sent to the PI upon completion. Further, the SRWG believes that the web sites for individual missions, provided by NSROC, may be very useful, depending on the mission.

Background.

The SRWG believes the NSROC mission close out reports are essential documents, yet are not routinely accessible to the experimenters. These should be readily sent to the PI upon completion. Such close out reports are particularly useful for understanding the performance of a given mission, as well as for planning future missions.

The SRWG believes that the web sites for individual missions, provided by NSROC, may be very useful for planning, documenting various aspects of integration, and for general communications with a payload team. Although these advantages may vary considerably between missions, the SRWG believes that the option to utilize such web sites should be offered and discussed with each mission P.I.

NASA Sounding Rocket Working Group

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

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. Mark Conde
University of Alaska

Dr. Massimiliano Galeazzi
University of Miami

Dr. James Hecht
The Aerospace Corporation

Dr. Marc Lessard
University of New Hampshire

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Doug Rowland
NASA/Goddard Space Flight Center

Dr. Thomas Woods
University of Colorado

SRWG Sub-Committee Report: "Comments on White Sands Upgrades"

The SRWG is excited to learn that facility improvements at WSMR are being pursued. The overall plan to move LC-35 N-200 / SPARCS activities to LC-36 VAB area is a good plan if additional facilities can be constructed to accommodate the total space needed for 3 simultaneous payload integrations. The SRWG suggests the following options to examine while planning the facility upgrades at WSMR. A subcommittee of the SRWG looks forward to reviewing the WSMR upgrade plans as they are updated.

1) Total space at VAB should be enough to accommodate 3 payload integrations. A large integration area for multiple payloads is acceptable. In such an approach, it is desirable to have the capability to isolate portions of the facility into separate integration areas. If the implementation of these improvements is conducted in two phases, a separate 3rd payload integration area could be part of the second phase of improvements.

2) The SRWG emphasizes the importance of control of the integration area environment for particulate and organic cleanliness as well as ESD. The SRWG envisions that the integration room could have ceiling-mounted blowers to maintain a simple down-flow clean environment, perhaps at class 100,000 level. Epoxy paint of normal construction walls provides a low cost solution for these surfaces. For higher level of cleanliness, a clean tent and flow benches would be used. Flow benches can provide class 1000 environment for optical assembly and clean-sensitive activities. ESD control is of utmost importance, so clean tent curtains and work bench areas need to be qualified for ESD control. Linoleum flooring is a low cost solution for ESD and cleanliness control of all areas of the room

3) The number of doors into the integration room should be limited to restrict the flow of people (dust) into the integration room. Access to any other area of the VAB should not involve traffic through the integration room. For example, the door for the stairways leading from the second floor should only be into the VAB and not the integration room. The external door in the integration room should only be used as an emergency exit (alarm on door).

4) The current VAB darkroom can be modified for SPARCS testing in a straightforward manner. However, the cleanliness level of this room must be upgraded in the process. The existing ceiling tile grid can be retained with the addition of drop-in cleanroom ceiling tiles and lighting panels. The existing HVAC is easily adapted to the necessary level of filtration. It is recommended the payload access door aperture be covered by a cleanroom strip curtain.

5) Maintenance of the cleanliness of these areas is critical to their functionality. However, this maintenance will be prohibitively expensive if it is simply contracted out. The SWRG suggests putting the day-to-day maintenance burden on the users of the facility. In this approach, the WSMR upgrade subcommittee will take the lead in developing a cleanliness manual for users of the VAB payload facility. Such a manual would contain a SOP and a maintenance checklist/schedule. In addition to the supplies and maintenance NSROC currently provided in support of N-200 and VAB clean tents, the SRWG recommends the provision of integration facility entryway sticky mats, disposable shoe covers, and basic cleaning tools (mops, buckets, wipes) dedicated to the facility in order to ensure a baseline. All other supplies (gowns, headcovers, gloves, etc.) will be specific to the individual requirements of an investigation and should be provided by the investigator.

6) The SRWG emphasizes the importance of near-line-of-sight communication between the integration facility, the ASCL room, and the ground station during any operation for solar payloads involving sequence testing. This capability in the current N-200 facility should be retained in the VAB accommodation.

7) Payload access between VAB high-bay and integration room may need to be reconsidered for a more direct path for long-payloads between these areas.

8) The SRWG recommends the phase-II payload integration facility addition be configured as a dedicated clean room unless the performance of the phase-I facility makes this redundant.

9) The SRWG emphasizes the need for adequate electrical power and internet connections to adequately accommodate multiple payload integrations. For example, consider 110 VAC and 220 VAC outlets and multiple breaker circuits.

10) The SPARCS vacuum station no longer meets the cleanliness requirements of of contemporary payloads. The SRWG recommends replacement of the vacuum station with modern equipment either as a part of this facility improvement or as a general capital equipment procurement. Any new vacuum station should be designed to accommodate operation on the launcher up through the final countdown (e.g. the NASA 36.240 Woods configuration).

SRWG Sub-Committee Report: "Comments on Poker Flat Science Instruments"

The SRWG sub-committee for Poker Flat science instruments discussed the issue of which instruments should be funded through the NASA range contract and be made available for routine launch support. The following points were raised during discussion:

-- Concern was expressed that PIs have over many seasons been generally disappointed with the level of readiness and reliability of the launch support instrumentation.

-- The sub-committee recognizes that there should be a "baseline" set of instruments that the range contract should support for all missions. Beyond these, there is a wide array of additional instruments potentially available -- but the relative priority of these will be strongly dependent on the science objectives of each mission.

-- The baseline support that the sub-committee felt should be available for all missions are:

	Poker	Fort Yukon	Kaktovik
Fluxgate Mag	X	X	X
All-Sky	X	X	X
MSP	X	X	X
Riometer	X		
Look-angle prediction	X	X	X

-- These instruments should provide real-time displays of their data during launch operations, archiving of the data, and distribution of data to experiment teams in a timely manner ASAP after launch.

-- For instruments such as the MSP and fluxgate magnetometers, the SRWG sub-committee also requires that these instruments have routine calibration and up-to-date baseline subtraction.

-- In addition, the SRWG sub-committee expects that the range will provide observing spaces (with power and communication) at Poker, Ft. Yukon, and Kaktovik for PI-provided instruments that could be deployed in an ad-hoc fashion as needed by specific missions.

-- The sub-committee noted that this is very much a minimal list, and that almost all experiments would require more support than this.

-- The sub-committee noted that Toolik Lake is an emerging new site that could be very attractive for supporting a number of new missions in the future. Some consideration should be given to whether any instrumentation could or should be supported at this site.

-- Other instruments that could/should be included under NASA support remains subject to negotiation. Examples include additional riometers and magnetometers, narrow-field cameras, grating spectrometers, induction magnetometers, photometers, Fabry-Perot spectrometers, and tomography receivers.

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of July 1, 2008

1. Review of the Sounding Rocket Technology Roadmap

Summary.

At the request of the Sounding Rocket Program Office (SRPO), the Sounding Rocket Working Group (SRWG) reconsidered which future technology developments promise the most significant scientific advances within the sounding rocket program. Rather than add new ideas to the existing SRPO Technology Roadmap, the SRWG reaffirms that the new technology ideas previously suggested remain highly relevant and scientifically promising. Our four highest priorities for new technology development are: (1) high altitude sounding rocket, (2) new mesosphere miniaturized rocket, (3) water recovery for astrophysics and solar payloads, and (4) significantly higher telemetry rates. Features of these new technology ideas are discussed below.

Background.

At the July 1, 2008 meeting, the Sounding Rocket Working Group (SRWG) was asked by the Sounding Rocket Program Office (SRPO) to reassess their priorities regarding new technology within the program from the standpoint of those developments which would enable significant, new scientific advances. The SRWG was also asked if there were new ideas which should be added to the SRPO "Technology Roadmap". The SRWG has reviewed the ideas previously discussed over the past several years and which were outlined in previous SRWG Findings, particularly those of the December, 2001 and June 2002 SRWG meetings.

The SRWG has reaffirmed that the new technology ideas suggested previously by the sounding rocket research community remain highly relevant and promise the significant advances in scientific research. Our four highest priority new technology advances are provided below:

High Altitude Sounding Rocket (HASR). The nominal performance requirements for the High Altitude Sounding Rocket (HASR) are that it achieve an altitude of at least 3000 km, provide ~40 minutes of observing time above 100 km, include a ~1 meter diameter experiment section, and provide an option to be recoverable, although this could be developed later. When implemented, the HASR would profoundly advance future rocket-based investigations across all scientific disciplines supported by NASA, including X-ray and UV astronomy, planetary science, space physics, earth sciences, and micro-gravity. Furthermore, this new vehicle presents a unique and inexpensive engineering test bed for high velocity landing and aerobraking systems, such as currently being considered for probes that will impact other planets and return samples to the earth.

The SRWG is mindful that that the HASR would not be inexpensive. Indeed, we do not advocate the implementation of this vehicle at the exclusion of the traditional, less expensive rocket systems, particularly those that uniquely address low altitude geophysics research (e.g., < 150 km) and the general rockets which permit frequent access to space for technology development and graduate student "hands on" experience. However, as the scientific reward in all disciplines of the HASR promises to be particularly significant, we urge that this new vehicle be developed as soon as possible and integrated as an option within the existing program.

New Mesosphere "Miniaturized" Rocket. Sounding rockets present the only means to gather *in situ* sampling of the many phenomena and critical processes in the earth's upper atmosphere between 40 and 120 km. Further, there is a demonstrated need for multiple (5-10) launches in a given experiment, either in a relatively rapid sequence or as simultaneous launches along different azimuths. Such multiple launches of standard, (larger) sounding rockets are either impractical and/or too expensive. Clearly, the development of a very small, low-cost vehicle and payload system would provide the necessary platform to achieve these measurement goals.

Consequently, the SRWG strongly supports the development of a low-cost, miniaturized (e.g., 4 inch diameter) sounding rocket system for sampling the 40 to 120 km region of the earth's upper atmosphere. We are pleased that such a new vehicle/payload development is currently underway at Wallops via the "Mosquito" program. Indeed, the SRWG has followed the development of this vehicle from its onset and we look forward to seeing it implemented for routine use within the program.

Water Recovery for Astrophysics and Solar Payloads. The SRWG believes that the development of a water recovery system for high flying payloads with as much as 1000 lbs of reentry mass should be a priority. Such a system would enable the recovery of heavy, high altitude payloads launched from the Wallops Flight Facility and Kwajalein Atoll, and would be particularly beneficial for astrophysics and solar payloads that desire to recover the telescope and fine-pointing attitude systems. In the near term, recovery of heavy payloads launched over water would enable the use of BBX, BBXI, and BBXII delivery systems, with high flying performance envelopes that preclude their use at WSMR. This would allow an immediate factor of two increase in observing time over that of payloads currently launched on BBIX's. In the long term, such systems could then serve as a model for development of a recovery technology for the High Altitude Sounding Rocket (HASR) payloads.

Significantly Higher Telemetry Rates. Increased telemetry rates will enable significant advances in a number of experiment areas, including the detection of multiple component HF plasma waves, high speed auroral imaging, and high resolution spectrometry. Higher data acquisition rates of (say) 10-100 times greater than the 10 Mbps rates currently available would provide an immediate increase in the quality and quantity of science experiments performed within the rocket program and we urge Wallops to pursue the technology development needed to provide such higher telemetry rates on a routine basis.

2. Southern Hemisphere Launch Sites

Summary.

The SRWG has expressed concern that a southern hemisphere launch site be available for astrophysics sounding rockets and is seeking information from the SRPO regarding the status of Woomera and Kwajalein as viable alternatives. The issue of non-recovery and water recovery of payloads at Kwajalein continues to command much interest and we seek to learn if these ranges might enable higher apogees for astrophysics payloads with recovery without the need for significant new technology development.

Background.

The Sounding Rocket Working Group is concerned that launch sites suitable for southern hemisphere astrophysics launches no longer appear to be in serious consideration as launch range alternatives. It has been more than 20 years since the last southern hemisphere sounding rocket campaign for astrophysics payloads. This took place at Woomera, Australia, involved land recovery on parachutes of all payloads, and was quite successful. An informal polling of the astrophysics community indicates a strong interest in conducting future flights from the southern hemisphere. Given such interest, the SRWG requests that the following questions be considered by the Sounding Rocket Program Office:

-- What is the status of the Woomera site? How soon could astrophysics flights be supported from Woomera? Would a "campaign mode" flight manifest be essential or could launches be conducted on an individual P.I. basis? Could higher altitude rockets be flown here (compared to White Sands) and still be recovered on land? If so, what are the highest apogees that the rockets might achieve and still be recovered on land, using existing parachute technology?

-- Is Kwajalein a possible site for astrophysics payloads? Given the lack of an alternate, there may be demand for a non-recoverable astrophysics flight opportunity if that could be accommodated at Kwajalein. For example, this might be the last flight of a multi-flight astrophysics program for a given payload. Would the SRPO be agreeable to such a non-recoverable flight of the fine pointing ACS and associated hardware?

-- What is the status of water-recovery analysis for high altitude astrophysics payloads? Kwajalein might become a particularly favorable astrophysics site if this were to become feasible. Astrophysics payloads may also be considered from Wallops if recovery were feasible and the apogees were significantly higher than those permitted at White Sands.

3. Ground-Based Science Instrument Support Within Poker Flat Contract

Summary.

The SRWG appreciates the detailed response of the SRPO to our finding of the January, 2008 meeting regarding support of ground-based science instruments within the Poker Flat Contract. To follow up to this response and the suggestions of the SRPO, the SRWG proposes to form a sub-committee to interact with both Poker and the SRPO to better understand specifics regarding the instruments supported by the range contract and how they will be supported.

Background.

The SRWG appreciates the detailed response of the SRPO to our finding of the January, 2008 meeting regarding support of ground-based science instruments (both at Poker and downrange) within the Poker Flat Contract. The SRWG proposes to form a sub-committee to interact with both Poker and the SRPO to better understand specifics regarding the instruments supported by the range contract and how they will be supported. We propose that this sub-committee would interact directly with the Poker Flat range representative and, if needed, the contract technical representative at Wallops. This appears to us to be the most expedient means to exchange information regarding the ground-based science instruments, their nominal operation, and the expected data flow within the confines of the existing contract. We are particularly interested in specifics on which instruments are supported and their specifications (beyond the Table listed in the range contract). We also request a status report on the instruments at Fort Yukon and Kaktovic that will be used in the winter campaign in 2009.

4. Mitigating PFISR Interference at Poker Flat

Summary.

The SRWG reiterates the urgent need to solve the problem of RF interference between the rockets and the Poker Flat Incoherent Scatter Radar and to develop workable guidelines regarding PFISR operation before, during, and after the sounding rocket launch.

Background.

The SRWG recognizes that the National Science Foundation (NSF) Poker Flat Incoherent Scatter Radar (PFISR) is a critical instrument that brings much needed context to auroral rockets launched from Poker Flat. Indeed, this radar was placed at Poker Flat expressly so that rocket and radar measurements of the high latitude upper atmosphere might be gathered simultaneously.

Recent Poker Flat campaigns (Joule-2, ROPA, CHARM) experienced significant interference on the launch pad between a harmonic of the PFISR operating frequency and the rocket telemetry links. This is especially problematic with payloads whose telemetry essentially fills the entire S-band, making PFISR interference difficult to avoid. The SRWG would like to reiterate its desire for NSROC to work with NSF, PFRR, and SRI to find ways to mitigate this interference, and to develop guidelines as to PFISR operation before, during, and after the moment of rocket launch. Especially critical are simultaneous measurements from PFISR while the rocket measurements are being made. If possible, SRWG would like to see operational modes and plans in place so that PFISR use before, during, and after rocket launches would be routine. This may require a combination of field testing, reduction in strength of harmonics while the rockets are on the pad, and a more realistic assessment of the impact of the interference on the pad.

5. Restoring Wallops Ionosonde Capability

Summary.

The SRWG recognizes the importance of having a local, ground-based ionosonde at the Wallops Island rocket range that provides both background and specific real-time information essential for many geophysical rocket launches as well as synoptic, statistical ionospheric data placed in a worldwide archive to be used for planning new missions as well as for research by the international scientific community. Despite being an integral part of the Wallops range, neither the normal Wallops digisonde nor the new, “enhanced” ionosonde at Wallops are currently working. The SRWG urges Wallops Range Operations management to help facilitate the restoration of these ionosondes to their routine, operational status, thus continuing their important role for the Wallops rocket range.

Background.

For almost 80 years an ionosonde has provided measurements of the mid-latitude ionosphere in the Washington, D.C. region. For over four decades, the “home” of such an ionosonde as been at the NASA/Wallops Flight Facility. Although two very capable ionosondes are set up and available at WFF, neither ionosonde is currently operational.

Ionosondes are ground based instruments that provide both practical (space weather) information (e.g., maximum useable frequency for navigation/communication purposes) as well as important geophysical data in their own right (e.g., ionospheric density motions, and irregularities versus altitude). Ionosondes at Wallops have provided a treasure trove of synoptic, statistical data regarding the ionosphere and are typically relied upon by geophysics sounding rockets for either background or specific real-time information regarding the local ionospheric conditions during launch operations at Wallops. They are also provide essential data for planning the season and local times of future ionospheric missions.

At Wallops, there is currently a traditional ionosonde, represented by the Air Force “digisonde” that has been in service for several decades and is currently linked to the worldwide digisonde network and data archiving facility. This instrument is currently not working, although may only be in need of a minor repair. Unrelated to the fact that this instrument is currently not operational, the Air Force has decided to discontinue its support of this instrument. The SRWG urges that Wallops assume responsibility for maintaining this instrument as part of its normal home base range operations. We note that in this manner, the support of this instrument would be similar to that of the nominal ground-based instrument support provided at Poker Flat as part of that range operations contract.

Wallops also recently helped install a state-of-the-art ionosonde, referred to as the Vertical Incidence Pulsed Ionospheric Radar (VIPIR) in support of the recent Earle rockets. This ionosonde was provided with funds from NASA HQ in support of the Earle mission, although continued maintenance support was not provided. Although successfully operated during the Earle rocket campaign, the VIPIR ionosonde currently needs additional work in order to operate autonomously and routinely as well as to provide daily ionospheric measurements available for archiving and web access. The SRWG requests that routine maintenance of the VIPIR ionosonde also be supported at some reasonable level by the Wallops Range Operations, with specific support and data analysis for concentrated data gathering during rocket campaigns to be borne by the individual rocket Principal Investigator.

The SRWG suggests that they designate a user who is knowledgeable of ionosonde operations and data usage to be an interface with the Wallops range management to help evaluate and facilitate the restoration of this essential ionospheric tool at the Wallops rocket range.

6. Praise for Wallops Sounding Rocket Annual Report

The SRWG is delighted with the annual report that was presented at the SRWG meeting and which comes on the heels of the very successful quarterly “Rocket Reports” that were presented at the previous SRWG meeting. To this end, the SRWG again salutes the work of Ms. Berit Bland and Mr. Charles Brodell for this welcomed accomplishment.

NASA Sounding Rocket Working Group

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

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. Mark Conde
University of Alaska

Dr. Massimiliano Galeazzi
University of Miami

Dr. James Hecht
The Aerospace Corporation

Dr. Marc Lessard
University of New Hampshire

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Doug Rowland
NASA/Goddard Space Flight Center

Dr. Thomas Woods
University of Colorado

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 23-24, 2008

1. Preparing for the New NSROC Contract

Summary.

As NASA is preparing to instigate a new NASA Sounding Rocket Contract (NSROC) to provide support services to the Sounding Rocket Program, the SRWG offers suggestions, remarks, and concerns regarding how the new contract might be set up:

(A) The SRWG strongly recommends that the present contract "award fee" structure be maintained and, in fact, strengthened, to ensure that costs are kept low and the contractor is a true partner with the experiment team with respect to innovation and problem solving.

(B) The SRWG urges that a 10 year contract be maintained instead of the proposed 5 year contract as the latter would introduce burdensome disconnects in a program that is based on missions that are nominally 3 years long, but may often be longer.

(C) Civil servant involvement should be included, where appropriate, in the contract structure, for example to manage "special" missions for the agency, to chair review panels, and to enable technical training for Goddard (and any other NASA center) engineers and managers.

(D) To avoid problems at the range regarding authority during operations, we urge that either the contractor be given full charge of operations (which has proven difficult since the range agreements are with the government), or that civil servants manage the launch operations, with support by NSROC personnel.

(E) To save money, we suggest that the US Government procure as much hardware as possible, including rocket motors. This will also enable the inventory to stay in government hands when the contract is re-competed every 5-10 years.

(F) The Principal Investigator must remain firmly in charge of each project and should be consulted in assessing NSROC's performance on the individual mission and the sounding rocket program as a whole.

Background.

The current NASA Sounding Rocket Contract (NSROC) will expire in one year, after which time, a new contract will be issued by NASA. The SRWG has been involved with NSROC since its inception and has issued a number of finding regarding how the program is managed and operated, particularly after it was transitioned from a civil servant-run program to one where the contractor is basically in charge of the missions.

(See, for example, the SRWG joint finding of its December 7, 2000 and June 15, 2001 meetings). Despite our initial skepticism, the SRWG has endorsed the NSROC approach and believes it serves the agency program objectives exceedingly well.

In this finding, we underscore those features of the current NSROC contract structure that we feel must be maintained, from both the scientific research and program standpoint, as well as offer suggestions for new contract features, since clearly this is the appropriate time to implement new ideas. We offer 6 such comments/suggestions below, and look forward to continued discussions with the Sounding Rocket Program Office (SRPO) beyond the presentation that was provided to us at the SRWG meeting in January, 2008.

A.) *Contract Structure to Incentivise Contractor to Save Costs and Encourage Innovation*

NASA's Sounding Rocket program is perhaps the last of the true "skunk works" operations at NASA. The unparalleled success of the program rests firmly on the fact that the program is enacted as a partnership between the scientist (P.I. and his/her team) and the Wallops engineering team (NSROC) that has been tasked to design, build, test, and launch a payload (or payloads) to fulfill cutting-edge scientific research. Often, this requires that NSROC develop innovative, new payload designs, in close cooperation with the PI science instrumentation, which is often also being developed for the first time in parallel with the Wallops engineering activities. Furthermore, since many of the NASA science missions are launched into one-of-a-kind geophysical events, the need for creative solutions to optimize and meet launch conditions (innovative countdowns, real-time data displays, joy stick operations, etc.), also require a close partnership between the science team and NSROC.

To this end, *the current contract structure of an award fee plus incentive fee makes sense and is appropriate for the program*. This structure incorporates both an objective and subjective criteria on which to award fee. The latter is important for cases where a mission falls between minimum and comprehensive success, as well as provides a means to reward the contractor for both innovation and time-saving measures (expedient integration and operations). By contrast, a contract that is based on a fixed fee, makes little sense for this type of program. The contractor would then be expected to inflate costs to make sure the company is well covered for any unforeseen contingency and removes any official incentive to save costs or be innovative.

B.) *Five year vs. Ten year Contract*

The SRWG was informed at its recent meeting that the new NSROC contract is likely to cover only a 5 year period, as opposed to 10 year (5 + 5 year) contract, as is presently the case. The SRWG believes that a 10 year contract is far more appropriate for the program. The reason is that most missions require a minimum of 3 years to be enacted. It is important to have continuity with the same engineering and management team working with each project for as much time as possible. A 10 year contract provides far fewer disruptions to the multiple parallel flight programs that are in process at any one time. For example, re-competing the contract every 5 years has the potential to disrupt the 20-30 flight programs that would be in various phases of development at any given time. We find this additional risk to this large number of flight programs to be unnecessary, particularly since it could be substantially minimized by a longer NSROC contract.

C.) *Civil Servant Involvement*

The SRWG urges that civil servants participate in the program beyond their current role. In particular, we believe that civil servants should be allowed to manage and/or provide engineering expertise for any NASA sounding rocket mission when the need arises (e.g., missions that address special agency needs, missions that provide training of certain civil servant skills, and/or missions or campaigns with a significant foreign component).

We have also suggested over the years that a civil servant should chair (or at least serve on) the Design Review and Mission Readiness Panels to ensure an objective assessment is made of all critical decisions, particularly ones involving the need to expend additional contractor resources. Although the current NSROC team has demonstrated that they are fully capable of "policing" themselves, there is nonetheless a conflict of interest. Further, the new contractor may not be as even-handed, particularly as they come up to speed on how to manage the individual projects.

Finally, as it is well-established that the program provides an excellent opportunity to train engineers, technicians, and managers, it would therefore be appropriate that NASA civil servant employees would also benefit from this opportunity, providing well-defined tasks working closely with the NSROC team.

D.) *Operations*

One area where the NSROC activities have encountered some difficulties has been in the area of operations, as noted in previous SRWG findings. This is primarily because the various range contracts and agreements (e.g., White Sands, Poker Flat) are made between the range and NASA, whereas the NSROC manager requires a great deal of real-time authority to get the mission staged and launched. We urge that the new NSROC contract be structured so that missions are led by civil servant field managers during the operations phase, or that NSROC be given much more authority at the launch site.

E.) *Procurement*

As the SRWG has suggested in the past, in order to save money, we recommend that the US Government procure as much hardware as possible, including rocket motors for the sounding rocket program. This will also enable the inventory to stay in government hands when the contract is re-competed every 5-10 years. Not having access to the relevant financial records, the SRWG requests that a simple analysis of major procurements for the program over the last 9 years be provided in order for the SRWG to better understand whether indeed significant money might have been saved via government purchases compared to those of the NSROC contractor.

F.) *PI Involvement in Mission and NSROC Assessments*

A hallmark of the program since its inception, the Principal Investigator (P.I.) is firmly in charge of his/her sounding rocket mission. The P.I. is thus the logical source to provide the assessment of individual mission performance, which includes an assessment of the NSROC contractor performance. He/she should also be consulted regarding overall NSROC performance, when it is appropriate to carry out assessments of the program. When the first NSROC contract was enacted in 2000, a review was conducted two years later to ensure that the most important program elements were still being met from the user (scientist) perspective. The SRWG believes that such a review would also be appropriate, and should be included, for all follow-on contracts.

2. Working with Export Control (ITAR) Guidelines within the Sounding Rocket Program

Summary

The SRWG commends NASA HQ, the SRPO, and NSROC for finding a workable interim solution, involving Technical Assistance Agreements, to the extremely difficult problem of complying with a top level interpretation of the US export control regulations in a hands-on, research-oriented space-flight program that services a wide variety of basic science investigations with extensive involvement of Foreign National students enrolled in US educational institutions and of collaborations with Foreign National co-investigator institutions. The SRWG extends its appreciation to NASA HQ for organizing a panel of agency experts that discussed the ITAR restrictions and received user input on how ITAR is affecting our scientific research programs.

Background

Sounding rockets traditionally include the extensive involvement of Foreign National students enrolled in US educational institutions, collaborations with Foreign National co-investigator institutions, and rocket launches on foreign ranges, which are necessary to carry out many geophysical research programs, as well as astrophysical missions that must observe southern hemisphere celestial targets. The SRWG is very concerned about the impact of national export control policies on the sounding rocket program, as they impact the ability to bring instrumentation to foreign ranges to conduct scientific research, the interactions of the payload science and engineering teams with Foreign National graduate students and collaborators, and the ability to share data, including such ancillary information as rocket trajectories and payload orientations.

As the merits of the ITAR restrictions are debated at higher levels, the SRWG commends NASA HQ, the SRPO, and NSROC for finding a workable interim solution involving Technical Assistance Agreements (TAA) to enable research to continue with Foreign National involvement. From the user perspective, the SRWG seeks ways to work with the SRPO and NSROC to efficiently and accurately administer the TAA paperwork so that this process does not require inordinate time and resources. The SRWG hopes that this process can become streamlined to the extent that it becomes “routine”.

The second day of the SRWG meeting included a panel of agency experts that discussed the ITAR restrictions and received user input on how ITAR is affecting our scientific research programs. The panel was highly informative and quite useful to the committee. The SRWG extends its appreciation to NASA HQ for organizing this information exchange and discussion.

3. Escalating Quality Assurance Oversight on Sounding Rocket Missions

Summary

The Sounding Rocket Program is based on an acceptable level of risk that is higher than for other NASA programs. The SRWG finds the current NASA mishap categories inappropriate for the Sounding Rocket Program. The cost threshold for a Category A level mission assurance (mishap) is $1M which now includes almost every sounding rocket mission. The SRWG strongly recommends that the SRPO retain control of mission assurance (mishap investigations) for missions < $5M. In particular, all reviews arising from failures and anomalies in missions at or below this level that do not involve injury or loss of life should be conducted by the SRPO.

Background

The Sounding Rocket Program is charged with three mission objectives, each of which requires a different approach to mission assurance in comparison to other NASA flight programs: (1) development and training of experimental space scientists, engineers & mission managers, (2) development through flight test of unproven technologies for future orbital missions, and (3) investigation of science questions with either immediate payoff or potential for opening new lines of investigation. Each of these activities involves a greater level of acceptable mission success risk to achieve goals vital for future activities. The NASA SRPO excels in optimizing its activities within this very specialized risk environment.

With current technology costs and cost accounting, a large number of SRPO missions fall within the $1M to $5M cost level. These missions are achieved with an outstanding success rate under a mission assurance approach refined over decades of experience in this risk environment. Unfortunately, the threshold for Category A mishaps is currently $1M and has not been adjusted to account for the unique features of the Sounding Rocket Program. The SRWG strongly recommends that the SRPO retain control of mission assurance (mishap investigations) for missions < $5M. In particular, all reviews arising from failures and anomalies in missions at or below this level that do not involve injury or loss of life should be conducted by the SRPO. The consequence of not making this adjustment is an increase of the overall program cost without any specific improvement in mission success. If this continues, there will be a net reduction of program success as resources are drained from productive activity to an activity with no demonstrable program utility.

4. Parachute Disreefing

Summary.

The SRWG applauds the NSROC efforts in exploring the cause of premature parachute "disreefing" which occurs at a rate of ~ 15%. Although this has not resulted in the loss or serious damage of recent payloads, NSROC has taken proactive steps to determine the root causes of disreefing, and develop mitigation and prevention plans to minimize its occurrence. These proactive steps have the potential to save significant costs to the sounding rocket program, especially if they prevent damage to expensive solar and astrophysics payloads, which are commonly recovered and reflown many times.

Background.

Premature parachute "disreefing" is the name for the situation where 1000 lb. parachutes used for recovery of payloads are fully deployed too rapidly. In principle, this can cause damage to the payload, or even total payload failure. Although premature disreefing has occurred on a number of flights (8 of 56) since NSROC's inception, it has only resulted in payload damage or failure on a small number of occasions, and most of those were early in the NSROC tenure.

Despite there having been no recent major damage to payloads, NSROC has recognized the potential for significant problems due to premature disreefing and has taken proactive steps to investigate and mitigate the causes of this phenomenon. Most recently, the

36.220 McCandliss and 36.241 Rabin flights exhibited this behavior. Although no definitive root cause has yet been identified, two possible scenarios include high levels of payload dynamics during the drogue stage, and sharp edges on the reefing line cutters. NSROC is performing lab testing and has instituted a monitoring program to better understand the causes of premature disreefing.

This level of proactive engineering and investigation has the potential to save the program significantly, and is the type of detailed analysis that can reduce risk to the program while not significantly increasing cost. The SRWG applauds NSROC efforts in this area, and believes that this investigative program should serve as a standard for systems-level engineering and risk mitigation.

5. Downrange Support of Investigations at the Poker Flat Research Range

Summary

The SRWG remains concerned about downrange support at the Poker Flat Research Range (PFRR) and seeks to clarify the SRPO and PFRR contractural agreement regarding the maintenance of the downrange ground-based science facilities.

Background

The vast majority of launches from PFRR require knowledge of ionospheric parameters prior to, during, and after launch and is typically based on data from ground-based all-sky cameras, meridian scanning photometers and magnetometers. This knowledge is of particular importance from “downrange” locations along the rocket trajectory where the payload instruments will gather their measurements, and is usually needed real-time, in order to provide information upon which the launch decision is made. Indeed, the health and availability of the downrange science instrumentation directly impacts the quality and efficiency of scientific research conducted at the range. The SRWG is concerned that some of these core instruments are not adequately supported during PFRR campaigns, and are not adequately tested prior to launch campaigns. We seek an understanding of which instruments are currently supported by the SRPO-PFRR contract.

Following the successful PFRR campaign in January/February 2007, a number of issues were brought to light which directly impact the ability and efficiency with which users carry out scientific research at the PFRR. For example, it became evident that many of the downrange science instruments at Fort Yukon and Kaktovik are in disrepair. Neither of the meridian scanning photometers at these locations were functioning. Although the science teams are generally responsible for funding and operating mission-specific ground-based science instruments, it is the SRWG’s understanding that the maintenance of a suite of standard ground-based science facilities are covered under the contract between NASA/WFF and the University of Alaska at Fairbanks. The SRWG requests clarification concerning which facility components are covered under this contract.

Given that science instrumentation evolves and there will always be a desire for improvements and additional measurements, the SRWG suggests that a sub-committee of users be formed to discuss ways to optimize the instrumentation and its operation and maintenance, including data transfer, display, and archiving, within the resource constraints and contractural agreements that exist between NASA/WFF and the PFRR.

6. University Student Experiment Ride Share (USERS) Program

Summary.

The SRWG is pleased to learn about the new University Student Experiment Ride Share (USERS) program at the Wallops Flight Facilty. The need for a program such as this is clear. The training of undergraduates in space science and engineering is important to all interests in the field, yet opportunities for students to be involved in the development, construction and testing of space hardware is very limited, at best. The USERS program may well fill an important need in fulfilling NASA's need for scientists and engineers in the future and is strongly endorsed by the SRWG.

Background.

The USERS program provides opportunities for up to four universities to provide instruments that will be flown on a sounding rocket from Wallops Island. At this point, the expectation is that this will become an annual event, with launches occurring each fall. Under the current structure, a single university, called the "integrating school" provides nominal support to the participating schools, including details related to mechanical and electrical interfaces, telemetry issues, etc. Once the instruments are built, they are to be delivered to the integrating school for integration into the payload. Afterwards, the entire payload is delivered to Wallops for detailed testing and then launched. Financially, each of the four participating institutions is required to contribute a nominal sum (e.g., from $5 to $15k) to the launch.

The USERS program, with its quick, 1-year turnaround, promises to provide an excellent mechanism to draw students into the field and is a solid investment on the part of NASA. It is our understanding that the program is going ahead in its first year as a trial. The SRWG commends the SRPO for this endeavor and hopes that the new program will be successful.

7. "Rocket Reports" Newsletter and Plans for a Program Brochure

The SRWG is pleased with the quarterly publication of the "Rocket Report" newsletter by the SRPO and salutes the work of Mr. Charles Brodell and Ms. Berit Bland for this accomplishment. The SRWG recognizes the importance of providing information to both the agency and the public regarding NASA's highly successful Sounding Rocket Program and plans to work closely with Wallops to produce a high quality brochure that highlights many of its unique features and important scientific accomplishments.

NASA Sounding Rocket Working Group

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

Dr. Scott Bounds
University of Iowa

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. John Craven
University of Alaska

Dr. Ray Cruddace
Naval Research Laboratory

Dr. James Hecht
The Aerospace Corporation

Dr. Marc Lessard
University of New Hampshire

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Thomas Woods
University of Colorado

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 21/22, 2007

1. A New Beginning for the Sounding Rocket Program

Summary.

The Sounding Rocket Working Group (SRWG) is delighted with the renewed emphasis on NASA's Sounding Rocket Program at NASA HQ, as expressed earlier this year by the Associate Administrator for the Science Mission Directorate, Dr. Alan Stern. Recognizing that the promised funding needed to re-invigorate the program will not be forthcoming until FY09, we endorse the approach outlined for us by the Chief of the Sounding Rocket Program Office, Mr. Phil Eberspeaker, that would enable the program to still meet a number of its FY08 commitments as well as position itself in an optimum way for FY09 and beyond.

Background.

As little as six months prior to its June, 2007, meeting, the Sounding Rocket Working Group (SRWG) was confronted with the stark fiscal reality that adequate funding to continue the sounding rocket program in its present form would not be available. Indeed, we were informed at the December 20, 2006 meeting that the lack of anticipated new funding over the years had left the program severely weakened, and that since no funds were projected to become available in future years, this vital experimental scientific program that had served the nation exceedingly well for over 45 years would essentially be crippled in FY08 and beyond. [See SRWG Finding #1 of December, 2006 meeting.]

In contrast, the SRWG was delighted to learn at its meeting of June, 2007, of the new emphasis on NASA's Sounding Rocket Program expressed by the Associate Administrator for Space Science, Dr. Alan Stern, at NASA HQ. This was indeed very welcomed news. Further, we learned that upper management at NASA HQ has underscored the vital role of the program in training future NASA Principal Investigators, a position solidly endorsed by the SRWG.

Recognizing that the promised funding needed to re-invigorate the program would not be forthcoming until FY09, we appreciate the approach outlined by the Chief of the Sounding Rocket Program Office, Mr. Phil Eberspeaker, with the SRWG at the June, 2007, meeting. These plans would optimize the limited assets available to the program in FY08 to enable it to still meet many of its FY08 commitments as well as position itself well for FY09 and beyond. We applaud the leadership and "can-do" spirit of Mr. Eberspeaker and we thank him for keeping the program on track during difficult times. We look forward to working with the Sounding Rocket Program Office at Wallops, as well as with the Program Leadership at NASA HQ, to ensure that a robust sounding rocket program will flourish at NASA in the years to come.

2. NSROC "Corporate Memory"

Summary.

The SRWG is concerned about the "corporate memory" at Wallops regarding both general practices as well as isolated experiences by members of the technical staff. The expertise and experience of Wallops personnel are very deep and the retention of knowledge from past missions is critical for future successes. We request insight into how such experiences are documented and made available for future missions, particularly when problems are identified that do not necessarily result in a mission failure (and thus may not undergo a formal review).

Background.

The SRWG continues to be impressed with the breadth and depth of experience that have accumulated over the 45 years of sounding rocket missions carried out by NASA engineers and contractors, both at the Goddard Space Flight Center in Maryland and at the Wallops Flight Facility in Virginia. Although it is clear that the success of most missions builds solidly on previously successful engineering practices including proven rocket motor performance, well-working sub-systems, and sound engineering design and analyses, we wonder to what extent this "corporate memory" of the nation's premier sounding rocket organization is documented and maintained. Although it is customary, particularly in recent years, for "lessons learned" to be discussed and, in some cases, documented, the SRWG wonders to what extent a formal data base is maintained and made available to the NSROC engineers, as well as to the users, to enable such knowledge to be used to avoid problems with subsequent missions.

As an example, the recent failure of the LaBelle mission (40.019, Poker Flat, 2007), apparently resulted from a shock caused by a pyro device. Had similar problems such as this occurred in the past that might have uncovered such a potential problem in this payload? How might a payload team have become aware of the potential for such a problem? Although we know that NSROC conducts and documents extensive reviews of official failures and mishaps, in cases where a problem does not result in a mission failure, how would such problems be documented, if at all?

The SRWG recognizes that the retention of corporate memory is non-trivial and we emphasize that it is not our intent to suggest burdening Wallops personnel with excessive and/or unwarranted documentation tasks. On the other hand, the loss of corporate memory is a real concern, particularly as the more experienced work force eventually will retire. Any insights that NSROC or the SRPO might provide on this matter would be welcomed.

3. Poker Flat Items of Concern

Summary.

The SRWG has noted a number of issues involving the Poker Flat Research Range for which we request clarification and understanding from the Sounding Rocket Project Office. These include: new cloud cover rules for launches, radio interference with the new NSF AMISR science radar, and maintenance of downrange ground-based science facilities. All of these items directly impact the quality and efficiency of scientific research conducted at the range and the SRWG seeks to understand the situation and limitations in order to help resolve and optimize operations for future campaigns.

Background.

Following the successful Poker Flat campaign in January/February 2007, a number of new issues were brought to light which directly impact the ability and efficiency with which users carry out scientific research at the Poker Flat rocket range. Our aim is to understand these constraints in an effort to mitigate them for future Poker campaigns.

Cloud cover launch limitation. During recent launch operations at Poker, an apparently new cloud cover requirement for launches was levied on the missions which severely limits the ability to launch rockets, particularly those whose launch conditions are episodic and difficult to predict. The motivation for the cloud cover requirements is unclear to the science teams (e.g., verify the ignition of the second stage? verify that no aircraft are overhead?) Although many experimenters require clear skies over Poker for science reasons (e.g., all-sky cameras, observation of TMA trails, etc.), for others no clear skies are required, or it is only important to have downrange observing sites that are clear. Indeed, some experiments are specifically proposed and planned to NOT require clear skies in an effort to maximize the launch possibilities. Although the SRWG understands the need for safety requirements, we nevertheless request clarification on the issue of cloud cover limits for launch at Poker Flat and whether these limitations are applicable to other ranges as well.

AMISR Radar. The National Science Foundation's (NSF's) new AMISR radar is an important scientific tool that is important, and in some cases critical, for the science operations of many missions conducted at Poker Flat. Indeed, this radar was expressly located at Poker Flat to enable coincident measurements with sounding rocket launches. During the recent Poker Flat campaign, interference of the radar with the telemetry system on several rockets as well as the command/destruct system on one rocket were identified as problems. In fact, for some missions, the AMISR radar was switched off during the countdown as well as the launch period as a precaution. This was particularly unfortunate as the AMISR data had been anticipated as an important part of the science investigation. The SRWG wishes to underscore the importance and in some cases, criticality, of the AMISR radar for sounding rocket experiments and we urge that solutions be found to mitigate and resolve the radio interference issues so that AMISR may operate fully, simultaneously, and without interruption, during the sounding rocket experiments.

Maintenance of down range science facilities. During the recent campaign at Poker Flat, it became evident that many of the downrange science instruments at Fort Yukon and Kaktovic are in disrepair. Neither of the meridian scanning photometers at these locations were functioning. The induction magnetometer at Kaktovic was off and fortunately was made operational without the need to send someone to the site. Although the various science teams are generally responsible for funding and operating mission-specific ground-based science instruments, it is the SRWG's understanding that the maintenance of a suite of "standard" ground-based science facilities are covered under the contract between WFF and the University of Alaska at Fairbanks. The SRWG requests clarification concerning which facility components are covered under this contract. We would like to learn the plans to ensure that such instruments are operational for future campaigns.

4. Improved Attitude Systems

Summary.

The SRWG has a number questions regarding the new attitude systems available to users. With respect to gyro-based attitude systems, there appears to be a timing uncertainty that seriously degrades the accuracy of the measurements, particularly roll angle. With respect to the star tracker based on the ST5000 system developed at the University of Wisconsin, there remain uncertainties regarding the plan to upgrade, manufacture, and test these systems, as well as to maintain adequate inventory for future flights. The SRWG requests an update regarding the status of both of these systems.

Background.

The SRWG has followed the development at NSROC of new attitude systems made available to users, including: (1) a new "gyro" based attitude systems with resolution of approximately 1 degree, and (2) a highly precise star tracker with 1-2 arc-sec resolution for astronomy payloads based on the ST5000 system developed at the University of Wisconsin (UW). Although these new capabilities are welcomed by the science community, a number of issues have recently come to light for which the SRWG requests clarification.

New Gyro Attitude Systems. The new NSROC gyro was flown in support of science payloads for the first time during the Poker Flat campaign in winter, 2007. Although it had been tested in a flight from White Sands, these were the first opportunities in which the gyro was flown for which the science results depended on the attitude outcome. Detailed analysis by the science teams revealed that the gyro data have no verifiable time stamp, or that there is great uncertainty regarding the time stamp. In other words, the user is not able to relate the time stamp provided by NSROC in the PCM stream to the precise time in which the attitude data was gathered by the gyro. Thus, it is impossible to use the gyro data to ascertain the precise position (attitude) of the payload at a given time. To illustrate this, empirical fits of the roll angle data by one science team showed for both payloads 21.138 and 36.234 that a time "correction" on the order of 50 msec was needed in order for the gyro data to agree with the roll angle attitude inferred from a high precision magnetometer flown on the same payloads. For yaw and pitch angles, this time uncertainty is not necessarily a major problem. However, it is a serious problem for the determining the roll angle with the required precision. For example, to determine the roll angle, a 50 msec timing uncertainty translates to a timing error of 18 degrees for a 1 Hz spin rate, far above the stated ±1 degree accuracy. It should be noted that the single most important reason why experimenters utilize the gyro for attitude information is to precisely determine the roll angle, particularly in cases where a magnetic ACS aligns the payload spin axis with the magnetic field direction. (This information is typically provided by a sun sensor or horizon sensor when a gyro is not available.) The SRWG understands that this problem may be remedied by modifying the gyro electronics. We request an update on this important and necessary upgrade.

Star Trackers. The ST5000 star-tracker, developed at the University of Wisconsin (UW), is one of the more significant developments in the NASA sounding rocket program in recent times, one which has been accentuated by the decision at WFF to develop in-house the new celestial attitude control system for very precise astronomical pointing. Indeed, the SRWG has had a number of findings on this system, including one at the last meeting, for which this finding might be considered a "follow-on".

The inventory of star trackers that the SRWG believes will be supplied by UW includes five units, four standard ones and a "flathead" (a miniaturized sensor head -- the others are physically "Ball-compatible"). There are a number of modifications that have been requested by NSROC, including recommendations from the anomaly investigation board (AIB), which we believe will be retrofitted by UW to the whole inventory. Although the SRWG understands that these modifications have been requested, it is not clear that funding has been allotted for all these mods. The SRWG knows of no design modifications beyond that that will be requested by NSROC.

The SRWG requests from NSROC a plan/schedule of how they will manage the acquisition of the star tracker inventory and what their plans are for the future. Questions include: Does NSROC believe the present inventory is sufficient? Who will do the regular flight maintenance? If additional star trackers are needed, how will they be obtained? Do they intend to manufacture duplicates? It appears to the SRWG that a proper inventory analysis, projection of future requirements, cost factors, etc., is needed to insure that these star trackers will be available for years to come.

5. Innovative Pyro Replacements

Summary.

The SRWG requests that NSROC consider the use of shaped memory alloy pin pullers and other innovative devices to replace pyros for various mechanical deployment functions on payloads. Advantages of these devices, compared to pyros, include the fact that their mechanical shock is extremely low, that far fewer safety personnel are needed during installation, and that tests can be repeated numerous times without the need to remove/install pin pullers with pyrotechnics.

Background.

Shaped memory alloy (SMA) pin pullers provide a number of advantages compared to traditional pyro devices. These include: (1) there is no (or minimum) shock associated with SMA devices (note that there have been reported instances when pyro pullers have tripped relays when fired); (2) the number of safety personnel providing oversight during the installation of SMA devices would be greatly reduced; and (3) deployment tests can be performed repeatedly without having to remove/reinstall pin pullers.

To illustrate the advantages and usage of SMA pin pullers by the science teams, on the CASCADES mission (40.017, Lynch), the University of New Hampshire (Dr. M. Lessard) utilized a SMA puller for the baffle on a scientific imager experiment. UNH was able to test the baffle deployment approximately 25 times, with the instrument oriented up, down, and sideways in an effort to ascertain the effects of gravity on the baffle movement. This degree of testing would not have been practical, if a standard pyro device had been used.

The SRWG urges NSROC to consider using SMA pin pullers and other innovative devices to replace pyros for various mechanical deployment functions on payloads where appropriate. Despite our enthusiasm for such devices, we are also interested in learning any negative aspects of their use, including comments on their reliability and cost.

NASA Sounding Rocket Working Group

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

Dr. Scott Bounds
University of Iowa

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. John Craven
University of Alaska

Dr. Ray Cruddace
Naval Research Laboratory

Dr. James Hecht
The Aerospace Corporation

Dr. Marc Lessard
University of New Hampshire

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Thomas Woods
University of Colorado

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of December 20, 2006

1. Program Funding Crisis

Summary.

The Sounding Rocket Working Group believes that the proposed cuts to the operations budget put NASA's sounding rocket program in great peril. Numerous NASA scientific advisory groups and the National Research Council have concluded that NASA's Sounding Rocket Program should be strengthened and preserved, not decimated. Because of the infrastructure costs at WFF needed to maintain the program regardless of the number and type of launches, even small cuts to an already weakened program have significant negative impact. We urge that the funding cut from NASA's sounding rocket budget since 2005 be re-instated.

Background.

The sounding rocket user community, represented by NASA's Sounding Rocket Working Group (SRWG), is greatly alarmed by recent cuts to the rocket operations budget. These cuts threaten the three hallmarks of the sounding rocket program:

(1) to carry out forefront scientific research, responding quickly and efficiently to new opportunities;
(2) to test new instruments and systems in space;
(3) to provide, at the graduate level, hands-on training in space research and instrument development.

They also imperil the ability of the rocket program to support NASA satellite missions by providing critically important validation and calibration of orbiting instruments, such has been recently carried out with TIMED, SOHO, and SORCE, and is anticipated to be carried out with SDO and AIM. The rocket program may also be expected to develop and test technology essential for implementing NASA's new Exploration initiative.

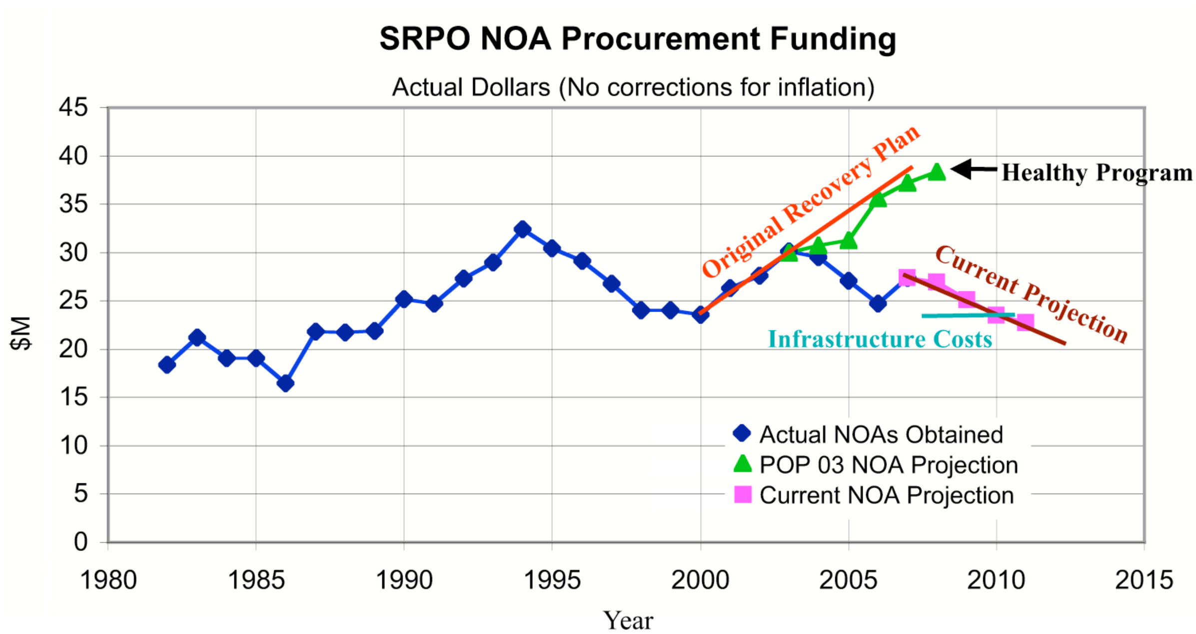
The purpose of this letter is to urge, in the strongest possible terms, your support in resolving the fiscal crisis facing NASA's Sounding Rocket Program. As discussed below, approximately $50M is required over the next five years to restore the program to health and a minimum of $25M is needed over this period (~$5M/year) in order to keep the program at its minimum viable level.

The Current Fiscal Crisis

Both the sounding rocket program budget and the main operations contract at Wallops Flight Facility (WFF) have changed considerably over the past decade. The Sounding Rocket Operations Budget (including funding for payload development) is shown in the graph below. Although rocket operations funding was substantially decreased in the latter half of the 1990's, the program was able to survive for several years by using reserve or carryover funds and by depleting its inventory of rocket motors. The advent of the NASA Sounding Rocket Operations Contract (NSROC) in 1999, together with both the loss of a large number of civil servants and the lack of any inflationary adjustments, placed additional strains on program finances.

Creative efforts by sounding rocket program managers at both NASA Headquarters and WFF led, in the first half of this decade, to a new, approved budget that included an infusion of sustained annual funding that was to begin in FY06 and be used to replenish the motor inventory and stabilize the program in the years to come. The sounding rocket community thus looked forward to a long awaited recovery in 2006 that would enable the minimum viable program to continue. Modest increases (overguides) were also sought to build some reserves in the motor inventory and for new technology development, including the exciting High Altitude Sounding Rocket.

In contrast to this promised increased funding, NASA's initial response to the President's Exploration Initiative in January, 2004, contained severe cuts to the sounding rocket program budget: \$4.2M in FY05, \$10.9M in FY06, \$9.4M in FY07, and \$11.7M in FY08 – **a \$36M cut over a four-year period**. Compounded by prior cuts that left the program severely weakened, these new cuts essentially crippled a program that has served the nation exceedingly well for over 45 years.



The Sounding Rocket Working Group believes that the proposed cuts to the operations budget put NASA's sounding rocket program in great peril. Numerous NASA scientific advisory groups and the National Research Council have concluded that NASA's Sounding Rocket Program should be strengthened and preserved, not decimated. (Some of these endorsements were documented in a similar finding by the SRWG from its June, 2004 meeting.) Because of the infrastructure costs at WFF needed to maintain the program regardless of the number and type of launches, even small cuts to an already weakened program have significant negative impact. We urge that the funding cut from NASA's sounding rocket budget since 2005 be re-instated.

2. Reducing Costs per Mission

Summary.

The SRWG is very concerned with the overall funding shortages for the program and is searching for ways to mitigate the costs per rocket as a means to launch more payloads for a given overall funding allocation from NASA HQ. Consequently, the SRWG requests insight and information concerning the costs per payload. We are particularly interested in learning the extent that flying payloads similar to past ones is an effective means to reduce costs. The SRWG also seeks to understand to what extent the new NSROC contract will include incentives to lower the cost impacts to the program.

Background.

The costs of the NASA-funded missions were revealed in the meeting of January 19, 2005, in which the user community learned that most Black Brant-class missions cost Wallops in the neighborhood of $2.5-3.0M, including operations costs. Detailed information on costs, however, has not been provided to the users. In an effort to learn how these costs might be decreased, the SRWG requests insight and information concerning the costs per payload broken down by sub-systems, particularly as the user requirements have such a direct impact on the costs. We note that the SRWG has had similar findings, requesting such cost information feedback, specifically Finding #7 from the June, 2000 meeting, the general Finding for the combined December, 2000 and June, 2001 meetings, and Finding #3 from the June 19, 2005 meeting. If detailed information is proprietary, perhaps approximate costs could be provided?

To illustrate our concerns, the user community notes that a payload that is similar to one that has flown previously appears to still cost a significant amount, even if it is put in a category reflecting a "near reflight". In other words, payloads with a great deal of similarity to previous ones do not appear to cost much less than new payloads of a similar complexity, except in cases where the payload is an *exact* re-flight of a *recovered* payload. Thus, it appears that the main cost of each mission is due to personnel, hardware, testing, and operations and not so much the design time. We conclude that there is not much financial incentive for users to propose to fly experiments similar to previous ones, except from the standpoint of reducing risk. We would appreciate comments on this conclusion from the Sounding Rocket Program Office.

Looking ahead, the SRWG hopes that the new NSROC contract will include stronger incentives for NSROC to lower the mission cost impacts to the program.

3. Impact of "Reimbursable" Missions on the Science Program

Summary.

The SRWG is concerned that the reimbursable portion of the NSROC activities appear, at least from our vantage point, to increasingly inflict an undue stress on the performance of NASA-funded science missions, even though NSROC has consistently demonstrated that they can meet such "dual-challenge" responsibilities. Although we recognize that the reimbursable activities pay their own way and, in times of fiscal constraints at NASA, help keep the program afloat, the SRWG wonders if improved planning and management might help mitigate some of the tension recently observed between NASA-funded and DoD-funded projects.

Background.

Reimbursable programs have become an important part of the NASA Sounding Rocket program, since the onset of the NSROC contract structure that started in 2000. The inclusion of reimbursable work (mostly DoD funded) was "welcomed with caution" at the onset, as there was an immediate fear that it might one day take priority over NASA-funded work. (See Finding #3 of January, 2003 SRWG meeting). Despite assurances that this would not happen, as the number of NASA-funded projects has diminished and the number of reimbursable projects has grown, there appear to arise conflicts over priorities (e.g., availability of personnel, machine shop, etc.). Furthermore, where this competition is between a NASA science mission and a reimbursable mission, the NASA mission appears, at least in our view, to suffer. Although ultimately, NSROC has, remarkably, been able to satisfy both sets of customers, this has not been without cost. Specifically, the SRWG continually hears of NSROC personnel "burn out", for many working overtime is typical, key managers work more than one job, staff attrition, etc. This, in turn, provides for a stressful situation, as discussed in Finding #6 of June, 2005 SRWG meeting. Furthermore, in cases where personnel have not been available for NASA payload design work and integration activities, some users have found their schedules impacted or "drawn out", resulting in significantly higher experimenter costs.

Although we recognize that the reimbursable activities "pay their own way" and, in times of fiscal constraints at NASA, help keep the program afloat, the SRWG urges NSROC to consider improvements in the management of projects such that the reimbursable work does not negatively impact the NASA-funded science projects.

4. Increase in Safety Requirements and Resources Impact

Summary.

The SRWG was surprised to learn that safety requirements have jumped and that the number of persons working safety issues in the rocket program (and being funded by the program) has significantly increased. The SRWG wishes to better understand the reasons for the increase in safety officers, their roles and responsibilities, and their impact on the operations as well as the sounding rocket budget.

Background.

The SRWG was surprised to learn that 17 of approximately 140 FTE associated with the rocket program at Wallops are dedicated to safety or quality assurance. Although launching rockets has inherent dangers, and although the SRWG is not expert in the practices of safety professionals, employment of more than 10% of the program's workforce by the Safety Department would seem to be in excess of the usual norms. We have heard that new safety requirements have greatly burdened the program and have led to a stretching out of field work, for example at the recent Poker Flat campaign. The SRWG would like to better understand the reasons for the increase in safety officers, their roles and responsibilities, and their impact on operations as well as on the budget.

5. Recent "Extended" Integrations and Procedures

Summary.

The SRWG has been informed by a number of users (including several who are currently on the committee) that recent integration schedules took far longer (10 weeks compared to 3-4 weeks in the past). The long integration is expensive for the payload teams as it ties up technicians, engineers, and scientists for lengths of time considerably longer than those budgeted. The SRWG is chiefly concerned about procedures and communication. We would like to better understand the role of the "Pre-integration Review" at Wallops and how the payload status is communicated to the PI and experiment teams prior to their travel to Wallops for integration.

Background.

Several experimenters experienced some exceedingly lengthy integrations in the Fall of 2006. For example, an integration that typically would last about three-four weeks ended up taking about 10 weeks. In two cases, payload systems were not ready (built and tested) when the experimenters arrived with their instruments for integration. Although in some cases, the experimenters contributed to some of the integration "stretch-outs", they were not the main cause, at least in these recent cases discussed by the committee. Apparently the pre-integration review system at Wallops that ensures that payloads are built and checked out prior to the experimenter's arrival was not explicitly followed last Fall. Another problem that was apparent was the lack of available personnel from NSROC who were needed in the field during critical times precisely when they were also needed at Wallops.

The SRWG would like to better understand the pre-integration procedures and review at Wallops. Is the review documented? Does the SRPO participate? Further, since we understand far too well that unforeseen technical problems may arise, the SRWG believes that communications between the payload teams at Wallops and the experimenters should be improved so that experimenters do not arrive prior to when they are needed, or prior to when their time would be most efficiently utilized. This is particularly important for experiment teams that travel to Wallops from foreign countries.

Finally, we note that the financial consequences of extended integrations for experimenters is severe. One of the most expensive mission phases for the experimenter is integration because of its deployment of dedicated personnel to the field. Substantial and unexpected delays during integration can rapidly deplete the funds of an experiment team, even to the extent that imprudent practices must be employed, such as staffing the integration only during the most critical phases, or with non-expert personnel.

6. High Precision Star Tracker for Astronomy Payloads

Summary.

The SRWG is pleased that Wallops continues to pursue development of a highly precise star tracker with 1-2 arc-sec resolution for Astronomy payloads based on the ST5000 system developed at the University of Wisconsin (UW). Whereas it has been suggested that UW provide such units for Wallops, the SRWG (including a representative from UW) believes that it is far better for NSROC to fabricate and test these units and that a separate, smaller contract with UW be set up to handle problem solving and future improvements such as jitter reduction.

Background.

The ST5000 star-tracker, developed at the University of Wisconsin (UW), is one of the more significant developments in the NASA sounding rocket program in recent times, one which has been accentuated by the decision at WFF to develop in-house the new celestial attitude control system (CACS) for very precise astronomical pointing. The ST5000 is far more precise than the old and trusted Ball Brothers (BB) tracker, for it is able, during a stabilized pointing at an arbitrary star field, to generate a position signal with an intrinsic jitter in the range 1-2 arc sec, to be compared with a figure of 5-10 arc sec previously attained primarily by the BB tracker on centered bright stars. Further, in any pointing attitude, whether this be planned or the result of the ACS losing its attitude reference frame ('lost-in-space'), it can recognize the star field using its own internally stored all-sky catalog, and in an emergency generate error signals which allow the payload to find its way to the desired target. These characteristics would assume still greater importance if, in the future, the SRPO were to build and fly payloads for low-cost orbital missions.

At the recent SRWG meeting, NSROC raised the possibility of meeting the requirement to provide the ACS ST5000 star-trackers for Wallops in the years to come through a contract with UW. Dr. Nordsieck of UW stressed at the meeting that the group at UW responsible for the ST5000 was too small for this task, and moreover its purpose at the university was to function as a small creative team which would address new research needs. Hence, in this context, manufacturing trackers at UW for WFF would be inappropriate. The SRWG agrees with this view and proposes the following:

1) Manufacture and calibration of the ST5000 for the sounding rocket program, and for any orbital programs which may develop in the future, should be undertaken by a section in the GNC branch at NSROC set up for this purpose.

2) The ST5000 contract with UW should be maintained. In this manner, the technology and experience built up over the past 10 years of ST5000 development may be transferred efficiently to NSROC, the UW group can work on unexpected difficult problems encountered by NSROC in using the ST5000, and finally the UW group can develop the improvements to the ST5000 which will be demanded by future missions, for example a reduction of the intrinsic jitter to a fraction of an arc second.

7. Appreciation: Frank Lau

Summary.

The SRWG applauds the work of Mr. Frank Lau during his 41 years of service to NASA and its Sounding Rocket Program. Frank's contributions in the areas of attitude control systems, management of solar rocket missions, and management of the NASA contract with the White Sands Missile Range have been superb. The SRWG offers its sincere appreciation and thanks for Frank Lau's dedication and contributions to the rocket program. He will be greatly missed.

Background.

On behalf of the NASA Sounding Rocket Working Group (SRWG) and sounding rocket user community, we offer our sincere congratulations to Frank Lau on his retirement.

Frank's 41 years of service for the NASA sounding rocket program, first at GSFC and then at WFF, have been outstanding. His contributions in the areas of attitude control systems, management of solar rocket missions, and management of the NASA contract with the White Sands Missile Range have been superb and are greatly appreciated by the user community. Indeed, Mr. Lau has received several NASA Achievement Awards for these exemplary efforts over the years.

Beyond his technical performance, Frank Lau's strong dedication and commitment to making NASA's sounding rocket program the best possible have greatly contributed to the success of the program from which unprecedented scientific research could be achieved. For these superb contributions, the SRWG offers its sincere appreciation and thanks. We extend our congratulations and best wishes to Frank for the years ahead.

NASA Sounding Rocket Working Group

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

Dr. Scott Bounds
University of Iowa

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. John Craven
University of Alaska

Dr. Ray Cruddace
Naval Research Laboratory

Dr. James Hecht
The Aerospace Corporation

Dr. Paul Kintner
Cornell University

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Thomas Woods
University of Colorado

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 29, 2006

I. MLRS Rocket Development

Summary. The SRWG applauds the development work with the MLRS rocket, as this promises to fill a much needed gap in the study of the mesosphere and lower thermosphere and ionosphere. We are particularly interested in the timeline regarding when this new capability will be available and the philosophy of the sub-system development with respect to the enhanced MLRS vehicle. Specific questions are provided in the background section below.

Background. The SRWG has followed the development of the small MLRS rocket system with much interest and is very happy with the progress demonstrated thus far. Indeed, we have provided input in past findings regarding science drivers to help guide the sub-system development priorities. The SRWG has a number of questions which are provided below.

The SRWG is very interested in trade studies concerning the MLRS apogee versus sub-system capabilities. What is the nominal apogee with the standard subsystems and what is the nominal apogee if the payload were to be very simple -- i.e., an inflatable sphere or small chemical release? Along these lines, we are particularly interested in knowing when the enhanced MLRS will become available, and whether the plan is for the enhanced MLRS to accommodate all of the standard sub-systems currently being developed for the standard MLRS vehicle. In other words, will the NSRODC developed payload/sub-systems be designed so that they might be simply bolted on to the higher performance vehicle when it becomes available?

Other questions include: What is the expected temperature of experiment section? Is the experiment section isolated from the Wallops T/M section? Is the MLRS vehicle in a class such that it might be more easily launched from remote (non-standard) launch sites in the US and abroad? The SRWG recommends that Wallops develop a payload to carry inflatable spheres such as those presented by Mr. Frank Schmidlin. Such inflatable sphere payloads have proven to be a workhorse for the miniature rocket program over the last several decades. Ultimately, the SRWG is very interested to learn the timetable for when the SRPO believes such a system will be available for science proposals to NASA HQ.

II. NSROC ACS/Attitude/Trajectory Manual

Summary. The SRWG is pleased that NSROC has released the first edition of the "Sounding Rocket Trajectory and Attitude Analysis Manual", particularly since the need for such a document has been long identified by the user community as essential to understanding how trajectory and attitude information are determined using data gathered by the NSROC sub-systems, including a discussion of the accuracy of the measurements.

The SRWG again reiterates its willingness to provide feedback on all sections of the manual.

Background. The success of the majority of NASA sounding rocket payloads relies on accurate measurements of trajectory and payload attitude. To this end, a variety of attitude sensors are utilized by the program, including gyros, sun sensors, horizon sensors, magnetometer, and star sensors, depending on the experimenter's needs as well as engineering requirements. As these attitude sensors have evolved over time and include new hardware developed in house by NSROC, detailed documentation of the operation of the sensors and their accuracies are essential. To this end, we applaud NSROC for producing a manual entitled, "Sounding Rocket Trajectory and Attitude Analysis Manual". This document has been long awaited by the sounding rocket user community, as discussed in our finding from the January 14, 2004 SRWG meeting.

With respect to the attitude sensors, the SRWG believes that the users are indeed the most appropriate persons to provide feedback on the operations and accuracies of the various NSROC attitude sensors. We thus suggest that small groups (2-3 persons each) organized by the SRWG, though not necessarily limited to SRWG members, provide detailed comments on the current version of the NSROC manual and work directly with the appropriate NSROC personnel to clarify points and identify any areas that may need further information. We suggest that one such team be comprised of solar and galactic/extragalactic astronomers who work with the solar and star sensors and a second team be comprised of geospace users who utilize the NSROC gyro and sun, horizon, and magnetometer sensor attitude descriptions.

With respect to trajectory data, the GPS system, C-band radars (skin track and beacon), TRADAT, and other techniques that provide accurate positional data of the sounding rocket payloads, the current version of the manual available to the SRWG at this time has very little discussion of the various trajectory techniques including their relative accuracies and limitations. The SRWG looks forward to more information on the trajectory measurements and would be very willing to provide feedback in this area as well.

III. Appraisal of NSROC ACS and Attitude Systems

Summary. The SRWG is interested to hear an assessment from SRPO as to the effectiveness of the transition of the various ACS and attitude systems from commercial vendors to the in-house systems. In particular, we are interested to learn how the new systems compare with the previous ones with respect to accuracy and performance, mass, power, volume, telemetry, cost, and ease of use, including the timeliness of providing accurate data products to the user.

Background. It has now been over 5 years since the new arrangement with NSROC has been enacted within NASA's Sounding Rocket Program. Chief among the new aspects of the program has been the transfer of all previously procured commercial ACS and attitude systems to in house design, fabrication, test, and evaluation of these sub-systems. In most cases, the in-house development has included extensive and challenging work. Although we have followed keenly the progress and success of these new systems over the last several years, the SRWG would appreciate having an assessment of how the new systems have fared. How do the in-house systems compare to the commercial ones in terms of accuracy and performance, mass, power, volume, telemetry, cost, and ease of use, including the timeliness of providing accurate data products to the user? What lessons have been learned about taking on such projects? Is the net result worth the effort expended? Are some cases better than others, and why?

IV. Communication between NSROC and Experimenters During Design Period

Summary. The SRWG seeks to alleviate problems during the design phase of the missions that result from the need for final experiment design information from the scientists as well as from the lack of feedback from NSROC on their payload designs well before the Design Review. Ultimately, these problems appear to be best remedied with improved communication between NSROC and the experiment team.

Background. As representatives of the science user community, the SRWG seeks to alleviate problems during the design phase of the missions that result from the perceived lack of final experiment design information from the scientists as well as the lack of feedback from NSROC on their payload designs well before the Design Review. The SRWG emphasizes that, except in cases of re-flights, the science experiments are not “black boxes” that are pulled off of shelves, but rather are one-of-a-kind experiments that undergo a final design phase during the period between the MIC and Design Review, in parallel with the final payload design work by the NSROC engineers. In practice, at a reasonable time prior to the Design Review, a date should be established for finalizing details such as mechanical and telemetry interfaces between the experiments and the payloads. This “freeze date” should be established jointly by the Payload Manager and P.I. This approach requires good communication between the NSROC and Science Teams and has worked well for the program in the past. For new payloads, team meetings between the experimenters and NSROC payload teams have proven to go a long way towards identifying problems and working towards solutions.

Ultimately, the experimenters want to work with NSROC and the SRPO to achieve a successful Design Review that is scheduled when the design of experiments and payloads are complete. The experimenters are, for the most part, fully conscious of the schedule and the need to launch their payloads in a timely fashion. Rather than impose additional deadlines and reviews, the solution to the apparent problems regarding preparations for the Design Review appear to rest with good communication between NSROC and the experiment team including mutually agreed upon dates to establish final interface information.

NASA Sounding Rocket Working Group

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

Dr. Scott Bounds
University of Iowa

Dr. Webster Cash
University of Colorado

Dr. Supriya Chakrabarti
Boston University

Dr. John Craven
University of Alaska

Dr. Ray Cruddace
Naval Research Laboratory

Dr. James Hecht
Aerospace Corporation

Dr. Paul Kintner
Cornell University

Dr. Dan Moses
Naval Research Laboratory

Dr. Ken Nordsieck
University of Wisconsin

Dr. Tom Woods
University of Colorado

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

Findings

Sounding Rocket Working Group
National Aeronautics and Space Administration

Meeting of June 16, 2005

I. Annual Operations at Poker Flat Research Range

Summary:

The SRWG strongly endorses the efforts of the SRPO to re-instigate annual launch operations at the Poker Flat Research Range. Not only does a new cost analysis show that there are no significant cost savings in the current bi-annual operations plan, but also annual operations would provide for risk mitigation, improved launch flexibility with respect to weather and other considerations, as well as potential scientific advantages.

Background:

The decision in the 1990's to restrict the NASA sounding rocket operations at the Poker Flat Research Range to every other year (i.e., bi-annually) was enacted in an effort to conserve project resources. However, the fiscal assumptions upon which this decision were based are no longer accurate. A new analysis by the Sounding Rocket Project Office (SRPO) presented at the June 2005 SRWG meeting shows that cumulative costs for annual and bi-annual operations to support eight launches (4 yearly or 8 bi-yearly) are, respectively, \$417K and \$396K per flight. These numbers include the fact that NASA pays a flat fee of essentially \$1M/year to Poker Flat to maintain the facility, even in the years in which no rockets are launched, in addition to the costs needed for the operations. The difference in the annual versus bi-annual costs per flight is within the uncertainties of the analysis. Furthermore, there will be funds saved in NSROC overtime at Wallops and at PFRR by distributing the work over two seasons instead of forcing it into one season. In this regard, flight risk mitigation is an important, positive outcome that immediately results from a re-distribution of the NSROC staff workload for PFRR-related payload preparation and operations.

A second advantage of a switch to annual operations is the flexibility with the launch scheduling in cases where a mission can not be launched in a given year due to weather or technical problems. Not having to wait two years has immediate advantages for graduate students who are relying on the launch of a particular mission to obtain data for thesis research. Finally, there are possible scientific advantages of being able to conduct rocket operations each year. This is particularly true for missions that rely on correlative measurements with satellites with limited instrument lifetimes as well as missions launched into geophysical events that are dependent on solar cycle or other variables for which a two-year delay is potentially more detrimental than a one year delay. Given these reasons, the SRWG strongly endorses a plan by which NASA HQ and the SRPO re-instigate annual launch operations at the Poker Flat Research Range. Finally, we note that the actual launch operations at Poker in any given year ultimately depends on which rockets are approved for Poker Flat launches by NASA HQ. This finding endorses the possibility of rocket operations each year.

II. Financial Concerns and Resulting Delays

Summary:

The SRWG continues to be concerned about the financial health of the rocket program, particularly the shortfall of funds needed to sustain NSROC, launch operations, and other program elements at Wallops. Despite much attention to this problem at NASA HQ and at the SRPO at Wallops, there does not appear to be any significant financial relief on the horizon. As a consequence, launches are being slipped and the overall number of rocket launches per year will continue to decrease. Furthermore, the number of staff at NSROC, including persons with unique technical expertise, is expected to ultimately decrease as a result of this predicament. Although the SRWG is pleased that a plan has been worked out to enable a new motor buy at this time, we note with great concern that, as a consequence of this, two Geospace missions have been delayed for two years.

Background:

The SRWG maintains a keen interest in the fiscal health of the sounding rocket program, and has expressed concern over the years regarding how the combination of budget cuts, increased NSROC costs, the loss of civil servant personnel, and the realities of "full cost accounting" at Goddard have seriously decreased the total number of rocket missions that can be supported each year by the agency. Despite much attention to this problem at NASA HQ and at the SRPO at Wallops, there does not appear to be any significant financial relief on the horizon. Indeed, launches are being slipped and the overall number of rocket launches per year will continue to decrease. Furthermore, the number of staff at NSROC, including persons with unique technical expertise invaluable to the rocket program, is expected to ultimately decrease.

Despite the grim financial news, the SRWG is pleased that a plan has been worked out to enable a new motor buy at this time. One of the consequences of the decision to proceed with the motor buy now, however, has been the slip by two years of the TRICE Geospace missions (Kletzing, 40.018 and 35.036) from Andoya, Norway. Although it is unfortunate that the Geospace community has shouldered this burden (as was true when the 5 Hecht Geospace rockets were cancelled a few years ago), the decision appears to be the most cost effective means to make some much needed funds available in the short term. The SRWG is in full agreement that the program must buy rocket motors now, as discussed in our finding from the last SRWG meeting. It is unfortunate that this requires a slip of two years of a two-rocket mission that had already completed its Design Review.

III. Black Brant Motors and Alternative Vehicles

Summary:

The loss of the Mk1 Black Brant motor in the recent Lynch mission (40.017) has put a temporary hold on the procurement of new Brant motors. The SRWG eagerly anticipates learning the exact cause of the motor failure as well as the recovery plan and schedule for this vehicle. Whereas we endorse efforts to re-establish the means to procure Brant vehicles, the SRWG also believes that it is prudent for the SRPO to devise at this time an alternative approach, including a cost analysis plan, regarding the procurement of other similar class vehicles, such as the Oriole and ASAS motors, in the event that the Brant recovery is either not successful, or not completed on a timely basis.

Background:

The Black Brant (BB) VC is a major element of various NASA launch vehicles used to launch standard sounding rocket payloads. The current NASA inventory of BB VC sustainers will become fully depleted near the end of FY 2006, as discussed in the SRWG finding from the January, 2005 meeting. Bristol Aerospace does not intend to continue production of the 'standard' VC, but instead, plans to manufacture the Mk 1, an improved version of the VC, containing a propellant of new composition providing a higher total impulse. The current NASA/NSROC plan is to procure a number of Mk 1 motors.

This procurement is on hold following the failure of NASA 40.017 (Lynch), in which the standard VC in the third stage was replaced with a Mk 1. The igniter functioned, but failed to ignite the propellant grain. An extensive series of ground tests of the igniter system will be carried out this summer, to be followed by a test flight in Fall, 2005, of a BB XI, in which the third stage will be a Mk 1. If the ground and flight tests are satisfactory, then the path to a resumption of the Mk 1 procurement will be clear.

However, should these tests leave major questions unanswered, then an alternative procurement for the replacement of the standard VC would have to be implemented. At the SRWG meeting on 16 June 2005, the SRPO proposed two options:

1) The 22-inch diameter Oriole motor
2) The 21-inch diameter Advanced Solid Axial Stage (ASAS) motor

Both sustainers are more expensive than the VC and both would require development of a thrust termination system (TTS) to support launches from WSMR. Performance metrics are somewhat different than the BB VC, although these motors are in the same class as the Black Brant. Mr. Phil Eberspeaker, Chief of the SRPO, stated that some consideration was being given to developing a steel motor casing for the ASAS to lower its cost.

In light of the uncertainty surrounding when and if the new Black Brant motors will be re-certified and available for procurement, we urge the SRPO to develop an alternate approach at this time, including a cost analysis plan, of the alternative vehicles. In this manner, the program will be ready to choose an alternative path, in the event that the Brant Mk1 recovery is either not successful, or is not completed on a timely basis. We see this as the most effective way to sustain the program objectives without a suspension of normal operations.

IV. Low cost mesospheric rocket development

Summary:

The SRWG is encouraged by plans for a 4-inch diameter "Mesquito" payload that would be launched on a surplus MRLS motor. The SRWG was surprised that so little payload volume and mass were left available for the experiment hardware, however. Recognizing that standardization of the payload is the most effective way to keep costs low, the SRWG is assembling user recommendations for this payload/vehicle that will be presented separately. One overriding concern at this time is that the total cost of the payload, motor, and operations remain very low in order to preserve the original intent of this development -- i.e., that multiple launches (e.g., 4 - 6) of such payloads might be launched as part of a single experiment.

Background:

As stated in previous findings, the SRWG has much interest in the development of a small rocket for mesospheric research, and indeed this initiative remains part of the technology roadmap developed by the SRPO with SRWG input.

The SRWG was encouraged by the NSROC presentation of first cut plans for a low cost, mesospheric payload to replace the earlier "Dart" 2-inch diameter payloads. The proposed 4-inch diameter "Mesquito" payload would be launched on surplus MRLS motor. The SRWG was surprised that so little payload volume and mass were left available for the experiment hardware, however. Recognizing that standardization of the payload is the most effective way to keep costs low, the SRWG is assembling user recommendations for this new payload/vehicle that will be presented separately. We also note that passive mesospheric experiments (e.g., inflatable sphere and/or chaff whose motions are tracked by radars) may also use the MRLS motor.

Given the current, severely constrained fiscal environment, we are particularly interested in ensuring that the resulting payload, vehicle, and operations remain at a very low cost. In this fashion, the mesosphere rocket initiative will preserve the original intent of this development -- namely that multiple launches (e.g., 4 - 6) of such payloads might be launched as part of a single experiment that will not cost more than a single, standard rocket payload.

V. Kwajalein as a New "Standard" Range

Summary:

The SRWG supports the inclusion of the Kwajalein range as a new standard location for the launch of sounding rockets without the need for a special campaign status. The unique range location near the equator, the existing infrastructure, and the powerful Altair scientific radar make this location a very appealing site in which to carry out Geospace experiments of the low latitude upper atmosphere. We note that since the Kwajalein range is not on the magnetic equator, however, those Geospace experiments that require close proximity to the magnetic equator will not be served by the Kwajalein launch location. However, astronomy payloads, with or without water recovery, may be able to take advantage of this location in the future in cases where southern hemisphere celestial targets are being studied.

Background:

The SRWG continues to follow with great interest the feasibility study being carried out by the SRPO of establishing the Kwajalein range as one where NASA sounding rocket operations might be carried out routinely, as is currently the case at ranges at White Sands, New Mexico, and Poker Flat, Alaska. As stated in our finding from the previous meeting, the SRWG applauds the work of the SRPO and NSROC in carrying out the very successful Equatorial Ionospheric Studies II (EQUIS-II) sounding rocket campaign in Kwajalein during the summer, 2004.

Kwajalein's unique location near the earth's equator opens the door to a large number of important scientific research problems, in a similar manner in which the Poker Flat range in

Alaska enables important high latitude science to be addressed. The unique range location near the equator, the existing infrastructure, and the powerful Altair scientific radar make this location a very appealing site in which to carry out Geospace experiments of the low latitude upper atmosphere. We note, however, that since the Kwajalein range is not directly on the magnetic equator, those Geospace experiments that require close proximity to the magnetic equator or to the unique NSF-funded Jicamarca observatory in Peru, will not be served by the Kwajalein launch location. On the other hand, future astronomy payloads, with or without water recovery, might be flown from the Kwajalein location where southern hemisphere celestial targets are studied.

The SRPO initial assessment that the Kwajalein range may be accessible to routine operations in much the same way that the White Sands and Poker Flat ranges are accessible now to NASA-funded science missions, is very encouraging news to the SRWG. The SRWG supports the inclusion of the Kwajalein range as a new standard location for the launch of sounding rockets without the need for a special campaign status.

VI. NSROC staffing

Summary:

As program budget margins remain extremely tight, NSROC is understaffed. For example, some NSROC managers lead more than one section and high levels of overtime are now commonplace. The SRWG is concerned that these tight margins with respect to manpower will result in the inability of the SRPO to support selected missions and leave the program vulnerable to increased risk resulting from an overworked staff.

Background:

Years of erosion of the sounding rocket budget have significantly reduced available NSROC personnel. The effects of these budgetary strains are still with us and will not be fixed in a single year. This manpower crisis at NSROC can be seen in many different areas across the program.

That NSROC remains short staffed has been presented at several SRWG meetings, with little relief in sight. NSROC staffing levels have dropped 6 FTEs since the preceding Sounding Rocket Working Group meeting. In order to support the upcoming 2007 Poker season, NSROC anticipates enormous overtime efforts. The high level of overtime puts strain on the work force and adds to the overall mission cost.

For example, in order to cover the need for vehicle system engineering, Mr. Giovanni Rosanova has agreed to head both the mechanical engineering section and the vehicle system engineering section. Although on the one hand, this is another example of the heroic efforts which are so common at Wallops, by making such heroic efforts standard practice, it becomes difficult for such a manager to respond to any crisis that may arise. How can one person run the mechanical engineering section, the vehicle system engineering, and respond to a crisis that develops in either section, all within a 24 hour day? Despite our appreciation of the hard work of the NSROC and Wallops workforce, the SRWG finds the overall staffing situation at NSROC very troublesome.

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
Aerospace Corporation

Dr. Jim Green
University of Colorado

Dr. Gerald Lehmacher
Clemson University

Dr. Paul Kintner
Cornell University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center

Findings

Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 19, 2005

I. Distribution of launches using standard (Brant-class) and surplus motors

Summary:

The SRWG remains extremely concerned about the proposed mix of 5 Brant-class and 15 surplus rocket launches per year as a means to save substantial program costs. As the price of a given payload is essentially the same whether launched on a surplus or a Brant-class vehicle, the only difference is the cost of the motor which typically amounts to less than 10% of the total mission costs. Hence, the SRWG does not understand how such a formula would save substantial dollars as well as saving jobs at NSROC and requests clarification from the SRPO concerning the payload class assumptions in the proposed mix and their relation to manpower requirements at NSROC. Our limited understanding is that only a significant increase of simpler payloads, such as chemical release payloads that do not require either telemetry or attitude control as well as high school student rockets launched to apogees of 50-60 km on single-stage Orion motors, might produce any significant reduction in program costs. The SRWG reiterates its strong belief that the proposed mix of vehicles would be extremely detrimental to the science served by the program, particularly to the astronomy, solar, planetary, and auroral acceleration physics disciplines that can only use the standard Brant-class platforms to meet their mission objectives.

Background:

The Sounding Rocket Working Group (SRWG) continues to be alarmed at the sudden drop in funding allocated to the program compared to the resources it expected to receive at the start of last year. To accommodate the reduced budget, the Sounding Rocket Program Office (SRPO) at Wallops has proposed a new yearly average distribution of missions that would utilize a mix of 5 standard or Brant-class vehicles and 15 surplus vehicles. Although we addressed this proposal at the previous meeting (see SRWG Finding #1 from its June, 2004 meeting), the SRWG has returned to this discussion as we seek clarification of the proposed mix, believe that the situation includes considerable misunderstanding and confusion, and remain convinced that the proposed formula would result in a significant deprecation of the scientific merit of the program.

The SRPO has argued that they would like to maintain an average launch rate of 20 rockets/year in order to satisfy the current NSROC contract and to maintain the critical contractor work force at Wallops. We applaud these goals and look forward to the restoration of the average launch rate of 30 science rockets/year, particularly as there is no dearth of excellent science proposals coming from the science community. As discussed at length in the June, 2004 meeting, during the last 10 years, approximately 70% of the science missions utilized Brant-class vehicles. Indeed, these are the "standard" launches that Wallops provides. The decrease to 5 standard (i.e., Brant-class) launches, or 25%, would severely limit the number of science missions, particularly from those disciplines such as astronomy, planetary, solar, and auroral acceleration physics that can only utilize Brant-class vehicles to meet their mission objectives.

At our most recent meeting, the SRWG learned that the cost of most nominal science payloads developed and launched on surplus vehicles would be about the same compared to ones launched on a Brant vehicle system, with the only difference being the relative cost of the motor which is usually about $200K. This is typically less than 10% of the total mission cost. The only significant difference is when a chemical release payload is launched on a surplus motor, as such payloads utilize no telemetry, fine pointing, gyro, etc. In FY2003 and FY2004, there were a total of 12 such chemical release payloads, all built by one experimenter, although these rockets supported more complex missions that were led by several different P.I.'s, all in ionospheric physics. Our understanding is that the SRPO-proposed mix of 5 Brant/15 surplus launches/year anticipates that a significant fraction of future missions each year would include such chemical release payloads. Additionally, payloads built and launched as part of the high school education program would also be included, which typically utilize single stage Orion surplus vehicles traveling to apogees of about 50-60 km.

We ask that the SRPO clarify the payload classes used in their "mix equation" and cost estimate. Indeed, the proposed mix of vehicles may rely to a larger extent on an anticipated ratio of simple/complex payloads, rather than primarily on a mix of Brant/surplus vehicles. Further, we note that there has a been a large number of test vehicles flown in the past few years, as NSROC has been developing new sub-systems in support of science missions funded by NASA HQ. What is the anticipated rate of such test missions that the SRPO has assumed in their future planning? We would also like to better understand how the manpower and costs factor into the various payload and launch vehicle mix, particularly since the maintenance of the work force at Wallops has been portrayed to us as the most important factor in proposing the new mix.

Ultimately, a combination of complex and simple payloads, as well as a mix of Brant-class and surplus vehicles, must be achieved to enable a minimum rate of excellent science missions that fits within the envelope of available NASA HQ resources and Wallops capabilities. The SRWG believes that a larger number of standard missions (i.e., Brant-class launches) are necessary to keep the science portion of the program viable, even if the overall number of missions launched per year might temporarily fall below 20, during this, hopefully brief, interlude of extreme fiscal restraint.

II. Lack of Brant-class motors in FY07 and beyond

Summary:

There will be no Brant-class motors left after FY06 if the program flys all of the missions currently approved. The SRWG urges the SRPO and NASA HQ to find a way to procure Brant-class motors in the current fiscal year to maintain this standard launch capability in FY07. As the severe fiscal cuts to the program came without warning and without time for appropriate planning, surely some creative solution might be put forward to rescue this absolutely vital aspect of the nation's sounding rocket program.

Background:

Regardless of the number of Brant-class systems to be launched each year, the number of

Brant motors currently available to the program is perilously low. Indeed, the SRWG has been informed by the SRPO that there will be no Brant motors left after FY06 if they fly all of the missions currently approved.

The SRWG feels it is imperative that Wallops purchase more Brant motors at this time, as the lead time for such a procurement is about one year. This is essential in order to maintain the current launch capabilities in FY07 and beyond, even if there will be a reduced number of Brant launches in those years. Further, we have been informed that there are considerable savings by ordering the motors in bulk, and that these savings begin to become appreciable with a minimum order of 5. We urge the SRPO and NASA HQ to find the resources to keep the inventory alive such that the program might stay "ahead of the curve". The new fiscal reality has had a strong, negative impact on the program that came without warning and with no time for appropriate planning. This loss of anticipated funding is particularly difficult for the program to absorb since an augmentation for FY06 had been promised and would have gone expressly to restore the commercial motor inventory. Although we know that the SRPO and NASA HQ are aware of this situation, the SRWG urges that a creative solution be found to make such a purchase now in order to maintain the minimum program capabilities in FY07 and beyond.

III. Future mission cost estimates and availability of past mission cost data

Summary:

The SRWG supports the plans both for NASA HQ to carry out more detailed estimates of total mission costs prior to selection and for cost data of past missions to be shared with the PI's so they might understand the specific impact of their mission to the program. Though a departure from over 45 years of "business as usual" in which the science PI's and other researchers have benefited from NASA's sounding rocket capabilities without any detailed knowledge of the payload or operations costs, such accountability should help reduce costs and help facilitate cost/benefit trades to be made by the program management.

Background:

The SRWG supports the plan for NASA HQ to obtain robust estimates of the total mission cost while evaluating sounding rocket science proposals. Certainly in this time of constrained budgets, it is important for program managers to understand how much a given project will likely cost the agency.

We are also pleased with the efforts of the SRPO to provide investigators with a detailed accounting of the costs of past missions, including the costs of launch vehicles, sub-systems such as gyros and attitude control systems, and operations. Such data provides information to both investigators and program management that will help enable cost/benefit trades to be made when planning future missions. Ultimately, we believe that such accountability will help hold down costs while continuing to enable state-of-the-art scientific advances and technology developments to be carried out.

Concerning the plans to estimate the total mission cost during the AO process, we are hopeful that such estimates can be implemented with a minimal drain on valuable SRPO and NASA HQ resources. To this end, we would like to understand the impact on proposers, the SRPO, and NASA HQ. If the results of these calculations are to contribute to the proposal evaluation process, at what point and how often will proposers be able to get feedback and cost estimates from the SRPO?

Finally, while the SRWG supports efforts to optimize the use of the scarce resources of the sounding rocket program, we hope that the traditional strengths of the program are not compromised. These include the program's flexibility, its small efficient mission teams, and its strong collegial working relationships between the experimenters, NSROC, and the SRPO. An overzealous application of detailed fiscal accounting might hinder the program by undermining these strengths.

IV. Recent NASA HQ review of SR operations and costs

Summary:

The SRWG acknowledges the observations of the NASA HQ review panel of the SR programmatic elements and is pleased with its conclusions that the program is run very efficiently, even heroically, at Wallops and that there are no obvious ways that the program might be run differently in order to save significant funds. The SRWG further comments on the wording of the one of the panel's observations and agrees that an increase in budget or a reduction in requirements are needed to maintain the current level of standard rocket services, adding that the latter is untenable from a scientific standpoint.

Background:

The SRWG acknowledges the observations of the Sounding Rocket Independent Review Team Report of the Programmatic Elements and Cost Structures of the Wallops Flight Facility Sounding Rocket Program Office as presented to us at the January 19, 2005 meeting. We are pleased that the review panel found very little room for improvement with the way the program is managed at Wallops as well as the fact that there are no obvious ways that the program could be run differently that would save significant resources. We particularly agree with the statement the review panel used to describe the Sounding Rocket Program: "Heroic efforts to meet the customer, public, or other stakeholder needs are common." The Sounding Rocket Program Office should be recognized and applauded for this level of sustained effort over the years.

In order to be clear, however, we take exception with the Review Team's observation that

"…there are no significant changes to be made that will result in an increase of high performance missions without a commensurate increase in budget to the program or a reduction of the requirements it needs to address."

Although this might just be semantics, we believe it is important to clarify that the missions under question are nominal performance, not high performance, and result from standard services provided by Wallops for decades. Further, the increase in the budget is required to simply maintain the present level of these standard missions. We have watched the sounding rocket budget erode significantly over the years with "promised" re-adjustments always around the corner. At this point we are simply trying to maintain the current level of mission support, without an increase in either numbers or performance.

Our interpretation of the last part of the sentence concerning a reduction of the requirements the program needs to address is that without an increase in budget, there must be a decrease in the requirements. The statement should acknowledge, however, that if the requirements are reduced, the sounding rocket program is in danger of falling below a scientifically valid level. The SRWG emphasized this point in its findings from its previous meeting. The situation is underscored by the NASA HQ review panel conclusion.

V. User access to NSROC data base

Summary:

The SRWG recommends that a more formal method for the archiving and distribution of mission related documents and post-flight data via the internet be established by NSROC.

Background:

The SRWG recommends that NASA and NSROC establish a more formal method for archiving and electronically distributing mission related documents and data via the internet. In general, the suborbital program PI's and Co-I's are unacquainted with the existing FTP site which is used to distribute limited program documentation. In fact, we learn that some PI’s are not even aware that detailed post flight reports are issued by NSROC, let alone how to access them. A more formal system should be developed to distribute electronic copies of program materials including design review documents and presentations, the science requirements data packages, and program schedules. The system should provide the science community access to relevant post-flight reports such as event times, trajectory, attitude and possibly raw flight data. This distribution system could be made consistent with the ISO 9000 document control and management requirements that NSROC is trying to implement. The SRWG also suggests that methods be explored to provide for security and access control of this information, as appropriate.

VI. Low cost mesospheric rocket development

Summary:

In response to a request by the SRPO, the SRWG reiterates its strong interest in the development of a low cost, small mesospheric payload. However, the SRWG needs to understand the projected costs of developing such a system before providing a blanket endorsement. Further, we would like to be involved in a discussion of the performance capabilities for such a vehicle and its standard sub-systems and suggest that the SRWG establish a sub-committee to work with the SRPO on the system requirements definition for such a new platform for scientific research.

Background:

The SRWG was asked by the SRPO at its recent meeting to provide feedback concerning the extent for which the community might be interested in the development of MRLS/Dart mesospheric rocket capabilities.

The SRWG remains very much interested in the development of a small rocket for mesospheric research, and indeed this initiative remains part of the technology roadmap developed by the SRPO with our input. Having said this, given the current severely constrained fiscal environment, we are particularly interested in discussing what new systems Wallops is proposing to develop and its projected costs, prior to providing our full endorsement. Further, since new development work is being considered, it is important that the system requirements be discussed and agreed upon by all interested parties before any new systems work is carried out.

For example, the 2-inch diameter Dart payload had been promoted at Wallops years ago, presumably because of its availability and low cost. Considerable work had been funded by NASA, both at universities and at Wallops, to develop the necessary sub-systems to make this small rocket available to the community as a standard launch platform. The rocket's high speed and its small diameter drove some very challenging engineering requirements that were never satisfactorily met to enable this rocket to be deemed "operational". We thus wonder whether Wallops should continue to pursue this vehicle, or whether developing a low-cost, small mesospheric rocket but with a somewhat larger diameter (e.g., 10-15 cm) payload might be a more prudent path to explore.

The SRWG is very willing to form a sub-committee (composed of members and interested community members) to work with Wallops on the requirements definition for a new mesospheric launch system. We look forward to working with the SRPO and NSROC in the development of this exciting new research vehicle.

VII. Kwajalein Campaign and possibilities for a new "standard" range

Summary:

The SRWG acknowledges the first-class achievement of the combined SRPO and NSROC efforts in the completion of its successful EQUIS-II sounding rocket campaign at Kwajalein Atoll in summer, 2004, that involved many logistical and operational challenges. The SRPO is currently accessing the feasibility of establishing this range as one where NASA sounding rocket operations might be carried out routinely, as is currently the case at ranges at White Sands and Poker Flat, Alaska. The SRWG supports this study and keenly awaits the cost estimates to learn if such launch activities might indeed be feasible on a routine basis.

Background:

The SRWG applauds the work of the SRPO and NSROC in carrying out the very successful Equatorial Ionospheric Studies II (EQUIS-II) sounding rocket campaign in Kwajalein during the summer, 2004. The campaign logistics and operations posed many challenges, and we appreciate the tremendous effort by Wallops personnel, led by Mr. John Hickman, to make this campaign a success.

Kwajalein's unique location near the earth's magnetic equator opens the door to a large number of important scientific research problems, in a similar manner in which the Poker Flat range in Alaska enables important high latitude science to be addressed. We understand that the SRPO is exploring the possibility of making the Kwajalein range accessible to routine operations, in much the same way that the White Sands and Poker Flat ranges are accessible now to NASA-funded science missions. The SRWG supports this activity and, together with the larger science community, we keenly await the cost estimates to learn if such proposed operations will indeed be affordable on a routine basis at Kwajalein.

NASA Sounding Rocket Working Group

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

Dr. Tim Cook
Boston University

Dr. Lynette Gelinas
Cornell University

Dr. Jim Green
University of Colorado

Dr. Walt Harris
University of Washington

Dr. James LaBelle
Dartmouth College

Dr. Gerald Lehmacher
Clemson University

Dr. Paul Kintner
Cornell University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Findings

Sounding Rocket Working Group
National Aeronautics and Space Administration

Meeting of June 16, 2004

I. Current Crisis Regarding Sounding Rocket Operations Budget

The following letter was sent to:

Dr. Edward J. Weiler
Associate Administrator for Space Science
Office of Space Science
NASA Headquarters
Washington, D.C. 20546-0001

The sounding rocket user community, represented by NASA's Sounding Rocket Working Group (SRWG), is greatly alarmed by recent cuts to the rocket operations budget. These cuts threaten the three hallmarks of the sounding rocket program: to carry out forefront scientific research; to test new instruments and systems in space; and to provide education and hands-on training at the graduate level. They also imperil the ability of the rocket program to develop and test technology essential for implementing NASA's new Exploration initiative.

The purpose of this letter is to urge, in the strongest possible terms, your support in resolving the fiscal crisis facing NASA's Sounding Rocket Program. As discussed below, $59M is required over the next five years to restore the program to health and a minimum of $25M is needed over this period ($5M/year) in order to keep the program at its minimum viable level.

After providing background material on the current fiscal crisis and a summary of recent community endorsements, we summarize possible solutions to the problem proposed by the Sounding Rocket Program Office at the Wallops Flight Facility (WFF) and provide our comments. This letter concludes with our findings and suggestions in view of this difficult financial situation.

The Current Fiscal Crisis

Both the sounding rocket program budget and the main operations contract at Wallops Flight Facility (WFF) have changed considerably over the past decade. Although rocket operations funding was substantially decreased in the latter half of the 1990's, the program was able to survive for several years by using reserve or overguide funds and by depleting its inventory of rocket motors. The advent of the NASA Sounding Rocket Operations Contract (NSROC) in 1999, together with both the loss of a large number of civil servants and the lack of any inflationary adjustments, placed additional strains on program finances.

Creative efforts by sounding rocket program managers at both NASA Headquarters and WFF led to a new, approved budget that included an infusion of sustained annual funding beginning in FY06 that was to be used to replenish the motor inventory and stabilize the program in the years to come. The sounding rocket community thus looked forward to a long awaited recovery in 2006 that would enable the minimum viable program to continue. Modest increases (overguides) were also sought to build some reserves in the motor inventory and for new technology development, including the exciting High Altitude Sounding Rocket.

In contrast to this promised increased funding, NASA's initial response to the President's Exploration Initiative last January contains punishing budget cuts to the sounding rocket program: \$3M in FY05, \$10M in FY06, \$14M in FY07, \$16M in FY08, and \$16M in FY09 – **a \$59M cut over a five-year period**. Compounded by prior cuts that left the program severely weakened, these new cuts essentially cripple a program that has served the nation exceedingly well for over 40 years.

Community Endorsements of the Sounding Rocket Program

NASA scientific advisory groups and National Research Council studies have recently recommended that NASA's Sounding Rocket Program be *strengthened*, not reduced. For example, the most recent NRC decadal survey, *The Sun to the Earth – and Beyond: A Decadal Research Strategy in Solar and Space Physics* (Space Studies Board, 2002), presented the following finding and recommendation:

> **Finding: Suborbital flight opportunities are very important for advancing numerous key aspects of solar and space physics research and for their significant contributions to education.**
>
> **Recommendation: NASA should revitalize the Suborbital Program to bring flight opportunities back to previous levels.**

This report further stated: "Besides addressing frontier space plasma problems such as small-scale particle acceleration regions, sounding rocket investigations have also served as exemplary tools for the development of scientific ideas and measurement technologies, and they have had a significant level of student participation, often far out of proportion to the program costs."

In a similar fashion, the NASA Sun-Earth Connection Advisory Subcommittee (SECAS) issued the following finding, dated 19 March 2004:

> *Restoring a Healthy Sounding Rocket Program*
>
> The sounding rocket program, like the Explorer program, makes crucial and productive contributions to NASA's mission of discovery and exploration. From the earliest discoveries of space exploration to those of today, sounding rockets provide a mechanism for cutting-edge science, the only access to certain regions of space, the fastest and most cost-effective access to space, and an irreplaceable opportunity for training space scientists and developing and testing instrumentation. For more than a decade, the sounding rocket operations and science budgets have been inadequate. **…SECAS urges that the funding for this essential infrastructure and science program be restored to the previously planned levels.**

Proposals by the Sounding Rocket Program Office to Alleviate the Crisis

As reported to the SRWG, program managers at the Sounding Rocket Program Office at WFF as well as at NASA Headquarters have considered various options including:

1. Decreasing the total number of flights (which includes student launches and test vehicles)
2. Reducing the NSROC employee workforce
3. Stopping the implementation of the new Oriole motor (for which development work is well advanced)
4. Canceling five approved flights scheduled for launch in FY05 from Hawaii
5. Not permitting any new campaigns from remote launch locations
6. Significantly limiting new technology development
7. Greatly restricting the use of the standard, high performance (i.e., Brant-class) motors

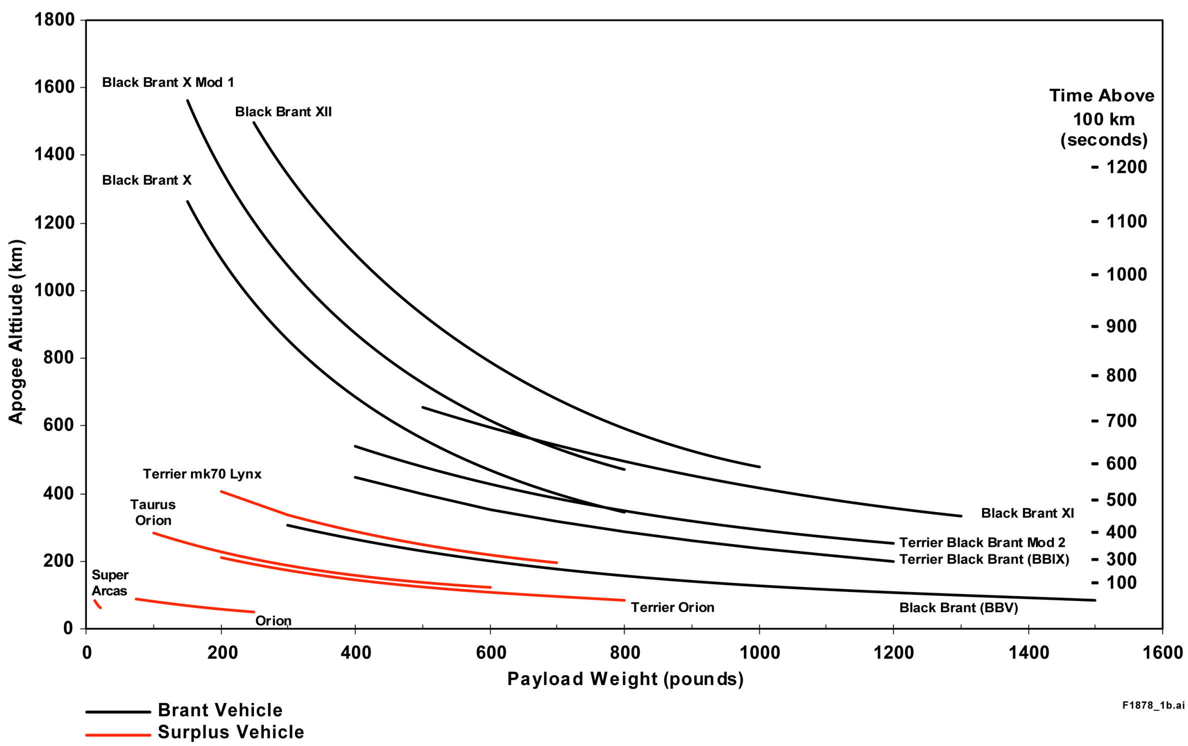
All of these actions would have important consequences for the program. NASA appears to be particularly reluctant to pursue Options 1 and 2 because of the implied changes to the baseline NSROC contract and the possibility of losing support personnel who possess unique skills and knowledge that are important to the future rocket program. On the other hand, Options 3–6 have each been implemented to some degree. A NASA contract to purchase 12 Oriole rockets from DTI (which sub-contracts to Alliant Tech Systems in West Virginia) is now being effectively cancelled (attempts will be made to transfer the contract to a different agency). At the direction of NASA Headquarters, five rocket flights from Hawaii have been cancelled. Headquarters has also put a hold on all future remote campaigns, an important feature of the program since its inception.

In order to maintain the 20 flights/year rate and not reduce the NSROC workforce, the Sounding Rocket Program Office proposes to change the mission mix to include 5 Brant-class rockets and 15 surplus rockets a year. Historically, Brant vehicles comprise approximately 70% of the science missions or 60% of the missions overall—approximately 12 Brant missions per year. These flights are flown by all disciplines, particularly UV and optical astronomy, high energy astrophysics, solar, planetary, microgravity, and a very large fraction of the geospace rockets, such as those that study high altitude auroral physics and those that utilize long payloads that are subsequently unstable on surplus vehicles. In fact, surplus rockets, which have very limited capabilities, are flown as Code S science missions by only a small portion of the geospace community.

Response to the Proposed Solution to Decrease the Number of Brant-class Launches

The Sounding Rocket Working Group believes that the proposed mix of 5 Brants (or equivalent high performance rocket) and 15 surplus rockets per year is not scientifically viable. A decrease in the Brant usage from approximately 60-70% to 25% would adversely impact all disciplines: astronomy, solar, and planetary flights which can *only* use Brant-class motors, as well as a significant portion of those rockets flown in the geospace program. If the program were to shift to this new paradigm, since surplus vehicles have such limited capabilities, *the scientific scope of the program would be severely reduced*. Although the mesosphere and lower ionosphere studies that typically use the surplus vehicles represent unique and important scientific research, this research niche represents only a small fraction of the sounding rocket science program.

NASA Sounding Rocket Vehicle Performance



The relative performance of the surplus rockets compared to the Brant-class rockets currently available to the program is shown in the above figure. Notice immediately that the performance capabilities of the surplus rocket motors are severely limited. All astronomy, solar, planetary, and microgravity payloads use either Terrier Black Brant or Nike Brants to accommodate their typically weight (~ 800 lbs.) and apogee (~ 400 km) requirements. Auroral physics payloads gather in-situ measurements in the 600-1500 km region and typically weigh 300-400 lbs. Surprisingly, lower ionosphere payloads also frequently utilize single stage Black Brants since those payloads (comprised of combined science instrument packages and telemetry and attitude control systems) are often too long for surplus vehicles which would subsequently render the vehicle unstable. We note also that the surplus fleet was much more capable in prior decades, when high performance surplus vehicles such as the Terrier-Malemute and Taurus-Nike-Tomahawk were available in plentiful supply. In essence, relying to such a large extent on the rather constrained suite of presently available surplus vehicles with their limited performance would harken the program back 30-40 years.

But the severe blow to the fundamental scientific research that the program would be able to address is not the only problem with the proposed solution. Since the majority of research groups rely on Brant-type vehicles, they would have access to space on a much less frequent basis. As the time in between launches for most groups would be longer than three years, the proposed scenario would likely trigger the collapse of several research programs at universities across the country. The loss of the three-year mission model would also hinder graduate student programs which rely on the quick-turn-around inherent in the rocket program, as well as the ability for the rocket program to provide technology test beds for instruments and detectors. *Hence, one of the most fundamental purposes of the sounding rocket program – to provide rapid, low cost access to space – would be defeated.*

Findings of the SRWG Relevant to the Current Fiscal Crisis

1. Restore Promised Funding to Provide a Robust Sounding Rocket Program

The Sounding Rocket Working Group urges that the proposed cuts to the program *not* be enacted and that funding be restored to provide a robust scientific sounding rocket program for the nation. Given the proven, long-term value of the program to the agency and the scientific community, the relatively small amount of resources that are needed constitutes an excellent investment and should be immediately restored to the program. Such funds would provide for adequate numbers of high performance vehicles (e.g., Brant-class rockets) including the introduction of the Oriole and other rockets into the program with increased performance and larger diameters, important for advanced astronomy, planetary, and solar telescope missions. The program should also pursue the development of the new high altitude sounding rocket, with its 1-meter diameter, 3500 km apogee, and 40-minute flight time, which would significantly benefit all Space Science disciplines.

2. Maintenance of Brant-Class Launch Rates

If funds cannot be found in the near term to meet the full program requirements, **we urge NASA to develop a plan which maintains the launch rate of high performance rockets (e.g., Brant-class vehicles) in order to meet the scientific and exploration goals of NASA and the nation's scientific community.** The scientific capabilities of the program would be drastically reduced if this rate were cut from 60-70% (average over the last 10 years) to 25%, as proposed by the Sounding Rocket Program Office to adjust to the recent cuts in operations funding. Surplus vehicles are extremely limited in their performance. Although they serve a small research "niche" of mesosphere and lower ionosphere scientists, such rockets are not suitable for astronomy, solar, planetary, and high altitude geospace investigations. Further, single stage Brants are frequently used to launch ionospheric payloads which are too long for the surplus rockets (and hence would render them unstable.) The sharp decrease in the number of Brant-class rockets would greatly reduce the time between launches of many university research teams and their graduate student programs, thus seriously affecting their ability to maintain their infrastructure and remain viable. We understand that ~ $5M per year would be needed to maintain the current rate of Brant-class rocket launches without reducing the overall number of flights or the NSROC workforce. We urge NASA to secure these funds to keep the program at its minimum viable level.

Should the necessary funds to maintain the launch rate of Brant-class vehicles be lacking, the SRWG believes that an interim, emergency solution be enacted that includes a larger number of Brant-class vehicles per year even if the overall number of sounding rockets per year must be temporarily reduced.

3. Support for Range Consolidation Studies

The SRWG encourages NASA to explore the range consolidation trade space in order to save significant costs. As is already under consideration, the White Sands Missile Range launches could be moved to Wallops if water recovery for the telescope payloads were shown to be reliable. This would also permit such telescope rocket launches to achieve higher apogees at Wallops than are currently allowed, due to range restrictions, at White Sands. Another possibility includes shifting the land recovery launches typically flown at White Sands to Poker Flat, Alaska, provided the science objectives could be met at the higher latitudes.

Furthermore, although the SRWG heard an exciting update on the Poker Flat Research Range, including plans to locate a portable NSF incoherent scatter radar there in 2005, auroral physics missions from Poker Flat could be carried out at ranges in either Norway or Sweden for significantly lower cost. This solution should at least be taken into consideration when seeking short-range solutions to the current fiscal crisis, although the long-range disadvantages of even temporary closure of Poker Flat and discontinuing hard-earned agreements with landholders to allow overflights make this solution particularly unattractive.

4. Support for Development of New Surplus Vehicles

The SRWG strongly supports WFF efforts to identify and develop higher performance surplus vehicles such as the Terrier-Patriot. Motor development of high performance surplus rockets is particularly important since previous higher performance surplus rockets such as the Terrier-Malamute and the Taurus-Nike-Tomahawk are no longer available. However, we caution the program against relying on unproven surplus rockets, with possible limited availability, to solve the immediate problem. Only when the new high performance surplus vehicles and their required support systems have been demonstrated, should the number of Brant-class vehicles be reduced.

Summary

The Sounding Rocket Working Group believes that the proposed cuts to the operations budget put NASA's sounding rocket program in great peril. Numerous NASA scientific advisory groups and the National Research Council have concluded that NASA's Sounding Rocket Program should be strengthened and preserved, not decimated. Because of the high infrastructure costs at WFF needed to maintain the program regardless of the number and type of launches, even small cuts to an already weakened program have significant negative impact. **We urge that these funds be re-instated.**

We believe that every effort should be made to preserve the fundamental aspects of the Sounding Rocket Program: to provide, rapidly and at a low cost: (1) unique, cutting-edge, focused scientific research and exploration; (2) testbeds for new instruments and technology; and (3) graduate education and training.

II. Systems Engineering and the Rocket Program

Sounding rockets are complex systems composed of many sub-systems. These subsystems are developed within a diverse set of disciplines including mechanical engineering, electrical engineering, and aerospace engineering. All of these subsystems must be integrated together with experience and common sense. This effort needs to be led by a capable systems engineer who has the required understanding of how these subsystems must perform as a whole. The involvement of young engineers, graduate students, and scientists in this systems engineering process creates a pool of well-trained professionals for the future of experiential space science. It is also a potential vulnerability of the sounding rocket program since system related errors are many times a principle source of failures.

The SRWG has noticed that, for many payloads particularly in the space physics arena, the responsibility for system engineering oversight appears to have increasingly shifted towards the experimental user, particularly in the past decade. Some involvement of the user in the system oversight is certainly necessary for making trade-offs efficiently. However, it appears to us that the balance has changed such that user work loads are often significantly impacted. Furthermore, since most users are usually distant from WFF, their system level input are not always efficiently implemented in the final design.

The SRWG notes that the sounding rocket program would benefit from offering system training to the project managers since those individuals are best situated to oversee sounding rocket experiments from a system engineering viewpoint. Along these lines, the program would also benefit from hiring and promoting individuals with appropriate engineering degrees best preparing them for a system-wide involvement in the payloads. At a minimum, the SRWG recommends that those project managers best prepared for system oversight should be assigned to projects where new sub-systems are employed that are critical to the success of the mission.

III. Software Control of ACS Functions

The SRWG has followed the development of the in-house ACS system at NSROC since its inception. In general, we commend NSROC for taking on this task and for their innovation in attempting to improve the systems.

One feature employed by the new NMACS system (i.e., the NSROC ACS system that aligns the payload spin axis with the magnetic field direction), that we heard about at the meeting, utilizes a software implementation to command the nozzle phasing within the ACS rather than a hardware implementation (e.g., by switching connectors) to achieve this function. As phasing errors are more likely to go unnoticed in a software implementation, this new approach does not give the user any added confidence that the system will perform as required. The SRWG would like to better understand the rationale for this new approach.

NASA Sounding Rocket Working Group

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

Dr. Tim Cook
Boston University

Dr. Lynette Gelinas
Cornell University

Dr. Jim Green
University of Colorado

Dr. Walt Harris
University of Washington

Dr. James LaBelle
Dartmouth College

Dr. Gerald Lehmacher
Clemson University

Dr. Paul Kintner
Cornell University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Findings & Concerns

Meeting of January 14, 2004
Sounding Rocket Working Group
National Aeronautics and Space Administration

I. Technology Roadmap -- Timeline and Priorities

The Sounding Rocket Working Group continues to be encouraged by the Technology Roadmap developed by the Sounding Rocket Program Office (SRPO) at Wallops. We are confident that such new technological thrusts will advance important new avenues for scientific exploration, discoveries, and understanding. Major items on the list that hold particular promise include the High Altitude Sounding Rocket, the Oriole rocket, the mesosphere dart-like payload, and the ability to routinely carry out recovery of high altitude telescope payloads at Wallops.

What is not at all clear, however, is how the timelines and priorities for these particular technology initiatives are established. How is it decided which of these so very useful new technology items will be done first? In fact, it is not clear how a cost benefit analysis might be conducted to articulate the trade studies to both the users and general science community. Certainly, some discussion of this point is needed.

We envision that the items on the Technology Roadmap might be divided into three categories:

1) General technology items needed to maintain the present payload and operational capabilities.

2) New technology items which are of modest cost and which can generally be covered within the annual program resources available for new technology.

3) New technology items for which augmentation of new funds is needed and for which the timescale for development requires an investment over several years.

Certainly for item 1, we presume the SRPO will continue to invest its resources soundly to maintain the present capabilities. It would appear that here, the role of the SRWG is to provide input and feedback on such developments. Items 2 and 3, however, represent areas where there is significant "trade space" and where the SRWG believes it could provide meaningful input, particularly as the working group represents the larger user community. For some trades, particularly where new resources are needed, we note that the NASA HQ Science Advisory committees will also be consulted.

To summarize, we would like clarification on how the timelines and priorities are established for the work to carried out on the SRPO Technology Roadmap. In particular, we urge that communication channels be established for user input on the "big ticket" items, both from the SRWG representing the user community as well as from the greater scientific community which NASA's sounding rocket program serves.

II. "Telescope" Payload Recovery at Wallops

The SRWG appreciates the response from the SRPO to our finding from the June, 2003 meeting in which we discussed the need to develop technologies to provide for the recovery of high flying rockets from Wallops. However, the response focused on innovative air recovery and mentioned that advanced, new water recovery techniques for heavy, high flying payloads could not be funded until 2009. We note that Wallops presently can routinely carry out water recovery of standard, 17 inch geophysics payloads launched from Wallops. We thus feel the need to revisit the previous finding with an emphasis on developing capabilities for water recovery of such "modest" payloads that carry astronomy/planetary/solar telescopes instead. Since these telescope payloads already include protection for land re-entry, what would it take to adapt them for water recovery?

As stated in our previous finding, this effort would have both near and long term benefits. In the near term, recovery of telescope payloads at Wallops would enable the use of Black Brant and Oriole delivery systems, with high flying performance envelopes that preclude their use at White Sands Missile Range (WSMR). This would allow an immediate factor of two gain in observing time over that of astronomy/solar payloads currently launched on BBIX's. In the long term, such systems could then serve as a model for the development of a recovery technology for High Altitude Sounding Rocket (HASR) payloads.

The SRWG encourages NSROC and the Sounding Rocket Project Office to rapidly mature the development of recovery systems for telescope-borne payloads for flights from the Wallops Flight Facility.

III. High Altitude Sounding Rocket

The SRWG once again salutes the Sounding Rocket Program Office for their continued efforts to develop the High Altitude Sounding Rocket (HASR). As discussed previously, such a vehicle would provide a significant new science exploration tool, both because of its higher altitude (and thus longer flight time) and because of its larger diameter. The SRWG realizes that circumstances beyond the control of Wallops limit the pace of development. Nonetheless, the SRWG strongly believes that a robust, innovative sounding rocket program depends on bringing new capabilities, such as the HASR, to fruition and urges Wallops to continue their efforts to develop the HASR at whatever pace resources will allow.

IV. Payload Events Set by GPS

The SRWG congratulates NSROC and the Sounding Rocket Program Office for bringing the GPS event module into service as quickly as it has. The module has great promise for improving the efficiency and accuracy of observations across a wide variety of disciplines. It will allow experimenters to more precisely coordinate their observations and instrument actuation, recovery system initiation, etc. with the actual rocket trajectory, which, in turn, provides for more efficient use of the flight time available. For example, rather than setting events that rely on the predicted altitudes (either for upleg or downleg) of the 2-sigma high and low nominal trajectories, the GPS event module will enable the events to occur precisely at the desired altitude, regardless of the dispersion in the actual flight profile. In many cases, this could afford up to 30 seconds (or even more) of additional observation time. We look forward to the widespread implementation of such event timers in the near future.

V. Sounding Rocket User's Guide

The SRWG strongly suggests that the Sounding Rocket Program Handbook be updated more frequently. The version of the Handbook currently available on the Wallops web site was last updated in July 2001, and some parts of the document may be even older. We feel that the Handbook is a valuable reference tool, since it provides an essential resource on all technical and operational aspects of the program, and in particular, provides important orientation information for new experimenters. The document also serves as a reference for more experienced experimenters, for example as new technology (e.g., the new GPS timer) becomes available and various sub-systems, such as attitude sensors and ACS systems, are improved. To this end, we suggest that examples of actual flight sub-system data, such as attitude information and verification, be provided in the handbook, with a discussion of the actual accuracies attained. To this end, the SRWG would be willing to provide feedback and work with NSROC to delineate those portions of the handbook that the users believe are most urgently in need of updates.

VI. Support for Studies of Proposal Submission Trends

The SRWG heard a presentation from a member of a “Task Force” commissioned in coordination with the NASA HQ Geospace Scientific Advisory Working Group (i.e., the Geospace MOWG) that discussed a planned analysis of trends in the number of proposal submissions over the years in that discipline. Because geospace investigations form a significant component of the sounding rocket program, trends in geospace participation and interest, reflected to some degree in numbers of proposals submitted, have a very large impact on both short-term and long-term strategic and logistic planning for the entire sounding rocket program. Therefore, the SRWG maintains a keen interest in the ongoing discussion of such trends in not only geospace, but also all disciplines served by the program.

Furthermore, as the SRWG represents the greater scientific user community for the program, we stand ready to support the efforts of this (and any other) task force in any way needed, particularly should input be requested on how proposals might be motivated by technical and operational factors that might influence the rate of proposals submitted to NASA HQ. For example, such factors might include the availability of high performance launch vehicles, launch ranges, foreign campaigns, new sub-systems such as high telemetry rate systems, the ability for Wallops to fly complex payloads including multiple payloads, etc. The SRWG encourages all efforts to elucidate such trends through polling members of the science community.

NASA Sounding Rocket Working Group

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

Dr. Mark Conde
University of Alaska

Dr. Tim Cook
Boston University

Dr. Lynette Gelinas
Cornell University

Dr. Jim Green
University of Colorado

Dr. Walt Harris
University of Wisconsin

Dr. James LaBelle
Dartmouth College

Dr. Gerald Lehmacher
Clemson University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Back to TOP Email us Home

Findings & Concerns

Meeting of June 26, 2003
Sounding Rocket Working Group
National Aeronautics and Space Administration

I. Oriole Launch Vehicle Development

The Sounding Rocket Working Group is following with great interest the development of the Oriole launch vehicle. A Terrier-Oriole configuration launched from White Sands Missile Range could provide significantly (~30%) longer time at altitude for astrophysics and solar physics payloads as compared with Black Brant configurations. Of added importance, the Oriole could also accommodate larger-diameter payloads (up to 30 inches) and therefore larger telescopes. Such telescopes would enable new scientific investigations because of their ability to study faint cosmic sources or time-variable solar activity at high, and in some cases unprecedented, angular resolution. The expanded range of potential investigations could be expected to attract new investigators to sounding rocket science, which has long been limited by the performance of Black Brant vehicles.

The Sounding Rocket Working Group would like to understand better the Oriole development plan and how it interacts with other programs such as the High Altitude Sounding Rocket. For example, has definite funding been identified to develop the necessary supporting systems such as boost guidance and fine pointing for 30-inch payloads, thrust termination, and recovery? Has funding been identified for an initial motor buy? What is the potential impact on the flight rate of existing configurations? When is it anticipated that investigators will be invited to propose payloads for the Oriole? While the Working Group recognizes the many uncertainties involved, a nominal schedule would stimulate research groups to conceive new experiments and carry out preliminary studies so that, when the vehicle is available, it will immediately attract both exciting and feasible scientific proposals.

II. Nihka Motor Availability

The Sounding Rocket Working Group is alarmed to learn that Nihka motors are no longer being manufactured, and that Wallops' current inventory of these motors is only 10-12 units, of which 2-3 are already committed to funded missions. Any NASA sounding rocket experiment with apogee above 1000 km currently requires a Nihka motor. Further, the Nihka is the only motor currently used in the sounding rocket program that can burn exo-atmospherically. This capability is required for any flight employing a complex trajectory in which the final stage and payload are reoriented prior to final stage ignition -- as was carried out successfully on the recent 35.034 Conde/HEX mission. Since considerable ongoing demand is anticipated for high alitude payloads as well as those that re-orient their final stage, the Nihka capabilities are considered absolutely essential to the NASA Sounding Rocket Program. Therefore, the SRWG strongly urges NASA/Sounding Rocket Program to either:

(a) Discuss with Bristol Aerospace their decision to cease manufacturing Nihkas;

(b) Identify and test an alternative off-the-shelf replacement for the Nihka;

(c) Consider developing a new motor with Nihka-like capabilities.

The SRWG believes that it is imperative that a replacement for the Nihka motor be secured prior to the elimination of the current inventory at Wallops.

III. Mesospheric Sounding Rocket

The SRWG strongly encourages Wallops to continue development of a Mesospheric Sounder, and are pleased that a suitable motor has been identified. The mesosphere region (60-100 km) has long been identified as one in which the only means to gather in situ measurements is the sounding rocket, as noted in several previous findings of the SRWG.

The Mesospheric Sounder represents a possible new direction in mesospheric studies towards coordinated experiments that study spatial and temporal variations in the mesosphere. Such campaigns would consist of ground-based observations, satellite measurements, and/or complementary larger sounding rocket payloads launched in conjunction with in situ measurements gathered by multiple launches of Mesospheric Sounders. In order to define potential experiments for the sounder, the science community needs information about the nominal performance specifications for these vehicles. These include their nominal payload diameters (e.g., 4 to 6 inch), apogees for a nominal mass, how position or trajectory information as well as attitude information will be obtained and at what accuracy, power, ACS systems, to align the payload forward end either with the ram direction or the magnetic field direction, and the feasibility of a portable system with the capability of multiple launches over the course of a few hours.

The SRWG requests an update on the status of the vehicle procurement and flight testing, as well as nominal performance specifications for this new vehicle system. We seek this information not only to determine how well the designated vehicle meets the desired performance criteria, but also to enable the community to prepare important and feasible experiments to propose when the vehicle becomes operational.

The SRWG would like information on the schedule for the development of the Mesospheric Sounder and looks forward to learning of plans for the initial vehicle flight tests.

IV. Water and Air Recovery from Wallops

The Sounding Rocket Working Group underscores the clear and pressing need to develop as quickly as possible the technologies required to support the recovery of heavy, high flying payloads launched from the Wallops Flight Facility. This effort would have both near and long term benefits, especially for payloads with high development costs as well as astronomy payloads. In the near term, recovery of heavy payloads at Wallops would enable the use of BBX, BBXI, and BBXII delivery systems, with high flying performance envelopes that preclude their use at WSMR. This would allow an immediate factor of two gain in observing time over that of astronomy payloads currently launched on BBIX's. In the long term, such systems could then serve as a model for development of a recovery technology for the High Altitude Sounding Rocket (HASR) payloads.

The SRWG encourages NSROC and the Sounding Rocket Project Office to rapidly mature the development of either water or air recovery systems for high flying payloads with as much as 1000 lbs of reentry mass.

V. Launches from Wallops

The Sounding Rocket Working Group continues to be concerned about the difficulties of launching out of Wallops due to conflicts with various naval, commercial and recreational ships and boats. Although we understand that Wallops has taken some steps to mitigate this problem, we would like further insight concerning how the range is controlled, who has authority over the range, and what sorts of obstacles and planning an experimenter might have to consider when developing a research program based on sounding rocket launches from Wallops.

Thinking ahead, as water/and or air recoveries become a reality and the High Altitude Sounding Rockets come into use, we anticipate that more missions will be launched from the Wallops launch site. This will put increasing demands on the launch availability of the WFF range. We therefore seek to understand the current policies of the Wallops Launch Range and seek ways to improve these policies to optimize the use of the Wallops Flight Facility as a launch range in the future.

NASA Sounding Rocket Working Group

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

Dr. Mark Conde
University of Alaska

Dr. Tim Cook
Boston University

Dr. Lynette Gelinas
Cornell University

Dr. Jim Green
University of Colorado

Dr. Walt Harris
University of Wisconsin

Dr. James LaBelle
Dartmouth College

Dr. Gerald Lehmacher
Clemson University

Dr. Dan McCammon
University of Wisconsin

Dr. Doug Rabin
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Back to TOP Email us Home

Findings & Concerns

Meeting of January 13, 2003
Sounding Rocket Working Group
National Aeronautics and Space Administration

I. High Altitude Sounding Rocket

The Sounding Rocket Working Group (SRWG) strongly supports the concept and implementation of a High Altitude Sounding Rocket (HASR) and urges the Wallops Flight Facility to continue all efforts to make this project a reality. We believe the HASR should be the highest priority new technology development for the program.

When implemented, the HASR will profoundly advance future rocket-based investigations across all scientific disciplines, including X-ray and UV astronomy, planetary science, space physics, and micro-gravity. Furthermore, this new vehicle presents a unique and inexpensive engineering test bed for high velocity landing and aerobraking systems, such as currently being considered for probes that will impact on other planets and return samples to the earth.

The preliminary performance requirements for an HASR are that it achieve an altitude of 3000 km, provide ~2400 seconds of observing time above 100 km, and include the option to be recoverable. In addition, the preliminary HASR configurations presented thus far have 38" (~1meter) diameter experiment sections, significantly larger than current payload diameters (17" and 22"). As typical astronomy/planetary/solar BBIX payloads currently achieve approximately 240 seconds of actual observing time above the atmosphere, the HASR would provide an order of magnitude more observing time. Since the larger diameter rocket payload would provide an additional 3 to 6 times more geometric collecting area, the combination of these factors would provide 10 to 60 times more sensitivity for telescope instruments than is typically afforded with the current rocket technology.

In addition to payloads that seek primarily to increase observing time above the atmosphere, a high altitude sounding rocket would also be very advantageous to Space Physics investigations of Geospace. For example, such a high altitude rocket would penetrate the prime auroral and cusp acceleration regions (> 2500 km) where they would gather high resolution particle and fields measurements at a very slow velocity compared to orbiting satellites. The payload would be able to stay within the region of interest on time scales that would permit longer period phenomena, e.g., pulsations, to be resolved, which is not possible with in-situ probes on low earth orbiting satellites, such as FAST, that traverse such regions in a few minutes. In addition to auroral studies, such missions would also provide new investigations of the inner radiation belts and other space physics phenomena. The larger diameter payload would permit more extensive sub-payloads to be developed for multi-point sampling of a variety of regions of geophysical interest.

In the realm of engineering, the new vehicle promises to be highly beneficial for the testing of new scientific instrumentation, such as that proposed for orbiting satellites at low perigee, as well as the testing of smart landers and aerobraking systems. The ability to test planetary re-entry engineering devices opens a new area for research within NASA's sounding rocket program.

The SRWG notes that the HASR promises to be highly cost effective. For example, a typical BBIX astronomy sounding rocket mission costs approximately $1.5M and provides approximately 6 minutes of observing time. In contrast, the HASR system is projected to cost $5M but would provide 40 minutes of observations. Thus, in addition to the new experiments that are afforded by such a longer duration, high altitude platform, the combined increase in observing time with the relatively low cost vehicle would decrease the cost of observations per minute by a factor of two.

Finally, the SRWG emphasizes that throughout the history of scientific exploration, major breakthroughs have traditionally occurred whenever instrument performance metrics have significantly increased. The development of the HASR represents just such an opportunity for NASA and the scientific community. The SRWG believes that the HASR is the next logical step for NASA's Sounding Rocket Program to take, not only for the immediate advances that it will achieve in scientific research, but also for the development of the next generation of instruments for future satellite missions.

II. New Mesosphere Rocket

The scientific community has long recognized the importance of exploring the earth's upper atmosphere between 50 and 120 km. Sounding rockets present the only means to gather *in situ* sampling of the many phenomena and critical processes in this region including momentum coupling, chemistry, and vertical transport.

<>The current inventory of NASA sounding rockets are not optimum for exploring the 50 to 120 km region. The single stage Orion vehicle barely reaches 90 km and the more complex two-stage Nike-Orion typically take payloads above this region. Although it is straightforward to include ballast on such higher performing vehicles, these larger diameter payloads tend to be somewhat bulky and ultimately, for certain experiments, may interfere in a detrimental way with the atmospheric medium that is being measured. Further, even though such rockets utilize surplus vehicles, their utilization is still too expensive for repeated (5-10) launches in a given experiment. The result is that missions based on simple (i.e., very small) payloads and repeated launches are impractical given the current inventory of NASA sounding rockets.

In the past, the low cost Super-Arcas vehicle was available for sampling this region but we understand that this supply of motors at Wallops has been exhausted. Efforts were made over the last 10 years to utilize the Loki and Viper motors with 2 inch "dart-like" payloads to study the lower part of this region. This effort has been largely unsuccessful due to the difficulty of working with the small diameter Dart payload and the vagaries of the Viper motor performance.

The SRWG strongly recommends that Wallops develop a low-cost sounding rocket system for studying the 50 to 120 km region. Experience with the small 2 inch Viper Dart systems has shown that a larger (e.g., 4 to 6 inch) system may be better suited for science payloads and should reduce developmental costs of instruments and sub-systems. In addition to telemetry and GPS positioning systems, some of the features that we recommend be included in the new mesospheric payloads are the following: The payload must be able to accommodate the deployment of booms through doors or by shedding skin sections. It is highly desirable to have a very portable launch system for these rockets with low dispersion so that it might be easier to take them to non-standard launch locations. Above all, the cost of preparing and launching such a vehicle must be small (e.g., significantly lower than that of the Orion vehicle) so that scientific investigations composed of numerous flights are practical within one launch campaign.

III. Apparent NASA/DoD Resource Conflict

The SRWG recognizes the importance and financial benefit of the new work that NSROC has brought to the program involving Department of Defense (DoD) projects. To the extent that this work improves the capability of the program and lowers the price tag to NASA of a given sounding rocket project, the SRWG congratulates NSROC. Our chief concern, however, is that such outside projects threaten to detract from the core NASA Code S-funded science projects. For example, we have already heard from NASA-funded experimenters that their mission development was held up while various NSROC team members were completing DoD projects. Although this may be true for a limited time for any given project, the SRWG is concerned that, in general, a “paying” external customer such as DoD could have priority compared to a NASA project that might be viewed as “in house” and hence capable of waiting.

Further, as stated in our findings from the last meeting, the SRWG is concerned that NSROC may focus on developing technology and support systems that enhances their ability to acquire non-NASA new business at the expense of the NASA science community needs. We would like to better understand how NSROC delineates, if at all, between R and D efforts for NASA projects and those, for example, for DoD. Again, we seek to understand whether there are separate resources for developing technologies for NASA compared to outside projects, and how the resources to develop technology for each effort are accounted for.

In summary, the SRWG acknowledges the benefit of NSROC bringing in outside work. We seek assurances that these additional projects will not be to the detriment of the NASA sounding rocket missions.

IV. Technology Roadmap

The SRWG applauds the Technology Roadmap developed by the Sounding Rocket Program Office. This constitutes an excellent formulation for the initiation and tracking of new technology within the Sounding Rocket Program. The SRWG fully endorses this initiative and believes that the SRPO is uniquely suited to both create and maintain this roadmap, matching both immediate needs and future possibilities with limited program resources. For our part, the SRWG seeks to provide inputs to the roadmap, particularly with respect to those new technologies that will provide the greatest scientific impact. We look forward to working with the SRPO on this new aspect of the program.

Although the new technology roadmap is off to a good start, it is not clear to the SRWG how various items on the roadmap are connected to science priorities and how the timeline for the achievement of several new technologies is established. We therefore, seek clarification of how the SRPO envisions the roadmap to develop over time. We also remain uncertain how resources for new technology are apportioned from NASA funds, and how NSROC determines which new technology to pursue using its R and D funds.

V. Coarse Gyro Attitude Determination

The SRWG is pleased that NSROC is dedicating resources to improving coarse attitude knowledge and its verification, as evidenced by recent presentations by NSROC.

The SRWG encourages NSROC to continue to poll the user community concerning required features of coarse attitude information and its application and to provide to investigators attitude data that has been verified to ensure its accuracy. This is particularly essential for new users who might use the attitude data without an independent means to check them before inclusion in the scientific analysis.

The SRWG notes that the documentation for using the coarse attitude data is essentially non-existent, and urges NSROC to prepare a brief document that outlines the procedures to use the Wallops coarse attitude data as well as the steps it takes to verify the data. The user community, represented by the SRWG, would be very willing to form a sub-committee or splinter group to work with Wallops to develop such a User Guide. We believe that such a guide is particularly important as NSROC prepares to implement new coarse attitude systems for routine measurements on future flights.

NASA Sounding Rocket Working Group

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

Dr. James Clemmons
Aerospace Corporation

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Walt Harris
University of Wisconsin

Dr. James LaBelle
Dartmouth College

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. Scott Porter
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Dr. Erik Wilkinson
University of Colorado

Back to TOP Email us Home

Findings & Concerns

Meeting of June 11, 2002
Sounding Rocket Working Group
National Aeronautics and Space Administration

I. Existing Technology Currently Undergoing Augmentation

A. Coarse Attitude Determination and Control

Improving both coarse attitude control and attitude knowledge continues to constitute an important dialogue among the SRWG, the SRPO, and NSROC. The SRWG is pleased that NSROC is dedicating resources to improving the situation, as evidenced by the presentation by NSROC at the last meeting. The SRWG has the following remarks relative to the current situation and future plans:

1. *Post-flight attitude determination*. The SRWG is pleased that NSROC recognizes the need to improve over past performance. The goal must be to provide accurate, routine, and easily interpretable attitude data to the scientists so they can analyze their data without the need to carry out extensive (and expensive) efforts on each payload simply to determine where it was pointing. The NSROC presentation of 11 June 2002 shows that improvements have been made in the visualization of gyro data and that work is underway to verify gyro solutions using other simultaneous on-board measurements (e.g., magnetometers). It is clear that many adjustable parameters (e.g., gyro drift, unmeasured magnetometer offsets, and non-orthogonality matrices) are used in the current paradigm. The SRWG would like to work with NSROC to better understand how these parameters are used and what magnitudes are ascribed to them for a given flight. We commend NSROC for embarking on this path and look forward to the day when such verifications are routine.

2. *Replacement of Space Vector systems*. The replacement of the Space-Vector supplied systems (gyros and coarse inertial and magnetic ACS units) is of paramount importance and urgency. The SRWG is alarmed that this replacement has been allowed to fall behind to the point that it is not clear whether missions currently awaiting design review will use Space Vector systems or newly-developed NSROC systems. We urge both SRPO and NSROC to place a high priority on this activity.

3. *Miniature Daytime Attitude Sensor -- "NSROC(a)".* On their own initiative, NSROC has placed a high priority on the development of a new, miniature attitude knowledge system called "NSROC(a)," although the motivation is not apparent to the SRWG. The most mature aspect of the NSROC(a) system is its use of a sun sensor to determine attitude. This sensor works only for daytime flights, which account for only a small fraction of the experiments that utilize coarse attitude. A horizon sensor will be substituted for nighttime flights. Both sun sensors and horizon sensors have been used by the Wallops rocket program for decades and have not proven to be as reliable as the gyro for providing accurate and routine attitude data to the experimenter. Since the NSROC(a) system has now been flown on numerous payloads, presumably each time as a test bed, we would like to know how well it has performed with respect to its absolute accuracy -- e.g., body azimuth, elevation, and roll position (or Euler yaw, pitch, and roll) relative to a fixed reference system on the earth. In this regard, traditionally, absolute roll position has been the most difficult

parameter to reliably ascertain (to within 1 degree), whereas body elevation and roll rate are comparatively simple.

The SRWG is puzzled as to why the NSROC(a) has received a priority in development. We believe that the developments most urgently needed in coarse attitude systems should emphasize replacement (and improvement) of the capabilities now provided by the Space Vector gyro systems. We wonder if the development of the NSROC(a) has been largely driven by the applicability of this system to non-NASA missions.

B. Fine Pointing ACS and the StarTracker 5000

The SRWG is concerned about the lack of progress toward implementing the ST5000 fine pointing star tracker (which has been discussed at several previous SRWG meetings) as well as the apparent reluctance of NSROC to fully investigate its potential for Lost-in-Space (LIS) tracking. The report of the flight performance of the ST5000 from last December is encouraging, despite the failure of the camera lens. However, no additional test opportunities were discussed or appear to be scheduled except for the initial flight of the University of Wisconsin FUSP payload in late 2003. This schedule is troubling, because of the importance placed by both the SWRG and NSROC on transitioning from the aging Ball trackers to a more modern system.

The SRWG expects the ST5000 to provide a dramatic improvement in attitude control by permitting the targeting of fainter guide stars and potentially the direct acquisition of the star (science) field without slewing between two fields (via LIS mode). The latter capability has the potential to increase time available for science operations by 10% or more. The ST5000 also represents a physical change from the Ball trackers. Several members of the science community are also in the design phase of new experiments where they must make the decision as to whether they can use the ST5000 or must make the necessary compromises to accommodate the existing units.

The SRWG believes that the approach to the development of the ST5000 could be greatly improved. Funding levels are low, timelines are ill defined, and only minimal NSROC resources appear to be committed to this urgently needed, valuable sub-system. This compares poorly with the effort level expended on the NSROCa system, for example, which the SRWG regards as having much lower priority than the ST5000. In this regard, the SRWG make several specific recommendations:

1. An implementation plan for the ST5000 should be developed that clearly outlines the roles that NSROC and the University of Wisconsin (UW) will play in the flight qualification of the ST5000. This should include a timeline of development including potential test launches, stages of use (Ball replacement only, followed by LIS), and a target date for the replacement of the Ball tracker.

2. A line of communication between NSROC and experimenters should be opened concerning the availability of the ST5000 for testing. Many community members are willing to support test flights that advance this program.

3. A feasibility study with UW should be conducted concerning the different ways in which LIS tracking can be used with the existing ACS and what costs would be involved.

C. DS-19 and the S19-D Guidance System

The SRWG shares NSROC's and White Sand Missile Range’s (WSMR's) concern over the recently identified possibility of a Black Brant IX vehicle exiting the range boundaries in the event of a hardware failure on the DS-19 that results from a ``hardover'' canard condition after T+15 seconds. Range safety is the highest priority of any mission and the possibility that a vehicle could exit the range within the 3 second window required for the missile flight safety officer to activate the command destruct is cause for the highest concern.

However, the SRWG points out that the envisioned solution, namely restricting the control loop to the old

S19 control loop (guidance through T+15 seconds), is not the only possible solution. We note that at least four other solutions were proposed after NSROC's DS-19 return-to-flight presentation at the June 11 SRWG meeting. These included: (1) computer activation of the command destruct issued from the ground; (2) autonomous destruct issued from the vehicle; (3) a canard hardover condition detect and cable cutout system; and (4) a creeping canard angular range restricter that gradually reduces canard authority towards the end of the burn where the full angular range is not required for control.

The SRWG believes that at the present time the parameter space for a possible solution has not been fully explored. We also believe that reverting to the old S19 control loop is a waste of a highly desired feature of the DS-19, namely full guidance through Black Brant burn-out and the resulting low impact dispersion, which is in-and-of-itself a safety feature. Hence, we strongly recommend that NSROC and WSMR pursue a solution for the full return of DS-19 capability (full guidance through BB burnout at T+44 seconds)that will provide the required safety margin for missile flight safety.

II. New Technology Currently Being Implemented at Wallops

A. GPS Based Altitude Event Triggers

The SRWG applauds NSROCs proactive development of the GPS Event Module (GEM) by the telemetry group. This technology has the potential to significantly increase the observing time for science payloads. The experimenter will no longer have to make conservative estimates based on historical booster performance to set timer events with large (2 or 3 sigma) margins. This allows instruments to turn on, open doors, deploy booms, or begin maneuvers and observations earlier than with timer events. Similarly on descent, the GEM allows experiments to be shut down and parachutes deployed at a later time than conservative timer settings would have allowed. Finally the GEM obviates the need for experimenters to include altitude sensors as fail-safes or event triggers in their payloads, reducing cost and complexity. This is potentially a major development by NSROC and promises to be a great benefit to the experimenter. That said, the SRWG would like to see more information on this system including reliability estimates and data, the possibility of adding redundancy and how exactly the traditional timer events will be used as backups. The system will not add value to the experiment unless the timer backups are set using optimistic values for motor performance. Thus redundancy and reliability are keys for making this highly desirable technical development a success for science payloads.

B. Patriot Rocket

The SRWG was very pleased to learn of the recent development of the Patriot rocket to provide an alternative launch system to the Brant, including both the single stage Brant and the Terrier Brant system. In addition to the higher performance (i.e., broader payload capacity), the cost savings are important for the program overall. We look forward to more information concerning the introduction of the Patriot rocket into NASA's inventory.

C. Advance Engineering Computer Design

The SRWG applauds the use of state-of-the-art advanced engineering computer aided design tools (e.g., SolidWorks@3D) in the mechanical design of payloads. Such software provides a better design, saves time, and calculates mass properties and other engineering parameters. Furthermore, by encouraging the users to submit their experiment lay outs in the same (or compatible) computer packages, the payload design is not only improved, but also fit checks can be made on the computer and the design optimized in a more efficient manner.

III. Technology for the Future

A. Technology Roadmap

The SRWG is encouraged by the efforts that WFF has made recently concerning implementation of new technology and new techniques, and updating of older hardware. We are concerned, however, that if undirected and unplanned, these efforts may not be used to optimally advance the research efforts of the NASA science community. Further, we recognize that NSROC may focus on developing technology that enhances their ability to acquire non-NASA new business at the expense of the NASA science community needs. We would like to better understand how NSROC delineates, if at all, between R and D efforts for NASA projects and those, for example, for DoD. Are their development resources for each effort that are accounted for separately?

From the perspective of the NASA research scientist, the insistent science requests for "more time on target" and "more and smaller sub-payloads to higher altitudes" appear to be most effectively addressed with innovative hardware and clever software. Indeed, the NSROC engineers can implement just about anything, given enough time and money. However, a balance must be struck between the endless requests of scientists and the limited resources of engineering design time and funds for prototypes and testing.

To achieve such a balance we look to the NASA Sounding Rocket Program Office (SRPO). One way of organizing such information is a technology "roadmap". Inputs to this roadmap include (a) science needs requests from the user community, including priorities, and (b) engineering technology ideas and possibilities from the NSROC engineering community, including costs. The output of such a roadmap from the SRPO should be a balance between the urgency of the science need and its expected scientific impact in the community, and the costs of the engineering implementation. An important consideration is the length of time needed to implement the new technology, as some small projects can be completed quickly to meet a specific goal and other longer-term developments can be done more slowly and in parallel. Such a roadmap, once initiated, should be perpetuated as a "living document", wherein NSROC engineers (or others) can post potential new technology ideas, and scientists can post wish-lists.

At the last meeting, the SRPO stated its intention to facilitate this endeavor. The SRWG fully endorses this initiative and believes that the SRPO is uniquely suited to both create and monitor a sounding rocket technology roadmap, matching up needs and possibilities, and optimizing the use of our limited community resources. For our part, we believe that the SRWG can help define and communicate scientific user input to the roadmap. We look forward to working with the SRPO on this exciting new aspect of the program.

B. The “Big Gun”

The ability to fire small ballistic payloads from a large gun, developed by the DOD during the 1960's, presents potentially significant new capabilities to NASA's suborbital program, particularly with regard to lower thermospheric/ionospheric and mesospheric investigations requiring multiple payloads launched at regular intervals over a period of several hours or several days. The proposed gun launcher augments a particular strength of the sub-orbital program -- namely providing the only means of directly sensing the region of the earth’s upper atmosphere between 40-180 km. Furthermore, the types of experiments made possible by this technique loom important as NASA-sponsored researchers are pressed to better understand space weather and climatology of this region and others.

The SRWG heard an excellent presentation introducing the idea of using the large gun and some of the expected science return if it could be returned to use as a scientific investigative tool. The SRWG strongly recommends that NASA undertake a feasibility study to determine whether it is possible to return the remaining big gun (in Yuma, Arizona) to operation, and what are the costs of doing so. This study should be conducted as soon as possible, because DOD support of the facility may lapse in the near future. This implies that urgent action may be needed in order to preserve the facility and make it operational.

IV. Welcome To Phil Eberspeaker

The SRWG extends a very warm welcome to the new Chief of the Sounding Rocket Program Office, Mr. Phil Eberspeaker. Many of us remember Phil as a payload manager and as the leader of the development team that helped implement NSROC. We believe that Phil Eberspeaker is very well qualified to serve as the Chief of the Sounding Rocket program. He brings much knowledge of how sounding rockets work, management skills necessary to keep the program on course, and leadership skills to guide the program to new and fruitful directions. The SRWG looks forward to working with Phil to advance the unique scientific research tools that sounding rockets provide to the nation's space program.

NASA Sounding Rocket Working Group

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

Dr. James Clemmons
Aerospace Corporation

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Walt Harris
University of Wisconsin

Dr. James LaBelle
Dartmouth College

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. Scott Porter
NASA/Goddard Space Flight Center

Dr. Charles Swenson
Utah State University

Dr. Erik Wilkinson
University of Colorado

Findings & Concerns

Meeting of December 19, 2001
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. New Technology Recommendations -- An Initial List

General Considerations

The Sounding Rocket Working Group has been asked to consider which new technologies it believes Wallops should pursue in order to maximize the science return of future missions. In particular, we seek to identify which new technology thrusts might open the door to completely new areas of research which would thus become immediately appealing to the scientific community, and by extension, to the Office of Space Science at NASA Headquarters.

The SRWG provides an interim list of new technology recommendations below. No attempt was made to canvas the community for their input that we view as essential to this process. Prior to taking this step, however, the SRWG feels that it is important to understand the budget available for the new technology development as well as the time-table. We would also like to better understand how NSROC decides on which new technologies to pursue and how it diverts/invests funds in these areas. For example, are direct NASA funds, marketing funds, overhead funds, and/or R and D funds used for these new initiatives? Are new technologies selected for development based on user needs or future marketing potential?

Although mindful of the rocket program's fiscally constrained environment, the SRWG wholeheartedly believes that new technology thrusts are essential for keeping the program viable and at the cutting edge of important scientific research. We thus enthusiastically participate in this activity and look forward to working with the Sounding Rocket Program Office, NSROC, NASA HQ, and the science community in promoting those new technology initiatives that show the most promise for advanced scientific research in the future.

We have divided our technology recommendations into two categories: (1) Critical technology that is needed to maintain or improve existing payload systems, and (2) New Technology Thrusts. As outlined below, we believe that there is a real crisis concerning the current capabilities involving ACS and attitude systems as older hardware used for decades in the program, as well as their standard contractor suppliers, may no longer be available. In some cases, this critical technology must be provided immediately as several approved programs are relying on such sub-systems for success.

I. Critical Technology to Maintain and/or Improve

* A. Fine pointing ACS systems for Astronomy and Solar Payloads
* B. Coarse Gyro and ACS for Space Physics Payloads

II. New Technology Thrusts

A. Astronomy/Planetary/Solar Physics

* 1. More time on target
2. Improved fine pointing, stability, and target acquisition time
3. Payloads to accommodate larger diameter telescopes
4. Long baseline interferometry using multiple telescopes

B. Space Physics

* 1. Small Payload and Launcher (e.g., Viper Dart) Development
* 2. Multiple Payload Technology
* 3. Higher Data Rates
4. Guided Trajectories

* -- Discussed below.

I. Critical Technology to Maintain and/or Improve

Fine pointing ACS systems for Astronomy and Solar Payloads

The most common fine pointing ACS configuration used on sounding rocket astronomy payloads is the Aerojet Mark VI platform with a Ball star tracker, which yields a typical pointing stability of 5 arc sec rms. We note that recent advances in ground- and space-based spatial resolving power are routinely below 1 arc sec. The SRWG believes that the next generation sounding rocket fine point capability should be better than 1 arc sec to remain competitive with the rest of the field. Towards this end, a new digital Mark VI was flown in October 1999 on Cruddace 36.162 DG and provided excellent performance. It is equally important to improve the pointing accuracy of the ACS star tracker. The current Ball star tracker has a number of limitations, namely a 4th magnitude brightness limit, the ability to track only 1 target within a 4 degree field of view, and a noise equivalent angle of 3 arc sec at Oth magnitude that grows to 9 arc sec at 3rd magnitude. In addition, these trackers are dwindling in number due to recent failures and are no longer manufactured.

A new star tracker and ACS system that can quickly identify where the telescope is pointed without the need for guide star acquisitions can increase the net observing time by up to 20% or 60 seconds. This new star tracker must track multiple faint targets within the same field of view and be functionally compatible with the digital Mark VI. Commercial star trackers tend to be expensive; in the $100K -- $1M range. Given the limited resources of the sub-orbital program, we believe an alternative source for star trackers is required that can address the immediate need for replacement star trackers and provide enhanced capability in the near future.

Such an effort is being lead by Drs. Kenneth Nordsieck and Jeff Percival at UW-Madison who are developing a cost effective alternative to the existing star tracker, as noted in the detailed SRWG finding on this subject from its June, 1999 meeting. The effort has been largely funded by NASA through an Explorer Technology Grant. The UW team has made considerable progress in developing and testing a direct replacement to the Ball star tracker with the aforementioned capabilities. Their system, known as the ST5000, has flown twice, in each case side by side with the Ball tracker and provided impressive results.

The SRWG strongly feels that the ST5000 is a viable and mature option for the sounding rocket community and recommends that NSROC aggressively pursue using the ST5000 to replace the Ball star trackers. The ST5000 addresses many of the recommendations by the SRWG: it can be used as a direct replacement for the Ball tracker and can identify where it is pointed within 2-6 seconds without the need for multiple guide star acquisitions. This second capability is important for increased observation time.

Coarse Gyro and ACS for Space Physics Payloads

Next Generation ACS Systems/Coarse-Pointing

The SRWG finds much need for improvement in the utilization of coarse-pointing ACS systems on sounding rockets. As noted in our previous finding on this subject from the June, 1999 SRWG meeting, there is a range of operation problems regarding the use of coarse-pointing ACS systems including inertial pointing inaccuracy and firing at inopportune times, including times inside the dead band. These types of ACS problems can lead to serious compromise of the science objectives because instruments are not oriented as desired and/or the firing operations disturb the scientific measurements. There is now the added concern that the regular supplier of these ACS systems, Space Vector Corporation, may not be able to provide these systems on a cost effective basis in the future.

The SRWG urges NSROC to develop a plan to provide new "coarse" ACS systems for space physics payloads. Such systems must be dependable, lightweight, easy to implement, capable of achieving a payload orientation in a short amount of time, not continuously disruptive of scientific instruments, and inexpensive. In general, space physics ACS systems must perform one of two tasks: (1) line the payload spin axis with the ambient magnetic field vector, or (2) follow a pre-programmed set of orientations such as lining the ram axis with the velocity vector on the upleg and downleg.

In the case where the ACS need only line the payload spin axis with the ambient magnetic field, a very simple system with a straightforward comparator circuit is needed to achieve the required alignment which is usually +/- 1 degree. In fact, NASA/Wallops Flight Facility used to build such analog magnetic ACS systems with a very high degree of reliability and low cost. The SRWG urges NSROC to consider flying the old "tried and true" systems for which the detailed drawings are still available at Wallops. Since space physics payloads are not routinely recovered, it is also paramount that NSROC develop an inexpensive ACS system (such as the analog magnetic system mentioned above) that it can afford to throw away.

Next Generation "Coarse" Attitude Systems

Another area of long-standing concern of the scientific user community and the SRWG in particular involves "coarse" (i.e., ~ 1 degree knowledge) attitude solutions, as also noted in the Findings from the June 1999 SRWG meeting. These attitude solutions are frequently supplied to the science teams only to be subsequently determined to be inaccurate. Consequently, a great deal of effort is expended by the science teams to both verify and develop acceptable solutions which should, in principle, be an accurate data product when delivered to the science team. Our greatest nightmare involves the publication of an incorrect scientific result that results from an erroneous attitude solution that was either never verified or improperly verified.

The standard payload system used to provide coarse attitude knowledge for most space physics payloads is the MIDAS gyro platform and its derivitives. These systems utilize designs that are over 25 years old and which are also made by Space Vector Corporation. We urge NSROC to develop a plan whereby accurate, inexpensive, and lightweight alternatives are available for those times when the MIDAS platform is no longer available or affordable. As with any new ACS system, it is essential that rigorous testing be carried out of the new attitude system, including the verified analysis of the attitude data, prior to its instigation in the program.

II. New Technology Thrusts

A. Astronomy/Planetary/Solar Physics

More time on target

For astronomical payloads, the flight time above the altitude where emissions are absorbed by the Earth's atmosphere (typically ~100 km) directly determines the signal obtained from the target. Most of these payloads are UV stellar and solar telescopes launched from WSMR, and there is a clear advantage to a longer "hang time". We note that even 60 second of extra hang time can significantly improve the science return on astronomical and solar missions by providing additional target opportunities. A doubling of the hang time would be equivalent to flying a telescope with a diameter 1.4 times larger than what exists, and lead to a similar improvement in the signal/noise. The tight impact dispersions achieved with the recently developed DS-19 opens the possibility of flying vehicles with higher trajectories, such as the BB-X, -XI, or XII, at WSMR. New parachute systems are also needed to accommodate the larger re-entry velocity environments, and in this regard we note the impressive recovery operations of the high altitude (750 km) MAXUS payloads launched on the Castor IVB motor within the narrowly constrained Esrange launch area in Sweden. The SRWG strongly urges NSROC to fully analyze the technical and logistical issues surrounding the launch and recovery of astronomical payloads at WSMR using higher performance vehicles and to develop an implementation plan for this enhanced capability.

B. Space Physics

Miniaturized Payloads and Small Launchers

Small, miniature platforms enable important new in-situ scientific measurements to be carried out in the mesosphere and lower ionosphere repeatedly and at low cost. Because of their small size, such payloads would perturb the medium to a minimum extent and would thus enable new types of measurements to be carried out. Because of their low cost and portability, scientists would be able to launch numerous such rockets in a single geophysical event or a series of such rockets over a relatively short period of time. The success of such a system relies on two engineering factors: (1) the development of a reliable, low cost launcher, such as the Viper Dart and other small motors; and (2) the development of a small payload with reliable, low cost sub-systems, such as GPS receivers, power, magnetometers, attitude knowledge, etc.

Based on previous reports to the SRWG, it appears as if the Viper Dart instrumented payload promises to be a valuable mesospheric research tool, as demonstrated by the success of the Norwegian engineering and scientific teams with similar payloads. We look forward to the successful NASA development of both a small launcher and miniature payload such that such systems might be routinely available to the scientific community via the AO process.

Multiple Payload Technology

Multiple payloads launched on a single rocket enable several exciting new areas of space physics research to be carried out. Although “daughter” or sub-payloads have been used in the program for decades, only recently have sub-meter spatial knowledge and sub-microsecond temporal knowledge between platforms separated in space become possible. Such inter-payload precision opens new avenues for investigating a variety of space physics phenomena, including wave data (for example, using in inter-payload interferometry), particle and fields electrodynamics (for example, solving curl equations with input from spatially separated payloads), and detailed differentiation between space/time causal effects (for example, with wave-particle interactions).

Such multiple payload technological advances have been pioneered by a number of individual research groups, including UNH, Cornell, and UCB, in recent years. At this juncture, we urge NSROC to develop those sub-systems that might provide the necessary high precision spatial and temporal accuracies between multiple payloads so that they may be available routinely and inexpensively to the scientific community at large. In particular, we urge that a small, lightweight, and inexpensive ACS system be developed for such sub-payloads.

Finally, we note that the new thrust of orbital missions in the Solar-Terrestrial Probes line as well as in the NASA Sun-Earth Connections Roadmap involve in-situ measurements gathered with clusters, swarms, and indeed constellations of payloads flying. The slower speeds of the rockets and their direct engagement of known geophysical events observed simultaneously with ground-based instrumentation provide unique opportunities for sounding rocket experiments to be the forerunners of the larger class investigations and indeed, to enable high level data analysis techniques to be developed. The SRWG thus acknowledges the pioneering role that the multiple sounding rocket payload technologies are playing for the development of a large new class of space experiments for the Space Physics community.

Higher Data Rates

With a few exceptions, scientific sounding rockets use telemetry for data acquisition. Some ongoing experiments have pushed the limits of telemetry rates supportable by Wallops engineering, and experiments which have exploited this capability to the maximum have produced exciting results. For example, key plasma resonance frequencies lie in the range 1-10 MHz in the ionosphere, and the ability to measure multiple components of fluctuating fields at comparable data rates has revealed for the first time the fine structure associated with these resonances. However, the need for high telemetry rates is not limited to wave experiments. Recently, imaging auroral and other phenomena has emerged as a top priority, with several groups proposing. Imagers, particularly when operated at high speed as must be done in state of the art science experiment, produce prodigious amounts of data and will push the bandwidth requirement. Another important frontier in space sciences and astrophysics can broadly be defined as "high energy resolution at high energies," whether measuring particles or photons. This challenge inevitably requires extremely high bandwidths.

With these trends clearly in view, the NASA sounding rocket support at Wallops should consider a significant qualitative upgrade in the data acquisition to rates 10-100 times greater than those available today. Although it might require an investment in new ground equipment, this upgrade would pay off in a large jump in the quality and quantity and excitement of science experiments performed within the rocket program. Acquiring broader bandwidth telemetry is one way to achieve this enhancement.

2. Wallops Geophysical Observatory

The SRWG was very pleased to hear the progress report on the Wallops Geophysical Observatory which consolidates a number of existing and planned ground based instruments at Wallops and provides a web-based distribution center for all of the data. The existing instruments include the SPANDAR radar, ionosonde, field mills, lightning detector, and meteorology. New instruments include a sensitive magnetometer, GPS receivers, and possibly a series of SPANDAR enhancements. Such scientific instrumentation not only provides valuable knowledge concerning the atmosphere and ionosphere in support of flight programs at Wallops, but also provides a long term baseline in which the flight data may be placed in context. Further, the instruments provide continuous measurements at a key mid-latitude site that will be accessible to the entire science community. We applaud the work of the Wallops Flight Facility staff in their creation, maintenance, and fostering of the Wallops Geophysical Observatory.

3. Emulator for the WFF93 Telemetry System

Wallops has been working with PSL for several years to create an emulator for the WFF93 telemetry system that would allow experimenters to develop and test their interfaces before arriving at Wallops for integration. The most important interface is the serial telemetry interface, as that is the one that is most difficult to work with. The SRWG would like to commend Wallops for this work, as several benefits are likely to come from such a development, including more efficient use of time and money at the experimenter institutes and at Wallops, and the flight of more reliable systems. However, although this development has been discussed at several SRWG meetings, the emulator has yet to be finished and distributed. The SRWG thus encourages NSROC to take a more active role in assuring that this new system will be delivered in a timely fashion so that experimenters can begin to take advantage of its important and tremendously useful capabilities.

4. Appreciation -- Mr. Bobby J. Flowers

The Sounding Rocket Working Group expresses its sincere appreciation and deep gratitude to Mr. Bobby J. Flowers, who managed the program so well over the past five years and who retired earlier this year. Bobby worked for over 40 years in the rocket program, including many years as a payload manager. The Sounding Rocket Working Group acknowledges in particular the contribution of Mr. Flowers who served as the Sounding Rocket Program Chief during a difficult time which included the initiation of the NASA Sounding Rocket Operations Contract at Wallops and a significant perturbation in program funding. The sounding rocket program that Bobby Flowers helped create has enabled unique scientific achievements to be carried out in space, reflecting highly on both NASA and the United States. We acknowledge Bobby's expertise regarding sounding rocket systems and thank him for his untiring dedication to the program.

NASA Sounding Rocket Working Group

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

Dr. James Clemmons
Aerospace Corporation

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Greg Delory
University of California at Berkeley

Dr. James LaBelle
Dartmouth College

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. Scott Porter
NASA/Goddard Space Flight Center

Dr. David Slater
Southwest Research Institute

Dr. James Ulwick
Utah State University

Dr. Erik Wilkinson
University of Colorado

Back to TOP Email us Home

Findings & Concerns

Combined Findings from SRWG Meetings:
Meeting of December 7, 2000 and June 15, 2001
Sounding Rocket Working Group
National Aeronautics and Space Administration

Introduction

The Sounding Rocket Working Group has followed the progress of the NASA Sounding Rocket Operations Contract (NSROC) since its inception. In the course of events over the last 6 years, it has provided advice and input for numerous panels that studied and eventually created NSROC, thereby helping to establish guidelines for the formation of the privately-owned and managed program that succeeded the NASA-managed sounding rocket program that had been in place for the 40 years since the creation of the agency.

When the initial ideas of a Government-owned/Contractor-operated (GOCO) system to take over NASA's sounding rocket program were first suggested, they were met with skepticism by the SRWG as well as the user (science) community in general, as discussed, for example, in the SRWG findings from its December 11, 1996 meeting. (The GOCO idea was eventually succeeded with the Performance Based Contract that is the current system in place today.) Despite our strong reservations, the SRWG affirmed its dedication to preserving the rocket program and thus provided support for the new operating system selected by NASA management. We expressed our commitment to being proactive and to helping the NSROC implementation in findings from the SRWG meetings of June 24, 1998 and December 16, 1998.

In a review of the proposed new operating system in 1996, the SRWG cited several areas that they felt were important to maintain a viable and scientifically efficacious sounding rocket program for the nation. These included: keeping costs contained while maintaining the flight rates of 30 flights/year, preserving flexibility and innovation, and maintaining the remote campaign capability. Regarding the contract that was being written at the time, the SRWG noted the importance of the "escape valve" that was promised by NASA management as an opportunity to make changes -- including both large scale and smaller course corrections -- after the initial phase of the transition to the new system was complete, in order to ensure that the unique capabilities of NASA's sounding rocket program were preserved. [See SRWG Finding #2 of December 1996].

At the present time, the NSROC has been in place for about 2 years and its implementation is currently being reviewed by NASA. Principal Investigator (customer) input is required for this review, as stated in the contract requirements (H.22, page 54). Indeed, input has been provided by individual scientists (Drs. R. Arnoldy, J. Clemmons, C. Korendyke, K. Lynch, K. Nordsieck, and R. Pfaff) at the NSROC Transition Review Committee meeting on November 16/17, 2000. Furthermore, the SRWG heard presentations from this review committee at both its December, 2000 and June, 2001 meetings for which comments and discussion were provided.

To summarize the user input represented by the SRWG, we present this finding which discusses not only the performance and implementation of NSROC but also the impact of the new management arrangement to the sounding rocket program in general. We anticipate that other user input may also be provided separately.

Performance

The current NSROC organization (Litton/PRC) has put together a highly capable blend of managers, engineers, and technicians. They know how to design, build, test, and launch sounding rocket payloads. This retention of the basic sounding rocket technical capabilities is a relief to the scientific community and for this we offer our commendation.

Having said this, the SRWG notes with concern the somewhat larger than usual percentage of failures (4 out of 16) in FY00 as well as two serious anomalies thus far in FY01, all of which have occurred during the first two years for which the program has been carried out entirely under NSROC management. Although not of adequate significance to indicate a trend, some of these failures might have resulted in indirect ways from a combination of new people as well as operation issues that may have otherwise been avoided in the previous arrangement. The responsiveness of NSROC to each failure and anomaly has been thorough, with NSROC management not only accepting responsibility but also demonstrating a clear path to identifying and resolving the problem(s). Thus, although the failures are a cause for concern, we do not believe they necessarily signal major problems with NSROC.

From the perspective of the user, the implementation of NSROC with respect to technical matters, has, for the most part, gone quite well. NSROC clearly understands the business. As anticipated, the technical aspects of the new NSROC arrangement have been enabled by the fact that Litton/PRC has (1) hired a very large number of the existing contractors at Wallops, who were already performing the vast majority (> 90%) of the non-managerial tasks in the sounding rocket program under the old arrangement, (2) assumed full use of the government-owned hardware, machine shop and test equipment, and (3) taken control of the designs and drawings of all past NASA rocket payloads that are typically used as the starting point for new projects. Although there are some areas of technical concern, such as in the attitude control area and the contractor support at the White Sands Missile Range, in the general areas of sounding rocket technical performance, both NSROC and its implementation have succeeded well.

Skill Mix of NSROC Personnel

NSROC management was wise to capture most of the existing contractors at Wallops, many of whom had been supporting the sounding rocket program for decades, as well as hire a few civil servants who had retired during this same period. In our view, this act alone has ensured the technical success of the program more than any other factor. New people were also added, such as the entire upper management tier of NSROC, and they appear to have readily adjusted to the special management needs of the sounding rocket program including the unique partnerships between the PI, NASA HQ, and Wallops that must be engendered and actively managed by all parties to ensure a vibrant and effective program.

The one skill area for NSROC at Wallops that has been significantly lacking has been expertise in the attitude control area. This is a critical area for a large number of rockets, including both fine-pointing astronomy and solar payloads as well as coarse-pointing plasma physics payloads. Indeed, the successful operation of such ACS units are frequently required for minimum success and the importance of a strong staff of experienced personnel is essential both to implement the current capabilities as well as to prepare the next generation of ACS systems.

In a related issue, the contractor support at White Sands Missile Range for the SPARCS and other fine-pointing ACS systems is critical and there does not appear to be an agreed-upon plan to maintain or replace this capability, except with the longer range strategy of trying to develop such systems in house. The SRWG is aware that NSROC is working on this issue and looks forward to learning their plans to remedy this situation.

Innovation and Responsiveness

Through both presentations at SRWG meetings and the actual implementation of new ideas, NSROC has demonstrated to the users its commitment to developing new technology and to innovation in general. To this end, it has indicated that it will pursue such ideas as new ACS systems, a replacement attitude system for the antiquated gyros in use for over 30 years, new ideas in telemetry, as well as rely more heavily on GPS for positional data. Although we are not aware of the costs involved in their investments in new technology and the future, the users are obviously strongly in favor of NSROC's position in regard to fostering new technology.

Despite our enthusiasm for the new approach, there is a need to understand where the funds come from and how the decisions are made for the new technology initiatives that are supported with funds that originate from NASA. Clearly, there may be conflicts between investing in technology that can be marketed by NSROC (e.g., new ACS systems) versus technology that is needed for science initiatives without any other apparent payoffs (e.g., DARTS).

NSROC has consistently demonstrated that it is forward looking and that they are considering the long term. They have taken the initiative to do this. The SRWG not only applauds this approach but also looks forward to working with NSROC and the SRPO to chart a course for the future that identifies the highest priorities for new technology with respect to anticipated new science thrusts.

Operations and Management

In general, field operations have not gone smoothly since NSROC was initiated. This has apparently been due to a variety of reasons, for which the breakdown of the traditional centralized management of the program is at the core. The main problem from our perspective appears to be a disconnect between NSROC and the Sounding Rocket Project Office (SRPO) in terms of resolving problems or adjusting to unexpected changes during the course of launch operations. For a given mission, there remain a number of decisions that can only be made by the SRPO as they involve NASA contracts with the range, international matters, safety concerns, or operations support from CSOC. For example, acceptable launch corridors might need to be changed and/or re-negotiated real-time, which directly affects the ability to launch the rocket, which is the responsibility of NSROC and determines their fee.

With regard to CSOC (which provides operational support for sounding rocket launches), advance input concerning available telemetry support and other matters are generally needed before a design can be completed. In many cases, it affects science and experiment design decisions. As NSROC has no control of CSOC which must interface directly with NASA, NSROC is often handcuffed from proceeding without CSOC decisions. For example, it is difficult to design a payload to be launched at a foreign site (e.g., Spitzbergen) without timely input on the telemetry systems that will be available. In most cases, NSROC must rely on the SRPO to interact with CSOC to discuss and gather the necessary input.

To a larger extent the operational problems encountered appear to stem from the fact that it is unclear who is actually in charge -- SRPO? NSROC?, the P.I.?, Range Management? Safety? In most cases, the SRPO ultimately must resolve range problems, but they are understaffed and it is difficult to actively support every launch particularly when unforeseen difficulties arise. The problems are exacerbated since the Mission Managers are NSROC employees who do not report to the SRPO but must bring problems to their attention and rely on them to resolve problems. Under the new rules, SRPO can not tell NSROC how to deal with their end of the problems and the resulting situation may be quite frustrating.

Another area is that of international launches, that include a whole host of additional concerns involving range details that can only be worked by the SRPO. NSROC has not yet supported a remote sounding rocket campaign, but we anticipate that this would present a new series of tests for NSROC in the operational arena that would probably be dealt with more efficiently under the old arrangement that was based on a centralized management approach for the entire program.

To conclude, operations represents a major area where the program does not appear to be as well off as a result of the switch to the new system, primarily because it is more cumbersome to resolve real-time problems under the new arrangement in which the NSROC and SRPO management teams are divided.

Costs

NSROC, by the very nature of its contract, is more expensive than the previous, "level of effort" contract managed by NASA that was used previously to carry out the work. The promise of lower costs to the sounding rocket project under NSROC has not materialized. There remains the possibility that marketing initiatives may eventually bring costs down to a level below what the program cost previously, as was originally envisioned by the planners, although to our knowledge evidence has not been shown that this is likely to occur in the near term, if at all. The fact that the past approach included civil servant manpower can only account for a limited portion of the large cost of the program today, since the vast majority of the work was still performed by contractors. Although the large NSROC costs are not a surprise, since the hallmark of NASA's "can-do" sounding rocket program has traditionally been low cost, efficiency, and innovation, the SRWG believes that certain aspects of the financial arrangements with NSROC should be re-evaluated, particularly as the program has recently undergone a general funding crisis at NASA HQ.

The chief reasons why one expects NSROC to be more expensive is that fees (profit) must now be paid on all costs as well as larger overhead costs. Furthermore, since NSROC is now procuring hardware, including costly rocket motors, they are charging overhead fees on these purchases which were not previously paid when the government procured them. Furthermore, sub-contractors have little incentive to lower prices, knowing that their costs will just be passed along via NSROC to NASA.

Another reason why we suspect NSROC is more expensive is that due to the costing model itself. Under the new arrangement, NSROC establishes "price tags" on individual rocket projects including estimates of labor which invariably must include contingencies since project testing and time in the field may vary considerably due to unforeseen experimenter variables. We wonder whether such agreed-upon price tags practically guarantees that the actual costs will be close to these values. (To this end, it would be useful to see a list of anticipated versus actual costs for the missions completed thus far by NSROC.) Although there are financial incentives for NSROC to save money on individual missions, these appear to be minimal. Various P.I.s have informed the SRWG of instances where NSROC seemed quite eager to "spend money" and do extra testing that did not appear to them to be necessary. Although from our vantage point we can not judge the merits of such expenditures, we can say that we know of no case thus far of significant savings or incentive fees that rewarded NSROC for completing any mission thus far well under its expected cost.

The SRWG admits that it does not have the insight into NSROC's financial picture to comment as effectively as it might wish on program costs, but it appears to us that the new structure and profit incentive of NSROC runs counter to doing the job for the least amount of money. Furthermore, in the past year, the sounding rocket project for the first time in its history had to delay approved payloads because of a lack of funds, and this occurred in a year where the total number of rocket launches was already well below the average. Although the reasons for the shortfall are not directly due to NSROC, in our view the project should be doing everything possible to save money and have the most efficient program as possible. The NSROC Transition Review committee might thus consider significant changes to the model to restore some of the fiscal advantages that the program enjoyed in prior years. (See comments on the appropriateness of the model and other suggestions below.)

Principal Investigator (Customer) involvement in the NSROC managed process

The SRWG feels it is appropriate to comment on the role of the Principal Investigator in the new NSROC arrangement, with particular emphasis on how the new management scheme is affecting science. We limit our comments to three areas:

<u>Experiment design, innovation, and paperwork.</u> For many missions, the scientific instruments are not "off-the-shelf" experiments. A large amount of detailed design, head scratching, and creativity takes place after the Requirements Definition Meeting (RDM), although prior to the Design Review. The RDM is a new meeting required by NSROC for pricing purposes that must take place within 45 days of the Mission Initiation Conference (MIC). Payloads are frequently designed as a team effort between the experimenter and Wallops, particularly as innovative designs are implemented. In other cases, the experimenter designs

and builds a large portion of the payload at his/her laboratory or university. Although such arrangements are still possible under NSROC, the P.I. now experiences pressure to have preliminary design work completed prior to the RDM which works for many projects but stifles innovation in others.

The RDM requires non-trivial resources from both NSROC and P.I.'s (i.e., personnel, time, travel, paperwork). This can be difficult for experimenters that have only been funded for a brief period prior to the RDM, if at all. Further, NSROC requests requirements significantly ahead of the meeting so it can do the paperwork and prepare the RDM packages. In sum, the RDM adds bureaucratic requirements for the experimenter that the program previously did not have.

Irrespective of the additional paperwork, the chief concern of the SRWG is that there is now subtle pressure to discourage innovative science payloads that require teamwork between Wallops engineers and the experimenter with long development times (e.g., DART project with Utah State University) that extend well beyond the RDM. As a result, the SRWG fears that the great experimental possibilities inherent in the shining jewel of NASA's crown that is the Sounding Rocket Program, may come down a notch.

<u>Success Criteria.</u> The SRWG is concerned that Principal Investigators have been pressured to water down their success criteria to ensure maximum fees for NSROC. This subject has been discussed at length at a number of SRWG meetings. In fact, the SRWG issued a lengthy finding on this subject after its meeting of June 9, 2000 which described the problem and gave examples. Although NSROC has indicated that it is not their intention that the scientist compromise minimum success criteria for the sake of facilitating a business arrangement, since clearly it is now in their interest to "negotiate" minimum success criteria such that cost and risk are minimized, there is again pressure for the experimenters to compromise their expectations. Some P.I.'s have emphatically insisted that allowing failure in the program on the experiment side is important since this means that new experiments are being tested, etc. However, the possibility for this does not seem to be encouraged under the new system.

<u>P.I. involvement in NSROC costing.</u> The SRWG is confused over who has responsibility for the cost of the mission. (A finding was issued on this after the SRWG meeting of June 9, 2000.) If the P.I. is to be the steward of the funds, as in NASA's SMEX and MIDEX programs, then he/she must be involved in the financial dealings, including knowledge of NSROC fees, prices of sub-systems, overtime decisions, field work, etc. It appears that the P.I. could be made aware in a general sense of big ticket items that are being considered for the payload, but may be shielded from the nuts and bolts of the financial details. However, if the P.I. is to be responsible for the overall costs, the details must be made available to him/her.

There appears to be a fundamental problem with cost feedback. It is in the P.I.'s interest to request more support for a given mission and in NSROC's interest to add them and to bill NASA accordingly, since P.I. satisfaction is a large part of the NSROC award fee. For example, there is little incentive for overtime not to be authorized for additional testing, etc. We note that such relationships differ considerably depending on the P.I. and his/her experience. However, in the past, the SRPO clearly laid down the law when it came to living within the program limits, judiciously regulating overtime, etc., and this clear chain of authority seemed to help rein in costs and keep things on track.

Appropriateness of Model

Although the SRWG does not purport to have worked out a detailed alternative model, we comment here on the appropriateness of the model being used in the new contract arrangement. Since the purpose of the current review is to instigate course corrections, we provide comments on those elements of the new program model that make sense and other obvious elements that we believe should be changed. Given that both the old and the new paradigm offer clear advantages, perhaps a new arrangement can be worked out that provides the best of both worlds.

A new model paradigm that the SRWG asks be considered is as follows: NASA's sounding rocket program would still be operated by one contractor (NSROC) that has responsibility for designing and building payloads for the rocket investigations selected by NASA HQ. Further, they have the sole right to "market" Wallops, bringing in business and directly profiting from these activities. However, with regards to the science rocket payloads, instead of providing detailed “bids” on individual missions, NSROC would provide contractor support for a suite of missions instead, defined by whatever payloads are selected by NASA HQ in a given year. In this arrangement, there would be no formal RDM for each mission, although a good estimate of the cost of each mission could still be provided to NASA HQ so they would be aware of the approximate cost of each selected investigation. Instead of working towards the overall price tag established at the RDM, the contractor simply bills for those hours spent on a specific payload, with award fees available annually depending on the overall success of the mission suite. Procurement is returned to the NASA side of the house to save costs with NSROC able to buy at cost NASA-specific hardware (e.g., rocket motors) that it needs for any non-NASA sounding rocket (or other) mission that it brings in via its own marketing efforts. Project management of the NASA (i.e., science) sounding rocket payloads (payloads and operations) would be returned to the SRPO (although mission managers may still be NSROC employees.) NSROC would entirely manage the missions it brings in via its marketing or other initiatives.

In our view, a new arrangement such as that proposed above provides much more efficient use of everyone’s time. It provides significant savings to the program, which are particularly needed now and in the foreseeable future given the tight fiscal situation in which the program is currently. The sole NSROC contractor still benefits from the considerable marketing potential of the Wallops Flight Facility. The centralized management approach brings together the several critical elements of the program -- payload design and testing, operations, range telemetry and radar support (CSOC), and safety -- all of which must be dealt with together to ensure a well-working and successful program. Finally, the Principal Investigator (customer) will no longer feel the pressure that the science is subordinate to the business world. Rather, the new model underscores the fact that efficient, high quality, cutting edge science remains at the forefront of NASA’s sounding rocket program.

Summary

Main Strengths:

NSROC is very competent and responsive to experimenter needs. It includes a first rate cadre of engineers and technicians that know how to “get the job done” . The new arrangement allows for marketing of Wallops which potentially has lucrative payoffs, particularly with DoD.

Main Weaknesses:

The current contract approach results in an expensive program which has not saved the program any money. The profit incentive of NSROC does not support the general philosophy of providing an ultra-streamlined operation that designs, builds, and launches the maximum number of high quality payloads for the least amount of money. The lack of a centralized management approach hurts the program and provides for a number of critical disconnects between the payload team, operations, range support, and safety. The scientists are concerned that the program is increasingly conservative, which could limit their innovation and high-risk development efforts, which in turn, limits their capabilities to test new instruments and make important new scientific discoveries.

Recommendations for Consideration

-- Strengthen the NASA Program Office management role of NSROC.

-- Perform all procurements (in particular of sounding rocket motors) on the government side.

-- Eliminate the formal RDM and detailed price quote for each mission.

-- Implement a plan where NSROC bills for hours spent on a given project, without bidding each rocket individually. Provide fees to NSROC for *overall* performance, not on a mission-by-mission basis.

-- Instigate a centralized management approach whereby payload design, operations, range telemetry and radar support (CSOC), and safety are all managed as a team.

-- Encourage new business ventures for NSROC to make optimum use of Wallops Facility which they will manage.

NASA Sounding Rocket Working Group

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

Dr. James Clemmons
Aerospace Corporation

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Greg Delory
University of California at Berkeley

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. Scott Porter
NASA/Goddard Space Flight Center

Dr. David Slater
Southwest Research Institute

Dr. James Ulwick
Utah State University

Dr. Erik Wilkinson
University of Colorado

Findings & Concerns

Meeting of June 9, 2000
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. Concern Over Program Funding

The chief finding of the SRWG from its June, 2000 meeting was its alarm over the current fiscal situation surrounding NASA's sounding rocket program. To this end, the SRWG wrote a separate letter to Dr. Edward J. Weiler, NASA Associate Administrator, Space Science. A copy of this letter is attached.

2. Flight Safety and Black Brant XII Launches

The SRWG is concerned that under many circumstances it appears difficult, if not impossible, to launch a Black Brant 12 mission from the Poker Flat range without one or more waivers to the current flight safety rules. The fact that these waivers are usually granted suggests that some of these safety standards may be revisited for their applicability at the Poker range. While it is certainly not the intent of the SRWG to compromise safety considerations in any way, it is hoped that a revised flight safety process might streamline Mission Readiness Reviews for Black Brant 12 missions in the future.

3. Maximizing Observing Time

Maximizing the observation time of a sounding rocket instrument, be it a micro-gravity payload, an astronomy payload, or a space physics payload, is often crucial to the success of the mission and, therefore, the sounding rocket program as a whole. Observation time is directly proportional to altitude and correspondingly to the combined payload mass and vehicle performance. For astronomy, planetary, and solar observations, as well as most microgravity experiments, such missions require recovery and thus improved guidance systems (e.g., DS-19) and recovery systems (that must perform higher re-entry speeds) must be utilized to accommodate the higher apogee missions.

The Sounding Rocket Working Group recognizes that the confluence of circumstance, i.e. the development of higher performance, lower mass technology and the continued need for extended observation times, is a unique opportunity to provide meaningful guidance to NSROC on the development of new hardware. The SRWG urges NSROC to aggressively pursue plans to launch payloads higher than has been done traditionally as payload weights are lowered. For example, many new technologies are under serious study which improve technical performance at a substantially lower mass, e.g. the ST5000 star tracker system.

4. DS-19 Performance

The SRWG is concerned with the level of quality control implemented during production of the DS-19 that led to a recent failure at White Sands. We appreciate the presentation on the DS-19 performance and believe that the problem has been understood. We support continued use of the DS-19, provided adequate quality assurance procedures are followed. The DS-19 provides a means to fly higher (longer) at WSMR, a capability keenly desired by several groups, especially with the potential of higher performance in the upcoming motor buy.

5. New ACS Systems

The SRWG supports NSROC's three year plan to transition attitude control system (ACS) operations into a consolidated guidance and navigation control (GNC) group. This plan should lead to lower support and refurbishment costs for all ACS's while improving performance. We especially encourage all efforts leading to expedient development and routine use of the ST-5000 startracker to replace the aging Ball startracker. Successful development of the ST-5000 has great market potential beyond the sounding rocket program, the exploitation of which would be especially beneficial to NSROC (and hence presumably to the sounding rocket program) given the current fiscal environment.

6. Success Criteria

Success criteria are used by NASA, according to the Sounding Rocket Program Handbook, "to provide objective criteria that will be used to determine the success or failure of the mission after all operations are completed." Two levels of success are defined. A "comprehensive" success results in all or nearly all of the mission objectives being achieved. A "minimum" success occurs when performance is degraded to the extent that some or all of the mission objectives are significantly compromised, although the return of scientific results is still likely. The formulation of these criteria is driven by the Principal Investigator, but negotiations with Wallops often result in minor modifications. These criteria are then "flowed down" to prescribe the design of the mission.

With the advent of the NSROC contract and its emphasis on performance-based fees, success criteria are now used not only to measure the degree of success of a mission, but also are a determinant of award fees. This new use of the success criteria has had some negative effects. For example, it is in the interest of the NSROC contractor to negotiate success criteria such that both cost and risk are minimized. Although the award fee structure is based on complexity and therefore has some basis in the assumed risk, it seems that there nevertheless is an impetus for the NSROC contractor to attempt to negotiate less challenging success criteria. Science goals may be compromised as a result. As an illustration, a requirement for pointing knowledge of one degree has become problematic under NSROC. The gyroscope subsystem successfully used in the past for such purposes has a stated accuracy of three degrees. The employment of rigid body mechanics in the post-flight analysis has routinely allowed one-degree attitude solutions. However, the NSROC contractor has been unwilling to accept this scenario and has insisted on either using a more accurate but more costly hardware solution or that the success criteria be relaxed. Here it is seen that the use of success criteria as a determinant for award fee can affect the total science return adversely.

There are other indications that the concept of success criteria may need to be modified. In some cases, a successful experiment requires multiple, nearly simultaneous launches to be successful. However, success criteria are attached to each flight. Success criteria requiring performance of more than one mission have not been allowed. In this paradigm, an experiment could fail despite each of the constituent missions meeting their individual success criteria. Another weakness in the current system is that experimenters have sometimes been required to revise success criteria regarding based on small changes in the performance predicted by refined NSROC estimates. The SRWG urges that the Sounding Rocket Program office ensures that success criteria not be watered down for the purpose of increasing fees for NSROC.

7. Feedback to PI's on Costs Dialog

The SRWG is confused about who has responsibility for the cost of an individual mission (the P.I.? Wallops? NSROC? HQ?), particularly with respect to detailed decisions regarding hardware items, overtime, field work, etc. We request that this situation be clarified. In particular, there is a fundamental problem with cost feedback. It is in the PI's interest to request more things for any given mission, and it is in NSROC's interest to add them to the mission, and to bill NASA accordingly. In the past, the constraint has always been the Program Office at Wallops. In the current situation, this oversight appears particularly difficult for the markedly understaffed program office. Such discussions concerning cost feedback could take place at the RDM, although the P.I. is not invited to discuss detailed costs and contract terms with NSROC.

8. Bookkeeping of Viper Darts (Lynch & Pfaff)

The SRWG does not believe that Viper Darts should be counted as separate launches (on par with larger rockets) from the standpoint of rating the overall performance of the program on a yearly basis.

Recognizing that sophisticated miniaturization of Viper Dart payloads require in many places advanced engineering, it still does not seem right to count Viper Darts alongside the larger rockets. This skews the statistics and falsely portrays the program launch activity as more robust than it actually is. We suggest that all Viper Darts in a given set be counted as one launch, or that some other criteria or category be used.

NASA Sounding Rocket Working Group

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

Dr. James Clemmons
Aerospace Corporation

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Greg Delory
University of California at Berkeley

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. Scott Porter
NASA/Goddard Space Flight Center

Dr. David Slater
Southwest Research Institute

Dr. James Ulwick
Utah State University

Dr. Erik Wilkinson
University of Colorado

Findings & Concerns

Combined Findings from SRWG Meeting
Meeting of November 30, 1999
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. New Rocket Motor Procurement

The SRWG was favorably impressed with the ongoing process for procurement of new rocket motors and the primary selection criteria that will be applied to the expected bids. In particular, the SRWG agrees that the priority must be to maintain current capabilities at the lowest cost. However, we were concerned that "added impulse" was lowest of all criteria in importance, behind even the bidder's marketing plan. For some payloads, the available impulse is an important science driver. Although in some cases range safety or the capabilities of the recovery system limit the apogee, these constraints may be eased through new systems such as the DS-19 Impact Dispersion Control system. In future procurements of new rocket motors, we believe that it would be beneficial to invite input and comments from the SRWG (or a subcommittee) regarding the rocket motor selection criteria.

2. New Recovery System

The new digital S-19 system with its extended boost phase guidance capability will further reduce the dispersion in impact point. Combined with a higher performance motor, the sounding rocket delivery systems will be able to fly higher and land more accurately than ever before. Recovery system development, however, has not kept apace with even the current suite of delivery systems.

For example, the ORSA recovery systems are stretched to their limit. Flights above 300 km, now routine with the BB IX with a MK70 Terrier, are exhibiting damage to the skins and exposed ORSA hardware on rentry prior to chute deploy. The situation will only worsen if a new motor is used with higher performance than the current Black Brant. In addition, there are no recovery systems for the high flying BB X -- XII. Development of recovery systems for these high flyers would provide longer "hang" times for astronomy and solar payloads as well as potentially lower costs to users who do not use recovery systems at this time (typically a space physics payload) as they could rebuild upon recovery instead of starting each time from scratch. It would also allow, in conjunction with the new digital S-19, the use of high flying BB X -- XII flights at WSMR, which could increase science return for the typical astronomy/solar mission. We urge Wallops and NSROC to develop new high altitude recovery systems, which can keep pace with the current suite of delivery systems and which could accommodate the potential increased performance of new motors.

3. Rocket Trajectory by GPS and Radar

Since the early days of rocket probing of the upper atmosphere, the use of radar for the tracking of payloads has been the most reliable and accurate method to obtain the rocket's position in space as a function of time. However, with the rapid development of GPS for very accurate determination of position for a host of applications, it is obvious that this system represents an important improvement for sounding rockets. NASA Wallops launched the first of numerous GPS hardware systems in 1994. The GPS has not only provided position, velocity, and time data, but also has been used for vehicle performance analysis, for locating payloads for recovery, for data time tagging, and for mother-daughter timing, separation and interferometry enabling. Present capabilities include uninterrupted track from launch to LOS of all standard 14" and 17" diameter WFF sounding rockets with real time differential tracking and display with <10m accuracy and post mission processing <1m accuracy.

The GPS NAVSTAR Documentation states that for a single point solution, the position will be within 100 meters in the horizontal and 156 meters in the vertical 95% of the time. A differential solution, which is more complex and takes longer, would provide more accuracy. We request that such solutions be made available to the experimenter, when required by the science.

With respect to the accuracy of the GPS compared to the radar, the SRWG is interested in reviewing detailed comparisons of GPS and other solutions. For example, we understand that NASA is using the GPS data from Mission 21.122 flown at ESRANGE, Sweden, and the Swedish radar results as a test, along with other suitable missions. The SRWG looks forward to detailed comparisons of the rocket trajectory results for all flights that used both radar and GPS.

4. TM Simulators

The SRWG commends NASA Wallops and NSROC contractor for initiating the development of a standard telemetery simulator for use by experimenters. This new simulator will speed the integration process by allowing experimenters to verify their hardware interfaces to the rocket telemetry system before arriving at Wallops. It is suggested that the development of this simulator first proceed with most common type of interface, serial transfer, and then proceed to parallel transfer. Once functionality is obtained for these two types of data transfer, it may then be desirable to add features that would give added functionality for the user. By proceeding in this manner, the most needed features will be ready the soonest, and 'bells and whistles' can come later.

5. Commercialization and Priority of Machine Shop

The SRWG is alarmed that the costs of the Wallops machine shop appear to be higher than the costs of comparable machine shops outside of Wallops. It is our understanding that Wallops would offer lower cost machine work to attract new business. Furthermore, we believe that discounts should be available to NASA-funded scientists to encourage business, better structure operations, and save program costs. In some cases, university overhead charges might be avoided in cases where direct payment is possible.

The SRWG is also concerned that NSROC's commercialization of the machine shop will eventually lead to priority conflicts between the commercial and sounding rocket sectors. The SRWG believes that in these cases, sounding rockets should always retain priority.

The SRWG was impressed by the shop tracking metrics that NSROC has instituted, and presented at the December 1999 SRWG meeting, showing the month number of jobs submitted and completed. To better appreciate the shop time allocation, we suggest that NSROC further break down this analysis to show the monthly commercial and sounding rocket shop usage (submitted and completed) along with a measure of what fraction of total shop capacity was used by each sector.

6. Solar ACS Future Requirements

Solar missions require accurate pointing and low jitter. The new digital LISS has reduced the jitter to approximately 0.3 arcsec. Improvement of the jitter toward 0.1 arcsec is required by the next generation of solar instruments.

The primary problem with the current ACS system is the relatively poor absolute pointing. This is especially troubling for instruments which do not have full sun field of view. Instruments with 0.1 arcsec resolution will need 10 arc sec (100 pixel) absolute pointing error to assure that the desired solar targets are observed. This will likely require significant modification of the current system which relies on magnetic field measurements to determine roll angle.

The SRWG urges NSROC and Wallops to develop a plan to improve the solar jitter and ACS performance in order to enable state-of-the-art observations to be made in the future.

7. Recommendation for Dedicated Flights for Instrument Development

The SRWG recommends that Wallops implement as standard procedure a "new technology" sounding rocket test flight at a rate of approximately one/year. The purpose is to provide continuous availability of a test-bed for new and innovative instrumentation. The flight could be performed from WFF and instruments would be proposed through normal NASA Research Announcements. By dedicating one such flight per year, NASA opens the door to new technology development by allowing flight tests of developing instrument concepts.

In concert with this initiative, we urge that the sounding rocket program explore obtaining additional operating funds through the New Technology branch of NASA HQ to the fullest extent possible, as discussed at the meeting.

8. Miniaturization

The SRWG was impressed with the new miniaturized, rugged systems for use in small sounding rocket applications that are being developed under the Hardened Subminiature Telemetry and Sensor System (**HSTSS)** program by the Army Research Laboratory. Such systems include rate and attitude sensors, transmitters, and data encoders that fit within less than a cubic inch of volume and can withstand loads of up to 100,000g for projectile and munitions tracking purposes. The HSTSS program is currently developing an S-band transmitter with an output range between 250 mW and 2W at data rates up to 10 Mbits/sec, and fits on a board about the size of a quarter. A PCM encoder is also available in a similar form factor (see figure) which is FPGA based and includes four 8 bit A/D channels. An integrated PCM-DAC (PCM-Data-Acquisition-Chipset) combines a transmitter delivering up to 10 Mbits/sec of NRZ-L or RNRZ-L with digital and analog data interfaces, including a 16-bit parallel and a modified 115 kbs RS-232 interface. Micro-electromechanical sensor (MEMS) based accelerometers and angular rate sensors are also being developed for attitude determination uses.

The systems described above have potential uses in sounding rocket experiments where low volumes and high g's represent significant design considerations. Miniature rocket systems currently under development at NASA Wallops and in foreign space agencies may be able to leverage these new devices in order to make small payloads an effective, inexpensive tool for low-altitude ionospheric science. In addition, these devices have useful applications in deployed micro-payload constellations from mother sounding rocket payloads, such as the free-flying-magnetometers (FFMs) on the February 1999 Enstrophy payload (UNH). These devices represent commercial-off-the-shelf (COTS) solutions for programs that may otherwise have to resort to unique development efforts for miniaturized systems.

We recommend that Wallops and NSROC explore utilizing and supporting such miniaturized systems where feasible.

NASA Sounding Rocket Working Group

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

Prof. David Burrows
The Pennsylvania State University

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Greg Delory
University of California at Berkeley

Prof. Greg Earle
University of Texas at Dallas

Dr. Mark Hurwitz

University of California, Berkeley

Prof. Craig Kletzing
University of Iowa

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. David Slater
Southwest Research Institute

Dr. James Ulwick
Utah State University

Findings & Concerns

Meeting of June 29, 1999
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. NSROC Beginnings

The Sounding Rocket Working Group (SRWG) is encouraged that the implementation of the NASA Sounding Rocket Operations Contract (NSROC) has gotten off to a good start. We are particularly pleased that NSROC management has retained the core group of first-class contractors at Wallops. The many ideas presented at the meeting by NSROC managers, including ideas concerning facilitating software and hardware sharing between groups, were well-received. In general, NSROC's apparent openness to input and communication was particularly heartening to the user community.

2. Next Generation ACS Specifications/Fine-Pointing

The most commonly-used fine-pointing ACS configuration on NASA sounding rocket astronomy payloads is the Aerojet Mark VI platform with a Ball star tracker, which yields a typical pointing stability of 5" rms. Recent advances in ground-based and orbiting, space-based spatial resolving power are routinely less than 1". The SRWG believes the next generation sounding rocket fine-pointing capability should be better than 1" in order to remain competitive with the rest of the field. Towards this end, a new digital Mark VI will be flown on Cruddace/36.162 DG and we look forward to reviewing the performance of this new system. However, it is equally important to improve the pointing accuracy of the ACS star tracker. The current Ball star tracker has a number of limitations, namely a 4th magnitude brightness limit, the ability to track only 1 target within a 4 degree field of view, and a noise equivalent angle of 3" at Oth magnitude that grows to 9" at 3th magnitude. In addition, these trackers are no longer manufactured and the stock is dwindling.

A new star tracker is desired that can track multiple faint targets within the same field of view and be functionally compatible with the digital Mark VI. Star trackers tend to be expensive, i.e., in the $100K -- $1M range. Given the limited resources of the suborbital program, we believe supporting experimenter-led development efforts is a more cost-effective approach. Towards this end Aerojet has developed a standardize interface that will accept user-provided error signals, which will be tested on Clarke/36.174 UL. They will provide ACS with "quad-cell" error signals while tracking Jupiter, which is very bright (-2.5 magnitude). A more sophisticated effort is being lead by Nordsieck at UW-Madison who has made considerable progress in developing and testing a direct replacement to the Ball star tracker with the aforementioned capability. Last April (1999) on Nordsieck/36.172 UG, this group flew their CCD star tracker (ST5000) alongside the Ball tracker. They successfully tracked the guide stars acquired on route to the science target and provided low bandwidth imaging and pointing monitoring of the gyro tracking on the science field. UW-Madison has recently been awarded an Explorer Technology Grant to further develop their low cost tracker; their reproduction cost target is $50K. (Further details may be found at the following web site: http://www.sal.wisc.edu/~jwp/st5000/st5000.html.) We note the successful development of such a low cost and highly capable tracker may represent a significant marketing opportunity for NSROC.

We recommend that Wallops and NSROC pursue these innovative ideas for improving fine-pointing ACS systems and, in particular, that the University of Wisconsin-Madison tracker be made available to the wider sounding rocket community, if indeed that system proves successful and cost-effective.

3. Next Generation ACS Systems/Coarse-Pointing

The SRWG finds much need for improvement in the utilization of coarse-pointing ACS systems on sounding rockets. An informal poll of sounding rocket users indicates that there is a range of operation problems regarding the use of coarse-pointing ACS systems including inertial pointing inaccuracy and firing at inopportune times, including times inside the dead band. These types of ACS problems can lead to serious compromise of the science objectives because instruments do not end up oriented as desired or the firing operations disturb the scientific measurements. The reasons for the occurrence of these problems is varied, but appear to arise from insufficient system level (payload and ACS) testing coupled with less than ideal communication between the manufacturer (which does the ACS programming) and the payload team.

It is recommended that these problems be mitigated by improving the ACS system-level design, by testing, and by ensuring that all key parties, including the payload development team, scientific team, and ACS manufacturer team, clearly communicate with one another. The ACS operations and timeline should be fully understood and achievable within the operational constraints of the payload and ACS systems. It may be advisable to put in place a separate review meeting (which could be conducted via telephone) among these key parties to ensure that all agree on the approach and implementation for the ACS system on a given rocket.

4. Next Generation "Coarse" Attitude Systems

Another area of long-standing concern of the scientific user community and the SRWG in particular involves "coarse" (i.e., ~ 1 degree knowledge) attitude solutions. These solutions are frequently supplied to the science teams only to be subsequently determined to be inaccurate. Consequently, a great deal of effort is expended by the science team to both verify and develop acceptable solutions which should, in principle, be an accurate data product when delivered to the science team. It is not clear exactly where the problem lies, but the technical specifications of the attitude systems indicate that accurate solutions should be routinely obtainable. One area where inaccuracy may creep in is through the use (or lack thereof) of accurate calibration data for the specific attitude system.

The standard payload system used to provide coarse attitude knowledge for most space physics payloads in the MIDAS gyro platform. These gyros utilize a design that is over 25 years old. Although a dependable "workhorse" of many NASA sounding rocket payloads over the years, these gyros have recently been shown to be noisy and to include unacceptable drift. Based on the presentation at the last meeting, we understand that a new procurement of attitude sensors is being carried out by NSROC and we urge that ease of data analysis and interpretation be taken into account, in addition to standard evaluation factors such as in-flight performance (accuracy, noise, drift), size, power, telemetry, cost, etc.

The SRWG believes that Wallops should clearly specify with whom the responsibility lies to determine if a given attitude solution is accurate and acceptable (e.g.., Wallops? NSROC? Attitude manufacturer? Users?) We urge Wallops to enact a process with which to verify the attitude solutions post flight before delivery to the science teams.

5. User's Manual

In the past, Wallops has provided a "User's Manual" for P.I.s which explained many of the basics of the program and helped new researchers get started. The User's Manual should provide a common location for information for Sounding Rocket PI's and engineers, including vehicle performance, NASA facilities, and documentation requirements. In addition to T/M and electrical requirements, it would be useful to include information about the ACS system data, such as details about how to interpret the MIDAS gyro data.

The current manual is out of date, and we encourage Wallops to update this information, particularly now that NSROC has been enacted. To this end, the SRWG would be more than happy to contribute to this endeavor, including reading of drafts and providing feedback.

6. Reviews/Independent Oversight

Several recent mission failures and near-failures have been caused by planning errors that should have been caught in reviews, such as mis-matched time-lines. This seems to point to a need to make the reviews more technically rigorous. This includes both Design Reviews and Mission Readiness Reviews. Impartial overseers with mission heritage should be present at the reviews, and required to ask hard questions. This appears to be especially necessary at the present time because of the large turnover in engineering personnel.

7. New Systems/Purchases -- SRWG input

The SRWG notes that several important procurement decisions will be made by NSROC over the next year, which could have significant impact on the scientific capabilities of the payloads and hence the sounding rocket users. These include decisions on a new rocket motor purchase, new gyro or other attitude platforms, standardization of TM stacks, and development of new ACS systems. The SRWG would like to be involved in the specifications for these and similar items that will impact the system, reliability, and scientific capabilities of the payloads for future flights. For example, we would like an opportunity to comment on the draft RFP concerning the requirements and specifications for the other systems mentioned above. This requires a closer working relationship between the NSROC contractor and the SRWG than has existed to date. A simple mechanism, which should not adversely impact the NSROC procurement process, might be to alert the SRWG to draft RFP information, particularly in cases where such a draft RFP is made public to potential bidders for comment prior to release.

8. Availability of TM Simulators

The Sounding Rocket Working Group strongly believes that experimenters, contractors, and NASA would all benefit from the development of a portable, PC-based telemetry interface emulator. As envisioned by the panel, these could take the form of plug-in PC boards or stand-alone modules built around the same hardware that NASA uses in their current TM systems. The emulator systems would be programmable in the same way that the flight TM systems are now programmed, and would be capable of producing the same synchronization and ENABLE signals as the flight systems (e.g., word clock, bit clock, frame synch, parallel word enable pulses, and serial handshaking signals).

Several experimenter groups already have developed or purchased key components of such systems, but no standard is in place and none of these systems uses all the same parts as the NASA TM systems.

There is a substantial cost savings to be realized by providing such standardized development systems to experimenters prior to integration. First, such systems would allow experimenter teams to solve telemetry interface problems at home on the bench instead of during the Wallops integration process. Telemetry interface issues are among the most common and time-consuming integration problems. Availability of standard emulators would optimize use of the TM groundstations, allowing more payloads to be processed in less time. Secondly, it is likely that availability of emulators would lead to a reduction in travel costs by the experimenter teams, and fewer overall problems during integration.

The Working Group recommends that a dozen such systems be created at Wallops. These could then be loaned to experimenter teams involved in active payload development activities. (The simulators could be returned at the Mission Readiness Reviews, for example.)

Implementation of a plan such as the one described here would likely result in shorter integrations, fewer scheduling problems with TM groundstations, and improved utilization of contractor resources. Despite these many advantages, we note that the SRWG has made this recommendation in the past and in each instance, it has received strong support from Wallops management. We thus urge that concrete steps be taken to make this idea a reality.

9. SPARCS Command Uplink System and ACS Optics Support -- Uplink Command and Optical Simulators at WSMR

We applaud NSROC for maintaining the existing corporate memory in the sounding rocket support personnel both at WFF and the White Sands Missile Range (WSMR). We note however two areas that require immediate attention at White Sands: programming support for the command uplink system (CUS) and ACS optics support.

A recent effort to make the CUS a “turn-key” system has been successful for the most part. However, we have lost the capability for making fiducial markings (overlays) and selectable cursors for reference and target identification. During one of the last flights (Feldman/36.136UG) the reference cursor was so large that it obscured the slit of the spectrograph frustrating the ability to make accurate point adjustments. In addition, the cursor colors were red and green while the Feldman CUS operator is red-green color blind. The capability to generate programmable overlays for accurately positioning field stars in the target region was not available and compromised operator tracking knowledge and data quality. We recommend that a programming effort be established to enable the “turn-key” CUS to provide widget driven selection options for these features.

It has also come to our attention that the star simulators (collimators) at WSMR and WFF are in need of maintenance. Current NSROC personnel either are too busy or lack the optical expertise to maintain these systems. In particular the collimator at WSMR is badly out of focus and the elevating mechanism is broken. Problems have also been encountered at both at WFF and WSMR with the ACS “cradle,” a table upon which the payload is placed to simulate ACS pointing maneuvers and allow for CUS practice during integration. We recommend additional resources be expended to properly maintain these critical testing systems.

NASA Sounding Rocket Working Group

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

Prof. David Burrows
The Pennsylvania State University

Dr. Joseph Davila
NASA/Goddard Space Flight Center

Dr. Greg Delory
University of California at Berkeley

Prof. Greg Earle
University of Texas at Dallas

Dr. Mark Hurwitz
University of California, Berkeley

Prof. Craig Kletzing
University of Iowa

Dr. Kristina Lynch
University of New Hampshire

Dr. Stephan McCandliss
Johns Hopkins University

Dr. David Slater
Southwest Research Institute

Dr. James Ulwick
Utah State University

Back to TOP Email us Home

Findings & Concerns

Meeting of December 16, 1998
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. NSROC

The Sounding Rocket Working Group (SRWG) looks forward to working with the NASA Sounding Rocket Operations Contractor (NSROC) at Wallops to both maintain, as well improve, the high quality research opportunities that the sounding rocket program affords the nation. The introduction of the NSROC system is an opportunity to move in new directions and we look forward to an exciting new era for the program.

The SRWG appreciated the opportunity to meet the new NSROC contractor, Litton/PRC, at its last meeting and learn of its general intended implementation plans. We look forward to increased dialogue with Litton/PRC and its subcontractors at future meetings. Furthermore, it is our position as users that the SRWG should be as proactive as possible in order to insure that the rocket program continues to thrive and produce low-cost, high quality science under the new arrangement.

Despite an optimistic outlook, the SRWG does have a number of concerns about how the new operations will be carried out, as we have stated in previous findings. Rather than re-iterate those concerns here, for now we state our most important, chief concern: that the number of successful sounding rocket missions launched per year not decrease under the new system. We urge Wallops, NASA Headquarters, and NSROC to work together to maintain a robust annual flight rate of highly successful scientific missions.

2. Civil Service Support at Wallops

The SRWG continues to be alarmed by the decrease of civil servant personnel retained in the Sounding Rocket Program Office at Wallops. This office must be maintained with strong leadership and highly qualified, knowledgeable, experienced personnel. In this manner, civil servant, agency "insight" into the program will remain a viable concept. It appears to us that there are far too few people left in the program office. We urge NASA to maintain at least one civil servant for every major system: vehicles, ACS/fine pointing, ACS/course pointing, electrical, telemetry, mechanical, and dynamics. Although we are painfully aware of the effects of downsizing and reorganizations over the past few years by NASA, this is one area in which we believe the elimination of such civil servant knowledge will have grave consequences for the future of the program. If the Agency is to maintain insight into the NSROC process, take a leadership role in advancing new technologies, and properly evaluate Sounding Rocket programmatic activities from the technical and operations viewpoint, such expertise must be maintained on the civil servant side with a strong cadre of highly experienced, technical personnel at Wallops.

3. ACS Systems

The SRWG continues to devote a large portion of its time to the evaluation and recommended improvements of the attitude control systems (ACS) used for both fine-pointing astronomy and solar payloads as well as for coarse-pointing space physics payloads. With the introduction of NSROC, it is clear that some of the former key ACS personnel (both civil servants and contractors) are no longer involved. Consequently, new plans must be made to not only ensure that the same capabilities are maintained, but also to improve the ACS systems so that they still enable first-rate scientific research to be carried out.

As discussed at the last SRWG meeting, the SRWG has agreed to work with Wallops and NSROC to involve community input to set technical specifications for future fine and coarse pointing ACS systems. The SRWG is forming subcommittees of scientific users (comprised of both committee members and other users) for both the ACS fine-pointing and ACS coarse-pointing systems to assist with this process. Attitude systems in general should also be included in these reviews. We propose that these subcommittees meet separately with Wallops/NSROC personnel. We also request that ACS systems be addressed by NSROC and Wallops personnel at the next SRWG meeting and encourage industry (subcontractor) participation in these discussions as well.

4. Code O/SOMO Operations Support

The SRWG has noted on several occasions its concern about the possible erosion of SOMO (previously Code O) support for the program, which is a major resource for the tracking and operations phase of all sounding rocket missions. Furthermore, we have been encouraged by both Wallops and NASA HQ personnel to help make sure that this support does not "fall through the cracks". We thus continue our vigilance by expressing our strong support such that SOMO resources are maintained at or above the current levels in order to insure that robust and viable operations support remains an integral element of NASA's Sounding Rocket Program.

NASA Sounding Rocket Working Group

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

Prof. David Burrows
The Pennsylvania State University

Prof. Greg Earle
University of Texas at Dallas

Prof. Paul D. Feldman
Johns Hopkins University

Dr. Mark Hurwitz
University of California, Berkeley

Prof. Timothy J. Kane
The Pennsylvania State University

Prof. Craig Kletzing
University of Iowa

Dr. Clarence Korendyke
Naval Research Laboratory

Dr. Fletcher Miller
NASA/Lewis Research Center

Dr. Alan Stern
Southwest Research Institute

Dean and Prof. Roy B. Torbert
University of New Hampshire

Prof. Edward C. Zipf
University of Pittsburgh

Findings & Concerns

Meeting of June 24, 1998
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. Resources and Code O Support

The Sounding Rocket Working Group (SRWG) acknowledges that NASA is restructuring the manner in which it administers and supports several of its flight programs. As the SRWG believes that a healthy sounding rocket program is vital to the nation's space research efforts, it also recognizes that such a program must make every effort to optimize its performance within its allocated resources.

The SRWG is concerned that a large portion of the support for the sounding rocket flight operations, particularly for field operations, which traditionally has been covered by Code O resources, may be lost in the current restructuring "shuffle". Sustained flight ops resources are essential for the sounding rocket program, and even more so under the NSROC arrangement. The SRWG thus urges that the allocation of such vital Code O resources (now covered under the SOMO arrangement), continue to be an enduring and protected asset of the sounding rocket program, and that they be protected from redistribution to other flight programs

2. NSROC and Project Scheduling

The SRWG is "cautiously optimistic" that the new NASA Sounding Rocket Operations Contract (NSROC) will maintain several important features of the sounding rocket program, such as flexibility, innovation, and P. I. satisfaction. We look forward to working with the selected contractor and Wallops during the transition period to help facilitate the successful enactment of the new program. To this end, we intend to encourage all outside users to attend our next meeting (in the Fall, 1998) to meet the NSROC contractor, to learn about the new aspects of the program, and to discuss what changes and new opportunities NSROC entails for the user community.

One aspect of the new "look" of the program that was presented at the last SRWG meeting and that is of particular concern to us is the scheduling of reviews and launch dates, and, in particular, the need to put these dates in "cement" at the onset of each new start mission. In some cases, entire new payloads built at experimenter institutions must be designed from scratch and in parallel with the Wallops systems engineering. In cases where the launch does not involve a remote campaign or other critical launch constraints, it would appear that "nominal" dates should be established at the onset of each program, for planning purposes, and that these dates be revisited at the Design Review, when experimenter progress can then be more definitively ascertained. Most missions will need to work towards a well-defined launch date (or launch date period) at the onset, but we believe it is inadvisable to prematurely box-in some of the special payloads, which frequently foster some of the program’s most innovative science results.

3. El Coqui II

The SRWG appreciates the detailed presentations by Prof. Miguel Larsen of Clemson University and Mr. Mark Cording of Wallops concerning the El Coqui II sounding rocket campaign which was carried out in Puerto Rico from February-March, 1998.

It is abundantly evident that the Wallops crew and the experimenters did a tremendous amount of hard work to carry out this successful campaign and they deserve nothing but the highest praise from the science community, and in particular from the Sounding Rocket Working Group.

Despite the many successful launches, the El Coqui II campaign was unique in that political activities by a small group altered the normal course of the range operations for a few of the experiments. Although we trust this will be an isolated event in the annals of NASA's remote field operations, the SRWG notes these reports with concern. We hope that the various "lessons learned" from this campaign will help circumvent any similar activities in the future, insofar as possible. Better publicity and advance pre-campaign notifications and meetings were put forward as suggestions to help alleviate such problems for future campaigns, although we recognize that such solutions may not always be as effective as one might wish.

Given the unique situation at the El Tortuguero range earlier this year, we again salute the Wallops personnel, the experimenters, and particularly the Campaign Scientist, Prof. Miguel Larsen, for their exceptional performance in carrying out the successful El Coqui II campaign.

4. Attitude Control Systems

The SRWG appreciates the presentations by the Wallops engineering staff concerning the current status of the attitude control systems, including both the fine-pointing and the coarse systems. Discussing of the performance and limitations of the current systems and to making suggestions for future ones are among the SRWG's chief functions. In each case, we hope these will be ongoing discussions, and confine our comments here to some general remarks.

(a.) Coarse Pointing ACS

The coarse-pointing attitude control systems (ACS) are basically utilized by the space plasma physics and ITM experiments. In the past 5+ years, such systems have all been commercially procured from Space Vector and use either a programmed set of commands to orient the payload along a pre-determined set of vectors or a simpler, auto-pointing system to align the payload with the Earth's magnetic field. Although the pointing requirements usually do not require exactitude to better than a degree, such coarse ACS pointers continue to experience problems. In some cases, the ACS failed simply because of programming or procedural errors, and not due to any hardware malfunction. Although such systems are great when they work, the failure of the ACS usually results in grave misfortunes in terms of experiment success.

The SRWG notes that Wallops has in the past used a simpler, analog magnetic ACS that was very reliable and inexpensive, but is no longer available as it was made "in house". Such a system also had the capability to be made very lightweight.

The SRWG looks forward to working with the Wallops R and D group as well as with the NSROC contractor to not only improve the performance of the coarse ACS systems, but also to define the experimenter requirements and desires for small, lightweight, inexpensive, and highly reliable coarse-pointing ACS systems in the future.

(b.) Fine Pointing ACS

The fine-pointing attitude control systems (ACS) are utilized by the astronomy, planetary, and solar experiments. These systems include the SPARCS pointing system that has achieved almost 0.1 arc-second pointing stability over 10-30 seconds on a recent NASA sounding rocket solar physics mission (reported to us by Dr. Clarence Korendyke of NRL at the January 21, 1998 meeting). In contrast, fine-pointed (non-solar) astronomy sounding rocket payloads are using 20-year-old technology that provide at best several arc-second stability. For example, as noted by the SRWG in previous findings, the Ball startracker currently used with the sounding rocket Mark VI guidance system has some serious limitations: notably its inability to guide on targets fainter than 4th magnitude and the need to have only one bright object in its 4 or 2 degree field-of-view.

As with the coarse-pointing ACS systems, the SRWG seeks to work closely with Wallops R and D engineers and the NSROC contractor to define and develop new ACS systems that we believe will translate directly to major new scientific accomplishments in the fields of astronomy, planetary, and solar physics. One suggestion is for the SRWG to establish a sub-committee (composed of both SRWG members and other users) to establish and bring to fruition this next generation of fine-pointing ACS systems.

5. Student Launch Program

The SRWG was delighted and impressed with the presentation on the Student Launch program, in which students from four high schools came to Wallops and successfully carried out a variety of science experiments on an Orion vehicle. The video tape and CNN news coverage showing the enthusiasm of the students was very well received, and we were impressed with both how serious the students and their teachers took this undertaking, as well as how much everyone seemed to enjoy the experience.

We commend Wallops for carrying out such a successful program and wish it much success for future, similar endeavors. We also note that the unselfish giving of time by the Wallops engineering staff helped make this program such a resounding success and for this we offer our highest praise and appreciation.

NASA Sounding Rocket Working Group

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

Prof. Dave Burrows
The Pennsylvania State University

Prof. Greg Earle
University of Texas at Dallas

Prof. Paul D. Feldman
Johns Hopkins University

Dr. Mark Hurwitz
University of California, Berkeley

Prof. Timothy J. Kane
The Pennsylvania State University

Prof. Craig Kletzing
University of Iowa

Dr. Clarence Korendyke
Naval Research Laboratory

Dr. Fletcher Miller
NASA/Lewis Research Center

Dr. Alan Stern
Southwest Research Institute

Dean and Prof. Roy B. Torbert
University of New Hampshire

Prof. Edward C. Zipf
University of Pittsburgh

Findings & Concerns

Meeting of January 21, 1998
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. NSROC

The Sounding Rocket Working Group (SRWG) appreciates the difficult job that the NASA Sounding Rocket Operatons Contract (NSROC) committee has undertaken. We are pleased that they have been able to maintain several key features of the sounding rocket program as part of the new proposed arrangement. The SRWG looks forward to working with Wallops during the transition period to help facilitate the successful enactment of the new program guidelines.

From our perspective, the NSROC committee has averted a disaster while being responsive to the user community. To their efforts, we extend our sincere congratulations and thanks.

2. Flight Rates and Competition for Resources

The SRWG is alarmed by the prospects of reduced flight rates under the new NSROC arrangement. The switch to a contractor with no compensation to replace the loss of civil servant support will likely result in a lower flight rate.

Although we are painfully aware that finances are scarce and that all areas of NASA are asked to tighten belts, a healthy sounding rocket program is vital to the nation's space research program, as concluded by numerous recent blue ribbon review panels, both within and outside of NASA. In our view, a new target average rate of only 20 flights/year not only undermines the advantages that the program accrues from "economies of scale" but also would starve the technology development opportunities that rockets provide, particularly to support future orbital missions. We urge NASA to maintain a robust, healthy baseline of sounding rocket support that the scientific community can continue to count on when planning research programs.

3. Poker Flat

The SRWG appreciates the presentation by Wallops personnel on the current NASA arrangement with the Poker Flat Research Range, and the elucidation (at least at the highest level) of the rough financial exchanges between Wallops and the University of Alaska, which owns the rocket range.

The current arrangement between NASA and the Poker Flat range allows sounding rocket launch opportunities only in alternate years. The cost to NASA in non-flight years is roughly half (about $700K) the cost during flight years ($1.5M). Although the SRWG understands that the decision for Wallops to launch rockets at Poker every other year is based both on cost savings and the decline in the numbers of Poker-launched sounding rockets, we are both startled and perplexed by the high cost (borne by the Sounding Rocket Project Office) of maintaining the Poker range during off years. Besides this drain in resources, the alternate year arrangement means that delays in launch schedules caused by weather or other uncontrollable factors creates scheduling slips of up to two years as well as the delay of priority science and technology development. Such two-year delays are not commensurate with NASA's emphasis on faster turn-around projects.

The SRWG notes that new activities at Poker Flat have been developing rapidly in many ways in recent years. For example, new ground-based scientific research initiatives are being instigated and run by the University of Alaska and other groups, and NASA continues to invest and expand in its orbital tracking stations that operate there continuously. Furthermore, other countries and agencies (e.g., Japan, DoD) are investing heavily in the scientific and operational infrastructure at Poker.

Since the new NSROC contract will soon be in place, and since one of the goals of this contract is to encourage better utilization of the facilities associated with NASA/Wallops, it seems logical that the alternate year arrangement at Poker Flat be revisited with the winning contractor under the NSROC arrangement. For example, non-NASA projects may be interested in exploring research opportunities that are afforded by the NSROC provider. In this manner, the NASA-owned Poker Flat facilities could become a source of income under NSROC (e.g., they could be leased in support of non-NASA programs), and help facilitate new arrangements whereby sounding rocket launches might be scheduled with more flexibility.

Community support for including the possibility of rocket launches from Poker every year is strong. In view of the new NSROC contract and the numerous changes now going on at Poker, the SRWG urges NASA/Wallops to search for creative, new scenarios with which to enable launch opportunities at Poker Flat every year, particularly if such activities can be carried out for the same total amount of funding presently allocated for Poker Flat support.

4. New Technology Presentations

The SRWG appreciates the presentations by the Wallops engineering staff concerning the new technologies being developed under the auspices of the NASA/Wallops Sounding Rocket Project Office. We are quite impressed with the developments concerning GPS, PCM CD-ROM storage, and the new ground systems at White Sands and at Wallops. The fact that Wallops is responsive to the user needs, which themselves are driven by new science requirements and emerging technologies, is indeed a hallmark of the sounding rocket program which can not be overemphasized. In our view, this an excellent example of why NASA's Sounding Rocket program enjoys such a first-rate reputation within the international space science community.

With regard to specific new technologies, the SRWG has comments at this time on three areas:

(a.) Future Startrackers

At the January 21, 1998 meeting, the committee heard a report from Dr. Clarence Korendyke (NRL) showing some beautiful solar data gathered with the current version of the SPARCS pointing system that achieved almost 0.1 arc-second pointing stability over 10-30 seconds on a recent NASA sounding rocket solar physics mission. In contrast, fine-pointed astronomy sounding rocket payloads are using 20 year old technology that provide at best several arc-second stability. Moreover, the Ball startracker currently used with the sounding rocket Mark VI guidance system has some serious limitations; notably its inability to guide on targets fainter than 4th magnitude and the need to have ONLY one bright object in its 4 or 2 degree field-of-view.

One area of new technology that the NASA suborbital program is well suited to develop is a "smart" startracker -- one that can track on crowded star fields as faint as 8th magnitude without becoming lost. The development of this technology would significantly enhance the current capability of fine pointed sounding rockets by eliminating the need for guide star acquisitions that use targets far from the intended target. Additionally, this will provide a means of testing a guidance system critical to the development of future low cost NASA orbital astronomy missions. The SRWG requests that Wallops consider the development of such new startrackers for astronomy payloads, and that the requirements and possibilities be discussed at a future meeting.

(b.) Telemetry Simulator Cards.

Now that the new Wallops telemetry system (WFF93) is standard, including the provision for up to 10Mbps per link, the SRWG suggests that WFF develop and provide a standard simulator card for this telemetry system that would permit investigators to test their instruments for compatibility before traveling to integration and into the field. This would save much time and resources, both for the scientists and for Wallops. Indeed, in one case involving a recent sounding rocket launched from Spitzbergen, a team at Goddard (Pfaff group) fabricated such boards and distrib uted them to 3 co-investigators (U. Md, SwRI, Norway) prior to integration, which resulted in substantial time and cost savings, as well as a more realistic instrument calibration in several cases. The SRWG suggests that Wallops explore providing (i.e., loaning) such simulator cards to all investigators early in the mission development phase.

In addition to the telemetry simulator card, we also suggest that Wallops consider a PCMCIA interface for the TM stack emulator, as this would allow both IBM/PC and Macintosh notebook computers to be used by the experimenters during checkout. Notebooks are much more practical for bench checkout as they allow users to have the exact same hardware to check their instruments during integration as was used for testing and calibration in their laboratories.

(c.) Future Data Formats

With today's complex payloads, analog recorders, while valuable for quicklook purposes, are often incapable of providing critical diagnostics for instruments involving large quantities of complex digital data (such as images). Investigators currently have to wait for long periods, often days, to get digital data from integration tests and flights from the WFF T/M section, thereby seriously compromising the utility of integration test sequences. (It is not uncommon, for example, for T&E to be completed before receiving digital data from the pre-T&E horizontal tests.) Data at some facilities (notably White Sands) are available on much shorter times (hours), but in formats incompatible with the formats used by WFF.

The SRWG applauds NASA's current plans to install CD-ROM writers in F-10 ground stations and remote field ground stations as a first step in the direction of remedying the situation. We find that the WFF T/M section should move as quickly as possible to insure the capability of providing the experimenter with rapid access (less than 1 hour from time of test) to the entire T/M stream of digital data at all ground stations (both at WFF and remote sites), using a common, well documented data format and readily available transfer media such as FTP file transfers across the Internet and CD-ROMs for permanent records.

NASA Sounding Rocket Working Group

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

Prof. Dave Burrows
The Pennsylvania State University

Prof. Greg Earle
University of Texas at Dallas

Prof. Paul D. Feldman
Johns Hopkins University

Dr. Mark Hurwitz
University of California, Berkeley

Prof. Timothy J. Kane
The Pennsylvania State University

Prof. Craig Kletzing
University of Iowa

Dr. Clarence Korendyke
Naval Research Laboratory

Dr. Fletcher Miller
NASA/Lewis Research Center

Dr. Alan Stern
Southwest Research Institute

Dean and Prof. Roy B. Torbert
University of New Hampshire

Prof. Edward C. Zipf
University of Pittsburgh

Back to TOP Email us Home

Findings & Concerns

Meeting of December 11, 1996
Sounding Rocket Working Group
National Aeronautics and Space Administration

1. The "Near Term" and Present Situation

The Sounding Rocket Working Group is alarmed by the sudden loss of significant numbers of persons from the Wallops Flight Facility work force with considerable expertise concerning scientific payloads, launch vehicles, and sounding rocket project management. It is also disconcerting to see large numbers of young engineers and technicians leave Wallops for jobs in other NASA centers or in industry.

We urge the NASA/Wallops Flight Facility management to develop policies to ensure that the needed technical and managerial expertise and "know-how" at Wallops, which is vital to the continued success of the program (even under a GoCo arrangement), will remain at sufficient levels to satisfy the agency's commitment to a healthy and robust sounding rocket program. We are particularly concerned that this loss of expertise could result in a decrease in the mission success rate in the future.

2. Government-owned, Contractor-operated Operations

The Sounding Rocket Working Group is committed to helping the transition process of the current rocket program to a government-owned, contractor-operated ("GoCo") arrangement, and has provided input to Wallops' GoCo transition and "statement of work" teams at its last two meetings. Despite this, we remain deeply concerned about how well the GoCo arrangement will actually run NASA's sounding rocket program.

The Sounding Rocket Working Group strongly believes that the new GoCo arrangement should be as cost effective, flexible, timely, and "all encompassing" as the present program, whose record of achievement is exemplary within NASA. Chief among our concerns are the following:

(a.) Costs and Flight Rates

Recent, high level programmatic reviews have concluded that the sounding rocket flight rate should be maintained near the current level of 30 flights/year (with the current average mix of mission complexity) in order to ensure the cost-effectiveness of the program and to maintain its viability within the science community. Anticipating that the GoCo arrangement may be very costly, we are concerned that the flight rate will therefore decrease significantly as will the science-per-dollar research return of NASA's investment.

(b.) Maintaining flexibility and innovation

Flexibility and innovation have been traditional hallmarks of NASA's sounding rocket program and are facilitated by the close partnership between the scientist (P.I.) and the Wallops engineer/technician teams. The Working Group is concerned that anticipated contractor requirements for: (1) technical specifications that are locked in at project initiation, (2) increased paperwork, and (3) rigid time schedules, such as one encounters in satellite programs, will leave little room for innovation and change, and thus are the surest way to create a mediocre experimental science program.

We recommend that NASA management vigorously pursue ways to prevent such a situation from occurring by structuring the new program to instill the present standards of performance, cost effective informality, and common sense "partnering" between the scientist and contractor.

(c.) Remote campaigns

An important ingredient of the sounding rocket program is its ability to conduct low cost scientific experiments at all latitudes -- whether it be space physics missions at high (e.g., aurora) and low latitude (e.g., magnetic equator) sites, or astronomy missions which observe southern hemisphere celestial targets in Australia. The success of such remote campaigns has relied on decades of experience of Wallops personnel who have planned, managed, and carried out highly successful programs at distant launch sites, often under adverse conditions.

The Working Group emphasizes the need for the GoCo contract to maintain the capability to carry out such remote campaigns at low cost so that this unique and vital aspect of NASA's scientific program is not lost.

(d.) New Technology

In addition to its main activities of designing, building, testing, and launching scientific payloads, an important element of NASA's sounding rocket program has included the development of new sub-system technologies and vehicle systems that subsequently engender a large number of experimental requirements. Examples include innovative recovery systems of upper atmospheric air samples, the Black Brant XII vehicle, and very high rate telemetry systems (see Item 4(a) below).

The Working Group urges the new program structure to include a cadre of civil servant engineers and technicians, free from the profit incentives that typically govern short- and medium- term business decisions, that may continue to explore and develop innovative and appropriate new technologies that are responsive to the evolving scientific requirements of the experimenters.

(e.) Escape valve

The Sounding Rocket Working Group has been informed on numerous occasions that the GoCo arrangement will contain an escape valve, and that provisions will be included so that if the new operating system does not work, the agency would then be able to recover the essential elements of the previous arrangement. The loss of critical Wallops personnel as noted above, however, raises grave concerns that the agency's critical expertise is quickly eroding in the areas of design, fabrication, testing, and launching of scientific payloads on sounding rockets and that this situation could thus prohibit a return to a program as robust and innovative as the current one.

The Working Group feels strongly that including the escape valve mechanism is a prudent and wise measure to be incorporated in the plans to transition to a GoCo arrangement. The importance of this is underscored by the fact that NASA's Sounding Rocket program provides unique scientific capabilities that virtually do not exist anywhere else in the world. Fearful that the escape valve check may be lost in the transition shuffle and contract negotiations, we recommend that a formal review committee be convened after an appropriate interval (e.g, 1-2 years) to evaluate the impact of the new system on the scientific yield and performance of NASA's Sounding Rocket program.

3. Funding at NASA Headquarters

Aware that funds are tight within the government and that all programs are being asked to undergo "belt tightening", the Sounding Rocket Working Group is highly concerned about the stewardship of the sub-orbital budget at NASA Headquarters, particularly since major portions originate from sources other than Code S (Space Science). (For example, operational support from Code O is a critical element of the sounding rocket program, amounting to approximately $10M/year.)

Given the changing fiscal environment of NASA, it is apparent to the Sounding Rocket Working Group that a clear plan is needed to detail how the necessary funds will be identified and maintained to ensure the success and vitality of the sounding rocket program in the future.

4. Technical presentations

The Sounding Rocket Working Group was impressed by the technical presentations made by the Wallops personnel and expresses its appreciation to all of the speakers. We offer the following comments:

(a) The fact that a 10 Mbit/s telemetry system will now be a "standard" option for experimenters represents the fulfillment of a long sought goal. This report is thus gladly accepted by the Working Group on behalf of the scientific community. For a large class of experiments, such high rates can be immediately and directly related to the yield of new scientific discoveries. Not only does the 10 Mbit/s rate represent significantly higher telemetry than the now standard 800 kbit/s rate, but also it is higher than that of most scientific satellites.

The Working Group congratulates the engineers and technicians at the Wallops Flight Facility for this achievement.

(b) Including GPS receivers to obtain positional data is a new way to provide trajectory data and may eliminate the need to send high powered radars on remote campaigns, as well as consolidate operations at existing ranges.

We are pleased with the successful follow on demonstrations of the GPS receivers on recent flights from White Sands and look forward to the results of detailed comparisons between the GPS-derived trajectories and those obtained from traditional C-band radars.

5. Appreciation

The Sounding Rocket Working Group expresses its sincere appreciation and deep gratitude to Mr. Ray Pless and to Mr. Warren Gurkin, who have managed the program so well over the past decades and who will be retiring in early 1997. The sounding rocket program that they have helped create has enabled unique scientific achievements to be carried out in space, reflecting highly on both NASA and the United States. We acknowledge their tremendous expertise regarding sounding rocket systems and thank them for their untiring dedication to the program.

Further, the Sounding Rocket Working Group acknowledges the Wallops Flight Facility as a whole for the exceptional job it has performed in the past year despite the stresses caused by frequent management shifts, re-organizations, and the uncertainty surrounding the GoCo arrangement and the future of the rocket program itself. The scientific community owes a real debt of gratitude to the men and women of Wallops for their hard work and dedication.

NASA Sounding Rocket Working Group

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

Dr. Fletcher Miller
NASA/Lewis Research Center

Prof. Paul D. Feldman
Johns Hopkins University

Prof. Wilton T. Sanders, III
University of Wisconsin

Prof. Timothy J. Kane
The Pennsylvania State University

Dr. Alan Stern
Southwest Research Institute

Prof. Paul M. Kintner
Cornell University

Dean and Prof. Roy B. Torbert
University of New Hampshire

Dr. Clarence Korendyke
Naval Research Laboratory

Prof. Edward C. Zipf
University of Pittsburgh

Prof. Miguel F. Larsen
Clemson University