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:

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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:

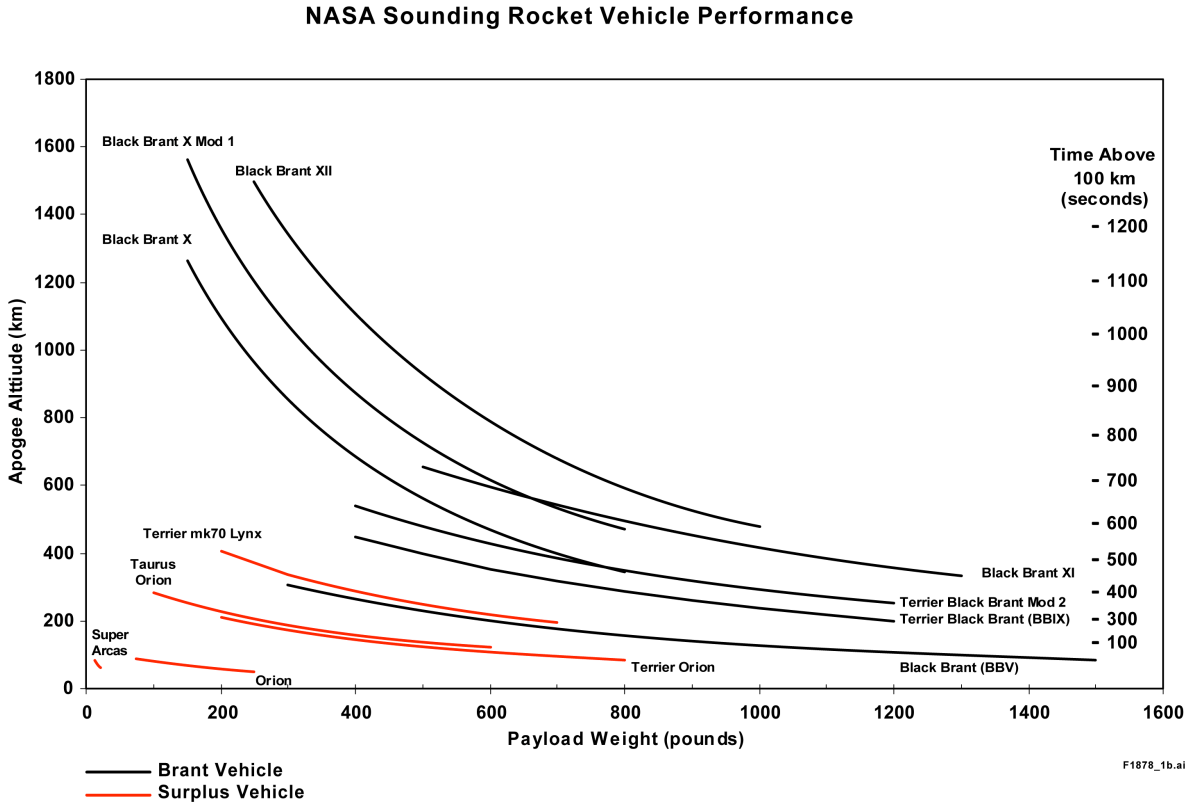
1. Decreasing the total number of flights (which includes student launches and test vehicles)
2. Reducing the NSROC employee workforce
3. Stopping the implementation of the new Oriole motor (for which development work is well advanced)
4. Canceling five approved flights scheduled for launch in FY05 from 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.



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

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