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.

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