U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

HEARING CHARTER

Status Report on the NPOESS Weather Satellite Program

Thursday, June 7, 2007
1:00 - 3:00 P.M.
2318 Rayburn House Office Building

Purpose

The Subcommittee on Energy and Environment meets on June 7, 2007, to continue oversight on the unsettled National Polar-Orbiting Operational Environmental Satellite System (NPOESS). The Government Accountability Office (GAO) will release the latest report on this critical weather monitoring platform requested by the Subcommittee, and the Program Executive Officer for NPOESS will respond to the findings and recommendations. Additionally, the Director of the Office of Science and Technology Policy (OSTP) will respond to questions about the status of sensors for tracking climate and so-called "space weather" phenomena that were removed during the recent program restructuring.

Witnesses

Mr. David Powner, Director, Information Technology Management Issues
Government Accountability Office

Mr. Powner is the head of the GAO team continuously monitoring the NPOESS program since 2001. He will present their latest report that discusses the effort to strengthen the management of the NPOESS program and evaluates the realistic cost estimate for the revised program. The report also examines the continuing risks that challenge the execution of the program.

Brigadier General Sue Mashiko, USAF
Program Executive Officer for Environmental Monitoring

General Mashiko has been in the post of Program Executive Officer for the NPOESS program since November 2005. The position was established in the wake of the program's restructuring to evaluate the performance of the Integrated Program Office (IPO) handling the system acquisition and to serve as the arbiter for awarding performance incentives to Northrop Grumman, the program's contractor. General Mashiko also took on the responsibility for external relations with the Executive Committee comprising the heads of the three agencies (NOAA, the Air Force and NASA) contributing to the program.

Hon. John Marburger III
Director, Office of Science and Technology Policy

OSTP has been managing reviews by NASA and NOAA of the sensors removed from NPOESS to identify other ways to fly the instruments and maintain the data sets. Dr. Marburger will discuss the process involved in these reviews, the results to date, and how these reviews will determine the alternative plan for preserving climate and space weather observations.

Background

A Short History of NPOESS

For decades, the United States has maintained satellites in orbit, looking down at Earth and gathering information that allows us to track and forecast weather. These satellites operated in both geostationary orbit (where they move fast enough to keep pace with Earth's rotation, thus staying in the same place above the equator and seeing an entire hemisphere at once) and in polar orbits (allowing them to pass over all points on Earth as the planet rotated underneath). Both the Air Force and NOAA were operating polar satellites to satisfy their diverse user needs. In 1993, the decision was made to combine both programs into a single system, and thus the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) was born.

In 2000, the NPOESS program anticipated purchasing **six satellites** for **$6.5 billion**, with a **first launch in 2008**. Following financial problems, a new program baseline was issued in 2004, which raised the expected **acquisition cost to $7.4 billion**. By November 2005, the program office determined that it was likely that NPOESS would run over that estimate by at least 25 percent, which triggered the Nunn-McCurdy review by the Department of Defense. In order to continue the program, it was necessary to report to Congress that:

- The program is essential to national security;
- No alternative program provides the same or improved military capability at lower cost;
- The new cost estimates are reasonable; and
- The program's management is adequate to manage and control costs.

The NPOESS Program was recertified on June 5, 2006, but there were some significant changes. The estimate for **acquisition cost rose to $11.5 billion** (and, as GAO notes in its report, there is an additional $1 billion to cover operating costs, making the **total life-cycle cost $12.5 billion**). Only **four satellites** will be built, with the **first launch now scheduled for 2013**. A major sensor, the Conical Microwave Imaging Sounder (CMIS), was removed because it seemed unlikely that the technical issues in its design and construction could be overcome. A new competition is to be conducted for an instrument whose capabilities will fall much closer to existing technology. The U.S. would fly satellites in only two, not three, polar orbits; data from the third orbit would now be the responsibility of European satellites.

The other major decision was to remove several sensors. Some would focus on the study of Earth's climate. Others monitor phenomena generated by the Sun that affect

the Earth's magnetic field and can play havoc with power lines, airline flights over the polar regions and satellites. Scientists studying climate were particularly concerned. Detecting the small changes in the ocean and atmosphere that signal climate changes is critically dependent on data collections that cover decades in time. Without the climate sensors on NPOESS, some of the most basic climate data would no longer be available. This has been the focus of articles that appeared in the last day regarding the NPOESS program and the loss of climate sensors from the satellites.

Central to the persistent problems in the NPOESS programs are the major sensors and the program's management. The cancellation of CMIS came about because the weight and size kept growing as the Boeing instrument team struggled to meet Army requirements for determining soil moisture. Even worse was the Visible/Infrared Imager Radiometer Suite (VIIRS), where subcomponent deliveries were behind schedule, testing of various items was harder and took longer than expected, ground support equipment was not working properly, and independent reviews of Raytheon management resulted in removal of the entire instrument management team. VIIRS is the primary instrument on NPOESS; it will contribute data to more of the expected products than any other sensor. The Integrated Program Office, lacking sufficient reserves, attempted to deal with the problems by redeploying resources from the other instrument contracts, upsetting their performance. Last year, the Cross-Track Infrared Sounder (CrIS) suffered a broken frame during its vibration testing. The program has since been checking the various pieces of the test instrument to learn if they can still be used. NPOESS managers believe that the second frame can be substituted for the first, minimizing disruption to the program.

The Committee's hearing in November 2005 on the NPOESS program examined the poor performance of NPOESS management levels. This extended all the way from subcontractors (as noted in the case of VIIRS) to the Executive Committee (ExCom), which comprises senior leaders of the three agencies involved in the program. Members questioned why the ExCom failed to meet as the NPOESS program spiraled further into crisis. Repeated analysis of alternatives often substituted for decisions. By August 2005, the head of NOAA declared he had no confidence in the information being reported by the Integrated Program Office. Part of the program change instituted by the Nunn-McCurdy process was the redesign of the management structure. General Mashiko became responsible for seeking direction from the ExCom and assuring that those decisions were executed by the IPO. The IPO also began hiring the technical and managerial talent needed to fill the many gaps that left it unaware of problems or unable to respond to them. The ExCom has been holding quarterly meetings on the program. For the moment, at least, turmoil in the management suites is not a primary contributor to risk in the NPOESS program.

Climate Change Science and the White Paper on Demanifested Sensors

NPOESS satellites, as originally designed, were to do more than support weather forecasting needs for NOAA and the military services. Sensors were also included to expand the type of climate data being collected by NASA’s Earth Observing System satellites, and to provide insight into the effects on Earth’s environment from solar activity. These sensors were removed in the Nunn-McCurdy process. The loss of these sensors was met with dismay among the affected user communities. The National Research Council, which was completing its first Earth science decadal survey, recommended immediate efforts to restore some of the sensors to NPOESS. On June

26, 2006, OSTP met with NASA and NOAA to discuss a response. NASA agreed to develop an analysis of the consequences of the removal of climate sensors.

NASA issued its first draft on August 15, 2006. NOAA added its contributions in drafts that were completed in December 2006. The final version of the white paper was delivered to OSTP on January 8, 2007.

In the paper, NASA and NOAA conclude that, "Unfortunately, the recent loss of climate sensors due to the NPOESS Nunn-McCurdy Certification places the overall climate program in serious jeopardy." In the August 15 draft, NASA devised a set of recommended actions for the canceled sensors. The main difference between the first draft and final version was the development of a priority listing.

The white paper lists its first priorities as the Total Solar Irradiance Sensor (TSIS) and the Earth Radiation Budget Sensor (ERBS). Together, these sensors track the amount of energy the Sun imparts to the Earth, and how much of that energy the Earth reflects from its surface, clouds and what is not absorbed by greenhouse gases. The difference between the values reported by these two sensors is a critical starting point for evaluating climate effects. TSIS data extends back over 28 years, and any loss would disrupt our understanding of the "dominant, direct energy input into terrestrial ecosystems."

NASA will fly part of the TSIS instrument on its *Glory* mission, currently scheduled to launch in December 2008. It will be a three-year mission, with hopes of two more beyond that. The white paper recommends three TSIS sensors, with the first to be launched on any available and suitable vehicle in time to overlap with the *Glory* mission. For ERBS, the possibility of a data gap between the end of the current *Aqua* mission and the launch of the first NPOESS mission leads to a recommendation that the last Clouds and Earth's Radiant Energy System (CERES) sensor be flown on NPP, rather than wait for NPOESS. ERBS would then be flown aboard the first and third NPOESS missions. The Decadal Survey agreed that these sensors "should be restored on NPOESS or provided by other means to avoid a measurement gap in the timeframe 2008 to 2012."

Fourth in the white paper priority list was the limb-scattering component of the Ozone Monitoring and Profiling Suite (OMPS-Limb). The decision to remove this particular sensor came at a point where the hardware had been completed and would have required a significant effort to decouple from the other part of the instrument. Since the cost of completing the instrument was not that much different from removing it, the NPOESS program decided that a full OMPS should be flown on NPP as originally planned. It remains uncertain if the full OMPS sensor will fly on NPOESS missions.

Of concern as this analytical process unfolds is its tenuous integration with the NPOESS program and the possibility that it will be overtaken by events. This first came to the Committee's attention in March when the instrument contractor indicated that if the OMPS-Limb sensor was to be flown on NPP, a decision had to be made by the end of that month to preserve the September 2009 launch date. Senior Members of the Committee wrote to Dr. Marburger, NASA Administrator Michael Griffin, and NOAA Administrator Conrad Lautenbacher to take advantage of the opportunity.

Testifying before the Committee a year ago, Admiral Lautenbacher stated:

> We specifically decided that the NPOESS spacecraft will be built with the capacity to house all of the [demanifested] sensors, and includes funding to integrate them on the spacecraft. The decision was made because the EXCOM agreed that any additional funding gain through contract renegotiation or in unutilized management reserve would be considered to procure these secondary sensors, in addition to other organizations bringing money for these sensors to the table.

Indeed, the white paper recommends taking advantage of this capability. Yet the drafters of the analysis indicated in a briefing to staff on May 17 that they learned the NPOESS program office would not accept any additions to the sensor complement on the first NPOESS satellite. Indeed, according to a briefing chart for the March 2, 2007 ExCom meeting, the "Lock-Down Dates for integration of Demanifested Sensors" on the first satellite was already past. Yet the white paper was delivered still recommending efforts to fly some sensors on the 2013 launch.

The ExCom briefing chart states that "C-1 requires significant additional development, integration and test time for sensors and spacecraft," and General Mashiko indicates that the NPOESS program made the decision to freeze the sensor complement to reduce risk of disruption. Yet these sensors were originally manifested aboard the satellite, and as Admiral Lautenbacher testified, the program was directed to maintain space and funding to accommodate them. The interfaces between sensors and satellite are already included in the requirements and specifications. While space on the first launch is not an issue for TSIS, it was an option for ERBS, OMPS-Limb and the Advanced Polarimetry Sensor. Is it indeed the case that there are no chances to fill up some of those available slots aboard the first NPOESS satellite?

In contrast to the decision to restrict further changes to the first NPOESS satellite, the decision to add CERES to NPP is still open. Now just two years from launch, making yet another change to the complement of instruments raises the risk calculations. Arguing in favor of the change is that it would reduce the threat of data loss, and that the contractor is willing to offer a fixed-price proposal to do the job. The government rarely receives such offers unless the bidder is truly confident that the task is completely understood.

Of more immediate concern for TSIS is the possible loss of the contractor's staff before the OSTP process reaches a conclusion on the sensor. With the decision to terminate TSIS, the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) has been dealing with the possibility that the employees on the project would disperse. LASP has proposed a follow-on mission that would update the technology now flying on the SOlar Radiation and Climate Experiment (SORCE) spacecraft with TSIS. This would bridge the gap between *Glory* and another TSIS that would be placed aboard the second NPOESS satellite in 2016. This would be consistent with the white paper's recommendation, but hard to execute if the sensor's builders have gone on to new jobs.

A similar situation may exist in the sensor for monitoring the effects from solar flares and coronal mass ejections – so-called "space weather" phenomena. Power companies, airlines and satellite operators have all discovered in recent decades that the energetic particles and plasmas can disrupt critical infrastructures or increase their costs. NOAA's ability to provide early warning of these events, particularly as the Sun enters the more

active phases of its 11-year cycle, has been improving in tandem with higher-capability sensors.

NPOESS was slated to carry the Space Environment Sensor Suite (SESS), a combination of five types of instruments that collected data on different aspects of the particles and fields involved in space weather. As a result of the Nunn-McCurdy decision, these were replaced with the Space Environment Monitor (SEM) instrument now aboard existing satellites. One of these instruments is the Thermal Plasma Sensor (TPS). It was designed to provide data on the geomagnetic and electric fields and plasma temperatures and fluctuations during solar events. With such information, the Air Force could quickly evaluate the loss of function in their satellites to determine if it was the result of a natural event or some adversary's action. In times of crisis, this would be an extremely time-critical analysis. Massive events in October and November of 2003 and again in December 2006 affected oil drilling in the Gulf of Mexico as the GPS signals that precisely locate drilling platforms above the tangle of seafloor pipelines were lost for up to fifteen minutes.

The United States has only one manufacturer for TPS sensors, a university group at the University of Texas at Dallas (UTD). The university anticipates that the group will disband as there is no other existing requirement for these detectors. Some of the UTD groups are expected to require and the lack of interesting projects is likely to cause the remainder of the team to seek other opportunities. The SEM package will not meet the requirements assigned to the TPS sensor, and yet we may lose the capability to obtain such instruments in the next few months. OSTP only initiated the effort to conduct an analysis of the Nunn-McCurdy impact on the space environment sensors in February, and there is nothing similar to the climate sensor white paper yet available.

In its original white paper draft last August, NASA stated, "The budgets and schedules associated with these recommendations will be incorporated in a subsequent draft of this white paper to be available in approximately one month." Staff was told in the May 17 meeting that the authors "were a bit optimistic" about their ability to provide such information. A month after the white paper was delivered, OSTP asked the agencies to begin a second study that would incorporate budget requirements and alternatives to replacing the sensors on the NPOESS satellites. The National Research Council was asked to convene an additional panel to provide assistance. However, the agencies are not anticipating a final report to OSTP before September, and that may only include interim information from the Research Council. While Office of Management and Budget representatives are attending OSTP's meetings to obtain updates on the analysis, there does not seem to be any discussion about required budget actions.

Members of the Decadal Survey recommended that "OSTP… should develop and implement a plan for achieving and sustaining global Earth observations." This experience raises the possibility that OSTP may not be ready to take on that more ambitious task.

GAO's New Report

The Committee first asked the Government Accountability Office to evaluate the NPOESS program in 2002, when concerns about NOAA's ability to handle the data volume expected from the satellites was at issue. In 2004, it reported that costs had jumped by $1 billion and that launch dates for the various satellites were slipping. In November 2005, Mr. Powner stated that cost and schedule trends were continuing to deteriorate and called NPOESS "a program in crisis." In this report, GAO focuses on the state of the NPOESS program as it starts to carry out the decisions made by the Nunn-McCurdy process.

GAO notes that the program managers have succeeded in imposing greater discipline on the program. The program managed to achieve 156 of 166 milestones in the interim program plan for fiscal year 2006, and has since addressed five of the residual items. Through January of 2007, the program had reached 62 of the 222 milestones planned for fiscal year 2007 - two more than planned. In a briefing to staff, Mr. Powner stated that the IPO maintains that NPP will meet its 2009 launch date and that the program cost estimate remains $12.5 billion. He said, though, that NPP will launch "as-is" (with instrument performance at whatever level can be achieved by launch day) and that there are still cost pressures that may push the estimate above $12.5 billion.

a. Acquisition planning documents

In April, when it delivered its report, GAO noted that major documents necessary for the development of program plans and renegotiation of the contract with lead contractor Northrop Grumman are still awaiting approval. These included:

- the reworked Memorandum of Agreement defining roles and responsibilities for NOAA, the Air Force and NASA;
- the system engineering plan;
- the test and evaluation master plan; and
- the acquisition strategy.

According to the decision memorandum that resulted from the Nunn-McCurdy process, the Memorandum of Agreement should have been completed August 6, 2006 and the other documents by September 1, 2006. These documents define the relationships between the Integrated Program Office and the agencies and lay out the predicted levels of resources in terms of time, money and effort that will be required to complete the NPOESS program in the wake of the Nunn-McCurdy recertification. The information in these documents will govern the budget requests for NPOESS from NOAA, the Air Force and NASA for years to come. That it has taken a year to complete these items, even though they should be little more than recording the hard choices already taken in the Nunn-McCurdy process, indicates that interagency coordination still serves to weigh down the program.

GAO recommended in the report that the agencies have the approvals completed by April 30. Yet in meetings with the Committee staff May 23 and 25, both GAO and General Mashiko indicated these documents still awaited signature. The agency comments included in the report indicate that the Department of Defense's process for approving the interagency Memorandum of Agreement appears to be the major

roadblock, as NOAA and NASA could not complete approvals until there was a final consensus on the text to be approved.

From General Mashiko's perspective, some documents are more important than others. She emphasized that the program office prioritized development and completion of the integrated master schedule and the integrated master plan. These, she said, were the prime tools for the program office's day-to-day activities and are the primary tools for the government's control of contractor activities. These documents are now developed to a point well beyond what the government previously had available and, according to Colonel David Stockton (the NPOESS Program Director), give him greater ability to measure actual performance by Northrop Grumman and the instrument manufacturers. These two documents should be in final form before completion of the contract renegotiation, because changes after that point will result in contract modifications. Such modifications rarely result in lower costs to the government.

b. Program Office management and staffing

GAO next moved to a discussion of program leadership and program office staffing. In July, General Mashiko will be transferred by the Air Force to the MILSATCOM program. GAO recommends that the Air Force delay the transfer until July 2008, when all of the instruments scheduled to fly on the NPP mission have been delivered. Before that point, GAO considers the increase in risk from management disruption "unnecessary." That recommendation has been rejected by DOD.

General Mashiko stated to staff that change in her position is less significant to progress in NPOESS than would be the case if the System Program Director, Colonel Dan Stockton, was to depart. The ExCom met May 21 to discuss the transition. According to the comments in the report, NOAA was expecting to supply the next Program Executive Officer; apparently the deadline in the position announcement had to be extended two weeks to attract candidates. General Mashiko indicated eight are now being considered. The Air Force will supply a deputy. The intent is to select the replacement quickly to allow as much time as possible to hand over responsibilities and to allow the new Executive Officer to participate in decision-making.

GAO argues in its report that management turnover is a contributing factor to the problems that have disrupted many other Air Force space system procurements. They believe senior managers should serve until completion of development or actual delivery of their product, not simply an arbitrary period of time. The former Chairman and CEO of the Lockheed Martin Corporation, Norm Augustine, wrote in his book *Augustine's Laws* about the problems that come from "…attempting to develop major new systems with ten-year technology, eight-year programs, a five-year plan, three-year people, and one-year dollars." GAO has lost the argument on this recommendation, but this now becomes another issue that the Committee will have to watch carefully as the new leadership takes over.

GAO also recommended that NOAA needed to develop plans for identifying the staffing needs in the NPOESS program office and to initiate steps to fill vacant critical slots. The lack of systems engineering personnel and budget and cost analysts in the Program Office has been a consistent concern of independent reviewers. As of April, GAO found that five budget analyst positions and 15 system engineering or technical manager positions remained unfilled; 16 were to be provided by NOAA. That these positions

remained open a year after the Nunn-McCurdy decision directive ordered expedited actions to fill vacant positions led GAO to express concern about the government's ability to develop an updated cost estimate for renegotiating the contract with Northrop Grumman or to handle management tasks.

General Mashiko stated in her staff interview that staffing actions had accelerated with the hiring of a personnel specialist with the ability to assist division managers in identifying staffing needs. The Program Office also received assistance from the human resource offices at the three agencies to find candidates with particular skills and see them assigned to NPOESS positions. General Mashiko indicated that there are now only six of NOAA's 16 slots still open, and those were in various stages of recruitment. Some positions had to be readvertised to identify candidates with appropriate skills. That NPOESS is competing with every other R&D agency in the government for these skill sets also slowed the process.

c. Continuing concerns

As noted earlier, the sensors for NPOESS remain the major concern in successfully executing both the early NPP mission and the operational NPOESS program. The VIIRS instrument was the subject of extensive discussion at the ExCom meeting of March 2, 2007. This so-called "Gate 8" decision required the instrument team to demonstrate that it had addressed design issues and that the instrument would perform as expected. According to the briefing slides, assuming that the flight unit performed as well as the current engineering development unit, the data would meet or exceed what is now provided by existing satellites. However, there was one issue – "optical crosstalk" – that remained open. It threatened to reduce ocean color measurements below the lower limit of the specification. If NOAA decided to buy a new filter from a different manufacturer, it might slip the delivery schedule. The ExCom decided to accept the recommendation to continue forward with VIIRS development while continuing to seek a solution to the crosstalk issue. General Mashiko indicated to the staff that VIIRS delivery for the NPP mission is still scheduled for late May next year, and there remains three months of margin in that schedule.

The Failure Review Board for the CrIS flight unit vibration test mishap believes an incorrect structural analysis of the instrument frame led to an overestimate of the frame's strength. The subassemblies are being tested to see if they suffered damage; particularly the interferometer, which is the primary sensor element. The IPO has already begun to build a second interferometer to minimize disruption if the first is unusable. The frame for the second flight unit will be used in the first instrument (the fixes defined by the failure analysis "will not be pretty" but they will work, according to Col. Stockton). The government technical team independently analyzed and approved the frame changes. Delivery of this unit slipped from December 2007 to February 2008; three months of margin still remains.

Loss of the CMIS sensor affected two important data items. CMIS was the prime contributor to the measurement of soil moisture, critical to the Army as it determines whether heavy equipment can operate in a particular region. Requirements for collecting data on ocean winds were also to be met with CMIS data, which factors into recent concerns about the possible loss of the QUIKScat scatterometer and the resulting impact on hurricane forecasting. In the Nunn-McCurdy decision memorandum, the NPOESS program was directed to initiate a new microwave imaging sounder that would

provide an instrument at least as capable as current technology in time to fly on the second NPOESS satellite in 2016. General Mashiko stated that the specifications for this new sensor have been developed, and that the program office is consulting the user community. The Program Office hopes to have a recommendation for Mashiko's replacement as Executive Officer in September in order to obtain ExCom approval by January 2008.

GAO notes in its report that during 2006 spending for NPOESS space items exceeded the cost target by $17 million (a four percent overrun of the planned budget for the year). Further, the contractor could not complete $14.6 million planned during the year. The problems with the VIIRS and CrIS instruments were the major factors. These negative trends are likely to persist as the testing programs on the instruments progress. GAO states that these issues may affect the life-cycle cost estimate.

There may also be impacts on the cost estimate from the contract modification negotiations now underway. Schedule milestones will be the primary criteria in award fee determinations, and the award fees will be small. Northrop Grumman delivered its proposals for the contract modification May 7. General Mashiko intends to have the new contract signed before she leaves.

GAO concludes that "restructuring is well under way, and the program has made progress in establishing an effective management structure." There has not been enough progress to show that the key technical risks which have bedeviled the program are being reduced, however. VIIRS flight hardware has yet to be built, and CrIS flight hardware suffered an unexpected failure in early testing. General Mashiko will not dispute that assessment but argues that the steps taken by the new program management give greater confidence that we have an accurate understanding of the risks and a realistic plan to deal with them. GAO has already accepted a request from the Committee to continue its independent evaluation as execution of the restructured program advances.