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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Weather Service Modernization and NOAA Corps Issues

Statement of Joel C. Willemssen
Director, Information Resources Management
Accounting and Information Management Division

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss our work in three areas under the responsibility of the National Oceanic and Atmospheric Administration (NOAA), a component of the Department of Commerce. At your request, we will, first, share preliminary findings of our ongoing audit work relating to the National Weather Service's (NWS) *Advanced Weather Interactive Processing System (AWIPS)*, the linchpin of NWS' $4.5-billion modernization program; second, discuss our report being released today concerning NOAA's *Geostationary Operational Environmental Satellite (GOES)* system, which plays a vital role in weather forecasting; and third, summarize findings from our report issued last year on the *NOAA Commissioned Corps*, relating to issues involving Corps officers' receiving military pay, allowances, and benefits. Attached to my statement today is a listing of prior reports and testimony dealing with these issues.

NWS' Advanced Weather Interactive Processing System (AWIPS)

Mr. Chairman, the National Weather Service has a mission of utmost importance to all Americans—helping to protect life and property through early forecasting and warnings of potentially dangerous weather. Almost 15 years ago, NWS decided to modernize its automated systems to improve forecasting while downsizing operations. The NWS modernization has entailed acquiring and putting into operation new and vastly more capable weather observing systems; these include the Next Generation Weather Radars (NEXRAD), GOES satellites, and the Automated Surface Observing System (ASOS).

While NWS acknowledges that unresolved operational issues concerning some of these observational systems remain, it has found that, overall, the new radars and satellites have greatly improved forecasts and warnings. An example of how important such improvements are was seen barely 2 weeks ago, with the severe weather endured by thousands in the south-central United States. Without the capabilities provided by satellites and radar, the speed with which forecasts and warnings of this dangerous weather were communicated to the public would have been reduced, possibly with more deadly consequences.

AWIPS—the system that integrates and interprets these data—is the centerpiece of the NWS modernization, designed to serve as both a decision-support and communications system. Its network of sophisticated workstations is intended to support forecasters by processing and analyzing large volumes of data coming in from a multitude

of observing systems, satellites, and radars. In concert with NWS computer models of weather patterns, AWIPS will use these data to aid local forecasters in making specific weather predictions and issuing timely warnings of threatening meteorological events. In addition, AWIPS is to provide the conduit for national communications, the structure through which NWS field offices, national centers, and customers will communicate. Through AWIPS, the Weather Service expects to tap a reservoir of data from its new observing systems—data that its current, aging processing and communications system cannot handle.

However, as we have reported several times over the past few years, *full* utilization of the data from these observing systems has been prevented by delays and continuing problems with AWIPS.[1] We have made several recommendations that we feel will strengthen NWS' ability to acquire AWIPS. Progress to date has, however, been uneven, and we continue to be concerned about risks in the development of AWIPS—risks that threaten the system's ability to be completed on time, within budget, and perform with the functional capability that AWIPS must be able to provide. Until AWIPS is deployed and functioning properly, NWS will not be able to take full advantage of the nearly $4 billion investment it has made in these new observing systems. Because of these concerns, the NWS modernization was placed on our list of high-risk government programs in 1995, where it remains today.[2]

After early successes in demonstrating the technical feasibility of system functions, design problems and disagreements between NOAA and the development contractor in 1993-1994 stymied progress. On the recommendation of an independent review team, some development responsibility was brought in-house—to NWS/NOAA labs—in 1995. The AWIPS program strategy was changed again in 1996, when even more development responsibility—for AWIPS data acceptance, processing, and display capabilities—was brought in-house, primarily to NOAA's Forecast Systems Laboratory (FSL). At that time, NWS decided to use FSL's prototype system, called Weather Forecast Office (WFO)-Advanced, which was being developed parallel to AWIPS as a risk-reduction tactic. NWS officials chose

[1]Weather Forecasting: Recommendations to Address New Weather Processing Systems Development Risks (GAO/AIMD-96-74, May 13, 1996); Weather Forecasting: NWS Has Not Demonstrated that New Processing System Will Improve Mission Effectiveness (GAO/AIMD-96-29, Feb. 29, 1996); Weather Forecasting: New Processing System Faces Uncertainties and Risks (GAO/T-AIMD-96-47, Feb. 29, 1996); Weather Service Modernization: Despite Progress, Significant Problems and Risks Remain (GAO/T-AIMD-95-87, Feb. 21, 1995); and Weather Forecasting: Improvements Needed in Laboratory Software Development Processes (GAO/AIMD-95-24, Dec. 14, 1994).

[2]High-Risk Series: Information Management and Technology (GAO/HR-97-9, February 1997).

WFO-Advanced because of its demonstrated superior data acceptance, processing, and display capability over the contractor's version, hoping that using it would enable the agency to deploy these AWIPS capabilities to field operations as quickly as possible. The contractor did, however, retain responsibility for communications, system monitoring and control, and other capabilities. With these changes, NWS expects AWIPS to be fully deployed in 1999, at a total cost of $550 million.

As we reported in December 1994, NOAA/NWS labs are research and development labs that primarily develop prototype systems, and as such did not employ software development processes characteristic of a production environment. Specifically, the labs did not have the software quality assurance and configuration management processes, among others, sufficient to ensure production of stable, reliable software code.[3] Developing software code for use in one or two prototype installations requires a far less rigorous approach than what is needed when nationwide deployment is planned. However, some of the software the NOAA/NWS labs were developing was intended for operational use in AWIPS and was essentially being handed off directly from the labs to the contractor. We therefore recommended in 1994 that NWS and NOAA strengthen their processes for developing production-quality software code.

Now, with the 1995 and 1996 AWIPS development changes, significantly more design and development responsibility has been transferred to the government, in particular to NOAA's FSL. In visiting FSL in Boulder, Colorado, just last week, we found that—with the exception of one subsystem that we specifically discussed in 1994—the question of capability remained: Lab quality assurance and configuration management processes for production-level software were still lacking. However, NWS and NOAA officials said that they have heeded our 1994 recommendations and are improving their processes in other ways. They said that, in order to preserve the labs' research and development missions, they do not wish to impose any unnecessarily rigorous software development procedures on the labs. Instead, NOAA management now plans to play a more active role in preparing the government-furnished software for the contractor.

[3]*Software quality assurance* refers to a program that independently (1) monitors whether the software and the processes used to develop it fully satisfy established standards and procedures, and (2) ensures that any deficiencies in the software product, process, or their associated standards are swiftly brought to management's attention. *Software configuration management* refers to a process by which changes to software products are controlled. It includes identification of products to be controlled, accounting for changes to these products, and reporting on the products' status.

According to NWS officials, they plan to improve the software development processes for WFO-Advanced and other government-developed software using NWS headquarters, NOAA Systems Acquisitions, and contractor staff. Specifically, NWS plans to (1) more fully document the lab's design and software code, (2) design the integration of government-furnished software and contractor-developed software, (3) fully test all government software before it is turned over to the contractor, and (4) strengthen quality assurance and configuration management. To help accomplish this, NWS has established several specific contract task orders.

NWS officials acknowledge that getting WFO-Advanced ready for the contractor is a large task because it constitutes such a significant portion of the AWIPS software. In addition, officials said that there is no room for schedule delays due to unforeseen problems. They feel confident, however, that they can meet this challenge because of the steps I have just described, and because they have experience in turning government software over to the contractor. For example, NWS' Office of Hydrology provided hydrometeorological software to the contractor for the AWIPS "build 1," which was successfully tested last summer. In addition, NWS officials said that they are applying to AWIPS lessons learned from their configuration management experiences in the radar and observing systems development projects.

According to NWS and NOAA officials, one of the critical success factors for the AWIPS development is preserving the knowledge investment made in contractor staff; internally, however, such resources have been dwindling, a problem exacerbated by downsizing. These officials noted that one result of this is that functions that should be performed by government personnel have had to be contracted outside the agency, such as configuration management.

Mr. Chairman, I have been discussing risks that we see in the development process, primarily in ensuring that government-developed software code is stable and reliable. Right now they are just that—risks. But they are significant risks, ones that must be managed lest they become actual problems. NWS has put into place appropriate plans and procedures to mitigate these risks. This is an important step. Even more critical, however, is implementation. For this reason, these issues are more managerial than technical. Risks are inherent in every large systems development effort; unfortunately, all too frequently they become reality. Whether or not this happens is often related to the quality of program management. Only by ensuring, through continual monitoring, that

risk-mitigation plans are effectively implemented can management hope to prevent these risks from becoming real problems. Development plans usually include cost and schedule padding to help absorb the effects of problems that arise. AWIPS has not been safe from development setbacks over the years; its cost has increased and its schedule has lengthened. Further, according to the program manager, while the current $550 million estimated cost at completion is a conservative one, there is no more cost or schedule padding available.

Given the magnitude of the task at hand—integrating software from several separate entities into a complex meteorological system that will enable forecasters to capitalize on the $4 billion worth of improvements already made by NWS—and that the Department of Commerce has committed to a $550-million funding cap, we believe it is essential that top managers both at NOAA and Commerce understand and acknowledge the importance of fully implementing their risk-mitigation plans, and that should these risks turn into real problems, more time and money will inevitably be required. Managers will need to deal with unexpected problems in an efficient, timely, and cost-effective manner, while at the same time ensuring that NWS operations—providing forecasts to the public and supporting the systems in place for use by forecasters—are not adversely affected.

Geostationary Operational Environmental Satellite (GOES)

Mr. Chairman, you also asked that we discuss NOAA's acquisition strategy for its Geostationary Operational Environmental Satellite (GOES) system. This system is an integral part of weather forecasting, as GOES satellites are uniquely positioned to observe the development of severe weather—such as hurricanes and thunderstorms—and provide information allowing forecasters to issue accurate and timely warnings. GOES satellites in the current series will begin to reach the end of their useful lives about 2002; consequently, NOAA is now in the process of planning the procurement of replacements for these satellites, which will need to be procured quickly to prevent a gap in coverage as the current series runs out. These satellites will be very similar to the current series.

However, decisions concerning what type of satellite system to build for the longer term are not simple. Given that NOAA's budget is expected to be constrained in the coming years, it is important that plans for the next generation of satellites ensure that they will be economical as well as effective. As requested by this Subcommittee, we recently completed a

review assessing NOAA's planning for the GOES system; our report is being released today, and copies are available at this hearing.[4]

In brief, we found NOAA's approach for the near term reasonable—competitively procuring two to four spacecraft that will carry the same meteorological instruments as the current series, with modest technical improvements. During our review, however, we noted the difficulty NOAA has in predicting exactly when replacement satellites will be needed, and how many should be bought. To help improve its planning process, we are recommending that NOAA clarify its policies for replacing partially failed satellites and backing up planned launches.

As part of our review of the GOES program, we were asked to look at whether opportunities exist for improving the system and reducing long-term costs. We believe that changing the GOES system design offers a number of potential benefits. A new design might better meet the evolving needs of forecasters and improve performance as well as reduce costs. A number of new approaches and technologies for geostationary meteorology have been suggested in recent years, by government, academic, and industry experts; many include technological options unavailable when the present generation of satellites was designed.

For example, new designs for the meteorological instruments that fly on GOES could take advantage of advanced sensor technology, which would allow them to collect data much more efficiently than do current instruments. Further, instead of using two large multipurpose satellites, the GOES system could be made up of smaller satellites focused on specific tasks. While potential drawbacks to this approach would need careful engineering assessment, the basic concept could lead to a more robust and flexible satellite system that better meets user needs at a lower cost.

These and other options need careful engineering analysis before an informed decision can be made about the future of the GOES program. Our greatest concern in this area is with NOAA's delay in conducting this analysis and developing specific plans for the follow-up series. During our review, the agency was planning to begin its GOES follow-up program in fiscal year 2000, and we questioned the decision not to begin planning earlier. Now, with the release of the President's budget request for fiscal year 1998, the start date has been delayed even further—the agency does not anticipate beginning a follow-up program until 2003 at the earliest.

[4]Weather Satellites: Planning for the Geostationary Satellite Program Needs More Attention (GAO/AIMD-97-37, March 13, 1997).

Given that it generally takes 10 years to develop a new satellite design, deferring the start of the program until 2003 likely means that NOAA will have to continue to rely on the current, early-1980s design well into the second decade of the next century.

GOES program officials within NOAA have anticipated this problem and, for several years, proposed funding to begin a planning process. However, NOAA and Commerce officials have repeatedly denied this request in favor of other programs. The danger NOAA faces—that a gap in coverage could develop beginning in 2002—has arisen because planning for the next-generation satellite series has been repeatedly deferred since 1989.

Mr. Chairman, given that options may exist for NOAA to develop a significantly improved follow-up GOES system, the Congress may wish to closely examine the costs and benefits of different approaches for the timing, funding, and scope of the follow-up program. Further, the Congress may also wish to examine the National Aeronautics and Space Administration's (NASA) potential role in working with NOAA to support the needs of geostationary weather satellites within NASA's advanced spacecraft technology programs.

We recommend that the NOAA Administrator ensure that the National Environmental Satellite, Data, and Information Service (NESDIS) clarify certain of its GOES planning policies. Further, we recommend that the Administrator prepare a formal analysis of the costs and benefits of several alternatives for the timing, funding, and scope of the follow-up program. This analysis should be provided to the Congress for its use in considering options for the future of the GOES program.

NOAA Commissioned Corps

In a report issued last year, we addressed issues involving the NOAA Commissioned Corps, focusing on the extent to which it meets Department of Defense criteria for performing military functions and receiving military pay and allowances.[5] In that report, we also estimated potential government savings if Corps officers were converted to civilian employment.

The NOAA Corps is made up of officers who operate and manage NOAA's research and survey ships. These vessels collect data needed to support fishery management plans, oceanographic and climate research, and

[5]Federal Personnel: Issues on the Need for NOAA's Commissioned Corps (GAO/GGD-97-10, Oct. 31, 1996).

hydrographic surveys, which chart bodies of water. Officers also fly and manage aircraft used by NOAA to penetrate hurricanes for research purposes and to carry out surveys for forecasting floods and mapping changing U.S. shorelines.

We reported that generally, the NOAA Corps does not meet criteria for receiving military compensation cited in a Defense report.[6] Further, NOAA Corps officers are not subject to the Uniform Code of Military Justice, which governs how military personnel are managed. We estimated that if Corps members were converted to civilian status, the government would realize an annual net savings of some $660,000. This figure would decrease if the Corps were to become smaller than it was during our review. We understand that reductions may have in fact occurred. The actual savings also depends on a variety of factors concerning how the transition would be made and the period of time over which it would take place.

Corps officers' entitlement to military rank and military-like compensation—including retirement eligibility at any age after 20 years of service—was an outgrowth of their temporary assignments to the armed forces during the first and second world wars. The Corps has not been incorporated into the armed services since World War II and, according to Defense officials, war-mobilization plans envision no role for them in the future.

Corps officials cited the fact that their officers can be assigned with little notice to any location and function where their services are needed, often in hazardous conditions. Yet some civilian employees are often similarly called upon to respond quickly to disasters and other emergencies, including those of the Environmental Protection Agency (EPA), National Transportation Safety Board, and Federal Emergency Management Agency. Further, both EPA and the Navy use ships operated by civilians to conduct oceanic research. NOAA ships themselves have, on occasion, been operated by civilians —an approach NOAA officials called successful.

If a decision to convert Corps officers to civilian status were made, a transition plan would need to consider, along with the time period to accomplish the change, (1) retirement benefits/credits to be allotted to officers who are converted to civilian capacity; (2) resources needed for potential recruitment, training, and retention of civilian employees who might replace Corps members choosing to leave federal service; (3) what

[6]The Fifth Quadrennial Review of Military Compensation, Department of Defense, January 1984.

additional resources, if any, NOAA would require to administer the civilian workforce; and other specific operational elements.

This concludes my statement, Mr. Chairman. I would be happy to respond to any questions you or other members of the Committee might have at this time.

Related GAO Products

Weather Satellites: Planning for the Geostationary Satellite Program Needs More Attention (GAO/AIMD-97-37, March 13, 1997).

High-Risk Series: Information Management and Technology (GAO/HR-97-9, February 1997).

Federal Personnel: Issues on the Need for NOAA's Commissioned Corps (GAO/GGD-97-10, Oct. 31, 1996).

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Weather Forecasting: Recommendations to Address New Weather Processing Systems Development Risks (GAO/AIMD-96-74, May 13, 1996).

Weather Forecasting: NWS Has Not Demonstrated that New Processing System Will Improve Mission Effectiveness (GAO/AIMD-96-29, Feb. 29, 1996).

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Weather Service Modernization: Despite Progress, Significant Problems and Risks Remain (GAO/T-AIMD-95-87, Feb. 21, 1995).

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Weather Forecasting: Improvements Needed in Laboratory Software Development Processes (GAO/AIMD-95-24, Dec. 14, 1994).

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Weather Forecasting: Important Issues on Automated Weather Processing System Need Resolution (GAO/IMTEC-93-12BR, Jan. 6, 1993).

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Weather Satellites: Cost Growth and Development Delays Jeopardize U.S. Forecasting Ability (GAO/NSIAD-89-169, June 30, 1989).

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