GAO

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Accounting and Information
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The Honorable Dana Rohrabacher
Chairman, Subcommittee on
Energy and Environment
Committee on Science
House of Representatives

Dear Mr. Chairman:

In response to your February 24, 1995, letter, we are providing the enclosed responses to questions that were submitted by Members of the Subcommittee following our February 21, 1995, testimony on the National Weather Service (NWS) modernization. These responses cover two NWS modernization projects--the Automated Surface Observing System (ASOS) and the Advanced Weather Interactive Processing System (AWIPS).

If you or your staff have further questions or would like to discuss our responses in more detail, please call me at (202) 512-6253 or Randolph C. Hite, Assistant Director, at (202) 512-6256.

Sincerely yours,

Joel C. Willemssen
Director, Information Resources
Management/Resources, Community,
and Economic Development

Enclosure

RESPONSES TO QUESTIONS ON ASOS AND AWIPS

Question 1: Can the Automated Surface Observing System (ASOS) accomplish the mission for which it was intended, or will we have to continue to rely on human weather observers?

GAO Response: ASOS can accomplish its intended mission if known system problems are fixed. However, NWS never intended for ASOS to be a stand-alone system. Instead, it was intended to be supplemented and augmented in some capacity by both humans and other observing systems.

The intent of ASOS is to automate the ground-based observation and dissemination of weather information nationwide and to allow the release of NWS employed and contract human observers. ASOS is not intended to observe all weather conditions that have been historically observed by humans.[1] To provide information on these conditions, NWS plans to use a combination of remote sensing systems (e.g., radar, satellite, and lightning detection systems), additional ASOS sensors, and human observation by persons other than NWS employed and contract observers (e.g., volunteers, on-call cooperators, and air traffic controllers). Not all of these supplementary sources are currently in place.

NWS has postponed plans to release its employed and contract observers until it (1) reaches agreement with the aviation community on what weather information is essential for aviation operations, (2) determines, through a 6-month demonstration, the workload associated with augmenting ASOS observations to include some of the information ASOS cannot provide, and with supplementing ASOS observations in case ASOS fails or errs, and (3) arranges to have non-NWS staff augment and supplement ASOS as needed.

Question 2: How much will it cost to fix ASOS?

GAO Response: The cost to fix all ASOS problems is not yet known. These problems include shortfalls in meeting contract specifications as well as requirements that users continue to cite that are beyond the scope of the current specifications.

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[1]Weather conditions that ASOS will not observe include thunderstorms, tornadoes, volcanic ash, hail, virga, snow depth and amount, cloud layers above 12,000 feet, blowing sand, blowing dust, blowing snow, and drizzle.

The current ASOS program cost estimate of $351 million includes the cost to purchase and deploy 868 ASOS units as contractually specified. Under the ASOS firm, fixed-price contract, the contractor is to absorb all costs to fix shortfalls in meeting these contract specifications. However, the government is responsible for (1) correcting any shortfalls in meeting specified requirements that are due to deficient government-furnished sensors; (2) improving or upgrading the system beyond its specified requirements; and (3) supplementing the system with observations from other sources (e.g., humans or other systems).

The cost of those problems that are due to deficient government-furnished sensors, such as the dew point sensor and the ceilometer, are included in the $351 million cost estimate. However, other reported problems or concerns that are outside the scope of the ASOS specification are only now being assessed, and thus the cost of addressing them, either by improving ASOS or supplementing it, is unknown. According to ASOS officials, these costs will, at a minimum, include (1) new airport tower display equipment, (2) a new all-weather precipitation accumulation sensor, and (3) other technology additions to improve various sensors, such as the precipitation identification sensor. They may also include the cost of improvements, additions, or supplements needed to make ASOS observations more representative of actual prevailing conditions.

Question 3: What are the potential consequences of ASOS inaccuracies?

GAO Response: Unless caught and corrected by human observers,[2] inaccurate ASOS observations can pose risks for aviation efficiency and safety, weather forecasts, and climate research. For example, ASOS visibility or ceiling observations that are much worse than actual conditions could inappropriately restrict airport operations and inconvenience flights. Conversely, ASOS visibility or ceiling observations that are better than actual conditions could lead pilots to visually approach an airport during what are actually instrument flying conditions. Also, inaccurate dew point observations could lead to forecasts for clear weather when in fact storms are developing. Further,

[2] The human observers who supplement ASOS observations are responsible for editing incorrect observations, providing missing observations should ASOS sensors fail, and augmenting the observations with some of the information ASOS was not intended to provide (e.g., thunderstorms and tornadoes).

inaccurate precipitation accumulation amounts could result in incorrect evaluations of flood and drought frequencies.

Question 4: Can ASOS' failure to perform in severe weather be fixed?

GAO Response: Until testing is completed, it is unknown whether all ASOS sensors will perform adequately in severe weather. Four ASOS sensors (the wind sensor, precipitation identification sensor, freezing rain sensor, and precipitation accumulation sensor) currently suffer performance problems in certain severe conditions.

NWS has developed modifications to address the performance problems on each of these sensors. On the basis of recently completed tests, NWS has approved the wind sensor modification for implementation on operational ASOS systems. Testing of the freezing rain, precipitation accumulation, and precipitation identification sensors will continue through March 1995. Additionally, NWS plans to procure an all-weather precipitation gauge to expand its precipitation accumulation capabilities to include frozen precipitation.

Question 5: What would you estimate is the cost to date of the Advanced Weather Interactive Processing System (AWIPS)? How much will it cost to complete?

GAO Response: The reported cost of the AWIPS program through February 1995 is $179 million. The estimated cost to complete AWIPS is $346 million, for a total estimated program cost of $525 million, according to the NWS Modernization Systems Manager.

Question 6: Has the money spent to date on AWIPS been wasted?

GAO Response: Since contract award over 2 years ago, NWS has made little progress on AWIPS. During this time, NWS and the contractor have expended considerable time and effort (1) attempting to agree on a high-level systems design and (2) restructuring the program and contract to address the root causes of its slow progress (see the answer to question 7 for a discussion of causes).

This time and effort was necessary to move the program beyond the difficulties it faced at the time. However, if the program had been effectively structured and managed from the outset, these difficulties could have been minimized. The increases in the revised AWIPS cost and schedule estimates--an additional $58

million and a 1-year delay--could be attributed, in part, to the early ineffective program management. But as we discuss in the answer to question 11, we have not analyzed the reliability of AWIPS' cost or schedule estimate.

Question 7: What has caused AWIPS' failure to date?

GAO Response: According to an independent review team of government and industry experts, a number of underlying problems led to AWIPS' situation. The review team cited insufficient technical expertise within the National Oceanic and Atmospheric Administration (NOAA) program office and the contractor, which led to inadequate system engineering and software development discipline. In addition, the NOAA program office, the contractor, and NWS had insufficient interaction. The review team also mentioned that NOAA inappropriately assigned the responsibility for developing certain software applications (e.g., hydrometeorological applications) to the contractor rather than to NWS. Finally, the review team stated that AWIPS' system development approach was not appropriate for a project the size and nature of AWIPS and recommended that the program use an evolutionary development approach.

Question 8: Will the AWIPS restructuring fix the problem?

GAO Response: NWS' restructuring of the AWIPS program is consistent with most of the recommendations made by the independent review team. Specifically, the restructured program provides for strengthened contractor system engineering and software development processes, new contractor and NOAA management teams, greater use of government expertise in developing the hydrometeorological applications software, and an incremental approach to developing and deploying AWIPS.

Restructuring the AWIPS program is a good first step in addressing the problems that are confronting AWIPS. However, these efforts alone will not fix AWIPS' problems. Rather, the success of AWIPS' recovery will be dependent on NWS' ability to effectively implement and manage each of these efforts.

Question 9: What potential pitfalls still await the AWIPS system?

GAO Response: Several potential risks still confront the AWIPS program. Most notable is the lack of a systems design. Without such a design, NWS cannot move forward on AWIPS, delaying any further development.

Another risk area is the technical and legal impact of the contractor and government sharing responsibility for developing AWIPS. In particular, it is unclear whether the government or the contractor will bear the responsibility for software problems that cannot be definitively attributed to either party. Such problems could greatly affect the government's cost for AWIPS. In light of the fact that the NOAA and NWS laboratories responsible for developing the AWIPS applications software lack mature software development processes, this is even more of a concern. Without these processes, NOAA and NWS are exposing AWIPS to unnecessary cost, schedule, and performance risks.

Another potential risk area is the degree to which AWIPS' incremental software development approach (1) permits one software increment to begin before the previous software increment is stabilized, and (2) does not require each software increment to be based on explicit cost/benefit criteria before its development begins.

Question 10: Does NWS have the software development processes in place to successfully develop their portion of AWIPS software?

GAO Response: As mentioned in our response to question 9, NOAA and NWS do not have the software development processes in place to successfully develop their portion of the software, although they have plans to improve these processes.

Question 11: How have AWIPS' problems over the last 2 years affected its cost and schedule objectives? How realistic are these objectives?

GAO Response: The cost and schedule estimates of the AWIPS program are $525 million and full deployment by 1999. These estimates represent an increase of $58 million and a 1-year schedule increase over 1992 estimates. While we have not analyzed the reliability of either estimate, NOAA and NWS officials told us that the cost estimate was derived using structured cost estimating techniques, which we find encouraging. However, since AWIPS is still very early in its development cycle and its design is not yet approved, any estimates of cost and schedule beyond the next 12 to 18 months are imprecise and subject to considerable change as the system development progresses.

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