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WEATHER FORECASTING

Radars Far Superior to Predecessors, but Location and Availability Questions Remain

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Mr. Chairman and Members of the Subcommittee:

We appreciate this opportunity to testify on the National Weather Service's (NWS) new Doppler radars, commonly called Next Generation Weather Radars or NEXRADs. This national network of radar systems truly represents a giant step in weather observing capability over the radars' predecessors. In particular, NEXRADs can better peer into weather events and extract the data forecasters need to understand the event's makeup and movement. In addition, NEXRADs provide forecasters with a much wider area of radar coverage than heretofore existed. Simply stated, NEXRADs have replaced weather event "nearsightedness" with "20/20 vision," and have given NWS the ability to save lives and money through more accurate and timely warnings of severe weather.

To perform effectively, NEXRADs must be located "in the right place" and available "at the right time," meaning that the radars must be sited to provide adequate national coverage and, once sited, they must be "up and running" when needed. Unfortunately, it is unclear whether this first requirement is being met because NWS has yet to report the results of its study on the adequacy of NEXRAD coverage, although it plans to next month. What is clear, however, is that the second requirement is not being met. That is, many NWS and Air Force NEXRADs are not available nearly as often as they are required to be. Further, a radar upgrade to address one cause of unavailability--namely, lack of an uninterruptible power supply or UPS--is not to be completed for several years.

NEXRAD: A Brief Overview

NEXRAD is a Doppler radar system[1] that is being acquired jointly by NWS, the Air Force, and the Federal Aviation Administration (FAA). Together, these agencies plan to deploy 161 NEXRADs--119 for NWS, 30 for the Air Force, and 12 for FAA--at an estimated cost of just over $1.4 billion. Of the 161 planned radars, 138 operational systems are to be located within the contiguous United States (CONUS)[2]--116 at NWS sites and 22 at Air Force and Army sites. To date, a reported $1.2 billion has been spent and 132 radars have been deployed, 124 of which are CONUS-based--102 at NWS sites and 22 at Air Force and Army sites.

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[1]Doppler radar is used to determine the speed and direction of rain or snow particles, cloud droplets, or dust moving toward or away from the radar. The radar accomplishes this by sending out a pulse using a stable frequency and then measuring the changing frequencies as the distances between the radar and the object changes.

[2]CONUS consists of all states except Alaska and Hawaii.

NEXRADs Are a Giant Leap Beyond the 1950s Technology They Are Replacing

NEXRADs provide more breadth and clarity of coverage than the radars they are replacing. Before the introduction of NEXRAD, NWS operated and maintained 128 1950s vintage radars. These radars, many of which rely on vacuum-tube technology, collectively covered roughly one-half of CONUS. In contrast, the CONUS-based NEXRAD network is to consist of 138 Doppler radars and provide coverage of almost all of CONUS. Additionally, according to the National Research Council (NRC), the positioning of the radars will for the first time provide complete coverage of areas prone to hurricanes, not to mention better coverage in areas subject to other severe weather phenomena, such as lake-effect snows. Further, with NEXRAD, coverage of atmospheric layers will be increased because changing the old radars' elevation angle for a given rotation required manual intervention. NEXRADs, on the other hand, can observe different atmospheric layers faster because they automatically scan multiple elevation angles.

With respect to coverage clarity, NRC also reported that NEXRADs meet or exceed their technical design specifications relevant to weather detection, and that they are ten times more sensitive and have better resolution than their predecessors. Additionally, whereas the old radars could only provide a picture at a specific point in time and space, the NEXRADs allow forecasters to see the movement of weather because the Doppler technology detects the movement of precipitation, cloud droplets, and dust in the air. As a result, NRC concluded that NEXRADs allow unprecedented short-term forecasting of thunderstorms, damaging winds, and tornadoes.

Overall, NWS has reported that NEXRADs have improved the accuracy and timeliness of severe local storm and flash flood warnings. In particular, NWS notes that lead times for tornado warnings have improved by an average of 4 minutes because of NEXRAD. A comparison of two similar California flood disasters, one in 1992 that was watched by the old radars and one in 1995 that was observed by NEXRADs, illustrates clearly the value of this increased warning time. In the 1992 incident, the radars were unable to detect small-scale, yet intense storms in a timely fashion. As a result, warnings and advisories were not issued until, and even after, severe flooding had already occurred. These small storms produced 8 inches of rain, and sadly resulted in the loss of human lives. In contrast, warnings and advisories were issued 3 to 6 hours in advance of the 1995 storms and flooding, allowing emergency crews to close at-risk roads and preventing any loss of life.

Final Decision on Radar Locations Pending
As NWS Considers Adequacy of Coverage Issues

According to NWS, its current NEXRAD location plans will provide national radar coverage that is equal to or better than existing coverage. However, public concern last year over relocating NWS radars prompted the leadership of the House Committee on Science, Space, and Technology (now the Committee on Science) to request NRC to review the adequacy of NEXRAD's national radar coverage. In response, in June 1995, NRC reported that coverage under the NEXRAD network may be degraded over existing service in five geographic areas and recommended further study of each area.

The Secretary of Commerce acted quickly on this recommendation by forming a departmental team of experts in meteorological operations and Doppler weather radar technology to study the 5 areas, as well as 27 others identified as possibly experiencing degraded service. This study has been completed and reviewed by a group of university experts; however, NWS has been unwilling to discuss the study's results until the Department of Commerce grants it approval to do so. NWS plans to release the final report in early November 1995.

Whether Radars Will be Available
When Needed Remains an Uncertainty

Because severe weather can occur suddenly at any hour of the day or night, NEXRADs are required to be "up and running" at least 96 percent of the time.[3] Regrettably, they are not. In May 1995,[4] we reported that between 10 and 62 percent of the Air Force's NEXRADs were falling short of this requirement each month. In fact, at some locations, NEXRADs were unavailable for an entire month, and at other locations, we found that the Air Force's availability data were likely overstated. To make matters worse, we found that NWS did not even know if its radars were meeting the availability requirement because it was not monitoring availability on a site-by-site basis.

Today, both the Air Force and NWS have initiated steps to implement our recommendations to improve NEXRAD availability data and correct

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[3]The NEXRAD Joint Operational Requirements define availability as the time that the system is operating satisfactorily, expressed as a percentage of total time (the time the system is operating satisfactorily plus the time the system is down). Downtime includes corrective and preventive maintenance time and delays encountered due to the delivery of needed spare parts. Most definitions of availability exclude scheduled downtime, such as preventive maintenance.

[4]Weather Forecasting: Radar Availability Requirement Not Being Met (GAO/AIMD-95-132, May 31, 1995).

any shortfalls that the data show. However, more needs to be done because NEXRAD availability remains and will likely continue to be an issue for several reasons. First, Air Force data for June 1995 through August 1995, which Air Force officials told us are now reliable because the data were validated with site officials, show that from 20 to 35 percent of Air Force NEXRAD sites are still falling short of the availability requirement each month. In fact, the availability at one of these sites during August 1995 was only 18 percent.[5]

Second, even though NWS has begun monitoring availability data on a site-by-site basis, its data for May 1995 through July 1995 show that about 15 percent of its sites are not meeting the availability requirement. Moreover, these data are likely to be overstated for the same reason we cited past Air Force data for being overstated--namely, numerous sites are reporting 100 percent availability, despite the fact that a NEXRAD fails, on average, about four times a month. NWS officials acknowledged that some sites may not be reporting all radar downtime, and stated that they are now taking steps to ensure that all radar failure data are reported.

Third, the NEXRADs lack an uninterruptible power supply, or UPS, which protects against unexpected power outages, because the NEXRAD program office did not expect loss of power to be a significant risk. This does not make good sense. Mission-critical systems, like NEXRAD, are typically designed with an UPS, usually batteries, that can take over temporarily when the primary power source is lost. Notwithstanding this normal design practice, the argument for why a NEXRAD should be UPS-equipped is even more compelling when one considers that the cause of most outages is severe weather--precisely when one would want to make sure that a NEXRAD is available. NWS and the Air Force now plan to retrofit their respective NEXRADs with an UPS capability at an estimated cost of $125,000 per radar. However, NWS and Air Force plans do not call for all sites to receive these retrofits until fiscal years 2002 and 1999, respectively.

NWS Has Acted Quickly in Buying Two NEXRADs From FAA

In the midst of public and congressional debate and skepticism about the adequacy of NEXRAD coverage, we reported in May 1995 that FAA bought five NEXRADs targeted for Alaska, Hawaii, and the Caribbean, which it planned to "warehouse" indefinitely because deploying them did not compete favorably with other funding priorities. We, therefore, recommended that NWS not buy additional radars to address weakness that may result from the on-going NRC study until it first assessed acquisition opportunities associated

[5]According to the Air Force, this extremely low availability was due to a lightening strike.

with these five radars. In September of this year, NWS bought FAA's two Caribbean radars for $4.6 million. The other three FAA radars are being installed in Alaska and Hawaii, as originally planned.

According to NWS officials, the two NEXRADs were purchased as a "hedge against inflation" and will be used to boost future replenishment spares stock at its National Logistics Supply Center. NWS estimates that this purchase will save $900,000 by offsetting spare part purchases through fiscal year 2003.[6] NWS officials also acknowledged that these radars could be used to fill holes in NEXRAD coverage should any materialize. To buy these radars, however, NWS had to use all the funds targeted for its UPS retrofit in fiscal year 1995. As a result, the start of the UPS retrofit has been delayed one year, and its completion has been delayed 3 years to fiscal year 2002.

Without question the two FAA NEXRADs constitute a tremendous bargain, assuming they are needed. By purchasing the two, NWS could fill four gaps at a relatively minimal cost because the FAA radars can be converted into essentially four stand-alone units. Specifically, the FAA radars have a redundant configuration in order to meet FAA's more stringent 99.7 percent availability requirement.[7] Under this configuration, the two radars have dual hardware and software modules to process the radar signals into digital data and create displayable radar products. However, each radar has only one transmitter tower, pedestal, antenna assembly, and radome. The program office's estimate of the costs to convert the two FAA radars into four systems is an additional $3.8 million, making the total price for getting four NWS NEXRADs about $8.4 million.[8] This price is just over one-third the cost that NWS would have to pay to buy new systems.

NWS' decision to buy the FAA radars raises several issues. First, NWS data show current and projected spare parts inventories above requisite levels through March 1997, and these levels do not even include four radars that the NEXRAD contractor is to deliver for

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[6]NWS estimates that this $4.6 million investment in spares will be recovered at a rate of about $700,000 a year over the next 8 years, thus producing a savings of about $900,000 over this period. We did not independently verify this cost-savings estimate.

[7]FAA has a more stringent availability requirement because FAA radars are located at isolated, non-CONUS sites, and thus do not have adjacent NEXRADs providing overlapping, back-up coverage in the event one goes down.

[8]This $8.4 million only includes hardware costs. The total cost to field four systems is $15.2 million, which includes land acquisition, installation, and construction costs of $6.8 million.

use as spare parts as part of a 1991 agreement with the contractor. Thus, the need for additional spares in the foreseeable future does not appear to be justified. Second, NWS has yet to acknowledge any gaps in NEXRAD coverage. Moreover, if any gaps are identified, the number of radars to be bought should be driven by the number of gaps that need to be filled. Thus, until NWS and its parent agencies decide that additional NEXRADs are required to fill gaps in coverage, the decision to buy radars in the event of gaps appears premature. Third, the decision to divert funds from the UPS retrofit carries an opportunity cost that must be considered. That is, it means sacrificing NEXRADs' ability to overcome unexpected power outages, which is a known cause of the radars' currently excessive downtime.

In summary Mr. Chairman, the Congress and the public at large should take comfort in the fact that the NEXRAD era offers expanded breadth and clarity of national weather radar coverage. However, important questions remain to be answered. Will any gaps in coverage nevertheless exist under the current siting scheme? The answer to this question is being closely held by NWS and its parent agencies and thus we do not know at this time. Will the radars, once deployed, be available when they are needed? This will depend on whether the Air Force and NWS act effectively to collect reliable availability data and address the root causes of excessive radar downtime.

Mr. Chairman, this concludes our statement. We will be happy to respond to any questions you or other members of the Subcommittee might have at this time.

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