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STATEMENT OF
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RESOURCES, COMMUNITY, AND
ECONOMIC DEVELOPMENT DIVISION
BEFORE THE
SUBCOMMITTEE ON AVIATION
OF THE
HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
ON
FAA'S TERMINAL DOPPLER RADAR EFFORTS

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to comment on the low level wind shear hazard to aviation and FAA's efforts to develop a terminal doppler weather radar system to detect and warn of this meteorological phenomenon. These widely divergent winds in the form of gust fronts, downdrafts, or microbursts, directly affect an aircraft's flying ability.

At the request of the Chairman of the House Appropriations Subcommittee on Transportation, we have, for the past 3 years, monitored and periodically reported on FAA's implementation of the multibillion dollar National Airspace System (NAS) plan. As part of this continuing commitment, we have been evaluating and reporting on various weather-related programs.

In March of this year, we began evaluating FAA's research efforts to develop a terminal doppler weather radar system. We are reviewing the status of research activities conducted under several FAA contracts related to terminal doppler radar development and the wind shear hazard.

My statement today is based on this ongoing GAO work. On July 19th, we met with the Administrator of FAA to share our observations and suggestions relating to FAA's terminal doppler efforts. Subsequently, the crash of Delta Flight 191 at the Dallas/Ft. Worth airport heightened congressional concern about the wind shear hazard to aviation and FAA's progress in developing a terminal doppler radar. Our ongoing work provides insight on (1) the difference between the terminal doppler radar and the next generation weather or NEXRAD radar, (2) the status of the two radars' development, and (3) other measures FAA can take to increase safety by minimizing the risk associated with wind shear.

DIFFERENCES BETWEEN NEXRAD AND THE TERMINAL DOPPLER RADAR

NEXRAD and the terminal doppler radar differ in both their purpose and their technical requirements.

The NEXRAD is a long-range (145 to 290 miles) weather surveillance radar. Its purpose is to identify severe storms as part of the national weather needs of the Departments of Commerce, Transportation, and Defense which are jointly funding its development. NEXRAD doppler characteristics are to identify very large wind shear formations, like tornadoes, gust fronts, and severe air turbulence, as well as precipitation normally associated with severe storms. National Weather Service radar meteorologists operating NEXRAD will provide enhanced aviation weather information, but they will not address airport wind shear hazards.

The terminal doppler is to be a short-range (12 miles) radar. Its purpose is to detect small, low wind shears, including extremely violent, rapidly developing, vertical wind shears called microbursts, in the approach and takeoff glide paths around airports and rapidly warn controllers. In these areas, aircraft are close to the ground and pilots have little time to adjust to abrupt changes in air speed. Research to develop this radar and its displays to warn controllers is being conducted under contract with FAA by the National Center for

Atmospheric Research (NCAR) and MIT's Lincoln Laboratory as part of the NAS plan.

Because of their different purposes, NEXRAD and terminal doppler radars have different technical requirements such as clutter suppression, data updating, and automation. Because NEXRAD radars are long-range components of a national weather network, each can be located with some local flexibility in order to minimize signal interference from aircraft and other radars and from "ground clutter" such as buildings and other obstructions. Conversely, terminal doppler radars must be located on or near airports in order to identify rapidly developing microbursts in the glide paths. Ground clutter and signal interference at the airports are likely to be a major problem. Thus, a terminal doppler radar may have to have more signal interference and clutter suppression capability than a NEXRAD.

Further, since some microbursts can become hazardous very quickly, terminal dopplers must be able to provide new information on the entire terminal coverage area very rapidly. Radar data must be updated every minute in order to provide adequate advance warning. In contrast, NEXRAD will provide updated information to meet long-range weather detection needs every 5 minutes.

In order for a terminal doppler weather radar to provide adequate advance warning FAA says that it must be fully automated because there are no radar meteorologists to interpret the data from the doppler radars and warn controllers of wind shears. FAA also says there are only about 35 seconds total operating time to provide a warning after a wind shear has been identified. Since NEXRAD will be operated by National Weather Service radar meteorologists and its data are not as time critical, it does not require a fully automated system.

STATUS OF THE TWO RADARS

Solutions to the technical requirements of terminal doppler radars depend on further research and development. More specifically, FAA plans to continue the research of Lincoln Laboratory on radar siting and wind shear detection capabilities and of NCAR on controller wind shear displays through 1987.

In contrast, the NEXRAD radar program has reached the procurement stage. Prototypes have been developed by two contractors and are being tested. Once tests are completed and the results evaluated, FAA plans to award a limited production contract in September 1986 to operationally field test 10 radars, with delivery of these radars beginning late in 1988. Plans are to award a full scale production contract for about another 150 radars in 1987 with delivery from 1989 through 1993.

Martin Marietta, FAA's NAS plan Systems Engineering Intergration Contractor, estimates that a prototype terminal doppler radar could be tested in 1988, with an operational radar delivered by July 1990. FAA believes that this proposed schedule may be close enough to the NEXRAD schedule to permit adding the terminal doppler radar procurement to the NEXRAD contract. If this could be done, Martin Marietta claims that about 3 years could be saved simply by avoiding repeating the first two key decision points of OMB A-109 competitive selection process.[1]

The most recent information which we have seen, however, clearly indicates that the NEXRAD and terminal doppler radar schedules are not in the same phase of development. As stated previously, technical solutions to the terminal doppler radar's clutter suppression, data update rate, and fully automated warning capabilities, have not been devised. According to FAA officials, they are now considering a different antenna, a different frequency band, and a different beam width than the NEXRAD radar in order to address these technical requirements and its planned research will not be completed until 1987, a year after the limited NEXRAD production contract is to be awarded.

GAO'S OBSERVATIONS OF FAA'S EFFORTS TO DEVELOP A TERMINAL DOPPLER RADAR

At our July 19th meeting with FAA's Administrator, we identified three issues where FAA actions were critical to improving terminal doppler radar efforts--siting priority, operational testing, and reducing costs. For each issue, we

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[1]There are four key decision points in th A-109 process--exploration of alternative sytems, competitive demonstration, full-scale development/initial production, and full-scale production.

suggested actions FAA might take and asked the agency to respond to our suggestions.

Wind frequency data are required to establish siting priorities

First, adequate national data on wind shear frequency are not availble to establish siting priorities. Aside from data relating to thunderstorms in the summer months, FAA has aggregate time series data on the number of wind shear occurrences for only four airports. Therefore, FAA does not know at which airports wind shears occur most frequently.

Several years ago, the National Academy of Sciences, the National Transportation Safety Board, and NCAR cited the need for such data and suggested using the existing Low Level Wind Shear Alert System (a network of ground based wind sensors on an airport joined to a small computer to show when there are divergent winds) to collect it. These systems are presently installed at 59 airports, and will soon be installed at 110 potential terminal doppler radar airports.

Because FAA had not collected these data, we suggested to the FAA Administrator that FAA use the existing Low Level Wind Shear Alert System to develop wind shear frequenty data. FAA has now agreed to use these systems to collect frequency data to supplement the traffic and thunderstorm activity data it presently uses to site wind shear detection and warning systems.

Initial production units should be tested in an operational environment

Second, FAA's planned efforts to expedite terminal doppler radar procurement do not include time to test and evaluate initial production units in an operational environment. A fully automated research doppler radar operating without a meteorologist to interpret the data and warn controllers is to be tested in Denver in 1987.

The integration of an automated terminal doppler radar warning system is extremely complex. Microbursts must be detected by a radar, interpreted by a computer, and warnings issued to a controller who must rapidly relay the warning to a pilot. Because of the complexity of the system and the life-critical decisions a controller and pilot must make relying on a terminal doppler radar, we suggested to FAA that initial production units be tested and evaluated in an operational environment to ensure effective performance. FAA is confident, however, that the operational aspects of the system can be thoroughly developed through research testing.

A study by an FAA contractor of several major systems acquisitions said that failure to adequately test operational systems in the field prior to full procurement is a major cause of subsequent performance problems. This supports our belief that operational testing of initial production units is crucial.

Terminal doppler radar costs should be re-examined

Third, although siting criteria based on the traffic levels, thunderstorm frequency, and low level wind shear alert system data may support installing terminal doppler radars at a large number of airports, the results of a benefit-cost analysis suggest a more limited deployment unless the doppler's cost can be reduced. The life-cycle cost of each terminal doppler radar is $4 million. Using this cost, Martin Marietta found that less than 15 airports had positive benefit-cost ratios when considering only the safety-related benefits. When efficiency-related benefits were added to the analysis by assuming that terminal doppler radars would reduce thunderstorm-related delays by 5 to 10 percent, 15 to 27 airports showed sufficient net benefits to justify their installation.

Martin Marietta added the positive net benefits from the 15 to 27 airports to the benefit-cost ratios of airports with negative net benefits. This "net benefit" approach increased the number of airports where the radars appear justified to between 41 and 101.

We understand that Martin Marietta has recently revised its benefit-cost ratios to include a higher technical and schedule program risk and to capture the effects of the recent crash of the Delta flight at the Dallas/Ft. Worth airport. The former would tend to reduce costs by having FAA assume a greater risk of failure while the latter would tend to increase program benefits by including the lives and aircraft lost in the Delta crash. This could increase the number of airports having positive benefit-cost ratios. We have not had an opportunity to review Martin Marietta's revised analysis.

We agree with FAA that terminal doppler radars should be installed at airports when frequency data indicate wind shear to be a hazard to aviation. However, we also support the rationale that program funding should be based on the safety and efficiency benefits to be derived. Rather than manipulate the benefit-cost justifications, we urged FAA to re-examine its cost-driving requirements in an effort to reduce the cost of terminal doppler radars.

FAA disagreed with us, citing Martin Marietta's conclusion that FAA's preferred radar would be the optimum system and the most cost-effective. However, Martin Marietta based its conclusion primarily on the assumption that FAA's perferred terminal doppler radar will be added to the interagency NEXRAD procurement contract thus saving 3 years by avoiding repeating the first two key decision points of the OMB A-109 process.

As we have pointed out earlier, this assumption may not prove accurate since the NEXRAD and terminal doppler radar schedules are not now in the same phase of development and FAA has not yet found solutions to the technical requirements that differentiate the terminal doppler radar from NEXRAD. Unless solutions to these technical requirements are found within the next year, it may not be possible to add the terminal doppler radar to the interagency NEXRAD limited production contract without delaying deployment of the NEXRAD radars.

FAA's Deputy Associate Administrator for Engineering testified before the Congress that development of alternative designs for a terminal doppler radar is being initiated and that FAA is looking at alternative ways in which to make the appropraite acquisition. According to the Director of the

NEXRAD Joint System Program Office, NEXRAD's cost-driving requirements were re-examined in June 1982. The re-examination resulted in reduced system requirements and revised cost proposals. We believe that a similar re-examination could result in reduced system requirements and revised costs for terminal doppler radars.

Other Measures

There are also other measures FAA can take to increase safety by minimizing the risk associated with wind shear. In March of this year, the National Transportation Safety Board issued a report identifying 34 wind shear-related recommendations made by the Board to FAA over the last 10 years. While FAA has acted on some of these recommendations, a number remain open. They include

--the need to evaluate methods and procedures for using current weather information as criteria for delaying arrivals and departures in severe weather conditions;

--the need to develop training aids such as educational video tapes for pilots and controllers and to encourage air carriers to provide their pilots with simulator training that incorporates microburst models for avoiding and escaping wind shears; and

--the need to promote development of airborne wind shear detection devices as well as airborne flight management systems to detect and escape wind shear.

Martin Marietta calculated that about 29 percent of all aviation wind shear accidents would still occur even with a fully automated terminal doppler system. Therefore, providing pilots with the training needed to take preventive or evasive action could be a top priority. Accordingly, FAA is planning to award a contract to a consortium of aircraft manufacturers, airlines, and scientists for the development of an improved pilot training program on wind shear. This program is to be conducted over a 2-year period and will provide training suitable for all categories of pilots.

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In summary, NEXRAD and terminal doppler radars differ in their purpose, technical requirements, and status of development. Further, solutions to the terminal doppler radar's three critical technical requirements may not be developed in time for FAA to add the terminal doppler radar to the interagency NEXRAD procurement.

We also believe that FAA should (1) collect the data on wind shear frequency necessary to establish terminal doppler radar siting priorities, (2) test and evaluate a fully automated initial production system in an operational environment before both controllers and pilots begin to rely on it to make life-critical decisions, and (3) re-examine the system's cost-driving technical requirements in a concerted effort to reduce production cost, thereby increasing the number of locations where its safety benefits exceed its costs and its installation is justified.

This concludes my testimony Mr. Chairman. I will be happy to answer any questions you may have at this time.

32400