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AVIATION SAFETY

FAA Has Not Fully Implemented Weather-Related Recommendations

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The Honorable Constance Morella
Chairwoman
The Honorable James Barcia
Ranking Minority Member
Subcommittee on Technology
Committee on Science
House of Representatives

The Honorable Bart Gordon
House of Representatives

In the last 10 years, icing, turbulence, dangerous winds, a lack of visibility, and other weather conditions have been cited as a cause or contributing factor in nearly a quarter of aviation accidents.[1] Even though aviation accident rates are dropping overall, the number of accidents could go up in future years if the number of passenger flights increases as expected. To minimize the danger that hazardous weather presents to the aviation system, the Federal Aviation Administration (FAA), in conjunction with other federal agencies, collects and analyzes weather information and disseminates this information to the users of the aviation system. However, between 1995 and 1997, one report by the National Research Council (NRC) and two reports by an FAA advisory committee cited problems in FAA's management of its aviation weather activities, such as inadequate interagency coordination and a lack of clarity about the agency's role in aviation weather.[2] These reports also recommended steps FAA could take to provide better weather information to aviation users.

Concerned about FAA's efforts to reduce weather-related accidents, you asked us to examine the actions FAA has taken to address the recommendations raised by NRC and FAA's advisory committee. In this report, we discuss FAA's actions in four areas of concern raised by the three reports: (1) policy and leadership, (2) interagency coordination,

[1]The National Transportation Safety Board, the official source of information on airline accidents, defines accidents as events in which individuals are killed or suffer serious injury, or the aircraft is substantially damaged (49 C.F.R. section 830.2).

[2]Aviation Weather Services: A Call for Federal Leadership and Action, National Research Council, National Aviation Weather Services Committee, (Washington, D.C.: 1995); Final Report of the Aviation Weather Subcommittee, FAA Research, Engineering, and Development Subcommittee, (Washington, D.C.: Oct. 1995); and Subcommittee Report of the NAS ATM R&D Panel to the RE&D Advisory Committee, FAA Research, Engineering, and Development Subcommittee, (Washington, D.C.: Mar. 1997).

(3) meeting different types of users' needs for weather information, and (4) the level of funding provided for weather activities.

To assist us in evaluating FAA's actions, we convened a panel of experts who were members of NRC's committee or FAA's advisory committee. These experts were chosen to represent different users of aviation weather information, such as airlines; air traffic controllers; and commercial, military, and private pilots. After discussing FAA's responses to the recommendations in the four areas of concern, the panel rated FAA's progress on each recommendation. Our methodology is discussed in more detail in appendix I.

Results in Brief

The panel of experts we convened concluded that FAA had made limited progress in implementing the weather-related recommendations made by NRC and FAA's advisory committee. Regarding the first area of concern, policy and leadership, the reports concluded that FAA is the agency best suited for leading federal aviation weather efforts but that it had not accepted that role. The NRC report linked this criticism to the dispersal of responsibilities among several FAA organizations. The reports also concluded that FAA did not have clear policy guidance to define its role in aviation weather activities. Since 1995, FAA has attempted to address these twin concerns by creating a new organization to direct aviation weather activities and by issuing a policy that states that FAA takes the responsibility for leading aviation weather activities. However, our expert panel concluded that because FAA has not yet produced a plan to implement the new policy, its actions did not go far enough to address the concerns that the report originally raised.

With regard to the second concern, interagency coordination, the reports questioned the adequacy of FAA's efforts to coordinate aviation weather activities with other federal agencies. For example, the reports found little evidence that the FAA officials involved in weather-related research communicated with officials from other agencies working in the same area. In response, FAA has increased the frequency of meetings between high-level FAA and National Weather Service officials. Our expert panel, however, did not believe that the agency had presented sufficient evidence to show that these meetings had led to improved coordination.

Concerning the third area—FAA's efforts to meet the needs all types of users (such as air traffic controllers, pilots, and dispatchers) have for weather information—the reports concluded that FAA was not providing

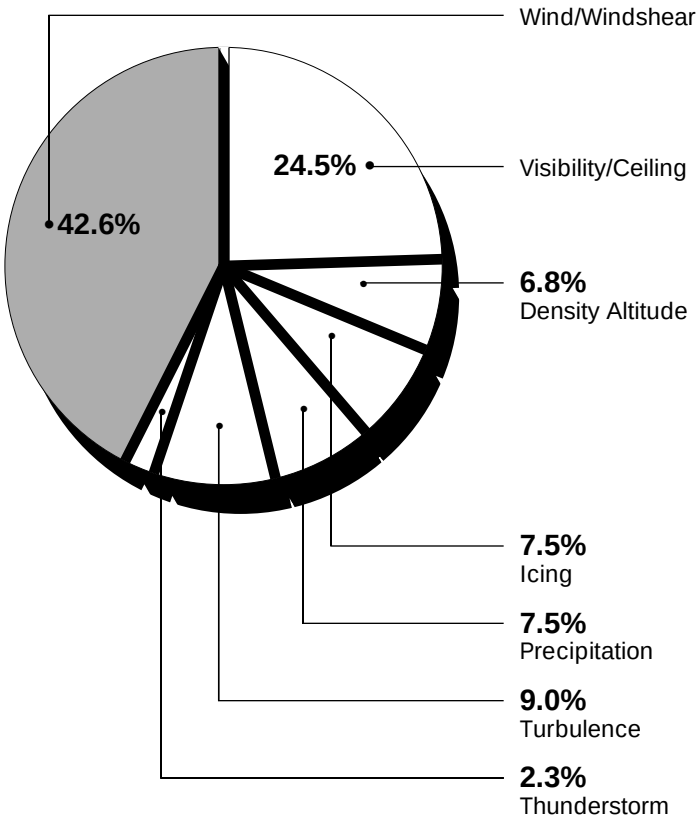
consistent information or adequate training. For example, users currently get weather information from different systems, which may not agree about current weather conditions. As evidence that it is meeting the needs of all types of users, FAA cited a list of systems it is developing to provide weather information to various users and a list of the training courses it offers. Our expert panel, however, expressed continuing concerns about whether the equipment FAA listed would form an integrated system to serve all users. Panelists also raised concerns about the training offered by FAA, stating that better training could help reduce disparities in the abilities of air traffic controllers to interpret weather information.

Finally, with respect to the amount of funding FAA has allocated for aviation weather activities, the reports raised questions about the low level of funding provided to weather-related projects compared with other activities. Our review of FAA's budget information for fiscal year 1990 through fiscal 1998 confirms that the agency has allocated less funding for aviation weather during this period than for most other acquisition and research priorities. FAA officials attribute this funding history, in part, to an emphasis on higher-priority issues, such as security and the replacement of air traffic control equipment. Several panelists raised concerns that without more consistent funding, multiyear research efforts on aviation weather problems might not be funded to their conclusion.

Background

Aviation weather refers to any type of weather that can affect the operation of an aircraft—anything from a brief delay in departure because of low visibility to a catastrophic accident during flight. For example, in March 1992, a USAir flight crashed during takeoff from La Guardia Airport in New York City, killing 27 people and injuring 21 others. Icing was identified as one of the factors that contributed to that accident. According to data from the National Transportation Safety Board and FAA, about 24 percent of all aviation accidents in fiscal year 1987 through fiscal year 1996 were weather-related. During the same period, about 35 percent of aviation fatalities occurred in weather-related accidents. About 88 percent of these accidents involved small private aircraft. Weather-related aviation accidents were most often caused by winds, poor visibility, or turbulence. Figure 1 shows all the types of weather events cited in aviation accidents over this period.

Figure 1: Distribution of 7,966 Weather Factors Cited in 5,286 Weather-Related Accidents, Fiscal Years 1987-96



Notes: Density altitude refers to less dense air that adversely affects an aircraft's performance, most often on takeoff. This condition typically occurs at higher altitudes; heat and humidity also contribute to its effect.

Multiple weather factors may be cited in an accident investigation.

Because of rounding, the sum of percentages exceeds 100.

Source: Analysis by FAA's National Aviation Safety Data Analysis Center of accident investigations completed by the National Transportation Safety Board.

Weather need not cause an accident to have an effect on aviation. FAA estimates that 72 percent of all delays over 15 minutes can be attributed to weather. These delays add to the cost of flying, either for passengers whose travel plans are disrupted or for airlines, which can incur additional

fuel, servicing, and crew costs. The Air Transport Association estimates that delays cost airlines and passengers about $4 billion in 1996. (App. II provides more detailed information on weather-related accidents and delays.)

FAA is responsible for maintaining the safety of the national airspace system. Because of the impact of weather on aviation, FAA has spent more than $1.4 billion in facilities and equipment funds since fiscal year 1982 to develop and purchase weather-related systems and equipment. In future years, FAA expects to spend another $440 million on those systems already in development. FAA believes that its purchases of improved weather systems will help it meet the President's stated goal of reducing fatal aviation accidents by 80 percent within 10 years. For example, FAA has purchased more than 500 automated surface observing system (ASOS) units, which use a series of instruments to automatically measure such meteorological data as wind speed and direction, temperature, and barometric pressure near airports. FAA is also buying systems, like the integrated terminal weather system (ITWS), that will collect and analyze weather data from ASOS, radars, and other systems, and display them for use by air traffic controllers and supervisors. FAA relays the data provided by such systems, as well as information provided by the National Weather Service (NWS) and private vendors, to pilots through automated systems or direct voice communications from air traffic controllers. FAA also uses weather information when deciding how to handle air traffic, such as which runway to use at an airport.

In addition, since fiscal year 1982, FAA has spent almost $169 million of its total funding of $3.3 billion for research, engineering, and development on research related to aviation weather. FAA's research has looked into ways to improve radars and other weather sensors, to detect and avoid turbulence, and to support the early development of some of the systems it has purchased or plans to purchase. Much of this research is conducted under contract by several universities and federally funded laboratories, including the National Center for Atmospheric Research, the National Oceanic and Atmospheric Administration's (NOAA) Flight Systems and National Severe Storms Laboratories, NWS' Aviation Weather Center and National Center for Environment Prediction, and the Massachusetts Institute of Technology's Lincoln Laboratories.

Several other federal agencies also collect and disseminate aviation weather information, as well as conduct aviation weather research. NWS, which is part of NOAA in the Department of Commerce, is responsible for

collecting, analyzing, and disseminating weather information in general and has worked with FAA on joint projects such as ASOS and an advanced national weather radar system. NWS also provides meteorologists for some of FAA's air traffic control centers. Other agencies with related aviation weather responsibilities include the National Aeronautics and Space Administration, which conducts basic research on weather-related topics, and the Department of Defense, which provides aviation weather information to military pilots and command officers. The Office of the Federal Coordinator for Meteorology (OFCM), which is also part of NOAA, was created to coordinate the meteorological services and research for all federal agencies. However, the office does not have the authority to direct the weather operations of other federal agencies.

Over the past 3 years, several reports have raised concerns about the quality of the weather information available to the aviation community. In 1995, NRC, examining the roles and missions of the agencies involved in aviation weather, found that FAA, NWS, and the other agencies involved did not coordinate their activities. NRC called upon FAA to take the lead in federal aviation weather efforts. At the same time, a subcommittee of FAA's RE&D Advisory Committee that was examining the adequacy of FAA's aviation weather research found a number of problems.[3] This subcommittee reported that FAA needed to improve its aviation weather research as well as its delivery of weather information to system users, such as pilots, controllers, and dispatchers. Finally, FAA's advisory committee released a report in 1997 on research related to the national airspace system. This report found that FAA's efforts on aviation weather were unfocused and that the agency had not clearly defined its role in providing aviation weather information.

We contacted the members of the NRC aviation weather committee and the FAA advisory committee that addressed weather issues and asked for their assistance in our efforts to follow up on their recommendations that were specifically addressed to FAA. In obtaining their assistance, we asked all of the committee members, in a survey, to identify the highest-priority recommendations. The highest-rated recommendations address three general topics: policy and leadership, interagency coordination, and efforts to address users' needs. We chose an expert panel from among those who answered our survey, with members representing the various users of aviation weather information, such as airline representatives, commercial

[3]Under authority granted by the Aviation Safety Research Act of 1988, as amended (49 U.S.C. section 44508), FAA established the RE&D Advisory Committee to obtain advice and recommendations from an outside, balanced representative group of aviation-oriented organizations, associations, and academic interests.

and private pilots, and air traffic controllers. The panel reviewed the information we had gathered on FAA's actions to implement the eight recommendations and rated FAA's general progress on each recommendation on a 5-point scale, from very poor to excellent. The panelists were also asked to indicate whether FAA's actions were sufficient to address the recommendation and whether FAA had taken these actions in a timely manner. In discussing the recommendations, the panelists repeatedly raised concerns about FAA's funding of weather activities, a fourth area of concern that was mentioned in the original reports.

Experts Found That FAA's Efforts to Exercise Leadership in Aviation Weather Fell Short

NRC and FAA's RE&D Advisory Committee found that FAA did not exercise leadership for aviation weather services, partly because it lacked a clear policy on weather and partly because of organizational inefficiencies. FAA has attempted to address these criticisms by creating an aviation weather directorate and issuing a policy on weather. However, members of our expert panel did not think these actions went far enough to address the previously identified weaknesses, generally rating FAA's progress in this area as poor.

Reports Criticized FAA's Lack of Leadership and Internal Coordination

Reports by NRC and FAA's RE&D Advisory Committee criticized FAA for failing to exercise leadership on aviation weather issues. For example, NRC found that "vigorous leadership within the federal government . . . [is] needed to build consensus and coordinate the overall effort to optimize aviation weather services and related research." It concluded that FAA was the agency best able to exercise that leadership because of its aviation expertise and legal authority. All three reports also criticized FAA for not developing a policy to define its role and priorities in aviation weather and recommended that FAA provide a clear policy statement on its role in providing aviation weather services.

For example, NRC noted that under FAA's policies, pilots have the primary responsibility for keeping their aircraft away from hazardous weather, while air traffic controllers are principally responsible for separating aircraft from one another, thus avoiding collisions. The report found that FAA's guidance required controllers to remain aware of current weather conditions and relay information on hazardous weather to pilots, but it did not allow controllers to direct aircraft away from hazardous weather, as they direct aircraft away from other aircraft. NRC concluded that FAA should develop procedures that allow controllers to take a more active role in separating aircraft from hazardous weather, especially when they

have more accurate weather information than the pilot. The 1995 advisory committee report reached similar conclusions. The 1997 advisory committee report concluded that even though the definition of hazardous weather is highly dependent upon the capabilities of the individual aircraft and flight crew, FAA's mission should include the responsibility for transmitting weather information to pilots and dispatchers in order to improve the separation of aircraft from hazardous weather and to increase collaboration between pilots and air traffic controllers.

NRC and FAA's advisory committee also cited weaknesses in FAA's internal organization as a reason for the agency's not taking a leadership role in weather issues. For example, NRC found that no single office within FAA had the authority and responsibility for setting priorities for aviation weather. The 1997 advisory committee report found that six offices within FAA were responsible for setting priorities for aviation weather research. According to FAA's Manager for Weather Research, prior to 1995, these offices did not set priorities to ensure that the most important research projects received funding. Instead, this official stated, FAA set its research priorities by reviewing the requests submitted by the national laboratories and contractors to the several offices with responsibility for aviation weather. These offices did not coordinate their efforts internally but submitted their requests separately to FAA's Office of Research and Acquisitions. As a result, NRC and FAA's advisory committee found that aviation weather research was hampered by a lack of coordination, funding, and priority setting. To address this problem, NRC recommended that FAA appoint an official to serve as the single focal point with responsibility for providing effective internal and external coordination of aviation weather activities.

FAA Issued a Weather Policy and Created New Organizations for Weather

FAA took several actions to address concerns about its leadership role in aviation weather. First, in response to concerns about how it organized its aviation weather activities, FAA made several organizational changes to consolidate these activities. In October 1995, FAA created an aviation weather directorate, which is intended to serve as the federal government's focal point for determining aviation weather requirements, policies, and plans. The directorate was intended to fulfill the aviation weather responsibilities previously carried out by several organizations within FAA. The directorate is responsible for setting requirements for, and developing programs and policies on, aviation weather. In February 1996, FAA created a program to coordinate its research efforts on improving weather observations, warnings, and forecasts. The weather research

program is organized into eight product development teams that focus on topics such as turbulence and visibility. According to program officials, the program oversees the research conducted by the national laboratories and universities and sets priorities for requests to conduct research on aviation weather.

Second, in response to congressional direction,[4] in April 1996, FAA began implementing a new acquisition management system designed to provide for more timely and cost-effective acquisitions for the entire agency. Under this system, FAA operates five integrated product teams, which are responsible for the research, development, acquisition, and installation of all new equipment within their area of expertise. To carry out these tasks, each team includes staff with various areas of expertise, such as systems engineers, lawyers, contract specialists, and representatives of the organizations responsible for the operation and maintenance of the systems acquired. In the past, according to FAA officials, the responsibility for the acquisition of such systems would be carried out sequentially through various FAA offices, depending on whether the systems were being designed, purchased, or deployed. Now, one team is responsible for all three of those activities. Two of these teams deal with weather systems: one with weather processor systems and one with weather sensors. The weather processor team, for example, develops and acquires systems such as ITWS, which takes data from various sensors and displays the data for users.

In addition, since the NRC and advisory committee reports were issued, FAA has worked with other federal agencies involved in aviation weather to develop the National Aviation Weather Strategic Plan, which was published in April 1997 and is intended to lay out a vision of how to reduce the number of weather-related aviation accidents and delays. According to FAA's Director of Aviation Weather, plans to implement the interagency strategic plan and FAA's aviation weather policy are still under development, and to date, no policies or regulations of FAA's have been amended to reflect the new weather policy.

Finally, in September 1997, the Administrator of FAA issued an aviation weather policy in which FAA accepted responsibility for taking the lead in aviation weather services. According to this policy statement, FAA will (1) work closely with the federal agencies concerned with aviation weather; (2) take the lead in developing a plan to meet stated national

[4]Section 348 of the Department of Transportation and Related Agencies Appropriations Act of 1996 (P.L. 104-50, Nov. 15, 1995) directed FAA to develop and implement a new acquisition management system.

goals concerning aviation weather; and (3) ensure that the needs of FAA and the aviation community are being addressed and that research, development, and acquisition are focused to improve the safety of the air traffic system.

Panelists Concluded That FAA Had Made Limited Progress in Defining Policy and Exercising Leadership

Three of the recommendations our January 1998 expert panel reviewed addressed FAA's lack of leadership on aviation weather issues. These recommendations included two by the RE&D Advisory Committee in 1997. One recommendation called for FAA to see weather as a safety issue, not just a delay issue. The committee also recommended that FAA issue a "clear and cohesive policy statement regarding the agency's important role" in aviation weather, including the need to separate aircraft from hazardous weather. In the third recommendation, NRC called for FAA to see weather as an important part of all of its operations.[5]

Several members of our expert panel applauded FAA for issuing a policy on weather, calling the policy "a step in the right direction." One panelist also stated, "I don't think that you can take a snapshot right now and evaluate where FAA is because . . . [this] is a long-term program." However, panelists also questioned whether the changes cited by FAA demonstrate that it has taken the lead for federal aviation activities. Specifically, several panelists expressed concern that FAA had not developed a plan to implement the new policy. For example, one panelist stated, "I . . . think that meetings and policy statements and all that are . . . just a first step. . . . [Y]ou have to . . . look at what has occurred." Another added, "I think the intent of the committee . . . was to suggest that if you come out with a policy statement that you would . . . take some action to put some teeth into it."

Several panelists were also concerned that FAA did not believe that a policy on separating aircraft from hazardous weather was necessary, as the advisory committee had recommended. According to one panelist, the responsibility for controllers to provide weather information to pilots is implicit and ambiguous, "but if that [policy] was articulated, then [it

[5]The panelists also discussed a recommendation made by NRC that FAA take immediate action rather than wait for the creation of an air traffic corporation. This recommendation was originally made when consideration was being given to awarding some of FAA's air traffic control functions to an independent organization. In response to this recommendation, FAA stated that such proposals are no longer being considered. While many panelists recognized that the establishment of a private corporation is no longer a current issue, some speculated that the respondents may have rated this recommendation highly anyway because they focused on its first part, which called on FAA to take swift action to improve aviation weather services. Most panelists thought FAA's progress on this matter had been fair.

would] provide a basis for saying that controllers need better weather information to actually provide that service."

We asked the panelists to rate FAA's overall progress on a 5-point scale.[6] In rating the recommendations dealing with policy and leadership, most panelists saw FAA's progress in treating weather as a safety issue as fair. However, most panelists also thought that FAA had made poor progress in establishing a weather policy that addresses the role of controllers in providing weather information and in seeing weather as an important part of its operations. In addition, most of the panelists indicated that FAA's actions on these three recommendations were neither timely nor sufficient.

Experts Questioned FAA's Efforts to Coordinate With Other Federal Agencies

NRC and FAA's RE&D Advisory Committee raised concerns about FAA's coordination with other federal agencies involved in aviation weather, especially in the area of research. FAA stated that it has increased its coordination with NWS as well as with multiagency working groups. Members of our expert panel commented, however, that they did not see any evidence that the increased number of meetings was having an impact on the agencies' aviation weather efforts. As a result, they generally rated FAA's progress in this area as poor.

Reports Cited Inadequate Coordination With the Weather Service and Other Federal Agencies

Two of the three reports by NRC and the advisory committee found that FAA did not effectively coordinate its aviation weather responsibilities with other agencies involved in weather. Inadequate interagency coordination was especially apparent in research and development. For example, in 1995, NRC found little communication between FAA and NWS and was unable to identify any interagency coordination for research and development. It also found that the National Aeronautics and Space Administration was not included in FAA's long-range planning for aviation weather. NRC recommended that FAA and NWS establish more formal coordination procedures. NRC and one advisory committee also criticized FAA for not implementing a 1977 memorandum of agreement with NWS, under which FAA was to provide NWS with a list of FAA's requirements for aviation weather services and research.

[6]The scale was 1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = excellent. The results of each ballot are included in app. VI.

FAA Has Increased Coordination With Other Federal Agencies

FAA, NWS, and Department of Defense officials we spoke with agreed with NRC's assessment that FAA's coordination on aviation weather activities had been limited. However, they also pointed out that FAA has taken a number of steps to increase its coordination with the other federal agencies engaged in weather activities. For example, FAA points to its work with OFCM, NWS, and other agencies on the National Aviation Weather Strategic Plan. FAA and the other agencies are continuing to work together to develop procedures to implement the goals outlined in the plan. According to FAA's Director of Aviation Weather, these procedures will be published in May or June 1998.

In addition, FAA and NWS have increased the frequency of their meetings to address aviation weather concerns. While FAA could document only one such meeting in 1995, it identified four meetings between the two agencies in both 1996 and 1997. Some of these meetings have been attended by high-level officials—FAA's Director for Air Traffic Requirements and NWS' Deputy Assistant Administrator for Operations.

FAA officials also believe that the agency's joint activities with NWS are further evidence of improved coordination. They cited, for example, the joint funding of aviation weather research and participation in management councils for two jointly developed weather systems.

Finally, FAA and the Department of Defense have arranged for a military officer to be detailed to FAA as a military adviser for aviation weather requirements. This position, currently staffed by an Air Force lieutenant colonel, is intended to provide FAA with advice on planning, implementing, and monitoring FAA's weather programs, including training, certifying, and integrating related weather programs operated by FAA and the Department of Defense.

Panelists Rated FAA's Progress on Coordination as Poor

Two of the recommendations our panelists reviewed addressed NRC's concerns about coordination. One recommendation called upon FAA and NWS to reestablish "high-level liaisons" to be responsible for defining and coordinating aviation weather research, development, and operations. NRC also recommended that FAA and NOAA work together to ensure that aviation weather research and development are "closely coupled" to the agencies' short-term operational needs.

In discussing FAA's implementation of these two recommendations, our panelists emphasized the importance of coordination among the federal

agencies. One panelist, for example, stated that while a number of agencies are involved in aviation weather research, they are not working to leverage their resources or coordinate their research projects. Another panelist commented that OFCM has not been an effective forum for coordination because it does not have any authority over other agencies.

While the panelists believed that FAA had taken steps to improve its coordination, they questioned whether the agency had gone as far as the recommendations intended. For example, one panelist stated, "[A]bsolutely, the dialogue between the FAA and NWS has improved. But . . . it would be very difficult for it not to improve because there was no dialogue [previously]." This panelist also noted that the meetings that have occurred do not appear to have contributed substantially to the development of a list of FAA's requirements for aviation weather services and research, as required by the 1977 memorandum of agreement.[7] On the topic of coordinating research with operational needs, several panelists praised the weather research projects FAA was pursuing. However, panelists also raised concerns about the extent of coordination among the agencies' research programs.

Several panelists cited the lack of communication between FAA's air traffic controllers and NWS' forecasters as an example of weaknesses in coordination at the operational level. According to the panelists, even when controllers and forecasters are in the same room, communication is limited. In regional centers, one panelist noted, few controllers use the forecasts provided by NWS meteorologists because they would have to leave their radar display and go to another part of the room to get the information.

Most panelists rated FAA's progress in implementing the recommendations on coordination as poor. The panelists also indicated that FAA's actions on these recommendations were neither timely nor sufficient.

[7]On Jan. 28, 1998, the week after our panel met, FAA sent a letter to NWS outlining its requirements for aviation weather. However, the letter primarily describes actions FAA needs to take to develop a list of requirements for NWS, rather than the requirements themselves.

Experts Saw FAA's Efforts to Meet All Users' Needs for Weather Information as Poor

In the reports by NRC and FAA's RE&D Advisory Committee, experts also raised concerns that FAA was not providing enough consistent weather information and training to aviation users, such as pilots, dispatchers, and air traffic controllers. FAA responded that it is developing or deploying systems to meet the needs of all users, as well as instituting a number of training courses. However, several panelists questioned whether the systems and training courses FAA cited adequately provide the type of information and training that system users have determined is necessary.

Previous Reports Found That FAA Did Not Adequately Address the Weather Needs of Aviation System Users

Each of the three reports raised concerns about the lack of attention paid to the needs of all users of the aviation system. According to NRC, one of FAA's goals is to provide consistent weather information to all types of users. However, NRC found that "pilots, controllers, and dispatchers often obtain weather information from different sources that may not agree about the location, duration, or severity of adverse weather." For example, a controller's radar screen may not show clouds that a pilot can see out the window or on a cockpit weather radar screen. In addition, some of the weather information given to pilots covers broad geographic areas, making it hard for them to determine if they will experience hazardous weather during their flight. According to NRC, the needs of various aviation system users were well known, but the federal government had not acted adequately to address these concerns. Similarly, the 1997 advisory committee report found that while the needs of users may vary because of such factors as the capabilities of the pilot or aircraft, "for safety and efficiency, all participants—controller, pilots, and dispatchers—should have consistent, timely, and common knowledge of the weather situation."

NRC cited FAA's experience with the automated weather observing system known as ASOS to illustrate the impact of inadequately considering user needs in developing a weather system. Although FAA worked with NWS on the development of ASOS, some aviation users complained that the system as deployed did not meet their needs. Specifically, ASOS was designed to replace human weather observers. However, while a human observer can look at weather conditions over a broad area, ASOS can measure weather conditions only directly overhead. As a result, several aviation groups commented that ASOS provided unrepresentative observations when weather conditions were patchy or changing rapidly. Such inaccurate observations could cause pilots to avoid an airport when it is safe to land but ASOS reports unsafe weather or could cause pilots to attempt to land at

an airport when unsafe conditions are not reported.[8] Because ASOS' observations cannot substitute for the completeness of human observations, FAA is still employing human weather observers. NRC cited ASOS as an example of FAA's failure to "serve as an effective intermediary between the NWS and aviation system users."

Both NRC and the advisory committee also cited the need for all users to receive adequate training and observed that they were not currently receiving such training. They cited weaknesses in the weather training provided to pilots and controllers that undermine their ability to use available weather information to their maximum advantage. "Training offers great potential for near-term reductions in weather-related accidents," NRC concluded. Similarly, the advisory committee reported in 1995, "The Administrator should set policies for [pilots' and controllers'] training and certification that will lead to enhanced understanding and decision-making regarding weather, taking into account the many significant forthcoming changes in the National Airspace System."

FAA Is Developing Aviation Weather Systems and Training for Various Users

FAA weather officials cited the various aviation weather systems it is developing and deploying as evidence that it is meeting the needs of all aviation users. Table 1 lists the intended users and the implementation schedule for each system cited by FAA.

[8]We raised similar concerns in Weather Forecasting: Unmet Needs and Unknown Costs Warrant Reassessment of Observing System Plans (GAO/AIMD-95-81, Apr. 21, 1995).

Table 1: FAA Aviation Weather Systems, Intended Users, and Implementation Schedules

Project	Intended users	Implementation schedule
Integrated Terminal Weather System (ITWS)	Controllers, terminal personnel, dispatchers	Prototypes in use; deployment scheduled for 2000-05
Low Level Windshear Alert System (LLWAS) Network Expansion	Pilots and controllers	Fully deployed by 2001
Terminal Doppler Weather Radar (TDWR)	Pilots and controllers	Currently deployed at 45 sites
New Generation Runway Visual Range (RVR)	Controllers	Deployment ongoing; currently deployed at 250 facilities
Automated Weather Observing System/Automated Surface Observing System (AWOS/ASOS) Data Acquisition System (ADAS)	Pilots and controllers	Fully deployed in 1997
Weather Systems Processor (WSP)	Controllers	Full production by 2001
ASOS/AWOS	Controllers, dispatchers, meteorologists, pilots	Federal AWOS completed; ASOS fully deployed by 1999
WARP (Weather and Radar Processor)	Controllers, meteorologists	Acquisition ongoing
NEXRAD (Next Generation Radar)	Controllers, dispatchers, meteorologists, pilots	Fully deployed; enhancements ongoing
OASIS (Operational and Supportability Implementation System)	Controllers, pilots	Deployment begins 1999

Note: In commenting on a draft of this report, FAA requested that this table include information on several weather systems (ASOS/AWOS, WARP, NEXRAD, OASIS) that were not included in the original list FAA provided for our expert panel. FAA also requested that several of the existing items be amended to reflect additional users: TDWR, dispatchers and meteorologists; and ADAS, dispatchers, meteorologists, and pilots.

Source: FAA.

FAA and NWS are also currently working to enhance ASOS to address some of the concerns raised by aviation users. Regarding training, officials at FAA's Academy provided materials describing the weather-related courses taught at the Academy and through computer-based instruction. While some of the computer-based courses offer an overview of weather topics,

most of the Academy's courses provide training on how to use systems like those identified in table 1.[9]

Panelists Rated FAA's Actions on Meeting User Needs as Very Poor

The final two recommendations the panel considered focused on meeting the needs of aviation system users. NRC called for FAA to focus on addressing users' urgent unmet needs, such as the improved communication of weather information, improved observations and forecasts, and a "comprehensive training program." In 1997, the advisory committee recommended that FAA support "a weather architecture, which includes the appropriate elements and interfaces needed to disseminate critical weather information to ALL aviation users, supported by adequate funding and priorities."

The panelists were most critical of FAA's actions to date in this area. Speaking about providing improved weather information to users, one panelist said, "You can get better information on the [Internet] than you can in the [FAA] system." Another panelist questioned who would benefit from the systems FAA is developing, saying, "The systems are designed to get the information to people on the ground, but, quite frankly, one of the key individuals who needs that information is the captain of the airline, who is up at 39,000 feet." Similarly, several panelists expressed concern that FAA had not integrated the systems that it provides to different aviation weather users. According to one panelist, "There was not, and is not yet, a coherent information architecture to distribute the weather information."

On the issue of training, the panelists agreed that the courses FAA identified did not fully respond to the recommendation. According to one panelist, "The recommendation is a comprehensive national plan. This is just a hodgepodge." Another panelist noted, "[Pilots] have a mandated 4, 5, 6 hours of security training every year for something that, fortunately, one out of a million . . . person[s] will encounter, and we have nothing, or relatively nothing, on weather, which is something that they will encounter every day in every one of their flights." The panelists also raised concerns about the adequacy of the weather training provided to air traffic controllers, noting that there is often a disparity among controllers' abilities to interpret weather information.

[9]In its comments on a draft of this report, FAA officials stated that the Academy is in process of developing an expanded basic weather course for air traffic controllers and that universities that provide controller training also provide training on weather.

Overall, most panelists rated FAA's progress in meeting users' unmet needs as very poor. The panel rated FAA's efforts to develop aviation weather systems to support all users as poor. The panelists did not believe that FAA's actions on these recommendations were either timely or sufficient.

Reports and Panelists Questioned FAA's Commitment to Funding Weather Activities

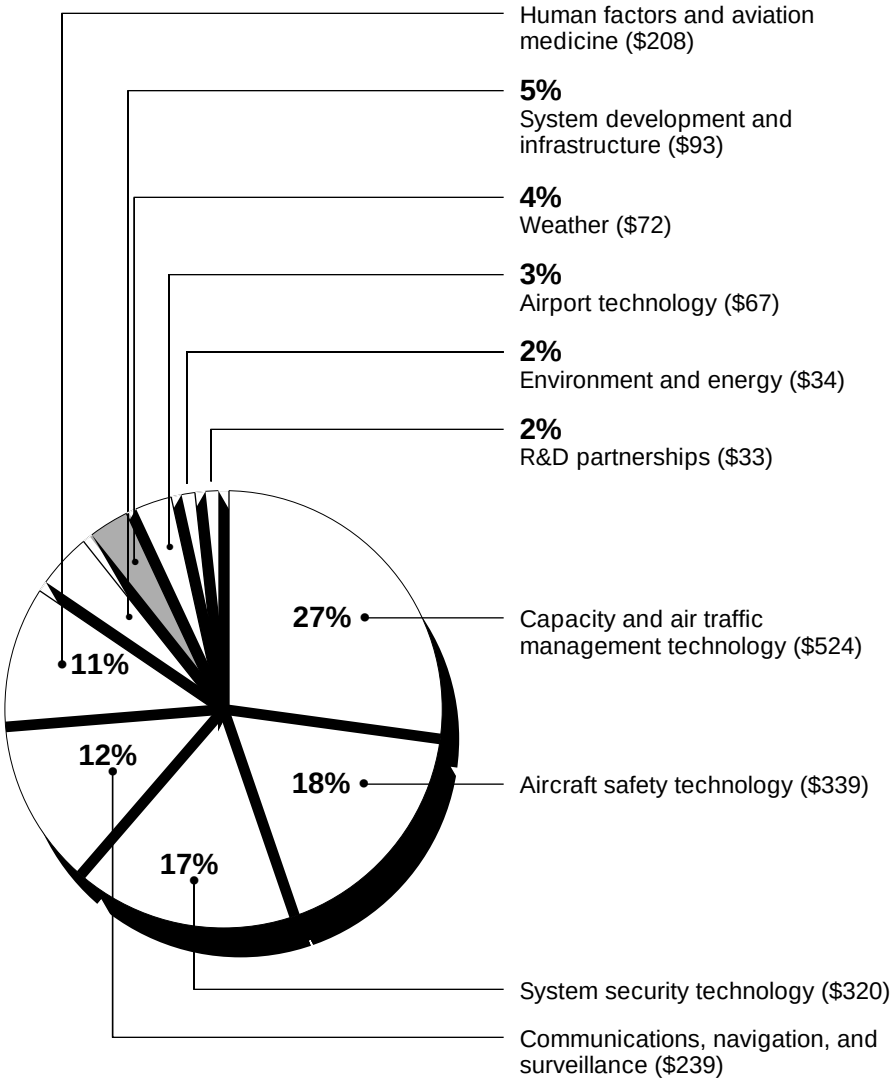
Each of the three reports also raised concerns about the amount of funding FAA has provided for weather activities. NRC, for example, found that while funding levels for activities such as training and research were small compared with the cost of acquiring aviation weather systems, the lack of funding for such activities could adversely affect system deployment. The RE&D Advisory Committee also stated in 1995 that, because of the low priority given to weather activities, "weather-related programs are inconsistently funded, causing less than acceptable performance." Finally, in 1997, the advisory committee found that "as a result of the present budget environment, the FAA management has decided to give weather programs a lower priority than other system areas, thereby causing cancellations or significant delays to critical weather efforts."

The reports discussed several instances that raised questions about FAA's commitment to funding aviation weather projects that meet users' needs. For example, FAA eliminated funding for the Advanced Weather Products Generator, a system designed to provide weather information to pilots and other external aviation users. According to NRC, this decision represented a "lack of focus on pilots' needs." The 1997 advisory committee report called FAA's plans to consolidate weather data using systems like ITWS logical but questioned FAA's commitment to fund such projects over the long term.

Our review of FAA's budget data confirms the committees' findings and the panelists' concerns about the relative importance FAA places on weather funding. FAA has a number of major activity areas linked to its mission and management goals. Although aviation weather is a prominent factor in aviation accidents, FAA's spending for research and acquisitions related to weather has been lower than spending for most other agency research and acquisition activities. For example, from fiscal year 1990 through fiscal year 1998, aviation weather research accounted for 4 percent of the funds allocated to all types of FAA research. Spending on weather activities was lower than spending on all but three other areas—airport technology, environment and energy, and research and development partnerships—as figure 2 shows. FAA spent 8 percent of its research funds on weather in fiscal year 1990 but only 1 percent in fiscal years 1994 and 1995. In fiscal

year 1998, FAA plans to spend 8 percent of its research funds on weather-related projects.

Figure 2: FAA's Research, Engineering, and Development Funding by Program Area, Fiscal Years 1990-98 (Dollars in Millions)

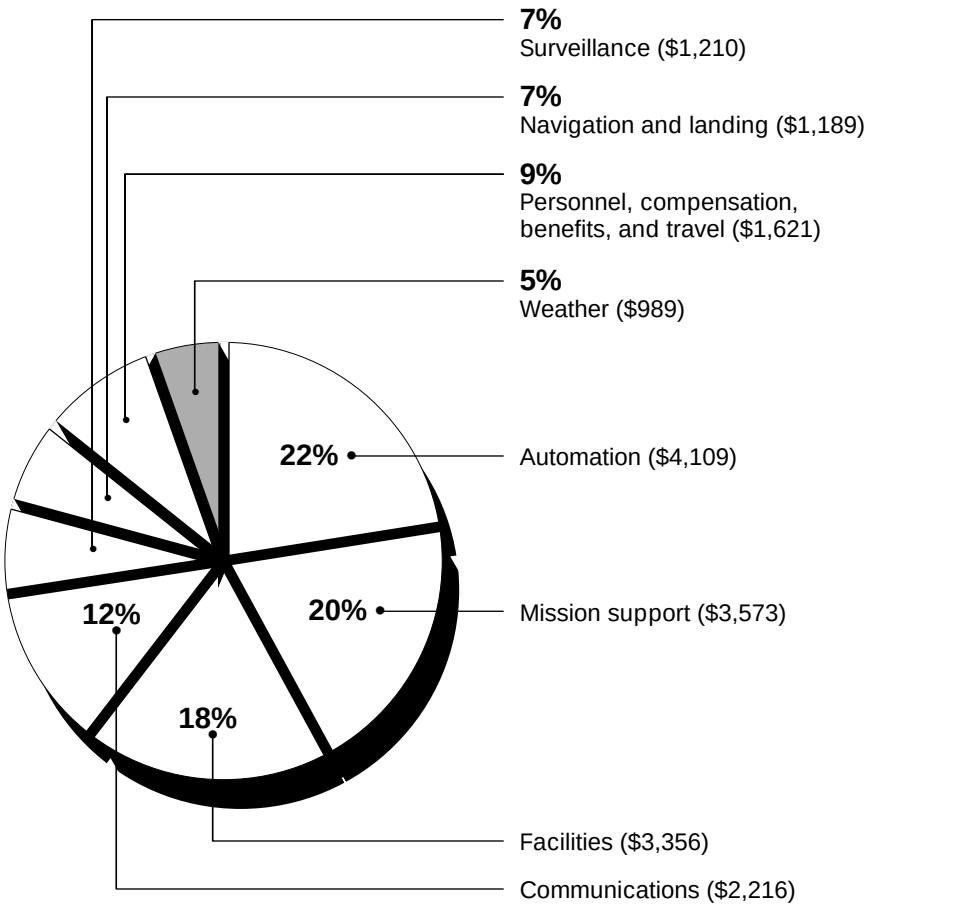


Note: Since fiscal year 1993, the Congress has allowed FAA to use facilities and equipment funds for development activities that were previously paid for with RE&D funds.

Source: GAO's analysis of FAA's data.

Similarly, funding for the acquisition of aviation weather systems was lower (eighth out of eight areas) than for all other program areas for fiscal years 1990 through 1998, as figure 3 shows. Over this period, acquisitions for aviation weather accounted for 5 percent of all spending for facilities and equipment, varying from a high of 8 percent in fiscal year 1990 to a low of 4 percent in fiscal years 1993 and 1997. In fiscal year 1998, FAA plans to spend nearly 5 percent of its facilities and equipment funds on weather-related projects.

Figure 3: FAA's Facilities and Equipment Funding by Program Area, Fiscal Years 1990-98 (Dollars in Millions)



Note: Since fiscal year 1993, the Congress has allowed FAA to use facilities and equipment funds for development activities that were previously paid for with RE&D funds.

Source: GAO's analysis of FAA's data.

Finally, during the last 3 fiscal years, FAA has requested less funding for aviation weather than the Congress has provided. Table 2 shows the amount of funding FAA requested for aviation weather research and acquisitions and the amount that the Congress provided.

Table 2: Funding Requested and Provided for Aviation Weather Research and Acquisitions, Fiscal Years 1996-98

Dollars in millions

Fiscal year	Research funds requested	Research funds provided	Acquisition funds requested	Acquisition funds provided
1996	$6.5	$6.5	$65.2	$87.7
1997	6.4	13.0	84.2	88.4
1998	4.0	15.3	82.2	88.7

Source: FAA.

Even though FAA's management has acknowledged the increasing value of weather research, it is still difficult for aviation weather to get funding, according to FAA's Manager for Aviation Weather Research. In addition, this official stated that neither FAA's request nor the recent level of appropriations has been enough to support an adequate weather research program. He estimated that FAA's planned aviation weather research for the next 5 to 7 years would cost $15 million to $18 million per year. Another FAA official pointed out that other competing demands, such as security programs, continue to have a higher priority.

Several factors may account for the lower funding levels given to aviation weather. First, according to FAA's Director of Aviation Weather and FAA's Manager for Weather Research, without a central office, aviation weather did not have a funding advocate when decisions were being made on the allocation of resources. In addition, these officials said, some of the FAA leadership, until recently, did not believe that weather was a contributing factor in safety and in delays and therefore did not consider it a high priority.

Finally, FAA does not assign weather information a high priority in its architecture plans for the national airspace system. FAA categorizes its information needs according to three classifications: critical, essential, and routine, with critical being the highest priority. Critical information is information that if lost would prevent the national air system from exercising safe separation and control over aircraft. Essential information is information that if lost would reduce the capability of the national air system to exercise safe separation and control over aircraft. Since FAA does not believe most aviation weather systems fall into the critical category, it classifies them as essential. Because weather information is not considered critical, aviation weather systems are often among the first areas cut, FAA officials told us.

Several panelists commented that the level of funding FAA was providing for research projects was not adequate, potentially jeopardizing multiyear research projects. While some panelists stated that FAA could be reducing its funding requests deliberately because it believed that the Congress would restore funding, others raised the possibility that the low funding requests reflect the fact that FAA continues to make weather issues a lower priority.

Conclusions

Owing to the significant impact of hazardous weather on aviation safety and efficiency, improving the weather information available to all users of the aviation system should be one of FAA's top priorities. However, a panel of experts presented with information on FAA's actions to improve its management of aviation weather concluded that FAA had done a poor job in addressing the most significant concerns raised by previous reports. While the panelists recognized that FAA had taken certain steps, such as issuing a policy to define its role in aviation weather and increasing coordination with NWS, many questioned FAA's commitment to implementing permanent changes resulting from these actions.

On the basis of the panel's discussion and the information we gathered, we agree that FAA has addressed some of the concerns raised in previous reports. However, FAA's responses also demonstrate that some of the issues raised by the three reports have not been fully addressed. For example, FAA indicated that issuing a policy defining its staff's role in separating aircraft from hazardous weather is not necessary—a key function if the weather information it collects is to improve safety. Furthermore, two conditions—weather information's being classified as a lower priority than other types of air traffic information and the lack of training for FAA staff on how to use weather information—indicate that despite the new policy, weather continues to be a lower priority for FAA than its traditional function of separating aircraft from other aircraft. The implementation plan FAA proposes to issue later this year provides the agency with an opportunity to respond to these continuing concerns with stronger evidence of its commitment to weather issues.

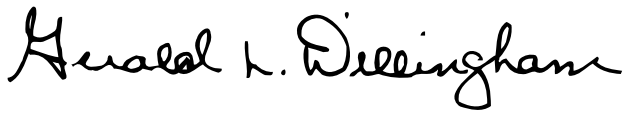
Agency Comments

We provided FAA with a draft of this report for its review and comment. We met with FAA officials, including FAA's Director for Aviation Weather, to obtain FAA's comments. FAA commented that the draft report accurately reflected the condition of the organization, and it agreed that corrective actions are needed. FAA also suggested that we add some information on

several points, including the findings from the advisory committee's 1997 report on separating aircraft from hazardous weather and additional actions FAA had taken regarding coordination, training, and deploying aviation weather systems. We added information to the report, where appropriate, to reflect these suggestions.

We performed our review from August 1997 through April 1998 in accordance with generally accepted government auditing standards. Our scope and methodology are discussed further in appendix I. We are providing copies of this report to interested congressional committees; the Secretary of Transportation; and the Administrator, FAA. We will also make copies available to others upon request.

If you or your staff have any questions, please call me on (202) 512-3650. Major contributors to this report are listed in appendix VII.



Gerald L. Dillingham
Associate Director,
Transportation Issues

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Abbreviations

ADAS	Automated Data Acquisition System
AOPA	Aircraft Owners and Pilots Association
ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
ATA	Air Transport Association
FAA	Federal Aviation Administration
ITWS	Integrated Terminal Weather System
LLWAS	Low Level Windshear Alert System
NASDAC	National Aviation Safety Data Analysis Center
NEXRAD	Next Generation Radar
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NTSB	National Transportation Safety Board
NWS	National Weather Service
OASIS	Operational and Supportability Implementation System
OFCM	Office of the Federal Coordinator for Meteorology
RE&D	Research, Engineering and Development
RVR	New Generation Runway Visual Range
TDWR	Terminal Doppler Weather Radar
WARP	Weather and Radar Processor
WSP	Weather Systems Processor

Scope and Methodology

At the request of the Chairwoman and Ranking Minority Member of the Subcommittee on Technology, House Committee on Science, we agreed to review the Federal Aviation Administration's (FAA) progress in addressing recommendations made by outside experts on FAA's management of aviation weather. To address this topic, we first reviewed the reports on aviation weather management prepared by the National Research Council and FAA's Research, Engineering, and Development Advisory Committee. We also interviewed officials and reviewed policy, budget, and planning documents at FAA's headquarters, the Orlando International Airport control tower, the National Weather Service, and the Office of the Federal Coordinator for Meteorology. Our discussions with agencies other than FAA focused on their joint efforts with FAA and were not designed to evaluate the agencies' individual aviation weather activities.

We also worked with the members of the committees that wrote the three reports. First, we sent a survey to each member of the committees that listed each of the recommendations made by those reports and asked the respondents to rate their importance. The survey form and results are included in appendix III. We received responses from 28 of the 35 committee members surveyed.

The seven recommendations most highly rated by the respondents dealt with the general topics of policy and leadership, coordination, and efforts to address user needs. One of the recommendations chosen by the respondents addressed coordination of research. To ensure that the panel adequately addressed concerns about coordination raised in the previous reports and the original request, we added the second-highest rated recommendation dealing with coordination, resulting in a final total of eight recommendations. We then asked officials responsible for FAA's weather activities to provide evidence of the actions FAA had taken to address these eight high-priority recommendations. FAA provided written responses and some supporting material to support its actions to address each of the eight recommendations. The full text of each of the recommendations, FAA's response, and selected supporting material are presented in appendix IV.

Finally, we convened an expert panel of individuals who had answered our survey, judgmentally selecting a subset of eight individuals who represented various users and providers of aviation weather information. The names and affiliations of the panel members are listed in appendix V. We held an all-day meeting with the seven-member panel (one invitee was unable to attend but provided written comments) at our offices in

Washington, D.C. For each of the eight high-priority recommendations, we presented the panelists with FAA's response, supporting material submitted by the agency, and any other information about FAA's actions that we had identified during our previous work. We asked for their comments on (1) the original intent of the recommendation, (2) any other actions FAA had taken to address the recommendation, and (3) the adequacy of FAA's response. At the end of each discussion, we asked the panelists to rate, using an anonymous ballot, FAA's progress in addressing each recommendation. The panelists were given the option of rating FAA's overall response as very poor, poor, fair, good, or excellent. They were also asked if FAA's actions were consistent with the intent of the recommendations, sufficient, and timely. The results of these ballots are included in appendix VI. We recorded and transcribed the meeting to ensure that we accurately captured the panel members' statements.

As also requested, we are providing information on the effect of weather on aviation accidents and delays. (See app. II.) To determine the impact of weather on aviation accidents and delays, we worked with FAA's National Aviation Safety Data Analysis Center to analyze data from the National Transportation Safety Board's accident database and FAA's Operations Network. We did not independently verify the reliability of the computer-based data provided by FAA, because they are not material to our findings.

Data on Weather-Related Accidents and Delays

Many factors contribute to aviation accidents[1] and delays. Weather has a significant role in these occurrences. Data from the National Transportation Safety Board (NTSB) show that weather is a cause or contributing factor in almost one-quarter of accidents and more than one-third of all injuries and fatalities. According to FAA data for 55 airports, weather caused almost three-quarters of all delays.

Accidents

On August 2, 1985, a Delta Airlines' Lockheed L-1011 with 165 persons aboard crashed after encountering severe weather conditions on its approach to the Dallas/Fort Worth International Airport: 135 persons died, and 28 were injured. Although NTSB concluded that the accident was the fault of the pilot, procedures, and training, the following weather conditions were cited as contributing factors: thunderstorm, lightning, rain, windshear, wind, and downdraft.

Of the 23,383 accidents from 1987 through 1996, NTSB had completed investigations of 22,489 accidents as of March 1, 1998. For its completed investigations, NTSB determined that weather was a cause or contributing factor in 5,286 or about 24 percent, of the accidents. See table II.1.

Table II.1: All Accidents and Weather-Related Accidents, by Year, 1987-96

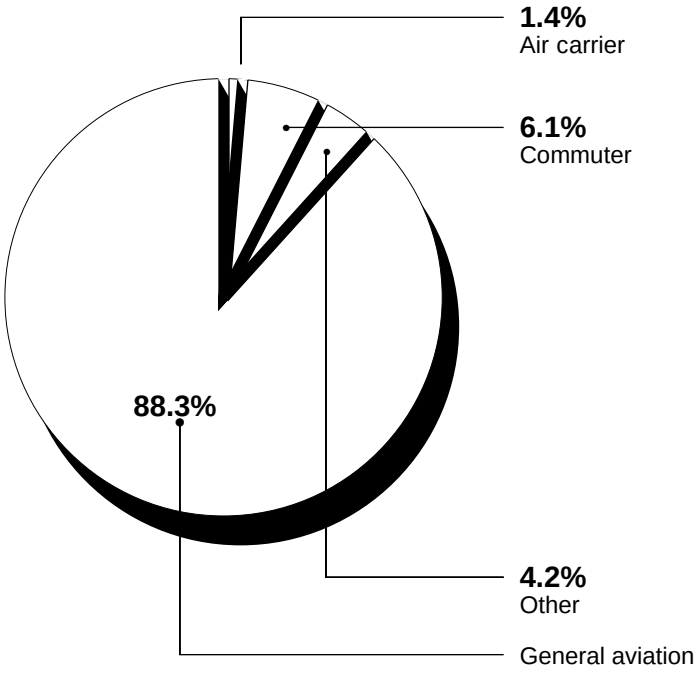
Year	All accidents	Weather-related accidents	Percent weather-related
1987	2,654	660	24.9
1988	2,522	726	28.8
1989	2,383	678	28.5
1990	2,343	538	23.0
1991	2,291	468	20.4
1992	2,179	500	22.9
1993	2,138	447	20.9
1994	2,076	388	18.7
1995	2,133	463	21.7
1996	1,770	418	23.6
Total	**22,489**	**5,286**	**23.5**

Source: Analysis by FAA's National Aviation Safety Data Analysis Center (NASDAC), Office of System Safety of completed NTSB accident investigations.

[1]The National Transportation Safety Board, the official source of information on airline accidents, defines accidents as events in which individuals are killed or suffer serious injury, or the aircraft is substantially damaged.

Of the 5,287 aircraft involved in the 5,286 weather-related accidents that occurred in 1987 through 1996 for which NTSB had completed investigations, 4,669, or about 88 percent, involved general aviation aircraft, and 73, or about 1 percent, involved air carriers. See figure II.1 for an analysis of accidents by type of aviation.

Figure II.1: Distribution of 5,287 Aircraft Involved in 5,286 Weather-Related Accidents, by Type of Aviation



Notes: Air carrier refers to operations conducted under the Federal Aviation Regulation, part 121; Commuter—part 135; Other—parts 91D, 105, 125, 129, 133, 137, and unknown; General aviation—part 91.

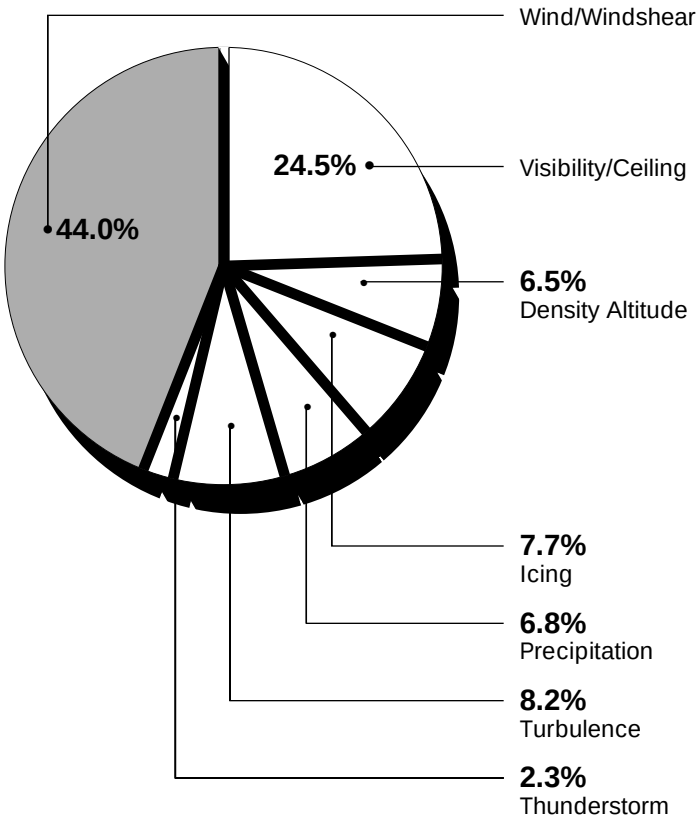
Multiple aircraft may be involved in an accident.

Source: NASDAC's analysis of completed NTSB accident investigations.

Of the 19,426 general aviation accidents and 240 air carrier accidents that occurred in 1987 through 1996 for which NTSB had completed

investigations, weather-related accidents accounted for 24 percent of all the general aviation accidents and about 30 percent of all the air carrier accidents. Wind/windshear was the most frequent cause or contributing factor cited in weather-related general aviation accidents. According to the Aircraft Owners and Pilots Association (AOPA), the most common problem in wind-related general aviation accidents is the loss of control of the aircraft while landing because of crosswinds, gusts, and tailwinds. This experience results in damage to the aircraft, usually with no injuries. Turbulence was the most frequent cause or factor cited in weather-related air carrier accidents. Turbulence-related accidents typically involve injuries to unbelted flight crew or passengers during the cruise phase of the flight. See figures II.2 and II.3.

Figure II:2: Distribution of 7,044 Weather Factors Cited in 4,669 Weather-Related General Aviation Accidents, 1987-96

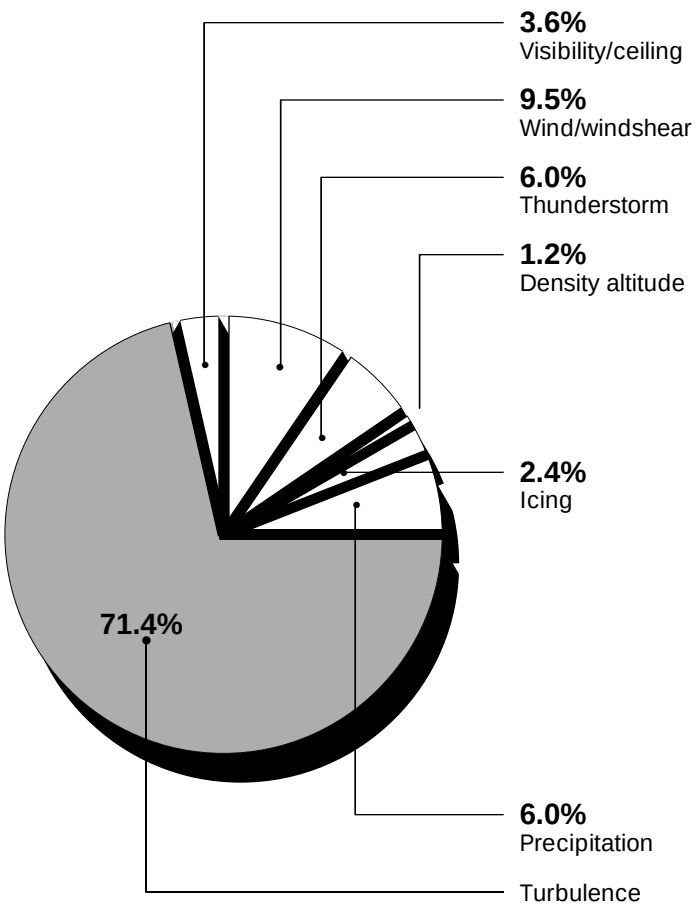


Notes: Density altitude refers to less dense air that adversely impacts aircraft performance, most often on takeoff. This condition typically occurs at higher altitudes; heat and humidity also contribute to its effect.

Multiple weather factors may be cited in an accident investigation.

Source: NASDAC's analysis of completed NTSB accident investigations.

Figure II.3: Distribution of 84 Weather Factors Cited in 73 Weather-Related Air Carrier Accidents, 1987-96



Note: Multiple weather factors may be cited in an accident investigation.

Source: NASDAC's analysis of completed NTSB accident investigations.

Injuries

On January 17, 1996, an American Airlines' Airbus A-300 with 268 persons aboard, en route from Miami, Florida, to San Juan, Puerto Rico, encountered severe turbulence. Although the captain had turned on the "fasten seat belt" sign, 20 passengers were injured, 3 of them seriously. NTSB determined that turbulence and noncompliance with the seat belt

sign were the cause of the injuries. NTSB also determined that American Airlines' failure to issue a hazardous weather advisory to the flight crew was a contributing factor.

In the more than 22,000 accidents that occurred between 1987 and 1996 for which NTSB had completed its investigation, 12,415 injuries were recorded. NTSB determined that weather was a cause or contributing factor in 3,199, or about 26 percent, of the injuries in these accidents. See table II.2.

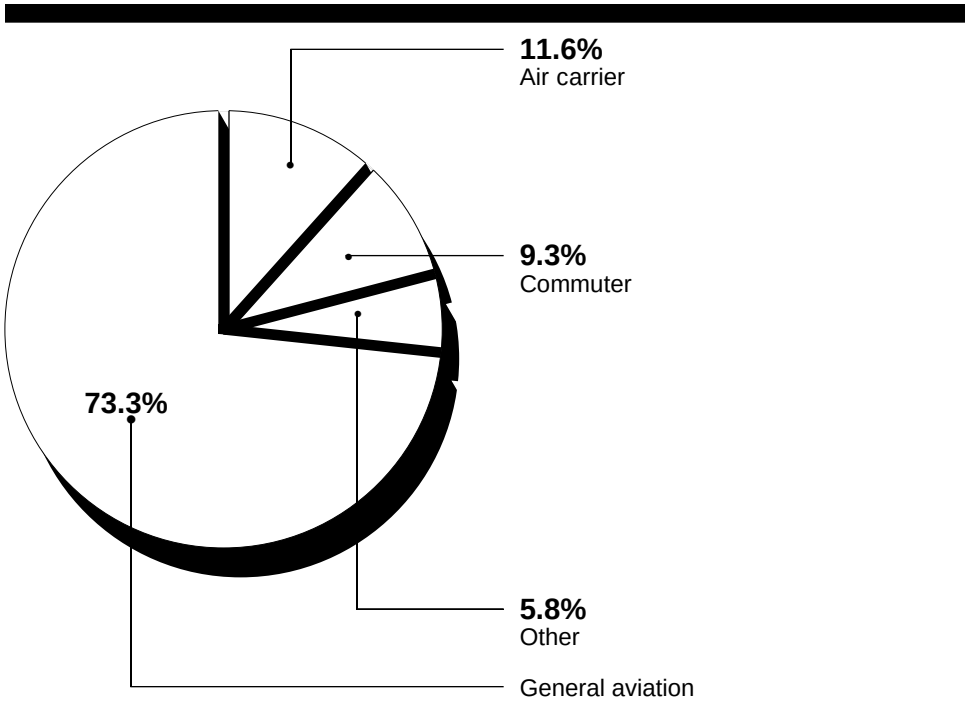
Table II.2: All Injuries and Weather-Related Injuries, by Year, 1987-96

Year	All injuries	Weather-related injuries	Percent weather-related
1987	1,402	406	29.0
1988	1,551	428	27.6
1989	1,416	390	27.5
1990	1,347	431	32.0
1991	1,235	281	22.8
1992	1,076	275	25.6
1993	1,302	237	18.2
1994	1,135	272	24.0
1995	1,092	273	25.0
1996	859	206	24.0
Total	**12,415**	**3,199**	**25.8**

Source: NASDAC's analysis of completed NTSB accident investigations.

Of the 3,199 weather-related injuries that occurred in 1987 through 1996, 2,345, or about 73 percent, involved general aviation aircraft, while 372, or about 12 percent, involved air carriers. See figure II.4 for an analysis by type of aviation.

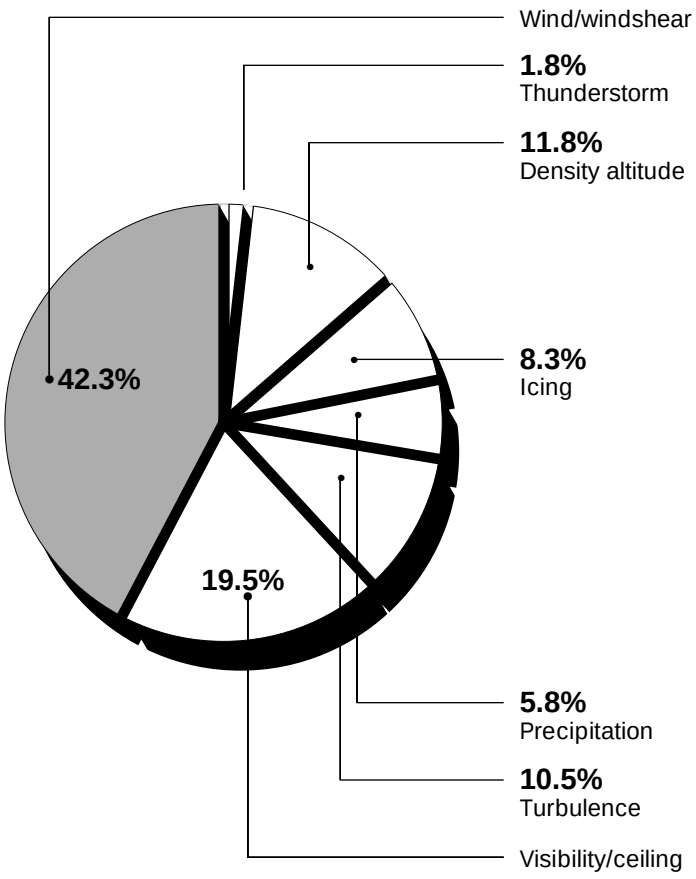
Figure II.4: Distribution of 3,199 Weather-Related Injuries, by Type of Aviation, 1987-96



Source: NASDAC's analysis of completed NTSB accident investigations.

Of 2,345 general aviation injuries and 372 air carrier injuries that occurred between 1987 and 1996 for which NTSB had completed accident investigations, weather-related injuries accounted for about 25 percent of all general aviation injuries and about 28 percent of all air carrier injuries. Wind/windshear was the most frequent cause or contributing factor cited in general aviation accidents with injuries. Turbulence was the most frequent cause or factor cited in air carrier accidents with injuries. See figures II.5 and II.6.

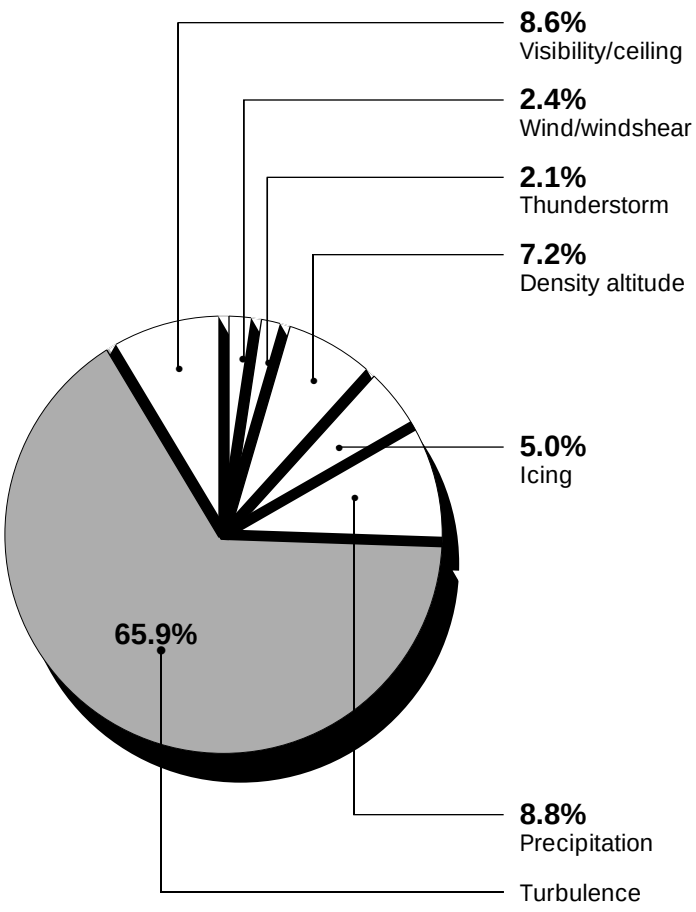
Figure II.5: Distribution of 3,463 Weather Factors Cited for 2,345 Weather-Related General Aviation Injuries, 1987-96



Note: Multiple weather factors may be cited in an accident investigation.

Source: NASDAC's analysis of completed NTSB accident investigations.

Figure II.6: Distribution of 419 Weather Factors Cited for 372 Weather-Related Air Carrier Injuries, 1987-96



Note: Multiple weather factors may be cited in an accident investigation.

Source: NASDAC's analysis of completed NTSB accident investigations.

Fatalities

On March 22, 1992, a USAir Fokker F-28 stalled on takeoff from La Guardia International Airport and became partially inverted and submerged in the bay. Of the 51 persons on board, 27 died and 21 were injured. NTSB determined that the accident was caused by USAir's and FAA's failure to provide the flight crew with adequate procedures as well as the

flight crew's failure to confirm that the wings were free of ice. NTSB determined that icing conditions was one of several other factors that contributed to the accident.

In the more than 22,000 accidents that occurred between 1987 and 1996 for which NTSB had completed its investigation, 8,791 fatalities were recorded. NTSB determined that weather was a cause or contributing factor in 3,043, or about 35 percent, of the deaths in these accidents. See table II.3.

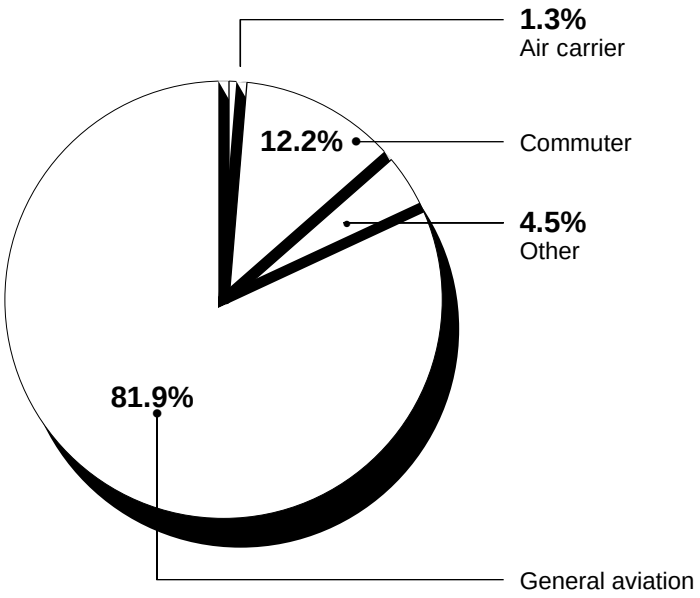
Table II.3: All Fatalities and Weather-Related Fatalities, by Year, 1987-96

Year	All fatalities	Weather-related fatalities	Percent weather-related
1987	1,171	356	30.4
1988	883	393	44.5
1989	1,024	371	36.2
1990	911	378	41.5
1991	946	278	29.4
1992	960	364	37.9
1993	784	276	35.2
1994	910	236	25.9
1995	760	244	32.1
1996	442	147	33.3
Total	**8,791**	**3,043**	**34.6**

Source: NASDAC's analysis of completed NTSB accident investigations.

Of the 3,043 weather-related fatalities that occurred in 1987 through 1996, about 2,493, or about 82 percent, involved general aviation aircraft, while 40, or about 1 percent, involved air carriers. See figure II.7 for an analysis by type of aviation.

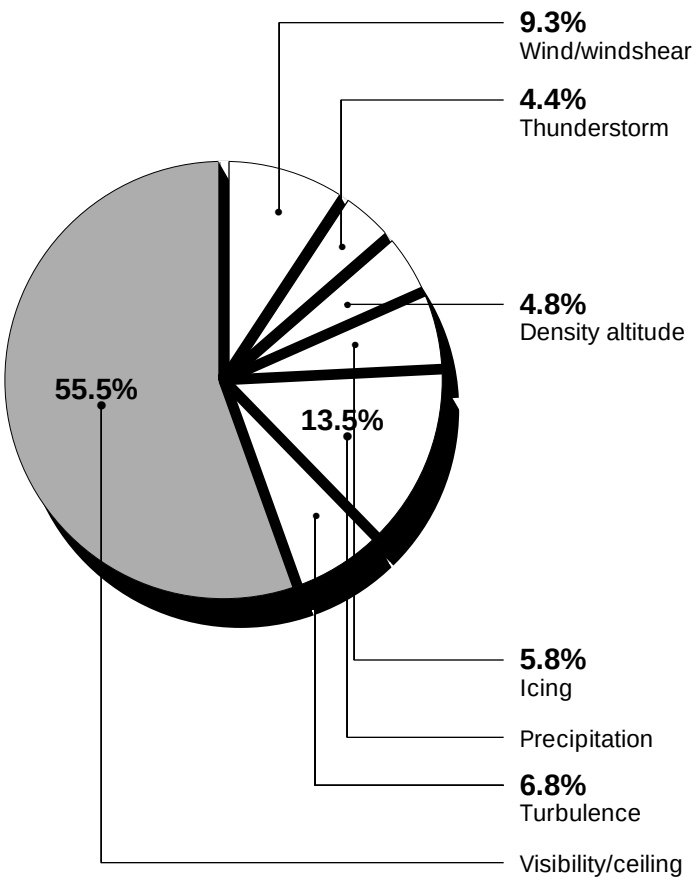
Figure II.7: Distribution of 3,043 Weather-Related Fatalities by Type of Aviation, 1987-96



Source: NASDAC's analysis of completed NTSB accident investigations.

Of the 7,064 general aviation fatalities and 570 air carrier fatalities that occurred between 1987 and 1996 for which NTSB has completed accident investigations, weather-related fatalities accounted for about 35 percent of all general aviation fatalities and 7 percent of all air carrier fatalities. Low visibility/ceiling was the most frequent cause or contributing factor cited in fatal general aviation accidents. According to AOPA, flying under visual flight rules into deteriorating weather conditions and dark nights is the most frequent cause of fatal general aviation accidents. Icing was the most frequent cause or factor cited in fatal air carrier accidents. However, because only six weather-related air carrier accidents involved fatalities, no conclusions can be drawn from this small number of occurrences. See figures II.8 and II.9.

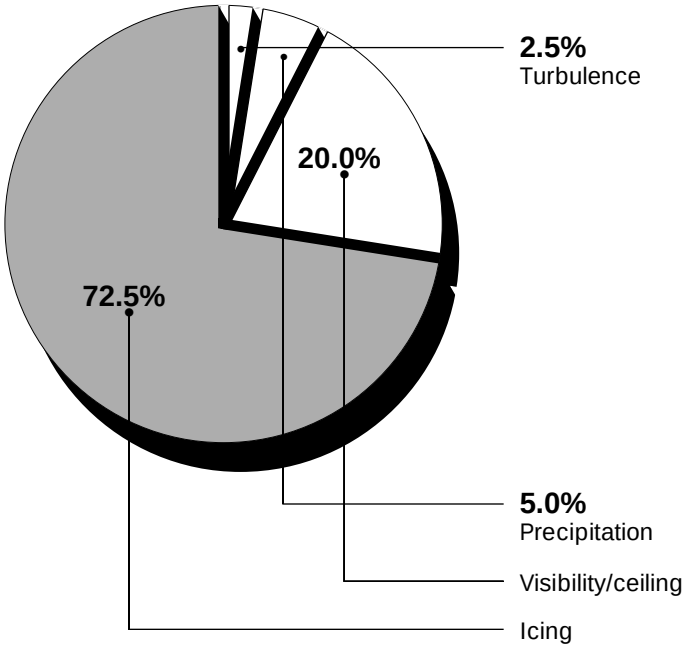
Figure II.8: Distribution of 4,883 Weather Factors Cited for 2,493 Weather-Related General Aviation Fatalities, 1987-96



Note: Multiple weather factors may be cited in an accident investigation.

Source: NASDAC's analysis of completed NTSB accident investigations.

Figure II.9: Distribution of 40 Weather Factors Cited for 40 Weather-Related Air Carrier Fatalities, 1987-96



Source: NASDAC's analysis of completed NTSB accident investigations.

Delays

According to the Air Transport Association (ATA), flight delays of 1 minute or more cost airlines and passengers more than $3 billion each year. See table II.4 for the costs of delays to U.S. major and national carriers and passengers in 1993 through 1996.

Table II.4: Total Aviation Delay Costs, 1993-96

Dollars in millions

Costs	1993	1994	1995	1996
Aircraft operating costs[a]	$1,502	$1,427	$1,380	$1,571
Ground costs	800	810	825	840
Costs to passengers	1,000	1,400	1,300	1,500
Total	$3,302	$3,637	$3,505	$3,911

Note: ATA does not estimate which percentage of total delay costs are related to weather.

[a]Aircraft operating costs include the flight deck crew, fuel, maintenance, equipment charges, cabin crew, and food.

Source: ATA.

In 1993 through 1997, according to FAA, more than 1.2 million flights were delayed for at least 15 minutes at the 55 airports connected to the Air Traffic Operations Network.[2] Of these flights, about 922,000, or 72 percent, were delayed for weather-related reasons. See table II.5 for a summary of delays by primary cause in 1993 through 1997.

Table II.5: Delays Over 15 Minutes, by Cause, 1993-97

	1993	1994	1995	1996	1997
Total flights delayed	**275,751**	**247,719**	**236,794**	**271,509**	**245,452**
Primary Cause					
Weather	71.8%	74.5%	72.4%	74.0%	68.0%
Volume	21.6%	19.3%	18.5%	18.5%	22.2%
Runway	2.9%	2.3%	2.8%	2.9%	3.3%
Equipment	1.7%	1.6%	2.7%	2.2%	2.6%
Other	2.0%	2.3%	3.6%	2.5%	3.9%

Source: FAA Air Traffic Operations Network.

[2]FAA's network tracks delays that are at least 15 minutes in duration.

Results of Survey of Members of NRC and FAA's Research, Engineering, and Development Committees

U.S. General Accounting Office

GAO Survey of Experts on FAA's Management of Aviation Weather Programs

Introduction and Purpose:

The U.S. General Accounting Office (GAO), an independent agency of the U.S. Congress, is studying FAA's management of aviation weather services. As part of our study, we plan to review FAA's implementation of some of the recommendations made by three expert panels: the 1995 National Research Council (NRC) report on Aviation Weather Services, the 1995 Subcommittee Report of the Aviation Weather Panel to FAA's Research, Evaluation and Development Advisory Committee, and the 1997 Subcommittee Report of the National Airspace System Air Traffic Management Research and Development Panel to FAA's Research, Evaluation and Development Advisory Committee. We plan to report our findings to the Congress by the spring of 1998.

Because we will not be able to collect detailed information on the status of each of the nearly 70 recommendations made by these panels, we are asking for your help in setting priorities for examining FAA's implementation of these recommendations. With your response, and those of your colleagues from the three panels, we intend to identify a subset of recommendations for follow up with FAA. We will document FAA's efforts to address these recommendations through interviews and the examination of relevant records and will then work with selected panel members to evaluate the extent to which FAA's actions have improved its ability to effectively manage aviation weather activities.

Instructions: Each of the panels' recommendations to FAA are listed on the following pages. Please indicate for each recommendation whether or not it should be included in the subset of recommendations examined to evaluate FAA's ability to effectively manage aviation weather activities. If you do not have a basis for rating any one of the recommendations, you have the option of indicating that on the form. The last page includes a section for any additional comments or information you may wish to share.

When deciding how to rate each recommendation, please consider the following:

- how important it is to FAA's ability to improve aviation weather services, and

- how reasonable it is to expect that FAA would have taken significant action since the recommendation was published.

Please complete this survey and return it to us within 10 days of receipt. We have provided a postage-paid, business-reply envelope to facilitate its return. However, in the event that this return envelope is misplaced, please send the completed survey to:

U.S. General Accounting Office
RCED/Transportation Issues
Attn: Mr. James Sweetman
441 G Street, N.W., Rm. 2T23
Washington, D.C. 20548

If you have any questions, please contact Mr. Sweetman at 202-512-3347.

Part I. Recommendations from NRC's 1995 Aviation Weather Services Report

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
I. Current Roles and Missions	
(1) The FAA should view meteorology as a significant component of every area of its responsibility in which weather could affect safety or efficiency.	1 = 24, 2 = 3, 3 = 0, 4 = 1, 5 = 0, 6 = 0
(2) The FAA should aggressively strive to improve the efficiency of air commerce just as it already strives to improve safety.	1 = 11, 2 = 6, 3 = 2, 4 = 4, 5 = 4, 6 = 0
(3) The FAA and NWS should re-establish the practice of assigning high-level liaisons who are formally tasked with defining and coordinating aviation weather requirements for research, development, and operations between the FAA and NOAA/NWS.	1 = 15, 2 = 7, 3 = 4 4 = 0, 5 = 1, 6 = 1
(4) The FAA and NWS should encourage informal interagency meetings between small groups of staff members at all management levels who are involved in providing or using aviation weather information.	1 = 12, 2 = 10, 3 = 3, 4 = 1, 5= 1, 6 = 1
(5) The FAA should examine selected weather-related Federal Aviation Regulations and undertake rulemaking to incorporate appropriate modifications to enhance efficiency as well as safety.	1 = 9, 2 = 12, 3 = 4 4 = 1, 5 = 2, 6 = 0
(6) The FAA should assess how proposals to establish a private or federal air traffic services corporation would impact aviation weather services and related research.	1 = 4, 2 = 9, 3 = 7, 4 = 6, 5 = 2, 6 = 0
(7) The FAA should expeditiously improve aviation weather services rather than delay action while the federal government decides whether to establish an air traffic services corporation to provide some or all of the functions currently provided by the FAA.	1 = 22, 2 = 4, 3 = 1, 4 = 0, 5 = 0, 6 = 1
II. Current Services	
(8) The FAA should ensure that long-term operational funding is provided for the Meteorological Data Collection and Reporting System (MDCRS). In addition, the FAA should enhance the value of MDCRS by encouraging more air carriers to participate in the program.	1 = 17, 2 = 7, 3 = 4, 4 = 0, 5 = 0, 6 = 1
(9) The FAA and NWS should continue to resolve user-identified issues associated with the ASOS and use the lessons learned from the ASOS acquisition to improve the process by which new systems are conceived, developed, and deployed.	1 = 17, 2 = 5, 3 = 4, 4 = 0, 5 = 1, 6 =0

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? --- 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No --- 6 = No Basis to Judge
(10) The FAA and NOAA should maximize the payoff of national investments in new weather observing systems by implementing improved information processing systems and new data analysis tools such as the Aviation Gridded Forecast System.	1 = 12, 2 = 8, 3 = 6, 4 = 1, 5 = 1, 6 = 0
(11) The FAA and NWS should develop a procedure to designate private weather services as approved sources of specific aviation weather products.	1 = 11, 2 = 8, 3 = 4, 4 = 4, 5 = 1, 6 = 0
(12) The FAA and NWS should develop a process to allow pilots and other users of airport terminal forecasts to provide timely feedback to the NWS forecasters who generate these forecasts.	1 = 9, 2 = 11, 3 = 6, 4 = 2, 5 = 0, 6 = 0
(13) The FAA should implement an improved Direct User Access Terminal Service (DUATS) that (1) makes it easier for pilots to understand what weather conditions are likely to impact their specific flights, (2) improves user access to graphic weather products (perhaps by using communications systems such as the Internet), and (3) improves the efficiency of pilot weather briefings by flight service specialists.	1 = 13, 2 = 9, 3 = 3, 4 = 2, 5 = 1, 6 = 0
(14) Flight service specialists should remain available as a source of preflight and en route weather information for general aviation and business pilots.	1 = 12, 2 = 5, 3 = 5, 4 = 4, 5 = 1, 6 = 1
(15) The FAA should take the lead in developing tailored and consistent graphic aviation weather products that feature improved accuracy, timeliness, and resolution.	1 = 16, 2 = 6, 3 = 1, 4 = 2, 5 = 2, 6 = 0
(16) The FAA should support ongoing work that addresses shortcomings in cockpit display and ground-to-air communications systems. The FAA should also continue to provide voice radio links to weather briefers on the ground, such as those currently provided by AFSSs, until a practical alternative system is fielded.	1 = 14, 2 = 7, 3 = 4, 4 = 2, 5 = 0, 6 = 0
(17) The FAA and NWS should improved the effectiveness of Center Weather Service Units (CWSUs) by taking the following actions: – The NWS should place all 21 CWSUs under the organizational authority of the Aviation Weather Center that the NWS [has established] in place of the National Aviation Weather Advisory Unit. – The FAA should challenge CWSUs to improve the level of services that they provide. In particular, the FAA should encourage managers and staff at Air Route Traffic Control Centers to use the full capabilities of the CWSUs, and it should ensure that en route air traffic controllers receive preshift weather briefings from CWSU meteorologists.	1 = 13, 2 = 6, 3 = 4, 4 = 0, 5 = 1, 6 = 3
(18) The FAA should facilitate the ability of airport operators to acquire appropriate weather information by granting their operational staff routine access to DUATs.	1 = 9, 2 = 4, 3 = 8, 4 = 2, 5 = 2, 6 = 2

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
(19) The FAA should take the following actions to improve weather-related training: – Encourage universities, flight schools, and other training facilities to focus initial and recurrent training of aviation weather users and providers on understanding and optimizing the use of available weather information. – Revise federal licensing procedures for pilots, controllers, flight service specialists, and dispatchers to test more effectively the abilities of candidates to use weather information in making safe operational decisions regarding the weather. – Increase the emphasis that weather receives during biennial flight reviews, safety seminars, and refresher courses for designated pilot examiners and flight instructors.	1 = 15, 2 = 8, 3 = 2, 4 = 1, 5 = 1, 6 = 0
(20) The FAA should take the lead in establishing and aggressively pursuing aviation weather goals and priorities that reflect the positions of other involved parties, including the following: – other federal agencies and departments; – other providers of aviation weather services (e.g., private weather services and state governments); and – user groups, including the unions, associations, and industry groups that represent those who work with the U.S. aviation weather system on a daily basis: air carrier personnel, pilots, air traffic controllers, flight service specialists, meteorologists, and dispatchers.	1 = 13, 2 = 10, 3 = 2, 4 = 3, 5 = 0, 6 = 0
(21) Near-term efforts by the FAA and NWS to improve the effectiveness of aviation weather services should focus on the urgent, unmet needs of aviation weather users, which include the following: – a comprehensive national training program to improve the practical meteorological skills of users and providers of aviation weather services; – advanced weather products that are relevant, timely, accurate, and easy to comprehend (e.g., graphically displayed); – ground-to-air communications and cockpit display systems for en route dissemination of advanced weather products; and – weather observations an forecasts that offer improved temporal, geographic, and altitude-specific resolution.	1 = 22, 2 = 3, 3 = 3, 4 = 0, 5 = 0, 6 = 0
III. Research and Development	
(22) The FAA should take the lead in implementing the recommendation of the Office of the Federal Coordinator for Meteorology (OFCM) to develop an interagency plan for aviation weather research and development.	1 = 10, 2 = 10, 3 = 2, 4 = 0, 5 = 3, 6 = 2
(23) The FAA should augment its meteorological expertise to enhance its ability to plan and implement effective aviation weather services.	1 = 11, 2 = 14, 3 = 2, 4 = 0, 5 = 1, 6 = 0

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
(24) The FAA and Congress should maximize the effectiveness of new aviation weather systems by ensuring that related research, training, system installation, and support systems are funded with priority equal to that of the system acquisition efforts with which they are associated.	1 = 19, 2 = 8, 3 = 0, 4 = 0, 5 = 0, 6 = 1
(25) The FAA, NOAA/NWS, National Science Foundation, National Aeronautics and Space Administration (NASA), and Department of Defense (DOD) should collaborate under FAA leadership to develop, fund, and implement a comprehensive plan for aviation weather research and development with firm objectives and closely integrated program plans and funding commitments. The OFCM should facilitate the development of such a plan, but final commitments should be made by agency heads.	1 = 13, 2 = 11, 3 = 2, 4 = 0, 5 = 2, 6 = 0
(26) The FAA and NOAA should ensure that aviation weather research and development are closely coupled to operational components of these agencies so that new concepts and new ideas can be swiftly integrated into ongoing operations.	1 = 20, 2 = 8, 3 = 0, 4 = 0, 5 = 0, 6 = 0
(27) The aviation weather research and development process should seek continuing and in-depth involvement with all users, especially the pilots, controllers, forecasters, and dispatchers who depend on weather information to facilitate safe and efficient operations.	1 = 18, 2 = 8, 3 = 2, 4 = 0, 5 = 0, 6 = 0
Regional Requirements	
(28) The FAA, on behalf of the federal government, should take the lead in finding the means to meet special regional needs for aviation weather services. In regions that have special needs, the FAA should establish a team that includes other responsible federal and state government agencies, the local aviation industry, airport operators, pilots, professional organizations, and local communities to identify, assess, and properly respond to these needs. Such a team should address the following areas: - The overall weather goals and priorities of the local user community and how they differ from those that drive national aviation weather systems. - The role that each of the involved parties should play in meeting these goals. - The extent to which it is practical to modify the structure and processes of the national aviation weather system to accommodate special needs of local users. There should be an appropriate balance between the competing goals of (1) maximizing the effectiveness of the regional system, which might call for highly customized services, and (2) minimizing regional variances in the national system so that users are not confused by differing procedures as they travel throughout the country.	1 = 10, 2 = 10, 3 = 3, 4 = 3, 5 = 1, 6 = 1

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
Future Roles and Missions	
(29) As part of its effort to provide necessary leadership, the FAA should accomplish the following tasks: – Specify national and regional aviation weather requirements. – Organize multiagency participation in aviation weather research, operations, and training. – Justify aviation weather budget requests. – Orchestrate a coordinated aviation weather research and development program. – Improve the understanding and use of weather information by aviation users. – Provide day-to-day dissemination of weather information to aviation users. – Respond to the other recommendation contained in this report and in *Weather for Those Who Fly* (NRC, 1994).	1 = 17, 2 = 7, 3 = 2, 4 = 0, 5 = 1, 6 = 1
(30) The FAA should seek a broad consensus on aviation weather goals and priorities with (1) other federal agencies; (2) other providers of aviation weather services (i.e., private weather services and state governments); (3) research organizations; and (4) user groups, including the unions, associations, and industry groups that represent those who work with the U.S. aviation weather system on a daily basis: air carrier personnel, pilots, air traffic controllers, flight service specialists, meteorologists, and dispatchers.	1 = 13, 2 = 10, 3 = 2, 4 = 2, 5 = 1, 6 = 0
(31) The FAA Administrator should designate an associate administrator to assume overall responsibility for carrying out the FAA's lead agency role for aviation weather and to serve as a single focal point within the FAA with the authority to provide effective internal and external coordination of aviation weather services and related research program that involve the FAA.	1 = 16, 2 = 7, 3 = 4, 4 = 0, 5 = 1, 6 = 0
(32) The FAA and NWS should develop more detailed guidance regarding the future role of private weather services. This guidance should view private weather services as partners in the overall effort to improve the quality and reduce the total cost of aviation weather services.	1 = 6, 2 = 15, 3 = 4, 4 = 2, 5 = 1, 6 = 0
(33) The FAA and NWS should use state aviation weather systems as a resource to improve the overall effectiveness of the national aviation weather system. The FAA and NWS should facilitate actions by interested states to improve local aviation weather systems, especially in regions of the United States, such as Alaska, that have special needs for aviation weather services that regional systems could help address.	1 = 11, 2 = 7, 3 = 8, 4 = 0, 5 = 1, 6 = 1

Part II. Recommendations from RE&D Advisory Committee, Aviation Weather Subcommittee Report (1995)

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
Systems Development	
(34) FAA should develop a weather system architecture to provide the proper aviation weather information to all users in a timely manner. It should include an end-to-end (sensor to user) subsystem that provides a mechanism to get the same aviation weather information to all users.	1 = 19, 2 = 6, 3 = 2, 4 = 1, 5 = 0, 6 = 0
Organizational	
(35) FAA must take additional actions to focus decision-making responsibility and authority for fulfilling approved aviation weather requirements. These include continued development of the Integrated Product Team to involve all stakeholders, from requirements setters to the flying public.	1 = 15, 2 = 10, 3 = 3, 4 = 0, 5 = 0, 6 = 0
Research and Development	
(36) The FAA should direct the focus of R&D activities toward operationally useful products so that the fruits of R&D can by provided to the users on a continual basis.	1 = 19, 2 = 8, 3 = 1, 4 = 0, 5 = 0, 6 = 0
(37) All research projects should be carefully chosen and, as part of the research activity, develop a comprehensive, defensible cost-benefit story and a planed implementation path that ensures timely operational delivery of its products to users.	1 = 14, 2 = 13, 3 = 0, 4 = 1, 5 = 0, 6 = 0

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
(38) The FAA should effectively coordinate weather-related R&D efforts of NASA, DOD and DOC with the FAA program. In any event, the FAA should comply with the agreement with DOC to provide an annual statement of weather requirements.	1 = 14, 2 = 8, 3 = 2, 4 = 1, 5 = 2, 6 = 1
Aviation Weather Entrepreneurship	
(39) [N]on-governmental organizations and private industry . . . must be encouraged through expedited acquisition, certification and in all available ways in order to expedite the introduction of services to the various classes of users, commercial air transport, commuters, general aviation and the military.	1 = 10, 2 = 9, 3 = 6, 4 = 2, 5 = 1, 6 = 0
Policy	
(40) The FAA Administrator should provide a clear and cohesive policy statement regarding the agency's important role in the provision of aviation weather services. The statement should reflect the need for further definition of the capability and responsibility of controllers and pilots in the issue of separating aircraft from hazardous weather.	1 = 23, 2 = 4, 3 = 1, 4 = 0, 5 = 0, 6 = 0
(41) [A] higher level of decisiveness and discipline must be enforced through a stabilized line of command empowered to make and execute decisions. . . . In the interim, FAA management must improve risk calculation and its assumption and get on the proactive decision-making track.	1 = 10, 2 = 11, , 3 = 3, 4 = 1, 5 = 1, 6 = 2
(42) The Administrator should set policies for [pilot and controllers'] training and certification that will lead to enhanced understanding and decision-making regarding weather, taking into account the many significant forthcoming changes in the National Airspace System.	1 = 10, 2 = 14, 3 = 1, 4 = 2, 5 = 1, 6 = 0

Part III. Recommendations from the Subcommittee Report of the NAS ATM R&D Panel to the RE&D Advisory Committee (1997)

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
(43) The FAA should facilitate the dissemination of consistent, common, and timely aviation weather information, in graphical format, to all users of the aviation system, both ground and airborne, as soon as possible. The FAA should take advantage of existing data links for this purpose.	1 = 19, 2 = 5, 3 = 3, 4 = 0, 5 = 0, 6 = 0
(44) The policy statement and strategic plans should consider hazardous weather information as an aviation safety issue, as well as a capacity one.	1 = 20, 2 = 5, 3 = 0, 4 = 2, 5 = 0, 6 = 0
(45) The Associate Administrator for Research and Acquisitions (ARA-1) should establish a separate weather IPT within the AND organization, to focus the leadership and responsibility for all research, engineering, development, and implementation of weather projects.	1 = 9, 2 = 11, 3 = 3, 4 = 0, 5 = 1, 6 = 4
(46) The FAA should support a weather architecture which includes the appropriate elements and interfaces needed to disseminate critical weather information to ALL aviation users, supported by adequate funding and priorities.	1 = 20, 2 = 4, 3 = 2, 4 = 2, 5 = 0, 6 = 0
(47) The FAA should continue to fund longer term (>1 hour) convective weather prediction, and longer term (>20 minutes) storm growth and decay forecasting R&D. These efforts are intended to develop improved techniques for sensor data analysis, develop techniques for effectively assimilating the sensor data into predictive models, and produce methods for converting these model outputs into products that benefit air traffic and aircraft and aircraft operators decision-making during convective weather.	1 = 12, 2 = 9, 3 = 2, 4 = 4, 5 = 1, 6 = 0

Recommendation	Should the recommendation be included in the subset examined to evaluate FAA's ability to effectively manage aviation weather activities? 1 = Definitely Yes 2 = Possibly Yes 3 = Uncertain 4 = Possibly No 5 = Definitely No 6 = No Basis to Judge
(48) The FAA should continue the research programs directed at improved one to two hour forecasting of Ceiling and Visibility at airports. This effort could be extended to allow improved C&V forecasts up to six hours.	1 = 12, 2 = 7, 3 = 4, 4 = 1, 5 = 2, 6 = 0
(49) The FAA should fund a research program that builds on NCAR research to develop a model whose output is an hourly gridded forecast of hazardous in-flight icing.	1 = 11, 2 = 10, 3 = 3, 4 = 1, 5 = 1, 6 = 0
(50) The FAA should fund a research program, in conjunction with NASA, to exploit ITWS products to produce reliable short-term forecasts of key variables which most affect wake vortexes.	1 = 7, 2 = 8, 3 = 6, 4 = 3, 5 = 2, 6 = 0

FAA's Response to GAO'S Questions on Aviation Weather

U.S. Department
of Transportation
**Federal Aviation
Administration**

NOV 1 4 1997

Mr. Jim Sweetman
General Accounting Office
Room 2474
441 G Street, NW
Washington, DC 20548

Dear Mr. Sweetman:

In response to your request, enclosed is our response to your questions pertaining to Aviation Weather. In addition, I am enclosing the following documents:

1. An Aviation Weather Policy paper dated September 27
2. An abbreviated organizational chart showing the Aviation Weather organization's place within the Federal Aviation Administration (FAA)
3. A list of Documented Bilateral Sessions Between the National Weather Service (NWS) and the FAA
4. National Aviation Weather Program Council Proposed Record of Actions 97-1 dated April 16, 1997
5. National Aviation Weather Program Council Proposed Record of Actions 96-2 dated December 10, 1996
6. National Aviation Weather Program Council Proposed Record of Actions 96-1 dated June 17, 1996
7. Responsibilities of the ASOS Implementation Management Team dated May 28, 1997
8. Airborne Flight Information Services Policy Statement dated September 15, 1997
9. Aviation Weather Research Briefing to ATR-200 dated January 21, 1997.

If we can be of further assistance, please to not hesitate to call Mr. David Kerr, Aviation Weather Policy Division, ARW-100, at (202) 366-9257.

Sincerely,

David Whatley for
Program Director for
Aviation Weather

Enclosures

GAO Questions

(1) The FAA should view meteorology as a significant component of every area of its responsibility in which weather could affect safety or efficiency.

During the past two years the FAA has significantly enhanced the role of aviation weather in every aspect of its operations and decision making. To highlight this role, and to assure that Aviation Weather Requirements are fully integrated into the Air Traffic System, the FAA has established the Aviation Weather Organization as a Directorate within the Air Traffic System Requirements Service. The mission of this organization is to represent the needs of the entire aviation community within the requirements process and to assure that aviation weather needs are fully integrated into all major areas of the FAA's concern.

From a broader philosophical perspective the Administrator of the FAA, Ms. Jane Garvey, has issued a formal policy statement stressing the importance of the FAA's role in Aviation Weather. In this statement Ms. Garvey emphasizes the FAA's role in improving the quality of aviation weather information and the application of that information in enhancing operational decision making at all levels. A dated copy of Ms. Garvey's policy statement is attached at enclosure 1.

(3) The FAA and NWS should re-establish the practice of assigning high level liaisons who are formally tasked with defining and coordinating aviation weather requirements for research, development, and operations between FAA and NOAA/NWS.

The FAA and the National Weather Service, working both independently and through the Office for the Federal Coordinator for Meteorology (OFCM), have made considerable progress in instituting a wide range of contacts and formal relationships to improve the process of coordinating requirements and dealing with pressing aviation weather issues. However, perhaps most important to this process has been the impact of the new FAA organizational structure in facilitating this enhanced interface with the National Weather Service. The attached chart (see enclosure 2) shows how the FAA merged the two requirements divisions, including the Aviation Weather Directorate to form an organization capable of relating directly with the NWS at an equivalent level. This allows for a much more efficient and direct communication of aviation weather requirements.

During the past two years there have been several high level bilateral sessions between the two agencies. These meetings, which on several occasions included the Director of the Air Traffic Requirements Service and the Deputy Assistant Administrator for Operations of the National Weather Service are shown at enclosure 3.

The National Aviation Weather Program Council is another high level forum between the two agencies. This group is a part of the Office of the Federal Coordinator for Meteorology and covers a wide range of Government wide, as well as agency specific issues. (A copy of the public minutes from the two most recent session is attached at enclosure 4).

There are several other liaison efforts to include the Joint Action Group (made up, among others, of NWS and FAA personnel) which is currently developing the National Aviation Weather Strategic Plan Implementation Packages and, from a more formal program management perspective, the Automated Surface Observation System (ASOS) Implementation Management Team. (A description of the Objective and Structure of the ASOS Management Group is shown at enclosure 5.)

(7) The FAA should expeditiously improve aviation weather services rather than delay action while the federal government decides whether to establish an air traffic services corporation to provide some or all of the functions currently provided by the FAA.

At present there is no immediate prospect of forming an air traffic services corporation and as such is not influencing the FAA focus on improving Aviation Weather Services.

(21) Near term efforts by the FAA and NWS to improve the effectiveness of aviation weather services should focus on the urgent, unmet needs of aviation weather users which include the following:

> ***-- A comprehensive national training program to improve the practical meteorological skills of users and providers of aviation weather services;***
>
> This question has already been addressed directly by ARW-200.
>
> ***-- Advanced weather products that are relevant, timely, accurate and easy to comprehend (e.g. graphically displayed);***
>
> The FAA recognizes the critical importance of making its advanced weather products relevant, timely and accurate to the personnel who rely on these tools. This emphasis can be seen in several of the FAA's new advanced weather systems to include Weather and Radar Processor (WARP), the Integrated Terminal Weather System (ITWS), the Operational and Supportability Implementation System OASIS, and the Terminal Weather Information for Pilots (TWIP).
>
> ***-- Ground to Air communications and cockpit display systems for enroute dissemination of advanced weather products;***
>
> The FAA has taken a dynamic leadership role in the long range improvement of ground to air communications by developing a proposed policy on Flight Information Systems/Datalink. This initiative has also been a central focus of the

Flight Two Thousand Program (F2K) as an integral part of the fielding of new products. A copy of the current "draft" Policy Statement on FIS/Datalink is attached at Enclosure 6.

-- Weather observations and forecasts that offer improved temporal, geographic, and altitude-specific resolution

The FAA and the NWS are focused on developing new systems that will provide more specific resolution for weather observations and forecasts. A formal presentation of the current objectives and strategy of the Aviation Weather Research Program is at enclosure 7.

The Aviation Digital Data Service is an example of a system that greatly enhances the resolution of the data and forecasts provided to the aviation community. Other programs aimed at improving the resolution and timeliness of forecast accuracy include the Water Vapor Sensing System and the NWS Model Development and Enhancement Program. A roll up of some of the aviation weather systems being developed by the FAA can be found on the FAA Homepage, under:
WWW.FAA.GOV/AUA/IPT_PROD/TOWER/AWR/PRODPROG.HTM

(26) The FAA and NOAA should ensure that aviation weather research and development are closely coupled to operational components of these agencies so that new concepts and new ideas can be swiftly integrated into ongoing operations.

This concern is very relevant to the FAA's effort to redefine the requirements development process. It is the FAA's objective, through the Air Traffic Systems Requirements Process, to more closely and accurately have requirements reflect operational needs. A key component of this process is the importance of linking research and development initiatives to practical and immediate operational needs early in the requirements process . The current Weather R&D plan (enclosure 7) reflects the operational priorities established by ARW.

The process of developing Aviation Weather RE&D priorities is closely coordinated with the major elements of our organization and the industry. The Aviation Weather projects were determined and prioritized by the consideration of input from the National Aviation Weather Users Forum and from general recommendations of the Air Traffic Weather Requirements Team.

The FAA has worked very hard to integrate aviation weather operational needs into the planning process. During the development of the Strategic Plan, our Research and Development organization was an integral part of the Joint Action Group assigned to write the plan. This relationship has been extended into the development of the Implementation Plan which is now on-going. In both the Strategic Plan, and in the now

developing Implementation Plan, there is clear emphasis on the need and the process for integrating operational needs closely with R&D.

(40) The FAA Administrator should provide a clear and cohesive policy statement regarding the agency's important role in the provision of aviation weather services. The statement should reflect the need for further definition of the capability and responsibility of controllers and pilots in the issue of separating aircraft from hazardous weather.

The FAA, as noted above, has issued a policy on aviation weather. This policy talks about the importance of an integrated national aviation weather strategy and the importance of providing services and tools that improve the quality of operational decision making. As for issuing a specific policy on the issue of separating aircraft from hazardous weather the FAA is reviewing the issue. The current policy addresses most of the basic issues, i.e. improved training, procedures and tools and thus may make it unnecessary to issue a separate policy.

(44) The policy statement and strategic plans should consider hazardous weather information as a safety issue, as well as a capacity one.

Without qualification the FAA's first interest is safety. This is clearly reflected in our National Aviation Weather Strategic Plan (already delivered), the FAA Aviation Weather Policy Statement (Attachment 1) and the current on-going efforts of the interagency implementation group. While capacity is an important concern, the focus of the FAA's efforts in Aviation Weather is safety oriented.

(46) The FAA should support a weather architecture which includes the appropriate elements and interfaces needed to disseminate critical weather information to ALL aviation users, supported by adequate funding and priorities.

It is the FAA's objective to create a weather architecture which integrates weather products and services in such a manner whereby critical information can be supplied to all those who need it. This is the philosophy behind the FAA's initiative in developing an FAA policy on providing Flight Information Services/Datalink. This guiding philosophy is also behind the development of the Digital-Automatic Terminal Information Service. The goal of this initiative is to reduce the amount of information traffic while at the same time allowing a freer flow of information to all aviation users.

September 27, 1997

Aviation Weather Policy

The Federal Aviation Administration (FAA) recognizes that the aviation weather system is a national system and that continued safe and efficient air transportation requires FAA commitment and leadership to aviation weather services.

The FAA will support the operation and development of the national aviation weather system by working closely with each of the departments and agencies in the Federal Government concerned with aviation weather. It will take the lead in developing a comprehensive national aviation weather strategy and in developing a plan to meet stated strategic goals. The FAA will do this in a cooperative environment encouraging the maximum participation and involvement of all elements of government. The FAA will encourage the development of new and expanded roles for the private sector that will cover a wide range of aviation weather services and products.

The FAA is committed to improving the quality of aviation weather information and the application of that information by pilots, controllers, and dispatchers. The FAA acknowledges that training is a critical component of this objective, enabling the aviation community to make the best use of weather information to make sound operational decisions and to ensure safety and efficiency.

The FAA will work to ensure that the new aviation weather products for pilots, controllers, and dispatchers can be interpreted with a minimum of analysis. These efforts will be assisted by a requirements development process which ensures that the needs of the FAA and the aviation community are being addressed and that research, development, and acquisition are focused on products that will improve the safety and efficiency of the Air Traffic System.

Jane F. Garvey
Administrator, AOA-1

U.S. Department
of Transportation
Federal Aviation Administration

DEC 3 1997

Mr. James R. Sweetman
General Accounting Office
Room 2474
441 G Street, NW
Washington, DC 20548

Dear Mr. Sweetman:

In response to your e-mail of November 20, enclosed are our responses to your questions pertaining to Aviation Weather. In addition, I am enclosing the following documents:

1. Meeting Agenda Federal Aviation Administration/National Weather Service Bilateral dated November 13
2. Aviation Weather Users' Coalition Charter - Draft of November 10
3. National Aviation Weather Program Implementation Plan briefing dated November 13.

If we can be of further assistance, please to not hesitate to call Mr. David Kerr, Aviation Weather Policy Division, ARW-100, at (202) 366-9257.

Sincerely,

James A. Sweet, PhD
for

David Whatley
Program Director for
Aviation Weather

Enclosures

The following GAO follow up questions, and their FAA responses, are based on the NRC recommendations.

Question on Recommendation # 1 (Aviation Weather Policy)

Question:

How was the recently signed policy publicized throughout the agency? Were any changes made to major FAA rules/orders as a result of the new weather policy? Is there an implementation plan specific to the new policy?

Response:

The Aviation Weather Policy Statement was widely disseminated throughout the agency and throughout the aviation industry. It is our intent to use this policy statement as a basis for many of our future actions in research, requirements development, and in operations. So far however, given the recent issuance of the policy, there have not been any formal changes to FAA rules or orders as yet.

The FAA policy will be reflected in the National Aviation Weather Implementation Plan. Specifically, this includes the important connection between users and the development of requirements, our commitment to improving training, and in providing more user friendly resources to pilots, controllers and dispatchers.

Question on Recommendation # 3 (FAA/NWS Coordination)

Question:

Can you provide any more detailed documentation of the bilateral meetings between FAA and NWS, such as who attended, what was discussed, or any agreements reached? Can you provide any concrete examples of actions taken as a result of those meetings? Has the responsibility for coordination with NWS been formally assigned to any FAA official?

Response:

There have been relatively few notes kept on bilaterals, since by their nature, these sessions are intended to be relatively non-structured and frank exchanges between the senior management of the FAA and the NWS. However, the most recent bilateral meeting, held on 13 November included several formal topics of presentation and discussion. A package showing some of these items is attached.

Question on Recommendation # 21 (Training)

Question:

Please provide the name and number of a knowledgeable contact who can discuss the COMET training program.

Response:

Mr. Larry Astor (non-government) at COMET would be the best POC. His number is (303) 497-8334. The government point of contact is Mr. Julian Wright, OFCM at 301-427-2002.

Question on Recommendation # 46 (improved information for users)

Please provide a list of planned aviation weather systems or capabilities by the primary intended user. Commercial, taxi/commuter, and GA pilots should be treated separately. A suggested format would be:

Project	Intended Users	Implementation Plan ITWS
ITWS	Supervisors/Controllers	2000-2005

Rec. #46 (Improved Information for users)

Project	Intended Users	Implementation Plan
Integrated Terminal Weather System (ITWS)	Controllers, Terminal Personnel Dispatchers	Prototypes in Use Fielding 2000-2005
Low Level Windshear Alert System (LLWAS) Network Expansion	Pilots and Controllers	Improvements, to include LLWAS-NE and an expanded network of sensors is expected to be fully deployed by 2001
Terminal Doppler Weather Radar (TDWR)	Pilots and Controllers	Deployed at 45 sites
New Generation Runway Visual Range (RVR)	Controllers	Deployment of RVR visibility sensors at over 250 facilities. Deployment is on-going.
AWOS/ASOS Data Acquisition System (ADAS)	Pilots and Controllers	Deployed this year
Weather Systems Processor (WSP)	Controllers	Full production by 2001

Members of Aviation Weather Expert Panel

Dr. John Dutton
Dean, College of Earth and Mineral Sciences
Pennsylvania State University
Vice Chairman, NRC Aviation Weather Services Committee[1]

Dr. John Hansman
Professor of Aeronautics and Astronautics
Massachusetts Institute of Technology
FAA RE&D Advisory Committee Member

Brig. Gen. Albert Kaehn (U.S. Air Force, retired)
Former Commander, Air Weather Service
Chairman, NRC Aviation Weather Services Committee

Brig. Gen. John Kelly, Jr. (U.S. Air Force, retired)
Former Commander, Air Weather Service
FAA RE&D Advisory Committee Member[2]

Mr. Bruce Landsberg
Executive Director, AOPA Air Safety Foundation
FAA RE&D Advisory Committee Member

Mr. Robert Massey
Chairman, Air Line Pilots Association Weather Committee
NRC Aviation Weather Services Committee Member

Mr. William Sears
Director of Air Traffic Capacity and Meteorology
Air Transport Association of America
(Representing Jack Ryan, FAA RE&D Advisory Committee Member)

Mr. Terry Shell
Air Traffic Systems Requirements Representative
National Air Traffic Controllers Association

[1]Dr. Dutton was unable to attend the panel meeting.

[2]General Kelly was appointed Director of the National Weather Service on Feb. 19, 1998.

Panelists' Ratings of FAA's Overall Progress in Addressing Eight Highly Rated Recommendations

As discussed in appendix I, we convened an expert panel to evaluate FAA's progress in implementing eight recommendations rated highly by respondents to our August 1997 survey. For each of the eight recommendations, the panelists were

- presented with the recommendation and offered the opportunity to comment on its intent;
- presented with FAA's response and supporting documentation,[1] as well as other evidence of FAA's activities that we identified during our review and given the opportunity to add any other FAA activities of which they were aware; and
- given a period of time to discuss the evidence presented.

After the discussion, the panelists were asked to individually rate FAA's overall progress using the following question:

Considering FAA's actions and progress made, and any other factors you feel are relevant, what is your overall rating of FAA's response to this recommendation?

1. ___ Very Poor
2. ___ Poor
3. ___ Fair
4. ___ Good
5. ___ Excellent

The panelists answers are presented in table V.1.

[1]Copies of FAA's responses and supporting material were mailed to the panelists before the meeting.

Table V.1: Expert Panel's Ratings of FAA's Overall Progress in Addressing Eight Recommendations

Panelist	1	2	3	4	5	6	7	Mean
Recommendations related to policy and leadership								
Recommendation 1: The FAA Administrator should provide a clear and cohesive policy statement regarding the agency's important role in the provision of aviation weather services. The statement should reflect the need for further definition of the capability and responsibility of controllers and pilots in the issue of separating aircraft from hazardous weather.	1	2	3	1	2	3	2	2.0
Recommendation 2: The policy statement and strategic plans should consider hazardous weather information as an aviation safety issue, as well as a capacity one.	2	2	2	3	3	3	3	2.6
Recommendation 3: The FAA should expeditiously improve aviation weather services rather than delay action while the federal government decides whether to establish an air traffic services corporation to provide some or all of the functions currently provided by the FAA.	4	3	3	4	3	3	3	3.3
Recommendation 4: The FAA should view meteorology as a significant component of every area of its responsibility in which weather could affect safety or efficiency.	2	1	2	2	2	2	2	1.9
Recommendations related to interagency coordination								
Recommendation 5: The FAA and NWS should re-establish the practice of assigning high-level liaisons who are formally tasked with defining and coordinating aviation weather requirements for research, development, and operations between the FAA and NOAA/NWS.	2	2	3	2	2	3	2	2.3
Recommendation 6: The FAA and NOAA should ensure that aviation weather research and development are closely coupled to operational components of these agencies so that new concepts and new ideas can be swiftly integrated into ongoing operations.	3	2	2	4	2	2	2	2.4
Recommendations related to efforts to address user needs								
Recommendation 7: The FAA should support a weather architecture which includes the appropriate elements and interfaces needed to disseminate critical weather information to ALL aviation users, supported by adequate funding and priorities.	1	2	2	2	2	2	2	1.9
Recommendation 8: Near-term efforts by the FAA and NWS to improve the effectiveness of aviation weather services should focus on the urgent, unmet needs of aviation weather users, which include the following: —a comprehensive national training program to improve the practical meteorological skills of users and providers of aviation weather services; —advanced weather products that are relevant, timely, accurate, and easy to comprehend (e.g., graphically displayed); —ground-to-air communications and cockpit display systems for en route dissemination of advanced weather products; and — weather observations and forecasts that offer improved temporal, geographic, and altitude-specific resolution.	1	1	2	1	1	2	2	1.4

Additionally, the panelists were asked to answer three more specific questions about FAA's efforts to address each recommendation. They were the following:

- Have FAA's actions been consistent with the intention of the recommendation?
- Have FAA's actions been sufficient to address the recommendation? and
- Has FAA made timely progress in implementing actions to respond to this recommendation?

For each of these questions, the panelists were given the choice of five responses:

1. ___ Definitely no

2. ___ Possibly no

3. ___ Uncertain

4. ___ Possibly yes

5. ___ Definitely yes

The panelists' responses are shown in table V.2.

Table V.2: Expert Panel's Ratings of Whether FAA's Actions Were Consistent With the Intention of the Recommendations

Panelist	1	2	3	4	5	6	7	Mean
Recommendations related to policy and leadership								
1	1	1	4	1	2	4	2	2.1
2	1	4	4	4	4	4	4	3.6
3	4	4	4	5	3	3	4	3.9
4	1	2	4	2	2	4	1	2.3
Recommendations related to interagency coordination								
5	2	4	4	2	4	4	2	3.1
6	3	3	4	4	2	3	3	3.1
Recommendations related to efforts to address user needs								
7	1	1	2	2	1	4	2	1.9
8	1	1	2	1	1	1	1	1.1

Table V.3: Expert Panel's Ratings of Whether FAA's Actions Were Sufficient

Panelist	1	2	3	4	5	6	7	Mean
Recommendations related to policy and leadership								
1	1	1	2	1	1	2	1	1.3
2	1	3	4	3	2	2	3	2.6
3	4	4	4	5	2	3	4	3.7
4	1	2	2	1	1	1	1	1.3
Recommendations related to interagency coordination								
5	1	1	1	1	1	1	2	1.1
6	2	2	3	4	1	2	2	2.3
Recommendations related to efforts to address user needs								
7	1	1	1	2	1	1	1	1.1
8	1	1	1	1	1	1	1	1.0

Table V.4: Expert Panel's Ratings of Whether FAA's Actions Were Timely

Panelist	1	2	3	4	5	6	7	Mean
Recommendations related to policy and leadership								
1	2	3	2	1	3	2	1	2.0
2	1	1	4	4	3	1	2	2.3
3	4	4	3	5	3	3	3	3.6
4	2	1	2	2	1	2	1	1.6
Recommendations related to interagency coordination								
5	1	2	1	1	2	1	1	1.3
6	3	2	2	4	2	2	2	2.4
Recommendations related to efforts to address user needs								
7	1	2	1	1	1	1	1	1.1
8	1	1	1	2	1	1	1	1.1

Finally, after reviewing the ratings assigned to the recommendations, the panel was asked to rate FAA on its general progress in addressing all eight recommendations.

Table V.5: Experts' Rating on FAA's General Progress in Addressing the Eight Recommendations

Panelist	1	2	3	4	5	6	7	Mean
Summary rating of FAA's progress in implementing all eight recommendations	1	2	2	2	2	2	2	1.9

Major Contributors to This Report

Resources, Community, and Economic Development Division, Washington, D.C.	Alice G. Feldesman Steven C. Martin Lynn M. Musser Thomas F. Noone Marnie Shaul Carol Herrnstadt Shulman James R. Sweetman, Jr. Robert E. White Mario Zavala
Office of General Counsel	Mindi G. Weisenbloom

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