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THE NATIONAL AVIATION WEATHER PROGRAM: AN UPDATE ON IMPLEMENTATION

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1. INTRODUCTION

Weather adversely impacts the flow of air traffic within the National Airspace System (NAS). Statistics show that weather is a contributing factor in about one third of aviation accidents and in about three quarters of air traffic delays. Over the last several years, significant work has been accomplished by federal agencies and the private sector in developing and fielding new systems and products designed to help mitigate the impacts of adverse weather. New systems for observing, processing, and disseminating weather information have increased the information available to decision-makers. New products that display graphical weather information are available and are making their way into the cockpit. Not only are these systems and products contributing to a safer NAS, they are contributing to more efficient flow of air traffic as well. The weather information being made available to traffic management personnel, pilots, dispatchers, and controllers is supporting more informed tactical and strategic decision making.

2. BACKGROUND

In 1992, the federal agencies published the National Aviation Weather Program Plan (OFCM 1992). This was the first attempt to develop an integrated, interagency plan to ensure that the aviation weather system evolved to meet the operational needs of NAS users and the future air traffic control system. Since that time, a number of events have helped focus the activities within the aviation weather program. In 1995, the National Research Council's Committee on National Aviation Weather Services issued a report containing several recommendations for improving aviation weather services (NRC 1995). In 1997, the White House Commission on Aviation Safety and Security established a goal of an 80 percent reduction in the fatal accident rate by 2007. In response to the White House Commission's report, the National Aeronautics and Space Administration (NASA) formed the Aviation Safety Investment Strategy Team (ASIST) with industry, government, and academic participation in defining aviation safety research needs. The ASIST findings provided the foundation and rationale for formulation of NASA's Aviation Safety Initiative. Also, in 1997, the federal agencies[1] under the auspices of the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) and led by the Federal Aviation Administration (FAA), issued the National Aviation Weather Program Strategic Plan (OFCM 1997) that established strategic objectives with the 10 year goal of reducing by 80 percent the fatal accident rate for accidents with weather as a contributing factor. In 1999, the federal agencies, with input from industry, issued the National Aviation Weather Initiatives (OFCM 1999) that established weather service area initiatives in support of the strategic objectives. In 2001 and 2003, the OFCM issued additional reports on aviation weather research and services. The first was the 2001 Baseline Report that compiled research and development activities of federal agencies and the private sector and mapped them against the aviation weather initiatives. In 2003, a report was issued that expanded and updated the compilation of aviation weather programs, products, and systems intended to improve safety and efficiency within the NAS (OFCM 2003a). Also in 2003, the OFCM issued the Mid-Course Assessment Report (OFCM 2003b) that evaluated progress towards the goal of an 80 percent reduction in the fatal accident rate by 2007. Based on weather-related accident statistics from the National Transportation Safety Board (NTSB) for the period 1996-2001, the report concluded that the goal was achievable for general aviation and the major air carriers. In 2004, in order to meet the challenges facing aviation in the 21st Century, the FAA issued Flight Plan 2004-2008. The Flight Plan lays out four goals which include achieving the lowest possible accident rate and providing NAS capacity that meets or exceeds demand. Weather plays a role in both these goals.

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3. PROGRAM IMPLEMENTATION

One way to look at the aviation weather program implementation is from the perspective of the strategic objectives contained in the National Aviation Weather Strategic Plan. The four objectives in the Strategic Plan are (1) to improve aviation weather information, (2) to direct and use research related to aviation weather, (3) to enhance the decision-maker's ability to use the weather information, and (4) to facilitate institutional arrangements. The National Aviation Weather Initiatives added a fifth strategic element; (5) to improve the capability of aircraft to fly safely and efficiently in all types of weather.

Since there are few metrics to assess implementation of the aviation weather program, it is hard to quantify progress toward meeting these objectives. However, it is fair to say that over the last several years real progress has been made with the first objective, improving aviation weather information provided to users of the NAS. This has occurred partially because of the events mentioned above and partially as a result of accidents and delays that have focused attention on mitigating weather's impact on NAS operations. For example, the rash of windshear accidents that occurred in the 1980's and early 1990's focused attention on mitigating this hazard. As a result, resources were brought to bear and the number of accidents caused by windshear has been greatly reduced. Similarly, in the 1990's, aircraft icing accidents made headlines. Although icing is a continuing concern for regional carriers and general aviation, considerable work has been focused on the icing problem. Research funded by the FAA has improved the detection and forecasting of in-flight icing. The development of training tools by NASA has provided pilots with the tools to better understand the icing hazard.

Other hazards such as turbulence, convection, volcanic ash, and ceiling and visibility continue to pose problems for aviation. In-flight turbulence encounters by commercial aircraft, although usually not fatal, have caused injuries to passengers and crew members on several occasions. The detection and forecasting of turbulence is recognized as a priority and research activities within the aviation weather program have resulted in new products and capabilities for improved turbulence detection and forecasting. Convection is both a safety issue and an efficiency issue for NAS operations. During the convective season, delays occur because of thunderstorms impacting airways and airports. Given sufficient lead time, plans for aircraft rerouting can be implemented but the challenge for the forecaster has been the ability to provide the lead time required. Without sufficient lead time, the NAS can quickly become bogged down as delays mount. Considerable research has been focused on the convection problem. As a result, 1-2 hour lead times are possible; however, more needs to be done in order to increase the lead time to 6 hrs.

Although not as common a hazard, volcanic ash poses a potential threat to airborne aircraft and airports in many parts of the world. There have been close calls with aircraft experiencing engine failures from airborne volcanic ash encounters. Fortunately, these aircraft were able to land safely, but, in some cases, the cost to repair the aircraft was in the millions of dollars. The challenge is the timely detection of volcanic eruptions and the associated ash cloud and the communication of that information to the appropriate authorities so airborne aircraft in the vicinity of the eruption can take evasive actions. The continued tracking of the ash cloud so advisories can be issued for other airborne aircraft and ground facilities also presents challenges for the research community. This is an international problem and, as evidenced by the recent International Conference on Volcanic Ash and Aviation Safety (OFCM 2004), work is ongoing in the United States as well as other countries to improve detection and tracking of volcanic ash clouds. Ceiling and visibility, like convection, causes delays in the NAS. Low ceiling and visibility at an airport can cause reductions in the landing rate for that airport which in turn can cause delays throughout the system. Low ceilings and visibility are also contributing factors in general aviation (GA) accidents; many of those being fatal accidents. Visual flight into instrument conditions continues to be a leading cause for GA accidents. The FAA is funding research aimed at improving the forecasting of low ceilings and visibility both at terminals and enroute.

There are many factors that contribute to improving weather information. These include, additional observations from surface, airborne, and space-based sensors; the capability to assimilate observations from varied sources into high-resolution numerical models; new algorithms for predicting aviation impact variables; the capability to disseminate the information to users when and where it is needed; the capability to present the information in a form easily understood by the user; and the development of display systems for cockpit use. Many of the improvements in these areas come from research programs within the aviation weather program. The second objective of directing and using aviation weather research is an area within the aviation weather program where considerable progress has occurred. The FAA's Aviation Weather Research Program

(AWRP) is addressing many of the weather service areas from the aviation weather initiatives. The AWRP has product development teams for convection, icing, turbulence, ceiling and visibility, oceanic weather including volcanic ash, and winter weather. There is also work in aviation forecasts, numerical models, and new radar algorithms. The transition of new products from the AWRP into operations is formalized by the Aviation Weather Technology Transfer (AWTT) process where milestone decisions are made concerning suitability for operational use. Several products have gone through the AWTT process over the last few years, and these products are being used operationally to help mitigate hazards from convection, icing, and turbulence. For example, a graphical turbulence guidance product for levels above Flight Level 200 became operational in 2003. This product combines model output, in-situ measurements, and pilot reports to produce a turbulence forecast. Other products that have gone through the AWTT process include the Current Icing Potential (CIP) product and the National Convective Weather Forecast (NCWF). The CIP integrates data from different sources to produce a graphical depiction of icing. The NCWF is currently a 1-hour forecast that includes thunderstorm initiation, growth, and decay. The goal is to extend the forecast period to 6 hours.

In addition to the FAA, NASA's Aviation Safety Program has invested heavily in research over the last few years with the goal of reducing the weather related fatal accident rate by 80 percent. The Weather Accident Prevention (WxAP) Project and the Aircraft Icing Project have focused their work on those areas where weather has been a contributor to accidents. These projects are not only looking at mitigating weather hazards, but they are also looking at how best to disseminate and display weather information to the pilot. The Aircraft Icing Project has also done considerable work on developing training modules for pilots on ways to mitigate the effects of in-flight icing encounters on aircraft performance. The Weather Accident Prevention Project is also involved in new atmospheric remote sensing technologies, onboard sensing of atmospheric variables, and the onboard detection of turbulence and icing.

The National Weather Service has begun a 7-year aviation initiative. Planned activities include new observations, new and improved products, and training for forecasters, pilots, and controllers. Observations include expanded collection of pilot reports and aircraft-based water-vapor sensors. Products include a new volcanic ash detection satellite product and forecast products for turbulence and icing. Training for forecasters includes terminal forecast preparation and the operational impacts of forecast products. The training for pilots and controllers includes the interpretation of weather products.

As can be seen from the above discussion, there has been considerable progress in the areas of research and aviation weather information within the aviation weather program. The progress with these two objectives overlaps, to a certain degree, the third objective of enhancing the decision-maker's ability to use the weather information. In order for the information to be useful to the decision-maker, it has to be relevant, timely, and understood. The progress in the research activities discussed above has done much to make the information relevant and timely. The emphasis on graphical products, data link technologies, and new display capabilities gets the needed information to the decision-maker so decisions can be made. The issue of understanding the information is more of a training issue than anything else. If the decision-maker; for example, a pilot, controller, or dispatcher, doesn't understand what is being presented, the most relevant, timely information in the world is not going to add value to the decision process. Some progress in training has been made. As pointed out, NASA has developed training modules for pilots on in-flight icing and the NWS initiative includes improved training for pilots and controllers. Also, the Aircraft Owners and Pilots Association has various training programs for general aviation pilots. The challenge with general aviation is reaching a large, diverse pilot population. In spite of available training, training is often cited as a deficiency and although training activities exist, there is more that can be done in this area.

The fourth objective is to forge the institutional arrangements necessary for an integrated aviation weather program. Given the number of federal stakeholders as well as those in the private aviation industry, coordination and cooperation among all the players is essential. By forging institutional arrangements and defining roles and responsibilities, the process of developing requirements and assigning the necessary resources can proceed with minimum delay and duplication. To some extent this has happened. The FAA is responsible for defining aviation weather requirements for the NAS; the NWS is responsible for providing aviation weather services to meet these requirements; and the OFCM has brought agencies together in the spirit of cooperation so the aviation weather program can move forward. To formalize working arrangements, Memorandums of Agreement have been established among the agencies. The Department of Defense (DOD) is also involved although its aviation weather services are primarily tailored to the defense mission. In the area of research, the DOD does work with other federal entities although the arrangements are less formal. There are, however, formal agreements among the civilian and DOD processing centers for mutual backup of numerical weather products, including those for aviation. The forging of institutional arrangements is one area where progress is difficult to assess. Aside from the agreements that have been forged in the recent past, many of the arrangements dealing with agency roles and responsibilities are historically based on policy and procedures from past decades. Given the large, diverse number of entities involved in all aspects of aviation weather, more needs to be done to ensure that user needs are being addressed in a cost effective manner, where safety and efficiency are used to measure benefit to the system.

The fifth objective is to improve the capability of aircraft to fly safely in all types of weather. This will happen as a result of accomplishing the objectives of improving aviation weather information and enhancing the decision-maker's ability to use the information. With possibly one exception, this objective does not mean that aircraft will intentionally fly through convection, icing, or turbulence hazards, but rather by knowing the hazard's location, they will be able to avoid those hazards. As forecast uncertainties in space and time are reduced, the efficient routing of aircraft to avoid hazards will be possible. This will be even more important as the air traffic control system moves away from structured routes to free flight where users fly the most efficient routes from departure to destination. The one exception to avoiding a hazard is low ceiling and visibility. Aircraft are often forced to fly in low ceiling and visibility conditions when departing and arriving at airports. To help mitigate this hazard, NASA is working on a synthetic vision system that will essentially allow an aircraft to fly using visual references even though the aircraft is actually in instrument meteorological conditions. Not only will this improve safety, but efficiencies will be realized by allowing increased arrival rates during conditions of reduced ceiling and visibility.

4. MEASURING SUCCESS

Studies show that considerable work is being done in the aviation weather service areas that present the greatest hazard to safe and efficient flight within the NAS. Since the goal established by the 1997 White House Commission was for an 80 percent reduction in the fatal aircraft accident rate by 2007, it seems logical to use the fatal accident rate as the metric to measure real success. In 2003, the OFCM completed an assessment which included analyzing the NTSB accident statistics from 1996 through 2001. Using FAA flight hour statistics, accident rates (per 100,000 flight hours) were computed and projected forward to 2007. Using 1996 as the baseline year, the 2007 goal was established as 20 percent of the 1996 fatal accident rate. Comparing the 2007 goal with the projected fatal accident rate, a determination was made as to whether the goal could be reached. At the time the assessment was published, using data through 2001, the goal of an 80 percent reduction in the fatal accident rate where weather was a contributing factor was achievable for general aviation (Part 91) and commercial carriers (Part 121). Of course this assumes that the rates for 2002 and beyond continue the trends established by the 1996 through 2001 data. For commuter and air taxi operations (Part 135), it was problematic as to whether the goal could be reached. The assessment recommended further analysis of Part 135 operations given the varying types of aircraft and nature of their operations. There are undoubtedly many factors contributing to the decreasing accident rate for Part 91 and to conclude that the aviation weather program is the sole cause is probably not realistic. But it does seem reasonable, based on the evidence, to say that the outputs from the aviation weather program such as new aviation weather products, improved training, graphical weather information in the cockpit, and new decision support capabilities are making a difference.

5. CONCLUSION

In looking at the implementation of the National Aviation Weather Program, we used the framework of the five objectives established in the National Aviation Weather Program Strategic Plan and the National Aviation Weather Initiatives. Research efforts such as FAA's AWRP and NASA's WxAP Project are providing improved aviation weather information to the decision-maker. Graphical products, digital data bases, improved models and algorithms, new display systems, and new methods to data link information to the cockpit are a reality. Agreements have been established among agencies to improve coordination and a formal process is in place for transitioning new products into operations. Training is expanding through the efforts of organizations such as the Aircraft Owners and Pilots Association, NASA's Aircraft Icing Project, and NWS's aviation weather initiative. The result of these activities is that the capability of the pilot-aircraft team to fly safely in all types of weather is improving. Based on preliminary NTSB accident statistics for 2002 and 2003, the fatal accident rate where weather is a contributing factor continues to decline for general aviation with the expectation that the 80 percent reduction goal will be met by 2007. For Part 121, the fatal accident rate where weather is a contributing factor remains very low.

6. REFERENCES

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