Chapter 2

Method

1. Service Areas

The rationale for the service area approach was discussed in Chapter 1. The choice of the eight specific Service Areas reflects concerns expressed by many aviation industry groups at previous users forums[1]. They also show considerable overlap with focus areas defined in the "Weather Investment Recommendations" section of the National Aeronautics and Space Administration's *Aeronautics Safety Investment Strategy* document[2].

The discussion in each service area chapter follows a standard outline:

- a problem description which includes a brief discussion of the meteorological phenomenon and how it affects aviation, and a summary of any available statistics describing the impact of the phenomenon on aviation safety,
- a statement of the service area objectives,
- an indication of who in the aviation community makes safety- and efficiency-related decisions regarding the phenomenon,
- a summary of the current operations concept for the service area,
- an examination of needed improvements in the service area, using the topics of weather product generation, product delivery, and decision making as the model, and
- a table of recommended initiatives for the service area, listed in order of relative ranking.

The spotlight in each service area chapter shines directly on the identification of needed improvements and the initiatives that flow logically from them. The remainder of this chapter describes the concept of initiatives in more detail and also identifies and discusses elements that are common across all service areas.

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[1] National Aviation Weather Program Plan User Forum, 1992, OFCM; National Aviation Weather User's Forum, 1993, FAA.

[2] "Weather Investment Recommendations", 15 April 1997, accessible on the Internet at www.hq.nasa.gov/office/aero/oastthp/programs/avsaf/res.htm

2. Initiatives

Each of the needed improvements in a service area logically leads to one or more initiatives which should be undertaken, both to improve the specific service area and to improve aviation safety and efficiency in general. Initiatives can fit into any of the five objective areas shown in the ovals in Figure 1.

Initiatives which contribute to delivering improved information to decision makers include providing better time and space resolution for observations, developing better and more accurate forecasts, generating weather products that are specific to users' needs, and making dissemination of information more efficient and more focused on decision makers.

Initiatives which apply to improving the ability of decision makers to make safe and efficient decisions include training of end users on the content of products and the operation of display equipment, training of end users on the impact of the specific parameter on the operational environment, and improving procedures for making better use of products.

Initiatives that apply to improving the capabilities of aircraft to be operated safely and efficiently in a specific weather environment include more aircraft-based sensors, more automated aircraft reports, improved aircraft designs, and better pilot training in specific avoidance and escape techniques.

Initiatives can also apply directly to the institutional arrangements necessary to keep information flowing rapidly or to research and development efforts to support improvements in any of the areas.

The initiatives, keyed to the needed service area improvements, are discussed in each of the chapters. In most cases, if a particular subject is not identified as a needed improvement, there is no corresponding initiative. For example, in some of the service areas training was not viewed as needing improvement. This is not to say that training is not important but simply indicates that the current level of training is deemed adequate.

2.1 Factors Examined. A large number of initiatives were examined in preparing this document. Only those which held the most promise for achieving significant improvements have been retained. In order to establish some order of relative ranking for these initiatives, a Delphi technique was used to organize expert opinions and attain consensus. Qualitative assessments of the costs and benefits of each initiative, in relation to each other, were simply stated as high, medium, and low. The degree to which benefits outweighed costs was then used to establish a relative ranking.

Factors examined in the qualitative assessment are presented in the Table 1. They include:

Cost factors:

- the *number of service* areas affected,
- the *time* it would take to complete the initiative,
- the *technical risk* associated with the likelihood of success, and
- the *funds needed*, in terms of approximate dollars, based on the type of effort required (small R&D costs, modify existing off-the-shelf products, large-scale R&D), changes to infrastructures, and industry costs.

Benefit factors:

- contribution to *reducing accidents and injuries*,
- contribution to *reducing operational delays*, and
- likelihood of *reducing operational costs for government and industry*.

COST FACTORS		BENEFIT FACTORS
How many service areas does this initiative contribute to? _____		Safety: (60 %) Contribution to reducing accident rate _____ Contribution to reducing injury rate _____
Time to complete the initiative (10 %) _____		
Technical risk associated with successful completion (20 %) _____		Operational delays: (20 %) Contribution to reducing delays or improving operational efficiency _____
Costs Incurred: (70 %) Type of effort _____ Level of Government infrastructure change required _____ Industry cost _____		Cost Avoidance: (20 %) Contribution to reduced current or future operations cost for Government _____ Industry/Private _____

Table 1. Schematic scoring sheet listing the cost and benefits factors taken into consideration in developing relative ranking . (Percent weighting given to factors is in parentheses)

2.2 Relative Rankings. Each initiative received a relative ranking, expressed on a scale from ★★★★ to ★, based on an assessment of the factors cited. A ranking of ★★★★ means that implementation of the initiative, when compared to others in all service areas, produces a level of benefit, relative to cost, that is perceived to be much higher. A ranking of ★ means only that the

relative value is somewhat lower, but that the initiative is still cost beneficial. Implementation of any of the initiatives identified would be beneficial to aviation.

2.3 Cooperating Organizations. Accompanying each initiative in the chapter tables is a listing of organizations which would cooperate to implement the initiative. The listings of organizations in these initiatives do not imply an identified hierarchy. Lead agencies will be identified during the resource planning phase on the basis of having a charter to pursue implementation, being most likely to have the resources to accomplish it, or being likely to be held accountable for the implementation. Multiple organizations were identified, both to underscore the fact that very few initiatives will be taken all the way to operational implementation within a single agency and also to point to possibilities for resource leveraging across agencies.

2.4 Initiatives Spanning Multiple Service Areas. Certain initiatives, if implemented, would clearly benefit multiple service areas. The process for assigning rankings recognized this fact and made it an explicit factor for increasing the level of expected benefits. Chapter 11 focuses on those initiatives which have a broad range of influence.

3. Common Elements

Because each service area chapter follows the same basic format, many elements of the discussion appear regularly. In order to avoid overloading the reader with repeated detail, these common elements are discussed here and then referred to in later chapters.

3.1 Accident Statistics. The accident statistics [3] cited throughout this document apply to civilian aviation accidents as reported by the National Transportation Safety Board[4] (NTSB). The NTSB often cites specific weather hazards as primary or contributory causes in an accident. However, the reader must be aware that these citations are for the purpose of making safety recommendations and not for establishing legal liability. Rarely do weather hazards *per se* cause an aircraft to fall from the sky. The reality is that the presence of the hazard may lead a pilot to make poor or unsafe decisions that, in turn, lead to a situation in which an accident becomes more likely. The operational rationale of the *National Aviation Weather Initiatives* is to provide pilots with the training, the supporting guidance, and factual weather information that they need to consistently make safe decisions that allow them to avoid accident-producing situations altogether.

The NTSB statistics for the period 1989 to early-1997 clearly indicate that weather-related hazards affect all classes of aviation. The National Aviation Safety Data Analysis Center (NASDAC) has

[3] An accident is defined as "an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage (49 CFR 830)."

[4] Comparable statistics for military aviation were not included in the analysis.

analyzed the 17,511 NTSB aviation accident reports mentioned in Chapter 1. Of these, 3,947 (22.5 per cent) had weather as a contributing or causal factor. The vast majority of these accidents (88 per cent) involved general aviation aircraft operating under FAR (Federal Aviation Regulations[5]) Part 91 — including personal, instructional, business, ferry, and executive/corporate users. Air taxi and commercial operators under FAR Part 135 rules accounted for 6 per cent, and commercial air carriers operating under Part 121 rules accounted for 2 per cent. The remaining 4 per cent of weather-related accidents occurred in either agricultural aircraft operations (3 per cent) or in other classes.

3.2 Decision Makers and Information Providers. The terms "decision makers" and "providers" will be used regularly in later chapters. In the context of this document, *decision makers* are the people who have to act on the weather information provided to them in order to maintain safety and efficiency of flight. These decision makers include the air traffic control (ATC) service providers, Airline Operations Center personnel, and pilots who all make decisions which affect both specific and multiple aircraft. In some service areas, ground operations managers have a major decision making role.

The operational decision makers in aviation are supported by a network of *information providers* who have a direct interest in obtaining weather information and providing it to the aviation community so safety-related decisions can be made. Such people are found in all sectors of aviation – federal, military, commercial, and civilian. The providers include the weather observers, analysts, and forecasters who obtain data on the current state of the atmosphere, assimilate the data to provide a coherent picture of the atmosphere throughout the National Airspace System, and produce the analyses and forecasts that are forwarded to users. The personnel and organizations that interpret, brief, or merely convey aviation weather information to decision makers also fall under the scope of the term "information providers".

3.3 Current Operational Concepts. The separation of hazards into distinct service areas is very convenient for the discussions to follow. In reality, however, this separation is artificial. A pilot preparing for a flight does not request an icing brief and then a non-convective turbulence brief and so on. Rather, he or she obtains all available weather information pertaining to the proposed flight path. Products pertaining to specific hazards exist, but much of the relevant information is found in general weather briefs. During the *preflight phase*, the pilot obtains this information via local service providers or the Direct User Access Terminal System (DUATS) or other Internet-based providers supporting automated flight service stations (AFSS). These latter are accessed from a computer terminal or, in more sophisticated aircraft, in the cockpit. Pilots flying under the control of a dispatcher may obtain weather information from those offices either in person or by voice/electronic communications. Thorough planning during preflight not only allows the pilot to make a sound decision on whether or not to fly and how to best structure the route to avoid hazards, but also makes airborne decision-making more reliable in the event hazards are unavoidable.

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[5] The Federal Aviation Regulations, or FARs, are more correctly referred to as Code of Federal Regulations, Aeronautics and Space #14, Parts 60-139, revised as of 1 January 1993.

While *en route* the pilot must consider current weather conditions and other traffic, as well as avoidance and escape options. The pilot needs updated information en route to make the correct escape decisions if the aircraft unexpectedly encounters hazardous weather conditions. The pilot uses visual and instrument observations to provide clues to hazards. At the same time, he or she takes advantage of transmitted information from service providers in order to maximize the likelihood of avoiding such conditions altogether. Only a very few of the most modern aircraft are equipped to receive graphical information in the cockpit and even this capability is limited in scope. Even though responding to an in-flight emergency is the highest priority for air traffic control personnel, the combination of hazardous weather conditions and airspace load can hinder the controller's ability to assist pilots of small aircraft encountering hazardous conditions. Conversely, the pilots of these aircraft may not be communicating with anyone while they focus on the problem at hand.

The *terminal environment* refers to aircraft movements in the airborne areas around the terminal, on the runways and taxi ways, and at the passenger arrival and departure gates. It also includes strictly ground-based operations such as baggage handling, refueling, de-icing, and runway/taxiway maintenance.

Because preflight, en route, and terminal operational procedures are, for the most part, independent of service area, they will be referred to in most service area chapters with little elaboration.

3.4 Definitions. Aviation, like all highly technical fields, has a unique jargon couched in fields of acronyms. This document was written with a conscious effort to keep jargon and acronym use to a minimum, even at the risk of sounding unsophisticated, in order to avoid confusion. When acronyms do appear they will, for the most part, be used only briefly. However, some acronyms are so pervasive that they cannot be easily restricted to a few paragraphs. These are:

ATC — Air Traffic Control. This term includes all of the organizations — federal, state, and commercial — which provide flight information to pilots and aircrews. This includes the Air Route Traffic Control Centers, Terminal Radar Approach Control Centers, Flight Service providers, etc. In this document these functions, and others not mentioned, will generally be referred to as "ATC service providers".

ICAO — International Civil Aviation Organization. The treaty-based international organization formed to promote the safe conduct of commercial aviation throughout the world. The United States is a signatory to the ICAO agreement.

NASDAC — National Aviation Safety Data Analysis Center. A part of the Federal Aviation Administration's Office of Aviation Safety. NASDAC analyses of National Transportation Safety Board accident reports appear frequently in the Service Area discussions.

NTSB — National Transportation Safety Board. The Federal agency charged with investigating transportation accidents and making recommendations to improve the safety of transportation in the United States.

PIREP — PIlot REPorts. The term has historically been used to refer to oral situation reports by airborne pilots to ATC service providers. However, many modern commercial aircraft are equipped for sending automated (non-voice) reports which contain similar types of information. To add to the confusion, many aircraft are also equipped to send meteorological reports automatically. Unfortunately, the term PIREP is often used without clearly identifying what type of report is meant.