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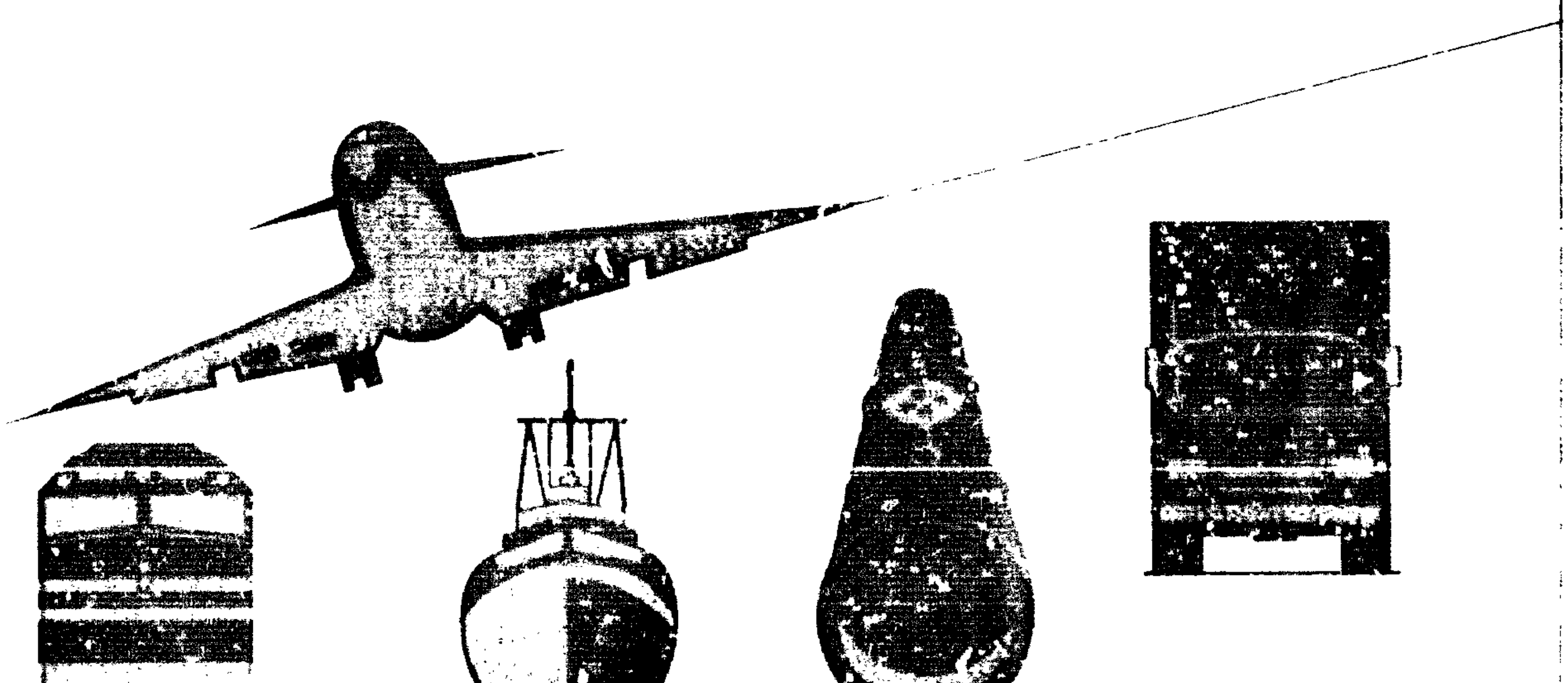
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY STUDY

AVIATION SAFETY IN ALASKA



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National Transportation Safety Board. 1995. Aviation safety in Alaska. Safety Study NTSB/SS-95/03. Washington, DC.

Flight operations in Alaska are diverse, and they are responsive to the State's challenging aviation environment and its unique air transportation requirements. The National Transportation Safety Board conducted this study to examine Alaska's current aviation environment and air transportation activities, to identify the associated risk factors and safety deficiencies, and to recommend practical measures for managing the risks to safe flight operations given the reality of Alaska's aviation environment and the potential of new technologies. The following safety issues are discussed in the study: (a) the operational pressures on pilots and commercial operators to provide reliable air service in an operating environment and aviation infrastructure that are often inconsistent with these demands; (b) the adequacy of weather observing and reporting; (c) the adequacy of airport inspections and airport condition reporting; (d) the potential effects on safety of current regulations for pilot flight, duty, and rest time applicable to commuter airlines and air taxis in Alaska; (e) the adequacy of the current instrument flight rules system and the enhancements needed to reduce the reliance of Alaska's commuter airline and air taxi operations on visual flight rules; and (f) the needs of special aviation operations in Alaska. As a result of the safety study, recommendations concerning these issues were made to the Federal Aviation Administration, the United States Postal Service, the National Weather Service, and the State of Alaska.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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AVIATION SAFETY IN ALASKA

Safety Study

Safety Study NTSB/SS-95/03
Notation 6465A

National Transportation
Safety Board

Washington, D.C.
November 1995

Acknowledgments

The National Transportation Safety Board acknowledges the contributions of the State of Alaska Department of Transportation and Public Facilities; Federal Aviation Administration, Alaskan Region; National Aeronautics and Space Administration, Ames Research Center; National Weather Service, Alaska Region; United States Postal Service; and the commercial aviation operators of Alaska and their personnel in providing information for the Board's use in this study.

Contents

Acronyms Used in the Report

AACA	Alaska Air Carriers Association
ADM	aeronautical decisionmaking
ADS	automatic dependent surveillance
AES	Canadian Atmospheric Environment Service
AFSS	Automated Flight Service Station
AMF	airport mail facility
APM	Aviation Safety Program Manager
ARTCC	Air Route Traffic Control Center
ASOS	automated surface observing system
ATC	air traffic control
AWOS	automated weather observing system
CFR	Code of Federal Regulations
DOD	U.S. Department of Defense
FAA	Federal Aviation Administration
FSDO	Flight Standards District Office
FSS	Flight Service Station
GPS	global positioning system
HAI	Helicopter Association International
IFR	instrument flight rules
IMC	instrument meteorological conditions
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NAVAIDS	navigational aids
NDB	nondirectional beacon
NOTAM	Notice to Airmen
NWS	National Weather Service
POI	principal operations inspector
RCO	remote communications outlet
SDO	supplementary data observation
USPS	United States Postal Service
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VOR	very high frequency omnidirectional range
WAAS	wide area augmentation system

Executive Summary

Flight operations in Alaska are diverse, and they are responsive to the State's challenging aviation environment and its unique air transportation requirements. Some characteristics of Alaska, such as rough terrain, adverse weather, and extreme isolation, increase the risks to safe flight operations. The risks associated with these characteristics can be managed, to varying degrees, by the operating practices of pilots and companies, and by the infrastructure of airports, navigational aids, air traffic control facilities, and weather reporting facilities. The potential for managing the risks associated with aviation in Alaska continues to improve because of developments in navigation and communications technologies. The Safety Board conducted this study to examine Alaska's current aviation environment and air transportation activities, to identify the associated risk factors and safety deficiencies, and to recommend practical measures for managing the risks to safe flight operations given the reality of Alaska's aviation environment and the potential of new technologies.

The study used data and information from the following sources: (a) the Safety Board's investigations of aviation accidents and incidents; (b) a survey of commercial pilots and operators in Alaska conducted in 1995 by the Board; (c) interviews with personnel from Alaska's aviation infrastructure; (d) public forums convened in Alaska by the Board; and (e) a survey of commercial pilots and operators in Alaska conducted in 1994 by scientists at the Ames Research Center of the National Aeronautics and Space Administration.

In recent years, fatal accident rates of Alaskan commuter airlines have decreased but remained greater than those of commuter airlines in the remainder of the United States; the fatal accident rates of Alaskan air taxis have fluctuated but in most years were greater than those of air taxis in the remainder of the Nation; and the fatal accident rates of Alaskan general aviation operations have been comparable to those of the remainder of the country.

The Safety Board's review of commuter airline, air taxi, and general aviation accidents in Alaska highlighted two accident types of major consequence: accidents during takeoff and landing; and accidents related to flying under visual flight rules into instrument meteorological conditions. Although takeoff and landing accidents are relatively frequent, few of them result in fatalities. Accidents related to visual flight into instrument meteorological conditions are less frequent but account for a large share of the fatal accidents, making them the leading safety problem for Alaskan commuter airlines and for Alaskan air taxis. Underlying this problem is the dependence of Alaskan commuter airline and air taxi operations on visual flight rules.

The following safety issues are discussed in the study:

- The operational pressures on pilots and commercial operators to provide reliable air service in an operating environment and aviation infrastructure that are often inconsistent with these demands.
- The adequacy of weather observing and reporting
- The adequacy of airport inspections and airport condition reporting.
- The potential effects on safety of current regulations for pilot flight, duty, and rest time applicable to commuter airlines and air taxis in Alaska.
- The adequacy of the current instrument flight rules system and the enhancements needed to reduce the reliance of Alaska's commuter airline and air taxi operations on visual flight rules.
- The needs of special aviation operations in Alaska.

As a result of the safety study, recommendations concerning these issues were made to th Federal Aviation Administration, the United States Postal Service, the National Weather Service, and the State of Alaska.

Chapter 1

Introduction

The National Transportation Safety Board has had a longstanding interest concerning aviation safety in Alaska. One segment of Alaska aviation, the air taxi industry, was the subject of a special study published in September 1980.[1] The Safety Board concluded in the study that three factors contributed most to the high air taxi accident rates in Alaska: (1) the "bush syndrome," defined as an attitude of air taxi operators, pilots, and passengers ranging from their casual acceptance of risks to their willingness to take unwarranted risks; (2) inadequate airfield facilities and inadequate communications of airfield conditions; and (3) inadequate weather observations, inadequate communications of the weather information, and insufficient navigation aids.

As a result of the air taxi study, the Safety Board issued safety recommendations to the Federal Aviation Administration, the State of Alaska, and the Alaska Air Carriers Association concerning the planning and development of Alaska's aviation system and infrastructure, weather observation and dissemination of weather information, and regulatory surveillance and operator safety oversight. Actions taken by the recipients in response to the recommendations combined with other safety developments during the 15 years since the Board's 1980 study have brought many improvements to the aviation system in Alaska. Improvements are discussed in this report. Despite the improvements, however, the Safety Board's investigations of aviation accidents in Alaska indicate that the safety issues identified in the 1980 study remain areas of concern.

Flight operations in Alaska are diverse, and they are responsive to the State's challenging aviation environment and its unique air transportation requirements. Some characteristics of Alaska, such as rough terrain, adverse weather, and extreme isolation, increase the risks to safe flight operations. The risks associated with these characteristics can be managed, to varying degrees, by the operating practices of pilots and companies, and by the infrastructure of airports, navigational aids, air traffic control facilities, and weather facilities. The potential for managing the risks associated with aviation in Alaska is particularly high now, because of developments in navigation and communications technologies. The Safety Board conducted this study to examine Alaska's current aviation environment and air transportation activities, to identify the associated risk factors and safety deficiencies, and to recommend practical measures for managing the risks to safe flight operations given the reality of Alaska's aviation environment and the potential of new technologies.

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[1] National Transportation Safety Board. 1980. Air taxi safety in Alaska. Special Study NTSB-AAS-80-3. Washington, DC.

Chapter 2 of this report describes the methodology of the study. Chapter 3 provides an overview of Alaska's aviation environment and air transportation needs. Chapter 4 describes the types of aviation operations that have developed in response to the State's aviation environment and air transportation needs, and accident rates. Chapter 5 examines factors affecting the safety of takeoffs and landings in Alaska. Chapter 6 examines factors affecting the safety of operations conducted under visual flight rules in Alaska. Chapter 7 discusses methods to enhance the low altitude instrument flight rules system to fulfill Alaska's air transportation requirements. Chapter 8 reviews special aviation operations in Alaska. The last sections present the Safety Board's findings and safety recommendations made as a result of the study.

Chapter 2

Methodology

For this study, the Safety Board obtained and reviewed information from several sources: (1) records in the Board's aviation accident/incident data base; (2) the Board's investigations of aviation accidents that occurred in Alaska; (3) a survey of commercial pilots and operators in Alaska conducted in 1995 by the Board; (4) interviews with Alaskan aviation infrastructure personnel conducted during site visits; (5) public forums convened in Alaska by the Board; and (6) a survey of commercial pilots and operators in Alaska conducted in 1994 by scientists at the Ames Research Center of the National Aeronautics and Space Administration (NASA).

Accident/Incident Data Base

Of the 31,878 aviation accidents that occurred in the United States between 1983 and 1994, 2,214 occurred in Alaska. The Safety Board's computerized data base enabled the Board to identify accident trends over time and to compare general characteristics of accidents occurring in Alaska with those in the remainder of the United States. To maximize the relevancy of the data to the present, for most comparisons, the Board focused on the 5-year period from 1989 to 1993.

Accident Investigations

The Safety Board also reviewed material from its investigations of aviation accidents that occurred in Alaska during the period 1989 through 1993, plus later accidents that occurred through mid-1995.[2] Several accidents are summarized in this report to illustrate specific safety issues. Pertinent safety recommendations issued as a result of the accident investigations, and actions taken in response, are also discussed.

In conjunction with its review of previously conducted investigations, the Safety Board classified accidents involving commuter airlines and air taxis between 1989 and 1993 into 12

[2] The Safety Board's review of its previously conducted investigations did not result in any revisions to the findings, conclusions, or determinations of the probable cause of the accidents. Further, the Board did not conduct any accident investigations specifically for this study of aviation safety in Alaska.

broad categories related to causal and contributory factors:[3] (1) airframe icing; (2) airframe/systems failure; (3) airport/runway conditions; (4) engine failure; (5) improper procedure for flight under IFR; (6) landing aim point/flare; (7) overloading; (8) pilot procedure; (9) stall/spin; (10) flight under visual flight rules (VFR) into instrument meteorological conditions (IMC); (11) wind/turbulence; and (12) other/undetermined. The classification, discussed further in chapter 4, highlighted the major areas of concern regarding the safety of Alaskan aviation. The associated safety issues are discussed in later chapters of this report.

Survey of Alaska Commercial Pilots and Operators

Description of the Survey.--Between March and August 1995, the Safety Board obtained information about aviation operations through structured, on-site interviews of 50 pilots and managers of commercial operations (commuter airlines and air taxis) in Alaska. The population of commuter airlines and air taxis was stratified to ensure representation for each of the seven geographic regions of Alaska (figure 2.1) and for operations of various types and sizes. Within each region and operator group, survey participants were chosen at random. Neither the names of the participants nor their employers were recorded.

The representation of the seven geographic regions by the 50 survey participants is shown in the following tabulation. Because some of the participants reported operating in more than one region, their number appears to total more than 50:

Region	Number of participants
Aleutian Islands	12
Arctic Circle	12
Central interior	10
Northwest	13
Southeast	10
Southwest	21
South-central	14

Survey participants were asked questions in the following areas: general operational information and demographics; hiring and initial qualification of flightcrews; ground and flight training; flight time, duty time, and compensation; operating environment; pressures to

[3] Each accident was assigned to a single category based on the Safety Board's previous determination of the probable cause of and contributing factors to the accident. The accident categories used for this study do not replace or alter the Safety Board's findings that resulted from the investigations.

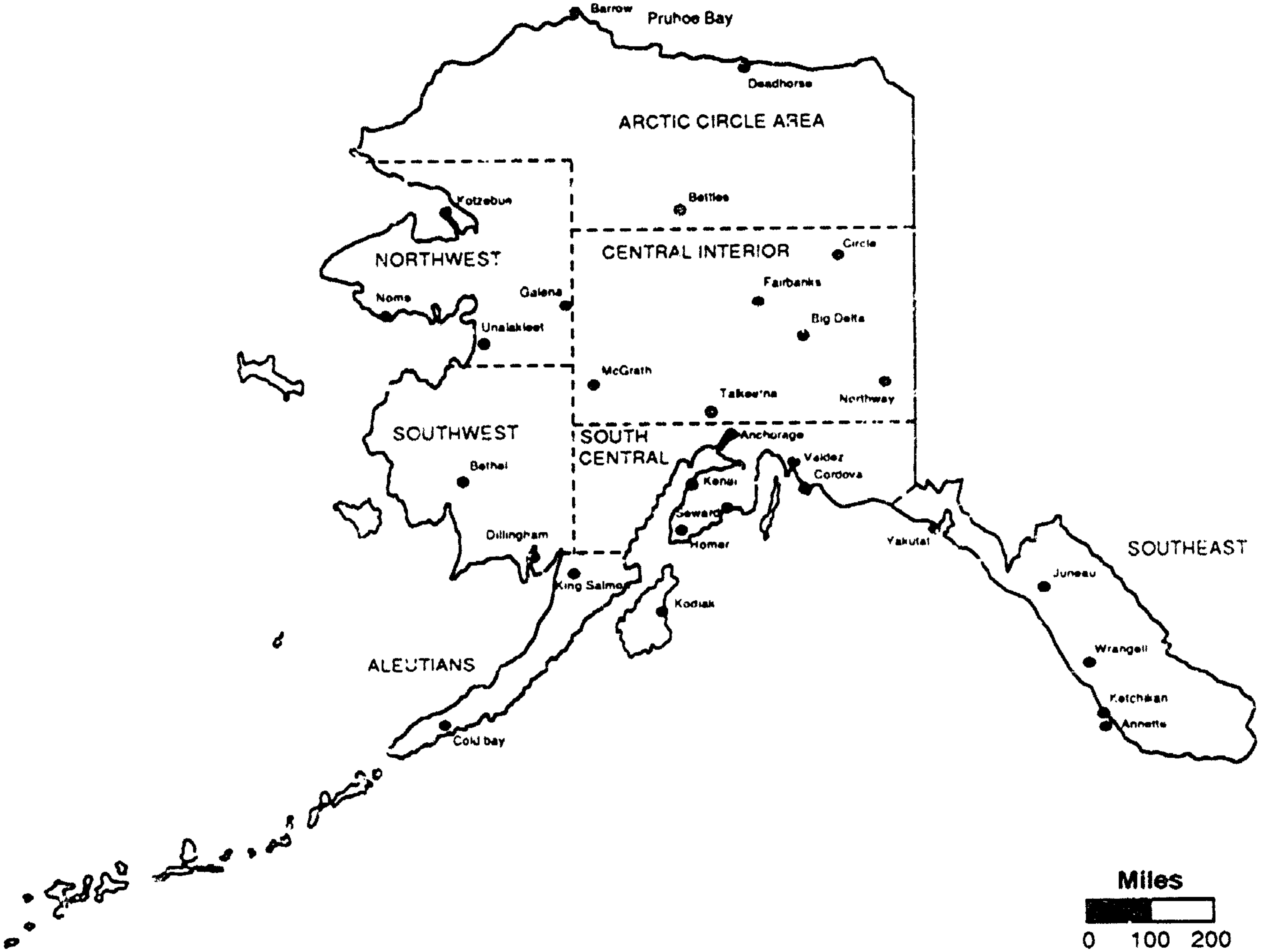

Figure 2.1—Geographic regions of Alaska.

fly; air traffic control, navigational aids, and communications; weather and environment; airport and airstrip information; aircraft maintenance; safety programs and accident prevention initiatives; airline management and oversight; and Federal Aviation Administration (FAA) surveillance and oversight. Information from the participants' responses relevant to specific safety issues is presented in the chapters that follow. Survey questions are provided in appendix A.

Demographics of the Participants.—Of the 50 participants, 39 (78 percent) identified themselves as pilots. Thirty-two (64 percent) of the participants identified themselves as managers; of these, 20 also served as pilots. Management responsibilities of the survey participants included owner/president (9 persons), director of operations (7 persons), and chief pilot (8 persons); other respondents served in a variety of operational, maintenance and station-related management positions. Most of the participating pilots had extensive flight experience; more than half had over 10 years of commercial flying experience in Alaska and had been employed by their current company for more than 5 years.

Demographics of the companies employing the survey participants were obtained from participants' responses to questions about the purposes of their flights, and about the characteristics and number of the aircraft in the company's fleet. One-quarter of the survey respondents reported that 95 percent or more of their flights were charter trips; the other three-quarters were more involved in scheduled commuter flying, but some had done charter flying as well. Of the 50 respondents, 33 provided information about their company's aircraft fleet. Companies operated between zero[4] (two companies) and 54 (one company) single-engine aircraft; half the companies had 7 or fewer single-engine aircraft. Companies operated between zero[5] (12 companies) and 28 (one company) multiengine aircraft; half the companies had only 1 or no multiengine aircraft.

Interviews With Personnel From Alaska's Aviation Infrastructure

In addition to the commercial pilot/operator survey, Safety Board staff specialists in air traffic control, weather, and airports interviewed personnel employed in those areas during field visits throughout Alaska. Information obtained from these interviews is presented in subsequent chapters.

[4] These companies operated only multiengine aircraft.

[5] These companies operated only single-engine aircraft.

Public Forums

The Safety Board held public forums on aviation safety in Alaska in Juneau on May 22, 1995, and in Anchorage on May 24 and 25, 1995.[6] During the 3 days, 28 representatives from government, industry, trade groups, and labor unions convened to discuss issues and concerns in the following areas: (1) Alaskan air tour operations; (2) aeroguide, aerolodge, and tundra tire operations; (3) aerologging in Alaska; (4) flight and maintenance operations; (5) air traffic control, navigational aids, and communications; (6) weather; and (7) airports.

The representatives participating in panel sessions were asked to submit written material pertinent to the areas being examined; the material was submitted to the Safety Board in advance of the proceedings. At the beginning of each panel session, the panel members presented a brief oral summary of their written submissions. After all members had completed their oral presentations, the panel members engaged in open discussion of the issues raised in their oral presentations or by questions posed by the Chairman and staff of the Safety Board. At the conclusion of each panel session, the audience was given the opportunity to question the panel members or bring issues to the attention of the Safety Board's representatives.

NASA Survey

In August 1994, scientists from the National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System, located at the Ames Research Center, surveyed 41 volunteer participants who were pilots or managers involved in commercial aviation in Alaska. The NASA scientists provided a preliminary report of their findings at the Safety Board's public forum in Anchorage on May 24, 1995. The Board used information from the NASA survey to supplement information obtained from the Board's own survey as part of its current study of aviation safety in Alaska. Pertinent findings of the NASA survey are discussed in this report.

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6 The proceedings were overseen by a Board of Inquiry that was led by the Chairman of the Safety Board and included Safety Board senior management and staff. The proceedings were transcribed.

Chapter 3

Alaska's Aviation Environment

This chapter briefly describes Alaska's aviation operating environment, which has many characteristics that make aviation in the State different from that of the remainder of the country. Alaska's aviation operating environment encompasses the State's geography, climate, special air transportation requirements, and its aviation infrastructure (weather reporting/forecasting system, navigational aids, air traffic control system, and airports).[7]

Geography

Alaska spans a distance of 2,000 miles from east to west and 1,100 miles from north to south. The State's land mass includes tracts of glacial ice and vast mountainous areas with numerous peaks over 10,000 feet elevation. These mountainous areas are barriers to surface transportation and challenges to light aircraft operations. Most inhabited areas, though, are below 1,000 feet elevation. Alaska also has a long coastline and many lakes, which are conducive to the use of seaplanes.

Climate

The climate of Alaska is affected by its northern location, vast land area, exposure to the sea, and varied topography. These factors produce diverse climatic zones that include maritime elements, characterized by moderate temperatures and moist air, and continental elements, characterized by extreme temperatures and drier air.

The combination of abundant moisture and coastal mountains produces annual precipitation amounts up to 200 inches in the maritime zone. Precipitation amounts decrease to near 60 inches on the southern side of the Alaska Range. The continental zone averages about 12 inches, and the Arctic zone averages less than 6 inches of total precipitation annually.

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[7] These are the elements of Alaska's aviation infrastructure that are relevant to the safety issues addressed in this study; the elements will be discussed in more detail in the chapters that follow.

Mean annual temperatures range from an average in the low 40°F in maritime sections of southern Alaska to near 10°F in the Arctic zone. The greatest temperature extremes occur in the continental zone, where summertime temperatures can reach into the 90°F and winter-time temperatures often drop into the -40°F.

Storms frequently affect the Aleutian Island chain, the Alaska Peninsula, and coastal areas of southern Alaska. Winds associated with these storms frequently exceed 50 miles an hour.

Flying weather in Alaska can be quite variable depending on the climatic zone and time of year. Although all parts of Alaska experience periods of instrument meteorological conditions (IMC), such conditions are frequent in the Aleutian Islands, Alaska Peninsula, southeast Alaska, and the Arctic Coast during the summer and early fall.

Alaska's geography also causes a large impact on flying weather conditions. Innumerable localized climatic conditions exist near mountainous terrain, mountain passes, and glaciers. Also, mountain tops are frequently obscured by clouds, and the freezing level is rarely above 7,000 feet. According to the National Weather Service (NWS), icing is most common and severe in the vicinity of higher terrain bordering the Gulf of Alaska, over the Alaska Peninsula, and in southeast Alaska.

Alaska's northern latitude causes the hours of daylight to vary to a greater extent than elsewhere in the United States. For example, Barrow, on the Arctic north slope, has weeks of continuous darkness in winter and light in summer, respectively. The extended periods of darkness in the State can pose challenges for visual navigation, weather avoidance, and runway operations; the extended periods of light can be stressful for operators and their personnel because of the long hours available to provide service.

Special Aviation Requirements

Of the 550,000 people who live in Alaska,[8] 283,932 (52 percent) reside in the State's three largest cities (Anchorage, Fairbanks, and Juneau). The isolation of residents in the remainder of Alaska is reflected by the State's population density of 1 person per square mile, less than one-quarter that of the next least densely populated State, Wyoming, and far less than the average population density for the Nation as a whole, 70.3 persons per square mile.

Between the State's remote population centers lie its difficult terrain and few ground transportation links. The single year-round intercity highway links Fairbanks with Anchorage

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[8] Population count in the 1990 U.S. Census. (U.S. Bureau of the Census. 1992. Statistical abstract of the United States: 1992. 112th ed. Washington, DC.)

and continues down the Kenai peninsula to Homer; a branch of this road runs along Prince William Sound to Valdez. A seasonal gravel road follows the Alaska pipeline north from Fairbanks to Prudhoe Bay. There is one railroad, which runs between Fairbanks and Anchorage with an extension to Whittier and Seward. Some residents of coastal communities are served by marine transportation. All other links between Alaska's cities, towns, villages, and encampments are provided solely by air transportation. Even the State's capital, Juneau, is not connected to the road system.

Alaska's extreme dependence on air transportation is marked by the aviation orientation of its population, unmatched elsewhere in the country. Compared to the remainder of the United States, the State has 6 times as many pilots, 14 times as many aircraft,[9] and 76 times as many commuter airline flights per capita.[10]

Lacking the ground alternatives so often present in the remainder of the country, Alaska's aviation operators are required to play a heightened role in fulfilling critical transportation needs. Food, fuel, and school children are regularly transported by air. Medical evacuation flights from remote areas are commonplace. The need to use aviation to meet these transportation requirements places pressure on the air transportation system to perform on time, all year, and frequently in adverse weather. Consequently, this pressure is part of the State's aviation environment.

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[9] Federal Aviation Administration. 1995. Alaska aviation fact sheet [Mimeo]. Office of Public Affairs. Anchorage, AK. May.

[10] Federal Aviation Administration. 1994. An analysis of the safety record of commuter air carrier accidents [Mimeo]. Washington, DC (p. 7).

Chapter 4

Alaska's Aviation Operations and Accidents

Since the days of the early bush pilots who pioneered the vast territory of Alaska, a diverse set of aviation operations have developed in response to the operating environment and air transportation requirements of the State. This chapter describes the Alaska-specific characteristics of commuter airline, air taxi, and general aviation operations and the accident rates of the operators. The chapter concludes with a comparison of two types of accidents that have plagued these three operator types in Alaska: accidents during takeoff and landing, and accidents related to VFR flight into IMC.

Operator Types and Their Accident Rates

Despite the need to cope with Alaska's difficult operating environment, aviation operations of all types in the State are extremely safe. Overall, commuter airline, air taxi, and general aviation operations in Alaska operated nearly 13 million flight hours from 1989 through 1994 and experienced 1,566 accidents, 193 of which resulted in fatalities.[11] The Safety Board recognizes the high level of safety achieved by Alaska's operators in recent years; nevertheless, its examination of the accident rates experienced by some types of operators in the State led the Board to consider ways to further improve the safety of their flights.

Commuter Airlines.—Nationwide, commuter airlines (scheduled air carriers that provide service using airplanes with 30 or fewer passenger seats, operating under 14 CFR Part 135) fulfill an increasing role in transporting people, goods, and mail from air carrier hubs to smaller communities. In Alaska, commuter airlines take this role to its extreme, serving as the only transportation link to most small communities. As of 1994, commuter

[11] The number of accidents, flight hours, and accident rates per 100,000 flight hours are provided in appendix B for air carrier, commuter airline, air taxi, and general aviation operations from 1986 through 1994. These data are presented separately for Alaska and the remainder of the United States. Appendix B shows that accident rates of the air carriers operating under Title 14 Code of Federal Regulations (14 CFR) Part 121 in Alaska have been comparable with those of Part 121 operators in the remainder of the United States, between 1986 and 1994. Consequently, this study focused on operations conducted under Part 135 (commuter airlines and air taxis) and Part 91 (general aviation).

airlines in Alaska served 238 locations;[12] of these, only 5 have road transportation to the airline hub and major city, Anchorage.[13] The absence of an alternative ground transportation system in Alaska has resulted in an extremely high demand for commuter airline operations. With 0.2 percent of the national population, Alaska accounted for 16 percent of commuter aircraft flight hours in 1994.[14]

Most U.S. commuter airline service outside Alaska is dominated by multiengine, turbine-powered airplanes of 19 seats or larger, operated under instrument flight rules (IFR), and crewed by two pilots (captain and first officer).[15] In contrast, commuter airline operations in Alaska are dominated by single-engine airplanes powered by a reciprocating engine, operated under visual flight rules (VFR), and crewed by one pilot. In 1993, 33 of the 39 commuter airline operators in the State used single-engine aircraft in scheduled service.[16] Of these, 7 operators used only single-engine aircraft. Of the 477 aircraft assigned to commuter airline service in Alaska, more than 300 (65 percent of the fleet) are single-engine aircraft powered by a reciprocating engine.[17] The single-engine commuter airplanes in Alaska primarily serve the remote villages, many of which have only gravel or dirt landing strips that are not long enough to accommodate larger aircraft.

From 1989 through 1993, commuter airlines in Alaska experienced 41 accidents. Nine (22 percent) of these resulted in fatalities.

Of the 41 commuter airline accidents, 25 (61 percent) involved single-engine airplanes. That number is not surprising given the common usage of single-engine aircraft types. In comparison, of the 60 commuter airline accidents that occurred in the remainder of the United States during the same period, only 6 (10 percent) involved single-engine airplanes.

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[12] Regional Airline Association. 1995 annual report. Washington, DC (p. 124).

[13] In the same year, commuter airlines in the remainder of the United States served 520 locations. Of these communities, only a few are not directly connected to the road network; however, they are located on islands that are close to land and have water ferry connections.

[14] Flight hours are estimated by the Federal Aviation Administration.

[15] According to the Regional Airline Association, turbine-powered, multiengine aircraft accounted for more than 80 percent of commuter airline (Part 135) aircraft hours flown during 1994 in the entire United States, including Alaska. Derived from the Regional Airline Association's 1995 annual report (p. 29).

[16] Federal Aviation Administration, Alaskan Region. [No date]. Single engine commuters in Alaska. Anchorage, AK: Flight Standards Division (p. 1).

[17] Alaska Air Carriers Association. June 27, 1995. Comments of the Alaska Air Carriers Association on commuter operations and general certification and operations requirements before the Department of Transportation, Federal Aviation Administration. Washington, DC.

Commuter airline accident rates are often based on the number of flights rather than flight hours; if most accidents occur during takeoff/climb and approach/landing, the number of flights better reflects the exposure to risk. Indeed, most fatal commuter airline accidents in the United States, excluding Alaska, have occurred during takeoff or landing: of the 17 fatal commuter airline accidents from 1989 through 1993, 14 occurred during takeoff/climb or approach/landing. However, most fatal commuter airline accidents in Alaska have occurred during en route operations: all of the 9 fatal commuter airline accidents in Alaska from 1989 through 1993 involved en route operations (7 accidents during the cruise phase, 2 during the maneuvering phase). Consequently, although commuter airlines in Alaska may perform more takeoffs and landings per flight hour than commuter airlines in the remainder of the United States,[18] the accident rate per 100,000 hours provides a fair comparison of commuter airline safety in Alaska and in the remainder of the country.

Figure 4.1 shows the accident rates per 100,000 flight hours[19] for commuter airlines in Alaska and the remainder of the United States for the period 1986 through 1994. In most of these years, the total accident rate (for fatal and nonfatal accidents) was substantially greater for commuter airlines in Alaska than for commuter airlines in the remainder of the United States. Although the fatal accident rate for Alaska shows a pronounced downward trend at the end of the period, in 1994 it was three times greater (worse) for commuter airlines in Alaska than for commuter airlines in the remainder of the United States.

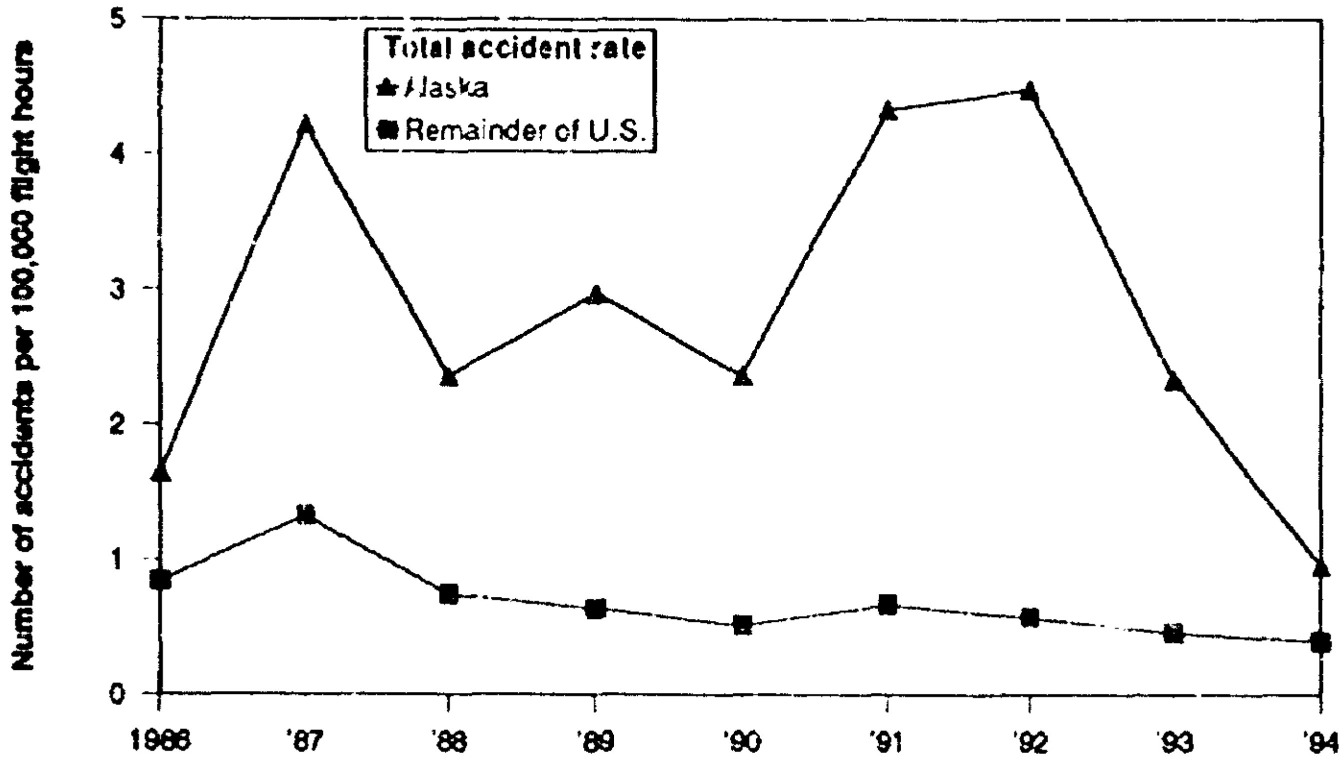
As mentioned in chapter 2, the Safety Board classified each commuter airline accident that occurred in Alaska between 1989 and 1993 into 1 of 12 broad categories related to causal and contributory factors. Distribution of the 41 commuter accidents among the categories is shown in table 4.1.

Most of the fatal accidents (6 of 9) were related to VFR flight into IMC, highlighting that category as the leading safety problem for commuter airlines in Alaska. Of the 32 nonfatal accidents, airport and runway conditions (which affect takeoffs and landings) accounted for the largest number of accidents (10 accidents). The airport/runway conditions cited by the Safety Board ranged from snow-covered, icy, rough, or soft surfaces to the presence of unauthorized vehicles and objects on the runway.

Air Taxis.—Air taxis (operators that provide nonscheduled commercial flights under 14 CFR Part 135) provide the primary link between hundreds of small, remote villages in Alaska. They also provide access to the States' wilderness areas. Of the 50 participants in the Safety Board's survey, 11 reported that they engaged solely in air taxi operations. The

[18] In a review of published schedules for several commuter airlines in Alaska, the Board noted that many flights are short-haul operations of less than 50 miles between a central hub (such as Barrow or Bethel) and a nearby village.

[19] Estimates of flight hours used to calculate the accident rates are from the Federal Aviation Administration.



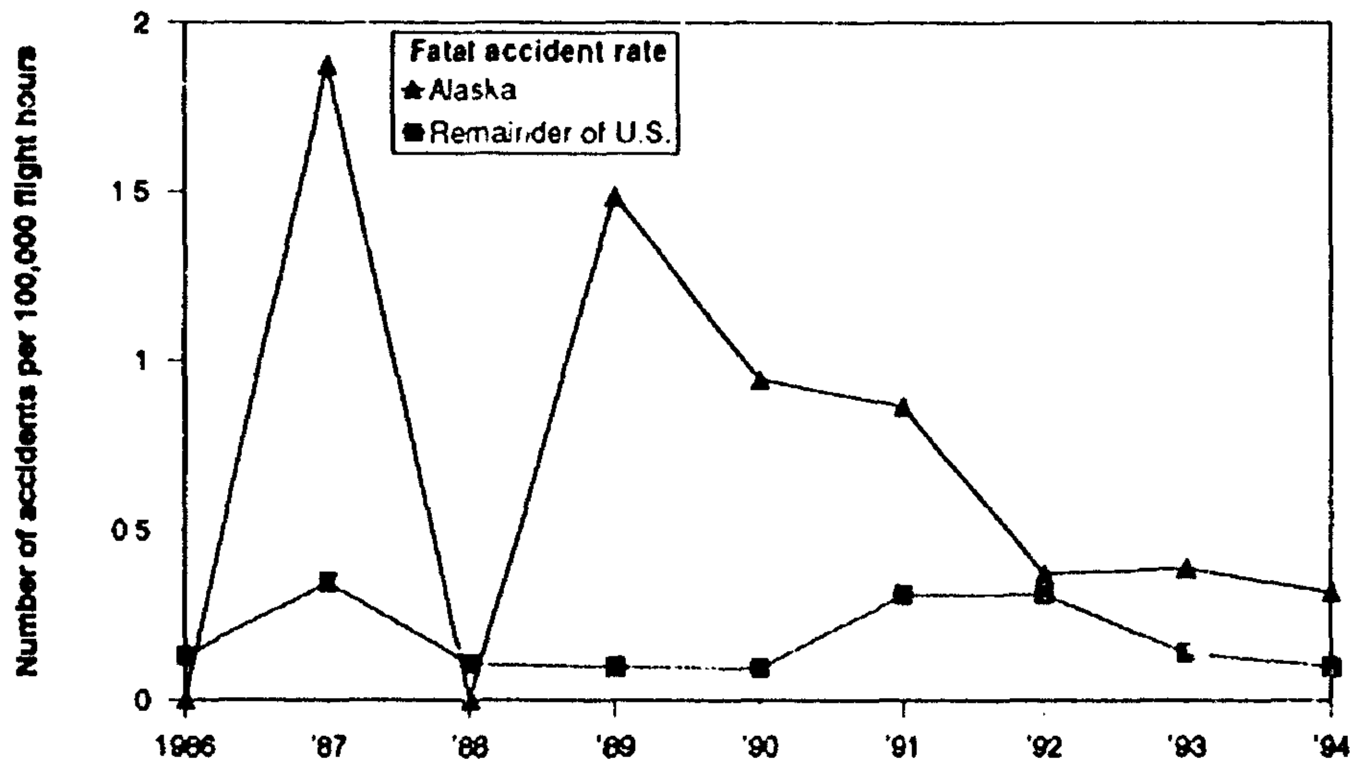


Figure 4.1—Accident rates for commuter airlines, 1986 through 1994.

Table 4.1—Number of commuter airline accidents occurring in Alaska by broad category related to causal and contributory factors, 1989 through 1993

Accident category	Nonfatal accidents	Fatal accidents	All accidents
Airframe icing	2	0	2
Airframe/systems failure	1	0	1
Airport/runway conditions	10	0	10
Engine failure	2	1	3
Improper IFR procedure	1	0	1
Landing aim point/flare	3	0	3
Overloading	0	0	0
Pilot procedure	1	1	2
Stall/spin	2	0	2
VFR flight into IMC	3	6	9
Wind/turbulence	6	0	6
Other/undetermined	1	1	2
All categories	32	9	41

diversity of the activities supported by their air taxi flights is shown in the following tabulation. Many of the 11 respondents reported operating flights for more than one activity. The hunt guiding, fish guiding, and air tour activities reported by many of the survey respondents reflect the importance of these activities to Alaska's aviation and tourism industries. Commercial flight operations related to guiding and sightseeing are conducted under both the air taxi regulations of Part 135 and the general operating rules of Part 91; these special aviation operations are discussed further in chapter 8.

Activity	Air taxi operators reporting
Hunt guiding	7
Fish guiding	7
Cargo transportation	7
Passenger transportation	6
Sightseeing	6
Mining	2
Game management	1
Camping	1

To perform air taxi services in the Alaskan environment necessitates frequent remote area operations, including off-airport takeoffs and landings. These operations are depicted in many of the operators' advertising brochures (signifying the attraction of customers to air services to remote areas), and the risks associated with such operations are reflected in the accident records.

Figure 4.2 shows the accident rates per 100,000 flight hours for air taxis in Alaska and the remainder of the United States for 1986 through 1994. Air taxis in Alaska consistently experienced a greater total accident rate than did air taxis in the remainder of the country throughout the period. The fatal accident rate of air taxis in Alaska fluctuated considerably, but in most years during the period it exceeded the rate of air taxis in the remainder of the United States. There was no pronounced trend over time.

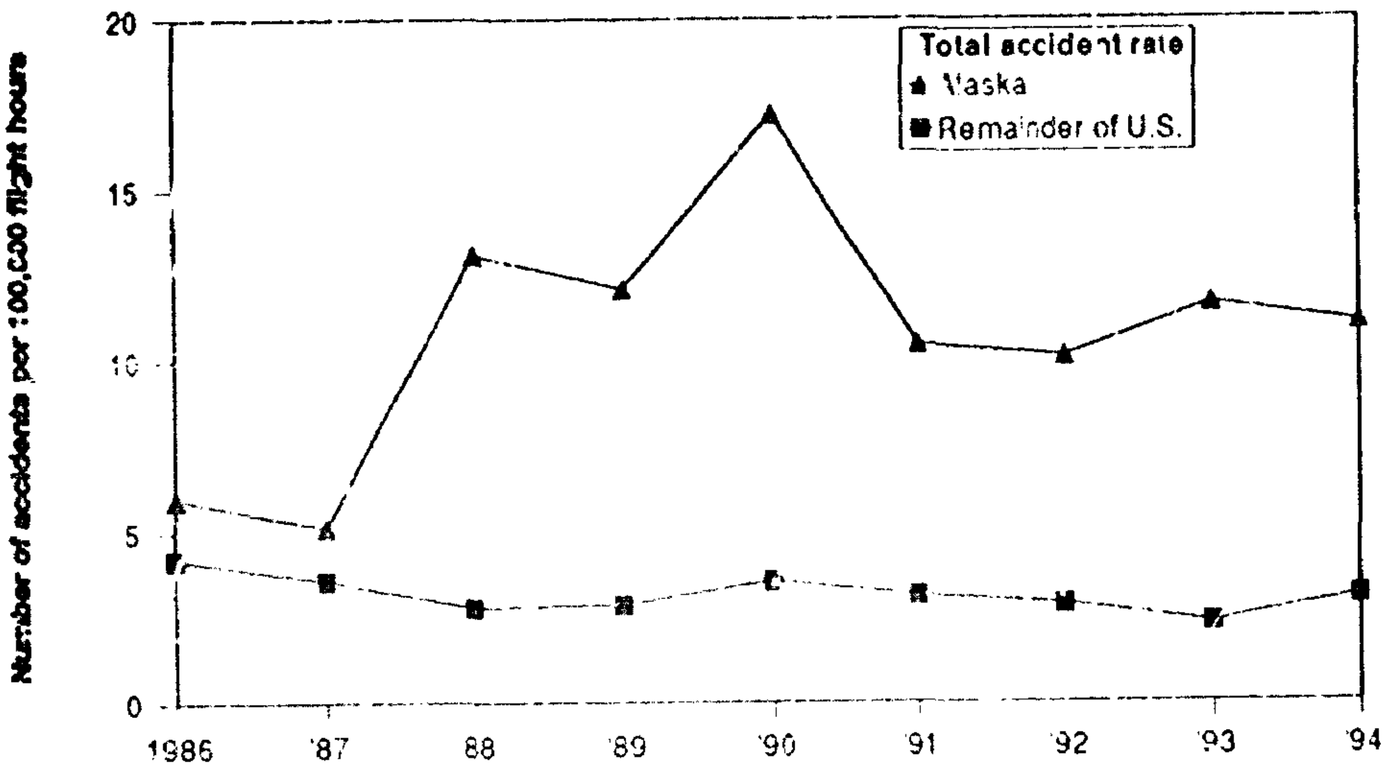
From 1989 through 1993, 142 air taxi accidents occurred in Alaska; 15 (11 percent) of these accidents resulted in fatalities. Of the 142 accidents, 21 (15 percent) involved helicopters; in comparison, 82 (25 percent) of the 331 air taxi accidents that occurred in the remainder of the country involved helicopters.

The Safety Board categorized the 142 air taxi accidents using the same causal/contributing factor classification scheme described earlier in this report. Distribution of the 142 air taxi accidents among the categories is shown in table 4.2.

The large percentage of fatal accidents related to VFR flight into IMC (7 of 15, or 47 percent) points to that category as the leading safety problem for air taxis as well as for commuter airlines in Alaska.

Many of the accidents related to airframe/systems failure, airport/runway conditions, and wind/turbulence involved off-airport operations. Landing gear fittings failed after repeated use on rough surfaces, such as takeoffs and landings on glaciers and rough waterways. Also, airplanes landed short of runways in gusty wind conditions, but the margin for error in the landing was small because the landing strip was only 500 feet long. Similarly, some accidents involved the loss of directional control during takeoff or landing on narrow airstrips that offered little room in which to make corrections.

The air taxi accidents showed a greater involvement of engine failures than did the commuter airline accidents. The engine failures occurred in various types of single-engine airplanes, multiengine airplanes, and helicopters. The Safety Board notes that among these were several types powered by radial engines; however, insufficient data exist to determine whether engine failure occurred more frequently than would have been expected based on the usage of these engines in the air taxi fleet.



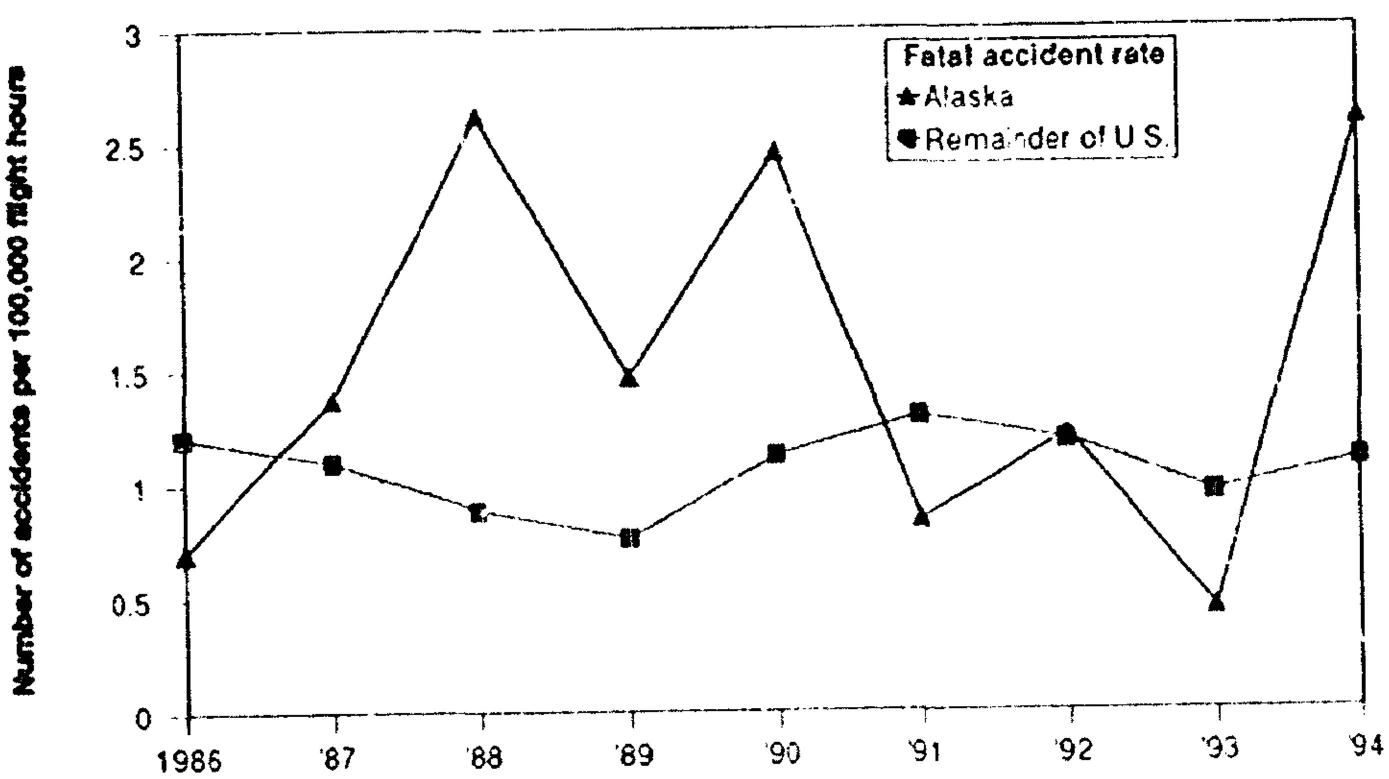


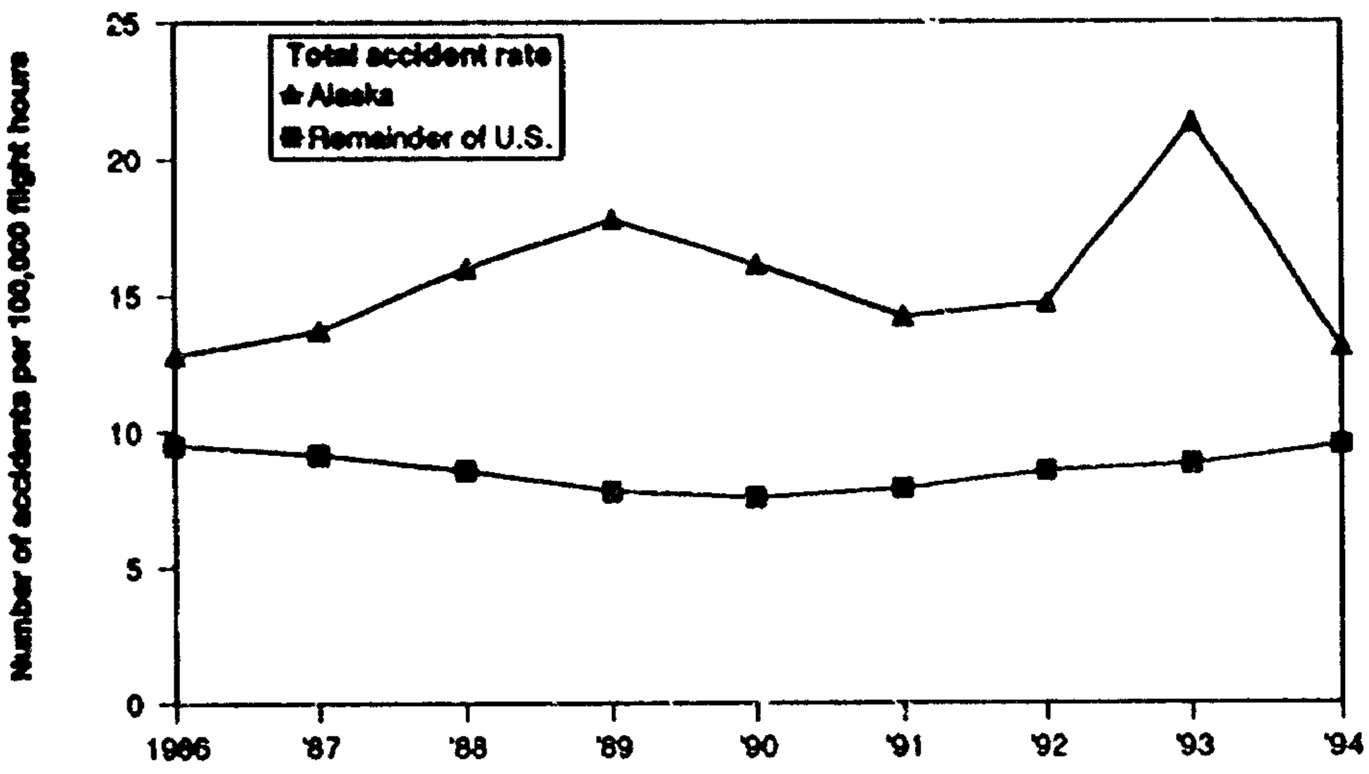
Figure 4.2—Accident rates for air taxis, 1986 through 1994.

Table 4.2—Number of air taxi accidents occurring in Alaska by broad category related to causal and contributory factors, 1989 through 1993

Accident category	Nonfatal accidents	Fatal accidents	All accidents
Airframe icing	4	0	4
Airframe/systems failure	14	1	15
Airport/runway conditions	23	0	23
Engine failure	22	1	23
Improper IFR procedure	0	1	1
Landing aim point/flare	3	0	3
Overloading	2	1	3
Pilot procedure	[illegible]	0	15
Stall/spin	3	1	4
VFR flight into IMC	11	7	18
Wind/turbulence	17	1	18
Other/undetermined	14	2	16
All categories	127	15	142

General Aviation.—General aviation (private and limited commercial operations, such as guiding and local area sightseeing) continues to play a vital role in Alaska's transportation system. General aviation operations conducted under Part 91 share many of the same purposes of flight, often use the same types of single-engine airplanes, and cope with the same environmental factors as air taxi operations conducted under Part 135. Accordingly, many factors affecting the safety of air taxi operations also affect general aviation operations. Likewise, most of the needed safety improvements for commercial aviation discussed later in this report would also improve the safety of general aviation.

Figure 4.3 shows the accident rates per 100,000 flight hours for general aviation in Alaska and the remainder of the United States for 1986 through 1994. As was the case for commuter airlines and air taxis, the total accident rates for general aviation in Alaska consistently exceeded the rates for general aviation in the remainder of the Nation. For the entire period, however, the fatal accident rate for general aviation in Alaska was nearly identical to that of the remainder of the United States.



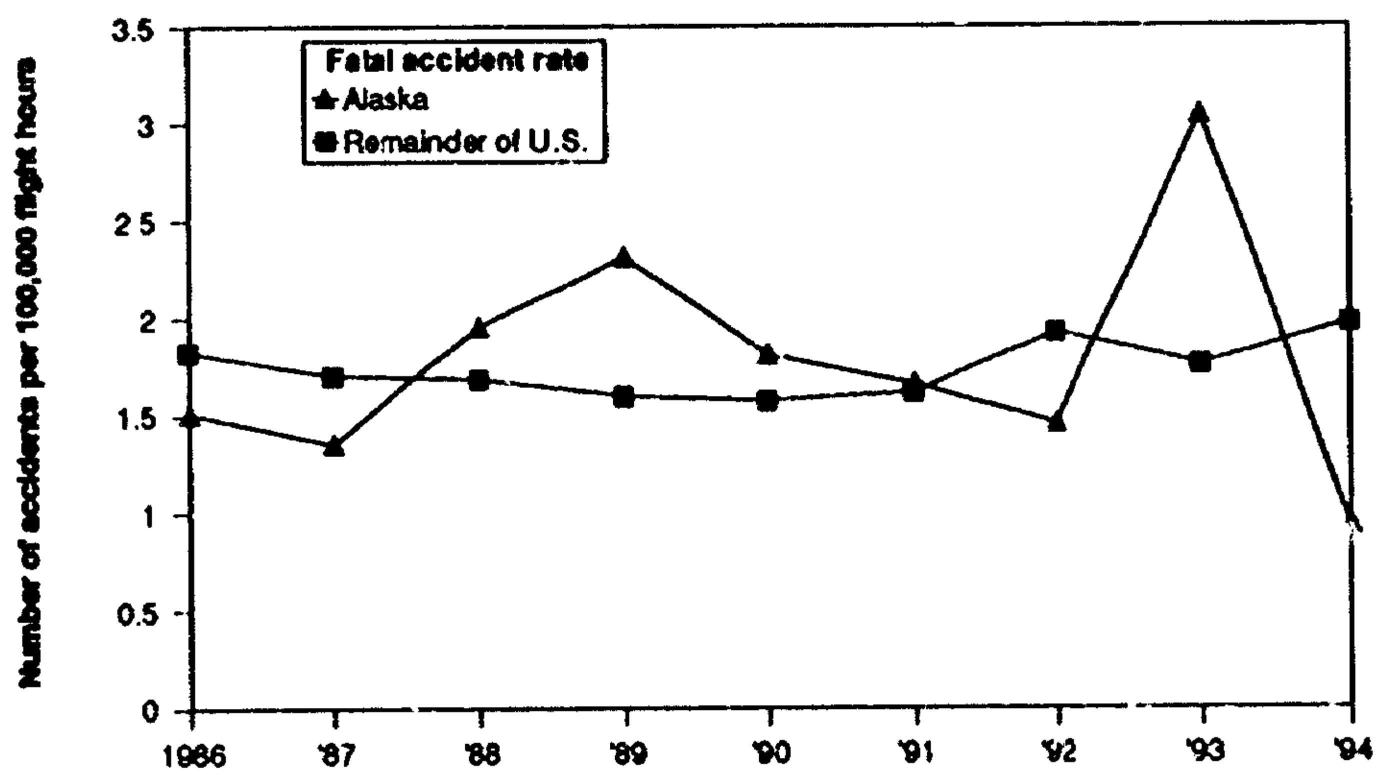


Figure 4.3—Accident rates for general aviation, 1986 through 1994.

Comparison of Two Accident Types

The Safety Board's review of commuter airline, air taxi, and general aviation accidents in Alaska highlighted two accident types of major consequence: (1) accidents during takeoff and landing, and (2) accidents related to VFR flight into IMC. Of the 172 commercial and private aviation accidents that occurred in Alaska during 1993, these two types accounted for 131 (76 percent). Of the 21 accidents that resulted in fatalities, the two types accounted for 9 (43 percent). The number of accidents and the percentage that were fatal differed greatly between the types (table 4.3).

Table 4.3—Number of aviation accidents in Alaska for the two accident types of most consequence, 1993

Accident type	Nonfatal accidents	Fatal accidents	All accidents
VFR flight into IMC	5	6	11
Takeoff/landing	117	3	120
Both types	122	9	131

Accidents Related to VFR Flight Into IMC.—On June 22, 1994, a float-equipped deHavilland DHC-3 Otter airplane, N13GA, carrying a pilot and 10 passengers, crashed into the Taku Inlet 12 miles east of Juneau, Alaska.[20] The flight was returning a group of cruise ship passengers from an outing at Taku Lodge to Juneau and their ship. The flight was operated under 14 CFR Part 135 by Wings of Alaska as a commercial air taxi flight. The accident resulted in fatal injuries to seven passengers, serious injuries to the pilot and three passengers, and substantial damage to the airplane.

During flights to and from Taku Lodge earlier on the day of the accident, Wings of Alaska pilots had noted low ceilings and visibility during the en route portion of the trip. Describing the accident flight, the pilot of N13GA stated that he encountered deteriorating weather en route and started a descent with the intention of making a precautionary landing on the Taku Inlet. As he began to level the airplane and noted visibility beginning to improve, the airplane hit the water's surface. Surviving passengers reported that at the time of the accident, the horizontal visibility was poor and they did not see the water prior to impact.

[20] NTSB accident ANC-94-FA-070.

The Safety Board determined that the probable cause of the accident was the pilot's attempted flight under VFR into IMC, and his failure to maintain altitude above the surface of the river. Factors contributing to the accident were the adverse weather conditions and the glassy water surface conditions, which made it more difficult for the pilot to judge the airplane's height above the water.

During its investigation of this accident, the Safety Board learned that flights in marginal weather conditions were not unusual for the Wings of Alaska operation. A former pilot of the company indicated to investigators that he and other company pilots had flown the Taku River in less-than-VFR weather minimums on numerous occasions. He stated, "It has always been a company standard to fly below 500 feet, if it was necessary to get under, around, or through...generally isolated cloud conditions."

Like the pilot of N13GA, pilots of three of the four other Wings of Alaska airplanes accompanying the accident flight also made low altitude turns and descents to underfly clouds and to maintain visual contact with the water surface and the shoreline. The fourth pilot stated that he flew above marginal VFR conditions consisting of a lower stratus layer at about 300 feet that was scattered to occasionally broken (more than 50-percent sky coverage). The four other pilots emerged from the poor weather area and landed uneventfully at Juneau. They indicated that their flights were unremarkable, until they noticed that N13GA had not arrived at the Juneau dock.

The flight of N13GA, which resulted in a fatal accident, and the four other flights that traversed the same adverse weather and arrived safely in Juneau, illustrate routine VFR operations in marginal visual meteorological conditions (VMC) and IMC. The pilots' apparent lack of concern about en route weather, as reported by those that survived, reflects the acceptance of elevated risks in VFR flying in the Alaskan environment.

The risks illustrated by the accident at Taku Inlet are not unique to this accident, company, type of operation, or group of pilots. All aviation operations in Alaska generally have experienced a greater rate of accidents involving VFR flight into IMC compared to other parts of the country. In the United States, excluding Alaska, 335 accidents involving VFR flight into IMC occurred from 1989 through 1993. In Alaska, during the same 5-year period, there were 48 such accidents. The accident rates for VFR flight into IMC in Alaska and remainder of the United States are shown in figure 4.4. The substantially greater rates in Alaska among commuter airlines, air taxis, and general aviation, compared to similar operations elsewhere in the country, also hold when compared with the accident rates of other States that also have sparse populations and diverse terrain characteristics. In 1993, Alaska's accident rate for VFR flight into IMC was eight times the rate of Washington, five times that of Colorado, and four times that of Oregon.

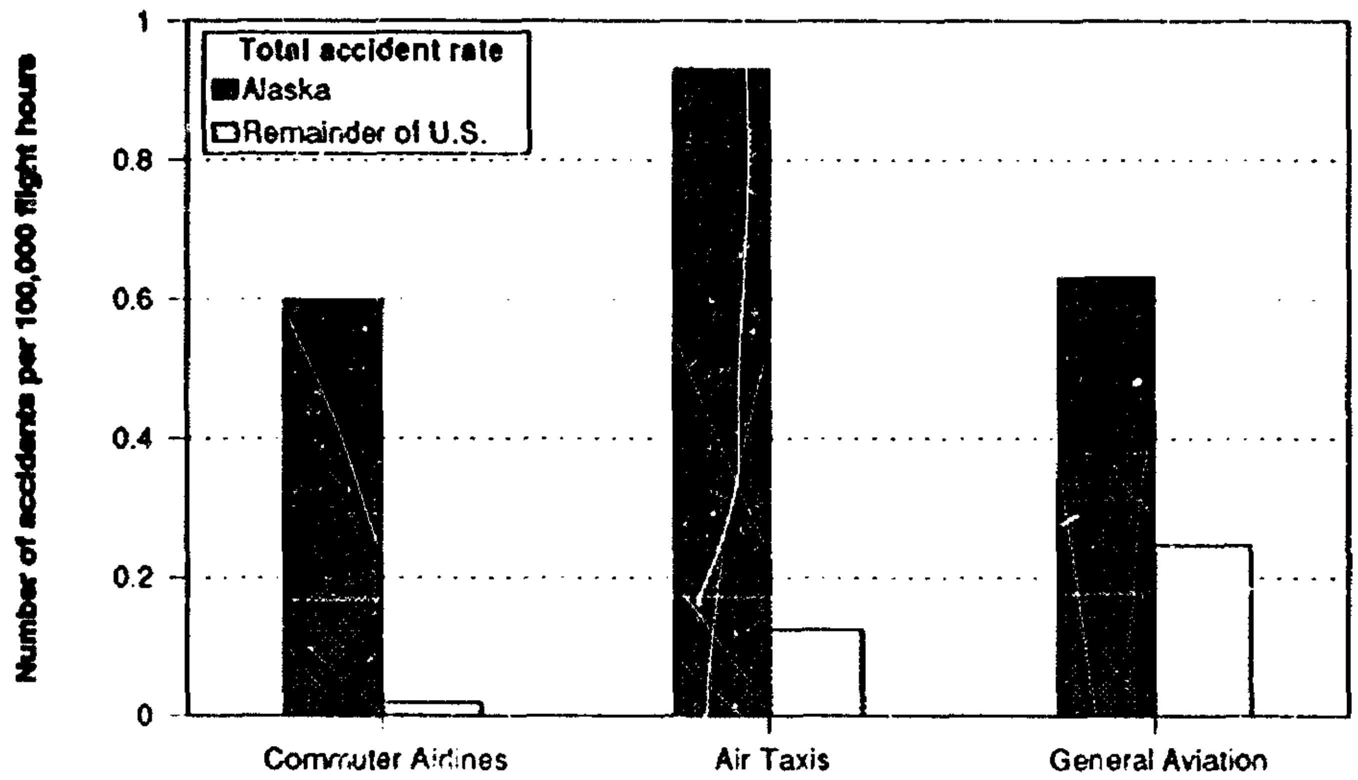


Figure 4.4—Accident rates related to VFR flight into IMC for the 5-year period 1989 through 1993.

Because VFR flight into IMC is the leading problem in Alaska's fatal accidents involving commuter airlines and air taxis, the aviation community must address the factors that affect the safety of VFR operations. There are inherent conflicts between safe VFR operations and the combined effects of the demand for reliable air service, the limitation of operations to VFR, and frequent adverse weather—all of which characterize aviation operations in Alaska. Methods for improving the safety of VFR flying and for reducing the reliance on VFR for operations are discussed in chapters 6 and 7 of this report.

Accidents During Takeoff and Landing.—Accidents in Alaska frequently occur during takeoff and landing; however, few of them result in fatalities (see table 4.3). An accident typical of many occurred on December 25, 1991, when a Piper PA-31 Navajo operated by Security Aviation as a Part 135 air taxi flight landed on an ice- and water-covered runway at Tatitlek, Alaska.[21] The pilot was unable to stop the airplane on the 2,200-foot-long runway, and the airplane was substantially damaged when it ran off the departure end. The pilot and three passengers aboard were uninjured.

[21] NTSB accident ANC-92-LA-023.

On the day prior to the accident, another pilot had reported to a nearby FAA Flight Service Station that the runway was covered with glare ice and water, and that the braking action on the runway was nil. The information was not placed into a Notice to Airmen (NOTAM), and the accident pilot was not aware of the runway condition prior to landing.

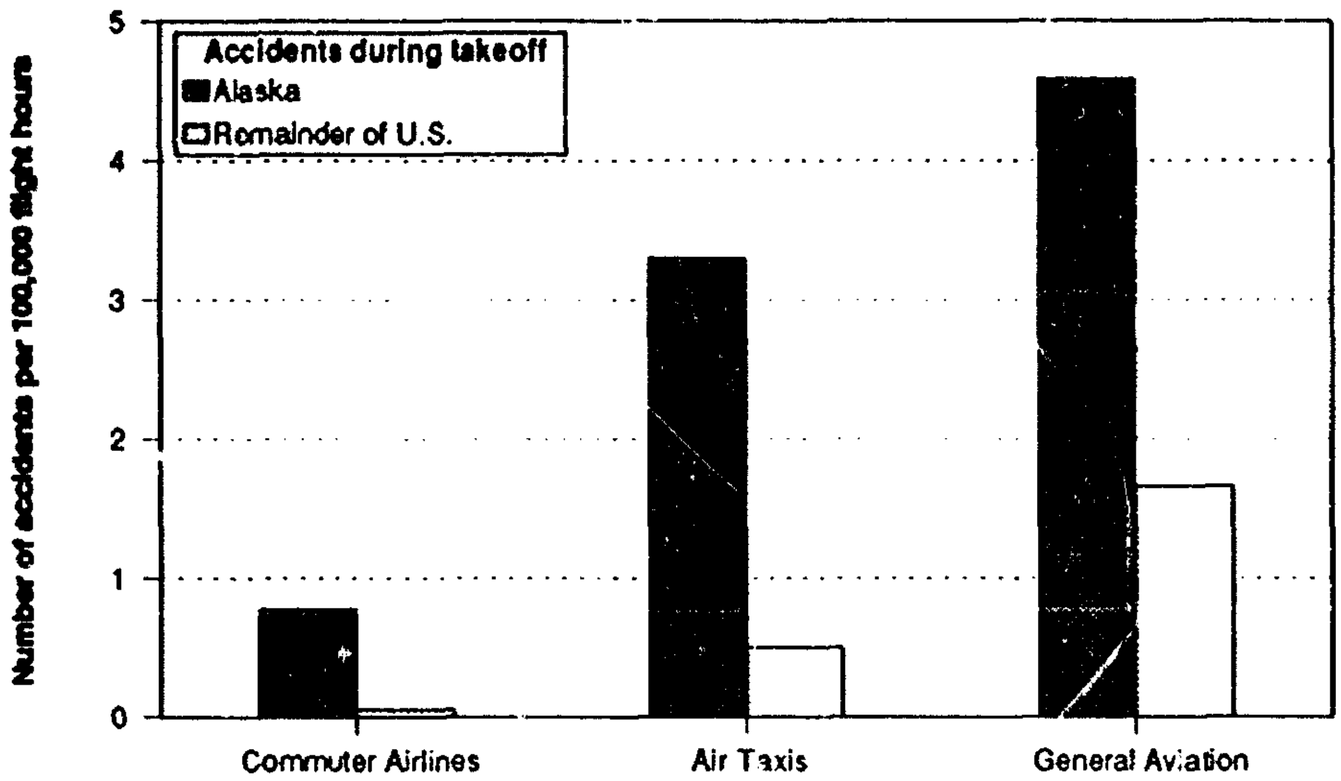
The Safety Board determined that the probable cause of the accident was the pilot's failure to perform a go-around. Contributing to the accident was the icy runway condition and the failure of the FAA Flight Service Station personnel to properly issue and disseminate a NOTAM concerning the icy runway condition.

The rates for takeoff and landing accidents are shown in figure 4.5. For all operations—commuter airlines, air taxis, and general aviation—the rates were greater for Alaska than for the rest of the Nation. The substantial number of nonfatal accidents during takeoff and landing in Alaska raised the State's nonfatal accident rates much more than its fatal accident rates.

The incidence of takeoff/landing accidents during commuter and air taxi operations is shown by the accidents classified in the "airport/runway conditions" category in tables 4.1 and 4.2. This category accounted for the largest number of nonfatal accidents in both commuter and air taxi operations.

The majority of takeoff/landing accidents in Alaska are associated with off-airport sites, such as river sand bars, mountain ridge lines, partially-cleared meadows, and harbors (seaplane operations). In 1993, 65 (54 percent) of the State's 120 takeoff/landing accidents involved off-airport operations. Of these 65 accidents, 18 (28 percent) were seaplane operations. Two of the 65 accidents (one seaplane takeoff and one landplane takeoff) resulted in fatalities.

Off-airport takeoffs and landings are typical of many general aviation and air taxi operations in Alaska. To some degree, these takeoff and landing accidents are byproducts of the demand for off-airport services and the risks inherent in the available runway configurations and conditions. Thus, some component of Alaska's takeoff/landing accident rate is inevitable. However, some accidents, like the one at Tatitlek, could be prevented by enhancements to airports or better dissemination of information about airport conditions. (These issues and others are discussed in more detail in the next chapter). Although accidents related to takeoffs and landings have taken few lives over the past several years, their toll in property damage has been high.



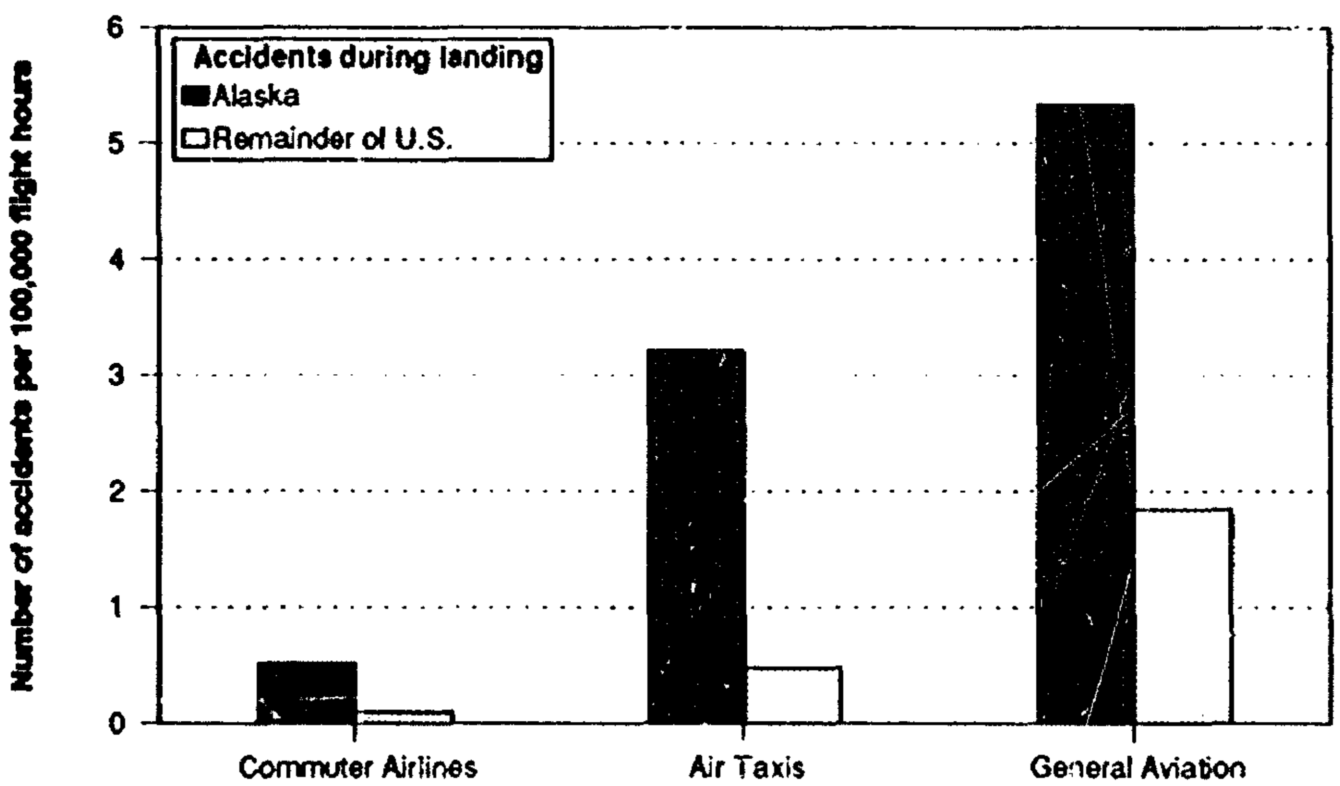


Figure 4.5—Accident rates related to takeoffs and landings during the 5-year period 1989 through 1993.

Chapter 5

Factors Affecting the Safety of Takeoffs and Landings in Alaska

A typical remote Alaskan village is the community of Tuluksak, which lies 30 nautical miles northeast of Bethel, along the Kuskokwim River, and is accessible year-round only by its airport. The runway is a single dirt/gravel strip 2,500 feet long and 30 feet wide, equipped with nonstandard lighting. A community road crosses the first 300 feet of the runway at one end, and a deep drop-off into a river tributary is located about 100 feet from the other end.

Tuluksak receives seven scheduled flights a day (as of January 1995), all originating in Bethel and several making intermediate stops at the villages of Akiak, Akiachak, and Kwethluk (each of these airports has a runway shorter than 2,000 feet). The scheduled service is normally conducted with Cessna 206/207 single-engine airplanes. At times, the ramp area at the Tuluksak airport becomes congested with arriving and departing aircraft conducting scheduled and nonscheduled flights. This flight activity is conducted amid open access to the airport for the village's residents, vehicles, and animals.

From October to March, the runway at Tuluksak is ice-covered. The runway, typical of many of the village airport runways in the southwest Alaska region (surrounding Bethel), is marked by fluorescent orange cones, with cones and orange-and-white metal sawhorses identifying the thresholds. The runway may become unusable for a week or more during the spring breakup because of potholes and ruts resulting from thawing snow and ice, and from water accumulation.

Airport Facilities

The Safety Board evaluated airport facilities in Alaska because of the large number of accidents (mostly nonfatal) that occur during takeoff and landing. According to the FAA, Alaska had a total of 545 airport facilities in 1995.[22] These 545 facilities comprise 424 fixed-wing airports, 19 heliports, and 102 seaplane bases. Airport facilities in Alaska and

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[22] Federal Aviation Administration Airport Master Record data of March 31, 1995, maintained by the Airport Safety Data Branch. An "airport facility" or "airport" can be an airport, heliport, seaplane base or STOLport, and is an area on land or water that is used or intended to be used for the landing and takeoff of aircraft. Alaska has no STOLport facilities.

Table 5.1—Airport facilities in Alaska and the remainder of the United States, 1995

Facility	Alaska		Remainder of the United States	
	Number	Percent	Number	Percent
Airport	424	77.8	12,689	71.9
Heliport	19	3.5	4,535	25.7
Seaplane base	102	18.7	331	1.9
STOLport	0	0.0	81	0.5
All facilities	545	100.0	17,636	100.0

Source: Federal Aviation Administration

Table 5.2—Ownership of airport facilities in Alaska and the remainder of the United States, 1995

Ownership	Alaska		Remainder of the United States	
	Number of facilities	Percent	Number of facilities	Percent
Public	383	70.3	4,699	26.6
Private	162	29.7	12,937	73.4
All ownerships	545	100.0	17,636	100.0

Source: Federal Aviation Administration

the remainder of the United States are compared in table 5.1. A large percentage of Alaskan facilities operate as seaplane bases relative to the facilities elsewhere in the Nation. (Many land airports also have seaplane facilities associated with them, not shown in the table.)

Of the 545 airport facilities, 408 are available for public use, and 383 are publicly owned. Public ownership is more common in Alaska than in the remainder of the United States (table 5.2). The State of Alaska lists a total of 252 airports and seaplane bases that it owns and operates; thus, the State is responsible for most of the 408 public use airports in Alaska.

The State of Alaska has adopted airport design standards that specify a minimum runway length of 3,000 feet.[23] Of the 424 public use and private use fixed-wing airports within the State, 250 have runway lengths less than 3,000 feet.[24] Of these 250 airports, 172 are for public use and 77 receive scheduled air service, according to the January 1995 issue of the *Official Airline Guide*. Many of these airports are within the southwest region centered around Bethel (figure 5.1), which closely resembles the situation found by the Safety Board in its 1980 air taxi study. Many of these airports are geographically located such that runway extensions to meet the State standards would be extremely difficult to engineer without relocating the airport.

In the 5-year period 1989 through 1993, the Safety Board investigated 20 accidents that occurred during takeoff or landing at an airport in which the Board cited airport or runway conditions as a causal or contributing factor. Of these accidents, 13 involved runways less than 3,000 feet in length. Most of the accidents that occurred on these shorter runways (9 of 13) were commuter airline or air taxi flights operating under Part 135. Of the 9 Part 135 accidents, 8 involved a combination of short runway length and contaminated runway surface (the remaining accident occurred when the pilot maintained excessive airspeed and landed long on a 1,700-foot-long airstrip). Given the prevalence of unpaved runway surfaces and weather-related runway contaminants in Alaska that can reduce airplane braking action, adequate runway length is critical to the safety of takeoffs and landings. The Safety Board acknowledges the difficulties of meeting State standards for runway length at some airports. However, based on the accident record of commercial operations on shorter runways, the Safety Board concurs with the State that 3,000 feet should be the minimum runway length for scheduled air service. Consequently, the Board encourages the State of Alaska to continue its efforts to improve to minimum State standards the airports currently receiving scheduled air service with runways less than 3,000 feet in length.

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[23] State of Alaska Department of Transportation and Public Facilities. 1986. Alaska aviation system plan [Mimeo]. Final report (p. 4-5). March.

[24] Federal Aviation Administration Airport Master Record data.

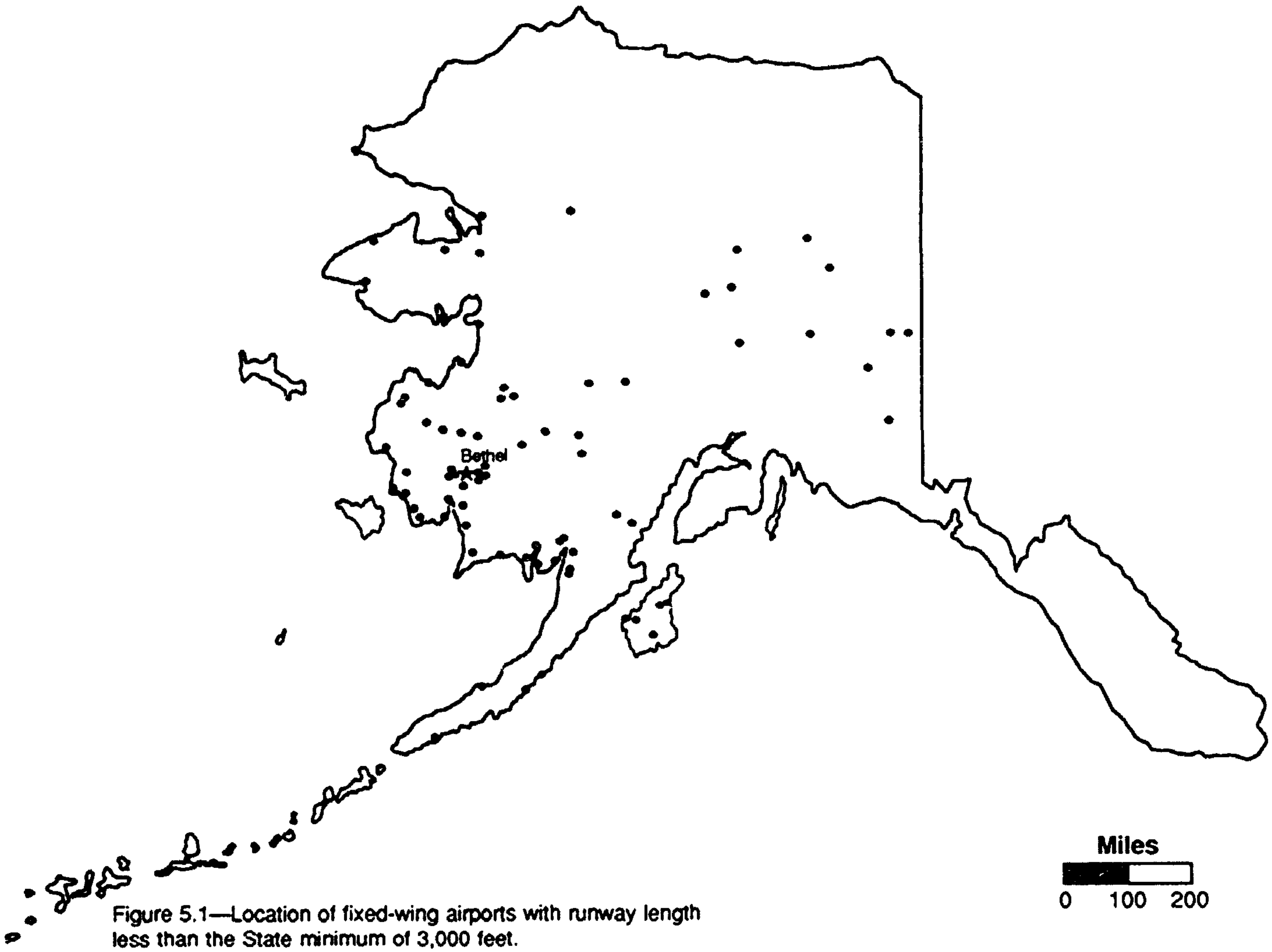

Figure 5.1—Location of fixed-wing airports with runway length less than the State minimum of 3,000 feet.

FAA Airport Inspection Programs

The FAA inspects all airports certificated under 14 CFR Part 139 (those airports served by air carrier aircraft larger than 30 passenger seats) to ensure that these facilities meet Part 139 standards. Further, the FAA requires inspection of all public use airports not certificated under Part 139, either by FAA personnel or by designees. These inspections are the FAA's primary means of gathering airport information that is critical to flight safety (such as the functionality of lighting systems and the condition of runway surfaces); that information is then disseminated to pilots through airport information publications.

The 29 fully certificated, civilian airports in Alaska are inspected annually, as required under Part 139, by the FAA Alaskan Region Airports Division, Safety and Standards Branch. Two full-time, certification inspectors are assigned responsibility for these airports; in addition, they are responsible for inspecting once every 2 years the seven civilian airports holding limited certification.

The additional 372 public use airports (excluding military airports) in the State fall under the FAA's 5010 program. FAA Order 5010.4 establishes that public use airports shall be inspected by FAA, State, or contractor personnel. Most of these inspections in States other than Alaska are conducted by contract personnel with oversight by the National Association of State Aviation Officials (NASAO) and the FAA. In Alaska, neither the NASAO nor the State supervises or assists in these inspections; consequently, FAA personnel from the Airports Safety and Standards Branch are required to conduct all airport inspections in the State.

Historically, the branch was staffed with an individual who was responsible for the 5010 program. As of mid-1995, that position had been unfilled for more than 2 years. During that period, the two airport certification inspectors responsible for inspecting Part 139 airports were assigned the 372 airports in the 5010 program as an ancillary duty. Further, in autumn 1995, the manager of the branch, who also conducted inspections, was reassigned, and one of the two airport certification inspectors retired. Thus, in 1995, staffing of the FAA department responsible for performing all airport inspections in Alaska was reduced to one person.

The Safety Board is unable to identify a direct connection between previous aviation accidents in Alaska and the frequency or quality of FAA airport inspections. However, during the Board's public forums, operators expressed a concern that the accuracy of airport information publications, including the *Alaska Supplement*, is dependent on these inspections. As a result, the Board is concerned about the recent reductions in airport inspection staffing. The current staffing level, combined with the lack of participation by the State of Alaska, will adversely affect the 5010 program until corrective measures are taken. To ensure that airport information critical to flight safety can be obtained, the Safety Board believes that by December 31, 1996, the FAA should complete an evaluation of the work program for inspectors responsible for the Part 139 and 5010 airport inspection programs within the

Alaskan Region then develop appropriate staffing standards and personnel work responsibilities based on the evaluation and encourage the State of Alaska to participate in the 5010 program. Further, the Board believes that the State should develop a program to participate in the FAA's 5010 airport inspection program.

Airport Condition Reporting

Many accidents that occurred during landings at small airports may have been averted had pilots been provided timely reports of airport and runway conditions. The following are examples of runway conditions that apparently were unforeseen in the absence of condition reports, taken from statements made to Safety Board investigators by pilots involved in landing accidents in Alaska:

Encountered a soft muddy area;
Braking action nil;
Snowdrift about 2 feet deep;
Runway covered with glare ice and water;
Hump on the landing strip; and
Left gear contacted a snow berm parallel with the runway.

At most of the State-owned rural village airports in Alaska, the State contracts with private individuals for airport maintenance, who observe runway conditions during the performance of their duties. Observations from these sources could be useful to pilots; however, the representative of the State of Alaska Department of Transportation and Public Facilities at the Safety Board's public forum expressed reluctance to allow maintenance contractors to issue runway condition reports for arriving/departing aircraft because the contractual personnel have limited qualifications and because of potential problems of liability. Further, the State representative expressed concern about the effectiveness of communication by equipment operators (such as a grader or snow plow operator) within the noisy operating environment of the equipment.[25] The State representative also reflected the positive aspects of direct communications between pilots and airport maintenance personnel, stating, "We feel it is extremely dangerous...when we no longer have any effective communication on a particular airport...when we're in an operation where we're cleaning snow off and...we don't have any means of having some communication to that pilot that we're on the airport."[26]

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[25] Transcript of proceedings before the National Transportation Safety Board, in the matter of: Forum on aviation safety in Alaska, May 22, Juneau, Alaska, and May 24-25, 1995, Anchorage, Alaska, p. 919.

[26] Transcript of proceedings, p. 916.

At most of the village airports in Alaska, the local State airport maintenance contractors are the only persons on site who are capable of providing direct, near real-time ("mike-in-hand") reports of airport conditions to the pilots of aircraft in flight. Such personnel, given appropriate training and procedures to follow, could provide valuable information to arriving pilots. The Safety Board recognizes the concerns of the State and of other potential mike-in-hand information providers (such as the National Weather Service, discussed in chapter 6) pertaining to liability exposure; however, in the Board's opinion, these concerns can be addressed by the proper training of personnel, particularly training in the skills of observing and reporting factual information straightforwardly. The Safety Board believes that by December 31, 1996, the State of Alaska, with the assistance of the FAA, should develop appropriate procedures and establish a training program to enable mike-in-hand reports of airport conditions by designated State and contractual airport maintenance personnel.

The Notice to Airmen (NOTAM) system operated by the FAA's flight service facilities currently relates to pilots information that is gathered by official sources; for example, FAA officials and airport managers. Pilots responding to the Safety Board's survey indicated that their preflight planning and safety of flight operations would be enhanced if NOTAMs included unofficial information about airport conditions gathered by designated persons (other pilots, airport maintenance personnel, air operator personnel, and local observers). Some respondents further suggested that the NOTAM system should be modified to include information from designated persons about field conditions at off-airport areas in Alaska that are frequently used by operators for takeoffs and landings. The Safety Board believes that the FAA should modify the NOTAM system in Alaska to accept and disseminate unverified information, labeled as such, about airport and off-airport field conditions that is provided by designated aviation and nonaviation sources.

Chapter 6

Factors Affecting the Safety of VFR Operations in Alaska

Information obtained through the Safety Board's public forums, survey of pilots and managers, interviews with aviation personnel, and accident investigations highlighted several factors affecting VFR operations in Alaska: risk-taking behavior of pilots and operators; operational pressures; pilot decisionmaking; management attitudes; FAA safety programs; flight/duty time limitations; navigational aids; and weather information. The Safety Board examined these factors to identify methods for enhancing the safety of current VFR operations, particularly methods for reducing the occurrence of accidents related to VFR flight into IMC. Improvements made in these areas, plus improvements in the reporting of airport and runway conditions discussed in the previous chapter, would benefit all commercial and general aviation operations performed under VFR in Alaska.

Risk-Taking in Alaska's Aviation Operations

In the Safety Board's 1980 study on air taxi safety in Alaska, a number of Part 135 pilots and air carriers reported the existence of a mindset of risk-acceptance and a willingness to take risks. Such risk-taking commonly has been called the bush syndrome. At the Safety Board's 1995 public forum in Alaska, a representative of the Alaska Air Carriers Association (AACA) suggested that there was no longer any evidence of the bush syndrome in Alaska. He explained, "Most of the pilots that fly for air taxi/air commuter operations here are highly experienced and they don't have an agenda to prove anything...they already have the respect of their peers and they don't need to go out with any macho type attitude. So I'd say I really haven't seen [the bush syndrome] in many years."[27]

However, information about risk-taking behavior abounds in the Safety Board's records for accidents occurring in Alaska in recent years; these were the flights in which the risks taken by pilots were demonstrably excessive. Risk-taking attitudes and risk-taking behavior were also evident from pilot and operator responses to the Safety Board's survey: 22 (50 percent) of the 44 respondents for whom information was available stated that, in response to operational pressures, they had flown in IMC on a VFR flight, and 29 (84 percent) of the 35 persons responding reported that they had inadvertently entered IMC on

[27] Transcript of proceedings, p. 425.

a VFR flight. The incidence of VFR flight in IMC among the survey group suggests that the possibilities of inadvertent[28] and intentional operation of VFR flights in IMC are accepted and that VFR flights in IMC are not unusual. Thus, risk-taking has not been eliminated from Alaska's commercial operations, and the consequences of risk-taking is reflected in the fatal accidents related to VFR flight into IMC.

The demands for reliable air service in Alaska can easily place pressures on pilots and operators to perform. An underlying factor in risk-taking, or "bush syndrome," is a response by pilots and operators to powerful demands for reliable air service in an operating environment and aviation infrastructure that are often inconsistent with those demands.

Operational Pressures

Pressures Reported by Pilots and Managers.—About 70 percent of the 50 respondents to the Safety Board's survey reported that they perceive inherent pressures in their flight operation. The pressure was most frequently reported as self-induced, although other sources, listed in the tabulation below, may have been factors in the pressures reported as self-induced:

Source of pressure	Number of respondents ranking source as most significant
Self-induced	18
U.S. Postal Service	9
Passengers	5
Management	4
Other pilots	2
Did not rank	12

The most frequently reported external (not self-induced) source of operational pressure was the United States Postal Service.

Pressures From U.S. Postal Service Policies.—During the winter months, many of the air taxi operators in Alaska depend heavily on revenues obtained by transporting U.S. mail. Between 50 and 70 percent of the annual revenue generated by many air carriers in Alaska comes from mail transportation.[29] The United States Postal Service (USPS) annually

[28] The Board's review of VFR flight into IMC accident sequences in Alaska indicates that most inadvertent VFR operation into IMC followed intentional operation in marginal VMC.

[29] Data from U.S. Department of Transportation Form 298-C.

moves more than 150 million pounds of mail in Alaska and provides more than $100 million in revenue. Between 1986 and 1991 the volume of mail to the bush communities grew by almost 43 percent.[30]

In their responses to the Safety Board's survey, several commuter airline pilots and managers stated that the current policies of the USPS applied pressure on air carriers to transport the mail in adverse weather conditions. To evaluate the extent and nature of this pressure, the Safety Board examined USPS policies and requirements for the transportation of "bypass mail" from distribution hubs to the remote villages of Alaska. The bypass mail program, unique to Alaska and closely resembling air cargo transportation in the remainder of the United States, involves the delivery by air of U.S. mail shipments of at least 1,000 pounds from the mailer via air carrier directly to the recipient, bypassing Postal Service processing.

The USPS requires air carriers to notify the airport mail facility (AMF) manager or representative at any time mail is not transported on the flight for which it is accepted within 15 minutes after the scheduled departure time of the flight. Notification is required regardless of the reason; for example, cancellation of a flight, mechanical prob[illegible]s, mail exceeding the capacity, weather delay. After being notified about backlo[illegible] the AMF manager or representative directs the air carrier concerning the disposition of the mail. Disposition may include transfer to another carrier, returning the mail to the AMF, or holding it for a later flight.

Bypass shipments must be transported in accordance with the "36/24-hour" rule. This rule requires a carrier to transport bypass mail from Anchorage or Fairbanks to a regional hub/bush point by the end of the day following the day of tender (36 hours). A carrier is required to transport bypass mail from the regional hub to the bush point within 24 hours after the mail was transported from Anchorage or Fairbanks.

USPS Handbook 508, "Intra-Alaska Certificated Air Carrier Instructions," defines the Postal Service policies concerning the movement of mail by certificated air carriers within the State of Alaska. The handbook does not specifically address inclement weather that restricts the movement of aircraft. In February 1993, the USPS issued a policy letter to clarify its position on weather-related mail delays. The letter stated, "The Postal Service does not condone any action on the part of any of its employees that would require an air carrier to operate when to do so would clearly be in conflict with safe aviation practice."[31]

The Safety Board did not identify specific pressures related to bypass mail shipments in any of the accidents it has investigated involving Alaska commuter airlines authorized to

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[30] United States Postal Service. 1993. Alaska parcel post [Mimeo]. Task force report.

[31] United States Postal Service, Western Distribution Networks Office, Seattle Branch. Unpublished memorandum dated February 9, 1993, on Postal Service policy.

transport U.S. mail. The Board notes that in four (67 percent) of the six fatal commuter airline accidents related to VFR flight into IMC from 1989 through 1993, the flights were carrying U.S. mail as cargo.[32]

Because of the prevalence of mail shipments among commuter airlines in Alaska, the presence of mail aboard these accident flights could have been incidental to the accident. Nevertheless, respondents to the Safety Board's survey indicate that some operators perceive pressures to operate in conditions they believe to be contrary to safety. Further, an FAA representative at the Board's public forums reported that pressure from Postal Service bypass mail requirements was a topic that came up frequently in the agency's discussions with the operators.[33]

Despite the general policies of the USPS, specific elements of Postal Service requirements may be responsible for the perceived operational pressure. The USPS representative stated at the public forum that the bypass mail "transportation window," with its embedded 24- or 36-hour limit until the operator's revenue is lost, does not begin until weather and airport conditions make flight operations possible. The USPS representative also stated that the 24- or 36-hour clock begins to run for all operators at an air facility as soon as the first operator decides to fly.[34] The Safety Board notes, however, that in some cases, the first operator's decision to transport the mail could put pressure on other operators at the same air facility to fly in conditions not conducive to safety: one operator's decision to accept greater risk could place pressure on other mail-transporting operators at the airport to do the same.

In 1992, a task force comprising representatives of the USPS, FAA, Alaska State Government, Alaska Chamber of Commerce, university researchers, and the AACA held open meetings attended by shippers, merchants, air carriers, and the general public. As an outcome of these meetings and subsequent deliberations, the task force recommended modifications to the 36/24-hour rule, and suggested other changes to the bypass mail program that would reduce peak load demands on air carriers by distributing shipments more evenly among the air carriers serving each route. Although these recommendations were primarily intended to increase the efficiency of the bypass mail program and obtain lower transportation rates from the air carriers, the task force also considered the potential safety enhancements from reducing the pressure to fly in bad weather.[35] The USPS has not taken action on the task force's recommendations.

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[32] One other flight was carrying cargo, but accident records did not specify whether the cargo included U.S. mail.

[33] Transcript of proceedings, p. 418.

[34] Transcript of proceedings, p. 417.

[35] United States Postal Service. 1993. Alaska parcel post [Mimeo]. Task force report.

The performance standard resulting from the current 36/24-hour rule for bypass mail is very specific in that it applies to each individual flight. Consequently, each flight is under specific pressure to perform, lest that flight's mail and revenue be awarded to a competitor. The information reviewed by the Safety Board suggests that application of the current bypass mail performance standard exerts pressure on at least some portion of the operators in Alaska. Alternatives to the current standard could, however, maintain essential delivery performance while relieving the pressure on individual flights. These alternatives include broader performance standards, such as those based on monthly average delivery rates, and more flexible standards, such as those encouraging a more even distribution of bypass mail among operators. Although the Safety Board recognizes the need for and benefits to the public of the prompt delivery of mail, the Board believes that the USPS should establish and implement a broader and more flexible performance standard for bypass mail transportation in Alaska that relieves the direct performance pressure on individual flights.

Pilot Decisionmaking

VFR flight into IMC usually involves poor pilot decisionmaking, whether in initiating the flight or continuing it into adverse weather. The FAA has developed and is now proposing to require the use of an innovative program on aeronautical decisionmaking (ADM).[36] The ADM program is designed to assist pilots in identifying specific hazardous thought patterns they may be employing in decisionmaking, and it provides positive thought patterns for substitution. Program materials include situational narratives for pilots to use in habituating themselves to the safe responses to hazardous thought patterns. The ADM program enhances the potential for effective pilot training in judgment and decisionmaking.

As a result of the April 4, 1991, midair collision between a Piper Aerostar air taxi flight and a Bell 412 helicopter over Merion, Pennsylvania, the Safety Board recommended that the FAA disseminate more aggressively the available information and materials pertaining to ADM training and actively promote its implementation among all categories of pilots in the civil aviation community (Safety Recommendation A-91-93). The FAA replied on December 27, 1991, that 2 weeks earlier it had issued Advisory Circular 60-22, "Aeronautical Decision Making." Additionally, the FAA stated that ADM information and materials were being actively disseminated through its "Back to Basics" program, an element of the nationwide FAA aviation safety program in which pilots could participate at their option. On May 8, 1992, the Safety Board classified Safety Recommendation A-91-93 "Closed--Acceptable Action." In closing this safety recommendation, the Board also asked the FAA to consider including ADM information in air carrier training programs and other recurrent pilot training and checking activities.

[36] A description of the ADM program is contained in FAA Advisory Circular 60-22.

As a result of the April 22, 1992, collision with terrain of a Beech E18S airplane conducting a commercial air tour flight on Maui, Hawaii, the Safety Board recommended that the FAA issue an air carrier operations bulletin instructing all FAA principal operations inspectors to aggressively encourage all commercial operators to incorporate comprehensive ADM training in their pilot training programs (Safety Recommendation A-93-13). The FAA responded on April 29, 1993, that it would issue a bulletin to emphasize to its field office inspectors the importance of encouraging operators to incorporate ADM in their company training programs. Based on this response, the Board classified Safety Recommendation A-93-13 "Closed—Acceptable Action." While conducting its study on aviation safety in Alaska, the Safety Board learned that the ADM bulletin was not issued; the FAA has informally told the Board that the bulletin will be issued in the near future.

On August 11, 1995, the FAA issued Notice of Proposed Rulemaking 95-11, which proposes integrating human factors and ADM/judgment training as requirements for all pilot certificate levels. The proposal does not, however, require the integration of ADM and judgment training into the initial and recurrent training programs of Part 135 commercial operators. The continued occurrence of accidents related to VFR flight into IMC in the commuter airline and air taxi industries in Alaska suggests that such training should be incorporated into operator training programs. Accordingly, the Safety Board believes the FAA should require, by December 31, 1997, operators that conduct scheduled and nonscheduled services under Part 135 in Alaska to provide flightcrews, during initial and recurrent training programs, aeronautical decisionmaking and judgment training that is tailored to the company's flight operations and Alaska's aviation environment. Further, the FAA should provide similar training for FAA principal operations inspectors assigned to commuter airlines and air taxis in Alaska so as to facilitate the inspectors' approval and surveillance of the operators' training programs.

Management Attitudes

Managers of commercial flight operations can build a corporate culture that enhances safety, or one that detracts from safety.[37] A pilot's judgment and decisions, for example, can respond to signals from management, which may transmit real or perceived attitudes toward safety. At the Safety Board's public forum, several operators commented that the corporate attitude toward safety is transmitted, in part, by the manner in which a manager reacts to the decision of a relatively young, inexperienced pilot to turn around when confronted by poor weather. As one operator explained, "You have to be careful to treat a pilot that turns around

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[37] Lautman, L.G.; Gallimore, P.L. 1989. Control of crew-caused accidents. Flight Safety Digest. October: 76-88. Flight Safety Foundation.

with kid gloves and make sure that you don't embarrass them in any way."[38] The operator added that the structure of any flight operation should be based on the comfort level of the least experienced pilot in the company: "You have to fly to the lowest common denominator....The pilot that can only fly 1,000 [foot ceiling] and 4 [miles visibility]—and that is way above the FAA minimum—that is what everyone should fly."[39] A key policy mentioned by several operators was never to offer one pilot a flight that another pilot had declined for safety reasons; if a flight was declined once, it was to be cancelled.

A 1991 incident report in the NASA Aviation Safety Reporting System illustrates a corporate culture that detracts from safety. The report of the incident was filed by an Alaskan air taxi pilot:

> After a precautionary engine shutdown due to engine roughness...light rime [icing] was enough to make me unable to maintain altitude...[descended and] broke out of clouds....Contributing factors: (1) propeller deice was inoperative, (2) deice boots inoperative, (3) autopilot inoperative. These have been inoperative for some time and we were expected to operate these aircraft without writing them up so they're not grounded. I guess it's the old air taxi problem....[40]

This incident report depicts a maintenance problem that reflects, at a deeper level, an operator with a poor attitude toward safety and compliance, and one who applies operational pressure on pilots.

FAA Safety Programs

The FAA Alaskan Region has a safety promotion program that combines elements of the national Aviation Safety Program with unique elements developed locally in Alaska. This program has the potential to help pilots and managers cope with the pressures of their flying environment and develop corporate attitudes that promote safety.

In the 1980s, the FAA established an Aviation Safety Program and assigned an Aviation Safety Program Manager (APM) to each of the three Flight Standards District Offices (FSDOs) in Alaska. The APMs are responsible for developing safety initiatives aimed at accident prevention, as well as volunteer and industry support for safety programs.

[38] Transcript of proceedings, p. 56.

[39] Transcript of proceedings, p. 56.

[40] National Aeronautics and Space Administration, Aviation Safety Reporting System. 1995. Analysis of Alaskan incidents. Quick response no. 279. Mountain View, CA. May 18.

The national policy is for each FSDO to have one APM regardless of the geographic area of responsibility or the number of pilots in the area. The policy, however, has caused workload disparities in Alaska. The Anchorage FSDO has 198 Part 135 air carriers, 7,060 pilots, and 1 APM; the Juneau FSDO also has 1 APM but only 38 Part 135 air carriers and 789 pilots. Currently, there are no national workload-based guidelines for establishing APM staffing levels. The Safety Board believes that the FAA should evaluate the APM work program and the associated Aviation Safety Program in the Alaskan Region, and develop appropriate national workload-based guidelines for staffing based on the evaluation.

In 1993, the FAA, in cooperation with the Alaskan Aviation Safety Foundation and the AACA, developed a Total Company Resource Management Human Factors Training Program for Part 135 operations. The program comprises six videotapes that examine how human performance contributes to commuter airline and air taxi accidents and incidents. The videos, which are between 5 and 8 minutes long, portray open-ended scenarios that raise safety issues and situations without resolving them. The videos are designed to trigger discussion between management and pilots regarding human factors issues, hence the name "trigger tapes." Several pilots and managers responding to the Safety Board's survey stated that they had received, watched, and used at least one trigger tape. Their comments to the Board were favorable.

About 205 of the 273 air carriers and commercial operators in Alaska had received the trigger tapes as of 1995. The Alaskan Region stated that it will take some time for trained FAA personnel to brief and provide the tapes to the remaining carriers. According to the FAA, it has received limited feedback from the air carriers about the trigger tapes and has not determined how many of the operators that initially received the trigger tapes ever used them, or if they are continuing to use the tapes in their initial and recurrent training programs. The trigger tapes program is an example of an innovative FAA accident prevention effort that appears to be appropriate for commuter airline and air taxi operators, but further action is needed to achieve its potential. The Safety Board believes that by December 31, 1996, the FAA should complete the distribution of trigger tapes to all Part 135 operators in Alaska, disseminate information about this program to the FAA principal operations inspectors assigned to Part 135 operators, and establish a program to evaluate operator use of the tapes.

Pilot Flight, Duty, and Rest Time

Regulations contained in 14 CFR Part 135.261(b)(1) allow commuter airline operations conducted solely within Alaska to comply with the limitations of 14 CFR Part 135.267 that elsewhere in the United States apply only to nonscheduled (air taxi) operations. The rule allows Alaska commuter airline and air taxi pilots to accrue a flight time of 500 hours in any calendar quarter, 800 hours in any two consecutive calendar quarters, and 1,400 hours in any calendar year. It permits a scheduled duty period of up to 14 consecutive hours, with a minimum rest period of 10 hours between duty periods. Operators are required to provide pilots with 13 24-hour periods free from duty per calendar quarter. Under the rules, operators could, theoretically, provide 13 duty-free days at the beginning of one calendar quarter and 13 at the end of the following quarter, thereby scheduling pilots for up to 156 consecutive 14-hour duty days. On March 29, 1995, the FAA issued a Notice of Proposed Rulemaking, "Commuter Operations and General Certification and Operations Requirements,"[41] that would eliminate the special treatment for Alaska and require operators of commuter airline service in Alaska using aircraft with more than 10 passenger seats to adhere to the more restrictive flight and rest time limitations of 14 CFR Part 121.[42] According to FAA personnel, the agency is also reviewing the flight and rest time rules for pilots involved in all commercial flight operations, including Alaskan commuter airlines and air taxis. The FAA has informed the Safety Board that proposed rulemaking was expected by the end of 1995.

In comments presented at the Safety Board's public forum, the AACA expressed support for special, less restrictive treatment for Alaska's commuter airline industry, contending that commuter airline pilots in Alaska are not subject to the same fatigue factors as pilots in other parts of the country. The AACA representative offered the following reasons in support of its contention: (a) Alaska's commuter airline operators do not use continuous duty overnight schedules; (b) all intra-Alaska commuter operations are conducted within a single time zone; (c) few Alaska pilots commute to their jobs from homes elsewhere in the State; and (d) less than 5 percent of Alaskan commuter operations occur after 9 p.m. The representative commented that the 14-hour duty/10-hour rest cycle, commonly scheduled at present, has the advantage of providing pilots the same 10 hours off duty every day.

In their 1994 survey, NASA researchers asked Alaska commercial pilots to describe aspects of their crew schedule that resulted in flying while fatigued; 85 percent cited the length of their duty day. Of the pilots in the southern half of Alaska, 83 percent said that summer flying resulted in more fatigue because the additional hours of daylight led to long flying hours and an increased number of flights. In the remainder of the State, winter was rated as the worst for fatigue by 75 percent of the pilots. The reasons they cited were the additional hours of darkness and increased workload associated with bad weather.

An air taxi pilot based in southeast Alaska told Safety Board staff during the study that the problem is the combination of long duty days and consecutive days without a day off. He said, "The 5-day week of 14-hour days is too much. We typically do 12 to 14 takeoffs and landings in a 14-hour day. An occasional 14-hour day is okay, by the second 14-hour day you feel fatigued, and by the end of the fifth one, you have noticeably deteriorated alertness." The pilot reported that in the winter, his duty days average 8 to 9 hours, and the pressures are less.

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[41] Federal Register, March 29, 1995, p. 16230-16296.

[42] Currently, the Part 121.471 domestic air carrier limitations include 30 flight hours per 7-day period, 100 hours per month, 1,000 hours per year, and at least 1 day free from duty per 7-day period.

During the Safety Board's public forum, another pilot based in southeast Alaska commented that the 14-hour duty day was detrimental to safety. The pilot stated that some Part 135 air carriers in Alaska were working their pilots 6 and 7 days per week with 14-hour duty days, and that loading, unloading, fueling, changing schedules, and changing weather contributed to pilots becoming too fatigued to make critical decisions.

Pilots responding to the Safety Board's survey also made the following comments about duty limitations:

> "Would like the length of the duty day reduced."
> "Need to define duty time so pilots actually get 8 hours of sleep; 10 hours off duty isn't enough to take care of personal items—eat, exercise, etc.—and still get 8 hours of sleep."
> "One day off in 7 is the most important safety factor."
> "Watch for burnout; require a consistent day off (1 in 7)."

The information received by the Safety Board indicates that the potential effects of consecutive, long duty days (as currently permitted by Part 135.261 for both commuter airline and air taxi crewmembers in Alaska) in contributing to fatigue should be considered during the FAA's current rulemaking activity that addresses the flight time and duty time limitations of air carrier and commercial operator flight crewmembers. Alaska pilots, in both scheduled and nonscheduled service, are subject to the same physiological constraints as pilots elsewhere in the country. Consequently, the Safety Board believes that the FAA should develop appropriate limitations on consecutive days on duty, and duty hours per duty period for flightcrews engaged in scheduled and nonscheduled commercial flight operations, and apply consistent limitations in Alaska and the remainder of the United States.

Navigational Aids for VFR Flying

More than half the persons responding to the Safety Board's survey of commercial pilots and operators in Alaska reported that they conduct at least 75 percent of their flights without electronic, ground-based navigational aids during part or all of the flight. Thus, Alaska pilots have been highly dependent on VFR pilotage and dead reckoning navigation methods. The relatively limited accuracy of pilotage and dead reckoning methods, combined with the State's widespread mountainous terrain and frequent, adverse weather conditions, can increase the difficulty of operating under VFR. Further, while navigating with pilotage/dead reckoning, a pilot can easily lose awareness of the aircraft's position; the consequences can be severe in mountainous areas, particularly in marginal VFR weather or IMC.

The recent development and establishment of the satellite-based global positioning system (GPS) has brought accurate navigational information to Alaska that is independent of ground-based aids. According to the FAA, Alaska receives GPS signal coverage equal to that available elsewhere in the United States. In the Safety Board's survey, 32 of 47 respondents (68 percent) stated that they had used GPS for en route navigation under VFR. This information suggests that the use of GPS for VFR navigation was already widespread in Alaska as of 1995. The demand for GPS across the entire aviation user community is a function of the private sector's provision of airborne GPS units with rapidly increasing capabilities at a decreasing cost. Other than the continued operation of the satellite-based and ground-based components of GPS (currently a function of the Department of Defense), further Federal initiatives are not required to develop GPS as an effective navigation tool for VFR operations.

Given the capabilities of the GPS, its use in VFR operations has the potential to prevent some of the VFR flight into IMC accident sequences that involve the loss of positional awareness and end as controlled collisions with terrain.[43] GPS applications for VFR navigation, combined with potential applications for the IFR system, are bringing a significant positive change to aviation in Alaska.

Although the long-term benefits of the GPS for VFR navigation are clearly positive, the Safety Board is concerned that the system might also be misused as a VFR navigation tool; the availability of precise navigational information may encourage some pilots to operate VFR flights in weather conditions that would otherwise have caused the cancellation of the flight. An example of such an operation occurred on August 31, 1994. A Cessna Caravan operated by Alaska Island Air departed Kotzebue for Cape Sabine. The flight was operated under Part 135. A VFR flight plan was filed, and visual meteorological conditions prevailed at the departure point. Arriving at Cape Sabine, the airplane dragged a wing during landing and was substantially damaged. The pilot and passenger were not injured.[44]

The passenger stated that the flight departed and climbed to 9,500 feet, passing through some clouds and icing conditions. He reported that he was holding a handheld GPS unit for the pilot so the pilot could navigate using the GPS. The passenger continued, "I believe that we descended over the ocean northwest of Point Lay about 6:15 p.m. [about an hour after departure], and leveled out at about 750 feet just beneath the clouds. Flew eastward until we saw the coast off the starboard side, circled back and followed the coastline off to the southwest staying about one-quarter mile offshore. Distance and direction to Cape Sabine were provided by the GPS." The passenger reported that he was able to see the buildings at Cape Sabine from about 1 mile out. He stated that as the pilot turned inland to

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[43] Other VFR flight into IMC accident sequences develop into the loss of aircraft control. The GPS is unlikely to prevent these accidents.

[44] NTSB accident ANC-94-LA-126.

find the airport, the airplane was at an altitude of 250-300 feet. The passenger continued, "The pilot saw the airstrip off to starboard and made a sharp banking turn to the right." He reported that the airplane crossed the airstrip at a 45° angle and struck the ground hard.

The representative for the Alaska Aviation Safety Foundation commented at the Safety Board's public forum that misuse of published and "home-made" GPS procedures appeared to be leading to mishaps. Although the Safety Board is concerned about potential misuse of the GPS, such misuse is likely transitional; that is, the kind of misuse illustrated by the accident at Cape Sabine should be reduced in the future by the establishment of approved GPS-based instrument approaches (discussed in chapter 7).

Observations of Weather Conditions

Weather conditions can change rapidly in Alaska, and the vast distances between some weather reporting points will often conceal significant local variations in the weather. A pilot may discover adverse weather conditions, especially in the early morning or late evening when many weather reporting sites are closed. An encounter with unforeseen adverse weather is probably a major factor in accidents related to VFR flight into IMC. Weather conditions in Alaska demand adequate weather observations from enough well-located reporting points so that pilots can make informed decisions about whether to initiate or to continue VFR flight.

As of 1995, 122 weather reporting sites[45] in Alaska provided full- or part-time aviation weather observations. The number of sites did not change between 1980 and mid-1995. The responses received by the Safety Board from the user community in its 1995 survey, interviews, and public forums indicate that, much as the Board concluded in its 1980 air taxi study, this weather reporting network provides inadequate coverage for VFR flight operations.

There are many examples of the lack of sufficient weather reporting facilities. Lake Clark Pass has part-time weather observers at each end, but no observers for 80 miles of its mountainous middle reaches. The corridor from Cordova to Juneau, which is about 400 miles long, has a weather station only at Yakutat, about halfway between the two locations. Also, the VFR route from Anchorage to Bethel, which is almost 400 miles in length and crosses two mountain ranges, has only one reporting station en route. A commuter airline official reported that only 18 airports of the 128 communities the airline serves daily have adequate

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[45] Not all of the aviation weather observing sites report observations daily. The tally also includes military sites and commissioned automated weather observing systems.

weather information. The airline relies on village agents to provide subjective reports at the other locations. According to the National Weather Service (NWS), there are only five weather reporting stations north of the Brooks Range in an area of 92,000 square miles.

Automated Surface Weather Observing Systems.--Air taxi pilots interviewed by the Board in 1980 stated that improvements in weather observations were necessary and that only a system based on human observers would be satisfactory; remote automated weather observing systems were considered inadequate to fulfill the needs of the pilots. Since that time, improvements in remote sensing technology have resulted in the development of automated surface weather observing systems that are capable of observing and reporting basic weather observation elements without manual input. The FAA, NWS, and Department of Defense (DOD) have committed to these systems, and it appears that most or all future expansions of the number of surface weather observing sites in the United States will utilize automated weather observing systems. Further, the FAA and NWS are implementing a national program to convert most existing sites from manual to automated weather observing.[46]

Most automated observations are generated by two systems: (a) the FAA-sponsored automated weather observing system-3 (AWOS), and (b) the NWS, FAA, and DOD-developed automated surface observing system (ASOS). The AWOS reports cloud/ceiling data, sensor-equivalent visibility, temperature, dew point, wind data, altimeter setting, and density altitude. The ASOS reports these elements plus the present weather/restrictions to visibility, such as precipitation type or fog. Currently, 91 civilian AWOS and ASOS[47] are planned for Alaska.[48]

The FAA plans to operate 44 AWOS facilities at airports in Alaska. As of mid-1995, 41 of the AWOS had been installed and 31 had been commissioned; 27 of the AWOS are or will be located at sites where observations were previously unavailable. An additional 12 AWOS units are at locations where contract weather observers currently provide manual weather observations during limited hours, with AWOS providing information for the other hours.[49]

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[46] In Alaska, the FAA will continue to conduct manual weather observations at about 20 locations. FAA facilities that conduct weather observations are discussed later in this chapter.

[47] An additional 14 military AWOS are operational in Alaska.

[48] FAA Alaskan Region. 1994. An overview of Alaskan aviation weather system capabilities [Mimeo]. (table 2-1). November 1.

[49] FAA Alaskan Region mimeo dated November 1, 1994 (table 4-1).

Forty-seven civilian ASOS units[50] are planned for Alaska; all but one will be located at airports. Thirty-eight of the ASOS units have been installed, and four units are scheduled to be installed during 1996. Eleven of the 47 ASOS units are or will be at locations where no observations were previously available.

None of the Alaskan ASOS units had been commissioned as of 1995. Besides siting difficulties, the NWS reported that the main problem with ASOS units installed to date has been poor communications of the observations to NWS and FAA facilities. NWS personnel stated that communications problems in 1994 resulted in Fairbanks ASOS observations being missed about 40 percent of the time. The NWS stated that no ASOS will be commissioned until communication problems are resolved and a sufficient supply of spare parts is available. The NWS was unable to give an estimated date for commissioning the first ASOS in Alaska.

Acceptance of the automated surface weather observing systems by users has been mixed. Some operators and pilots who were interviewed expressed appreciation for the coming expansion of the weather observing network. Others expressed dissatisfactions with the accuracies of the existing (AWOS) units' ceiling and visibility determinations and with the systems' reliability. Another complaint expressed by users about automated surface weather observing systems was the absence of remarks concerning the surrounding weather in these systems' reports submitted to the weather observing network. VFR pilots are concerned about weather along the route of flight, and the remarks of distant weather (beyond the airport boundaries) from the surface weather observations taken by human observers are very useful in filling in the "big picture." Pilots consider information such as cumulonimbus clouds, fog banks, mountain obscuration, lenticular and rotor clouds, and other distant weather phenomena crucial in making sound decisions on whether to initiate or to continue flights under VFR conditions.

Because current technology does not allow automated systems to replicate all elements of a manual weather observation, such as the presence of a thunderstorm at an airport, Federal agencies have determined that certain additional weather information relevant to the airport should be added at selected automated weather observing sites. This will be accomplished by maintaining trained weather observers at these sites to oversee the automated observations and to augment the weather elements observed by the automated systems.

An FAA weather specialist stated that the agency currently augments AWOS observations at the six locations in Alaska where AWOS operates during hours that qualified weather observers staff the site. Likewise, the NWS plans to augment the ASOS observations at the 13 NWS offices where ASOS has been installed, once the units are commissioned. However, both agencies limit the number and type of weather phenomena that an observer augmenting the AWOS/ASOS can add manually to an automated weather observation.

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[50] An additional two military ASOS are planned for Alaska.

FAA and NWS national guidelines[51] define information relevant to an airport as weather phenomena occurring within a 5-mile radius of the airport. These guidelines also limit the weather phenomena for manual augmentation of automated weather observations to thunderstorms, tornados, freezing rain, hail, virga (precipitation aloft that evaporates prior to reaching the ground), and volcanic ash. However, according to FAA weather specialists interviewed by the Safety Board, the FAA Alaskan Region currently relies on interim guidelines[52] that allow the weather observer slightly more flexibility in the augmentation process, but do not extend to the full set of operationally significant remarks found in standard manual observations.

NWS specialists interviewed by the Board reported that at designated stations where the NWS has a presence, the agency is planning to report operationally significant aviation information that is not obtained by ASOS by means of a supplementary data observation (SDO).[53] The SDO for an airport is to be included in a separate bulletin rather than attached to the automated observation. Currently, the SDO bulletins are disseminated on internal NWS communications circuits and to some external users, but not to FAA weather briefers or to pilots via the aviation weather data network.

Because automated surface weather observing systems do not provide pilots all of the operationally significant weather information that manual weather observers can provide, it is essential to continue augmenting the automated (AWOS and ASOS) observations with additional information at locations in Alaska where qualified observers are available. Further, the current guidelines defining the number and type of observation elements that may be added to automated weather observations are too restrictive, because they exclude some operationally significant weather phenomena, such as fog banks in the vicinity of an airport. Finally, the dissemination of manually augmented weather information from automated weather observing sites is inadequate because the information is not transmitted within a single weather observation from all automated systems to the aviation weather data network.

The Safety Board believes that at all automated surface weather observing sites in Alaska where currently there are qualified FAA or NWS weather observers (including contract weather observers) on site, the responsible agency should ensure that (1) operationally significant information, including distant weather information, is manually added

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[51] (a) NWS Observing Handbook No. 7, Surface Observations. (b) FAA Order 7900.5, Surface Weather Observing.

[52] (a) FAA Observer Handbook (Interim), Automated Weather Observing System (AWOS). (b) Notice 7110.97, Interim Operating Procedures for Surface Automated Weather Observing Systems.

[53] The following elements and remarks pertinent to aviation are among those specified to be included in the SDO: ice crystals, ice fog, blowing snow, snow increasing rapidly, sector visibility, significant cloud types such as rotor and altocumulus standing lenticular, and distant clouds obscuring mountains.

to automated weather observations until technological progress eliminates the need; and (2) all such information is combined and disseminated in a single aviation weather report.

Video Camera Observations.--Remote black and white video cameras have been used for experiments in weather observations in Alaska with varying amounts of success since the late 1970s. As a result of its 1980 study of air taxi safety in Alaska, the Safety Board recommended that the FAA:

> Continue to develop and improve, in cooperation with the National Weather Service, the technology of the television weather observation system in Alaska. (A-80-104)

The FAA tested a closed circuit video camera during the early 1980s at Unalakleet. According to the FAA, the system was unsuccessful because of the lack of contrast in the terrain. The remote video test program was terminated during 1984 except for a unit at Potato Point. On October 9, 1984, the FAA replied to the Safety Board that difficulties with camera resolution and physical location, exacerbated by local terrain and climatological conditions, resulted in unsatisfactory performance of the video weather observation system. The FAA believed that further installations were unwarranted. Consequently, the Board classified Safety Recommendation A-80-104 "Closed—No Longer Applicable" on January 17, 1985.

Since the test program was terminated, video imaging technology has developed considerably, with better results. The most successful and still ongoing use of video camera technology is at Valdez (Potato Point). Information from the Potato Point images is manually placed in the remarks section of the Cordova hourly weather observation.

The Canadian Atmospheric Environment Service (AES) has successfully used color cameras to provide either supplementary qualitative information for automated weather observation sites or information about specific phenomena, such as fog, at nonairport locations. Calls to the sites where cameras are installed are generally done as needed, although calls may be scheduled. The captured video images are displayed on either a personal computer or a forecaster meteorological workstation. Information from the video images is not attached to weather observations disseminated to pilots, but it is used by forecasters to verify automated observations and to provide supplementary weather information, such as distant weather.

The typical system, consisting of three fixed cameras per site, housing, computers, and installation expenses, costs about $9,000. As of 1995, AES video systems have been installed at about 30 locations across Canada. According to an AES official, 6 additional systems are to be installed in Alberta and Northwest Territories during 1996.

The NWS does not have a national policy concerning the applications of remote video camera technology, and it has no plans to incorporate remote video data into ASOS observations. However, the NWS Western Region has experimented with remote color video cameras at several locations in Utah. The video images have been well-received by Utah weather forecasters and have proven valuable to forecasters in determining precipitation type, visibility, and distant clouds. The NWS Alaska Region expressed its interest in remote video systems and their possible applications in the Alaskan environment. Although the Region has briefly looked at some current technology in cooperation with the regional telephone company, further efforts are hampered because there is no national policy or funding.

Remote color video systems could conceivably be of great benefit in Alaska at selected airports or other locales where, because of terrain features or unique weather phenomena, automated observations are not able to provide the necessary ancillary area weather intelligence. The Safety Board believes that the NWS should evaluate, with the assistance of the FAA, the technical feasibility and aviation safety benefits of remote color video weather observing systems in Alaska.

Dissemination of Weather Information

In addition to examining the dissemination of weather information obtained by automated surface weather observing systems, discussed in the previous sections, the Safety Board was especially interested in the dissemination of all weather information used by VFR pilots in Alaska for preflight planning and en route decisionmaking. In this regard, the Board reviewed the current status of the Flight Service Station (FSS) and Automated Flight Service Station (AFSS) systems, and evaluated the associated FAA communications facilities and near real-time weather update services by FAA and NWS personnel.

Flight Service Facilities.—In 1980, Congress approved initial funding for a nationwide modernization and consolidation program for the FSS system. The Flight Service Modernization Program provided for the establishment of 61 AFSS facilities throughout the United States (3 in Alaska), and the replacement of the existing 318 FSS facilities nationwide (27 in Alaska) by the AFSS.[54]

[54] At a traditional FSS facility, the flight service specialist on site uses a variety of video and paper-based resources to obtain information on weather, airports, and flight plans. The specialist then consolidates the information to prepare a pilot briefing. At an AFSS, the specialist uses a computer-generated video display that provides consolidated textual and graphical information. The specialists at both types of facility verbally relay the information to pilots by telephone or radio. At most traditional FSSs, in-person pilot briefings also are available.

According to the FAA, the primary objectives of the modernization program were to provide pilots with better access to critical information and essential services, to increase the productivity of flight service personnel, and to decrease overhead costs. To fulfill these objectives, the program would centralize the control and operation of the system, reduce labor-intensive workloads by providing information to flight service specialists by computer, and meet increased demands for service without a corresponding increase in the number of flight service personnel. The intent of the program was to provide pilots with a level of service equivalent to that provided by the FSS system with no derogation of safety.

In 1990, Congress altered the FAA's planned consolidation of the FSS facilities by requiring the development and implementation of "a system of manned auxiliary flight service stations" to support the AFSSs in "areas of unique weather or operational conditions which are critical to the safety of flight."[55] The FAA's plan and schedule for implementing the auxiliary FSS system, submitted to Congress in October 1991, indicated that the 14 remote FSSs remaining in Alaska would be converted into auxiliary FSSs, and at least 6 contract weather office locations would be established to support the AFSS facilities located in the State.[56]

The AFSSs in Alaska provide services for areas that range between a 500- and a 1,500-mile radius of the facility. When a remote FSS closes for the night, an AFSS becomes responsible for that area. For example, after 10 p.m., the Fairbanks AFSS is also responsible for the areas served by the Nome, Kotzebue, and Barrow FSS facilities. Many of the AFSS's responsibilities are identical to those of the remote FSSs, albeit with a much wider geographic area of coverage. In contrast to a remote FSS, however, an AFSS is not required to issue airport advisories or to make weather observations.

Communications with Flight Service Facilities.—Pilots communicating by very high frequency (VHF) with flight service facilities throughout Alaska are dependent on remote communications outlets (RCOs). RCOs are ground-based transceivers located in remote areas that are linked by satellite to AFSSs and FSSs, extending the range of communications. A pilot can transmit to a distant flight service facility via the receiver at a nearby RCO, and a flight service specialist at the facility can reply to the pilot via the RCO's transmitter. There are about 140 RCOs located in Alaska, many on high terrain for wide coverage. For example. Tatalina Mountain RCO, about 15 miles south of McGrath, is usable for more than

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[55] The provisions are contained in the Aviation and Capacity Expansion Act of 1990 (Public Law 101-508), and the Department of Transportation and Related Agencies Appropriations Act for FY 1991 (Public Law 101-516).

[56] As described by the FAA's plan, an auxiliary FSS will provide services (traffic advisories, flight plan services, and weather observations) to pilots operating in the immediate vicinity of the airport. Unlike a traditional FSS or an AFSS, the auxiliary FSS will not provide radio services to a larger, outlying area, nor will it provide preflight weather briefing services. A summary of the FSS consolidation effort is contained in the FAA's 1994 report to Congress entitled "Effects on Safety of the FSS Consolidation in Alaska."

100 miles in some directions. Another outlet, controlled by the Kenai AFSS, is on a 3,500-foot mountain overlooking Anchorage, and is usable throughout the Susitna Valley; the outlet on Murphy Dome, controlled by the Fairbanks AFSS, covers much of the interior of Alaska. As FSSs are consolidated, signals from the RCOs that they control are directed to AFSSs to provide continued in-flight services.

The RCOs provide communications coverage down to 2,000 feet above terrain along principal flyways throughout most of Alaska and down to the surface over much of southeast Alaska because of the high elevations of some RCO sites in that region. RCOs are located in the most heavily used VFR mountain passes, such as Lake Clark Pass, Windy Pass, and Chickaloon Pass. Generally, a pilot in most parts of Alaska can contact an FSS or AFSS via an RCO by climbing a few thousand feet.[57]

Several pilots who participated in the Safety Board's survey stated that they had experienced inadequate response times by AFSS specialists to radio calls over the RCOs. The problem did not appear to be one of RCO density or location: 41 (87 percent) of 47 respondents stated that the number of existing RCO frequencies was sufficient. However, specialists at AFSS facilities can be responsible for more than 75 different radio frequencies during evening hours when seasonal and part-time FSS facilities are not operating. Consequently, a specialist must often communicate simultaneously with several airplanes on different RCOs, creating a backlog in the system.

The situation was described to the Safety Board by a pilot operating out of Dutch Harbor in the Aleutian Islands. The pilot reported that when Cold Bay FSS closes for the evening, the response from Kenai AFSS over the RCO is not good. A pilot often receives no response to a radio call, or is told to "stand by." In the meantime, the airplane may travel many miles, and the need for weather information may become critical. Other pilots reported that they were placed on standby and were out of radio range when it was their turn to receive service, or specialists would reduce the amount of information contained in a briefing, hurrying to serve the next pilot.

Inadequate response times to pilots may result from what the FAA considers to be a temporary staffing shortage at the AFSSs. In its 1994 report to Congress on the FSS modernization program, the FAA acknowledged AFSS staffing shortages and attributed them to the need to operate the three AFSS facilities in Alaska while continuing to operate much of the old FSS network. The FAA stated, "This has led to a shortage of staffing and resources that has necessitated emergency FSS closures and part-timings and left AFSSs without a full staff to handle peak activity period."[58] The staffing situation needs to be resolved so that the quality of service provided by the AFSS facilities does not adversely

[57] Alaska Airmen's Association. 1994. Logbook for Alaska, Northwest Canada, and Russia. 2d ed. Anchorage, AK (p. 47).

[58] FAA 1994 Report to Congress, p. 3.

affect safety. The Safety Board believes that, by December 31, 1996, the FAA should ensure that staffing levels and utilization at AFSS facilities in the Alaskan Region are adequate to resolve the reported problems in radio services over RCO frequencies.

Mike-In-Hand Weather Updates.—In addition to the weather reports that pilots need for preflight planning and decisionmaking, pilots also need updates of recent (near real-time) weather and airport conditions during en route flight. The dissemination by radio of near real-time weather and airport information to pilots in flight is referred to as "mike-in-hand" service. The FAA provides mike-in-hand service at all FSS and FAA contract weather observing facilities in Alaska. In contrast, the NWS has a longstanding national policy that generally prohibits NWS employees from providing radio service to pilots.[59] In the past when this issue has been raised by users, the agency has stated that its personnel have neither the training nor experience to provide the service. More importantly, the agency was concerned that if employees were given the additional responsibility, there was potential for a conflict of duties; for example, when employees conduct the weather watch during adverse terminal weather conditions, they are required, at times, to be out of the office.

The commissioning of ASOS units and other planned restructuring of weather office duties should relieve NWS employees of many of their routine weather observing duties and allow more time for other tasks. These forthcoming changes in the Alaskan weather program provide the NWS an opportunity to reevaluate its policy. Mike-in-hand capability at the NWS offices would be a means by which pilots could obtain significant terminal area weather information that otherwise would be unavailable.

The safety advantages of providing near real-time weather information to pilots are significant, especially in Alaska, given the current limitations of automated surface weather observing systems. The Safety Board believes that the NWS should revise its current policies to provide mike-in-hand radio service for aviation surface weather information at locations in Alaska where NWS and contract weather observers are sited until automated surface weather observing systems transmit observations of all operationally significant weather phenomena to pilots operating in the terminal area.

Graphical Weather Products for Aviation in Alaska.—The Alaska Aviation Weather Unit, developed through an NWS initiative, is scheduled to be commissioned early in 1996. The unit will add two additional aviation forecasters during each 8-hour shift and will be responsible for the issuance of all area forecasts and in-flight advisories for the State. Equally important, the unit will produce weather graphics specifically tailored for aviation in Alaska and then disseminate them to AFSS and NWS offices. The graphics products will be designed primarily for the FAA personnel who provide weather briefings to pilots. Proposed graphics products include a composite area forecast, 12- and 24-hour aviation

[59] For many years, however, the NWS has informally provided radio service to pilots at St. Paul Island, Alaska, where the agency operates an installation.

significant weather prognosis charts, Alaska surface map, weather depiction chart, radar chart, winds aloft chart, and satellite pictures specially annotated by NWS personnel.

These graphics will represent a major improvement over currently available products and should result in better pilot weather briefings. Further, the safety benefits of these graphic products can be increased through their wide dissemination on graphics-capable media that reach Alaska's pilots. The Safety Board believes that the NWS, with the assistance of the FAA, should provide Alaska-specific graphical weather products on the NWS's aviation weather program telecast nightly on Alaska public television and the Rural Alaska Television Network, on the Direct User Access Terminal System, on the Internet, and on commercial weather information services that use NWS information.

Chapter 7

Enhancing the Low Altitude IFR System To Fulfill Alaska's Air Transportation Requirements

The most promising countermeasure to many of the problems of providing safe and reliable commercial air service in Alaska is to reduce the reliance on VFR and conduct more flight operations under IFR. A low altitude IFR system appropriate for Alaska's aviation environment would reduce the occurrence of fatal accidents related to VFR flight into IMC and would result in a safer aviation transportation system in Alaska. Such an IFR system would not resolve all of the safety issues of commercial VFR flying in Alaska, nor would it be usable by all operators for all purposes of flight. Still, such a system is well worth exploring to determine its benefits and to begin what would probably be a gradual process of adjustment—by owners of commercial operations, managers, pilots, and the remainder of the aviation system and user community—to a new way of doing business.

The aviation community in Alaska has expressed interest in the benefits of using IFR but has also indicated some deficiencies in the current IFR system. Several respondents to the Safety Board's survey indicated their desire for an improved IFR system for small aircraft operations in Alaska. In the NASA survey of Alaska commercial pilots, two-thirds of the respondents indicated that the lack of an appropriate IFR system affected them; two-thirds also commented that the lack of a workable IFR system had resulted in their having to fly under VFR when they would have preferred to operate under IFR. A pilot told NASA researchers, "Set up a real system; this is not VFR weather."[60] A panelist at the Safety Board's public forum suggested, "Get some of these...aircraft out of the scud-running mode [and] into the IFR system."[61]

As part of its study on aviation safety in Alaska, the Safety Board examined the deficiencies in the current IFR system that prevent the system from fulfilling the State's air transportation needs: inadequate navigational aid coverage for en route low altitude navigation and for instrument approaches; insufficient instrument approach procedures at destinations served by commercial operators; and inadequate aircraft position surveillance capabilities for air traffic control. Fulfillment of the State's air transportation needs is further limited by regulations that prohibit most of the commercial-use airplanes in Alaska (single-

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[60] Connell, L.J.; Chappell, S.L. 1995. Alaska human factors safety study: pilot survey. Presentation to the Alaska Air Carriers Association annual convention, Oahu, Hawaii, February 12-15.

[61] Transcript of proceedings, p. 403.

engine airplanes) from flying under IFR, and by regulations that prohibit commercial flights from operating under IFR in most of the low altitude airspace in Alaska. The remainder of this chapter discusses these issues and ways in which many of them can be remedied by the application of emerging technologies.

Alaska's Infrastructure

Navigational Aids.—IFR pilots depend on electronic navigational aids (NAVAIDs) to assist with en route navigation and with instrument approaches that allow safe descents to airports in IMC. In Alaska, the system of ground-based NAVAIDs is a network of ultra high, very high, and low/medium frequency transmitters. In 1969, because of the State's sparse population and rugged terrain, the FAA issued a waiver to the requirement that NAVAIDs be provided every 50 miles.[62]

As a result of the long distance between NAVAIDs in Alaska, many routes are published with a gap in signal coverage or have high minimum en route altitude requirements; both are disadvantageous to low and medium performance aircraft. Pilots operating under IFR in the contiguous United States generally use very high frequency omnidirectional ranges (VOR), which are subject to line-of-sight reception that limits operational range at lower altitudes above terrain. In contrast, pilots operating in Alaska generally rely on the less accurate but longer range nondirectional beacons (NDBs) for instrument flying in both en route and terminal phases of flight, because of the State's rugged terrain and long distances between communities. The FAA has installed 20 NDB facilities in Alaska since 1980 and currently maintains a network of 74 NDBs in the State. There are 39 VORs in Alaska, as well.

Overall, the State has a density of 0.15 VOR/NDB NAVAIDs per 1,000 square miles; in comparison, the remainder of the United States has a density of 0.61, more than four times greater. Besides its effects on en route navigation, the Alaska's lower NAVAID density is seen in the relative paucity of published instrument approaches. Of the 238 airports that receive scheduled commuter air service in Alaska, 185 (78 percent) do not have a published instrument approach. In comparison, of the 520 airports that receive scheduled commuter airline service in the remainder of the country, only 35 (7 percent) do not have a published instrument approach.[63]

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[62] Federal Aviation Administration, Alaskan Region. 1982. Ten year plan, 1984-1993. Anchorage, AK (p. 8-1). June.

[63] Derived from the Regional Airline Association 1995 annual report and from FAA data.

The GPS is currently approved for use in domestic en route IFR navigation, including use in Alaska, but to use the GPS, the aircraft and route structure must be equipped with ground-based navigation equipment (VOR, NDB, or LORAN-C for civilian users) to provide redundancy.[64] The GPS also is approved for instrument approaches, but current FAA guidelines specify that it can be used only when an alternate airport with an instrument approach that is not based on GPS or LORAN-C also is available.[65] These IFR operations using the GPS also require an airborne GPS receiver equipped with a receiver signal integrity monitoring function that is available on many current-production GPS units.

Air Traffic Surveillance.—Air traffic control (ATC) facilities throughout the United States, including the Anchorage Air Route Traffic Control Center (ARTCC), track and control aircraft primarily through the use of radar. Because of Alaska's size and the State's rugged terrain, there are areas with marginal or no radar coverage. The FAA stated during the Safety Board's public forum that prior to 1988, radar service was available only for about 20 percent of Alaska's airspace. Controllers used nonradar separation techniques in the remaining portions. Radar coverage in the Alaskan radar network doubled in 1986 with the incorporation of 8 radars owned and operated by the U.S. Air Force, bringing the total to 15 radar sensors. In 1996, three additional radars will be added, allowing coverage for over 90 percent of Alaska's airspace 12,000 feet and above. Despite the expanded radar coverage in Alaska, most of the airspace used for departure, en route (in airplanes equipped with a reciprocating engine), and arrival under IFR will remain below the limits of radar coverage.

The Need for an Enhanced Low Altitude IFR System in Alaska

Because commuter airlines and air taxis in Alaska need to provide highly reliable service in an environment of frequent instrument meteorological conditions, they need an IFR system that enables the following capabilities: to operate the single-engine airplanes that meet the demands of the small markets and airports the operators serve; to navigate under IFR on routes currently classified as uncontrolled airspace; to communicate with ATC while cruising below 10,000 feet; to communicate with company flight followers or dispatchers; and to execute instrument approaches at nearly 200 airports where no instrument approach facilities or procedures currently exist.

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[64] Federal Aviation Administration. 1994. Guidelines for using global positioning equipment for IFR en route or terminal operations and for non-precision instrument approaches in the U.S. national airspace system. Advisory Circular 90-94 (p. 2-3). December 14.

[65] FAA Advisory Circular 90-94 (p. 15).

The current IFR system in Alaska does not enable these capabilities. Enhancing the current system so that it provides the IFR capabilities needed by the operators can be accomplished through the integration of emerging technologies and regulatory changes. However, if these technologies are not applied and regulations are not changed in a coordinated manner, the needed IFR capabilities will not be achieved.

Emerging Technologies

Navigation.—The GPS is well suited to Alaska, which has never enjoyed adequate ground-based NAVAID coverage for widespread, low altitude IFR operations. The GPS could be used to great advantage for Alaskan IFR operations through establishment of instrument approaches at most or all of the airports served by commercial flights. The GPS also would provide the information required for en route navigation under IFR on direct routings to all of these airports. Thus, the GPS is the most appropriate IFR en route and terminal area navigation system for Alaska's future, obviating the need for further development of the ground-based NAVAID system.

The GPS is operational for VFR and limited IFR use throughout the United States. However, Alaska's GPS applications are demanding because, in the absence of an infrastructure of ubiquitous VORs and NDBs, the GPS often will have to serve as the sole source of navigational information for both en route flight and instrument approaches. Although GPS airborne receivers now being used for navigation under IFR have signal integrity monitoring, the FAA has not approved GPS as a sole source of navigation information, pending the development of additional integrity monitoring functions. These additional functions will be provided by the wide area augmentation system (WAAS),[66] which will also provide increased accuracy needed for precision approaches.[67]

A contract for the installation of the WAAS was awarded in late summer 1995. The initial WAAS will comprise 24 wide area reference stations and two wide area master stations throughout the United States. Although one wide area reference station will be located in Alaska at the Anchorage ARTCC, the initial WAAS will not provide full coverage in Alaska. The FAA projects that WAAS coverage for the entire United States, including all of Alaska, will be completed by the year 2001.

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[66] A system of satellite and ground stations that is designed to provide more accurate GPS navigation and improved verification of signal accuracy over large areas for IFR navigation.

[67] Federal Aviation Administration. 1994. Global implementation of GNSS. Information paper presented at the 15th annual meeting of the International Civil Aviation Organization All-Weather Operations Panel; September 26-October 12, 1994; Montreal, Canada (p. 2).

The Safety Board is aware that the DOD is resisting implementation of WAAS because of security concerns stemming from the increased accuracy of the GPS when WAAS is used. Although not aware of the details of the DOD's concerns, the Safety Board recognizes that WAAS will be extremely important to civilian aviation safety in particular and to transportation safety in general. The Board urges all U.S. governmental agencies concerned with the implementation of WAAS to consider the safety benefit that WAAS will provide.

Communications.—For the purposes of IFR operations, the ability to navigate throughout Alaska is of limited benefit if flights cannot also communicate with ATC. A low altitude IFR system that meets the needs of the users in Alaska must enable direct communications between air traffic controllers and pilots operating at low altitudes in terminal airspace and on the ground. Although the current system of remote communications facilities provides en route communications, it does not enable these capabilities. A solution to this problem appears to be with satellite-based voice and data communication systems that are or will soon be available throughout Alaska from commercial providers.[68]

Traffic Control.—Currently, the Anchorage ARTCC provides IFR traffic separation services at low altitudes using nonradar separation methods for most parts of Alaska. These methods separate aircraft by altitude and route segment based on position reports made by the pilots. Only one aircraft at a time can execute an instrument approach. In contrast, ATC uses radar separation methods to handle much of the commuter airline and air taxi traffic in the remainder of the United States, because radar coverage exists in most other parts of the country at en route and initial approach altitudes.

In order for ATC to handle a larger volume of IFR traffic in Alaska—such as would be generated if more commuter airline, air taxi, and general aviation flights were to operate under IFR—the FAA would need to establish a more efficient separation method. Respondents to the Safety Board's survey wanted the FAA to continue with its planned installation of radar in the Bethel region. However, given the dispersal of low-traffic-volume village airports over Alaska's expanse, it would not appear economical to install the number of radar systems needed to achieve low altitude radar coverage throughout Alaska.

The emerging technology of automatic dependent surveillance (ADS) provides an alternative to radar traffic separation that, like GPS-based navigation and satellite voice communications, suits low altitude IFR operations in widespread Alaska regions while obviating the need to install an expensive ground infrastructure. ADS by satellite data link recently has become operational over the Pacific Ocean. As the oceanic satellite data link system develops, it will route messages between aircraft and ground computers using FAA-

[68] One system will consist of a constellation of 66 satellites in low earth orbit, providing voice communications from aircraft in flight anywhere in the world. Completion of this system is planned for 1998.

operated Mode S sensors, industry-operated satellites, and VHF data links. Eventually, data link services will be available throughout U.S. oceanic and domestic airspace.

A lower cost version of ADS may become available for Alaska's small-airplane commercial operators in the near future, based on the same low-cost satellite-based voice and data communications systems that could be used for ATC voice communications, or on Mode S transponder and VHF data links that are currently being tested by the FAA. The ADS system would obtain position information from an airplane's GPS receiver and altitude reporting transponder, and report this information to ATC. To control air traffic using this system as ATC does using radar, the FAA would need to install equipment and establish procedures for ATC to display the locations and altitudes of aircraft, based on GPS and data link. The FAA has installed this equipment for oceanic traffic control in the airspace of the ARTCC in Oakland, California, and plans to install it at the Anchorage ARTCC at an undetermined time.

The technologies of GPS navigation and ADS also could bring additional safety advantages through enhanced corporate operational control of flights in progress. Commercial aviation operators are required to perform a flight-following procedure that tracks the progress and safe arrival of company flights. In many remote parts of Alaska, this function is hampered by the lack of radio or telephone communications between aircraft in flight or village facilities and the operator's offices.[69] Operators speaking at the Safety Board's public forum reported that they were experimenting with various forms of communications technologies that would permit them to track the locations of their aircraft in real time. In these experiments, the operators were using remote VHF receiver/transmitters similar to the FAA's RCOs; initial experience with them has been disappointing because of the limited geographic coverage. In contrast, the same satellite-based voice and ADS technologies needed for a low altitude IFR system also could provide coverage throughout Alaska for company operational control.

Although some of these navigation, voice communications, and data link technologies are not operational in an IFR system application as of 1995, similar technologies are already used in the private sector to track and control the movements of trains and small package delivery trucks in real time. The remaining technological challenge, on which the Safety Board would like to see progress, is to make the IFR system application of these technologies available to aviation users at a reasonable cost.

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[69] Under 14 CFR Part 135.471, operators may use the FAA's IFR or VFR flight plan services to perform their flight following, obviating the need for a separate, company tracking function. Under the FAA's proposed requirements for commuter airlines to conduct their flight operations under Part 121, these operators may be required to replace flight following with more formal dispatch functions, which will need company communications independent of the FAA.

Regulatory Changes Needed

Single-Engine IFR.—Current regulations contained in Part 135 limit the commercial, passenger-carrying operations that may be conducted under IFR in single-engine airplanes.[70] The FAA has received several petitions since 1979 seeking relief from these limitations. All have been denied, except the latest petition, to which the FAA has not yet responded. This petition, submitted in 1992 by the Alaska Air Carriers Association, sought permission to operate single-engine airplanes powered by a turbine or reciprocating engine under IFR while carrying passengers. The FAA referred the issue to an Aviation Rulemaking Advisory Committee, which reported its findings to the FAA in early 1995.[71] It is the Safety Board's understanding that the committee recommended approval of IFR passenger-carrying operations under Part 135 using turbine-powered single-engine aircraft, and that the FAA is currently considering proposed rulemaking that might permit a broader scope of commercial, passenger-carrying IFR operations in single-engine aircraft.

In 1993, Canada provided an exemption that permitted commercial, passenger-carrying IFR operations in turbine-powered single-engine airplanes, subject to specific airplane equipment, pilot experience, pilot proficiency, pilot training, and company requirements. On February 24, 1994, the FAA released a study of Part 135 single-engine IFR operations.[72] In the study, the FAA framed the issue as a tradeoff between the risk of serious accidents following failure of an airplane's single engine and the risk of serious accidents caused by VFR flying in adverse weather. The study concluded, "Allowing single-engine operations in IMC may benefit regions like Alaska, which relies extensively upon single-engine airplanes, but where a highly disproportionate share of accidents occur that involve continued flight under visual flight rules into IMC."

The Safety Board agrees with the conclusion of the FAA study and considers the prevalence in Alaska of accidents related to VFR flight into IMC as impetus for the FAA to proceed with rulemaking to allow commercial, passenger-carrying IFR operations in turbine-powered single-engine airplanes. Several single-engine airplane models powered by turbine engines have achieved very low rates of in-flight engine failures, and approving commercial, passenger-carrying IFR operations in these models, as Canada has done, would appear to

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[70] 14 CFR Part 135.181 permits single-engine airplanes to depart under IFR if VFR conditions can be reached in 15 minutes or less. Part 135.211 allows operations in IMC or over the top of clouds in a single-engine airplane carrying passengers only when a safe engine-out emergency descent and landing can be made in visual conditions.

[71] An Aviation Rulemaking Advisory Committee is a group of industry, labor, and government representatives convened by the FAA to facilitate the FAA's rulemaking process. The group is charged with examining issues pertinent to a particular area of concern and developing recommendations for advisory material and/or revisions to current regulations.

[72] Federal Aviation Administration. 1994. Part 135 single-engine instrument flight rules operations in instrument meteorological conditions. Final Report. Washington, DC.

provide a favorable reduction in exposure to VFR flight into IMC in exchange for a very small risk of engine failure in IMC.

However, most Alaska commuter airlines and air taxis will be using smaller, single-engine airplanes powered by a reciprocating engine well beyond the next decade. Allowing the use of these airplanes in commercial, passenger-carrying IFR operations may provide a greater level of safety than current operations under VFR, by preventing some accidents related to VFR flight into IMC. If properly operated and maintained, the modern reciprocating engines that power many of these airplanes may experience low enough rates of in-flight failure to achieve a net positive safety benefit from operating under IFR. Accordingly, the Safety Board believes that by December 31, 1997, the FAA should determine whether a positive effect on safety would be gained by allowing commercial, passenger-carrying IFR operations in single-engine airplanes powered by a reciprocating engine by evaluating the associated operating methods, maintenance methods, in-flight engine failure rates, accident rates related to in-flight engine failure, and accident rates related to VFR flight into IMC; then take appropriate action based on the evaluation.

Commercial IFR Operations in Uncontrolled Airspace.—Part 135 regulations and the operations specifications typically approved by the FAA for commuter airlines and air taxis limit an operator's ability to conduct commercial flights under IFR in uncontrolled airspace.[73] Nearly all of the low altitude airspace in Alaska is uncontrolled airspace. Noncommercial flights can operate legally in IMC, in uncontrolled airspace, without an air traffic clearance or ATC separation; thus, the current restrictions on Part 135 operations in uncontrolled airspace are effective in separating IFR Part 135 flights from this traffic. If the FAA were to establish low altitude IFR routings based on GPS in currently uncontrolled airspace, the agency would have to either establish large swaths of additional controlled airspace or amend the current restrictions of Part 135 and assure separation from traffic operating in IMC without ATC clearance by other means.

Weather Reporting for Instrument Approaches.—Current provisions of 14 CFR Part 135.225 prohibit a commuter airline or air taxi pilot from beginning an instrument approach unless the airport has an NWS or NWS-approved weather reporting facility, or a source of weather information approved by the FAA. Further, the latest weather report must indicate that weather conditions are at or above authorized IFR landing minimums for that airport. As indicated earlier in the report, many of the small airports at outlying villages now served by commuter airlines and air taxis do not have the type of automated or manual weather reporting facilities currently required for instrument approaches under Part 135. Thus, when an instrument approach to these airports becomes technically possible with the GPS, the current weather reporting requirements of 14 CFR Part 135.225 would prevent the execution

[73] 14 CFR Part 135.215 allows IFR operations in uncontrolled airspace, if specifically approved under a carrier's operations specifications, but only to begin and end a flight that operates in controlled airspace en route.

of an instrument approach; consequently, incoming flights will have to rely on VFR and will be denied the safety advantages of IFR operation.

To enable use of a GPS-based IFR system for flights to the majority of Alaska's airports served by commuter airlines, the FAA will need to take action in one of two areas: either (a) expand AWOS/ASOS installations to include additional sites in Alaska that are served by commuter airlines; or (b) approve the execution of instrument approaches at small village airports where weather information is more limited. Accordingly, the Safety Board believes that by December 31, 1997, the FAA should evaluate the costs and benefits (including the safety benefits of converting commercial VFR operations to IFR operations) of the following three alternatives, then take appropriate action based on the evaluation of the three alternatives: (1) continuing the current limitations of 14 CFR Part 135.225 with no expansion of weather reporting facilities at the village airports served by commuter airlines in Alaska; (2) continuing the current limitations of 14 CFR Part 135.225 and installing automated or manual weather reporting facilities at these village airports; and (3) amending 14 CFR Part 135.225 to allow the execution of instrument approaches at these village airports with less extensive weather information, or with weather information obtained from a less official source, than the regulation currently requires.

Demonstrating the Benefits of an Enhanced IFR System

VFR flight into IMC that results in fatal accidents continues to be the most significant safety problem in Alaskan aviation. The applications of satellite-based navigation, communications, and data link technologies to IFR operations can reduce the occurrence of such accidents. These applications need to be accelerated, especially in Alaska where their safety benefits are potentially the greatest.

Demonstration of an enhanced low altitude IFR system in Alaska would provide the aviation community with important information about how such a system will better fulfill the State's air transportation needs while improving aviation safety. A demonstration would also help identify issues that may need to be resolved before an enhanced IFR system is implemented Statewide; for example, the geographic areas in Alaska that would be amenable to conversion from VFR to IFR operations.

Respondents to the Safety Board's survey and participants in the Board's public forums identified two geographic areas of Alaska that they believed would benefit most from an enhanced low altitude IFR system: the Arctic region, with its expanse of flat terrain and widespread IMC; and southeast Alaska, with its mountainous terrain, routings along shorelines and through water passages, and widespread IMC.

These areas have different IFR flying environments, such as minimum en route altitudes, available course widths, and exposure to in-flight icing conditions. Selecting portions of both regions, or one or more commercial operators in both regions, for the demonstration program would allow the FAA to evaluate the applicability of IFR to commuter airline and air taxi operations in each environment. In the Arctic region, the demonstration program will provide valuable information about the utility of an enhanced IFR system used in standard IFR operations. In the southeast coastal regions, the program will provide information about the need for airplanes to be equipped with anti- and de-icing capabilities. Also, the coastal regions will provide the opportunity to evaluate the feasibility of establishing reduced-width IFR airways that follow shorelines and water passages, below nearby higher terrain, because of the accuracy of the GPS and the capabilities of airborne GPS receivers to identify airway turning points and to display preplanned routes.

To reduce the occurrence of fatal accidents related to VFR flight into IMC as soon as possible, it is essential to begin making the current IFR system more usable for Alaska's aviation operators. The current level of technology is appropriate for a demonstration program. Accordingly, the Safety Board believes that by December 31, 1997, the FAA should implement a model program in the Arctic and southeast regions of Alaska to demonstrate a low altitude IFR system that better fulfills the needs of Alaska's commercial air transportation system. The model program should include the following components:

(1) The use of the global positioning system (GPS) as a sole source of navigational information for en route navigation and for nonprecision instrument approaches at a representative number of airports where instrument approaches do not currently exist. (Operators participating in the program will have to be allowed to conduct these operations without the integrity monitoring functions of the wide area augmentation system (WAAS) until WAAS is fully implemented in the demonstration region.)

(2) The use of satellite-based voice communications and satellite-based, Mode S, or VHF data link (for aircraft position and altitude) between aircraft in flight and air traffic controllers.

(3) The operation of commercial, passenger-carrying flights under IFR in turbine-powered single-engine airplanes equipped with redundant sources of electrical power and gyroscopic instrument vacuum/pressure.

(4) The use of currently uncontrolled airspace for IFR departures, en route flight, and instrument approaches in the demonstration program region.

Chapter 8

Special Aviation Operations in Alaska

Three kinds of specialized commercial services—air tours, aerolodge/guide services, and aerologging--play major roles in Alaska's air transportation system. Issues of particular relevance to these services were examined as part of this study and were addressed in the Safety Board's public forums. Additionally, the Board reviewed safety issues related to oversized (tundra) tires, which are widely used in Alaska's air taxi and general aviation operations.

Air Tours

In 1985, about 73,000 people toured Alaska by air. In 1993, there were about 175,000 flight-seeing tourists.[74] The air tour season in Alaska runs from May through September. Although air tour excursions occur throughout the State, the activity occurs primarily in southeast Alaska and in the north-central part of the State around Mount McKinley (Denali) and the Denali National Park.

The Safety Board reviewed the safety of air tour operations at a nationwide level during a 1995 special investigation.[75] Regulations, operations specifications, emergency equipment requirements, and FAA certification and oversight of air tour operators were examined, and safety recommendations addressing these areas were issued to the U.S. Department of Transportation, the FAA, the State of Hawaii Transportation Department, and the Hawaii Helicopter Operators Association.

In 1995, the Helicopter Tour Operators' Committee of the Helicopter Association International (HAI) drafted standards for the helicopter tour industry. These include weather minimums that are higher than FAA requirements, pilot training that is more stringent than the Part 135 requirements, ground support procedures and personnel training, and a

[74] State of Alaska Division of Tourism. 1995. Flight-seeing activities in Alaska. Position paper dated April 1995 submitted to the National Transportation Safety Board public forum on aviation safety in Alaska, Juneau, Alaska, May 22, 1995.

[75] National Transportation Safety Board. 1995. Safety of the air tour industry in the United States. Special Investigation Report NTSB/SIR-95/01. Washington, DC.

commitment to safety that includes regular safety audits. Industry-led quality assurance programs such as the HAI helicopter tour standards program can be effective in enhancing safety. The Safety Board supports the HAI's initiative to enhance the safety of helicopter air tour operations and, based on the popularity of both helicopter and fixed-wing air tours in Alaska, the Board encourages fixed-wing air tour operators to review and adopt relevant provisions.

Aerolodge/Guide Services

Hunting and fishing are important economic activities in Alaska and contribute to the livelihood of a large portion of the population. Transporting hunting and fishing customers by air is a well-established practice of commercial lodge operators and guides in the State. Based on judicial decisions from the early 1960s, the carriage by air of these customers is considered incidental to the hunt or fish guiding services. As a result, current FAA policy allows guides to fly their customers as noncommercial operations under the general operating rules of 14 CFR Part 91, which are less restrictive than those in Part 135.

A typical "lodge/guide" operation involves taking customers to a lodge or other remote site by light aircraft, and while there, providing guide service, food, lodging, and supplies. In some cases, several trips by air are involved, and usually the customer pays a single fee for the trip, including transportation.

From July 1991 through August 1993, the Safety Board investigated 29 accidents involving pilot guides (hunting/fishing guides who routinely transport clients to game locations by aircraft) or aerolodges (lodges that are accessible only by aircraft).[76] In all 29 accidents, the operations were being conducted under the provisions of Part 91. Fourteen of these accidents resulted in fatalities or serious injuries.

As a result of its investigations, the Safety Board asked the FAA to establish minimum pilot certification, experience, qualification, and training requirements under Part 135 for pilot guide/aerolodge operations presently conducted under Part 91 (Safety Recommendation A-94-99, issued May 4, 1994). The FAA responded on July 13, 1994, that it was reviewing all facets of the pilot guide/aerolodge industry to determine what measures were required to address the issues that were identified by the Board. Based on the FAA's action, the Safety Board classified Safety Recommendation A-94-99 "Open—Acceptable Response."

At its 1995 public forums in Alaska, the Safety Board heard comments from representatives of the Alaska Professional Hunter's Association and the recently formed

[76] NTSB accident data.

Alaska Sport Fishing Industry Association. Both organizations believe that the industry should establish basic pilot experience, qualification, and training criteria. However, they also believe that these enhancements could be addressed under Part 91.

The Safety Board continues to believe that the requirements of Part 135 would provide an enhanced level of safety to aerolodge/guide activities. For example, Part 135 certification for aerolodge/guide operators would introduce safety improvements such as commercial licenses and instrument ratings for pilots, recurrent pilot training and checkrides, and standards for operational and maintenance procedures contained in FAA Operations Specifications. Further, certification under Part 135 would facilitate FAA oversight by requiring the owners of the services to obtain operating certificates, which would, in turn, result in enhanced surveillance in accordance with FAA work program guidelines. However, achieving these safety improvements might be possible without requiring aerolodge/guide operators to comply with all of the provisions of Part 135; developing and adding special provisions for such operations under Part 91 could also offer an enhanced level of safety. Accordingly, the Safety Board believes that by December 31, 1996, the FAA should complete the review of the aerolodge/guide flight activities and propose rulemaking to place these activities under Part 135 or to modify Part 91 as needed to provide an equivalent safety standard. The Board classifies Safety Recommendation A-94-99 "Closed—Acceptable Action/Superseded" by the new recommendation issued as a result of this study.

Aerologging

In aerologging, a hovering helicopter picks up a felled tree and carries it as an external load, suspended beneath the aircraft, usually for a short distance to a staging area for further transport by other means. Helicopters are also used to transport loads of logs to yarding areas. The short-distance trips result in multiple cycles of a highly loaded engine and airframe structure.

During an 18-month period between January 1992 and June 1993, there were seven aerologging helicopter crashes that resulted in nine deaths.[77] All of the accidents involved single-engine helicopters in long-line logging operations in Alaska. The Safety Board's investigations identified, in all seven cases, improper operational and/or maintenance practices that reflected inadequate FAA surveillance of logging operations in southeast Alaska. In a letter to the FAA dated June 17, 1993, the Safety Board recommended actions to address the surveillance responsibility within the FAA (Safety Recommendation A-93-78), team inspections of aerologging operators (A-93-79), and on-site surveillance of aerologging operators (A-93-80). Based on subsequent actions taken by the FAA, the Board classified

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[77] NTSB accidents ANC-93-LA-095, ANC-93-FA-061, ANC-93-FA-056, ANC-93-FA-033, ANC-92-LA-090, ANC-92-FA-044, ANC-92-FA-040.

Safety Recommendations A-93-78 and -79 "Closed—Acceptable Alternate Action" on June 20, 1995. The Board also classified Safety Recommendation A-93-80 "Closed—Unacceptable Action" following the FAA's response that on-site surveillance was not feasible.

At the public forum session devoted to aerologging, panelists agreed that the FAA needed to assess airframe and component replacement and inspection intervals because of the heavy, high-cycle loading of these helicopters in aerologging service. The Safety Board agrees that the unique nature of aerologging justifies special attention from the FAA in its oversight of the certification and maintenance of the aircraft and component parts utilized in the operation. Consequently, the Safety Board believes that the FAA should review the maintenance programs of helicopters used in aerologging and develop prescribed service life limits and overhaul times on engines, airframe parts, and components as necessary to provide an adequate margin for safety.

Oversized (Tundra) Tires

Oversized (tundra) tires are commonly used by air taxi and general aviation operators in Alaska to facilitate takeoffs and landings on unimproved airstrips and off-airport locations. The Safety Board recognizes the contributions of oversized tires to enabling the off-airport operations that are part of Alaska's transportation needs, and to making these operations safer. The Board has noted in its investigations that many accident-involved airplanes in Alaska are equipped with these tires, which is consistent with their frequent use. In a letter to the FAA Administrator on February 7, 1995, the Board expressed its concerns about the lack of flight testing on previous FAA approvals for tundra tire installations to determine whether the oversized tires adversely affect aircraft performance, handling, aerodynamic stall, or aerodynamic (inherent) stall warning characteristics. In Safety Recommendation A-95-13, the Board asked the FAA to develop an appropriate flight test program. In April 1995, an FAA test pilot flew a Piper Aircraft Corporation PA-18-150 Super Cub equipped with oversized tires up to 29-inch diameter. According to the FAA, analysis of the flight test showed that a pilot of average skills can fly the Super Cub, both with standard tires and with larger, heavier tires, without any adverse effects on handling qualities or performance as long as the certificated weight and balance limitations of the aircraft were maintained. The test program did not identify any stall behavior or handling problems with tundra tires installed.

The test, however, did reveal a feature of the Piper PA-18 Super Cub that should be of concern to pilots. The PA-18, as tested, did not demonstrate adequate inherent aerodynamic stall warning characteristics such as buffeting, shaking, or vibration of the control wheel just prior to stalling. Artificial stall warning devices are available for the PA-18 series, but they are not required equipment and many PA-18s are not so equipped.

On July 17, 1995, the FAA informed the Safety Board of its initial test findings and commitment to the development of an advisory circular (AC) to advise the public of the results of the flight tests and to provide general information on the safe use of tundra tires. In its reply to the FAA on August 21, 1995, the Board expressed its appreciation for the FAA's timely flight tests, suggested that similar flight testing would be appropriate for tire sizes larger than 29 inches for which the FAA would be willing to approve installation, and suggested that the FAA should resolve the issue of Piper PA-18 aerodynamic stall warning to its satisfaction. The Safety Board will monitor the progress of the FAA's advisory circular and these related activities; meanwhile, Safety Recommendation A-95-13 remains classified "Open—Acceptable Response."

Findings

1. In recent years, fatal accident rates of Alaskan commuter airlines have decreased but remained greater than those of commuter airlines in the remainder of the United States; the fatal accident rates of Alaskan air taxis have fluctuated but in most years were greater than those of air taxis in the remainder of the Nation; and the fatal accident rates of Alaskan general aviation operations have been comparable to those of the remainder of the country.

2. Commuter airline and air taxi operations in Alaska are dominated by single-engine airplanes powered by a reciprocating engine and operated under visual flight rules.

3. Pilots and commercial aviation operators in Alaska continue to conduct flights with higher-than-normal risks, in response to demands for reliable air service in an operating environment and aviation infrastructure that are often inconsistent with these demands.

4. The current performance standard of the United States Postal Service for the transportation of bypass mail on commercial flights in Alaska exerts pressure on some aviation operators, because the standard is based on the completion of individual flights.

5. Flying under visual flight rules into instrument meteorological conditions was the leading safety problem for Alaskan commuter airlines from 1989 through 1993, accounting for 6 of the 9 fatal accidents during the period, and for Alaskan air taxis, accounting for 7 of the 15 fatal accidents.

6. The continued occurrence of accidents involving flight under visual flight rules into instrument meteorological conditions in Alaska's commuter airline and air taxi industries highlights the need to provide flightcrews, during initial and recurrent stages of the operators' training programs, aeronautical decisionmaking training that is tailored to commercial operations and Alaska's aviation environment.

7. Although an improved low altitude instrument flight rules system in Alaska would not resolve all of the safety issues of commercial flying under visual flight rules (VFR) in Alaska, nor would it be usable by all operators for all purposes of flight, it would reduce the incidence of fatal accidents involving VFR flight into instrument meteorological conditions in the State and result in a net safety improvement for Alaska aviation.

8. The current low altitude instrument flight rules system in Alaska has several deficiencies that prevent it from fulfilling the State's air transportation needs: inadequate navigational aid coverage for en route low altitude navigation and for instrument approaches; insufficient instrument approach procedures at destinations served by commercial operators; and inadequate voice communications and aircraft position surveillance capabilities for air traffic control.

9. Current regulations contained in 14 CFR Part 135 prohibit most of the commercial-use airplanes in Alaska (single-engine airplanes) from flying under instrument flight rules (IFR), and prohibit commercial flights from operating under IFR in most of the low altitude airspace in Alaska.

10. Deficiencies in the current instrument flight rules system in Alaska can be remedied by the integration of emerging technologies and regulatory changes, if applied in a coordinated manner.

11. The global positioning system's applications for navigation under both visual and instrument flight rules have the potential to bring about a significant positive change to Alaska aviation.

12. Although instrument approaches will become technically possible at most airports in Alaska with the global positioning system, the current weather reporting requirements of 14 CFR Part 135.225 would prevent the execution of such approaches at most of the small airports in outlying villages in Alaska now served by commuter airlines and air taxis because the airports do not have the type of weather reporting facilities required for instrument approaches under Part 135.

13. The number of aviation weather reporting sites in Alaska did not change between 1980 and mid-1995, and the user community continues to indicate that this weather reporting network provides inadequate coverage for operations under visual flight rules.

14. Most future expansions of the number of weather observing sites in Alaska will utilize automated surface weather observing systems (AWOS and ASOS), yet current technology does not allow these automated systems to replicate all of the elements of a manual weather observation taken by a trained observer that provide operationally significant information, such as distant weather phenomena, to pilots, National Weather Service forecasters, and Federal Aviation Administration weather briefers.

15. The existing and planned programs of the Federal Aviation Administration and National Weather Service for augmenting the automated surface weather observing systems (AWOS and ASOS) in Alaska are inadequate because the programs do not permit observers to manually add all operationally significant information.

16. At automated surface observing system sites where the National Weather Service (NWS) has personnel, supplemental data observations (SDOs) will be used to report operationally significant weather information manually obtained by NWS observers to the agency's weather forecasters, but the NWS will not attach the SDO to the aviation weather reports that are disseminated to pilots and Federal Aviation Administration weather briefers.

17. Remote color video systems may be beneficial at selected airports or other locales in Alaska where, because of terrain features or unique weather phenomena, automated observations cannot provide the necessary ancillary area weather intelligence.

18. The National Weather Service has a longstanding national policy that generally prohibits its employees from providing "mike-in-hand" radio service to pilots, but the safety advantages of providing near real-time weather information are significant, especially in Alaska.

19. The safety benefits of graphical weather products to be produced by the Alaska Aviation Weather Unit of the National Weather Service can be increased through wide dissemination of the products on graphics-capable media that reach Alaska's pilots.

20. The modernization program for the Federal Aviation Administration Flight Service Stations (FSS) was to provide pilots with a level of service equivalent to that provided by the traditional FSS system without compromising safety, but some users in Alaska report continued problems with radio services provided by Automated Flight Service Stations over remote communications outlet frequencies.

21. Workload disparities exist among Aviation Safety Program Managers at Flight Standards District Offices in the Alaskan Region, and the Federal Aviation Administration has not established national workload-based guidelines for staffing these positions.

22. The 3,000-foot minimum runway length adopted as a standard by the State of Alaska is appropriate for current commuter airline services that use single-engine airplanes, given the prevalence of runway surfaces and contaminants that can reduce airplane braking action, yet 77 airports receiving scheduled air service have a runway length that is less than the State-adopted minimum of 3,000 feet. The runway length at many of these airports is limited by the geography of the surrounding terrain.

23. Staffing of the Federal Aviation Administration department responsible for performing all the airport inspections in Alaska was reduced to one individual during 1995, significantly limiting the primary means of gathering airport information critical to flight safety.

24. Accidents that occur during landings at village airports and at off-airport landing sites in Alaska may be prevented if pilots of arriving flights were provided direct, near real-time reports of airport and runway conditions by State airport maintenance contractors at airport sites, and if Notices to Airmen were to include conditions reported by local aviation and nonaviation observers at both airport and off-airport sites.

25. The consecutive, long duty days currently permitted by Part 135.261 for commuter airline and air taxi flightcrews in Alaska can contribute to fatigue and are a detriment to safety.

26. The safety of commercial aerolodge/guide operations in Alaska would be increased by standardizing operational and maintenance procedures with those of other commercial operations, and by increasing the effectiveness of Federal Aviation Administration surveillance of aerolodge/guide activities.

27. The unique nature of aerologging justifies special attention from the Federal Aviation Administration in its oversight of the certification and maintenance of the aircraft and component parts utilized in the operation.

28. Industry-led quality assurance programs, such as the helicopter tour standards program of the Helicopter Association International, can be effective in enhancing air tour safety in Alaska.

29. The "trigger tapes" program, an innovative accident prevention effort of the Federal Aviation Administration, appears to be appropriate for commuter airline and air taxi operators, but requires further action to achieve its potential.

Recommendations

As a result of this safety study, the National Transportation Safety Board made the following safety recommendations:

To the Federal Aviation Administration—

Implement, by December 31, 1997, a model program in the Arctic and southeast regions of Alaska to demonstrate a low altitude instrument flight rules (IFR) system that better fulfills the needs of Alaska's air transportation system. The model program should include the following components:

(1) The use of the global positioning system (GPS) as a sole source of navigational information for en route navigation and for nonprecision instrument approaches at a representative number of airports where instrument approaches do not currently exist. (Operators participating in the program will have to be allowed to conduct these operations without the integrity monitoring functions of the wide area augmentation system (WAAS) until WAAS is fully implemented in the demonstration region.)

(2) The use of satellite-based voice communications and satellite-based, Mode S, or VHF data link (for aircraft position and altitude) between aircraft in flight and air traffic controllers.

(3) The operation of commercial, passenger-carrying flights under IFR in turbine-powered single-engine airplanes equipped with redundant sources of electrical power and gyroscopic instrument vacuum/pressure.

(4) The use of currently uncontrolled airspace for IFR departures, en route flight, and instrument approaches in the demonstration program region. (Class II, Priority Action) (A-95-121)

Determine, by December 31, 1997, whether a positive effect on safety would be gained by allowing commercial, passenger-carrying, instrument flight rules operations in single-engine airplanes powered by a reciprocating engine by evaluating the associated operating methods, maintenance methods, in-flight engine failure rates, accident rates related to in-flight engine failure, and accident rates related to visual flight into instrument meteorological conditions; then take appropriate action based on the evaluation. (Class II, Priority Action) (A-95-122)

Evaluate, by December 31, 1997, the costs and benefits (including the safety benefits of converting commercial visual flight rules operations to instrument flight rules operations) of the following three alternatives, then take appropriate action based on the evaluation of the three alternatives. (1) continuing the current limitations of 14 CFR Part 135.225 with no expansion of weather reporting facilities at the village airports served by commuter airlines in Alaska; (2) continuing the current limitations of 14 CFR Part 135.225 and installing automated or manual weather reporting facilities at these village airports; and (3) amending 14 CFR Part 135.225 to allow the execution of instrument approaches at these village airports with less extensive weather information, or with weather information obtained from a less official source, than the regulation currently requires. (Class II, Priority Action) (A-95-123)

Require, by December 31, 1997, operators that conduct scheduled and nonscheduled services under 14 CFR Part 135 in Alaska to provide flightcrews, during initial and recurrent training programs, aeronautical decisionmaking and judgment training that is tailored to the company's flight operations and Alaska's aviation environment, and provide similar training for Federal Aviation Administration principal operations inspectors who are assigned to commuter airlines and air taxis in Alaska, so as to facilitate the inspectors' approval and surveillance of the operators' training programs. (Class II, Priority Action) (A-95-124)

Develop appropriate limitations on consecutive days on duty, and duty hours per duty period for flightcrews engaged in scheduled and nonscheduled commercial flight operations, and apply consistent limitations in Alaska and the remainder of the United States. (Class II, Priority Action) (A-95-125)

Ensure, at all automated surface weather observing sites in Alaska for which the Federal Aviation Administration is responsible, and where currently there are qualified FAA weather observers (including contract weather observers) on site, that (1) operationally significant information, including distant weather information, is manually added to automated weather observations until technological progress eliminates the need; and (2) all such information is combined and disseminated in a single aviation weather report. (Class II, Priority Action) (A-95-126)

Assist the National Weather Service (NWS) in providing Alaska-specific graphical weather products on the NWS aviation weather program telecast nightly on Alaska public television and the Rural Alaska Television Network, on the Direct User Access Terminal System, on the Internet, and on commercial weather information services that use NWS information. (Class II, Priority Action) (A-95-127)

Assist the National Weather Service with an evaluation of the technical feasibility and aviation safety benefits of remote color video weather observing systems in Alaska. (Class II, Priority Action) (A-95-128)

Assist the State of Alaska with the development of appropriate procedures and establishment of a training program to enable mike-in-hand (near real-time) reports of airport conditions by designated State and contractual airport maintenance personnel. (Class II, Priority Action) (A-95-129)

Ensure, by December 31, 1996, that staffing levels and utilization at Automated Flight Service Station facilities in the Alaskan Region are adequate to resolve the reported problems in radio services over remote communications outlet frequencies. (Class II, Priority Action) (A-95-130)

Evaluate the Aviation Safety Program Manager work program and the associated Aviation Safety Program in the Alaskan Region, and develop appropriate national workload-based guidelines for staffing based on the evaluation. (Class II, Priority Action) (A-95-131)

Evaluate, by December 31, 1996, the work program for inspectors responsible for the Part 139 and 5010 airport inspection programs within the Alaskan Region, then develop appropriate staffing standards and personnel work responsibilities based on the evaluation and encourage the State of Alaska to participate in the 5010 program. (Class II, Priority Action) (A-95-132)

Modify the Notices to Airmen system in Alaska to accept and disseminate unverified information, labeled as such, about airport and off-airport field conditions, that is provided by designated aviation and nonaviation sources. (Class II, Priority Action) (A-95-133)

Complete, by December 31, 1996, the review of the aerolodge/guide flight activities and propose rulemaking to place these activities under Part 135 or to modify Part 91 as needed to provide an equivalent safety standard. (Class II, Priority Action) (A-95-134) (Supersedes A-94-99)

Review the maintenance programs of helicopters used in aerologging and develop prescribed service life limits and overhaul times on engines, airframe parts, and components as necessary to provide an adequate margin for safety. (Class II, Priority Action) (A-95-135)

Take appropriate action, by December 31, 1996, to (1) complete the distribution of videotapes designed to trigger discussion between pilots and managers about human factors issues ("trigger tapes") to all Part 135 operators in Alaska, (2) disseminate information about the trigger tape program to the FAA principal operations inspectors assigned to Part 135 operators in Alaska, and (3) establish a program to evaluate operator use of the tapes. (Class II, Priority Action) (A-95-136)

To the United States Postal Service—

Establish and implement a broader and more flexible performance standard for bypass mail transportation in Alaska that relieves the direct performance pressure on individual flights. (Class II, Priority Action) (A-95-137)

To the National Weather Service—

Ensure, at all automated surface weather observing sites in Alaska for which the National Weather Service is responsible, and where currently there are qualified NWS weather observers (including contract weather observers) on site, that (1) operationally significant information, including distant weather information, is manually added to automated weather observations until technological progress eliminates the need; and (2) all such information is combined and disseminated in a single aviation weather report. (Class II, Priority Action) (A-95-138)

Provide, with the assistance of the Federal Aviation Administration, Alaska-specific graphical weather products on the National Weather Service's aviation weather program telecast nightly on Alaska public television and the Rural Alaska Television Network, on the Direct User Access Terminal System, on the internet, and on commercial weather information services that use NWS information. (Class II, Priority Action) (A-95-139)

Evaluate, with the assistance of the Federal Aviation Administration, the technical feasibility and aviation safety benefits of remote color video weather observing systems in Alaska. (Class II, Priority Action) (A-95-140)

Revise current policies to provide mike-in-hand (near real-time) radio service for aviation weather information at locations in Alaska where National Weather Service and contract personnel are sited until automated surface weather observing systems transmit observations of all operationally significant weather phenomena to pilots operating in the terminal area. (Class II, Priority Action) (A-95-141)

To the State of Alaska—

Develop, by December 31, 1996, with the assistance of the Federal Aviation Administration, appropriate procedures and establish a training program to enable mike-in-hand (near real-time) reports of airport conditions by designated State and contractual airport maintenance personnel. (Class II, Priority Action) (A-95-142)

Develop, by December 31, 1996, a program to participate with the Federal Aviation Administration in its 5010 airport inspection program. (Class II, Priority Action) (A-95-143)

By the National Transportation Safety Board

James E. Hall
Chairman

Robert T. Francis II
Vice Chairman

John A. Hammerschmidt
Member

John J. Goglia
Member

Adopted: November 28, 1995

Appendix A

Survey Questions for Part 135 Pilots and Operators

14 CFR Part 135
Pilot/Operator Questionnaire for
1995 NTSB Safety Study on
Aviation Safety in Alaska

Part No.	Topic	Question No.
1	Operations General Information	1 through 11
2	Hiring/Initial Qualifications	12 through 13
3	Ground/Flight Training	14 through 29
4	Flight/Duty/Compensation/Fatigue	30 through 40
5	Operations Environment	41 through 45
6	Operations-Related Pressures To Fly	46 through 49
7	ATC/NAVAIDS/Communication	50 through 72
8	Weather/Environment	73 through 99
9	Airport/Airstrip Information	100 through 117
10	Aircraft Maintenance	118 through 141
11	Safety Programs/Accident Prevention Initiatives	142 through 148
12	Airline Management/Oversight	149 through 153
13	FAA Surveillance/Oversight	154 through 172

Person Interviewed: Pilot_____(Capt._____, F/O_____)

Operator/Management___________
Title:___________________

NTSB Personnel: 1.___________________________

2.___________________________

Part 1: Operations General Information

1. In which of the seven geographic area(s) do you routinely conduct operations?

_______ Arctic Circle	_______ South-Central
_______ Central Interior	_______ Aleutians
_______ Northwest	_______ Southeast
_______ Southwest	

2. As a percentage, what is the purpose of your flights?

Hunting:	_______ %	Photography:	_______ %
Fishing:	_______ %	Game spotting:	_______ %
Passenger transfer:	_______ %	Surveying:	_______ %
Sightseeing:	_______ %	Camping:	_______ %
Mining:	_______ %	Training:	_______ %
Trapping:	_______ %	Checking:	_______ %
Cargo:	_______ %	Other:	_______ %
Mail transport:	_______ %		

3. Do all of your pilots have an instrument rating? yes no

If no, what percentage have an instrument rating? _______%

4. What is the annual turnover of pilots?

5. How many years have you lived in Alaska?

6. How many years have you flown in Alaska?

7. What aeronautical rating(s) do you possess?

   _____ ATP
   _____ Commercial

8. What is your total flight time?

9. How long have you flown as a commercial pilot in Alaska?

10. What is your total flight time as a commercial pilot in Alaska?

11. How long have you been employed as a pilot by your present employer_________ or as self-employed_________?

Part 2: Hiring/Initial Qualifications

12. Does the airline have minimum flight time and experience qualifications for pilot new hires? yes no

    If yes, describe:

13. From what resource(s) does the airline typically obtain its pilots?

Recommendation(s):
If applicable, are there any changes/recommendations you would like to see relative to the initial hiring and qualifications of Part 135 pilots in Alaska?

Part 3: Ground/Flight Training

14. In what geographic location did you receive your initial pilot training?

15. Not withstanding the pilot training and testing requirements contained in the FARs, is there any specialized training that the airline provides its pilots for flying in Alaska? yes no

    If yes, describe:

16. Does the airline provide CRM training to its pilots? yes no

    If yes, describe:

17. Have you had any training on assessing risk and decisionmaking? yes no

    If yes, describe (length, content, applicability, effectiveness, and if provided on a recurring basis):

18. How does the airline evaluate the decisionmaking/judgment skills of its pilots?

19. Has the FAA provided any assistance to the airline in developing a decisionmaking/judgment training program? yes no

    If yes, describe:

20. What are the elements that foster inappropriate decisionmaking?

21. Have you received specific training on conducting VFR flight in marginal VFR conditions? yes no

    If yes, describe:

22. Have you received specific training in Alaska that addresses inadvertent entry into IMC conditions? yes no

    If yes, describe:

23. Have you received specific training in Alaska that addresses encounters with whiteout conditions? yes no

    If yes, describe:

24. Have you received specific training on how to determine in-flight visibility? yes no

    If yes, describe:

25. Have you received training in the recognition of and recovery from unusual attitudes with partial panel? yes no

    If yes, describe:

26. Have you received specific training in mountain/ridge flying and/or in mountain pass operations? yes no

    If yes, describe:

27. What is your opinion of the effectiveness of your initial and recurrent pilot training in relation to the knowledge and skills necessary for safe Alaskan flying?

    Initial:

    Recurrent:

28. Was a simulator used in your ground/flight training? yes no

    If yes, to what extent:

29. What was the fidelity of the simulator to the airplane?

Recommendation(s)
Are there any changes/recommendations that you believe should be made concerning the ground/flight training of Part 135 pilots in Alaska? yes no

If yes, describe:

Part 4: Flight/Duty/Compensation/Fatigue

30. What was the average monthly flight/duty time of the airline's pilots in 1994?

31. What was the average annual flight time of the airline's pilots in 1994?

32. What was your average monthly flight/duty time in 1994?

33. What was your annual flight time in 1994?

34. As a percentage, what is the frequency in which the flight/duty time exceeds the schedule? _______% During which months is this most likely to occur?

35. How are pilots compensated for flying?

_____ Salary _____ Flight hours and salary

_____ Flight hours only _____ Completion of flight

36. What aspects of the crew schedule, if any, have caused you to fly while fatigued; i.e., less than what you feel would be at your full performance level?

______ None	
______ No. days worked per month	Frequency:
______ No. flight hours flown per month	Frequency:
______ Flying late at night	Frequency:
______ Early shift followed by late shift	Frequency:
______ Standup overnight	Frequency:
______ Length of duty day	Frequency:
______ Length of rest period	Frequency:
______ Other	Frequency:

37. Has management been apprised?

38. What was management's response?

39. Do you have another occupation besides this one? yes no

If yes, describe:

40. Are policies/procedures in place at the airline that are designed to guard against pilots flying while fatigued? yes no

If yes, describe:

Recommendation(s):
If applicable, are there any changes/recommendations that you would like to see relative to flight/duty time and/or the manner in which pilots are compensated?

Part 5: Operations Environment

41. As a percentage, what is the ratio of on-demand versus scheduled flights?

On demand ______%
Scheduled ______%

42. What is the percentage of total flights conducted on a VFR flight plan versus an IFR flight plan?

VFR ______ %
IFR ______ %
VFR/IFR ______ %

43. What percentage of your flights do you conduct under the following?

Day VFR ______ %
Night VFR ______ %

44. What time of year is the most operationally challenging?

_____ Spring _____ Fall

_____ Summer _____ Winter

45. Which geographic area is the most operationally challenging?

_____ Arctic Circle
_____ Central Interior
_____ Northwest
_____ Southwest
_____ South-Central
_____ Southeast
_____ Aleutians

Why?
_____ Ceilings
_____ Visibility
_____ Wind
_____ Other

Part 6: Operations-Related Pressures To Fly

46. Are there inherent pressures in your flight operation? yes no

    If yes, describe:

47. On a ranking scale of 1 through 5, with 1 being the most significant, what role do the following play in generating pressures to fly?

    _____ Pilot self-induced
    _____ Other pilots (your company ___, competition ___)
    _____ Company management
    _____ Passengers
    _____ Postal Service/mail

48. Is the airline's management aware of these pressures? yes no

    If yes, what has been management's response?

49. Have any of the above-mentioned pressure factors resulted in any of the following:

    Operating the aircraft at an overweight condition?
    yes If yes, describe:
    no

    Operating in IMC on a VFR-only flight plan?
    yes If yes, describe:
    no

    Accepting an aircraft for flight that has inoperative equipment which is listed on the minimum equipment list (MEL) for that aircraft?
    yes If yes, describe:
    no

Recommendation(s):
If applicable, what changes/recommendations would you like to see to eliminate these pressures?

Part 7: ATC/NAVAIDS/Communication

50. What percentage of your flying is spent flying on an IFR flight plan versus VFR flight plan? _______ %

51. What percentage of VFR flights do you conduct without the aid of any electronic ground-based navigation facility? _______ %

52. What percentage of VFR flights do you conduct that some portion of the flight does not have a ground-based navigation aid to assist you? _______ %

53. How many airports currently served by your Part 135 operation require approaches into a nonradar environment or to altitudes below center radar coverage?

54. Of the total flights that you conduct on a daily basis, what is the percentage with which you are able to communicate throughout the flight with:

    Company/management? _______ %
    With FSS facilities? _______ %

55. Of the airports that you frequent, what percentage has ground-to-air communication capability? _______ %

56. Does the absence of air-to-ground communication capability have any affect on your operation? yes no

If yes, describe:

57. Has the closing of Flight Service Stations in Alaska had any affect on your operation? yes no

If yes, describe:

58. Did the FAA request input from the aviation community prior to closing/reducing the FSS hours/FSS/tower facilities? yes no

If yes, describe:

59. Which FAA facilities were closed/services reduced that you believe should be changed?

Why?

60. How would you rate the service provided by the FAA Flight Service Stations in Alaska?

_____ Excellent Why?
_____ Good
_____ Fair
_____ Poor

61. Of the airports you frequent, how many have an air traffic control tower?

62. Are there any facilities that are presently noncontrolled that you believe should have an operating control tower? yes no

If yes, describe:

63. Has the reduction in the hours of control tower operation had any affect on your operation? yes no

If yes, describe:

64. Are there sufficient radio frequencies/RCOs available to allow you to communicate effectively with Flight Service Stations? yes no

If no, cite specific examples:

65. Do you actively participate in passing PIREPS? yes no

If no, why not?

66. Does your airline utilize special instrument approaches in Alaska? yes no

If yes, at how many airports?

Do pilots undergo special training? yes no

If yes, describe:

67. Do you utilize the published frequencies in the Alaska Supplement when operating into/out of airports. yes no

If no, why not?

68. Are you personally aware of any problems in the following areas:

Airport traffic density? yes no
If yes, describe:
Locations:

Airport traffic patterns? yes no
If yes, describe:
Locations:

En route traffic density? yes no
If yes, describe:
Locations:

FSS frequency congestion? yes no
If yes, describe:
Locations:

Common traffic frequency overlap? yes no
If yes, describe:
Locations:

En route electronic navigation aids? yes no
If yes, describe:
Locations:

69. Have you used LORAN for en route navigation on VFR flights? yes no

If yes, describe frequency used, reason(s) for using, and if airline management endorses its use:

70. Have you used GPS for en route navigation on VFR flights? yes no

If yes, describe frequency used, reason(s) for using, and if airline management endorses its use:

71. Which en route areas and airports in Alaska would benefit most from GPS technology?

72. If applicable, list in ranking order of importance, the three most significant issues confronting the air traffic control, navigation, and/or communication network in Alaska?

1.
2.
3.

Recommendation(s):
As a followup to question 72, what changes would you like to see concerning the air traffic control, navigation, and/or the communication network in Alaska?

Part 8: Weather/Environment

73. Are you provided with minimum weather criteria for the launching of a flight?
    yes no

    If yes, are they published _____ or verbal _____ ?

74. What are the weather criteria?
    Ceiling:
    Visibility:
    Wind:
    Other:

75. Are you provided with minimum weather criteria for the en route continuation of a flight? yes no

    If yes, are they published _____ or verbal _____ ?

    What are the weather criteria?
    Ceiling:
    Visibility:
    Wind:
    Other:

76. As a percentage, how do you normally obtain weather information for preflight planning purposes? In person _____ % By telephone _____ %

From:

Company representative	_____	%
Village personnel	_____	%
Pilot reports	_____	%
FSS	_____	%
NWS	_____	%
ASOS	_____	%
AWOS	_____	%
Other	_____	%

77. On average, how old is the weather information that is used by you for flight planning purposes?

_____ Real time
_____ Less than 1 hour
_____ 1-2 hours
_____ 2+ hours

78. As a percentage, what is the average accuracy record of the sources from which you obtain preflight weather?

Company representative	_____	%
Village personnel	_____	%
Pilot reports	_____	%
FSS	_____	%
NWS	_____	%
ASOS	_____	%
AWOS	_____	%
Other	_____	%

79. As a percentage, where do you normally obtain weather information while en route?

Company representative _____ %
Village personnel _____ %
Pilot reports _____ %
FSS _____ %
NWS _____ %
ASOS _____ %
AWOS _____ %
Other _____ %

80. On average, how old is the weather information that you receive from sources while en route?

_____ Real time
_____ Less than 1 hour
_____ 1-2 hours
_____ 2+ hours

81. As a percentage, what is the average accuracy record of the sources from which you obtain en route weather?

Company representative _____ %
Village personnel _____ %
Pilot reports _____ %
FSS _____ %
NWS _____ %
ASOS _____ %
AWOS _____ %
Other _____ %

82. Which geographic area presents the most weather challenges to you?

Why?

83. Of the geographic areas you frequent, which area has the least accurate weather reporting information network/system?

_____ Arctic Circle   Why?
_____ Central Interior
_____ Northwest
_____ Southwest
_____ South-Central
_____ Southeast
_____ Aleutians

84. Of the geographic areas you frequent, are there any AWOS or ASOS sites that, in your opinion, provide less than satisfactory service? yes no

If yes, explain:

85. As a percentage, how frequently are you advised by FSS personnel that "VFR Flight Is Not Recommended" for your area of flight and once aloft you determine that the FSS advisory was correct and you return to your departure point or an alternate airport? _______ %

86. As a percentage, how frequently are you advised by FSS personnel that "VFR Flight Is Not Recommended" for your intended area of flight but once aloft you find that you are able to safely navigate to your destination? _______ %

87. Have you <u>knowingly</u> initiated a VFR flight in weather conditions you have identified as less than 1,000 ft ceiling and less than 2 miles visibility? yes no

If yes, how frequent?

Reason for initiating the flight:

88. Have you <u>knowingly</u> continued a VFR flight in weather conditions you have identified as less than 1,000 ft ceiling and less than 2 miles visibility? yes no

If yes, how frequent?

Reason for continuing the flight:

89. Have you inadvertently entered IMC conditions while on a Part 135 VFR flight plan? yes no

If yes, how frequent?

On average, what produced the IMC conditions?

Low ceilings/visibility	______ %
Low ceilings	______ %
Low visibility	______ %

Visibility restrictions due to:

Rain	______ %
Snow	______ %
Whiteout	______ %
Flat light	______ %

90. What do you consider to be the hazardous weather elements in your flying activity in Alaska?

Which element is the most hazardous?

91. On a scale of 1 to 3, with 3 representing the highest priority, list three weather-related subject areas that you believe warrant improvements and would enhance aviation safety in Alaska:

1.
2.
3.

Winter Operations:

92. What are your winter months of operation?

93. What are the primary tasks confronting your operation during the winter months?

94. Is de-icing service available at every airport you operate into and out of? yes no

If no, why not?

95. Is the de-icing service conducted by the airline or by contract?

96. Who performs the actual de-icing of the aircraft?

_____ Pilot
_____ Ground personnel

97. Do the individuals who perform the actual de-icing of the aircraft receive training on de-icing procedures and the use of the equipment? yes no

If no, why not?

98. Are there any areas you frequent that warrant improvement in the de-icing service/ equipment? yes no

If yes, explain:

99. If your primary source of de-icing is not available, is there currently in place at your airline a backup means of obtaining this service? yes no

If no, why not?

Recommendation(s):
If applicable, what changes/recommendations would you like to see implemented concerning winter operations?

Part 9: Airport/Airstrip Information

100. How many Part 135 revenue flights do you complete on a typical peak period day?

In what season would this peak period day occur?
_____ Spring _____ Fall
_____ Summer _____ Winter

101. On this typical day, as a percentage, how many of these cycles are conducted at:

Part 139 fully certificated airports? _____ %
Part 139 lighted certificated airports? _____ %
Non-Part 139 certificated airports? _____ %
Do not know. _____ %

102. On this typical day, as a percentage, how many of these airports/airstrips are operated by:

The State? _____ %
Local municipality? _____ %
Private company? _____ %
Do not know. _____ %

103. On this typical day, how many of these flight operations are conducted on landing surfaces composed of the following:

Paved? Number: _____
Gravel? _____
Tundra? _____
Snow? _____
Mud? _____
Sand? _____
Fresh water ice? _____
Sea water ice? _____
River? _____
Lake? _____
Open salt water? _____

104. On this typical day, what is the average length and width of these landing surfaces? Length _____ Width _____

105. What is the length and width of the shortest of these landing surfaces?
Length _____ Width _____

106. How often, while in flight, do you request updat· s of NOTAMS regarding airport/runway conditions?

_____ Never Why not?
_____ Sometimes
_____ Frequently
_____ Always

107. How often do you find this local NOTAM information inconsistent or in error with reality for your destination airport(s)?

_____ Never
_____ Sometimes
_____ Frequently
_____ Always

Do you know why this is?

108. Of the number of airports you fly into on this typical day, of what percentage are you made aware of airport/runway conditions:

During preflight planning? _____ %
In flight prior to landing? _____ %
No appraisal prior to landing? _____ %

109. For those airports where you are made aware of airport/runway conditions, as a percentage, who provides this information?

Company representative _____ %
Village personnel _____ %
Other pilot(s) _____ %
FAA Flight Service _____ %
Other (describe) _____ %
Do not know _____ %

110. Do you know how to contact the appropriate airport management authority (e.g., reporting a problem)? yes no

111. On a scale of 1 to 5, with 1 being totally unreliable and 5 being totally reliable, how reliable is the reported information about the airport/runway on this typical day by each of the following (as appropriate)?

_____ Company representative
_____ Village personnel
_____ Other pilot(s)
_____ FAA Flight Service
_____ Other

If the reliability of the information is less than 5, describe why you think the information is less than fully reliable:

Geography:

Human factors (e.g., airfield/community personnel skewing information to ensure completion of the mission):

Equipment (e.g., poor/unreliable radio gear):

Lack of time (e.g., station does not have time):

Meteorological/climatological conditions (e.g., weather or sunspot interference):

Self-induced conditions (e.g., insufficient time for the pilot to access information):

112. Of the airports you operate into/out of, what percentage have the following:

Operational wind direction indicator? ______ %
Some form of runway/waterway marking? ______ %
Runway threshold markings? ______ %
Some form of signage? ______ %
Runway lighting? ______ %
Rotating beacon? ______ %
Two-way radio communication (air to ground) ______ %
Aircraft rescue and fire fighting equipment? ______ %

Type of equipment:
Vehicles ______ %
Wheeled fire extinguisher ______ %
Handheld fire extinguisher ______ %
No equipment at all ______ %
Do not know what equipment they have ______ %

Provider of the ARFF service:
Your company ______ %
State of Alaska ______ %
Village personnel ______ %
Other ______ %
Do not know ______ %

113. Have you ever intentionally landed at an airport/airstrip when you had been advised prior to landing that the facility was closed? yes no

If yes, why?

114. Local Airport Advisories are not handled at all by remote FSS. Has the dissemination of such information from other sources had any affect on your flight operation? yes no

If yes, explain:

115. Are there any airports that you frequent that, in your opinion, need improvements to any of the following:

_____ Wind direction indicator. Which airport(s) and why?

_____ Runway marking. Which airport(s) and why?

_____ Signage. Which airport(s) and why?

_____ Lighting. Which airport(s) and why?

_____ Rotating beacon. Which airport(s) and why?

_____ Crash/fire/rescue capability. Which airport(s) and why?

_____ Obstructions. Which airport(s) and why?

_____ Timeliness and quality of runway maintenance. Which airport(s) and why?

_____ Animal/people control. Which airport(s) and why?
Annual frequency:

_____ Dissemination of runway assessment information. Which airport(s) and why?
Annual frequency:

116. On a scale of 1 to 5, with 1 being totally unsatisfied and 5 being totally satisfied, what is your level of satisfaction with the FAA's oversight of airports in Alaska?

_____

What is the trend of the FAA's oversight?
_____ Improving
_____ Static
_____ Getting worse

117. In your opinion, what are the three most difficult/challenging airports to operate into and out of in order of difficulty (#1 being the most difficult)? Describe briefly why (e.g., terrain, obstructions, winds, poor conditions, etc.):

1.
2.
3.

Recommendation(s):
If applicable, what changes/recommendations would you like to see relative to airports within the State of Alaska?

Part 10: Aircraft Maintenance

118. Who at the airline (title only) is in charge of aircraft maintenance?

    To whom does this individual report?

119. What type of aircraft maintenance program has the airline adopted?

120. What percentage of your maintenance is contracted out? _____ %

121. What type of maintenance is contracted out?

122. If aircraft maintenance is contracted out, what quality control measures are implemented by your airline to ensure that the maintenance is being completed?

123. How is outstation maintenance conducted?

124. Does your operation have a spare aircraft in its inventory for unplanned maintenance problems? yes no

125. How many aircraft are operated by the airline?

_____ Single engine
_____ Multi-engine

126. What is the average age of your fleet aircraft?

_____ Years
_____ Flight hours

127. How many hours is the airline's aircraft fleet flown on an annual basis?

128. Are there any problems getting new replacement parts? yes no

If yes, why?

129. Are there any problems getting used replacement parts? yes no

If yes, why?

130. At each of your maintenance facilities, either in-house or contract, is there a building into which the aircraft can be brought out of the elements? yes no

131. As a percentage, how much scheduled aircraft maintenance is performed during the day versus at night? Day _____ % Night _____ %

132. What is the distance between your main area of flight operations and the primary maintenance facility?

133. How often does your PMI visit your maintenance facilities?

What percentage of inspections by your PMI are unannounced? _____ %
What percentage of inspections by your PMI are done at night? _____ %

134. What is the total number of full-time aircraft mechanics?

135. What is the total number of full-time licensed A&P mechanics?

136. What is the annual turnover of licensed A&P mechanics?

137. What is the total number of full-time aircraft inspectors?

138. Is there an aircraft inspector at each maintenance facility? yes no

139. What is the annual turnover of company aircraft inspectors?

140. In your opinion, are maintenance write-ups corrected in a timely fashion? yes no

If no, why not?

141. If applicable, and in order of importance, what are the three most significant maintenance-related issues confronting your flight operation?

1.
2.
3.

Recommendation(s):
If applicable, what changes/recommendations would you like to see concerning aircraft maintenance?

Part 11: Safety Programs/Accident Prevention Initiatives

142. If you had a concern about safety in your airline, who in management would you contact?

143. How is safety promoted on a daily basis at your airline?

    How effective is this method?

144. Does your airline have a safety department? yes no

145. Does the airline have a professional standards committee for the pilot group? yes no

    If yes, how effective is the committee?

146. Does the airline have safety meetings? yes no

    If yes, how effective are the safety meetings?

147. Is there a network between Part 135 airlines in Alaska and/or among the airlines' pilots that promotes safety? yes no

    If yes, how effective is this network?

148. Is the FAA involved in the airline's safety program? yes no

    If yes, describe the extent:

Recommendation(s):
If applicable, what changes/recommendations would you like to see implemented concerning safety programs/initiatives?

Part 12: Airline Management/Oversight

149. What methodology is used by the airline to oversee the safety of flight operation?

150. What methodology is used by the airline to evaluate the effectiveness of its flight operations oversight program(s)?

151. What measures does the airline employ to guard against its aircraft being operated over gross weights?

152. What methodology is employed by the airline to guard against pilots operating in IMC on a VFR flight plan?

    What methodology is used by the airline to evaluate the effectiveness of these measures?

153. What methodology is used by the airline to oversee the safety of ground/ramp operations?

    What methodology is used by the airline to evaluate the effectiveness of its ground/ramp operations oversight program(s)?

Recommendation(s):
If applicable, what changes/recommendations would you like to see implemented concerning airline management oversight of the ground and flight operation programs?

Part 13: FAA Surveillance/Oversight

154. How far away, in miles, is your most distant operations base from the FAA facility that has oversight responsibility for your airline?

155. How many of the airports that you serve are accessible solely by aircraft?

156. On average, how often does the following FAA personnel visit your outlying operations facilities?

POI:
PMI:
PAI:

157. Do you feel that your principal inspectors are sufficiently familiar with the FARs that affect your operation?

POI: yes no
PMI: yes no
PAI: yes no

158. Does your FAA certificate-holding office use geographic inspectors from other FAA offices to monitor your training program? yes no

159. How many POIs, PMIs, and PAIs have you had since you have been in business, or in the past 5 years, whichever is shorter?

POIs:
PMIs:
PAIs:

160. Have you ever requested that your POI, PMI, or PAI be replaced? yes no

If yes, explain:

161. Do you believe that you are being assisted by the FAA? yes no

Provide examples:

162. Does your POI, PMI, and/or PAI provide explanations for required changes to your operation?

POI: yes no
PMI: yes no
PAI: yes no

163. How would you rate the relationship between your principal inspectors and your company management?

	POI	PMI	PAI
Extremely Poor	____	____	____
Bad	____	____	____
Neutral	____	____	____
Good	____	____	____
Excellent	____	____	____

164. Does your company have a self-disclosure program with the FAA? yes no

If yes, explain:

165. Have you found it necessary to contact the FAA regional office concerning FAA matters? yes no

If yes, explain:

Were you satisfied with its response? yes no

166. Have you found it necessary to contact FAA Washington headquarters or the FAA SURE hotline concerning FAA matters? yes no

If yes, explain:

Were you satisfied with the response? yes no

167. Do you find the FAA to be consistent in its administration of the regulations and performance of duties from inspector to inspector, office to office within the Alaskan Region? yes no

If no, explain:

168. Do you find that the same standards are applied to all of the air carriers of your type by the FAA? yes no

If no, describe some of the differences:

169. Have you ever had a "no notice" inspection from either your POI or PMI?
yes no

If yes, from whom, and how frequently?

170. Have you ever had an en route or ramp inspection from your POI? yes no

If yes:

After 5 p.m.?	yes	no
On weekends?	yes	no
From another FAA inspector?	yes	no

171. In your opinion, how effective is the FAA's surveillance/oversight program on Part 135 operations in Alaska?

What are the merits of the program?

Are there any areas that warrant improving? yes no

If yes, explain:

172. In your opinion, how effective is the FAA's accident prevention program, which consists of safety symposiums and safety meetings around the State?

Do you attend these programs? yes no
If yes, with what frequency:
If no, why not:

What are the merits of the program?

Are there any areas that warrant improving? yes no
If yes, explain:

Recommendation(s):
If applicable, what changes/recommendations would you like to see implemented concerning the FAA's surveillance/oversight of Part 135 operations in Alaska?

Appendix B

Accidents, Flight Hours, and Accident Rates, 1986 through 1994

	Alaska					Remainder of the United States				
	Accidents			Accident rates		Accidents			Accident Rates	
Year	Total	Fatal	Flight hours	Total	Fatal	Total	Fatal	Flight hours	Total	Fatal
Air Carriers (Part 121)										
1986	1	0	32,736	3.0547	0.0000	22	2	9,943,368	0.2213	0.0201
1987	0	0	32,262	0.0000	0.0000	37	5	10,612,930	0.3486	0.0471
1988	0	0	39,499	0.0000	0.0000	29	3	11,101,049	0.2612	0.0270
1989	0	0	45,053	0.0000	0.0000	28	11	11,229,490	0.2493	0.0980
1990	1	0	50,621	1.9755	0.0000	24	7	12,099,495	0.1984	0.0579
1991	0	0	47,305	0.0000	0.0000	27	4	11,852,718	0.2278	0.0337
1992	0	0	53,576	0.0000	0.0000	18	4	12,442,091	0.1447	0.0321
1993	0	0	58,342	0.0000	0.0000	23	1	12,852,182	0.1790	0.0078
1994	1	0	73,993	1.3515	0.0000	20	4	13,146,007	0.1521	0.0304
Commuter Airlines (Part 135, Scheduled)										
1986	3	0	182,472	1.6441	0.0000	13	2	1,542,114	0.8430	0.1297
1987	9	4	213,297	4.2195	1.8753	23	6	1,733,052	1.3271	0.3462
1988	5	0	212,168	2.3566	0.0000	14	2	1,880,521	0.7445	0.1064
1989	6	3	202,033	2.9698	1.4849	13	2	2,038,522	0.6377	0.0981
1990	5	2	211,422	2.3649	0.9460	11	2	2,125,530	0.5175	0.0941
1991	10	2	230,790	4.3329	0.8666	13	6	1,940,277	0.6700	0.3092
1992	12	1	267,631	4.4838	0.3736	11	6	1,914,738	0.5745	0.3134
1993	6	1	256,710	2.3373	0.3895	10	3	2,165,844	0.4617	0.1385
1994	3	1	314,172	0.9549	0.3183	8	2	2,015,828	0.3969	0.0992
Air Taxis (Part 135, Nonscheduled)										
1986	17	2	284,619	5.9729	0.7027	101	29	2,405,381	4.1989	1.2056
1987	15	4	291,176	5.1515	1.3737	85	26	2,365,824	3.5928	1.0990
1988	35	7	266,846	13.1162	2.6232	66	21	2,365,154	2.7905	0.8879
1989	33	4	272,316	12.1133	1.4689	79	21	2,747,684	2.8751	0.7643
1990	35	5	203,465	17.2020	2.4574	73	23	2,045,535	3.5687	1.1244
1991	25	2	238,224	10.4943	0.8395	63	26	2,002,776	3.1456	1.2982
1992	25	3	246,370	10.1473	1.2177	51	21	1,762,630	2.8934	1.1914
1993	26	1	222,530	11.6838	0.4494	44	18	1,877,470	2.3436	0.9587
1994	30	7	269,676	11.1245	2.5957	54	19	1,730,324	3.1208	1.0981

(continued)

Year	Alaska					Remainder of the United States				
	Accidents			Accident rates		Accidents			Accident Rates	
	Total	Fatal	Flight hours	Total	Fatal	Total	Fatal	Flight hours	Total	Fatal
General Aviation (Part 91)										
1986	161	19	1,258,862	12.7993	1.5093	2,454	471	25,814,138	9.5064	1.8246
1987	162	16	1,182,550	13.6992	1.3530	2,361	440	25,789,450	9.1549	1.7061
1988	139	17	870,014	15.9768	1.9540	2,277	449	26,575,986	8.5679	1.6895
1989	143	19	821,168	17.7796	2.3138	2,115	434	27,098,832	7.8048	1.6015
1990	151	17	937,696	16.1033	1.8130	2,089	435	27,572,304	7.5764	1.5777
1991	128	15	902,294	14.1861	1.6624	2,081	426	26,323,706	7.9054	1.6183
1992	141	14	959,231	14.6993	1.4595	1,951	440	22,832,769	8.5447	1.9271
1993	140	20	657,096	21.3059	3.0437	1,921	385	21,818,904	8.8043	1.7645
1994	98	7	750,000	13.0667	0.9333	1,924	400	20,250,000	9.5012	1.9753

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