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ALASKA PART 135 OPERATIONS: THE NEED FOR ADDITIONAL REGULATORY OVERSIGHT AND CONTINUOUS AIRCRAFT TRACKING

by

April A. Larsen

A Graduate Capstone Project Submitted to the College of Aviation,
Department of Graduate Studies, in Partial Fulfillment
of the Requirements for the Degree of
Master of Science in Safety Science

Embry-Riddle Aeronautical University
Prescott, Arizona
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ALASKA PART 135 OPERATIONS: THE NEED FOR ADDITIONAL REGULATORY OVERSIGHT AND CONTINUOUS AIRCRAFT TRACKING

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This Graduate Capstone Project was prepared under the direction of the candidate's Graduate Capstone Project Chair, Ed Colemen, Department Chair and Professor, Robertson Safety Institute, Prescott Campus, and has been approved. It was submitted to the Department of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Science in Safety Science

Graduate Capstone Project:

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Ed Coleman
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Date

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Dedication

Thanks to my family and friends for all the support over the last two years. Jessica and Hector, I appreciate all your encouragement and being my cheerleaders throughout this. Without you Jess, I may have not had the courage to go back to school. Dad and Jennie, your texts and calls and encouragement has really helped me achieve this Degree. Mom and Ken, thanks for your support and encouragement. Bethany, you have rooted me on for years, sent supportive notes, and never failed to check-in, you have a huge part in this as well.

I would also like to recognize all the pilots and passengers who have lost their lives flying in Alaska. This research is for you.

Abstract

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Title: ALASKA PART 135 OPERATIONS: THE NEED FOR ADDITIONAL REGULATORY OVERSIGHT AND CONTINUOUS AIRCRAFT TRACKING

Institution: Embry-Riddle Aeronautical University, Prescott, Arizona

Degree: Master of Science in Safety Science

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With a focus on Alaska, this research illustrates the lack of regulatory oversight pertaining to Title 14 CFR Part 135 operators, including SMS, training, and equipment requirements. As of January 2020, under the Federal Aviation Administration's NextGen initiative, all aircraft flying in controlled airspace are required to have an Automatic Dependent Surveillance – Broadcast (ADS–B) system installed and operational. Many Alaskan operators fly in hazardous terrain, and marginal weather, with little to no communication, yet ADS-B is not a requirement as they are in uncontrolled airspace. Alaska also lacks vital aviation infrastructure including adequate instrument approach procedures, weather monitoring stations, and communication capabilities. In addition, real-time aircraft tracking is not required for Part 135 operations. These issues have all contributed to a significantly high accident rate, and a considerable amount of extended search and rescue operations, costing the lives of many.

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Chapter I – Introduction

Part 135 Operators vs. Part 121 Air Carriers

Part 135 of Title 14 in the United States (U.S.) Code of Federal Regulations (CFR) applies to operators who fly on-demand or scheduled operations with aircraft that are limited to 30 passengers or less. While scheduled operators offer scheduled flights, with set times, that are predetermined prior to departure, and landing, on-demand operators offer flights that are requested by the customer, who sets the locations, departure and landing (Regularly Scheduled Air, 2019).

Part 135 operators can vary in size from operations with one pilot and one small aircraft, operators with several small aircraft, emergency medical transport operations, air-taxi's, operators with multi-engine aircraft carrying 30 passengers or less, as well as operations that fly exclusively cargo and United States Postal Service (USPS) mail. Many of these operators are essential, as they service remote areas, with both cargo and passengers, that cannot be serviced by larger Part 121 carriers (Charter-Type Services, 2019).

Title 14 CFR § 121 applies to operators that are generally large, U.S. based airlines, regional air carriers, as well as operations involving the movement of cargo (Regularly Scheduled Air, 2019). These carriers have stringent regulations involving, dispatchers, weather, pilot flight hour requirements, extensive training, and consistent recurrent training in aircraft systems, emergency operations, weather, traffic avoidance, terrain avoidance, and fatigue programs just to name a few. They are also required to follow regulations involving Safety Management Systems (SMS), which not only include active monitoring programs, but constant data tracking and trending, voluntary reporting programs, methods for promotion of safety culture, and constant evaluation of risk controls.

Part 135 Accident Rates in Alaska vs. the lower 48 states of the United States

On August 21, 2010, a pilot departed a remote area on the coast of the Alaska Peninsula, in reduced visibility and heavy rain. The float-equipped de Havilland Beaver had three passengers onboard and was operating as a 14 CFR § 135 certified on-demand air taxi. The aircraft failed to reach its destination and was subsequently reported overdue. Extensive search-and-rescue efforts along the coast and inland ensued (National Transportation Safety, 2013).

After 21 days the large search effort was called off. Nearly two weeks after the search was terminated, small portions of the fragmented airplane were discovered washed ashore 28 miles northeast of the departure lagoon. The 121Mhz Emergency Locator Transmitter (ELT) onboard never transmitted a traceable signal. The deceased and the remainder of wreckage, including the engine, wings, and floats were never located despite extensive sonar searches near the wreckage site (National Transportation Safety, 2013).

This accident was a culmination of unfortunate decision making, deteriorating weather conditions and eventual collision with the water. If this aircraft would have been equipped with available technology that included terrain, weather, and tracking capabilities, could this accident have been prevented? At the very least, could the wreckage have been found earlier, preventing undue emotional anguish and thousands of dollars on search and recovery operations?

Figure 1. The Alaska Coast near the site of the Fatal Crash of the de Havilland Beaver (Larsen, 2009)

According to the National Transportation Safety Board (NTSB) database, aircraft operating under 14 CFR § 135 have experienced 7,408 reportable aircraft accidents and incidents from 1989-2019, 3,159 were considered "accidents", and 735 of those accidents resulted in one or more fatalities. Of the 7,408 events, 1,936 (26.1%) took place in Alaska. Alaska is responsible for over one third (1,022 or 32.4%) of the total accidents (3,159) reported in the United States, and of that, 21.4% (157) of 735 accidents involving one or more fatality (Aviation Accident Database, 2002).

With a population of only 0.3 % of the continental United States, and a landmass making up 20% of the United States (Census Population Density, 2020), a large population of Alaskans live in remote villages, where the only mode of transportation, in and out, is by air or water. According to the Alaska Department of Transportation (DOT), as of 2018, there are 15,718 miles of public roads, of that, 4,857 miles (31%) are paved (see Figure 2.) (State of Alaska, 2018). A large part of the state consists of a significant amount of uninhabited land, including nearly 34,000 miles (55,000 km) of tidal shoreline, 3.5 million lakes (20 acres or larger), marshlands, wetlands, and permafrost cover 188,320 square miles, frozen water in the form of glacier ice cover some 16,000 square miles, 40 active volcanos and 14 mountain ranges, one which is home to the third highest mountain in the world. (Geography of Alaska, 2019). This not only makes it challenging terrain to navigate, but extremely challenging terrain to find missing aircraft in as well.

Figure 2. Alaskan Paved Roads (*Accessing Alaska, 2020*)

When things go wrong, resulting in a missing aircraft, whether it be consequences involving extreme weather changes, Controlled Flight Into Terrain (CFIT), mid-air collisions, engine problems, or other unfortunate circumstances, there is a good chance it will require a search and rescue effort to find the aircraft. Of the reported accident statistics above, 64 have resulted in search and rescue operations, and all but 17 were in Alaska. Only two of them were not located in remote areas, the other 62 required extensive SAR operations, nearly all in rugged mountainous or challenging terrain. There were 115 fatalities involved in the 64 SAR operations, 105 of them occurred in Alaska (Aviation Accident Database, 2002). According to the National Search and Rescue Plan, "The life expectancy of an injured survivor decreases as much as 80 percent during the first 24 hours, while the chances of survival of uninjured survivors rapidly diminishes after the first 3 days (GEN 3.6, n.d.)."

Figure 3. Alaskan Terrain from a Cessna Caravan (Larsen, 2009)

Statement of the Problem

First, Part 135 operators are held to less stringent regulations and safety standards than Part 121 air carriers, resulting in higher accident rates. Combined with the particularly challenging environment Alaskan Part 135 pilots fly in, with very little the margin for error, these operators experience even higher accident rates.

Second, Alaska is lacking some of the most basic aviation infrastructure including adequate instrument approach procedures, weather monitoring stations, communication capabilities, and now ADS-B coverage.

Third, the FAA's NextGen initiative, which requires aircraft to be equipped with ADS-B, including all Part 121 carriers, is not required outside of controlled airspace, and not mandatory for Part 135 operators. A substantial portion of Alaska is uncontrolled airspace, and some Part 135 operators see no point in installing ADS-B equipment, as they do not fly to the region of Alaska where it is required. Although there are major gaps in the ADS-B infrastructure, encompassing large portion of the state, there are still many advantages to using the equipment including terrain awareness, traffic avoidance, weather monitoring, and aircraft tracking. All commercial aircraft should be required to have this equipment.

Fourth, ADS-B or comparable forms of satellite-based tracking are not required for Part 135 operations by either the FAA or the International Civil Aviation Organization (ICAO), unless flying outside the country of origin. Subsequently, the lack of reliable communication, and real-time tracking systems, have led to a substantial amount of extended search and rescue (SAR) operations in Alaska, costing the lives of many and significant financial burden to the State.

Consequently, the lack of regulatory oversight, lack of required aircraft tracking and extremely poor infrastructure is threatening Alaska's pilots and travelers. Although the number of paying passengers on an aircraft operating under Part 135, is much smaller than most 121 carriers, the lives of those onboard are no less valuable, therefore, it is not acceptable these operations are not held to the same regulatory safety standards.

Research Questions

1. Would requiring regulations comparable to that of Part 121 operations, on a scale appropriate the size of the operation, decrease the accident rate of Alaskan Part 135 operations?

2. Would these operators benefit from an FAA directive requiring use of the NextGen mandate involving ADS-B, and or other tracking technology, even in uncontrolled airspace?

3. Will these programs help facilitate timelier search and rescue operations, saving lives, time and money?

Research Topics

The first topic of this research will be the delineation of CFR Part 135 regulations, in contrast to Part 121 regulations. The difference in these sets of regulations is paramount to understanding the importance of being held accountable, and subject to the same regulations, if the carriage of paying passengers is transpiring. There will also be research involving Safety Management Systems (SMS), and the benefits of collecting flight data, and its usefulness in Part 135 operations, regardless of size.

The terrain, weather, airports, type of operations, and lack of navigational aids, all lead to inherently riskier operations in Alaska. This requires substantially different training, equipment, weather monitoring, and communication then most operators in the lower 48 states require. The need for hiring more experienced pilots (raising minimums), more training including weather (whiteout, inadvertent VMC to IMC, icing, etc.), training specific to operators' environment, CFIT, and traffic avoidance are also addressed.

A review of literature Involving ADS-B and the FAA's NextGen Mandate required January 1, 2020 is given. This includes the Alaska Capstone project that took place in Alaska from 2001-2006, and a statistical analysis of the before, during and after data related to Alaskan Part 135 accidents. Another topic discussed will cover research involving Search and Rescue operations. It will discuss statistical information, what helps rescuers find aircraft in a timely manner and what operators can do to help.

In the 1990's the Aviation Rulemaking Committee was tasked with looking into how Part 135 operations could improve safety, their recommendations for additional federal oversight will be discussed. This will be followed by the current NTSB recommendations to the FAA regarding the 2019-2020 "Most Wanted List", as well as recommendations specific to Alaska. And lastly, what the FAA has to say about the recommendations made by the NTSB. Are they working to fix these problems of simply putting them off? Finishing up with a discussion of how of how additional regulations, mandatory tracking, and safety management can all substantially decreased the accident rate for Alaskan Part 135 operations.

Purpose Statement and Significance of Study

This research seeks to aid in creating policy reform that requires regulations comparable to that of CFR Part 121, for all Part 135 operators on a scale appropriate to the size of operation. It also pushes for the FAA to require use of the NextGen mandate involving ADS-B, and/or other tracking technology for all Part 135 operators regardless of airspace, resulting in timelier search and rescue, saving lives and decreasing expenditures incurred by the states. Alaska operators flying under Part 135 have suffered a substantially higher accident rate than that of operators working in the lower 48 states. These policy reforms would aid in decreasing the amount of accidents experienced by Part 135 operators, particularly in Alaska. The research hopes to add yet another voice to the ever-growing push for regulatory change.

Delimitations

There has been a significant amount of research done on similar topics, yet the Federal Aviation Administration has yet to implement policy on any of the recommendations. The lack of significant statistical information makes this research challenging to complete to the extent desired. A quantitative data set would assist in proving, with the implementation of some of these programs, active monitoring, tracking with ADS-B or satellite-based equipment, SMS, TCAS training, and better oversight, accident rates would decrease substantially. It will be interesting to see the data from 2019 versus 2020, to see if the NextGen initiative improved safety of flight, although with the current COVID 19 pandemic, the data will surely be skewed.

Definitions of Terms

Accident	An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage (NTSB § 830.2 Definitions).
ADS-B	Automatic dependent surveillance – broadcast system, technology which allows the aircraft to establish its position and regularly broadcast it, while allowing it to be tracked.
Air Taxi	An operator which directly engages in the air transportation of persons or property or main or in any combination, and does not directly or indirectly utilize large aircraft (CFR § 298.3)
Capstone	A joint industry effort to improve aviation safety and efficiency in Alaska from 1999-2006.
Flight Data Monitoring	A method for monitoring and capturing flight data for analysis.
Flight Tracking	Live tracking of an aircraft, available to operators to track and monitor their aircraft for deviations from flight path, and/or used for search and rescue operations.
Incident	An occurrence other than an accident, associate with the operation of an aircraft, which affects or could affect the safety of operations (NTSB § 830.2 Definitions).
Instrument Approach	A series of predetermined maneuvers for the orderly transfer of an aircraft under instrument flight conditions from the beginning of the initial approach to landing, or to a point from which a landing may be made visually (Pilot/Controller Glossary, 2016).
Lower 48 States	The contiguous United States
Minimums	Weather conditions at or below the minimums prescribed by the regulation for the action involved (Pilot/Controller Glossary, 2016)
Mode C Transponder	Transmits aircraft's altitude in 100-foot increments on a radar scope.

On-Demand	Scheduled passenger-carrying operations conducted with a frequency less than five round trips per week on at least one route between two or more points according to the published flight schedules; in non-turbo jet aircraft with a payload capacity of 7,500 pound or less, and 9 seats or less (14 CFR § 110.2).
Part 121	Certification for air carriers operating aircraft with 30 or more seats.
Part 135	Two types of certificates: Air Carrier (issued for interstate, foreign or overseas transportation, or carriage of mail) or Operating Certificate (conduct intrastate transportation wholly within the same state) (14 CFR 135)
Part 135 Operator	For the purpose of this research, any information that speaks to Part 135 will be focused on operations operating under an Operating Certificate, that includes fixed-wing aircraft with single or multi-engines, turbo prob or lower power producing engines, and aircraft with 9 seats or less.
Pilot in Command	Crewmember ultimately responsible, and with final authority for the safety of the flight
Scheduled	Operators flying under a Part 135 Commuter certificate may conduct flights with 9 seats or less, with unlimited scheduled operations as well as On-demand operations.
Second in Command	Crewmember who is designated to be second in command of the aircraft.
Transponder	Automatically receives radio signals from interrogators on the ground, and selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond (Pilot/Controller Glossary, 2016).

List of Acronyms

ACARS	Aircraft Communications Addressing and Reporting System
ADS-B	Automatic Dependent Surveillance - Broadcast
AFRCC	Air Force Rescue Coordination Center
AOPA	Aircraft Owners and Pilots Association
ARC	Aviation Rulemaking Committee
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATP	Airline Transport Pilot
ATTF	Aircraft Tracking Task Force
AWOS	Automated Weather Observing System
CAP	Civil Air Patrol
CFIT	Controlled Flight into Terrain
CFR	Code of Federal Regulations
DOT	Department of Transportation
ELT	Emergency Locator Transmitter
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDR	Flight Data Recorder
FIS-B	Flight Information System - Broadcast
FOQA	Flight Operations Quality Assurance
FSIMS	Flight Standards Information Management System
FSS	Flight Service Station
GADSS	Global Aeronautical Distress and Safety System
GAJSC	General Aviation Joint Steering Committee
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
LPV	Localizer Performance with Vertical guidance
MMGFT	Multidisciplinary Meeting on Global Flight Tracking
MOPS	Minimum Operation Performance Standards
MSL	Mean Sea Level
NAS	National Airspace System
NBAA	National Business Aviation Association
NM	Nautical Mile
NTSB	National Transportation Safety Board
RCC	Rescue Coordination Center
RTCA	Radio Technical Commission for Aeronautics
SARP	Standards and Recommended Practices
SBS	Surveillance and Broadcast Services
SC	Special Committee
SMS	Safety Management System
TERPS	Terminal Instrument Procedures
TIS-B	Traffic Information Service - Broadcast
T-Routes	Terminal Transition Route
TWAS	Terrain Awareness and Warning System
USPS	United States Postal Service
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WASS	Wide Area Augmentation System

Chapter II – Literature Review

Part 135 Regulations

This topic is intended to delineate relevant Part 135 of Title 14 Code of Federal Regulations (CFR), in contrast to Part 121 regulations. These differences are paramount to understanding the next sections of this research.

According to 14 CFR § 135 Operations, there are two types of certificates issued to Part 135 Operators (General Information, 2020).

1. *Air Carrier Certificate*: operations include state to state, foreign, and overseas transportation, or carriage of mail.
2. *Operating Certificate*: operations include transportation wholly within the state of registry. (The research is focused on business operating under a Part 135 Operating Certificate)

Next there are two types of Operating Certificates each having their own limitations.

1. *On-Demand*: conducted in aircraft with 30 seats or less, with a maximum payload of 7,500 pounds. They can also conduct scheduled operations but must be less than 5 specified round trips per week, no turbo-jet aircraft can be used, and aircraft seating configuration of 9 seats or less. (This research focus' on non turbo-jet aircraft)
2. *Commuter*: conducted on aircraft with 9 seats or less, with a maximum payload of 7,500 pounds, and no turbo-jet aircraft can be used. Those holding a commuter certificate may also conduct On-Demand operations.

According to 14 CFR § 135, a certificate holder's options, for the extent of operations they wish to conduct, will depend on the scope and size of the business. The scope of the operation must get FAA authorization thru the issuance of Operation Specification (OpSecs) A039 and

A040. These operations each come with their own set of regulations specific to the operation. They include 135 Single Pilot, 135 Single Pilot in Command, 135 Basic, and Standard Part 135 (General Information, 2020).

- *135 Single Pilot*: limited to using only one pilot, who is listed as the only/sole operator. These operators are not required to develop and maintain manuals or training programs. They are not required to designate any roles, as they alone are the sole operator. However, they are required to having a Hazardous Materials (HazMat) training regimen for themselves and anyone helping with the logistics of the operation.
- *135 Single Pilot in Command*: operate aircraft with 9 seats or less and limited to one Pilot in Command (PIC) and up to 3 Second in Command (SIC). Both the PIC and SIC's are listed by name on the operating certificate, no other pilots may serve in either of these duties. Requirements include development and maintaining of manuals, training programs, and certain management positions. Depending on the scope of the operations deviations for these requirements may be granted.
- *135 Basic*: operate aircraft with 9 seats or less, limited to 5 aircraft or less, maximum of 3 differing types of aircraft, and maximum of 5 pilots, including both PIC's and SIC's. Requirements include development and maintaining of manuals, training programs, and management positions. Depending on the scope of the operations deviations for these requirements may be granted.
- *Standard Part 135*: no limitations on size or scope of the operation. Must receive authorization from the FAA for each type of operation they conduct. Requirements include development and maintaining of manuals, training programs, and management positions.

14 CFR § 121 has extremely robust requirements for certification, including an entire process to ensure the air carrier was able to "design, document, implement, and audit safety critical processes with Safety Management Systems (SMS), that both comply with regulations and safety standards, and also manage hazard-related risks in their operating environment (Introduction to Part 121, 2020)." The pre-application process alone includes five phases and three gates. The entire process is built upon the "assurance that the carrier has shown their processes, programs, systems, and intended methods of compliance are acceptable, thoroughly reviewed, evaluated and tested (Introduction to Part 121, 2020)." The FAA will not issue a certificate unless three different management oversight teams are satisfied that the carrier is able to "provide service at the highest possible degree of safety in the public interest (Introduction to Part 121, 2020)." These oversight teams include the Safety Analysis and Promotion Division, Certification and Evaluation Program Office, and Air Carrier Safety Assurance.

Under 14 CFR the hiring minimums for Part 135 and Part 121 are as follows. Part 135 operators: *Pilot in Command of Single Engine Aircraft* - Commercial Pilot and Instrument ratings / 1500 hours minimum. *Second in Command of Single Engine Aircraft* - Commercial Pilot and Instrument ratings / 500 hours minimum. *Pilot in Command of Multi-Engine Aircraft* - Airline Transport Pilot and applicable type ratings. *Second in Command of Multi-Engine Aircraft*- Commercial Pilot and Instrument ratings (§ 135.4 Applicability, 2020). For Part 121 carriers' minimums are as follows: *Pilot in Command* - Airline Transport Pilot Certificate, and applicable type ratings / 1000 Second in Command in the same type aircraft. *Second in Command* - Airline Transport Pilot Certificate with applicable type ratings (§ 121.436 Pilot Qualification, 2020).

Flight locating requirements for Part 135 operators require that each aircraft must have a transponder and that each operator must have a method and procedures for locating each flight if an FAA flight plan is not filled. This includes providing the certificate holder with at least the information required to be included in a VFR flight plan; timely notification of an FAA facility or search and rescue facility, if communication cannot be maintained, provide location, date and estimated time for reestablishing communications, and all information must be retained until completion of the flight. Each certificate holder is also required to provide the FAA with a copy of the above procedures, upon request. No requirement for real-time flight tracking, or requirement for gathering any flight data for quality assurance programs, as Part 135 operators are not required to have a Safety Management System (SMS) (Part 135, 2020).

14 CFR § 121 expects airlines, not only to obtain flight data in real time, but requires them to perform consistent data downloads per their SMS, which must be reviewed by quality assurance programs such as Flight Operations Quality Assurance (FOQA). They are also required to know the location of aircraft, at all times, through real time flight monitoring. The International Civil Aviation Organization (ICAO) has issued subsequent aircraft tracking Standards for all commercial carriers, as well as Recommended Practices (SARP's). After the disappearance of both Air France Flight 447 in 2009, and Malaysia Flight MH370 in 2014, ICAO began the special Multidisciplinary Meeting on Global Flight Tracking (MMGFT), at this meeting the Global Aeronautical Distress and Safety System (GADSS) was introduced. Soon after the Aircraft Tracking Task Force (ATTF) was set in place to address the gaps in commercial air transport tracking. In 2016, ICAO issued Amendment 39 to Annex 6, normal aircraft tracking SARPs. The SARPs addressed the carrier's responsibility to track their aircraft (all carriers with a seating capacity of 19 or more) throughout their operation, with a required interval time of 15 minutes. They recommended this to all aircraft with a takeoff weight of 59,000 pounds or more and required

it for all aircraft 100,000 pounds or more when flying over oceanic areas (Update on GADSS, 2016).

The new SARPs specific to locating an aircraft in a distress situation are soon going to require the aircraft to autonomously transmit their location at least once every minute. ICAO defines a distress condition as “the aircraft behavior event, if left uncorrected, could result in an accident (Update on GADSS, 2016)”. They estimate the aircraft has a high probably of being within a 6 nautical mile (NM) radius of the accident site and require the data to be available to assist in the search and rescue process. This transfer of information is not “technology-specific”, but after January 2021, it will be required on newly manufactured aircraft weighing more than 59,000 pounds and is recommended for aircraft as light as 12,500 pounds (Update on GADSS, 2016).

SMS – Too small, too expensive, too busy…

The Federal Aviation Administration (FAA) Advisory Circular (AC) 120-92B - Safety Management Systems for Aviation Service Providers, provides guidance for the implementation of Safety Management System (SMS) in compliance with 14 CFR Part 5. It explains the four pillars of SMS as Safety Policy, Safety Risk Management, Safety Assurance and Safety Promotion. According to the AC, the scalability of these pillars should depend on the size and complexity of the organization but does require all Part 121 carriers to have a SMS. In CFR Part 5, Part 135 operators are not required to have a SMS but are given the option of participating in a voluntary program (Safety Management Systems, 2015).

In September 2019, the NTSB held a Roundtable for their Most Wanted List, titled Alaska Part 135 Flight Operations – Charting a Safer Course. This roundtable focused on aggressive solutions to Alaska flight safety issues. Leading the discussion was Robert Sumwalt, Chairman of the NTSB. In the discussion relating to SMS he began by saying, smaller operations should think of it less in the terms of SMS, and more in terms of a "business approach to managing safety", simply put, "let's just manage safety" (NTSB Most Wanted, 2019). In the Roundtable the four pillars of SMS were simplified for these smaller Part 135 operators. Safety Policy, Chairman Sumwalt suggested, could be as simple as 1-2 sentences: What you are going to do, and how you're going to do it. Safety Risk Management: Identify hazards, are you going to accept the level of risk associated with those hazards, if not, create controls for the risks you do not accept. Safety Assurance: Make sure the controls you have in place are having an effect, this can be done through flight data monitoring and routine audits to keep a finger on the pulse of what's going on, it can also help identify systemic issues. The collection of flight data, one panelist described as the "lifeblood of SMS", will depend on the scope of the operation. And lastly, Safety Promotion: Thanking people for making the right decisions not to fly, leading by example, offering voluntary reporting, use of the FAA Aviation Safety Action Programs (ASAP), and always non-punitive (NTSB Most Wanted, 2019).

According to the NTSB, Alaskan Part 135 operators can benefit from the many facets of SMS. One example is by implementing consistent flight data monitoring programs, where developing threats can be easily identified, mitigating further risk. Data may be collected through multiple methods including technology geared specifically toward very small operations such as Spidertracks. This technology may not require an installation process but has the ability to monitor aircraft in 4D and generate replays. For more extensive flight data collection, technology requiring installation and integration may provide data involving multiple parameters. It is important this data is analyzed on a regular basis, should the operator not have the manpower to analyze the data, it can easily be sourced out to a variety of contractors.

Out of the 303 Part 135 certificate holders in Alaska, just 8 (3%) have utilized this voluntary program (NTSB Most Wanted, 2019). Many Alaskan operators believe they are too small to benefit, the cost is to great, they are too busy, or question whether it is worth the effort at all. Although, according to Advisory Circular 120-92-B, “the difference between the organization’s SMS is primarily one of size and complexity of the operations to be covered, volume of data available, the size of the workforce, and the resources needed to manage the organization. The SMS requirements are the same regardless of the size of your organization. However, part 5 allows organizations of different sizes to meet those requirements in different ways. An SMS does not have to be large, complex, or expensive in order to add value. If you have active involvement of the operational leaders, maintain open lines of communication up and down the organization and among peers, stay vigilant in looking for new opportunities, and ensure that your employees know that safety is an essential part of their job performance, you will have an effective SMS that helps you make better safety management decisions (Safety Management Systems, 2019).”

Extreme Conditions in an Extreme Environment

With over 7,900 active pilots, and 9,346 registered aircraft, Alaska has 4.8 million enplanements a year (Alaskan Region Aviation, 2016). There are 306 certified Part 135 operators providing scheduled and on-demand services to 169 communities, and a countless number of other destinations (NTSB Most Wanted, 2019). Air transportation is vital to everyday life, as more than three quarters of Alaskan communities have no access to highways or roads, leaving air as the only method to transport residents, tourists, mail, materials, and medical supplies (Mölders, 2008). In 2015, the 8 FAA control towers (Anchorage, Bethel, Lake Hood, Kenai, Fairbanks, King Salmon, Juneau, Kodiak, and Merrill Field) reported 839,593 tower operations. Lake Hood, located in Anchorage, which on any given day in the summer can host upwards of 600 takeoffs and landings, is the world's largest floatplane base, and the only one of its kind with "primary airport status". The state also has an additional 114 bases, the largest amount of floatplane bases in the country (Alaskan Region Aviation, 2016).

A substantial amount of income for Alaskan Part 135 operators comes from the U.S. Postal Service. The Postal Service relies on many of these operators to move mail, as larger cargo aircraft do not have ability to land at many of the smaller airports. These operators are required by law to move the mail within three days, regardless of weather or other circumstances. If the mail is not moved within this time frame, the Postal Service will begin searching for other operators to move it (NTSB Most Wanted, 2019). Ed Coleman, Professor and Department Chair of the Robertson Safety Center at Embry-Riddle Aeronautical University stated, "it does not take much to see how this could present undue pressure on an operator to fly when the weather is less than ideal (Coleman, 2019)."

Another common issue in Alaska, is a lack of instrument approach procedures, leaving pilots flying in low level visual metrological conditions (VMC) in unforgiving terrain. Of the 287 public use airports, 79 have some form of instrument approach procedures, but only 21 have wide area augmentation systems (WASS). These systems use satellite navigation combined with GPS, to offer localizer performance with vertical guidance (LPV), versus just localizer procedures used in normal GPS approaches, which result in lower minimums (Airports in Alaska, 2009). Although instrument procedures exist at the other 58 airports, many operators do not use them, as minimum decision heights and visibility requirements are much higher than required for Visual Flight Rules (VFR). For VFR there is a 500 foot minimum altitude designated by CFR §135.203 - VFR: Minimum altitudes, and §135.205 - VFR: Visibility requirements (in uncontrolled airspace when the ceiling is less than 1,000 feet), includes a visibility requirement of 2 miles (Title 14 Part 135, 2020). This leads to a significant amount of missed approaches and air turn backs, leaving many pilots choosing to fly VFR even when the weather is marginal. This has resulted in a considerable amount of inadvertent flight from VMC to instrument metrological conditions (IMC), resulting in a loss of visual contact with terrain and other aircraft (Airports in Alaska, 2009).

Professor Coleman recently addressed the problems with the lack of navigational infrastructure in Alaska, after attending the NTSB Alaska Roundtable Discussion. He spoke to the issue of high approach minimums, resulting in many operators flying in marginal VFR, and suggested to reduce terminal instrument procedure (TERPS) requirements. After reviewing TERPS requirements, which necessitate an obstacle clearance (ROC) of 10 miles wide and 15 miles from the approach point, he discovered they hadn't been updated since 1976. He, along with others, believe these requirements do not account for the modern-day accuracy, which in most cases is within feet, using GPS and WASS technology. He suggests the regulations regarding these missed approaches be revisited, and the minimums decreased. With the understanding the risks may be increased, he believes this risk would be justified by, "reducing the amount of time these operators would spend flying around at 500 feet trying to maintain VRF (Coleman, 2019)."

Many Alaskan Part 135 operators serve as links between regional hubs and villages (82% of which are not accessible by road) and remote camps and lodges. This means these aircraft operators are landing in unique places. According to the Alaska Airport Association, Alaska has

287 total public use (land-based) airports, and approximately 735 recorded landing areas throughout the state (Dowd, 2018). Of those, only 48 (less than 10%) have paved runways (Airports in Alaska, 2009). Landing areas for these pilots can vary from the usual paved runways, to short and narrow gravel runways, one third of which are 2,000 feet or less (the other two thirds being 3,000 feet or less), and nearly half with no lighting (Capstone Phase I, 2003). Pilots routinely land on volcanic spits, beaches, gravel bars, grass strips, at lodges and hunting camps that have no runways, and water landings on thousands of lakes and rivers. On top of the risky landing areas, the terrain in Alaska can be just as hazardous. The state is known for its large areas of high mountainous terrain, and flat marshy tundra, as well as a substantial amount of rugged coastline (Conway, 2004).

The large amount of varying terrain in Alaska can lead to extreme weather changes. According to Mölders, et. all (2008), "the challenges in forecasting Alaskan weather, as well as the questions about the application of forecasting tools are quite different from those in the contiguous United States. Alaska is the largest state, with the longest coastline, the most volcanoes, the largest area of permafrost and sea ice, the longest snow season, some of the highest mountains, the largest acreage burned annually, and the lowest density in observational networks in the United States." Those factors mixed with extreme climate and temperature differences, pose a large challenge to forecasters. Although the forecasts must serve a much larger range, there are fewer resources and far less scientists to perform the modeling then anywhere in the nation. Another factor that needs consideration is fire weather prediction, as plumes from wildfires, as well as ash clouds from volcanic eruptions cause major disturbances to air transportation.

When asked through a survey, about Alaskan pilot attitudes regarding safety, both operators and pilots agreed that one way of preventing crashes would be to give pilots improved weather and regional hazard training (Conway, 2004). One condition pilots routinely encounter is whiteout. This is a condition caused when uniform lighting from snow-covered terrain and low clouds or precipitation (usually in the form of snow) make the features of the terrain nearly indistinguishable. This potentially can lead a pilot to become unaware they are nearing terrain, and if not properly trained, may result in controlled flight into terrain (CFIT). Additionally, pilots often face rapidly changing weather, flat light, fog, and ice fog. The lack of local forecasts leaves pilots routinely encountering unexpected bad weather. On top of that, pilots have no low-altitude ATC coverage, resulting in low altitude flying with few navigational aids (Capstone Phase I, 2003).

According to CFR §135.213 - Weather Reports and Forecasts: “Whenever a person operating an aircraft under this part is required to use a weather report or forecast, that person shall use that of the U.S. National Weather Service, a source approved by the U.S. National Weather Service, or a source approved by the Administrator. However, for operations under VFR, the pilot in command may, if such a report is not available, use weather information based on that pilot's own observations or on those of other persons competent to supply appropriate observations (Title 14 Part 135, 2020).” In many communities the person greeting the aircraft is also the person to give the pilot the current weather report, which may not always be accurate.

To address the lack of weather reporting, the FAA has deployed 235 weather stations with 904 cameras across Alaska to help pilots determine when and where it is safe to fly, by giving them actual views of current weather conditions. According to the FAA, “this program improves safety and efficiency by providing pilots with near real-time visual weather information. The camera images are updated every 10 minutes and have been critical to help pilots make better safety decisions (Miller, 2019).” Most cameras are powered by solar and wind generators, and images are sent via satellite, however upkeep is required. The cameras offer views of sky conditions around airports, as well as "extreme" mountain passes (Miller, 2019).

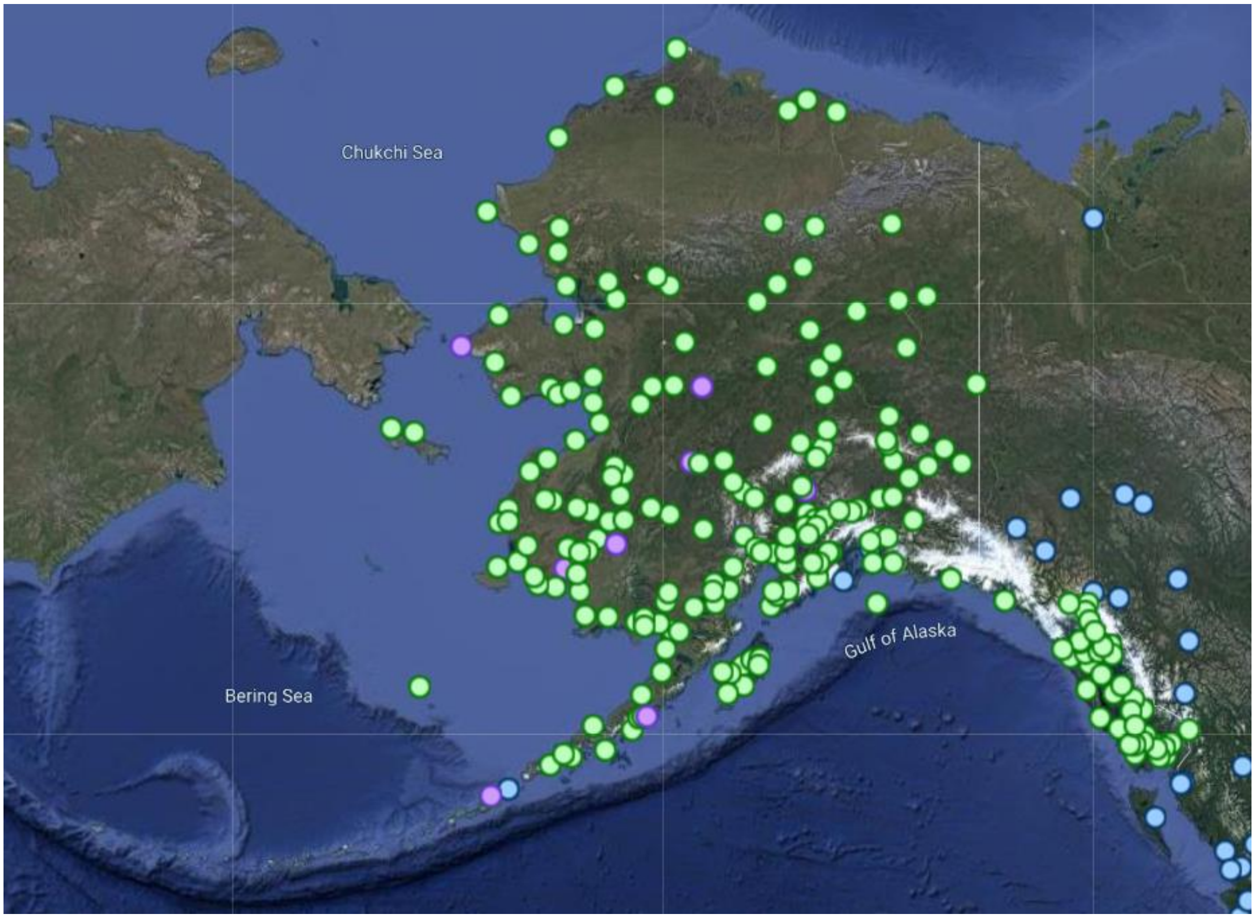

Figure 4. Map of Alaska Weather Cameras (FAA Aviation Weather Cameras, 2020)

ADS-B & NextGen

Alaska Capstone

In 1995, a report published by the NTSB found that the leading causes of accidents involving air taxies and commuter airlines (now scheduled and non-scheduled operators) was narrowed down to several issues including; pressure on pilots and commercial operators to provide services in a difficult environment with inadequate infrastructure, weather reporting, airport condition reporting, and the instrument flight rule (IFR) system. They determined enhancements to IFR system were needed to reduce reliance on VFR (Capstone Phase I, 2003). In 1999, the FAA published findings from a further report addressing CFIT accidents, saying commercial operators were more likely to have these type of accidents, as they felt pressured to take flights when weather was marginal even with the inadequate infrastructure (Capstone Phase I, 2003). These factors all lead to the decision to go forward with the Alaska Capstone project, a joint industry and FAA research and development effort to improve aviation safety and efficiency throughout the state. The assumed results of the study would include three things; 1. ADS-B would reduce midair collisions; 2. FIS-B would help reduce inadvertent VFR into IMC; and 3. The moving map would reduce CFIT accidents.

In Capstone Phase 1, the FAA and partners installed ADS-B on 150 commercial aircraft in the Yukon-Kuskokwim Delta (Y-K Delta), and established the ground infrastructure for weather observation, including Flight Information Services Broadcast (FIS-B) systems, which provided regional and local information using the Terminal Area Forecast (TAF) system, giving pilots access to forecasted weather and weather-related information. It also included a Traffic Information System-Broadcast (FIS-B), which transmitted current aircraft position to other aircraft equipped with ADS-B. Additionally, it offered terrain awareness, relative to the aircraft's position, alerting them when the aircraft was within 500 vertical feet, and within two minutes horizontally of terrain (Next Generation Navigation, n.d.). The FAA also increased the number of airports with instrument approaches. The intention behind the program was to reduce the number of mid-air collisions, controlled flight into terrain accidents, and weather-related accidents (FAA Alaskan Region, 2007).

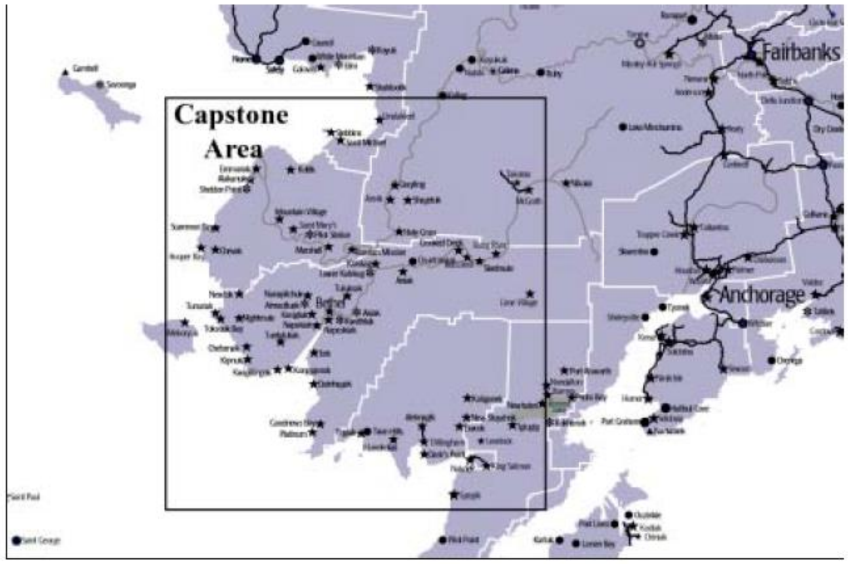

Figure 5. Phase 1 Areas of the Alaska Capstone Project (Capstone Phase I, 2003)

After the success of Phase 1, Phase 2 was initiated in South East Alaska. The published safety study determined, “It is definitely worthwhile for the FAA to continue this program. Accident rates have declined for Part 135 operations in the Y-K Delta, among both Capstone-equipped and non-equipped aircraft. All pilots in the Y-K Delta receive the benefits of more weather information and additional instrument approaches. Capstone training for pilots may provide safety benefits whenever those pilots fly, not just when they are using the avionics. There may be even greater safety benefits in the future. Only when all the Capstone equipment and capabilities are in place, and all pilots have been well-trained and used the equipment for a longer period, can we expect to see the program’s full safety benefits (Capstone Phase I, 2003). The Capstone Project operated from 1999 to 2006, and its success in Alaska laid the groundwork for the nationwide deployment of the current ADS-B system. It was in 2006, when the FAA announced that it would integrate Capstone into the FAA’s Surveillance and Broadcast Services

(SBS) program office tasked with implementing ADS-B across the national airspace system (Bergman, Brian, Daniels, 2006).

Current Use of ADS-B

As part of the Federal Aviation Administration's (FAA) NextGen initiative, on January 1, 2020, all aircraft must be equipped with ADS-B Out when flying in controlled airspace, or into any airport that requires a transponder. According to the FAA it will lead to better situational awareness, more efficient search and rescue, and surveillance at low altitudes not covered by radar. The FAA estimates full deployment of ADS-B will reduce aviation fatalities by 80% and save $3.5 billion a year in fuel costs (What is NextGen, 2018). Yet, this is not currently required for operators who fly outside of controlled airspace.

According to 14 CFR §91.225 Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use: after January 1, 2020, and unless otherwise authorized by ATC, no person may operate an aircraft below 18,000 feet MSL and in airspace described in paragraph (d) of this section unless the aircraft has equipment installed that (§91.225 Automatic Dependent, 2020):

> *(1) Meets the performance requirements in—*
>
> *(i) TSO-C166b; or*
>
> *(ii) TSO-C154c, Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment Operating on the Frequency of 978 MHz;*
>
> *(d) After January 1, 2020, and unless otherwise authorized by ATC, no person may operate an aircraft in the following airspace unless the aircraft has equipment installed that meets the requirements in paragraph (b) of this section:*
>
> *(1) Class B and Class C airspace areas;*

(2) Except as provided for in paragraph (e) of this section, within 30 nautical miles of an airport listed in appendix D, section 1 to this part from the surface upward to 10,000 feet MSL;

(3) Above the ceiling and within the lateral boundaries of a Class B or Class C airspace area designated for an airport upward to 10,000 feet MSL;

(4) Except as provided in paragraph (e) of this section, Class E airspace within the 48 contiguous states and the District of Columbia at and above 10,000 feet MSL, excluding the airspace at and below 2,500 feet above the surface; and

(5) Class E airspace at and above 3,000 feet MSL over the Gulf of Mexico from the coastline of the United States out to 12 nautical miles.

(f) Each person operating an aircraft equipped with ADS-B Out must operate this equipment in the transmit mode at all times

Figure 6. FAA Required ADS-B Out Airspace (Airspace, 2020)

ADS-B technology has the ability to transmit data automatically (A) with no operator input but is dependent (D) on a Global Positioning Systems (GPS) or other navigational system to provide position and velocity vectors. It also provides its users a 3-dimensional position and identification of other aircraft by surveilling (S) the area, and by broadcasting (B) the information it gathers to anyone with the appropriate receiving equipment. The major benefit of ADS-B versus radar is the use of satellite signals to track aircraft instead of relying on radio signals and antennas to determine location, and it broadcasts every second versus every 5-12 seconds, offering more precise locations (Ins and Outs, 2020). This technology also allows the operator to register their aircraft with their own specific ICAO address. This allows ATC and search and rescue to identify the aircraft automatically.

What about ADS-B Out versus ADS-B In? ADS-B Out is capable of broadcasting, once every second, an aircraft's location, altitude and speed, to both ground stations and other aircraft. This means other aircraft equipped with the same technology, as well as Air Traffic Controllers (ATC) can immediately receive the same information. ADS-B In offers the same, but with some additional advantages, including ADS-B broadcast services. These services provide a traffic information service (TIS-B), as well as real-time weather through Flight Information Service – Broadcast (FIS-B). FIS-B is a broadcast system provided by the FAA that allows operators with cockpit displays to have access to real-time aviation weather, including lightning, icing, turbulence and more, as well as additional aeronautical information, but it is limited to line-of-sight (Aeronautical Information Manual, 2017).

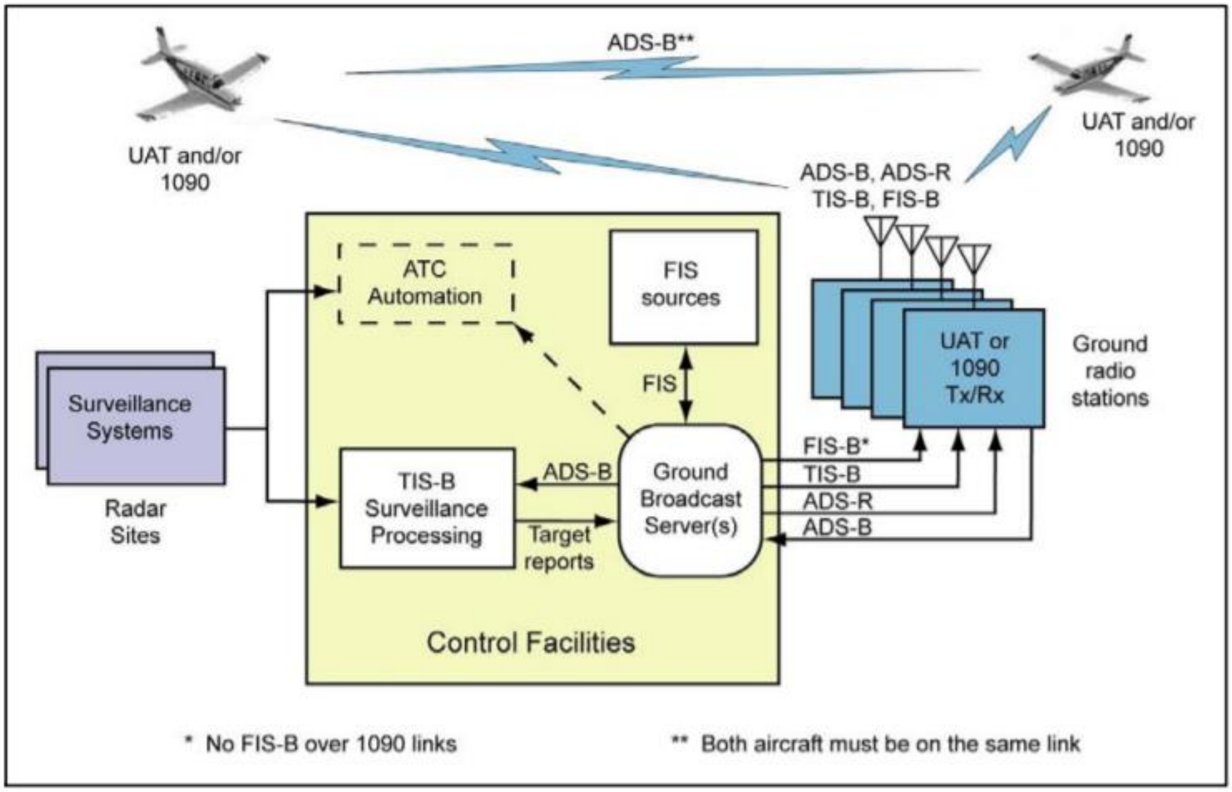

Figure 7. How ADS-B's Additions of FIS-B and TIS-B Work (Aeronautical Information Manual, 2017)

Current ADS-B data is transmitted to satellite or ground based receivers, which then relay it to ATC, other aircraft, and search and rescue teams if necessary (ADS-B Technologies, 2019). Depending on the equipment in the aircraft, some may require pairing with other software, this technology can offer additional aids to increase situational awareness such as real-time weather monitoring, Traffic Collision Avoidance Systems (TCAS), Terrain Awareness and Warning Systems (TAWS), and Ground Proximity Warning Systems (GPWS) (Croft, 2018). The GPWS is required for Part 135 operators flying turbine-powered aircraft. CFR §135.154 states, no person may operate a turbine-powered aircraft configured with 6-9 passenger seats, unless the aircraft is equipped with a Ground Proximity Warning System (GPWS) (§135.154 Terrain Awareness, 2020). Most ADS-B aircraft have a display on the avionics deck with a "moving map", which allows the pilot to see their location relative to terrain, weather, and equipped airplanes in the vicinity (Next Generation Navigation, n.d.).

Figure 8. ADS-B moving map inside of the cockpit (Next Generation Navigation, n.d.)

Alaska has a very minimal amount of airspace that falls under the ADS-B NextGen requirement. First, Alaska has no Class B airports, only one Class C airport, which is Ted Stevens International Airport in Anchorage, and seven Class D airports. In the entire 586,412 square miles of land and 2,427,971 square miles of airspace that make up the state, there are only 8 FAA control towers, 3 Flight Standards district offices, 2 terminal radar approach control facilities, 17 Flight Service Stations and 146 aviation weather reporting stations (Alaska Region Aviation, 2016). This makes ADS-B airspace far less restrictive in Alaska versus the lower 48 states, as it only pertains to Class A airspace above 18,000 feet MSL, and in and above Class C airspace which is Anchorage and the terminal area surrounding it (Collins, 2017).

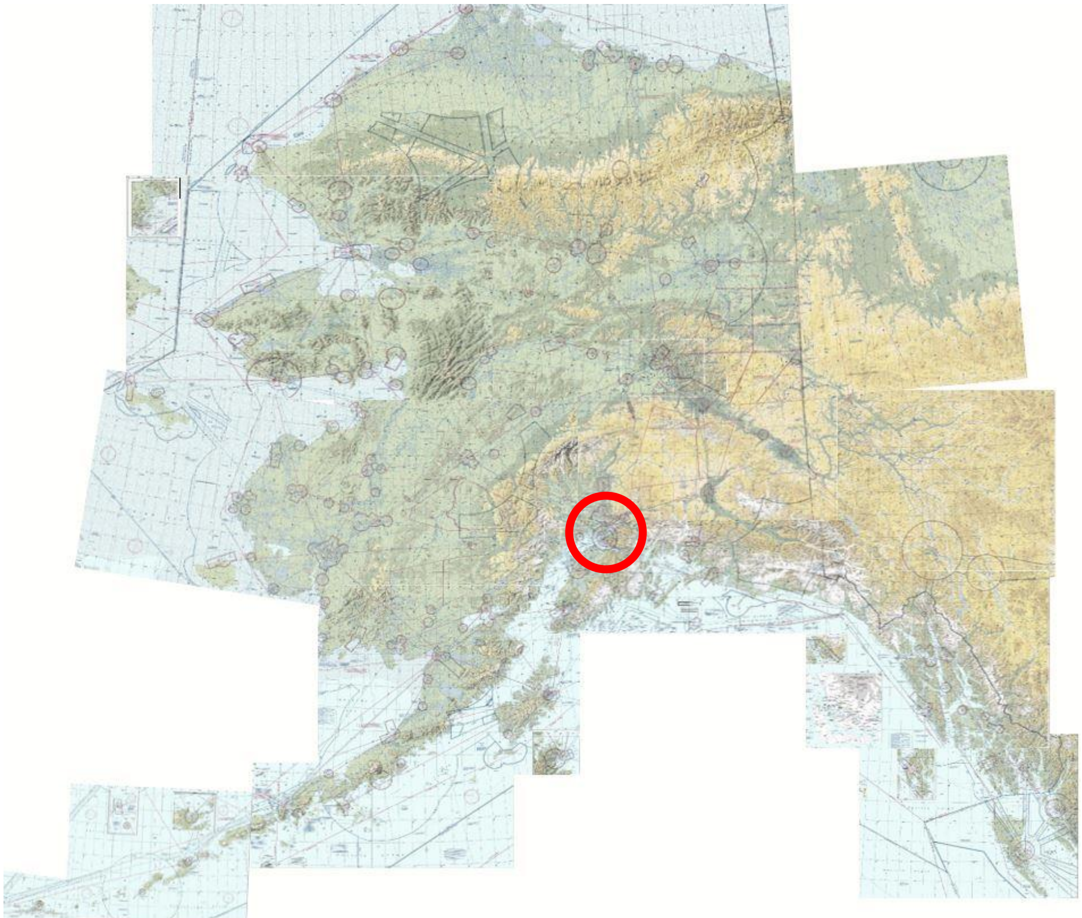

Figure 9. Sectional Charts of Alaska. The Red Circle Depicts the Airspace Requiring ADS-B (VFR Raster Charts, 2020)

A study by Gerhardt, et. all (2016), has shown if just sixteen additional satellites were launched and connected to the current Automatic Dependent Surveillance Broadcast system (ADS-B), more than 99% of Alaska would have the same coverage as the lower portion of the United States. This technology would guarantee just a six-minute maximum time gap, where any airplane in Alaska would not be covered, which translates to the location of any aircraft would be known within the last 6 minutes of flight time. As of now this exceeds the International Civil Aviation Organization (ICAO) standard of fifteen minutes (Gerhardt, Nag, Pham and Rios, 2016).

The Aircraft Owners and Pilots Association (AOPA) has specifically requested funding for additional ADS-B ground stations. "For Alaskans to see the benefit of ADS-B to equip, they are going to need the benefit of ADS-B In, said Rune Duke, AOPA director of airspace and air traffic. Coverage is not available where a lot of aircraft fly, especially low-altitude VFR, he said. We see a lot of IFR routes in Alaska that lack coverage, and that impacts efficiency (Collins, 2017)." They also pointed out the added benefit that ADS-B has regarding improved search and rescue in Alaska. "We know that we can get to aircraft more quickly with ADS-B surveillance," Duke said (Collins, 2017).

According to the Alaska Department of Transportation (DOT), in the event of an aircraft accident NextGen lets Air Traffic Control know the precise location of a downed aircraft. This allows rescue workers to know exactly where they should go to locate the aircraft, greatly improving the chances of a successful rescue effort in remote locations, while substantially reducing search and rescue costs. Capstone (ADS-B) provides all players in the aviation system a greater amount and far more detailed information improving safety and rural community access for the flying public (Next Generation Navigation, n.d.).

Although ADS-B technology was first launched in Alaska over 20 years ago, it is still only capable of using ground-based receivers in certain areas and can only be used when in range and without mountainous obstructions (See Figure 10. below). "Existing aircraft tracking capability is also lacking when encountered with water, like in the event that an aircraft crashes into the ocean (Ong, Wei, 2015)." Current technology is limiting, as it does not have the capability to track aircraft over remote oceans or sparsely populated regions, which make up nearly the entire state, consequently creating a "search and rescue bottleneck" (Gerhardt, Nag, Pham and Rios, 2016).

The National Business Aviation Association (NBAA) joined with the Aircraft Owners and Pilots Association (AOPA), the Alaska Airmen Association and the Alaskan Aviation Safety Foundation, to urge the FAA to create a Minimum Operational Network for ADS-B coverage in Alaska. Their official letter stated, “Our organizations have been involved in the development of ADS-B since the start of the Capstone Program, which provided the operational demonstration of this technology for the nation, and while the two areas used to prototype this technology are covered, and additional stations have been added for some portions of Alaska, we continue to experience large gaps in coverage in areas of the state that have significant air travel (NBAA, 2019).” To cover the major sections of the low-altitude routes used by commercial and general aviation aircraft, the letter identified 23 additional ADS-B ground stations. The additional locations are the result of an analysis of the existing ADS-B coverage, proposed RNAV terminal transition routes (T-Routes), and recent flight tracks from the satellite-based Aireon ADS-B coverage of Alaska. “Filling these gaps should also encourage more aviation businesses and aircraft owners who fly in Alaska to equip, as they will obtain the benefits in the areas they operate (NBAA, 2019).” The FAA has acknowledged that the regulatory impact analysis did not specifically include ADS-B in Alaska, and the system could improve by using ADS-B coverage in non-radar airspace as well (Statement of Policy, 2019).

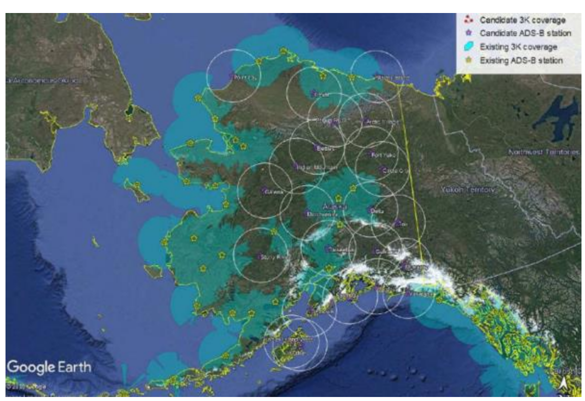

Figure 10. Proposed ADS-B Minimum Operational Network in Alaska (NBAA, 2019)

Search and Rescue

In 1943 the Coast Guard began using their Aviation branch for search and rescue (SAR) operations. One of the first known airborne SAR's took place on November 29, 1945, with a Sikorsky R-5 Helicopter, to rescue a group of men on a sinking oil barge. Today, search and rescue operators assist people in need throughout the country and the world (The Early Years, 2017). The United States Air Force Rescue Coordination Center (AFRCC), the Civil Air Patrol (CAP), the National Park Service Inland Search and Rescue, the Alaska State Troopers, and the Rescue Coordination Center (RCC) in the United States Defense Department are just a few.

"By the federal interagency agreement, the National Search and Rescue Plan provides for the effective use of all available facilities in all types of SAR missions. These facilities include aircraft, vessels, pararescue, ground rescue teams, and emergency radio fixing. Under the Plan, the U.S. Coast Guard is responsible for the coordination of SAR in the Maritime Region, and the U.S. Air Force is responsible in the Inland Region. To carry out these responsibilities, the Coast Guard and the Air Force have established RCCs to direct SAR activities within their regions. For aircraft emergencies, distress and urgency information is passed to the appropriate RCC through an air route traffic control center (ARTCC) or flight service station (FSS) (GEN 3.6, n.d.)."

There are five major search and rescue operators in the state of Alaska, all of which are controlled by the U.S. Coast Guard Rescue Coordination Center (RCC). This includes the U.S. Coast Guard, Alaska State Troopers, Alaska Air National Guard, Alaska Division of Emergency Services and the Alaska Department of Public Safety. According to the Coast Guard, "the primary mission of the Alaska RCC is to provide a 24-hour rescue coordination capability in support of US military and civil aviation search and rescue needs in Alaska. Ultimately, the role of Alaska RCC in civil SAR is in direct support of the National SAR Plan. Representing Alaska's federal inland search and rescue coordinator, the Alaska Rescue Coordination Center serves as the single agency responsible for coordinating on land and aviation federal SAR activities in the mainland of Alaska (Alaska Rescue Coordination, 2020).”

Figure 11. Alaska Search and Rescue Asset Map (Alaskan Pilot, 2011)

The Alaska Rescue Coordination Center (AKRCC) is located in Anchorage at the Joint Base Elmendorf-Richardson. The AKRCC is manned by the Alaska Air National Guard, and operates 24 hours a day, seven days a week. The center connects directly into the Federal Aviation Administration's alerting system and the U.S. Mission Control Center. The RCC uses satellite aided tracking information and hosts a database that contains all information relating to federal, state and volunteer civilian search and rescue operations (Alaska Rescue Coordination, 2020).

Each state is required to provide the funding for all search and rescue operations. According to the Alaska Statue Title 13 AAC 20.010, "the expense of the search and rescue party shall be paid out of the state treasury upon vouchers properly made out, signed, and sworn to by the person appointed to direct the search and rescue party. The oath to the voucher shall be taken and made before the commissioner of public safety or a designee and may be paid only after it has been approved by the commissioner of public safety or a designee. In approving the voucher, the commissioner of public safety or a designee shall consider the necessity of the search and rescue party, the reasonableness of the expenses, and the proper audit of the voucher (Alaska Admin Code 20.010, 2020)."

Although not specific to aviation, according to the leader of the volunteer search and rescue group called the Alaska Search and Rescue Association (ASARA), "On any given day in Alaska, someone will go missing. Over the last five years, a person or group was reported missing or overdue on average of once every 12 hours. Whether it is an overdue hiker unfamiliar with the terrain, or someone unprepared for the capricious weather, emergency personnel in Alaska are on constant alert for search and rescues (Alaska Incident Management, 2015)." According to ASARA, only 7 of the 16 boroughs and municipalities have government run emergency services. These 16 boroughs and municipalities cover approximately 38 percent of the land mass. The rest is the responsibility of the Department of Public Safety and a dedicated volunteer search and rescue community (Alaska Incident Management, 2015). Alaska realizes without the dedication of search and rescue volunteers the job would not get done. The state willing gives those who volunteer equal benefits of state employees should they get injured or suffer an untimely death. Alaska Statute 23.30.244 states that "any resident of the state who temporarily volunteers to participate in a search and rescue training exercise, or activity, and who suffers injury or death during the course, and within the scope of the services, will be considered an employee of the state (Alaska Admin Code 23 30.244, 2020)."

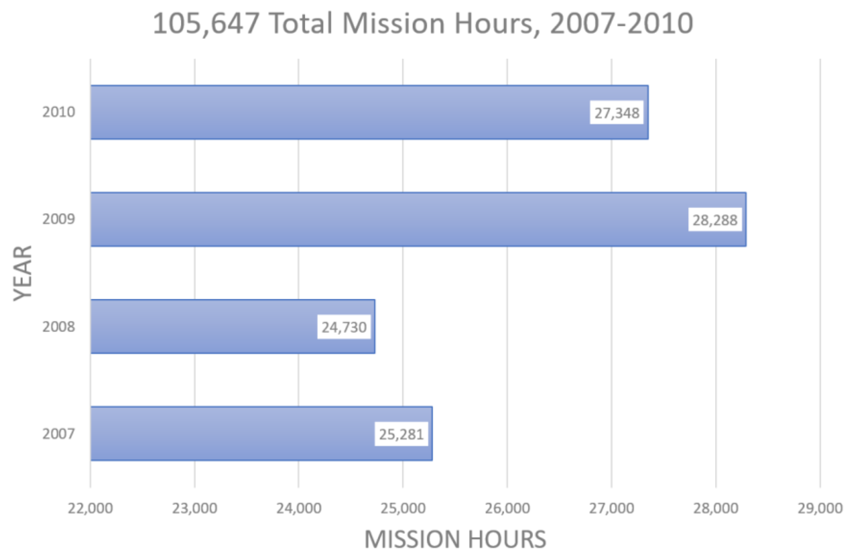

Figure 12. Total mission hours dedicated by volunteer search and rescue personnel in Alaska from 2007-2010 (Alaska Incident Management, 2015)

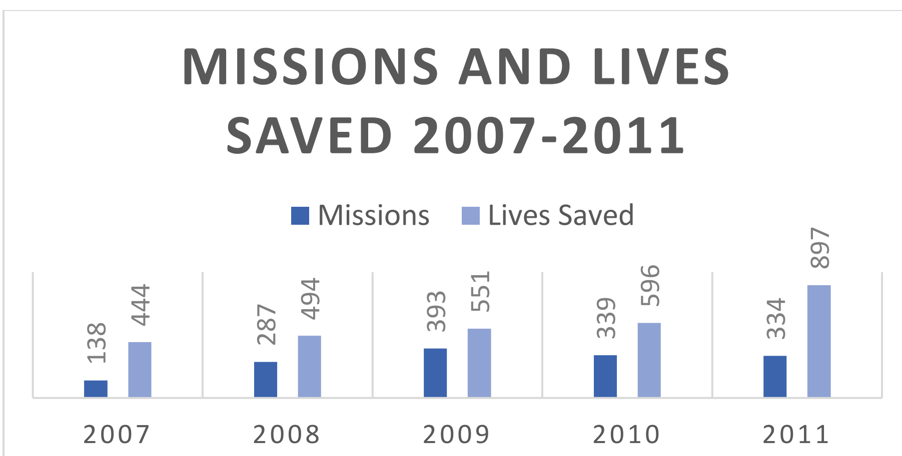

Figure 13. Total search and rescue missions and lives saved by search and rescue volunteers from 2007-2011 (Alaska Incident Management, 2015)

The importance of proper aircraft tracking technology is essential to search and rescue operations. As discussed previously, ICAO has created an entire board dedicated solely to establish recommendations and requirements for aircraft tracking capabilities. This includes the following criteria; tracking equipment must be operational while the aircraft is airborne, the information required must include 4D position (latitude, longitude, altitude and time) and identification, accuracy of position report must be within 1 NM, and location reporting must take place every 15 minutes (every 1 minute beginning in 2021) (Aircraft Tracking, 2014). There are multiple technologies, in accordance with these guidelines, that exist today for all aircraft including air carriers, commercial operators and general aviation.

Many airlines use the Aircraft Communications Addressing and Reporting System (ACARS), which is a digital datalink system that transmits short messages between the aircraft and company operation control centers or dispatchers, which also includes tracking capabilities, via satellite communications. This system works well in populated areas, but there are areas of the world where these tracking capabilities are limited or simply don't exist (Reynolds, 2002). In addition to ACARS, ADS-B, according to the FAA, "is a highly precise GPS-based surveillance system which assists ATC with tracking aircraft through more accurate information about last reported position (every one second), taking the search out of search and rescue (Aeronautical Information Manual, 2017)." However, as previously discussed, this technology has many limitations and simply does not exist in certain unpopulated areas including large sections of Alaska.

There are several companies that have designed and currently offer tracking capabilities that cover the globe, in addition some even offer real-time flight data monitoring within the same unit. Spidertracks, created Spider X, a program that offers flight tracking and data monitoring to all operators with "simple to install, cost effective, light-weight solutions". According to Spidertracks website, Spider X uses virtual flight data recording (FDR) with an attitude and heading reference system (AHRS), transmits in air, and allows operators to see their aircraft's position, as well as orientation in real-time, including 4D flight replay. The ability to offer FDR, allows even small operators to establish Flight Operational Quality Assurance (FOQA) programs, which many have never had the capability of doing. The information is transmitted automatically via the Iridium® global satellite network every minute, allowing tracking of aircraft anywhere in the world, regardless of infrastructure (Track, 2020).

Another tracking system currently available is a web-based alerting system called GlobalBeacon. This system works with existing ADS-B Out technology to provide 100% global coverage. It offers real-time aircraft tracking and 4D position information, all within the one-minute reporting window. GlobalBeacon "works with Aireon's space-based ADS-B position data and FlightAware's (a public aircraft tracking system) web interface and worldwide flight information, including origin, destination, flight plan route and estimated time of arrival (GlobalBeacon, n.d.)." This system is also designed to work with existing equipment, requiring no additional hardware. The intention of this all this technology is to provide coverage and accuracy to make tracking aircraft easier and faster in an emergency or search and rescue situation.

The NTSB & the Aviation Rule Making Committee

On February 4, 2019, the NTSB issued their 2019-2020 "Most Wanted List" of Transportation Safety Improvements. "Improve the Safety of Part 135 Aircraft Flight Operations" was the one of several focus topics for aviation. They offered many recommendations to the FAA, many of which were specific to Alaska. According to the NTSB, "most of the organizations that conduct Part 135 operations do not have, and are not required to have, a safety management system (SMS), flight data monitoring (FDM), or controlled flight into terrain (CFIT) avoidance training programs (Improve the Safety, 2019).” They also do not know how many operators have SMS or FDM programs because the FAA does not require operators to implement and report on them. CFIT-avoidance training programs are required for Part 135 helicopter operations, but not for Part 135 fixed-wing operations. “We have investigated several fatal CFIT accidents involving flights operated under visual flight rules at low altitudes. Despite the availability of SMS, FDM, and CFIT-avoidance programs, preventable crashes involving Part 135 aircraft are occurring all too frequently (Improve the Safety, 2019).” According to data, controlled flight into terrain (CFIT), loss of control in-flight, midair collisions, and unintended encounters with instrument meteorological conditions caused roughly 80% of fatal Part 135 accidents in Alaska from 2008 to August 2019 (NTSB). Therefore, the safety of Part 135 operations made the NTSB’s most wanted list for 2019-2020 (NTSB Most Wanted, 2019).

Figure 14. All Part 135 Alaska Accidents 2008-2019 (NTSB Most Wanted, 2019)

Figure 15. Fatal Part 135 Accidents by Cause 2008-2019 (NTSB Most Wanted, 2019)

The NTSB convened in Anchorage, Alaska in September 2019, for a Round Table discussion lead by the Chairman of the NTSB, Robert Sumwalt, with a panel of Part 135 operators, safety experts, and government officials to discuss chronic safety issues. During this discussion previous solutions arose, and participants spoke about the intention of the FAA to conduct studies or make plans to enhance safety, but they had stalled. The NTSB's Safety Recommendation Report to Revise Processes to Implement Safety Enhancements for Alaska Aviation Operations, came out of this discussion. The statement spoke of a report the came out in 2017, titled Recommendations for the Performance Based Navigation Route System (which was commissioned by the FAA), contained 23 recommendations for improving Alaska flight operations. In 2019 the FAA requested a feasibility study of the recommendations, but as of now have been delayed again (Safety Recommendation Report, 2020).

A member of the FAA's Navigation Programs senior management team suggested, "FAA staffing reorganizations, in Alaska, the lack of coordination between FAA and industry safety initiatives were significant factors in the lack of progress involving safety enhancements (Safety Recommendation Report, 2020).” The discussion led to a concern that a lack of coordination in the FAA’s organization has made it difficult to develop a comprehensive plan for safety efforts. One example was a decision to purchase more Automated Weather Observing Systems (AWOS), but there were no funds earmarked for ongoing maintenance. It was brought up there is a “need to make sure we’ve got somebody at the FAA, that can coordinate across different parts of the FAA to get something done (Safety Recommendation Report, 2020).”

“The longstanding effort to increase IFR operations in Alaska is another area that continues to be met with obstacles. The director of operations for an Alaskan carrier stated that despite the increased availability of instrument approaches, the inability to comply with current FAA flight standards that are required throughout the United States, such as weather reporting requirements and terminal instrument procedures, render the approaches unusable for many operators. He stated, a possible remedy would be to adjust the FAA’s flight standards for Alaska, to accommodate its unique aviation environment, which is a risk management decision requiring extensive knowledge of the environment; yet such an adjustment has yet to even be evaluated (Safety Recommendation Report, 2020).”

The round-table discussion resulted in the conclusion that the FAA’s lack of action has resulted in safety issues continuing. The NTSB formally recommended to the FAA (A-20-11), “Work with stakeholders that service the Alaska aviation industry to implement a safety-focused working group to review, prioritize, and integrate Alaska's aviation safety needs into the FAA's safety enhancement process (Safety Recommendation Report, 2020).”

The Aviation Rulemaking Committee

In 2003, the FAA initiated the Aviation Rulemaking Committee (ARC). This committee was tasked with presenting to the FAA and an assigned United States Congress subcommittee. The ARC was tasked with making suggested updates to Part 135 Federal Aviation Regulations (FAR), as they had not been updated since 1978 when they were created. The regulations lacked in the areas of flight crew requirements, maintenance, and technology requirements. According to the ARC, the FAA's oversight was based on compliance with 'outdated' regulations. They were to provide suggestions to increase safety and applicability standards that reflect the current industry trends and emerging technologies and operations (FAA's Oversight, 2010).

In the ARC proceeding transcripts, it was stated, "135 operators, particularly in Alaska, typically fly in inherently risky environments, have shorter flights with more takeoffs and landings, and fly to and from small airports that are not controlled (FAA's Oversight, 2010)." They also operate at altitudes 'vulnerable' to weather and terrain hazards. It determined that most on-demand flights, unlike Part 121 carriers, "operate without dispatchers that utilize flight-following systems to monitor progress of airborne flights and to advise pilots of hazardous weather or other operational hazards. Part 135 operators are not required to follow the progress of flights, although they are required to have a flight-locating system, such as an ELT, to locate missing or overdue aircraft (FAA's Oversight, 2010)." The ARC sent 124 recommendations to the FAA in 2005, to date the FAA has not issued any final rules based on the ARC's recommendations (FAA's Oversight, 2010).

What the FAA has to say

The NTSB has issued the Federal Aviation Administration an extensive list of recommendations, based off the 2019-2020 Most Wanted List. The following recommendations are specific to this research with the applicable information extracted from each, including Part 135 operators, and Part 135 operators specifically operating in Alaska. The Federal Aviation Administration (FAA) has addressed these recommendations through the following proposed "Actions" (Fact Sheet, 2020).

The first recommendation (A-10-29) is to routinely download and analyze all available sources of safety information as part of a quality assurance program. This would help identify deviations from established norms and procedures. The FAA has they will update relevant guidance to inspector in FAA Order 8900.1 (Fact Sheet, 2020). The purpose of this order is to establish the Flight Standards Information Management System (FSIMS) as the repository of all Flight Standards policy and guidance concerning aviation safety inspector job tasks. Technically speaking, FSIMS is a Flight Standards directive, which aviation safety inspectors use as the system of record for all Flight Standards policy and guidance (Flight Standards, 2007).

The next NTSB recommendations (A-13-12 and A-13-13) seek to require the installation of a crash-resistant flight recorder system, as well as a cockpit voice recorders, on all newly manufactured turbine-powered aircraft, or retrofitted on existing aircraft, operating under Part 135. The FAA has stated, "they are not considering rulemaking at this time, instead they will examine possible ways of polling operators through our aviation safety inspectors to identify voluntary flight data monitoring (FDM) system equipage rates (Fact Sheet, 2020)."

The next recommendation (A-16-34), is to require all Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program. The FAA has said they will determine the feasibility of requiring all Part 135 operators to instill these systems. This was followed by a recommendation (A-16-35), to then require these operators establish a structured flight data monitoring program with all available data sources to identify deviations from established norms and procedures and other potential safety issues. The FAA has actioned, a review of the level of participation of Part 135 certificate holders in voluntary programs and evaluate additional actions that can increase awareness and participation (Fact Sheet, 2020).

Next, the NTSB has recommended (A-16-36) that each Part 135 operator establish a safety management system (SMS). The FAA stated as they have only recently (in 2015) required Part 121 carriers to have an SMS program, and pointed out, that although they have not required all Part 135 operators to have one, they do have a voluntary program in which they can participate. They have also stated they will conduct a review and hold meetings to determine the feasibility of recommending SMS for Part 135 operators and determine of further action is needed (Fact Sheet, 2020).

The next recommendation (A-17-35) asks for ways to provide effective terrain awareness and warning system (TWAS) protections while mitigating nuisance alerts for single-engine aircraft operating at altitudes below their warning system threshold. The FAA is actively participating in the General Aviation Joint Steering Committee's (GAJSC) Controlled Flight into Terrain (CFIT) workgroup, which will likely provide a final report by December 2020 concerning CFIT accidents. In addition, the FAA is actively participating in quarterly meetings of the Radio Technical Commission for Aeronautics (RTCA) Special Committee (SC) 231, on TAWS. SC-231 is attempting to produce solutions to enhance TAWS protections and determine if further standards are necessary for RTCA/DO-367, Minimum Operational Performance Standards (MOPS) for

TAWS Airborne Equipment. The FAA will review the SC-231 recommendations and determine the next appropriate actions (Fact Sheet, 2020).

From 2000-2019 Ketchikan, Alaska has had 18 total accidents, 6 of which resulted in 26 fatalities. Two sightseeing aircraft collided midair in VMC, killing six and severely injuring another 6. Two aircraft suffered controlled flight into terrain after continuing a VMC flight into IMC conditions, in total killing 14. Two aircraft were attempting to climb out of rising terrain after getting into poor weather, lost control of the aircraft, both suffering a stall condition and collision with the ground, killing 6 people (Aviation Accident Database, n.d.)

This recommendation is specific to Ketchikan, Alaska. The NTSB would like the FAA to "work with the air tour industry, which has had several weather related accidents in the last few years involving continuation of flight under visual flight rules (VFR) into instrument meteorological conditions (IMC) (see above), to improve training programs geared toward reducing such accidents. They would like them to focus on human factors involving pilot decision making, specifically the need for pilots to better decided on what constitutes safe weather conditions based on objective standards. They suggest a set criteria for determining whether to proceed on certain routes through visibly clear identification of landmarks. They also formally addressed the need to train pilots, especially those new to the area, on the dynamic local weather patterns. In the same recommendation they also as the FAA to address operational influences on pilot decision-making (National Transportation Safety, 2019)." The FAA has said they will conduct customized surveillance specifically focused on operator training programs, as well as the way in which the training is implemented and delivered (Fact Sheet, 2020).

The following recommendation (A-17-38), asks the FAA to expand the application of Order 8900.1, for helicopter operations, to include Part 135 fixed wing operators, to establish a

Safety Assurance System that includes flight training curriculum segments, which address controlled flight into terrain. The FAA has said they plan to evaluate current guidance, regulations, and policy, to determine “potential options” to satisfy the recommendation (Fact Sheet, 2020).

Recommendation (A-17-42) again is specific to Ketchikan air tour operations. The NTSB would like the FAA to analyze the air tour operators ADS-B data on an ongoing basis and host a yearly meeting to “engage in a non-punitive discussion” of operational hazards and collaborate on mitigation strategies for hazard identification. The FAA said it has determined there is a large portion of the Ketchikan area where ADS-B data is not available, but they have been in touch with operations who are currently using Spider Track, a commercially available GPS tracking device, that gives the operators coverage over the entire area. This information has been openly shared with the FAA and is “routinely incorporated into the bi-annual air tour safety meetings” (Fact Sheet, 2020).

The next recommendation (A-17-43) is again tailored to Ketchikan air tour operators. This recommendation asks the FAA to develop and implement specific operating rules, including en route visual flight rule weather minimums that are more conservative than what 14 CFR Part 135 currently requires. The FAA has actioned this item by saying they are “evaluating policy and rulemaking options regarding the full adoption of the recommendation” (Fact Sheet, 2020).

Although CFIT avoidance training is not required by Alaskan operators, there are some who have voluntarily implemented these programs. The NTSB recommends (A-18-13) that the FAA works with these operators to improve training specifically as it relates to inadvertent VFR into IMC leading to CFIT. They would like special attention paid to (1) the challenges of flying in mountainous terrain in Alaska and low-altitude VFR flight in an area subject to rapid changes in weather; and (2) limitations of the Alaska infrastructure, particularly weather observations, communications, and navigation aids. The FAA is currently partnered with the GAJSC CFIT working group, with combined efforts they will work to improve these areas of voluntary CFIT training (Fact Sheet, 2020).

Next, the NTSB recommends (A-18-14) asking the FAA to work with Part 135 operators, that operate under visual flight rules in mountainous terrain at altitudes below the required terrain clearance of the aircraft's required TAWS class to (1) ensure that management and pilots are aware of the risks associated with distraction (from continuous nuisance alerts) and complacency (brought about by routine use of the terrain inhibit feature); (2) develop plans for mitigating those risks and minimizing nuisance alerts; and (3) develop procedures that specifically address when pilots should test, inhibit, and uninhibit the TAWS alerts. The FAA has stated they are currently developing a Safety Alert for Operators to address this recommendation (Fact Sheet, 2020).

The last two recommendations (A-18-16 & A-18-17) were made to address the lack of communication and navigational aids available to Part 135 operators in Alaska. They recommend installing communication equipment throughout Alaska to allow these operators increased access to the IFR system, including ensuring that the airports these operators serve, have functional instrument approaches equipped with weather reporting capabilities to enable IFR operations that meet the current regulations. The FAA has stated they are reviewing how to best address these recommendations (Fact Sheet, 2020).

Chapter III – Methodology

This research was conducted to illustrate the benefits of implementing regulations, similar to that of Part 121 operations, on a scale appropriate the size of the operation, as this would help decrease the accident rate of Alaskan Part 135 operations. It also seeks to determine if these same operators could benefit from an FAA directive requiring use of the NextGen mandate involving ADS-B, and/or other tracking technology, in uncontrolled airspace. And lastly, to determine if said tracking programs would help facilitate timelier search and rescue operations, saving lives, time and money.

Research approach

This research was compiled to show the lack of content, and disproportionate amount of Federal Aviation Regulations, between Part 121 carriers, and Part 135 operators, particularly emphasizing Alaskan operators. It also focuses on the lack of requirement for Alaskan operators to use ADS-B or other tracking devices outside of controlled airspace, when a majority of the scheduled and on-demand operators, in fact operate outside of controlled airspace. Additionally, it highlights how lack of aircraft tracking programs can lead to lengthier search and rescue times, resulting in unfavorable outcomes.

The mixed methods research was gathered using a grounded theory approach by the construction of theories, using collected data and compiling it to form a story. This has helped identify rules and regulations implemented in 121 operations that have made a difference, and the lack there of in 135. The qualitative data was then combined with quantitative data to highlight accident rates in 135 versus 121 operations, and the reasons behind them. Through inductive reasoning this research paints a clear picture of how, with implementation of additional regulations, safety programs, and flight tracking and monitoring, Alaska could become a safer place to operate.

Apparatus and materials

The following materials and equipment were used by the researcher.

Physical equipment

Computer with internet connection. This was used to gather all data, literature, regulations, satellite imagery, and aircraft navigation sectionals.

Software

Microsoft Office Suite. The use of Microsoft Word, PowerPoint, and Excel helped the researcher sort information, compile and present in an orderly manner. Charts, tables and were also created using the Office Suite.

Google Earth. This was used to determine ADS-B coverage areas for the entirety of Alaska, using the overlay function.

Sources of the Data

This research used existing data accessed through the following methods:

NTSB Aviation Accident Database & Synopses: Accident data was extracted through the public electronic database containing information about all civil aviation accidents and selected incidents in the United States. The ability to filter from operation to cause, helped the researcher narrow down the information need. The NTSB also provide previously conducted statistical analyses which was used as well.

NTSB Website: This was used to find the NTSB 2019-2020 Most Wanted List, Recommendations made to the FAA, Information and conference proceedings regarding the Alaska 135 Operator's Tabletop discussion.

Electronic Code of Federal Regulations: This database was accessed to gather pertinent regulations pertaining to both 14 CFR Part 135 and Part 121.

ICAO Website: Information on tracking requirements and search and rescue requirements.

Federal Aviation Administration Website: This website provided data regarding regulations, ADS-B implementation information, FAA's responses to NTSB recommendations, the Alaskan "Survival Guide", aviation weather camera information, airspace descriptions and dimensions, Alaskan Capstone Project, Alaskan Air Traffic Control statistics, NextGen information.

Embry-Riddle Hazy Library & Learning Center's Electronic Database: This data provided information on SMS, GPWS, TCAS, Alaska weather hazards to pilots, peer reviewed journal articles, and the Alaska Capstone project.

Electronic Articles of the Alaska State Legislature: This database was used to find statutes pertaining to Alaska Search and Rescue procedures and expenses.

Treatment of the Data

Data was collected from the NTSB aircraft accident database, where it was filtered for specifics, including:

1. “Part 135”, “Aircraft”, combined “Accident and Incident”

2. “Part 135”, “Aircraft”, “Accident”

3. “Part 135”, “Aircraft”, “Accident”, “Fatalities”, this gave the total number of accidents involving fatalities, the number of individual fatalities were counted by manually for each of the accidents

4. Steps 1-3 were repeated adding “Alaska” to each

5. “Part 135”, “Aircraft”, “Accident”, with a key word search of “Search and Rescue” or “SAR” - Each occurrence found in this search was looked at individually by going into the associated investigation report to verify if SAR was used, and where it was used.

6. Steps 5-6 were repeated adding “Alaska”

7. Steps 5-6 were repeated, instead using the following three key word searches, “Controlled Flight into Terrain”, “Visibility”, and “Midair”. This search was used with a variety of dates throughout the data collection.

After collecting quantitative data from the NTSB accident investigations database, the data was segregated and made into relevant graphs for comparison and easy visualization. All the graphs were labeled and titled appropriately. Some data was used within the body of the report to give an overview of the statistical analysis, including the rates, numbers and percentages of Part 135 accidents that occurred in Alaska during various timeframes, the rest reside in Chapter IV - Results & Discussion.

Chapter IV – Results & Discussion

Through this research it is apparent there is a large disparity between CFR Part 121 and Part 135 regulations. For example, pilots flying for either scheduled or on-demand operations (Part 135) are required to have less flight time, less flight certifications, less training, and less rest requirements (§ 135.4 Applicability, 2020). For Part 135 operators SMS is not required, nor is flight data monitoring, flight tracking, any form of internal reporting, and depending on the size and scope of the operation may not even be required to have a training program or even an operations manual (CFR Part 135 (OpSecs) A039 and A040). In addition, nearly everywhere in the world a Safety Management System (SMS) is required to fly commercial operations, yet this is not required for Part 135 operators, even those carrying paying passengers, here in the United States.

Statistical Data – Accidents involving Part 135 vs. Part 121

Below you will find statistical data, gathered from the NTSB aviation accident database, comparing the amount of Part 135 accident rates, fatalities, and contributing factors to the same data set but on the Part 121 air carrier side. This data is being utilized to show the large split in accident numbers from the under regulated side (Part 135) versus the highly regulated side (Part 121).

Accident Totals for Part 135 Operators and Part 121 Air Carriers from 2008-2017

(*Not Specific to Alaska, but Alaska counts are given in the caption of each figure*)

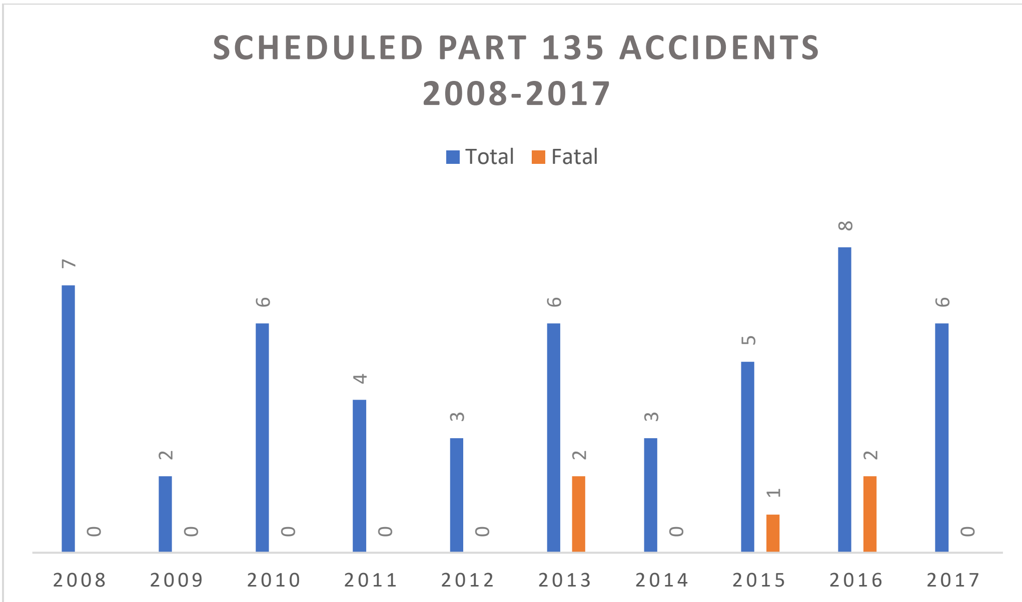

Figure 16. Scheduled Part 135 Accidents, 2008-2017 (Alaska: 36 Total Accidents, 13 Total Fatalities Involving 4 Accidents)

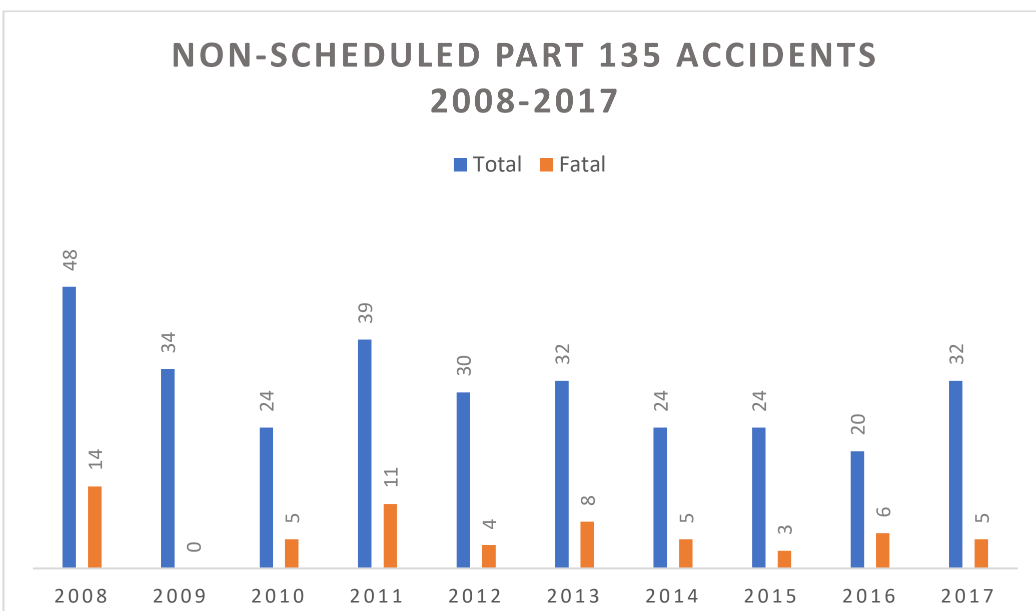

Figure 17. Non-Scheduled Part 135 Accidents (Fixed-Wing), 2008-2017 (Alaska: 162 Total Accidents, 60 Total Fatalities Involving 23 Accidents)

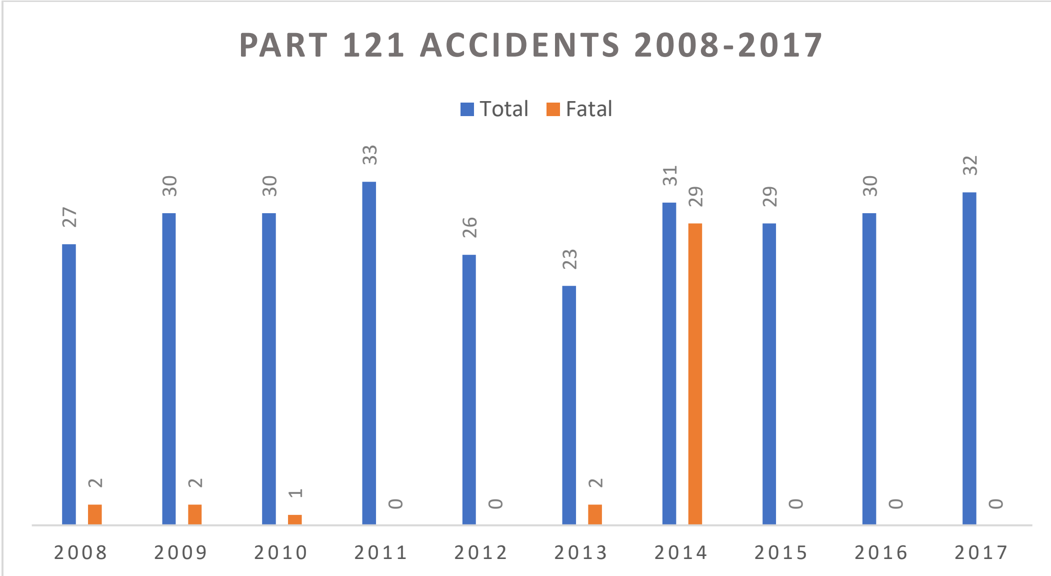

Figure 18. Part 121 Accidents (291 Total), 2008-2017

Accident Rates 2008-2017

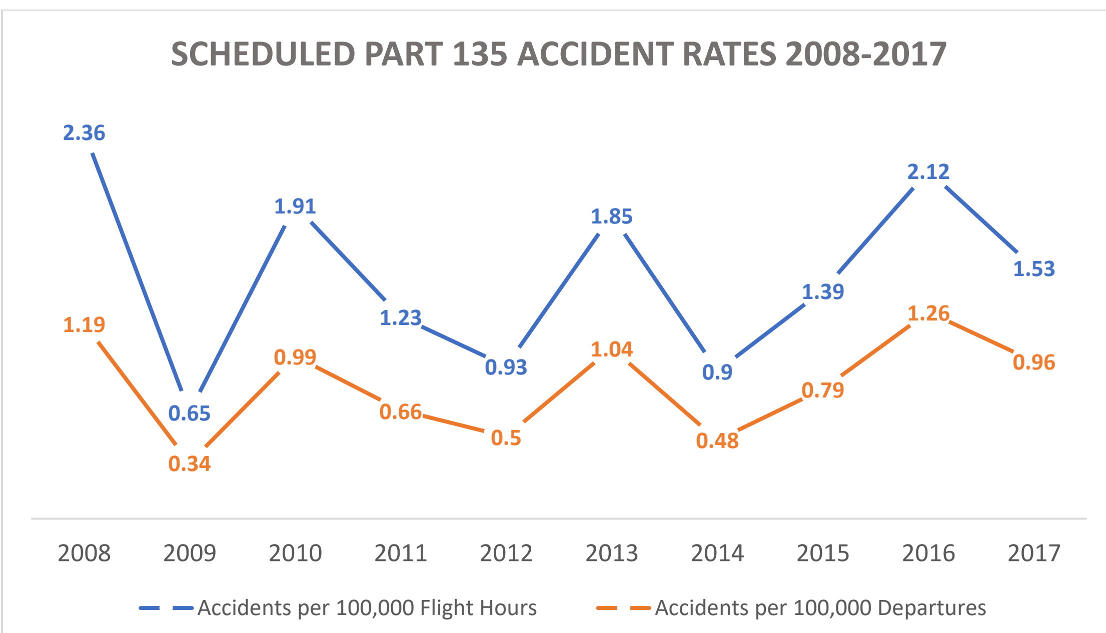

Figure 19. Scheduled Part 135 Accident Rates, 2008-2017

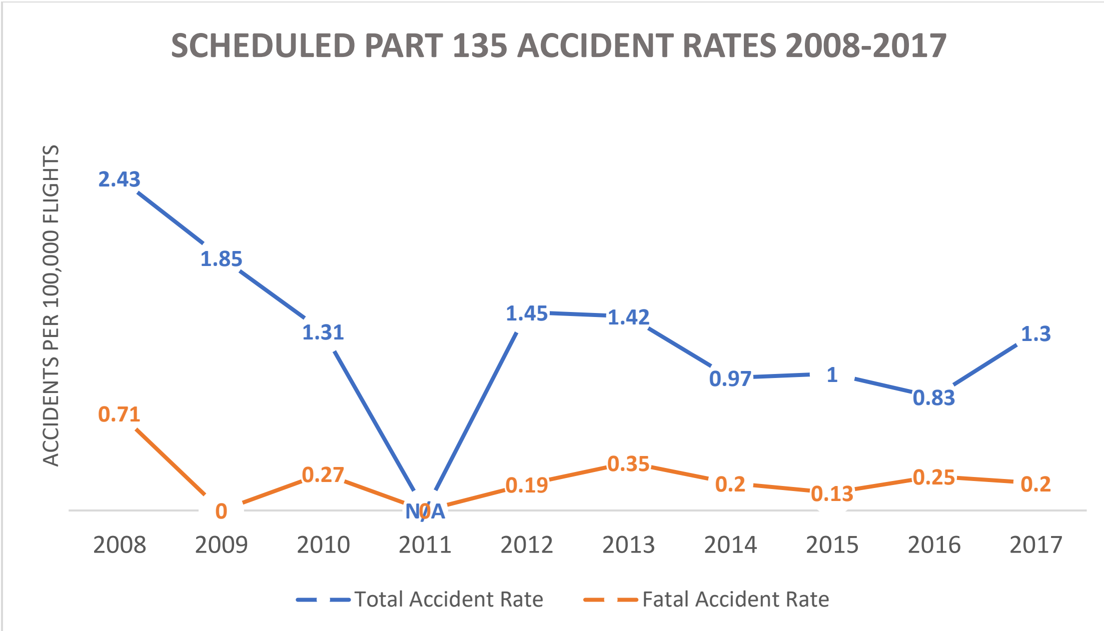

Figure 20. Non-Scheduled Part 135 Accident Rates (Fixed-Wing), 2008-2017

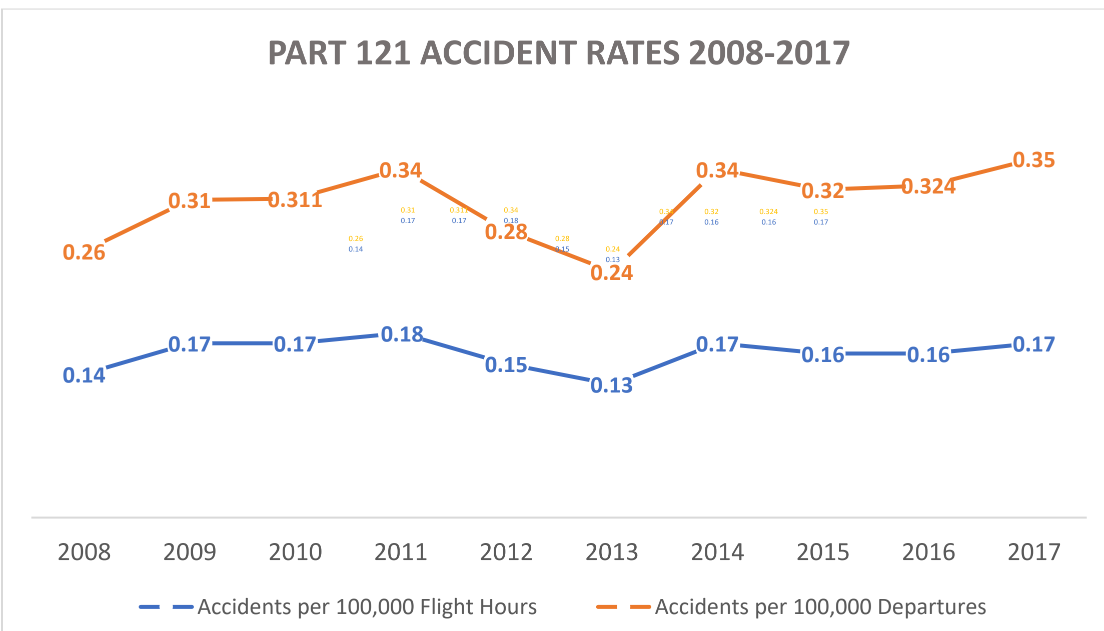

Figure 21. Part 121 Accident Rates, 2008-2017

In 2017 the accident rate per 100,000 flight hours, of scheduled and non-scheduled Part 135 operations, was 1.53 and 1.30 respectively, while Part 121 operations was just 0.35. Just one year later, in 2016, the 135 scheduled operators had an accident rate 6.6 times higher than 121 operators. The data also shows a significantly higher rate of Part 135 accidents on non-scheduled operations vs scheduled.

Accident's by Phase of Flight, 2017

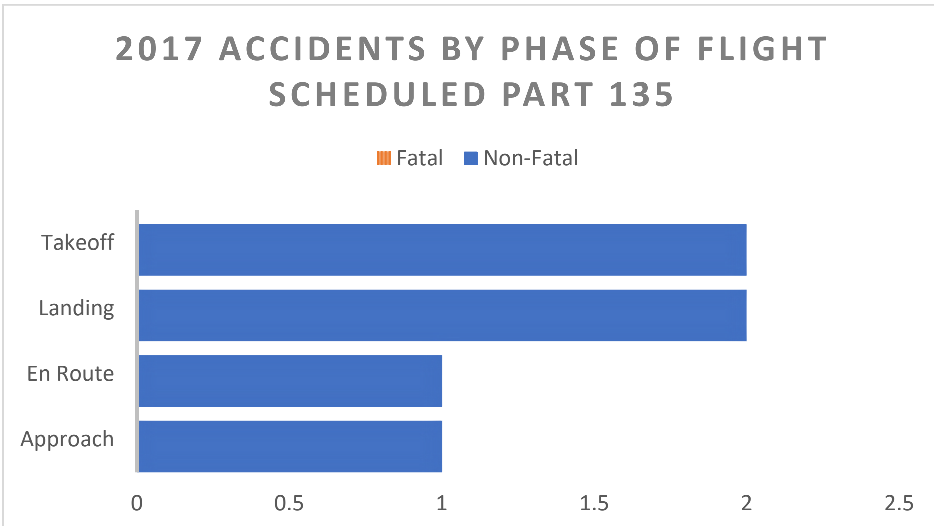

Figure 22. Phase of Flight for Scheduled Part 135 Accidents, 2017

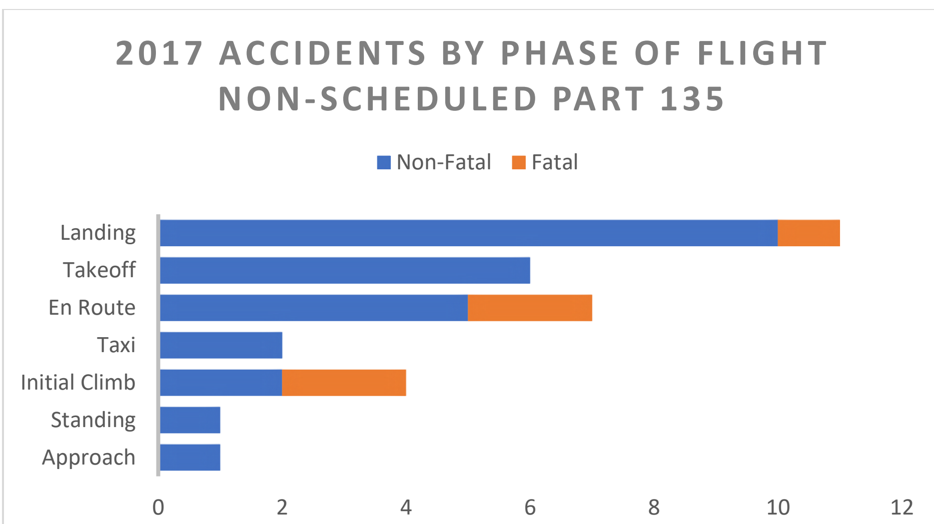

Figure 23. Phase of Flight for Non-Scheduled Part 135 Accidents (Fixed-Wing), 2017

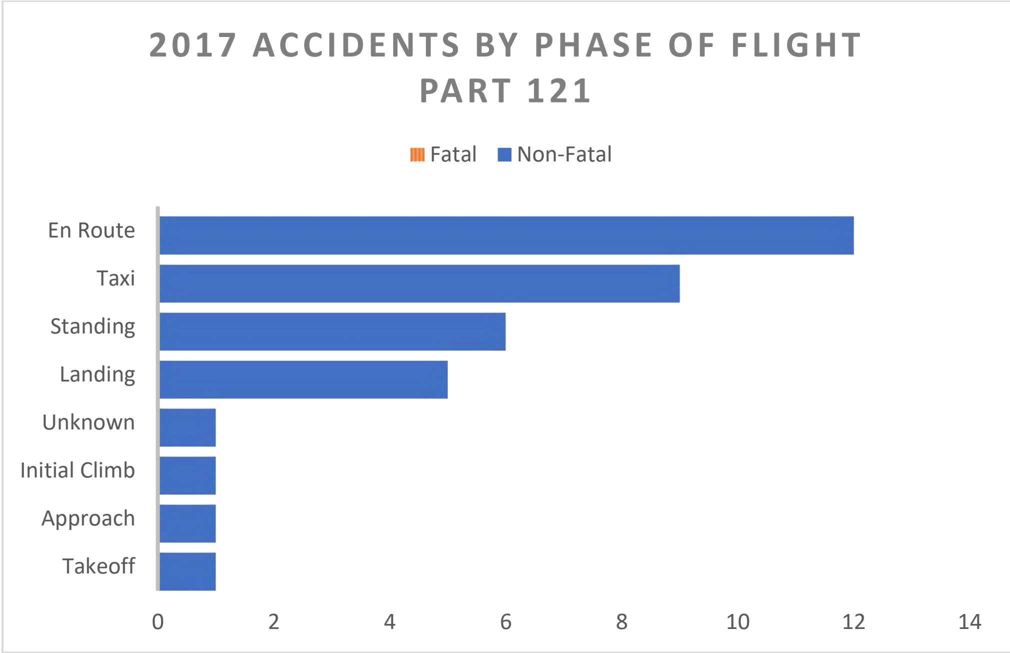

Figure 24. Phase of Flight for Part 121 Accidents, 2017

Defining Event Accident Data, 2017

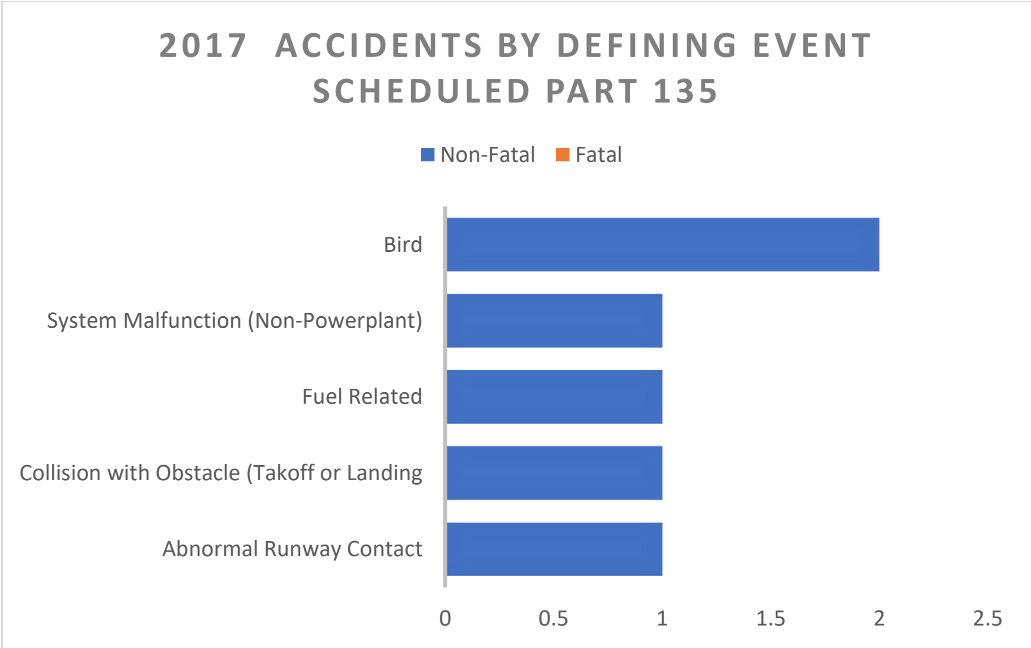

Figure 25. Defining Event for Scheduled Part 135 Accidents, 2017

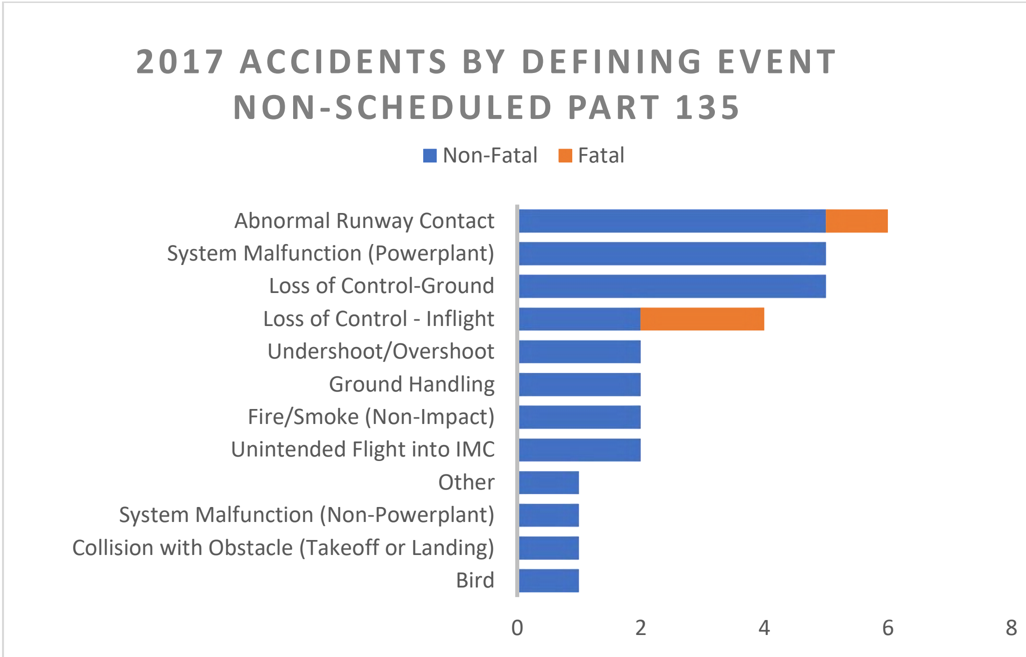

Figure 26. Defining Event for Non-Scheduled Part 135 Accidents (Fixed-Wing), 2017

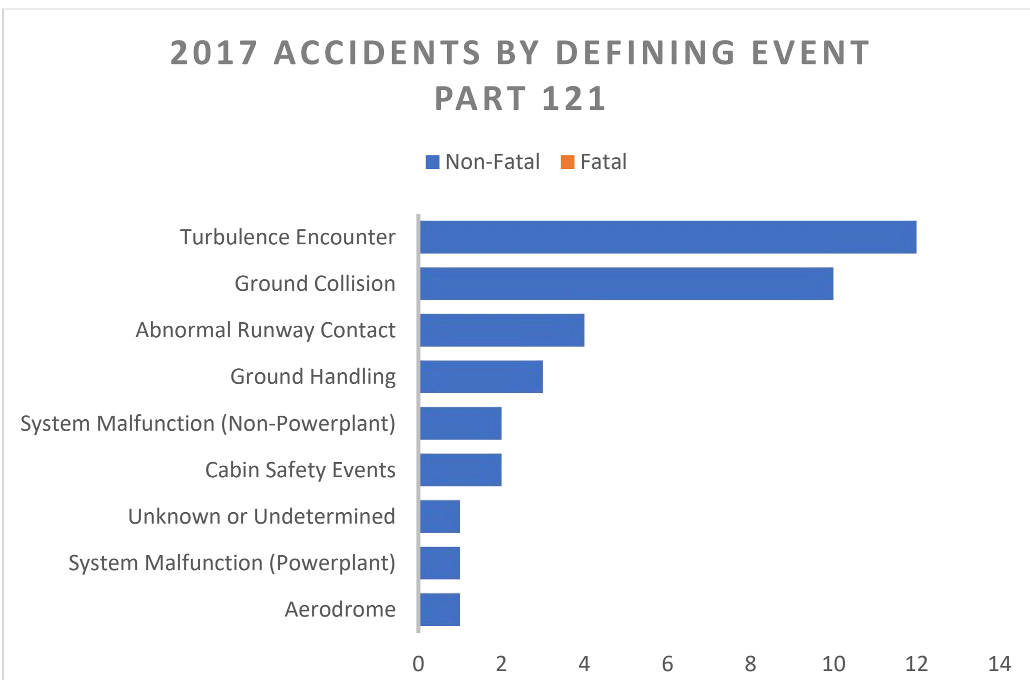

Figure 27. Defining Event for Part 121 Accidents, 2017

Alaskan Part 135 Accidents from 2008-2018

According to the 2017 NTSB US Civil Aviation Accident Statistics, accident rates are much higher in both Scheduled and Non-Scheduled Part 135 operations conducted in single engine aircraft, versus their counterpart, Part 121 operations. In fact, in 2008-2012 Part 135 operators experienced a total of 131 accidents, 17 of which resulted in 49 fatalities. Of these, only 29 (three of which lead to a total of 10 fatalities) took place in a multi-engine aircraft (2017 NTSB US, 2019).

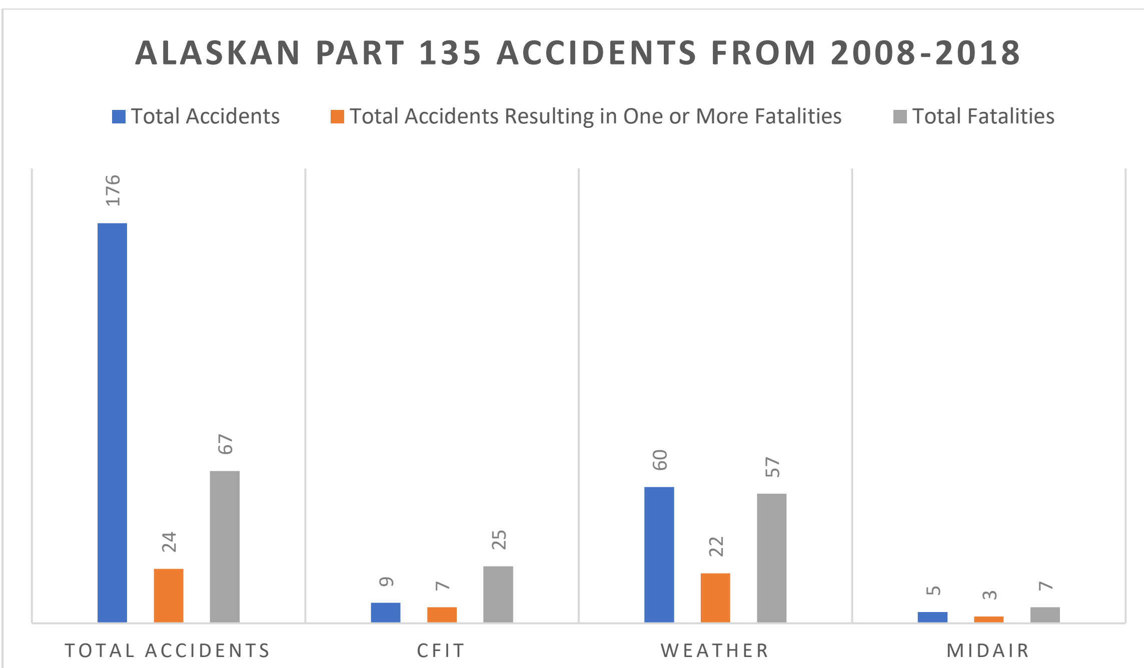

*Figure 28. Alaskan Part 135 Accident Totals and Separated out by Category. (*A search using the key terms "Controlled Flight into Terrain", "Visibility", and "Midair" were used to gather this information*)*

Hazards to Alaskan Operators

One study, which conducted performed a statewide survey of pilot safety practices and attitudes, concluded that aviation crashes are a leading cause of occupational deaths in Alaska. In fact, they found overall a fatality rate 100 times greater than the U.S. workforce overall (Conway, 2004). Alaskan pilots face hazardous terrain, extreme weather, lack of resources, and an inadequate infrastructure, all of which makes flying inherently riskier.

Hazardous Terrain and Weather

Alaska covers 586,412 square miles of land, is home to 14 mountain ranges, 40 volcanos, 34,000 square miles of shoreline, 3.5 million lakes, and thousands of miles of arctic tundra (Geography of Alaska, 2019). These extreme terrain changes also contribute to rapidly changing severe weather patterns. All these issues combined can make flying in Alaska exceptionally challenging. On top of that, 82% of Alaska cannot be accessed by road, making air transportation a necessity as it may be the only method of getting people, mail, food, and cargo to and from the villages they reside in (NTSB Most Wanted, 2019).

Pressure to Fly

Although pressure from management may not as big of an issue as it once was, Part 135 pilots are under a lot of pressure to take and complete flights, as sometimes they may be solely responsible for transporting people, mail and food in and out of remote villages (NTSB Most Wanted, 2019). Operators are under pressure as the transport of passengers and goods may be their only source of revenue. Another substantial issue is with the United States Postal Service. Operators have three days to move mail, regardless of weather or other unforeseen circumstances. If the three-day window is exceeded the postmaster is obligated to offer the mail to another operator. The income many operators receive from the postal service can make up a significant amount of their revenue, "so it does not take much to see how this could present undue pressure on an operator to fly when the weather is less than ideal (Coleman, 2019)."

Training

As this research has demonstrated, a large percent of accidents that occur in Alaska result from three major types of events, weather, controlled flight into terrain, and midair collisions. Alaskan pilots are particularly exposed to these hazards, nearly every time they get into an aircraft, given the challenging terrain and rapidly changing weather. Although many Part 135 operators are required to have training programs, it simply is not sufficient for the conditions they fly in. In a statewide survey of Alaskan Air Carriers: Pilot Safety Performance and Attitudes, a majority of pilots expressed strong support for improvement in training regarding decision making, CFIT, flat light, white-out, and inadvertent VMC to IMC conditions. Pilots also thought it would be beneficial that each operator offer training and require more supervised flight time particular to the region they are operating in. They also believed there is a necessity for each operator to implement a written policy regarding go/no go decisions (Conway, 2004).

Lack of Infrastructure

The vast and varying terrain in Alaska presents many challenges for instrument flying. To begin with; in the 2,427,971 square miles of airspace, there are only 8 FAA control towers, 3 Flight

Standards district offices, 2 terminal radar approach control facilities, and 17 Flight Service Stations, and the ADS-B infrastructure is severely lacking (Alaska Region Aviation, 2016). Of the 287 total public use (land-based) airports, 79 have instrument approach procedures, but only 21 have WASS capabilities (Airports in Alaska, 2009). Many instrument approach procedures are not being used, as minimums are very conservative, and in some cases hundreds of feet above the 500-foot VFR requirement. This has led to a significant amount of accidents involving CFIT from inadvertently flying from VMC into IMC.

Another issue is pertaining to the national weather service stations. There are just 16 of these stations to cover the entire state of Alaska (Alaska Region HQ, 2020). This means that forecasts must serve a much larger range, yet there are fewer resources and far less scientists to perform the modeling then anywhere in the nation (Mölders, 2008). Having little to no low-altitude ATC coverage, pilots end up flying at low altitudes with very few navigational aids, and the lack of local forecasts leaves them routinely encountering unexpected bad weather (Capstone Phase I, 2003). Although the FAA has attempted to address this issue by deploying 235 weather stations with 904 cameras to give pilots actual views of current weather conditions (FAA Aviation Weather, 2020), many are out of service, and the FAA doesn't have the funds to maintain them (NTSB Most Wanted, 2019).

The Alaska Capstone Project (1999-2006): Benefits Observed

The Alaska Capstone Project operated from 1999 to 2006. Over the six years following the project, in comparison to the six years prior to the actual implementation of ADS-B, Part 135 operators experienced a 38% reduction in accidents, a 48% reduction in accidents producing fatalities, and a 40% reduction in fatalities overall (Aviation Accident Database, n.d). The success of this project laid the framework for the current ADS-B system (Bergman, 2003). The data below was gathered through the NTSB aviation accident database (Aviation Accident Database, n.d).

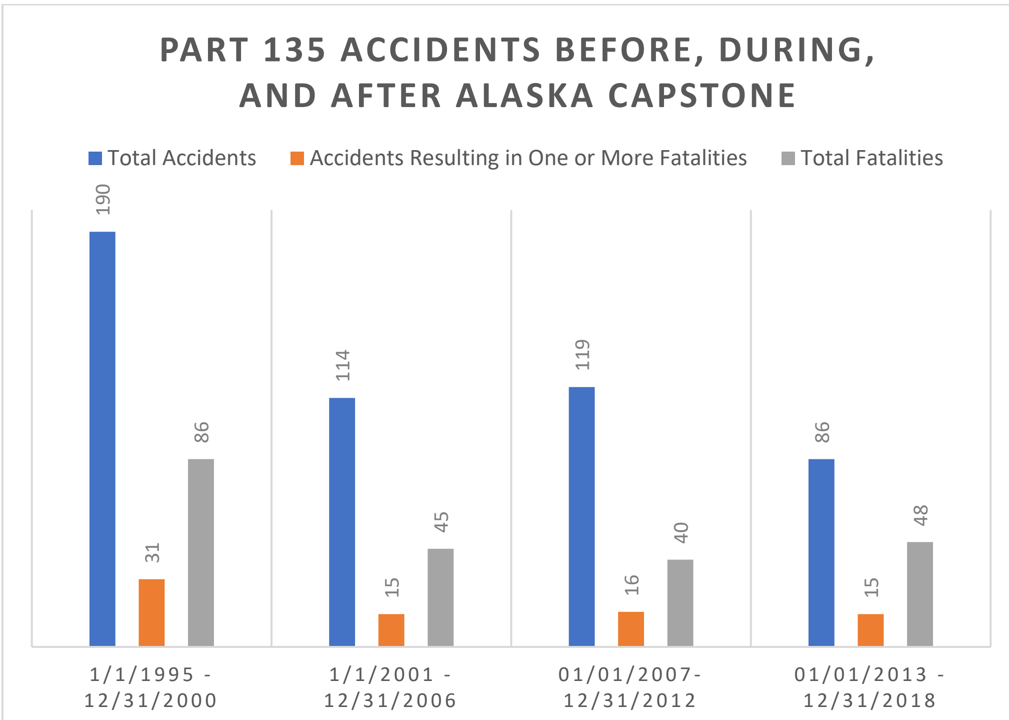

Figure 29. A Count of Total Accident's, Accident's Involving One or More Fatalities, Total Fatalities, for Part 135 Operations, the 6 Years Prior to, 6 Years During, 6 Years Immediately After, and the Subsequent 6 Years After Capstone

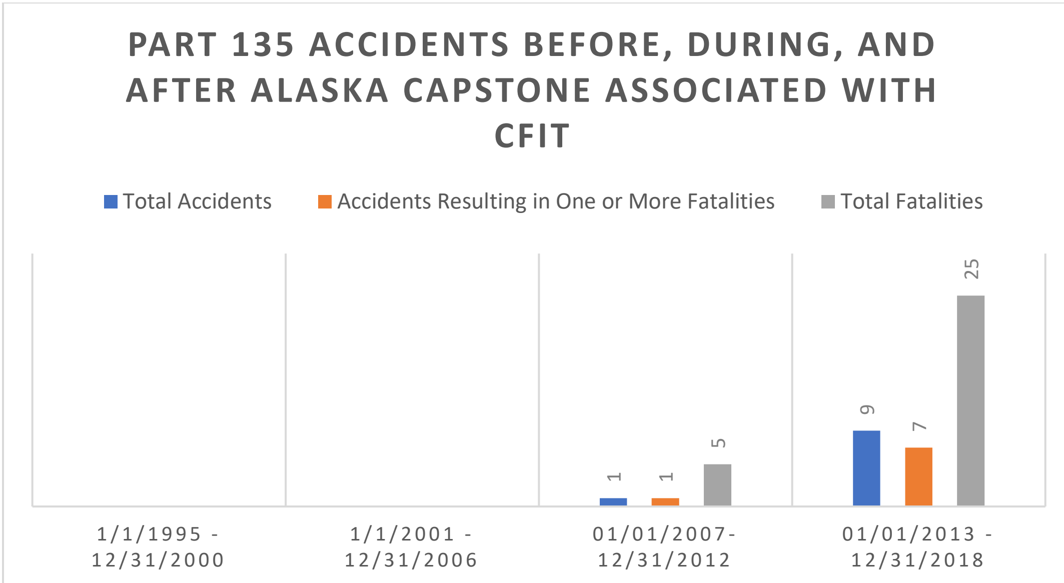

*Figure 30. A Count of Total Accident's, Accident's Involving One or More Fatalities, Total Fatalities, for Part 135 Operations Involving CFIT, the 6 Years Prior to, 6 Years During, 6 Years Immediately After, and the Subsequent 6 Years After Capstone (*A search using the key term "Controlled Flight Into Terrain" was used to gather this information. Data from 1995-2006 was unavailable*)*

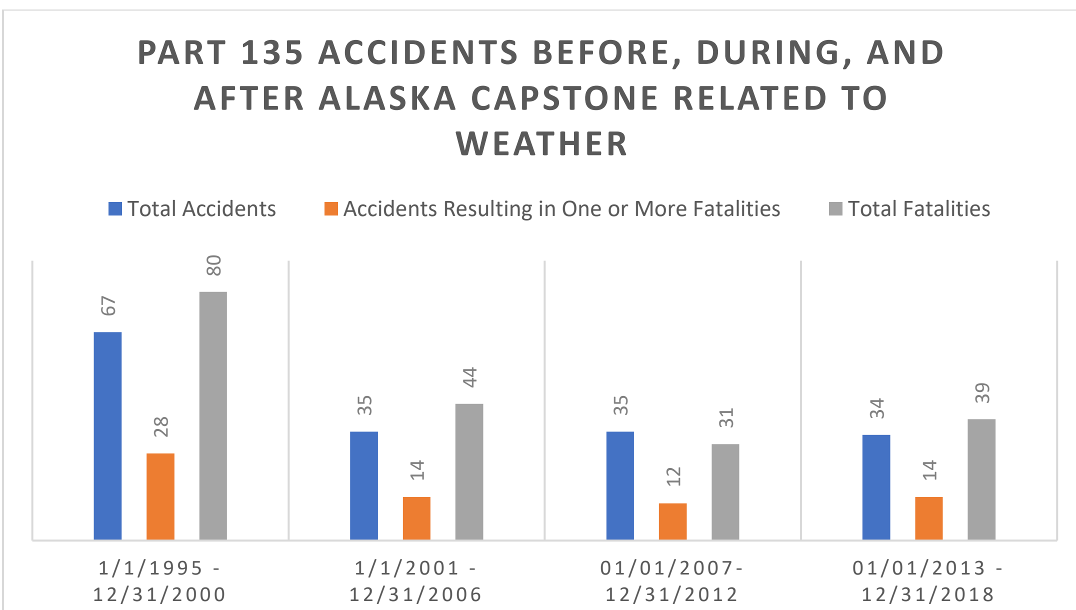

*Figure 31. A Count of Total Accident's, Accident's Involving One or More Fatalities, Total Fatalities, for Part 135 Operations, Involving Weather for the 6 Years Prior to, 6 Years During, 6 Years Immediately After, and the Subsequent 6 Years After Capstone Involving Weather (*A search using the key term "Visibility" was used to gather this information*)*

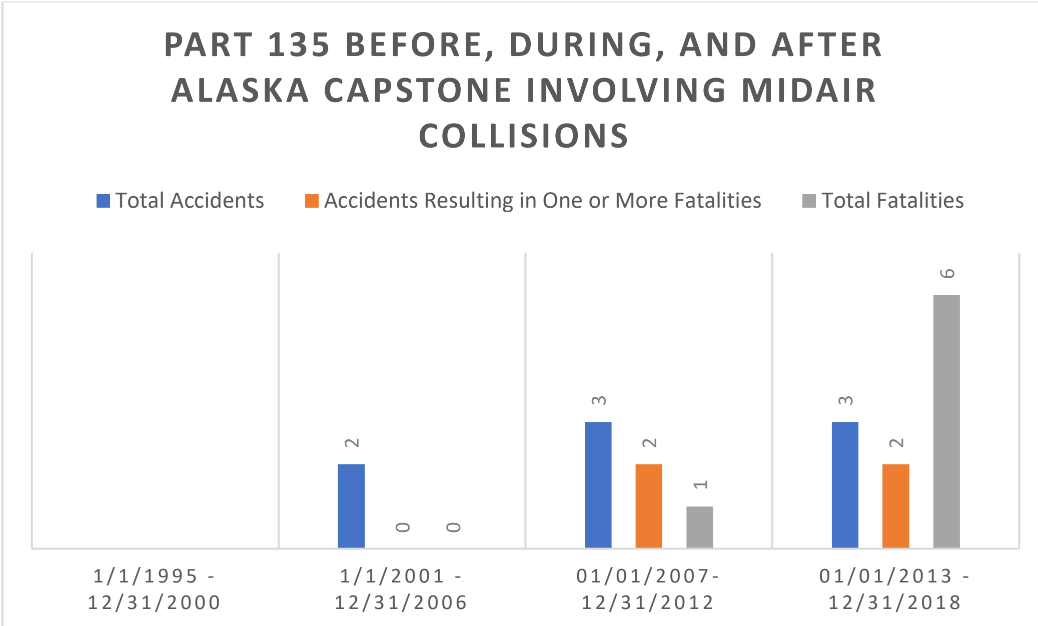

*Figure 32. A Count of Total Accident's, Accident's Involving One or More Fatalities, Total Fatalities, for Part 135 Operations, Involving Weather for the 6 Years Prior to, 6 Years During, 6 Years Immediately After, and the Subsequent 6 Years After Capstone Involving Midair Collisions (*A search using the key term "Midair" was used to gather this information. Data from 1995-2000 was unavailable*)*

Part 135 Operators and ADS-B

After the nation-wide rollout of the FAA NextGen initiative, the ADS-B system is fully operational in the lower 48 states. All aircraft must be equipped with ADS-B Out when flying in any controlled airspace or where transponders are required. Although the rule does not preclude Alaska, ADS-B is only required in Class A airspace above 18,000 feet MSL, and in and above the only Class C airspace, which is located over Anchorage and the surrounding terminal area (Collins, 2017). The current ADS-B coverage in Alaska is exceedingly insignificant. The Capstone project installed the infrastructure in two regions, the Southwest and the Southeast, but still in minimal areas. The ground stations are limited to line of sight and have not been upgraded since the project's culmination in 2006. According to the FAA Reauthorization Act of 2018, Section 321, "the FAA shall conduct an evaluation of providing additional ground-based transmitters for Automatic Dependent Surveillance-Broadcasts (ADS-B) to provide a minimum operational network in Alaska along major flight routes (H.R. 302, 2018)." This has yet to be accomplished.

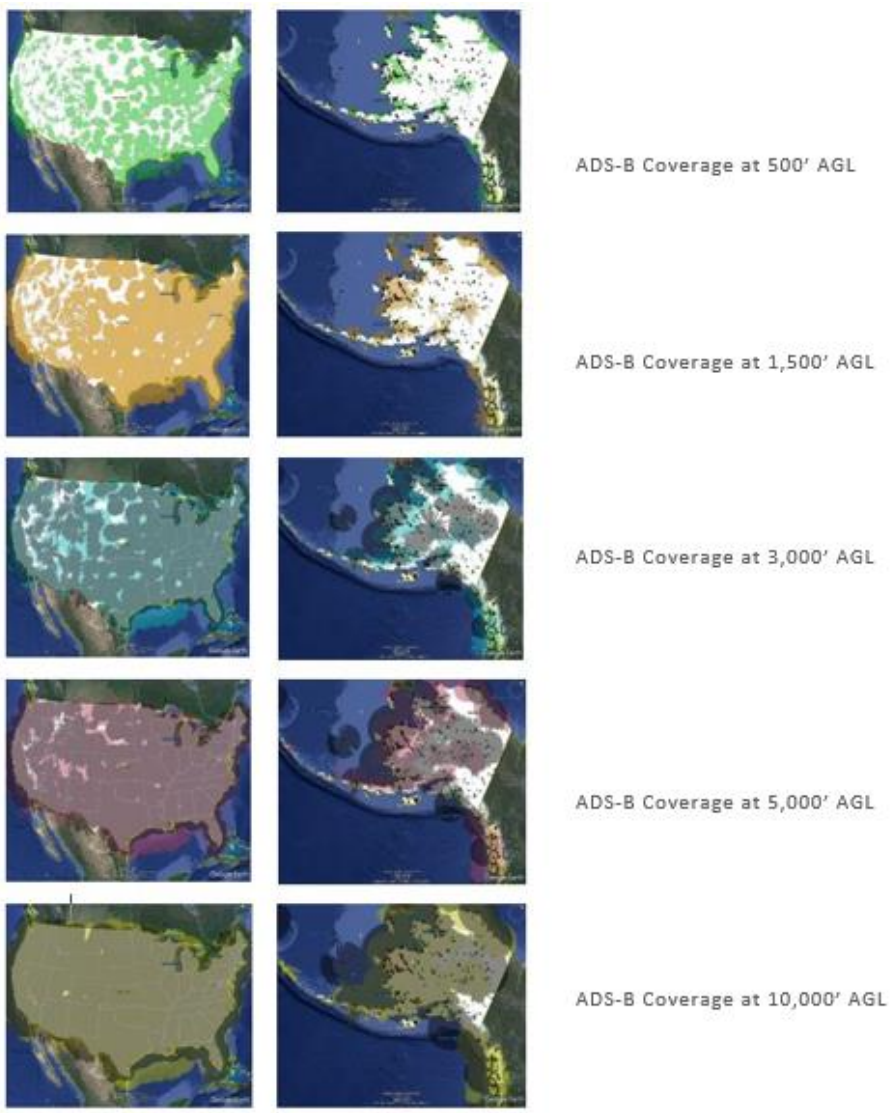

Figure 33. Coverage of Alaska vs. The Lower 48 States, as shown on Google Earth with the FAA ADS-B Filter.

As the ADS-B infrastructure is lacking in Alaska, many operators are not planning on installing ADS-B equipment as it is not required. However, if a requirement were in place, these operators could reap the many additional benefits ADS-B has to offer, even when used in uncontrolled airspace. If all operators are equippted and broadcasting, at the very least they will have traffic collision avoidance benefits. Another benefit, regardless of ground-based transceiver access, is CFIT awareness through the moving map integrated with the GPS. Giving pilots the continuous access to their route and height above the ground, is invaluable. All Part 135 operators should be required to integrate (with ADS-B equipment) the terrain awareness and warning system (TAWS), regardless of the aircraft size or engine type, especially since a majority of Alaskan operators fly smaller, single engine aircraft at low altitudes. An additional benefit of ADS-B, depending on the choice of equipment, is real-time weather through Flight Information Service-Broadcast (FIS-B), although this may be line-of-sight limited, pilots may have access at some point along their routes, giving them the opportunity to gather additional information they may not have had prior (Capstone Phase I, 2003).

Satellite-Based Tracking

The NTSB has offered an exceptionally detailed list of recommendations to the FAA, with the objective of improving Alaska Part 135 operations. However, there is a very important topic neither the NTSB nor FAA regulators have addressed in the current discussion. This is the lack of regulations pertaining to flight tracking and aircraft locating requirements for domestic intrastate Part 135 operators. According to CFR §135.79 Flight locating requirements; pilots are not required to file a flight plan, but operators are required to have "a method and procedures for locating each flight". This includes the use of an ELT, a transponder, as well as gathering the information the pilot would give if they were to file an actual flight plan. This includes departure city, destination, estimated time of arrival, and planned route. The regulation also states, if communication cannot be maintained, they must provide a location, date and estimated time for reestablishing communications (Part 135 Operating, 2020).

Many problems exist with the above regulation. First, these pilots are not required to file a flight plan, which should be an absolute requirement for every commercial operator. Second, the phrase "if communication cannot be maintained", Alaska makes up 20 percent of the land mass of the United States and has less than 0.3% of the U.S. population (Part 135 Operating, 2020). Most aircraft servicing its rural areas are small (9 seats or less) single engine aircraft, which fly at much lower altitudes than air carriers. Many of these aircraft predominately fly in terrain with no ATC coverage, some at low altitudes in mountainous terrain, resulting in an inability to be reached, even via VHF radio. This means, a majority of their flight path will lack the ability to communicate with anyone.

The extreme weather shifts, and varying terrain can rapidly change a pilot's flight path, which necessitates additional extended periods of time out of the said communication window. In the even an aircraft suffers an accident and goes down, in airspace with no ATC coverage, and with no other tracking device than an ELT, there would be no real method for pinpointing their location. This would subsequently result in the need for extensive search and rescue operations. Unfortunately, the chances of survival for an injured individual decrease by nearly 80% within the first 24 hours, and for the uninjured begin to rapidly decline after three days, making it absolutely necessary to find the aircraft as quickly as possible (GEN 3.6, n.d.).

It is necessary, for the purpose of this argument, to understand Alaskan operators are not required to use ADS-B outside of the Anchorage area, although ADS-B has considerable tracking capabilities. Regardless, in many part of Alaska there are not enough ground stations to maintain consistent coverage. The FAA has not installed any new ADS-B ground stations, nor have they updated any of the existing equipment used in the Alaska Capstone project. The varying terrain, including 14 mountain ranges, makes the use of ground-based ADS-B stations difficult as they function via line of sight, leaving a majority of the state not covered. By both not requiring the use of ADS-B, and not providing the necessary infrastructure for its use, many operators are not currently equipped with any tracking capabilities, which needs to be addressed.

Given the amount of Part 135 aircraft requiring search and rescue operations, nearly 50 since 1998, it is essential to require all Alaska based Part 135 operators to use satellite-based tracking systems. There are many companies, including Spidertracks and GlobalBeacon, which can provide these services at a reasonable cost to operators. Even the current space-based ADS-B technology would cover the entirety of Alaska if just 16 additional satellites were launched (Gerhardt, 2016). This technology would likely cost the state less than adding the amount of additional ADS-B ground stations, and their upkeep, necessary to guarantee coverage throughout the state. The most important objective of satellite tracking, in the event of an aircraft going down, is to provide search and rescue operators the location of the aircraft, saving valuable time, and thus lives.

In 2015, a pilot contacted Anchorage Approach to notify them he was about 60 miles from Valdez and was experiencing engine trouble, 15 minutes later an ELT signal was detected, triggering a search and rescue operation. Even with radar contact, the precise aircraft location was unknown. The Coast Guard began the rescue effort in what they believed to be the approximate location of the downed aircraft. Shortly after, the family was notified, they informed the Coast Guard that the aircraft was equipped with Spidertracks. They were able to provide them with the last known altitude, airspeed, and heading, enabling them to triangulate the actual location of the aircraft. Less than two and a half hours later they found the pilot's body, along with the left landing gear and a strut from his Cessna 180. The aircraft was located, seven miles from the initial search area. The pilot's son told a local news reporter, "had we not had the data to share with them, I do not believe he would have been found (Mondor, 2017)."

SMS Should not be Optional

In the rest of the world SMS is not optional, no matter the size of the commercial operation. Why is it not required here in the United States, and "why would we have a different level of safety for 135 operators, when they've got paying passengers? They should not be subjected to a significantly lower level of safety then what is required for 121 carriers (NTSB Most Wanted, 2019)." The challenging environment Alaskan Part 135 operators fly in should require no less than the best safety practices, which absolutely necessitates a strong safety management program.

The figure below depicts a reduction in accidents after the implementation of SMS for Part 121 carriers, demonstrating its effectiveness. (*Note, the final implementation did not take effect until 2015, but the FAA issued the final SMS rule in 2012*).

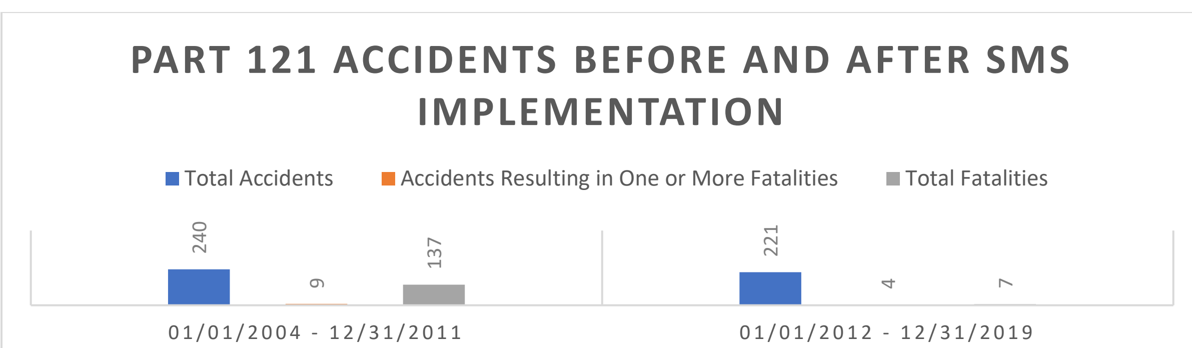

Figure 34. A Count of Total Accident's, Accident's Involving one or More Fatalities, and Total Fatalities, for Part 121 Carriers, the 8 Years Prior and 8 Years After SMS Implementation

One of the most vital components of SMS is data collection and monitoring. Currently Part 135 operators are not required to perform any flight data monitoring (FDM), most aircraft are not even equipped to do so. Expensive equipment is not necessary to achieve this, matter of fact, many of the satellite-based tracking systems, previously spoken of, offer this service as well. For basic parameters (4D), this technology may only require a small mounted box, and if operators find the need for additional parameters, there are plenty of options for more extensive equipment. Again, depending on the scale of operations, and which equipment is chosen, many operators are able to do this for a reasonable cost.

As it currently stands there are 303 Part 135 Certificate holders in Alaska, 8 have a FAA "Voluntary SMS Program" (NTSB Most Wanted, 2019). Operators need to understand "the nature and dimensions of these programs may vary according to the size and structure of the organization; that is larger organizations may require more or different dimensions than small ones (Von Thaden, 2003)." All things required in safety management are scalable, period, it is evident through this research operators do not understand this. There should be no excuse, for all operators, not to use and maintain safety management practices.

Chapter V – Conclusion

Conclusions

The particularly challenging environment Alaskan Part 135 pilots are required to fly in presents many challenges. The margin for error is extremely tight, and regulators are offering little in the way of support. It is important for regulators to understand their inaction is continually adding to the problems these pilots face, including loss of life. Air transportation is an absolute necessity for the over 169 communities these 303 Part 135 operators serve. Action must be taken to address this lack of regulatory oversight, lack of required aircraft tracking and extremely poor infrastructure threatening Alaska's pilots.

Requiring regulations comparable to that of Part 121 operations, on a scale appropriate the size of the operation will help decrease the accident rate of Alaskan Part 135 operations. Although they are carrying paying passengers, Part 135 operators are not being held to the same regulatory standards as Part 121 carriers. It is evident through this research, that the implementation of SMS and flight data monitoring must be required for Part 135 operators. Regulators need to start by making it clear, to operators of all sizes, that these systems are meant to be scaled to meet the needs of the individual operation. SMS is simply a method to determine and record how the operator is planning on keeping the pilots, customers and cargo safe. Requiring flight data monitoring will contribute by helping operators discover where they need improvement, identify trends that may lead to poor safety outcomes, and hold pilots accountable for their decision making. Training, flight hour requirements and pilot certification requirements need to be revisited as well. For Alaskan Part 135 operators it is vital they provide extensive CFIT, whiteout, flight light, VMC into IMC, and regional hazard training. These changes may help aid in reducing accident rates in not only Alaskan Part 135 operations, but all Part 135 operations.

Alaskan Operators would also benefit from an FAA directive requiring use of the NextGen mandate involving ADS-B, and other tracking technology, especially in uncontrolled airspace. It is essential that the FAA update the existing ADS-B infrastructure in Alaska, as well as add additional ground stations, or fund the implementation of space-based ADS-B technology. In addition, regardless of airspace and the poor infrastructure, ADS-B should be required for all Alaskan operators, at all times, as it offers many additional benefits including traffic avoidance, terrain awareness, weather monitoring, and aircraft tracking. As reliable communication and ADS-B infrastructure is currently lacking in Alaska, it is also vital to require satellite-based aircraft tracking for Part 135 operations, as this requirement will help facilitate timelier search and rescue operations in the event of an aircraft goes down, saving lives, time and money.

Alaska is currently lacking the most basic aviation infrastructure, including adequate instrument approach procedures, weather monitoring stations, communication capabilities, and now ADS-B coverage, which must be addressed. It is also necessary to reassess existing IAPs with modern technology as a consideration. This will increase the likelihood of pilots using the approaches versus attempting to maintain VFR in marginal conditions. Addressing these deficiencies would unquestionably help reduced the accident rate of Part 135 operators.

Recommendations

1. Require all aircraft used for Part 135 operations, regardless of airspace to use ADS-B out.

2. Update the existing ADS-B infrastructure in Alaska, as well as add additional ground stations, or fund the implementation of space-based ADS-B technology.

3. Invest additional funds to improve the instrument navigational infrastructure in Alaska, including determining if current approach minimums can be updated to coincide with current GPS and WASS technology.

4. Require all Alaska based Part 135 operators to obtain satellite-based tracking systems.

5. Require all Part 135 operations to implement a safety management system in line with the size and scope of their operation.

6. Require all Part 135 operators to perform flight data monitoring.

7. Require all Part 135 operators in Alaska to provide extensive CFIT, whiteout, flight light, VMC into IMC, and regional hazard training.

Call for further research

A statistical analysis should be performed to determine how many aircraft have gone missing in the state of Alaska, including time it took to find them, what locating equipment was on board, expenses incurred by the state on search and rescue operations, and recommendations on how to improve. It is my hope this will solidify the need for required satellite-based tracking on all aircraft. Additionally, there will be the need for research to determine how the NextGen initiative will affect accident rates within the lower 48 states, followed by research specific to the lack of NextGen infrastructure in Alaska. Lastly, in the FAA Reauthorization Act of 2018, some of the issues in this research are earmarked for the FAA to address. It is highly recommended continuing research be conducted to determine if these actions are being address or if they are again being deferred.

House Resolution 302 – FAA Reauthorization Act of 2018

> *Section 311*
>
> *The FAA shall: (1) determine, in collaboration with the National Transportation Safety Board and part 135 (title 14, part 135 of the Code of Federal Regulations) industry stakeholders, what additional data should be reported as part of an accident or incident notice to more accurately measure the safety of on demand part 135 aircraft activity, pinpoint safety problems, and form the basis for critical research and analysis (2) provide a briefing to the appropriate congressional committees on such findings (H.R. 320, 2018).*

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