Capstone Phase I
Interim Safety Study,
2002

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1 Introduction

Alaska relies on aviation more than any other state does. It is 615,230[1] square miles—16 percent of the total U.S. land area—but it has only 13,628 miles of public roads.[2] Less than 10 percent of the state is accessible by road. Rivers are frozen most of the year. But because Alaska is huge, has fewer than 650,000 people, and is divided by mountain ranges, many areas of Alaska lack the aviation infrastructure and services common in other states.

The FAA Alaskan Region's Capstone program is a joint initiative with industry to improve aviation safety and efficiency in Alaska, by using new tools and technology to provide infrastructure and services. Capstone's first phase began in 1999 in southwest Alaska, primarily in the Yukon-Kuskokwim Delta (Y-K Delta). The program involves:

- Equipping commuter airlines, air taxis and selected part 91 operators[3] with avionics that shows pilots their location and information about nearby terrain, other aircraft, and weather
- Building ground stations that broadcast weather and flight information and that can provide radar-like surveillance of planes equipped with the new avionics
- Installing weather observation stations and creating and publishing instrument approaches, in order to provide more weather information and enable pilots to land at isolated airports in poor weather

This technology is most likely to help prevent mid-air collisions and controlled-flight-into-terrain (CFIT) accidents, which make up only a small part of the small-plane accidents in southwest Alaska but are the most likely to cause deaths. Aside from helping prevent accidents, the technology is designed to make it easier for pilots to fly—by making it easier to navigate, by providing more current weather information, and by making instrument landings possible when weather deteriorates.

To learn the benefits and limitations of these new tools and technologies, the Capstone program contracted with two units of the University of Alaska Anchorage—the Institute of Social and Economic Research and the Aviation Technology Division—to evaluate aviation safety changes in the Capstone area. This interim safety report describes those changes during 2002; earlier reports established a baseline and evaluated changes in 2000 and 2001.

1.1 The Capstone Area and the Yukon- Kuskokwim Delta Region

The Capstone Phase I area is a geographic region from 58° to 64° north latitude and 155° to 167° west longitude (Figure 1-1, next page). Nearly all the Capstone Phase I ground

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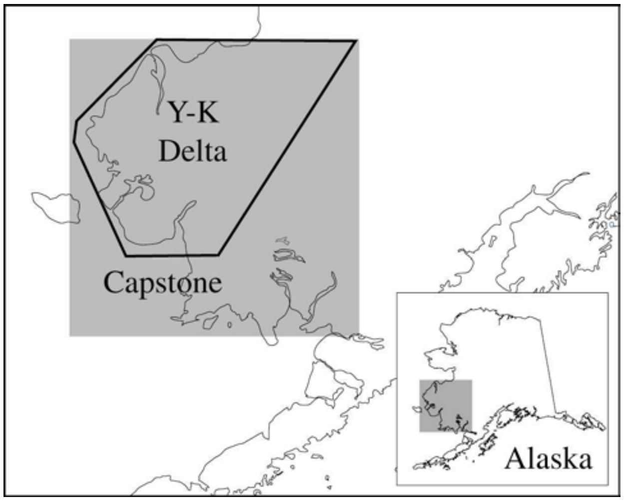
[1] Statistical Abstract of the United States, 2001, Table 343.

[2] Alaska DOT&PF, http://www.dot.state.ak.us/stwdplng/highwaydata/pub/cprm/2001cprm.pdf , Certified Public Road Mileage as of December 21, 2001. Excludes Marine Highway miles.

[3] In 2000 and 2001, these were typically government agencies such as the state troopers or U.S. Fish and Wildlife Service that operate fleets of aircraft under part 91.

systems and avionics are in the Yukon-Kuskokwim Delta within the Capstone area. Bethel is the aviation center of the delta. It is also the largest community in the Y-K Delta and the economic, governmental, and cultural center of the region. Aniak to the northeast and St. Marys to the northwest are also economic and mail distribution hubs for the delta.

Figure 1-1. The Capstone Area and the Yukon-Kuskokwim Delta



Aviation activities are concentrated in Bethel, Aniak, and St. Marys, as shown in Figure 1-2, next page. The hubs receive daily scheduled service from passenger and cargo carriers. The mainline passenger and cargo flights to Bethel originate in Anchorage, the largest hub airport in Alaska. These flights are on Boeing 737 and Beech 1900 passenger aircraft and DC-6, Boeing 727, and EMB 120 Brasilia cargo craft.

Since air is the only transportation system that can operate in the region year-round, essentially all passengers and 95 percent of cargo arrive via scheduled air service. Bethel, Aniak, and St. Marys are mail hubs for 52 smaller communities in the delta. Single-engine and light twin-engine aircraft such as Cessna 207, Cessna 208 Caravan, Cessna 172, and Twin Otter carry passengers and cargo to those smaller communities.

An example of a typical flight would be a Boeing 737 combi (passengers and freight combined) operated by Alaska Airlines from Anchorage to Bethel, with 16,000 to 20,000 pounds of freight and mail and about 50 passengers.[4] In Bethel, passengers, freight and mail headed for other communities would be transferred to the local carriers. A typical flight out of Bethel might be a Cessna 207 with 4 passengers and 300 pounds of mail going to Hooper Bay, Scammon Bay, and Chevak and then returning to Bethel.

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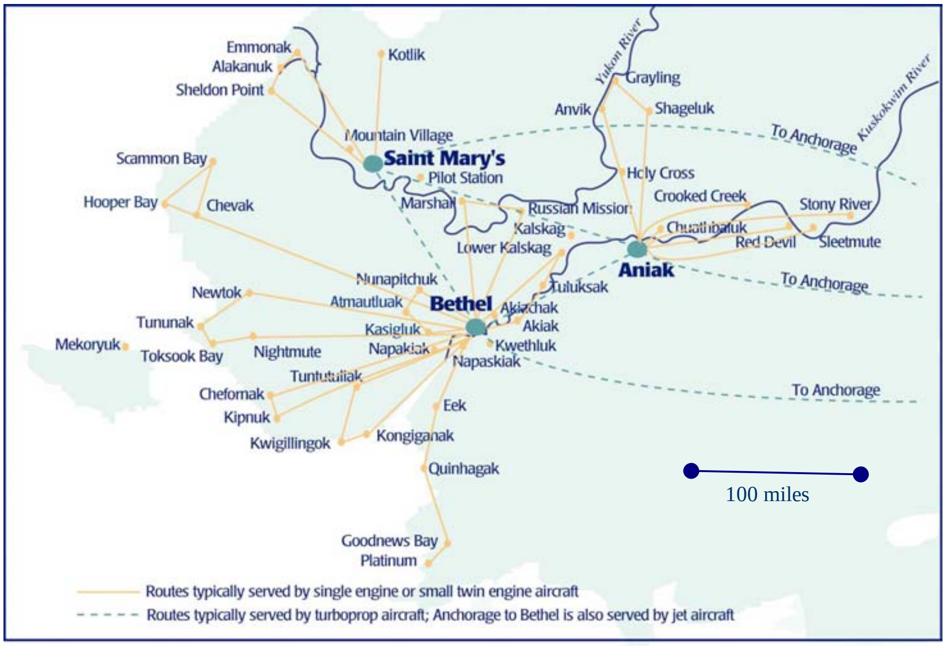
[4] Personal communication, J.D. Hill, Anchorage Operations Office, Alaska Airlines, November 2002.

Figure 1-2. Air Routes in the Yukon-Kuskokwim Delta



The economic, social, political, cultural, and regulatory factors affecting aviation safety in the Y-K Delta—and the Capstone-equipped aircraft flying there—are the focus of this report. The Capstone area does include communities outside the Y-K Delta—Iliamna, Unalakleet, Dillingham, King Salmon and McGrath— but the focus of Capstone activity is aircraft and flight activity based in Bethel, Aniak, and St. Marys.

Pilots in the Y-K Delta routinely face weather hazards: rapidly changing weather, flat light and white-out conditions, fog, and ice fog.[5] These hazards are made worse by incomplete or unavailable weather information. Only Bethel has a manned weather observation station; the rest of the information routinely available to pilots is from automated stations. While this information is useful, the distance between observation stations—and the relative lack of local forecasts that combine information from multiple stations over time—mean that pilots routinely encounter unexpected bad weather.

And besides those hazards, pilots with no low-altitude ATC radar coverage must fly with relatively few navigation aids, to airports with unpaved runways (90 percent are gravel or dirt). These runways are often short (one third are less than 2,000 feet; two-thirds are less than 3,000 feet), and half have no lighting. Most flights between Bethel and the surrounding villages are single-pilot flights, leaving the pilot to meet these varied challenges without help.

Accident rates in the Y-K Delta area are similar to Alaska's statewide rates, which are higher than national averages. Alaska's aircraft crash rate (crashes per 100,000 flight hours) for air taxi and general aviation flights during 1992-94 was 2.5 times higher than the U.S. average (*FAA Statistical Handbook of Aviation*, 1997). From 1990 through

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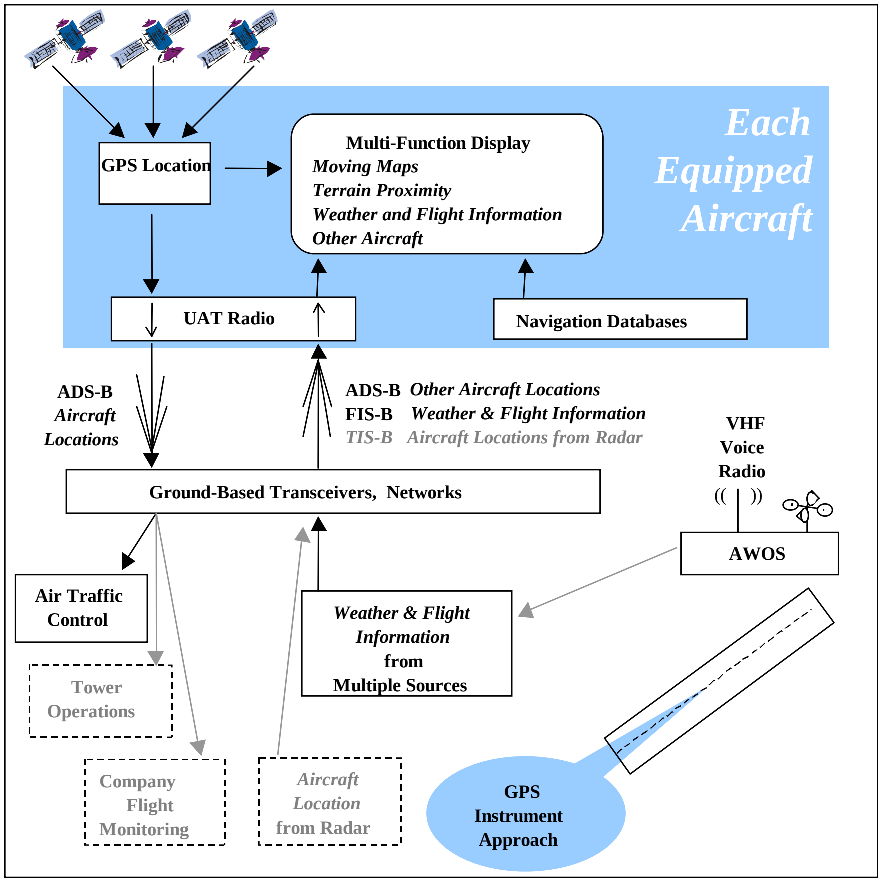
[5] These are described more completely in Chapter 7 of the Capstone Baseline Report, http://www.alaska.faa.gov/capstone/docs/baseline.pdf.

1999, commercial operators in the Capstone area had 204 accidents. About one tenth of those accidents (20) were fatal accidents, accounting for 31 deaths.

1.2 Capstone Program

As we described earlier, Capstone Phase I is equipping aircraft in the Y-K Delta with a new type of avionics that shows pilots their location, nearby terrain, other aircraft, and weather and flight information. Another part of the program is installing ground stations that broadcast weather and flight information and receive GPS-location messages (sent by aircraft), allowing radar-like surveillance and providing company managers with the ability to follow flights. Capstone is also installing weather observation stations at isolated village airports and creating non-precision instrument approaches that enable instrument flight rules (IFR) operations when weather conditions are inadequate for visual flight rules (VFR) operations. Figure 1-3 illustrates these systems.

Figure 1-3. Capstone Systems



The Capstone avionics and ground systems are designed to help prevent many of the accidents that occur in rural Alaska by using new technologies to help compensate for remote location and limited infrastructure. The Capstone avionics has a GPS location sensor, on-board databases with digital maps that include information on navigation and terrain elevation, and a display on which pilots are able to see their location centered on a moving map and thus be alerted to dangerously close terrain. A universal access transceiver (UAT) broadcasts the aircraft's location to the ground and to other Capstone-equipped aircraft. The UAT receives location information from other Capstone aircraft and displays that information, to warn pilots before there is a possibility of collision. The UAT can also receive messages from ground systems about locations of non-Capstone aircraft that are visible to radar, as well as weather maps and other flight information that are displayed to pilots to warn them about hazardous conditions and to aid in-flight planning.

Capstone ground systems are designed to work with the avionics to help pilots manage and control aircraft more effectively. Ground systems relay the locations of Capstone aircraft for air traffic controllers to use where radar coverage is not available; for tower operators to use for more rapidly locating planes; and for the companies that operate the aircraft to use in following the progress of their flights.

Capstone is installing automatic weather observation systems (AWOS)[6] at remote airports to tell pilots the conditions at possible destinations. These AWOS also help meet the safety and regulatory requirements for instrument operations, which can safely continue in poorer weather. Capstone makes this possible by allowing for publication of FAA-approved, non-precision GPS approaches at these locations.

The Capstone program was funded in October 1998, and the first avionics were installed in November 1999. Phase I had equipped most of the Y-K Delta commuter and air taxi fleet by the end of 2002, and will continue ground infrastructure improvements and data collection through 2004.

How does Capstone Improve Safety?

Capstone was designed to affect safety both directly–by preventing a few specific types of accidents–and more generally, by providing capabilities that could be helpful to pilots and operators in a broad range of circumstances.

- Capstone was designed to prevent accidents by ***showing pilots their location*** on a moving map display, and by ***displaying the locations of other Capstone-equipped aircraft*** on the same display. We discuss these direct accident prevention capabilities in more detail below.
- Capstone provides ***improved weather and flight information*** through new AWOS installations at remote airports and by broadcasting text and graphical weather information to the cockpit. The pilot can display the broadcast information on the multi-function display. Many accidents have a contributing weather cause; if pilots know about poor weather conditions they can adjust their plans accordingly.

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[6] Automated Weather Observing System (AWOS) stations measure, collect, and disseminate current weather information. They do not forecast weather. They provide airport identifier, Zulu time, and current information on sky conditions, visibility, wind speed, wind direction, temperature, dew point, altimeter setting, density altitude, and wind gusts to pilots, usually by VHF radio. Hourly AWOS data are available by telephone.

Both pilots and operators in our surveys have cited more complete and up-to-date weather information as an important factor for improving safety.

- Capstone supports ***increased IFR operation***. The program has installed new AWOS equipment at remote airfields and published GPS instrument approaches for those airfields. For qualified aircraft and pilots, this allows safe IFR operations in low-visibility conditions that are unsafe for VFR operations. Capstone also improves and expands IFR operations by allowing air traffic controllers to use automatic dependent surveillance-broadcast (ADS-B) to support radar-like services. ADS-B takes an aircraft's location from GPS[7] and transmits it to ground-based transceivers, which forward it to ATC computers—where the aircraft locations are displayed much like aircraft locations from radar. This capability allows controllers to provide flight-following and surveillance-based separation services in airspace that is not visible to radar.
- Capstone will allow tower operators at Bethel airport to use a BRITE display of ADS-B targets to help them locate aircraft, better coordinate arrival and departure sequencing, and monitor surface operations. However, this capability was only available intermittently between late June and early November, 2002.
- Capstone allows managers in companies that operate Capstone-equipped aircraft to monitor flight locations on PCs connected to the Internet. This capability may significantly improve managers' awareness of risks and help improve safety posture. Three companies had signed up to use this capability by December 2002.

What Kind of Accidents is Capstone Intended to Directly Prevent?

Capstone is designed to help prevent several specific types of accidents:

- Among ***navigation*** accidents, Capstone addresses ***enroute CFIT*** and ***GPS-Map*** accidents (see Table 1-1, page 9 for descriptions of accident types). It should prevent ***enroute CFIT accidents*** through a cockpit display showing the pilot the aircraft's proximity to high ground. The system compares information about nearby terrain (stored in an on-board database) to the aircraft's altitude (from a barometric altimeter) and Global Positioning System (GPS) location and then color-codes the information on a multi-function display (MFD). Terrain 500 feet or less below the plane is displayed in yellow; terrain level with the aircraft or higher is displayed in red. ***GPS-Map*** accidents may occur when a pilot attempts to land (typically in poor visibility) but misses the runway because of a navigational (rather than an altitude) error. Capstone could potentially prevent these accidents if the pilot used Capstone's published GPS approaches or used the avionics to approach the runway correctly.
- Capstone can prevent accidents associated with aircraft ***traffic*** (see Table 1-1) through ATC radar-like services (discussed below) and by showing pilots the locations of other Capstone-equipped aircraft. Each equipped aircraft broadcasts

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[7] Capstone Phase I avionics determines the aircraft altitude from the aircraft's barometric encoder and not from satellite positioning. Latitude and longitude information is derived from the GPS.

its location to other Capstone equipped aircraft within line-of-sight.[8] This helps keep pilots aware of other aircraft in their vicinity and helps them coordinate with nearby pilots. In the future, the Capstone program might provide locations of aircraft that are not Capstone-equipped but that are visible to ATC radar through traffic information service broadcast (TIS-B) from the network of ground-based transceivers (GBTs).

- In the future, Capstone will be able to prevent some ***flight information*** accidents that happen because of inadequate weather information. Once advanced icing weather information is available, Capstone can provide it to pilots in the cockpit. This will allow them to avoid flying into icing areas. However, this capability is not available in Phase 1.

1.3 Safety Evaluations

This report assesses changes in aviation safety in the Capstone area from January through December 2002 and provides a second preliminary estimate of the safety benefits of Capstone. Equally important—since Capstone is an ongoing program and adjustments can be made—this report estimates whether individual elements of Capstone have or have not improved safety so far.

This report builds on two previous reports, *Air Safety in Southwest Alaska – Capstone Baseline Safety Report* (baseline report) and the *Capstone Phase I Interim Safety Study, 2000/2001* (interim study).[9] The baseline report described aviation in the Capstone area from 1990-1999. It characterized commercial operations (employees and training levels, aircraft and avionics) and facilities and services. That report estimated a rough "best-case scenario" for Capstone's potential safety benefits by dividing historical accidents into broad groupings that Capstone might prevent. It also reported pilots' initial assessments of how they expected the Capstone technology to affect operations and safety. The interim report revised and extended the "best case scenario" from the baseline study, assessed potential safety gains from Capstone though December, 2001, and reviewed pilots' and companies' changing attitudes towards the program.

Baseline Accidents

Understanding how the Capstone program is affecting safety begins with understanding the situation before the program began, and how the Capstone program was designed to address the region's safety problems. The baseline period is from January 1990 to December 1999.[10] In our baseline report, we assessed how Capstone avionics and

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[8] The Capstone avionics also transmits the location to GBTs, which provide that information to air traffic controllers, to aircraft within line-of-sight of the GBTs, and through an internet service to companies wishing to flight-follow their aircraft.

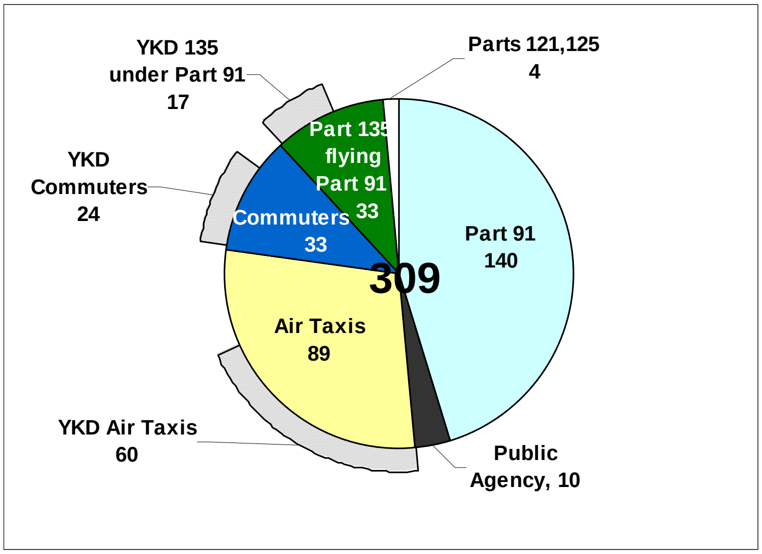
[9] Both reports are available at http://www.alaska.faa.gov/capstone/docs/docs.htm

[10] The baseline period for operations data, and therefore accident rates per flight hour or departure, is from January 1995 through December 1999. Operations data for the Capstone area are problematic, as described in the Baseline and Interim reports and in section 2 of this report; we did not feel it would be possible to produce a consistent, adjusted seta of operations data, adequate for computing reliable accident rates, for the years before 1995.

training might have affected flights in the Capstone area, had it been in place during that period. The baseline covers all flights in the Capstone area and focuses on carriers operating under Federal Aviation Regulation (FAR) part 135 and based in the Y-K Delta.

From 1990 through 1999 there were 309 accidents in the Capstone area; 101 of these were Y-K Delta part-135 operator accidents (as shown in Figure 1-4). There were 26 fatal accidents; 10 of them were Y-K Delta part-135 fatal accidents.

Figure 1-4. Capstone Area and Y-K Delta Accidents by FAR Part Number of the Flight, 1990-1999



There were 309 accidents in the Capstone area from 1990-99 (pie) of which 101 were aircraft operated by Y-K Delta part-135 operators (gray outer wedges). The categories "part 135 flying part 91" and "YKD 135 under Part 91" refer to those flights that commercial operators may make under the less restrictive general aviation regulations (part 91). These are non-revenue producing flights, such as return flights from a one-way charter or flights to and from a maintenance location.

To assess how many accidents we might expect the Capstone program to prevent, we collected and analyzed data on all accidents in the Capstone area from 1990 through 1999. These included general aviation flying under FAR part 91; scheduled and non-scheduled aircraft flying under FAR part 135 (commuters and air taxis);[11] passenger and cargo transport flying under FAR part 121; and aircraft flown by or for governments for public use. In the *2000/2001 Interim Report*, we grouped baseline accidents into nine broad categories[12] (Table 1-1 next page). In addition to looking at all Capstone area accidents, we also analyzed Y-K Delta part-135 accidents– that is, just the accidents that are the focus of Capstone Phase I: accidents among the air taxi and commuter operators based in Bethel, St. Marys and Emmonak. From those part 135 accidents, we then broke out just the fatal Y-K Delta part-135 accidents. Figure 1-5 shows , for the baseline

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[11] We also analyze FAR part 135 flying as part 91—air taxis and commuters that crash during positioning or instruction.

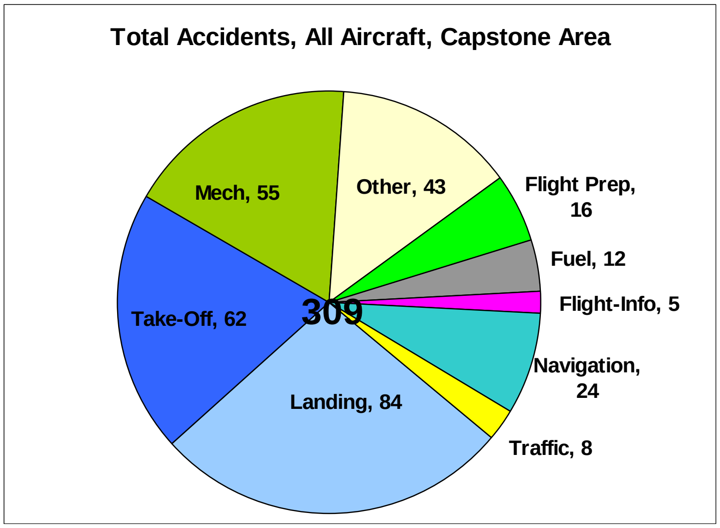
[12] We have chosen the accident cause categories in this report to facilitate analysis of the potential impact of Capstone capabilities. Therefore, they differ from categories used in other reports such as *Nall*.

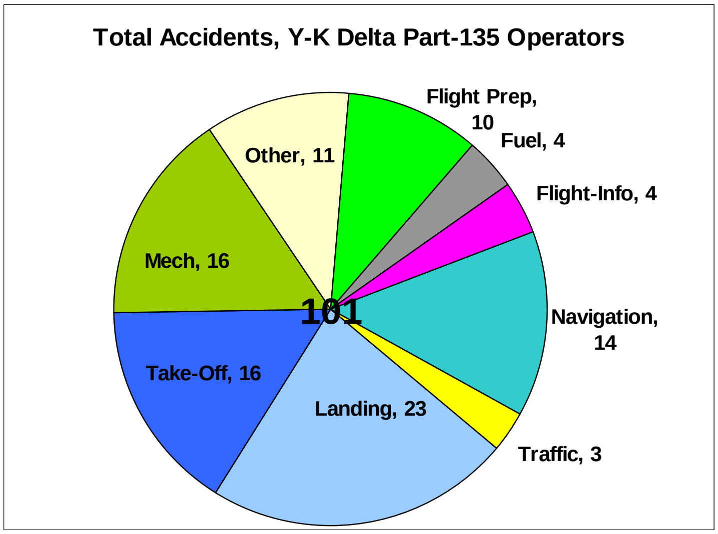
period, causes of: (1) all aircraft accidents in the Capstone area, (2) accidents among Y-K Delta part-135 operators; (3) and fatal accidents among Y-K Delta part-135 operators.

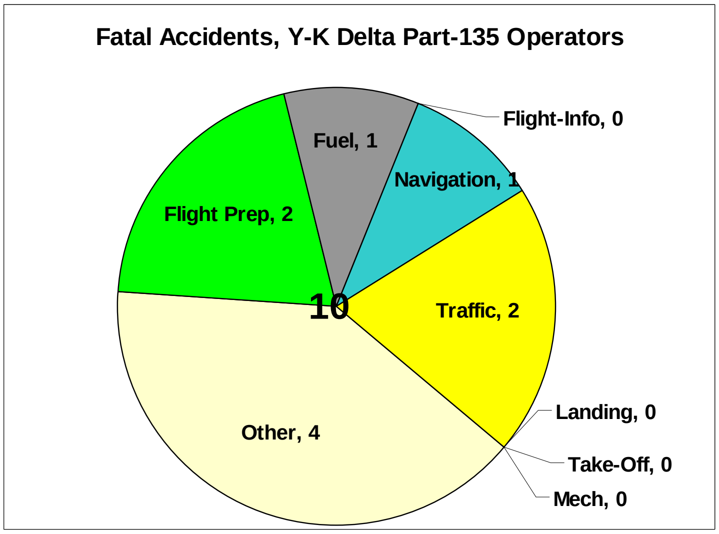
Table 1-1. Categories of Accident Causes for Capstone Safety Evaluation

Causes	**Explanations**
Mechanical Failure	Engine failure, inoperable control surfaces, failed landing gear, propeller or shaft failure. (There were no fatal accidents in this category among part-135 aircraft based in the Y-K Delta during the 1990s. In the Lower 48, 10 percent of mechanical accidents are fatal.)
Navigation	Controlled-Flight-into-Terrain (CFIT) accidents while enroute are often associated with low visibility and small navigational errors. In the Y-K Delta, CFIT accidents also occur in VFR when flat light on snow-covered ground prevents pilots from recognizing terrain. Terrain Clearance Floor (TCF) warnings are planned for Capstone Phase II; this function would address the 20 to 30 percent of CFIT accidents that occur on approach or departure. Phase I avionics is not designed to directly deal with such accidents. Rarely, CFIT accidents on approach for landing are due to pilots being off their intended path. GPS-map displays can help reduce those accidents.
Traffic	Usually mid-air collisions between aircraft. Also accidents from last-moment avoidance of other aircraft and from jet blast on airport surface.
Flight Information	Accidents that result from inadequate weather information are often caused by icing and sometimes poor visibility. Surface winds contributing to take-off or landing accidents have been included under take-off or landing rather than here. Occasionally, lack of information on changes in procedures or facility status also contributes to such accidents.
Fuel Mis-Management	Typically accidents caused by running out of fuel. Sometimes, pilots fail to switch fuel tanks.
Flight Preparation	Accidents caused by a variety of poor flight preparation measures, including failure to insure that cargo is tied down and within the aircraft’s weight and balance limits and failure to check whether fuel has been contaminated by water. Rare in the Lower 48 but significant in the Y-K Delta are accidents caused when pilots or others fail to remove ice or snow from the aircraft; these are often serious or fatal accidents.
Take-off	Accidents during take-off from various causes, including accidents when pilots fail to maintain control (especially in wind), maintain improper airspeed, or don’t take adequate care near vehicles or obstacles. In the Y-K Delta, an unusually high number of such accidents results from poor runway conditions or hazards at off-runway sites such as beaches and gravel bars; floatplanes sometimes hit obstacles in water.
Landing	Same sorts of accidents as during take-off, but during landing
Other	Includes a variety of accidents from unusual causes, such as hitting birds or colliding with ground vehicles.

Figure 1-5. Capstone Area Accidents by Cause Category, 1990-1999







Of the 101 Y-K Delta part-135 accidents, 17 were navigation and traffic accidents that Phase I technology could potentially have prevented.[13] Of the 10 fatal accidents, 3 were due to navigation and traffic causes. We reviewed the detailed narratives for each accident. Based on that information and expert opinion, we estimated a best-expected prevention likelihood for each Capstone area accident from 1990 through 1999[14]–that is, the percent chance that the accident would have been prevented by Capstone, if the Phase I program had been completely implemented. This best case reflects what we would have expected, if all Y-K Delta part-135 aircraft had been equipped with Capstone avionics, all of their pilots were fully trained to use the equipment, and 100 percent of the area was within GBT coverage. As discussed earlier, we would expect Phase I technology to prevent only navigation and traffic accidents.

Even if all the Phase I technology had been in place, we estimate that it would have been about 80 percent effective in preventing enroute CFIT and GPS-map accidents. In some cases, other causes such as icing or turbulence might have caused the accident, despite Capstone's capabilities. And in some conditions, such as flat light or white-outs, pilots' attempts to maneuver in response to terrain warnings can induce spatial disorientation, causing them to lose control of the aircraft.[15] We estimate Capstone could be 100 percent effective in preventing mid-air collisions by helping pilots be aware of nearby aircraft, if both aircraft were equipped and both pilots trained to use the equipment perfectly. Most collisions occur in good visibility with many safe ways to avoid collisions.

In the *2000/2001 Interim Report* and again in Section 3 of this report, we adjust these best expected prevention numbers to reflect Capstone's implementation progress. Additional background on aviation safety in Alaska is available in the following reports:

> Mitchell (American Airlines Training Corporation); *Final Report on Definition of Alaskan Aviation Training Requirements*; (1982).
>
> National Transportation Safety Board (NTSB); *Aviation Safety in Alaska;* (1995).
>
> Garrett et al; "Epidemiology of Work-Related Aviation Fatalities in Alaska 1990-94," in *Aviation, Space and Environmental Medicine* Vol. 69, No. 12; (1998).
>
> FAA; *Joint Interagency/Industry Study of Alaskan Passenger and Freight Pilots;* (1999).
>
> Thomas, Timothy K., et al; "Controlled Flight into Terrain Accidents among Commuter and Air Taxi Operators in Alaska", *Aviation Space and Environmental Medicine*, Vol. 71, No. 11; (2000).

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[13] See Capstone Interim Safety Study 2000-2001, pp. 12-23, for an analysis of baseline accidents by each of the nine causes and the potential for Capstone to prevent these types of accidents.

[14] The full list of accidents, estimated percent of causes addressed and best expected prevention is included in appendix B of the 2000-2001 interim report.

[15] *Broadcast Services Evolution Path: Preventing Fatal GA Accidents by Market or FAA Services*; Kirkman, Stock, Peed; MITRE Corporation, 2002. This analysis estimated a 25% residual for fatal CFIT accidents by general aviation pilots provided with terrain awareness capability. Our assessment of accidents by Y-K Delta commercial pilots resulted in a smaller percentage, because the pilots have higher experience levels and experience many fewer spatial disorientation accidents than general aviation pilots.

1.4 Organization of This Report

Section 2, Evaluation of 2002 Safety Factors, identifies relevant aviation safety data from 2000, 2001, and 2002. Section 2.1 discusses implementation of Capstone Phase I ground infrastructure and services. Section 2.2 looks at Capstone avionics–installation, pilot training, and usability. Section 2.3 assesses changes in the level of aviation operations in the Capstone area. Section 2.4 identifies changes in pilot and operator safety attitudes and practices. Section 2.5 examines the weather in the Capstone area. Section 2.6 discusses the limitations of our ongoing data collection.

Section 3, Changes in Safety, estimates the overall safety benefits of Capstone for the Y-K Delta and for the entire Capstone area by assessing changes in accidents from the baseline period, part-135 accidents among equipped and non-equipped aircraft, and user assessments. Section 4 states conclusions of the study team. Appendixes include data tabulations, details of data collection, and analysis methods.

2 Evaluation of 2002 Safety Factors

This section describes the implementation of Capstone technology, and Capstone's effects on safety in the study area, through 2002. But keep in mind that other factors besides Capstone also affect safety, and consequently also affect the risk of aircraft accidents from the various causes we analyzed in Section 1.3. So we also describe those other factors and discuss how we might distinguish their effects from those of the Capstone program.

2.1 Infrastructure and Services

Capstone has provided new infrastructure and services that support IFR and improve VFR operations in the Y-K Delta. These include AWOS installations, improved navigation, data-linked weather, and radar-like ATC services. (There's no radar below 6,000 feet in the Capstone area.) In 2002, online flight-following was implemented for operator management. A BRITE display for tower operators and traffic information broadcast had not yet been implemented at the end of 2002.

AWOS Stations and GPS Approaches

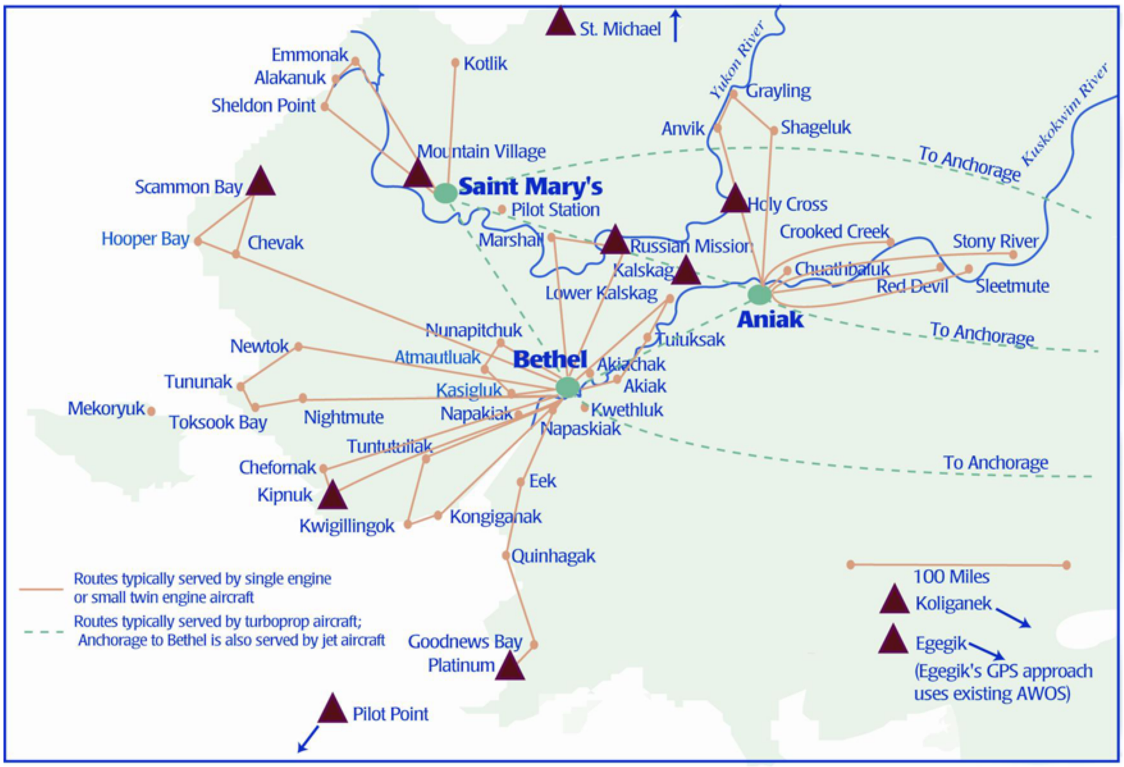
As part of the Capstone program, ten airports had received AWOS weather reporting stations and associated GPS non-precision instrument approaches through 2002 (Table 2-1). Except for those at Pilot Point–which is just outside the Capstone area–all were in place before 2002. Figure 2-1 shows the locations of the new facilities in the Y-K Delta.

Table 2-1. Weather Stations and GPS Approaches Added From 1999-2002

Airport	AWOS	GPS Approach
Egegik	Baseline	2001
Holy Cross	2001	2000
Kalskag	2001	2000
Kipnuk	2001	2000
Koliganek	2001	2000
Mountain Village	2000	1999
Pilot Point	2002	2002
Platinum	2001	1999
Russian Mission	2001	2000
Scammon Bay	2001	2000
St. Michael	2001	1999

Source: FAA Capstone program, http://www.alaska.faa.gov/capstone/status.htm

Figure 2-1. New AWOS Stations and GPS Approaches in the Y-K Delta



The AWOS stations and GPS approaches are most useful to IFR flights, but they also provide helpful services to VFR flights. Pilots flying between Bethel and other communities that have weather information and GPS approaches are less likely to encounter unexpected bad weather and more likely to be able to land safely if they do. Even without the GPS approaches, the additional AWOS stations represent a real improvement in the weather data available to all Y-K Delta flight operations.

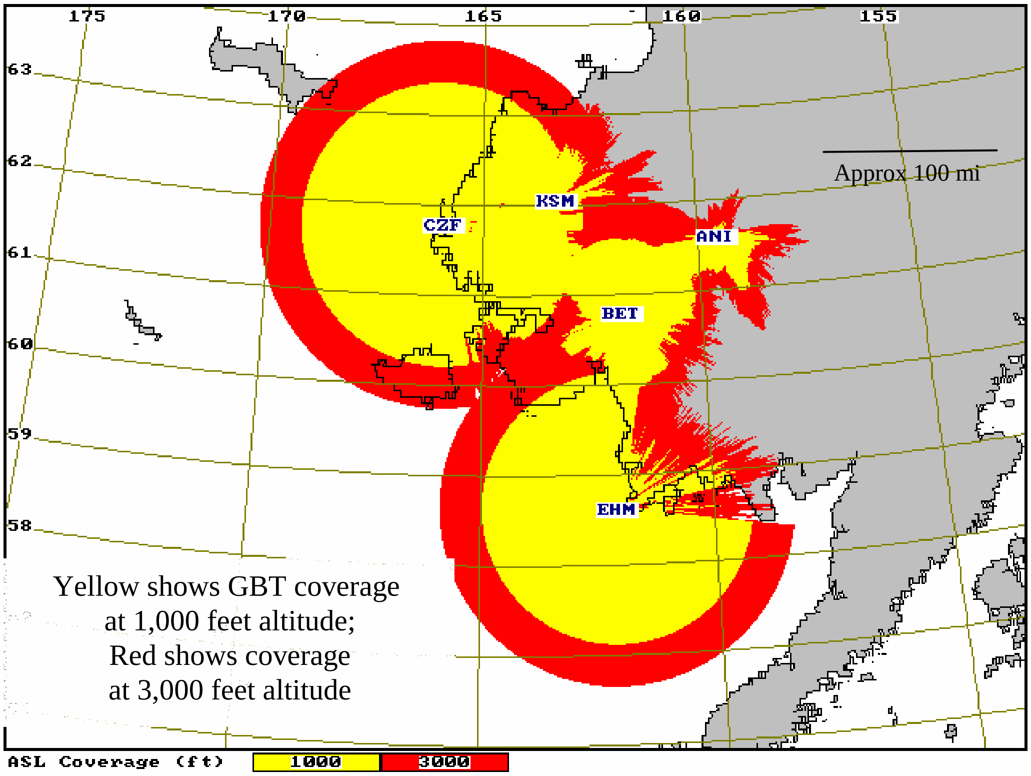
Besides improving the available weather information, increasing the number of destinations to which IFR flights are possible also increases the potential return to operators if they develop IFR-capability. It is expensive to equip aircraft and keep pilot IFR training current; operators will make that investment only if they can recover those expenses through fewer cancelled flights (and so, more revenue). Once operators make that investment, pilots flying VFR can file and fly under IFR, rather than guess about deteriorating weather.

In the *2000/2001 Interim Report*, we assessed how much this new infrastructure contributes to safety in the Y-K Delta by looking at how many more operations were served by the new equipment, compared to operations served by weather reporting and instrument approaches in the baseline period. Since no new IFR-capable destination airports in the Y-K Delta were added in 2002, our previous analysis has not changed. As we reported, the number of operations into IFR-capable airports (excluding Bethel) increased by more than 75 percent as a result of the AWOS stations and GPS approaches added through 2001.

Data-link weather

The flight information system-broadcast (FIS-B) function of the Capstone system is intended to provide aircraft with current weather information and forecasts. Pilots' access to up-link weather data is limited by the extent of ground-based transceiver station (GBT) coverage. Even in areas served by GBTs, pilots' access to information is still affected by several factors: whether the GBTs are operating or are temporarily shut down for maintenance; if they are operating, whether the pilot is within radio line-of-sight of a station; and what weather products exist and are linked to the GBTs. There was no change in GBT coverage during 2002. Figure 2-2 shows the current coverage in the Y-K Delta, which is the same as it was when we prepared the *2000/2001 Interim Report*.

Figure 2-2. Ground Based Transceiver Coverage, July 2002



Yellow shows GBT coverage
at 1,000 feet altitude;
Red shows coverage
at 3,000 feet altitude

Text weather (METAR and TAF) is available through the GBTs at Cape Romanzof (CZF), Cape Newenham (EHM), and Bethel (BET); graphic weather from Bethel weather radar (NEXRAD) has been available since late 2001. One of the implementation difficulties was establishing a robust data connection from NOAA (which produces the NEXRAD data) to the GBTs for broadcast to aircraft. The Bethel NEXRAD radar covers most of the Y-K Delta. However, because there is only one radar installation covering an area from several different directions—rather than the multiple installations typical for NEXRAD products in other states—bad weather may be obscured from the radar's view, if there is precipitation directly between the area of bad weather and Bethel. To interpret Bethel's NEXRAD graphics, pilots have to do more analysis than they would with similar weather products elsewhere.

Radar-like Services

Flight below 6,000 feet in the Y-K Delta is in a non-radar environment. The only radar coverage in the area is high-altitude coverage for long-range jets, controlled from Anchorage Center. Capstone's traffic awareness function, which lets anyone with an ADS-B receiver see the locations and altitudes of Capstone-equipped aircraft, brings the potential of "radar-like" services to the Y-K Delta. Controllers in Anchorage could use Capstone's ADS-B feature to guide Capstone-equipped aircraft just as they now use radar to guide aircraft over 6,000 feet. This idea was successfully tested in January 2001.

But few operators have used radar-like services since they became available. Capstone operators are accustomed to operating without air traffic control and have little motivation to change at this time. The greatest potential benefit of radar-like services for most Capstone operators would be to provide approach control to the Bethel airport—and that service was not yet available in 2002.

As more Y-K Delta part-135 operators upgrade their operations to become IFR-capable, radar-like services for both enroute operations (currently available) and approach control (not yet implemented) will be more useful to them. Until we see how Capstone operators use this capability, it's impossible to estimate even the potential safety benefit.

Tower Services and Approach Control

The Bethel tower currently provides services for VFR and Special VFR (SVFR) traffic and coordinates with Anchorage Center on IFR traffic to and from the Bethel airport. Intermittently during 2002, Bethel controllers were able to use a BRITE display to more easily acquire and track ADS-B equipped aircraft. The FAA continued to work on implementing ADS-B capability as part of an approach control system for Bethel through 2002. Approach control, if implemented, could potentially allow air traffic controllers (who might be located in Fairbanks or Anchorage rather than Bethel) to use Capstone technology to space and sequence IFR or SVFR aircraft landing at Bethel. It is anticipated that the surveillance capabilities of ADS-B as part of an approach control system will improve traffic flow in IFR and MVFR conditions. Operators are eager to see this capability in place, and the FAA is working through the complex regulatory and contractual difficulties.

Flight Monitoring

In 2002, the flight physics laboratory at Johns Hopkins University developed software that runs a CRABS (Comprehensive Real-Time Assessment Broadcast System) display, allowing operators who sign up for the service to monitor the locations of their Capstone-equipped aircraft over the Internet. By the end of 2002, the three operators who had signed up for the service were pleased with the capability. These operators had 45 Capstone-equipped aircraft among them at that time, or about 27 percent of the Y-K Delta part-135 fleet.

TIS-B

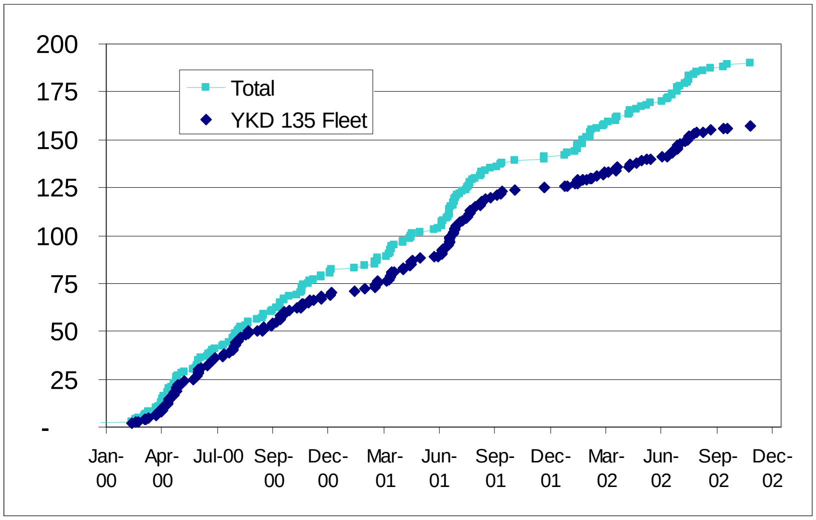
Traffic information system-broadcast (TIS-B) will send location data into the Capstone avionics for aircraft that are visible on radar. The multi-function display (MFD) will then display aircraft visible on radar, as well as the ADS-B equipped traffic. One of the potential drawbacks of Capstone's traffic display is that some pilots may rely on the MFD to show all other aircraft, forgetting that those without ADS-B won't be visible. TIS-B will, however, make one category of aircraft currently invisible—those on radar—visible, thus improving the effectiveness of Capstone's traffic awareness functions. But TIS-B was not yet operating at the end of 2002.

2.2 Avionics

Equipped Aircraft and Operations

Capstone's effectiveness depends on what fraction of flights take place in equipped aircraft. This is especially true for the traffic functions, where both aircraft need to be equipped to "see" each other. From January 2000 through the end of December 2002, the Capstone program equipped 190 aircraft, of which 153 were in the Y-K Delta part-135 fleet. Over 90 percent of that fleet is now equipped; the FAA has expanded the program to include more part 91 aircraft. On average from 2000 to 2002, about 55 percent of aircraft operated by part-135 operators in the Y-K Delta were equipped with Capstone avionics. For just 2002, the figure is 90 percent. The dark line in Figure 2-3 shows growth in equipped Y-K Delta part-135 fleet; the lighter line shows total equipped aircraft.

Figure 2-3. Number of Y-K Delta Part-135 Operators' Aircraft that were Capstone Equipped



Sources: Equipped aircraft from FAA; fleet size from participating Capstone operators

Our assessment of the likelihood for Capstone traffic avoidance features to prevent collisions is based on the assumption that no part 91 aircraft are equipped. Through 2002, the small number of equipped general aviation aircraft made this a reasonable simplification. In 2003, we will need to assess what fraction of the local general aviation fleet is equipped and modify our traffic accident prevention estimates accordingly.

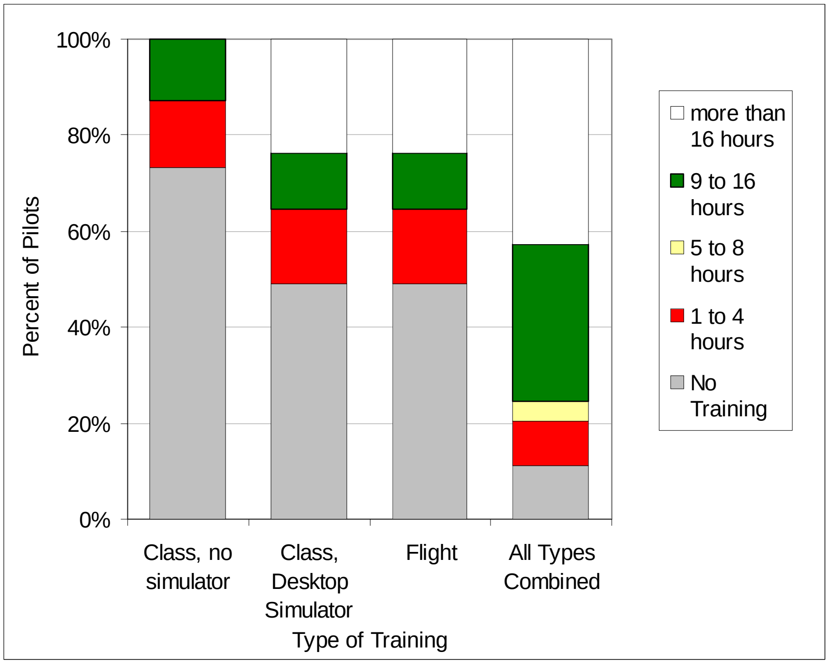
Training on Capstone Avionics

Training is a key element in the effective use of Capstone equipment. Under contract with the FAA, the University of Alaska Anchorage's Aviation Technology Division conducted train-the-trainer classes on Capstone avionics for participating operators. Those classes, mostly in 2000, were designed to provide an instructor cadre and give Capstone operators the capability to provide "in-house" training for their pilots on the equipment.

In 2001 and 2002, the division contracted with Capstone operators to provide (at their expense) the Capstone portions of those carriers' initial and refresher training programs. To provide additional support to carriers for their in-house training, the aviation technology division produced and distributed to Capstone participants a series of eight video training tapes that work with other training materials. The division also schedules the use of Capstone simulators that air carriers can check out to conduct their in-house Capstone training. All these efforts have paid off in measurably increased training levels of pilots flying Capstone-equipped aircraft.

Operators and pilots we surveyed generally agreed that Capstone training should include both initial and recurrent training; classroom, desktop simulator, and flight training; and flight checking. We asked Capstone pilots in 2000, 2001, 2002 how many hours of classroom training, classroom with desktop-simulator training, and flight training they had received. The answers to those questions for 2002 are summarized in Figure 2-4.

Figure 2-4 Type and Hours of Training on Capstone Avionics Reported by Y-K Delta Part-135 Pilots, Fall 2002



Training levels ranged from none up to several days of classroom/simulator training supplemented by substantial flight training. We summarized the training levels of Capstone pilots employed by Y-K Delta part-135 operators by sorting them into five groups and estimating an effectiveness rating for each. A 100 percent effectiveness would mean that the pilot would always use the equipment perfectly, in every instance where it could be useful. Fifty percent effectiveness would mean that over time, we expect that the pilot would avoid 50 percent of the accidents and incidents where Capstone avionics could theoretically be useful. Zero percent effectiveness would be the same as leaving the avionics turned off.[16] Table 2-2 shows the definitions for each training level and our estimates of the effectiveness of each level.

Table 2-2 Training Levels and Their Estimated Effectiveness

Level	Description	Effectiveness
0	No formal Capstone training	25%
1	Up to 12 hours of classroom training but less than 4 hours of classroom/simulator training; up to than 1 hour of flight training	40%
2	More than 4 hours classroom or classroom/simulator training and up to 1 hour flight training	50%
3	More than 1 hour flight training but less than 4 hours classroom or classroom/simulator training	60%
4	More than 1 hour flight training and more than 4 hours classroom or classroom/simulator training	90%

Ninety percent effectiveness means that when a highly trained pilot encounters a situation in which the Capstone avionics could potentially help avoid an accident, nine out of ten times the pilot will use the equipment effectively to avoid the accident. Twenty-five percent effectiveness means that an untrained pilot using Capstone might be able to avoid an accident in one of four situations where Capstone avionics could potentially help.

Figures 2-5 and 2-6 (next page) show the distribution of Y-K Delta part-135 pilots by training level, the estimated effectiveness of each training level, and an estimated average effectiveness for all Capstone pilots in January 2002 and in November 2002. The width of each bar is the percentage of pilots reporting each training level (for example, 18 percent of pilots in January reported no training; 13 percent of pilots reported training level 4). The height is the estimated effectiveness of their Capstone use, given the training they received; the average line represents the average effectiveness of Capstone pilots taken as a group.

The figures make clear how much pilot training improved during 2002. In January, nearly 40 percent of surveyed pilots were at levels 0 or 1 (representing minimal or no training),

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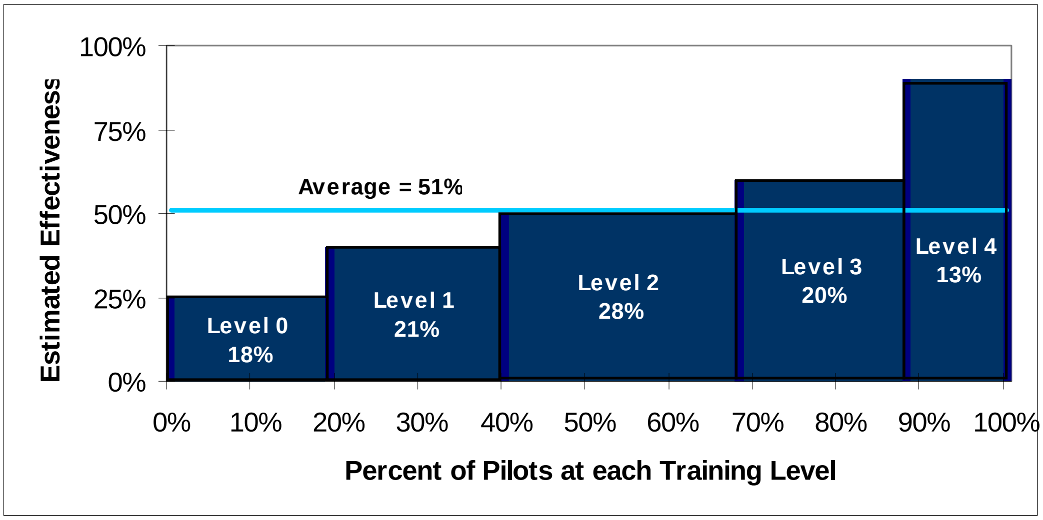
[16] Leonard Kirk estimated effectiveness levels based on classroom assessments, self-reports, and observations and interviews in the field. These assessments draw on models of learning and effectiveness in *Human Factors in Flight*, Chapter 9; Frank H. Hawkins; Ashgate Publishing Limited; 1993, and in the FAA's advisory circular AC 60-14; *Aviation Instructors Handbook;* U.S. Government Printing Office, Washington D.C.

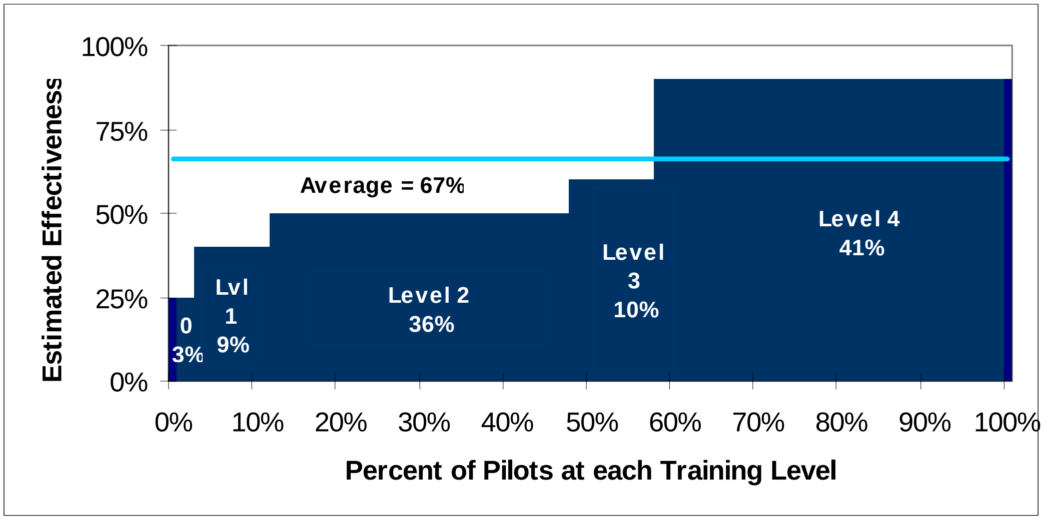
with only 13 percent at level 4 (representing 90 percent effectiveness). By November, 41 percent were at level 4, and only 12 percent were at levels 0 and 1.

Figure 2-5. Percent of Surveyed Y-K Delta Part 135 Pilots at Each Training Effectiveness Level, January 2002



The height of each bar is drawn from Table 2-2; the width (specified in the bars) shows the percent of pilots whose reported types and hours of training indicated that they were at each training level. The 51 percent line is the weighted average training level across all surveyed pilots.

Figure 2-6. Percent of Surveyed Y-K Delta Part 135 Pilots at Each Training Effectiveness Level, November 2002



Usability of Capstone Avionics

"Usability" measures how easily pilots can use the equipment to accomplish the tasks it was designed for and to evaluate the equipment's effect on cockpit workload. Usability of the Capstone equipment is critical: a piece of equipment that is difficult to use may not deliver the safety benefits it was designed for. Further, a piece of equipment that becomes a distraction or causes too much heads-down time in the cockpit could actually decrease safety.

We assessed the usability of Capstone avionics through surveys, observation flights, and simulator demonstrations. In 2000 and 2001, the FAA's Civil Aerospace Medical Institute (CAMI), Wichita Certification Office, and VOLPE Transportation Systems conducted two additional surveys, focused primarily on usability.

Many users reported initial difficulties with some Capstone features, especially flight planning. However, with training and experience they reported becoming proficient—at least with the functions they used regularly. In actual flights and in simulator demonstrations, pilots were able to display traffic and terrain information without difficulty or excessive heads-down time. But even with functions they used frequently, pilots wanted fewer required button pushes—for example, they wanted to move between the terrain and the custom map modes, or the traffic page and map pages, with only one push of a button. Pilots with ground and flight training followed by 20 or more hours of operating experience demonstrated little difficulty using the equipment, although both surveys and interviews indicate that the flight planning function is difficult to use, even for IFR flight and two-pilot operations.

Pilots with less training or experience tended to use the equipment in much more limited ways. For example, many pilots, especially those with limited training, simply circumvent the flight planning function by using either the "nearest" or "direct-to" capability of the GX-60.

In summary, Capstone avionics is certainly usable enough to provide safety benefits—but many pilots would prefer it to be easier to learn and use. And to get the full safety benefit, pilots must have adequate training—including ground training using a simulator and flight training in a Capstone-equipped aircraft.

2.3 Operations

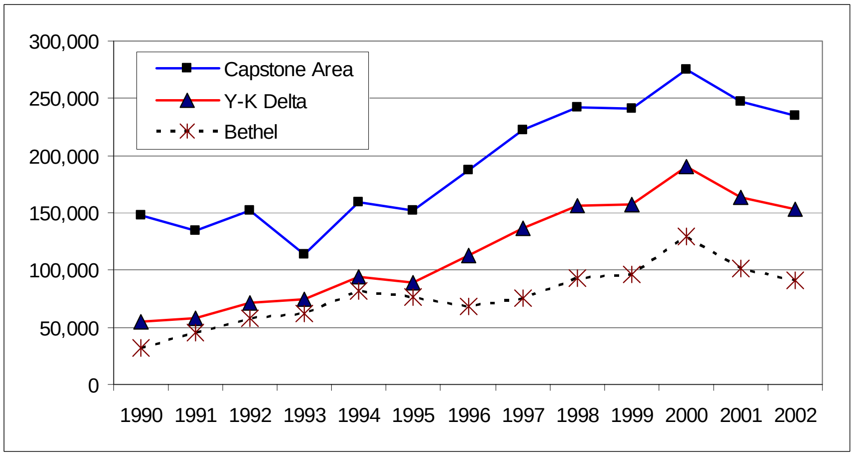
We made a major effort in the *2000/2001 Interim Report* to establish accurate data about the amount of flying in the Capstone area. We both extended the baseline data and compared it with other data sources including enplanements, mail shipments and SVFR operations levels. In this report we extend those estimates through 2002.

Operations Levels

In the baseline report, we used the APO Terminal Forecast (TAF) Survey Summary Report from the FAA's Aviation Policy and Plans Office. This report uses historical data on traffic counts from FAA Form 5010, the airport master record. These counts are the only systematic data available for the Capstone area; however, in rural Alaska they represent estimates from airport managers rather than systematically collected data. In addition, airport managers have incentives to overestimate airport activity—to qualify for more state funding. Finally, the currently published TAF data for 2002 are forecast rather than actual. We are not certain these data represent a reliable count of aviation activity. This means that we're not confident about our calculations of accident rates. However, accident rates are the primary way of assessing Capstone's effects on safety—so therefore we continue to try to develop the best operations data possible.

In the *2000/2001 Interim Report*, the 2001 operations data were not actual counts, but were forecast from historical activity. Since then, TAF data for 2001 have been revised downward to reflect the decrease in aviation activity since September 11, 2001. The forecast estimates for 2002 also reflect a downward trend. Figure 2-7 shows estimated operations levels for part-135 operators[17] in the Capstone area, Y-K Delta, and at Bethel airport from 1990 through 2002.

**Figure 2-7. Air Operations of Part-135 Operators
Capstone Area, Y-K Delta and Bethel, 1990–2002**



We assess these data in conjunction with enplanement data. We regard those data as the most reliable and accurate measure of commuter activity, although air taxis are likely to be undercounted, because reporting is voluntary for air taxi operators. Enplanement data is available from FAA Airport Planning, at http://www2.faa.gov/arp/planning/stats/. At this time, numbers for 2002 are preliminary, and available for only selected airports. Therefore, Figure 2-8 shows total enplanement data (including both air carriers and commuter and air taxi operators) for Bethel, Emmonak, Aniak and St Marys.[18] These four hubs serve most of the smaller communities in the Y-K Delta, and trends in their enplanements should reflect enplanement trends region-wide. The trend since 2000 is for slight growth: 2001 and 2002 each showed a two percent increase in enplanements over the previous year.

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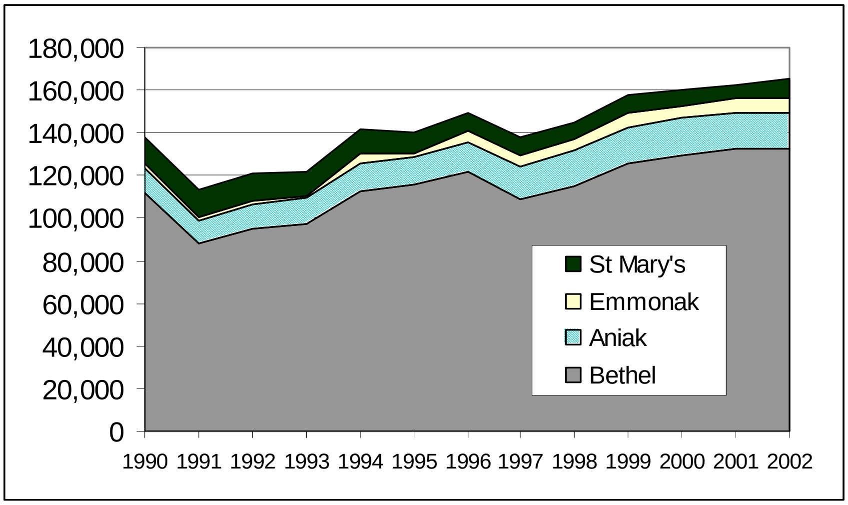
[17] Includes commuters, air taxis, and part-135 operators flying under part 91, e.g., maintenance flights, re-positioning, etc. The Capstone area and Y-K Delta lines extend the "Commuters, Air Taxi, and Part-135 flying as 91" lines from Figures 3-11 and 3-12 of the *2000/2001 Interim Report*.

[18] Enplanement data from FAA Airport Planning, at http://www2.faa.gov/arp/planning/stats/

Figure 2-8. Enplanements in Selected Y-K Delta Communities, 1990–2002



Source: FAA, data Aviation Policy and Plans (APO)

Declining operations could occur at the same time as increasing enplanements, if passengers were shifting to larger aircraft. However, this does not appear to have been the case. Almost all (95 percent) of Bethel's enplanement growth from 2000 to 2001 was in air taxis and commuters. Enplanement growth in 2002 wasn't in Bethel – and Aniak, Emmonak and St. Marys have essentially no air carrier activity, so that growth was also air taxi and commuter growth.

So the available operations data shows a decline in activity, but the enplanement data indicates a small increase. For our analysis, we estimate 2002 operations were essentially unchanged from 2000 and 2001. In estimating the "projected" accidents against which we measure actual accidents, we continue to use the number derived in the *2000/2001 Interim Report*: operations in the Y-K Delta in 2002 were about 40 percent higher than the average from 1990 to 1999—the period on which our expected accident occurrences are based. We estimated that number by adjusting reported Bethel operations from 1998 onward.

However, when we compare accident rates in the Y-K Delta and the rest of Alaska, we have to use consistent data for the two areas. Since we don't have the sort of detailed information for the rest of Alaska that we have for the Y-K Delta, we can't make the same sorts of adjustments. Therefore, for those comparisons we use the operations data from Figure 2-7.

2.4 Safety Posture

As we're defining the term here, "safety posture" for flights in the Y-K Delta is the total environment affecting aviation safety—including not only practices of pilots and operators, but also public policies and market forces. Some of the factors contributing to that environment are human factors, pilot training, aircraft maintenance, FAA oversight, operator management, economics, and industry initiatives. All these are inter-related, affecting and being affected by the Capstone program.

Operators set the bounds and provide the motivation for pilots to conduct safe flights, within the context of both regulatory oversight (which pressures them to improve safety) and economic factors (which pressure them to get the job done at the least cost). Economic pressures are varied, including all sources of revenue (mail, passengers, and freight) and costs (aircraft, training, maintenance, and insurance). Pilots can feel economic pressure on their operators, and that in turn can make them feel pressured to take larger risks.

We need to track and (insofar as possible) quantify changes in safety posture for two reasons. First, changes unrelated to Capstone may cause accident rates to increase or decrease. We don't want to mistakenly attribute to Capstone changes that are actually caused by other factors. Second, the Capstone program may indirectly affect safety posture and indirectly affect accident rates (again, rates may increase or decrease). We want to identify and if possible quantify any indirect safety effects of the Capstone program.

We measured the safety posture in the Capstone area by interviewing pilots and operators, examining relevant data, and making ground and in-flight observations of facilities, equipment, and personnel. Operators and pilots—the primary source of Capstone assessments—have increasingly cooperated with our efforts to collect data on human factors that affect safety. This increased cooperation provides us with an opportunity not only to measure opinions and attitudes, but also to identify safety issues and possible solutions and to evaluate Capstone's effectiveness more broadly than we could by just relying on the aircraft accident rate as an indicator.

Human Factors

The mix of Capstone pilots continues to change. Pilots continue to believe the Capstone program contributes to aviation safety in the Y-K Delta, but their attitudes vary with experience. Overall, they told us that:

- There is a need for better weather information enroute (e.g., barometric pressure settings) to help them avoid CFIT accidents. Conversely, the availability of weather information may support some pilots' inclinations to fly into marginal conditions.
- There is high turnover among pilots and a pilot shortage. By making navigation simpler, Capstone permits newer pilots to become productive sooner. However, new pilots may be especially vulnerable if the equipment fails.
- The availability of radar-like services is not useful to many pilots. The Bethel tower Capstone display was inoperative for most of 2002.
- Some pilots worry that other pilots may be overconfident that the traffic display is showing ALL other traffic, since not all aircraft are Capstone-equipped, and there continue to be comments during interviews that some pilots pull the circuit

breaker in the ADS-B to avoid identification. Still, pilots most often cite the traffic feature as a major safety benefit.

- Some pilots said the Capstone equipment has too many functions for single-pilot operations and that there is too much head-down time for pilots until they become experienced with the equipment.
- Most pilots believe the Capstone program has improved flight safety, but some are reluctant to say how much until the program has been in place longer.
- Several pilots commented that there are runway location errors in the Capstone GPS database.
- Many pilots believe that to realize the full potential benefits of Capstone's traffic avoidance function, the FAA will need to relax enforcement of minor altitude or visibility infractions in marginal weather.

The central measure of safety improvement is fewer aircraft accidents. While improved terrain awareness is a primary Capstone benefit, there were nevertheless two CFIT accidents involving Capstone-equipped aircraft in the Y-K Delta in 2002 (see appendix B for information on those accidents). Human factors clearly constrain Capstone's ability to prevent accidents.

Operator Management

Medallion Foundation programs are designed to provide management training to maintenance professionals and improve operators' safety and training programs. In 2002, nine Y-K Delta Capstone operators began participating in the program. We describe the Medallion program under Industry Initiatives below.

FAA Oversight

The oversight by the FAA's FSDO inspectors has not changed since the *2000/2001 Interim Report*. However, the FAA reviewed the oversight situation as part of its Report on Phase I Implementation produced by AAL-240.

Economics

Economic factors influence management decisions of Capstone operators. Those operators are currently facing increasing economic pressure as a result of the terrorist attacks on 9/11/2001—which has led to increased safety costs across the industry—and as a result of the State of Alaska's current fiscal crisis. In addition to these pressures, the two most important economic factors throughout rural Alaska (not just in the Capstone area) are the U.S. Postal Service regulations for carrying mail and insurance rates.

Changes in the federal law governing the "bypass mail" system and its funding were pending in late 2002. Those changes could reduce the incentive for carriers to fly in marginal weather to deliver mail; increase the number of passenger seats; and limit the number of aircraft hauling only mail. The effect of such flight changes will be more apparent over time.

Insurance rates have increased. Alaska's high accident rate and generous claims settlements have led many underwriters to avoid the Alaska market. Those who do write insurance for Alaska carriers charge especially high rates to those who carry passengers, so some operators have stopped carrying passengers and instead carry mail and cargo only. Other operators have moved toward twin-engine and turbine-power aircraft, which cost more to operate but less to insure. Of the 155 operators we surveyed statewide, 107 reported that their insurance rates had increased since early 2000. The increases ranged from 1 to 350 percent, with an average of 23 percent. Some operators see Capstone as part of a process that—together with training and other efforts to improve safety—will help reduce their insurance costs. Insurers vary their rates due to perceived risk (passenger, type of aircraft, pilot qualifications, and accident history). Increased safety has the potential to restrain insurance costs, thereby increasing operator revenue. This is a key incentive for carriers to participate in the Medallion program.

Passenger choices may also improve aviation safety in the Y-K Delta, if passengers are willing to pay more to fly with safer operators. According to Capstone pilots we interviewed, passengers are selecting airplanes with the "Capstone" logo on the side. The passengers like the airplanes with the "TV" and perceive they are in safer aircraft. (More data is needed to determine the magnitude of this trend, which would tend to give an advantage to carriers with Capstone-equipped aircraft.)

Travel planners also report that some travelers are willing to pay a higher fare to ride on safer aircraft. Some corporate travel offices put their passengers in the Y-K Delta on twin-turbine aircraft with two-pilot crews improve safety, even though fares for this class of aircraft are higher. All these twin-turbine, two-pilot aircraft are now Capstone-equipped. One Y-K Delta air carrier will not carry passengers on single-engine aircraft.

Industry Initiatives

The Alaska Air Carriers Association has created the Medallion program— a comprehensive, voluntary program intended to raise the standard of safety for commercial carriers throughout the state. It is based on safety and risk-assessment programs already in place in some companies. Under the program, carriers will be evaluated by the Medallion Foundation's safety personnel in five areas and will receive a star for each area they complete. They will receive a Medallion award when they complete all five steps:

1) Safety Program

2) Operational Control

3) Flight Simulator Training

4) Maintenance and Ramp Safety

5) Internal Audit System

To help operators meet the standards, the Medallion program plans to install computer-based aviation training equipment and to conduct safety seminars throughout the state. There were nine Capstone operators in the Y-K Delta participating in the Medallion Program in 2002, with the first two awards of Medallion stars pending.

2.5 Weather in the Bethel Area

Because weather contributes to so many accidents in the Bethel area, analyzing weather there is an important part of assessing aviation safety changes. Better or worse weather will influence the number of accidents, independent of any safety measures. To assess weather changes over time, we obtained a consistent and complete set of weather data for the period from 1998 through 2002. We used hourly ASOS reports taken from the National Weather Service (NWS) station in Bethel, which we obtained from the Western Regional Climate Center.[19]

Weather data classes for analysis

Based on the reported visibility and ceiling, we categorized each cleaned observation by weather class, as defined in Table 2-3. Because this data is to help us analyze flight safety, we used ceiling and visibility limits the FAA defines for various flight rules. Finally, we aggregated data by day/night, day of the week, and month, allowing us to summarize the number of good, bad, and variable weather days each month.

Table 2-3. Weather Classes

Class 0	Ceiling less than 500' and visibility less than 1 mile. IFR operations only
Class 1	Ceiling 500' or greater and visibility 1 mile or greater. Day special VFR minimum limits 500' and 1 mile
Class 2	Ceiling 500' or greater and visibility 2 miles or greater Day en route VFR minimum limits for FAR 135 operations in uncontrolled airspace
Class 3	Ceiling 1000' or greater and visibility 3 miles or greater. Basic VFR as defined by FAR 91.155
Class 4	Ceiling 2000' or greater and visibility 3 miles or greater. Night VFR operations authorized
Class 5	Ceiling 10,000' or greater and visibility 6 miles or greater. AWOS observation limits

Weather Observations

First we looked at annual data: how much of the time during each year did the weather observations fall into each category? Figure 2-9 (next page) shows the percentage of total daytime observations that fell in each weather class. The annual averages from 1998 to 2002 are fairly consistent. From 60 to 70 percent of the time, the daytime weather was good enough to permit VFR flight with no special requirements or restrictions; about 10 to 15 percent of the time, flights were permissible only under instrument flight rules, if at all. (Because the operators that we focus on fly almost exclusively under visual flight rules, we didn't distinguish bad weather that didn't permit VFR flight from weather that was so bad as to prohibit even IFR flight.)

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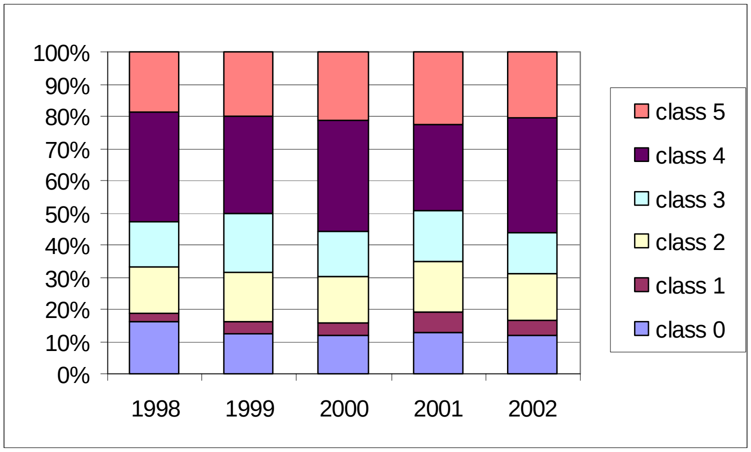
[19] Data came in the form of delimited text; we imported the data into SPSS and cleaned them by dropping corrupted observations, assuring values appeared in the correct fields, and deleting repeated observations. We then matched in data on civil twilight hours from the U.S. Naval Observatory, which allowed us to assign each weather observation to day or night.

Figure 2-9. Daytime Observations by Weather Class and Year Bethel, 1998-2002



Next we looked at typical weather by month, averaged from 2000 to 2002—the period of Capstone Phase 1 implementation. Figure 2-10 shows the percentage of days each month during which the worst weather observation was class 2 or below—that is, at some time during the day, the weather did not meet basic VFR requirements. Figure 2-11 shows the percentage of days with "variable weather," that is, days with some observations in class 4 or 5, and some in class 0, 1, or 2. The graphs are similar: almost all the "poor weather" days are also "variable weather" days. Variable weather days may tempt pilots to start a flight when the weather improves above VFR requirements, only to face deteriorating weather before they reach their destinations. Figures 2-12 and 2-13 compare these recent data with the baseline data (1996-1999) data.

Figure 2-10.

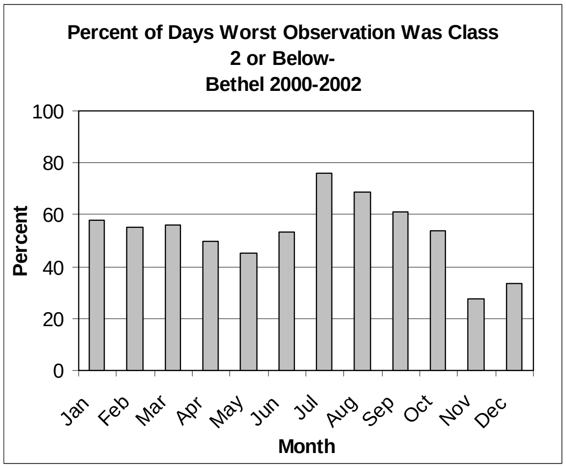


Figure 2-11.

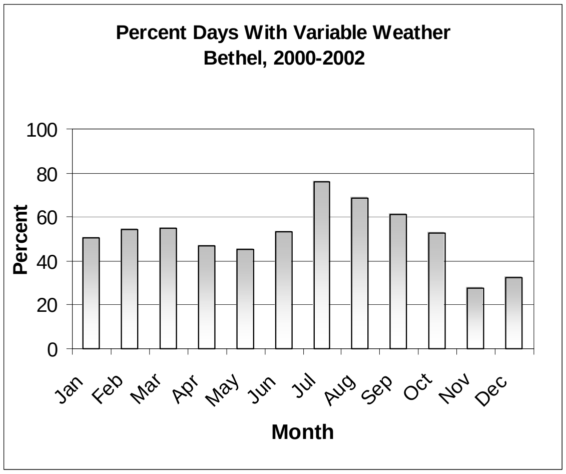


Figure 2-12

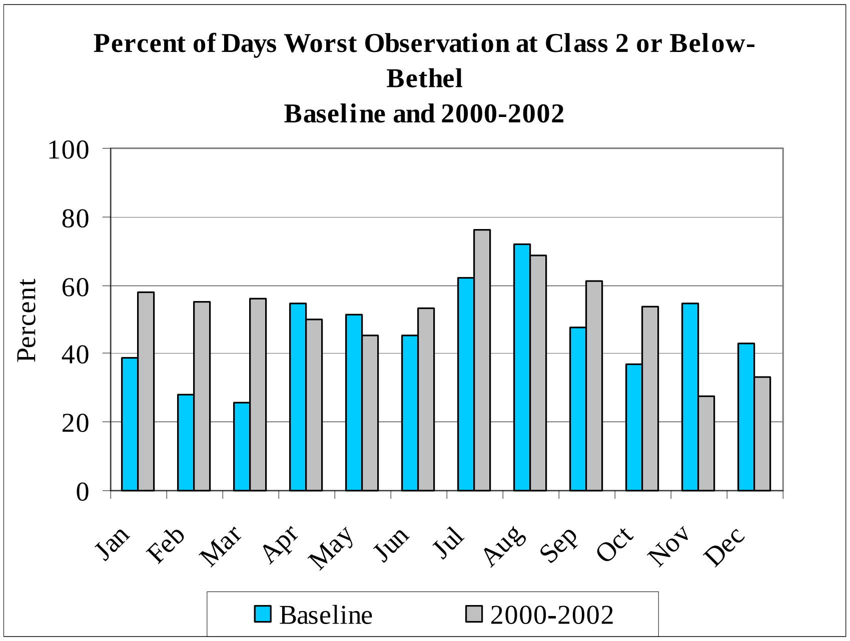
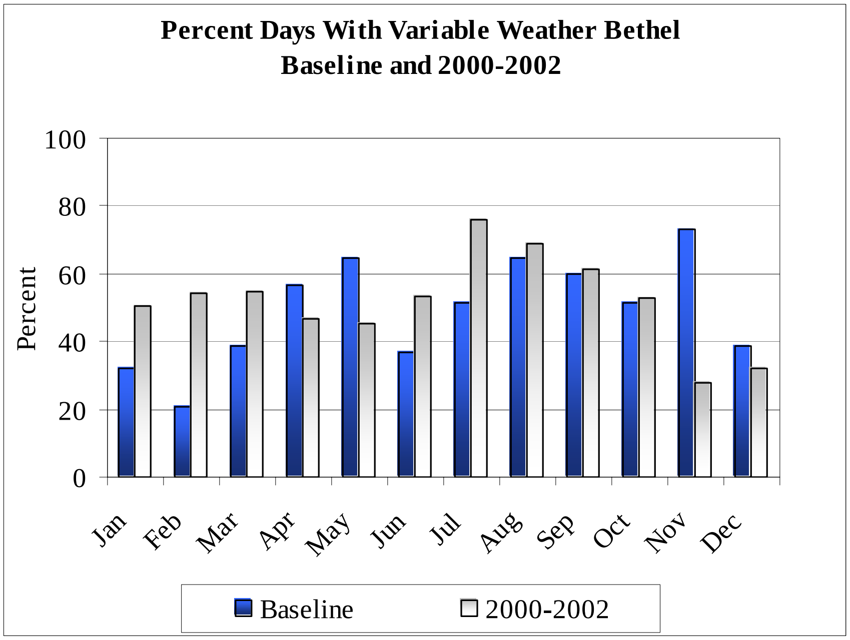


Figure 2-13



Data Sources:
Western Regional Climate Center
Desert Research Institute
2215 Raggio Parkway
Reno, NV 89512; (http://www.wrcc.dri.edu/)

U.S. Naval Observatory (For Civil Twilight Tables)
(http://aa.usno.navy.mil/data/docs/RS_OneYear.html)

No clear pattern emerges. More days in January and February in recent years had bad or variable weather than in the baseline period, and recent Novembers have had fewer bad or variable weather days than baseline Novembers.

2.6 Limitations of Ongoing Data Collection

This section briefly discusses limitations of four critical types of data that we use to evaluate 2000-2002 safety improvements in this report: weather, accident reporting, air operations data, and operator and pilot survey data.

Weather Data

Section 2.6.1 of the *2000/2001 Interim Report* discusses limitations of weather data during the baseline period. More recent data are subject to the same limitations. While the Capstone program has installed nine new weather reporting stations in the region, the weather data recorded at these new stations are not being archived at the National Climate Data Center or Alaska state climate centers—so the data collected at these new stations were not available for analysis.

Accident Reporting

Often there is a significant delay between when an aircraft accident occurs and when the National Transportation Safety Board (NTSB) completes its investigation of the cause. For serious accidents, especially ones involving fatalities, the NTSB may take more than a year to reach its final determination. For some accidents occurring in 2002, our analysis is based on preliminary assessments subject to change.

Often the NTSB determines that multiple factors played a part in a given accident. This may complicate the task of projecting whether Capstone program components might have been able to prevent a particular accident. In accidents with multiple causes—one which is Capstone-related and others which are not—we must use professional judgment to determine the relevance of Capstone. Such determinations are inevitably somewhat arbitrary.

Operations Data

Section 2.6 of the *2000/2001 Interim Report* discusses limitations of operations data during the baseline period, and section 3.3 of that report details our efforts to find consistent data and reconcile differences between sources. The quality of operations data remains one of the most problematic areas of this safety study. There is limited data; different sources conflict, with no way to reconcile them; and we cannot explain the discrepancies. In the end, we must make a judgment call on the balance of the evidence.

Survey Data

The data on operator and pilot characteristics, as well as information on pilot experience with Capstone avionics, are drawn from interviews with a sample of operators and pilots. Survey data of this kind contain four potential sources of error: sampling error, sample selection bias, response bias, and non-response to certain questions. Sampling error describes the potential discrepancy between the survey estimates and true values, based on the fact that only a portion of the population was interviewed. Response bias occurs if some types of operators or pilots are systematically more likely than others to respond to the survey. Both of these sources of error occur in our follow-up surveys, as pilot and operators are busy or unavailable, keeping samples small and potentially producing a biased group of respondents: those who are cooperative and those who have time. However, the total population is small, and our interviewers have been able to establish ongoing relationships with companies and pilots. We attempt to contact not only as many pilots and operators as possible, but also to ensure we that those we talk to reflect as broad a range of experiences and opinions as possible, based on previous experience with them and their companies.

3 Changes in Safety

Capstone's goal is fewer accidents. The challenge with directly measuring progress toward that goal is that traffic and navigation accidents–the primary types of accidents Capstone was designed to prevent–are more common in the Y-K Delta than in many places, but are still relatively rare. In two of the ten years from 1990 to 1999, Y-K Delta part-135 operators had no traffic or navigation accidents. So if there were no such accidents in any one year after Capstone went into effect, that could be just the result of chance and not necessarily of improved safety. Therefore, we measure Capstone's safety effects from two perspectives–both direct (fewer accidents) and indirect (changes in attitudes, policies and actions that we believe improve safety).

Specifically, this section assesses the safety effects of Capstone in four ways: (1) the number of aviation accidents in the Y-K Delta before and after Capstone was implemented; (2) differences in accident rates between Capstone-equipped and non-equipped commercial aircraft based in the Y-K Delta; (3) differences in accident rates over time among Y-K Delta part-135 operators and part-135 operators statewide, and (4) operator and pilot assessments of the program. We conclude by summarizing our assessment of Capstone's safety effects through 2002.

The previous section, Section 2, discussed additional weather information and instrument approaches Capstone has provided, as well as describing changes in operator policies and programs. All these factors should improve safety.

3.1 Changes in Accidents from the Baseline Period

Total Accidents: Y-K Delta Part-135 Operators

We first assess how numbers of accidents in the Y-K Delta have changed from the baseline period. In Figure 3-1 (next page), we compare the actual number of accidents among Y-K Delta part-135 operators from 2000-2002 with the number that would likely have occurred, if the accident rate in that period had been the same as in the baseline period, from 1995-1999.[20] And because the number of accidents in the baseline varied from year to year, we not only show the actual and projected numbers of accidents but also project a range of accidents.[21]) So Figure 3-1 shows actual accidents (gray bars), expected accidents[22] (blue bars), and an expected range of accidents (narrow black bars)

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[20] The *Baseline Report* calculated accidents per 100,000 departures based on data from 1995-1999, which we use for this analysis of total accidents.

[21] Because accidents are relatively rare events, and occur in discrete numbers (no half-accidents), this expected range is best calculated using a Poisson distribution. The expected range is always an integer number of accidents and never less than zero. The width of the range (the likelihood that a random observation will fall within that range) varies–for the graphs in Section 3.1, we'd expect the observed number of accidents to fall within the ranges 92% to 97% of the time.

[22] The expected (average) number is not always an integer, because it's the mean of several years of accident data, adjusted upwards to account for increased operations. The range, calculated with the Poisson distribution, is mathematically restricted to integers. This makes sense, since when we compare actual accidents to the range, we are looking at one or two or three accidents, not 2.4 accidents.

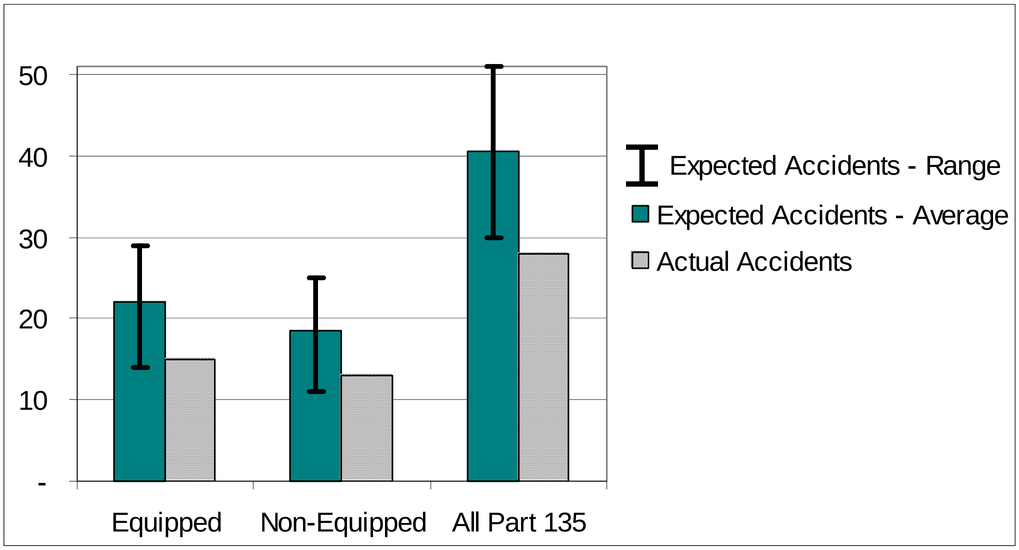
for Capstone-equipped, non-equipped, and all part-135 carriers. The range encompasses about 95 percent of the expected annual variation in accident numbers. If Capstone had no effect, we would most likely observe an actual number of accidents close to the historical average. The further the actual number of accidents falls below the center of the historical range, the more likely it is that Capstone is improving safety. And if the actual number falls below the low end of the historical range, that would mean the accident rate has in fact changed.

For all aircraft (bars at the far right of Figure 3-1), the actual number of accidents (28) was below the range we would have expected (29 to 51), at historical averages. So the accident rate among Y-K Delta part-135 operators as a group was in fact lower during 2000-2002 than it was during the baseline period.[23]

Accident rates among both Capstone-equipped and non-equipped aircraft were at the low end of their historical ranges. The equipped aircraft did a little better–there's a 92 percent chance that equipped aircraft actually had a new, lower accident rate, rather than just a chance variation–and an 88 percent chance that non-equipped aircraft had a lower rate.

However, there isn't enough difference between accident rates of equipped and non-equipped aircraft from 2000 through 2002 to demonstrate that Capstone avionics alone reduce accidents. Other factors may have affected safety among both equipped- and non-equipped aircraft. When we have data for a longer period, it will become easier to distinguish the effects of Capstone alone. But the data so far do indicate that aviation safety improvements in the Y-K Delta are working–and the Capstone program is a major component of those improvements. (Later in this section we will look at how these changes in the Y-K Delta compare with changes in the rest of the state.)

Figure 3-1. Expected and Actual Accidents, Y-K Delta Part-135 Carriers, Equipped Aircraft, Non-Equipped Aircraft, and All Aircraft, 2000-2002



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[23] There is just a 1-in-40 chance that this is an unusually low three-year period at the baseline accident rate.

Accidents by Cause: Total Capstone Area and Y-K Delta Part-135 Operators

Now we compare projected accidents with actual 2002 accidents among Y-K Delta part-135 operators in the nine cause categories detailed in Table 1-1, as well as fatal accidents among those operators. This analysis updates the analysis in Section 4.1 of the *2000/2001 Interim Report.*

In Section 1 we described grouping accidents in the Capstone area between 1990 and 1999 into nine cause categories and estimating for each category the number that we'd expect to have been prevented by the Capstone program, if it were 100 percent implemented. For this analysis, we start by converting these numbers–actual accidents and best-expected accidents prevented- into accidents per year.[24] We project the results upward to reflect increased aviation operations in 2002 (described in Section 2). We did this for total Capstone area accidents, Y-K Delta part-135 accidents, and Y-K Delta part-135 fatal accidents.

Next we reduce the number of accidents Capstone might have prevented, because Capstone was only partly implemented during the study period. We take into account the proportion of aircraft that are equipped and the levels of pilot training, both of which gradually increase as Capstone is implemented. We assume the effects of these factors are linear.

For navigation accidents, we multiply the number of accidents potentially prevented by (1) the percentage of aircraft equipped–90 percent in 2002–and (2) the estimated training effectiveness level of pilots. We estimated 67 percent pilot effectiveness using the equipment:

$$\begin{matrix}\textit{Nav Accidents}\\ \textit{Prevented}\end{matrix} = \begin{matrix}\textit{Nav Accidents}\\ \textit{Ideally Prevented}\end{matrix} \bullet \begin{matrix}90\%\ a/c\\ \textit{Equipped}\end{matrix} \bullet \begin{matrix}67\%\ \textit{Training}\\ \textit{Effectiveness}\end{matrix}$$

For traffic accidents, we multiply preventable traffic accidents by the likelihood that the first aircraft is equipped, the likelihood that the second aircraft is equipped, and the training levels of the two pilots. Other aircraft include not only part-135 but also part-91, part-121, and public use aircraft with which a Y–K Delta part-135 aircraft might collide. We include the training effectiveness only for the pilot of the first aircraft in the equation, since typically if one aircraft takes evasive action the other aircraft does not need to.[25] The likelihood that the first and second aircraft will be equipped is different for the Y-K Delta and the entire Capstone area. The example on the next page is for Y-K Delta part-135 operations.

Ninety percent of Y-K Delta part-135 aircraft were equipped, on average, in 2002. We assume that no part 91 aircraft are equipped (a simplification of the low average percentage equipped in 2002), and available data indicate that the Y-K Delta part-135 fleet accounts for about 70 percent of all operations in the delta. So the chance that a

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[24] Because there were 10 years in the baseline, this is simply the number for each category divided by 10.

[25] Because the pilot of either Capstone-equipped aircraft could take action to avoid collision, we could refine this equation by replacing Training Effectiveness (TE) with 1-(1-TE)(1-TE). In this report, the difference between the two equations is less than 1/20th of one accident.

random aircraft encountered by a Capstone-equipped aircraft flying in the Y-K Delta would also be Capstone-equipped is:

$$\genfrac{}{}{0pt}{}{63\%\ \mathit{Chance}}{A/C\ \mathit{Equipped}} = \genfrac{}{}{0pt}{}{70\%\ \mathit{chance}}{YKD-135\ A/C} \bullet \genfrac{}{}{0pt}{}{90\%\ \mathit{chance}}{A/C\ \mathit{Equipped}} + \genfrac{}{}{0pt}{}{30\%\ \mathit{chance}}{\mathit{Other}\ A/C} \bullet \genfrac{}{}{0pt}{}{0\%\ \mathit{chance}}{A/C\ \mathit{Equipped}}$$

Combining this with the estimate of 67 percent training effectiveness, we estimate prevented traffic accidents as:

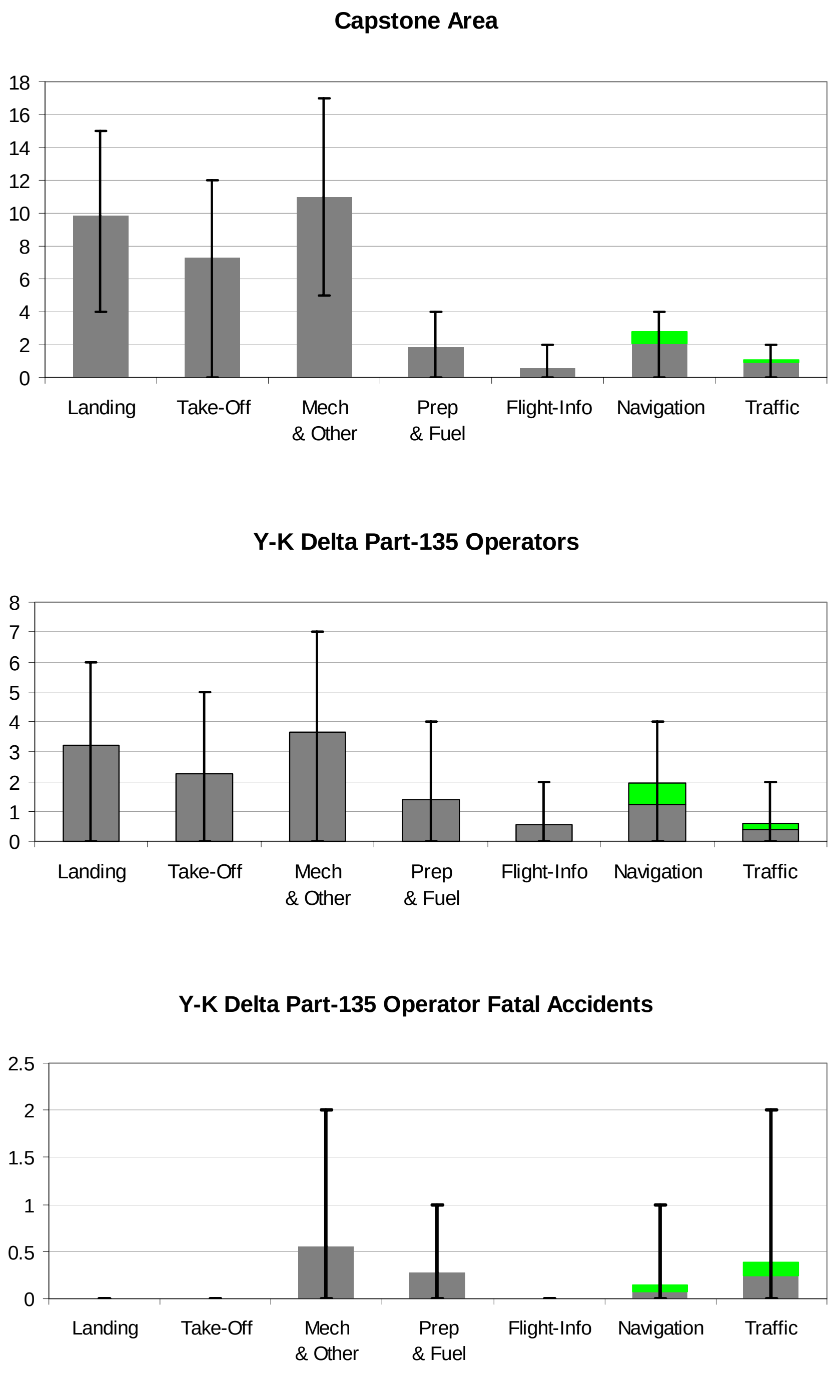
$$\genfrac{}{}{0pt}{}{\mathit{Traffic\ Accidents}}{\mathit{Prevented}} = \genfrac{}{}{0pt}{}{\mathit{Traffic\ Accidents}}{\mathit{IdeallyPrevented}} \bullet \genfrac{}{}{0pt}{}{90\%\ \mathit{YKD}135}{a/c\ \mathit{Equipped}} \bullet \genfrac{}{}{0pt}{}{63\%\ \text{Other}}{\mathit{Aircraft\ Equipped}} \bullet \genfrac{}{}{0pt}{}{67\%\ \mathit{Training}}{\mathit{Effectiveness}}$$

Capstone might prevent a collision during take-off, even if only one plane were Capstone-equipped—if the airport tower had a BRITE display that allowed the tower operator to observe the equipped plane. Since responding to the tower operator does not require the pilot to use avionics, it does not depend on Capstone pilot training. However, tower-display capability was only intermittently available during 2002.

Figure 3-2 (next page) shows, by cause, the projected range of accidents in 2002 (black lines); the number of navigation and traffic accidents Capstone might have been expected to prevent (green bar area) and the remaining accidents (gray bar area). The top chart shows all accidents in the Capstone area, the middle chart, just accidents of Y-K Delta part-135 operators, and the bottom chart, fatal accidents among Y-K Delta part-135 operators. To make the charts easier to read, we show just seven categories, combining mechanical with other and flight preparation with fuel mismanagement.

The number of accidents in each cause category varies from year to year; the projected range we show encompasses about 95 percent of the annual variation. For example, we project between 4 and 15 landing accidents in the Capstone area, and between 0 and 12 take-off accidents.

Figure 3-2. Projected Range of Accidents, by Cause, with Estimated Potential Reduction from Capstone Technology, 2002



Legend

🟩 Expected Prevention

■ Accidents Remaining

I Expected Accidents - Range

These data show projected–not observed–accidents in 2002, calculated by adjusting annual average accidents from 1990 through 1999 upwards for increased operations

The green "expected prevention" bars –navigation and traffic only–show the number of accidents we project Capstone could have prevented, given that Capstone was not fully implemented in 2002.

The gray "accidents remaining" bars show accidents that (1) have causes that Capstone does not address; (2) have causes Capstone does address, but we wouldn't expect Capstone to prevent because it was not fully implemented; or (3) have causes Capstone does address, along with other causes that it does not address, so they may happen despite Capstone.

The number of accidents varies from year to year by chance. The "Expected Accidents – Range" bars reflect the expected range of this variation around the mean.

The number of accidents Capstone might have prevented is small, compared with the total number of accidents and the annual variation in numbers of accidents: on average, it might have prevented about one navigation accident and just less than one-half a traffic accident per year, compared with an expected range of zero to four navigation accidents and zero to two traffic accidents, based on historical figures.[26] Table 3-1 summarizes where the actual number of accidents, in the entire Capstone area and within just the Y-K Delta, fell in the historical range. Figures 3-3 and 3-4 provide the detail supporting the table. Figure 3-3 (next page) shows the 25 accidents that occurred in the Capstone area and the 9 in the Y-K Delta in 2002 by the nine accident cause categories (inner pie) and selected sub-categories (outer ring). Figure 3-4 (page 39) shows both the expected (from Figure 3-2) and actual 2002 accidents by cause category.

Table 3-1. Comparison of Projected and Observed Accidents, 2002

Cause Category:	Capstone Area	Y-K Delta Part-135	Y-K Delta Part-135 Fatal
Landing	In Range	In Range	0/0
Take-Off	In Range	In Range	0/0
Mech & Other	Low End of Range	Low End of Range	Low End of Range
Prep & Fuel	In Range	Low End of Range	Low End of Range
Flight Info	Low End of Range	Low End of Range	0/0
Navigation	**In Range**	**In Range**	**In Range**
Traffic	**In Range**	**In Range**	**Low End of Range**

We categorized the results, for each cause category and in each area, as "In Range," "Low End of Range," or 0/0 (meaning that no accidents were expected or occurred). The shaded causes are those Capstone is designed to prevent–navigation and traffic. Accidents from those two causes were either within the historical range or at the low end of the range (as shown in Figure 3-4) for the entire Capstone area and for Y-K Delta operators. Traffic accidents may appear to be at the top of their range, but in fact are not. The range is zero to two; most traffic accidents-including the one that occurred in the Capstone area in 2002–involve two aircraft, and so count as two accidents. Therefore, within the range we could only have observed zero or two accidents, and so either zero or two is "Within Range" rather than "Low End" or "High End." In the navigation category, we projected Capstone could potentially have prevented one of the two accidents that occurred.

But accident narratives for both navigation accidents reveal that there were additional causes that could have kept Capstone from preventing the accidents. In one case, the cause of the accident is still unknown, but we know weather was a factor–icing may have been the cause. In the other accident, the pilot took off from a new runway, oriented differently from the old runway that was still in the database, and also encountered turbulence. These comparisons are very similar to what we found in the *Interim Report* comparing Capstone area projected and observed accidents for 2000-2001.

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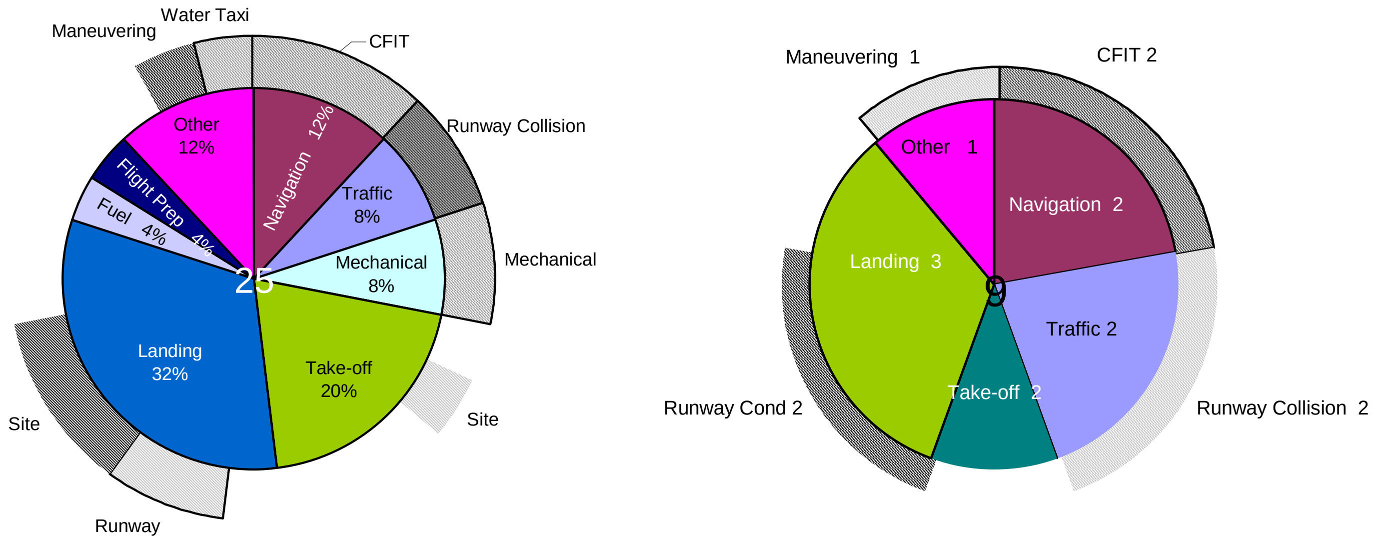
[26] This is further complicated by the fact that we can't observe fractions of accidents. Traffic accidents, because they almost always involve 2 aircraft, occur in twos. So, although two is the top of the expected range for traffic, it is also the first number above zero we would likely observe.

Figure 3-3. Capstone Area and Y-K Delta Part-135 Operator Accidents by Cause, 2002



Capstone Area

Y-K Delta Part-135

Nine Cause Categories (inner pies)

1. **Mechanical:** Engine failure, inoperable control surfaces, failed landing gear, propeller or shaft failure.
2. **Navigation:** Controlled Flight into Terrain (CFIT) while en route is often associated with reduced visibility and small navigational errors. Some CFIT accidents are due to pilots being off-course.
3. **Traffic:** Usually mid-air collisions. Also includes ground accidents from last-moment avoidance of other aircraft and from jet blast on airport surface.
4. **Flight Information**: Usually accidents that result from inadequate weather information and are often caused by icing, sometimes poor visibility, but rarely convective weather.
5. **Fuel**: Accidents caused by running out of fuel.
6. **Flight Prep:** Accidents caused by a variety of poor flight preparation measures, including failure to insure that cargo is tied down and within weight and balance limits, failure to check for water in fuel.
7. **Takeoff:** Accidents during take-off, including pilots' failure to maintain control in wind, improper airspeed, poor runway conditions and obstacles at off-runway sites.
8. **Landing:** Accidents during landing, including pilots' failure to maintain control in wind, improper airspeed, poor runway conditions and obstacles at off-runway sites.
9. **Other:** Includes hitting birds, colliding with ground vehicles, pilots under the influence of alcohol or drugs.

Detailed Sub-Categories (outer ring)

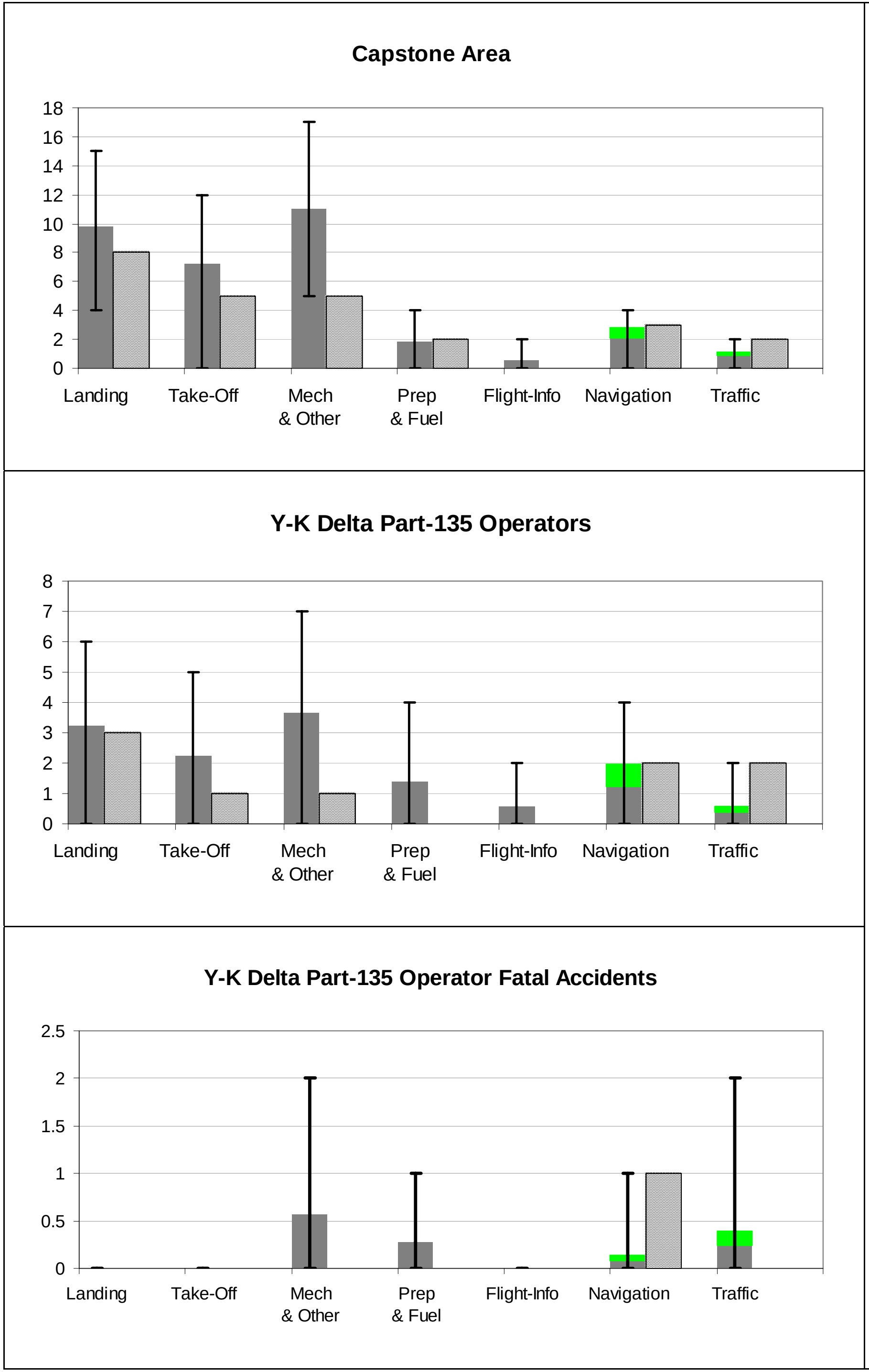
Capstone-Relevant Causes

1. **CFIT:** Controlled Flight into Terrain accidents
2. **Runway Collision**: Collisions between aircraft on the ground.

Other Causes

3. **Runway:** Accidents on take-off or landing related to runway conditions such as potholes, debris on the runway
4. **Site:** unusual hazards at off-runway sites
5. **Water taxi**: collisions with objects (not a/c) while taxiing on the ocean, rivers or lakes.
6. **Maneuvering**: Typically, stalling the aircraft while maneuvering

Figure 3-4. Projected versus Actual Accidents, 2002
with Estimated Potential Effect of Capstone Technology



These charts compare the projected 2002 accidents from Figure 3-2 with accidents that occurred in 2002. The gray bars and range bars on the left are the same as in Figure 3-2; the striped bars on the right are actual 2002 accidents.

The green "expected prevention" bars –navigation and traffic only– show the number of accidents we project Capstone could have prevented, given that Capstone was not fully implemented in 2002.

The gray "accidents remaining" bars show accidents that(1) have causes that Capstone does not address; (2) have causes Capstone does address, but did not prevent because it was not fully implemented; or (3) have causes Capstone does address, along with other causes that it does not address, so they may happen despite Capstone.

The number of accidents varies from year to year by chance. The "Expected Accidents – Range" bars represent the range of total projected accidents–prevention plus remaining plus no impact–that reflects that chance variation, projected into the future.

3.2 Y-K Delta Part-135 Accidents, Equipped and Non-Equipped Aircraft

Another way of evaluating the possible safety benefits of Capstone is comparing the accident rates between equipped and non-equipped part-135 aircraft based in the Y-K Delta from 2000 though 2002. Aircraft were gradually equipped over the evaluation period, and for much of the period there were no systematic differences in how equipped and non-equipped planes were used and the conditions they flew in. In the first months of 2000, when few aircraft were equipped and few pilots had training or experience with Capstone, equipped aircraft may have been more likely than non-equipped to be piloted by someone unfamiliar with that aircraft's avionics. And by the second half of 2002, when over 90 percent of the fleet was equipped, non-equipped aircraft may have been flown only when equipped aircraft weren't available. Still, these two groups of aircraft provide the most sensitive measure of the safety effects of Capstone avionics.[27]

We know when aircraft were returned to service after Capstone avionics were installed; we also know approximately how many aircraft part-135 operators had that were not equipped. This information allows us to calculate the number of total aircraft-days for equipped and non-equipped aircraft in the Y-K Delta part-135 fleet[28] (Figure 3-5, next page). Given accidents over the same time periods, we can calculate the accident rate per aircraft day, shown in Figure 3-6 (next page).

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[27] Comparing equipped and non-equipped sub-populations is convenient for direct assessment of safety changes associated with Capstone's implementation. Aircraft turnover (due to accidents and to companies' changing their operations) means that Y-K Delta part-135 operators still operated a few non-equipped aircraft through 2002. By December 2002, we estimate only about three of the aircraft routinely operated by Y-K Delta part-135 operators were not equipped. All the results must be interpreted with caution, because of the small numbers of accidents in each sub-group each year.

[28] We eliminated some Capstone-equipped aircraft from the analysis: Northern Air Cargo aircraft fly under part 121; PenAir is no longer a Y-K Delta part-135 operator, nor are UAA, FAA, and the U.S. Fish and Wildlife Service. This was necessary because we had to define the fleet strictly as Y-K Delta part-135 operators to be consistent in our counts of equipped aircraft, non-equipped aircraft and accidents. We kept ERA Aviation aircraft in the analysis, because although ERA is a part 121 carrier, it flies a defined fleet of Capstone-equipped aircraft in the Y-K Delta area, operating within the delta much like the part-135 operators participating in Capstone.

Figure 3-5. Count of Equipped and Non-Equipped Aircraft-Days, Y-K Delta Part-135 Operators

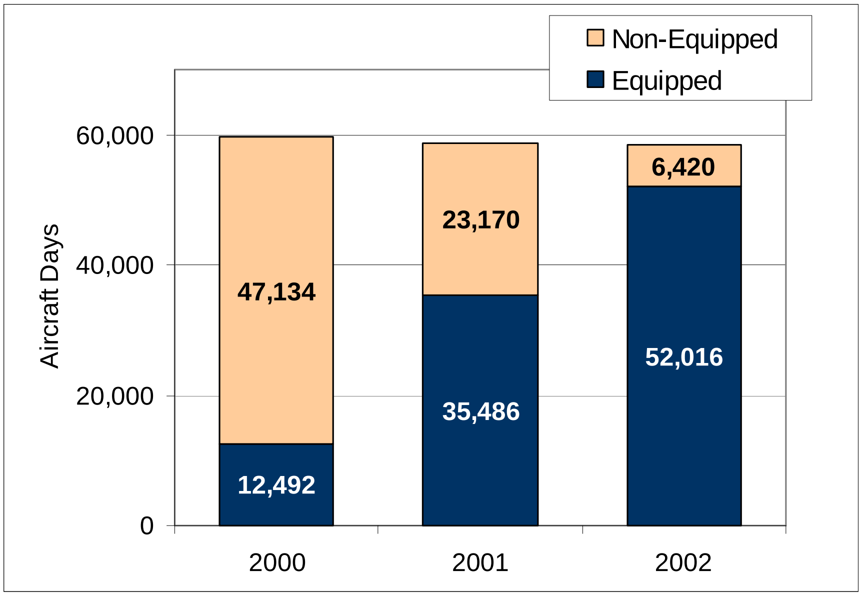
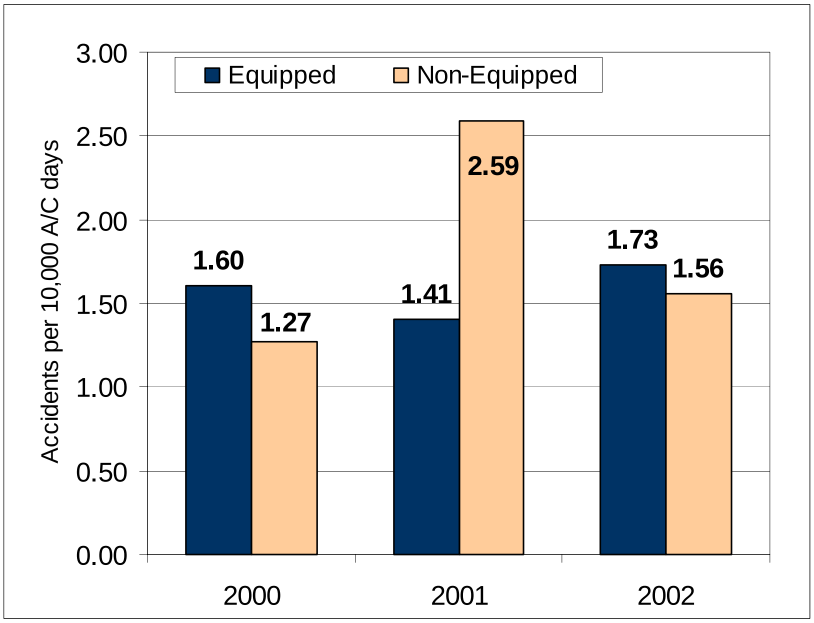


Figure 3-6. Accident Rates for Capstone Equipped and Non-Equipped Aircraft, Y-K Delta part-135 Operators



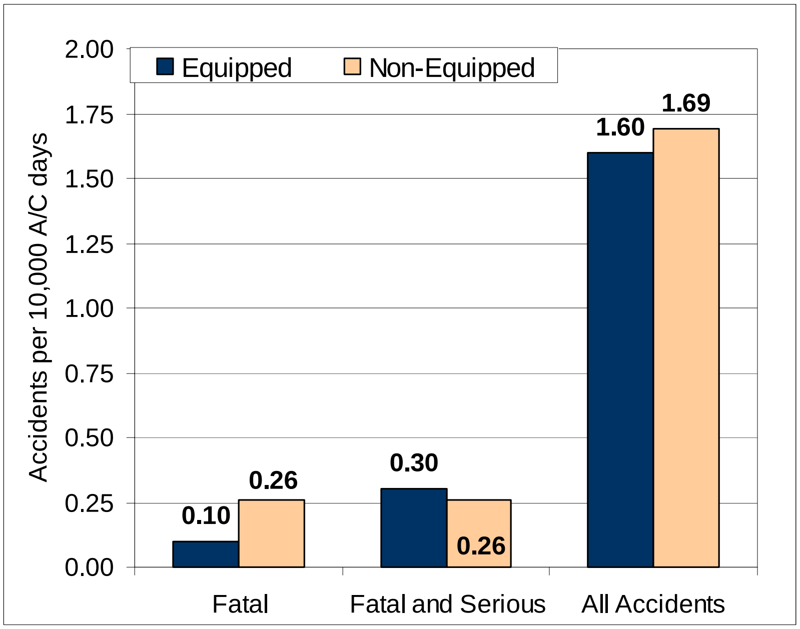
The aircraft days and accident rates for 2000 and 2001 are revised slightly from those published in the *2000/2001Interim Report*. In those earlier calculations, we let the fleet shrink by one aircraft with each crash, although in many cases the aircraft sustained only minor damage. When we extended the analysis into a third year, this was no longer a reasonable simplification, as it would have resulted in assuming that the fleet (which has stayed about the same size) shrank from about 165 to fewer than 140 aircraft. Therefore, we revised our methodology to return aircraft into the fleet after 0, 30, or 90 days, depending on the damage reported in accident narratives. Only if the aircraft was reported destroyed (four cases) did we subtract it from the fleet. This change resulted in slightly lower accident rates for both equipped and non-equipped aircraft.

In 2000, equipped and non-equipped aircraft belonging to Y-K Delta part-135 operators had similar accident rates. In 2001, the rate of accidents among Capstone-equipped aircraft was only about half that of non-equipped aircraft. In 2002, rates among equipped- and non-equipped aircraft were again very similar. However, the small number of non-equipped aircraft and accidents in 2002 means that we have to interpret these comparisons with caution. For example, in 2002 one more accident involving a non-equipped plane would have doubled that rate; one fewer would have dropped it to zero.

If we look at all accidents, for the entire three-year period (Figure 3-7 below), the accident rate for Capstone-equipped aircraft was 1.6 per 10,000 aircraft days, compared with a rate 0f 1.69 among non-equipped aircraft. But that difference is slight; just one more accident among equipped aircraft would have made the rate the same as for non-equipped aircraft.

But for just fatal accidents, the rate among non-equipped aircraft was 2.6 times higher than among equipped aircraft from 2000 through 2002. There is a three in four chance that this difference actually reflects a lower underlying accident rate. In other words, there is about a 75 percent chance that Capstone-equipped aircraft had a lower rate of fatal accidents, and that the difference was not due just to chance variation.

Figure 3-7. Fatal, Serious, and Total Accident Rates for Equipped and Non-Equipped Aircraft, Y-K Delta part-135 Carriers, 2000 – 2002



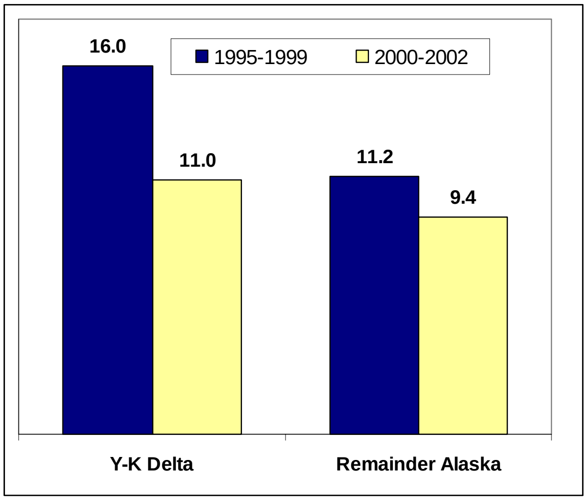
3.3 Part-135 Accidents in the Y-K Delta and Elsewhere in Alaska

Another way of assessing safety improvements in the Y-K Delta is examining this question: Is the reduction in accidents the result of safety improvements in the Y-K Delta, or does it reflect a statewide decline in accidents? To assess this question, we also looked at the commuter and air taxi accident rates per 10,000 departures for the Y-K Delta compared with the rest of Alaska, both during the baseline period (1995-1999) and in 2000-2002. Figure 3-8 below shows that both statewide and Y-K Delta accident rates for part-135 operators declined in the 200-2002 period–but the drop was much greater among operators in the Y-K Delta: a 15 percent drop in rates statewide, compared with 30 percent in the Y-K Delta.

These figures imply that Y-K Delta safety efforts–of which the Capstone program is a major part–are paying dividends. The safety improvements are helping all the area's part-135 pilots. This finding is not surprising, since the additional training and safety emphasis pilots receive through the Capstone program help them fly more safely, whether or not their aircraft is equipped with Capstone avionics. The instrument approaches and additional weather information Capstone provides are likewise helpful to pilots of non-equipped as well as equipped aircraft.

The importance of the Capstone program in those safety efforts is made clear by the fact that accidents rates among part-135 operators in the Y-K Delta have declined much more than among those operators statewide. There are many differences between the Y-K Delta and other parts of Alaska–but those differences were the same in the 1990s as in the 2000-2002 period. Likewise, there are other efforts to improve safety, in addition to the Capstone program. But most of those, like the Medallion Foundation, are statewide. Capstone is the most striking difference in aviation safety efforts between the Y-K Delta and the rest of Alaska.

Figure 3-8. Accidents per 10,000 Departures for Part-135 Operations, Baseline (1995-1999) and Current (2000-2002) Y-K Delta and the Remainder of Alaska



3.4 User Assessments of Capstone Safety Benefits and Problems

A final way of assessing safety changes resulting from Capstone is asking the pilots who use the new technology what they think. During the baseline study, in the winter of 2001/02, and again in November 2002, UAA asked pilots to assess the expected safety benefits of Capstone. The pilots we talked to in the baseline period were familiar with Capstone and some had had classroom training, but few had flown with the equipment. In 2001/02 all the pilots had flown aircraft with Capstone avionics, although a significant number (over 10 percent) had not been trained to use the equipment. In November 2002, all the pilots we talked with had received at least some training on the equipment.

We asked pilots about 11 potential benefits and gave them an opportunity to cite benefits that we had not listed. (Almost no one did). They rated each potential benefit on a 1-to-5 scale from “no benefit” to “major benefit.”[29] Figure 3-9 (pages 45-47) summarizes their answers about expected safety benefits.

In general, pilots tended to rate the safety benefits lower in 2001/02 than they had in the baseline period. This pattern is consistent with pilots’ optimistic expectations giving way to reality as they gained experience using Capstone avionics. The November 2002 answers are generally more optimistic than those from the previous winter, although still not as optimistic as in the baseline. This probably reflects both higher training levels and greater experience. We documented the increased training levels earlier in this report. Interviews and observations throughout the safety study have indicated that both training and experience are critical if pilots are to benefit from Capstone.

Some of these ratings also reflect experience with Capstone implementation. Pilots assessed “improved SVFR procedures” far lower in 2001/02 than in the baseline—which is not surprising, since that potential use of Capstone is not yet implemented. However, ratings went up again in 2002–perhaps reflecting pilots’ perceptions that the FAA is making progress in this area, even though it is still not implemented. The other area where pilots’ assessments went down, and then back up, is in search and rescue capabilities. By November 2002, pilots in the Y-K delta had seen the equipment used for a successful search and rescue effort.

The majority of pilots rated all the potential benefits we listed as at least of minor benefit. The percentage that chose 3, 4, or 5 ranged from 60 to 97 percent, except for the two measures that involved new instrument approaches–“fewer cancelled flights” and “safer operations at remote airports.” In order for IFR benefits to be fully realized, operators will have to gain instrument capability as well.

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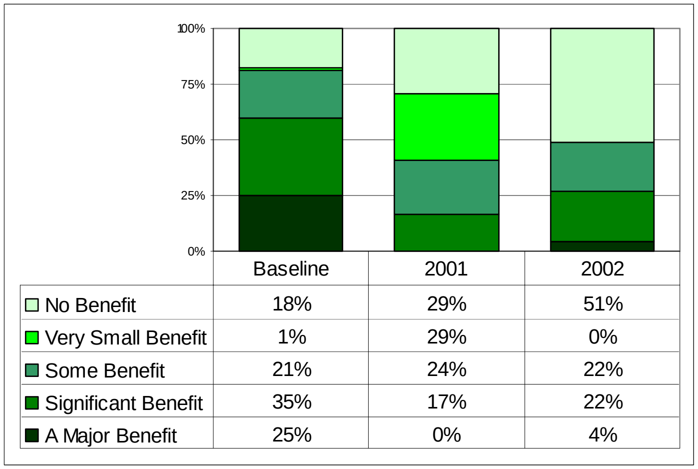
[29] Some baseline and 2000/01 percentages are different than in the *Baseline* and *2000/2001 Interim* reports because the results have been re-weighted for consistency across the three survey periods.

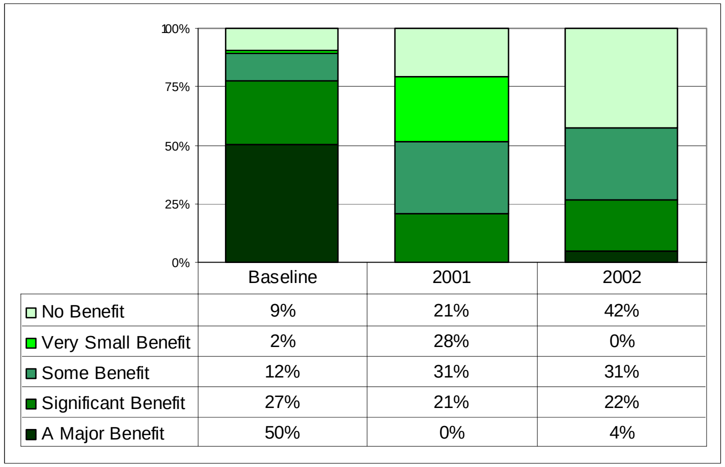
Figure 3-9. Pilots Assessment of Capstone's Potential Benefits: Baseline, 2001, and 2002

a. Fewer cancelled flights due to new instrument approaches at remote airports



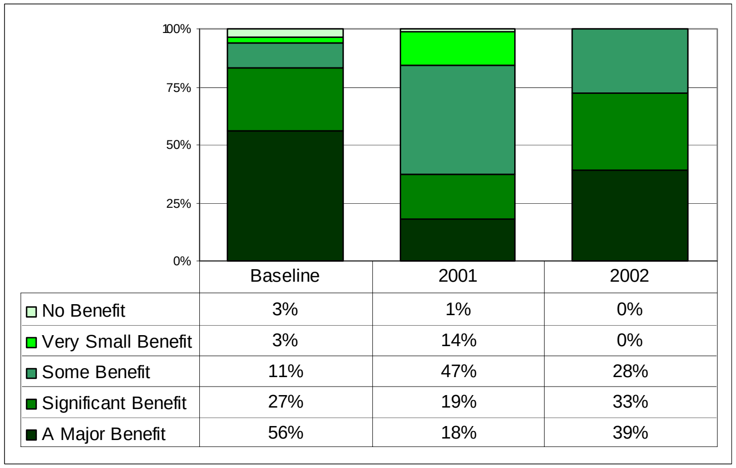
	Baseline	2001	2002
No Benefit	18%	29%	51%
Very Small Benefit	1%	29%	0%
Some Benefit	21%	24%	22%
Significant Benefit	35%	17%	22%
A Major Benefit	25%	0%	4%

b. Safer operations at remote airports due to new instrument approaches



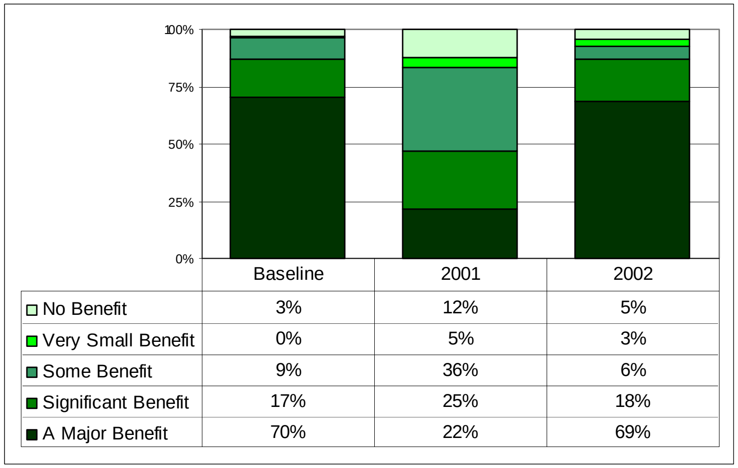
	Baseline	2001	2002
No Benefit	9%	21%	42%
Very Small Benefit	2%	28%	0%
Some Benefit	12%	31%	31%
Significant Benefit	27%	21%	22%
A Major Benefit	50%	0%	4%

c. Safer flying in minimum legal VFR conditions



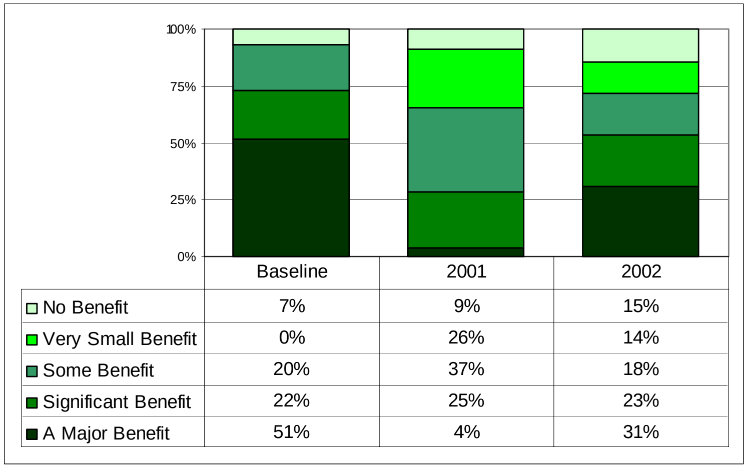
	Baseline	2001	2002
No Benefit	3%	1%	0%
Very Small Benefit	3%	14%	0%
Some Benefit	11%	47%	28%
Significant Benefit	27%	19%	33%
A Major Benefit	56%	18%	39%

d. Fewer near mid-air collisions



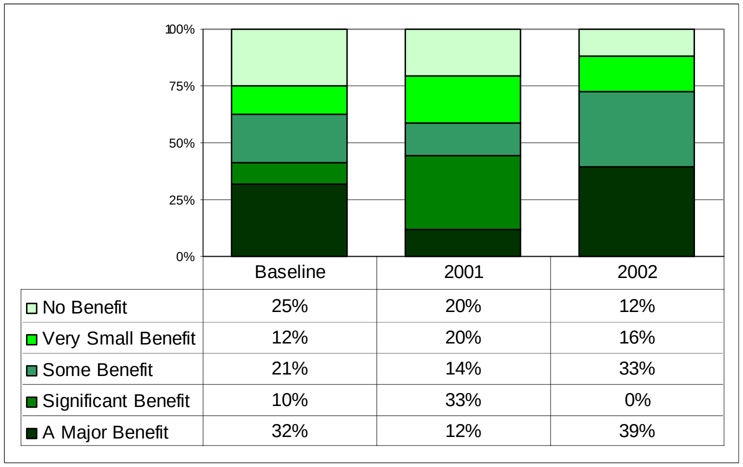
	Baseline	2001	2002
No Benefit	3%	12%	5%
Very Small Benefit	0%	5%	3%
Some Benefit	9%	36%	6%
Significant Benefit	17%	25%	18%
A Major Benefit	70%	22%	69%

e. More useful weather information



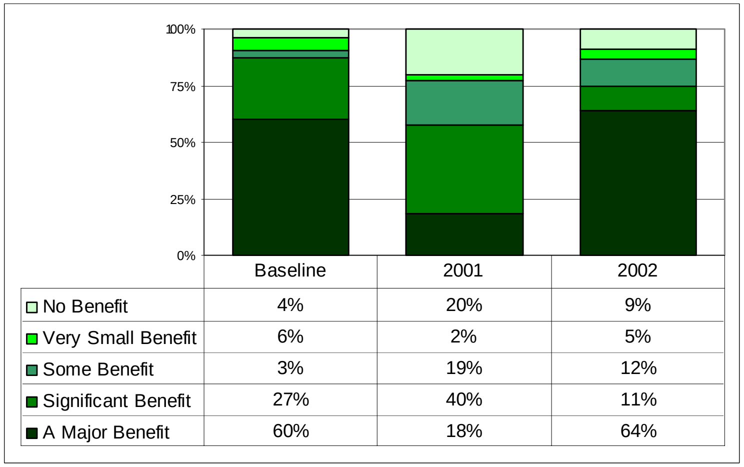
	Baseline	2001	2002
□ No Benefit	7%	9%	15%
■ Very Small Benefit	0%	26%	14%
■ Some Benefit	20%	37%	18%
■ Significant Benefit	22%	25%	23%
■ A Major Benefit	51%	4%	31%

f. Better knowledge of other aircraft and ground vehicle locations when taxiing



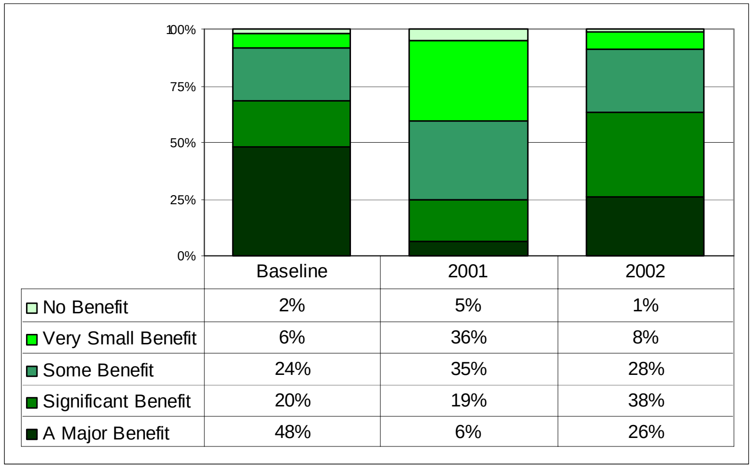
	Baseline	2001	2002
□ No Benefit	25%	20%	12%
■ Very Small Benefit	12%	20%	16%
■ Some Benefit	21%	14%	33%
■ Significant Benefit	10%	33%	0%
■ A Major Benefit	32%	12%	39%

g. Improved SVFR procedures due to better pilot and controller knowledge of aircraft locations



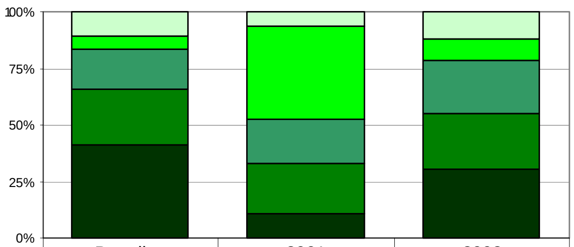
	Baseline	2001	2002
□ No Benefit	4%	20%	9%
■ Very Small Benefit	6%	2%	5%
■ Some Benefit	3%	19%	12%
■ Significant Benefit	27%	40%	11%
■ A Major Benefit	60%	18%	64%

h. Easier in-flight diversions or re-routes



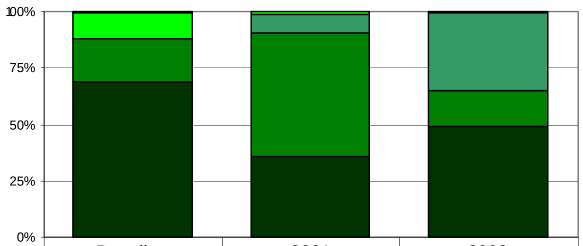
	Baseline	2001	2002
□ No Benefit	2%	5%	1%
■ Very Small Benefit	6%	36%	8%
■ Some Benefit	24%	35%	28%
■ Significant Benefit	20%	19%	38%
■ A Major Benefit	48%	6%	26%

i. Time savings from more direct flight routes



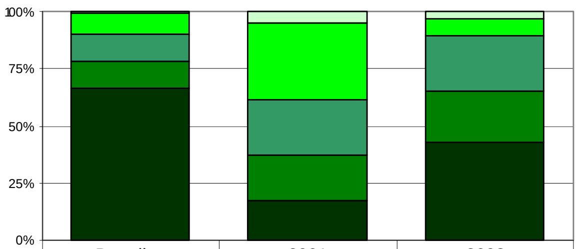
	Baseline	2001	2002
□ No Benefit	11%	6%	12%
■ Very Small Benefit	6%	41%	9%
■ Some Benefit	17%	20%	24%
■ Significant Benefit	25%	22%	24%
■ A Major Benefit	41%	11%	30%

j. Improved terrain awareness for pilots



	Baseline	2001	2002
□ No Benefit	1%	0%	0%
■ Very Small Benefit	11%	1%	1%
■ Some Benefit	0%	9%	35%
■ Significant Benefit	20%	55%	16%
■ A Major Benefit	68%	35%	49%

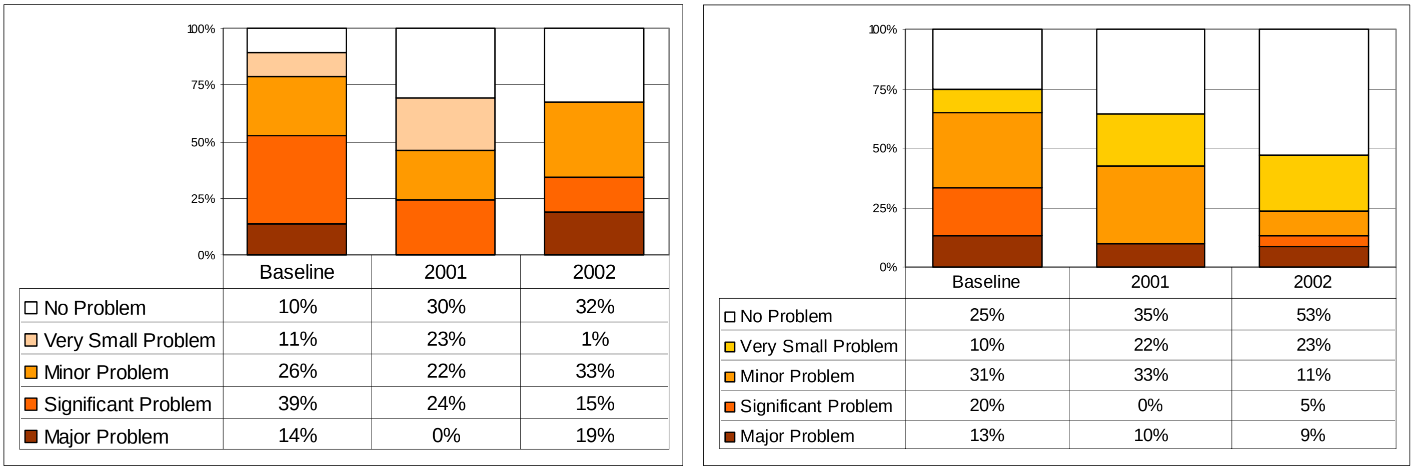
k. Improved search and rescue capabilities



	Baseline	2001	2002
□ No Benefit	1%	5%	3%
■ Very Small Benefit	9%	33%	8%
■ Some Benefit	12%	25%	24%
■ Significant Benefit	11%	20%	22%
■ A Major Benefit	67%	17%	43%

As Figure 3-10 shows, the pilots' ratings of potential Capstone problems generally declined from the baseline study period to 2002, with pilots much more likely to say that less heads-up time, heavier cockpit workload, and traffic congestion were "no problem." Pilots' attitudes about potential problems with the equipment are strongly affected by their training and experience with that equipment. Their concerns about heads-up time and cockpit workload obviously decline as their ability to use the equipment improves. It's less obvious why their concerns about traffic congestion on point-to-point routes also declined so dramatically, and we'll be looking into that in our next set of interviews.

Figure 3-10. Pilot Assessments of Capstone's Potential Safety Problems, Baseline, 2001, and 2002



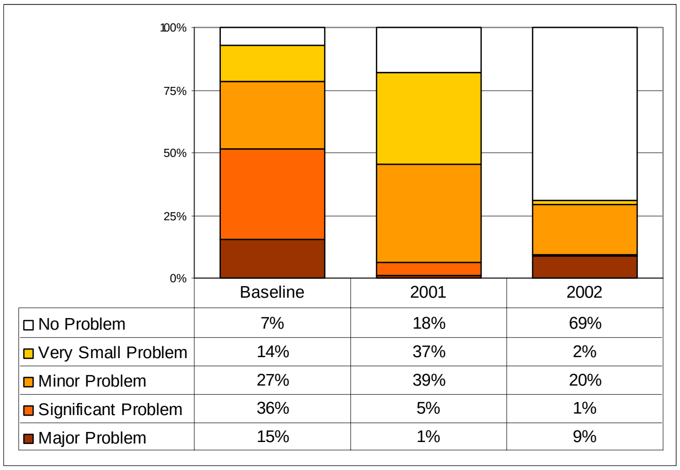
a. Less Heads-up Time

	Baseline	2001	2002
☐ No Problem	10%	30%	32%
🟧 Very Small Problem	11%	23%	1%
🟧 Minor Problem	26%	22%	33%
🟥 Significant Problem	39%	24%	15%
🟫 Major Problem	14%	0%	19%

b. Heavier Cockpit Workload

	Baseline	2001	2002
☐ No Problem	25%	35%	53%
🟨 Very Small Problem	10%	22%	23%
🟧 Minor Problem	31%	33%	11%
🟥 Significant Problem	20%	0%	5%
🟫 Major Problem	13%	10%	9%

c. More aircraft flying in the same airspace/point-to-point routing



	Baseline	2001	2002
☐ No Problem	7%	18%	69%
🟨 Very Small Problem	14%	37%	2%
🟧 Minor Problem	27%	39%	20%
🟥 Significant Problem	36%	5%	1%
🟫 Major Problem	15%	1%	9%

3.5 Interim Evaluation

Table 3-2 summarizes our assessment of Capstone's effects on safety through 2002. The first column lists individual capabilities or factors that might affect safety. The next group of columns characterizes the implementation status of each capability in 2000 through 2002. The third group of columns assesses the effects of each capability as of December 2002. The light blue (X→) represent the evaluations in the *2000/2001 Interim Report*, if they were different from those in this report. Both ratings of "Nearly Complete by 12/31/01" and "Partly Implemented" in the *Interim Report* are represented here with a light blue X in "Partly Implemented."

Table 3-2. Capstone Phase I: Interim Assessment of Safety Effects by Components and Capabilities

	No Y-K Delta part-135 Implementation	Planned Future Implementation	Partly implemented	Nearly Complete by 12/31/02	Completed	Negative	Not Known or Not Significant	Positive	Very Positive
Capability or Contributing Factor	Status					Impact: 2000 - 2002			
Navigation Systems									
Enroute Terrain (CFIT) Avoidance			(X→)		X		X		
Approach Terrain (TCF) Avoidance	X								
Location			(X→)		X		X		
Non-precision Instrument Approaches			(X→)	X			X		
Flight Information Systems									
FIS-B: text weather				X			X		
FIS-B: graphical weather			X				X		
FIS-B: additional AWOS observations		X					X		
Spatial Icing product		X					X		
Additional AWOS (VHF voice)			(X→)		X		X		
Pilot reports guided by traffic display				X				X	
Traffic Systems									
Cockpit display of ADS-B aircraft			(X→)	X			X		
Cockpit Display of Transponder a/c (TIS-B)	X						X		
Radar-like Services: Surveillance			(X→)	X			(X→)	X	
Radar-like Services: Approach Control		X					X		
Tower "Bright" display		X					X		
Flight Following for operators		(X→)		X			X		
Over-all									
Installation of Capstone Avionics				X				X	
Installation of Ground Systems			X					X	
Pilot training on Capstone Avionics			(X→)	X				X	
Operator Safety Postures			X					X	
IFR Capable operations			X					X	

Our confidence in these assessments varies, depending on the available data. Table 3-3 describes the basis for our assessments. A few consist only of a conjectured rationale for improved safety, which should be regarded skeptically. The best are measured changes in accident rates, which over time will provide very high confidence. At this time the grounding for most of our assessments is in between these extremes and is based on (1) what pilots and operators using the equipment have told us, and (2) on measurement of factors that contribute to changes in safety, but are not themselves measures of improved safety. Each of these is an interim evaluation that we can make with more confidence later, when Capstone has been in existence longer.

Table 3-3. Capstone Phase I: Basis for Assessments of Safety Effects by Components/Capabilities

	Rationale for Benefit	Ability to Characterize Potential Benefits	Consistent with User Expectations	Factors in Rationale Measured	Assessed change in accidents
Capability or Contributing Factor					
Navigation Systems					
En Route Terrain (CFIT) Avoidance	X	X	X	X	
Approach Terrain (TCF) Avoidance	X	X			
Location	X	X			
Runway Alignment	X				
Non-precision Instrument Approaches	X			X	
Flight Information Systems					
FIS-B: text weather	X				
FIS-B: graphical weather	X				
FIS-B: additional AWOS observations	X				
Spatial Icing product	X	X			
Additional AWOS (VHF voice)	X			X	
Pilot reports guided by traffic display	X	X		X	X
Traffic Systems					
Cockpit display of ADS-B aircraft	X	X	X	X	
Cockpit Display of Transponder a/c (TIS-B)	X				
Radar-like Services: Surveillance	X	X			
Radar-like Services: Approach Control	X		X		
Tower "Bright" display	X		X		
Flight Following for operators	X		X		
Over-all					
Installation of Capstone Avionics	X	X	X	X	X
Installation of Ground Systems	X	X	X	X	X
Pilot training on Capstone Avionics	X	X		X	
Operator Safety Postures	X			X	X
IFR Capable operations	X			X	

Based on Tables 3-2 and 3-3, as well as the accident data analysis, we developed some interim assessments of the effects on aviation safety of Capstone Phase I in southwest Alaska between 2000 and 2002:

- *Accidents among Capstone-equipped aircraft declined slightly more than accidents among non-equipped aircraft during 2000-2002, but the difference was too small to demonstrate that Capstone alone reduced accidents.* Figure ES-4 (facing page) shows that equipped aircraft crashed at a rate of 1.6 per 10,000 aircraft days, compared with 1.69 among non-equipped aircraft. That difference is too slight to base any conclusions on. But with more data, we should be better able to distinguish the effects of Capstone from the effects of other changes that may also be improving safety.

- *From 2000 to 2002, Capstone-equipped aircraft in the Y-K Delta had a lower fatal accident rate than non-equipped aircraft.* As Figure ES-4 shows, aircraft with and without Capstone equipment were about equally likely to be involved in serious accidents in 2000-2002. But when we look at fatal accidents alone, the rate was twice as high among aircraft without Capstone equipment. There's about a 75 percent chance that this difference indicates a lower underlying rate that will continue into the future.

- *Capstone may be helping to prevent serious accidents from becoming fatal.* One of Capstone's features is flight surveillance with radar-like services. That feature may have prevented a serious accident with a Capstone-equipped aircraft in 2002 from becoming a fatal accident. Because of flight surveillance, the plane's flight trajectory was known–so the search and rescue mission quickly located the downed plane.

- *Safety posture–the entire environment affecting safety–has substantially increased in the Capstone area*. That improvement is evident in the reduced accident rates cited above. And the Capstone program played a significant role in that improvement, in particular through providing additional weather stations, GPS approaches, avionics, and pilot training.

- *Pilots and operators are generally pleased with the program*. Their expectations may have originally been too optimistic; their views about the potential benefits and problems associated with Capstone have become more realistic. They still see the program's benefits as valuable and the problems as tractable with training and experience. And indeed, as more pilots become better trained, user assessments of potential problems have diminished.

- *Unanticipated or auxiliary uses of Capstone equipment may be producing safety benefits*. Flight surveillance with radar-like services may have prevented a serious accident with a Capstone-equipped aircraft in 2002 from becoming a fatal accident. With the flight trajectory known, the search and rescue mission located the downed plane rapidly. Pilots also told us that they get up-to-date information on their destinations by contacting other pilots at those locations—and they identify those pilots using Capstone's ADS-B feature. This could explain the absence of landing accidents attributed to poor runway conditions in 2001, since pilots can learn about those conditions in advance and be prepared for them. However, landing accidents recurred in 2002, so it is not clear that this Capstone has had a systematic effect in that area.

- *Improved infrastructure that supports IFR flight is encouraging Y-K Delta operators to use IFR operations.* Additional weather stations and GPS approaches have increased the number of Y-K Delta airports with instrument approaches from 3 to 11, with 3 additional instrument approaches added at southwest Alaska airports outside the Y-K Delta. At the same time, the number of IFR-certified commercial aircraft operating in the area rose from 8 to 22 and will likely continue to increase.

• *Accidents still happen—even some of the types that Capstone was designed to prevent*. Human factors—ranging from overconfidence to relying on technology that may not be perfect—appear to explain at least some of the discrepancy between expectations and experience. We know that both pilot training and attitude are important in helping Capstone be fully effective. These kinds of changes take more time than it takes to install avionics and ground systems.

• *Capstone's full benefits weren't apparent during this evaluation period*, because the program was still only partly implemented. While 90 percent of Y-K Delta part-135 operators' aircraft were on average equipped in 2002, not all the traffic and flight information capabilities were functional, even by December 2002. There are still a few pilots with no training, and many with only limited training and experience with the equipment. Given this partial implementation, it is still unrealistic to expect to be able to observe a systematic reduction in crashes due to Capstone.

4 Findings and Recommendations

Capstone Phase I had been largely but not fully implemented by the end of 2002. Nearly 90 percent of the Y-K Delta part-135 fleet had Capstone avionics installed by the close of 2002. About 90 percent of pilots had received some training to use Capstone systems, but nearly half lacked flight training—yielding an estimated training effectiveness of 67 percent. To fully realize Capstone’s potential benefits, the FAA would have to equip the entire fleet and fully implement the ground infrastructure to support the system’s capabilities. Operators must continue to provide training and support for pilots to use the equipment effectively, especially as new pilots are hired.

Despite a number of positive indications of safety improvements, there is insufficient evidence to say that the Capstone program has systematically reduced crash risks in the region. However, the short study period and the random variation in crashes from year to year mean that there would have to be a dramatic—and probably unrealistic—reduction in crashes to allow us to determine statistically that Capstone has made a difference. However, we do know that it has improved search and rescue capabilities in the region–which has the potential to reduce the severity of injuries and the number of fatalities associated with serious crashes that do occur. That, and the improved safety posture Capstone has facilitated, are the most important safety benefits of the program so far.

Our preliminary recommendations include:

• *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’re 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 have used the equipment for a longer period can we expect to see the program’s full safety benefits.

• *The Capstone program won't see its full benefits until pilots and operators use all its capabilities*. Safety research needs to continue tracking pilot and operator attitudes about the program and assessing the effectiveness of pilot training. Pilots and operators continue to worry that the system may be used for enforcement. The Flight Standards District Offices (FSDOs) need to assure them that the technology won't be used for enforcement.

• *Operators also need to allocate time and money for thorough initial and continuing training*. FAA oversight could help to insure this happens. Pilots have observed that Capstone training helps newly hired pilots become productive sooner, but caution that this may leave them inadequately prepared for the hazards of flying in the region. Also, pilots have expressed concerns that some pilots may become overconfident, mistakenly believing that the traffic display shows all traffic, rather than just Capstone-equipped traffic. Capstone training is not a substitute for other types of training.

• *Simulators with Capstone avionics, available at UAA by 2003, will be a valuable addition to the pilot training currently available*. Pilots report that the learning curve is steep for some functions of the Capstone avionics package, and the FAA should encourage simulator training as a safe, cost-effective way to provide the necessary training.

- *To get the most benefit out of data-link weather and other relevant information* Capstone potentially makes available in the cockpit, pilots need to be able to access this information wherever they fly and not just in a part of the Y-K Delta. It's important to increase the number of ground-based transceiver stations so they cover at least the full Y-K Delta.
- *To fully realize the potential benefits of radar-like services, the FAA should work to implement* approach-control services for Bethel airport using Capstone's capabilities.
- *To fully realize the potential benefits of the new GPS approaches and terrain awareness features*, the FAA needs to assure pilots and operators that data on runway locations and flight hazards remain continuously up to date.
- *When extending the program beyond the part-135 operators currently enrolled, the FAA should require future Capstone participants to provide information* on how often and where they fly, what training they provide, who their pilots are, and what their qualifications are. Lack of such information in the Y-K Delta continues to hamper our ability to estimate safety benefits.

Appendices

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Appendix A. Capstone Area Accidents, 2002

The table below summarizes the Capstone area accidents in 2002. Cause category explanations are listed below, with the abbreviations used in the table in parentheses.

Mechanical Engine failure, inoperable control surfaces, failed landing gear, propeller or shaft failure.

Navigation Usually Controlled Flight into Terrain (CFIT) while en route, most often associated with reduced visibility. In the YK Delta, CFIT also occurs in nominal VFR conditions when “flat light” on snow-covered ground prevents recognition of terrain. Terrain Clearance Floor (TCF) warnings are a Terrain Awareness and Warning System (TAWS) function planned for Capstone Phase 2 that addresses the 20%-30% of CFIT accidents on approach or departure. These are not directly addressed by Capstone Phase 1 avionics. Rarely, accidents are due to disorientation, which can be addressed by a GPS-map display.

Traffic Usually mid-air collisions or near mid-air collisions (NMACs) between aircraft. Also includes accidents from last-moment avoidance of other aircraft and from jet blast on airport surface.

Flight Information (Weather, Ice, IMC) Usually inadequate weather information, especially icing, but also visibility; rarely convective weather. (Surface winds contributing to take-off or landing accidents have been included under take-off or landing rather than here.) Occasionally, lack of information on changes in procedures or facility status.

Fuel Usually fuel exhaustion. Occasionally, failure to switch fuel tanks.

Flight Preparation Failure to ensure cargo is tied-down and within the aircraft’s weight and balance limits. Failure to check fuel for the presence of water. Rare in the lower 48 but significant in the YK Delta is failure to remove ice or snow from the aircraft – often resulting in serious or fatal accidents.

Take-off and **Landing** Failure to maintain control (especially in wind), improper airspeed, or inadequate care near vehicles or obstacles. The YK Delta also includes unusually high numbers of accidents due to poor runway **conditions**, hazards at off-runway sites such as beaches and gravel bars, and submerged obstacles struck by float-planes.

Other Includes unusual causes such as bird strikes or collisions with ground vehicles.

NTSB Report Number	**Date**	**Injury Level**	**FAR**	**Cause**	**Does Capstone Apply?**	**YK-Delta Based 135**	**Capstone Equipped?**
ANC02FA025	23-Mar-2002	FATAL	091	Weather	yes	no	no
ANC02LA044	07-Jun-2002	NONE	091	Take-off	no	no	no
ANC02LA074	11-Jul-2002	NONE	091	Take-off	no	no	no
ANC02LA095	13-Aug-2002	MINOR	091	Take-off	no	no	no
ANC02FA106	28-Aug-2002	FATAL	091	Landing	no	no	no
ANC02LA123	20-Sep-2002	NONE	135 as 91	Take-off	no	yes	no
ANC02LA024	20-Mar-2002	NONE	091	Landing	no	no	no
ANC02LA058	23-Jun-2002	SERIOUS	091	Fuel	no	no	no
ANC02LA071	07-Jul-2002	NONE	091	Other	no	no	no
ANC02LA102	11-Aug-2002	NONE	091	Mechanical	no	no	no
ANC02LA100	18-Aug-2002	NONE	091	Landing	no	no	no
ANC02LA109	29-Aug-2002	NONE	091	Landing	no	no	no
ANC02LA127	29-Sep-2002	NONE	091	Mechanical	no	no	no
ANC02LA047	11-Jun-2002	NONE	135 as 91	Landing	no	yes	yes
ANC02LA061	26-Jun-2002	NONE	135 as 91	Landing	no	no	no
ANC03LA007	28-Oct-2002	SERIOUS	135 as 91	Navigation	yes	yes	yes
ANC02FA014	04-Feb-2002	FATAL	135	Navigation	yes	yes	yes
ANC02LA016	24-Feb-2002	NONE	135	Landing	no	yes	yes
ANC02LA019	01-Mar-2002	NONE	135	Landing	no	yes	yes
ANC02LA043	06-Jun-2002	NONE	135	Other	no	no	no
ANC02LA066	30-Jun-2002	NONE	135	Landing	no	yes	yes
ANC02LA079	13-Jul-2002	NONE	135	Take-off	no	no	no
ANC03LA005A	22-Oct-2002	NONE	135	Traffic	yes	yes	no
ANC03LA005B	22-Oct-2002	NONE	135	Traffic	yes	yes	yes
ANC02TA036	16-May-2002	NONE	PUBU	Landing	no	no	no

Appendix B. Narratives for Capstone Area Accidents by Part-135 Operators

There were 25 accidents in the Capstone area in 2002. We provide NTSB narratives below for 13 of these accidents. Ten involved Y-K Delta part-135 carriers. All the operators of aircraft in those 10 accidents are Capstone program participants, and nine of the ten aircraft were Capstone-equipped. Two accidents occurred outside the Y-K delta area; the operator involved is based in Fairbanks and is not a Capstone participant. One accident was a public-use flight by the state of Alaska, Department of Public Safety.

NTSB Identification: **ANC02FA014**. Nonscheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Monday, February 04, 2002 in Bethel, AK Aircraft: Cessna 206, registration: N756HL Injuries: 1 Fatal.	Capstone Area: Yes Y-K Delta 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

HISTORY OF FLIGHT

On February 4, 2002, about 1042 Alaska standard time, a wheel-equipped Cessna 206 airplane, N756HL, was destroyed when the airplane collided with remote, snow-covered terrain, during cruise flight, about 80 nautical miles northwest of Bethel, Alaska. The airplane was being operated as a visual flight rules (VFR) on-demand cargo/U.S. mail flight under Title 14, CFR Part 135, when the accident occurred. The airplane was registered to a private individual, and operated by Flight Alaska, Inc., dba: Yute Air Alaska. The solo certificated commerical pilot received fatal injuries. Visual meteorological conditions prevailed at the departure airport, and no flight plan was filed. The flight originated at the Bethel Airport, Bethel, at 1004, and was en route to Chevak, Alaska.

According to the company's director of operations, when the flight failed to return to Bethel by 1430, company personnel initiated a phone search, and discovered that the flight had never reached Chevak. The flight was officially reported overdue to the Federal Aviation Administration (FAA) about 1545.

About 1209, an emergency locator transmitter (ELT) signal was received by a search and rescue satellite. Personnel from the Bethel wing of the Civil Air Patrol were dispatched to conduct an aerial search, and determine the source of the ELT signal. The Civil Air Patrol personnel reported that they were unable to complete the mission due to low clouds, low visibility, and icing conditions. At 1605, an Alaska Army National Guard HH-60 helicopter was dispatched from Bethel to begin an aerial search. The helicopter crew located the wreckage about 1650, about 70 miles east of Chevak, along the accident airplane's anticipated route of flight.

CREW INFORMATION

The pilot held a commerical pilot certificate with airplane single-engine land, single engine sea, and instrument airplane ratings. The most recent second-class medical certificate was issued to the pilot on April 6, 2001, and contained no limitations. No personal flight records were located for the pilot. According to company records, the pilot's total aeronautical experience consisted of 7,800 hours, of which 200 hours were accrued in the accident airplane make and model. In the preceding 90 and 30 days prior to the accident, the company listed the pilot's flight time as 20 and 10 hours, respectively. The operator hired the pilot on May 7, 2001. According to the operator's director of operations, prior to joining the company, the accident pilot had accrued extensive 14 CFR Part 135 experience flying in Alaska,. The pilot completed an airman competency/proficiency check flight under Title 14 CFR Part 135.293 (Initial and Recurrent Testing), and 135.299 (Pilot-in-Command Line Check), with the chief pilot for the operator in a Cessna 207 airplane on April 25, 2001. In the remarks section of FAA form number 8410-3 (airman competency/proficiency check form), the chief pilot wrote: "Demonstrated instrument proficiency."

The accident flight was the pilot's first flight of the day.

AIRCRAFT INFORMATION

The airplane had accumulated a total time in service of 10,607.2 hours. The most recent 100 hour inspection was accomplished on November 29, 2001, 46.2 hours before the accident. The engine had accrued a total time in service of 5,337.1 hours, and 844.5 hours since overhaul.

METEOROLOGICAL INFORMATION

According to the company's director of operations, the pilot obtained current weather information for Chevak from the flight-planning desk located at the operator's base of operation in Bethel. The director of operations reported that company operations personnel in Bethel collect this weather information by calling each village agent in the villages serviced by the operator.

In a written statement provided to the National Transportation Safety Board, the employee who prepared the weather information prior to the accident flight's departure, said that he called the village agent in Chevak about 0900, and requested the current weather conditions. He added that weather information and aircraft loading calculations were relayed to the accident pilot prior to his departure. According to company records provided by the operator, the 0900 weather for Chevak was reported as: Sky conditions and ceiling, 5,000 feet overcast; visibility, 20 statute miles; wind from the northeast at 10 knots.

The closest weather observation station to the accident site is Hooper Bay, Alaska, which is located about 60 nautical miles west of the accident site. On February 4, at 1035, an unaugmented AWOS was reporting, in part: Wind, 190 degrees (true) at 6 knots; visibility, missing; clouds, 100 feet overcast; temperature, 19 degrees F; dew point, 17 degrees F; altimeter, 28.93 inHg.

Bethel is located about 80 nautical miles southeast of the accident site. At 1053 an Aviation Routine Weather Report (METAR) was reporting, in part: Sky conditions and ceiling, 3,900 feet broken; visibility, 10 statute miles; wind, 050 degrees at 13 knots; temperature, 10 degrees F; dew point, minus 6 degrees F; altimeter, 28.90.

An area forecast for the Yukon-Kuskokwim Delta, issued on February 4, 2002, at 0545, and valid until 1800, was forecasting, in part: Clouds and weather, 2,000 feet scattered, 5,000 feet broken, tops at 8,000 feet, with layers above 26,000 feet.

An AIRMET valid until 0000, was forecasting mountain obscuration in clouds and precipitation along the pilot's planned route of flight, with occasional moderate rime icing conditions in the clouds from 1,200 feet to 10,000 feet.

A pilot who departed from Chevak about 1043 en route to Bethel, characterized the weather conditions between Bethel and the accident site as overcast with ceilings ranging between 1,000 and 1,300 feet. He said that as his flight progressed, and as he approached the site where the wreckage was eventually discovered, he encountered momentary visibility restrictions due to fog and light snow. He added that flat light conditions made it very difficult to discern any topographic features among the featureless, snow-covered terrain. The pilot stated that he changed his route in order to avoid worsening weather conditions.

A pilot who departed Bethel about 25 minutes before the accident airplane's departure, also en route to Chevak, characterized the weather conditions along the accident airplane's route as "low visibility with light snow squalls moving through the area." He added that flat light conditions made it very difficult to discern any topographic features. He said that with satisfactory weather conditions, and given the intended destination of the accident airplane, the standard route of flight would be directly over the flat, featureless area where the accident occurred.

COMMUNICATIONS

Review of the air-ground radio communications tapes maintained by the FAA at the Bethel Flight Service Station (FSS) facility, revealed that just before takeoff from Bethel, the pilot communicated with the local ground and tower control positions. After departure, no further communications were received from the accident airplane.

A transcript of the air to ground communications between the airplane and Bethel local control is included in the public docket for this accident.

WRECKAGE AND IMPACT INFORMATION

The National Transportation Safety Board (NTSB) investigator-in-charge, along with an additional NTSB investigator, and the operator's chief pilot, examined the wreckage at the accident site on February 6, 2002. About 2 inches of snow had fallen at the wreckage site since the accident. A depression in the snow, followed by a path of wreckage debris to the main wreckage point of rest, was observed on a magnetic heading of approximately 095 degrees, consistent with the airplane impacting the ground on a southeasterly heading (opposite of the on-course heading for the intended flight).

The first observed point of impact was the semi-circular depression noted above. It was about four feet wide and eight feet long. Two smaller impressions were observed on either side of the main depression. The first portion of the airplane located along the wreckage path was the right-side fuselage step. The step was located within the initial impact depression. About 20 feet beyond the depression was the aft section of the airplane's right-side cargo door. Additional portions of the airplane were found along the wreckage path, and included, in the order observed: right elevator, portions of the upper engine cowling, the right wingtip fairing, the nose wheel strut, the right main landing gear leg, the forward section of the right-side cargo door, fragments of the engine mount, nose cargo door and nose wheel, portions of the nose/engine keel structure, and propeller.

The main wreckage came to rest about 250 feet from the initial impact depression. The airplane was lying inverted. Both wings remained attached to the fuselage.

Both wing lift struts were attached to the wing, but separated from the fuselage. Both wings displayed extensive aft crushing of the leading edges.

The empennage, just forward of the vertical stabilizer attach point, was twisted and buckled to the left. The empennage came to rest in an upright position. Both horizontal stabilizers sustained extensive aft crushing of the leading edges. The vertical stabilizer and rudder were free of any major damage.

The flap jackscrew actuator was in the retracted position. According to the airplane manufacturer, the flap jackscrew extension corresponded to a zero flap condition.

The propeller hub assembly separated from the engine at the engine crankshaft propeller flange. The propeller was located about 204 feet from the initial observed point of impact. All six bolts attaching the propeller to the crankshaft flange were sheared. All three propeller blades were retained in the hub, but were loose and rotated within the hub. The first propeller blade had about 90 degree aft bending and aft curling at the tip. The leading edge had file marks, and a gouge about 10 inches inboard from the tip, but was generally free of damage. Minor paint removal was evident about 8 inches inboard from the tip, with minor scuffing along the upper surface of the blade. The second blade had an aft 90 degree bend, about 10 inches inboard from the tip. Spanwise scuffing and scratching were observed about two inches inboard from the tip. The third blade had an aft 90 degree bend, about 8 inches inboard from the tip. The blade had significant torsional twisting, and minor scuffing at the tip. The leading edge had file marks, but no chordwise scratching or gouging.

The engine separated from the fuselage, and was located about 5 feet from the fuselage, and about 245 feet from the initial observed point of impact. It sustained impact damage to the underside, and front portion of the engine oil sump. The exhaust tubes had minor bending and denting without sharp creases. The muffler tube extensions were crushed and flattened. The creases and folds of the metal were not cracked or broken.

Flight control system cable continuity was established from each control surface to the point of impact-related damage.

MEDICAL AND PATHOLOGICAL INFORMATION

A postmortem examination of the pilot was conducted under the authority of the Alaska State Medical Examiner, 4500 South Boniface Parkway, Anchorage, Alaska, on, February 6, 2002. The cause of death was attributed to multiple impact injuries.

A toxicological examination was conducted by the FAA's Civil Aero medical Institute (CAMI) on March 21, 2002, and was negative for drugs or alcohol.

TEST AND RESEARCH

On March 5, 2002, under the supervision of the NTSB investigator-in-charge, an engine teardown and inspection was conducted at Alaskan Aircraft Engines, Inc., Anchorage, Alaska. No evidence of any preimpact engine anomalies was discovered.

ADDITIONAL INFORMATION

The airplane was equipped with an avionics package provided by the Federal Aviation Administration's Capstone Program. The Capstone Program is a joint industry/FAA demonstration program that features, among others, global positioning system (GPS) avionics, weather and traffic information provided through automatic dependent surveillance-broadcast (ADS-B), traffic information service-broadcast (TIS-B) equipment, and terrain information depicted on a multifunction display (MFD) installed in the cockpit. The Capstone program can provide radar-like services to participating air carrier aircraft operating in a non-radar environment of Western Alaska. At the time of the accident, position information from Capstone equipped airplanes, to the Anchorage Air Route Traffic Control Center (ARTCC), Anchorage, Alaska, was provided by the ADS-B equipment in the airplane, and required ground based radio repeater sites to facilitate the transmittal of position data.

Terrain depiction information, based on GPS data, is one of several visual display options available to the pilot on the MFD. Other options include custom maps, VFR sectional charts with topographical features, IFR charts, flight plan and traffic information, and weather data. The airplane's position can be displayed in relation to its location over the terrain, and may include bearing and distance information to selected points. Selection of the terrain mode for display, provides the pilot with color shading, depicting areas of terrain that are black (2,000 feet below the aircraft), green (between 2,000 and 700 feet below the aircraft), yellow (between 700 and 300 feet below the aircraft), and red (at or within 300 feet of the aircraft). Accurate depiction of terrain (in the terrain mode) requires the pilot to manually set a barometric pressure setting in the multifunction display menu. The Capstone avionics equipment does not automatically receive barometric pressure data from the aircraft's altimeter. Selection of the map mode does not provide any terrain warning/awareness information. Damage to the accident airplane's MFD precluded a determination of the visual display option selected at the time of the accident.

The recorded ARTCC data were reviewed by National Transportation Safety Board investigators to determine the flight track of the accident airplane. The radar-like track from the accident airplane, identified as Yute 6HL, depicted the accident airplane's departure from the Bethel Airport area on a heading of approximately 300 degrees. While en route to Chevak, the airplane climbed to an altitude of about 1,800 feet msl. As the track continued in a northwesterly direction and approached the accident site, a gradual descent was noted. The radar-like track stopped at approximately 1040, about 1.8 miles east of the accident site, with a ground speed of approximately 108 knots, and an altitude of 1,475 feet msl. The accident site elevation was 42 feet msl.

WRECKAGE RELEASE

The Safety Board released the airplane wreckage to the owner's representative on February 6, 2002. On August 7, 2002, the FAA owned Capstone Program equipment, consisting of an Apollo GX-60 GPS, a Multifunction Display (MFD), and a Universal Access Transceiver (UAT), was returned to the Capstone Program office located in Anchorage, Alaska.

NTSB Identification: **ANC02LA016**. Nonscheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Sunday, February 24, 2002 in Tununak, AK Aircraft: Cessna 208B, registration: N454SF Injuries: 1 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On February 24, 2002, about 1830 Alaska standard time, a wheel-equipped Cessna 208B airplane, N454SF, sustained substantial damage during taxi, after landing at the Tununak Airport, Tununak, Alaska. The airplane was being operated as a visual flight rules (VFR) cargo flight under Title 14, CFR Part 135, when the accident occurred. The airplane was operated by Grant Aviation, Inc. of Anchorage, Alaska. The solo certificated airline transport pilot was not injured. The flight originated at the Bethel Airport, Bethel, Alaska, about 1750.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on February 25, the director of operations for the operator reported that while en route to the Tununak airport the pilot had received a pilot report, stating that only half of the length of the 2,010 foot runway was plowed. When the pilot braked to a stop on the runway, the nose wheel of the airplane stopped on a snowdrift crossing the runway. When he released the brakes, the airplane started to roll backward off the snowdrift. When he reapplied the brakes to stop the roll, the airplane rocked rearward, pivoting on the main landing gear, and the tail struck the snow-covered ground. The pilot inspected the airplane and found that the tail tie down ring and the aft fuselage bulkhead were damaged.

During a telephone conversation with the IIC on March 4, the director of maintenance reported that the two furthest-aft fuselage bulkheads (Station 474.4 and 475.88), and the tail tie down ring and doublers, were replaced due to the damage received in the accident. He said the airplane had no known mechanical problems or damage prior to the accident.

NTSB Identification: **ANC02LA019**. Scheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Friday, March 01, 2002 in KOTLIK, AK Aircraft: Cessna 207A, registration: N7373U Injuries: 5 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On March 1, 2002, about 1435 Alaska standard time, a Cessna 207A airplane, N7373U, sustained substantial damage during landing at the Kotlik Airport, Kotlik, Alaska. The airplane was being operated as a visual flight rules (VFR) scheduled domestic passenger flight under Title 14, CFR Part 135, when the accident occurred. The airplane was operated as Flight 408, by Hageland Aviation Services Inc., Anchorage, Alaska. The commercial certificated pilot, and the four passengers, were not injured. Visual meteorological conditions prevailed. VFR company flight following procedures were in effect. The flight originated at the Mountain Village Airport, Mountain Village, Alaska, at 1338.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) on March 1, the director of operations for the operator reported the pilot told him that he was on final approach for landing on runway 19 at Kotlik. The airplane was about 300 feet above the ground, with 15 degrees of flaps, and an airspeed of about 80 knots. The pilot said that the airplane's airspeed seemed too fast, so he reduced engine power. The airplane's airspeed then became too slow, so he increased engine power, but the airplane collided with terrain short of the runway threshold. The airplane received damage to the nose gear, propeller, and left wing.

Runway 19 at Kotlik has a gravel surface, and is 4,422 feet long, by 100 feet wide. The remarks section of the airport facility directory/Alaska Supplement for Kotlik states, in part: "Unattended. Runway condition not monitored, recommend visual inspection prior to landing. ...Runway 01-19 marked with reflective cones."

NTSB Identification: **ANC02TA036** 14 CFR Public Use Accident occurred Thursday, May 16, 2002 in HOLY CROSS, AK Aircraft: Piper PA-18, registration: N82735 Injuries: 2 Uninjured.	Y-K Delta part 135 Carrier: No Capstone Participant: No Capstone Equipped: No

The commercial certificated pilot, a Fish and Wildlife Protection Officer, was landing on the beach area of a lake, adjacent to a remote lodge. The pilot and passenger were concluding a cross-country public use flight to conduct a criminal investigation. During the landing roll, the right wingtip contacted willow bushes, pivoting the airplane to the right. The airplane received damage to the propeller, the tailwheel assembly, the rudder post, and a fuselage longeron.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The pilot's selection of unsuitable terrain for landing. A factor in the accident was the presence of high vegetation (willows) along the right side of the landing area.

NTSB Identification: **ANC02LA043**.
Nonscheduled 14 CFR Part 135: Air Taxi & Commuter
Accident occurred Thursday, June 06, 2002 in GALENA, AK
Aircraft: Robinson R-44, registration: N7130G
Injuries: 3 Uninjured.

Y-K Delta part 135 Carrier: No

Capstone Participant: No

Capstone Equipped: No

The commercial certificated pilot landed the skid-equipped helicopter in an area of brush/grass to pick up two passengers who had been conducting a ground survey. The pilot stayed at the controls of the helicopter, and reduced the engine rpm to 70 percent as the ground personnel were loading their equipment into external baskets on the helicopter. The equipment included packs and a chain saw. The ground personnel reported that the chain saw had not been used in the previous hour, and the engine was cold. The pilot smelled smoke, and the passengers noticed flames under the helicopter. The pilot attempted to regain full engine rpm to lift-off from the landing area, but was unable to do so because the engine quit running. The pilot exited the helicopter, and along with the ground personnel, attempted to extinguish the flames on the ground. They were unsuccessful, and the pilot attempted to restart the helicopter. It would not start. The fire consumed the helicopter, and about 60 acres of brush/grass. This model helicopter's exhaust system is positioned at the rear and bottom portion of the aft fuselage. The underside of the engine area is open, allowing cooling-fan air to exit aft and downward, around the muffler and exhaust. The bottom of the muffler, at the rear area of the engine compartment is about 19.5 inches above the ground. The exhaust pipe, routed through the rear bulkhead of the engine compartment, exits the aft end of the fuselage about 27 inches above the ground. The pilot/operator manual for the helicopter contains a safety advisory that states, in part: "Never land in tall dry grass. The exhaust is low to the ground and very hot; a grass fire may be ignited."

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
The pilot's selection of unsuitable terrain for landing which precipitated a grass fire. Factors contributing to the accident were the manufacturer's inadequate design of the helicopter's exhaust system, placing it low to the ground, and terrain conditions consisting of dry tussock grass.

NTSB Identification: **ANC02LA047** 14 CFR Part 91: General Aviation Accident occurred Tuesday, June 11, 2002 in BETHEL, AK Aircraft: Cessna 172, registration: N7564G Injuries: 1 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On June 11, 2002, about 1235 Alaska daylight time, a wheel-equipped Cessna 172 airplane, N7564G, sustained substantial damage when the right wing struck the paved runway during landing at the Bethel Airport, Bethel, Alaska. The airplane was being operated as a visual flight rules (VFR) cross-country positioning flight under Title 14, CFR Part 91, when the accident occurred. The airplane was operated by Hageland Aviation Services Inc., Anchorage, Alaska. The commercial certificated pilot, the sole occupant, was not injured. Visual meteorological conditions prevailed. VFR company flight following procedures were in effect. The flight originated at the Tuluksak Airport, Tuluksak, Alaska, about 1220.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on June 11, the pilot reported that he was landing on runway 18 at Bethel (runway 18 is paved, 6,398 feet long by 150 feet wide). The pilot said that during the landing roll, as he applied the airplane's brakes, the airplane suddenly veered to the left, and the right wingtip struck the runway surface. The airplane departed off the left edge of the runway. The pilot said the weather conditions at Bethel were clear, and the winds were light and variable. The airplane received damage to the right wingtip, the outboard wing nose rib, and the leading edge of the wing.

On June 20, the director of maintenance for the operator reported that the repair of the wing entailed replacement of the wingtip, nose rib, and the leading edge of the wing between wing stations 190 and 208. No mechanical malfunction was reported by the director of maintenance, or the pilot..

NTSB Identification: **ANC02LA061** 14 CFR Part 91: General Aviation Accident occurred Wednesday, June 26, 2002 in Shageluk, AK Aircraft: Robinson R-44, registration: N144AK Injuries: 1 Uninjured	Y-K Delta part 135 Carrier: No Capstone Participant: No Capstone Equipped: No

On June 26, 2002, about 0900 Alaska daylight time, a Robinson R-44 helicopter, N144AK, sustained substantial damage during an approach to a beach for landing, about 12 miles south of Shageluk, Alaska. The helicopter was being operated by Quicksilver Air Inc., of Fairbanks, Alaska, as a visual flight rules (VFR) positioning flight under Title 14, CFR Part 91, at the time of the accident. The solo commercial pilot was not injured. Visual meteorological conditions prevailed, and company VFR flight following procedures were in effect.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) on June 27, the Federal Aviation Administration (FAA) inspector who interviewed the pilot, said the pilot told him he had been ferrying surveyors and survey equipment, and was returning to pickup surveyors when the accident occurred. The pilot said he was about 200 feet above the lake, making an approach to a beach, when he looked inside the helicopter to check the carburetor heat. The pilot said when he looked up he was headed, nose down, toward the surface of the lake. He leveled the helicopter above the surface of the lake, but during the attitude recovery, the tail rotor struck the water. The helicopter then settled into the lake, and sank in about nine feet of water.

During a telephone conversation with the IIC on June 28, the director of maintenance for the operator said the helicopter had been recovered from the lake. He said a preliminary examination of the helicopter revealed some fuselage damage, and the drive-shaft flex coupling to the tail rotor gearbox was sheered. He said the bulkhead adjacent to the flex coupling was also damaged.

NTSB Identification: **ANC02LA066** Nonscheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Sunday, June 30, 2002 in CHEVAK, AK Aircraft: Cessna 207, registration: N7384U Injuries: 2 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On June 30, 2002, about 1450 Alaska daylight time, a wheel-equipped Cessna 207 airplane, N7384U, sustained substantial damage when it landed short of the intended runway at the Chevak Airport, Chevak, Alaska. The airplane was being operated as a visual flight rules (VFR) nonscheduled domestic cargo flight under Title 14, CFR Part 135, when the accident occurred. The airplane was operated by Flight Alaska Inc., Anchorage, Alaska. The airline transport certificated pilot, and the sole passenger, were not injured. Visual meteorological conditions prevailed, and a VFR flight plan was filed. The flight originated at the Newtok Airport, Newtok, Alaska, about 1424.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on July 1, 2002, the director of operations for the operator reported the pilot was landing on runway 32 at Chevak. The pilot told the director of operations that the airplane encountered a downdraft during the landing approach. The airplane landed short of the gravel runway threshold. The nose landing gear assembly was torn off the airplane, and the left main landing gear was folded aft.

In the Pilot/Operator Aircraft Accident Report (NTSB form 6120.1/2) submitted by the pilot, the pilot indicated the weather conditions as clear with light turbulence. He reported the wind was 290 degrees at 8 to 10 knots.

The FAA's Airport Facility Directory/Alaska Supplement for Chevak, lists the runway as a gravel surface, 2,610 feet long by 40 feet wide. The remarks section of the directory states, in part: "Unattended. Caution: Runway condition not monitored. ...Caution: Strong crosswinds at this location. ...Runway is trough shaped, low in center and high at both ends."

Airport personnel at Chevak reported the airplane collided with the lip of the runway at the approach end of runway 32.

The closest official weather observation station is Hooper Bay, Alaska, which is located 16 nautical miles west of the accident site. At 1455, an automated weather observation system (AWOS) was reporting in part: Wind, 300 degrees (true) at 11 knots; visibility, 10 statute miles; clouds and sky condition, clear; temperature, 52 degrees F; dew point, 39 degrees F; altimeter, 29.88 inHg.

NTSB Identification: **ANC02LA079** Scheduled 14 CFR Part 121: Air Carrier ERA AVIATION INC Accident occurred Saturday, July 13, 2002 in Toksook Bay, AK Aircraft: de Havilland DHC-6, registration: N885EA Injuries: 13 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On July 13, 2002, about 1026 Alaska daylight time, a de Havilland DHC-6 airplane, N885EA, sustained substantial damage when it struck a bird during takeoff from Toksook Bay Airport, Toksook, Alaska. The airplane was being operated by ERA Aviation Inc., of Anchorage, Alaska, as Flight 4862, a visual flight rules (VFR) scheduled passenger flight under Title 14, CFR Part 121, at the time of the accident. The two crewmembers and the eleven passengers were not injured. The airplane was departing Toksook Bay en route to Bethel, Alaska. Visual meteorological conditions prevailed, and an IFR flight plan was filed.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) on July 16, a Federal Aviation Administration (FAA) air safety inspector said he had issued a ferry permit for the accident airplane to return to the ERA maintenance facility in Anchorage. He said he inspected the damage to the accident airplane, and noted the repairs required the replacement of two ribs, and six feet of the leading edge of the right wing.

During a telephone conversation with the IIC on July 23, the director of operations for the operator said the pilot told him that during the initial climb, about 20 feet above the runway, the airplane encountered a flock of seagulls. The pilot told him that one of the seagulls struck the leading edge of the airplane's right wing. He said the airplane continued to its destination without further incident. The director of operations said he was only aware of one rib, and about six feet of the leading edge, being replaced as a result of the accident.

NTSB Identification: **ANC02LA123** 14 CFR Part 91: General Aviation Accident occurred Friday, September 20, 2002 in Bethel, AK Aircraft: de Havilland DHC-2, registration: N144Q Injuries: 2 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On September 20, 2002, about 0815 Alaska daylight time, a float-equipped de Havilland DHC-2 airplane, N144Q, sustained substantial damage during takeoff from a remote lake, located about 1 mile north of Bethel, Alaska. The airplane was being operated as a visual flight rules (VFR) local area instructional flight under Title 14, CFR Part 91, when the accident occurred. The airplane is registered to Sheryl L. Williams, and operated by Steven C. Williams, dba Ptarmigan Air, Anchorage, Alaska. The first pilot, seated in the right seat, and the second pilot, seated in the left seat, both certificated commercial pilots, were not injured. Visual meteorological conditions prevailed, and VFR company flight following procedures were in effect. The flight originated at the accident lake, about 0810.

During a telephone conversation with a National Transportation Safety Board investigator on September 20, the first pilot, a certificated flight instructor, reported that he was providing flight instruction/recurrent training to the second pilot. The first pilot said that just after takeoff, as the airplane climbed to about 50 feet above the water, the airplane began to buffet, and the right wing dropped. The airplane descend and subsequently struck an area of water-covered marshy terrain. The airplane sustained substantial damage to the wings, fuselage, and empennage.

The first pilot reported that the accident flight was the first flight of the day. He added that a postaccident inspection of the airplane revealed an accumulation of frost on the wings.

NTSB Identification: **ANC03LA005A** Nonscheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Tuesday, October 22, 2002 in BETHEL, AK Aircraft: PIPER PA-32, registration: N76RL Injuries: 6 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: No
NTSB Identification: **ANC03LA005B** Nonscheduled 14 CFR Part 135: Air Taxi & Commuter Accident occurred Tuesday, October 22, 2002 in BETHEL, AK Aircraft: Piper PA-32, registration: N31657 Injuries: 6 Uninjured.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

These two accidents are two aircraft that collided with each other; thus, we provide only one narrative.

On October 22, 2002, about 1415 Alaska daylight time, a Piper PA-32 airplane, N76RL, collided with another Piper PA-32, N31657, on the ramp area of the Bethel Airport, Bethel, Alaska. N76RL was being operated as a visual flight rules (VFR) cargo flight under Title 14, CFR Part 135, when the accident occurred. The airplane was operated by Bellair Inc., Fairbanks, Alaska, and received minor damage to the propeller and engine cowling. The airline transport certificated pilot, the sole occupant, was not injured. Visual meteorological conditions prevailed, and VFR company flight following procedures were in effect. The flight was destined for Eek, Alaska, as Flight 400.

The second airplane, N31657, operated by Larry's Flying Service Inc., Fairbanks, Alaska, was being operated as a VFR on-demand passenger flight under Title 14, CFR Part 135, from Russian Mission, Alaska, to Bethel. The airplane received substantial damage to the left wing. The commercial pilot and the four passengers were not injured. VFR company flight following procedures were in effect.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on October 22, a Federal Aviation Administration (FAA) inspector, Anchorage Flight Standards District Office (FSDO), reported that N31657 was taxiing from runway 03 toward his parking spot on the west ramp of the Bethel Airport. He said the two operators involved in this accident have loading areas adjacent to each other on the ramp, and that each pilot's view was blocked by a fuel truck that was positioned in front of N76RL. As N31657 was approaching its parking spot, the pilot began a right turn. The fuel truck pulled away, revealing N76RL that had just begun to taxi forward away from its parking spot. The pilot of N31657 tightened the right turn, but the propeller of N76RL sliced into the leading edge of N31657's left wing.

NTSB Identification: **ANC03LA007** 14 CFR Part 91: General Aviation Accident occurred Monday, October 28, 2002 in Marshall, AK Aircraft: Cessna 207, registration: N91090 Injuries: 1 Serious.	Y-K Delta part 135 Carrier: Yes Capstone Participant: Yes Capstone Equipped: Yes

On October 28, 2002, about 2000 Alaska standard time, a Cessna 207 airplane, N91090, sustained substantial damage when it collided with terrain during cruise flight, about four miles southeast of Marshall, Alaska. The airplane was being operated by Grant Aviation Inc., Anchorage, Alaska, as a visual flight rules (VFR) positioning flight under Title 14, CFR Part 91, at the time of the accident. The solo commercial pilot received serious injuries. Night visual meteorological conditions prevailed, and company flight following procedures were in effect. The flight originated at the Marshall Airport about 1955, and was bound for Bethel, Alaska.

The accident airplane departed the 'new' Marshall airport (MLL). The 'old' Marshall airport (MLL) was decommissioned several days earlier. The new airport is 3 miles east-northeast of the old airport, and was not yet depicted on current navigation charts, nor listed in the current United States Government Flight Information Publication, Alaska Supplement.

When the flight failed to arrive at Bethel, a search was initiated. On October 29, about 0100, search personnel located the wreckage about 4 miles southeast of Marshall. The airplane was located about 1,200 feet msl, on the north side of a ridgeline that runs generally east to west. The ridge has a summit elevation of 1,714 feet msl.

The airplane was equipped with Capstone navigation and terrain avoidance avionics. The Capstone equipment uses GPS mapping technology and aircraft position information, in conjunction with a multifunction display in the instrument panel, to graphically represent the aircraft's position relative to terrain. Terrain that comes within set parameters for altitude and horizontal distance is displayed in color bands. Terrain depicted within the red color band is intended to warn the pilot of the close proximity of terrain to the aircraft.

During a telephone conversation with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on November 4, the pilot said he departed Marshall on runway 07, and made a climbing right turn at 80 knots indicated airspeed toward Bethel. He said the vertical speed indicator read in excess of 1,000 feet per minute rate of climb, that it was a very dark night, and there were no visible horizon or ground references discernible. He said his route was direct to Bethel at 1,200 to 1,400 feet msl, and that upon reaching his cruise altitude, there was a strong headwind and turbulence. He said just prior to impacting the terrain, his vertical speed indicator showed a high rate of descent, and his Capstone display was almost completely red. He further stated the airplane's GPS had not been reprogrammed to reflect the location changes for the old Marshall airport and the new Marshall airport. The pilot said he had made one flight into the old Marshall airport, and this was his second flight into the new Marshall airport. This was the first flight when he departed either airport after dark. He said there were no preimpact mechanical anomalies with the airplane.

Direct flight from either Marshall airport to Bethel requires crossing an east-west ridgeline on the north side of the Yukon River. The direct route from the old Marshall airport to Bethel crosses the western foot of the ridgeline at a point with an elevation of less than 500 feet msl. The direct route from the new airport to Bethel crosses the ridge at a point where the elevation of the ridge exceeds 1,200 feet msl.

During a telephone conversation with the NTSB IIC on November 6, the pilot of the Army helicopter that located the accident airplane said their initial attempts to locate the missing airplane were futile. He said they then flew to the new Marshall airport and attempted to recreate the accident flight by taking off into the wind, conducting a right down wind departure replicating the performance of the Cessna 207, and heading direct to Bethel. He said when they reached the ridgeline on the north side of the Yukon River they headed east up the ridge toward the summit (1,704 msl). They located the accident airplane within minutes at 1,200 feet msl. He said the airplane impacted near the crest of the ridge, with a shallow angle of attack. He also stated that all the major airframe components sustained substantial damage, and the engine had separated from the airplane. The helicopter pilot said after they landed he noted that the wind was strong out of the northeast, with gusts above 40 knots. He said during the time they were searching for the accident airplane they did not encounter turbulence.

The weather forecast for the Yukon/Kuskokwim Delta area at the time of the accident was scattered clouds at 3,500 feet msl, occasional broken clouds at 3,500 to 6,000 feet msl, with an outlook for VFR and windy conditions. The freezing level was at 1,500 feet msl, and no turbulence was forecast.

During the accident sequence the emergency locator transmitter (ELT) did not activate. The injured pilot removed the ELT from its holder, and took it with him into the empennage where he sheltered himself from the weather. He was not aware the ELT was not transmitting. Rescue personnel recovered the pilot and the ELT. The ELT was released to the operator who proceeded to functionally test the ELT until it activated. It is unknown why the ELT did not operate upon impact.

Appendix C. Data on Aircraft Equipped and Accidents of Y-K Delta Part 135 Fleet, 2001 and 2002

Table C-1 Data for Analysis of Y-K Delta Equipped and Non-equipped Aircraft Accidents

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
RTS Equipped a/c	1-Jan-00			0	0
ACCIDENT	07-Feb-2000	30	not equipped	6031	37
RTS Equipped a/c	11-Feb-00			648	8
RTS Equipped a/c	18-Feb-00			1127	21
ACCIDENT	04-Mar-2000	0	not equipped	2400	45
crash return	04-Mar-2000		not equipped	0	0
RTS Equipped a/c	4-Mar-00			0	0
RTS Equipped a/c	7-Mar-00			477	15
crash return	08-Mar-2000		not equipped	160	5
RTS Equipped a/c	10-Mar-00			318	12
RTS Equipped a/c	22-Mar-00			1896	84
RTS Equipped a/c	23-Mar-00			157	8
RTS Equipped a/c	27-Mar-00			624	36
RTS Equipped a/c	3-Apr-00			1085	70
RTS Equipped a/c	3-Apr-00			0	0
RTS Equipped a/c	11-Apr-00			1224	96
RTS Equipped a/c	11-Apr-00			0	0
RTS Equipped a/c	12-Apr-00			151	14
RTS Equipped a/c	13-Apr-00			150	15
RTS Equipped a/c	21-Apr-00			1192	128
RTS Equipped a/c	21-Apr-00			0	0
RTS Equipped a/c	25-Apr-00			588	72
RTS Equipped a/c	25-Apr-00			0	0
RTS Equipped a/c	26-Apr-00			145	20

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
RTS Equipped a/c	27-Apr-00			144	21
RTS Equipped a/c	4-May-00			1001	154
RTS Equipped a/c	4-May-00			0	0
RTS Equipped a/c	8-May-00			564	96
RTS Equipped a/c	23-May-00			2100	375
RTS Equipped a/c	26-May-00			417	78
RTS Equipped a/c	30-May-00			552	108
RTS Equipped a/c	31-May-00			137	28
RTS Equipped a/c	1-Jun-00			136	29
RTS Equipped a/c	1-Jun-00			0	0
RTS Equipped a/c	5-Jun-00			536	124
RTS Equipped a/c	14-Jun-00			1197	288
RTS Equipped a/c	16-Jun-00			264	66
RTS Equipped a/c	21-Jun-00			655	170
ACCIDENT	22-Jun-2000	1000	not equipped	130	34
RTS Equipped a/c	23-Jun-00			129	35
RTS Equipped a/c	28-Jun-00			640	180
RTS Equipped a/c	11-Jul-00			1651	481
ACCIDENT	12-Jul-2000	30	equipped	127	36
RTS Equipped a/c	12-Jul-00			0	0
RTS Equipped a/c	20-Jul-00			1000	304
RTS Equipped a/c	27-Jul-00			868	273
RTS Equipped a/c	28-Jul-00			123	40
RTS Equipped a/c	29-Jul-00			122	41
RTS Equipped a/c	31-Jul-00			242	84
RTS Equipped a/c	1-Aug-00			120	43
RTS Equipped a/c	4-Aug-00			357	132
RTS Equipped a/c	6-Aug-00			236	90
RTS Equipped a/c	9-Aug-00			351	138
crash return	11-Aug-2000		equipped	234	94

EVENTS	**Date**	**If accident. A/C Days out**	**Was accident or return A/C Equipped?**	**Un-equipped a/c days**	**Equipped a/c days**
RTS Equipped a/c	16-Aug-00			580	240
RTS Equipped a/c	21-Aug-00			575	245
RTS Equipped a/c	21-Aug-00			0	0
ACCIDENT	06-Sep-2000	30	not equipped	1808	800
ACCIDENT	14-Sep-2000	90	not equipped	896	400
RTS Equipped a/c	15-Sep-00			111	51
RTS Equipped a/c	15-Sep-00			0	0
ACCIDENT	20-Sep-2000	1000	not equipped	545	260
RTS Equipped a/c	27-Sep-00			756	371
RTS Equipped a/c	30-Sep-00			321	162
crash return	06-Oct-2000		not equipped	648	324
RTS Equipped a/c	6-Oct-00			0	0
RTS Equipped a/c	12-Oct-00			636	336
RTS Equipped a/c	12-Oct-00			0	0
RTS Equipped a/c	12-Oct-00			0	0
RTS Equipped a/c	20-Oct-00			824	472
RTS Equipped a/c	20-Oct-00			0	0
RTS Equipped a/c	27-Oct-00			707	427
ACCIDENT	03-Nov-2000	90	equipped	707	420
RTS Equipped a/c	9-Nov-00			600	366
RTS Equipped a/c	17-Nov-00			792	496
RTS Equipped a/c	17-Nov-00			0	0
RTS Equipped a/c	27-Nov-00			970	640
RTS Equipped a/c	29-Nov-00			192	130
crash return	13-Dec-2000		not equipped	1358	910
RTS Equipped a/c	18-Dec-00			480	330
RTS Equipped a/c	18-Dec-00			0	0
End of year	31-Dec-00			1222	884
ACCIDENT	03-Jan-2001	30	equipped	282	201
RTS Equipped a/c	3-Jan-01			0	0

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
RTS Equipped a/c	5-Jan-01			184	138
ACCIDENT	19-Jan-2001	90	not equipped	1274	966
crash return	01-Feb-2001		equipped	1183	910
crash return	02-Feb-2001		equipped	91	71
RTS Equipped a/c	14-Feb-01			1080	864
RTS Equipped a/c	18-Mar-01			2848	2336
RTS Equipped a/c	18-Mar-01			0	0
RTS Equipped a/c	21-Mar-01			261	225
RTS Equipped a/c	21-Mar-01			0	0
ACCIDENT	03-Apr-2001	1000	equipped	1118	975
RTS Equipped a/c	10-Apr-01			595	532
RTS Equipped a/c	11-Apr-01			84	77
RTS Equipped a/c	12-Apr-01			83	78
RTS Equipped a/c	13-Apr-01			82	79
RTS Equipped a/c	13-Apr-01			0	0
ACCIDENT	14-Apr-2001	90	not equipped	80	80
RTS Equipped a/c	17-Apr-01			237	243
crash return	19-Apr-2001		not equipped	160	162
ACCIDENT	24-Apr-2001	30	not equipped	395	405
ACCIDENT	03-May-2001	30	not equipped	702	729
RTS Equipped a/c	3-May-01			0	0
RTS Equipped a/c	3-May-01			0	0
RTS Equipped a/c	12-May-01			675	756
RTS Equipped a/c	14-May-01			148	170
RTS Equipped a/c	15-May-01			73	86
RTS Equipped a/c	16-May-01			72	87
ACCIDENT	17-May-2001	90	equipped	72	86
crash return	24-May-2001		not equipped	511	602
RTS Equipped a/c	29-May-01			360	435
crash return	02-Jun-2001		not equipped	292	348

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
ACCIDENT	19-Jun-2001	90	not equipped	1224	1479
RTS Equipped a/c	22-Jun-01			213	264
RTS Equipped a/c	4-Jul-01			840	1068
RTS Equipped a/c	4-Jul-01			0	0
RTS Equipped a/c	5-Jul-01			68	91
RTS Equipped a/c	6-Jul-01			67	92
crash return	13-Jul-2001		not equipped	476	644
RTS Equipped a/c	13-Jul-01			0	0
RTS Equipped a/c	14-Jul-01			66	94
RTS Equipped a/c	16-Jul-01			130	190
RTS Equipped a/c	16-Jul-01			0	0
RTS Equipped a/c	16-Jul-01			0	0
RTS Equipped a/c	16-Jul-01			0	0
RTS Equipped a/c	20-Jul-01			244	396
RTS Equipped a/c	23-Jul-01			180	300
RTS Equipped a/c	24-Jul-01			59	101
ACCIDENT	25-Jul-2001	30	equipped	59	100
RTS Equipped a/c	26-Jul-01			58	101
RTS Equipped a/c	26-Jul-01			0	0
RTS Equipped a/c	27-Jul-01			56	103
RTS Equipped a/c	30-Jul-01			165	312
RTS Equipped a/c	2-Aug-01			162	315
RTS Equipped a/c	6-Aug-01			212	424
ACCIDENT	13-Aug-2001	0	equipped	371	735
crash return	13-Aug-2001		equipped	0	0
RTS Equipped a/c	13-Aug-01			0	0
RTS Equipped a/c	16-Aug-01			153	324
crash return	17-Aug-2001		equipped	51	109
RTS Equipped a/c	17-Aug-01			0	0
RTS Equipped a/c	20-Aug-01			147	333

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
RTS Equipped a/c	20-Aug-01			0	0
RTS Equipped a/c	23-Aug-01			141	339
crash return	24-Aug-2001		equipped	47	114
RTS Equipped a/c	29-Aug-01			230	575
RTS Equipped a/c	5-Sep-01			315	812
RTS Equipped a/c	7-Sep-01			88	234
RTS Equipped a/c	7-Sep-01			0	0
RTS Equipped a/c	13-Sep-01			252	714
crash return	17-Sep-2001		not equipped	172	476
RTS Equipped a/c	23-Sep-01			252	720
RTS Equipped a/c	3-Oct-01			410	1210
RTS Equipped a/c	8-Oct-01			200	610
RTS Equipped a/c	11-Oct-01			117	369
ACCIDENT	16-Oct-2001	30	not equipped	190	615
RTS Equipped a/c	2-Nov-01			629	2108
crash return	15-Nov-2001		not equipped	494	1612
RTS Equipped a/c	19-Dec-01			1258	4250
End of year	31-Dec-01			432	1512
RTS Equipped a/c	22-Jan-02			770	2794
ACCIDENT	04-Feb-02	1000	equipped	455	1638
RTS Equipped a/c	08-Feb-02			136	508
RTS Equipped a/c	12-Feb-02			132	512
RTS Equipped a/c	13-Feb-02			32	129
ACCIDENT	24-Feb-02	0	equipped	352	1408
crash return	24-Feb-2002		equipped	0	0
ACCIDENT	01-Mar-02	30	equipped	160	640
RTS Equipped a/c	05-Mar-02			124	516
RTS Equipped a/c	15-Mar-02			300	1300
RTS Equipped a/c	26-Mar-02			319	1441
RTS Equipped a/c	28-Mar-02			56	264

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
crash return	31-Mar-2002		equipped	84	399
RTS Equipped a/c	15-Apr-02			405	2010
RTS Equipped a/c	16-Apr-02			26	135
RTS Equipped a/c	18-Apr-02			50	272
RTS Equipped a/c	09-May-02			504	2877
RTS Equipped a/c	20-May-02			253	1518
RTS Equipped a/c	28-May-02			176	1112
RTS Equipped a/c	05-Jun-02			168	1120
ACCIDENT	11-Jun-02	30	equipped	126	834
ACCIDENT	30-Jun-02	90	equipped	399	2622
RTS Equipped a/c	01-Jul-02			20	139
crash return	11-Jul-2002		equipped	200	1400
ACCIDENT	11-Jul-02	30	equipped	0	0
RTS Equipped a/c	13-Jul-02			38	280
RTS Equipped a/c	17-Jul-02			72	564
RTS Equipped a/c	18-Jul-02			17	142
RTS Equipped a/c	25-Jul-02			112	1001
RTS Equipped a/c	25-Jul-02			0	0
RTS Equipped a/c	26-Jul-02			14	145
RTS Equipped a/c	30-Jul-02			52	584
RTS Equipped a/c	07-Aug-02			96	1176
crash return	10-Aug-2002		equipped	36	444
RTS Equipped a/c	12-Aug-02			22	298
RTS Equipped a/c	13-Aug-02			10	150
RTS Equipped a/c	13-Aug-02			0	0
RTS Equipped a/c	23-Aug-02			80	1520
RTS Equipped a/c	26-Aug-02			21	459
RTS Equipped a/c	18-Sep-02			138	3542
ACCIDENT	20-Sep-02	90	equipped	12	306
crash return	28-Sep-02		equipped	48	1232

EVENTS	Date	If accident. A/C Days out	Was accident or return A/C Equipped?	Un-equipped a/c days	Equipped a/c days
RTS Equipped a/c	09-Oct-02			55	1705
ACCIDENT	22-Oct-02	0	not equipped	52	2015
crash return	22-Oct-2002		not equipped	0	0
ACCIDENT	22-Oct-02	30	equipped	0	0
ACCIDENT	28-Oct-02	90	equipped	30	918
crash return	21-Nov-2002		equipped	120	3696
RTS Equipped a/c	22-Nov-02			4	155
crash return	19-Dec-2002		equipped	108	4212
END	31-Dec-02			36	1884

Table C-2 Summary Statistics for Equipped and NonEquipped Accidents, Aircraft-days, and Accidents per Aircraft-day, 2000-2002

Accidents			
	Equipped	Non-Equipped	Overall
2000	2	6	8
2001	5	6	11
2002	9	1	10
All Years	16	13	29
Aircraft-Days			
	Equipped	Non-Equipped	Overall
2000	12,492	47,134	59,626
2001	35,486	23,170	58,656
2002	52,016	6,420	58,436
All Years	99,994	76,724	176,718
Accidents per 10,000 Aircraft-Days			
	Equipped	Non-Equipped	Overall
2000	1.60	1.27	1.34
2001	1.41	2.59	1.88
2002	1.73	1.56	1.71
All Years	1.60	1.69	1.64

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Appendix D. Capstone Phase I Participants

Table D.1. Capstone Area Operators: Participation and Number of Equipped Aircraft

Operator name	Participation Date	Completed as of 12/31/02
Alaska Central Express	2002	2
Alaska Island Air	2001	2
Arctic Circle Air	2000	15
Arctic Transportation Services Inc.	2000	12
AvAlaska	2002	1
Baum Air	2002	1
BellAir, Inc	2002	5
Cub Drivers	2000	1
Craig Air	2000	6
ERA Aviation	2001	5
Frontier Flying Service	2000	6
Grant Aviation	2000	20
Hageland Aviation	2000	28
Husky Aviation.	2002	1
Inland Aviation Services Inc.	2001	5
Kusko Aviation Inc.	2000	2
Larry’s Flying Service	2000	7
Neitz Aviation Inc	2000	1
Northern Air Cargo	2000	6
PenAir	2000	7
Ptarmigan Air	2000	3
Shannon's Air Taxi (Shade Av)	2000	1
Tanana Air Service	2000	8
Village Aviation	2000	5
G & L Air Svc (George Walters)	2000	1
Yukon Helicopters, Inc.	2000	6
Yute Air Service	2000	13
Civil Air Patrol	2002	2
FAA Alaskan Region	2000	2
Office of Aircraft Services	2000	3
UAA	2000	1
Other Part 91	2001	10
Total Aircraft		**188**

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Appendix E. Pilot Survey Research Methodology and Frequencies

Objective

This survey was part of a larger effort to collect information about qualifications, practices and attitudes of pilots and company management for aviation operators in Alaska. Based on survey responses, focus group results, and consultation with Alaskan aviation safety experts, the National Institutes of Occupational Safety and Health (NIOSH) will develop policy options designed to reduce aviation fatalities.

NIOSH contracted with the Institute of Social and Economic Research (ISER) of the University of Alaska Anchorage to design and administer two statewide aviation safety surveys, one of air carrier managers and one of active commercial pilots. In the fall of 2002, we conducted follow-up surveys of Y-K Delta part 135 pilots. We collected surveys from 19 pilots for this follow-up, and anticipate quarterly follow-up surveys of 15-30 pilots each in 2003.

This document describes the methodology for the pilot survey, which addressed pilot demographics, flight hours (total, aircraft type, and instrument hours), Alaska flying experience, attitudes about safety, flying practices, and other salient risk factors.

Instrument Development

Focus Groups

We hypothesized that there were measurable differences in attitudes, policies and behaviors of pilots and operators that put some pilots and operators at greater risk of a crash than others. We further hypothesize that aspects of the economic and/or regulatory environment may be reinforcing those higher-risk characteristics. To investigate these hypotheses, NIOSH conducted focus group meetings between May and November of 2000 among pilots, operators, and villagers in five Alaska regions. Both NIOSH and ISER reviewed the findings of previous Alaska aviation studies. Findings from these two sources became the foundation of the research questions, and core of both the pilot and operator survey questionnaires.

Draft Questionnaire

Respondents were asked to reply to questions about flight practices, attitudes, and perceptions from their personal perspective. The questionnaire consisted of several sections:

1. Pilot demographics, certifications and flight experience
2. Flight experiences in their current employment relevant to the identified safety issues
3. Training provided by their current employer relevant to the identified safety issues
4. Attitudes about those safety issues and about potential ways to address them
5. For pilots who fly with Capstone equipment, questions about their experiences with and attitudes about that equipment.

Pre-Test

The questionnaires were pre-tested on six pilots to filter out confusing questions and terms, confirm that perception and attitude questions worked, and to determine the time required to administer the survey. We also had to deal with sensitivity to questions about practices that are contrary to federal aviation regulations (FARs). In addition to an understandable reluctance to admit to breaking the law, some pilots also raised concerns that their survey responses to such questions would be used for enforcement purposes. For the same reasons, we chose not to ask pilots questions about their employers that might call for explanations of practices or procedures contrary to FARs.

Use of previously collected data

While prior studies examining crashes in commuter and air taxi services have provided useful leads on comparative information and examples of how to conduct this type of research, they do not provide the specific information needed for the reduction of deaths related to air crashes in Alaska. No existing information, such as that available from the NTSB or FAA accident data reporting systems, has been identified of the type required for these studies. Additionally, appropriate denominators and exposure estimates of commercial pilots are inaccurate and unreliable. Our review of the scientific and technical literature did not yield the number of commercial pilots per year or the number of pilot flight hours or flights per year in Alaska.

Sample Design

The pilot was the unit of analysis in this study. The survey population consists of pilots who flew for:

- Air carrier companies who identify themselves as air transportation companies who transport passengers and/or freight, operating in Alaska (other than companies who are scheduled airline companies operating only aircraft having more than 10 seats), as of November 2000.
- Government agencies that have public use aircraft operating in Alaska (such as the Alaska Department of Fish and Game, Alaska State Troopers, U.S. Department of Interior, etc.).

The Capstone sample had three groups, as shown in Table F-1 (next page):

a. We randomly selected about one-quarter of pilots whose employers participated from the NIOSH operator survey's large operator stratum. This random sampling produced 41 responses to the Capstone module[1].

b. We randomly selected companies having only one or two pilots for a combined pilot/operator survey. Obtaining both operator and pilot information in one contact reduced the time burden on small operator respondents. Four of these pilot-operators were Capstone participants.

c. We interviewed 61 pilots in person either at their place of work in Bethel or at Capstone training sessions in Bethel or Anchorage. These pilots were all the Capstone pilots we could contact at a given time and place (for example, during a 4-day visit to Bethel, or at a given training class).

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[1] The large operator stratum consisted of all companies/operators that were shown as employing 3 or more pilots by the FAA's VIS database in June, 2001. The design sampling fraction for large operators was 21.5 percent. However, we had to sample discrete numbers of pilots in small companies, so the actual sampling fraction varied by company size from 40 percent (2 pilots in a 5-pilot company) to 21.51 percent (20 pilots in a 93-pilot company). Over all large operators, it averaged 24.8 percent.

Table F-1. Capstone Operators and Pilots Completing Capstone Module Surveys

	One or Two Pilots	Three or More Pilots	Total
Capstone Participating Operators*	6	17	23
Capstone Operators Sampled	4	16	20
Pilot Responses from group a	n/a	41	41
Pilot Responses from group b	4	n/a	4
Pilot Responses from group c:	1	60	61
Total Capstone Pilot Interviews	5	101	106

*This table includes PenAir, an original Capstone operator, which ceased most of their operations in the Y-K Delta in 2001.

Survey Protocols

We generated the pilot sample from interviews with the air carrier operators. ISER interviewed operators from August 2001 through February 2003; we interviewed pilots from December 2001 through February 2003. As described above, the universe from which we drew the pilot sample was the pilots employed by operators that we interviewed. In the final section of the large operator/company questionnaire we requested a list of pilots employed by that carrier and their telephone numbers. If the operator provided the list, the interviewer verified that the number of pilots on the list was the same as the number reported in question 1 (pilots currently employed by the carrier). If the numbers were different, the interviewer resolved the inconsistency, either by correcting question 1 or correcting the pilot list, as appropriate. Once the numbers were the same, the interviewer chose a pilot sampling sheet with the same number of pilots as listed. The pilot sampling sheets (generated by an excel spreadsheet) randomly selected which pilots on a numbered list should be interviewed. We generated a new sampling sheet, with different random sample, for each company.

If the operator refused to provide pilot information after follow-up by an interviewer experienced in turning around refusals, we tried one of several options. We preferred option (1) or (2), but used option (3) when that was all the operator would agree to.

1. Work with the operator to obtain contact information only for pilots selected for interview. We would never see the full list of employees. The interviewer would direct the operator to choose names based on where they fell on list. For example, the interviewer, using a sampling sheet, would direct the operator to choose the 3rd, 5th and 8th pilots on the operator’s list. The operator then provided us with names and contact phone numbers for the selected pilots.
2. Obtain a list of pilot names without contact information; draw the sample and mail the questionnaire to the company for delivery to the selected pilots.
3. Work with the operator (as above) so that the operator could select the random sample, but in addition, have the operator distribute the questionnaires to the selected pilots (rather than providing contact information to ISER).

In all cases when ISER mailed questionnaire to pilots we included a self addressed stamped envelope for the pilot to return the questionnaire to ISER. We also provided a form so that the pilot could mail us their telephone number, in which case we would call the pilot directly and conduct the survey over the telephone.

Initially we mailed surveys or called all selected pilots, and followed-up by telephone and fax as necessary. In most cases, we expected interviewers to complete surveys over the telephone. In cases where telephone contact was unsuccessful or where the pilots preferred face to face contact, interviewers arranged to complete the interview in person.

Our methodology incorporated the standard strategies used to obtain high survey response rates. We trained interviewers thoroughly so that they understood the goals of the research, the questionnaire, and the protocols for administering the questionnaire. We followed up by telephone (wherever possible) if we did not receive a response to an initial contact by mail. If necessary, we followed up with face-to-face contact where both telephone and mail contacts were unsuccessful. We did not assign the “unable to contact” disposition to a telephone number until we had made repeated calls on different days of the week and at different times of day. Likewise, we attempted face-to-face contacts on different days of the week and at different times of day. If potential respondents refused the survey, interviewers experienced at turning refusals around called them and attempted to change their minds. This rigorous telephone interview approach minimizes non-response bias at the outset by generating a non-biased sample, and then by ensuring a high response rate.

Interviewer Training

ISER hired and trained interviewers for telephone and face-to-face, interviews with respondents. The initial training was 16 hours and used the following outline:

Day 1

Research ethics - statement of professional ethics
Confidentiality
History of ISER
Purpose of survey
Background
Purposes and structure of Alaska Aviation Safety Survey
Selecting the respondent
General rules for interviewing
Thumbnail sketch
Style
Introductions
    Special interview circumstances
    Handling reluctant respondents
Some techniques to prevent or turn around a refusal:
Misinterpreted questions
Vague answers and answers that don't fit
Clarifying respondent's role using positive feedback
Disposition of interview and record keeping

Evaluation

Day 2

Practice interview
    Disposition of interviews, record keeping
    Paired interviewer practice
    Readiness check —1
    Practice interviews
    Readiness check —2
    Initial sample assignment

Interviewers are evaluated and approved by the field supervisor for readiness prior to their starting telephone interviews

Confidentiality

All respondents received voluntary participation and confidentiality information in a consent form. Participants who responded by mail or face-to-face were given a copy of the form to keep, and also signed a copy that was attached to the interview. If respondents returned a mail for fax survey without a signed consent form, we considered them to have given their implied consent. For telephone respondents, interviewers read the consent form and obtained the respondent's verbal consent. The form included the following items:

1. The authority and purpose for data collection,
2. an explanation that participation was voluntary,
3. An explanation of the confidentiality of their responses, including assurances that

- responses would not be used in any enforcement actions ,
- although survey results would be available to the air carrier operator and pilot associations, federal agencies, and other interested parties, this would be in summary format only -- without any personal or corporate identifiers.
- the information provided is kept confidential. Responses are locked in a file cabinet with access limited to research staff on the project

Current Events

Respondents were expected to naturally refer to their own experience and prior flying experience in thinking about their responses. Three events occurred during the course of this survey, which are certain to have affected pilot's responses. On September 11 there were the tragic events at the World Trade Center and the shut-down of aviation nationwide. In response to the uncertainty in the aviation industry and concern among respondents we stopped interviewing for one week. On October 11, there was the worst commercial crash in Alaska since 1987 involving one of the largest regional operators in Alaska. On October 19, there was a helicopter crash in Anchorage involving another of the largest regional carriers. How and to what extent these events may have influenced pilots' responses is unknown, but a series of events of this magnitude are likely to have affected public attitudes, perceptions, and business practices.

Survey Dispositions and Response Rates

Table F-2 shows the response rates for Capstone operators and pilots. Every operator and pilot selected for the NIOSH sample was ultimately assigned a disposition code:

- Refusals
- Respondent Unavailable During the Study
- Completed Interview

The response rate is calculated as:

$$\frac{\text{Total \# of completed interviews}}{\text{Number in the original sample}}$$

For purposes of calculating the response rates, we did not include the 61 Capstone pilot modules obtained by Dr Daniels in Bethel and at Capstone training classes.

Table E-2. Response Rates for Capstone Operators and Pilots

	Sample	Completed Interviews	Response Rate
Capstone Operators	20	18	90%
Pilots Employed by Capstone Operators*	62*	45	73%

*We estimated the Capstone pilot response rate from large operators as being the same as the response rate for all pilots employed by Capstone operators. Several large operators have both Capstone and non-Capstone pilots. We used the fraction of responding pilots who are Capstone pilots to estimate the number of non-responding Capstone pilots from large operators.

Data Set

A data editor reviewed the completed survey forms for completeness and consistency; whenever possible, our interviewers called back respondents to resolve any problems we found. We reconfirmed our data entry programs to reject some types of incorrect data. We entered a sample of the surveys twice and compared the two entries to measure the accuracy of data entry. Once all the survey data was entered, we reviewed it and corrected for missing or unreasonable values.

Weighting

We calculated two sets of weights for the pilot Capstone modules. The first–*pilotwt* and *normalized pilotwt*–weighted sample pilots to represent all pilots flying for the 19[2] operators whose pilots we interviewed. The second set–*totalwt* and *normalized totalwt*–adjusts the first set of weights to represent all pilots in our universe: pilots employed by air taxi and commuter air operators and public agencies flying in Alaska.

To weight to the operators represented in the survey, we calculated a separate weight for each company

$$\text{Pilotwt} = \frac{\text{Total pilots employed by company}}{\text{Total Pilot Interviews completed from company}}$$

This formula reflects the fact that the pilot's probability of selection was different for each company size. We then normalized this weight, so that the weighted total pilots equaled the number of respondents (261):

$$\text{Normalized Pilotwt} = \frac{\text{Pilotwt} * 106}{\text{Sum of Pilotwt for the full (106) sample}}$$

To adjust the sample to represent all pilots in our universe, we needed to account for the operator's probability of selection, as well. We multiplied the (non-normalized) pilot weight by the (non-normalized) company weight[3]. The calculation of the company weights is discussed in the methodology documentation for the operator survey.

$$\text{Totalwt} = \text{Pilotwt} * \text{Company Weight}$$

The normalized the total weight adjusts the weighted total of pilots to equal the number of respondents (106):

$$\text{Normalized Totalwt} = \frac{\text{Totalwt} * 106}{\text{Sum of Totalwt for the full (106) sample}}$$

Use of normalized weights is appropriate to accurately calculate statistical significance and confidence intervals from the survey data. Since the pilot sample was stratified by company there is a unique weight for each of the 133 air operators represented in the sample. Consequently, the weights themselves are confidential.

The following pages show the instrument with weighted frequencies included.

---

[2] Although we had only 18 completed operator interviews, we picked up one pilot interview from a company that refused the operator interview.

[3] For the company that had refused the operator interview, we used the appropriate company weight for that company's stratum. While it would be preferable to re-calculate all the company weights taking the additional company into account, the change is very small and does not affect the results measurably.

SURVEY INSTRUMENT WITH FREQUENCIES: CAPSTONE PILOT MODULE
All Numbers Represent Percentages Unless Otherwise Noted

CP1. Have you completed this survey before? (*to be completed by interviewer*)

75.4 No➔ 24.6 Yes: When? ________________

Demog1. Are you 100 Male 0 Female

Demog2. How old are you: 32.76___________

Demog3. Please check below all the pilot ratings that you hold:

88.9 Commercial	47 ATP
84.8 Instrument	7.9 Rotary Wing

Please check below all the FAR parts under which you ***routinely*** fly:

12.2 Part 91	40.8 Part 121
79.1 Part 135	100 Other (specify) _________

FltHrTot. Please estimate your ***total*** flight time: 5410.09 _________hours

FltHrAk. How many hours have you flown in ***Alaska***: 6030.71_________hours

FltHrYr: How many hours have you flown ***in the last 12 months***? 800______hours?

FltHrIFR. How many ***instrument*** hours have you flown in the last 12 months? 14.31_____

FltHrCap. About how many hours have you flown ***Capstone-equipped aircraft?***

900__________hours

CP1. Have you received formal training to use the Capstone equipment? (Include all training, initial, recurrent, etc.)

3.3 No → **Skip to Question CP3**

96.7 Yes

↓

CP2. For each type of Capstone training, please write how many hours you received and check who provided the training.

Type of Training	**Hours**	**1 Training was taught by**		
		UAA personnel	**Someone in your company**	**Someone else (please specify)**
a. Classroom no simulator	2.32	16.5	65	3_______18.5__________
b. Classroom with desktop Capstone simulator	16	19.5	79.9	3________.6_________
c. Flight or Capstone-equipped flight simulator	2.27	15.3	42.8	3_________41.9________

CP3. How useful is each feature of the Capstone equipment?

	Very useful	**Somewhat useful**	**Not useful**
GPS	82.6	9.6	7.8
MFD	74.1	18.1	7.8
Radar-like services	55.6	7.4	32.9

CP4rev.For each of the functions of Capstone avionics listed below, please tell us how often you use that feature, how easy it is to use, and how helpful it is to you.

	CP4_1**. How often** do you use this feature?	CP4_2. Compared to other avionics you use, **how easy** is this feature to use?	CP4_3**. How helpful** has this feature been to you as a pilot?
a. Traffic Avoidance	92.2 Routinely 7.8 Rarely 0 Never	20 Easier 67.7 About the same 12.3 Harder	0 Not helpful 17.7 Somewhat helpful 82.3 Very Helpful
b. Terrain Avoidance	55.6 Routinely 42.5 Rarely 1.9 Never	39 Easier 56.7 About the same 4.4 Harder	7.9 Not helpful 31.7 Somewhat helpful 60.5 Very Helpful
c. Flight Planning	67.1 Routinely 16.3 Rarely 16.6 Never	39.9 Easier 47.6 About the same 12.5 Harder	15.5 Not helpful 16.8 Somewhat helpful 67.7 Very Helpful
d. Navigation	100 Routinely 0 Rarely 0 Never	55.8 Easier 40.1 About the same 4.1 Harder	.5 Not helpful 16.3 Somewhat helpful 83.3 Very Helpful
e. Access to weather info while flying	56.1 Routinely 32.4 Rarely 11.5 Never	44.4 Easier 41.8 About the same 13.8 Harder	25.8 Not helpful 21.8 Somewhat helpful 52.3 Very Helpful
f. Access to PIREPs, airspace info etc., while flying	46.3 Routinely 37 Rarely 16.7 Never	19.2 Easier 67.3 About the same 13.5 Harder	22.1 Not helpful 8.8 Somewhat helpful 69.1 Very Helpful
g. Radar-like services	52 Routinely 10.6 Rarely 37.4 Never	36.2 Easier 48.9 About the same 14.9 Harder	35 Not helpful 6.7 Somewhat helpful 58.3 Very Helpful
h. GPS approaches	20.4 Routinely 35.6 Rarely 43.9 Never	15.8 Easier 84.2 About the same 0 Harder	33.9 Not helpful 3.9 Somewhat helpful 62.3 Very Helpful

CP5. Which functions do you like best about Capstone avionics? Why?

Comments Recorded=79.6%

CP6. What do you dislike the most about Capstone avionics? Why?

Comments Recorded=38.8%

CP7. How often do you use the new GPS-based instrument approaches at remote airports? *(Note: new GPS-based approaches are at Holy Cross, Kalskag, Kipnuk, Koliganek, Mountain Village, Platinum, Russian Mission, Scammon Bay, St. Michael)*

0 Daily 0 Weekly 27.1 Monthly 5.4 Less than Monthly

5.4 Never, we don’t fly to those airports

51.7 Never, we never use instrument approaches

10.4 Never for other reasons

RLS1. Are you familiar with the capabilities of “Radar-Like Services” available for Capstone-equipped aircraft?

48.3 No ➔ *describe with standard definition, below and skip RLS2*

51.7 Yes

Capstone’s ADS-B transmits the aircraft’s location to ground stations, which forward it to Air Traffic Control computers. Those computers display the locations along with aircraft locations from radar and transponders. This allows controllers to provide flight-following and surveillance-based separation services in the Y-K Delta. Eventually, Bethel tower controllers should also be able to provide approach control services as well.

RLS2. Do you know how to obtain those services?

65.2 No (Skip to CP8)

25.2 Yes

9.6 skipped

RLS3. On how many flights in the last 12 months have you requested radar-like services?

__16.09 ___

RLS3b. On how many of these flights have you received the requested radar-like services?

____

RLS4. If controllers in the Bethel tower had been able to use radar-like services to provide approach control, how many times in the last 12 months do you think you would have used those services?

______

CP8. What benefits have you experienced from the Capstone program in the Bethel area?

	No Benefit	**Very Small Benefit**	**Some Benefit**	**Signifi-cant Benefit**	**A Major Benefit**
a. Fewer cancelled flights due to new instrument approaches at remote airports	51	0	22.3	22.3	4.5
b. Safer operations at remote airports due to new instrument approaches	42.5	0	30.8	22.3	4.5
c. Safer flying in minimum legal VFR conditions	0	0	27.8	33.3	38.9
d. Fewer near mid-air collisions	4.5	3.1	5.5	18.3	68.6
e. More useful weather information	14.5	13.7	18.2	22.8	30.8
f. Better knowledge of other aircraft and ground vehicle locations when taxiing	12.1	15.6	33	0	39.3
g. Improved SVFR procedures due to better pilot and controller knowledge of aircraft locations	9	4.5	12.1	10.7	63.6
h. Easier in-flight diversions or re-routes	1	7.7	27.8	37.5	26
i. Time savings from more direct flight routes	12.2	9.1	23.9	24.4	30.5
j. Improved terrain awareness for pilots	0	.5	34.8	15.7	49
k. Improved search and rescue capabilities	3.1	7.7	24.3	22.4	42.6

CP9. If there are other benefits you believe that Capstone provides, please list them.

Comments recorded=9.7%

CP10. What problems have you experienced with the Capstone program in the Bethel area?

	No Problem	**Very Small Problem**	**Minor Problem**	**Signifi-cant Problem**	**Major Problem**
a. Less heads-up time	32.3	.5	32.8	15.2	19.1
b. Heavier workload in the cockpit	53	23.3	10.7	4.5	8.5
c. More aircraft flying in the same airspace because they are using GPS point-to-point routing	69.2	1.5	19.8	.5	9

CP11. Please list any other problems you believe that Capstone may cause or add to.

Comments Recorded=27.8%

CP12. When you fly for <your employer>, how often is the aircraft Capstone equipped?

96.1 Always 3.9 Usually 0 Sometimes 0 Rarely 0 Never

↓

Skip to Question CP 15, next page

CP14. How much does the Capstone equipment help you to make go/no go decisions under the conditions listed below?

	Not at all	**A small amount**	**A great deal**	**Don't know**
a. Low ceilings	55.1	3.4	20.2	21.3
b. Low visibility	55.1	3.4	20.2	21.3
c. High winds	66.3	4.3	8.2	21.3
d. Icing potential	63.3	11.1	4.3	21.3

CP15. For what reasons might pilots choose not to use Capstone equipment?

	Yes	**No**	**Don't Know/ No Opinion**
a. Too distracting	22.7	56	21.3
b. Too difficult to use	0	78.7	21.3
c. Don't want company watching aircraft location at all times	46.3	32.4	21.3
d. Don't trust equipment to provide reliable information	35.7	57.1	7.2
e. Concerned that equipment might break	18.3	56.1	25.6

CP15b. If you answered yes, above, please explain:

Comments Recorded=45.3%

CP16. Please list any other reasons you believe pilots might choose not to use Capstone equipment.

Comments Recorded=45.4%

The next five questions ask about potentially dangerous situations that pilots sometimes encounter. Capstone equipment might be helpful in preventing or coping with these particular problems. Therefore, we're interested in how often pilots in the Yukon Kuskokwim delta encounter these problems. For each situation, think about how often in the last 12 months you've encountered it.

	Daily	**Weekly**	**Monthly**	**Less often than monthly**	**Never**
CP17. How many times during the past year have inaccurate weather forecasts caused you to encounter instrument meteorological conditions when you didn't expect to?	2.0	7.7	8.6	43	37.7
CP18. How many times during the past year have deteriorating ceilings or visibility made you unsure of your own position relative to the surrounding terrain?	0	7.2	8.6	21.1	63
CP19. During the past year, how many times have you unexpectedly seen other aircraft close enough to you that you felt it created a collision hazard?	3.7	0	21.3	56.7	18.3
CP 20. During the past year, how many times have you been cleared into SVFR when the separation between aircraft in the pattern made you uncomfortable?	0	3.	5.4	20.8	70
CP21. During the past year, how many times might your go/no go or routing decisions have been improved if you would have had access to real time weather or Special Use Airspace status?	0	0	12.3	52	35.7

CP22. How do you think the Capstone program has affected flight safety in the YK Delta?

Much less safe=0 Somewhat safer=0 No change=0 Somewhat safer=18.5 Much safer=81.5

CP23. Please add any other comments you would like us to know about Capstone, safety or about flying in the YK Delta.

Comments Recorded=76.1%

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Appendix F. Acronyms

A & P	Airframe And Powerplant (Aviation Mechanic Certification)
ADS-B	Automatic Dependent Surveillance – Broadcast
ASOS	Automated Surface Observing System
ATC	Air Traffic Control or Controller
AWOS	Automated Weather Observing System
CDTI	Cockpit Display of Traffic Information
CFIT	Controlled Flight Into Terrain
CTAF	Common Traffic Advisory Frequency
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FIS-B	Flight Information System – Broadcast
GBT	Ground-Based Transceiver
GPS	Global Positioning System
IFR	Instrument Flight Rules
ISER	Institute of Social and Economic Research, U Alaska Anchorage
IMC	Instrument Meteorological Conditions
METAR	Meteorological Aviation Report
MFD	Multi-Function Display (of Capstone Avionics)
NDB	Non Directional Beacon – a navigation aid
NEXRAD	Next Generation Radar
NIOSH	National Institutes of Occupational Safety And Health
NMAC	Near Mid Air Collision
NOTAM	Notices To Airmen
NTSB	National Transportation Safety Board
PIREP	Pilot Report
SVFR	Special Visual Flight Rules
TAF	Terminal Aerodrome Forecast
TAWS	Terrain Awareness and Warning System
TCF	Terrain Clearance Floor
TIS-B	Traffic Information System – Broadcast
UAA-ATD	University o Alaska Anchorage Aviation Technology Division
UAT	Universal Access Transceiver
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Variable Omni-Directional Radio – a navigation aid
Wx	Weather

For detailed definitions of a wide variety of aviation terms, refer to the FAA's Pilot/Controller Glossary, available at

http://www.faa.gov/atpubs/PCG/