Executive Summary
Capstone Phase I, Interim Safety Study 2002

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 has only 13,628 miles of public roads.[2] Less than 10 percent of Alaska 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 lack the aviation infrastructure and services common in other states.

What is the Capstone Program?

To help improve aviation safety, the Federal Aviation Administration (FAA), in cooperation with industry, began testing new technology in the Yukon-Kuskokwim (Y-K) Delta region of southwest Alaska in 1999. The FAA contracted with the Institute of Social and Economic Research and the Aviation Technology Division of the University of Alaska Anchorage to evaluate the benefits of the new safety program, known as Capstone (for the way it brings together recommendations of government agencies and private organizations with interests in aviation safety). Capstone involves:

1) Equipping commuter airlines and air taxis[3] with avionics that shows pilots their location and information about nearby terrain, other aircraft, and weather
2) Building ground stations that broadcast weather and flight information and that provide radar-like surveillance of planes equipped with the new avionics
3) Installing weather observation stations and creating and publishing instrument approaches, 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 few of the small-plane accidents in southwest Alaska but are the most likely to cause deaths. And in addition to 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.

Why Test in Southwest Alaska?

Communities in southwest Alaska are far from highways and depend heavily on aviation to transport people and cargo. The Capstone program covers a broad area of southwest Alaska, as shown in Figure ES-1 (next page). But the program focuses on the Yukon-Kuskokwim (Y-K) Delta, with its primary transportation hub of Bethel, the smaller hubs of Aniak and St. Marys, and the villages those hubs serve (Figure ES-2, next page). More than 20 air taxi and commuter airlines serve the delta, mainly with aircraft seating fewer than 10 passengers.

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

[2] Alaska DOT&PF, 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] These commuters and air taxis are the focus of Capstone, but selected other aircraft operating under a different FAA regulation (FAR part 91) were also equipped. In 2000 and 2001, most of these were aircraft operated by government agencies such as the state troopers or U.S. Fish and Wildlife Service.

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

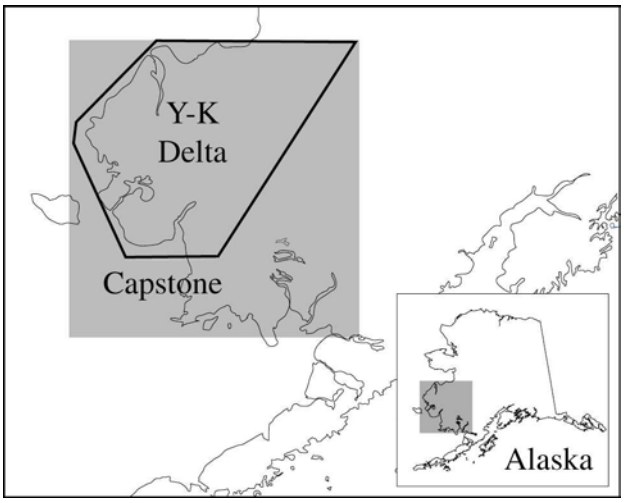
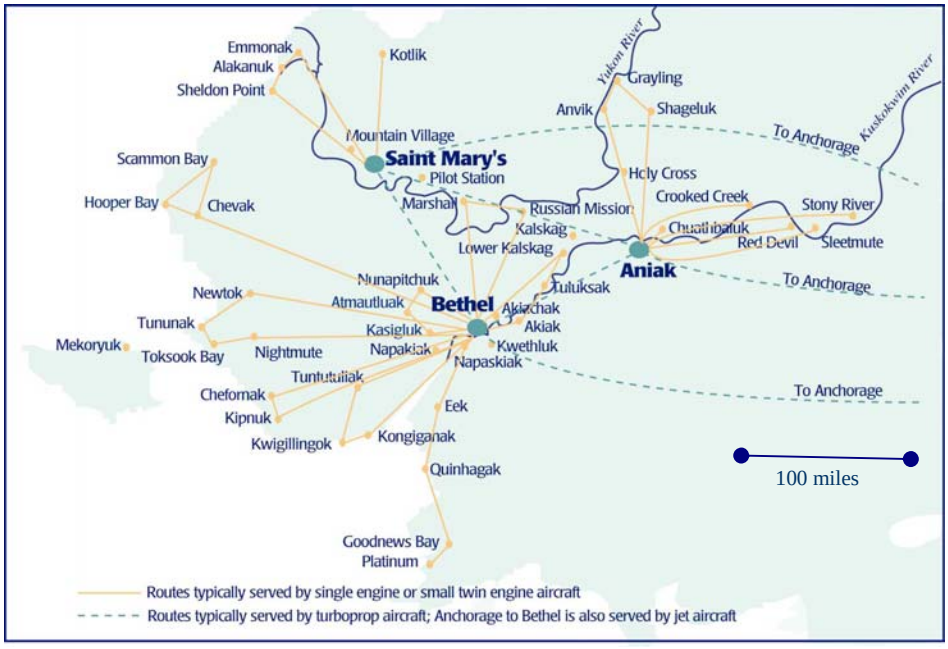


Figure ES-2. Y-K Delta Communities and Selected Air Routes



Like the rest of Alaska, the Y-K Delta has an accident rate considerably above the U.S. average. Pilots in the delta face rapidly changing weather, flat-light and white-outs, fog, and ice fog. Before the Capstone program started, weather stations were 100 miles or more apart, so local weather information often wasn't available. In 2003 the area still had only a single manned weather station, at Bethel. And pilots in this region have historically had to land with few navigational aids, at airports with short, unpaved runways; 90 percent of the airports in the region have gravel or dirt runways,[4] and two thirds are less than 3,000 feet long.

[4] FAA 5010 database

What's the Status of Capstone So Far?

• *Nearly 90 percent of the commuter and air taxi fleet in the Y-K Delta had Capstone avionics installed by the end of 2002*. We often refer to these aircraft as part-135 aircraft, because part 135 is the FAA regulation under which commuter airlines and air taxis typically operate.

• *About 90 percent of pilots flying part-135 aircraft in the delta had received some training on Capstone systems by the close of 2002, but nearly half still lacked flight training*. We estimate, based on the varying levels of training pilots had in using Capstone avionics, that overall Capstone training effectiveness among part-135 pilots in the delta was 67 percent by the end of 2002–a substantial improvement from 51 percent at the start of the year. This means that, on average, pilots flying Capstone-equipped aircraft could be expected to use the equipment effectively to avoid accidents about two thirds of the time. Individual pilots with the most training would be able to avoid accidents more of the time; those with less training would use the equipment less effectively.

• *Ten airports had received AWOS weather reporting stations and associated GPS non-precision instrument approaches by December 2002*.

• *Other changes by the end of 2002 included improved navigation, data-linked weather, and radar-like services*; there is no radar for aircraft flying under 6,000 feet in this region. Also in 2002, online flight-following was implemented for operator management. A BRITE display for tower operators and traffic information broadcast was partially implemented at the end of 2002. Ground infrastructure improvements and data collection will continue through 2004.

What is ISER Evaluating?

ISER's evaluation began in 1999, primarily looking at how well the Capstone program is meeting its central goal of improving aviation safety. We began with a baseline report that documented existing conditions in the Capstone region, quantifying the scarcity of navigation aids and weather information for pilots flying in the region, and then did a first interim evaluation of Capstone effects during the 2000-2001 period.

How Has Capstone Affected Safety?

Below we summarize our interim assessments of how Phase I of the Capstone program improved aviation safety in southwest Alaska between 2000 and 2002. Our confidence in these assessments varies, depending on the available data. The best are measured changes in accident rates, which over time will provide a very strong measure of how Capstone is improving safety. Several of our interim assessments are based on (1) what pilots and operators using the equipment have told us, and (2) factors that contribute to changes in safety, but are not themselves direct measures of improved safety. Remember that each of these is an interim evaluation that we can make with more confidence later, when the Capstone program has been in place longer.

• *Accident rates among commuter airlines and air taxis fell statewide from 2000-2002, but the rate fell twice as fast in the Capstone region*. As Figure ES-3 (facing page) shows, the accident rate among part-135 operators in the Y-K Delta from 2000-2002 was 30 percent below the rate from 1995-1999. In the rest of Alaska, the rate dropped 15 percent.

While aviation safety is improving statewide, the Capstone program is the most striking difference in safety efforts between the Y-K Delta and the rest of Alaska. The bigger decline in Y-K Delta accidents may indicate that the program is improving safety there. We don't yet have enough data to say how much of that improvement is due specifically to Capstone and how much to other factors.

• *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–that is, the entire environment affecting safety–has substantially improved 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 and are less likely to worry about potential problems*. Their views about the potential benefits and problems associated with Capstone have become more realistic since 1999. They still see the program's benefits as valuable and the problems as tractable with training and experience. As pilots have become better trained, their assessments of potential problems have diminished.

• *Unanticipated or auxiliary uses of Capstone equipment may help improve safety*. We cited one such example earlier–the use of Capstone's radar-like feature to help rescuers find downed planes faster. Pilots also told us that they get up-to-date information on their destinations by contacting other pilots at those locations—and that they identify those pilots using Capstone's automatic dependent surveillance-broadcast (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 prepare for them. But landing accidents recurred in 2002, so it is not clear that this Capstone has had a systematic effect in that area.

Figure ES-3. Commuter and Air Taxi Accident Rates, 1995-1999 and 2000-2002 (Accidents per 10,000 Departures)

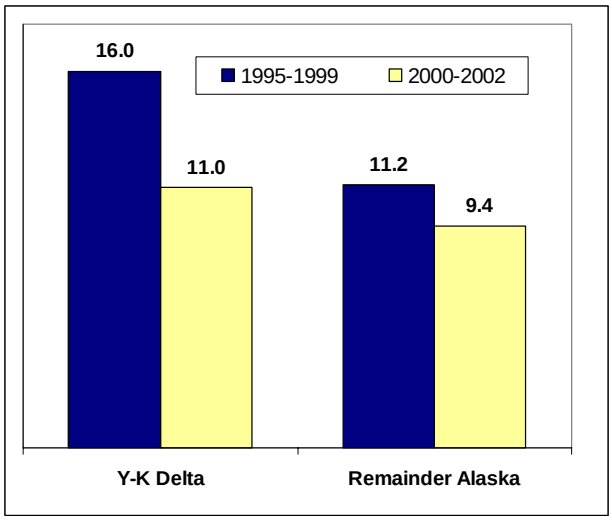
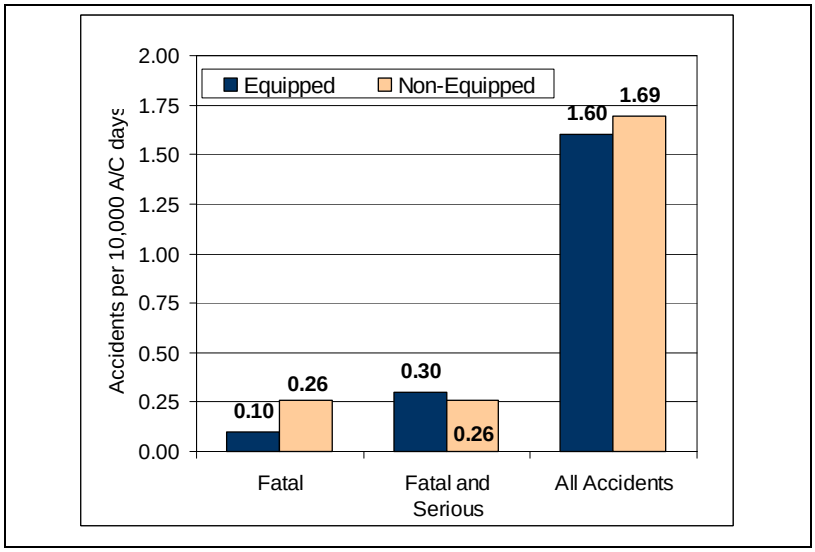


Figure ES-4. Commuter and Air Taxi Accident Rates, Capstone-Equipped and Non-Equipped Aircraft, Y-K Delta, 2000-2002



• *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. Also, 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 will always influence the accident rate. 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 unrealistic to expect to observe a systematic reduction in crashes due to Capstone.

What Are Initial Recommendations?

As we noted earlier, Capstone Phase I had been largely but not fully implemented by the end of 2002. 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 would have to 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 improvements in the future, when all the Capstone equipment and capabilities are in place, all pilots have been well-trained, and pilots have used the equipment for longer*. 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 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 that Capstone potentially makes available in the cockpit*, pilots need to be able to access this information wherever they fly in the Y-K Delta. It's important to increase the number of ground-based transceiver stations so they cover the full area.

• *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.