Executive Summary

Alaska relies on aviation more than any other state does. It is 615,230[1] square miles—representing 16 percent of the total U.S.—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 for most of the year. But because Alaska is huge, has fewer than 650,000 people, and is divided by mountain ranges, the infrastructure and services that support aviation in most other states are lacking in many areas of Alaska.

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 University of Alaska Anchorage's Institute of Social and Economic Research (ISER) and Aviation Technology Division (ATD) to evaluate the benefits of the new safety program—known as Capstone. The program involves:

1) 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.
2) Building ground stations that broadcast weather and flight information and that can provide radar-like surveillance of planes equipped with the new avionics.
3) 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.

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 focuses on the Y-K Delta's primary transportation hub of Bethel, the smaller hubs of Aniak and St. Marys, and the villages those hubs serve (Figure ES-1, next page). More than 20 air taxi and

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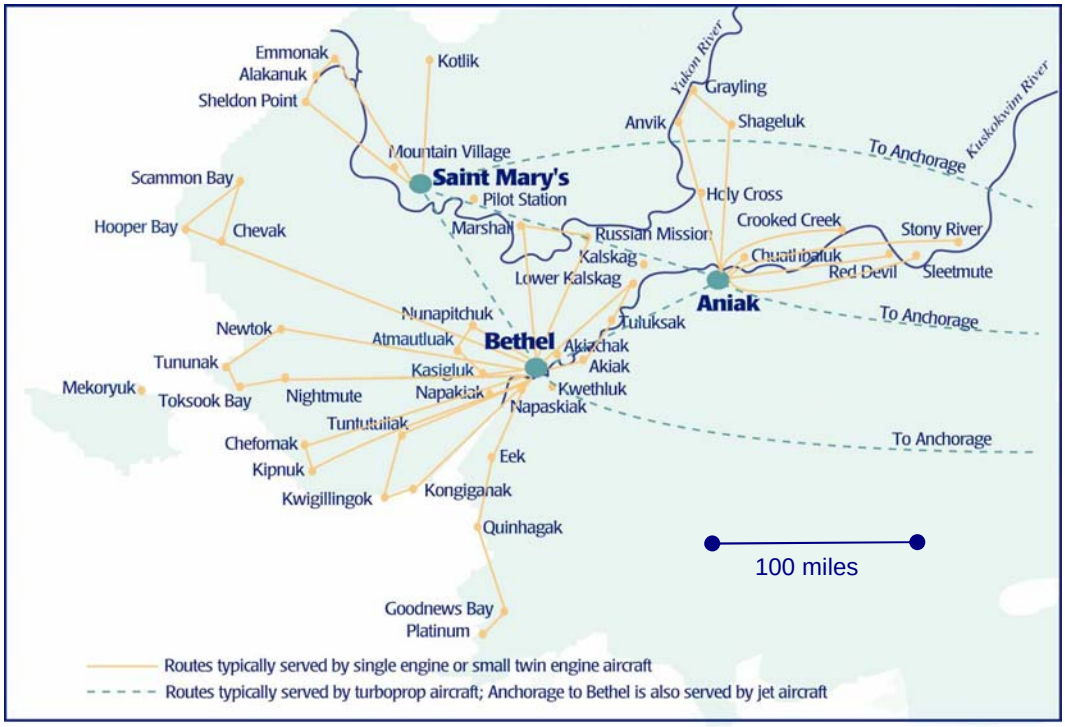
[1] Statistical Abstract of the United States, 2001, Table 343.
[2] Alaska DOT&PF, www.dot.state.ak.us/stwdplng/highwaydata/pub/cprm/2001cprm.pdf, Certified Public Road Mileage as of December 21, 2001. Excludes Marine Highway miles.
[3] In 2000 and 2001, most of these were government agencies such as the State Troopers or USFWS that operate fleets of aircraft under part 91.

commuter airlines serve these places, mainly with aircraft seating fewer than 10 passengers.

Figure ES-1. 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 routinely face rapidly changing weather, flat-light and white-out conditions, fog, and ice fog. Also, weather information is limited. Before the Capstone program started, the Y-K Delta had only seven locations with regularly available weather information. Only Bethel, the major hub, has a manned weather station.

Weather stations were 100 miles or more apart, before the Capstone program began, meaning that local weather information was often unavailable to pilots flying into many communities. Finally, pilots in this region often have 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.

What's the Status of Capstone So Far?

As of December 2001, the FAA had equipped 140 aircraft in the Y-K Delta with Capstone avionics. That included about 85 percent of air taxi and commuter planes operating in the Y-K Delta. The FAA had also installed automated weather stations (AWOS) at nine airports and published non-precision instrument approaches—landing instructions—for ten airports. Six of the planned 11 ground stations that transmit

[4] FAA 5010 database

weather, traffic, and other information to aircraft in flight were also operating by the end of 2001, although at somewhat less than their final planned capabilities. In mid-2002, the FAA was continuing to install the new avionics in planes and build ground stations.

What is ISER Evaluating?

ISER's evaluation began in 1999 and will continue through 2005. We are primarily evaluating how well the Capstone program is meeting its central goal of improving aviation safety.

What Did the Baseline Study Find?

ISER first analyzed data for the period 1990-1999, before the Capstone program started. We quantified the scarcity of navigation aids and weather information for pilots flying in the Y-K Delta (as described earlier). We then looked at accidents and found that if the new technology had been installed on all aircraft in the test region during the 1990s, it might have:

- Prevented about 1 in 7 of all accidents and nearly 1 in 2 fatal accidents, by mitigating all causes of the accidents.
- Helped pilots avoid more than half of all accidents and fatalities, by mitigating some but not all of the causes of the accidents.

How Has Capstone Affected Safety?

We can't expect to see the full safety effects of the Capstone program yet, because the program was still being phased in during the period we evaluated. By mid-2002, almost all air taxi and commuter planes in the Y-K Delta had been equipped with Capstone avionics—but averaged over 2000 and 2001, only about half had the avionics.

Also, as of mid-2002 the Bethel air control tower still lacked the equipment it needed to efficiently manage Capstone-equipped planes. Finally, as of mid-2002, the new weather reporting stations—while helpful—had not yet been tied in to the ground stations that send information to the Capstone-equipped planes. That means pilots could only get the weather information by telephone before they took off, or once they were within radio range.

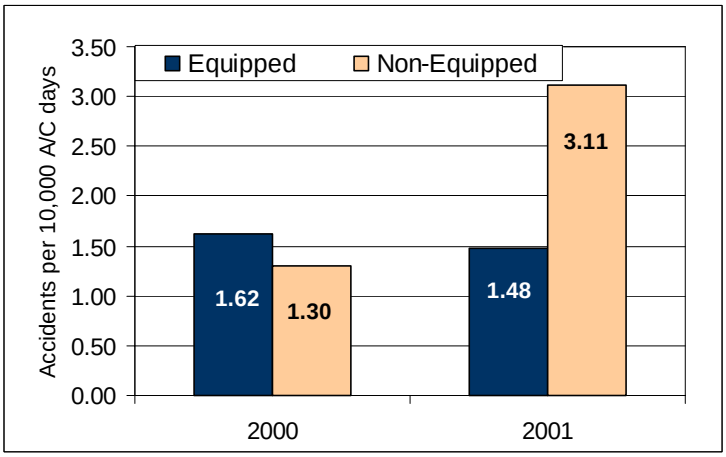
With that level of implementation, we would expect the Capstone equipment to have prevented only one in four controlled flight into terrain (CFIT) crashes and one in ten mid-air collisions. In an average year, there might be no such accidents.

Still, we do have some preliminary results from this phase-in period:

- Aircraft equipped with Capstone avionics had fewer accidents in 2001 than similar aircraft not equipped with the new avionics (Figure ES-2, next page). Commuters and air-taxi operators in the Y-K Delta had 7 accidents with Capstone-equipped planes and 12 accidents with planes that did not have the

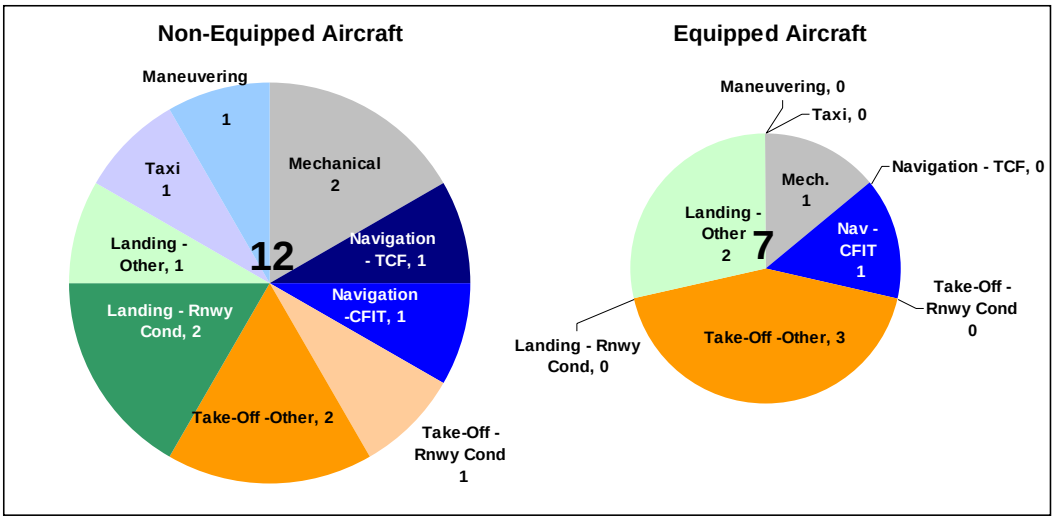
new avionics. However, it's still too early to assess whether this is a systematic change that will continue, or just the result of chance variation.

Figure ES-2. Accident Rates for Capstone Equipped and Non-Equipped Aircraft, Y-K Delta Part-135 Operators



- The only fatal accident with a Capstone-equipped plane during 2000-2001 took place in Dillingham, which is outside the Y-K Delta. That plane crashed on take-off in clear weather, not a type of accident that Capstone was designed to address. The NTSB investigation was not complete in mid-2002, but there is no evidence that the Capstone avionics could have prevented that crash.
- Pilots flying aircraft equipped with Capstone avionics had no accidents that were the result of poor runway conditions in 2000 and 2001. But 3 of the 12 accidents with planes lacking the new avionics–two landing and one take-off– did result from poor runway conditions (Figure ES-3, next page). We did not anticipate that Capstone avionics could reduce runway-related accidents. But pilots have told us that because they have Capstone equipment, they can identify other planes that have just landed at a particular airport—and then get in touch with the pilots of those planes and find out runway conditions.
- Of the seven Capstone-equipped planes that had accidents in the Y-K Delta in 2000 and 2001, only one was of the type that the new technology should have prevented. That was a controlled-flight-into-terrain (CFIT) accident. But the National Transportation Safety Board (NTSB) found that the pilot had disabled the avionics feature that might have helped him avoid the crash (NTSB Final Report ANC01LA046). Other accidents were five minor ones where pilots misjudged take-offs or landings and one in which the propeller came off during flight, but the pilot successfully landed.
- Additional weather stations and GPS approaches have encouraged Y-K Delta operators to pursue certification for instrument flight rules operations. As the number of Y-K Delta airports with instrument approaches increased from 3 to 13, the number of IFR-certified commercial aircraft operating in the area rose from 8 to 22 and will likely continue to increase.

Figure ES-3. Y-K Delta Commuter and Air Taxi Accidents, 2000 – 2001 Among Equipped and Non-Equipped Aircraft



Accident categories are explained in detail on page 20, figures 2-5 and 2-6. TCF=terrain clearance floor; CFIT=controlled flight into terrain

We also surveyed pilots and operators in the Y-K Delta to ask their opinions about Capstone's effectiveness and worked with the FAA when it surveyed and observed pilots and operators to find out how easy the equipment is to use. Those surveys found:

- Nearly half the 106 pilots ISER surveyed believe the program has made flying in the test area much safer. Most of the rest said it had improved safety somewhat.
- Operators who were reluctant to take part in the Capstone program in 1999 and 2000 have now asked to be included. As of mid-2002, all small commercial operators based in or operating out of Bethel had agreed to participate.
- Pilots especially liked Capstone's ability to warn them about terrain hazards and nearby traffic. They also liked having additional weather information.
- Capstone's GPS, along with the published landing approaches at nine additional airports, have encouraged several operators to upgrade their capacity to fly under instrument flight rules (IFR). Being able to fly IFR means operators can fly safely under worse weather conditions.
- Pilots also noted potential problems with using Capstone: more time spent using avionics instead of looking at where the plane is going and more aircraft flying close together, because they are all using Capstone's GPS to fly in a straight line between villages. But only about 15 percent saw these as major problems.
- Pilots reported that in the winter, when they're wearing heavy gloves, they find it more difficult to push the buttons and turn the knobs on Capstone equipment.
- Pilots need thorough and repeated training as well as practice to use this equipment effectively. Learning to use the GPS takes time. Also, the equipment has so many functions—weather, traffic, flight planning—that pilots can't master them all in one training session.

- Operators provide pilot training, and the quality of that training varies—so some pilots are trying to use the Capstone equipment with only minimal training.
- The Capstone program is one of several attempts to improve aviation safety in Alaska. In the Y-K Delta these include improved maintenance facilities, increased management oversight, and increased pilot training. Capstone has played a significant role, by providing additional weather stations, GPS approaches, avionics, and training. We know other changes have also improved safety, but we can't identify how much each is contributing.

What Are Initial Recommendations?

Capstone Phase I has not yet been fully implemented. To fully realize Capstone's potential benefits, the FAA must finish equipping the fleet as planned and building the ground infrastructure to support the system's capabilities. Operators must continue to provide training and support for pilots to use the equipment effectively. Our preliminary recommendations include:

- *Continue the Capstone program.* Only when all the Capstone equipment is in place and pilots have been well-trained—and have used the equipment for a longer period—can we expect to see the full safety benefits.

- *Market program to operators and pilots.* The Capstone program won't see its full benefits unless pilots and operators support it and use all its capabilities. The FAA needs to continue to market the program to pilots and Flight Standards District Offices (FSDOs) need to assure pilots and operators that the technology won't be used for enforcement.

- *Ensure adequate pilot training.* Operators need to allocate time and money for thorough initial and continuing training. FAA oversight could help to ensure this. Simulators with Capstone avionics would be a valuable addition to the pilot training.

- *Expand GBT coverage.* To get the most benefit out of data-link weather and other relevant information the Capstone program 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.

- *Provide radar-like approach control services.* To fully realize the potential benefits of radar-like services, the FAA should work to provide approach-control services for Bethel airport using Capstone's capabilities.

- *Require more operator feedback.* The FAA should require future Capstone participants to provide more 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 hampers our ability to estimate safety benefits. Operators in Phase I of the program weren't required to provide this information when they received the Capstone equipment.