NTSB Recommendation A-21-23: Reducing the Risk of Midair Collisions

May 13, 2022

Midair collisions in the United States accounted for about 2% of all fatal aircraft accidents between January 1982 and August 2020 but 7% of fatal Part 135 sightseeing accidents. The higher percentage of midair collisions involving sightseeing aircraft could stem from a concentration of aircraft in some scenic areas and from an overreliance on the “see-and-avoid” approach to aircraft separation. There are inherent limitations to see-and-avoid, including the limited field of view from the cockpit (such as “blind spots” similar to those in vehicles), limitations of human attention (such as vigilance decrements or sub-optimal scanning patterns), and visual performance (difficulty perceiving small targets that lack apparent motion and may be masked by complex backgrounds). These limitations, which have been noted in U.S. civil aircraft accident reports dating back as far as the 1950s, spurred the development of the modern air traffic control system and a 1991 requirement for larger commercial aircraft to be equipped with traffic collision avoidance systems.

The National Transportation Safety Board’s (NTSB’s) final report on a fatal May 13, 2019, midair collision between a de Havilland DHC-2 Beaver and a de Havilland DHC-3 Otter near Ketchikan, Alaska, which occurred at 1221 local time in visual meteorological conditions, has highlighted once again the limitations of see-and-avoid. An analysis of the visibility of each airplane from the cockpit of the other indicated that the Otter was obscured from the Beaver pilot by the Beaver’s cockpit structure, right wing, and the passenger in the right front seat. Similarly, the Beaver was intermittently obscured from the Otter pilot’s field of view by a window post, most critically during the last 11 seconds before the collision. The pilot of the Beaver and all four passengers were killed. One passenger on the Otter was killed, the pilot sustained minor injuries, and nine passengers sustained serious injuries. A good samaritan operating a private vessel was located near the spot where the Otter crash-landed in a remote ocean inlet, and he was able to assist the survivors. Without his help, additional fatalities may have occurred.

Over the last 2 decades, automatic dependent surveillance-broadcast (ADS-B)-supported collision avoidance technologies featuring displays of traffic and aural and visual alerting features have become widely available and increasingly affordable in the United States. Such technologies, if widely adopted, could substantially reduce the occurrence of midair collisions like this one. Surprisingly, the pilots of both aircraft involved in the Ketchikan accident had ADS-B-supported cockpit displays of traffic information (CDTI) available to them, but the systems installed in each airplane had certain limitations, and they were not effectively utilized. The ADS-B system on the Otter was not broadcasting pressure altitude information because an ADS- B control head that relayed pressure altitude information to the ADS-B transceiver was not switched on. The NTSB’s investigation determined that this device was turned off during a maintenance inspection performed 2 weeks earlier on the Otter, and its deactivation was not noticed by three different pilots (including the accident pilot) who subsequently operated the airplane. Pilots did not normally manipulate the ADS-B control head, and it was not listed on company checklists for the airplane. As a result, information about the Otter’s pressure altitude was not transmitted to the Beaver’s ADS-B system.

The Beaver’s ADS-B system supplied traffic information to a ForeFlight mobile application that could provide a CDTI on the Beaver pilot’s Apple iPad. The version of ForeFlight on the iPad had the ability to produce both visual and aural alerts but required the altitude of relevant traffic targets to do so. Because the Otter was not broadcasting pressure altitude and though it was transmitting GPS-based

altitude, the transceiver on the Beaver was configured to only transmit pressure altitude, not geometric altitude, to the iPad. As a result, the ForeFlight application on the Beaver did not have altitude information about the Otter and so would not have identified the Otter as a collision threat or produced an alert as the airplanes converged. Additionally, if the Beaver's ForeFlight "Hide Distant Traffic" option had been enabled, the Otter would not have been displayed at all (the lack of altitude data for the Otter would have resulted in the ForeFlight application treating it as a "distant" target). Simulations performed by the NTSB indicated that, if the Otter had been broadcasting pressure altitude, the ForeFlight application could have generated aural and visual alerts concerning the Otter 1 minute 44 seconds before the collision.

The Otter was equipped with a Chelton electronic flight instrumentation system that provided a CDTI on a display mounted on the instrument panel. The Chelton system was designed to produce aural and visual traffic alerts but, to do so, required that the relevant traffic messages it received from the transceiver (a FreeFlight RANGR 978) be in "alert status." Although the Otter was originally equipped with a transceiver that could place targets in "alert status," in 2015, the transceiver was replaced with a newer model that did not have, and was not required to have, such an algorithm. After this change, the alerting features available on the CDTI could not be activated. Therefore, although the Beaver was displayed on the CDTI, the Otter pilot did not receive any visual or aural alerts concerning the Beaver as the airplanes converged. Simulations performed by the NTSB indicated that a CDTI with alerting capability might have generated an alert concerning the Beaver 37 seconds before the collision. According to the Otter pilot, the last time he looked at the CDTI was about 4 minutes before the accident. At that time, he saw "two groups of blue triangles," or aircraft targets, several miles away; but his experience with common patterns of flight operations in the local area led him to believe that the targets would not intercept his intended flightpath. If the Otter pilot had subsequently been alerted to the approaching Beaver, he would likely have looked for the Beaver and maneuvered to avoid it.

The NTSB determined that the probable cause of this accident was the inherent limitations of the see-and-avoid concept, which prevented the two pilots from seeing the other airplane before the collision, and the absence of visual and aural alerts from both airplanes' traffic display systems, while operating in a geographic area with a high concentration of air tour activity. Contributing to the accident were (1) the Federal Aviation Administration's (FAA's) provision of new transceivers that lacked alerting capability to Capstone Program operators without adequately mitigating the increased risk associated with the consequent loss of the previously available alerting capability and (2) the absence of a requirement for airborne traffic advisory systems with aural alerting among operators who carry passengers for hire.

This accident highlights how CDTI with traffic alerting can help pilots to overcome the limitations of the see-and-avoid concept and can mitigate the risk of midair collisions. As demonstrated in this accident, the presence of a CDTI in the cockpit does not by itself guarantee the effectiveness of the technology. Pilots must be familiar with ADS-B equipment installed in their aircraft and ensure that it is always fully operational in flight. Pilots should know whether their equipment includes a conflict-alerting feature and, if so, what types of alerts will be given under different scenarios. Because of the variety of CDTIs available and the different capabilities of these systems, pilots might not be aware of the aural or visual information their system can provide. Understanding the potential differences between CDTIs is particularly important for pilots who fly multiple aircraft with different systems. If a CDTI with aural and visual alerting is not installed, one should be installed and consistently used. Pilots must continue to visually scan outside for conflicting traffic in visual flight rules conditions, but the circumstances of this accident underscore the importance of combining an effective visual scan with CDTIs and alerting in the cockpit.

Existing information published in the *Aeronautical Information Manual* and the *Pilot's Handbook of Aeronautical Knowledge* does not adequately address the limitations of human visual monitoring, the benefits of incorporating CDTIs in a pilot's traffic scan, and the importance of traffic alerting. Therefore, the NTSB has recommended that the FAA update these publications to include this

information. In the meantime, we believe aviation industry groups can help to inform pilots about the lessons that can be learned from this accident. Specifically, the NTSB has recommended that industry groups take the following actions to proactively reduce the risk of midair collisions:

> Inform your members about the circumstances of this accident and encourage them to:
> - Become familiar with the traffic display equipment installed in their aircraft
> - If their equipment does not provide an aural alert concerning proximate targets that might pose a collision threat, encourage pilots/operators to supplement the equipment with devices that provide both an aural and visual alert; and
> - Remind pilots to include the traffic display when scanning for traffic through the aircraft's windows.

Additional information about the midair collision involving two sightseeing aircraft that occurred near Ketchikan, including the full accident report, can be found on the NTSB website at www.NTSB.gov, aviation accident report NTSB/AAR-21-04. An animation of the accident can be found on the NTSB's YouTube channel at: NTSB Ketchikan Animation - YouTube

Additional NTSB information and publications regarding midair collisions and the benefits of CDTI:

- Safety Alert – "Prevent Midair Collisions – Don't Depend on Vision Alone"
- NTSB Safety Compass blog – "Do we See and Avoid or Avoid Seeing?"