## 3. Conclusions

## 3.1 Findings

1. None of the following safety issues were identified for the accident flight: (1) pilot qualification deficiencies; (2) pilot impairment; or (3) a malfunction or failure on either airplane.

2. The circumstances of this accident underscore the inherent limitations of the see-and-avoid collision avoidance concept, including how collision geometry, obscuration by aircraft structures, and limitations of human performance can make it difficult to see nearby aircraft.

3. Aural and visual alerts that draw the pilots' attention to conflicting traffic presented on the cockpit display of traffic information can greatly increase the pilots' awareness of potentially conflicting traffic and avoid a collision.

4. Because of the high concentration of traffic in popular air tour areas, the risk of collision is higher than in the general National Airspace System and technology that supplements pilots' traffic scans by providing aural and visual alerts can mitigate this risk.

5. Although existing automatic dependent surveillance-broadcast traffic alerting applications can help draw pilots' attention to conflicting traffic, these applications are currently not required.

6. Requiring automatic dependent surveillance-broadcast–supported airborne traffic advisory systems with aural alerting in high-traffic air tour areas, through a special federal aviation regulation or other means, would mitigate the risk of midair collisions.

7. The manner in which the ForeFlight application currently handles missing altitude data from traffic targets precludes the application from providing visual and aural alerts concerning these targets and, in certain configurations of the application, removes the targets from the moving map entirely, which degrades the ability of the application to call attention to potential collision threats.

8. Because the Garmin GSL 71 can be manually turned off without any obvious indication on the Chelton display that pressure altitude is not being reported with the automatic dependent surveillance-broadcast data, there is a potential for the GSL 71 to be inadvertently left in the OFF position, which can lead to other pilots not receiving appropriate visual and aural alerts of traffic.

9. The combination of automatic dependent surveillance-broadcast (ADS-B) components in the de Havilland DHC-3 did not have the same conflict detection capability that was present in systems installed as part of the Capstone Program, which provided visual and aural alerting; this reduction in capability was a result of the Federal Aviation

Administration's upgrade of ADS-B equipment for aircraft participating in the Capstone Program with components that did not maintain the existing alerting functions. 10. A procedural safeguard, such as a checklist item that addresses the position of the Garmin GSL 71 control head selector knob, can mitigate the hazard of the selector knob being inadvertently and indefinitely placed in the OFF position.

11. Increasing pilots' awareness of the inherent limitations of the see-and-avoid collision avoidance concept and the benefits of cockpit displays of traffic information with traffic alerting can mitigate the risk of midair collisions.

12. If Taquan Air had been required to have a safety management system (SMS) at the time of the accident, the activities required by the safety risk management element would have provided better opportunities for Taquan Air to discover and mitigate the increased risk of airborne collision posed by changes to the Capstone-affiliated avionics installed in its aircraft, which provides another example of the value of SMS for all Title 14 *Code of Federal Regulations* Part 135 operators.

## 3.2 Probable Cause

The NTSB determines 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 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.