

3. Conclusions

3.1 Findings

1. The flight crew was properly certificated and qualified in accordance with applicable Federal regulations.
2. The airplane was properly certified, equipped, and maintained in accordance with Federal regulations.
3. The recovered components showed no evidence of any preimpact structural, engine, or system failures, including no indications of any problems with the airplane's ice protection system.
4. The air traffic controllers who were responsible for the flight during its approach to Buffalo-Niagara International Airport performed their duties properly and responded immediately and appropriately to the loss of radio and radar contact with the flight.
5. This accident was not survivable.
6. The captain's inappropriate aft control column inputs in response to the stick shaker caused the airplane's wing to stall.
7. The minimal aircraft performance degradation resulting from ice accumulation did not affect the flight crew's ability to fly and control the airplane.
8. Explicit cues associated with the impending stick shaker onset, including the decreasing margin between indicated airspeed and the low-speed cue, the airspeed trend vector pointing downward into the low-speed cue, the changing color of the numbers on the airplane's indicated airspeed display, and the airplane's excessive nose-up pitch attitude, were presented on the flight instruments with adequate time for the pilots to initiate corrective action, but neither pilot responded to the presence of these cues.
9. The reason the captain did not recognize the impending onset of the stick shaker could not be determined from the available evidence, but the first officer's tasks at the time the low-speed cue was visible would have likely reduced opportunities for her timely recognition of the impending event; the failure of both pilots to detect this situation was the result of a significant breakdown in their monitoring responsibilities and workload management.
10. The flight crew did not consider the position of the reference speeds switch when the stick shaker activated.

11. The captain's response to stick shaker activation should have been automatic, but his improper flight control inputs were inconsistent with his training and were instead consistent with startle and confusion.
12. The captain did not recognize the stick pusher's action to decrease angle-of-attack as a proper step in a stall recovery, and his improper flight control inputs to override the stick pusher exacerbated the situation.
13. It is unlikely that the captain was deliberately attempting to perform a tailplane stall recovery.
14. No evidence indicated that the Q400 was susceptible to a tailplane stall.
15. Although the reasons the first officer retracted the flaps and suggested raising the gear could not be determined from the available information, these actions were inconsistent with company stall recovery procedures and training.
16. The Q400 airspeed indicator lacked low-speed awareness features, such as an amber band above the low-speed cue or airspeed indications that changed to amber as speed decrease toward the low-speed cue, which would have facilitated the flight crew's detection of the developing low-speed situation.
17. An aural warning in advance of the stick shaker would have provided a redundant cue of the visual indication of the rising low-speed cue and might have elicited a timely response from the pilots before the onset of the stick shaker.
18. The captain's failure to effectively manage the flight (1) enabled conversation that delayed checklist completion and conflicted with sterile cockpit procedures and (2) created an environment that impeded timely error detection.
19. The monitoring errors made by the accident flight crew demonstrate the continuing need for specific pilot training on active monitoring skills.
20. Colgan Air's standard operating procedures at the time of the accident did not promote effective monitoring behavior.
21. Specific leadership training for upgrading captains would help standardize and reinforce the critical command authority skills needed by a pilot-in-command during air carrier operations.
22. Because of the continuing number of accidents involving a breakdown of sterile cockpit discipline, collaborative action by the Federal Aviation Administration and the aviation industry to promptly address this issue is warranted.
23. The flight crewmembers' performance during the flight, including the captain's deviations from standard operating procedures and the first officer's failure to challenge these deviations, was not consistent with the crew resource management (CRM) training that they had received or the concepts in the Federal Aviation Administration's CRM guidance.

24. The pilots' performance was likely impaired because of fatigue, but the extent of their impairment and the degree to which it contributed to the performance deficiencies that occurred during the flight cannot be conclusively determined.
25. All pilots, including those who commute to their home base of operations, have a personal responsibility to wisely manage their off-duty time and effectively use available rest periods so that they can arrive for work fit for duty; the accident pilots did not do so by using an inappropriate facility during their last rest period before the accident flight.
26. Colgan Air did not proactively address the pilot fatigue hazards associated with operations at a predominantly commuter base.
27. Operators have a responsibility to identify risks associated with commuting, implement strategies to mitigate these risks, and ensure that their commuting pilots are fit for duty.
28. The first officer's illness symptoms did not likely affect her performance directly during the flight.
29. The captain had not established a good foundation of attitude instrument flying skills early in his career, and his continued weaknesses in basic aircraft control and instrument flying were not identified and adequately addressed.
30. Remedial training and additional oversight for pilots with training deficiencies and failures would help ensure that the pilots have mastered the necessary skills for safe flight.
31. Colgan Air's electronic pilot training records did not contain sufficient detail for the company or its principal operations inspector to properly analyze the captain's trend of unsatisfactory performance.
32. Notices of disapproval need to be considered along with other available information about pilot applicants so that air carriers can fully identify those pilots who have a history of unsatisfactory performance.
33. Colgan Air did not use all available sources of information on the flight crew's qualifications and previous performance to determine the crew's suitability for work at the company.
34. Colgan Air's procedures and training at the time of the accident did not specifically require flight crews to cross-check the approach speed bug settings in relation to the reference speeds switch position; such awareness is important because a mismatch between the bugs and the switch could lead to an early stall warning.
35. The current air carrier approach-to-stall training did not fully prepare the flight crew for an unexpected stall in the Q400 and did not address the actions that are needed to recover from a fully developed stall.
36. The circumstances of this and other accidents in which pilots have responded incorrectly to the stick pusher demonstrate the continuing need to train pilots on the actions of the stick pusher and the airplane's initial response to the pusher.

37. Pilots could have a better understanding of an airplane's flight characteristics during the post-stall flight regime if realistic, fully developed stall models were incorporated into simulators that are approved for such training.
38. The inclusion of the National Aeronautics and Space Administration icing video in Colgan Air's winter operations training may lead pilots to assume that a tailplane stall might be possible in the Q400, resulting in negative training.
39. The current Federal Aviation Administration surveillance standards for oversight at air carriers undergoing rapid growth and increased complexity of operations do not guarantee that any challenges encountered by the carriers as a result of these changes will be appropriately mitigated.
40. Mandatory flight operational quality assurance programs would enhance flight safety because all operators would have readily available data to identify operational risks and use in developing corrective actions.
41. The viability of flight operational quality assurance programs depends on the confidentiality of the data, which would currently not be guaranteed if operators were required to implement these programs and were required to share the data with the Federal Aviation Administration.
42. The systematic monitoring of all available safety data, as part of a flight operational quality assurance program, could provide operators with objective information regarding the manner in which flights are conducted, and a periodic review of this information would enhance flight safety by assisting operators in detecting and correcting deviations from standard operating procedures.
43. Distractions caused by personal portable electronic devices affect flight safety because they can detract from a flight crew's ability to monitor and cross-check instruments, detect hazards, and avoid errors.
44. The current use of safety alerts for operators to transmit safety-critical information is not effective because oversight and documentation of an operator's response are not required and critical safety issues may not be effectively addressed.
45. Weather documents missing key weather products or containing products that are no longer valid prevent flight crewmembers from having relevant, readily available weather-related safety information for preflight and in-flight decision-making.
46. Detailed icing definitions that include accretion rates and recommended pilot actions would help pilots more accurately determine the icing conditions to report in airframe icing pilot reports and more effectively respond to those conditions.