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AUTOROTATION, WINDMILL, AND POWER OFF RECONVERSION TESTING OF THE BA609 TILTROTOR

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ABSTRACT

As part of its novel certification basis, the BA609 tiltrotor must be able to transition from One Engine Inoperative (OEI) flight to All Engines Inoperative (AEI) flight and reconfigure the nacelles from airplane mode to helicopter mode. In AEI airplane mode (nacelles fixed at 0°) the rotor inflow is from the top of the rotor, whereas in AEI helicopter mode (nacelles fixed at 95°) the rotor inflow is from below the rotor. As the nacelle begins to transition from airplane to VTOL mode, in tiltrotor parlance a “reconversion”, the proprotors go through edgewise flow, at approximately 75° nacelle, and the rotor receives no acceleration. The reconversion from airplane mode to helicopter mode is accomplished dynamically at an angular rate of 8° per second to minimize exposure to edgewise flow. The dynamic nature of this reconversion left few opportunities for buildup. The test team initially used flight test to gain confidence in the simulation, and simulation to develop procedures for exploring edgewise flow in flight test. The development was accomplished in three phases: steady state in airplane and VTOL modes; risk reduction using intermediate nacelle angles; and finally AEI reconversion.

The BA 609 successfully demonstrated dual engine out capability by performing numerous autorotations from 70 to 110 knots in VTOL mode, demonstrating airplane mode windmill state from 140 to 180 kts and performing power off reconversions from airplane mode to helicopter mode. The autorotations to power recovery demonstrated that the flare could reduce the vertical speeds and ground speeds close to landing gear design speeds. Using flight test data to anchor simulation, and simulation data to develop techniques for flight test, was the key to safe and successful engine out testing.