

# Wind Tunnel Testing Techniques for a Tandem Tilt-Wing, Distributed Electric Propulsion VTOL Aircraft

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**Urban Air Mobility (UAM) vertical takeoff and landing (VTOL) aircraft designs frequently include multiple propulsors, complex wing-propulsor aerodynamics, significant airframe configuration changes during normal flight operations, and no historical database regarding the best ways to transition between vertical and horizontal flight. This paper describes the methodology used for the wind tunnel testing of the Langley Aerodrome No. 8 (LA-8) in the NASA Langley 12 Foot Low-Speed Wind Tunnel during multiple test entries in 2019 and 2020. The LA-8 is a tandem tilt-wing aircraft with four motor-propeller units and four control surfaces distributed across each wing, plus an inverted V-tail with two ruddervators. An initial tunnel entry in the spring of 2019 used one-factor-at-a-time (OFAT) testing to define candidate trimmed transition corridors between vertical and horizontal flight, to assess whether there was adequate control authority, and to define appropriate individual independent parameter ranges for subsequent design of experiments (DOE) wind tunnel testing. The 23 independent variables for the LA-8 wind tunnel tests made DOE testing an efficient option for assessing the large number of potential interactions. The general advantages and disadvantages of OFAT and DOE wind tunnel testing techniques are also discussed, along with the benefits of a combined approach.**

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