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AEROACOUSTIC MEASUREMENTS OF LARGE CHORD WIND TURBINE AIRFOILS

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Abstract. Aerodynamic and acoustic measurements of six wind turbine airfoils with a 0.9-meter chord were tested in the Virginia Tech Stability Wind Tunnel, in its anechoic configuration. The models tested were the NACA 0012, Delft DU96, Sandia S831, and Delft DU97 in three different geometrical configurations. Except for the NACA0012, these airfoils are commonly used in the wind energy industry. The four models were tested for various flow conditions ranging in nominal chord Reynolds number from 0.8 to 3.8 million. Since the aero-acoustic configuration of the Virginia Tech Stability Wind Tunnel is relatively new, noise measurements of a small 0.2-meter chord NACA 0012 airfoil were also carried out to provide benchmark data. Results from this small size airfoil were compared to data obtained in an open jet aero-acoustic tunnel with a NACA 0012 model of almost the same chord by Brooks et al. (1989).

The aerodynamic flow measurements of the airfoils consisted of static pressure distributions on the airfoil's surfaces, wake profile measurements downstream of the airfoil mid-span and single hot-wire measurements in the vicinity of the trailing edge. Noise measurements were carried out with a 63-element microphone phased array located in the far-field of the models.

Results obtained in the wind tunnel with the small chord NACA 0012 model are in good agreement with those obtained by Brooks et al. (1989). This comparison provided the first validation of the capabilities of the new Virginia Tech anechoic tunnel.

Aerodynamic flow mean pressure distributions were successfully measured for the three DU97 airfoil configurations (W300, Flatback, Flatback with splitter plate). These measurements were used in conjunction with a panel method code (for free flight conditions) to compute effective angle of attack. The interference correction was found to be 22% for all airfoils. Wake measurements were also performed and used to estimate drag.

Noise measurements using phased arrays were successful in identifying airfoil self noise for most of the configurations, in particular for the lower angles of attack. The measurements revealed significant insight in the noise characteristic of the wind turbine airfoils.