Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

The Role of Free Stream Turbulence on the Aerodynamic Performance of a Wind Turbine Blade VICTOR MALDONADO, Texas Tech University, ADRIEN THORMANN, CHARLES MENEVEAU, Johns Hopkins University, LUCIANO CASTILLO, Texas Tech University, TURBULENCE GROUP COLLABORATION — In the present research, a 2-D wind turbine blade section based on the S809 airfoil was manufactured and tested at Johns Hopkins University in the Stanley Corrsin wind tunnel facility. A free stream velocity of 10 m/s produced a Reynolds number based on blade chord of 2.08.x10^5. Free stream turbulence was generated using an active grid placed 5.5 m upstream of the blade which generated a turbulence intensity, T_u of up to 6.1% and an integral length scale, L_∞ of about 0.15 m. The blade was pitched to a range of angles of attack, α from 0 to 18 degrees in order to study the effects of the integral length scales on the aerodynamic characteristics of the wind turbine under fully attached and separated flow conditions. Pressure measurements around the blade and wake velocity deficit measurements utilizing a hot-wire probe were acquired to compute the lift and drag coefficient. Results suggest that turbulence generally increases aerodynamic performance as measured by the lift to drag ratio, L/D except at 0 degrees angle of attack. A significant enhancement in L/D results with free stream turbulence at post-stall angles of attack of 16 and 18 degrees, where L/D increase from 2.49 to 5.43 and from 0.64 to 4.00 respectively. This is a consequence of delaying flow separation with turbulence (which is observed in the suction pressure distribution) which in turn reduces the momentum loss in the wake particularly at 18 degrees angle of attack.

Victor Maldonado
Texas Tech University

Date submitted: 03 Aug 2012 Electronic form version 1.4