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Characterization of Reynolds and deterministic stresses through phase-dependent measurements in the near wake of a wind turbine in an infinite turbine array NICHOLAS HAMILTON, Portland State University, MURAT TUTKUN, Institute for Energy Technology, RAÚL BAYOÁN CAL, Portland State University, Portland, OR — The wake of a wind was investigated experimentally through stereo-PIV measurements made in planes parallel to the rotor. Phase-locked data were collected at four angles of rotor orientation beginning from one blade at top-dead-center. The phase angle of the turbine rotor was measured with a remote optical sensor detecting a reflective portion of the rotor blades. Measurements in the wind turbine array include turbulent effects and mixing from leading devices, making phase dependence in turbulent structures difficult to detect for small differences in phase angle of the turbine rotor. Analysis of the flow field from a polar-cylindrical reference frame (r,θ,x) with the axial coordinate aligned with the hub of the rotor highlights differences in the Reynolds stress tensor not evident in the Cartesian frame. The axial normal stress becomes independent of the phase angle of the rotor for x/D $\geq$ 1.5. Stresses including the radial and azimuthal velocity fluctuations retain phase dependence throughout the near wake of the turbine. Deterministic stresses are approximately two orders of magnitude smaller than the turbulent stresses indicating that they can be neglected at first order. The flux of kinetic energy and production of turbulence composed with phase-locked turbulent stresses make periodic contributions to the time-averaged values.

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