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Experimental Investigation of Very Large Model Wind Turbine Arrays KYLE CHARMANSKI, MARTIN WOSNIK, University of New Hampshire — The decrease in energy yield in large wind farms (array losses) and associated revenue losses can be significant. When arrays are sufficiently large they can reach what is known as a fully developed wind turbine array boundary layer, or fully developed wind farm condition. This occurs when the turbulence statistics and the structure of the turbulence, within and above a wind farm, as well as the performance of the turbines remain the same from one row to the next. The study of this condition and how it is affected by parameters such as turbine spacing, power extraction, tip speed ratio, etc. is important for the optimization of large wind farms. An experimental investigation of the fully developed wind farm condition was conducted using a large array of porous disks (upstream) and realistically scaled 3-bladed wind turbines with a diameter of 0.25m. The turbines and porous disks were placed inside a naturally grown turbulent boundary layer in the 6m x 2.5m x 72m test section of the UNH Flow Physics Facility which can achieve test section velocities of up to 14 m/s and Reynolds numbers $\delta^+ = \delta u_\tau/\nu \approx 20,000$. Power, rate of rotation and rotor thrust were measured for select turbines, and hot-wire anemometry was used for flow measurements.

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