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DAMAGE MEASUREMENTS ON THE NWTC DIRECT-DRIVE, VARIABLE-SPEED TEST BED[*†]

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Abstract

The NWTC (National Wind Technology Center) Variable-Speed Test Bed turbine is a three-bladed, 10-meter, downwind machine that can be run in either fixed-speed or variable-speed mode. In the variable-speed mode, the generator torque is regulated, using a discrete-stepped load bank to maximize the turbine's power coefficient. At rated power, a second control loop that uses blade pitch to maintain rotor speed becomes active. The load bank controller continues essentially as before, i.e., using the load bank to maintain either generator torque or (optionally) generator power. In this paper, we will use this turbine to study the effect of variable-speed operation on blade damage. Using time-series data obtained from blade flap and edge strain gauges, the load spectrum for the turbine is developed using rainflow counting techniques. Miner's rule is then used to determine the damage rates for variable-speed and fixed-speed operation. The results illustrate that the variable speed controller algorithm used with this turbine introduces relatively large load cycles into the blade that significantly reduce its service lifetime, while power production is only marginally increased.

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