

## Decades of Wind Turbine Load Simulation

Matthew Barone\*, Joshua Paquette†, Brian Resor‡  
Sandia National Laboratories§, Albuquerque, NM 87185

Lance Manuel¶  
University of Texas, Austin, TX 78712

**A high-performance computer was used to simulate ninety-six years of operation of a five megawatt wind turbine. Over five million aero-elastic simulations were performed, with each simulation consisting of wind turbine operation for a ten minute period in turbulent wind conditions. These simulations have produced a large database of wind turbine loads, including ten minute extreme loads as well as fatigue cycles on various turbine components. In this paper, the extreme load probability distributions are presented. The long total simulation time has enabled good estimation of the tails of the distributions down to probabilities associated with twenty-year (and longer) return events. The database can serve in the future as a truth model against which design-oriented load extrapolation techniques can be tested. The simulations also allow for detailed examination of the simulations leading to the largest loads, as demonstrated for two representative cases.**

---

\*Wind Energy Technology Department., mbarone@sandia.gov, Senior Member AIAA

†Wind Energy Technology Department.

‡Wind Energy Technology Department.

§Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

¶Professor, Dept. of Civil, Architectural, and Environmental Engineering