Combined Individual Pitch Control and Active Aerodynamic Load Controller Investigation for the 5MW UpWind Turbine

David G. Wilson* Dale E. Berg† Brian R. Resor‡ Matthew F. Barone§ Jonathan C. Berg¶

Sandia National Laboratories P.O. Box 5800, Albuquerque, NM 87185

Abstract

This paper investigates the combined performance of Individual Blade Pitch (IPC) and Active Aerodynamic Load Control (AALC) applied to the 5MW UpWind reference turbine. IPC is an advanced wind turbine control method for fatigue load reduction. IPC is realized by reducing the 1p blade load through mitigation of the static rotor tilt and yaw moments. AALC uses trailing edge flap devices to reduce fatigue loads or bending moments. This work is motivated by assessing the benefit for the combination of using both approaches one which addresses low frequency (such as the 1p loading) and the other addresses, in addition, higher frequency loading on the blades. This study developed and simulated several IPC and AALC designs to reduce blade loads and potentially pitch duty cycles. The numerical simulations were performed on the NREL 5MW UpWind reference wind turbine model. Two IEC turbulent wind conditions (16 mps and 20 mps) were explored. Results are shown for pitch angles and rates, flap angles and rates, blade flapwise root moments, blade flapwise tip deflections, and flap bending moment power spectral density plots. Other relevant wind turbine components, such as tower moments were also monitored. This study shows that the combined controller designs, when compared with a baseline conventional collective pitch control strategy, demonstrate the trade-offs, load reductions, and potential performance benefits for future large wind turbine control design.

*Member of Technical Staff, Energy Systems Analysis, dwilso@sandia.gov
†Member of Technical Staff, Wind Energy Technology, deberg@sandia.gov
‡Member of Technical Staff, Wind Energy Technology, brresor@sandia.gov
§Member of Technical Staff, Wind Energy Technology, mbarone@sandia.gov
¶Student Intern, Wind Energy Technology, jcberg@sandia.gov

AWEA WINDPOWER 2009 Conference & Exhibition, Chicago, Illinois, May 4-7, 2009