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Blade System Design Studies Phase II: Final Project Report

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Abstract

This report details the work completed under Phase II of the Sandia National Laboratories Blade System Design Study blade design and manufacturing project; an integrated 9 meter blade design, tooling design and manufacturing, assembly fixture design and fabrication, blade production, blade instrumentation and blade shipping. This project successfully demonstrated the design and manufacturing of a wind turbine blade integrating several innovations including flatback airfoils on inboard blade stations, a carbon fiber spar cap and an iterative blade design process. Flatback airfoils differ from truncated airfoils and offer the structural benefits of thicker sections without large aerodynamic losses. Although the concept of using carbon fiber for a spar cap had been considered by TPI before, this is the first instance in which details such as the best architecture of carbon fabric for infusibility and for load transfer, the optimal method to transition a carbon spar cap into the blade root and the manufacturing issues of handling, cutting and infusing carbon fiber have been worked out. The design approach used for this project demonstrated the myriad advantages of integrating the aerodynamic design, structural design and manufacturing efforts into an iterative process that sought to maximize the strengths of each area without detracting from the others. Following a detailed integrated design of the blade, TPI designed and produced production molds and assembly fixtures for this blade, culminated in the production, instrumentation and shipping of seven BSDS prototype blades. The resulting blade proved to be easier and cheaper to build, as well as lighter, compared with prior 9 meter blade designs.