Results from WINDIE Experiment to Characterize Inspection Methods for Wind Blades and Use of Probability of Detection Studies to Quantify NDI Performance

Dennis Roach
Stephen Neidigk
Tom Rice
Randy Duvall
Sandia National Laboratories

Abstract

Wind turbine blades pose a unique set of inspection challenges that span from very thick and attentive spar cap structures to porous bond lines, varying core material and a multitude of manufacturing defects of interest. The need for viable, accurate nondestructive inspection (NDI) technology becomes more important as the cost per blade, and lost revenue from downtime, grows. NDI methods must not only be able to contend with the challenges associated with inspecting extremely thick composite laminates and subsurface bond lines but must also address new inspection requirements stemming from the growing understanding of blade structural aging phenomena. Under its Blade Reliability Collaborative program, Sandia Labs quantitatively assessed the performance of a wide range of NDI methods that are candidates for wind blade inspections. Custom wind turbine blade test specimens, containing engineered defects, were used to determine critical aspects of NDI performance including sensitivity, accuracy, repeatability, speed of inspection coverage, and ease of equipment deployment. The Sandia Wind NDI Experiment (WINDIE) was completed to evaluate fifteen different NDI methods that have demonstrated promise for interrogating wind blades for manufacturing flaws or in-service damage. These tests provided the information needed to identify the applicability and limitations of advanced inspection methods for wind turbine blades. Ultimately, the proper combination of several inspections methods may be required to produce the best inspection sensitivity and reliability for both near-surface and deep, subsurface damage. Results from WINDIE will be presented in this paper. As a natural follow-on to WINDIE, the Wind Turbine Blade Flaw Detection Experiment (BFDE) will be conducted to quantify the flaw detection performance of NDI in composite wind turbine blades. This experiment seeks to determine an industry wide probability of detection (POD) curve for the wind turbine blade industry. In general, inspectors will be asked to locate and size hidden flaws in the test specimens which mimic the construction and include damage types found in today’s wind turbine blades. After a sufficient number of inspectors have completed the experiment, industry-wide performance curves will be established that determine: 1) how well current inspection techniques are able to reliably find flaws/damage in wind structures, and 2) the degree of improvements possible through the integration of more advanced NDI techniques and procedures. The detection of fabrication defects helps enhance plant reliability and increase blade life while improved inspection of operating blades can result in efficient blade maintenance, facilitate repairs before critical damage levels are reached and minimize turbine downtime.