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**FATIGUE LIFE PREDICTION FOR WIND TURBINES:
A CASE STUDY ON LOADING SPECTRA
AND PARAMETER SENSITIVITY**

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ABSTRACT: Wind turbines are fatigue-critical machines used to produce electrical energy from the wind. These rotating machines are subjected to environmental loadings that are highly irregular in nature. Historical examples of fatigue problems in both research and commercial wind turbine development are presented. Some example data on wind turbine environments, loadings and material properties are also shown. Before a description of how the authors have chosen to attack the cumulative damage assessment, questions are presented for the reader's reflection. The solution technique used by the authors is then presented, followed by a case study applying the procedures to an actual wind turbine blade joint. The wind turbine is the 34-meter diameter vertical axis wind turbine (VAWT) erected by Sandia National Laboratories near Bushland, Texas. The case study examines parameter sensitivities for realistic uncertainties in inputs defining the turbine environment, stress response and material properties. The fatigue lifetimes are calculated using a fatigue analysis program, called LIFE2, which was developed at Sandia. The LIFE2 code, described in some detail in an appendix, is a PC-based, menu-driven package that leads the user through the steps required to characterize the loading and material properties, then uses Miner's rule or a linear crack propagation rule to numerically calculate the time to failure. Only S-n based cumulative damage applications are illustrated here.

The LIFE2 code is available to educational institutions for use as a case study in describing complicated loading histories and for use by students in examining, hands on, parameter sensitivity of fatigue life analysis.