

Reliability Analysis and Design Procedures for Offshore Wind Turbines

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Industry standards for the design of wind turbines, such as the guidelines from the International Electrotechnical Commission (IEC), recommend the use of statistical extrapolation methods to establish long-term design loads. Extrapolation refers to prediction of a desired load fractile associated with a low probability of failure using loads data, typically from stochastic simulations. Several different extrapolation techniques are available. These include the method of global maxima in which the maximum value over ten minutes is treated as the load random variable of interest; the peak-over-threshold method in which maximum values between successive upcrossings of a selected threshold are the random variables; and the block maxima method where the maximum value over a fixed block of time is used. After obtaining such "extremes," one needs to fit an appropriate parametric distribution to the loads data to estimate load levels associated with rare exceedance probabilities (generally on the order of 10^{-4} to 10^{-6}). Structural reliability principles can be employed in such computations. Ultimate and fatigue limit states will be evaluated by first studying short-term turbine load statistics (conditional on wind speed, wave height), etc. and then upon integration of these short-term distributions with environmental climate descriptions, long-term turbine loads may be derived.