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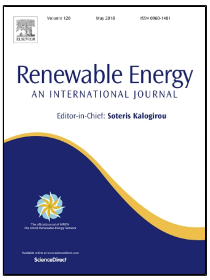

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Hurricane Risk Assessment of Offshore Wind Turbines

Spencer T. Hallowell[a], Andrew T. Myers[b], Sanjay R. Arwade[a], Weichiang Pang[c], Prashant Rawal[c], Eric M. Hines[d], Jerome F. Hajjar[b], Chi Qiao[b], Vahid Valamanesh[e], Kai Wei[f], Wystan Carswell[g], Casey M. Fontana[a]

[a]University of Massachusetts Amherst, [b]Northeastern University [c]Clemson University, [d]Tufts University, [e]Risk Management Solutions, [f]Southwest Jiaotong University, [g]Haley & Aldrich, Inc.

Abstract

A barrier to the development of the offshore wind resource along the U.S. Atlantic coast is a lack of quantitative measures of the risk to offshore wind turbines (OWTs) from hurricanes. The research presented in this paper quantifies the risk of failure of OWTs to hurricane-induced wind and waves by developing and implementing a risk assessment framework that is adapted from a well-established framework in performance-based earthquake engineering. Both frameworks involve the convolution of hazard intensity measures (IMs) with engineering demand parameters (EDPs) and damage measures (DMs) to estimate probabilities of damage or failure. The adapted framework in this study is implemented and applied to a hypothetical scenario wherein portions of nine existing Wind Farm Areas (WFAs), spanning the U.S. Atlantic coast, are populated with ~7000 5 MW OWTs supported by monopiles. The IMs of wind and wave are calculated with a catalog representing 100,000 years of simulated hurricane activity for the Atlantic basin, the EDPs are calculated with 24 one-hour time history simulations, and a fragility function for DM is estimated by combining variability observed in over one hundred flexural tests of hollow circular tubes found in the literature. The results of the study are that, for hurricane-induced wind and wave, the mean lifetime (i.e., 20-year) probability of structural failure of the tower or monopile of OWTs installed within the nine WFAs along the U.S. Atlantic coast ranges between 7.3×10^{-10} and 3.4×10^{-4} for a functional yaw control system and between 1.5×10^{-7} and 1.6×10^{-3} for a non-functional yaw control system.

Keywords: offshore wind; risk; hurricane; fragility; framework

Nomenclature

c: Component (monopile or tower)
D: tube diameter
DG: design group