Advancing reliability information for Wave Energy Converters

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I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

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Abstract

Marine renewable energy promises to provide a significant contribution to the future electricity supply. It is estimated that 17% of today's UK electricity demand could be generated from wave and tidal sources. The ambition to harvest this resource is in the public interest, as it eases the pressures on energy security, holds the potential to reduce carbon emissions and has the prospect to create a new UK industry sector worth £15 billion. From an engineering perspective, marine energy is one of the least developed renewable energy technologies and has to be regarded as unproven. The reliability of components and devices in the harsh marine environment is one of the main engineering challenges. Reliability assessments and the assurance of acceptable reliability levels are dependant on the adequacy of failure information, which is scantily available for marine energy.

This thesis shows that large failure rate uncertainties impede the reliability assessment for wave energy converters and how a suite of experimental, numerical and statistical methods can be applied to improve scarcely available reliability information. The analysis of component load conditions identifies fatigue as failure mode of concern and the fatigue life of mooring lines and marine power cables is quantified in a floating wave energy application. A Bayesian statistical approach and dedicated service-simulation component testing is proposed, and implemented to improve the quality of reliability estimates and to provide relevant data and assurance.

The methods presented, along with the results, will assist reliability assessment and design during early development stages, and will inform the prediction of maintenance requirements during operation. Reliable marine energy systems will be the technical enabler for the successful transition of prototype devices to a commercially viable marine energy industry.

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