Reliability of marine energy converters

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Work stream 8: Reliability

Context and perspective

To make marine energy converters (MECs) a future energy option cost-effective devices need to be created. “Survivability and reliability represent key challenges for marine renewables, due to the economic consequences of catastrophic failures and/or long periods of unavailability.” [1, p. 25]

Need for reliability

Structural reliability: A catastrophic failure happened to the Wavedragon device in 2004. The force transducer, connecting the mooring lines to the anchor blocks, broke during a large storm leaving the platform stranded (Fig. 1).

Fig. 1: Stranded Wavedragon due to broken force transducer [2, p. 17]

Component reliability: Annual O&M contribute about 40% of the estimated specific cost per kWh generated by WECs (calculated for a 300 TWh/a Pelamis scheme off the US coast) [3, p.22].

These two examples demonstrate that it is not only important to consider low frequency, high consequence structural reliability events, but the more frequent failure of components, which has significant economic consequences for MEC due to issues of access and replacement.

Reliability defined

A mathematical reliability definition may be stated as:

$$R = P(C > L) \qquad [4, p. 397]$$

with reliability *R*, probability *P*, capacity *C* and load *L*.

However, several interconnections and tradeoffs make putting reliability into context vital (see Fig. 3).

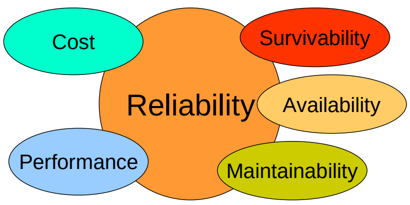

Fig. 3: Reliability in context

Identifying critical components

With limited resources it would be beneficial to develop a criticality analysis for MECs. Such analysis is commonly undertaken in safety sensitive industries (e.g. nuclear, aviation) but needs to be adapted towards the marine energy application.

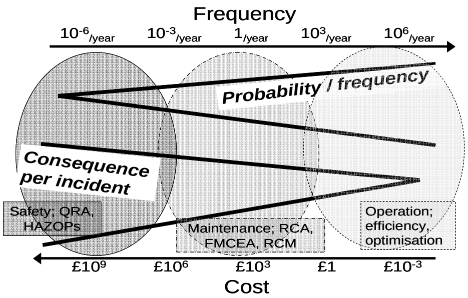

Fig. 3: Risk, probability and consequence [5, p. 120]

Environmental and material aspects

To identify the most critical components and corresponding types of component testing a multitude of environmental factors and material phenomena have to be considered.

Environmental influences [6]	Material phenomena [7]
External water pressure	Corrosion
Damp, saline atmosphere	Fatigue
Temperature variations	Corrosion fatigue
Linear and rotational cyclic motions and accelerations	Stray current corrosion
	Wear and fretting fatigue
Inaccessibility	Marine fouling
Human factors	Impact loading and fracture

Research Objectives

- Developing a criticality analysis for MECs
- Identifying (generic) critical components of MECs
- Develop and conduct component tests for most critical parts

References

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