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MET-CERTIFIED
European Regional Development Fund

Development of International Standards and Certification schemes for Marine Energy Technologies

Deliverable A1.7.1

Recommendations for procedures adaptation to

- IEC TS 62600-2 Marine energy - wave, tidal and other water current converters Part 2: Design requirements for marine energy systems and
- IEC TS 62600-10 Marine energy - wave, tidal and other water current converters Part 10: Assessment of mooring system for marine energy converters

Project No. 2S01-020

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Revision history

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
V1.0	07/03/2018	PGD	Lloyd's Register	Original

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1. Introduction

This review was carried out as part of the MET certified project. This MET certified project deliverable involved carrying out a gap analysis between what the client has undertaken and what the IEC technical specifications outline. This should result in two outcomes:

- **The client may be able to identify if for the next design iteration there will be anything they may choose to do differently.**
- **The practicality and ability to implement the specifications will be tested aiming to lead to improvement in the specifications. Aspects of the standard that are not best practice, unduly onerous, costly or not practical to implement can be identified and feedback into future revisions of specifications.**

It is clear that the client has not used the IEC technical specifications for the design process (IEC TS 62600-2 and IEC TS 62600-10). The review has tended to look at high level principles, when reviewing the client design process rather than listing all the deviations between the approach used by the client and the IEC technical specification. In addition the adequacy of the IEC technical specifications has also been tested (based on a review of the client design process).

2. Notes on clients documents

2.1. Failure Mode Effect and Criticality Analysis (FMECA)

The FMECA was clearly laid out. However, compared to similar FMECA for other renewable devices it seemed quite brief. It is expected that the FMECA would include control system failures as these can have a significant impact on device behaviour (and thus loading).

2.2. Site conditions and load cases for deployment site

The client site condition document is very brief. Some assumptions are either not verified or not demonstrated as being verified (e.g. Turbulence intensity or wave height). For example Wave Height is based on site observations rather than historical data. However, the approach used is probably sufficient for a limited site deployment. The load cases mentioned are rather brief and do not include any failures of the control system. The design load cases listed in IEC TS 62600-2 are divided into the following categories:

- Normal operation;
- Normal operation with fault;
- Start procedures;
- Normal shut down procedures;
- Emergency shut down procedures;
- Parked / survival conditions;
- Parked with fault; and
- Transport, Installation and maintenance.

2.3. Line Load Estimation Process

The FMECA does not appear to be referenced in this document. It appears that only Ultimate Load State (ULS) and Accidental Limit State (ALS) have been considered. It is unclear if Serviceability limit state (SLS) or Fatigue limit state (FLS) has been considered (as would be required by IEC TS 62600-10).

2.4. Design report

Although the report is very detailed in places only a limited number of design cases have been considered (see also comments on site conditions and load cases for Deployment site). Again it appears that only Ultimate Load State (ULS) and Accidental Limit State (ALS) have been considered. It is unclear if Serviceability limit state (SLS) or Fatigue limit state (FLS) has been considered (as would be required by IEC TS 62600-2).

2.5. Primary Load Path Engineering Report

As mentioned previously the load cases list is very brief when compared with IEC TS 62600-2. It is unclear if the Anchor has been tested to verify its capacity. This would only be necessary if the anchor is novel (as appears to be the case here).

2.6. Summary

It is noted that several different design codes have been used. This does risk that they are not compatible with each other. A common approach across all aspects would be a better. The level of detail presented in the documents reviewed is variable so it is not clear if all aspects have been designed to the same accuracy. Some aspects have considered fatigue (such as the turret and hull) but it is not clear if other aspects of the device have considered fatigue. It would appear that a frequency domain approach has been used for the analysis. Best practice for marine renewable devices would be to use a time domain analysis. Fault conditions such as grid connection or turbine control faults do not appear to have been considered.

2.7. Conclusions

The approach used for the design of the device may be adequate for very short deployments. However, for deployments of more than 4 months a more rigorous approach is recommended. It is suggested that if more than one design code is adopted that the compatibility of approaches / loads etc. is investigated.
Whilst the IEC TS for design (62600-2) and mooring (62600-10) have not been used in this instance it is recommended that they are used for devices with longer deployments. It should be noted that these documents reflect the experience of domain experts across several countries.

3. Review of IEC standards

3.1. Notes on IEC TS 62600-2

In the review of the documents the following was noted with respect to IEC TS 62600-2

- It is noted that section 5.12 does not refer to time domain practice as being best practice (see also 7.3.6).
- The heading of 6.2.2.6 should refer to NTM.
- Section 7 should consider if all load cases are necessary for short deployments (say less than 4 months). For example are all return periods, design categories and limit states applicable for short deployments. This could be covered in an annex.
- Section 10 is too brief to be of much use and does not appear to refer to other standards / TS where more detail might be found. The level detail is not consistent with other sections for example section 12. It is unclear if swivels are covered by section 10 or 11. It is assumed the later in which case there is not sufficient detail to be of use.

3.2. Notes on IEC TS 62600-10

In the review of the documents the following was noted with respect to IEC TS 62600-10

- Figures 2 – 4 appear to be based on an FPSO. It is recommended that more realistic figures are included in the next revision. Pictures showing clump weights and buoyancy aids within a mooring system would add clarity to section 6.
- The section on anchors does not appear to include anchors drilled into rock (as have been used).
- Risk assessment (section 8.3) should align with other parts of the TS and align with the design TS (62600-2). It should be noted that the risk assessment should form part of the overall Technology Qualification process.
- It is suggested that it would be helpful if the load cases in section 9 aligned the design TS (62600-2).