II.B Sea Trials

Purpose of Sea Trials

To conduct a set of trials in an uncontrolled ocean environment that build confidence in the functionality, maintenance, operation and performance of the device and its ability to survive extreme conditions.

Objectives of Sea Trials

Sea-trials, normally carried out at the prototype stage, have the following objectives:

A. Demonstration of system integrity and viability of technology;
B. To seek for aspects that had not been identified during the previous project phases and to gain experience;
C. Establish controllability;
D. Gain operational experience;
E. Calibration of analytical/mathematical model from data from prototype at sea;
F. Early indication of availability of systems considering degradation mechanisms and maintenance routines;
G. Establish power conversion capabilities.

Reporting from Activity

The power performance statement should:

1. Define the status of the product development;
2. Define the state and target of the tests, for instance first trial, decommissioning, preliminary result, result for R&D, data to be made publically available, etc.;
3. Describe the conditions under which data was monitored;
4. Describe the setup and setting of the measurement and control system including level of accuracy of measurements, what parameters are critical and the level of accuracy of the measurement, control philosophy / version, areas not covered during the period of sea trials and limitations (directionality, parameters / variables not observed during sea trials);
5. Consider the parameters influencing the power performance and identified in this protocol. In the case that any parameter is considered not relevant to the application, justification should be provided and the principles listed above applied.

It is possible that some concepts may need to deviate from the best practices given here. However, the deviations should be documented and should be in compliance with the principles given above.

Contents of Protocol

1.Measurements

(i) Provide a rationale for the type, number and duration of the measurements;
(ii) Describe the provisions for data archiving to ensure traceability;
(iii) Provide guidance on statistical quality assurance procedures for data.

2.Analysis and presentation of results

(i) Recommend appropriate techniques for data processing including the generation of summary statistics and estimates of uncertainty;

3.Power performance

(i) Provide equitable methodology for assessment of performance through the power chain.

4.System integrity and functionality

(i) Provide guidance on establishing and demonstrating system integrity;
(ii) Provide guidance on the collection of data for monitoring the operation and degradation of the device and its components.

5.Model validation

(i) Provide procedures to validate previous physical test results;
(ii) Provide guidance on validating mathematical models.

6.Exclusions

This protocol will not give guidance on Objective D ('Gain operational experience').

Principles

7.Power performance

- Measurements should be sufficient to allow for calibration of an analytical model in order that the analytical model should also be able to predict, within a reasonable level of certainty, the power production for different metocean conditions and site characteristics from those investigated. Level of accuracy needs to be stated and considered in the final calculation of power production.
- The main parameters investigated for power production measurements are identified and described from the point of view of the device application. System identification test protocols should identify these main parameters. This might require periods with control configurations which result in sub-optimal performance to provide information resulting from different parameter settings.

- The period of time dedicated for evaluation of power production should be defined to allow for the relevant metocean conditions to be recorded and provide the necessary statistical data. The impact of the duration of evaluation should be considered in the power calculations.
- Extrapolation of results should be based on trends manifested during measurements and the level of accuracy evaluated and included in the power performance value.
- Reference should be made to any limitations on the measurement process, field characteristics, metocean measurements at site and level of uncertainty that may affect the overall power take-off calculations. The level of availability assumed and quality of output should also be referred to. (see I.A Resource Assessment)
- An independent party should be allowed to monitor the test at all times.
- The power production should, where possible, be recorded at the various conversion steps from wave to wire, in order to enable evaluation of the losses at the different steps.

8.Temporal and spatial test site considerations

(See I.A Resource Assessment)

- Sources of resource data for test sites should be quantified (fixed facilities and independently chosen locations), and the quality of available data appraised.
- The minimum level of characterisation of the resource at the test site for good quality validation of device power performance will be assessed, including quality, frequency, accuracy, spatial coverage and time period of measurements

9.Monitoring of system integrity; survivability

- Device specific sub-system monitoring should be performed to ensure high availability from marine energy device (based upon device classification template, see II.C Deployment and Performance Assessment of Multi-Megawatt Device Arrays).
- Appropriate pre-deployment testing of most vulnerable sub-systems / components to minimise device failure and maximise availability will be carried out.
- A means of measuring (during sea trial) and/or predicting (pre-deployment) device survivability should be considered. It should be noted that test sites possibly have less extreme environment than full ocean-going sites where 2nd generation devices will be installed.

Key Aspects

1. At the sea trials, emphasis is given to the capacity of the unit to perform. The location where the power is measured should be consistent with the status of the test.

2. It is expected that the end user may be interested in seasonal aspects, such as likely average output in periods such as monthly, seasonal, annual. The other aspects should consider demonstrated availability with due consideration of accuracy of the data obtained so far.
3. Improvements will be made to the unit design with time and experience, and are connected to the amount and quality of data collected. Modification of the characteristics of the device and controls will influence the power measurements, and the revision of any power curve should follow the principles given in this protocol.
4. Power performance is derived from analytical models. It is possible to focus on the impact of modifications on the power performance if analytical modelling shows consistency with expected impact and previous assessment of the importance of the parameters modified.
5. The design and preparation for sea trials should include measures to evaluate reliability (based on failure modes and risk assessment) and the aspects affecting reliability. Design, manufacturing and testing actions leading to reliability robustness should be documented.
6. Development of procedures to obtain data for early indication and qualitative identification of reliability of main components influencing the performance and survivability of the device should be obtained from the sea trial.