



IECRE OPERATIONAL DOCUMENT

IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications (IECRE System)

ME Certification Scheme: Test Report for Electricity producing tidal energy converters – Power performance assessment





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Summary

The purpose of this Operational Document is to establish a common approach amongst all IECRE Test Laboratories (RETLs) operating within the IECRE System, Marine Energy Sector, regarding the competence area “IEC/TS 62600-200: Electricity producing tidal energy converters - Power performance assessment” via the following:

- Procedures for an RETL to apply to perform tests for the power performance assessment of electricity producing tidal energy converters under the IECRE ME Sector;
- Guidance for an RETL issuing a Renewable Energy Test Report (RETR) stating compliance with IEC/TS 62600-200 Ed. 1, power performance assessment of electricity producing tidal energy converters;
- Details on the eventual peer assessment of RETLs for the power performance assessment of electricity producing tidal energy converters.

OD 300-200: Test Report for Electricity producing tidal energy converters - Power performance assessment

1 Purpose of Test

The purpose of the power performance measurement is to document a measured power curve and predicted annual energy production for the Tidal Energy Converter (TEC) type, in accordance with the relevant standards and covers:

- an individual TEC, not affected by others which may be present in an array
- a machine whose behaviour is consistent over time and of a design which is intended for normal operation

1.1 Test Outcome / Deliverables for the Test Laboratory & Client

To achieve this objective, the details of testing will be included in a test report with the following:

- TEC make, type, serial number, production year;
- type of energy capture technology employed and standard dimensions of the TEC;
- device equivalent diameter;
- location of the energy extraction plane;
- description of the control system (device and software version);
- TEC power rating and operational parameters, as described in Clause 6.2, including:
 - rated TEC output power;
 - rated water velocity;
 - cut-in water velocity to begin power production;
 - low cut-out water velocity to end power production (if different than the cut-in water velocity);
 - cut-out water velocity (maximum water velocity for TEC operation);
 - rotational speed range or period for an oscillating device; and
 - description of the power take-off system up to the power measurement location.

The following is reported which is of particular pertinence for end users:

- Power curve on the flood and ebb tide, which is a plot of the active power production (y-axis) e.g. kW against the incident tidal current resource (x-axis) e.g. m/s. This is based on averaged values of power at a series of averaged current speeds across the capture area of the TEC. It should display mean recorded power, the maximum and minimum values, and the standard deviation should be plotted against the mean recorded current velocity. The uncertainties on the power curve are also included based on natural uncharacterized variation and based on the measurement instruments.
- Velocity vertical shear profile from cut-in to cut-out for the flood and ebb datasets showing the variation of current speeds above the sea bed
- TEC overall efficiency being the ratio of the net power produced by the TEC at its output terminals according to how much energy is contained within the flow of the same projected capture area, which is reported for each velocity bin for the flood and ebb.
- RMS fluctuating velocity and corresponding standard deviation at hub height from cut-in to cut-out velocity

- Tidal ellipse at hub height for the full tidal current velocity range from cut-in to cut-out water velocity using average tidal current magnitude and direction
- TEC Annual Energy Production based on a frequency distribution of the tidal currents for the site

Additional items are requested to be reported to fulfil the requirements of the standardized testing such as bathymetry identifying unique features, tidal ellipse and principle flow directions relative to the TEC, any variation from the representative water density, reporting of the wave climate, Electrical grid, Test equipment conformity, etc. These are useful in the independent assessment that the standardized procedure has been carried out. It should be noted that moorings play a critical role in the design which may impact performance.

1.2 Procedure

The power performance measurements are to be in accordance with the relevant IEC 62600 series of standards:

IEC/TS 62600-200 Marine energy – Wave, tidal and other water current converters – Part 200: Electricity producing tidal energy converters – Power performance assessment

Adherence to this standard should be made when planning, performing and analysing the test. Exceptions to this to meet compliance with the IECRE ME Sector requirements are included in Table 1 below.

The procedure for power performance measurement of TECs is detailed below.

1. A suitable site and test conditions must be carefully selected and characterized, per Section 5 of IEC/TS 62600-200. The minimisation of effects on the performance assessment from physical artefacts such as bathymetric features, weather, test site grid connection as well as regulatory restrictions are mandated. By minimising these known effects on performance, they can be accommodated in the calculation of the device Type at the chosen commercial deployment location. In particular, test site and external considerations indicated in Sections 5.4 and 5.5 of IEC/TS 62600-200 must be addressed.
2. TEC equipment manufacturer must provide TEC description as per Section 6 of IEC/TS 62600-200. If not provided, the test laboratory conducting power performance testing must evaluate the TEC to collect prescribed information.
3. Prior to conducting tests and collecting data, the test laboratory must verify and document conformity of test equipment to be used with Section 7 of IEC/TS 62600-200. Instrument calibration requirements are provided in Section 8.4 of IEC/TS 62600-200.
4. Performance is not determined during times of shutdown, maintenance, or performance limiting factors such as grid interruptions.
5. Performance is determined in part from a measurement of electrical power produced by the machine. Requirements for electric power measurement (as documented in Section 8.8 of IEC/TS 62600-200) should be considered and documented in advance of performance testing.
6. Requirements for incident resource measurement (as documented in Section 8.9 of IEC/TS 62600-200) should be considered and documented in advance of performance testing. It is strongly encouraged that test laboratories also consider measuring turbulence and wave spectra. Guidance for wave measurement is included in IEC/TS 62600-200 Annex D. Turbulence measurements, if taken, should not compromise the fidelity of current profiler measurements taken for power performance assessment. Test laboratories who elect to perform these measurements should document selected equipment and methods. Turbulence and wave measurements are not to be included in power performance assessment, but provide data that could be considered once additional guidance becomes available.
7. Data collection should be performed according to Section 8.3 of IEC/TS 62600-200. Considerations for operational status of the TEC, data processing, averaging, and other test data properties are provided in Section 8 of IEC/TS 62600-200.
8. At the conclusion of performance assessment measurement, the test laboratory will perform calculations and data processing according to Section 9 of IEC/TS 62600-200.

9. Results will be reported according to Section 1.4 below.

1.3 Test Reporting Requirements

The test report shall include:

- Identification of the test procedure document and document revision that the test was carried out to.
- TEC report as detailed in Section 10.2 of IEC/TS 62600-200

And in addition,

- That the supplied documents refer to the relevant machine or components;
- Any differences between the converter or component under test with the corresponding part being tested
- TEC test site report as detailed in IEC/TS 62600-200 Section 10.3

And in addition,

- Any significant unexpected site behaviour or occurrences
- Electrical grid and load report as detailed in IEC/TS 62600-200 Section 10.4
- Test equipment report as detailed in IEC/TS 62600-200 Section 10.5
- Measurement procedure report as detailed in IEC/TS 62600-200 Section 10.6
- Presentation of measured data as detailed in IEC/TS 62600-200 Section 10.7
- Presentation of the power curve as detailed in IEC/TS 62600-200 Section 10.8
 - Including Uncertainty assumptions as detailed in IEC/TS 62600-200 Section 10.10
- Presentation of the TEC overall efficiency as detailed in IEC/TS 62600-200 Section 10.9

And in addition,

- Names of the test engineer and the applicant's engineer approving the report
- Deviations from the procedure as detailed in IEC/TS 62600-200 Section 10.11
- Any significant unexpected behaviour
- Conclusion

1.4 Test Reporting Template

The results of reporting should be documented in the format provided in Annex A for consistency.

2 Procedure for an RETL to Apply to Perform Power Performance Assessment of Electricity Producing Turbines under IECRE ME Sector

While acceptance of RETLs is detailed in IECRE 03, a temporary (3-year) transition period, beginning from the approval of this OD (edition 1, published on 2018-06-29), is proposed here to allow for RETL self-assessment, assuming ISO/IEC 17025 accreditation for the IEC/TS 62600-200. The requirements for this self-assessment are outlined in Annex C and below. During this transition period, the ME-SWG will finalize the rules for peer assessment and all self-assessed labs will undergo a peer assessment within one year of the completion of the transition period. Clause 3 below provides a template for developing the peer assessment procedures and additional information regarding the self-assessment.

The application for the acceptance of a laboratory as an RETL shall be submitted to the IECRE Executive Secretary using the Application Form included here, Annex C.

3 Peer Assessment

For acceptance as an RETL to deliver this testing activity, Test Laboratories must indicate their agreement to undergo peer assessment on a periodic basis according to IECRE 03.

Clause 10.2: TEC report	
Make	
Type	
Serial Number	
Production Year	
Energy Capture Type	
Standard Dimensions (w/ Diagram) (see 10.2 Bullet point 2)	Insert diagram
Equivalent Diameter	
Energy Extraction Plane Location	
Control System Description, including software version number	
Rated Output Power	
Rated Water Velocity	
Cut-in Water Velocity	
Low Cut-out Water Velocity	
Cut-out Water Velocity	
Rotational Speed or Period	
Power Take-off System (w/ Diagram)	
Cable Losses	
Mooring/Foundation System*	
Clause 10.3: TEC test site report	
Hydrographic/Navigational Chart (Chart number and extract of the chart showing requested as described in 10.3 bullet 1)	
Bathymetry	
Current Profiler Position	
Current Profiler Bins	
Tidal Ellipse (ref fig 8)	Insert figure here
Channel Cross-Sectional Area with TEC (ref figure 9)	Insert figure here
External Constraints	
Water Density Variation	
Wave Climate	
Clause 10.4: Electrical grid and load report	
Grid Voltage	
Grid Frequency	
Permitted Tolerances	

Prevailing Conditions	
Electrical Load Description	
Report of any <u>grid conditions</u> limiting or having the potential to limit the power output during the testing period	
<u>Clause 10.5: Test equipment report</u>	
Sensor(s)	
DAQ	
Current Profiler	
Power-take Off Component(s)	
Other	
DAQ End-to-end Testing Results	
<u>Clause 10.6: Measurement procedure report</u>	
Timestamp Details	
Log Book	
<u>Clause 10.7: Presentation of measured data</u>	
Flood Scatter Plot	
Ebb Scatter Plot	
Flood Velocity Vertical Shear Profile	
Ebb Velocity Vertical Shear Profile	
Flood RMS Fluctuating Velocity	
Ebb RMS Fluctuating Velocity	
<u>Clause 10.8: Presentation of the power curve</u>	
Tabular Data	
Graphical Data	
<u>Clause 10.9: Presentation of the TEC overall efficiency</u>	
Tabular Data	
Graphical Data	
<u>Clause 10.10: Uncertainty assumptions</u>	
Description	
<u>Clause 10.11: Deviations from the procedure</u>	
Documentation (w/ Rationale)	
<u>Annex C (informative): Calculation of TEC annual energy production</u>	

Additional guidance requested by the ME-SWG.

Figures/Diagrams/Tables

<<INSERT FIGURES, DIAGRAMS AND TABLES AS REQUIRED HERE>>

Annex B: Checklist to be covered during RETL Assessment

The following is a non-exclusive list of the checklist for the assessment of test reporting to be used by the peer assessors, once peer assessment begins:

1	General Information	Is general information on the project, developer, device and abbreviations included?
2	Device Information	Are the TEC device details included? i. Device status definition ii. Operations manual information iii. Location iv. Mode of operation v. Device parameters
3	Test Design	Is the test design adequately described? i. Test site(s) –physical details and dimensions in relation to the TEC, details of maps, surveys etc; ii. Resource analysis including ADCP deployment procedure, model details, tidal components modelled iii. Test duration iv. Test method and validation, whether AEP or similar is required, deviations from TS v. Test Equipment for measuring resource and electrical output, other data collection required, sampling rates vi. Standard Methods used vii. Instrument calibration certificates viii. Test documentation location ix. Test Staffing and authorisations x. Health & Safety requirements
4.	Test Schedule	Is the test schedule included and does it detail: i. Site characterization ii. Measuring instrument details iii. Dummy deployment iv. Test programme to include device availability, detail of any grid failures, record of data interruptions v. Test lab./client communications log vi. Operations manual
5.	Data Management	Is the analysis method and data management adequately documented on: i. Analytical methods ii. Performance requirements iii. Data management including storage, manipulation and control iv. Software list
6.	Quality Control	Have appropriate Quality Control measures been employed and reported? Including on: i. Observation of data collection ii. Manipulation iii. Reporting
7.	Quality Assurance	What internal auditing has been carried out on the i. Test Plan ii. Analysis and measurements iii. Test system control iv. Data integrity check v. Test Report
8.	Test Report	i. Based on IEC template or with appropriate coverage ii. Deviations with estimates of impact on results iii. Authorisation of report including use of any accreditation logo. iv. Construction of the uncertainty budget to give a clear picture of the accurate performance

Annex C: Application Form for ME-SWG IECRE Test Laboratories (RETLs) during the Transition Period

Please provide the information requested (as applicable) below.

The following application shall be completed by the candidate RETL and shall be submitted by the Member Body in which the candidate resides. The Member Body shall ensure that the application package, as noted below, is complete.

NOTE: Incomplete applications will not be processed until full documentation has been received.

NOTE: Once this application is accepted and approved by the Secretariat, it shall be noted that additional documentation will be required to establish the assessment team and to facilitate the assessment, e.g. test reports, results of proficiency testing, accreditation reports, internal quality management documentation, etc.

Applicant RETL shall provide the information in the tables below:

Table C.1: Applicant Information

Legal Entity Name:	Click here to enter text.
Address:	Click here to enter text.
Contact person:	Click here to enter text.
E-mail:	Click here to enter text.
Tel.:	Click here to enter text.
Fax:	Click here to enter text.
Website:	Click here to enter text.

Table C.2: Application Criteria and Documentation/Confirmation

Application criteria	Documentation / Confirmation provided
1. Test Laboratories must be accredited to ISO/IEC 17025 for IEC/TS 62600-200 when applying for recognition under IECRE (the actual application must be submitted by an REMC Member Body) or be evaluated against it by the peer assessment team	Please provide a copy of your accreditation certificate & scope, or state of not currently accredited.
2. The Test Laboratories must show experience in testing according the standard and provide an overview of reports submitted the last three years issued that state compliance with the standard, or a representative report	Please provide a list of tests conducted. Click here to enter text.
3. Test Laboratories must indicate their agreement to undergo peer assessment on a periodic basis that is established by the ME-SWG and REMC.	Please check "yes" below: <input type="checkbox"/> Yes
4. Test Laboratories must agree to adhere to the (draft) RoP, ODs and current and future clarification sheets.	Please check "yes" below: <input type="checkbox"/> Yes
5. Test Laboratories agree to pay the relevant application fee.	Please check "yes" below: <input type="checkbox"/> Yes

Application criteria	Documentation / Confirmation provided
<p>6. Test Laboratories must agree to pay the assessment fee, which will be established together with the assessors.</p> <p>NOTE: The candidate may withdraw from the application process after the assessment fee has been established without incurring any costs.</p>	<p>Please check "yes" below:</p> <p><input type="checkbox"/> Yes</p>
<p>7. For a period of 3 years from the approval of this document, a self-assessment scheme will be in place which will negate the need for on-site peer assessment. This will require document submission.</p>	<p>Please check "yes" below, if applying under this mechanism:</p> <p><input type="checkbox"/> Yes</p>
<p>8. A site based or remote peer assessment will be done by a (group of) identified peers. A specific peer may be refused provided that appropriate and acceptable argumentation is submitted.</p>	<p>Please check "yes" below:</p> <p><input type="checkbox"/> Yes</p>

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