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IECRE OPERATIONAL DOCUMENT

IEC System for Certification to Standards relating to Equipment for use in Renewable Energy applications (IECRE System)

Blades testing assessment –type certification

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CONTENTS

1 Background

This document is intended to be used as a guide to assess the competency of test laboratories as RETL or RECTF under IECRE for blade testing per IEC 61400-23. Note that throughout this document the terms laboratory or test laboratory apply to either RETL or RECTF.

The check list In Annex A should be filled out during the assessment. Assessors are requested to continuously improve this checklist~~checklists~~ based on experience using it.

Annex A: Assessment Checklist

Item nr	category	requirement	question	finding
General				
1	Facility	Personnel qualifications	How are people authorized for performing testing? (training, mentoring?). Is sufficient documentation available?	
2	Facility		Is authorization done for specific parts like test design, instrumentation, inspection, data validation analysis, etc.?	
3	Facility	Proficiency testing	Review proficiency testing results and discuss reason for differences. Document these and assess if these are interpretation of the standard or deviations from clear requirements	
4	Facility	Test article tampering	Is the test article under the test laboratory's (or another independent organization) control so no unknown repairs/ fixes can be made? When repairs or modification of a test article are made, how are they documented by the laboratory?	

Item nr	category	requirement	question	finding
5	Facility	Laboratory procedures and forms (Typically part of ISO 17025 QA system)	Review laboratory and test specific procedures and forms. Procedures should provide sufficient detail to ensure consistency in tasks such as installing instrumentation, maintaining calibration records, etc. When forms are used to assist in complying with log book requirements, these should be collected in a way that ensures a complete test record is available.	

Have test lab identify executed tests available for assessment, select one of the tests to use in the remainder of this checklist. Document which test is being used:_____

To provide a complete evaluation the selected test should ideally include all aspects of the minimum requirements for a full IEC-61400-23 certification test:

- Mass, center of gravity and natural frequencies
- Static tests
- Fatigue load tests
- Post fatigue static tests

Specific sections in the 61400-23 standard are referenced by section number at the beginning of the following requirements where applicable.

Note: a blade test is conducted as collaboration between the designer or manufacturer of a blade and the test lab. The discussion below will use the term “customer” to refer to this outside party who is requesting and specifying the details for the structural test.

Item nr	category	requirement	question	finding
6. Documentation and procedures for the test blade				
6	Facility	6. Documentation: Test records include • Unique identification • Relevant drawings and specifications	Is the test article model and serial number clearly defined?	
7	Facility		Is documentation or data provided by the customer or other third parties clearly identified as such in any reports produced by the test lab?	
8	Facility		Are the responsibilities of the test lab and the customer clearly delineated? For example, typically the designer will often specify the fully factored target test loads including the test factors required by the IEC 61400-23 while the lab will design the test to achieve or exceed those loads.	
9	Facility	6. Repairs should also be documented. Repairs or modifications performed after the blade arrives at the test lab should be noted in the test documentation.	Are any repairs made by the manufacturer during the testing process noted in the test lab report(s)? Full documentation of repairs is responsibility of manufacturer.	
7. Blade test program and test plans				
10	Facility	Areas to be tested. Critical areas of the blade to be loaded shall be identified in the test plan.	If test design is responsibility of test lab, has customer identified critical areas of the blade to be tested?	

Item nr	category	requirement	question	finding
11	Facility	9.2 Influence of load introduction	Often the customer is responsible for assessing if reinforcement is required around a load introduction and for implementing this. Areas around load introduction points are constrained and not considered tested.	
12	Facility	Test plan(s) shall be established for all the individual tests in a blade test program. The test plans shall include: • Blade description • Specification of loads • Conditions of loading • Instrumentation to be applied • Inspections to be performed	Review information included in test plans.	

13	Facility	7.3.2 Blade description
		• Geometry
		  ○ Blade length
		  ○ Chord and twist distribution
		  ○ Pre-bend and/or sweep
		• Mass and CG (predicted)
		• Blade surface condition
		• Blade mounting details
		• Lifting and handling procedures
		• Maximum expected deflections under load
		• Profile geometry at load introduction points.
			~~Typically~~Typically, the customer provides this information in a test specification or similar document. Test plan may reference this.	

14	Facility	7.3.3 Loads and conditions: Test plan shall include the target loads, test loads, application methods and sequence of test to be conducted. Environmental conditions that impact the test shall also be given.		
15	Facility	7.3.4 Instrumentation position and orientation of load cells, strain gauges, deflection transducers and other sensors shall be specified in the test plan.		
16	Facility	7.3.5 Expected (predicted) test results.	The 61400-23 recommends predictions of deflections, strains, etc. be provided to assist in planning and executing a test.	

8. Load factors for testing				
17	Test	8. Load factors for testing.	Are the partial test factors stated in test plan and report or are pre-factored load provided that are used to design the test? Ensuring that a test loads include the required test factors from section 8 is typically the responsibility of the customer.	
9. Test loading and test load evaluation				
18	Test		Typically defining the target test loads is the responsibility of the customer. If the test lab has a role in this, than that work should be reviewed.	
19	Test		The test lab may assist the customer in determining if their applied loading is acceptable – for example by comparing the extreme fatigue loads to be applied to the static test loads.	
10.1 Test execution requirements				
20	Test	10.1.1 Test records	Review log book entries to assess if sufficient detail is being recorded to allow for proper time categorization, if unsure copy excerpts to discuss with other assessors.	

21	Test		Review laboratory forms. In combination with the log book these should provide sufficient information to document the test and provide any test geometry or instrumentation details not included in the data files or log book. Forms should be completed accurately and identify the test article, person who filled it out and date.	
22	Facility	10.1.4 Root fixture and test stand requirements	Has the lab evaluated the stiffness of their test stand and either verified that the influence on tip deflection is less than 1% or accounted for the deflection of the test rig in the analysis?	
23	Facility	10.1.5 Environmental condition monitoring	Meet minimum requirements of recording temperature outside, inside and on the surface of the blade. Ambient humidity may also be required for some materials.	
24	Test	10.1.6.1 Tare loads	Are tare loads and their locations documented?	
25	Test		Is it documented under what conditions and with what tare loads channels are offset to read zero (i.e. what is the reference condition for the measurements)?	
26	Test	10.1.6.2 Load angle changes	Are the load angle changes during deflection taken into account? See analysis section.	
27	Test	10.1.6.3 Induced torsion loading	Is induced torsional loading considered? Is it necessary to consider for the test in question?	

10.2 Static test				
28	Test	10.2.1 General	Static tests should provide information demonstrating the blade supports the required loads and evaluating the deflection (stiffness) relative to the design.	
29	Test	9.3 Static load testing	Duration of 100 % load shall exceed 10 seconds or time specified by customer based on design.	
30	Test	10.2.2 Static test load: During static load tests, shall measure: • Magnitude and direction of the applied load(s) at the five load levels where strains are measured. • a time signal (actual or derived from sample rate	Review raw and post-processed data. Direction of applied loads may be assessed in a variety of ways. Consider if the uncertainty in the method used is reasonable.	
31	Test	10.2.3 Strain measurement. Strain measurements shall be taken for at least five load levels distributed over the load range used in the test.	Strain gauges locations are typically specified by the customer.	
32	Test	10.2.4 Deflection measurement: Deflections shall be measured at three or more points along the span.	Deflection measurements are typically used to verify the global stiffness and evaluate or validate the load cable angles determined for 10.2.2	

10.3 Fatigue test				
33	Test	The following shall be recorded: • Cycle count • Signals used to control the blade test (applied loads, deflections, accelerations, strains) • Functionality of sensors shall be verified throughout the test. Critical sensors shall be fixed or replaced when the fail. Stiffness of the blade shall be checked and documented several times throughout the test.	This data should be sufficient to ensure that the required damage equivalent load is achieved. Review what the lab does when various sensor types fail. How is the data processed and reported when a sensor (e.g. a strain gauge) failed for a portion of the test?	
34	Test	9.4 Fatigue load testing	Typically the customer defines the Miner summation slope factor. The test lab may be responsible for determining the total damage equivalent load applied during the test.	
35	Test Evaluation	Repairs during fatigue testing	If any repairs were performed during fatigue testing how were they documented? Had the repaired area already achieved the target damage level?	
10.4 Other blade property tests				
36	Facility Evaluation	10.4.1 Blade mass and CG shall be determined.	How was the mass/cg measurement obtained? Are the uncertainty estimates reasonable for these results? Is any additional hardware noted? Are any tare loads appropriately accounted for?	
37	Test	10.4.2 Natural frequencies.	Review how natural frequency	

		Minimum of 1st and 2nd flatwise and edgewise frequencies shall be measured.	measurements are conducted. Is any instrumentation attached to the blade during these measurements noted? Is it necessary to account for the influence of that equipment mass?	
Data acquisition and instrument calibration				
38	Test Evaluation		If different data acquisition systems are used is synchronization set and maintained. Is the error evaluated?	
39	Facility		Is the data under the TL's / CTF's control fromform the moment it is generated?	
40	Test		Is the sample rate sufficient to achieve accurate measurement results during static and fatigue testing?	
41	Test		Is any resampling or down-sampling performed?	
42	Facility	10.1.2 Instrument Calibration	Is there evidence that all instruments were calibrated?	
43	Facility		Are all calibration factors applied correctly? How is this checked or verified? How is it corrected if an error is detected later?	
44	Test		Were additional checks performed to assure signals were wired correctly and functioning (end-to-end checks)?	
45	Test		If any instrument changes were performed during the test how is it assured that those changes were implemented correctly? Were	

			those changes documented (for example, replacing a strain gauge).	
46	Test		Were any recalibrations or post-test calibrations performed?	
47	Test		Is the range for all channels set properly (no clipping, sufficient resolution)	
48	Test	Data acquisition system	How is the data acquisition system (including software) validated?	
Analysis				
49	Evaluation	Analysis software	Custom analysis software will typically include tools for designing static and fatigue tests and post-processing tools for mass and CG, Eigenfrequency, static and fatigue tests.	
50	Evaluation		If custom analysis tools are used. Is the software version controlled?	
51	Evaluation		How is the software validated?	
52	Evaluation	10.1.6.2 Effects of Load angle.	Does the lab correctly evaluate the bending moment applied to the blade accounting for the large deformations and actual test setup?	
53	Test	10.1.6.3 Induced torsional loading	Is this considered in designing tests or evaluating test results? Is it necessary for the example test under review?	

54	Evaluation	Fatigue test load evaluation	If the fatigue test is performed by resonance excitation, review the measurement of strain sensitivities (static calibration) and calculation of the fatigue during fatigue. Is constant amplitude loading assumed or is damage equivalent load for the entire test calculated? Are the assumptions made reasonable? How is missing data handled?	
55	Evaluation	10.1.3 Measurement Uncertainties The following shall be estimated and reported: Uncertainties in magnitude, direction and location of the applied load, displacement and measured strain.	Are all device uncertainties evaluated including entire measurement chain (calibration referenced, data acquisition accuracy and precision).	
56	Evaluation		Review estimation of uncertainty for any final measure and results including: • Applied static bending moments • Fatigue load applied or damage equivalent load. • Mass and CG • Natural frequencies And any other calculated results. How are the inputs estimated or assessed? Are reasonable engineering approaches used? Are the inputs and method followed indicated in the reports?	

	11. Inspections			
57	Test	11.1 Visual Inspection. Before test, after test and at frequent intervals during fatigue test. Inspection results shall be documented in the logbook.	In general the lab is responsible for observing and reporting any irreversible changes observed in the blade over the course of the testing. If any repairs are conducted this should be noted in the test log.	
58	Test		Was an inspection performed when the blade arrived at the lab?	
59	Review		Review inspection logs.	
60	Evaluation		Were inspections documented with sufficient in depth and detail to determine type of damage observed.	
61	Test Evaluation	Critical electrical or imbedded systems (lightning down conductors) shall be checked for proper function periodically	Is the LPS system resistance monitored through the test program? Are the measurements/results reasonable?	
	12. Reporting			
62	Report	12.2 The test reports shall contain the following information:	Review if the report(s) meets the reporting requirements. Report(s) should clearly document what tests were performed and provide sufficient information to enable recreate the test or an accurate simulation of the test conditions applied to the blade.	
63	Report	• Table of contents		
64	Report	• Contractor for the test		
65	Report	• Dates and locations for the tests		

66	Report	• Blade identification		
67	Report	• Blade description		
68	Report	• Test set-up and procedures	Are any unique coordinate systems described? Is any non-standard nomenclature or abbreviations described?	
69	Report	• Description of test load		
70	Report	• Test equipment used (including make, model, serial number, etc.)		
71	Report	• Reference to calibration records of measurement equipment		
72	Report	• Locations of sensors and measurement points		
73	Report	• Blade specific calibration details (tare loads, strains, etc.)		
74	Report	• Estimated uncertainties	Are uncertainty estimates given for each result? Are methods used for the estimation ~~reasonable.~~reasonable?	
75	Report	~~•~~ Description of inspections, repairs, and observations •	Was any damage noted and if so documented sufficiently to determine type and extent of observation and when in the testing process it occurred? Was the blade altered in any way after it reached the lab and if so noted in the report?	

76	Report	• Summary of tests and test results	Should include test type, environmental conditions, loads applied and results.	
77	Report	• Deviations from test plans, laboratory procedures or normative references		
78	Report	• List of references (test plans, laboratory procedures, and normative references).		
79	Review	12.3 Evaluation of test in relation to design requirements		
80	Review	• Evaluation of the test loads including test load distribution	Is the load distribution applied to the blade evaluated accurately considering large deformations (static)? Evaluation of fatigue loading applied (moment distribution and damage equivalent load)? Are the uncertainty in these measurements estimated and reported?	
81	Review	• Evaluation of the test results with respect to the basis for design (the test target loads are typically used for reference).	Are comparisons to the test target loads provided?	
82	Review	• Evaluation of the blade stiffness		

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