



IECRE OPERATIONAL DOCUMENT

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

Assessment of anemometer calibration facilities





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Assessment of anemometer calibration facilities

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1 Introduction

This OD covers the assessment of anemometer calibration facilities for Test Laboratories who want to get this competence area recognised under IECRE.

The full assessment is based on four elements:

- A review of three reports issued by the Test Laboratory within the last three years
- Successful participation in an anemometer calibration proficiency test (no older than 3 years on the date the assessment concludes)
- Review of key internal procedures
- Witnessing of one anemometer calibration

In this document, the Test Laboratory is the organisation asking for an assessment according to this OD. An RETL refers to an IECRE recognised Test Laboratory.

2 Review of historic reports

In order to have three reports reviewed, the RETL shall submit an overview of reports submitted the last three years with the IECRE logo. In case the assessment is for a candidate RETL, or the RETL has issued fewer than three IECRE test reports for anemometer calibrations, the assessed Test Laboratory shall submit to the IECRE Secretariat a list of reports issued that state compliance with IEC 61400-12-1 Annex F.

The Lead Assessor, together with the Technical Assessors and/or experts, shall select from this list three reports. These reports have to be submitted to the IECRE Secretariat by the assessed Test Laboratory.

The reports shall be reviewed for compliance with IEC 61400-12-1 Annex F, as per the checklist in Annex A of this OD. A filled-out version of the checklist shall be included in the final assessment report.

3 Proficiency testing

3.1 Topic of proficiency test

The following outputs of anemometer calibration shall be considered in the proficiency test.

Text to be added

3.2 Requirements

The allowed limitations for each of the outputs are indicated below.

Text to be added

3.3 Process

The process that shall be followed for the proficiency testing is described in OD XXXXX. (Reference to OD with process description for proficiency testing, this OD does not exist yet).

4 Review of internal procedures

4.1 Identification of key procedures

Text to be added

4.2 Guidance

For the review of these procedure the following guidance is given:

text to be added.

5 Witnessing of test

As part of the assessment the assessment team shall witness one test to establish:

- Compliance with the standard IEC 61400-12-1 Annex F
- Compliance with the key internal procedures as defined under section 4 of this OD
- Identify further process or technical issues that could affect the result of the test

Annex A - Checklist

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
Annex F: Cup anemometer calibration procedure				
Clause F.1: General requirements				
1	page 58, paragraph 1, line 2	All transducer and measuring equipment shall have traceable calibrations. Calibration certificates and reports shall contain all relevant traceability information. All reference standards used during the calibration of the anemometer shall be stated within the test report of the calibration campaign.	Check for all calibration certificates.	
			Check for the references to international standards used during calibration.	
2	page 58, paragraph 1, line 6	The pitot tubes used shall be calibrated for appropriate wind speed ranges, and be documented.	Check for calibration details of pitot tubes used.	
			Check for the defined wind speed ranges against the calibration range for pitot tubes.	
3	page 58, paragraph 1, line 8	Prior to every calibration round the integrity of the experimental set-up shall be verified by means of comparative calibration of a "reference anemometer" of the institute.	Check for details of the reference anemometer of the calibrating institute.	
			Check for details of verification of test set up integrity.	
4	page 58, paragraph 1, line 10	Flow quality measurement shall be carried out	Check for the measurement of flow quality in the calibration set up.	
5	page 58, paragraph 1, line 11	The repeatability of the calibration shall be verified.	Check for all adequate information required to repeat the calibration.	
6	page 58, paragraph 1, line 12	Anemometer calibration shall be supported by a thorough assessment of calibration uncertainty, carried out in accordance with ISO guidelines.	Check for assessment of uncertainty in the anemometer calibration	
			Check for reference to ISO guidelines.	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
Clause F.2: Requirements of the wind tunnel				
7	page 58, paragraph 2, line 1	The wind tunnel shall be well equipped and carefully prepared to carry out accurate anemometer calibration.	<p>Check for the details of equipment required to carry out anemometer calibration</p> <p>Check for the details of all the equipment used for anemometer calibration</p>	
8	page 58, paragraph 3, line 1	The presence of the anemometer shall not substantially affect the flow field in the wind tunnel.	Check for assessment of flow distortion caused by the anemometer in the wind tunnel.	
9	page 58, paragraph 3, line 3	The blockage ratio - defined as the ratio of the anemometer frontal area (including its mounting system) to the total test section area - shall not exceed 0.1 for open test section and 0.05 for closed test section.	<p>Check for the geometrical specifications of the wind tunnel and the anemometer to be calibrated</p> <p>Check for the estimation of blockage ratio</p>	
10	page 58, paragraph 4, line 1	The flow across the area covered by the anemometer shall be uniform. The flow uniformity shall be assessed prior to the anemometer's calibration.	Check for details of flow assessment across anemometer area before calibration	
11	page 58, paragraph 4, line 4	The flow shall be uniform to 0.2%. These investigations shall be carried out for the wind tunnel once and additionally after each modification of the wind tunnel aerodynamics.	<p>Check for the measure of the flow uniformity</p> <p>Check for the details of modifications done on the tunnel aerodynamics. If any, additional measure of the flow uniformity.</p>	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
12	page 58, paragraph 5, line 2	Therefore, it is useful to check the horizontal wind gradient by using two identical pitot tubes. They shall be placed at the exact position where the anemometer will be placed with their heads spanning approximately the area covered by the cup anemometer rotating cups. A set of measurements shall be made and the linear regression between the dynamic pressures measured by the two pitot tubes shall be calculated. The difference shall be less than 0.2%. The axial turbulence intensity at the anemometer's position shall be below 2%.	<p>Check for estimation of horizontal wind gradient.</p> <p>Check for estimation of axial turbulence intensity.</p> <p>Check for details of two pitot tubes used for the purpose and verification that they are identical</p>	
13	page 58, paragraph 6, line 1	The wind tunnel calibration factor, which gives the relation between the conditions at the reference measurement position and those at the anemometer position, shall be appraised using pitot tubes.	Check for the details of assessment of wind tunnel calibration factor.	
14	page 59, paragraph 1, line 1	The facility shall undergo a detailed examination of the repeatability of anemometer calibration. The facility shall designate a reference anemometer for use in these tests. The reference anemometer shall be used only for checking performance of this and other anemometer facilities.	<p>Check for all the details required to repeat the anemometer calibration</p> <p>Check for details of the designated reference anemometer for the facility</p>	
15	page 59, paragraph 1, line 4	The repeatability examination shall include at least 5 calibrations of the reference anemometers (over various atmospheric conditions). The maximum difference between calibrations should be less than 0.5% at 10 m/s wind speed. The process shall be repeated after any modification or recalibration of the facility.	<p>Check for details from 5 calibrations performed on reference anemometer during repeatability examination.</p> <p>Check for the measure of difference between 5 calibrations</p> <p>Check for details of any modifications or recalibration of the test facility.</p>	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
16	page 59, paragraph 2, line 1	The facility shall prove, through round robin testing, that its results are comparable with other anemometer calibration facilities.	Check for details of round robin tests.	
Clause F.3: Instrumentation and calibration set-up requirements.				
17	page 59, paragraph 3, line 1	Dedicated external signal conditioning equipment such as frequency to voltage converters, etc. shall be calibrated in isolation from the anemometer, so allowing the anemometer's calibration to be derived and reported in isolation from signal conditioning equipment.	Check for details of the signal conditioning equipment used in the test facility.	
			Check for the calibration reports of the entire listed signal conditioning equipment.	
18	page 59, paragraph 4, line 1	The resolution of the data acquisition system shall be at least 0.02 m/s. Care shall also be exercised in the case of an analogue voltage instrument, to ensure that the signal is adequately buffered to prevent its attenuation by low impedance logging equipment.	Check for details of the data acquisition system	
			Check for the resolution used in the data acquisition system	
19	page 59, paragraph 5, line 1	During calibration the anemometer shall be mounted on top of a tube in order to minimize flow distortion. This tube shall be of the same dimensions as the one on which the anemometer will be mounted in service in the free atmosphere.	Check for details of mounting specifications during the anemometer calibration.	
			Check for details of mounting specifications required during service.	
20	page 59, paragraph 6, line 1	It is important to ensure that the anemometer is not influenced by the presence of any reference wind speed measurement equipment. Conversely, the presence of anemometer shall not affect the flow in the region of the reference instrument. If flow distortion effects are encountered, then the pitot tube shall be repositioned.	Check for details of position of anemometer and reference wind speed measurement equipment in the wind tunnel.	
			Check for details of assessment of flow distortion from instruments on each other.	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
21	page 59, paragraph 7, line 1	The pitot tubes shall be positioned at the test section perpendicular to the flow field of the wind tunnel as accurate as possible.	Check for positioning of pitot tube with respect to flow field.	
22	page 59, paragraph 8, line 1	The anemometer shall be positioned at the test section perpendicular to the flow field of the wind tunnel as accurate as possible.	Check for positioning of anemometer with respect to flow field.	
23	page 59, paragraph 9, line 1	During calibration, the anemometer output signal shall be examined to ensure that it is not subjected to interference or noise.	Check for quality assessment of the anemometer output signal.	
Clause F.4: Calibration procedure				
24	page 59, paragraph 10, line 1	The anemometer shall run in for about 5 min before the calibration procedure begins in order to avoid the effect that large temperature variations may have on the mechanical friction of the anemometer bearings. Calibration shall be performed under both rising and falling wind speed in the range of 4 m/s to 16 m/s at a calibration interval of 1 m/s or less.	Check for details of operational procedures followed during the anemometer calibration (test log)	
			Check for the range of wind speed in which the calibration was performed and the calibration interval within the defined range.	
25	page 60, paragraph 1, line 1	The sampling frequency shall be 1 Hz and the sampling interval at least 30 s. This time shall be increased when low resolution anemometers are calibrated.	Check for details of the sampling frequency and sampling interval.	
			Check for resolution details of the anemometer which will be calibrated.	
26	page 60, paragraph 1, line 4	Before collecting data at each wind speed, adequate time shall be allowed for stable flow conditions to become established.	Check for details of operational procedures followed during the anemometer calibration (test log)	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
27	page 60, paragraph 2, line 1	Air density ρ shall be calculated on the basis of the mean wind tunnel air temperature T , relative humidity ϕ and barometric pressure B using equation (F.1).	<p>Check for records of measured air temperature, pressure and relative humidity.</p> <p>Check for estimation of air density at the time of calibration.</p>	
28	page 60, paragraph 4, line 2	If no blockage correction factor is calculated, then about 1/4 of the blockage ratio shall be used for the uncertainty calculation for closed wind tunnels and 1/16 for open wind tunnel.	<p>Check for details of estimation of blockage correction factor.</p> <p>Check for details of estimation of blockage ratio.</p> <p>Check for the details of wind tunnel type being used for anemometer calibration</p>	
Clause F.5: Data analysis				
29	page 61, paragraph 1, line 1	A linear regression analysis shall be carried out on the calibration data for the estimation of the following regression parameters: offset, slope, regression coefficient, standard uncertainty in the slope and intercept and covariance of the slope and intercept of the wind speed. The wind speed values shall be regressed upon the anemometer outputs.	Check for the details of linear regression carried on the calibration data.	
30	page 61, paragraph 2, line 1	If the correlation coefficient, r , for the data is less than 0.99995 then the calibration shall be repeated. If coefficient is still insufficiently high, then either the calibration facility is inadequate or the anemometer is excessively non-linear and shall not be used.	Check for estimation of correlation coefficient r , for the calibrated data.	

Item no	Reference in standard	Requirement in the standard (verbatim)	Guidance on assessment of requirement	Finding (including Discussion/ Comment)
Clause F.6: Uncertainty analysis				
31	page 61, paragraph 3, line 4	The magnitude of the net uncertainty shall be assessed statistically and shall take account of: - flow speed measurement uncertainty - frequency measurements - wind tunnel calibration including blockage effect - flow variability in the vicinity of the anemometer.	<p>Check for the assessment of uncertainty in the calibrated data.</p> <p>Check against the list of uncertainties in the estimation.</p>	
Clause F.7: Reporting format				
32	page 61, paragraph 4, line 1	The relevant documentation shall provide information on the procedure followed and the facility used for calibrating the anemometers (test report on the calibration campaign) and on the individual anemometer calibration (anemometer calibration report).	<p>Check for all the documentations necessary to understand the anemometer calibration process.</p> <p>Check for the details of all the procedures followed during the calibration.</p> <p>Check for details of both the facility and the calibration process in the documents.</p>	
33	page 61, paragraph 5, line 1	The test report on the calibration campaign shall contain the following information as a minimum:	Check against the list of minimum requirements in the test report.	
34	page 62, paragraph 1, line 1	The calibration report of an anemometer shall as a minimum contain the following information:	Check against the list of minimum requirements in the calibration report.	

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