VAISALA

Power Performance Testing with WindCube® Nacelle

New IEC classification

Already included in multiple developer and manufacturer Turbine Supply Agreements, WindCube® Nacelle is the first lidar to receive full classification according to the new IEC standard for nacelle-mounted lidars. Classified by DNV in collaboration with Vaisala, this paves the way for increased adoption and acceptance for state-of-the-art Power Performance Testing (PPT).

Read on for highlights from the IEC classification process. The results are clear: WindCube Nacelle is speeding the adoption of nacelle lidar for PPT.

New WindCube Nacelle enhancements

Cloud-based WindCube Insights — Fleet
Rotor Equivalent Wind Speed (REWS)
World-class Vaisala weather sensor
Adaptable mounting options

Get the details on our website

WindCube Nacelle IEC classification and enhancements

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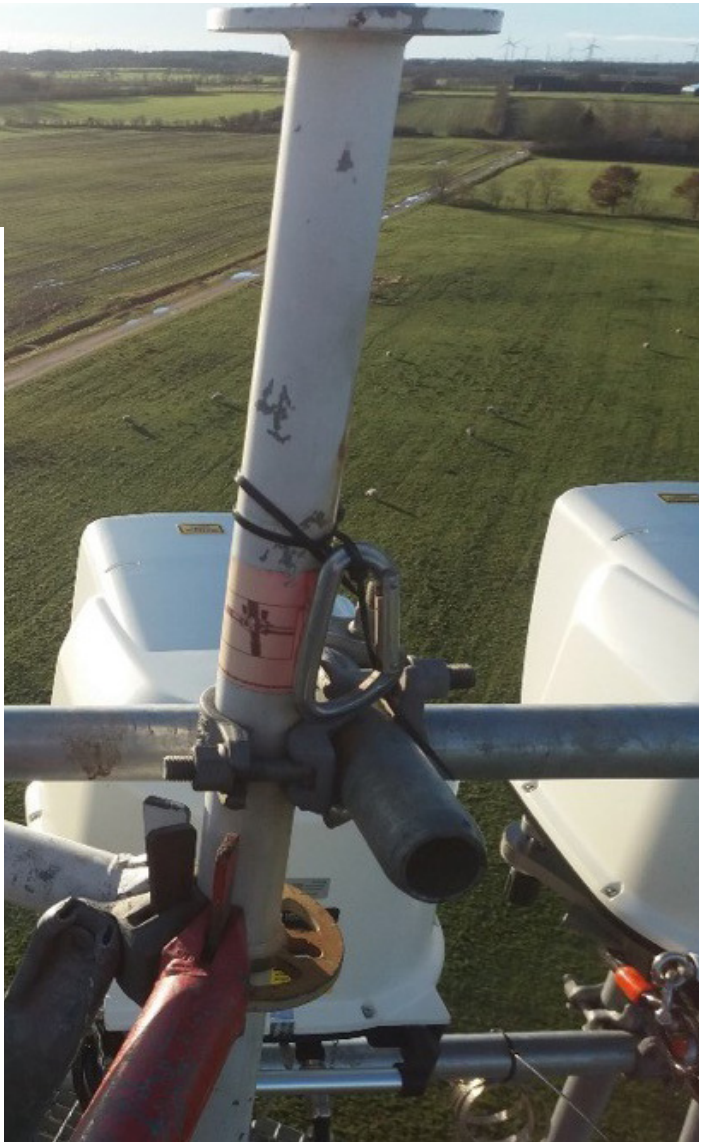
IEC Classification with DNV

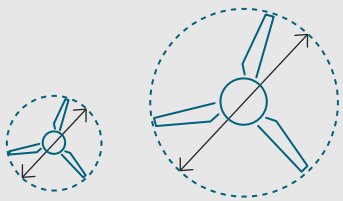


The new IEC 61400-50-3 standard provides the wind energy industry with extensive guidelines for the use of nacelle-mounted lidars for PPT. This contributes to the acceptance of nacelle-mounted lidar as a go-to wind measurement technology for onshore and offshore turbine performance verification.

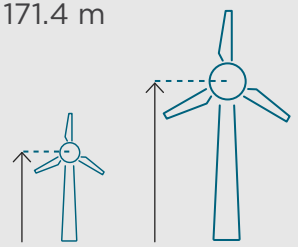
For a nacelle-mounted lidar device to fully comply with the IEC 50-3 standard, an extensive metrological validation of the lidar—"Classification"—has to be performed by the lidar manufacturer. DNV worked with Vaisala to perform the industry-first classification of WindCube Nacelle lidar in accordance with the IEC 50-3 standard.

WindCube Nacelle is the first nacelle-mounted lidar classified according to the new IEC standard. The classification is valid for all current turbine sizes:

Rotor diameters from 97.7 m to 238.5 m



Hub heights from 68.5 m to 171.4 m



What is the IEC 61400-50-3 standard?

The newly released IEC 61400-50-3 (2022) standard provides the wind energy industry with guidelines for the use of nacelle-mounted lidars for wind speed measurements. This standard allows the use of nacelle-mounted lidars as standalone wind measurements instruments for Power Performance Testing (PPT) according to the existing IEC 61400-12-1 ed. 2 (2017) standard.

This IEC 61400-50-3 standard is the consequence of several years of development of guidelines for the use of 2-beam and 4-beam nacelle lidars for PPT such as EUDP or UniTTe guidelines. The release of the new standard in January 2022 is a key milestone for the use of nacelle-mounted lidars for onshore and offshore turbine performance verification.

Sensitivity study and evidence base

According to the IEC-50-3 standard, each lidar has to be calibrated against a reference cup anemometer prior to a PPT campaign. Since environmental conditions during a PPT campaign can differ from those during calibration of the nacelle lidar, the influence of environmental variables (EVs) on the measurement accuracy needs to be accommodated in uncertainty analyses. According to the IEC 50-3 standard, this can be done via a nacelle lidar classification. DNV and Vaisala completed this in two steps, following the standard requirements:

1. Sensitivity study: analyze the influence of EVs on lidar Line of Sight (LOS) measurements.

2. Evidence base: datasets of several field tests supporting the accuracy of the Wind Field Reconstruction (WFR) model.

1: Sensitivity study

The first step performed by DNV was to analyze how the lidar LOS measurements were impacted by external parameters (EVs) such as air temperature, pressure, humidity, wind direction, windshear, turbulence intensity.

DNV performed this analysis by mounting a WindCube Nacelle on a 30-meter platform at their test site in Germany. The lidar LOS measurements were compared against the measurements of reference anemometers mounted on two met masts.

The sensitivity study performed by DNV showed that most EVs do not have an impact on the lidar LOS measurements. The only two significant EVs are air density and windshear exponent.

2: Evidence-base

The second step of the classification performed by DNV was to confirm, using an evidence base, the accuracy of the lidar Wind Field Reconstruction (WFR) algorithm. This evidence base is composed of several “off-nacelle” and “on-nacelle” campaigns where measurements from reference instruments, such as cup anemometers mounted on met mast, are compared with the nacelle lidar final outputs, such as horizontal wind speed.

The off-nacelle tests determine if the WFR model works and can provide accurate final values in a stable environment, while the on-nacelle campaigns are the ultimate test of whether the WFR can provide good final values while tilting, yawing, being blocked by the blades or dealing with any other challenges associated with sitting on top of an operating turbine.

The analyses performed by DNV showed that all IEC requirements were met for the off-nacelle and on-nacelle tests. This means the WindCube Nacelle WFR model is not sensitive to any EVs and is compliant with the IEC-50-3 standard.

Results

Both the sensitivity study and evidence base analysis performed by DNV proved the accuracy of WindCube Nacelle as per IEC-50-3 requirements — making it the go-to reference for accurate PPT of onshore and offshore wind turbines.

How to calculate the “classification” uncertainty

The results of the sensitivity study can be used for the uncertainty calculation as part of a power curve verification campaign. This is done by assessing the difference in environmental conditions between the calibration and the PPT campaign. For this uncertainty calculation, the range and slope of significant EVs - air density and shear exponent should be used.

In case the air density and windshear were only measured during the calibration campaign, the maximum range should be used for the uncertainty calculation. In case the air density and windshear were measured during both the calibration campaign and the specific measurement campaign, the calculated range can be used for the uncertainty calculation. Using the calculated range will lead to lower “classification uncertainty” and therefore lower final uncertainty.

WindCube Nacelle can be equipped with an optional PTH sensor to enable measurement of air density without an external data logger. Additionally, windshear can be measured by the lidar itself. Therefore, there are no additional sensors required to measure the significant EVs to use that information for the uncertainty calculation.

Why Vaisala for renewable energy?

We are innovators, scientists, and discoverers who are helping fundamentally change how the world is powered. Vaisala elevates wind and solar customers around the globe so they can meet the greatest energy challenges of our time.

Our renewable energy solutions are guided by several key priorities:

Thoughtful evolution

Remain a pioneer in renewable energy, always providing sensible, trusted solutions at the leading edge of R&D.

Smarter at every stage

Provide end-to-end weather and environment solutions and critical insights throughout the renewable energy life cycle.

Legacy of leadership

Extend our proven track record and global trust to reach more customers in more ways.

Vaisala is the only company to offer 360-degree weather and environmental monitoring solutions — from sensors and systems to digital services and actionable intelligence — nearly anywhere on the planet (and even on Mars). Every Vaisala solution benefits from our 85+ years of experience, pioneering deployments in 170+ countries, and unrivaled thought leadership.

Our innovation story, like the renewable energy story, continues.

Get the full details

Watch the webinar: **Lidar without limits: New IEC classification and WindCube® Nacelle enhancements speed adoption of nacelle lidar for PPT.** Go in-depth with these topics presented by Vaisala, DNV and GE Renewable Energy.

Watch the webinar

windcubelidar.com