Certification Testing

Wind turbine certification is becoming increasingly important for companies competing in the international marketplace. In support of the U.S. wind energy industry, the National Renewable Energy Laboratory (NREL) now offers testing services at the National Wind Technology Center (NWTC) that lead to wind turbine certification.

NREL certification test reports provide an important element in the documentation package required for certification. These tests provide a third-party assessment of a wind turbine's characteristics. Certification testing requires adherence to a strict quality assurance system and use of methods that are recognized by certification agents. In some cases, methods are formalized in international standards and recommended practices. In others, the certification agent must understand and approve of the methods developed by the testing laboratory. Prior testing experience and involvement with international testing and standards development place NREL in an excellent position to provide this important service to the U.S. wind turbine industry.

Tests Available Now

NREL now offers three types of tests: power performance, noise emissions, and blade structural tests. The first two tests are currently required for certification and are done in accordance with well-defined procedures that have obtained international acceptance. These procedures are being formalized in standards by the International Electrotechnical Commission (IEC). In addition to the IEC protocols, NREL abides by guidelines that are established jointly by wind turbine testing laboratories throughout the world. Blade structural tests are not now required for certification, but are strongly recommended by NREL.

Power Performance Testing

Power performance tests quantify the relationship between power output and wind speed, commonly known as a power curve. The power curve is used to estimate annual energy production from a wind turbine. This estimate is often used as a basis for revenues, taxes and, in some cases, subsidies. Thus, accuracy in the power curve measurement can have a strong impact on business decisions.

Warren Gretz, NREL PIX 02131

Certification test engineer measures noise emissions from a wind turbine at the National Wind Technology Center.

During power performance testing, instrumentation measures wind speed and direction, air temperature and pressure, and turbine power output and status. At least 180 hours of performance data are gathered when winds are between low-wind cut-in speeds and high-wind cut-out speeds. Wind speed is measured by precision anemometers on a meteorological tower placed 2.5 rotor diameters upwind of the turbine. NREL participates in a program developed by European test stations to ensure comparability of anemometry readings.

Power performance testing may also require site calibration if the turbine site does not have a flat and unobstructed terrain. Site calibration measures the offset, if any, between wind speed at the meteorological tower and the turbine.

Noise Emissions Testing

Wind turbine noise is often discussed during siting negotiations, especially in Europe where wind turbines are commonly located close to homes and businesses. A weighted sound-power level, octave, and tones are three acoustic measurements that are required for certification. These measurements are made with four microphones placed around the turbine on hard plywood "sound boards." Microphone signals are recorded by an instrument-quality, digital tape recorder and are analyzed using a dynamic signal analyzer. Other measurements include wind speed and direction and turbine power level.

All instrumentation meets IEC standards and all procedures follow a recently approved IEC standard for wind turbine acoustic measurements. These procedures call for

determination of source power levels as functions of wind speed and microphone direction relative to wind direction.

Blade Structural Testing

Although blade structural tests are not required for certification, they address the key concerns about wind turbines: Will the blades stay on? How long will they last? NREL recommends two tests: an utimate-load test and a fatigue test. An ultimate-load test simulates extreme wind loading and indicates the blade's strength safety margin over the worst winds expected at the installation site. A fatigue test applies cyclic bending loads to the blade. The fatigue test simulates repetitive, high-wind conditions that the turbine might undergo during a 20- to 30-year exposure to the environment. A comprehensive description of NREL's structural testing capability is available in the information sheet entitled *Structural Testing*.

Certification Testing Equipment

Certification Test	Instrument	Rating
Power Performance	Met One anemometers	Accurate to 1%
Power Performance	Power transducers	Accurate to 0.5%
Acoustic Noise	HP 4 channel dynamic signal analyzer	0–10 kHz frequency range
Acoustic Noise	Multi-channel, high-capacity, instrument-quality digital data recorder	95-dB dynamic range
Loads	Robust, multi-channel Advanced Data Acquisition System	Accurate to 0.1%

Test Capabilities Under Development

In addition to the three tests presently offered, NREL is developing the capability to provide additional testing services:

- Loads testing seeks to ensure that the turbine assembly will withstand the wind conditions it might encounter during its lifetime. Typical measurements will include blade edgewise and flapwise bending, mainshaft bending and torsion loads, tower bending, yaw and rotor positions, and environmental conditions.
- Safety system verification tests verify the performance of the key safety features of the turbine, especially the turbine braking systems.
- Power quality testing measures the effects that wind turbines have on a grid's voltage and current characteristics. These effects are important when wind turbines comprise a significant addition to power from conventional generators. Tests may include power variation, reactive power demand, voltage and current fluctuations, start-up and shutdown transients, and harmonics.
- Drivetrain testing is used to verify the structural integrity of drivetrains, gearboxes, generators, power electronics, and yaw drive systems. NREL is developing a 1-MW dynamometer facility.

Integrating Turbine Design and Certification

NREL assists industry in developing new turbine designs. As part of the turbine design process, NREL requires manufacturers to satisfy international standards for wind turbine design safety. These standards are also required by international certification agencies. The design and certification testing documentation is compiled by the manufacturer and submitted to the certification agency for approval. In addition to performing certification tests, NREL offers guidance and review of design documentation. Such an approach integrates certification requirements into the turbine design process.

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