Improving wind turbine reliability is critical to realizing the promise of a clean, sustainable and economically viable global wind power infrastructure. Manufacturers and suppliers who successfully optimize their wind turbine and component designs to minimize costs and maximize uptime will emerge as industry leaders.

As the world’s premier test and simulation solution provider, MTS stands uniquely qualified to deliver the technology and expertise required to improve wind turbine reliability and durability. MTS solutions are deployed worldwide, subjecting wind turbine materials, components and structures to a full spectrum of mechanical testing, including characterization, strength testing, durability testing and systems testing.

Visit us at Booth 2521 and explore all the ways MTS is meeting the wind turbine industry’s critical mechanical testing needs.

**MTS TEST & SIMULATION LEADERSHIP**

Test engineers and researchers worldwide rely on MTS for the innovative testing technologies and expertise required to accelerate and improve research, design, development and manufacturing processes. High performance MTS solutions have long been deployed to meet demanding material, component and structural testing needs across a broad spectrum of industries, including aerospace, automotive and civil engineering. MTS has extended this array of mechanical testing capabilities into the rapidly developing field of wind power generation:

- MTS supports the world’s leading wind turbine manufacturers, suppliers and research facilities with state-of-the-art technology and testing solutions, facilities planning, test consulting, and complex systems integration
- Advanced MTS testing technologies are simulating the complex and extreme loading environments of wind turbine drive trains, blades, bearing systems, towers and more
- Robust MTS materials test systems are conducting static and dynamic testing of advanced composite materials and alloys
- MTS testing expertise is proving crucial to the development of the next generation test and simulation technologies required to test the extremely large wind turbine structures planned for the near future

Be certain.
Addressing a Full Spectrum of Wind Turbine Mechanical Testing Needs

Drive Train Test Solutions

High-performance MTS Drive Train Test Solutions apply real-world rotational and off-axis loading for optimizing the reliability of complete nacelle assemblies, complete drive train systems, and drive train components such as gear boxes and bearing systems.

» Applications include:
  – System simulation and verification
  – Performance and durability testing

» Employs innovative MTS Non-Torque Loading (NTL) System to apply extreme loads in six degrees of freedom
  – Highly robust and efficient design results in low cost of operation, high uptime and long life
  – Rotation/moment input via prime mover
  – Off-axis, or non-torque, loads (3 forces, 2 moments) via MTS NTL System

» Integral, low-friction hydrostatic bearing technology delivers superior dynamic performance

» High-fidelity simulation and optimum test accuracy achieved with state-of-the-art FlexTest® digital controls, Multipurpose TestWare® software and RPC® Pro software

* Patents Pending
Multi-Purpose Bearing Test Solutions

The highly flexible MTS Multi-Purpose Bearing Test Solution accurately replicates rotor hub and blade loading for performing mechanical tests on a wide array of wind turbine bearings, including pitch, yaw and main bearing systems.

» Applications include:
  – Performance under load
  – Static deflection and stiffness measurements
  – Durability/fatigue

» Employs state-of-the-art MTS Non-Torque Loading (NTL) System to apply extreme loads in five degrees of freedom

– Highly robust and efficient design results in low cost of operation, high uptime and long life
– Rotation input via actuator or motor
– Off-axis, or non-torque, loads (3 forces, 2 moments) via MTS NTL System
– Features changeable specimen adapters for modeling hub and blade stiffness characteristics
– Allows independent programming of off-axis loads

» High-fidelity simulation and optimum test accuracy achieved with state-of-the-art FlexTest digital controls, Multipurpose TestWare software and RPC Pro software

Blade Pitch Bearing Test Solutions

Available in multiple configurations, MTS Blade Pitch Bearing Test Solutions accurately replicate blade loading (Fy, Fz and Mz) for performing mechanical tests on blade pitch bearings and blade pitch drive systems.

» Applications include:
  – Performance under load
  – Static deflection and stiffness measurement
  – Durability/fatigue

» Features changeable specimen adapters for accurately replicating a range hub and blade stiffness characteristics

» May utilize loading fixtures (shown below) or actual wind turbine components

High-fidelity simulation and optimum test accuracy ensured with state-of-the-art FlexTest digital controls, MTS FlexDAC™ data acquisition, Multipurpose TestWare software and RPC Pro software
Addressing a Full Spectrum of Wind Turbine Mechanical Testing Needs

**Blade Static Test Solutions**

MTS Blade Static Test Solutions apply tightly controlled static loading to blades for performing stiffness and strength tests required for FEM model validation and/or certification to International Electrotechnical Commission (IEC) Technical Specification 61400-23. These solutions integrate robust MTS hydraulic winch and/or linear actuation technologies to achieve coordinated loading at multiple pull points on blade.

**MTS Linear Actuator System**
- Features durable, single-ended MTS 201 actuators
- Used to apply static loading with displacements up to 15 meters
- Pulley systems can be employed to triple, double or halve displacement
- System control manifold features manual mode for setup and automatic mode for testing
- State-of-the-art FlexTest digital controllers, MTS FlexDAC data acquisition and advanced AeroPro™ software provide tightly integrated, synchronized test and simulation environment

**MTS Hydraulic Winch System**
- Combines test quality winches and articulating pulley assemblies
- Used to apply static loading with displacements greater than 15 meters
- System control manifold features manual mode for setup and automatic mode for testing

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[Diagram of Horizontal and Vertical Pull Configurations]
Blade Fatigue Test Solutions

Highly accurate MTS Blade Fatigue Test Solutions apply automated cyclic loading to full-scale blades and sub-components at resonant frequencies for meeting the fatigue testing demands of International Electrotechnical Commission (IEC) Technical Specification 61400-23. These solutions are configured to apply the necessary energy into the blade to offset damping and thus produce the desired blade bending moment per the IEC specification. The MTS offering includes two different loading solutions: the easier-to-implement and faster running GREX, which can serve as the base solution for most labs; and the compact and flexible IREX, which can function as a complimentary solution to augment lab efficiency and extend testing capabilities.

MTS GROUND RESONANCE EXCITATION (GREX) SYSTEM

- Easy-to-implement, floor-coupled load application system features versatile base and swivel design to accommodate wide variety of loading fixtures and blade angles
- Well suited for large (40+ meter) blades, including low stiffness blades where inertial based devices have reduced effectiveness*
- Extendable base options available
- Lower equipment mass added to blade affords faster testing
- Multiple GREX units can be deployed in a single test without slowing test frequency
- Integrates MTS 244 Actuators and Model 249 swivels
- Very low system maintenance requirements

MTS INERTIAL RESONANCE EXCITATION (IREX) SYSTEM

- Flexible, energy-efficient blade-mounted load application system, developed through a Cooperative Research and Development Agreement (CRADA) between the U.S. DOE’s National Renewable Energy Laboratory (NREL) and MTS Systems Corporation
- Well suited for shorter, stiffer blade specimens*
- Integrates MTS 244 Actuators, linear bearings and adjustable masses
- Performs both flap-wise and edge-wise fatigue testing; does not require change in blade orientation on reaction mass
- Performs both flap-wise and edge-wise fatigue testing; requires change in blade orientation on reaction mass
- Capable of dual-axis resonant blade testing – in combination with IREX system or additional actuator inputs
- Features automated control of test end-levels and test frequency
- State-of-the-art FlexTest digital controllers, MTS FlexDAC data acquisition, 793.86 Blade Resonance Search & Tracking software and advanced AeroPro software provide tightly integrated, synchronized test and simulation environment
- Capable of dual-axis resonant blade testing – with one or multiple IREX systems, or in combination with GREX system
- Features automated control of test end-levels and test frequency
- State-of-the-art FlexTest digital controllers, MTS FlexDAC data acquisition, 793.86 Blade Resonance Search & Tracking software and advanced AeroPro software provide tightly integrated, synchronized test and simulation environment

* Individual blade test configurations vary and are determined by a blade design’s specific geometry and properties, as well as the test laboratory’s infrastructure and equipment requirements
Seismic Simulators (Shake Tables)

MTS Seismic Simulators subject full wind turbine structures, towers and substructures to forces and motions in up to six degrees of freedom to simulate real-world earthquake conditions and perform modal testing.

» Available in custom six degree-of-freedom configurations for subjecting full structures to real earthquake conditions; special-purpose configurations for evaluating extremely large specimens that require fewer degrees of freedom; and affordable standard uniaxial and bi-axial seismic simulators for testing substructures and components in more compact laboratory environments

» Combines state-of-the-art FlexTest digital controls modified for seismic simulation and MTS Seismic Test Execution System (STEX Pro) software

Materials Test Systems

The MTS portfolio of materials testing solutions comprises a broad array of high-performance load frames, high-resolution controls, versatile MTS TestSuite™ application software and a full complement of grips, fixtures, extensometers and environmental simulation systems. Available in uniaxial and multi-axial configurations, these systems are engineered to accurately apply monotonic and/or cyclic loading to determine the mechanical properties of a variety of advanced materials, including:

» Glass fiber reinforced polymer matrix composites

» Composite materials that will be used in self-feathering blades (anisotropic properties)

» Carbon fiber composites under consideration for longer (100+ meter) turbine blades

» Advanced alloys and ceramics
State-of-the-art MTS Testing Technologies

Multipurpose TestWare (MPT) Software
MPT software features an easy-to-use “drag and drop” environment for quickly and easily building, running and reporting on complex material, component and structural tests. The MPT package includes 793.86 Blade Resonance Search & Tracking software.

AeroPro Software
Advanced AeroPro software features a tightly integrated control and data acquisition user interface, advanced control loop optimization tools, and a host of test setup utilities to streamline and accelerate complex, multi-axial structural testing.

MTS TestSuite Software
The MTS TestSuite software platform serves as the foundation for a growing set of easy-to-use material test modules for a full range of fatigue and fracture mechanics test applications.

RPC® Pro Software
World-renowned for automotive road simulation applications, powerful RPC Pro software can also be used to accurately and efficiently replicate real-world loading environments of wind turbines. State-of-the-art simulation, analysis, signal processing and system diagnostic capabilities make this package an ideal tool for pursuing hybrid simulation, which loops mechanical testing of physical systems and components into virtual wind turbine models of a wind turbines.

FlexTest Controllers
State-of-the-art FlexTest digital controllers deliver the speed and channel density required to keep pace with evolving test demands. Features particularly useful for wind turbine testing include: limit detectors, which provide the ability to initiate a controlled shutdown when user-defined limits are reached; and dual mode control, which allows the system to run in displacement control while performing tests based on the specimen acceleration or strain.

MTS FlexDAC™ 20 Data Acquisition Systems
Fast data acquisition speeds and high channel-count capabilities make new MTS FlexDAC 20 systems ideal for evaluating the behavior of complex, full-scale structures under load. High-performance FlexDAC solutions acquire data from bridge-based devices such as strain gages and load cells, as well as high-level devices such as accelerometers and thermocouples. They integrate seamlessly with FlexTest controllers to provide a truly synchronized solution that eliminates data skew and yields exceptional test accuracy.

Unrivaled Global Support
Facilities Planning
MTS fields the most experienced worldwide service, support and consulting staff of any mechanical testing solution provider. This global team can provide the facilities planning expertise required to ensure that your test laboratory is properly configured at the outset to readily accommodate all your foreseeable wind turbine testing activities. This consulting spans a wide range of considerations, including:
» Hydraulic power supply and distribution
» Foundation and strong floor design
» Floor plan efficiency
» Hose and cabling schemes
» Electrical power requirements
» Materials and equipment handling capabilities

Maximizing Uptime & Productivity
Upon facility completion, MTS will coordinate the installation and integration of test systems and train your laboratory personnel to operate them safely and efficiently. During the installation phase, MTS personnel can work with you to determine the best Routine Maintenance and Fluid Care Program plan to match the expected operation of your test equipment. Once your laboratory is fully operational, MTS lifecycle management programs can serve to maximize system uptime and productivity to help you complete test programs as quickly as possible.