October, 2010

RENK LABECO Test Systems Corporation Supports Largest Wind Turbine Test Facility with October 28th Groundbreaking at Clemson University Restoration Institute

RENK LABECO Test Systems Corporation has signed a contract with Clemson University, South Carolina, to supply two test stands for testing the large drivetrains and generators that will be used in the next generation of wind power equipment. The test rigs, capable of testing wind turbines from 5 MW to 15 MW, are at the heart of a new test facility that is part of the Clemson University Restoration Institute (CURI). The Wind Turbine Drive Train Testing Facility is being funded by a grant of $45 million from the U.S. Department of Energy, combined with $53 million in matching funds from public and private partners that include RENK LABECO. Groundbreaking for the test facility will take place October 28, 2010 on the site of a former U.S. Navy base in North Charleston, South Carolina.

The two RENK LABECO test stands are intended to provide endurance and acceptance testing for both R&D and post-assembly quality assurance.

Together with its parent company, RENK Test System GmbH of Augsburg, Germany, RENK LABECO is drawing on a long history of designing and manufacturing industrial test systems that cover a wide range of products. A long and successful history of specializing in large-vehicle gearbox testing has enabled RENK Test System to become an integral player in the emerging large wind-turbine drivetrain test arena. With this contract for Clemson University, however, RENK LABECO and RENK Test System are undertaking larger projects than either has ever tackled.

To meet the requirements of designing, manufacturing, and managing the twofold project, RENK has added personnel in both the Mooresville and the Augsburg offices. In South Carolina, the Restoration Institute has estimated that the project will result in the creation of at least 113 temporary jobs associated with construction of the test facility, as well as 21 permanent jobs. The Restoration Institute foresees the test facility as supporting the establishment of a wind energy manufacturing cluster in South Carolina.

15-MW Test Stand

The larger of the two test stands is a flexible unit that accommodates complete wind-turbine nacelles up to 15 MW, in addition to large turbine gearboxes and generators. This test stand handles wind turbine equipment rated at what is projected to be the upper limit for wind generation. (Currently, the largest wind-power equipment in production is rated at 6 MW, while at least two wind turbines capable of 10 MW are in development.)

The test rig drive unit consists of two 8,500-kW, asynchronous, water-cooled motors and an adaptation gearbox. Each motor is controlled by its own variable frequency drive and is capable of producing a nominal torque of 68 kNm at 1,200 rpm, with a maximum speed of 2,000 rpm. The motors can handle a current overload of 30% for up to 5 minutes.

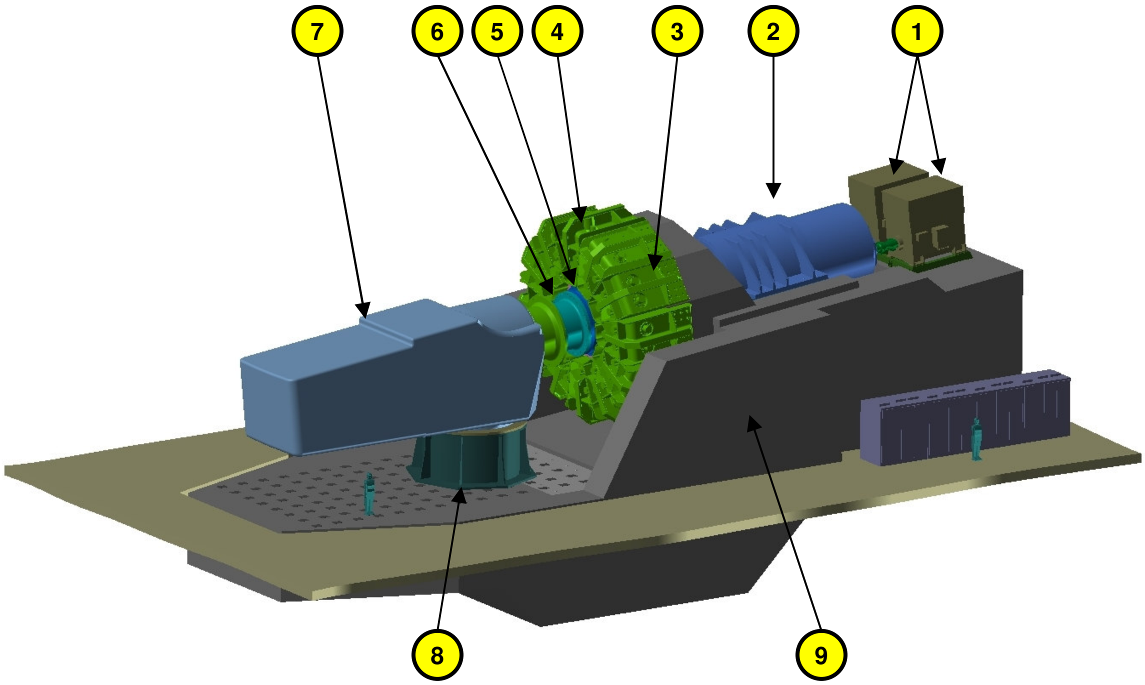

Figure 1 The 15-MW test stand configured for nacelle testing (concept)

1	8,500-kW, asynchronous, water-cooled motors (2)
2	Adaptation gearbox
3	Torsion-proof, angular-flexible coupling (hidden in drawing)
4	Load-application system
5	Force measurement system
6	Adapter shaft (customer-supplied)
7	Test specimen (shown as current unit of ~ 7.5 MW)
8	Specimen support (customer-supplied)
9	Test system frame

For testing of complete nacelles, the two drive motors are connected in parallel to an adaptation gearbox with a ratio of 120:1. Each input shaft is rated for a maximum torque of 68 kNm and a maximum speed of 2,000 rpm. The gearbox's single output shaft can handle a maximum output torque of 16,000 kNm and a maximum output speed of 17 rpm. The gearbox with its integrated lubrication system is equipped for monitoring oil and critical bearing temperatures as well as vibrations, and the gearbox's lubrication oil is water cooled.

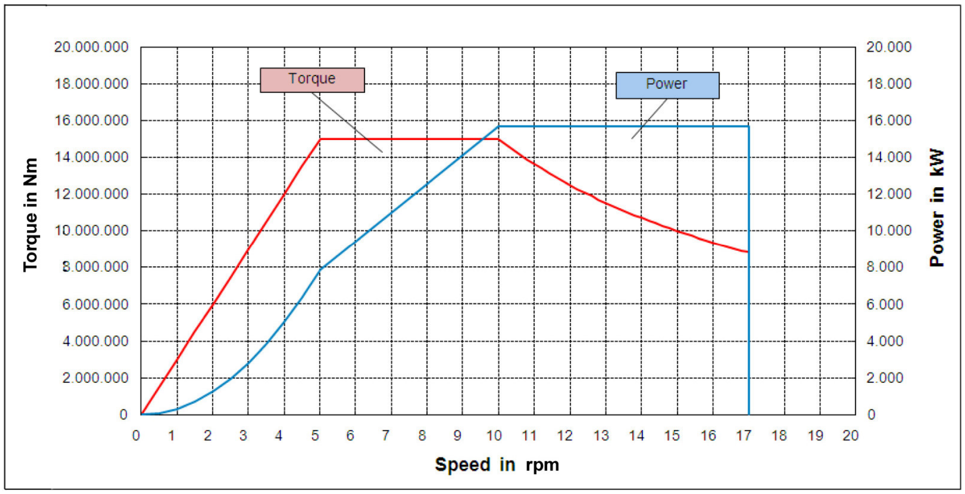

Figure 2 Drive unit of 15-MW test stand: torque and power vs speed

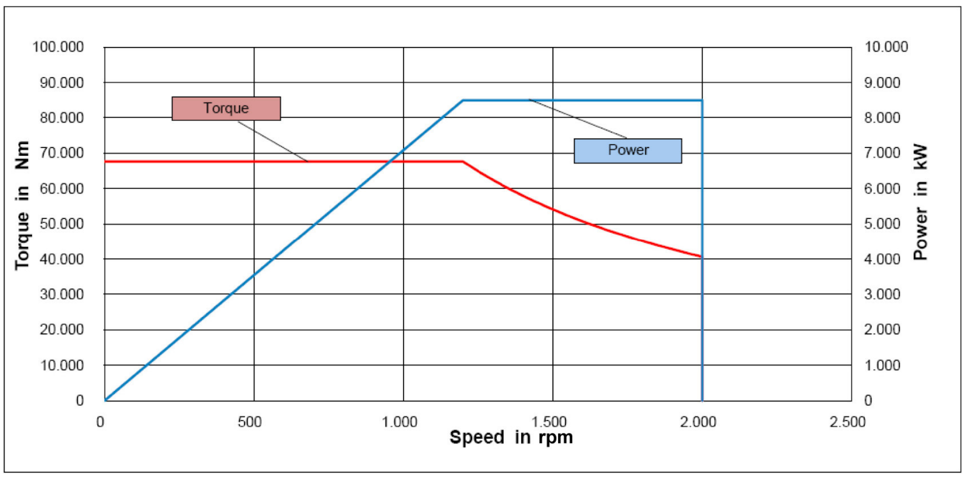

Figure 3 One 8,500 kW motor: torque and power vs speed

The adaptation gearbox uses a planetary design with a special feature to address the concern of axial motion in the drivetrain: the gear system is designed to permit the sun gear to float axially in a 60-mm range. This feature reduces tensile and compressive stresses in the drivetrain shafts, thereby extending the working lives of the shafts and, particularly, of the flexible coupling, the next component in the drivetrain.

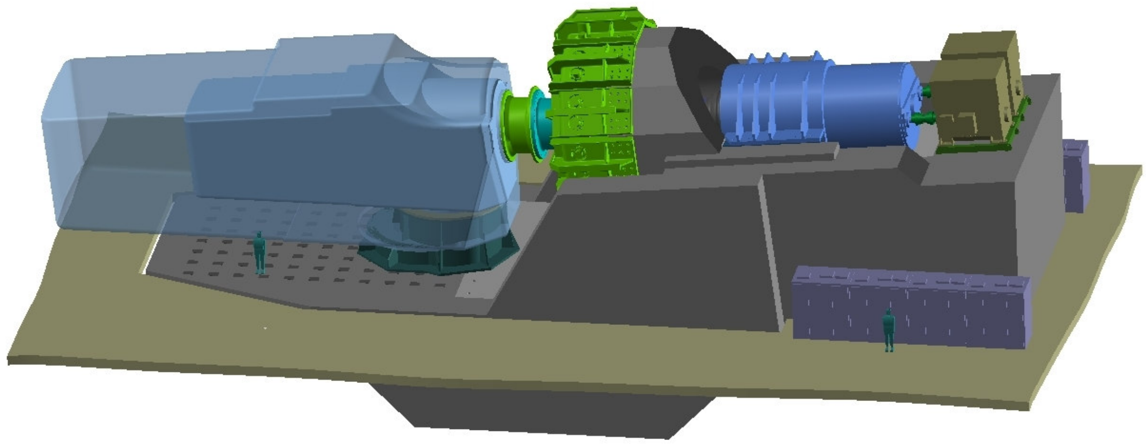

Figure 4 The 15-MW test stand with projected 15-MW nacelle superimposed on current 7.5-MW nacelle (concept)

Power out of the adaptation gearbox is transmitted via a torsion-proof, angular-flexible coupling into an enclosed, hydraulic load-application system. This system consists of a load disk mounted on the test stand's central shaft and of six hydraulic actuators that apply radial and axial loads on the disk in order to simulate forces and bending moments acting in three axes on the test specimen. A measurement system at the test stand's central shaft gathers data about the forces generated by the load-application system and inputs these data to the test-stand control system, which monitors conditions and provides control signals to the system actuators.

The load-application system is capable of a maximum axial load of ± 4,000 kN; a maximum radial load of ± 8,000 kN; a maximum rotational moment of ± 50,000 kNm; and a maximum load-application frequency of 1 Hz. Using various load frequencies and magnitudes, simulation of static and dynamic loads is possible in a range from normal, cyclical conditions to the extreme, erratic forces caused by violent winds.

A rigid adapter shaft provided by the test specimen manufacturer connects the test stand's central shaft to the test specimen, which is mounted on a specimen support that is, in turn, mounted on the test stand base frame. The 35 x 12-m base frame has been designed with the flexibility to accommodate test specimens and specimen supports in a range of sizes and configurations, ensuring that essentially any nacelle, gearbox, or generator can be tested on the CURI test stand. All components are mounted so that the centerline of the shafts has a vertical angle of 6°; this reflects the typical axis angle when the nacelle is installed on its tower.

Electrical power generated during nacelle or generator testing is fed back into the drive system via switchgear included with the test stand.

When the test stand is used to test a wind turbine gearbox, one of the test-stand drive motors is repositioned from the adaptation gearbox input to the output side of the test specimen, resulting in a closed-loop system.

7.5-MW Test Stand

The smaller test stand is a flexible unit handling gearboxes for wind turbines up to 7.5 MW. The drive unit of the 7.5-MW test stand consists of two 8,500-kW, asynchronous, water-cooled motors, with one motor serving as a driving unit and the second as a torque-load unit. Specifications of these motors are identical to those used on the big test stand: each has its own variable frequency drive, is capable of producing a nominal torque of 68 kNm at 1,200 rpm with a maximum speed of 2,000 rpm, and can handle a current overload of 30% for up to 5 minutes.

The drive motor connects to a 100:1 adaptation gearbox rated at the input side for a maximum torque of 68 kNm and a maximum speed of 2,000 rpm and at the output side for a maximum torque of 6,500 kNm and a maximum speed of 20 rpm. The gearbox has an integrated lubrication system with water cooling and is equipped for monitoring oil and critical bearing temperatures as well as vibrations. Like the adaptation gearbox on the 15-MW test stand, this gearbox boasts the feature of an axially floating sun gear to reduce stresses in the drivetrain shafts and flexible coupling.

Power out of the adaptation gearbox travels through a torsion-proof, angular-flexible coupling into an enclosed, hydraulic load-application system that is a smaller version of the unit on the larger test stand. Able to apply radial and axial loads via six hydraulic actuators, as on the larger test stand, this load-application system is capable of a maximum axial load of ± 2,000 kN; a maximum radial load of ± 2,000 kN; and a maximum rotational moment of ± 10,000 kNm. However, in contrast to the dynamic load simulation on the 15-MW test rig, load application on this test rig is static. A measurement system at the test stand's central shaft gathers data about the forces generated by the load-application system and sends this information to the test-stand control system.

The gearbox under test is connected to the test stand's central shaft via a rigid adapter shaft and is mounted on its own specimen support, which is mounted on the test stand base frame. The base frame is designed to accommodate test specimen supports of varying sizes so that a wide range of gearboxes from various manufacturers can be tested.

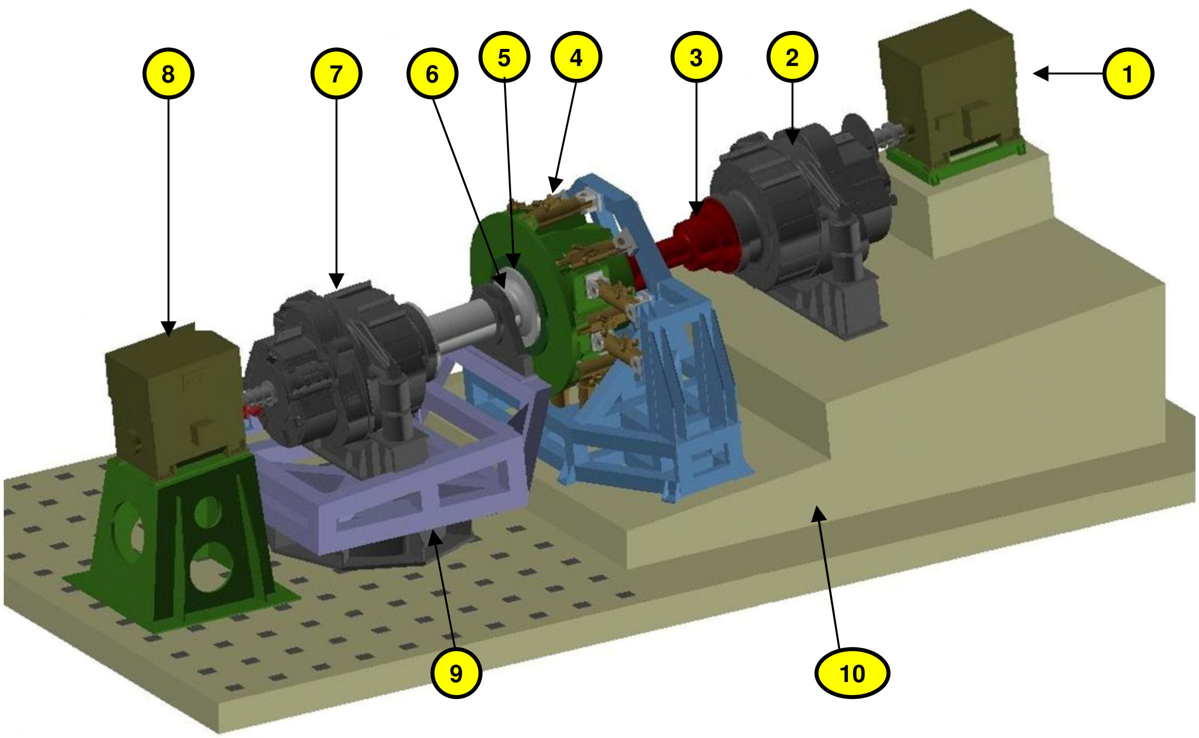

Figure 5 The 7.5-MW test stand (concept)

1	8,500-kW, asynchronous, water-cooled drive motor
2	Adaptation gearbox
3	Torsion-proof, angular-flexible coupling
4	Load-application system
5	Force measurement system
6	Adapter shaft (customer-supplied)
7	Test specimen
8	8,500-kW, asynchronous, water-cooled torque-load motor
9	Specimen support (customer-supplied)
10	Test system frame

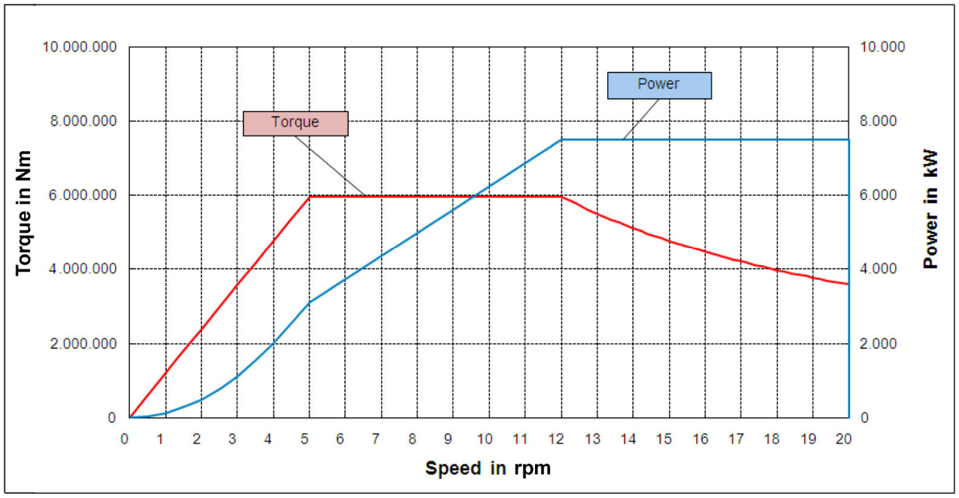

Figure 6 Drive unit of 7.5-MW test stand: torque and power vs speed

The gearbox output shaft connects to the torque-load motor. Any electrical power generated by this motor is fed back through switch gear to the drive motor.

As with the larger test stand, components on the 7.5-MW test rig are mounted so that the centerline of the shafts has a vertical angle of 6°.

Data Acquisition and Systems Control

RENK Test System's flexible Windows-based software, RENK Dynamic Data System (RDDS), is used to coordinate data acquisition, real-time monitoring, and systems control. The drive- and load-motor controllers connect to the test stand control computer, and a fieldbus system delivers data from the sensors on the various components—including motors, gearboxes, load-application system, and test specimens—to the computer, and carries signals out to component actuators. In addition, the RDDS provides real-time displays for the test stand operators, and monitors selected input data channels for potentially unsafe conditions.

Delivery of the test stands will take place in January, 2012, and the test facility is expected to be operational in the third quarter of that year.