

## NWTC Collaborative Increases Gearbox Reliability and Helps Reduce Cost of Wind Energy

A collaborative at the National Renewable Energy Laboratory's (NREL's) National Wind Technology Center (NWTC) leads to wind turbine gearbox reliability and lowers the cost of wind energy.

Gearbox failures significantly impact the cost of wind plant operations. In 2007, the NWTC initiated the Gearbox Reliability Collaborative (GRC) which follows a multipronged approach based on a collaborative of manufacturers, owners, researchers, and consultants. The project combines analysis, field testing, dynamometer testing, condition monitoring, and the development and population of a gearbox failure database. The NWTC and other GRC partners have been able to identify deficiencies in the design, testing, and operation of wind turbines that contribute to reduced gearbox reliability. In contrast to private investigations of these problems, GRC findings are quickly shared among GRC participants, including many wind turbine manufacturers and equipment suppliers. Ultimately, the findings are made public for use throughout the wind industry. This knowledge results in increased gearbox reliability and an overall reduction in the cost of wind energy.



An NWTC engineer inspects the monitoring system for a GRC study. *Photo by Joe Verrengia, NREL 16867*

GRC activities include the development of two redesigned and heavily instrumented representative gearbox designs. Field and dynamometer tests are conducted on the gearboxes to understand how selected loads and events translate into bearing and gear response. The GRC also evaluates and validates current wind turbine, gearbox, gear, and bearing analytical tools and models, develops new tools and models, and recommends improvements to design and certification standards as required. In addition, the GRC is investigating condition monitoring methods to improve turbine reliability. Gearbox deficiencies are the result of many factors, and the GRC team recommends efficient and cost-effective improvements to expand the industry knowledge base and facilitate immediate improvements in gearbox life cycle.

### Gearbox Reliability Collaborative Projects

#### Gearbox Modeling and Testing

A complete gearbox redesign was completed in an effort between NREL and industry partners. Collaborative members have initial access to non-proprietary models and test data.

#### Condition Monitoring

Gearbox condition monitoring techniques are examined during testing. Collaborative members have initial access to non-proprietary data from the condition monitoring tests.

#### Failure Database

A robust, well-populated failure database of gear and bearing condition information gathered during gearbox tests, inspections, rebuilds, and overhauls provides a summary of gearbox component faults to document root-cause analyses in a tool that identifies key failure trends. Collaborative members have initial access to non-proprietary, summary information and statistics from the failure database.

## Partner With Us

The GRC welcomes gearbox industry and research partners seeking to contribute to and benefit from our projects.

- Gearbox modeling and testing—non-proprietary testing and modeling and condition monitoring data and documentation are shared by the GRC with industry and research partners. Members of the GRC share their research results to increase knowledge and facilitate improvements in wind turbine gearbox reliability. No monetary

contributions are required to become a partner. As a condition of participation, GRC partners agree to provide modeling results and constructive feedback, not distribute GRC-provided data outside their organization, inform NREL of their intent to publish results from GRC data, and consider NREL suggestions prior to final publication.

- Condition monitoring—the GRC actively seeks industry partners to contribute condition monitoring equipment for use in the test program and makes selected test

data available to GRC partners. Such collaboration requires the establishment of a no-funds exchanged Memorandum of Understanding (MOU). Proprietary data is protected.

- Failure database—members of the Collaborative have access to summary reports and statistics across the GRC's failure database. Industry partners are actively encouraged to contribute to the failure database which protects proprietary data from individual contributors. Failure database software is available to Collaborative partners under a Non-Disclosure Agreement (NDA) with NREL. No monetary contribution is required to receive the failure database software.

## Contact

Jonathan Keller, [Jonathan.Keller@nrel.gov](mailto:Jonathan.Keller@nrel.gov)—for information on becoming a GRC member and for modeling and testing data

Shawn Sheng, [Shuangwen.Sheng@nrel.gov](mailto:Shuangwen.Sheng@nrel.gov)—for information on operations and maintenance research, the failure database, or condition monitoring data



A GRC test article in the NWTC's 2.5-megawatt dynamometer. Photo by Scott Lambert, NREL 19222



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