Wind Turbine Gearbox Reliability Collaborative

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Background

• Wind Turbine Gearboxes do not meet their design life.
• Standards and improved industry practices have helped but wind system costs are still rising.
• Failures are not specific to one machine type or application.
• NREL’s 2.5 MW dynamometer has completed most of the scheduled backlog.
• NREL/DOE will address drivetrain reliability as a significant new area for long term R&D.
Dynamometer

Background/Specifications

- 2.5 MW rated power capacity - Power regeneration at 480 volts or 4160 volts.
- Torque range 0 - 1.62 million N-m (13.5 million in-lb).
- Speed range from 0 - 2250 RPM
- 488 kN (110 kip) force capacity for dynamic shaft bending with servo-hydraulic controls.
- Fully automated SCADA torque/speed controls
Gear Reliability Collaborative Objectives

- Develop dynamometer testing capability to assess gearbox/ drivetrain problems and solutions.
- Understand how gearbox loads translate to bearing response, stress, slip, and other gearbox problems.
- Develop a more comprehensive gearbox design load case matrix.
- Evaluate and validate current drive train analytical tools.
Wind Turbine Gearbox Reliability Collaborative Organization

- **Collaborative Advisory Committee**
- **Project Management Team**
  - **Field Test Team**
    - Test plan
    - Test turbine
    - Test setup & execution
    - Data analysis
  - **Dyno Test Team**
    - Test plan
    - Test article
    - Test setup & execution
    - Data analysis
  - **Analysis Team**
    - Load cases
    - System loads
    - Internal loads

- Proprietary and/or CRADA IP Protected Data
- Public Data
- Results
Intellectual Property Protection

Participants shall not use their membership in the collaborative as a means to promote or advance litigation against other participants or potential participants.

- IP protection highest priority
- Cooperative Research and development Agreements (CRADA) can protect data brought in.
- Data exchange among members will be limited as needed.
Dynamometer Testing

- Gearbox system instrumented to measure strain, deflections, shaft displacements, and loads.
- Simulated field loading to replicate gearbox failures.
- Failure modes will be correlated with external loading.
- Root cause forensics
Dynamometer Test Envelope

Target Test Article
- 600 to 900 kW Gearbox
- Failures are representative of current fleet
- Cheaper
- Failure database established
- 3X loading possible
Test Platform Options

• V-47 – 660-kW
• NM -750 – 750 – kW
• GE 1.5 kW bedplate with rebuilt Flender gearbox. (default option)
Field Testing

• Drivetrain the same as dynamometer system.
• Tests will correlate damaging internal bearing loads with external loads.
• Forensic verification
• Field test partners wanted.
Gearbox Analysis

• Provide modeling support to the testing groups.
• Use project field data or dynamometer test data to model dynamometer test article response.
• Correlate Dyno response to turbine response.
• Use test data to gain confidence in codes.
Project Schedule

• Workshop was held at NREL July 11-12, 2006.
• Draft plan distributed September 28, 2006
• Comments, feedback, and commitments through end of 2006.
• Dynamometer testing to begin in early 2007 depending on commitments.
• Annual reviews to determine project continuation.
Project Teams Minimum Requirements

- Group with Common Purpose (preferable established working relationship)
  - Bearing Manufacturer
  - Turbine Manufacturer
  - Owner/Operator
  - Gearbox Manufacturer

- Articulated Problem

- Benefits larger Industry with basic conclusions

- Example: *Investigating response of SRB in LS planets*
Methods of Participation

- Cash is always accepted.
- In kind equipment
- In-kind labor and support
- Data, Data, Data (value negotiable)
- Minimum thresholds of participation to be determined.
Conclusions

• New collaborative to address gearbox reliability.
• Generic root causes to be addressed.
• Confidentiality top priority
• 20 year gearboxes???