

Wind Turbine Condition Monitoring at Edison Mission Energy



An EDISON INTERNATIONAL® Company



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EME Wind Turbine Fleet

- 15 monitored wind farms
 - 578 Wind Turbines
- 9 additional wind farms to tie into PI
 - 204 Wind Turbines
- 4 new wind farms to come on-line
 - 308 Wind turbines
- Total: 28 Farms; >1075 wind turbines







EME Wind Turbine Monitoring Objectives

- 1. Obtain an earlier warning on impending problems before a failure occurs
- 2. Leverage the tremendous investment in data acquisition and storage to produce actionable warnings of equipment degradation
- 3. Identify chronic and repetitive failure situations
- 4. Modify OEM inspection schedules to CBM approach
- 5. Remote monitor and apply technologies fleet-wide
- 6. Overall
 - Improve Availability
 - Reduce costs
 - Schedule Maintenance Reduce unplanned events
 - Prioritize tower inspections and analysis trouble shooting
 - Optimize crane usage





CM Technologies Applied at EME

- DCS parameter monitoring
- Oil Analysis
- Enhanced Vibration Analysis
- PdP On-Line monitoring







What's Been Accomplished

- 15 Wind Farms, >575 wind turbines, monitored by PdP
- APR technology is primary early warning indicator for WT conditions
- PdP findings transmitted to sight and OEMs for additional problem insight
- Additional multi-channel vibration diagnostic system being installed
- Improving information presentation and reporting mechanisms







The Nacelle – What's Inside the Box



Ref: Siemens SWT36107 Wind Turbine

- 1 Spinner
- 2 Spinner Bracket
- 3 Blade
- 4 Pitch Bearing
- 5 Rotor Hub
- 6 Main Bearing
- 7 Main Shaft
- 8 Gear Box
- 9 Service Crane
- **10 Brake Disc**
- **11 Coupling**
- 12 Generator
- 13 Yaw Gear
- 14 Tower
- 15 Yaw Ring
- 16 Oil Filter
- 17 Generator Fan
- 18 Canopy / Nacelle





Wind-Turbine (WT) Modeling Approach

Model Configurations

- Presently configured one model type (generic) for all WTs
 - Transitioning to 2-3 models per WT
- Models are each comprised of 12-26 real-time sensor signals
- Utilizing PMAX calculation for generating on-line power curve
- Utilizing PI-ACE to calculate a WTG efficiency

Monitoring

- PdP application server interfaced with common WT PI server
- Models processed every five minutes
- Results reported to responsible engineer and wind management persons
- Using web features for reporting findings
- Will export more PdP results to PI





PdP Catches & Anomalies

- Gearbox temperatures
- Gearbox vibrations
- Generator bearing temperatures
- Generator stator cooling
- YAW condition
- Main bearing
- Pitch control
- Nacelle temperature
- Power output
- Voltage control
- Signal anomalies from circuit card issues
- Multiple sensor issues





Unusual Load Limiting Catch

PdP identified Power Section temperature oddities

low Control Company SCIENTECH

- Additional review found similar findings on other WTs
- Review found limited WT power output, speed limitation condition
- Root problem with FSS circuit
- Impact calculated at >\$250K lost revenue









Generator Cooling Catches

- PdP identified NDE increasing Generator bearing temps, intermittent then more regular (A)
- Other Generators experiencing similar condition (B)
- Found cooling valve problem with Generator cooling system







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Gearbox Bearing Temp Catch

- PdP identified an elevated & increasing Gearbox temperature
- Inspection found cooling fan not running
- No operator indication
- Gear damage avoided (big \$\$)







Nacelle & Generator Slip Ring Temp Catches

- PdP identified temperature step change for Generator slip ring; and Nacelle temps
- OEM inspection found problem with a run control switch for cooling fan
- Switch replaced, temp back to normal











Blade Pitch Drive Cooling Fan Catch

- Abnormal pitch drive temperatures observed
- Found drive for cooling fan seized
- 2nd time in 2weeks time
- Other WTs have had similar situations
- Prevented excessive downtime; fixed in evening on available down-time







Blade Pitch Voltage Control Catch -2

- PdP identified 'B' Pitch Voltage change
- Found control voltage was drifting low
- Problem traced to the battery backed voltage control system
- Other similar situations found
- Critical element for blade
 braking







Blade Pitch Voltage Control Catch -3

- PdP identified 'A' Pitch Voltage changes
- Found blade pitch drive to have problem of irregular voltage control
- Verified OEM part problem
- Critical element for blade
 braking







What's Next

- More wind farms & more wind turbines due to come on line
- Dealing with OEM maintenance contract expirations
- Upgrading PI & supporting servers and more information integration
- Moving towards more extended wind fleet monitoring
- Optimize PdP models and continue to utilize Scientech services











The secret of success is constancy of purpose.

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