EU Consortium ReliaWind Chooses Relex Software

Relex Software Was Chosen to Analyze Wind Turbine Reliability and Help Increase Renewable Energy in the EU

Reliawind Consortium, EU

The ReliaWind consortium is made up of ten industry and academic leaders – including Gamesa, a Spanish wind turbine producer; Iberdola, a wind farm operator; Garrad Hassan, a wind energy consultant; and Durham University, an academic consultant. Convened in March 2007 to face a threefold challenge outlined by the European Union Council of Ministers – meet increasing energy demands, promote a cleaner environment, and ensure the security of its energy supply – ReliaWind chose Relex software to help analyze and improve the reliability and maintainability of offshore wind turbines used to generate renewable energy.

The Goal: Reduce the EU's Contribution to Climate Change

- Renewable energy will cover up to 20% of energy demand by 2020
- Energy efficiency will improve 20% by 2020
- Carbon dioxide emissions will be cut 20% by 2020

The Challenge: Overcoming Obstacles to Using Wind Turbines

- Maximize the advantages offered by offshore turbine
- Meet the increased maintenance demands of offshore turbines
- Establish reliability and maintainability benchmarks and models

The Solution: Relex Software Is Selected as an Analysis Tool

- Key Relex modules offer the analysis tools to “Design for Reliability”
- “Design for Reliability can” change how wind turbines are developed
- More reliable turbines offer lower costs to operate and maintain

ReliaWind, a consortium of 10 EU contributors in the field of wind power, selected Relex software for the important task of analyzing and improving the reliability and maintainability of offshore wind turbine technology.

The EU Council of Ministers, held in March 2007, declared that “renewable energy will cover at least 20% of the EU’s energy demand by 2020.” Wind power can make the most important contribution to these targets if sufficient emphasis is established on technological research and development and market development. Offshore wind energy is called to play a key role.

The Case

Due to goals promoted by the European Union Council of Ministers to improve renewable energy resources, reduce the EU's contribution to climate change, meet rising energy demands, and ensure the security of its energy supply, ten organizations vital to the improvement of wind turbine technology throughout the EU formed the consortium ReliaWind. Manufacturers, power companies, independent consultants, and university contributors from seven countries throughout the EU set goals to analyze and improve the reliability and maintainability of offshore wind turbines in order to contribute more renewable energy to the EU by the year 2020. Determined to improve the way offshore wind turbines are designed, built, and maintained, and to educate other organizations about their findings, ReliaWind hopes their research will begin impacting construction of new turbines from 2015 forward.

The Advantages of Offshore Wind Turbine Technology

Offshore wind turbines offer many advantages over land-based wind farms, but can be more expensive to maintain. ReliaWind was established with the goal of offsetting this paradigm, allowing offshore wind power to be deployed with costs similar to onshore solutions. The advantages of offshore wind turbines include:

- Offshore winds exhibit a type of flow that improves turbine efficiency and decreases maintenance costs
- Offshore wind farms can be developed nearby large population grids, allowing the use of shorter lines for power transmission
- A greater variety of wind patterns offshore create more consistent wind turbulence than is available onshore
- Offshore winds tend to increase during the day when the demand for power is greatest
- Many countries throughout the EU don't have suitable sites for land-based wind farms
- Environmental impact on bird species is reduced by offshore installations

Challenges: Overcoming the Reliability Challenges

As advantageous as offshore installations are, they also present environmental and access challenges, including the following:

- Offshore winds require sturdier, more durable designs for blades, masts, and other components
- Increased corrosion on both surface and interior parts requires more rigorous anti-corrosion and water sealing technologies
- Preventive maintenance must be as automated as possible to increase service intervals due to the difficulty and cost of access

As advantageous as offshore wind turbine installations are, they present additional reliability challenges, including the need for more a robust design, increased anti-corrosion and water sealing, and more demanding preventive maintenance.

Goals: Why Relex Was Selected

Ambitious reliability goals were set for this project, including:

- A 20 percent improvement in MTBF (mean time between failures) in offshore turbines and a 10 percent improvement in onshore turbines
- A 50 percent reduction in MTTR (mean time to repair) for offshore and 20 percent for onshore turbines
- A boost in availability to between 97 to 98 percent from a previous range of 85 to 90 percent for offshore, and to 98 or 99 percent from 97 to 98 percent for onshore

Methodology: How the Analysis Will Be Completed

Methodology was established to analyze current system metrics and discover ways to improve the design of wind turbines and to positively impact future metrics.

1. Failure and service data from existing turbines will be gathered from partner organizations, standardized, and logged to identify faults contributing to failures and to trend energy production to track any inconsistencies in units
2. Failure rates and repair times will be quantified from existing systems at the component, subsystem, and system levels, considering four main categories: manual restart, minor repair, major repair, and major replacement
3. Reliability block diagrams will be used to model complex system relationships for each functional subsystem, integrating contributed data from all partners to calculate reliability metrics such as availability, unavailability, MTBF, failure rate, expected number of failures, mean unavailability, total downtime, failure frequency, and hazard rate

"Due to its advantages and compatibility with the ... ReliaWind project, Relex can be used not only for the FMEA but also for reliability prediction, reliability block diagram (RBD), Fault Tree, and Markov modeling, which are all suitable for wind turbine reliability studies."
– Hooman Arabian and Peter Tavner, Durham University

The Results

Key Relex modules each played a unique part in the analysis process, as described below:

Relex Reliability Prediction

- **What is it?** To predict the reliability of a system, it is necessary to first define the system and all of its component parts.
- **How was it used?** The Reliawind project began by dividing the turbine into 12 separate subassemblies, and dividing these further into their component modules, parts, and units. It was determined that the reliability prediction for the turbine and its component systems and subsystems would be based on the Parts Stress Method MIL-HDBK-217F. This international standard, which is included with and built into Relex Reliability Prediction, provides procedures for calculating failure rates from information about component parts. This data includes stress data, quality information, temperature, and environmental factors. Calculations for each component part is completed based on standard equations, and overall system failure rate is determined by adding up all of the component failure rates.

Relex OpSim (Optimization and Simulation)

- **What is it?** A reliability block diagram (RBD) created in Relex OpSim combines a visual representation of complex systems with calculation tools used to analyze their reliability and availability, even for complex systems that include parallel and series redundancies.
- **How was it used?** It was determined that, for each identified function of the wind turbine system, a reliability block diagram would be developed to represent parallel redundancies, series redundancies, or a combination of the two redundancies depending upon the complexity of each system.

Relex FMEA

- **What is it?** A FMEA, or Failure Mode and Effects Analysis, is a bottom-up approach to analyzing system design and performance. It proceeds by identifying all potential failure modes of the system, and it is used to determine the end effect of every potential failure mode and analyze the criticality of each failure effect.
- **How was it used?** It was determined that a piece part FMECA, which starts from the components level and includes a consideration of the criticality of each failure, would be performed according to MIL-STD-1629: a long-recognized standard used by government, military, and commercial organizations worldwide for the calculation of criticality and the ranking of failure modes based on severity classifications. This standard is included with and built into Relex FMEA.

Relex Fault Tree

- **What is it?** A fault tree analysis provides useful information about the likelihood of a failure occurring and the means by which it could occur. Often completed after a preliminary hazard analysis or a FMEA, the results of a fault tree analysis can help focus and refine design efforts to improve system safety.
- **How was it used?** Fault tree analysis was determined to be important throughout the "Design for Reliability" of the new wind turbines: a fault tree analysis of existing turbine systems would assist in building a body of data representing how wind turbines operate and how they are most likely to fail. It was also determined that fault tree models would be used to measure improvements in early production units.

Conclusion

The benefits of a fully integrated reliability analysis solution like Relex stem from the ability to use a single source of data across multiple analysis tools. In addition to eliminating the error-prone, time-intensive process of redundant data entry, legacy information can be used to support new system designs and provide real-world results for use in reliability prediction calculations. And when system metrics are calculated, they can be used as input for one of the two complementary risk analysis types–FMEA and Fault Tree–to quantify the probability and severity of system risks in which part failure is a contributing factor. A fully integrated analysis using multiple Relex modules considers multiple dimensions of system reliability simultaneously, saving time and streamlining analysis activities.

For More Information

For more information about Relex and each of the software modules used in this analysis, please visit **www.relex.com/products.**