Wind Farm Visit

Meeting Date: Wednesday, November 14, 2008 from 8:45 to 10:15
Meet with: Wind Farm O&M Manager
Attended: Samad Erogbogbo, Earl Fairall, Richard Ike, Mithon Michael, Viral Patel, Don Ruffatto
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General Overview

The wind farm we visited is a $700-million dollar project that will be built in several phases and eventually span 25,000 acres of farm land. The final project will consist of 233 General Electric 1.5 MW wind turbines sited about 2500 feet apart for a total project capacity of 350 MW. Currently there were 66 turbines operational, which just came online in October 2008. The site is located adjacent to a nuclear power plant which provides some power transmission advantages. The owner is both the developer and operator of the wind farm and also owns others across the country, most notably multiple sites in western Texas. Their general business plan includes trying to standardize the size and type of the wind turbines that they use in their wind farms which in this case is the GE 1.5 MW turbine. This is so that common components and maintenance practices can be used across all of the wind farms that they operate.

Sub-Station

The substations job is to collect power from multiple wind turbines and to combine it and providing circuit breaker protection. The breaker and the sub-station in general requires little maintenance beyond periodic cleaning as break down are relatively rare. Most of the maintenance done on the substation is therefore scheduled, allowing it to be performed during time periods of low power production.

Turbine Information

The GE 1.5 MW wind turbine used by the wind farm owner has a 253-foot tower sporting a 143-foot blade leading to a height of 405 feet at its peak. The rotor generally rotates at between 10-20 rpm which does not sound very fast but corresponds to around 10 to 20 mph at the tip of the blade. This is then run through gearbox which increases the rotational speed and feeds a 575V asynchronous AC generator. This power is then feed to a transformer at the base of the tower which steps up the voltage to 34500V and then sends it to the power sub-station. We went into the base of the wind turbines tower which is set up for easy access. Inside there were several racks of electronic equipment which included a workstation with a monitor and keyboard. The workstation allowed access to a variety of different monitored variables used by the wind turbine to intelligently start up and shut down based on wind conditions. While we were there the wind speed was very close the turbines cut-in speed which caused it to start up and shut down several times. When the rotor was active it made a very audible "whooshing" sound as the tip passed by. When the turbine tried to generate power the electronic equipment came on (cooling fans and transformer hum) and it was too loud to talk while inside the base of the tower, maybe on the order of 70-80 DbA (estimate).

GE Warranty

The warranty for the GE turbines lasts for two years and covers both electrical and mechanical problems. It was noted that the wind farm owner/operator preferred to replace most of the smaller components themselves and have GE pay for the cost of the component. This was so that their technicians could acquire experience in the field. Larger failures such as a generator they would be replaced by GE during the warranty period although they would have there technicians observe and assist, again to gain experience in the field. This focus on gaining experience is so that once the warranty period runs out the wind farm personal would be about tackle even the larger repairs themselves. Our tour guide stressed that they are in both the business of owning and operating the wind farms themselves.

Maintenance Procedures

We did not climb up the tower but for human access there is simply a latter. It was stated that it generally takes 5 to 10 minutes to climb to the nacelle and catch your breath. There is also a service host that has the capability to carry up to 250 kg which is used to carry up smaller replacement parts and tools when needed. Replacement parts that are larger than 250 kg require an external crane in the form of either a "truckable" or crawler crane. A "truckable" crane is the smaller of the two and much cheaper to rent due to it simply being integrated into a transport truck. Most notably it was mentioned that basically anything that does not require the removal of the rotor, such as the pitch control motors, can be replaced with this type of crane. Anything that does require the removal of the rotor needs a much larger crawler crane. These are very expensive as they need to be transported as components (it requires upwards of 30 trucks just to deliver one of these cranes) and assembled "on site". It costs $150000 just to get the crane "on site", it then costs $9000/day to just to let the crane sit or $32000 per day if it is in use and then it costs another $150000 to get the crane "off site". Two crawler cranes that were mentioned were the Manitowoc 16000 ton and Lieherr. It was also noted that planned crane time is much less expensive than emergency crane time which is charged at "time and material".

GE initially provided them with a list of recommended maintenance parts to be locally stocked which amounted to over a million dollars. As their experience grew though they indicated that they have cut that list down and sent many of the expensive parts which are rarely used to a central storage location. Interestingly it was indicated that around 80-90% of the routine maintenance performed on the turbines are mechanical in nature while 80-90% of the reactive maintenance is electrical in nature. As a good example we were shown a burnt out DC power supply unit (PSU) that powers some of the electronics in the base of the wind turbine. This was a relatively simple problem as he said most of the electrical issues are and just required the PSU to be swapped out with a new unit. He estimated as little as 30 minutes of down time for most failures if they are "down tower" but over an hour if it is "up tower". The point was stressed that they are very interested in trying to become more predictive of problems rather than reactive to problem that have already occurred.

At the end of the tour we were shown the GE monitoring screen which is accessible in both the base of the wind turbine and on central computer in their offices. This monitoring screen allows the user to view a multitude of sensor statuses and diagnostic outputs. When this is a problem it is flagged and the diagnostic goes "red". At the time with saw the monitoring screen there were 22 turbines shown as being active, 22 being inactive (presumably due to lack of wind) and 22 showing "red". Most of those "red" statuses were indicated to be "nuisance faults" and they really did not like them. He mentioned that most of the "nuisance faults" that they encounter are due to the blades not adjusting their pitch at a high enough rate which causes the status signal to be triggered. This normally happened in low wind conditions when the turbines sometimes sit inactive for long periods of time. They are able to correct this problem right from the central computer we they can run the blade through 90 degrees of pitch movement and reset the system remotely.

List of Sensory Data (Main)

Parameter	***Comments***
Temperature	The computer was able to receive temperature data on the inside/outside of the turbine, bearing temperature, hydraulic fluid temperature and possibly others.
Pressure	Hydraulic pressure readings.
Speed	It was explicitly stated that the computer displayed the wind speed but other it was probably recorded for other items as well.
Angular Acceleration	The computer was able to display the angular acceleration of different rotational component, specifically the rotors, to make sure that they stayed within set parameters.
Torque	A measurement of how much torque is being applied on the input shaft.
Rotor Pitch	A measurement of what pitch the rotor blades are set at (how much they are pitched into the wind).
Yaw Angle	Angle at which the nacelle is pointing.
Voltages	Used for over/under voltage protection.
Frequency	Frequency of the electricity being produced (60 Hz in North America, 50 Hz in Europe).
Power	Energy currently being produced by the wind turbine.
Cut-In Speed	Wind speed at which the turbine begins to try and produce electricity.
Cut-Out Speed	Wind speed at which the turbine pitches its blades out of the wind so as to not damage the internal mechanical component due to excessive wind speeds.
Tower Vibration	They measure the tower vibration in case one of the rotational components becomes misbalanced due to damage or any other factors.