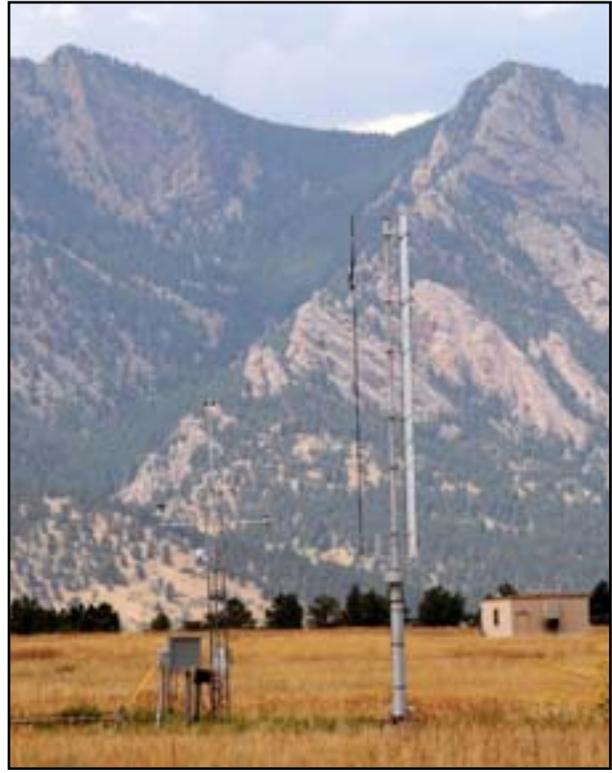


Mariah Windspire Project Summary

As part of the National Renewable Energy Laboratory and U.S. Department of Energy (NREL/DOE) Independent Testing project (<http://www.nrel.gov/wind/>), NREL was testing Mariah Power's Windspire Giromill small wind turbine at the National Wind Technology Center (NWTC) through January 14, 2009 when NREL terminated its testing.

The full suite of tests will not be completed on the Mariah Windspire. The turbine experienced several problems as listed below. For more information about the suite of tests, please see the Small Wind Turbine Independent Testing Web site at http://www.nrel.gov/wind/smallwind/independent_testing.html

The Windspire is a 1.2-kW vertical-axis small wind turbine. The turbine tower is 9.1 meters tall, and its rotor area is 1.2 x 6.1 meters. The turbine has a permanent-magnet generator with a single-phase output at 120 volts AC.



Notable events:

- 5/5/08 The turbine was fully installed and operational. The turbine was installed without the inverter on March 17, 2008. The inverter was not installed until May 5, 2008.
- 5/9/08 Two screws were found missing at the top of the turbine where the ring attaches to the airfoil. The tower base bolts/nuts were retightened/loosened and marked to show alignment.
- 6/12/08 The inverter parameters were changed to increase output at rated levels from 1,000 watts to 1,100 watts.
- 6/23/08 The testing team found two loose bolts at the tower base. The nuts were retightened and remarked, and a small adjustment was made to vertical.
- 7/21/08 Routine inspection found a noise emanating from the turbine, a broken washer, loose nuts, and movement in the base tower plate.

7/30/08



While the leading edge tape was being replaced (due to detachment), a broken weld was found at the top of the turbine and another crack was observed on a different weld. Initially, the welding was done in two spots per airfoil side. The airfoils also slid out of the struts that are supposed to clamp them. This may have caused the broken weld. The turbine was visibly wobbling and was tilted down.

8/7/08

The manufacturer was on-site to replace the airfoils and struts. This is a change that will be required for all production machines. The tower base bolts were replaced with bolts with set screws to keep bolts from loosening. The weld was improved to a continuous weld.

8/18/08

The magnetic bearing was replaced. The initial magnetic bearings did not have a dust cover and were susceptible to iron dust getting into the magnetic air gap, which can stop operation of the turbine.

9/13/08



The inverter failure occurred because the set points of the inverter were set to optimize power performance. The increased performance caused the temperature to rise, and over time, caused the inverter to fail. The inverter was replaced. The set points were set for normal production.

10/7/08

The power performance test was stopped because the inverter failed. The test was not completed because the wind speed range requirement was not fulfilled/met. A new power performance test was started after the inverter was replaced.

10/14/08

Mariah informed us that: “the welding of the top shaft has not been stress relieved properly and has a heat affected zone that has reduced strength and fatigue life below the design.” Based on the findings from an accelerated life test conducted at the Mariah facility, Mariah requested that the testing team stop and/or lower the turbine in winds above 40 mph until a fix could be implemented, The fix is not expected until January 2009.

The testing team complied with Mariah’s request. However, they decided to terminate duration testing because the turbine did not meet the operation requirements. The testing team decided to continue power performance and noise testing.

10/21/08

The testing team confirmed that the turbine does not shut down in high winds.

10/30/08

The testing team found three loose nuts at the base of the tower. The nuts were tightened per Mariah’s direction.

11/19/08



Two out of three airfoils slid down through the struts. In the picture, the black markings show where the airfoils used to be.

12/16/08



During the noise testing, a clanging sound emanated from the turbine. The testing team found two broken welds at the top of the turbine. The turbine was shut down until further notice. This photo shows one of the broken welds that caused the airfoil to separate from its end plate. However, the airfoil did not completely separate as it did in the previous occurrence.

1/14/09



The testing team checked the turbine after it observed possible higher rotational speeds while the turbine was shut off. Measurements that were taken to check for generator continuity were varied when they should have been less than 5 ohms. The team found that two of the three wires from the generator were missing insulation and bare wire was exposed. There was no noticeable difference in resistance when force was applied while the generator was connected or not.

The turbine was lowered.

Testing
Update

Noise data was not collected.

Duration testing was terminated in October 2008.

The safety and function test was mostly completed and a report will be written with exceptions.

Power performance data collection for the two inverters were almost completed, the last required wind speed bin was not filled. A test report will be written with exceptions.