WIND TURBINE OPERATION STRATEGY UNDER EXTREME WIND CONDITION

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ABSTRACT

Wind energy development in Taiwan started by three demo wind farms in Yunlin, Penghu, and Chupei which are promoted and subsidized by government around 2000. Since then, over 600 MW capacities have been installed in 15 years, which are equivalent to 300 more 2 MW wind turbines, each with 60 more meters height. Taiwan's plenty wind resource also the important reason for wind power development. An offshore wind farm promotion project is ongoing by government so to solve the very limited onshore location for wind turbine installation [1].

However, the special weather condition Typhoon passing Taiwan frequently and causing serious damage to buildings, farms, and structures. This kind of weather condition, normally called Tropical Cyclone also happened a lot in Asian countries like Japan, China, and Korea. The load effect that a Typhoon will exert to a wind turbine can be very different compare to other wind conditions.

It's also well known that design guidelines for wind turbine have been published for years. These guidelines were established not only by IEC (International Electrotechnical Committee) experts' domain knowledge but also their operation experiences in Europe and U.S, especially. It can provide good references for manufacturers to design a turbine structure that can sustain various normal and extreme wind conditions so as to be operated more than 20 years under some specific fatigue load combinations call DLCs (Design Load Cases) [2]. It should be noted that little experience from Typhoon has been considered into the guidelines. This makes turbines in Taiwan maybe exposed to a very dangerous operation condition. The fact is that many crash or fall down events of turbines happened in Japan, China, and Taiwan. All these events shown the turbine may not strong enough to resist the force by Typhoons. [3].

This article tried to figure out the load condition under a Typhoon so as to evaluate a better operation strategy to protect the wind turbine for extreme weather. In this research, the turbine is a normal 2 MW turbine, with 3 pitch regulated blades and an auto yawing system for nacelle to face the wind direction. And the wind profile as the input to the wind turbine structure is shown in Figure 1. This gusty wind starts with 45 m/s, then reaches a 56 m/s high wind speed during 10 s to 15 s. And the wind direction will came from different angles to see the load variation. Because the blade should be fixed at a safe position to prevent the rotor running. The extreme load to be examined is the moment of the blade pitching axis.

The simulation result by Bladed software [4] shows that under some specific wind directions, the Z-axis moment of the is 5 times more than the normal wind direction comes directly to the rotor surfaces. As shown in Figure 2, six different wind directions, 35, 180, 185, 215, 355, and 360 degree were performed to obeserve the M_z of the blade. Its obviously that the wind came from South (185 degree) shows a -80 kNm moment compare to a -15 kNm from North direction (360 degree). The result can be verified on the assumption of an asymmetric shape of the blade section. When the wind came from the trailing edge of the

blade, the distance to the fulcrum is much longer than the wind came from the leading edge. This makes the output moment much bigger than normal condition. It can be concluded that under this extreme Typhoon wind condition, if the yawing system can't rotate the nacelle to the right direction, the wind turbine will face a very dangerous parking condition. Of course, this article only gives an brief idea on this topic. Further survey, calculation and analysis will be addressed when detailed turbine design and blade geometry.

Keywords: Wind Turbine, Operation Strategy, Extreme Wind

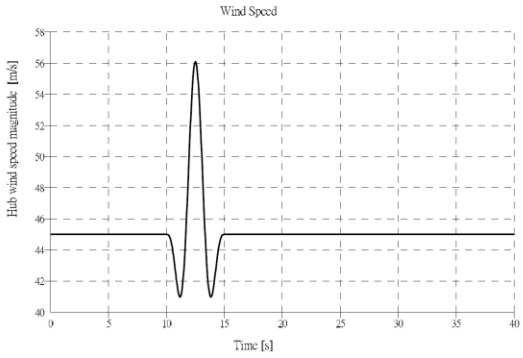

Figure 1 Design Wind Speed Profile

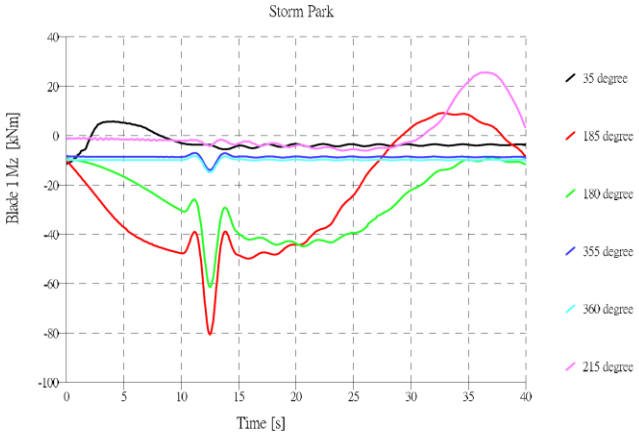

Figure 2 Blade Load M_z by Different Yaw misalignment (degree)

REFERENCES

[1] Thousand Wind Turbines Project, Bureau of Energy, "Statistics of Wind Power Promotion Status in Taiwan", Website Information, http://www.twtpo.org.tw/eng/Home/, last visit 28th, Sep., 2015.
[2] IEC, "IEC 61400-1-am1 ed3.0, Amendment 1 - Wind turbines - Part 1: Design requirements", International standard of IEC publication, 2010.
[3] Jui-Hung Liu, "Design Parameters for Tropical Cyclone Sites in International Wind Turbine Design Requirement ", Annual Conference of TWNWEA, 5th, Dec., 2013.
[4] DNV GL, "Bladed User Manual", 2008.