SOME EXTEMPORANEOUS COMMENTS ON OUR EXPERIENCES WITH TOWERS FOR WIND GENERATORS

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The supporting tower of a wind generator is subjected to various forces, the dominant ones being the horizontal component of the rotating machine (horizontal or vertical axes) plus the horizontal force of the wind. Also, because the wind is usually fluctuating in time, the tower is subjected to vibratory forces and hence fatigue forces. Hence, a tower must be designed to withstand the fatigue forces imposed on it.

Another important design consideration is that caused by high winds and gusting. Heavy gusts cause little trouble with fast rotating rotors that have high tip to wind speed ratios because the rotor blades are stalled and the forces on the blades do not increase. The more serious danger is that of overspeeding of the rotor which could destroy the machine. Hence, the structural integrity of the tower is dependent not only on the strength of the tower, but also on the regulating systems. If the regulating systems are not foolproof, the tower will be destroyed even if it is 10 times stronger than it should be. Finally, the regulating system has a great influence on the cost of the plant because of the influence on the cost of the tower. Thus, it is essential that all possible accidents be considered and that fail-safe controls be incorporated into the plant.

Another important force is imposed on the tower by the rotor. If the rotor is located upwind of the tower, the wake of the passing rotor blades causes a change in the wind forces on the tower. Thus, the tower is subjected to pulsating forces caused by the passing blades. If the rotor is situated downwind of the tower, the vibrations on the tower are drastically reduced, but the blades are subjected to vibratory forces because they pass through the tower wake. Given a choice of failures, it would be less catastrophic for a blade to fail than for the tower to fail.

The last important question considered concerns the height of the tower. The wind velocity increases with height according to a power law where the velocity is proportional to the height raised to a power, say 1/7 (the exponent depends on the ground roughness, among other factors). The optimum tower height depends on the cost of the energy to the customer because an increase in height results in an increase in the cost of the plant, which, in turn, offsets the increased energy output. My studies of this question suggest that the costs are minimum for the shortest tower and that, since the energy extracted varies as the square of the rotor diameter, the rotor should be as large as possible.