INTERFERENCE TO TELEVISION RECPETION CAUSED BY LARGE WIND TURBINES

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SUMMARY

Since 1976 the Radiation Laboratory, under sponsorship from the U.S. Department of Energy, has been investigating the effects of large wind turbines (WTs) or windmills on the performances of a variety of electromagnetic systems. In particular, electromagnetic interference effects to television (TV) reception caused by large horizontal axis wind turbines (HAWTs) have been identified and quantified by comprehensive theoretical and experimental (laboratory and on-site) studies. The present paper summarizes our investigation to date of the problem of television interference (TVI) produced by a large HAWT.

To a TV receiver in the vicinity of a WT, the rotating blades act as a time varying multipath source. Theoretical considerations of the electromagnetic scattering from idealized model of a WT blade showed that the rotating blades can pulse amplitude modulate the total signal received in its vicinity, and a simple signal analysis of the basic detection process of a TV receiver indicated that such extraneous modulation, is sufficiently strong, could produce video but not audio distortion on reception. The distortion itself manifests in the form of horizontal jittering (when the received is in the backscattering

region of the WT) or intensity fluctuation (when the receiver is in the forward scattering region of the WT) of the entire received picture, at a frequency equal to twice the rotation frequency of the blades. In the case of strong interference, the TV receiver may lose its vertical sync resulting in complete picture break-up.

Our laboratory tests established a modulation threshold defined as the largest value of the amplitude modulation index (m) of the received signal for which the resulting video distortion was still judged acceptable for short periods of viewing. The threshold value of $m = m_0 \simeq 0.15$ has been found to be substantially independent of the ambient signal strengths and the receiver used.

Using the above modulation threshold, the scattering behavior of the blades and rigorous diffraction theory of propagation of radio waves over a spherical and smooth earth, a method has been developed to determine the interference region about a WT for any given transmitter, and the results were in good agreement with those obtained from on-site measurements using operational WT. The interference distance generally increases with the frequency of the TV Channel.

The paper will be highlighted by the results of a recent on-site TVI measurements using the locally available commercial TV signals as the RF sources and a large HAWT, referred to as the MOD-1 WT which is a two-bladed machine located on top of a 43 m tall steel tower and whose two steel blades are about 61 m from tip-to-tip. The rated power output of the machine is 2 MW and is achieved at a rated rotor speed of 35 rpm in a 25 mph wind. In the vicinity of the MOD-1 WT, varying amounts of TVI were observed on all of the available VHF

and UHF TV Channels. It appears that unacceptable forward region interference on Channel 5 could extend up to 5 km from the WT.

Theoretical techniques and measurement procedure required for WT-interference studies, selected results and their implication with regard to proper siting of a WT having minimal impact on the TV reception in its vicinity will be discussed.