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WHITE PAPER

WIND FARMS AND THEIR EFFECTS ON PUBLIC SAFETY RADIO SYSTEMS

Revised February 24, 2005

SUMMARY OF WHITE PAPER:

In many parts of the country, wind farms are being installed to alleviate the need to build more electrical generating plants. These wind farms can have a profound effect on your public safety, utility, and governmental microwave systems by chopping and reflecting the microwave beam. .

WHAT YOU SHOULD DO:

Notify your city and county zoning authority that any application for a wind farm can profoundly affect your emergency communications system and a design review focused on the wind farm's effects on critical communication systems.

BACK GROUND:

As a source for renewable energy, wind farms are being installed throughout the upper Midwest. Being subsidized by the US Government heightens the interest of entrepreneurs in building these for profit. Some wind farms contain hundreds of windmills. One of the biggest is on Buffalo Ridge between Marshall and Pipestone, Minnesota. Other large farms are northwest of Mason City, Iowa near Joice and northwest of Algoma, WI. The largest of the windmills and farms are in the western US.

The zoning laws of each state vary based on the generating size of the group of windmills, called a wind farm. Below a certain size in generating capacity, local city and county planning and zoning regulate these farms. Above a megawatt threshold, the state enters the picture especially in Minnesota.

Wind farms have their down side that is often overlooked by champions looking for clean renewable energy and profits.

1. Windmills have aviation hazard flashing beacons displaying a flashing light display. Some are set in a sequence to flash together or individually as a marquee across the farm. Because most windmills are above 201 feet, the Federal Aviation Administration dictates they be marked as an aviation hazard. The hazard beacon can be red at nighttime, medium intensity white strobe lights used in daytime (sometimes at night), or a combination of both.
2. The metallic blades chop and reflect certain types of radio signals ruining the continuity of the communications circuit. This is the subject of this paper.

The attached drawing, WIND-01 Figure 1 shows the drawing of a typical windmill. They consist of a metal pole, a wind generator mounted atop the pole, and a 100 foot tri-blade. Because the installation is all-metal, radio signals passing through the windmill are reflected or blocked. Worse yet, the moving blades cause the signal to be chopped. Think of trying to shine a flashlight through an oscillating fan. The once steady light passing blades becomes pulsed on the wall behind the fan.

On television sets of homeowners in or near the wind farm, the viewer will see their TV picture as a high-speed flicker as the blades pass through the signals. This is especially bad where the homeowner is trying to pull TV signals from 30-60 miles away. This will worsen as the country switches to high definition television (HDTV) because that signal is a synchronized computer bit stream not the present and much more forgiving analog signal.

With microwave, similar fading takes place. Microwave is a digital computer bit stream synchronized (timed precisely) between both ends of the circuit. As the blade passes through the beam or its companion first Fresnel zone, it causes the microwave receiver at the other end to lose signal or synchronization with the other end. While the blade rotates, the microwave system struggles to resynchronize itself only to have the next blade chop the signal. In the end, the microwave never resynchronizes unless the blades stop turning.

Public safety microwave is built to telephone company standards and the signal is framed into blocks of channels. Communications must take place in a real time (no delays) state. On the other hand, microwave links used for computer networks are not necessarily real time. If a circuit fails due to an encounter with a windmill's blade, the computer system will simply retry repeatedly to pass the message. If a synchronized public safety signal fails, the ambulance or fire truck may not come to someone's door!

A reasonable analogy might be a motion picture of an airplane propeller or a car tire turning. There are times that the moving device appears to slow, stop, and then reverse itself in the film. It is the strobe light effect as the pulsing interval of the film begins to match the rotating speed of the propeller or wheel and then leaves synchronization. It is possible and depending on the speed of the windmill's blades for the microwave beam to come in synchronization with the moving blades.

A microwave beam or a TV signal for that matter is not like a laser beam. Per the attached drawing WIND-02 Figure 1, as the beam leaves the antenna at either end, it fattens just like if you point a flash light at a wall and walk backwards. The main power of the radio beam lies in the main beam or the red area in the drawing. The first Fresnel (pronounced Fra'-nel) zone lies in the blue area. In Figure 2 of WIND-02, the white zones are higher Fresnel zones and contain little power. The main beam and the first Fresnel zone must pass through the wind farm and not be reflected or chopped by any metallic members of the wind farm. Depending where the microwave terminal points are and the frequency of the microwave signal, the Fresnel zone can be hundreds of feet wide. A complex mathematical formula can calculate the size of the Fresnel zone for any frequency passing through the farm.

Some but not all of the problem can be alleviated by the windmill designer using non metallic blades. However, I have been told a metal blade is part of the lightning protection for the facility and thus there is a resistance to using non-metallic blades. Even if they did, you still have the metal pole and generator units to block and reflect radio waves,

The wind farms do not seem to bother regular two-way radio transmissions. As the mobile communications industry switches from analog signals to synchronized digital signals (APCO-25 Standard), problems could develop because of the same mechanisms exist as with microwave.

I would not want a user to build a critical communications tower in a wind farm unless the windmills were at least ½ mile away—better yet a mile. As the electrical energy is generated, signals from high electric fields and degrading generating equipment can radiate noise that will degrade two-way radio system receivers in the range of 25-200 Megahertz.

WHAT SHOULD BE DONE IF SOMEONE WANTS TO BUILD A WIND FARM?

All is not lost if an application for a wind farm is submitted to a zoning authority. If one is received:

1. The applicant should employ a microwave search firm such as Micronet in Plano, Texas or Comsearch in Ashburn, Virginia to identify which FCC licensed microwave paths will pass through the proposed wind farm.
2. The zoning authority should alert City and County public safety, utility, pipeline company, and your school district to provide their licensed and unlicensed microwave point to point routing to the applicant. The wind farm can especially effect:
    a. Point to point microwave.
    b. Wireless computer networks- 802.11 systems, WAN.
    c. Instructional TV for schools
    d. DTN Weather used by farmers and construction companies.
    e. Intercity wired telephone via microwave
    f. Cellular cell-site interconnection via microwave
    g. The real problem is the unlicensed data links. They are not in any database. You must seek out potential critical use owners.
3. The applicant should retain a Registered Professional Engineer with radio experience to be part of the design team for the wind farm to allow for microwaves to pass unaffected through the farm as shown in the attached drawing WIND-01 Figure 2. This may be as simple as leaving aisles open in the wind farm windmill-grid.
4. A wind farm advocate has suggested to me that some form of registration system of windmills and critical wireless communications circuits by the state might be reasonable to the work above.
    a. Critical communications circuits,
        i. Whether FCC licensed or not,
        ii. Planned or existing,
        iii. Can be registered in a GIS file along with the precise location of the planned and existing windmills
    b. Then, as new critical communications circuits are designed, engineers can consult the GIS system and be advised of the presence of a proposed or existing wind farm. They can register funded but not yet build circuits.
    c. The same is true with the planner of a wind farm.
    d. This sounds reasonable but the big issue would be keeping the data current and informing the planners and installers in both industries.

The Federal Communications Commission, when licensing a microwave system, offers no protection from new man-made objects obstructing a microwave system. Critical infrastructure communications systems are expensive and usually in planning for a long time. The very owners of most critical infrastructure systems are the approvers of wind farms. Therefore, the governmental entity should protect their interests otherwise, the fire department may be signaled by the 911 center and never show up at the fire. A signal may go out from a pipe line to shut the valves on a leaking line and the valve never close.

Leonard J. Koehnen, PE
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We have written many other White Papers that may be of interest to you. They are freely distributed to clients and other interested parties at no charge. Please write for a copy.

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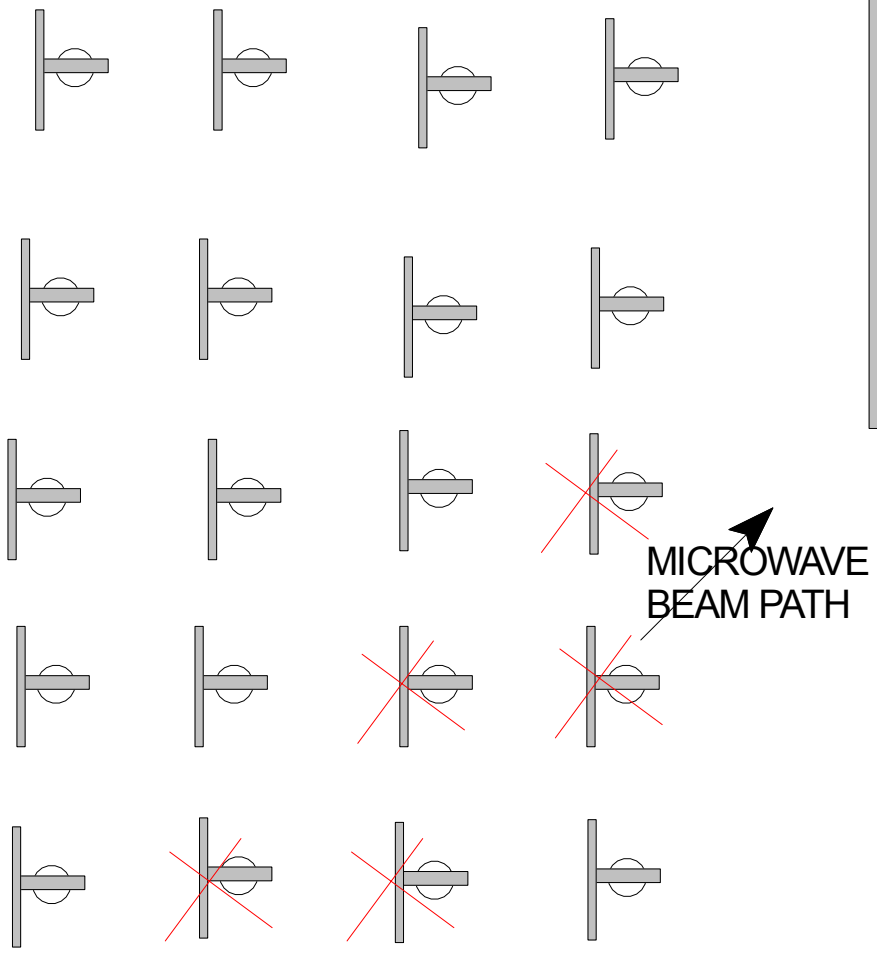
WIND-01

DELETE WINDMILLS IN GRID TO PROVIDE AN AISLE FOR THE MICROWAVE BEAM



WIND-01

MICROWAVE BEAM PATH

FIGURE 2: WIND FARM INSTALLATION GRID

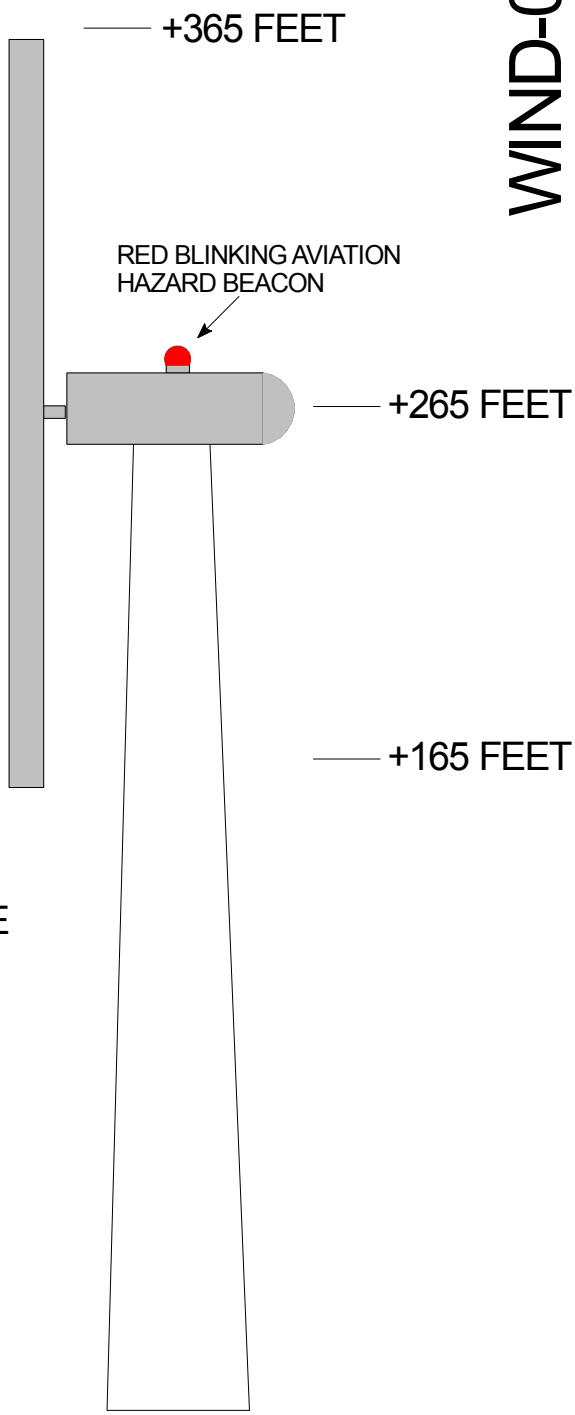


FIG 1: TYPICAL WINDMILL

REVISION HISTORY:	*THIS DRAWING WAS PREPARED BY ME AND THAT I AM A REGISTERED PROFESSIONAL ENGINEER IN MINNESOTA.* LEONARD J. KOEHNEN, PE MINNESOTA 9298	WIND FARM EFFECTS ON MICROWAVE STANDARD SPECIFICATIONS *Leonard J. Koehnen, PE* *Consulting Engineer* *Leonard J. Koehnen & Assoc., Inc.* *9348 Jonathan Road* *Woodbury, MN 55125 651-739-1614* DATE: 12-20-04 REVISION: ORIG DWG: WIND-01

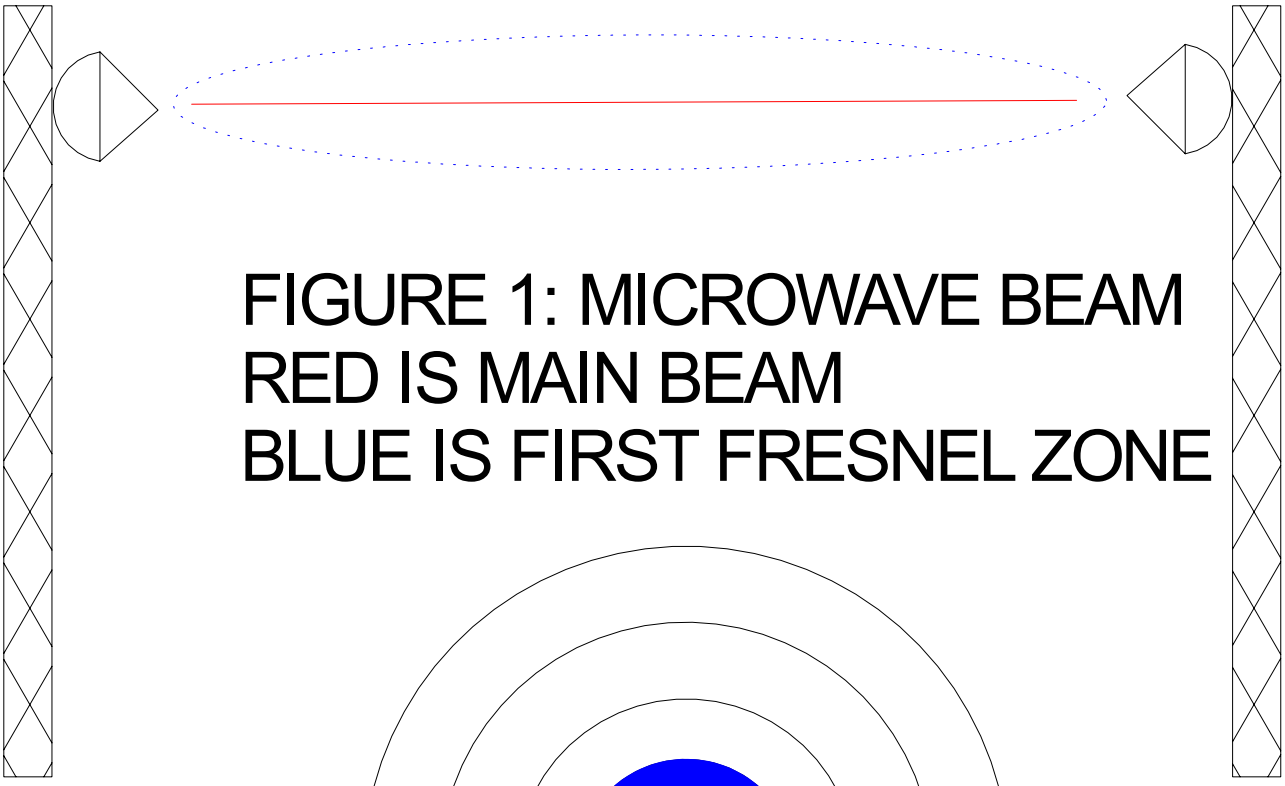
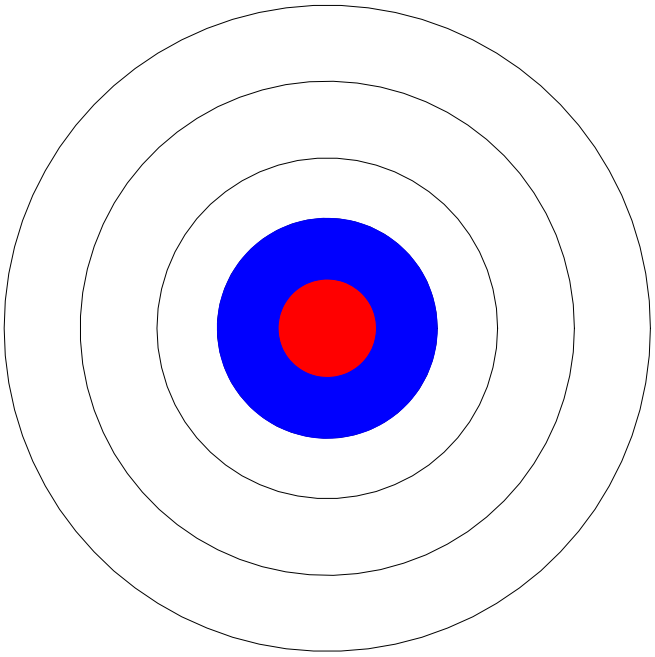


FIGURE 1: MICROWAVE BEAM
RED IS MAIN BEAM
BLUE IS FIRST FRESNEL ZONE



WIND-02

FIGURE 2: CROSS SECTION OF A MICROWAVE BEAM
RED IS THE PRIMARY BEAM
BLUE IS THE FIRST FRESNEL ZONE
WHITE ARE THE SECOND-THIRD ETC FRESNEL ZONES

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