WATTS ANTENNA COMPANY
270 Sunset Park Drive
Herndon, VA 20170-5219

TECHNICAL SUMMARY: WA-TS 20.002

SUBJECT: *DESIGN CRITERIA FOR THE WATTS MODEL 300 SERIES FRANGIBLE IMAGE GLIDE SLOPE ANTENNAS*

April 08, 2000

PURPOSE

Preliminary design criteria have been established for a unique type of image glide slope antenna to provide Category I/II/III glide slope signals at sites with severely limited runway shoulder. The frangible design is intended to allow placement as close as practicable to the runway shoulder. It is reasonable to expect that the tower offset will be, in part, governed by the wingspan + wing-tip clearance for the class of aircraft using the facility. The Watts 300 series antenna design will include three models; 1) Null Reference, Model 301, 2) Sideband Reference, Model 302, and 3) Capture Effect, Model 303. Specific features include a frangible tower design, wide aperture radiating elements, and employing lateral capture effect signals. A reduction in the lateral dimension of the antenna system critical area is expected but has not yet been quantified.

FRANGIBLE TOWER DESIGN

The antenna tower is being designed as a “goal post” style with two vertical members, spaced approximately 6 feet apart, up to a height of 50 feet for the capture effect type (Model 303). The goal post type design is necessary to provide support for the wide horizontal aperture antennas and to permit the large antenna offsets required for close to runway installations. The vertical members of the tower are comprised of thin wall filament wound fiberglass tubing and can be obtained in various diameters. One type of vertical member being considered is currently used in light lanes structures and, when used individually, complies with Federal Aviation Administration (FAA) specifications for frangibility. These types of supports are available from several vendors, each with unique frangibility features. A design has been developed by the FAA as low impact resistant (LIR) and may be directly applicable to the glide slope tower construction. One desirable characteristic is to have frangible points spaced along the entire structure to permit passage of the aircraft wing at various heights. Stabilizing braces or rod assemblies are necessary to meet requirements for 100 mph wind loading with 1 inch radial ice. Stabilizing braces would be constructed of smaller diameter thin wall fiberglass tubing. Fiberglass stabilizer rod assemblies are currently available and are also used on taller light lane poles.

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WIDE APERTURE RADIATING ELEMENTS

Close to the runway installation of the frangible tower permits more directive radiating elements to be employed. At some sites, directive elements alone would be enough to solve problems associated with multi-path signals from structures displaced laterally. Today’s solution, using broad radiating elements, is to cant the antenna away from the reflections source such that a lower level of incident signal will be present in that direction. This technique is undesirable if multi-path sources exist on both sides of the approach and further should ideally be a consideration in determining a uniquely defined critical area.

The vertically disposed radiating elements being designed have a horizontal aperture of 15 feet with 12 probe-fed slot cavities across the aperture. Two different antennas are used in each vertical array regardless of model. The first type has a voltage distribution with maximum radiation near the center and tapered on each end to reduce sidelobe levels. This antenna is to radiate, although much narrower in azimuth, the conventional signals required for the Null Reference, Sideband Reference, and Capture Effect type image glide slope systems. Optimum coverage can be provided with a pattern exhibiting a 3dB beam-width on the order of 15 degrees and 6dB beam-width near 20 degrees. The ability to manufacture antennas with tight tolerances on these values is required. The radiation pattern is canted toward the runway such that the approach will begin at a positive angle with respect to the maximum. During a centerline approach, the aircraft will transverse the radiation pattern passing through the maximum of the main beam between ILS points B and C and down the other side of the pattern between ILS Point C and the threshold. For both monitoring and manufacturing purposes, it is important that the minimum approach geometries can be made in the area of the radiation above the 6 dB beam points. The second type antenna has a voltage distribution to produce a radiation pattern with a second order null essentially broadside to the aperture. The antenna is used to radiate fly-up clearance signals to the side of the main proportional guidance area. An illustration of this concept is given in Figure 1.

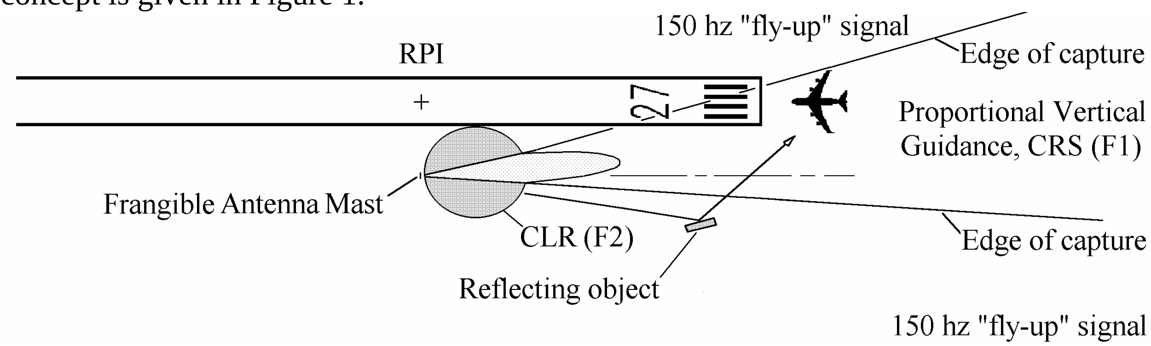

Figure 1. Narrow radiation patterns with proportional guidance are provided on frequency F1. Fly-up clearance signals exist outside of the course area on frequency F2. Additional immunity to lateral multi-path and a reduction in the glide slope critical area can be expected using this technique.

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LATERAL CAPTURE EFFECT SIGNALS

The 300 series design includes a unique feature of lateral capture effect signals on the image type glide slope systems. At sites with lateral truncations, the path angle from conventional image systems will become increasingly lower depending on the severity of the truncation and the type of system used. Application of two-frequency signals in the lateral plane provides a method to extend the horizontal glide path coverage area in the direction of the truncation. Clearance capture outside of 5.0 degrees, on the side of the runway containing the array and the truncation, will prevent the occurrence of low path angles and minimize concerns regarding the need to probe these areas in all monitor fault conditions. Radio Frequency (RF) radiation patterns and the resulting difference-in-depth of modulation (DDM) patterns are shown in Figure 2.

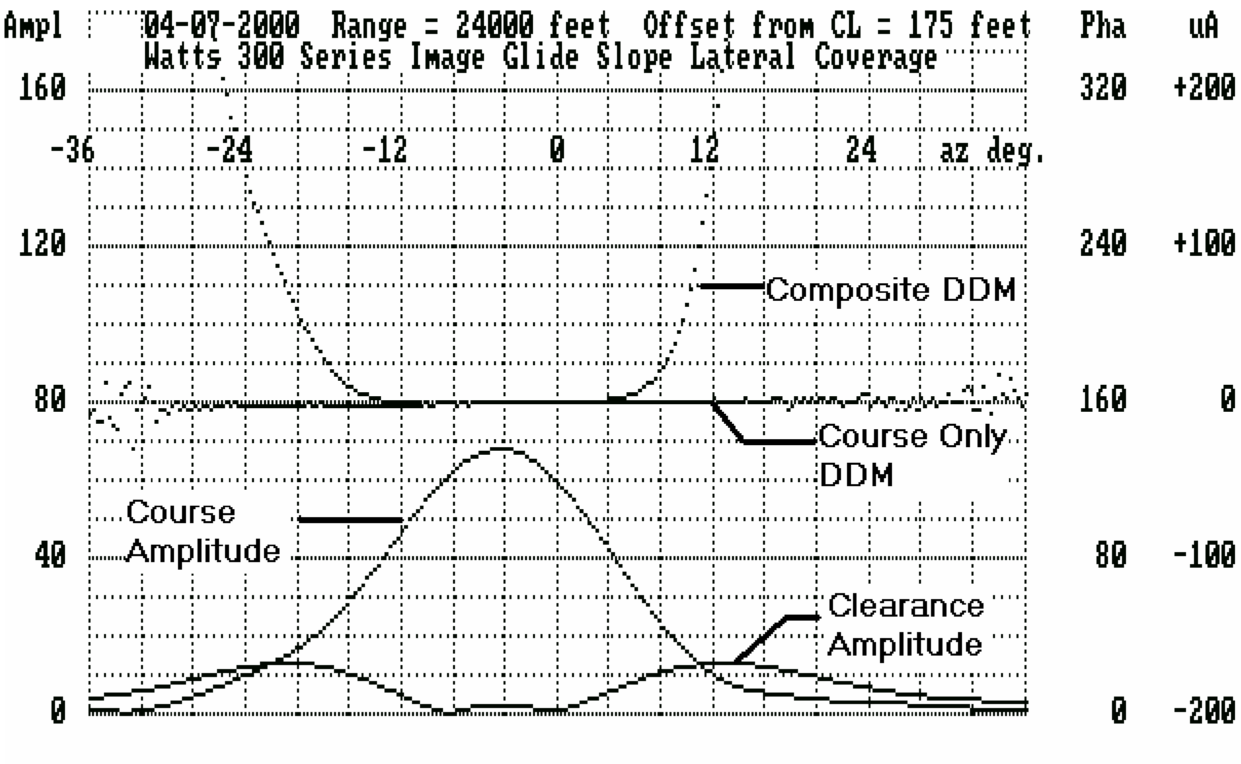

Figure 2. Initial Design Objectives for the Lateral RF Radiation and DDM Patterns of the Two-Frequency, Watts 300 Series, Frangible Image Glide Slope Arrays.

Note that the modeling results shown in Figure 2 did not involve a truncated site. If the lateral ground plane were truncated, the course only DDM would exhibit decreasing path angle with increasing positive angles.

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