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AN IMPROVED METHOD FOR CALCULATING THE FIGURE OF MERIT OF A NON - UNIFORM RADIATION PATTERN (SUPPLEMENT TO ERB - 647)

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ABSTRACT

In the evaluation of the performance of an omnidirectional antenna, an improved method is given for taking into account variations, especially deep nulls, in the azimuth pattern. Specifically, the proposed method is intended to replace the original method for determining the pattern deviation factors described in report ERB-647.

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Introduction

In an earlier report [1], a procedure is described for evaluating the performance of an HF shipborne transmitting antenna based on model radiation pattern measurements. The method follows the three-dimensional pattern analysis outlined in the USAF Military Specification MIL-A-9080. One of the major shortcomings of the procedure is its failure to discriminate adequately between antennas having different azimuthal patterns. In an attempt to overcome this limitation, a deviation factor is introduced which accounts for variations in the measured pattern from an ideal omnidirectional one. With reference to Fig. 1, the deviation factor is defined as the ratio of the shaded area which falls below the isotropic level to the total area of the pattern. If δ represents the deviation factor, then $1 - \delta$ can be thought of as representing the pattern figure of merit.

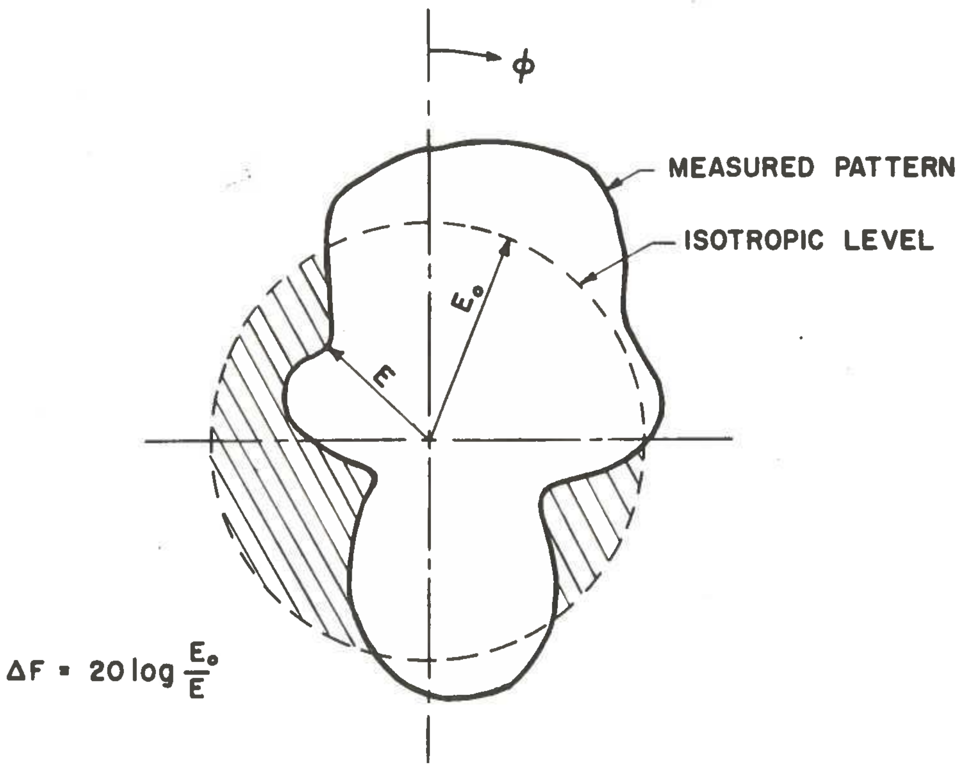


Figure 1 Diagram to illustrate method for determining pattern figure of merit

Although this method has been used to evaluate the performance of shipboard antenna systems over a number of years with some measure of success, it still fails to account satisfactorily for a deep null in the radiation pattern. It is not difficult to visualize two patterns, one having a sharp deep null, the second having a broad shallow null, and both having equal figures of merit. Yet we know from operational experience that the second pattern would have been given the higher rating. What is needed then is a more realistic approach for analyzing and assessing a non-uniform pattern, particularly one which has a deep null. The following procedure has been developed in an attempt to correct this fault in the original method.

Method for Determining Pattern Figure of Merit

For sake of argument, the pattern is assumed to be plotted on a linear voltage scale.

i) First obtain the equivalent isotropic level of the measured pattern.

ii) Compute $\Delta F = 20 \log \frac{E_0}{E}$ for every 5-degree increment in ϕ. It is assumed that only signals below the isotropic contribute to a deterioration in the antenna performance, hence ΔF is obtained for only that portion of the pattern which falls below the isotropic level.

iii) Find the square root of the mean value of the sum of the squares of ΔF. Algebraically, one obtains,

$$\sigma = \sqrt{\frac{\Sigma(\Delta F)^2}{n}}$$

where n is the number of azimuth points.

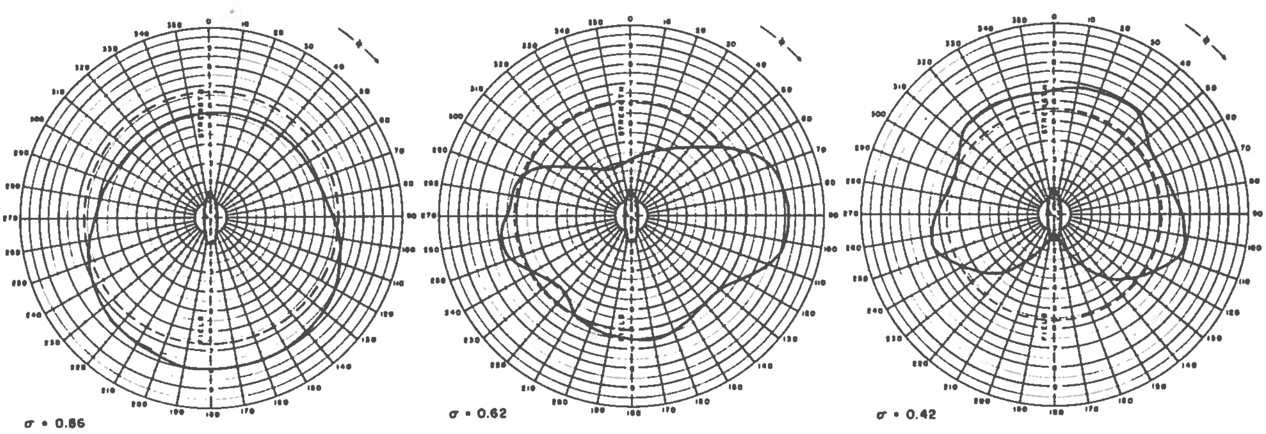
The quantity σ expressed as a number is taken to be the pattern figure of merit. Similarly $1 - \sigma$ is considered to be the deviation factor.

Discussion

To illustrate the proposed method, three arbitrarily measured radiation patterns are given (Fig. 2). Each has been analyzed and assessed in accordance with the above-mentioned procedure. The pattern figures of merit obtained are tabulated below:

Pattern No.	σ
1	0.86(0.86)
2	0.62(0.82)
3	0.42(0.78)

For comparison, the numbers in parenthesis are values which have been determined by the original method. It is noted that both methods give the same qualitative rating to the patterns, although the actual numbers obtained for the figures of merit are very different. Both methods give 0.86 for pattern No. 1, whereas for pattern No. 3, 0.78 is obtained using the original method, and only 0.42 using the new method. It is observed that the pattern has a rather deep null of about -18 db and it seems that this undesirable feature is more realistically reflected in a figure of merit of 0.42 than 0.78.



(a) (b) (c)

Figure 2 Arbitrarily measured azimuth radiation patterns

Conclusion

In the evaluation of the performance of an HF shipborne transmitting antenna, a new method is proposed which takes into account variations in the azimuth pattern. The method provides a more realistic measure of the seriousness of a deep null in the radiation pattern. Finally, to calculate the *antenna* figure of merit, the step-by-step procedure described in report No. ERB-647 still applies.

Reference

1. J.Y. Wong A proposed method for evaluating the performance of an HF shipborne transmitting antenna. NRC Report No. ERB-647, September 1963.