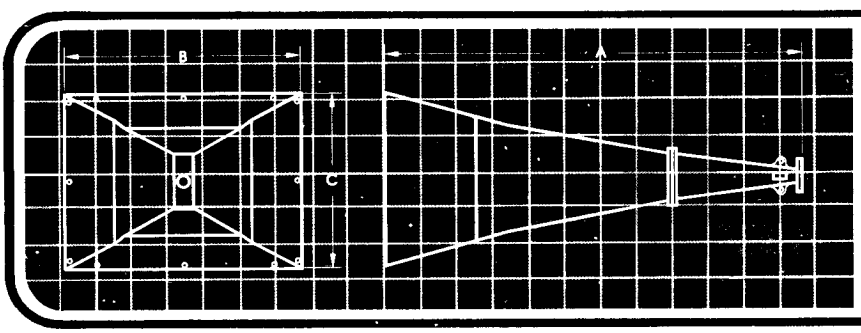

ALTEC ENGINEERING NOTES

TECHNICAL LETTER NO. 241

APPLICATIONS FOR THE ALTEC LANSING MANTARAY CONSTANT DIRECTIVITY HORNS

BY
CHRIS FOREMAN

This is an important Tech Letter, important because the Altec Lansing MANTARAY horns represent one of the most significant advances in mid/high-frequency horn technology in several decades: constant directivity. Neither Altec Lansing, nor any other manufacturer has ever been able to offer a family of horns with the degree of directivity control inherent in the MANTARAY design. In this Tech Letter we explain how the unique advantages of the MANTARAY horns can be put to use in just about any type of system design, from small, single-horn systems, to multi-horn clusters.

Coverage pattern, "Q" and frequency response are three of the most important criteria for selection of a mid/high-frequency horn/driver combination. Often, the system designer will select a horn for its rated coverage pattern and then select a high frequency driver, with a suitable frequency response, to complete the horn/driver combination. Q data, and information on variations in the horn's coverage angle are found in Altec Technical Letter #221. All neat and simple; or is it?

The coverage pattern and Q of every device listed in Tech Letter #221 vary with frequency. Some of the devices vary more than others. *These variations are normal, and are typical of similar devices from any manufacturer.* Thus, the choice of a "90° × 40°" horn becomes a little more complicated. "90° × 40°" *at what frequency*? The same question applies to the required Q for the horn: *at what frequency*? Recognizing that these parameters may vary with frequency, sound system designers often select a horn for its coverage pattern and Q at 4000 Hz (a critical frequency for maximum intelligibility). Careful overlapping of coverage patterns in a multi-horn cluster may also help compensate for variations in horn parameters.

Unfortunately, these compensation methods, which do help us deal with the problem of variable horn parameters, do not *solve* the problem. The only real solution would be a family of horns whose coverage pattern and Q were essentially constant over their rated frequency band, that is to say, a family of horns with *constant directivity*. The Altec Lansing MANTARAY horns are such a family.

The MANTARAY MR94 has a 90° by 40° coverage pattern; the MANTARAY MR64 has a 60° by 40° coverage pattern; the MANTARAY MR42 has a 40° by 20° coverage pattern. At what frequencies are these coverage patterns accurate? The happy answer to that question is, that within very narrow limits, the coverage patterns and Q of the

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MANTARAY horns are constant: OVER THEIR ENTIRE RATED FREQUENCY BAND of 800 Hz to 16 kHz. And, the best is yet to come:

As a direct result of their constant directivity, the frequency response of the MANTARAY horns is consistent, on or off axis, anywhere within each MANTARAY's rated coverage pattern!

Thus, the sound system designer can select a horn from the MANTARAY family, and be confident that the horn will perform as it is specified — at all frequencies within its rated frequency band. In addition (neglecting room factors):

a) Intelligibility will remain essentially constant within the entire rated coverage pattern of a MANTARAY horn.

b) All listeners within the rated coverage pattern of a MANTARAY horn will hear essentially the same frequency response — the same subjective "sound" —. The MANTARAY horns make the goal of "every seat a good seat" much easier to realize.

c) Indoor sound system design equations which include the factor Q will be valid at all frequencies within the MANTARAY's rated frequency band.

d) A cluster of MANTARAY horns will require very little overlapping to assure even coverage of an area. This may reduce the number of horns needed for a job, and should reduce the "lobing" or "fingering" often present when several horns cover the same area.

INTERPRETING THE MANTARAYS' SPECIFICATIONS

The catalog sheets for each MANTARAY horn contain detailed performance information including:

a) *Horizontal and Vertical Coverage Angle vs Frequency* — The polar patterns for each MANTARAY horn provide highly detailed information about the coverage patterns of each horn. In many cases, detailed polar patterns are more data than needed for a given application. In this case, the Coverage Angle vs Frequency graphs provide essentially the same information in a form which allows rapid interpretation. Each point on these graphs represents the angle between −6 dB points on the corresponding polar pattern. Thus, the Coverage Angle vs Frequency graphs could be called "reductions" (simplifications) of each MANTARAY's polar patterns.

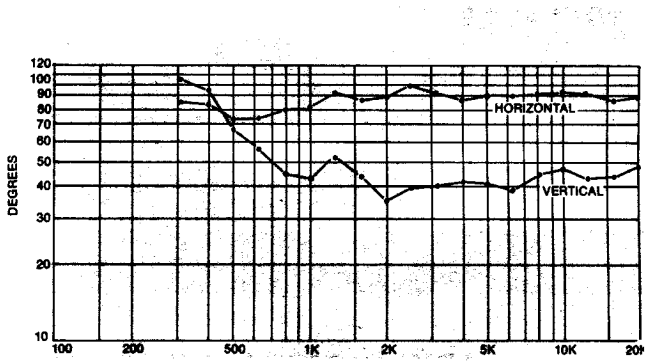

Figure 1: Coverage Angle vs Frequency of the MR94 MANTARAY

b) *Q and D.I. vs Frequency* — Since D.I. = 10logQ, these two parameters are presented with the same curve. This data is similar to the Q vs frequency data presented in Tech Letter #221 for other Altec devices. However, the data in Tech Letter #221 was prepared using computer programs to gain Q information from polar plots. The Q and D.I. data in the MANTARAY catalog sheets was obtained by Altec's new "Auto-Q" method[1].

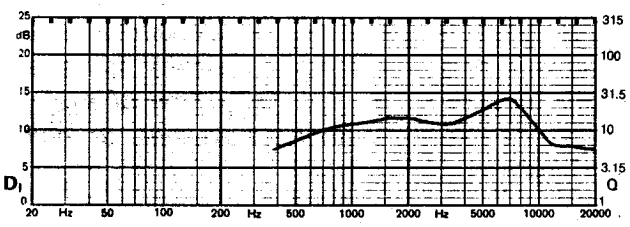

Figure 2: Q and DI vs Frequency of the MR94 MANTARAY

These two specifications, coverage angle vs frequency and Q vs frequency, are dramatic illustrations of the term "constant directivity". No other horns, by any manufacturer, can boast this kind of parameter consistency.

c) *"Normalized" On and Off-Axis Frequency Response* — For these graphs, we held the on-axis frequency response flat. Thus, for these "normalized" graphs, any frequency response variations caused by the high-frequency driver are essentially

eliminated. This means that the off-axis curves represent the true off-axis frequency response variations of the MANTARAY horn. These graphs display another side of the term "constant directivity": the MANTARAY horns have essentially the same frequency response characteristics on and off axis.

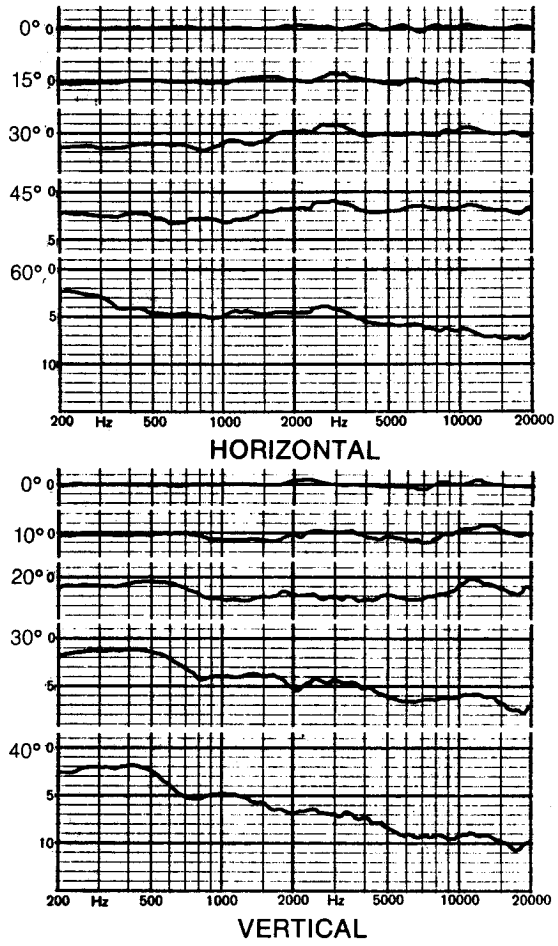

Figure 3A: Normalized On and Off-Axis Frequency Response of the MR94 MANTARAY

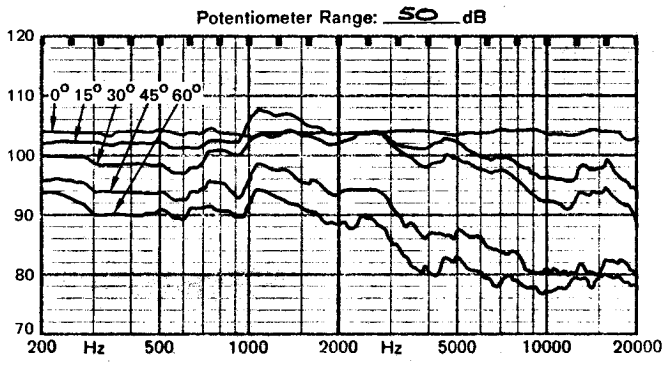

Figure 3B: Normalized On and Off-Axis Frequency Resonse of the 329A

d) *Unequalized On-Axis Frequency Response* – The normalized on and off-axis response curves show the response of the MANTARAY horn when the on-axis output is held flat. The unequalized on-axis frequency response curve shows the actual frequency response of the MANTARAY horn when connected to a 288-16G driver.

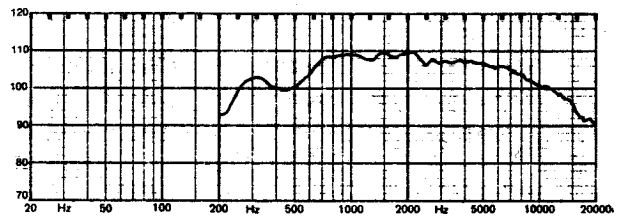

Figure 4A: Unequalized On and Off-Axis Frequency Response of the MR94 MANTARAY with a 288-16G Driver

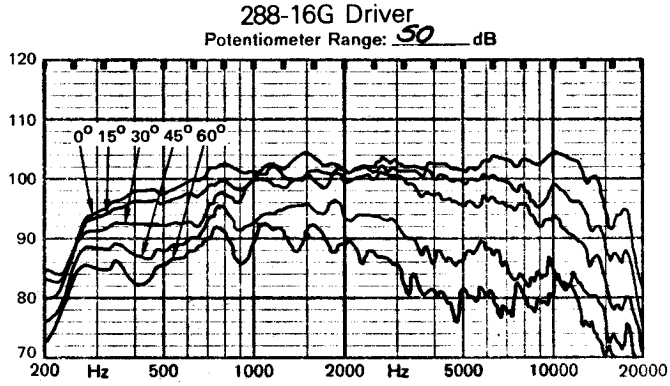

Figure 4B: Unequalized On and Off-Axis Frequency Response of the 329A with a 288-16G Driver

Compare the unequalized *on-axis* frequency response of the MR94 MANTARAY horn/288-16G driver shown in Figure 4A with the unequalized *on-axis* frequency response of the Altec 329A-horn/288-16G driver shown in Figure 4B. At first glance, it would seem that the frequency response of the 329/288 combination is much better than that of the MR94/288 combination. Next, examine the *off-axis* unequalized frequency response curves for the same two combinations as shown in Figures 4A and 4B. Then, examine the *normalized on and off-axis* response curves of the two combinations as shown in Figure 3A and 3B. The off-axis frequency response of the MR94/288 combination is significantly smoother and flatter than the off-axis response of the 329/288 combination.

The difference between these two horns is that the 329A horn "beams" the high frequency energy

from the 288 driver into a narrow angle at high frequencies. Thus, the *on-axis* frequency response curve of the 329/288 appears better than the MR94/288. However, the *off-axis* curves of the MR94/288 are significantly better in both smoothness and high frequency response than the 329/288. Thus, if you are planning a cluster specifically for those listeners that will sit on-axis of the horn (a small percentage of the total number of listeners), you would probably choose a 329A horn. If you are planning a cluster to distribute high and mid-frequency energy evenly over its entire coverage pattern, you would choose the MR94 horn!

It is worth mentioning that the 329A horn used for these comparisons is a discontinued Altec Lansing product. Other conventional horns built by Altec Lansing do not exhibit severe high frequency beaming.

More About the MANTARAYS' Frequency Response

a) In undocumented tests in the Altec listening room, we were able to equalize the frequency response of a MANTARAY MR94/288-16G flat ±2 dB to 10 kHz with a gradual roll-off above 10 kHz (as monitored on an Altec/Hewlett-Packard 8050 1/3rd Octave Real Time Analyzer). This approximates a common "preferred house curve". In this test, using the Altec 1650A Equalizer, we used only five filters, with no filter more than −3 dB from its flat position. This frequency response curve remained essentially the same throughout the room as long as the measuring microphone was within the rated coverage pattern of the MR94.

b) Listening tests performed at the same time, demonstrated to us that the subjective performance of a MANTARAY horn is as good as, or better than, the subjective performance of a conventional horn.

c) From these objective and subjective tests, we feel that a two-way system (with no super-tweeter) is at least as viable with a MANTARAY horn as it is with any conventional horn. *In fact, a two-way system using MANTARAY horns will have a very good on-axis frequency response, and a better off-axis frequency response than a two-way system using conventional horns.*

WHEN TO USE THE ALTEC LANSING MANTARAY HORNS

In Traditional Sound Reinforcement Systems

a) In a traditional sound reinforcement system, such as might be installed in a church or other auditorium, a cluster of MANTARAY horns will cover an area evenly with very little overlapping. Thus, the cluster may require fewer horns than a conventional cluster. In addition, the frequency response and subjective "sound" of a carefully designed cluster of MANTARAY's will be *consistently* good throughout its entire coverage pattern.

b) In large indoor or outdoor paging systems, the MANTARAY horns will cover an area evenly with uniform sound. The MANTARAY horns give the system designer the ability to put the sound where it is needed — with considerably less "spill-over" than a cluster of conventional horns. In highly reverberant indoor spaces, this reduced "spill-over" may reduce the apparent reverberation by keeping the sound where it should be — at the listeners ears, not on the walls, ceiling or elsewhere.

In Portable Concert Systems

Most portable concert sound systems (or other high-level entertainment systems) use multiple horn clusters for two reasons: 1) To produce high sound pressure levels; 2) To cover wide areas. The MANTARAY horns offer advantages in both areas:

1) All but a very small percentage of the sound output of a MANTARAY horn is contained within the horn's rated coverage pattern (see Figure 5). Since almost none of the sound output is wasted in out-of-pattern areas, the average sound pressure level over the intended coverage pattern may be higher than it would be for a conventional horn.

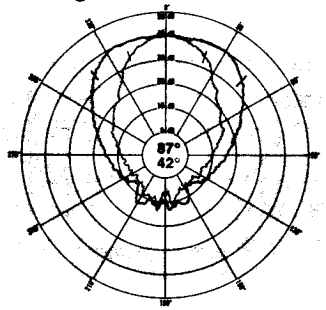

Figure 5A: 4 kHz Horizontal and Vertical Polar Response of the MR94 MANTARAY

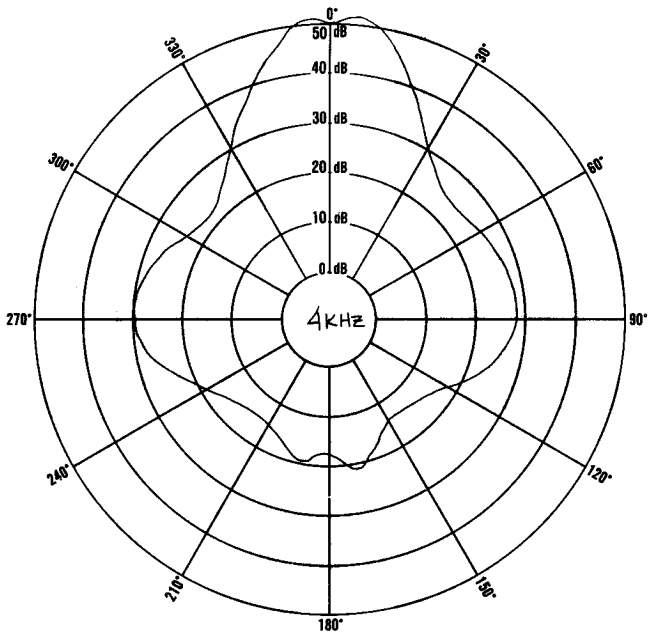

Figure 5B: Polar Response of a Horn with Poor Directivity Control

2) At first, it might seem that the relatively large MANTARAY horns would not be desirable for a portable system where space is at a premium. However, the multiple horns in a concert system are primarily needed for consistent coverage of an area* Because the MANTARAY horns require minimal overlapping, an array of MANTARAY's may require fewer horns than an array of conventional horns for uniform coverage of a given area. This means fewer horns, fewer drivers, fewer carrying cases and fewer power amplifiers for a concert system. In addition, the MANTARAY horns come apart at the throat for storage or traveling and the throat will fit in the bell of the horn.

In Discotheque, Studio Monitor and Other Playback Systems

For playback systems, such as discotheque systems, the constant directivity of the MANTARAY horns means that there will be fewer "weak spots" on the dance floor (weak spots caused by room irregularities may remain). In a recording or broadcast studio, constant directivity means that a studio engineer will not have to remain within a few inches of the center of a mixing console to hear consistent sound from the right and left studio monitor loudspeakers.

*The maximum sound pressure level of a concert system is usually limited by the output capabilities of the *low-frequency devices*. The high-frequency horns and drivers, because of their higher efficiency, are often used at electrical power levels below their rated maximums.

A FEW WORDS ABOUT CLUSTER DESIGN WITH MANTARAY HORNS

With a few exceptions, cluster design methods which have been successful with conventional horns, will be successful with MANTARAY's. Here are those exceptions and a couple of extra guidelines to help you take advantage of the unique capabilities of the MANTARAY horns.

1) The MR42 MANTARAY covers a 20° by 40° pattern, plus or minus only a few degrees, from 800 Hz to 16 kHz. The Altec 203B covers a pattern that approaches 40° by 60° at some frequencies (see Tech Letter #221). Thus, the MR42 is not a direct replacement for the 203B. If you need a coverage pattern of 40° by 60°, choose an MR64, not an MR42. The coverage of the MR42 (or any of the MANTARAY horns) is very poor outside its rated coverage pattern! (We designed them that way on purpose!) The same argument applies to the other MANTARAY horns. We strongly suggest that you carefully calculate the actual required coverage patterns for a system using MANTARAY horns. The MANTARAY's simply do not have any "spill-over" (and you'd better not expect any!).

2) Use as few horns as possible to cover a given area. It is not necessary to overlap the MANTARAY horns past their −6 dB points to get an even coverage pattern. Excess overlapping may cause "hot spots" and lobing in a cluster of MANTARAY's (as it would in a cluster of conventional horns).

3) For doubling the horizontal coverage angle of a pair of MANTARAY MR94's, we recommend the stacking/splaying method illustrated in Figure 6A and 6B. This method uses minimal overlapping to produce a smooth 180° horizontal polar response. The vertical coverage of this pair remains constant at 40°. While only one horizontal polar pattern is shown, the horizontal polar patterns at other frequencies are similar — all the way from below 800 Hz to above 16 kHz. Similarly, a pair of MR64's will produce a smooth 120° horizontal polar response as shown in Figure 6C. This means that you have a choice of 20°, (an MR42 turned sideways), 40°,

60°, 90°, 150° or 180° horizontal coverage patterns from one or a pair of MANTARAY horns — not a bad set of choices!

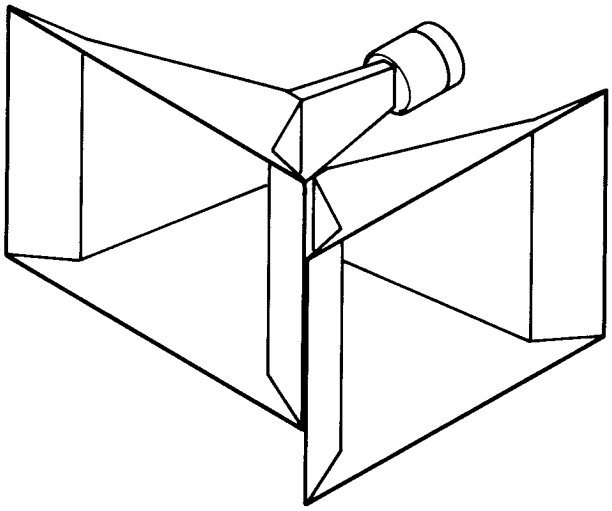

Figure 6A: Recommended Method of Doubling the Horizontal Coverage of a Pair of MANTARAY's

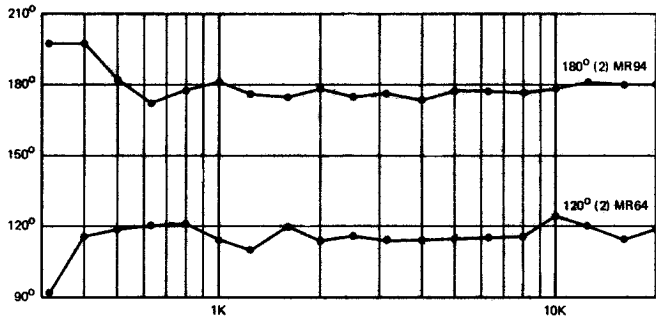

Figure 6C: – 6 dB Angles vs Frequency for a Pair of MR94's and a Pair of MR64's Arrayed as Shown in Figure 6A

5) In no case should the above guidelines be considered hard and fast rules. The best cluster design is the one that covers the area evenly with uniform, pleasing sound.

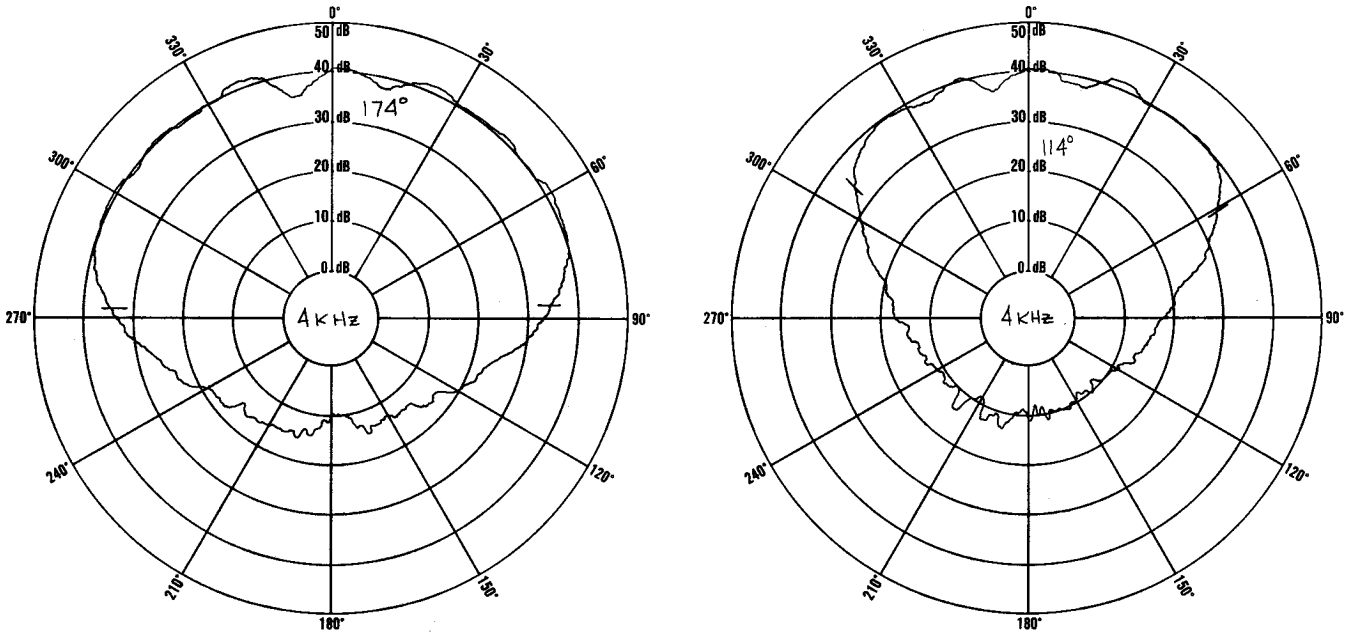

Figure 6B: 4kHz Horizontal Polar Pattern for a Pair of MR94's and a Pair of MR64's Arrayed as Shown in Figure 6A.

4) For doubling the vertical coverage angle of a pair of MANTARAY's, we recommend the stacking/splaying method illustrated in Figure 7A and 7B. The polar patterns for this array are as smooth as those shown for the horizontal pairs in Figure 6.

CONCLUSION

Better products and more data result in better sound systems. For that reason, we intend to continue supplying products like the MANTARAY

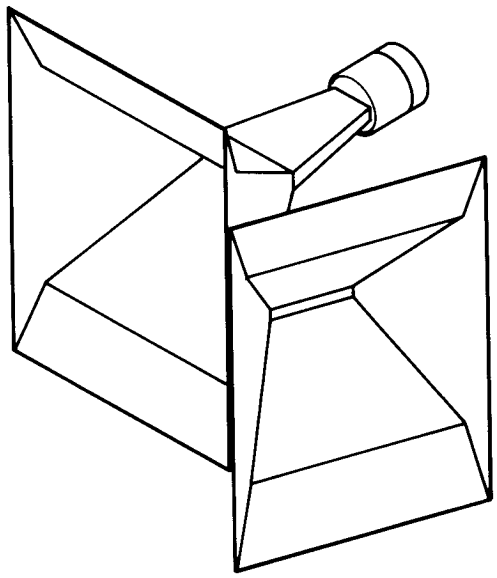

Figure 7A: Recommended Method of Doubling the Vertical Coverage of a Pair of MANTARAY's

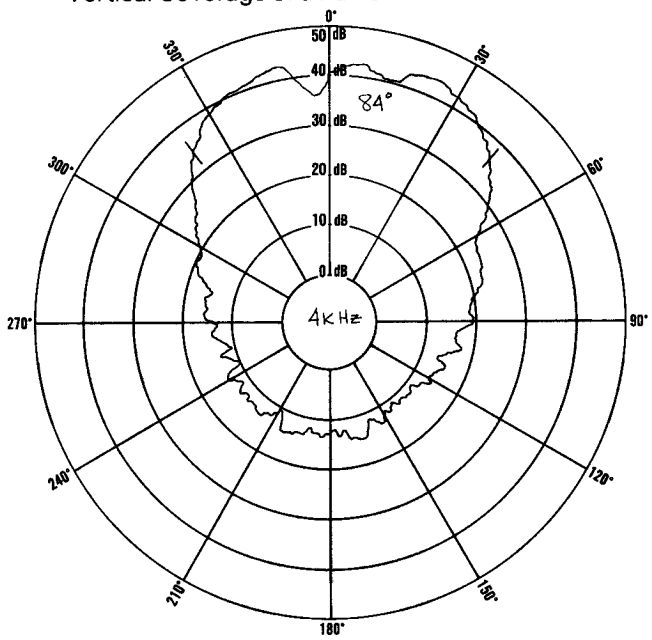

Figure 7B: 4 kHz Vertical Polar Pattern for a Pair of MR94's Arrayed as Shown in Figure 7A

horns along with extensive data of the type given in the MANTARAY catalog sheets. We hope that this will help make your designs easier and your systems more successful.

Bibliography:

1) *Auto-Q: A New Directivity Measurement System** by Clifford Henricksen, Altec Lansing; AES Preprint #1360 (F-6) presented before the 60th Convention of the Audio Engineering Society at Los Angels; May, 1978.

2) *Blasphemy — The MANTARAY Horns!** by Clifford Henricksen and Mark Ureda, Altec Lansing; AES Preprint #1288 (0-2) presented before the 58th Convention of the Audio Engineering Society at New York; November, 1977.

3) *Directivity of Altec Loudspeakers* Altec Technical Letter #221, by Mark Engebretson.

*Patents Pending