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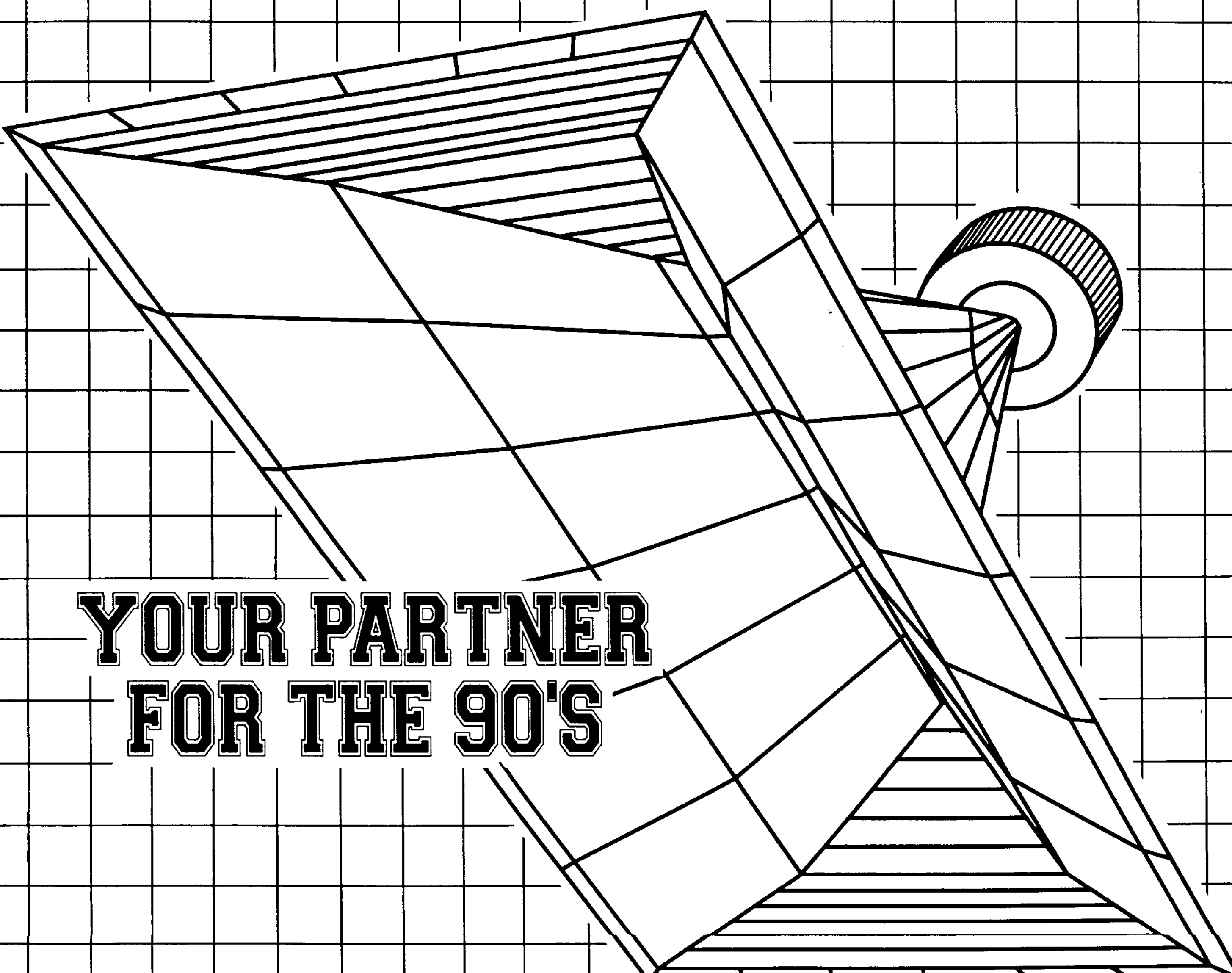

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Applications Guide for VI Horns

ALTEC ENGINEERING NOTES

APPLICATIONS FOR THE ALTEC LANSING VARIABLE INTENSITY HORNS
by Paul Fidlin

INTRODUCTION

The VI horns offer the installer new opportunities to both improve coverage and to achieve this result with less hardware (horns, drivers and amplifier channels). In order for the installer to obtain these benefits a better understanding of the concept behind these devices is required. The following sections will help the user understand the new terminology created and will provide practical examples in the art of using VI horns alone, or in combination with conventional CD horns within clusters.

USER NOTES

It will be appreciated that the asymmetrical dispersion patterns associated with the VI horns are impossible to fully characterize with horizontal and vertical polars alone. These offer only a slice of what is happening. In addition to "long throw" horizontal, "short throw" horizontal and vertical 1/3 octave polars, we have provided three new ways of viewing 3-D directivity data. They are the floor plan isobar, 3-D directivity balloon and the 3-D floor plan isoloon.

FLOOR PLAN ISOBARS

The sound pattern radiated by a loudspeaker can be described by a set of isobar curves. Floor plan isobar curves show the "footprint" (the sound pattern created on the floor including SPL correction for distance) of a horn mounted in the air and pointed down at various angles, figure 1 shows the floor plan isobar for the VIR horn at 4kHz. The patterns shown in figure 1 consist of five contour lines with an "X" in the center. The "X" marks the horn aiming spot, and the contours represent locations off axis where the sound pressure is constant. The inner two contours define the -3dB and -6dB down boundaries. The middle solid contour indicates the coverage area where the SPL is 9dB below maximum, and the outer two dotted contours show -12dB and -15dB respectively.

The -9dB contour gives an accurate indication of the area that can be covered by the VIR horn. Notice how sharply the SPL drops off at the edges of the coverage area, ie. beyond the -9dB contour, this helps keep reflections off near by surfaces to a minimum and thereby maximizes intelligibility.

The floor plan isobars shown in figure 1 are scaled in units of "H", the height above the floor that the horn is mounted. Two aiming angles are provided, giving an indication of the range of room aspect ratios that can be achieved by varying the aiming angle. The examples given illustrate room coverage ratios of 1H to 2.2W to 3L and 1H to 4.5W to 6.5L.

REFERENCE AXIS

With horns of conventional design, it is clear that the reference axis of the horn is also the axis of greatest sensitivity. This axis is the drivers axis of symmetry, and it is also the mounting axis of the horn. With horns such as the Altec Lansing VI horns there exist multiple aiming points, (as the object of the exercise is to cover a complete seating plane). Figure 2 shows the interrelationship between the driver plane, aiming angles and the

horn's nominal vertical coverage pattern. Notice that, for consistency, we continue to designate the horn aiming axis at the axis of greatest sensitivity.

It is useful to also consider a second reference angle that represents the axis of the "short throw section" of a VI horn. For both the VIR and VIT horns this angle is separated from the "long throw / maximum SPL axis" by 40 degrees. (see figure 2)

3-D DIRECTIVITY BALLOON

This presentation format relates the output of the VI horns to the surface of a sphere, where the surface represents 0dB and the center -25dB (see figure 3). The high SPL section touches the surface of the sphere and is highlighted by the dotted line that comes from the sphere center. This is the long throw portion of the horn and has a nominal horizontal coverage angle of 60 degrees. Notice that the SPL slopes away from the sphere surface as we move in the direction of the short throw end. The horizontal coverage at this end is nominally 90 degrees. The short throw section is approximately 10dB down from the aiming point. The slope between long throw and short throw sections indicates the degree of SPL correction that has been achieved.

3-D FLOOR PLAN ISOLOON

Figure 4 shows what happens if we combine the floor plan isobar (figure 1) with the 3-D balloon (figure 3), this presentation has been designated "Isoloon", and is one of the most intuitive ways of viewing sound system performance. As with the floor plan isobar the isoloon is scaled in units of "H" the height above the floor.

PRACTICAL EXAMPLES

We will consider a number of simple examples in this section to better illustrate how to utilize VI horns within a cluster.

1. Let us begin by comparing a VIR horn to a conventional cluster consisting of a long throw, large format 40°x 20° horn together with a short throw, large format 90°x 40° horn. Both systems will be attempting to fill a rectangular area defined by 1H by 2.5W by 3.2L, where "H" is the cluster mounting height.

Figure 5A shows the conventional two horn cluster. The horn/driver sensitivities are 116dB, 1W @ 1M and 112dB, 1W @ 1M respectively for the 40°x 20° and 90°x 40° horns. The horns have been arranged to provide 60 degrees of vertical coverage and their respective aiming points "A" and "B" have been indicated. In this particular example there is a 2:1 ratio in distance between points "A" and "B" and the cluster location, leading to a 6dB inverse square law difference that needs to be compensated for (see Appendix 1 for a more complete examination). There is a sensitivity difference of 4dB between the long and short throw horns, leaving a differential of 2dB to be compensated by adjusting the drive level to each horn/driver combination. Driving the long throw combination with 0.6W and the short throw combination with 0.4W would achieve the desired power apportionment. For direct comparison to a single VIR horn we have conveniently ensured that the total power to the cluster sums to 1 watt.

With path length "O-A" being 10 meters (-20dB), the SPL at point "A" will be 88dB (112dB -20dB -4dB). The path length "O-B" is 20 meters (-26dB), and so the SPL at point "B" will also be 88dB (116dB -26dB -2dB).

Now let us consider the VIR horn/driver combination (see figure 5B). Once again the horn has been arranged to provide 60 degrees of vertical coverage and the long throw reference angle aimed at point "B". The short throw reference angle is 10 degrees closer than the two horn example above, however the path length difference still results in an academically close to 6dB inverse square law difference.

Notice that the short and long throw sensitivity figures for the VIR horn differ by 6dB compensating exactly for the inverse square law difference. With path length "O-A" again being 10 meters (-20dB), the SPL at points "A" and "B" will be 86dB (106dB -20dB and 112dB -26dB) with an input of 1 watt.

For the same total input power (1watt) the VIR horn is 2dB lower in sensitivity than the double horn \ double driver \ double amplifier channel example. This difference is best resolved by thinking in terms of sensitivity and/or in terms of "Q" for a cluster of horns. The "Q", and hence the sensitivity, are lower for the VIR horn than for the two horn cluster. However figure 6 shows clearly the reason for this. Notice how the VIR horn is able to fill the "long throw" corners.

In addition to the sensitivity difference mentioned above we also need to consider power handling. The maximum output of the two horn cluster is limited by the input capacity of the harder driven long throw driver; where as the single horn \ single driver VIR case effectively distributes all of its acoustic output to the listening area. Instead of a 3dB advantage, only 2dB of additional output will be realized.

The two cases are remarkably close in terms of ultimate output. In addition the VIR case has the advantage of less hardware (and hence lower bulk, weight and cost) and reduced destructive interference due to the single rather than dual acoustic sources.

It can be seen that the VIR horn is capable of replacing the two horn cluster and requires one less driver, one less horn and one less amplifier channel.

2. Now let us consider a second example. We will compare the performance of an Altec VIT horn against that of a three horn cluster consisting of a near throw 60°x 40° horn and two long throw 40°x 20° horns. Both cases are providing coverage for a trapezoidal listening area, see figure 7.

A side view of the three horn cluster is shown in figure 8A. The horn/driver sensitivities are 116dB, 1W @ 1M and 114dB, 1W @ 1M respectively for the 40°x 20° and 60°x 40° horns. The horns have been arranged to provide 60 degrees of vertical coverage, and the two long throw horns have been splayed by 30 degrees to cover the entire trapezoidal listening area. Only two of the aiming points "A" and "B" are shown in the side view. In this particular example the distance ratio between points "A" and "B" and the cluster location results in a 4.5dB inverse square law difference.

In order to achieve the same SPL at both points "A" and "B" it will be necessary to drive the long throw horns with 2.5dB more electrical input; 0.39W into each of the long throw horns and 0.22W into the short throw horn will achieve the desired results with a total of 1 watt into the cluster.

The SPL at point "B", assuming a path length "OB" of 20 meters, will be 86dB (116dB -26dB -4dB). The SPL at point "A" will also be 86dB (114dB -21.5dB -6.5dB) after allowing for the inverse square law difference between points "A" and "B".

Now let us consider the VIT horn/driver combination. Figure 8B shows a side view of the VIT horn. As with example 1 the horn is arranged to provide 60 degrees of vertical coverage and the long throw axis is aimed at point "B". With the pathlength "OB" being 20 meters the SPL at point "B" will be 86dB (112dB -26dB). The SPL at point "A" will also be 86dB (106 -20dB).

As in example 1 we need to compare performance both in terms of sensitivity and power handling. Notice that in this case the VIT horn has the same effective sensitivity as that of the three horn cluster. In the three horn solution the long throw horns are only being driven with 0.39W ; consequently the three horn solution will have a 4dB advantage in maximum SPL capability. However this brings with it the expense of two additional horns, drivers and amplifier channels when compared to the much simpler VIT solution.

The floor plan and 3-D isobars shown in figures 9 and 10 respectively, show clearly that the VIT horn provides superior coverage within the trapezoidal space without the inherent comb filtering problems that occur when multiple sources overlap.

We have seen with the examples shown how the VIT and VIR horns can be used to replace small two and three horn clusters. It will be evident that Altec Lansing VI horns can be used as elements within larger clusters, or used together with regular CD horns to help provide optimum solutions to sound reenforcement problems.

Please refer to the VIR and VIT engineering data sheets for more information. Full AcoustaCADD data files are available for the VIR and VIT horns upon request.

APPENDIX 1

The Altec Lansing VI horns have been designed to provide 6dB of inverse square law correction between the long and short throw axis (40 degree included angle). In the examples given this was used to correct for the SPL difference resulting from the path length difference ("OA - OB"). [*please note that a total of 10dB of inverse square law correction is available within the 60° included vertical coverage angle of both horns*]

Let us look at a generalized situation in order to obtain some useful guidelines. Figure 11 shows generalized horn aiming conditions.

The parameters shown are defined as follows ;

- a - length of audience coverage
- H - horn mounting height
- θ - horn tilt angle
- O - horn mounting position
- OC - long throw aiming axis of VI horn

In the specific case of c = 2b the following can be derived.

The law of cosines is $a^2 = b^2 + c^2 - 2bc.\cos A$ (1)

substituting in c = 2b we obtain

$$a^2 = b^2(5 - 4\cos A) \quad (2)$$

With both VI horns A is 40° substituting into (2) gives us

$$a = 1.39\ b \quad (3)$$

Looking now at the smaller triangle in figure 11 containing the angle θ , $\cos\theta = H/b$

substituting this into (3) gives us

$$\cos\theta = \frac{1.39\ H}{a}$$

This expression will provide a fast way of determining the tilt angle, θ , required when "H" and "a" are fixed. The VI horns have been found to give excellent results within the range θ = 15° to θ = 30°.

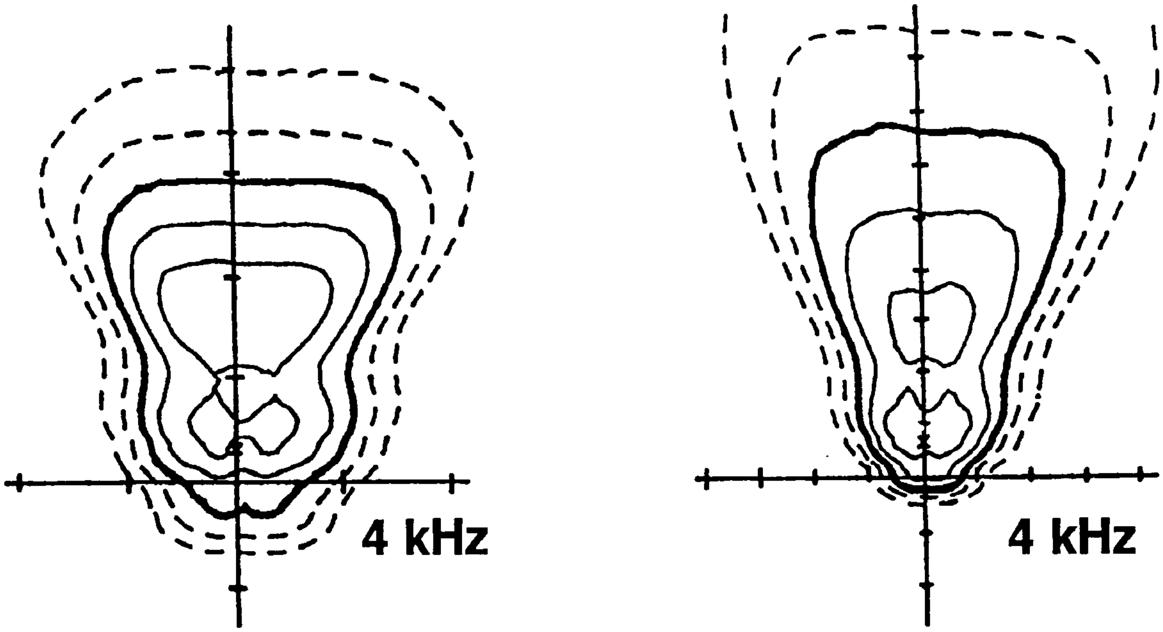

FIGURE 1
FLOOR PLAN ISOBARS - 4 kHz, VIR.

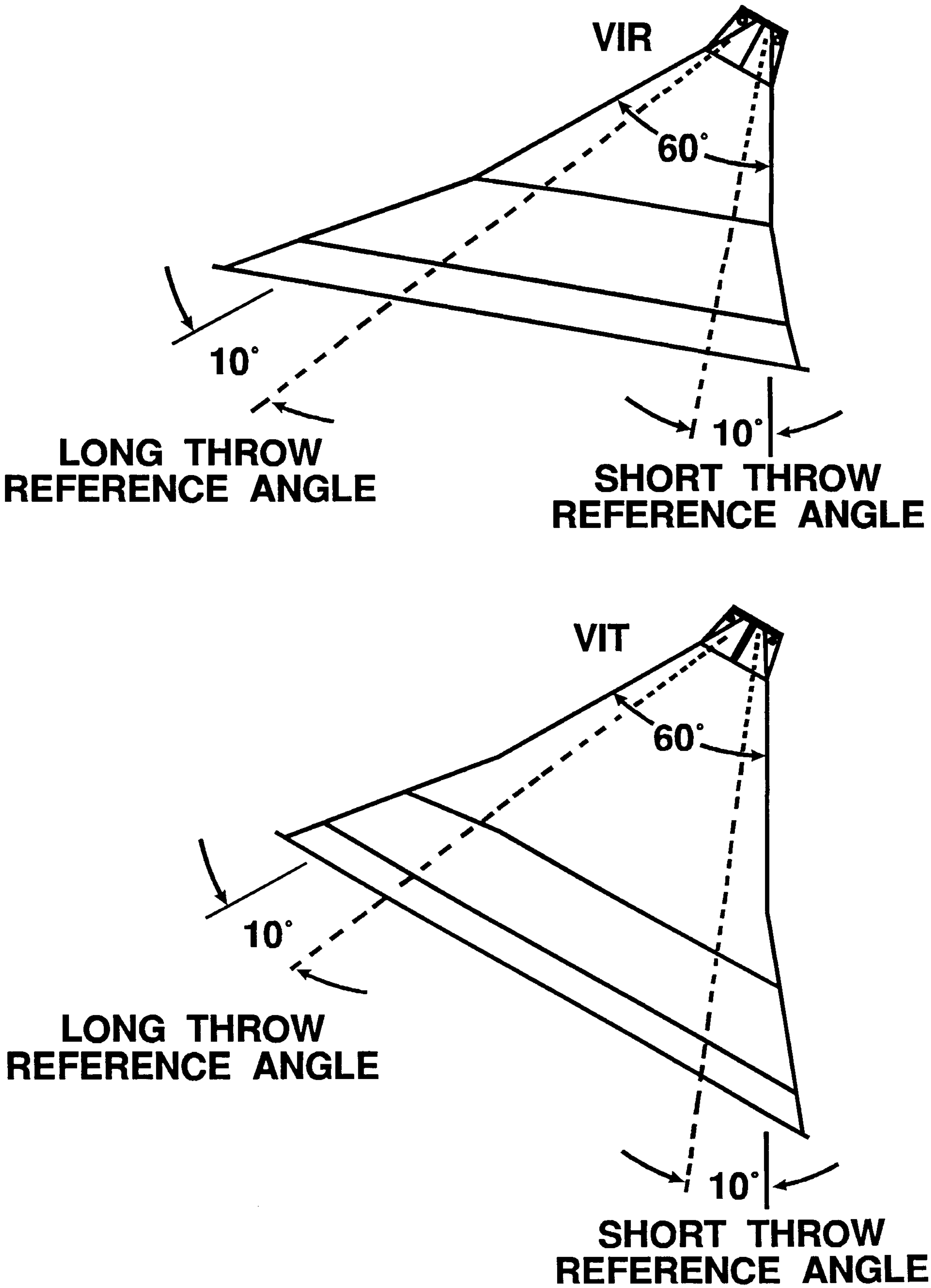

FIGURE 2
VI HORN AIMING ANGLES

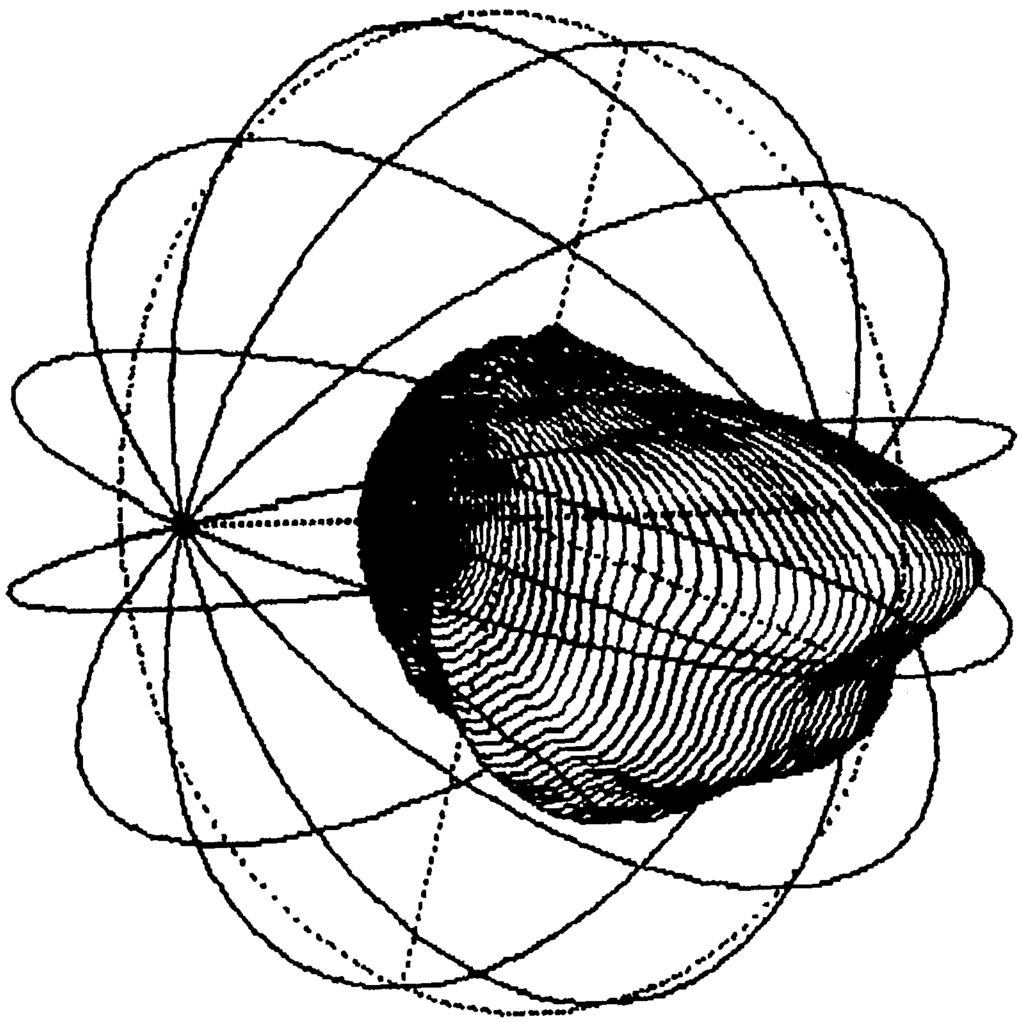

FIGURE 3
VIR HORN 3-d BALLOON - 4 KHz

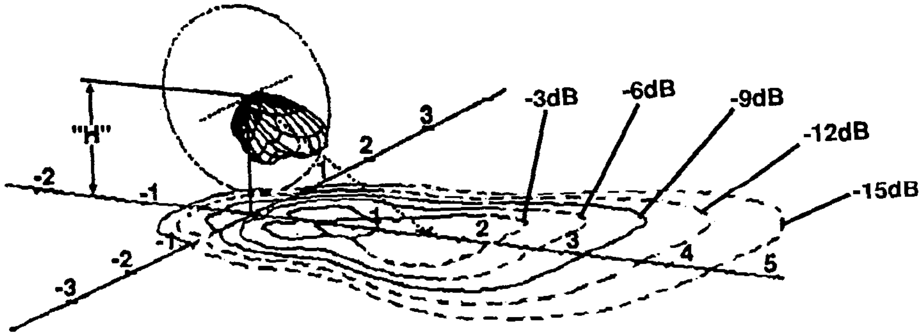

FIGURE 4
VIR 3-D FLOOR PLAN ISOLOON

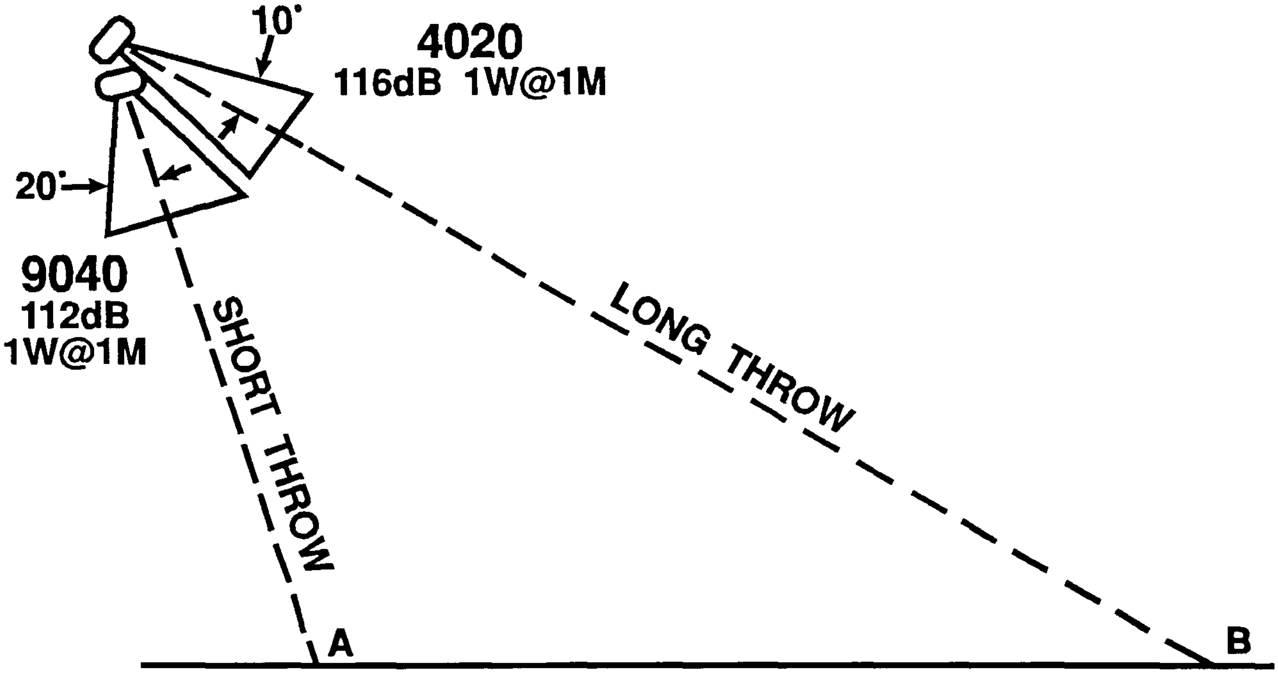

FIGURE 5A
CONVENTIONAL TWO HORN CLUSTER

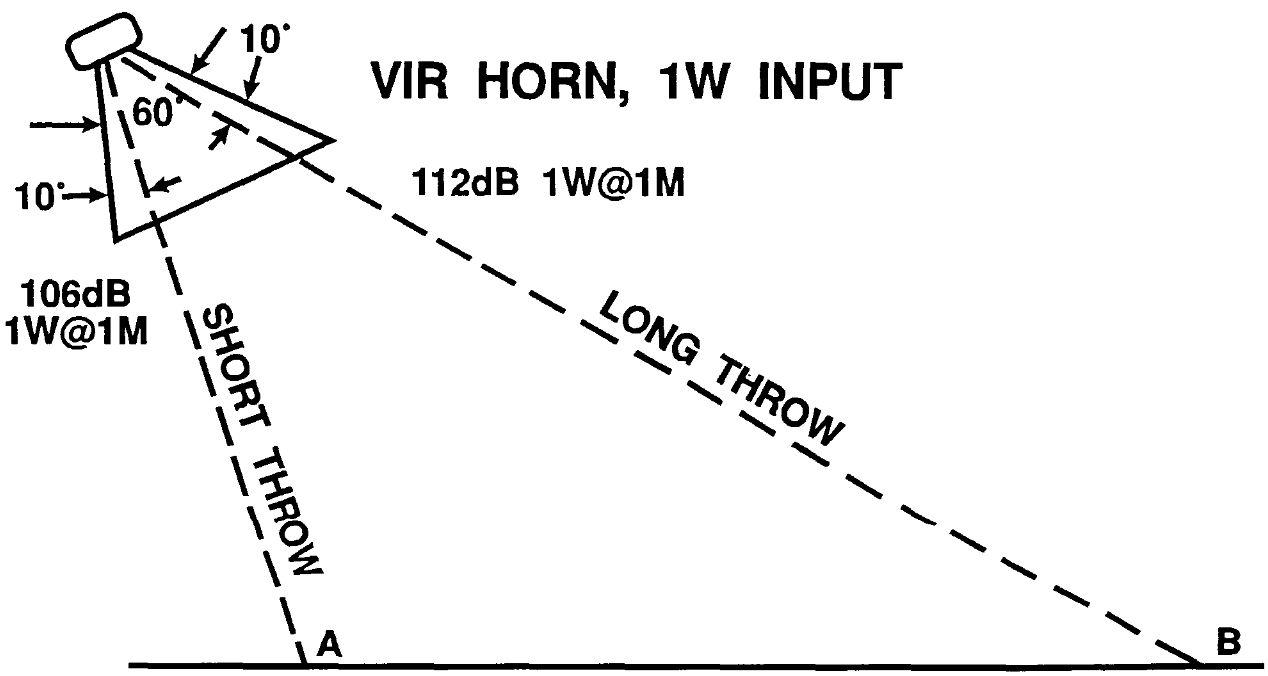

FIGURE 5B - VIR HORN

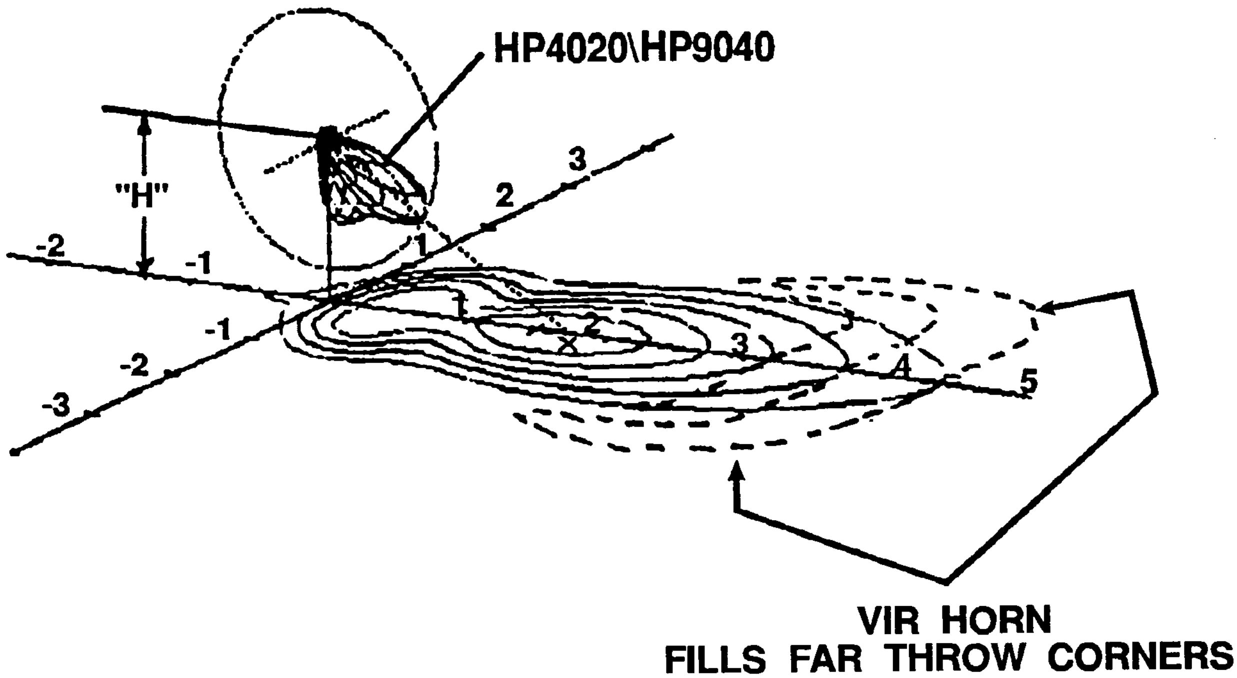

FIGURE 6
VIR HORN VS TWO HORN CLUSTER

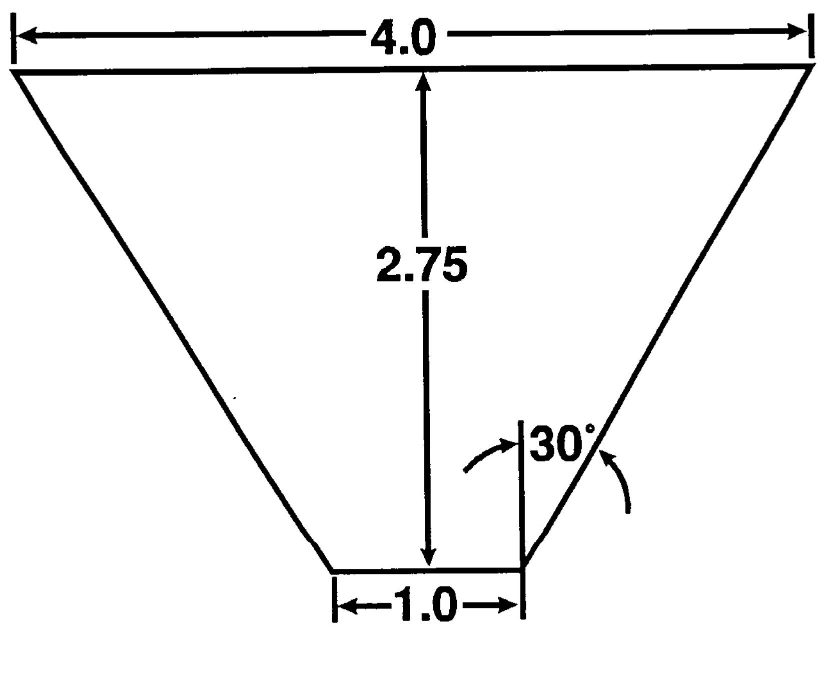

FIGURE 7
TRAPEZOIDAL LISTENING AREA DEFINED IN UNITS OF "H"

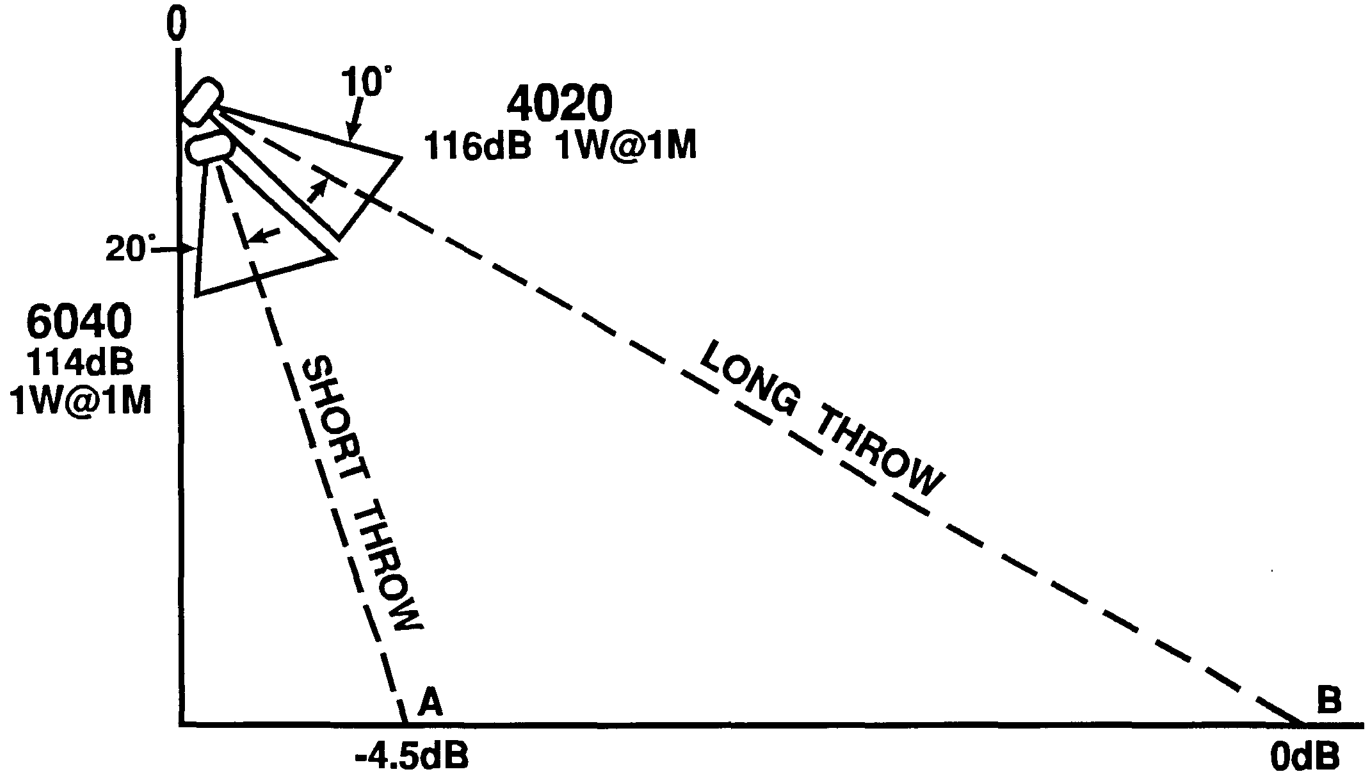

FIGURE 8A
THREE HORN CLUSTER

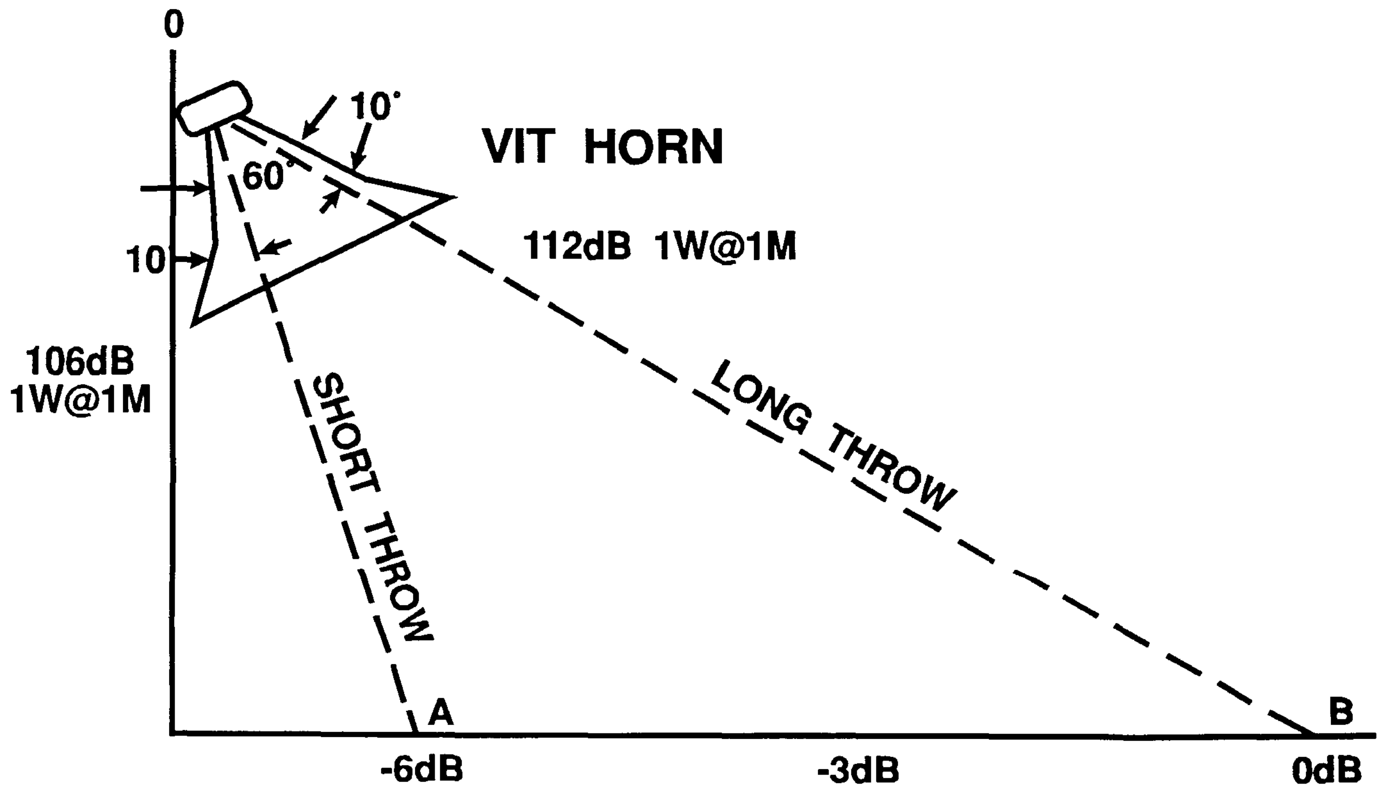

FIGURE 8B - VIT HORN

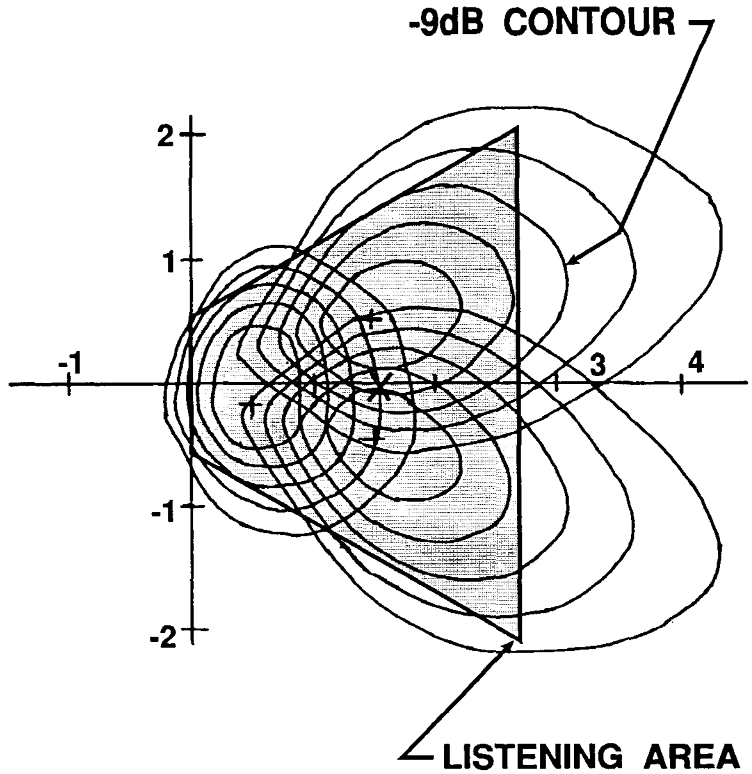

FIGURE 9A
FLOOR PLAN ISOBAR - 3 HORN CLUSTER

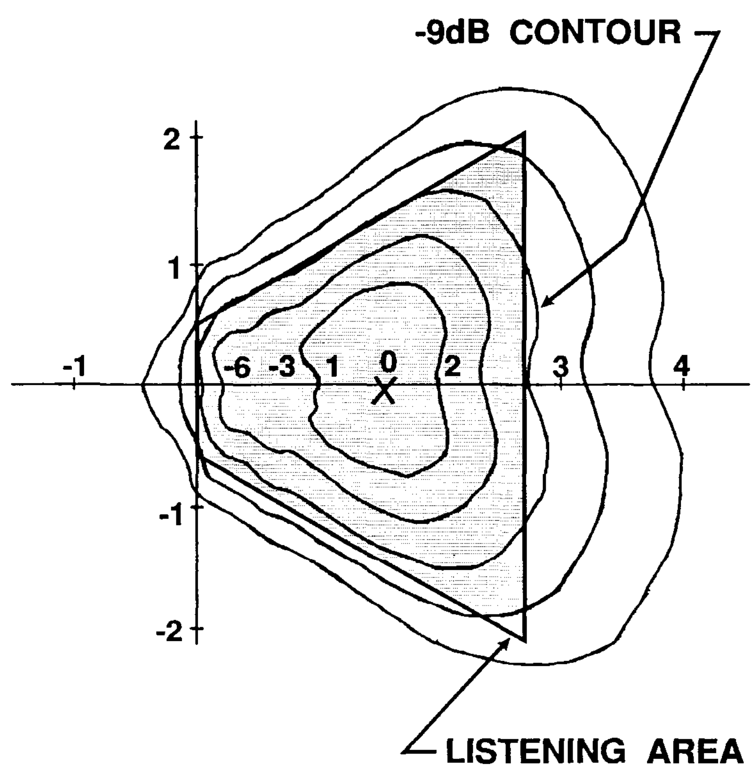

FIGURE 9B
FLOOR PLAN ISOBAR - VIT HORN

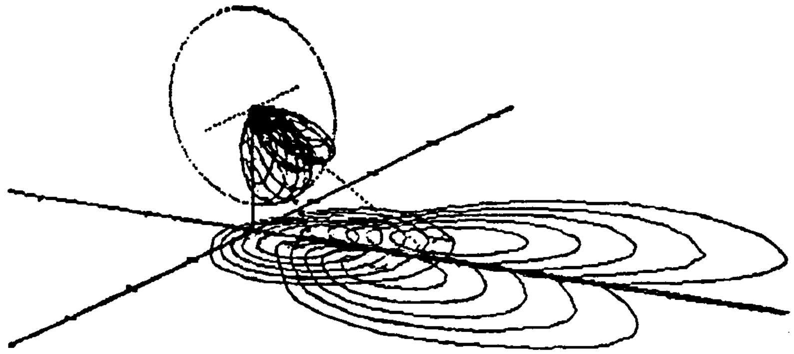

FIGURE 10A
3-D ISOLOON - 3 HORN CLUSTER

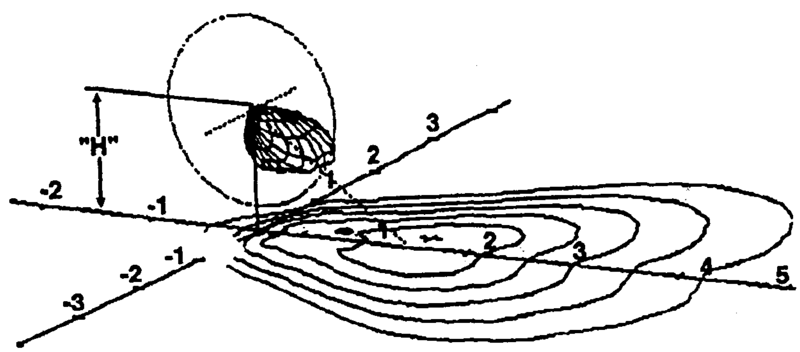

FIGURE 10B
3-D ISOLOON - VIT HORN

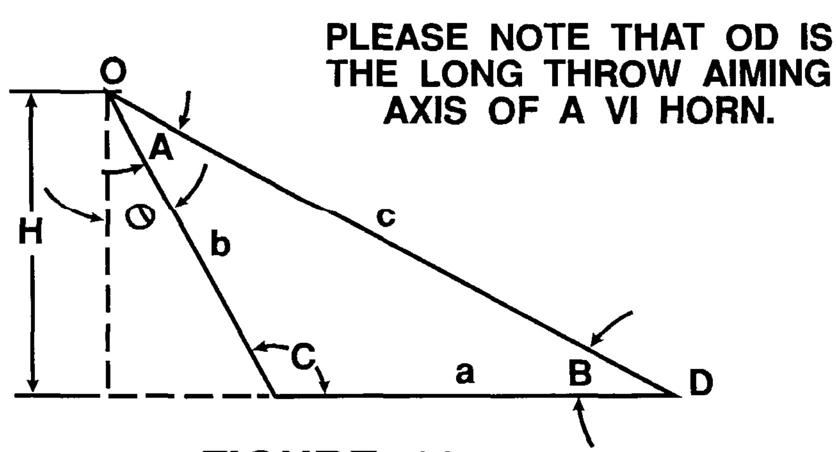

FIGURE 11
GENERALISED HORN AIMING CONDITIONS

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