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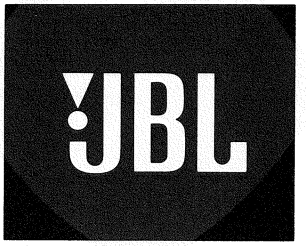


# Technical Note Vol. 1, No. 10

# Use Of The 4612OK, 4671OK, And 4660 Systems In Fixed Installation Sound Reinforcement

## Introduction:

For many small and medium scale sound reinforcement applications, preassembled systems are often the ideal choice. Among their advantages are:

1. The engineering has already been done. HF and LF elements are coupled in an optimum fashion, with minimal interference between elements.

2. The appearance is finished. Enclosure and grille details allow them to be installed with little further concern for esthetics.

3. They are economical, both in initial cost and cost of installation.

These systems lend themselves to small auditoriums, small to medium houses of worship, and meeting/lecture rooms. In terms of power capability, they are all rated at 200 watts, IEC pink noise, and they have nominal sensitivities of 97 dB, one watt at one meter. Thus, they will deliver enough output for speech applications, even in moderately large spaces.

In this Technical Note, we will discuss their application in detail, with special emphasis on the unique characteristics of the model 4660.

## MODEL 4612OK:

Because its low-frequency complement is a pair of 200 mm (8 in) woofers placed horizontally, the coverage in the horizontal plane narrows to 35 degrees (−6 dB included angle) in the midrange. For those applications where the system will be required to cover a wide horizontal angle, *it should be turned 90 degrees*, so that its wider nominal coverage of 100 degrees will then cover the room in the horizontal plane. For applications where relatively long throw is required, the normal orientation of the system will be best.

Above 4 kHz, the angular coverage of this system is 100 degrees in both the horizontal and vertical planes, due to the nature of the Bi-Radial 2404 HF ring radiator.

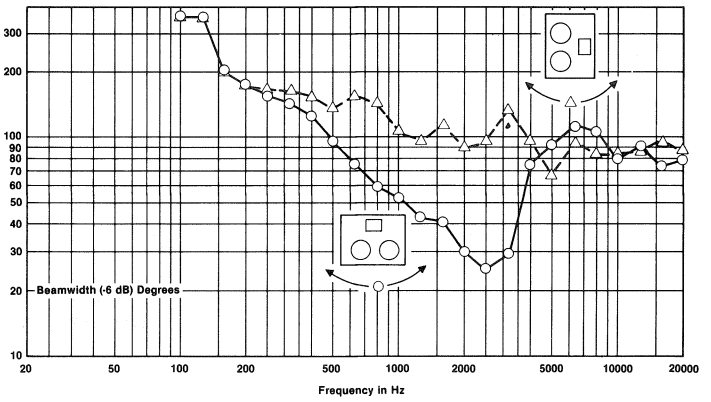
Details of horizontal and vertical coverage are shown in Figure 1. The DI (Directivity Index) of the system is between 8 and 10 dB from 800 Hz up to 20 kHz, indicating smooth power response and a consistent reverberant field. (See Sound System Design Reference Manual, pages 3–6 to 3–13.)

The 4612OK has bass response which begins to roll off below about 80 Hz. This is no problem with speech, however, and over this range it can deliver substantial output levels. In its Cabaret Series configuration, it can be used as a high-level vocal reinforcement system for many club applications.

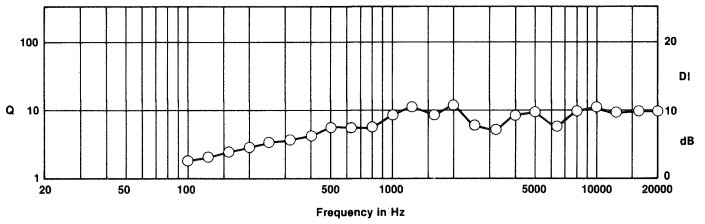
For speech reinforcement, its size is ideal for wall placement in meeting rooms and board rooms. There is no better system in its price range for audio-visual applications. It has also been utilized successfully as a motion picture surround system. For most of these applications, it should be oriented so that its LF drivers are vertical. For stereo music reproduction the normal orientation, with the two systems toed inward, will provide best effect.

**FIGURE 1. BEAMWIDTH (A) AND DIRECTIVITY DATA (B) FOR 4612OK**

**A.**




**B.**



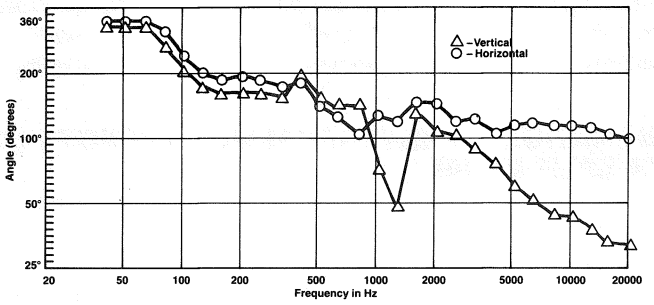

## MODEL 4671OK:

With its 380 mm (15 in) woofer, the 4671 provides about an octave more bass than the 4612OK. As a result, it can be specified for wide-band music applications, such as smaller theaters, dubbing rooms, and as surround systems in large motion picture theaters. In all of these applications, it should be kept in its normal orientation, tilted downward as required.

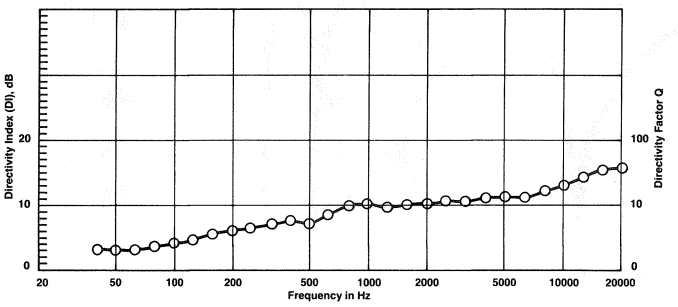
An examination of its nominal vertical and horizontal coverage angles (Figure 2) show that the vertical HF coverage progressively narrows with frequency above 1600 Hz. For this reason, it must be carefully tilted so that the axis of the horn is aimed about two-thirds the way back into the seating area, as shown in Figure 3.

## FIGURE 2. BEAMWIDTH (A) AND DIRECTIVITY DATA (B) FOR 4671OK

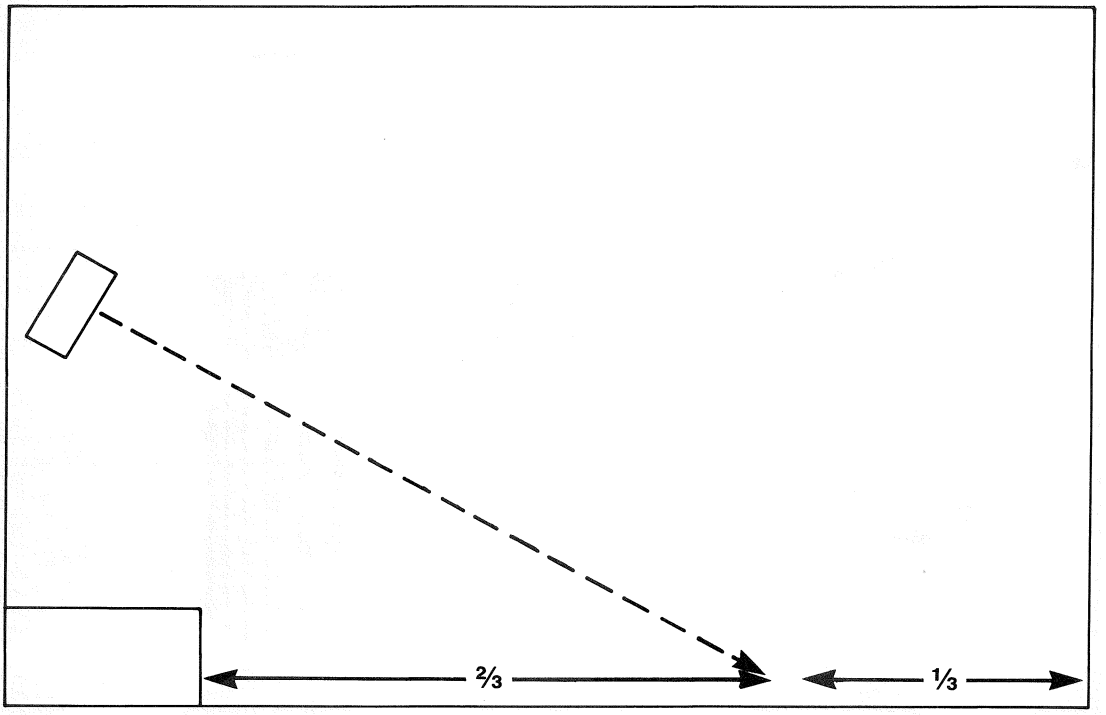
**A.**




**B.**




## FIGURE 3. AIMING THE 4671OK



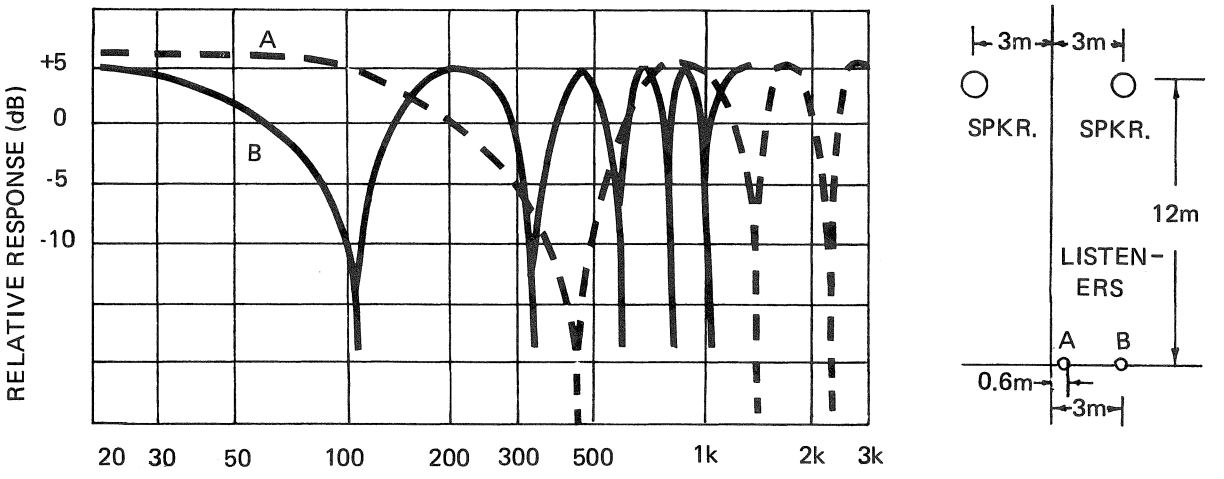

The horizontal coverage is consistently maintained from just above 500 Hz out to 20 kHz. This evenness of coverage is unusual, and it gives the system a very natural quality, both in the motion picture theater and for speech reinforcement applications.

Its DI is 10 dB, +/–2 dB, from 500 Hz to 10 kHz, ensuring smooth reverberant response in the typical environment. It is the ideal choice for speech reinforcement in wide, shallow spaces where there is no far-throw requirement.

In houses of worship, the system should be suspended high overhead and centered. In spaces which do not have considerable height, there is a strong temptation to use two loudspeakers, one on either side of the platform, feeding both the same program. We DO NOT recommend this. Figure 4 shows what happens with split systems for listeners who are displaced from the center line by just a small amount.

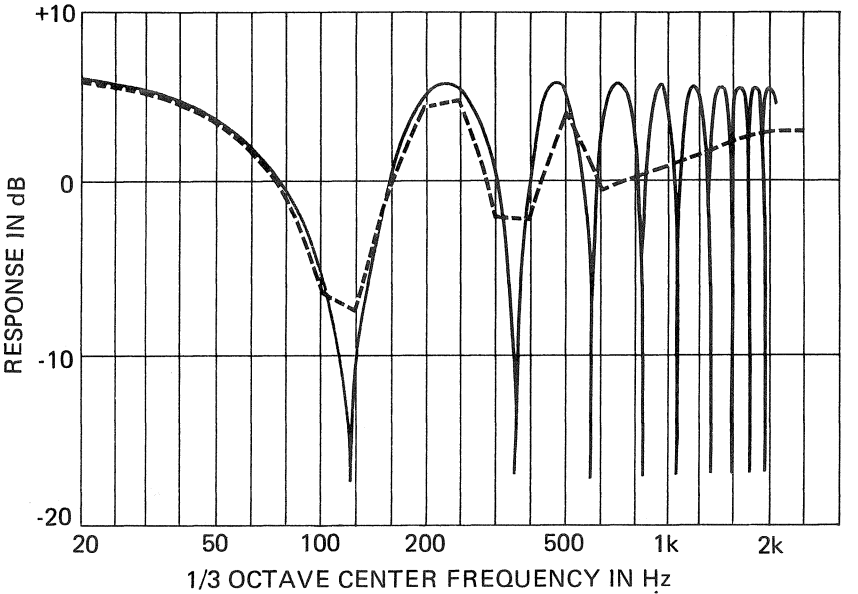
**FIGURE 4. GENERATION OF INTERFERENCE EFFECTS (COMB FILTER RESPONSE) BY A SPLIT ARRAY.**

**A.**




**Interference Effects from Two Separated Loudspeakers Producing Coherent Signals**

**B.**




SOLID LINE – MEASURED SINE WAVE FREQUENCY RESPONSE.

DOTTED LINE – 1/3 OCTAVE BAND RESPONSE, CLOSELY CORRESPONDING TO SUBJECTIVE TONAL QUALITY WHEN LISTENING TO NORMAL PROGRAM MATERIAL. ABOVE 1 kHz SUBJECTIVE RESPONSE IS ESSENTIALLY FLAT.

**Subjective Effect of Comb Filter Response**

## MODEL 4660:

The next step upward in smooth coverage is the 4660. This unique system provides wide coverage for the front of a room and narrow coverage for the back, thus providing a degree of compensation for the room's foreshortening, as seen from the loudspeaker itself.

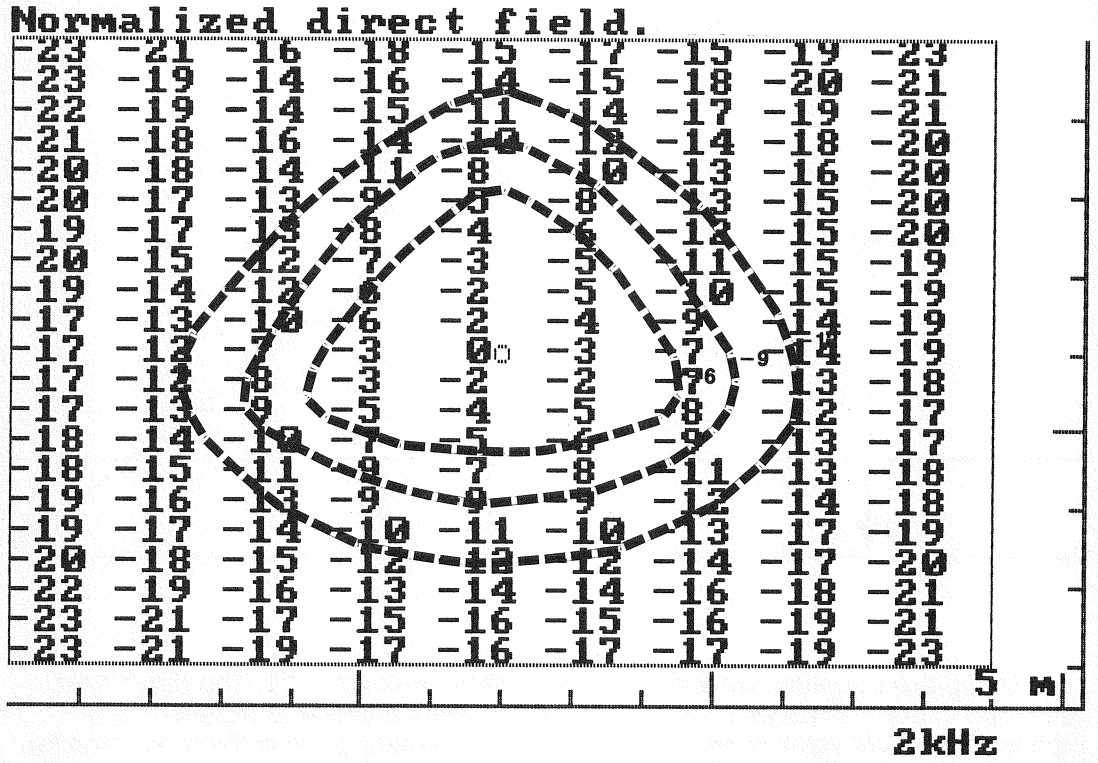
Those sound contractors who have specified the system for medium size houses of worship have reported remarkable results, commenting most favorably on the small size of the 4660, its attractive appearance, and its seamless coverage.

Perhaps the most important advantage of the 4660 is that it provides tailored coverage for the back of long spaces—but without any of the interference effects which all multi-horn systems exhibit.

Even though the 4660 was designed with a target rectangular space requiring 110 degrees at the front and 38 degrees at the rear, it is quite adaptable for many aspect ratios. Its effective vertical coverage angle is about 50 degrees.

Because it does not have symmetrical vertical and horizontal coverage characteristics, we cannot plot its nominal horizontal and vertical −6 dB beamwidth, as we did in the case of the two systems discussed earlier. The best way to appreciate the unique coverage aspects of the 4660 is to look at its isobar plots at 2 kHz. Figure 5 shows the CADP plot of the 4660 facing downward with an elevation angle of −90 degrees. The orientation is such that the top of the figure corresponds to the long-throw coverage in the rear of the room.

**FIGURE 5. −6, −9, AND −12 dB ISOBARS.**



## Applications of the 4660:

### A. The first application is a long house of worship with the following dimensions:

Length = 40 meters
Width = 15 meters
Height = 14 meters

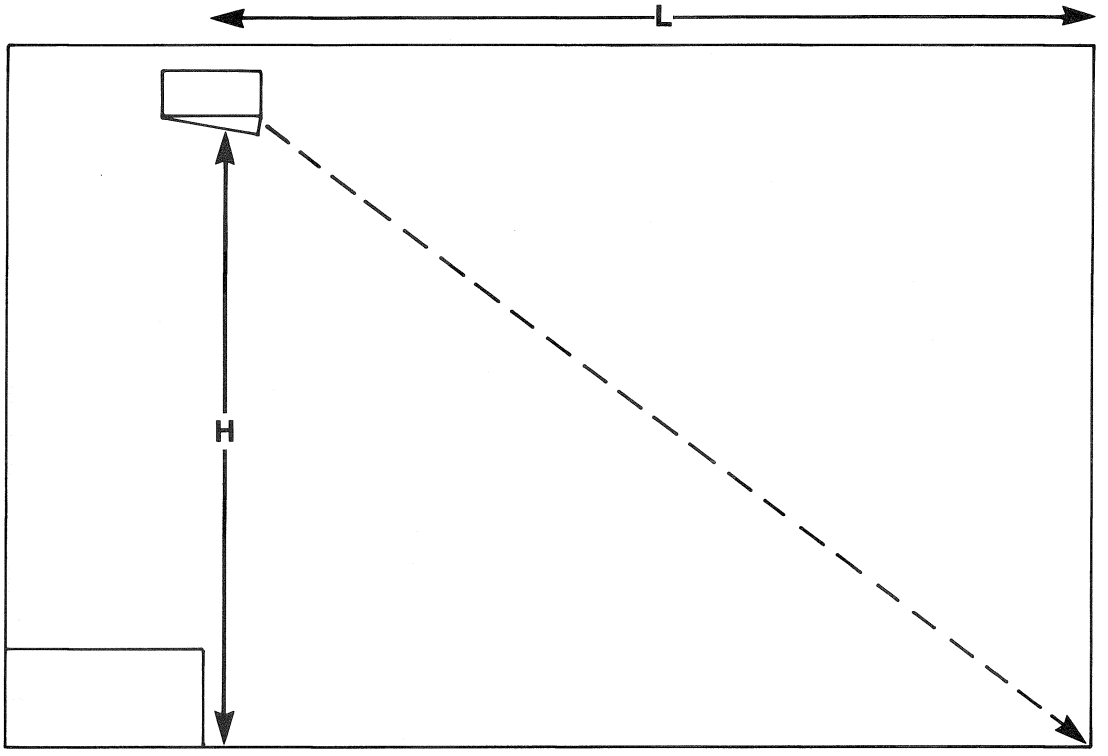
The 4660 location is in the ceiling at a distance of 2 meters from the front wall.

We have found that the best general elevation angle for the 4660 is that which points its axis directly at the back row of the seating plane. The following equation can be used to arrive at this angle:

$$\text{Elevation Angle} = -\arctan(H/L), \quad (1)$$

where H is the height of the 4660 above the seating plane and L is the horizontal distance from the 4660 to the last row of seats. (Remember that the axis of the 4660 is along the firing line of the high-frequency driver.) Details of this are shown in Figure 6.

**FIGURE 6. AIMING THE 4660**

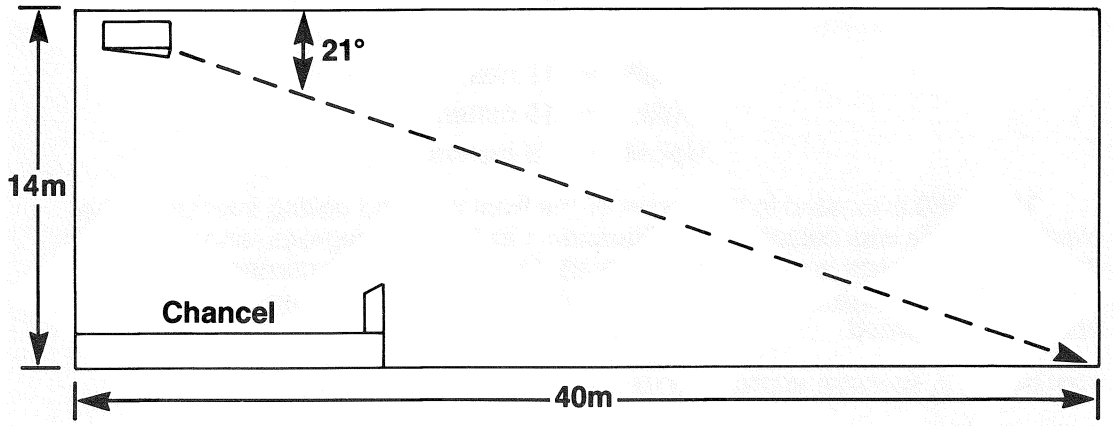



Using this equation, we arrive at an elevation angle of −21. The direct field coverage in the room is as shown in Figure 7B. The coverage is excellent; the highest direct field value is just a little beyond the halfway point in the room, and the total variation over the seating area is no more than ± 1.5 dB.

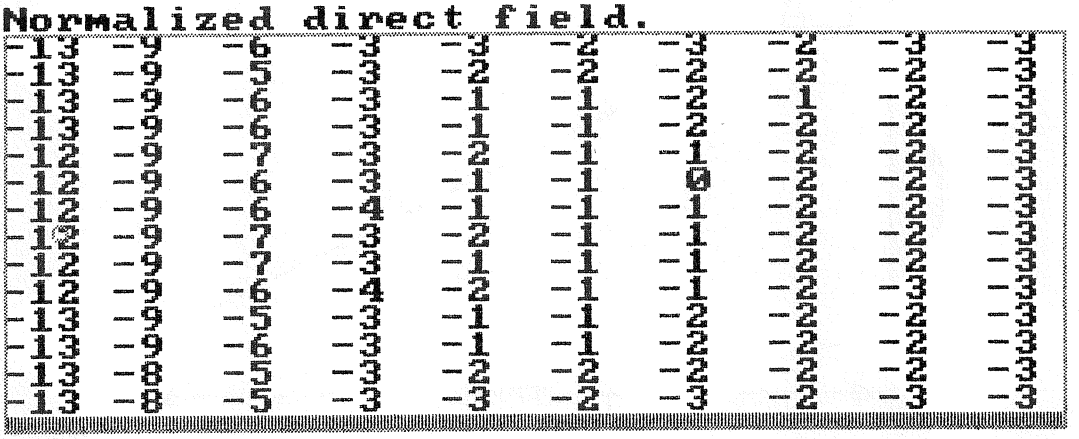
If we assume that the reverberation time in this space is 2 seconds, we can calculate the estimated intelligibility for the system when the room is occupied. This is shown in Figure 7C. The system works very well, and only the chancel area, where the system is not required to provide coverage, has questionable intelligibility (QU).

FIGURE 7. 4660 IN A HOUSE OF WORSHIP.

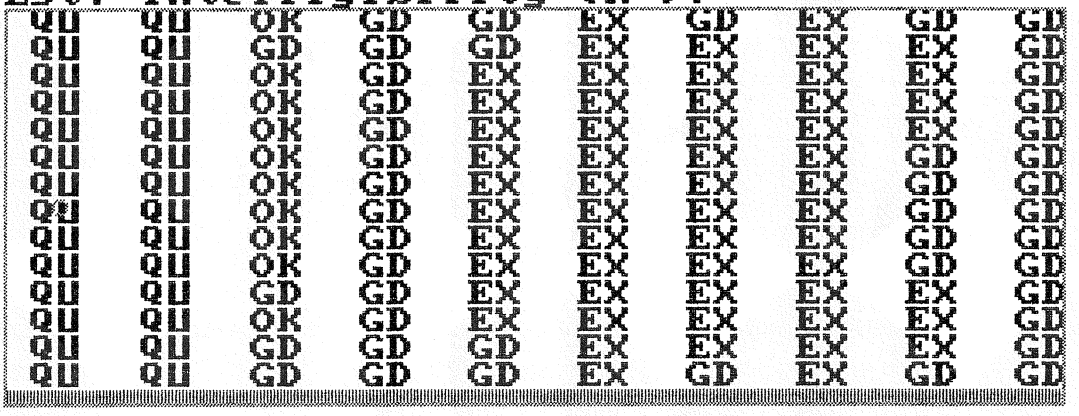
A. SIDE VIEW




B. TOP VIEW




C. TOP VIEW



### B. A Short, Wide Room:

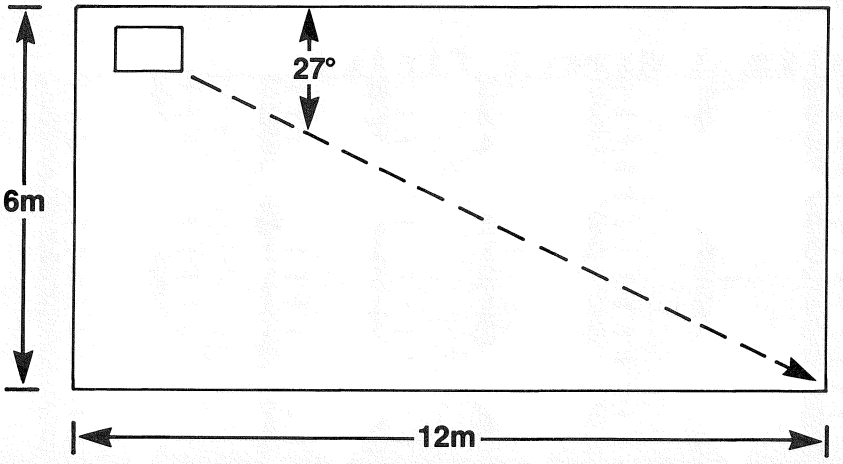
Because of its long-throw aspect, the 4660 might not normally be chosen for use in a short, wide room. In this case, it works well. The room has the following dimensions:

Length = 12 meters
Width = 15 meters
Height = 6 meters

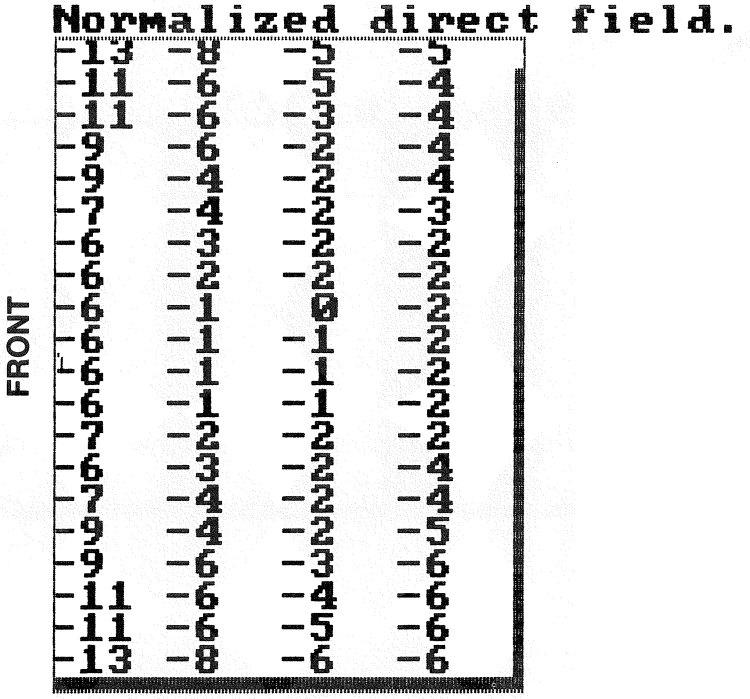
The 4660 is located in the center of the front wall and ceiling interface. The elevation angle was calculated by Equation 1 to be −27 degrees, and the CADP direct field coverage is shown in Figure 8B. Only the far front corners are shown to be down in coverage, but these are parts of the room where listeners would not normally be located.

**FIGURE 8. A SHORT, WIDE ROOM**

**A. SIDE VIEW**




**B. PLAN VIEW**

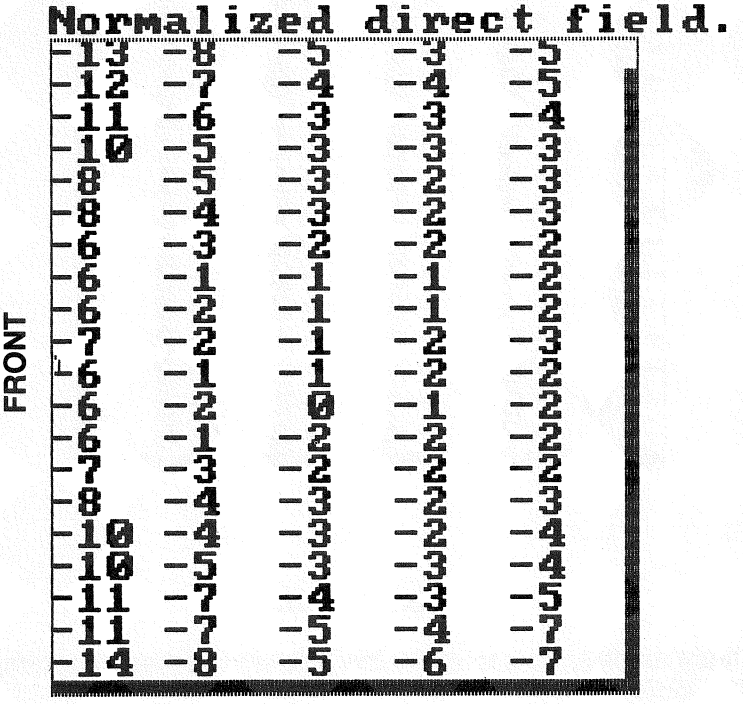


### C. A Square Room with Different Ceiling Heights:

Figure 9 shows the direct field coverage for a 20-by-20 meter room with ceiling heights of 7 meters (A), 10 meters (B), and 13 meters (C). In each case, we calculated the elevation angle using Equation 1. In all three cases, the direct field response is excellent.

**FIGURE 9. COVERAGE IN A 20x20 METER ROOM WITH THREE DIFFERENT CEILING HEIGHTS.**

**A. CEILING HEIGHT = 7m**
**ELEVATION ANGLE = −19°**




**B. CEILING HEIGHT = 10m**
**ELEVATION ANGLE = −27°**

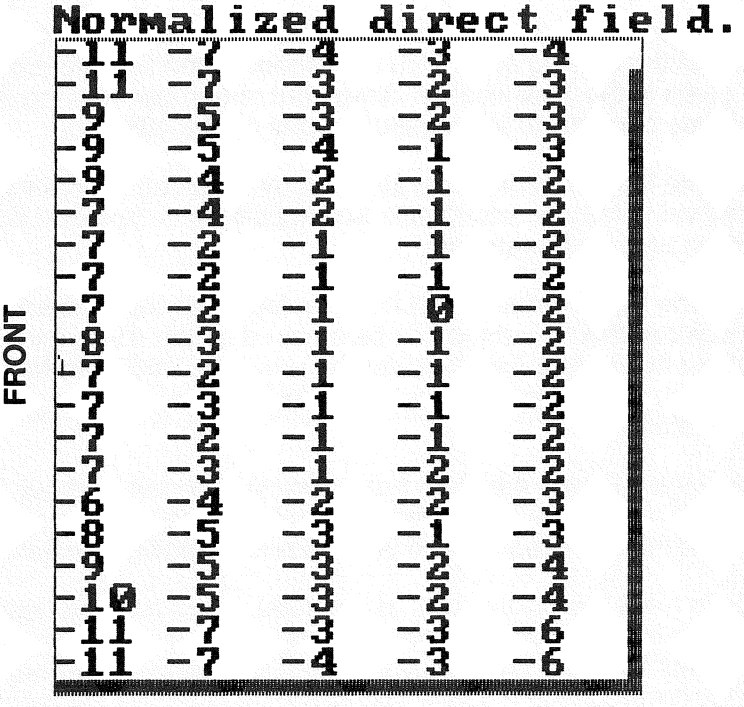
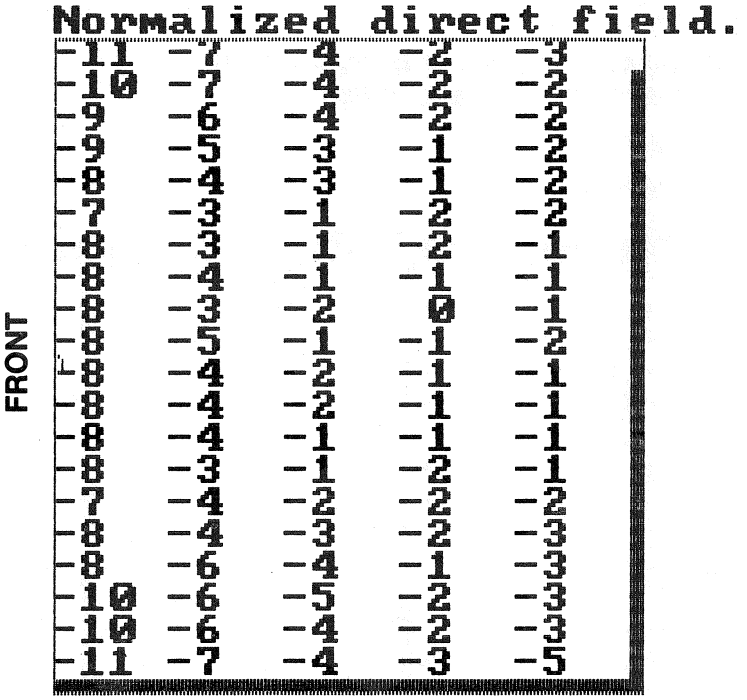


**FIGURE 9, CONTINUED**

**C. CEILING HEIGHT = 13m**
**ELEVATION ANGLE = −33°**




**Conclusions:**

From these studies, we can make the following general recommendations on the use of the 4660:

1. Keep the 4660 as high as possible. The higher it is, the less will be the side-to-side coverage variation in the front of the seating area.

2. Do not specify the 4660 in rooms where its height is less than about one-third the width of the seating area. This may seem in conflict with the "standard orientation" given in the Specification Sheet, but remember that the data given that document relates primarily to the measurements on the 4660.

3. Calculate the elevation angle as given by Equation 1. Minor variations from this calculated value may be acceptable and should be determined by experimentation and measurement.

4. Watch the ratio of room width to room depth. As we have shown here, a room which is wider than it is deep can be covered by the 4660, if the ratio is not more than about five-to-four (width-to-depth), and if the 4660 can be located high enough. In rooms of this sort, the front corners will suffer in coverage, and this must be taken into account.

5. As a single system, the 4660 has a directivity index of about 11 dB in the range above 1 kHz. Because of this, the system will not excite excessive reverberant field response in most live rooms, and adequate intelligibility can be expected.

6. Keep in mind the power class of the 4660. The system is designed for speech coverage in rooms up to moderately large size. It is no substitute for a large cluster, but it does have the advantage of providing interference-free, seamless high-frequency coverage—and this is something that no multi-element system can provide.

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