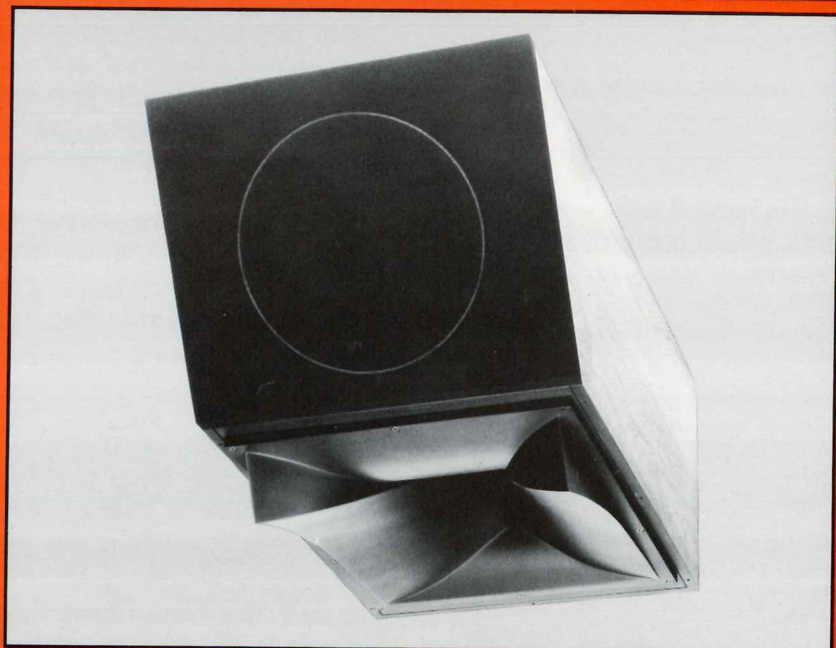
4660 DEFINED COVERAGE LOUDSPEAKER SYSTEM



FEATURES:

Compact Sound Reinforcement System.

99dB sensitivity, 1W, 1m (3.3 ft).

40 Hz to 15 kHz frequency range.

Skewed Coverage (110 degrees front — 38 degrees back) for ideal performance in rectangular rooms.

Unique Patented Bi-Radial Horn Design.

150 Watts Input Power Capacity.

380mm (15 in) Low-frequency Transducer.

Walnut Veneer Enclosure.

The Model 4660 Sound Reinforcement Loudspeaker System is the first of its kind. It is designed to provide controlled coverage in a normal rectangular space so that, at frequencies above 1 kHz, the coverage is very uniform in both the front and back of the room.

The high-frequency coverage pattern is symmetrical from side to side, but it is skewed front to back in such a way that the nominal front coverage angle is 110 degrees, while the nominal back coverage angle is 38 degrees.

The 4660 system is ideal for moderate to large meeting rooms and moderate-size houses of worship. In most cases, it will provide a degree of

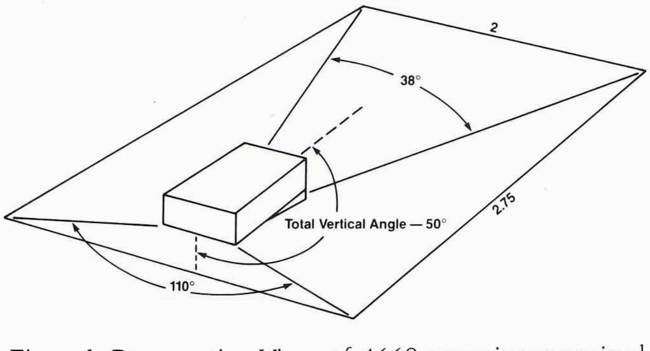


Figure 1. Perspective View of 4660 covering nominal aspect ratio.

speech coverage which, if achieved with conventional components, would require three or more high-frequency devices.

SYSTEM CONCEPT

The Model 4660 defined coverage system is designed to normally cover a rectangular space with an aspect ratio of 2 by 2.75. The system is ideally placed 0.6 unit high and 0.35 unit beyond the front coverage edge, as shown in Figure 1.

HIGH-FREQUENCY PERFORMANCE

The unique high-frequency horn* was designed according to the same principles used in the design of JBL's Bi-Radial horn family. Accurate pattern control is maintained at high frequencies, and smooth loading is maintained down to the crossover frequency of 800 Hz. The high-frequency driver is the model 2425J. The integral dividing network contains power response correction circuitry, which maintains very flat and smooth response in all directions over the solid angle covered by the system.

LOW-FREQUENCY PERFORMANCE

Below 800 Hz, smooth coverage is provided down to 40 Hz by the model 2225H 380mm (15 in) low-frequency transducer mounted in a ported 195 liter (6.9 cu ft) enclosure.

REFERENCE AXIS

With horns of conventional design, it is clear that the reference axis of the system is also the axis of greatest sensitivity. This axis is also parallel to the driver's outlet, and it is also the mounting axis of the horn.

With a system such as the 4660, there are several conflicting requirements. In normal use, the system is tilted as shown in Figure 2. The nominal zero axis of the system is that parallel with the high-frequency driver's outlet, and its angle is 60 degrees downward from the back of the enclosure.

In the normal mounting attitude, this reference "zero" axis points about one-third to one-fourth of the way into the room, and all isobar plots are referred to this axis. In this manner, the isobar plots will provide maximum data over the entire coverage area. This advantage extends to JBL's CADP computer program as well.

The low-frequency driver is aimed toward the back coverage area. In the 500-to-800-Hz range, the directional characteristics of the driver are significant, and aiming the driver accordingly helps maintain good spectral balance in the back of the room.

DIRECTIONAL DATA

Figures 3 through 8 show the on- and off-axis frequency response of the system as measured along the side-to-side lines marked A through F in Figure 2. The curves have been normalized with respect to the on-axis readings along lines A through F. Isobar data on octave centers from 1 kHz to 8 kHz are shown in Figures 9 through 12. Data in this form may be useful to system designers using spherical mapping programs for determining horn coverage.

Figure 13 shows the views of the target rectangular space as seen in spherical coordinates at the position of the 4660. Note that the isobars, especially at the high frequencies, follow the outline of the space quite accurately.

SYSTEM PERFORMANCE

Figures 14 through 19 show additional aspects of system performance. The data relating to maximum power input will allow calculations of maximum system acoustical output in both direct and reverberant fields.

*Patent No. 4,580,655

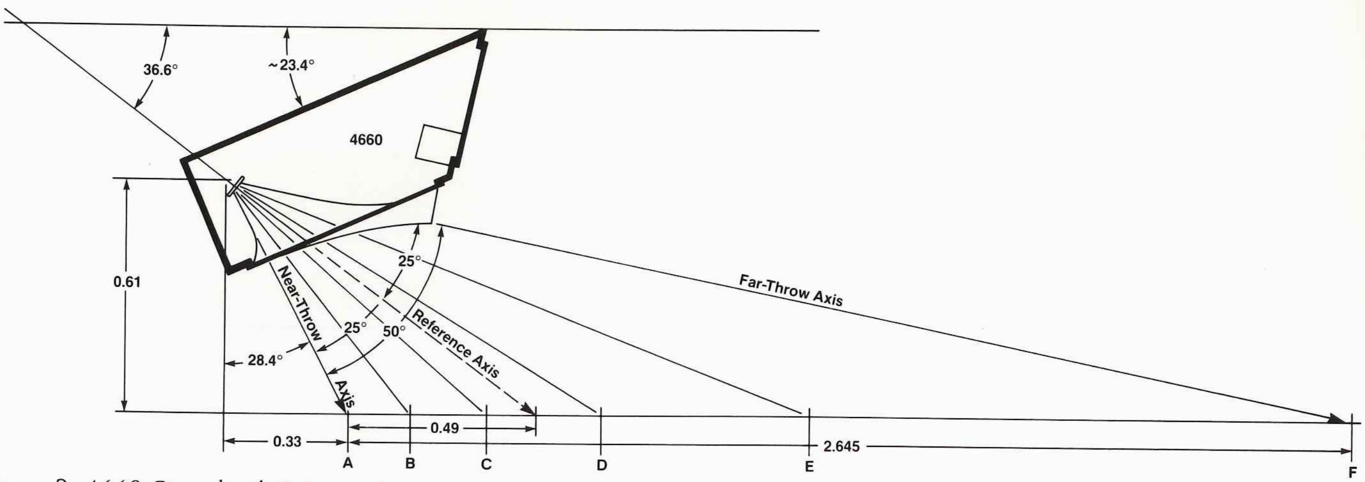


Figure 2. 4660 Standard Orientation.

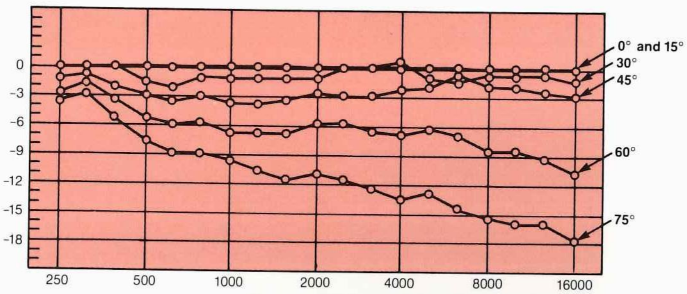


Figure 3. Off-axis Response at A.

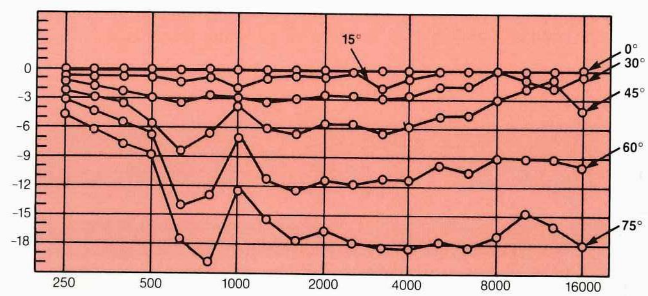


Figure 6. Off-axis Response at D.

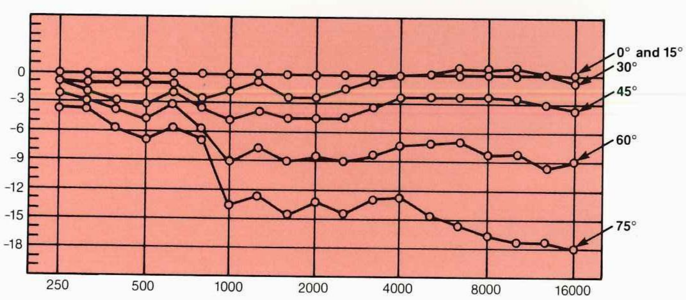


Figure 4. Off-axis Response at B.

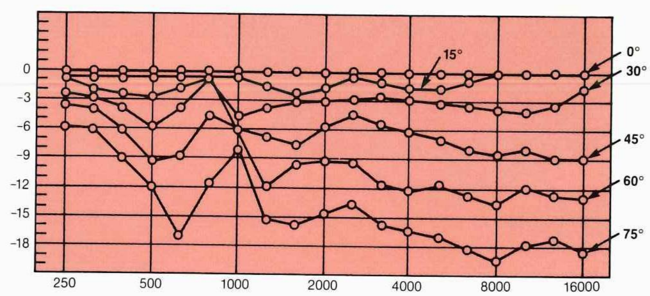


Figure 7. Off-axis Response at E.

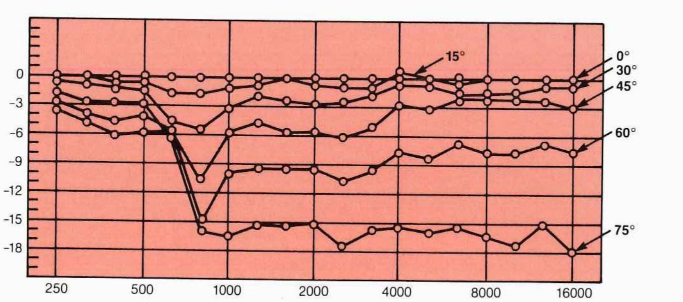


Figure 5. Off-axis Response at C.

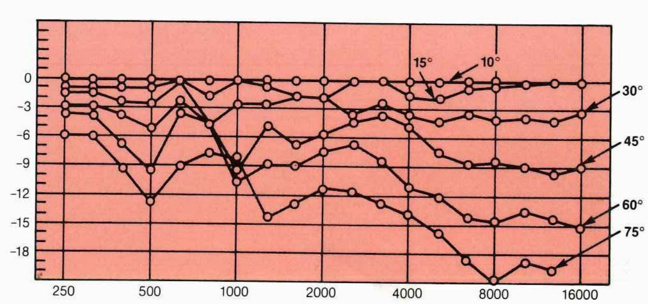


Figure 8. Off-axis Response at F.

–3, –6, –9, and –12dB Isobar Plots.

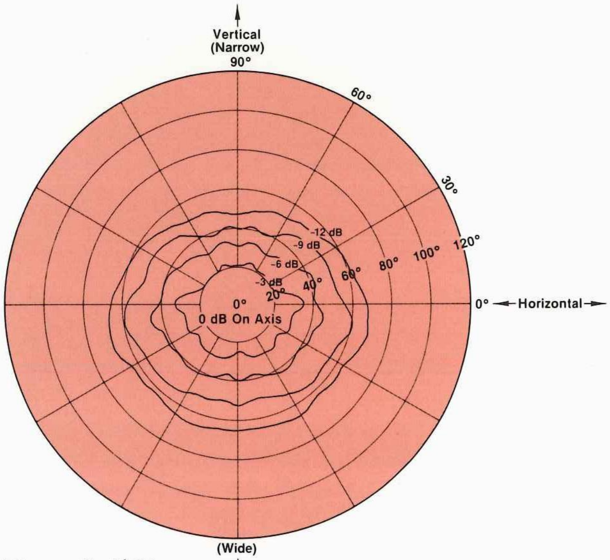


Figure 9. 1kHz.

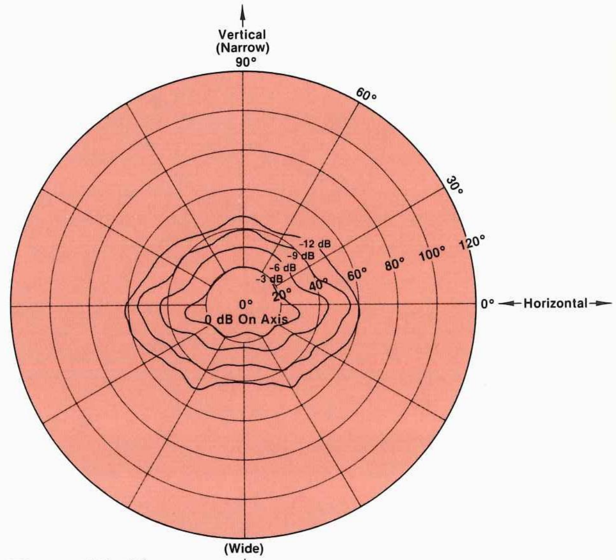


Figure 10. 2kHz.

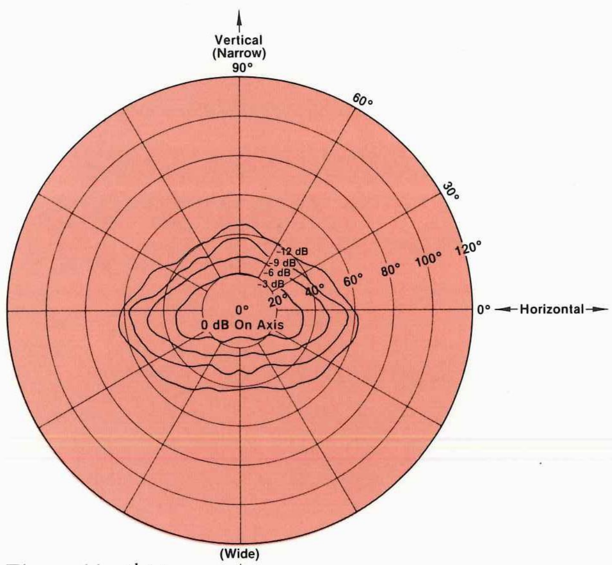


Figure 11. 4kHz.

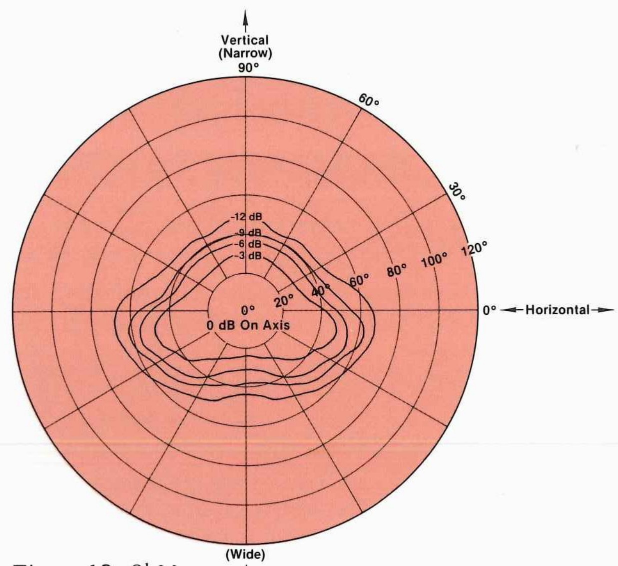


Figure 12. 8kHz.

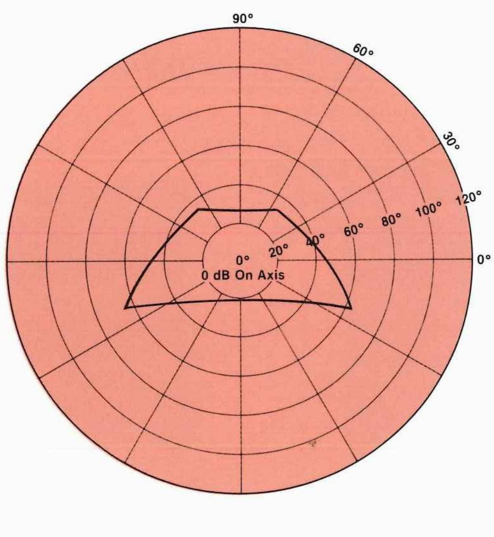


Figure 13. View of Target Floor Area as Seen from the 4660.

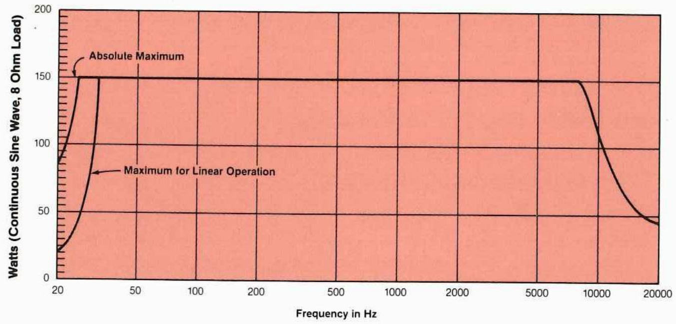


Figure 14. Maximum Continuous Sine-wave Input Power vs. Frequency.

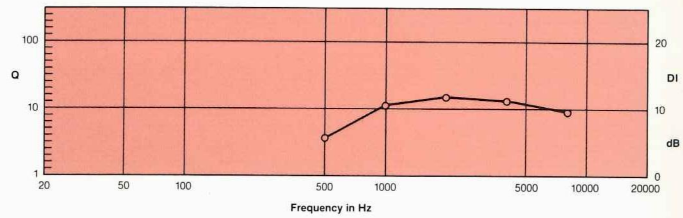


Figure 17. Axial DI and Q vs. Frequency.

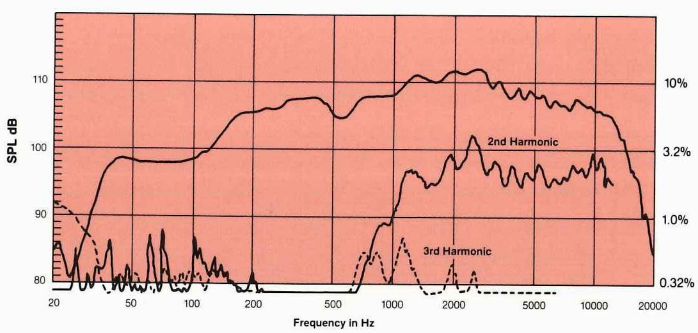


Figure 15. Distortion vs. Frequency, 10 Watts Input.

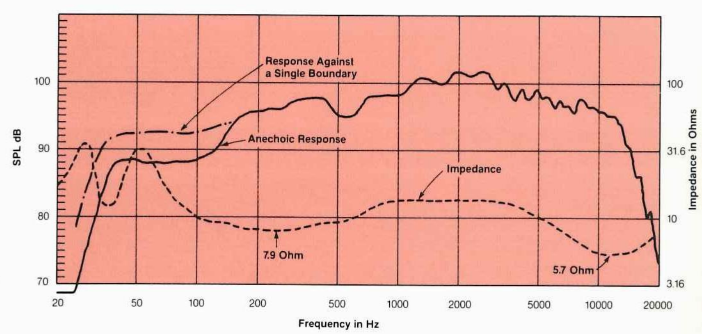


Figure 18. On-axis Frequency Response.

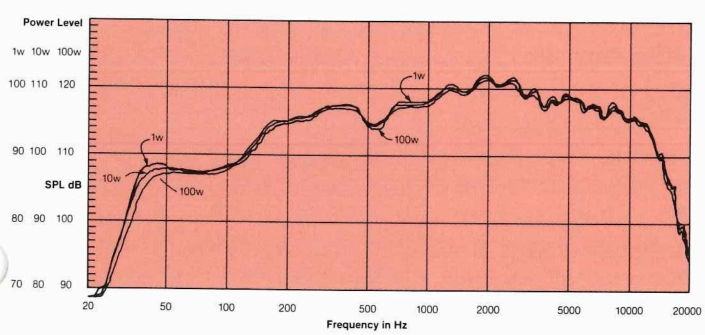


Figure 16. Power Compression, (85, 95, and 105dB-SPL at 1 meter) vs. Frequency.

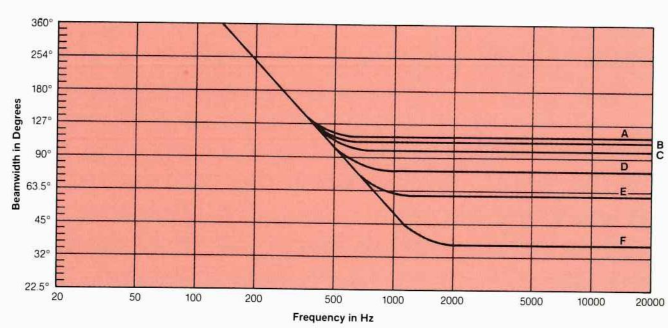


Figure 19. Beam Width vs. Frequency at A through F.

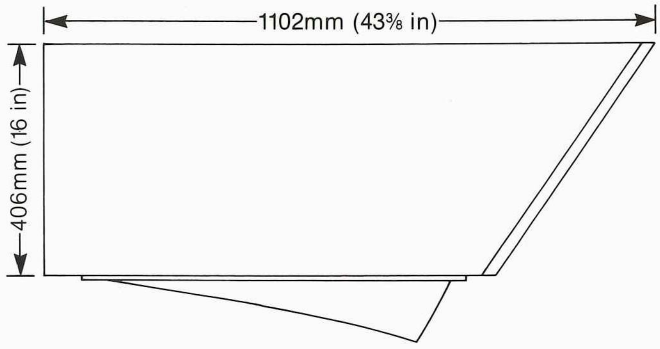


Figure 20. Side View 4660.

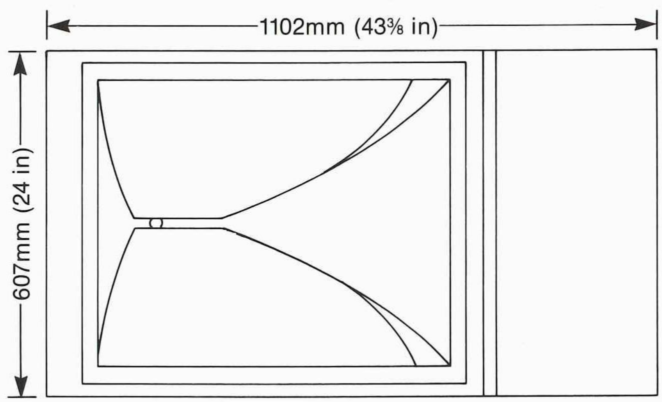


Figure 21. Bottom View 4660.

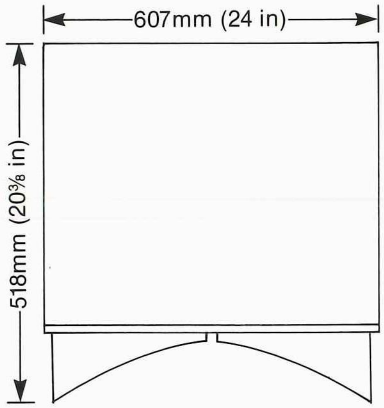


Figure 22. Front View 4660.

NOTES ON USAGE

It is not necessary that the 4660 be specified only for rectangular spaces of the target aspect ratio. By tilting the system appropriately, the system can be used to achieve excellent coverage in square rooms as well as those which are longer than the target aspect ratio. Those system designers having access to JBL's CADP computer program can determine directly the coverage of the system on any arbitrary seating area as a function of elevation angle.

Figures 2 through 8 represent the *design limits* on the front and back coverage angles of the 4660. DO NOT assume that the system can only be used where these aspect ratios exist.

The front-back distance ratio shown is 2.75-to-1, and this represents an inverse square level difference of about 8 dB. Placing the 4660 at a higher position than that indicated in Figure 2 will result in less front-back level variation.

In general, we can make the following recommendations for using the 4660.

1. Point the axis of the 4660 toward the last row of seats in the space. (The axis of the 4660 is in line with the axis of the high-frequency horn.)
2. The correct elevation angle of the 4660 can be determined by:
   Elevation Angle = –arctan (H/L),
   where H is the height above the seating plane and L is the horizontal distance from the 4660 to the last row of seats.
3. Keep the 4660 as high as possible. This will minimize side-to-side coverage variations.
4. Do not specify the 4660 in rooms where the height will be less than about one-third of the width of the seating area.
5. Watch the ratio of room width to room depth. A room which is wider than it is deep can be properly covered by the 4660, provided the width-to-depth ratio is not more than about five-to-four and provided that the 4660 can be placed high enough. Figure 23 shows the performance of the 4660 in such a room. Note that only the front corners of the room are low in coverage.
6. Square rooms are easily covered by the 4660, as shown in Figures 24, 25, and 26. In these examples, the room is 20-by-20 meters, and the height of the 4660 is varied from 7 to 13 meters. In each case the elevation angle was calculated according to the equation given in paragraph 2. Note that the higher positions of the 4660 produce less side to side variation in level.
7. Rooms which are longer than they are wide are easily covered by the 4660. Figure 27 shows a room which is 40 meters long and 15 meters wide. The 4660 is placed at a height of 14 meters and at a distance of 2 meters from the front wall. Note that coverage is remarkably smooth over the seating area. Again, the elevation angle was determined from the equation given in paragraph 2.
8. 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.

Figure 23. A Short, Wide Room

Normalized direct field.

-13	-8	-5	-5
-11	-6	-5	-4
-11	-6	-3	-4
-9	-6	-2	-4
-9	-4	-2	-4
-7	-4	-2	-3
-6	-3	-2	-2
-6	-2	-2	-2
-6	-1	0	-2
-6	-1	-1	-2
-6	-1	-1	-2
-6	-1	-1	-2
-7	-2	-2	-2
-6	-3	-2	-4
-7	-4	-2	-4
-9	-4	-2	-5
-9	-6	-3	-6
-11	-6	-4	-6
-11	-6	-5	-6
-13	-8	-6	-6

Front

4660 at center of left wall, 6 meters high.
Elevation Angle = –27°
Width of Room = 15m
Depth of Room = 12m

Figure 24. A Square Room 20-by-20 meters

Normalized direct field.

-13	-8	-5	-3	-5
-12	-7	-4	-4	-5
-11	-6	-3	-3	-4
-10	-5	-3	-3	-3
-8	-5	-3	-2	-3
-8	-4	-3	-2	-3
-6	-3	-2	-2	-2
-6	-1	-1	-1	-2
-6	-2	-1	-1	-2
-7	-2	-1	-2	-3
-6	-1	-1	-2	-2
-6	-2	0	-1	-2
-6	-1	-2	-2	-2
-7	-3	-2	-2	-2
-8	-4	-3	-2	-3
-10	-4	-3	-2	-4
-10	-5	-3	-3	-4
-11	-7	-4	-3	-5
-11	-7	-5	-4	-7
-14	-8	-5	-6	-7

Front

4660 at center of left wall, 7 meters high.
Elevation Angle = –19°

Figure 25. A Square Room 20-by-20 meters

Normalized direct field.

-11	-7	-4	-3	-4
-11	-7	-3	-2	-3
-9	-5	-3	-2	-3
-9	-5	-4	-1	-3
-9	-4	-2	-1	-2
-7	-4	-2	-1	-2
-7	-2	-1	-1	-2
-7	-2	-1	-1	-2
-7	-2	-1	0	-2
-8	-3	-1	-1	-2
-7	-2	-1	-1	-2
-7	-3	-1	-1	-2
-7	-2	-1	-1	-2
-7	-3	-1	-2	-2
-6	-4	-2	-2	-3
-8	-5	-3	-1	-3
-9	-5	-3	-2	-4
-10	-5	-3	-2	-4
-11	-7	-3	-3	-6
-11	-7	-4	-3	-6

Front

4660 at center of left wall, 10 meters high.
Elevation Angle = –27°

Figure 26. A Square Room 20-by-20 meters

Normalized direct field.

-11	-7	-4	-2	-3
-10	-7	-4	-2	-2
-9	-6	-4	-2	-2
-9	-5	-3	-1	-2
-8	-4	-3	-1	-2
-7	-3	-1	-2	-2
-8	-3	-1	-2	-1
-8	-4	-1	-1	-1
-8	-3	-2	0	-1
-8	-5	-1	-1	-2
-8	-4	-2	-1	-1
-8	-4	-2	-1	-1
-8	-4	-1	-1	-1
-8	-3	-1	-2	-1
-7	-4	-2	-2	-2
-8	-4	-3	-2	-3
-8	-6	-4	-1	-3
-10	-6	-5	-2	-3
-10	-6	-4	-2	-3
-11	-7	-4	-3	-5

Front

4660 at center of left wall, 13 meters high.
Elevation Angle = –33°

Figure 27. A Long Room, 40-by-15 meters

Normalized direct field.

-13	-9	-6	-3	-3	-2	-2	-2	-3
-13	-8	-5	-3	-3	-2	-2	-2	-2
-13	-9	-5	-2	-1	-2	-2	-1	-2
-12	-9	-5	-3	-1	-2	-2	-2	-2
-12	-9	-6	-3	-1	0	-1	-2	-2
-12	-9	-6	-3	-1	-1	-1	-2	-3
-12	-9	-6	-3	-1	-1	-2	-2	-3
-12	-8	-6	-3	-2	-1	-2	-2	-3
-12	-9	-6	-3	-1	-1	-2	-3	-3
-12	-9	-6	-3	-1	-1	-2	-2	-3
-12	-9	-5	-3	-1	-1	-2	-2	-2
-12	-9	-6	-2	-1	-2	-2	-2	-2
-13	-8	-5	-3	-1	-2	-2	-2	-2
-13	-8	-5	-3	-3	-2	-2	-2	-3

Front

Seating Area

4660 14 meters high and 2 meters from front wall.
Elevation Angle = –20°

9. 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 high-frequency array can provide.

Additional information on the design of the horn used in the 4660 system may be found in the paper, *A Loudspeaker Horn that Covers a Flat Rectangular Area from an Oblique Angle* by D. B. Keele, presented at the 74th New York AES convention in the fall of 1983 (Preprint number 2052).

SPECIFICATIONS

SYSTEM:	
Frequency Range:	(—10 dB) 40 Hz to 15 kHz
Frequency Response:	(±4 dB) 80 Hz to 12 kHz
Power Capacity[1]:	150 W continuous pink noise
Sensitivity[2]:	99 dB SPL, 1 W, 1 m (3.3 ft)
Nominal Impedance:	8 ohms
Crossover Frequency:	800 Hz
LOW FREQUENCY LOUDSPEAKER:	
Model:	2225H
Nominal Diameter:	380mm (15 in)
Voice coil:	100mm (4 in) edge-wound copper ribbon
Magnetic Assembly Weight:	8.5kg 18⅝ lb
Flux Density:	1.2 T (12,000 gauss)
Sensitivity[3]:	97 dB SPL, 1 W, 1 m (3.3 ft)
HIGH FREQUENCY DRIVER:	
Model:	2425J
Voice Coil Diameter:	44mm (1¾ in)
Throat Diameter:	25mm (1 in)
Flux Density:	1.5 T (18,000 gauss)
GENERAL:	
Finish:	Oiled Walnut
Grille Color:	Dark Brown (Horn Grille optional)
Dimensions:	1102mm x 518mm x 607mm wide 43⅜ in x 20⅜ in x 24 in wide
Net Weight:	297kg (135 lb)
Shipping Weight:	354kg (161 lb)

[1]Rating based on test signal of filtered random noise conforming to international standard IEC 268-5 (pink noise with 12 dB/octave rolloff below 40 Hz and above 5000 Hz with a peak-to-average ratio of 6 dB), two hours duration.

[2]Averaged from 500 to 2.5 kHz

[3]Averaged from 100 Hz to 500 Hz

ARCHITECTURAL SPECIFICATIONS

The loudspeaker system shall consist of a 380mm (15 in) low-frequency transducer, a defined coverage high-frequency horn and driver, and a frequency dividing network installed in a ported enclosure. The frame of the low-frequency transducer shall be manufactured of cast aluminum, and its magnetic assembly shall utilize a ferrite magnet and produce a symmetrical magnetic field at the voice coil gap. In addition, an aluminum ring encircling the pole piece shall act to reduce flux modulation. The voice coil shall be 100mm (4 inch) in diameter and shall be made of flat copper ribbon wire operating in a magnetic field of not less than 1.2T (12,000 gauss).

The frequency dividing network shall have a crossover frequency of 800 kHz and shall be of the L-C type.

Performance specifications of a typical production unit shall be as follows: Measured sensitivity (SPL at 1 m (3.3 ft) of axis with 1 W input, swept 500 Hz-2.5 kHz) shall be at least 99 dB SPL. Usable frequency range shall extend from 40 Hz to 15 kHz. On-axis response, measured at a distance of 2 m (6.6 ft) or more under free-field conditions, shall be ±4 dB from 80 Hz to 12 kHz. Nominal impedance shall be 8 ohms. Rated power capacity shall be at least 150 watts continuous pink noise, based on test signal of filtered random noise conforming to international standard IEC 268-5 (pink noise with 12 dB octave rolloff below 40 Hz and above 5000 Hz with a peak-to-average ratio of 6 dB), two hours duration.

The enclosure shall be solidly constructed of 19mm (¾ inch) stock with all joints tightly fitted and glued. Overall dimensions shall be no greater than 1102mm (43⅜ in) long by 518mm (20⅜ in) deep by 607mm (24 in) wide. Finish shall be walnut veneer with brown fabric grille. Internal L-brackets facilitate safe and sure mounting of the system by means of four eye-bolts, which can be mounted on the top of the enclosure. The system shall be JBL Professional Model 4660.

JBL continually engages in research related to product improvement. New materials, production methods, and design refinements are introduced into existing products without notice as a routine expression of that philosophy. For this reason, any current JBL product may differ in some respect from its published description, but will always equal or exceed the orginal design specifications unless otherwise stated.

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