Acoustic Evaluation SMA Community Church

Revised 2 December 2025

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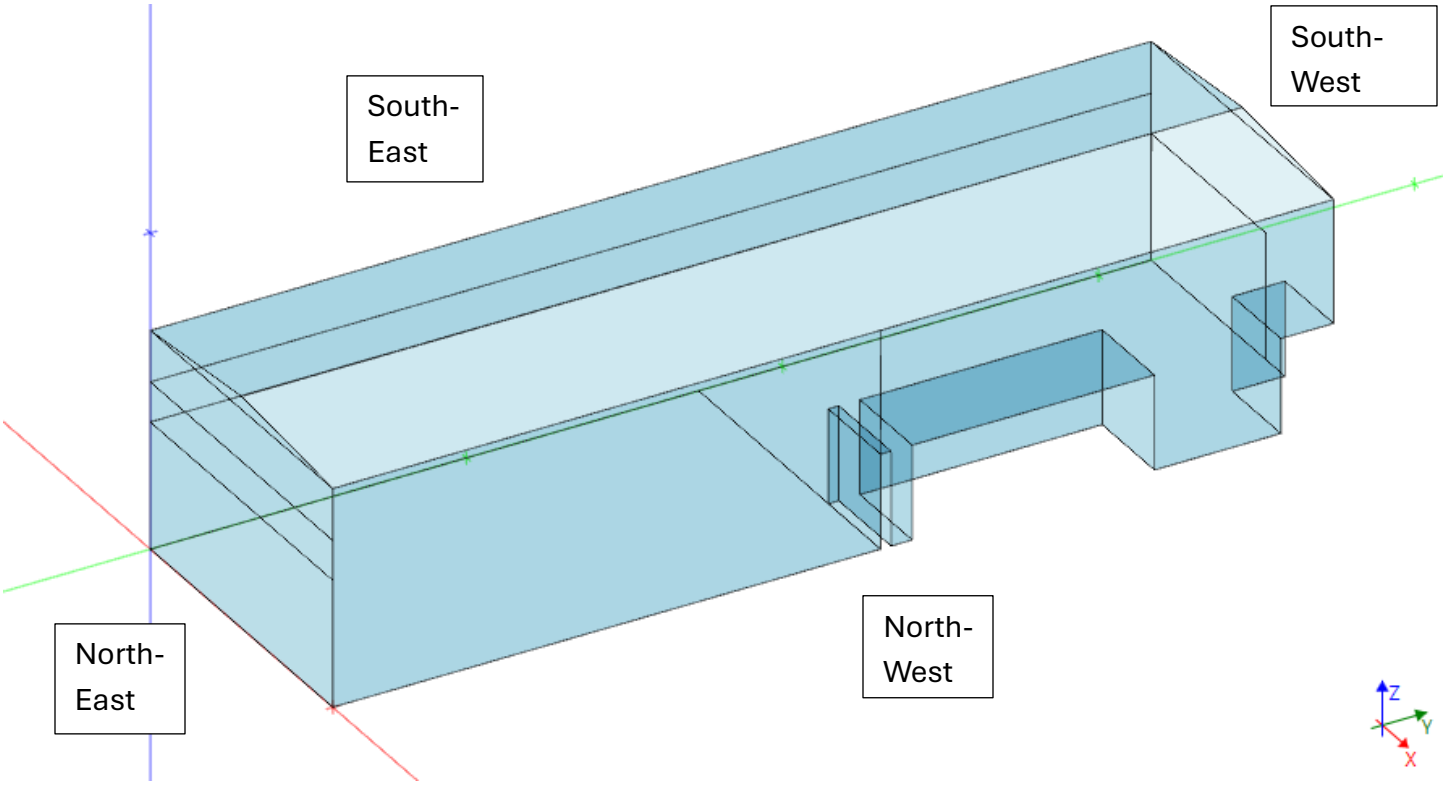
The software program EASE 5 was used to model the acoustics of the room and evaluate potential improvements.

Acoustic Room Model and Reverberation Time

The interior wall surfaces were entered resulting in the following geometric model.



The building is oriented with the entrance on the South-West side via a steel door. It is a concrete block and steel frame construction with the back half configured as the worship area and the front half a social area. Interior walls along the front North-West wall form a restroom and storage area. The floor is smooth finished concrete and the ceiling is made with corrugated steel panels. Supporting walls are concrete block.

The EASE 5 model calculates an interior surface area of 11,244 square feet. (That includes the walls, ceiling and floor area). The interior volume is 58,695 cubic feet.

There are acoustic panels along the North-East and South-East walls. I estimate these cover 20% of those wall areas and they are modeled as a band between the 12 ft and 16 ft height along those two walls. The North-West wall is curtained in the worship area which is the back half of the building, about 30 ft wide by 52 ft deep

Each interior surface has acoustic properties used in the model to determine absorption. These are summarized below:

Surface	Material	Area (sq ft)
Exterior walls	Painted concrete block	3109
Acoustic panels	Acoustic wall panels	477
Curtains in worship area	Curtains in folds against wall	1079
Floor	Smooth concrete	2602
Ceiling	Steel decking	2860
Door	Steel	226
Interior walls for rooms	Gypsum ½ inch	889

If carpet is added to the worship area, it replaces the concrete floor and the seating in that area (1560 sq ft). If the entire floor area is carpeted (front and back), the carpet area is 2602 sq ft.

One of the first acoustic parameters calculated by EASE is the reverberation time, abbreviated RT or RT60. This is the time required for a very loud sound to die out 60 dBs (a factor of 1000 in intensity) which is the dynamic range of the human ear. With no acoustic treatment at all, that is no panels, no curtain, and no carpet, the RT is 3.10 seconds. With the wall panels this reduces to 2.32 seconds. With panels and curtains, RT is 1.51 seconds. This is the current configuration. If the worship area is carpeted, RT drops to 1.13 seconds. If the entire floor (front and back areas) were carpeted, RT drops to 0.97 seconds. The carpet should be relatively thick to get these reductions.

So the current acoustic treatment is pretty good since it has reduced RT from 3.1 to 1.5 seconds. Additional wall panels would help as would making the curtain thicker, but the recommended change is to simply carpet the worship area.

Note that RT is a room property independent of the sound system or listening area. These will be evaluated separately in the next section. Also, adding people will improve RT as people are good acoustic absorbers. However, I did not do this as it adds another dimension to the analysis (how many people in attendance). It also makes any future testing to verify the model all but impossible to do.

Sound System and Performance

To evaluate the sound system performance, we need to add the listening area and the loudspeakers. The listening area is currently a semicircular area centered on the altar in front of the curtain. It extends back and to the sides to about 3 ft of the walls, but for simplicity it is modeled as a rectangular area running from 4 ft from the side and back walls to 10 ft from the front (curtained) wall. By convention, it has a height of 4 ft above the floor. This corresponds to the average height of a seated person's head.

There are many performance measurements used to quantify the performance of a sound system in a room. Two factors are important – the uniformity of the direct sound loudness and the ratio of early arriving sound to later arriving sound coming from reflections and reverberations. All sound arriving within the first 35 or so milliseconds is interpreted by the human ear as a direct sound due to the so-called Haas effect. So, a single floor bounce in the worship area might arrive 5 or 10 milliseconds after the

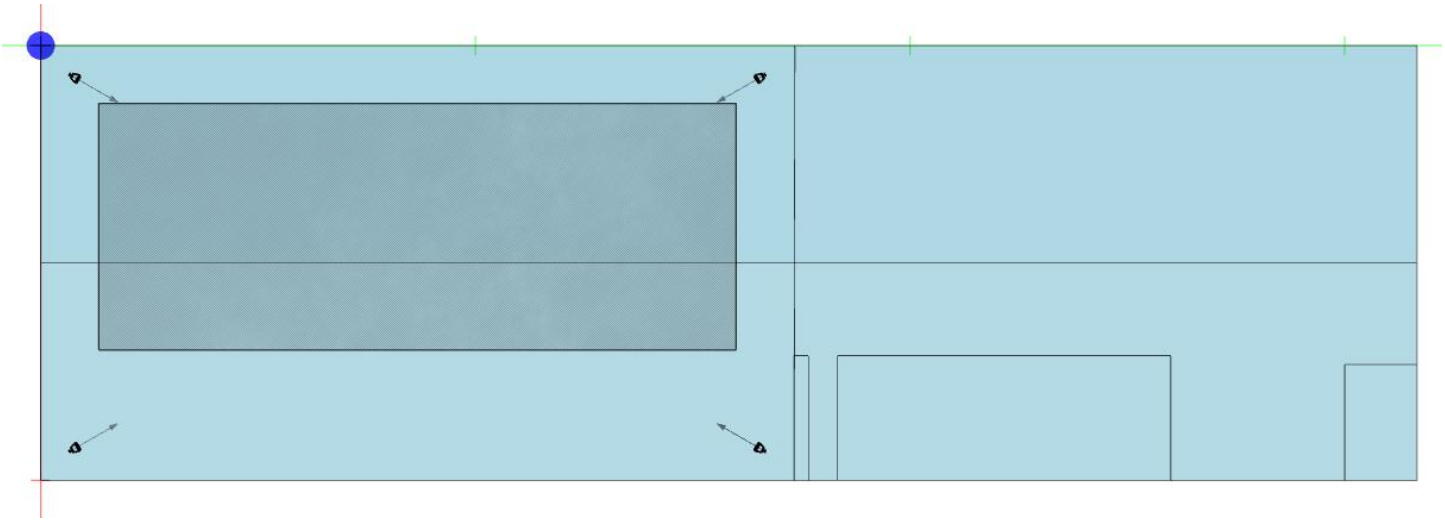
loudspeaker-to-ear air path, but the ear treats it as reinforcing the direct sound. Ease 5 can calculate the ratio of early to late energy called C35 where the 35 indicates the time interval in milliseconds. It does this for a number of locations over the audience area (84 in this case) and includes all frequencies between 500 and 4,000 Hz which is the band in which speech is concentrated. At the same time, Ease calculates L35 which is the magnitude of the early arriving sound. The absolute value of L35 is not important, but its uniformity over the audience area is. Both C35 and L35 are usually specified in decibels (dB) which is a logarithmic value. If C35 is less than -3 it is considered poor, between -3 and +3 fair and greater than +3 good. If the variation in L35 is less than 3 it is considered good, between 3 and 6 it is fair and greater than 6 poor.

In the following sections, C35 and L35 are shown as colored maps across the listening areas and as histograms.

(4) Control 25-1 Speakers

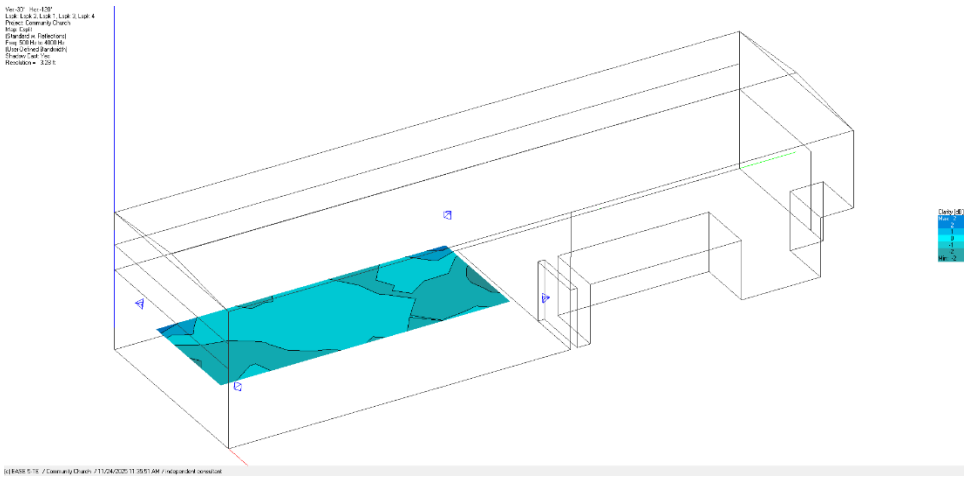
The current sound system consists of 4 loudspeakers with integrated amplifiers. Three of these are Behringer model CE500D and the fourth is a dB Technologies K70. All four have essentially the same characteristics of 60 Hz to 20 KHz frequency response, 100 Watts peak output power, using a single 5.25-inch speaker which provides a 100 by 100-degree dispersion pattern. This is a very broad (non-directional) pattern. Unfortunately, neither Behringer nor dB Technologies offers a speaker characteristic file that can be used by Ease. However, there is a nearly identical loudspeaker made by JBL, model Control 25-1, which is frequently used to model these speakers. It does not have an internal amplifier, but this does not make any difference to the acoustic performance of the sound system.

The current speakers are mounted at approximately 7.5 ft above the floor to the walls around the worship area. (They are offset 2 ft from the four corners to account for the mounting bracketry.) All four speakers are then aimed at the center of the listening area. A plan view of this arrangement is shown below. The shaded area is the listening area, 4 ft above the floor, and the four loudspeakers are shown near the corners of the worship area with the very small arrows indicating their alignment.



C35 performance is shown in Figure 1 for no carpet and in Figure 2 for the worship area only carpeted. The carpeting assumed is indoor outdoor carpet but thicker is better acoustically. Figure 3 and Figure 4 show the mapping and distribution of L35 for the same two cases.

Figure 1 C35 with Current Loudspeakers, No Carpet



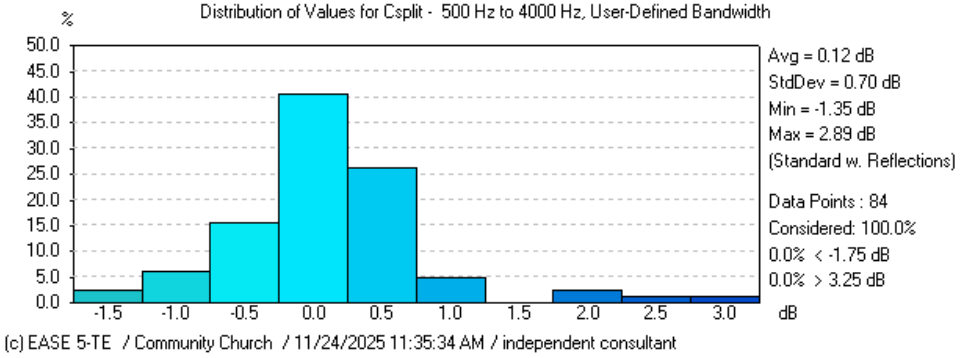


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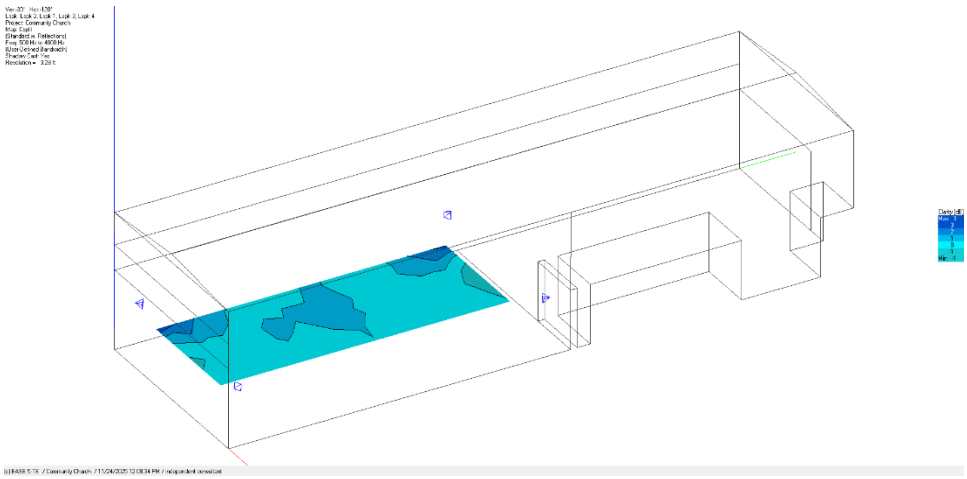
Figure 2 C35 with Current Speakers, Carpeting



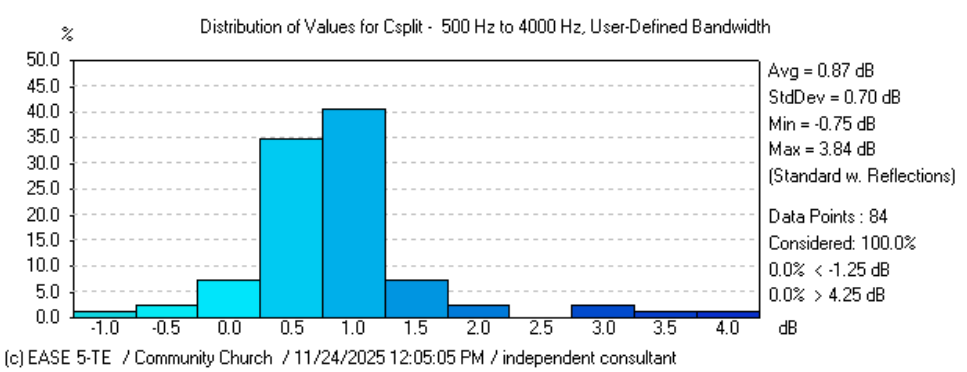


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Figure 3 L35 with Current Speakers, No Carpet

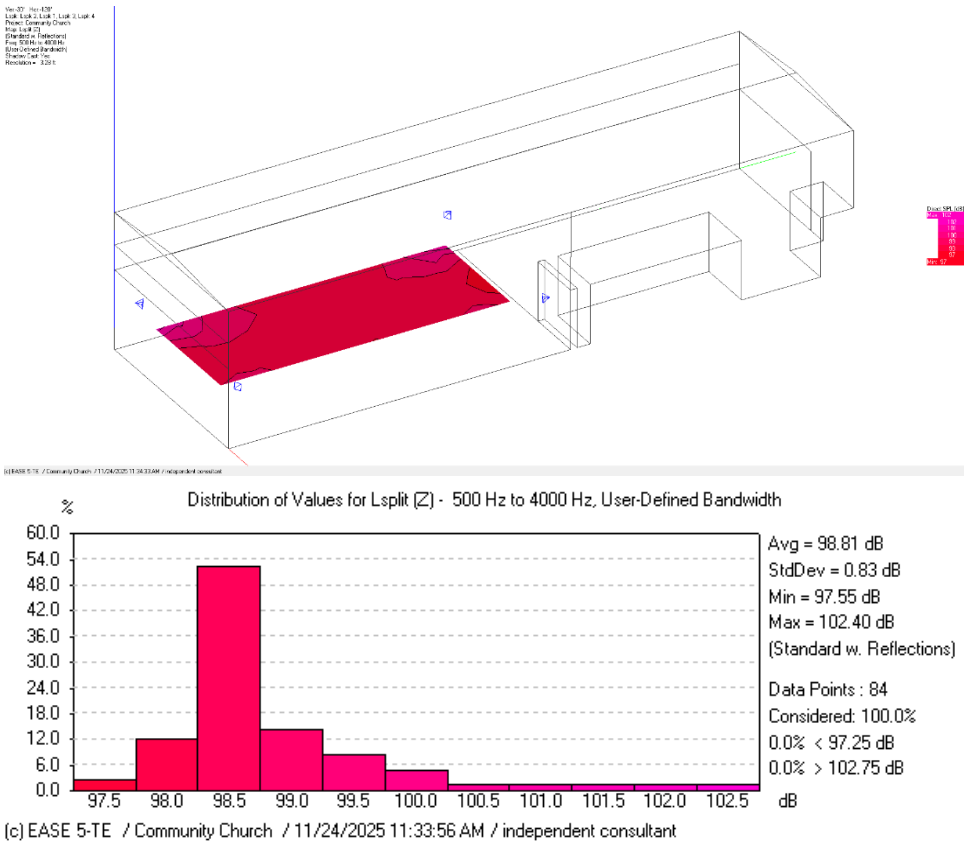
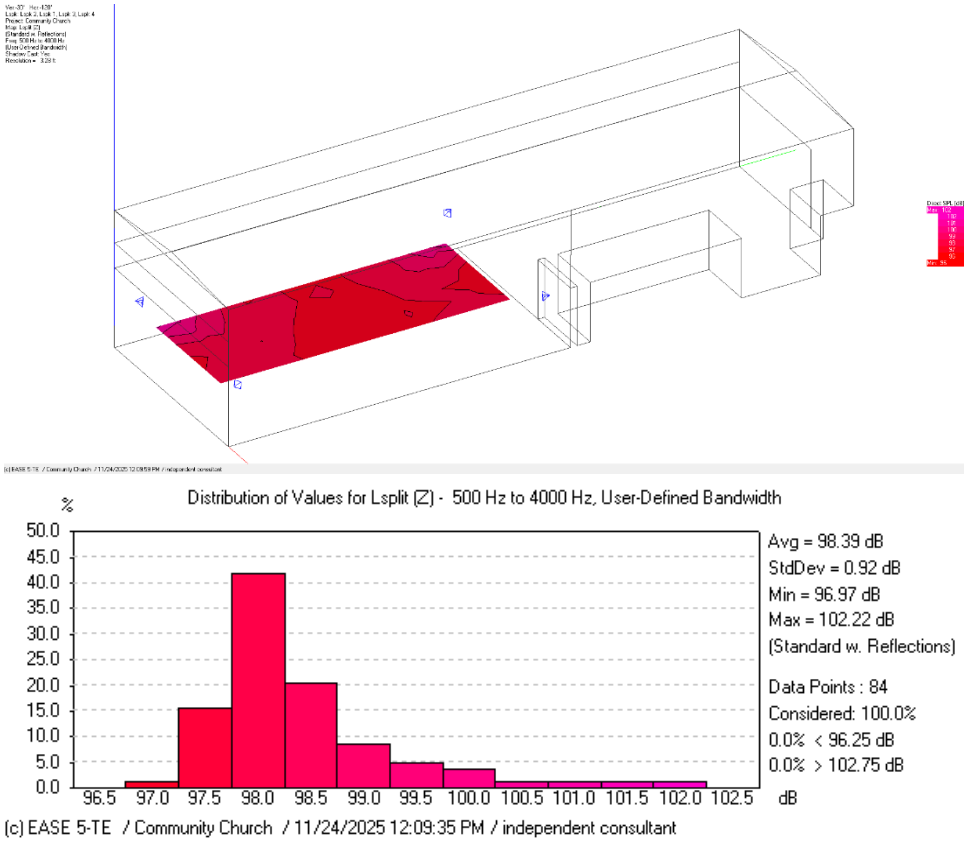


Figure 4 L35 with Current Speakers, Carpeting



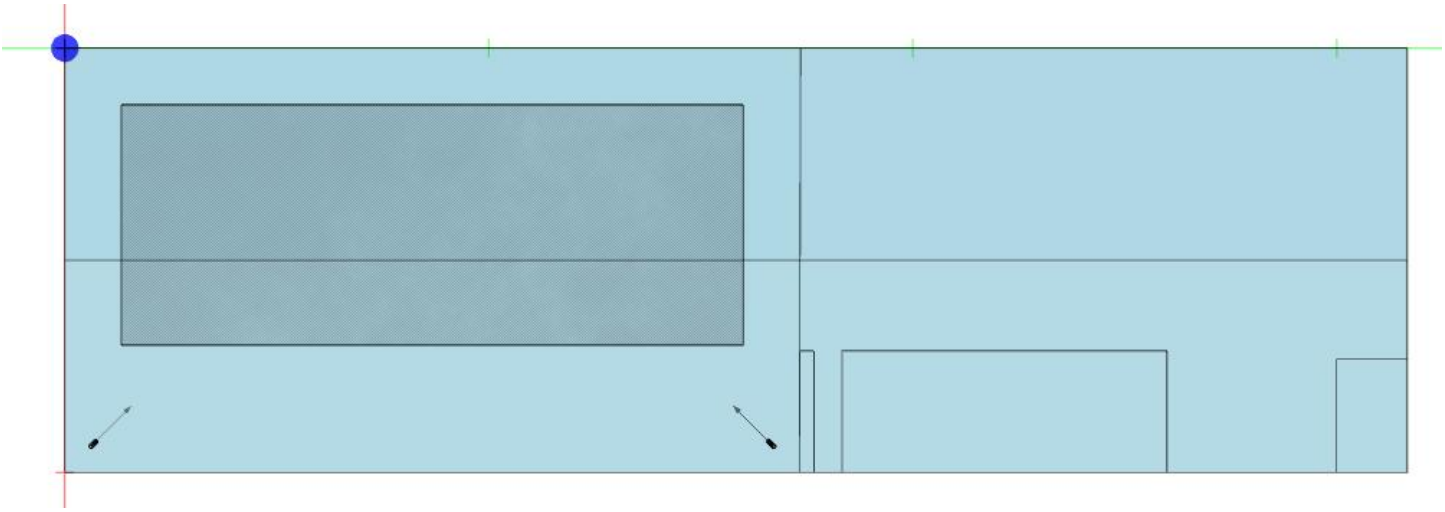
With or without carpet, both C35 and the variation of L35 fall into the “fair” range. Comparing Figure 1 and Figure 2, the carpet made about 0.75 dB increase (improvement) in the clarity C35. This might be noticeable to the ear, but it is only about a 18% increase in power. Figure 3 and Figure 4 show that the carpeting increases (worsens) the L35 variation by about 0.1 dB as measured by the standard deviation. That change is insignificant.

These results were a bit disappointing since adding carpet to the worship area seemed an obvious next step in reducing reflections. So, an alternative speaker system was next evaluated.

(2) TOA SR-H2S Speakers on Front Wall

These loudspeakers are frequently used in church settings as they blend in well with classical church architecture (columns) and are designed to create a fan shaped pattern that can be focused on the audience. Although the speakers are narrow (3.3 inches) and tall (26.1 inches), they contain nine smaller (2.8 inch) speakers that combine to produce a horizontally broad (90 degree) and vertically narrow (20 degree) pattern that minimizes the acoustic energy that would otherwise strike the walls, ceiling, floor, etc. and cause reverberation. These speakers have a broad frequency response of 90 Hz to 17 KHz and a peak power output of 180 Watts.

The two speakers are mounted at the 7.5 ft level along the front (altar), 2 ft from the walls.



C35 performance is shown in Figure 5 for no carpet and in Figure 6 with carpet. There is now a 3 dB improvement over the current speaker system and the carpet makes a 1.0 dB additional improvement in the clarity. This is very significant as 3 dB is a factor of 2 in intensity. L35 is shown in Figure 7 without carpet and in Figure 8 with carpet. The variation is about 0.4 dB more than with the current speakers. Actually, the plots shows there are just a couple of seats (those farthest from the speakers) to avoid or eliminate so this is not considered a problem.

Figure 5 C35 with 2xSR-H2S Speakers Near Walls, No Carpet

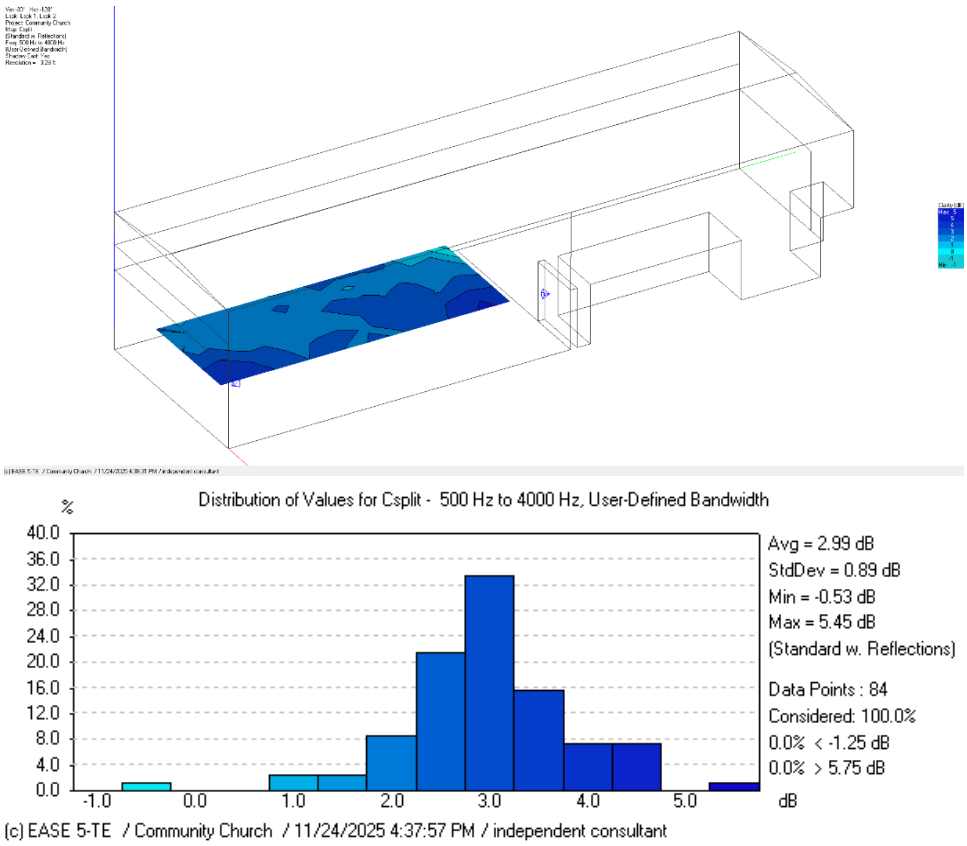


Figure 6 C35 with 2xSR-H2S Speakers Near Walls, Carpeting

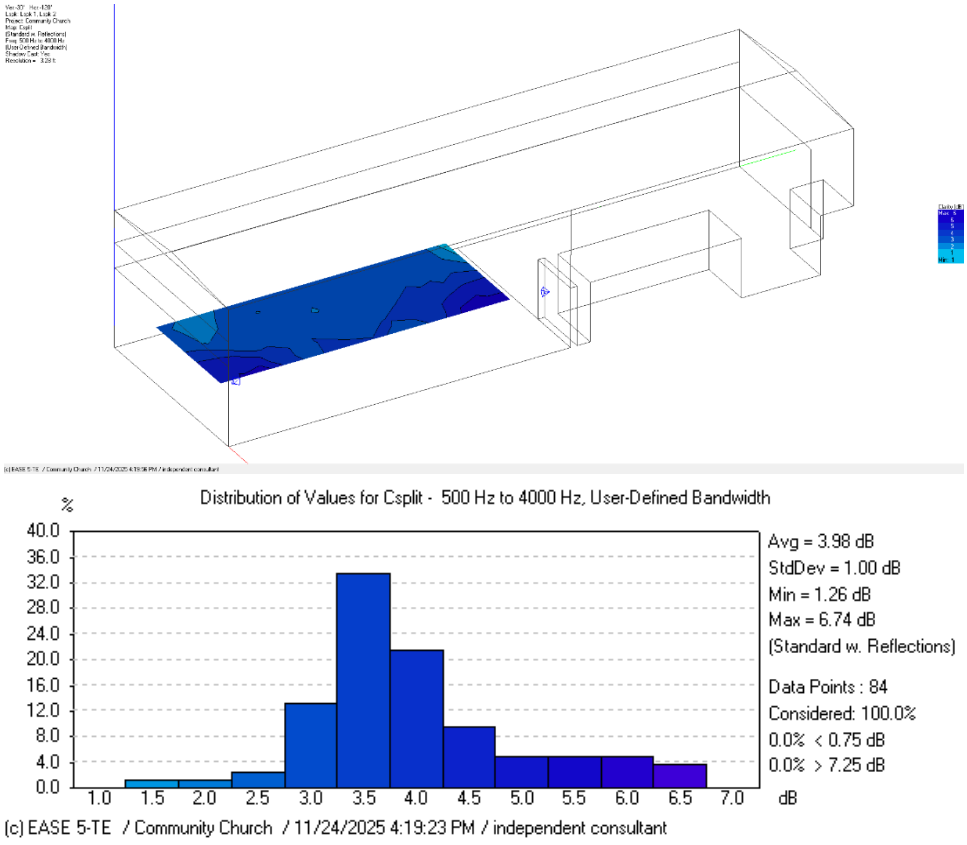


Figure 7 L35 with 2xSR-H2S Speakers Near Walls, No Carpet

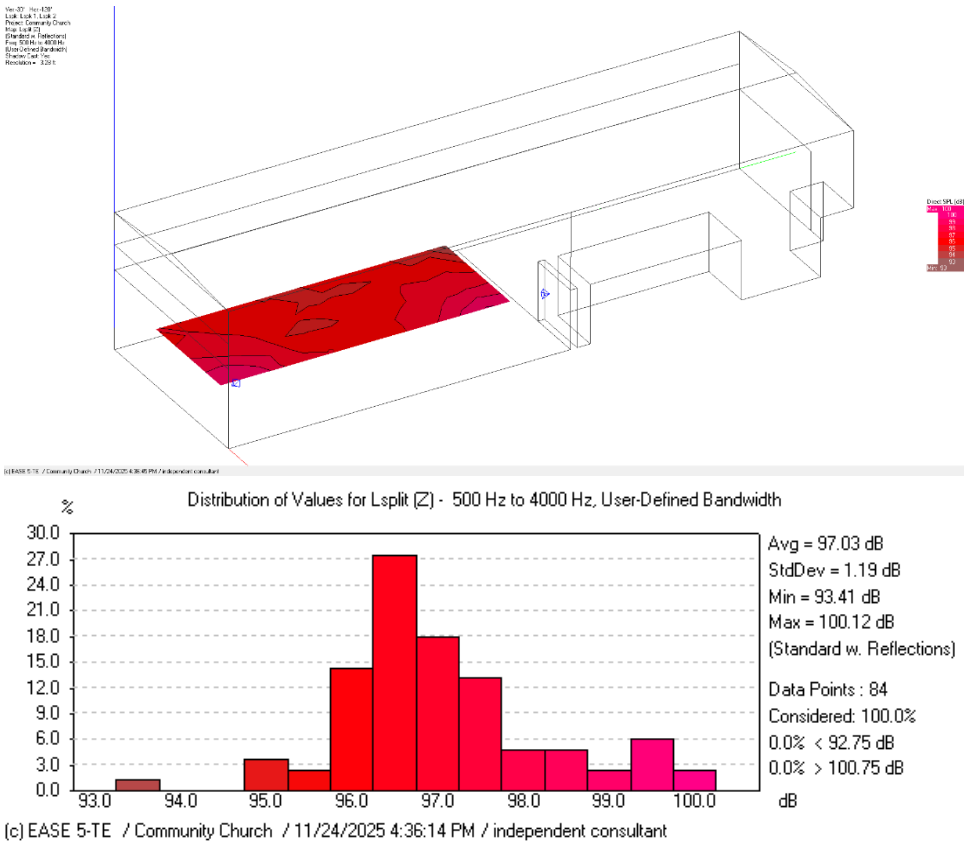
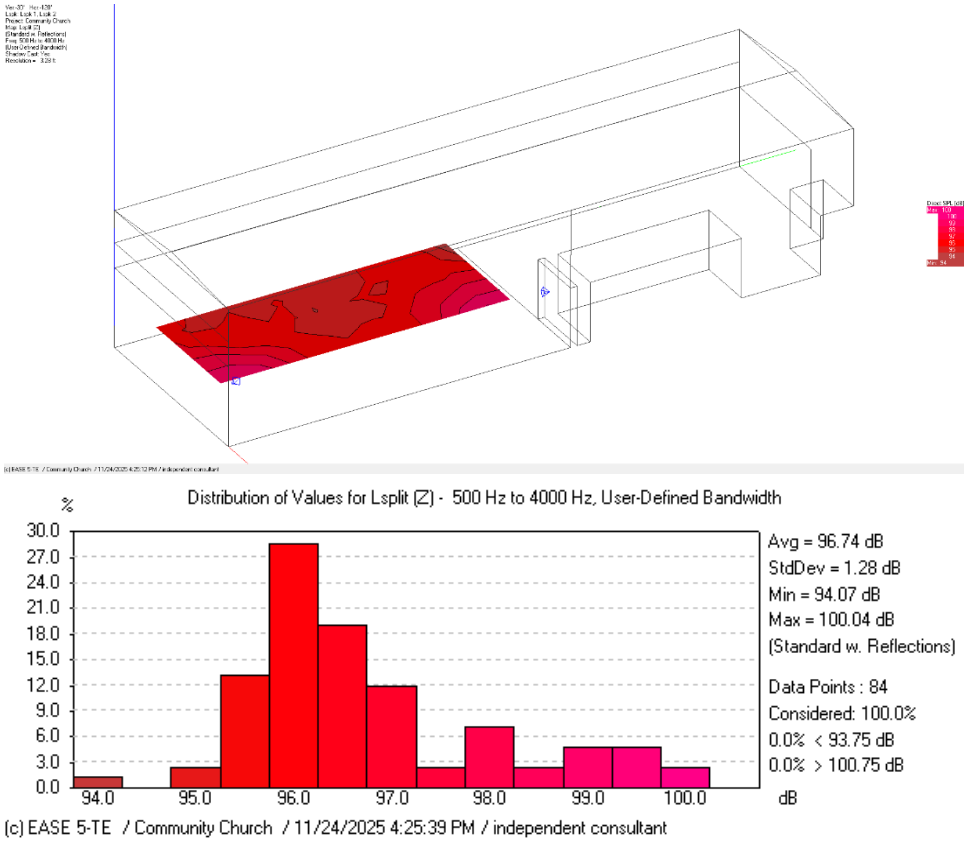
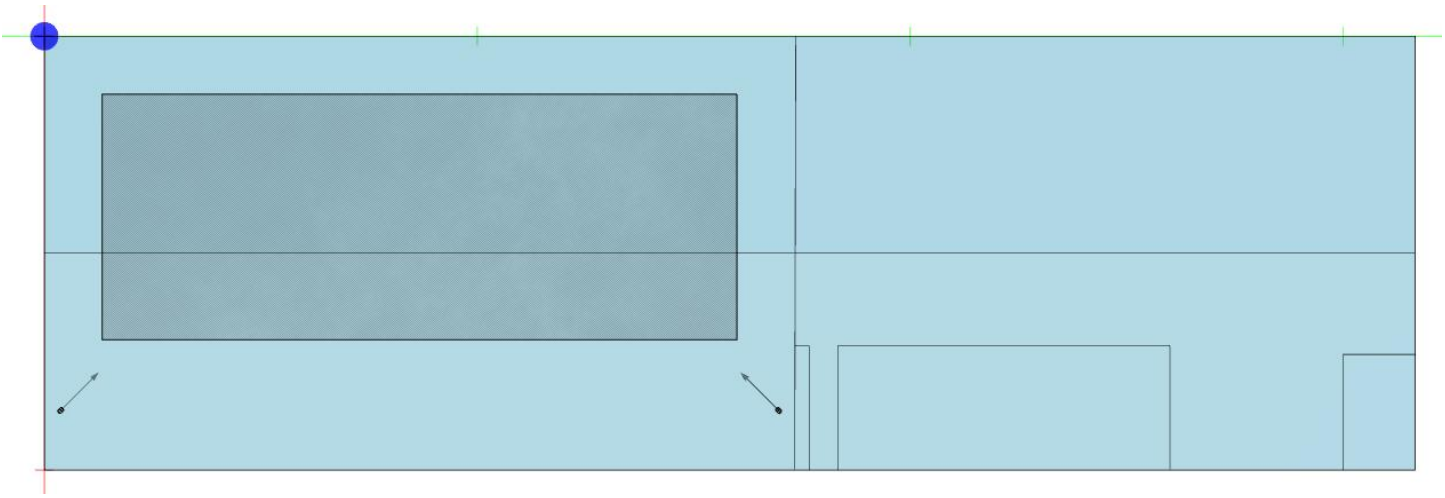


Figure 8 L35 with 2xSR-H2S Speakers Near Walls, Carpeting



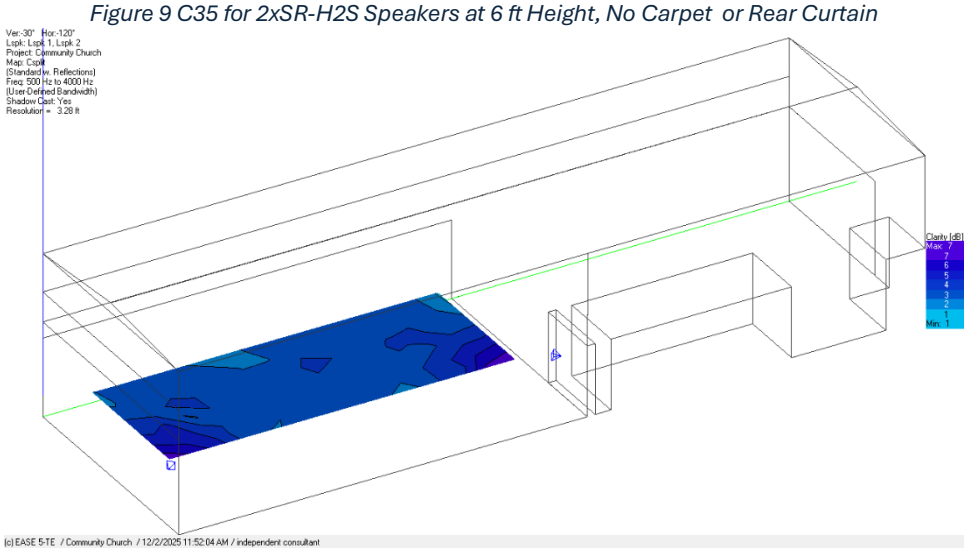
(2) TOA SR-H2S Speakers at (26,1,6&26,51,6)

This case uses the same speakers but moves them closer to the audience (4 ft from the front wall vs 2 ft in the previous case). It is the result of some optimization of the location, height and alignment. The 6 ft height is the height at the top of the speaker and was based on lowering the speakers so that the vertical angle could be held to 0 degrees since the standard mounting brackets do not provide for angle adjustment. At 6 feet high, the center of the speakers is actually at 5 ft above the floor, and the 20 degree (+/-10 degree) vertical coverage includes the audience heads whether they are seated at 4 feet or standing at 6 feet. Also, the position along the side walls permits the horizontal angle to be set at 45 degrees. This could be provided by mounting the brackets on a 4x4x2 ft wooden adapter with a 45 degree cut along one edge. The model was additionally changed to add an optional 10 ft tall curtain along the rear wall of the worship area.



This change makes an additional improvement in clarity as shown in Figure 9 and Figure 10. Average C35 increases to 3.84 without carpet or rear curtain and to 5.65 with both carpeting and curtain – well within the “good” range. The L35 variation increases some from the previous case; its standard deviation is about 0.5 dB worse. C35 and L35 were also evaluated for this speaker configuration with the carpet and rear curtain individually removed. Each of these absorbers make approximately the same contribution to the increase in C35.

Figure 9 C35 for 2xSR-H2S Speakers at 6 ft Height, No Carpet or Rear Curtain



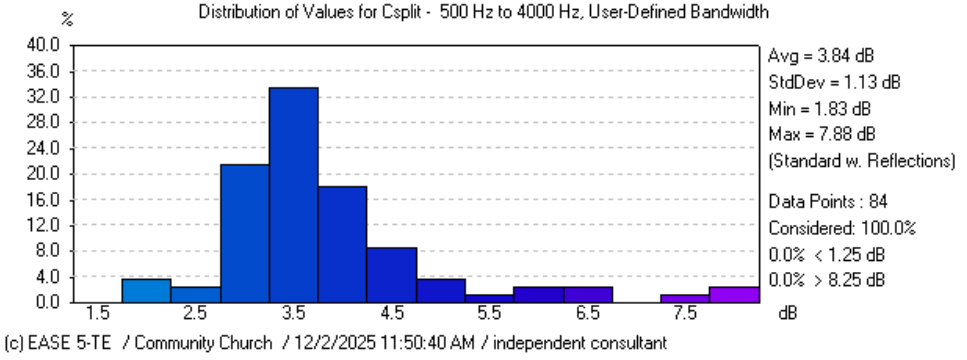


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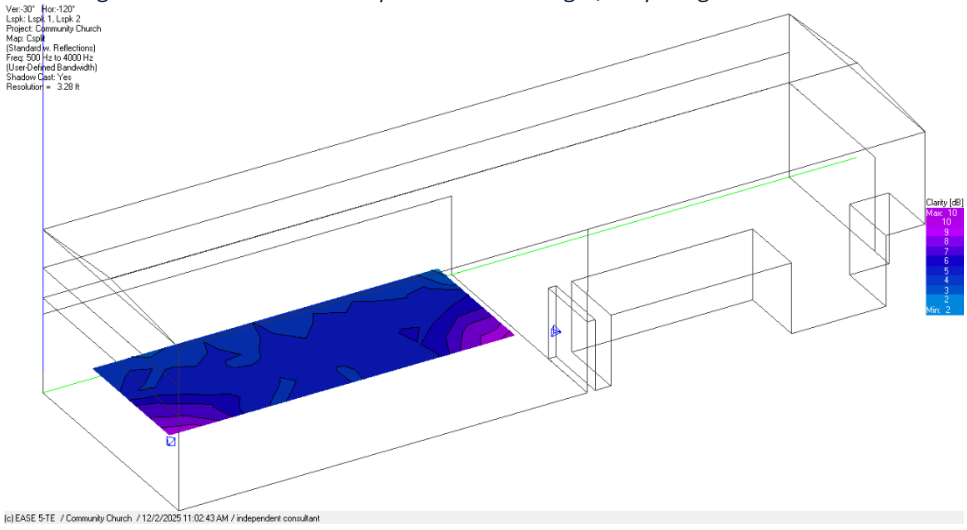
Figure 10 C35 for 2xSR-H2S Speakers at 6 ft Height, Carpeting and Rear Curtain



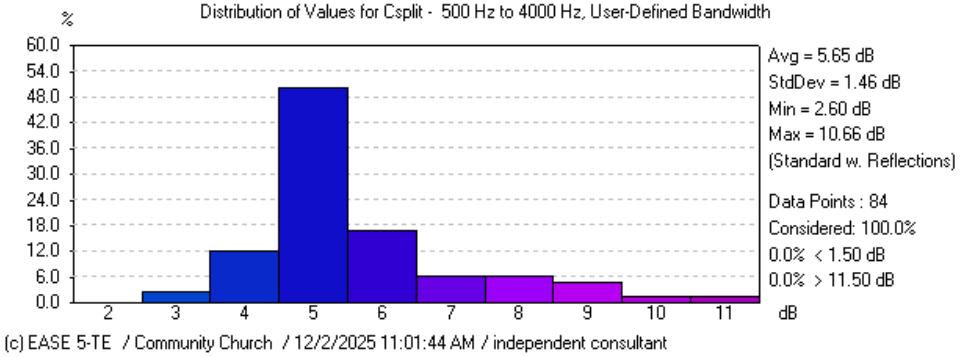


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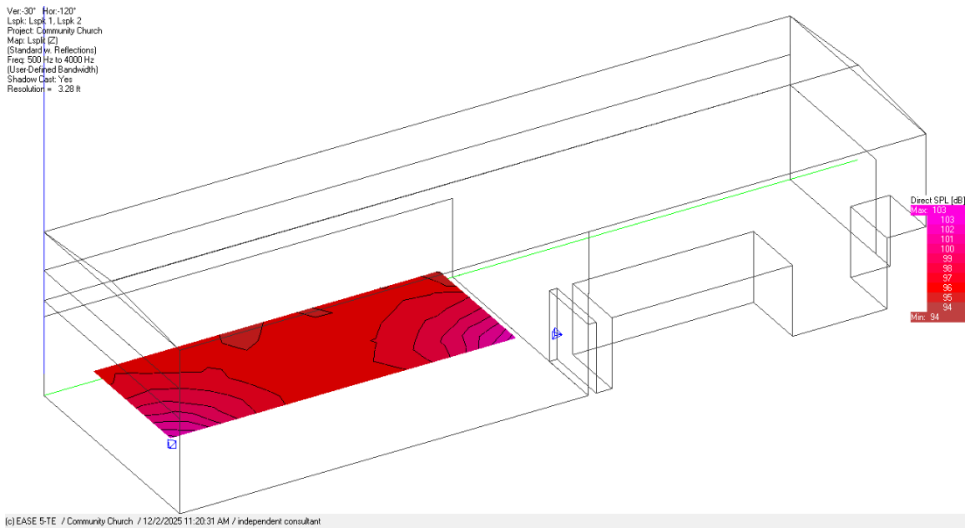
Figure 11 L35 for 2xSR-H2S Speakers at 6 ft Height, No Carpet or Rear Curtain



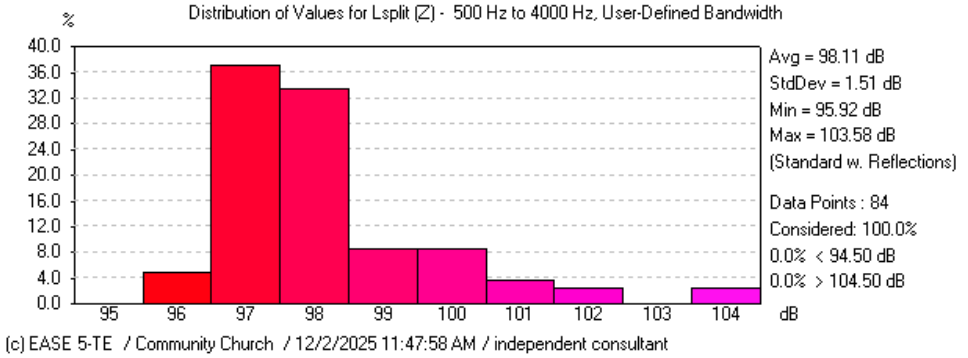


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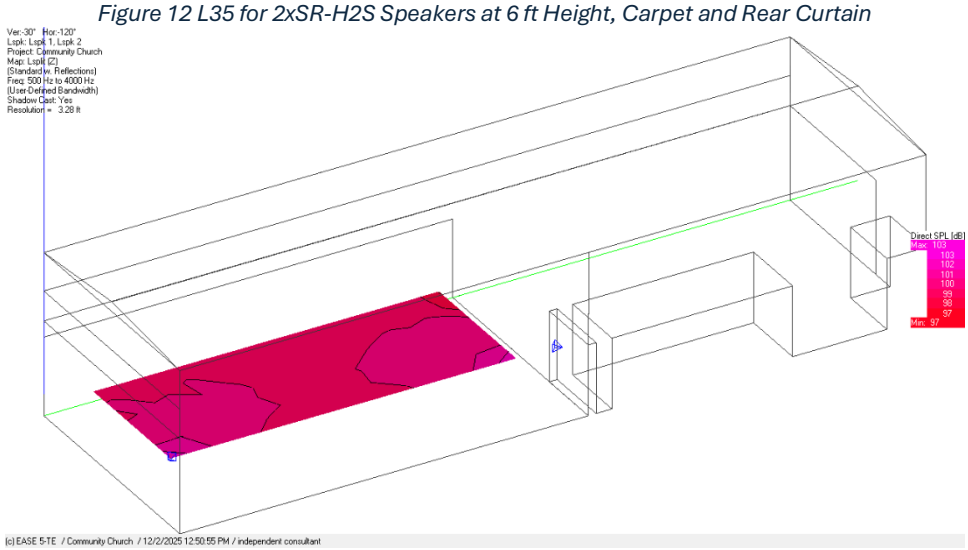
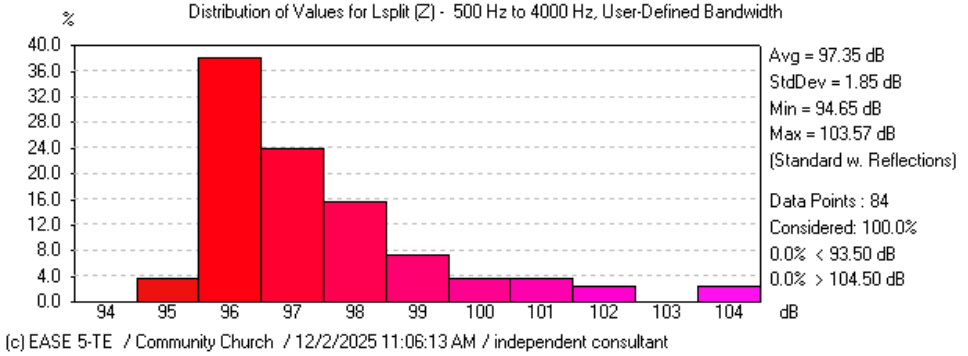
Figure 12 L35 for 2xSR-H2S Speakers at 6 ft Height, Carpet and Rear Curtain





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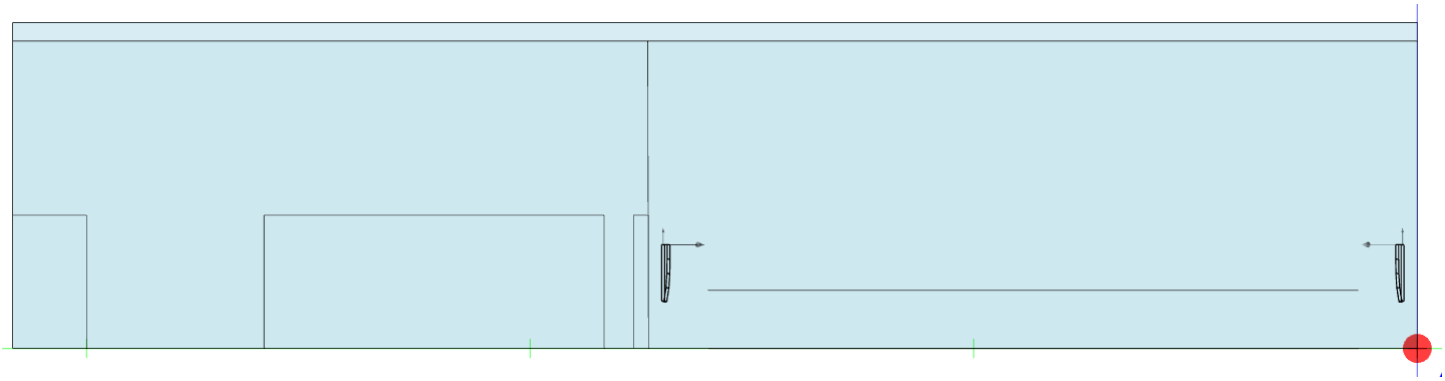
(2) TOA SR-H3S Speakers at (26,1,7&26,51,6)

The SR-H2S speakers were replaced with SR-H3S speakers at the same locations. The height changed to 7 ft but again this is the height of the top of the speakers. Since these speakers are nearly 4 ft tall compared to the 2 ft height of the SR-H2S speakers, the center height remains at 5 ft – midway between the audience heads sitting and standing. Only the case where carpet and rear curtains was considered.

The results are shown in Figure 11 and Figure 12. The average clarity is about the same but the minimum value improves nearly 1 dB. And the uniformity of L35 improves significantly.



The above section view shows the SR-H3S speakers to scale mounted with the tops at the 7 ft level. The horizontal line is the 4 ft head level corresponding to the audience seated. For comparison, the SR-H2S speakers are shown to scale below.

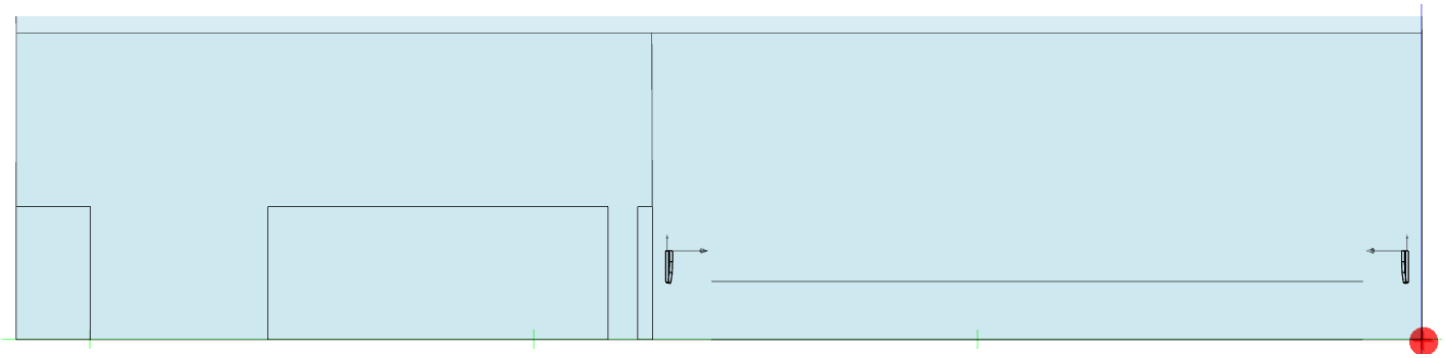
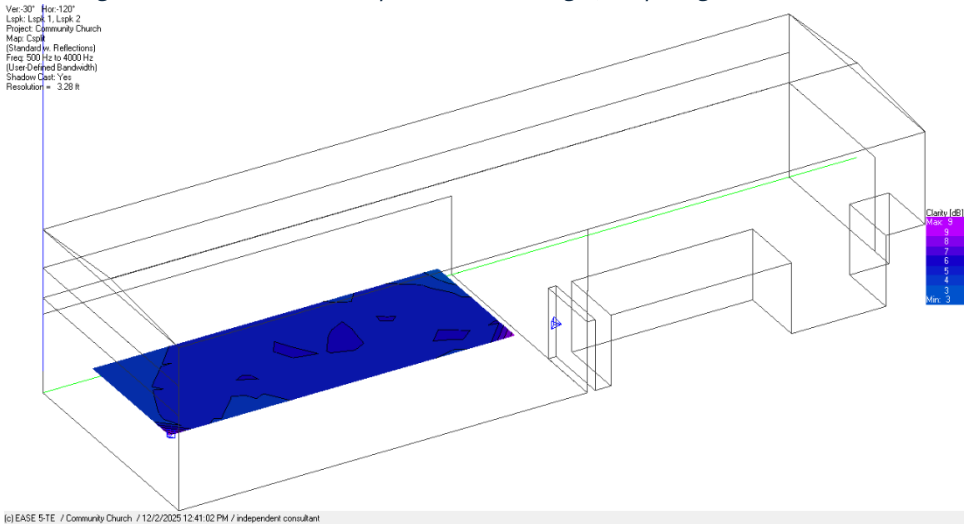


Figure 13 C35 for 2xSR-H3S Speakers at 7 ft Height, Carpeting and Rear Curtain



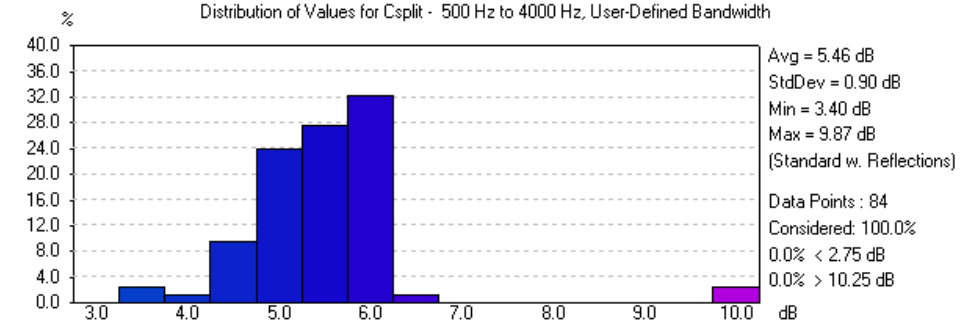


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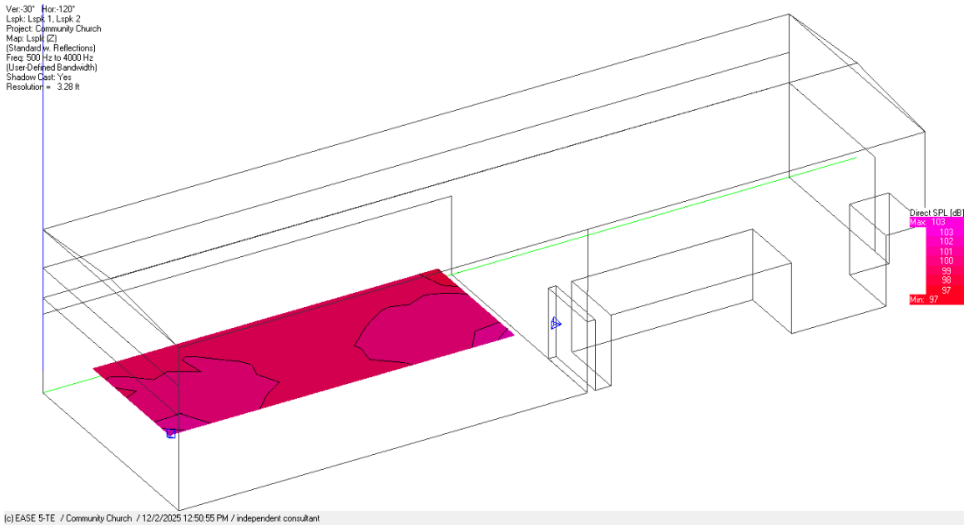
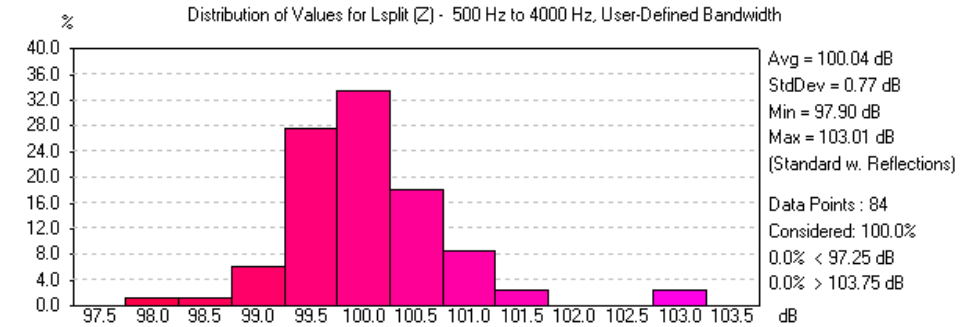
Figure 14 L35 for 2xSR-H3S Speakers at 7 ft Height, Carpeting and Rear Curtain





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Conclusions and Recommendations

The following table summarizes the results of the simulations. The color coding indicates poor (red), fair (yellow) and good (green) values. The current system is considered fair. Adding the carpet to the worship area alone improves the clarity C35 by 0.75 to 1.0 dB.

Speaker Configuration	Carpeting	Rear	Clarity C35			Early Sound Intensity L35			
(X,Y,Z)		Curtain	Min	Max	Avg	Min	Max	Max-Min	Std Dev
Current System modeled as	no	no	-1.35	2.89	0.12	97.55	102.40	4.85	0.83
4x Control 25-1 in corners	yes	no	-0.75	3.84	0.87	96.79	102.22	5.43	0.92
2xTOA SR-H2S	no	no	-0.53	5.45	2.98	93.41	100.12	6.71	1.19
at (28,2,7.5) & (28,50,7.5)	yes	no	1.26	6.74	3.98	94.07	100.04	5.97	1.28
	no	no	1.83	7.88	3.84	95.92	103.58	7.66	1.51
2xTOA SR-H2S	yes	no	1.64	8.64	4.82	94.50	103.57	9.07	1.61
at (26,1,6) & (26,51,6)	no	yes	2.01	9.63	4.65	94.82	103.57	8.75	1.76
	yes	yes	2.60	10.66	5.65	94.65	103.57	8.92	1.85
2xTOA SR-H3S									
at (2,1,7) & (26,51,7)	yes	yes	3.40	9.87	5.46	97.90	103.01	5.11	0.77

The current speakers provide very little directionality. This results in a lot of acoustic energy striking reflecting surfaces and increasing the reverberation which affects the sound clarity. A directional speaker system focused on the audience area will improve clarity.

Use of column speakers such as the TOA SR-H2S will improve clarity by 3 dB or more, especially if they are centered at the 5 ft level along the side walls near the front. With these speakers the variation in early sound intensity gets worse as the clarity improves, but this appears to be a result of the proximity of the TOA speakers to a few chairs in the rectangular listening area. The L35 maps show that with the removal of a few chairs which are closest to the speakers, the uniformity would be much more level and fall into the fair range (3 to 6 dB variation). The standard deviation of L35 tends to automatically remove these outliers.

The larger TOA SR-H3S speakers provide the best clarity and sound uniformity of all. Assuming that the esthetics of these taller speakers is acceptable, they are recommended. Carpet and rear wall curtaining also are recommended because they both improve the clarity.

Cost Estimate

The tables below list the cost of the TOA speakers and the amplifier required to drive them.

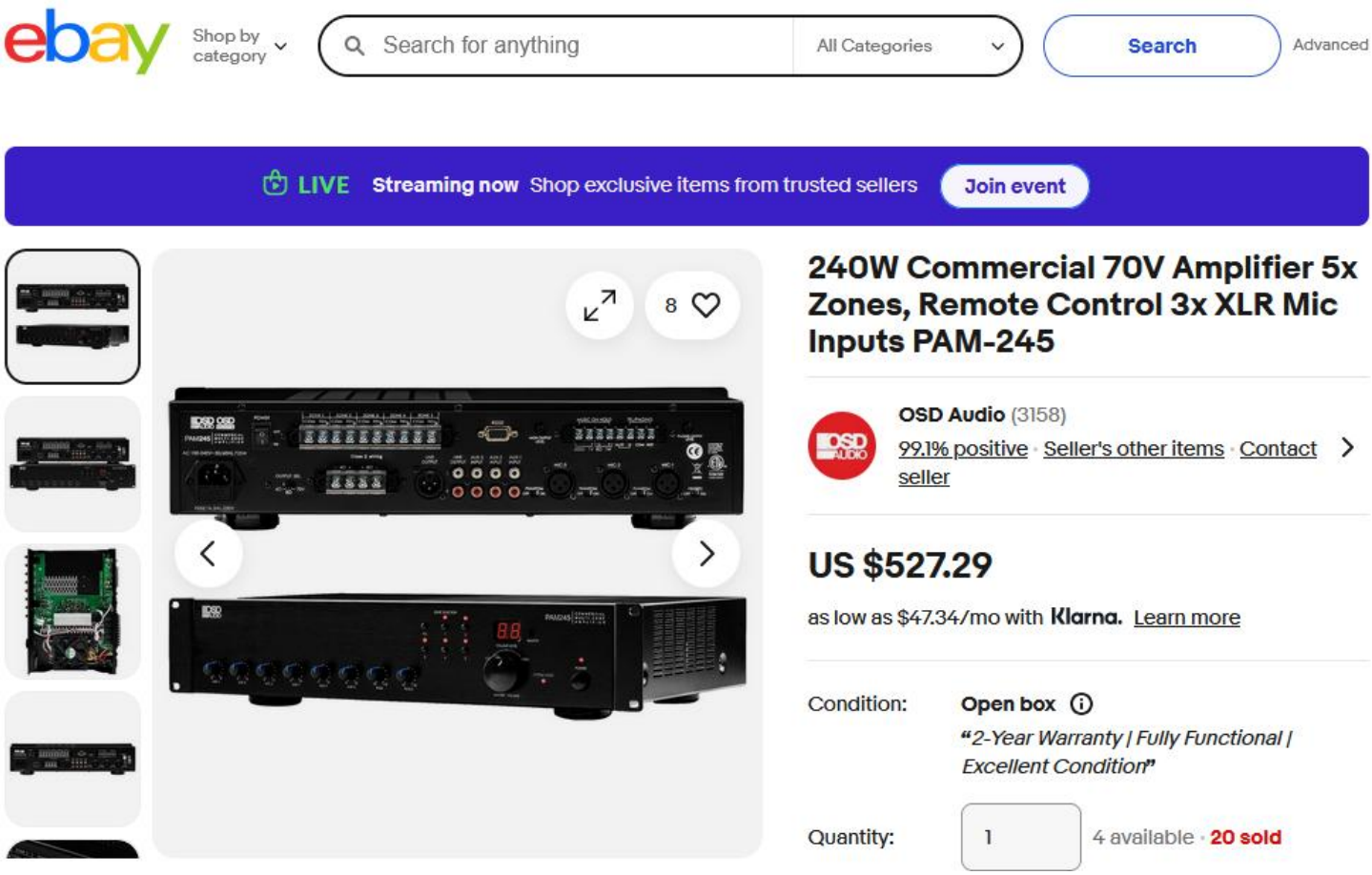
Item	New	Used
2xSR-H2S speakers	$ 1,258.00	$ 400.00
2xSR-WB3 mtg brackets	$ 182.00	included
2xMT-S0301 transformers	$ 206.00	included
1xPAM245 amplifier	$ 527.00	$ 500.00
Total	$ 2,173.00	$ 900.00

Item	New	Used
2xSR-H3S speakers	$ 1,882.00	$ 500.00
2xSR-WB3 mtg brackets	$ 182.00	included
2xMT-S0301 transformers	$ 206.00	included
1xPAM245 amplifier	$ 527.00	$ 500.00
Total	$ 2,797.00	$ 1,000.00

The new speakers, brackets, etc. are sold by Full Compass. Used ones are on EBAY and have been for several months, but they could sell at any time. These prices do not include delivery or tax.

The new amplifier is sold by OSD as an “open box”. The used one listed was left over from the San Juan de Dios project. It was used for testing for about 2 hours. It is complete, in its original box, and in San Miguel so no tax or shipping is required on it.

You may need to use a VPN to reach the following items on EBAY.



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TOA Line Array Speakers (PAIR) SR-H2S Impedance, 180W with 70 Volt Transformers

gman3rh6 (508)
100% positive · Seller's other items · Contact seller

US $400.00

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Condition: **Used**

"Very Good, Used in Catholic Church, Spoken Word Only. Includes 1 SRWB3 brackets and 70 volt"... Read more

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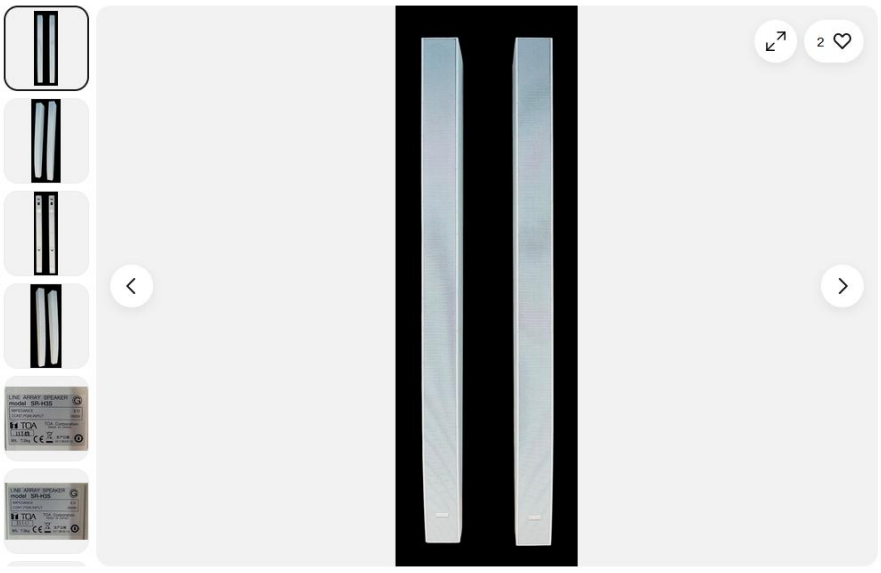

Toa SR-H3S (Pair) with Brackets and 70 Volt Line Transfomers Installed

gman3rh6 (508)
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