ENTASYS

Application Guide

Community®

THE COMMUNITY ENTASYS COLUMN ARRAY

ENT-FR
ENTASYS Full-Range Column

- Three-Way, Full-Range
- 200 Hz – 20 kHz
- 66 Driver elements:
  LF: (6) 3.5”
  MF: (18) 2.35”
  HF: (42) 1” x 1”
  (configured as six 1” x 7” Compact Ribbon Emulators™)
- 600 Watts continuous, 1500 Watts program, 12 ohms
- Available nominal coverage pattern:
  120˚ x 12˚ or 120˚ x 6˚
- Sensitivity: Curved (12˚V): 93dB, Straight: (6˚V): 95dB
- Maximum SPL: Curved (12˚V): 120 dB,
  Straight: (6˚V): 122 dB

Vertical coverage angle varies by system configuration, frequency and listener distance.

ENT-LF
ENTASYS Low Frequency Column

- Low Frequency driver array for added directivity control and output level
- 200 Hz – 1.6 kHz
- LF: (6) 3.5”
- 600 Watts continuous, 1500 Watts program, 12 ohms
- Sensitivity: 90 dB
- Maximum SPL: 116 dB

Variable vertical coverage based on the number of units arrayed.

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NOTICE: Every effort has been made to ensure that the information contained in this application guide was complete and accurate at the time of printing. Due to ongoing technical advances, changes or modifications may have occurred that are not covered in this publication.

DESCRIPTION

The two models in the ENTASYS line of loudspeakers have been designed to achieve very high SPL, exceptional sound quality and outstanding speech intelligibility when deployed as part of a professionally designed sound system. They offer controlled, tightly focused vertical directivity with wide horizontal coverage. They are easy to install and provide unparalleled sound quality and performance.

The ENTASYS Full-Range loudspeaker module and Low Frequency loudspeaker module may be combined in several configurations to deliver outstanding performance and consistent coverage over a wide range of applications. Their modular design allows multiple enclosures to be stacked and joined together to form larger column line arrays.

The Full-Range and Low Frequency modules can be arranged in any order to direct sound only where it is needed, and to extend the length of the column to provide additional low frequency directivity control. This enables the sound system designer to specify the optimal configuration for a given application.

Utilizing only a passive internal crossover and three-way driver topology, ENTASYS partners easily with any popular DSP loudspeaker control. Thus, precise control over a superb sounding column loudspeaker becomes possible without complex and costly multi-channel DSP controls.

FEATURES

Attractive Low Profile Enclosure

The narrow enclosure and its attractive shape makes it virtually invisible when installed. The enclosure can also be custom painted to match any color scheme.

Driver Protection

ENTASYS drivers are protected by Community's exclusive DYNA-TECH™ protection circuitry, which functions as a limiter to ensure precise and reliable protection to the drivers.

Advanced Passive Crossover Circuit Design

A proprietary three-way crossover design optimizes the performance of ENTASYS systems while allowing operation at high input levels and high SPL output.

Compact Ribbon Emulator™ HF Radiator

Community's patent-pending CRE high frequency elements provide narrow, well-behaved vertical directivity control, comparable to that of a ribbon driver.

Seamless Arrayability

The modular design of ENTASYS allows both the Full-Range and Low Frequency loudspeaker modules to be joined together to form a monolithic column, delivering the acoustical performance of a much longer line array column with a truly unique and impressive visual design.

Weather Resistant Design

The enclosure and drivers are constructed from sturdy, weather resistant materials, making ENTASYS systems inherently weather resistant and ideal for outdoor use.

MODELS

Full-Range Column (ENT-FR)

The ENTASYS Full-Range column is a three-way loudspeaker system consisting of six 3.5 inch (90 mm) neodymium low frequency drivers, eighteen 2.35 inch (60 mm) midrange drivers, and forty-two 1 inch x 1 inch (25 mm x 25 mm) high frequency drivers. The high frequency drivers are configured into groups of seven, and integrated to form six planar-coupled Compact Ribbon Emulator™ devices. These high-output, low-distortion high frequency devices enable ENTASYS to radiate a very narrow, controlled beamwidth into the last octave of typical human hearing before vertical off-axis beams begin to form. This helps to keep the sound focused and directed where it needs to be, and minimizes unintended reflections from walls and other surfaces.

INTRODUCTION

The ENTASYS Full-Range column can also be modified to provide a range of coverage patterns. The horizontal coverage is a very consistent 120 degrees, while vertical coverage is easily reconfigured. Nominal vertical beamwidth is 12 degrees in its default "curved" configuration (as shipped). This beamwidth can be narrowed in the midrange and high frequency regions by replacing the smaller stand-offs behind the midrange/high frequency driver modules with the larger 34.2 mm spacers included with the loudspeaker. This "straight" configuration will alter the nominal vertical beamwidth to 6 degrees. The loudspeaker may also be configured as "asymmetrically curved" by replacing the stand-offs at half of the column. In this manner, a vast number of coverage combinations with shaped vertical coverage patterns can be achieved using various modular configurations. Refer to the ENTASYS Installation/Operation Manual for details on making these modifications.

For most applications comprising a single ENTASYS Full-Range column, the curved configuration is recommended.

When two Full-Range columns are arrayed immediately above and below each other, optimal performance will be achieved using the straight configuration for each column. The top of the upper column and the bottom of the lower column could remain curved. This will yield a symmetrical array when assembled.

ENTASYS Full-Range modules offer exceptionally tight vertical beamwidth and excellent vertical directivity control. The beamwidth begins to widen in the lower frequency regions below 1 kHz; this is not unique to ENTASYS, but rather is consistent with the laws of physics for a line array with the height of a single full-range column. The beamwidth in this lower frequency region can be significantly narrowed, to virtually match the beamwidth at higher frequencies, by adding ENTASYS Low Frequency columns to the array. Adding ENTASYS Low Frequency columns can be a much more cost effective solution than adding more Full-Range columns, making it possible to achieve the required pattern control and SPL in the lower frequency region while using a limited number of Full-Range modules.

Part of the superior performance of ENTASYS is due to its internal passive crossover. This crossover employs high order slopes, passive equalization, and proprietary design techniques to integrate each cabinet's sixty-six drivers into a single radiating line array to deliver a broad frequency range.

Low Frequency Column (ENT-LF)

The ENTASYS Low Frequency column is visually externally identical to the Full-Range column. Both FR and LF units are designed with the same enclosure, grille, input connectors, etc., resulting in a seamless aesthetic design that blends unobtrusively with any environment.

Internally, the Low Frequency column contains no midrange or high frequency drivers, nor the passive crossover circuitry for these drivers. Instead, it is designed with its own passive low pass filter, optimized for seamless integration with the Full-Range or other Low Frequency columns in an array.

Note that the Low Frequency column is not intended as a low frequency extension device or a subwoofer. It is designed to augment the maximum output level of the low frequency pass band for ENTASYS, as well as enhance its vertical directivity control. To maintain this directivity control, the Low Frequency column should utilize the same external high pass filter as the Full-Range column when multiple columns are employed (reference Page 17).

ACCESSORIES AND OPTIONS

Custom Painting

ENTASYS systems are available as standard items with a black or white powder coat finish. Custom colors are available upon request and approval from Community. The powder coated aluminum enclosure may be painted using standard off-the-shelf paint suitable for use on powder- coated surfaces. The nylon end caps cannot be painted with this type of paint. These should be painted with Krylon® Fusion for Plastic®, Plasti-Kote® Plastic-Bond Enamel, or Rust-Oleum® Plastic paint specifically formulated for use on plastic parts. Alternatively, the enclosure may be coated first with a plastic surface primer such as Plasti-Kote® Plastic Primer or Rust-Oleum® Plastic Primer. A second coating of paint may then be applied on top of the primer coat.

ENTASYS grilles are powder-coated steel. To paint the grille, carefully remove the cloth backing and use paint that is compatible with powder coating. Do not paint the cloth. Apply replacement grille cloth (available from Community) by using a fine mist of spray adhesive on the grille. Do not put adhesive on the cloth. Then, attach the cloth by pressing it onto the interior surface of the grille. Be careful not to clog the pores in the cloth.

Community offers several different mounting brackets as well as an autoformer to extend the functionality of ENTASYS systems. These mounting brackets are designed to provide the proper safety factor when used correctly. See the ***ENTASYS Installation/Operation Manual***, Pages 17-30, for additional information on these brackets and their use.

ENTASYS Mounting Bracket (included): ENT-MB, ENT-MBW

The ENTASYS Mounting Bracket (**Figure 1**), also referred to as the “T-bracket”, is included and shipped attached to each ENTASYS column loudspeaker. This bracket is the primary means of attaching all other brackets and fly kits to the loudspeaker enclosure, and can also be used to mount an ENTASYS enclosure directly to a wall or other surface.

ENTASYS Coupler Bracket: ENT-CB1, ENT-CB2, ENT-CB1W, ENT-CB2W

The ENTASYS Coupler Bracket (**Figure 2**) is used to attach two ENTASYS columns together. Multiple Coupler Brackets may be used to connect up to five columns. The Coupler Brackets must be attached to the “T” Bracket of each ENTASYS column to be connected together. Connecting the ENTASYS modules together is the first step required when constructing multiple column arrays, regardless of the other brackets that will be used to mount or suspend the columns.

ENTASYS Pan Bracket: ENT-PB, ENT-PBW

The ENTASYS Pan Bracket (**Figure 3**) can be used to mount up to five ENTASYS columns flush on a wall while enabling vertical axis rotation (panning) of up to 80 degrees (from 5° - 80° aiming angles) of the entire array. Pan Brackets may be installed on a wall in either a left-hand or right-hand orientation, as required for aiming the array. The Pan Bracket kit contains two curved metal brackets and all hardware required to attach these brackets to the “T” Bracket.

ENTASYS Pan-Tilt Bracket: ENT-PT, ENT-PTW

The ENTASYS Pan-Tilt Bracket (**Figure 4)** is used to provide both horizontal axis rotation (down-tilt) and vertical axis rotation (panning) when an array is mounted to a wall. The Pan-Tilt Bracket consists of two primary parts: the Top Assembly and the Bottom Piece. The Top Assembly consists of multiple parts, configured and assembled to provide the desired down-tilt angle for an array of up to five columns. Once the Pan-Tilt Bracket Assembly has been assembled, it is mounted to a wall and the ENTASYS system(s) are then attached to it.

The Pan-Tilt bracket can be used with a one, two, or three column array to provide a down-tilt angle of up to 10 degrees. With a four or five column array the maximum down-tilt angle is 5 degrees.

ENTASYS Fly Kit: ENT-FK, ENT-FKW

The ENTASYS Fly Kit (**Figure 5**) can be used to suspend an array of up to five ENTASYS modules. The Fly Bracket provides multiple attachment points at the top of an array while the Pull Back Bracket provides points lower on the array for additional aiming flexibility. The attachment points on the Fly Bracket at the top of an array alone will allow various down-tilt angles with a dead hang, this point alone is not recommended. The attachment points on the Pull Back Bracket at the bottom of an array should also be used for fine control of vertical tilt. Use both points: the Fly Bracket plus the Pull Back Bracket. Attach a secondary safety line to the top of the Fly Bracket as a safety cable.

FOR MORE INFORMATION

For more information on installing and operating your ENTASYS systems, please refer to Community’s web site at: http://www.communitypro.com/index.php/product-list/102-entasys

For applications support, service or warranty information, refer to Community’s web site or contact Community at 610-876-3400 / 1-800-523-4934.

INTRODUCTION

Figure 1: ENTASYS Mounting Bracket

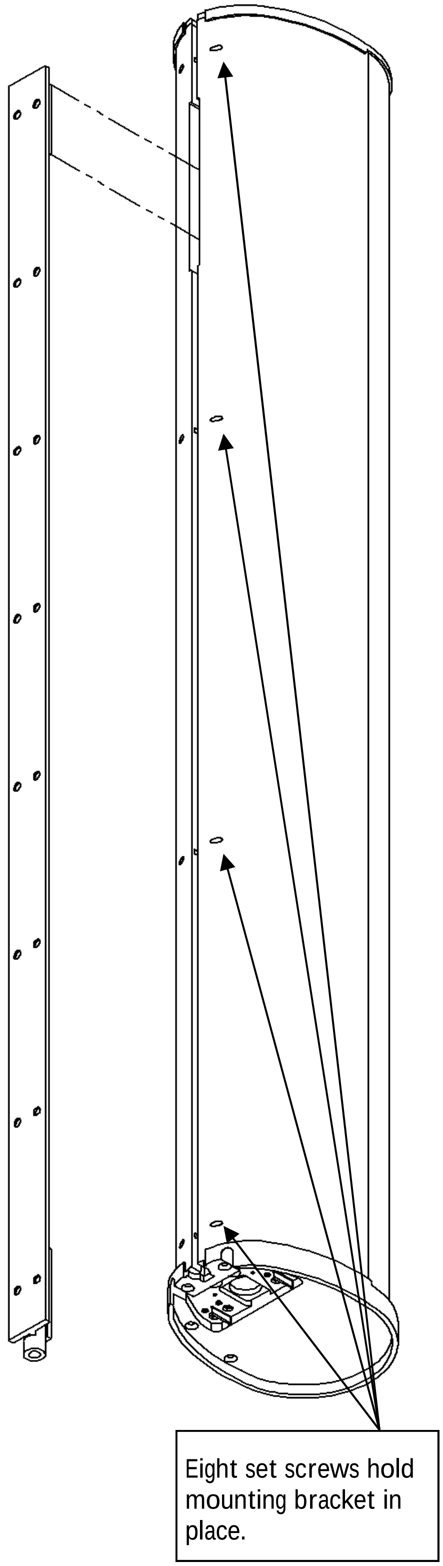


Figure 2: Coupler Bracket

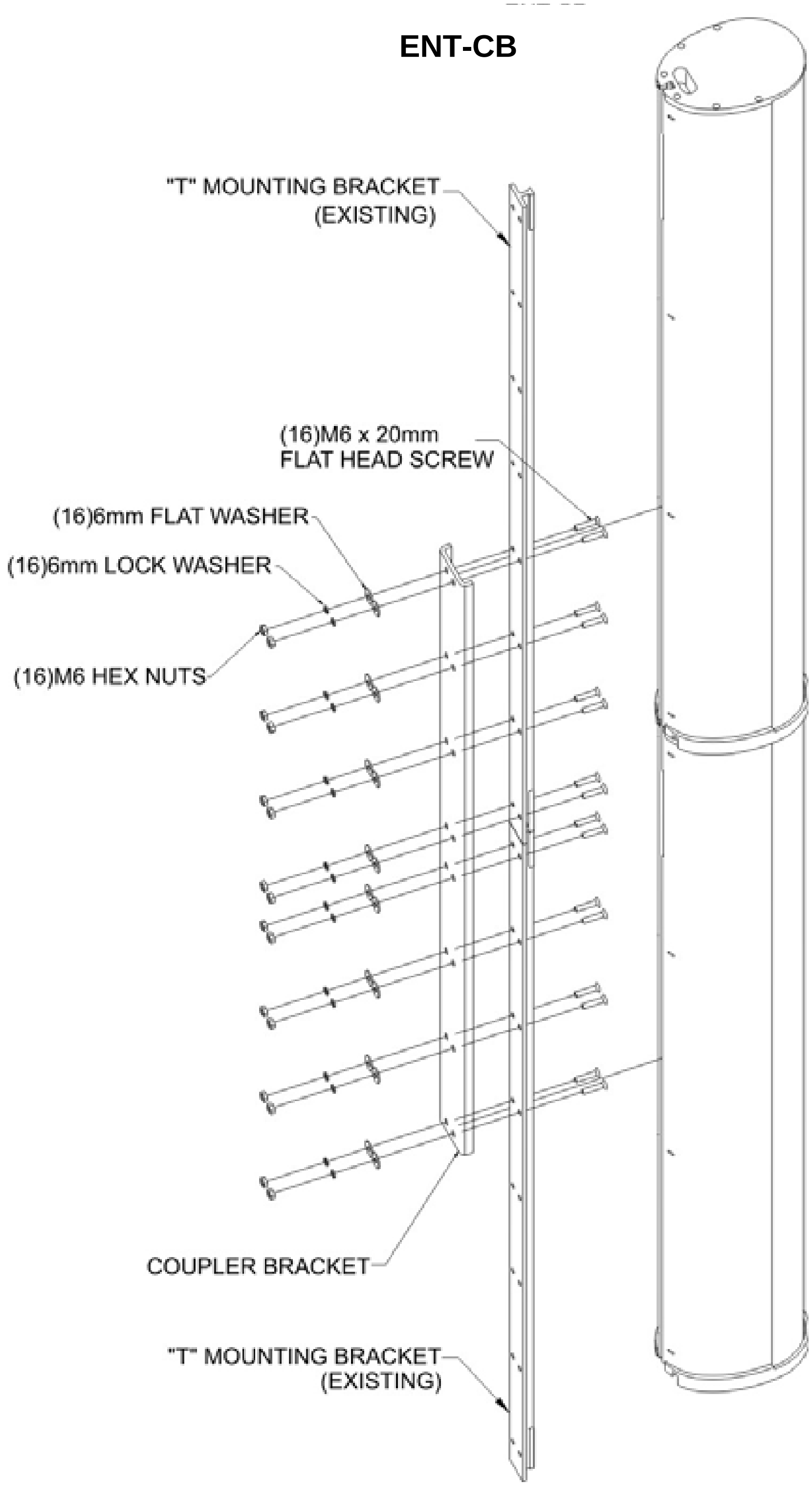


Figure 3: Pan Bracket

ENT-PB

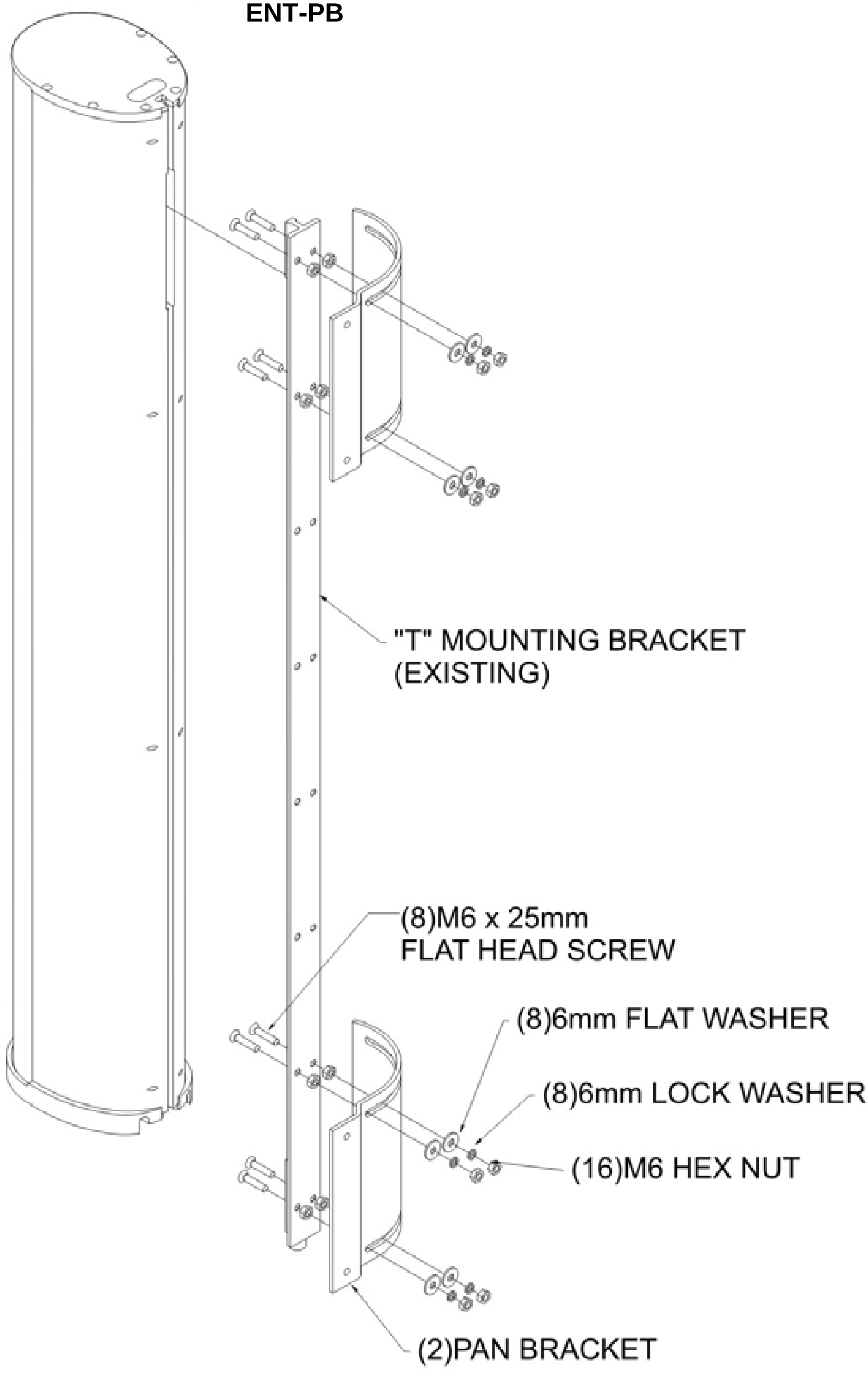


Figure 4: Pan-Tilt Bracket on Multiple Columns

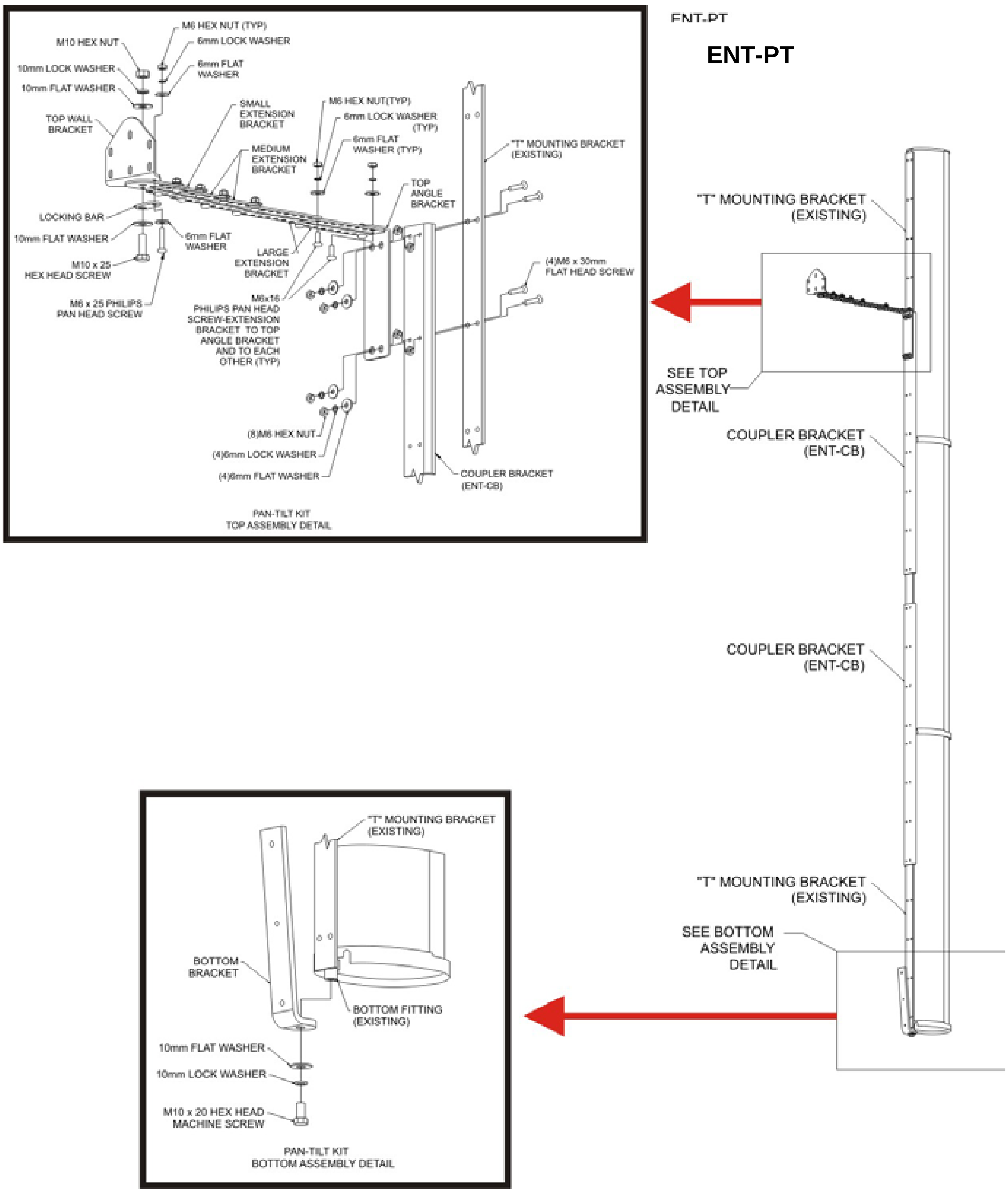
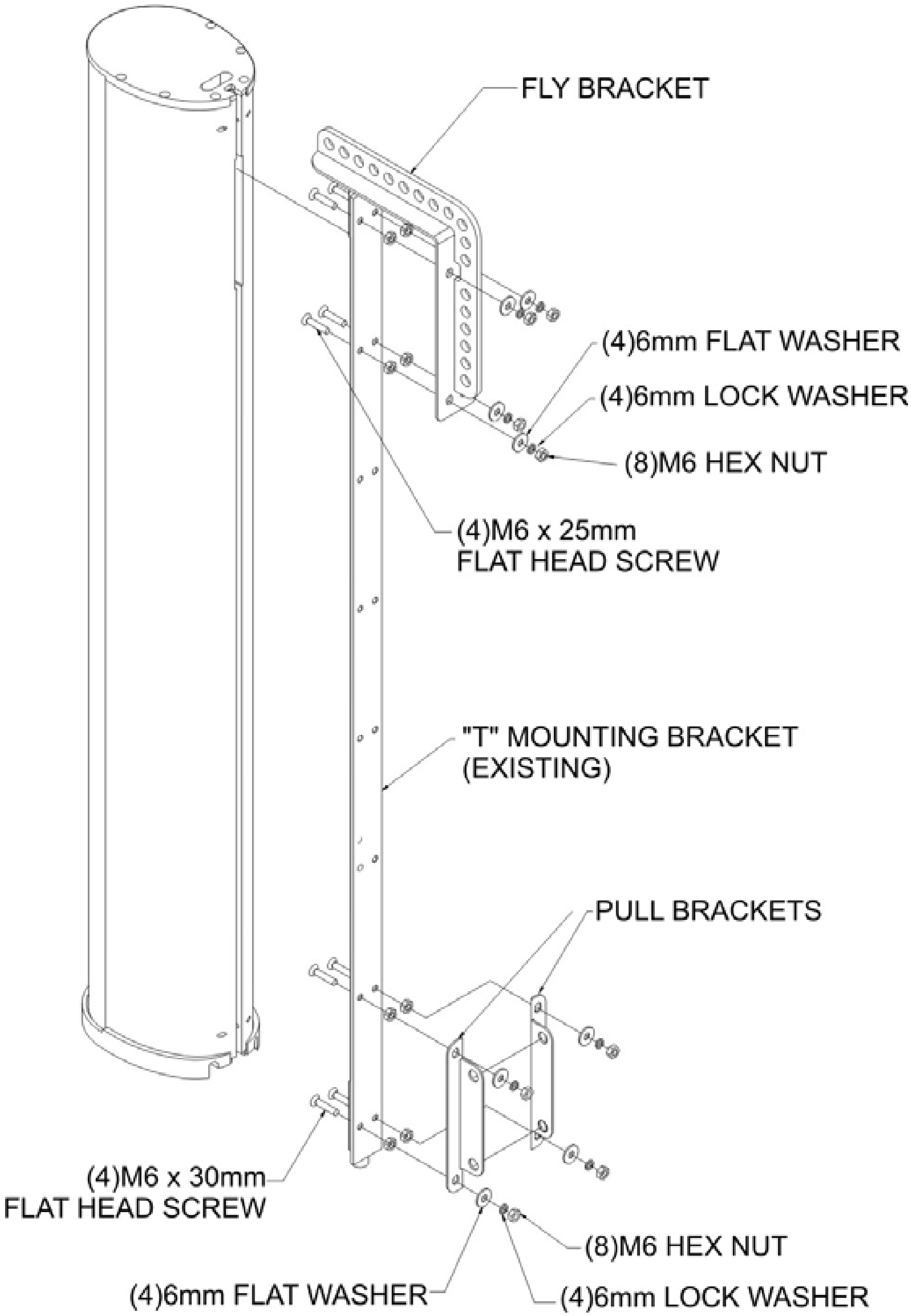


Figure 5: Fly Kit

ENT-FK



COMMUNITY'S TECHNICAL APPLICATIONS GROUP (TAG)

Contact Community's "TAG Team" for applications support on ENTASYS systems and other Community products. Our TAG Team can help select the best product for each application and assist in system design, loudspeaker layout, acoustic simulation analysis, and provide information needed for system commissioning.

Contact the TAG Team at 610-876-3400 / 1-800-523-4934 or email TAGTEAM@communitypro.com.

ASSEMBLY OF ARRAYS

Assembling individual ENTASYS system modules into a multi-column array is easy, but should be done with care to ensure that all components fit together correctly and securely to maintain the design safety and integrity of the array.

Please refer to the ***ENTASYS Installation/Operation Manual***, Pages 17-30, or the instructions included with the individual mounting brackets, for complete details on the correct procedure for attaching the ENTASYS enclosure to these brackets.

When two Full-Range columns are arrayed immediately above and below each other, optimal performance will be achieved using the straight configuration for each column. The top of the upper column and the bottom of the lower column could remain curved. This will yield a symmetrical array when assembled (See **Figure 6**). For information on altering the configuration of the mid and high frequency drivers please refer to the ***ENTASYS Installation/Operation Manual***, Pages 43-44.

CONNECTORS

Each ENTASYS module provides multiple connection terminals; these are provided for convenience, and to facilitate connection to each module in a multi-column array without visible, external wiring between the enclosures. This results in an efficient and clean looking, aesthetically pleasing installation.

The input terminals are located on the bottom of each module (see **Figure 7)**. ENTASYS systems are equipped with three types of input connectors:

- Industry standard NL4-type locking connector
- Dual banana jack connector
- Two-position barrier strip terminal

All of these connectors are wired in parallel.

The NL4-type input connector should be wired according to **Figure 8**.

The top of the ENTASYS module is also equipped with a Signal Thru terminal, configured as a male dual banana jack (See **Figure 9)**. Using the dual banana Jumper Plug included with each ENTASYS module, this Signal Thru terminal is used to connect adjacent ENTASYS modules in a multiple array.

A bottom cover panel (**Figure 10**) is provided to seal the recessed area when using the barrier strip terminals. This enhances the weather-resistant properties of the enclosure.

The bottom cover has a knock-out for a 1/2-inch conduit. This allows for the use of conduit, or cables larger than 16-2 SJO, while sealing the connector area from the ingress.

A rubber plug is also provided to seal the recess on the top of the enclosure when the Signal Thru connection is not used.

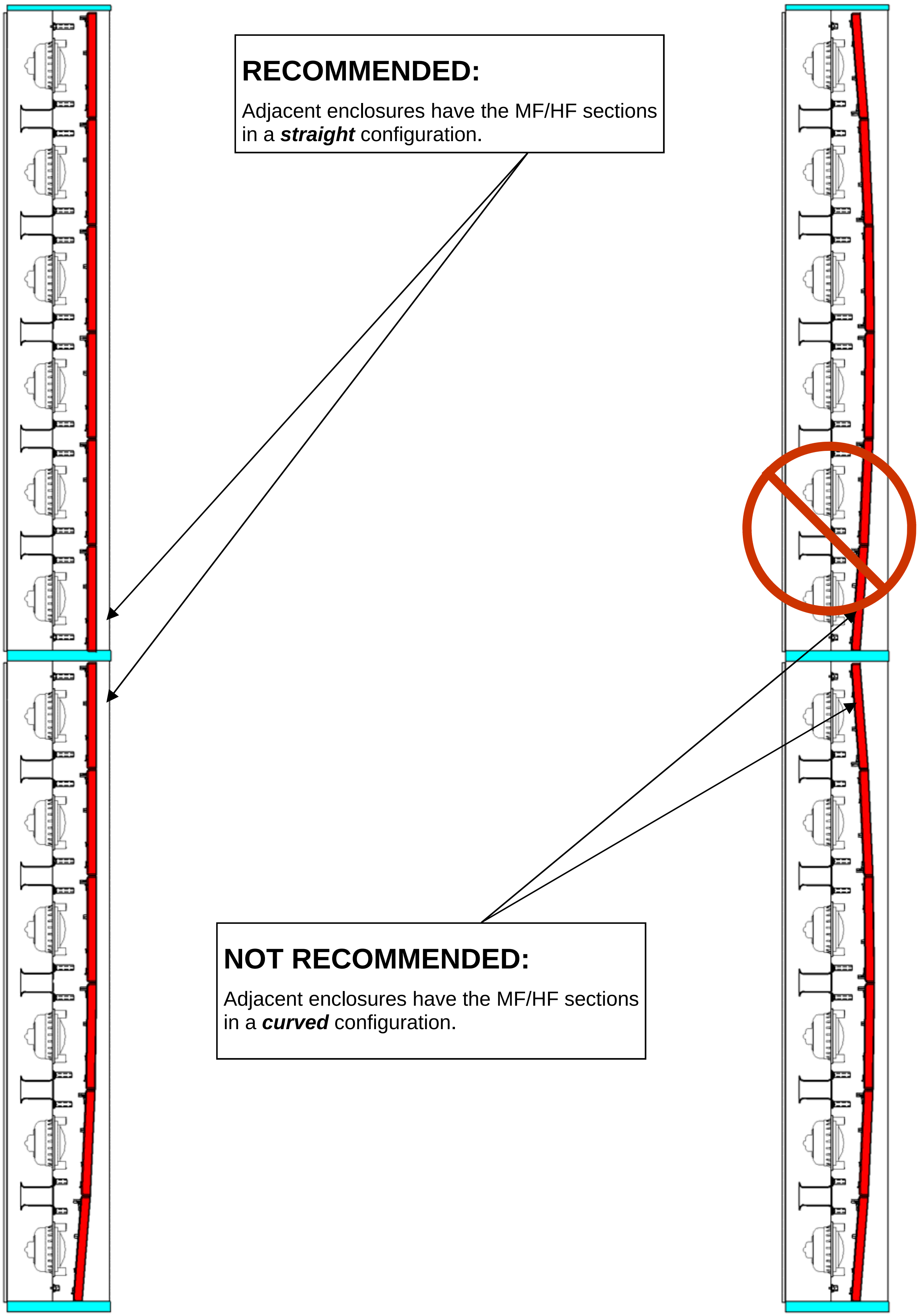
Note: When using ENTASYS Outdoors, use the barrier strip input terminals and replace the cover panel. The NL4 type inputs may be used for short-term connections outdoors but are not recommended for long-term outdoor usage.

Please refer to the ***ENTASYS Installation/Operation Manual***, Pages 35-41 for additional information about connections to, and between, ENTASYS modules.

GUIDELINES FOR USING ENTASYS OUTDOORS

ENTASYS is suitable for outdoor installations and has an IP rating of 54W when used as recommended in our Installation/ Operation Manual on page 43.

Figure 6: Recommended and Non-Recommended Configuration for Adjacent ENTASYS Systems



QUICK START

Figure 7: ENTASYS Full-Range Column Input Panel

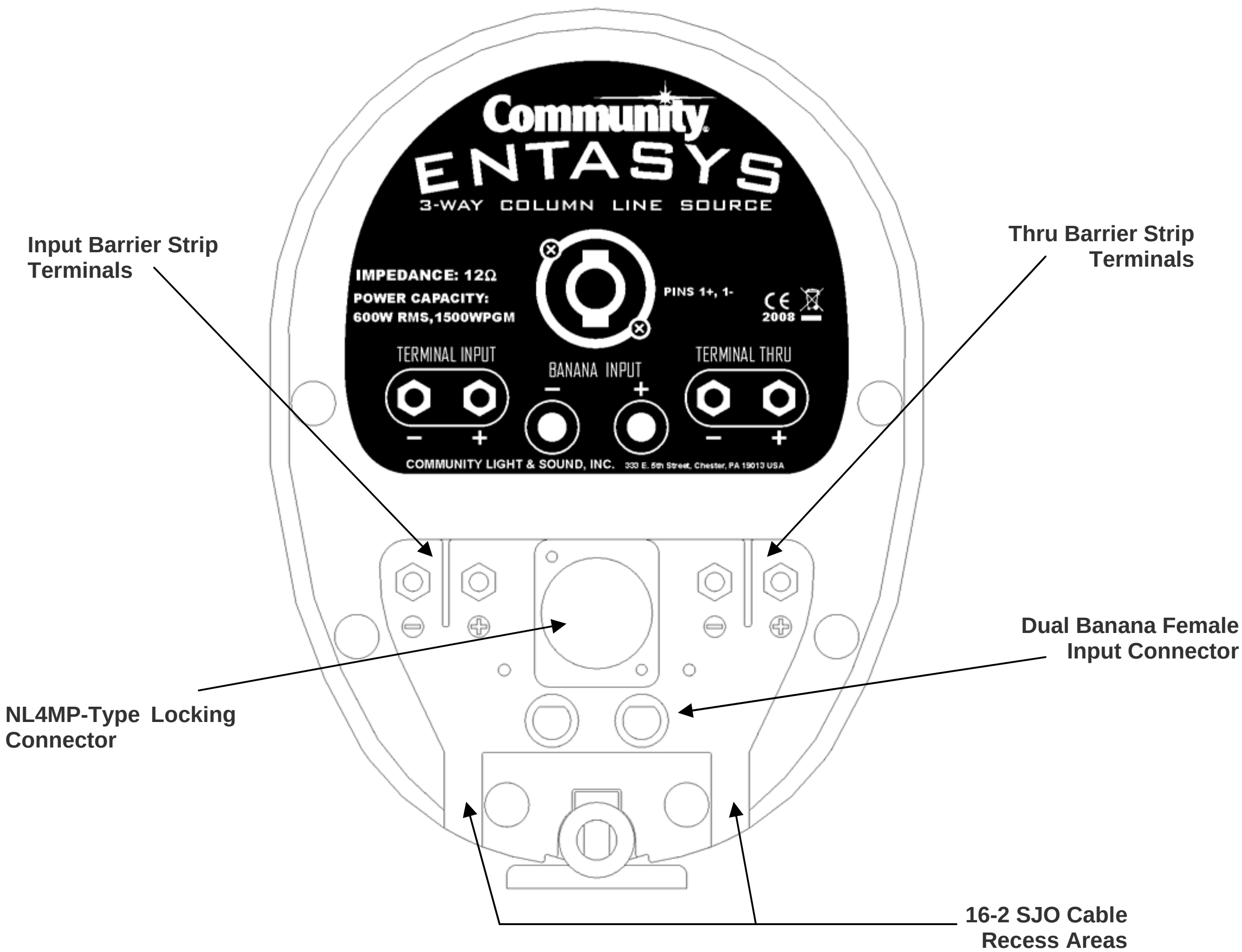


Figure 8: NL4-Type Connection Detail

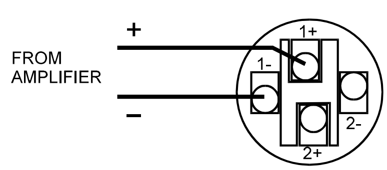


Figure 9: ENTASYS Dual Banana Plug Jumper

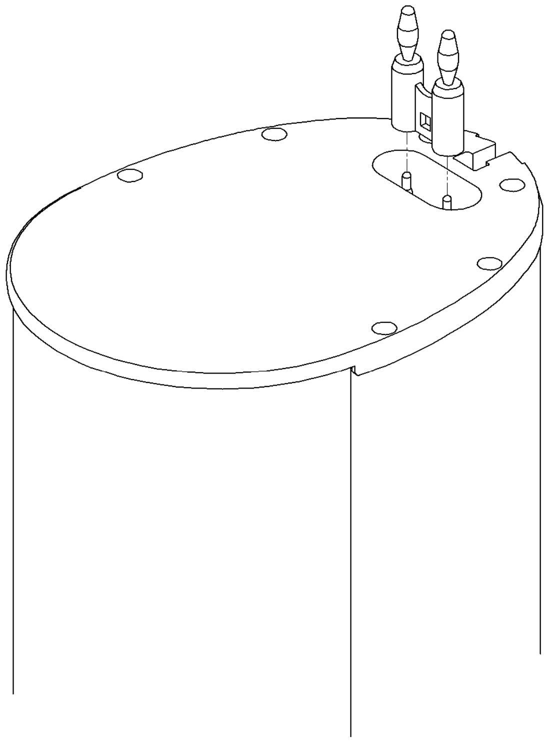


Figure 10: ENTASYS Bottom Cover Panel with Conduit Knock-Out

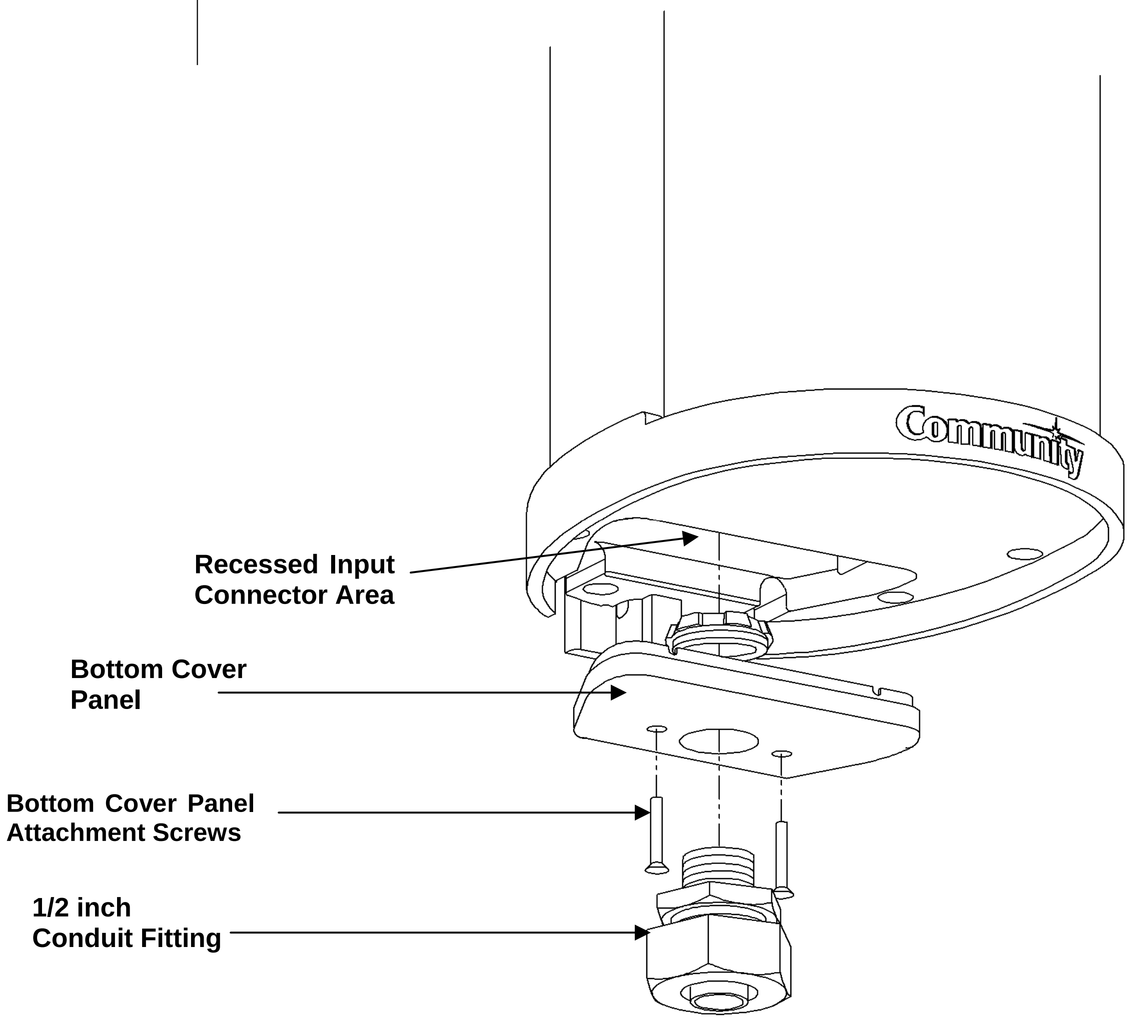


Figure 11: Autoformer Mounting On Top of an Enclosure

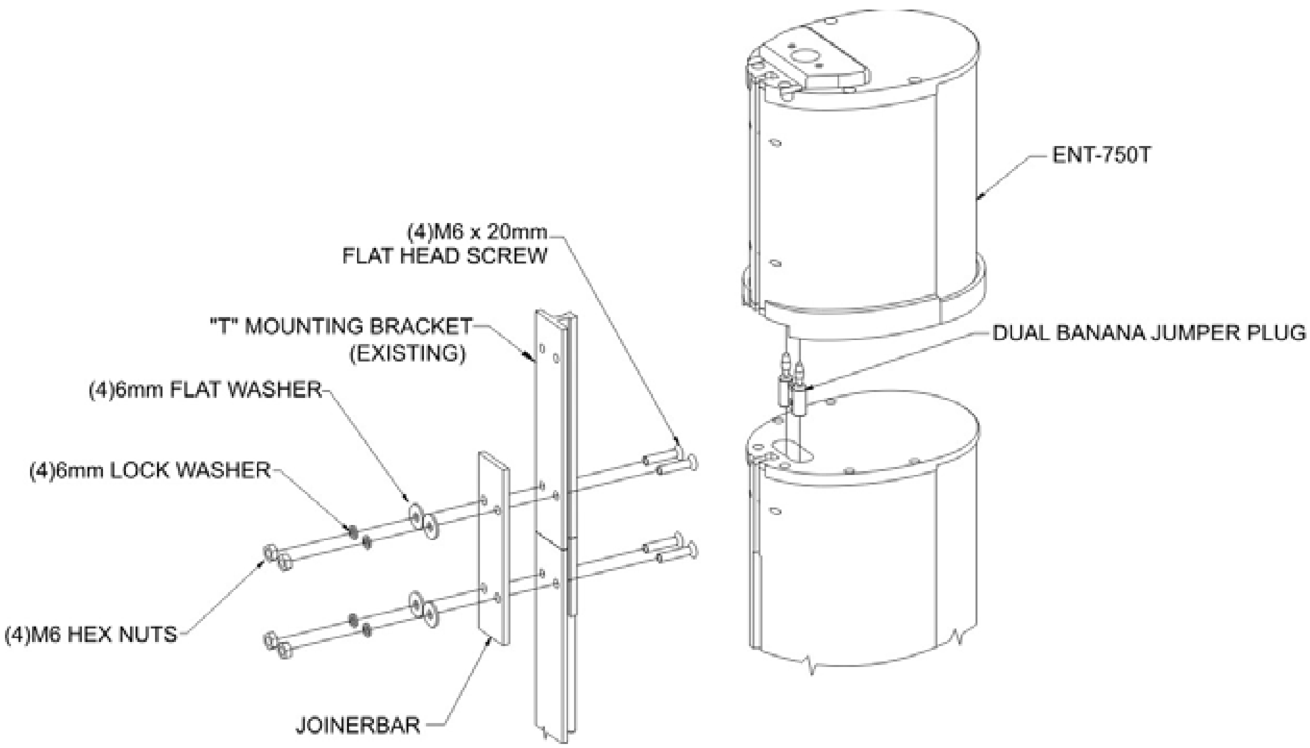
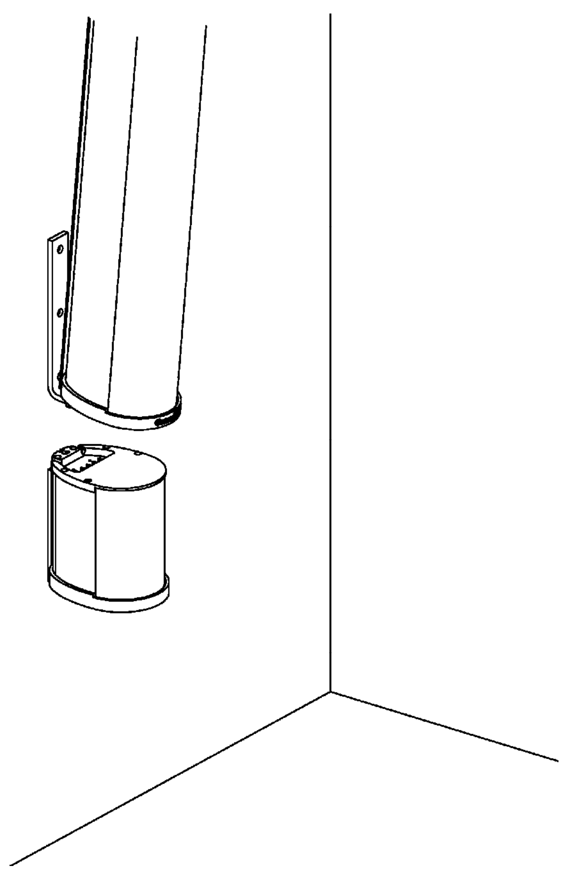


Figure 12: Autoformer Mounting Below Array



AUTOFORMER PLACEMENT

The optional autoformer, ENTASYS 750-Watt Autoformer (ENT-750T) may be located either above or below ENTASYS module(s). When located below the module(s), the autoformer ***must*** be attached directly to a wall or other mounting surface (**Figure 12**). It is not designed to support the weight of an ENTASYS module, and should therefore not be directly mounted to an ENTASYS module from below.

The autoformer may be electrically connected to the input terminals on the bottom of an ENTASYS system using the barrier strip terminals on the top of the autoformer.

The autoformer may be mechanically attached to the top of an ENTASYS enclosure using the Joiner Bar and the associated hardware included with the autoformer. (See **Figure 11**.) Mounting the autoformer in this manner allows the output of the autoformer to be routed to the input of an ENTASYS module via the Dual Banana Jumper Plug, also included.

For additional information on the ENTASYS 750-Watt Autoformer and how it interfaces with ENTASYS modules, please refer to the ***ENTASYS Installation/Operation Manual***, Pages 31-32.

Table 1: Recommended Amplifier Size

Full-Range Columns	Total Rated Impedance (ohm)	Recommended Power (watts)	Required Voltage (V_{RMS})	Amplifier Rating @ 8 ohm (watts)	Amplifier Rating @ 4 ohm (watts)
1	12	600	85	1,800	3,600
2	6	1,200	85	-	3,600
3	4	1,800	85	-	3,600

Low Frequency Columns	Total Rated Impedance (ohm)	Recommended Power (watts)	Required Voltage (V_{RMS})	Amplifier Rating @ 8 ohm (watts)	Amplifier Rating @ 4 ohm (watts)
1	12	600	85	1,800	3,600
2	6	1,200	85	-	3,600
3	4	1,800	85	-	3,600

Low Frequency Columns	Full-Range Columns	Total Rated Impedance (ohm)	Recommended Power (watts)	Required Voltage (V_{RMS})	Amplifier Rating @ 4 ohm (watts)
1	1	6	1,200	85	3,600
1	2	4	1,800	85	3,600
2	1	4	1,800	85	3,600

AMPLIFIER SELECTION

Table 1 shows the recommended power amplifier ratings for driving ENTASYS systems. Specifying amplifiers with these output power ratings will allow the maximum power to be delivered to the loudspeaker when the amplifier is driven to full output with a signal that has a 6 dB crest factor. For a discussion of crest factor, reference Page 36.

With each ENTASYS enclosure housing sixty-six individual drivers, ENTASYS loudspeaker systems are designed to handle exceptionally high amplifier power ratings. However, if high SPL is not required for a particular application, a lower powered amplifier may be used.

WARNING: Amplifiers used should not be overdriven or clipped during operation. Doing so could damage the loudspeaker(s) it is powering. For more information on amplifiers and limiters, please refer to the ***ENTASYS Installation/Operation Manual***, Pages 38-39.

If an amplifier is routinely clipping during operation in an attempt to achieve the desired SPL, it should be replaced with an amplifier with a higher output rating. If an amplifier with a higher output rating would exceed the recommended 3,600 watts into 4 ohms, it may be necessary to increase the number of loudspeakers to achieve the desired SPL in the audience area of a venue.

A good method for determining the size of the power amplifier for an application is to do a quick model of the seating and array location using EASE Focus (reference page 17). Set the Bandwidth to Broadband and the Level to RMS (Max SPL). The Level View should then display the maximum SPL at the audience ear height. If the SPL in the audience area is much greater than it needs to be, the size of the power amplifier may be reduced. Alternatively, an amplifier rated at 3,600 watts into 4 ohms may still be used, passing signals with a greater crest factor while providing the average SPL desired. An overview of this is shown in **Table 2**.

Table 2: Amplifier Size Reduction for Decreased SPL and Increased Crest Factor

	For 6 dB Crest Factor	For 9 dB Crest Factor	For 12 dB Crest Factor	For 15 dB Crest Factor
Reduction of SPL	Amplifier Rating (4 ohm)	Amplifier Rating (4 ohm)	Amplifier Rating (4 ohm)	Amplifier Rating (4 ohm)
0	3,600			
-3	1,800	3,600		
-6	900	1,800	3,600	
-9	450	900	1,800	3,600
-12	225	450	900	1,800
-15	112	225	450	900
-18	56	112	225	450
-21	28	56	112	225
-24	14	28	56	113
-27	7	14	28	56
-30	4	7	14	28

Using **Table 2**, locate the SPL reduction value in the column on the left. Any amplifier size in that row can be used. The heading at the top of that row lists the crest factor of a signal that the amplifier will pass without clipping while still driving ENTASYS to the desired SPL.

For example, if an EASE (or EASE Focus) model shows that the SPL is 6 dB too high, it can be reduced by employing a smaller amplifier (e.g., with a 900 W into 4 ohm rating), thereby allowing a signal with only a 6 dB crest factor to yield the desired SPL. Alternatively, an amplifier rated at 3,600 W into 4 ohms will allow a signal with a 12 dB crest factor to yield the desired SPL.

REQUIRED HIGH PASS FILTER

The use of an external, active high pass filter before the power amplifier(s) driving ENTASYS systems is **always** required. This high pass filter will help to protect the woofers from damage due to excessive low frequency excursion. It will also avoid wasting amplifier power attempting to reproduce frequencies below the loudspeakers' intended operating range. A high pass filter set to 200 Hz, 24 dB/octave or higher frequency should always be used. Increasing the high pass filter to a higher frequency or greater slope will not present any problems for an ENTASYS system.

EASE Focus is a line array software modeling program that may be downloaded without cost from www.easefocus.com/downloads.html. EASE Focus is an extremely helpful tool for determining how many ENTASYS modules should be used, where they should be placed, and how they should be aimed to quickly obtain the desired SPL for an audience area.

For more information on EASE Focus see the *System Design Guidelines* section on Pages 25-26.

DIFFERENCES BETWEEN LINE ARRAYS AND POINT SOURCE LOUDSPEAKER SYSTEMS

There are several distinct differences between line arrays and point source loudspeakers. Sometimes, point source loudspeakers are comprised of simply full-range drivers. Many times, they include multiple drivers including combinations of horns and direct radiating cones that reinforce specific frequency bands. In either case, point source loudspeaker cabinets are generally built so that all the drivers function as one source. An example of point source type loudspeakers are Community VERIS and iBOX systems. Much like the behavior of a true acoustical point source, these systems usually have a fairly short near-field coverage; as the distance from the source increases, their SPL decreases according to the inverse square law.

A line array, on the other hand, is typically very large in one dimension (usually vertical), compared to the wavelength of frequencies it radiates. This gives it superior directivity control for frequencies with wavelengths greater than twice the length of the line. Put another way, the length of a line array should be equal to or greater than one-half the wavelength of the lowest frequency over which directivity control is desired. At frequencies much higher than determined by $L = \lambda/2$ (λ = wavelength), a line array can have a very small coverage angle.

Typically line arrays are oriented vertically. This enables a small vertical coverage angle, or opening angle as it is sometimes called, to be used to great advantage in reducing reflections and keeping sound off ceilings and other surfaces. This can be very beneficial in highly reverberant spaces.

In the near-field of a line array, the SPL falls off at -3 dB per doubling of distance, instead of -6 dB as dictated by inverse square law. Line array systems tend to have a much greater near-field coverage distance than point source systems. This enables a line array to potentially offer higher SPL at a given distance than a point source system. However, there is a limit to the distance at which the line array can maintain this -3 dB SPL decrease per doubling of distance. It can only do this in the near-field of the line array. Beyond the near-field, the SPL from a line array will decrease at -6 dB per doubling of distance.

The near-field can extend very far from a line array, and is dependant on the length of the line array as well as the given frequency. This means that for a fixed-length line array the near-field distance will change as a function of frequency. Thus the frequency response of a line array may change depending on the distance away from it.

Another important point to consider is the difference in the size of the origin of radiation for these two types of loudspeakers. As the name implies, a point source has its origin at a single point. (While this is overly simplistic, it will help to illustrate this difference.) The sound from a line array, on the other hand, does not originate from a single point, but from a line. While a point is infinitesimally small and has no physical height, a line does. This difference can play a large role in understanding the radiation and coverage from a line array.

As an example, consider a point source with a 5 degree vertical coverage angle. At a distance of 30 feet (9.15 m), this point source will cover a vertical height of approximately 2.6 feet (0.80 m). By comparison, a 3-foot (0.91 m) line array with the same 5 degree vertical angle will cover a vertical height of approximately 5.6 feet (1.71 m). This sets the origin for its radiation and will have a bearing on the overall coverage. (This is an extreme example but it does help to demonstrate this fundamental difference.) For an illustration of this please refer to the ***ENTASYS Installation/Operation Manual***, Pages 49-50.

WHEN TO USE LINE ARRAYS

A line array's high degree of directivity control makes it particularly well suited for use in highly reverberant spaces, where it is imperative that sound be directed to the audience areas only and not excite other highly reflective surfaces. This will help to maximize speech intelligibility in these difficult spaces.

Line arrays also work well in rooms with relatively low ceilings. When the ceiling is low in relation to the depth of the room, it may not be possible to position a point source system located at the front of the room sufficiently high enough to provide consistent coverage from the front to the rear-most point in the room. Additional point source loudspeakers would be required more farther back in the room on a separate "delay" feed. Using a line array system at the front of the room can make it possible to achieve a consistent SPL distribution from the front to the back of the room, without the need for delay loudspeakers.

GENERAL INFO ON LINE ARRAYS

The directivity control of a line array is generally only within the plane of the line. That is, if the drivers in a line array are arranged vertically (which is most often the case), the directivity control will be in the vertical plane. In the horizontal plane, directivity will be fairly broad. For this reason, line arrays cannot be rotated on their side and still maintain high vertical directivity.

PERFORMANCE COMPARISON OF A LINE ARRAY AND POINT SOURCE SYSTEM IN THE SAME ROOM

Perhaps one of the best ways to understand the differences between a line array and a point source system is to design a system for the same room using each type of system and compare them. It would be prohibitively costly to actually execute, install, and evaluate each system in this manner, however this comparison can be carried out virtually using acoustical computer modeling. Two designs were prepared and modeled in the same room using EASE 4.2. The example used was a small house of worship with a 2.0 - 2.5 second reverb time.

The ENTASYS line array system is shown in **Figure 13.** This system uses columns of two stacked ENTASYS Full-Range loudspeakers on each side at the front of the main seating area. One additional ENTASYS Full-Range loudspeaker is flown to provide coverage to the balcony area.

By comparison, **Figure 14** shows a point source system in the same space. This system uses a main cluster of two Community SLS960 and two SLS915 loudspeakers covering the floor area. Three SLS915 loudspeakers are used on a delay to provide coverage to the balcony area.

Note that on the SLS center cluster design, a high mounting position was necessary to preserve sightlines for the religious symbols. If those sightlines were not a consideration, the array could be lower and the intelligibility would be higher for the front of the audience especially. Sightlines of this nature are a common important consideration to the loudspeaker design. The sightline issue is completely avoided by using the ENTASYS system design.

The direct SPL on the room surfaces is shown in **Figures 15 - 22**. The odd number figures reflect the ENTASYS system, while the even numbers illustrate the point source system.

The SPL maps confirm that both systems provide good coverage to the audience areas, averaging approximately 95 dB SPL for the direct field. However, the point source system maintains this SPL slightly better from the front to the back of the room due to its high elevation.

The potential intelligibility of each system is compared in the graph shown in **Figure 23**. This shows C50 for each system in this room. C50 is a measure of the clarity and correlates well with intelligibility. (Higher values indicate greater clarity and potential intelligibility.) The ENTASYS system offers, on average, about 2 - 3 dB greater clarity below 5 kHz than the point source system, indicating greater potential intelligibility. This is further confirmed by the predicted %Alcons (percentage articulation loss of consonants) of 13.3% for the point source system and 10.6% for the ENTASYS system.

It should also be noted that the point source system design delivers considerably higher SPL to the altar area (**Figure 16** & **Figure 18**) than the ENTASYS system design (**Figure 15** & **Figure 17**). This would confirm the ENTASYS system's potential for considerably higher gain before feedback – another distinct advantage.

From a cost perspective, the point source system utilizes seven loudspeakers (all requiring rigging to be flown), four channels of amplification, and a signal delay unit. The ENTASYS system employs just five loudspeakers (only one requiring rigging), three channels of amplification, and a signal delay unit. While the loudspeakers used in the point source system are physically larger and capable of reproducing some lower frequencies that the ENTASYS systems will not, adding a VLF208 dual 8-inch subwoofer below each ENTASYS on the front wall would deliver comparable low frequency output, while still coming in at or below the cost of the point source system.

Figure 13: House of Worship with ENTASYS Systems

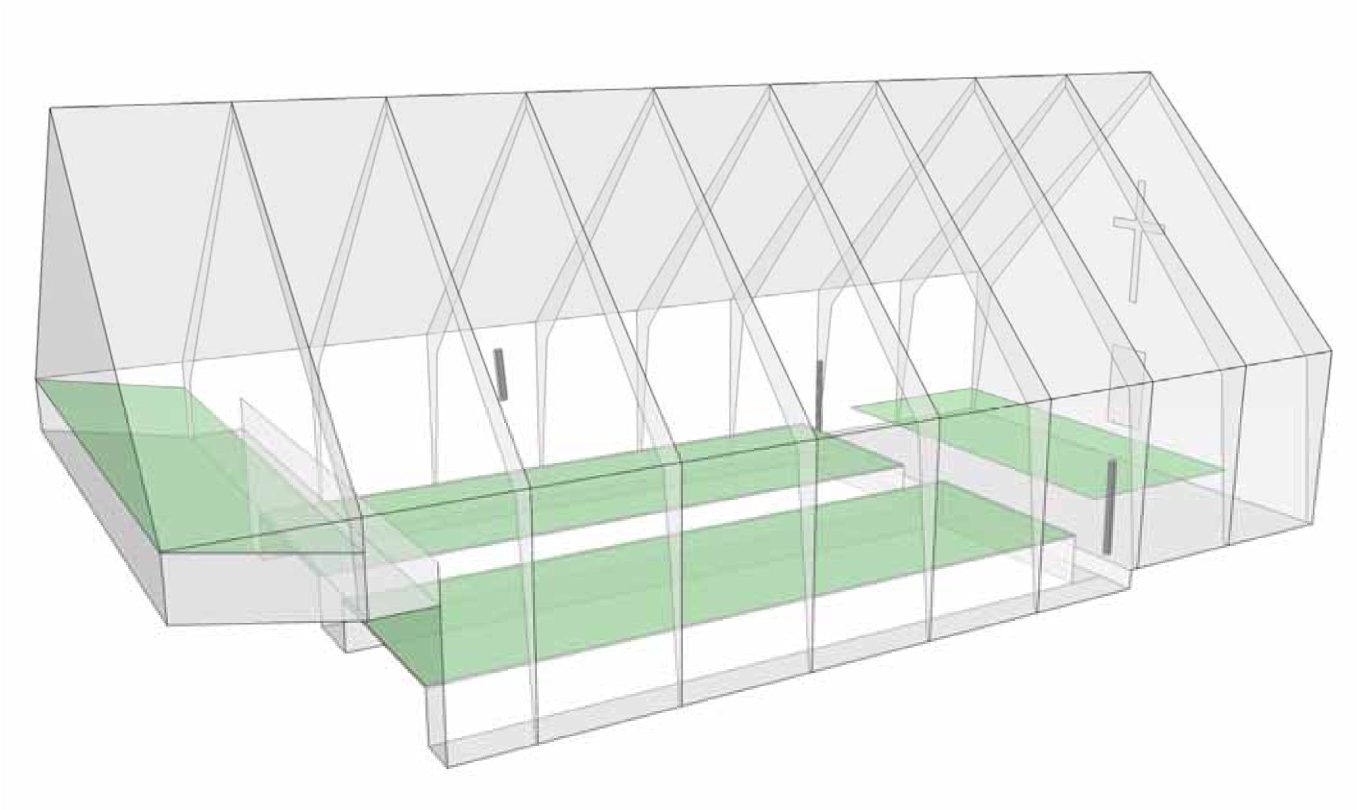


Figure 14: House of Worship with Point Source Loudspeaker System

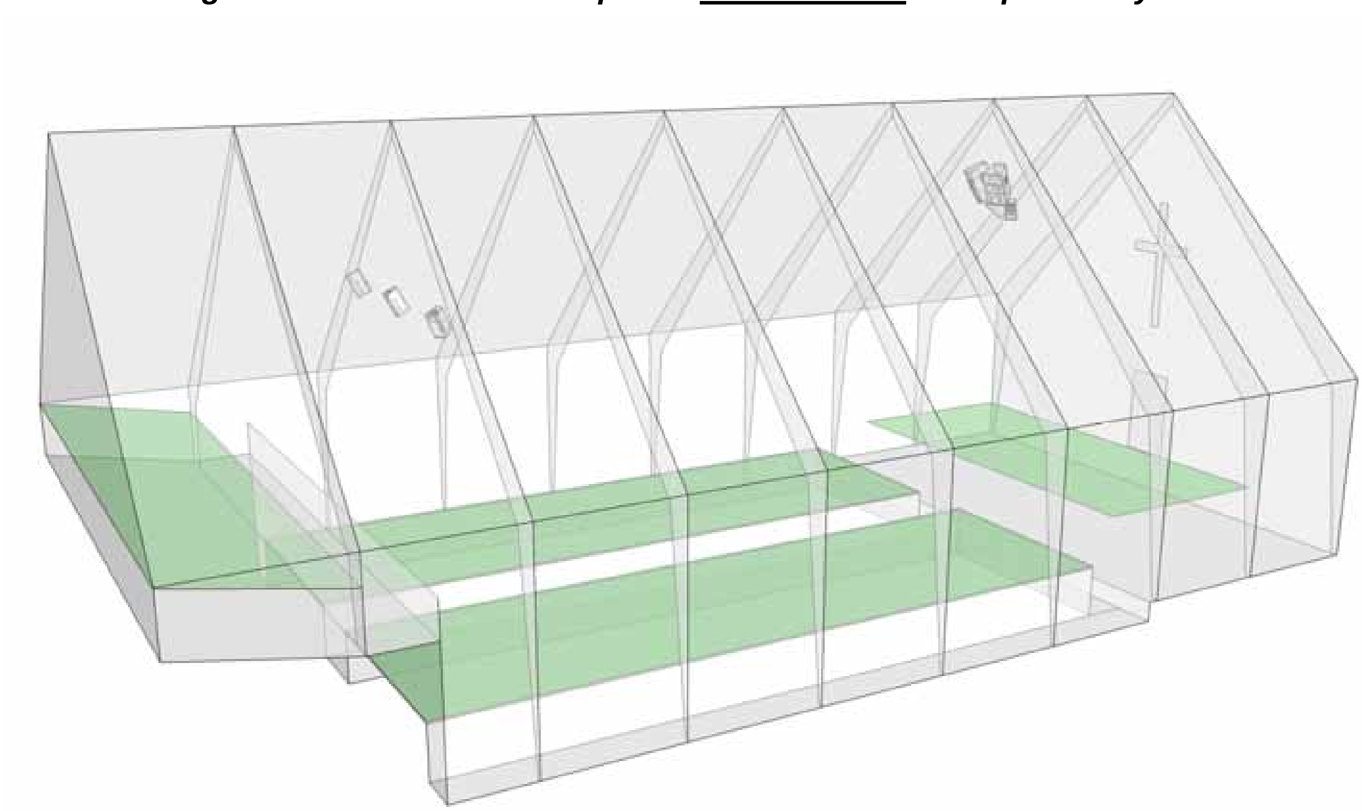


Figure 15: <u>ENTASYS</u> System - Direct Sound SPL Map on Room Surfaces, Isometric View

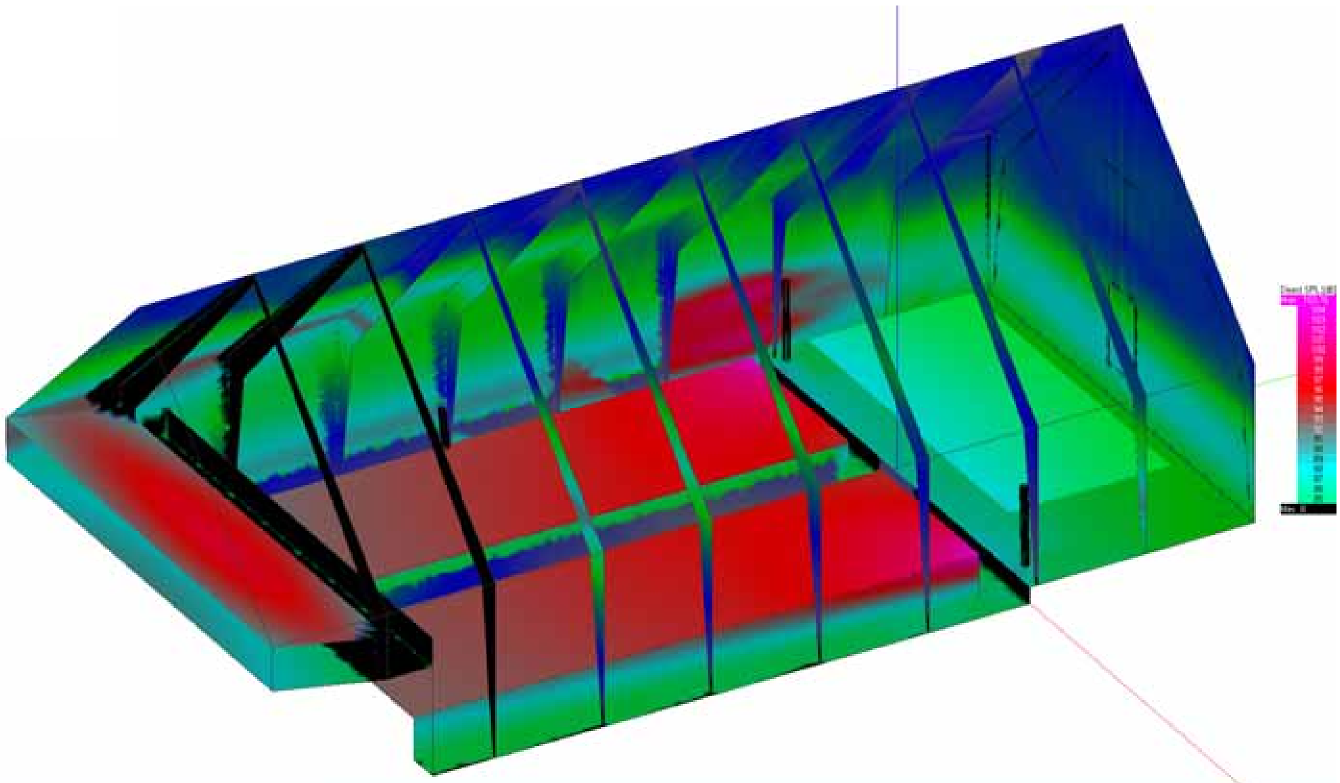


Figure 16: <u>Point Source</u> System - Direct Sound SPL Map on Room Surfaces, Isometric View

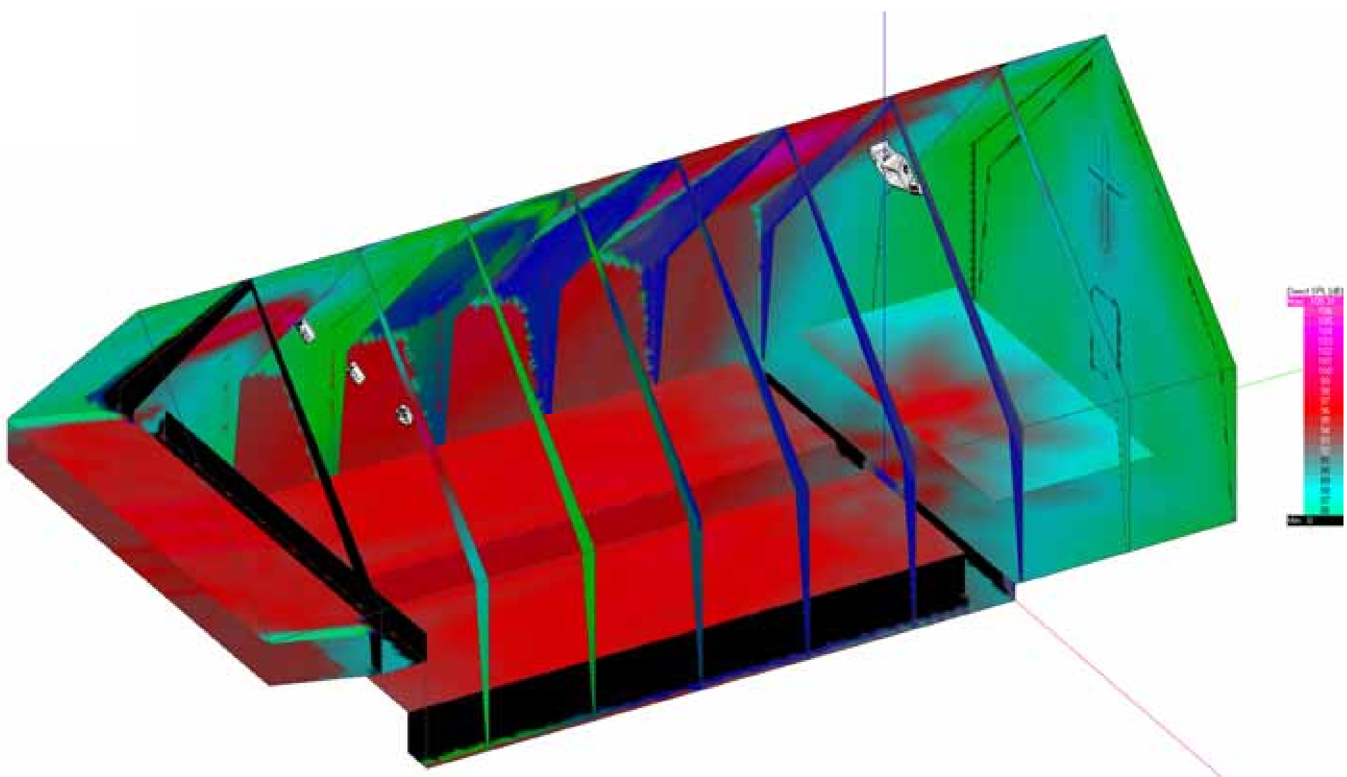


Figure 17: <u>ENTASYS</u> System - Direct Sound SPL Map on Room Surfaces, Plan View

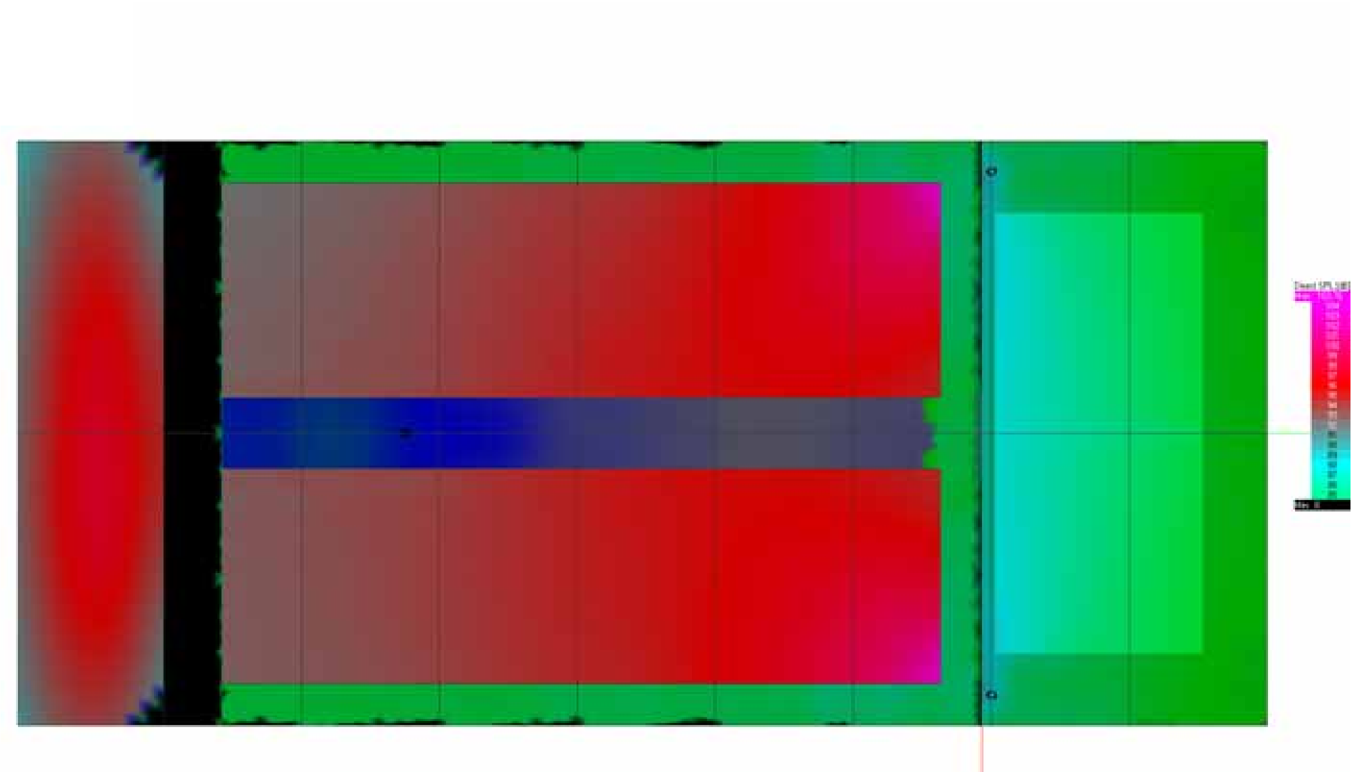
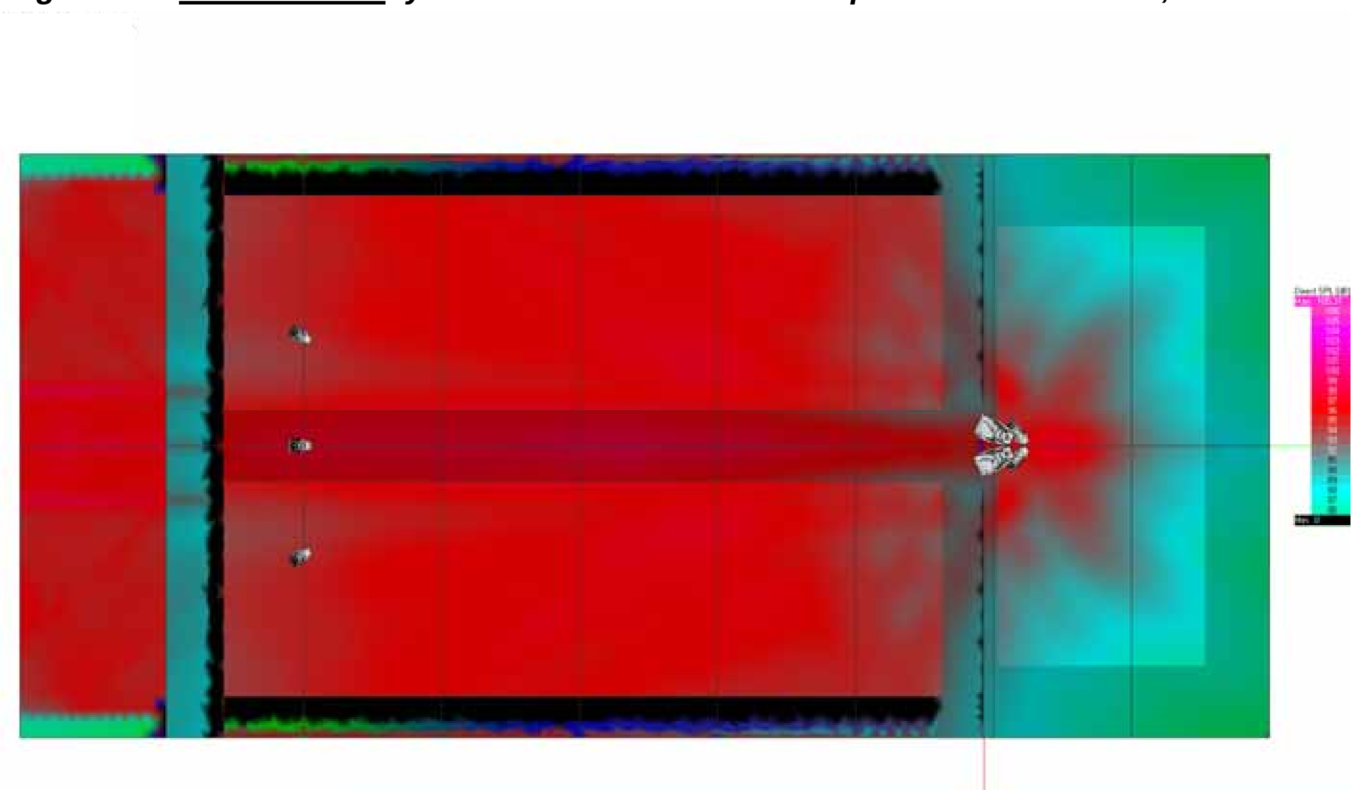


Figure 18: <u>Point Source</u> System - Direct Sound SPL Map on Room Surfaces, Plan View



GENERAL INFO ON LINE ARRAYS

Figure 19: <u>ENTASYS</u> System - Direct Sound SPL Map on Room Surfaces, Side Elevation View

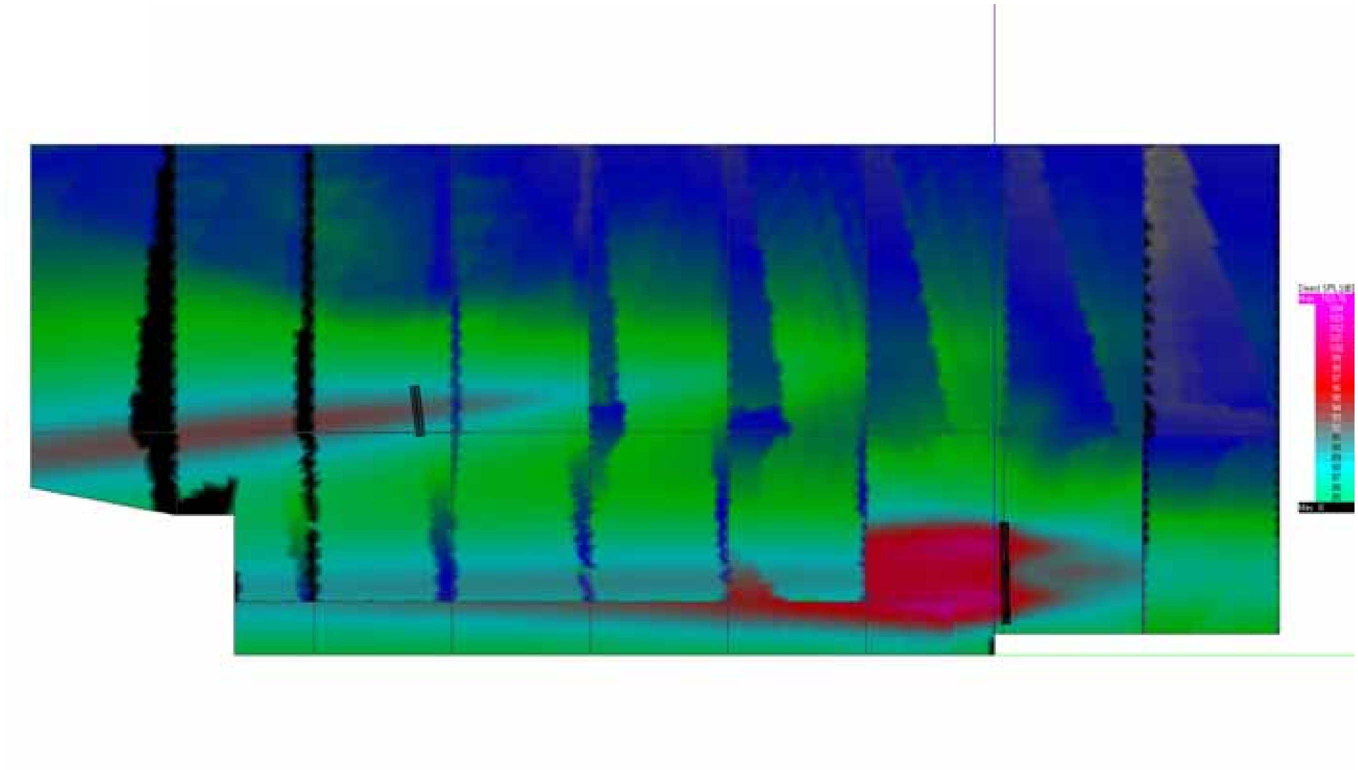


Figure 20: <u>Point Source</u> System - Direct Sound SPL Map on Room Surfaces, Side Elevation View

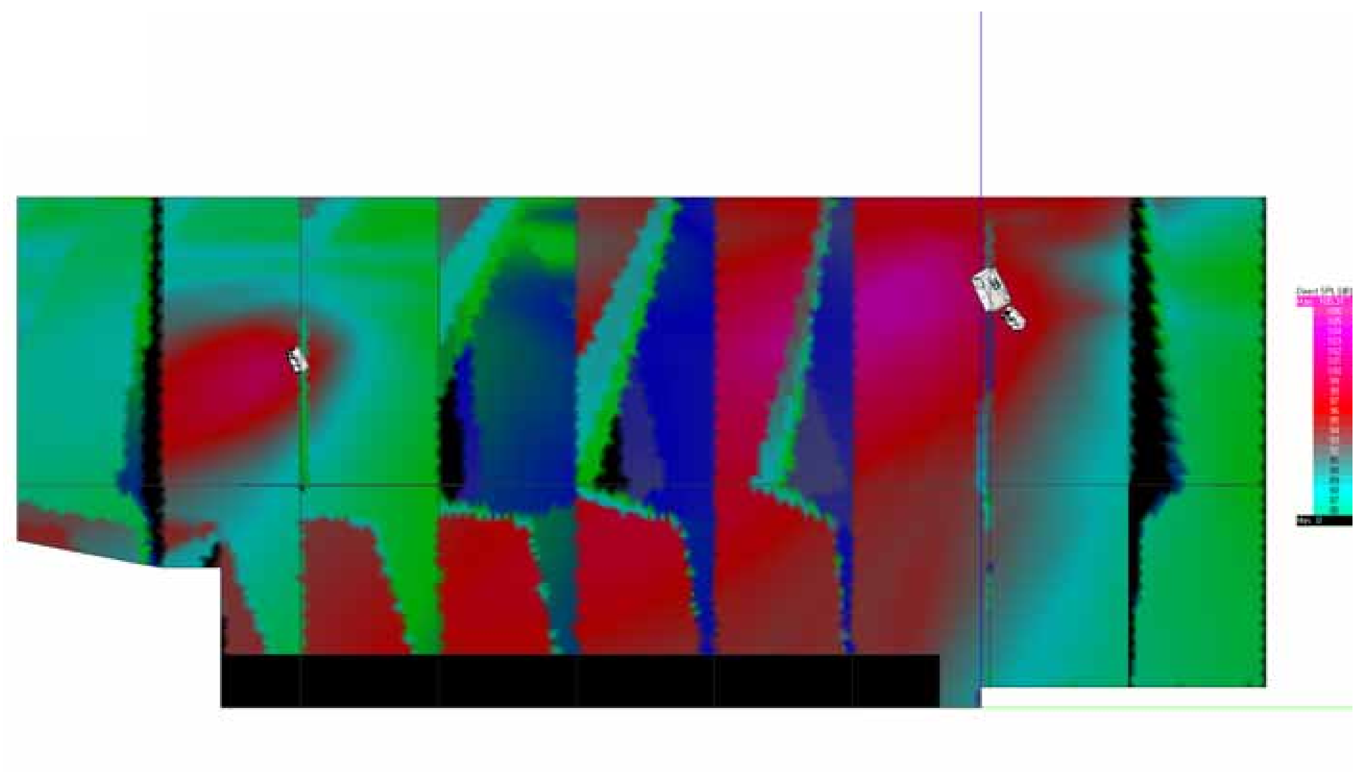


Figure 21: <u>ENTASYS</u> System - Direct Sound SPL Map on Room Surfaces, End Elevation View

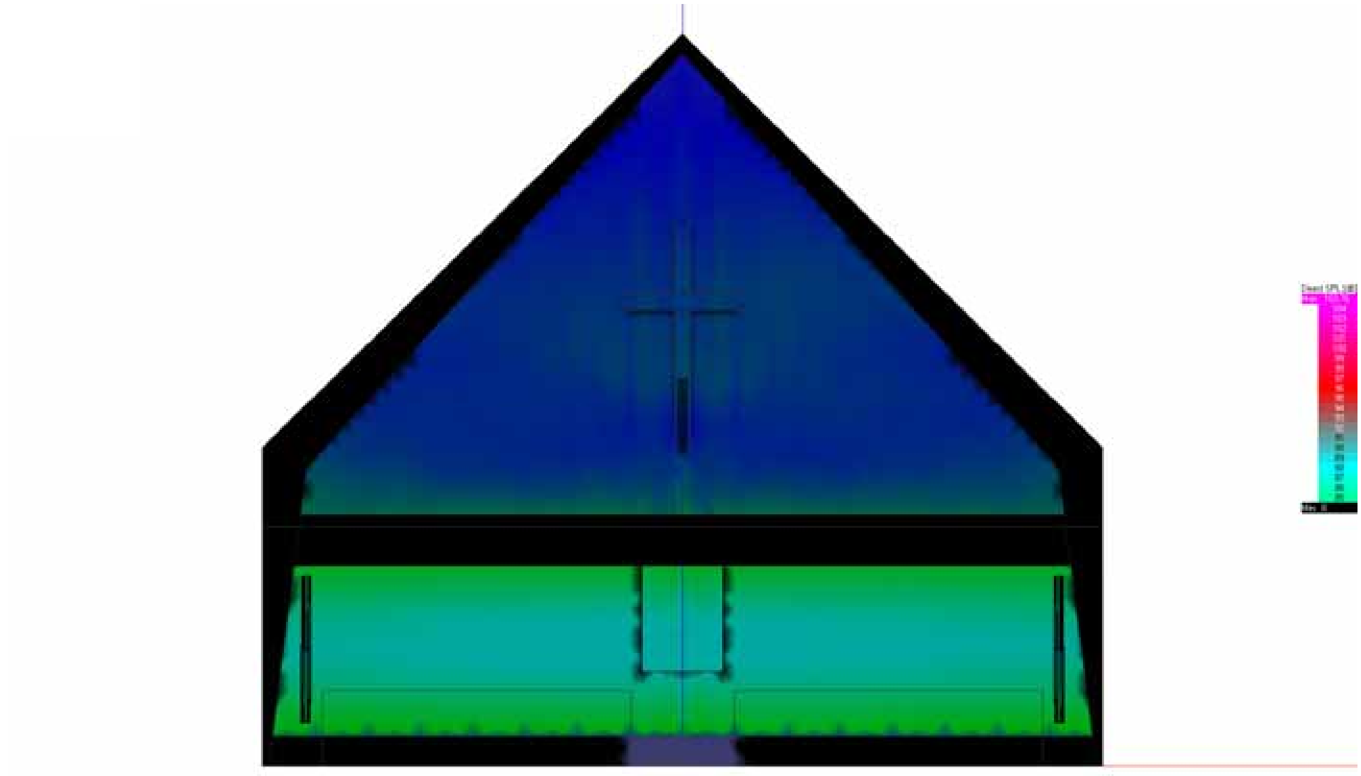


Figure 22: <u>Point Source</u> System - Direct Sound SPL Map on Room Surfaces, End Elevation View

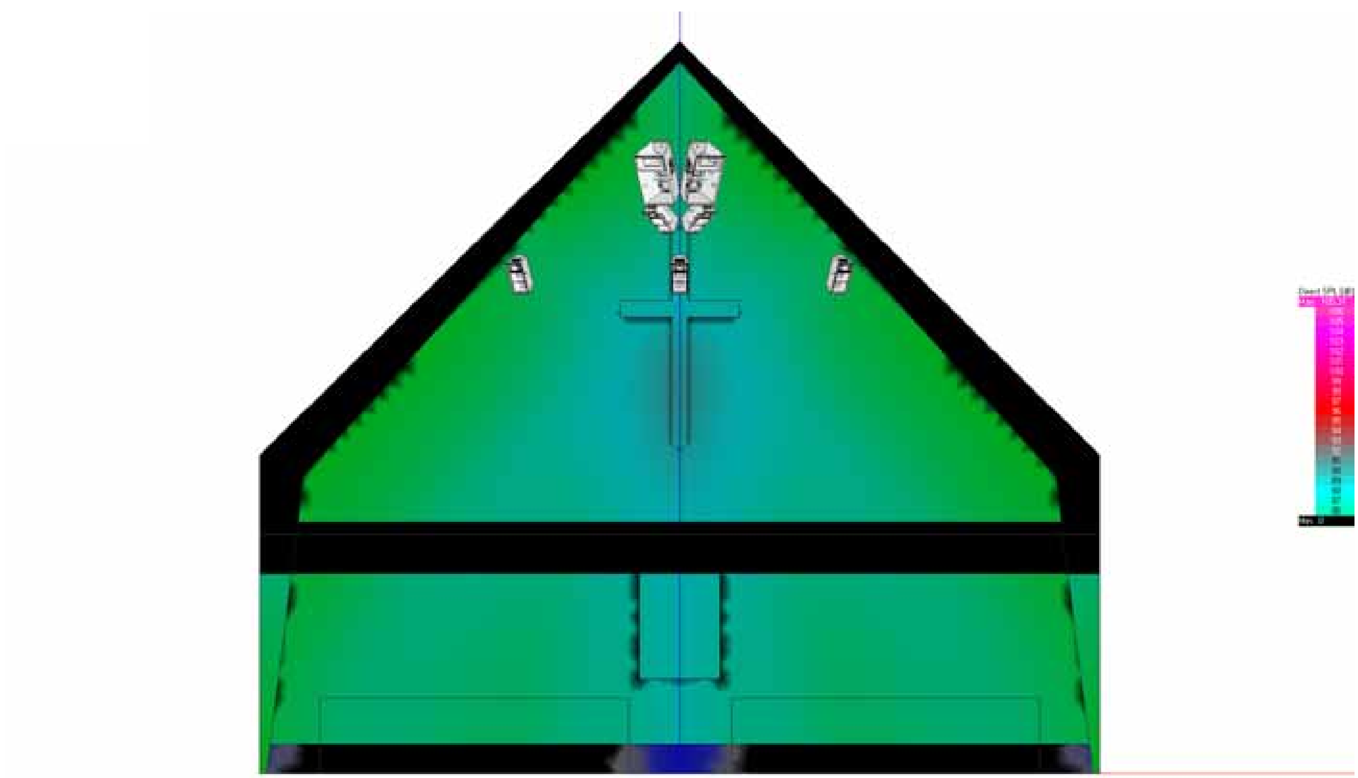
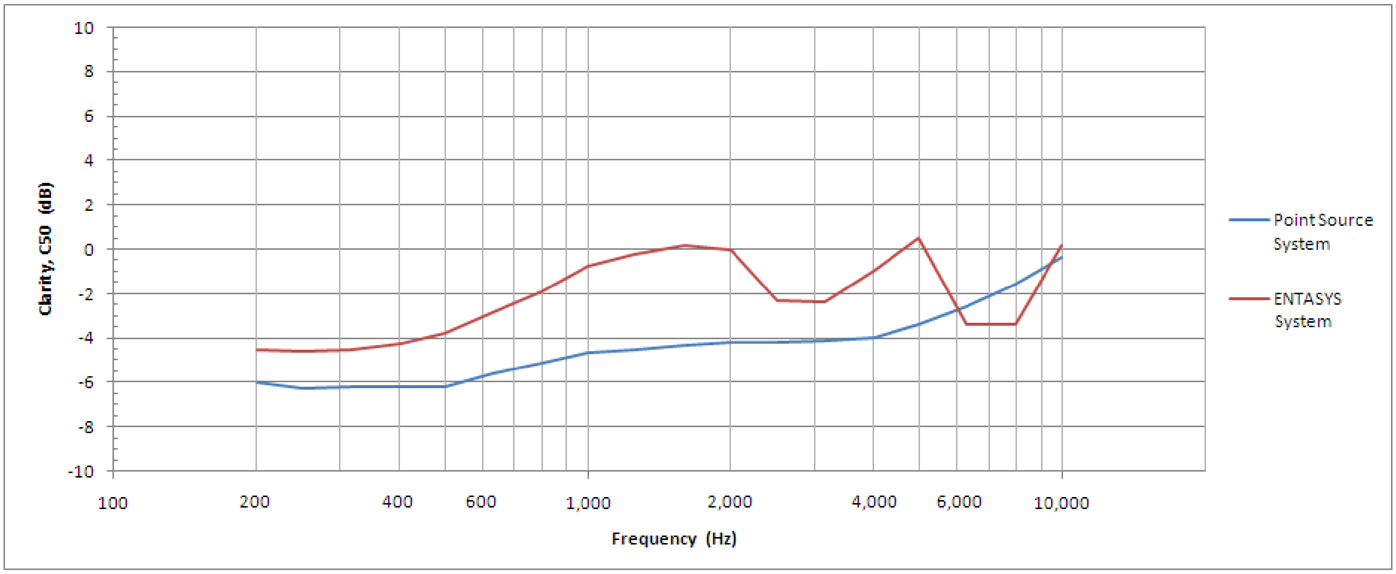


Figure 23: Clarity (C50) of Point Source and ENTASYS Systems in the Same Room



AIMING

Aiming any line array device is critical to achieving consistent coverage over the desired area. The opening (vertical coverage) angle of a line array is typically very small, and without precise planning and aiming of the line array it is possible that a considerable part of the audience area may not be adequately covered.

The preferred method for initially determining the vertical aiming of ENTASYS is with the use of EASE Focus. This will be discussed in detail in the following section.

In the field, the preferred methodology to ensure that the aiming conforms to the system designer's specifications is with the use of a laser. The laser should be mounted to the top of the ENTASYS systems, and the point of the laser should then be compared between the projection in EASE and an actual reference point in the room.

In most applications, it is fairly important to avoid sound waves directly hitting a rear wall, as the resulting reflections can be loud enough to cause comb filtering, late echoes and other intelligibility problems. Employing just a couple of degrees of down-tilt can redirect the sound waves to the floor, where there is usually some absorptive and/or diffusive material including the audience.

EASE FOCUS

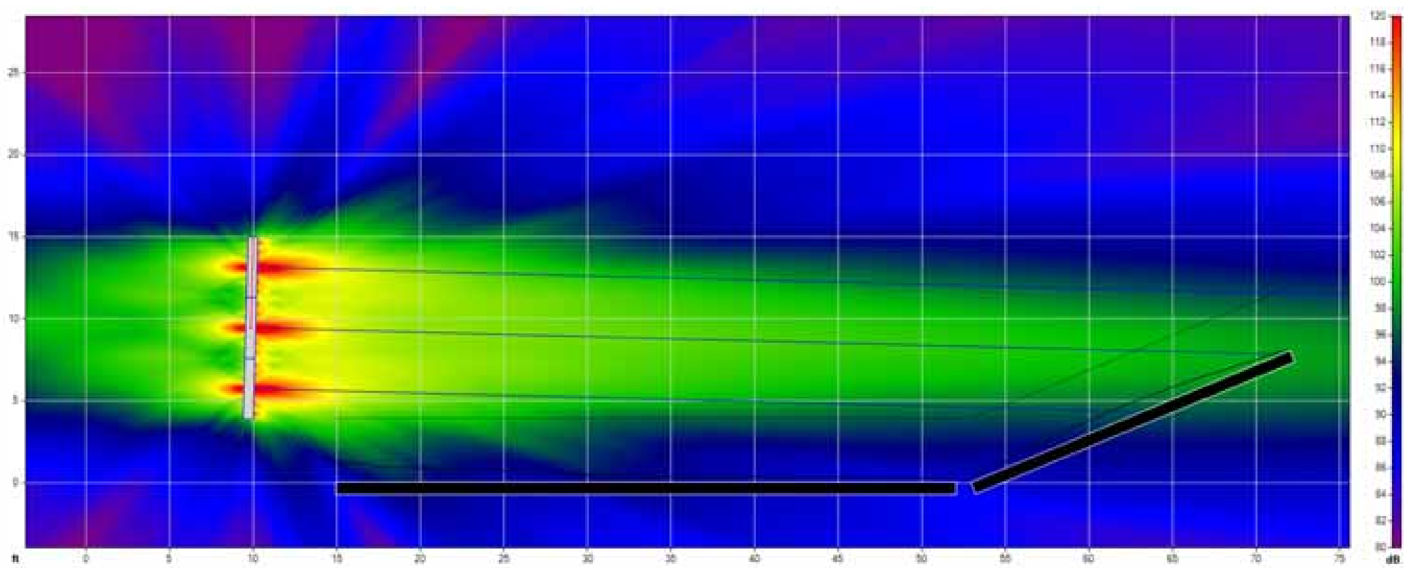
It is important here to note the distinction between EASE and EASE Focus. EASE is a commercial software application that allows the creation of a 3D acoustic model of a room and a sound system within a room, while EASE Focus is a free generic line array aiming software application that provides for a 2D modeling of the SPL and directivity of a sound source. Data from EASE Focus can be transferred into EASE to facilitate whole-system analysis in an acoustical space (this will be covered in greater depth later in this section).

EASE Focus may be downloaded at no charge from www.easefocus.com/downloads.html. It is an extremely helpful tool for determining how many modules should to be used, where they should be placed, and how they should be aimed to quickly achieve the desired SPL and coverage pattern for an audience area.

EASE Focus allows the user to enter the cross sectional elevation of the audience area for a venue (such as the sloped seating on the main floor and the balcony area of a theater) and position the line array for optimal coverage of the entire area. EASE Focus generates an SPL map of the sound coverage, which can be an excellent aid in visualizing and helping to understand the radiation pattern of line arrays. A brief introduction to the software and tutorial can be found at www.communitypro.com.

EASE Focus can be an excellent tool and a great time saver in determining the preliminary aiming of a line array. It is important to note, however, that EASE Focus provides only a 2D representation of the loudspeaker coverage (**Figure 24**). Once the number and types of loudspeakers are determined, along with the positioning and aiming required to achieve the desired coverage and response across the audience area(s), the array configuration and position can then be copied to a 3D model in EASE, where the horizontal coverage of the loudspeaker array can be verified and adjusted. This cannot be done automatically; the number of units in an array and their positioning must be manually input into the EASE program. Even so, using EASE Focus provides for faster and easier array configuration and positioning than can be accomplished using EASE alone.

Figure 24: SPL Map from EASE Focus of Three ENTASYS Full-Range Modules (400 Hz - 4 kHz)



USE OF THE LOW FREQUENCY MODULE

The ENTASYS line of loudspeakers features two models; the Full-Range loudspeaker ENT-FR and the Low Frequency module ENT-LF.

1. Both models are identical in appearance until the grille is removed. The Low Frequency module is designed for two purposes: They may be added to an array to increase its low frequency SPL output capability. This will not extend the low frequency cut-off of an array below 200 Hz. However, it will increase the output capability of an array in the 200-1,000 Hz region.

2. The Low Frequency module will also provide greater directivity control for an array below 1,000 Hz.

The Low Frequency module is equipped with its own internal passive crossover to facilitate integration with the Full-Range module. The recommended high pass filter should still be used in the signal path before the power amplifiers driving the ENTASYS systems.

As noted in the *Differences Between Line Arrays and Point Source Loudspeakers* section (Page 18), the LF directivity control of a line array is based on its length. More specifically, the length of a line array should be equal to or greater than one-half the wavelength of frequencies over which directivity control is desired. Moreover, for a line array to have the very small opening angle typically associated with line arrays, the length of the array should be much larger than this – typically two to four wavelengths long. In air, 1,000 Hz has a wavelength of approximately 1.13 ft (0.34 m). This means an array length of approximately 4.52 ft (1.38 m) is needed for the array to have a small opening angle at 1,000 Hz. For lower frequencies the array length must be even longer to maintain the same small opening angle.

Figure 25: Vertical Directivity Map of a Single ENTASYS Full-Range Loudspeaker (ENT-FR)

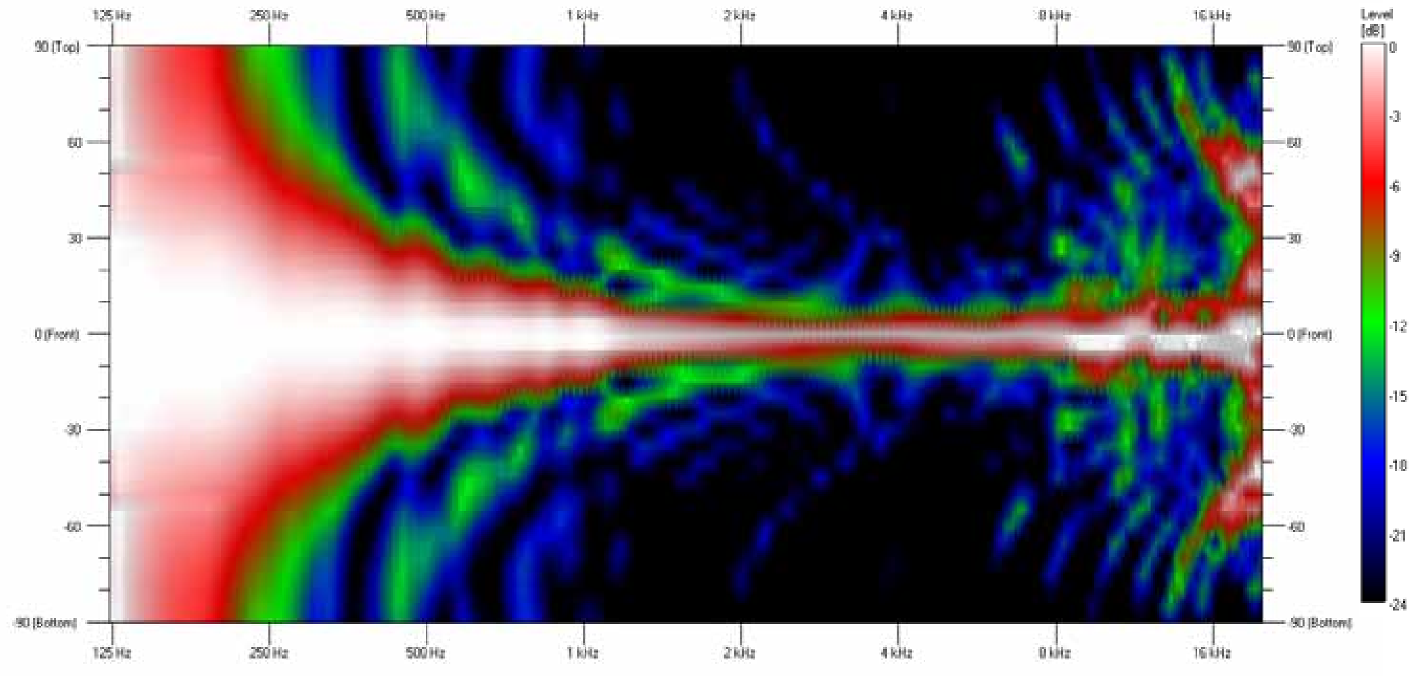
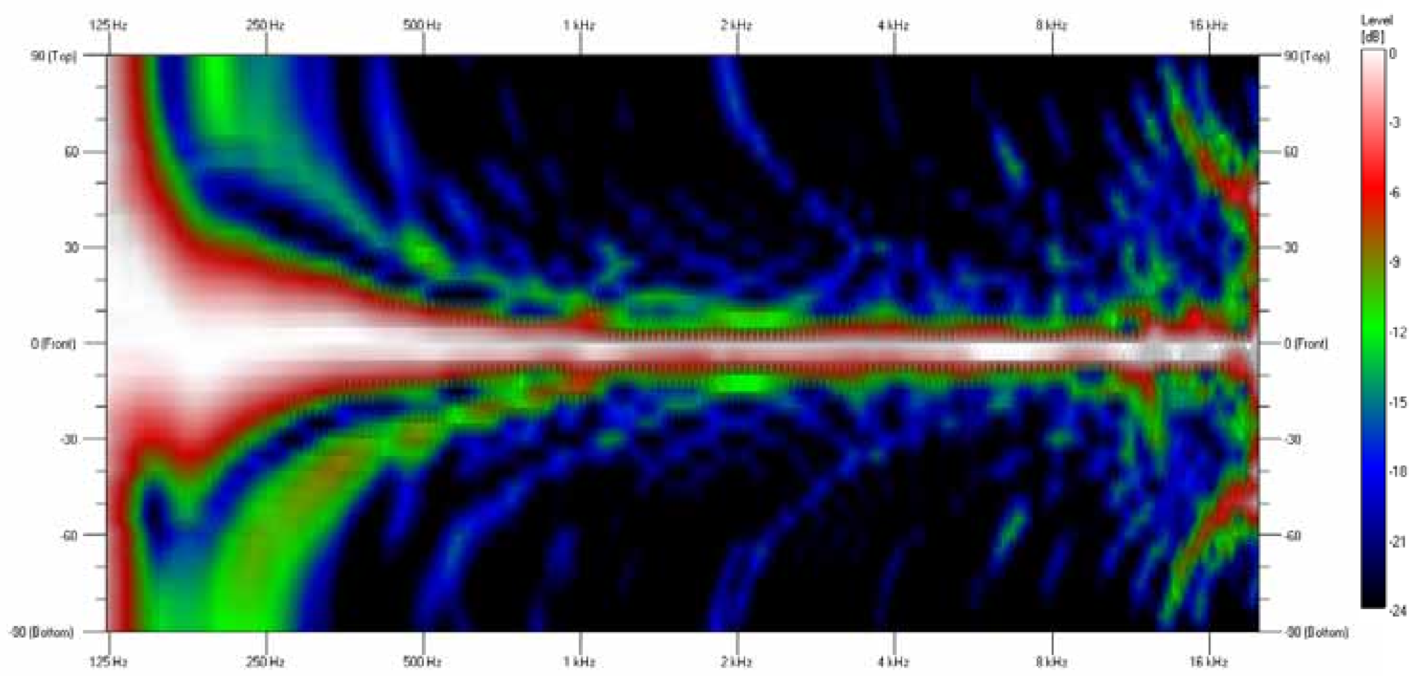


Figure 26: Vertical Directivity Map of One ENTASYS Low Frequency Module (ENT-LF) Over One Full-Range Loudspeaker (ENT-FR)



A directivity map is a plot of the radiated directivity pattern of a loudspeaker. It shows frequency on the x-axis (horizontal) and the off-axis radiation angle on the y-axis (vertical). The SPL is denoted as color variation. It is normalized to the on-axis response. A horizontal slice through the map will yield the normalized off-axis response. A vertical slice through the map will yield the values for a conventional polar plot.

Low Frequency Section

The low frequency section of the ENTASYS Full-Range loudspeaker is approximately 44.5 inches (1129mm) in length. It offers considerable directivity control at 1 kHz (the opening angle is slightly less than 20 degrees), but not quite as much control as it has at 2 kHz or 4 kHz (where the opening angle narrows to approximately 10 degrees). At 500 Hz the opening angle is greater still, resulting in even less directivity control. This is illustrated in the vertical directivity map (**Figure 25)**.

By comparison, **Figure 26** depicts a vertical directivity map for an array comprising one ENTASYS Low Frequency module stacked on top of a Full-Range module. The opening angle of this array at 1 kHz is now much closer to the opening angle at 2 kHz and 4 kHz. In fact, the opening angle at 500 Hz is not much larger (just over 20 degrees), and at 200 Hz (the low frequency limit of ENTASYS) the opening angle is only 60 degrees. If tighter directivity control is required in this frequency region, the addition of a second Low Frequency module to the array will narrow it to an even more impressive 35 degrees at 200 Hz.

This increased directivity control occurs only below 1 kHz, just where it is needed. If more Full-Range modules are added, the opening angle above 1 kHz would also decrease. By adding Low Frequency modules to the array, we are only increasing the length of the array at low frequencies.

Considering the Full-Range

The required height of an array is best determined with the use of an acoustical modeling program. As a rough rule of thumb, one module should be used for every second of reverb time in the lower midrange region (typically 250 - 800 Hz). Hence, for a room with an RT of approximately 2 seconds, two modules would be a good starting point. Referring back to the section on *Performance Comparison of a Line Array and Point Source System in the Same Room (Page 17),* the room shown has a average RT of approximately 2.5 seconds in the 250 - 800 Hz region. The SPL maps on the walls and the graph of C50 indicates that an array comprised of one Low Frequency and one Full-Range module should work well.

Some applications may be better served in the high frequency region by using two or more Full-Range modules. The above rule of thumb does not necessarily indicate that additional Low Frequency modules should be added to an array of three Full-Range modules for use in a room with a 3 second RT (i.e., three seconds = three modules). Using all Full-Range modules or a combination of Full-Range and Low Frequency modules could be equally effective.

Please keep in mind that this is just a rough rule of thumb. It is not meant to serve as a strict guideline. Every acoustical space and each application is different, and “cookie cutter” approaches rarely work in the design of audio systems.

PLACEMENT OF ENTASYS

Close to Performers/Presenters and Open Microphones

Selection of the correct microphone directivity pattern is critical in the proper design and installation of a sound system. The high degree of vertical directivity control exhibited by ENTASYS systems typically allows for microphones to be located fairly close to the loudspeakers. As with all loudspeakers, though, open microphones should not be placed too near the side or directly in front of an ENTASYS system.

For applications where microphones are located between the loudspeaker and the audience, ENTASYS can be employed with very good results. One key aspect for designs of this type is to ensure that the microphones are located above or below the primary radiation beam. This is another situation where EASE Focus can be used to quickly determine the loudspeaker array’s SPL at a proposed microphone location. Using EASE Focus with a good estimate of the SPL from the presenter and their distance from the microphone, the potential gain-before-feedback of the system can be calculated.

Of course, as more open microphones are connected to a sound reinforcement system, less gain will be needed to drive the system into feedback. Note that the issue is not the microphones’ distance from the loudspeaker, but from the primary beam of sound being radiated by the loudspeaker. Using EASE Focus to visualize the vertical radiation from the loudspeaker array will help in understanding the best microphone placement when used close to ENTASYS.

Close to the Audience

Placing an ENTASYS system (or any line array) very close to the audience is generally not recommended. A distance of five (1.5 m) to six feet (1.8 m) is the minimum that should be considered; ideally the array should be at least ten (3 m) feet from the closest listener. The sound of a line array at very close range is considerably different from its sound farther back, and is typically perceived as being overly bass-heavy.

ROOM TYPES

Low Ceiling - Short RT (Reverberation Time)

Rooms with low ceilings are not uncommon. These spaces usually lack sufficient height for a point source system to yield the desired uniformity of SPL across the entire audience area unless augmented by a distributed ceiling system. Distributed ceiling systems can improve coverage, but localization to the source (performer/presenter) is often lost. This is an excellent application for an ENTASYS system, which can provide optimal coverage with a limited number of loudspeaker locations.

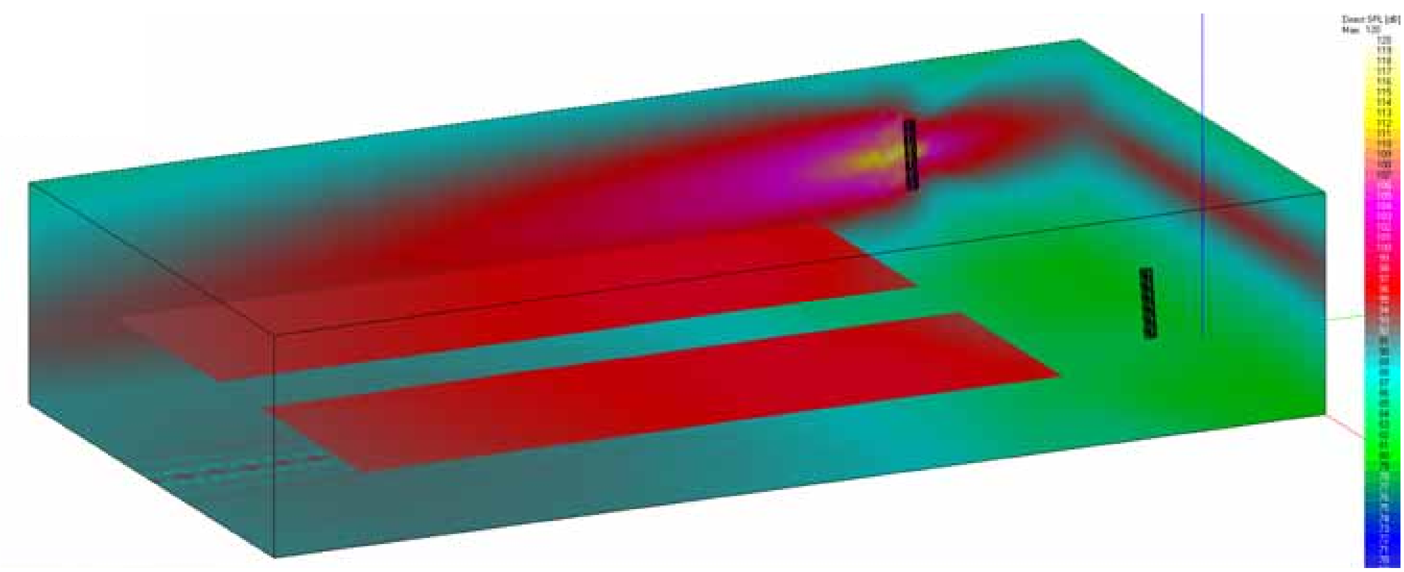
Figure 27 shows a room with dimensions of 60L x 30W x 12H feet (18.3 x 9.1 x 3.7 m), with a single Full-Range ENTASYS system on each side of the room. The loudspeakers are located at a height of 9 ft (2.7 m), aimed downward by 4 degrees and inward by 10 degrees. This same positioning could be accomplished in a room with a ceiling height of less than 10 ft (3.0 m).

A small room such as this would most likely have a reverberation time of 1.0 - 1.5 seconds or less, so the use of a Low Frequency module is probably not required. (If it is, the Low Frequency module can easily be located below the Full-Range module.) The entire array can be raised higher, and angled down a bit more, if needed.

The SPL map of the room surfaces and audience area shows a good uniformity, ranging from 100 dB in the very front (and slightly less at the rear) to 103 dB about one-third of the way back. The wide horizontal radiation excites the side walls in the front half of the room, a result of the ENTASYS system being placed very close to them; the application of some absorptive and/or diffusive material on the walls in the immediate vicinity of the loudspeakers would help minimize the sonic coloration of these close reflections. (The later reflections, which are also lower in level, are often beneficial in increasing intelligibility as well as the overall SPL.) Reference Page 54, regarding early reflections and their effect on the quality of sound.

There is very little sound being directed toward the area behind and between the loudspeakers. This should yield very good gain before feedback for microphones being used in this area. If more isolation is required, the loudspeaker can be raised higher and aimed down more toward the audience area.

Figure 27: SPL Map of Room with Low Ceiling



High Ceiling, Shallow Room - Long RT

Sometimes rooms are encountered that are very wide in relation to their depth. These shallow rooms can present a challenge in adequately covering the audience area without employing numerous loudspeakers. The room shown in **Figure 28** is typical of a multipurpose room found in schools, houses of worship, or municipal meeting rooms. It is 50L x 80W x 20H ft (15.2 x 24.4 x 6.1 m) with an elevated stage area 4 ft (1.2 m) high that measures 18W x 40W x 16H ft (5.5 x 12.2 x 4.9 m).

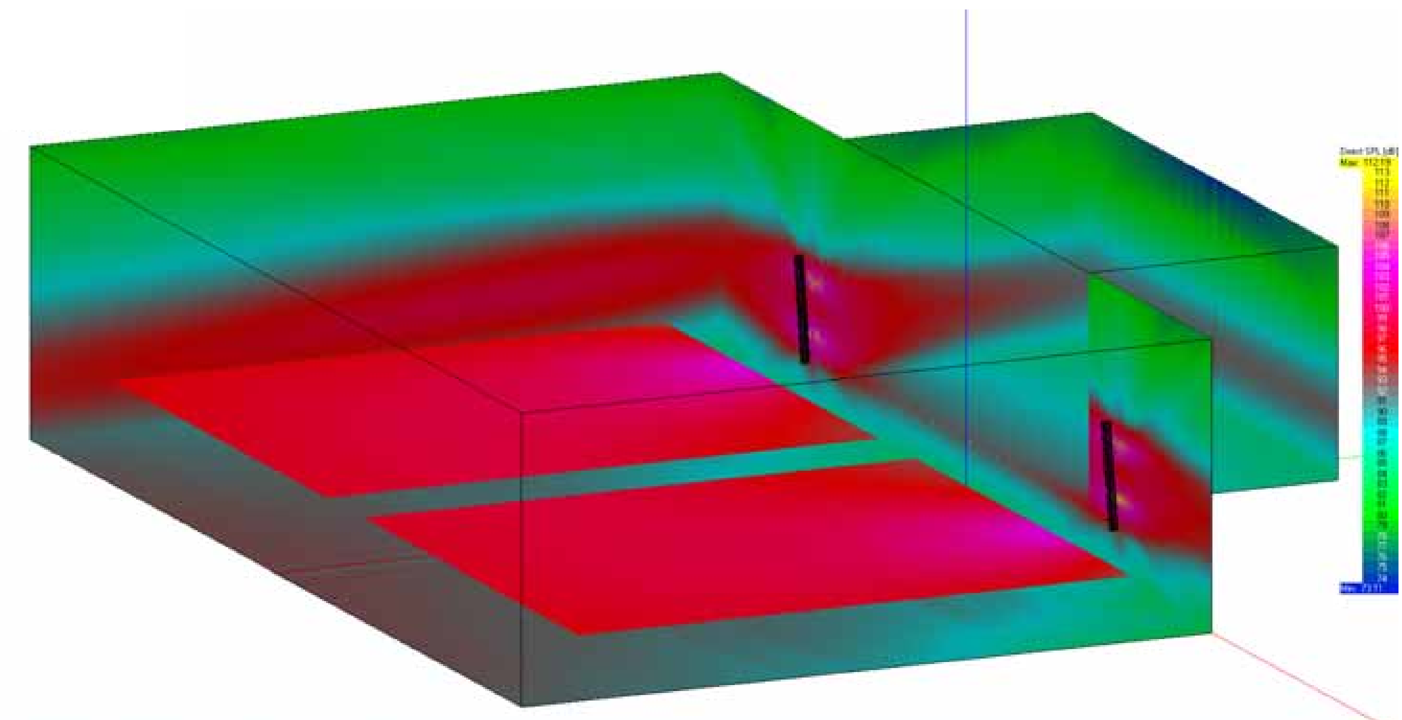
Here we have employed two arrays, each comprising two Full-Range ENTASYS systems. They are located 11 ft (3.4 m) above the floor, angled downward 4 degrees and aimed inward 5 degrees. Again, this positioning can be accomplished even with a greatly reduced ceiling height, should conditions dictate. A room such as this could have a reverberation time in the 2.5 - 3.0 second region. If additional low frequency directivity control is needed, a Low Frequency module may be added to the arrays shown here.

The uniformity of SPL in the audience area is very good, ranging from about 108 dB in the very front near the loudspeakers to around 102 dB at the back. The average SPL over most of the audience area is approximately 104 dB. It is only significantly louder in the front area right next to the loudspeakers.

The wide horizontal radiation does a very good job of providing coverage to the entire audience area. Here again we see some energy reflecting off the side walls. The loudspeakers are far enough away to not require acoustical treatment, though any coloration caused by those reflections can be reduced by placing some diffusive material or some midrange and high frequency absorption behind and to the sides of the loudspeakers. (Again, the later arriving lateral reflections from the side walls may be beneficial in increasing intelligibility.) Reference Page 54, regarding early reflections and their effect on the quality of sound.

The sound directed toward the stage area is significantly less than that being radiated forward, and should result in good gain before feedback. Overhead microphones suspended above the performers, which often do not work well, may perform adequately in this situation. The main lobe of energy radiated from the rear of the arrays is just below where these microphones would be positioned, making them likely to deliver acceptable gain before feedback.

Figure 28: SPL Map of Shallow Room with High Ceiling



High Ceiling, Deep Room - Long RT

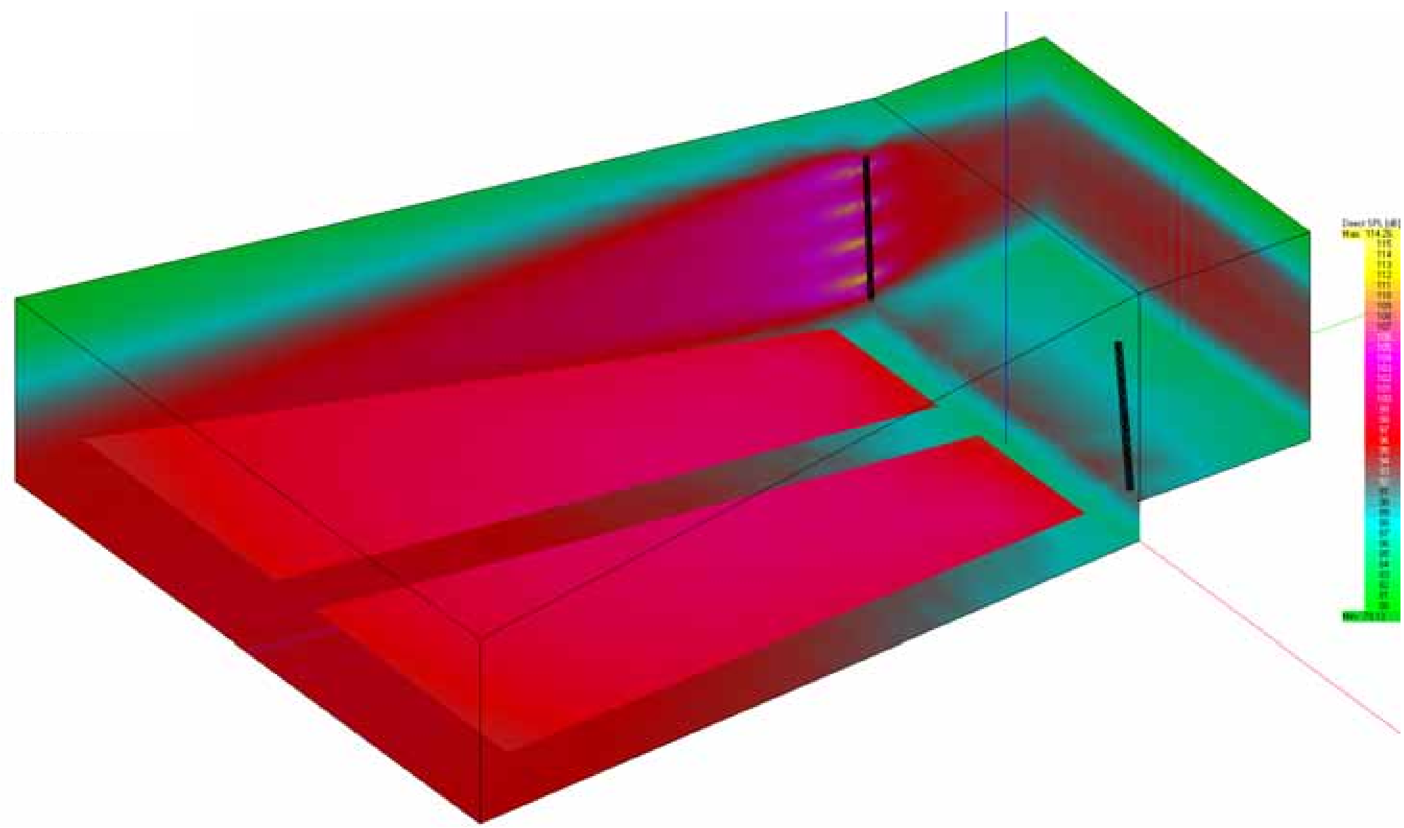
Another common room type is one that is very deep, or long, in relation to its width. This is typical of some theaters or converted cinema houses. They may or may not have flared side walls as shown in **Figure 29**. This room is 80L x 40W x 25H ft (24.4 x 12.4 x 7.6 m) at the front. The side walls are angled and the floor is sloped so that the rear is wider at 70 ft (21.3 m) and the ceiling is lower at 18.5 ft (5.6 m). The stage area is elevated 4 ft (1.2 m) and is 18 ft (5.5 m) deep with a height of 21 ft (6.4 m). Rooms of this size often have significant reverberation times, in excess of 3 or 4 seconds, unless acoustical treatments have been applied.

For this room two arrays, each comprising four ENTASYS Full-Range modules, are placed slightly in front of the stage area along the side walls. The tops of the arrays are 20 ft (6.1 m) above the floor. The arrays are angled downward 4 degrees and aimed inward 30 degrees. This cross-firing of the loudspeakers, along with the room's relatively narrow width, allows for good stereo reproduction within this space. The SPL map indicates that the direct sound from the loudspeakers yields very uniform coverage of approximately 104 dB over most of the audience area. It approaches 106 dB about one-third of the way back, and is around 101 - 102 dB at the very front and very rear extremes.

The narrow vertical directivity of ENTASYS will help to significantly maximize the potential intelligibility of a sound system in this venue. However, because of the room size, potentially high reverb time, and the wide horizontal radiation of the loudspeakers, the use of acoustical treatment is suggested on the side walls in the front part of the room, where the SPL reflections are the greatest. Reference Page 54, regarding early reflections and their effect on the quality of sound.

The SPL from the rear of the loudspeakers on the stage area is a bit greater than in the previous examples. This is due in part to the 30 degree inward cross-firing of the arrays. This on-stage SPL is still much less than might be experienced with a point source system. A further reduction in level can be achieved by decreasing the inward angle of the arrays.

Figure 29: SPL Map of Deep Room with High Ceiling



Low Ceiling, Deep Room - Long RT

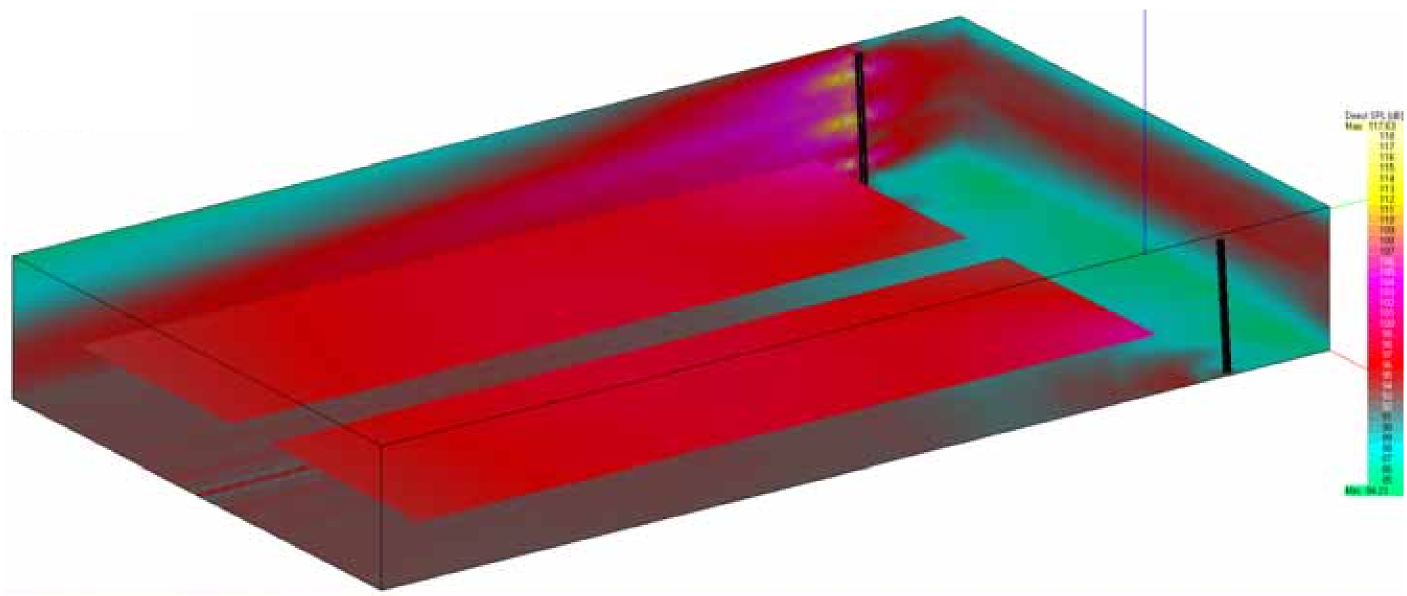
The last example of spaces typically encountered is one that is very deep (long) with a low ceiling. The room in **Figure 30** differs a bit from the first example shown (in Figure 27), in that it is considerably longer and a bit wider, with dimensions of 90L x 50W x 12H ft (27.3 x 15.2 x 3.7 m). As a result, the reverberation times may be greater.

We chose to use ENTASYS systems along each side wall, comprised of two Full-Range modules on top with one Low Frequency module on the bottom. These arrays are positioned at a height of 11.25 ft (3.43 m), only 9 inches (22.9 cm) from the ceiling. The three module array extends almost all the way to the floor. Although the Low Frequency module could have been omitted, it provides additional directivity control in the low mid-bass frequency region, helping to minimize the potential for a "boomy" sound.

The coverage across the audience area is uniform. The SPL averages about 104 dB throughout, decreasing to just 101 dB in the very back. In the very front corners of the audience area the SPL is a bit high at just over 107 dB, but this accounts for less than 1% of the audience.

Even in a room such as this one, with a relatively long reverb time of approximately 1.5 - 2.0 seconds (potentially longer in the mid-bass region), intelligibility should be good without acoustical treatment. Reference Page 54, regarding early reflections and their effect on the quality of sound.

Figure 30: SPL Map of Long Room with Low Ceiling



WHEN TO USE SUBWOOFERS

The option of employing subwoofers or low frequency extension loudspeakers with ENTASYS systems will, of course, be largely dependent on the specific application. ENTASYS systems deliver a frequency response down to 200 Hz, making additional low frequency extension loudspeakers unnecessary for sound systems intended only for vocal reproduction or speech playback. For systems used in music reproduction, adding low frequency loudspeakers to increase the system response to approximately 80 - 100 Hz can result in a more natural sounding system.

SYSTEM DESIGN GUIDELINES

Rooms with Longer Low Frequency RT

In rooms with relatively long reverberation times in the low frequency region, the use of subwoofers and other low frequency loudspeakers should be approached with caution. Due to the nature of low frequency sound waves, these types of loudspeakers do not offer the directivity control of ENTASYS, and will radiate low frequency energy into the room in virtually all directions. Increased low frequency reinforcement – and the resulting increased low frequency reverberation – can have the effect of masking the perception of higher frequencies, thereby reducing the system's overall intelligibility.

The sound system designer must weigh the benefits of low frequency extension, as compared to the potential for decreased intelligibility. In some spaces, adding low frequency reinforcement may have a limited impact on intelligibility, while in others it may be quite detrimental. As always, each space and application is unique.

Suggested Low Frequency Systems from Community

Community offers several high quality, low frequency loudspeaker systems that complement ENTASYS-based systems by extending low frequency response. These include the Versatile Low Frequency (VLF) Series, VERIS subwoofers, SBS45 and the iLF218.

VERIS subwoofers are ideally suited to ENTASYS, providing low frequency extension to approximately 45 Hz. The Versatile Low Frequency (VLF) Series loudspeakers also work well with ENTASYS, particularly where space considerations limit the size of the loudspeaker enclosures. The dual 8-inch VLF208 can extend the system response to 60 Hz, while the dual 12-inch VLF 212 can extend system response to 43 Hz. For high SPL requirements, the dual 18-inch iLF218 or the SBS45 with four 15-inch drivers provide high output at low frequencies down to approximately 40 Hz.

Suggested Crossover and EQ Settings

Community suggests the crossover and equalization settings detailed in **Table 3** when using these low frequency systems with ENTASYS. (Regardless of the size or configuration of ENTASYS systems being used with these subwoofers, these processing parameters should suffice as a starting point.) The overall levels between ENTASYS and the additional subwoofers may need to be adjusted to achieve the optimal balance of the system.

Directional Low Frequency Systems

In critical applications where additional low frequency reproduction is required, but might otherwise lead to problems with intelligibility or feedback, the use of directional low frequency loudspeakers and subwoofers may offer a possible solution. A well designed directional subwoofer system can help prevent low frequency spillage onto stage areas, reducing unwanted bass buildup and helping to minimize low frequency feedback.

Custom built cardioid arrays or end-fire subwoofer arrays may be constructed using stock low frequency loudspeakers. The construction of these directional low frequency arrays requires multiple low frequency loudspeaker modules, as well as a multi -channel DSP (Digital Signal Processor) and multiple power amplifiers to drive each loudspeaker module. The spacing between the low frequency loudspeakers and the special processing used to drive them is what creates the directivity of these arrays.

Community makes it easy and convenient to design a cardioid or end-fire low frequency array with the use of our ***Subwoofer Steering Simulation Software (S4)***. Using ***S4,*** designers can quickly and easily determine the processing parameters required to build these arrays using Community's VLF-Series or any other subwoofer system. ***S4*** is a useful tool for predicting and controlling the direction of bass frequencies in a given space. ***S4*** can be downloaded from Community at www.communitypro.com. When using directional low frequency arrays with ENTASYS, the normally recommended crossover and EQ settings may not be applicable. Contact Community's TAG Team at 610-876-3400 / 1-800-523-4934 or email TAGTEAM@communitypro.com for additional information and support.

Table 3: Recommended Crossover and EQ Filter Settings for Use With Community Subwoofers

Filter	Frequency	Bandwidth	Q	Level
ENTASYS Full-Range only (ENT-FR)				
High Pass Filter	200 Hz	36 dB/octave	Butterworth	
EQ 1	160 Hz	0.50	2.8	-7 dB
EQ 2	375 Hz	0.30	4.7	-6 dB
EQ 3	725 Hz	0.65	2.2	-6 dB
EQ 4	1.0 kHz	0.30	4.7	-3 dB
EQ 5	1.8 kHz	0.20	7.0	-3 dB
ENTASYS Full-Range (ENT-FR) and Low Frequency Modules (ENT-LF)				
High Pass Filter	200 Hz	36 dB/octave	Butterworth	
EQ 1	160 Hz	0.50	2.8	-7 dB
EQ 2	375 Hz	0.30	4.7	-6 dB
EQ 3	725 Hz	0.65	2.2	-6 dB
EQ 4	1.0 kHz	0.30	4.7	-3 dB
EQ 5	1.8 kHz	0.20	7.0	-3 dB
EQ 6	275 Hz	0.25	6.0	-8 dB
EQ 7	1.3 kHz	0.25	6.0	-5 dB
VLF208 Subwoofer				
High Pass Filter	55 Hz	48 dB/octave	Linkwitz-Riley	
Low Pass Filter	200 Hz	36 dB/octave	Butterworth	
EQ 1	71 Hz	0.20	7.0	+4 dB
EQ 2	92 Hz	0.32	4.5	-4 dB
EQ 3	160 Hz	0.30	4.7	+5 dB
EQ 4	230 Hz	0.30	4.7	-7 dB
VLF212 Subwoofer				
High Pass Filter	32 Hz	48 dB/octave	Linkwitz-Riley	
Low Pass Filter	200 Hz	36 dB/octave	Butterworth	
EQ 1	47 Hz	0.30	4.7	+4 dB
EQ 2	67 Hz	0.40	3.5	-5 dB
EQ 3	190 Hz	0.30	4.7	-9 dB
EQ 4	460 Hz	0.25	5.6	-6 dB

Table 3 continued: Recommended Crossover and EQ Filter Settings for Use With Community Subwoofers

Filter	Frequency	Bandwidth	Q	Level
VERIS 210S Subwoofer				
High Pass Filter	60 Hz	24 dB/octave	Butterworth	
Low Pass Filter	190 Hz	24 dB/octave	Butterworth	
EQ 1	70 Hz	0.33	4.4	+3.5 dB
EQ 2	220 Hz	0.40	3.6	-9 dB
VERIS 212S Subwoofer				
High Pass Filter	45 Hz	24 dB/octave	Butterworth	
Low Pass Filter	180 Hz	24 dB/octave	Butterworth	
EQ 1	80 Hz	0.21	6.8	-7 dB
EQ 2	244 Hz	0.33	4.4	-14 dB
iLF218 Subwoofer				
High Pass Filter	31 Hz	24 dB/octave	Butterworth	
Low Pass Filter	185 Hz	24 dB/octave	Butterworth	
EQ 1	35 Hz	0.38	3.8	+5 dB
EQ 2	169 Hz	0.50	2.8	-10 dB
EQ 3	581 Hz	0.33	4.4	-6 dB

Please contact Community's Technical Applications Group (TAG Team) at 610-876-3400 / 1-800-523-4934 or email TAGTEAM@communitypro.com for usage outside of these parameters.

ACOUSTICAL MODELING PROGRAMS AND MAXIMUM SPL

Data Files for Modeling

Acoustical prediction programs handle loudspeakers' maximum SPL output data in different ways. Due to the inherent radiation characteristics of ENTASYS, Community recommends the use of EASE and EASE Focus for best results. EASE data is provided in GLL (Generic Loudspeaker Library) format. Data is also available as an EFO file for use in EASE Focus.

These data files allow for accurate calculation of the SPL and directivity of ENTASYS systems at any distance greater than approximately 8 ft (2.4 m). Other methods of acoustical prediction cannot accurately model the radiation of ENTASYS due to its extended near-field to far-field transition distance (line array behavior).

Maximum SPL and Crest Factor

The maximum achievable SPL for any loudspeaker is dependent on both the loudspeaker itself and on the signal it is reproducing. Specifically, signals with higher crest factors will generally produce lower SPL output from a loudspeaker. This is because the RMS level of the signal is lower than its peak level.

The predicted maximum SPL in EASE and EASE Focus are based on a signal with a 6 dB crest factor (*refer to the box below for more information.) This is a standard signal for testing the maximum input and output capabilities of loudspeaker systems. The sounds generated by live sources typically have crest factors greater than 6 dB. The sound system designer should take this into account when determining the maximum achievable SPL for a particular design.

A quick determination of this can be reached by subtracting 6 dB from the crest factor of the program material to be reproduced by the sound system. The result will be the value by which the predicted SPL should then be reduced to yield a more accurate maximum SPL when using the recommended 3,600 W into 4 ohm amplifier to power ENTASYS.

As an example, an EASE model predicts the maximum SPL in the audience area to be approximately 104 dB. The anticipated program material is estimated to have a crest factor of 15 dB. Using this program material, a more realistic maximum SPL in the audience area would be 95 dB (15 dB - 6 dB = 9 dB, 104 dB - 9 dB = 95 dB).

***** Crest Factor

The crest factor of a signal is the difference between the RMS voltage level and the peak level of the signal. This is illustrated in the graphs shown in **Figures 31 - 32**. In each figure the actual waveform of the signal is shown at the top (green trace). Below that, the graph shows the RMS level as a solid purple area, above which is a yellow trace of the instantaneous peak level of the signal. The space between the purple RMS voltage level and the yellow peak level represents the crest factor of the signal at that particular instant.

The signal shown in **Figure 31** is a typical pink-noise signal with a 6 dB crest factor used to test loudspeakers. The difference between the RMS voltage level and the peak level is not 6 dB at every instant of the signal, but when averaged over several periods of the lowest frequency component in the signal, this difference will be approximately 6 dB.

The signal shown in **Figure 32** is a slightly compressed speech. The difference between the RMS voltage level and the peak level varies from about 10 - 15 dB.

For additional information on a signal's crest factor and how it may affect SPL please refer to the *Maximum SPL and Crest Factor* section above.

Figure 31: Wave Form and Peak/RMS Level of Noise with 6 dB Crest Factor

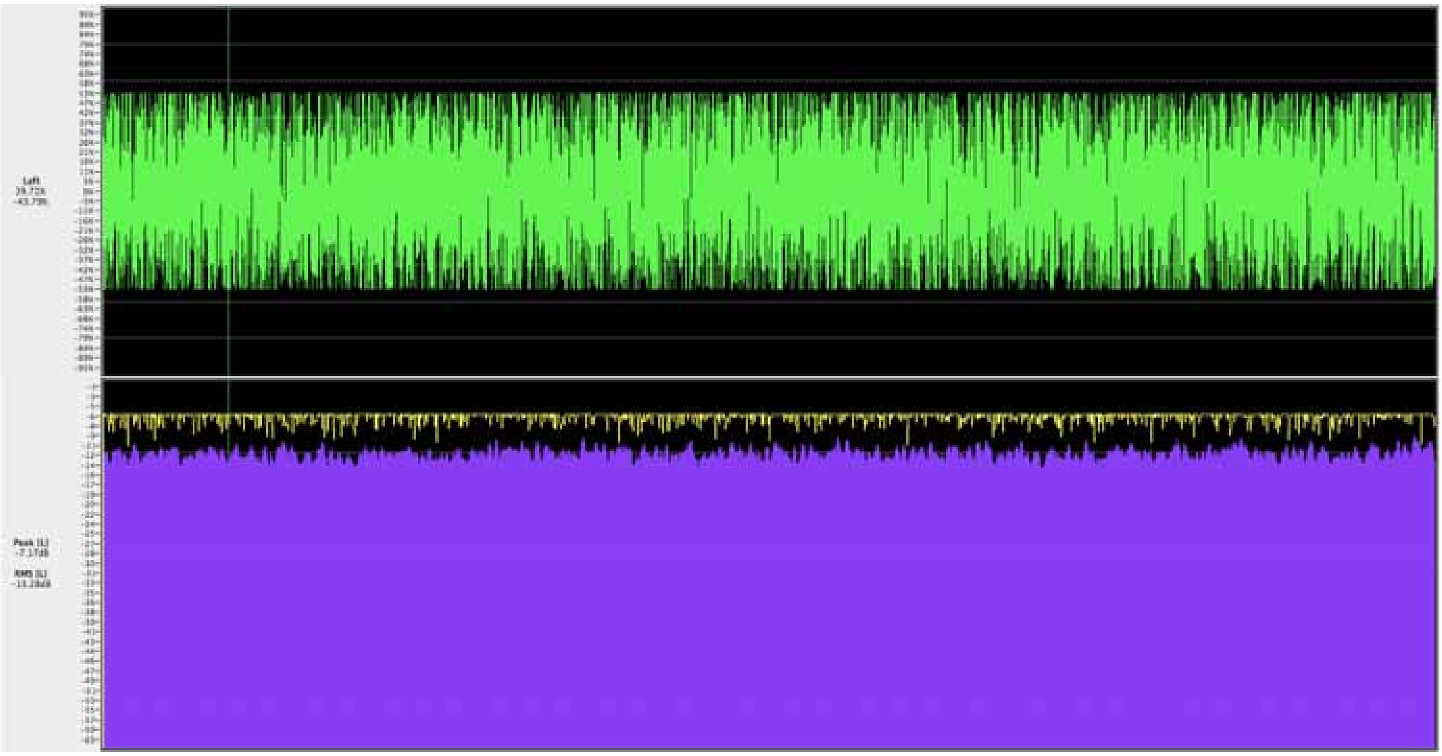
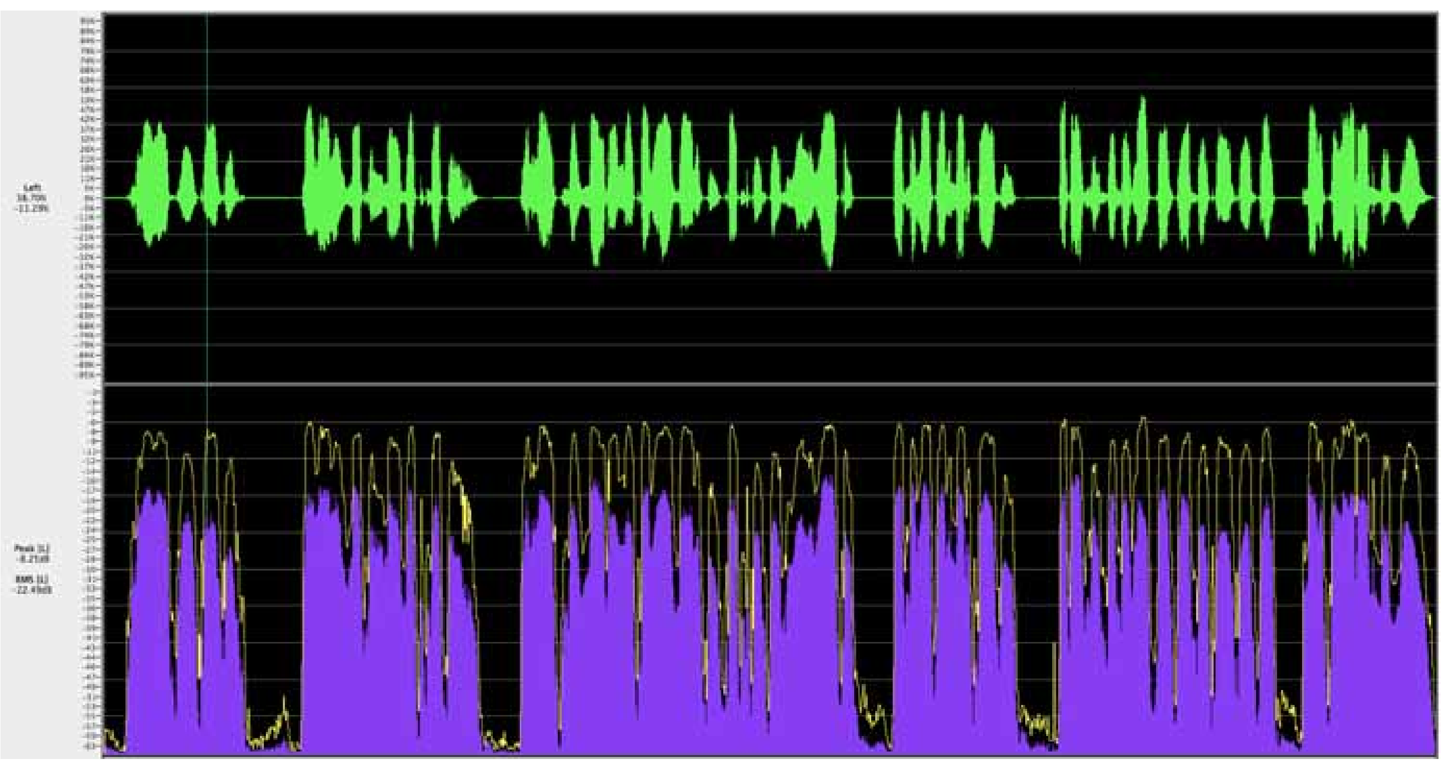


Figure 32: Wave Form and Peak/RMS Level of Speech with 10 - 15 dB Crest Factor



HIGHLY REVERBERANT HOUSE OF WORSHIP

Design Approach

This house of worship, exhibits a mid-band RT of 3.0 - 3.5 seconds; RT increases to 4 - 5 seconds at frequencies below 500 Hz. In this case, the RT was measured live and then input to EASE in order to more accurately evaluate intelligibility (Reference Figure 33). The primary reproduction for this application will be spoken word. This is a challenging space due to its highly reverberant nature. Subwoofers are not shown in this design but could be added easily with no detrimental effects.

It is important in this application to maintain good directivity control and keep as much energy as possible off the ceiling and upper walls to avoid exciting excess reverberation. Therefore, neither subwoofers nor low frequency extension loudspeakers will be used. Cost is also a factor, so a minimum number of loudspeakers and channels of amplification will be used. Aesthetics is also a concern, and the less visually obtrusive the system can be, the better.

A minimum number of installation locations are preferred for this project to minimize architectural impact. Two arrays, three modules tall at the front of the room can provide marginally acceptable intelligibility for 80% of the audience. Despite the very high directivity of the ENTASYS full-range modules, a distributed approach yields higher intelligibility by way of providing high levels of direct sound to the audience compared to reflected sound.

Therefore, the preferred method locates one ENTASYS full-range module at three locations along the sides aimed at the audience. Each Full-Range module mounts snugly to the structural columns as shown in Figure 32. Progressive signal delays must be applied to units farther from the Full-range units at the front of the audience. Each delay can be synchronized with the direct sound from the front full-range units so as to maintain the perception in the audience's mind that the sound proceeds from the forward units.

EASE Focus can be used to evaluate the need for any vertical down-tilt which was not needed due to the audience members position in the system's near-field. Also, all listeners are located within 35 ms of each array. Therefore, they will perceive the direct sound of multiple loudspeakers as integrated.

The azimuth (horizontal aiming angle) of the arrays must be adjusted in the EASE 3D model to achieve optimal coverage. This is accomplished by aiming each of the modules inward 15-28 degrees.

Results

The audience area shown in **Figure 34** indicates very uniform direct SPL ranging from 101 dB in front to 98 dB in the rear. The C50 (clarity) of this system in the audience area is -5 dB (+/- 1 dB). This correlates with an STI of 0.45 - 0.58 and a %Alcons of 7.8 - 10%, and should result in very good speech intelligibility given the reverberant behavior in this room.

What To Look Out For

Generally, taller arrays of ENTASYS columns with additional LF modules will help to maintain consistent directivity control over very low frequencies. By harnessing this characteristic of line array technology, stimulation of low-frequency resonances can be avoided.

Loudspeakers, Brackets, and Power Amplifiers Used in This Design

- (6) ENTASYS Full-Range Modules (ENT-FR (curved)) - three per side
- (6) ENTASYS Pan Brackets (ENT-PB)
- (3) Two channel amplifiers rated at 3,600 W per channel into 4 ohms for maximum power

  However, lower levels may be sufficient. See Pages 16-17 regarding amplifier selection.
- (1) High pass filter or DSP unit with 2 output delays

Figure 33: Measured RT60 (1 octave) interpolated to 1/3 octave resolution

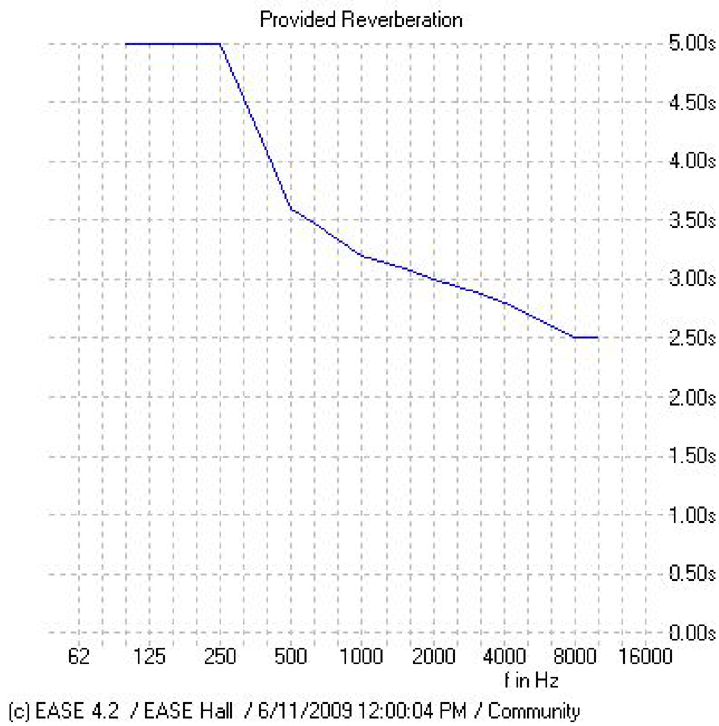
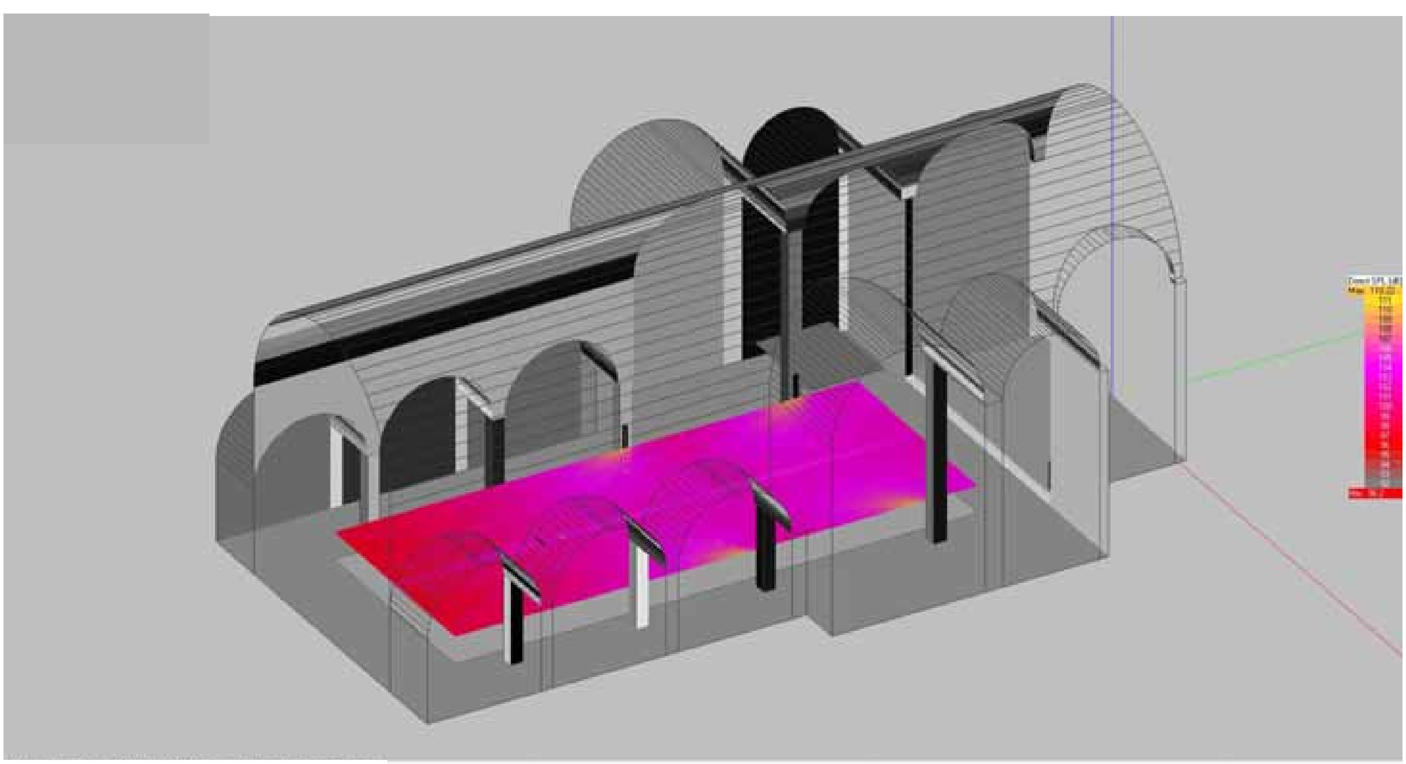


Figure 34: EASE SPL Map on Audience Area in Highly Reverberant House of Worship



MULTI-PURPOSE CONFERENCE CENTER

Design Approach

This space, a multi-purpose conference center, is very wide in the rear portion of the room. The mid-band RT of this room is very low at 0.6 - 1.1 seconds. The primary application for this system will be spoken word with the possibility of background music. Subwoofers are not shown in this design but could be added easily with no detrimental effects. Cost is a consideration so a minimum number of loudspeakers and channels of amplification will be used.

The desired location for the arrays is along the room's front walls. Clearly, the audience areas located at the far sides of the rear of the room can't be covered from this position. Additional loudspeakers will be required along the side walls farther back in the room to reach these areas.

The main audience area is drawn in EASE Focus, with the array located on the front wall (**Figure 35**). The front corner of this audience area is only about 3 ft (0.9 m) from the loudspeaker; this is closer than recommended, but unavoidable in this space. A single Full-Range module is used in the array, positioned 7.8 ft (2.4 m) high and aimed downward 2 degrees.

A second EASE Focus model is created for the delayed loudspeakers (**Figure 36**). Here we locate the loudspeakers on the short section of the side wall (parallel to the front wall), facing the rear of the room. The front of the audience area for this loudspeaker is a bit farther away at about 9 ft (2.7 m). Again, a single Full-Range module is used but positioned slightly lower at 7.5 ft (2.3 m) high and aimed downward 1 degree.

The configuration and position of the arrays are transferred from EASE Focus to the EASE model. Since EASE Focus only models in two dimensions, the azimuth (horizontal aiming angle) of the arrays must be adjusted in the EASE 3D model to achieve the optimal coverage. To accomplish this, the front arrays are aimed inward 15 degrees, while the delayed arrays are aimed inward 32 degrees.

Results

The audience areas in **Figure 37** exhibit uniform direct SPL ranging from 102 - 105 dB over the majority of the coverage area. The very front corners reach 106 dB due to their proximity to the loudspeakers, but this only affects 2 - 4 seat locations. The very rear-most corners of the side areas are also about 1 dB lower at 101 dB, but again, this only affects 2 - 4 seats. The potential intelligibility of this system is good, with C50 ranging from 1.5 - 5.0 dB. The STI is approximately 0.66 and the %Alcons is about 5.0%

What To Look Out For

The side walls should not present too much of a problem in a room like this, and their reflections can often increase both the overall SPL and the potential intelligibility if their time-of-arrival is within the proper interval relative to the direct sound. Reference Page 54-55, regarding supportive reflections. Should these reflections present problems, diffusion can be employed to decrease their detrimental effects while maintaining a high SPL. If rear wall reflections appear to be problematic, diffusion or absorption may be added.

Loudspeakers, Brackets, and Power Amplifiers Used in This Design

- (4) ENTASYS Full-Range Modules (ENT-FR) Each configured fully curved (as shipped from Community).
- (4) ENTASYS Pan-Tilt Brackets (ENT-PT)
- (1) Two channel amplifier rated at 3,600 W per channel into 4 ohm
- (1) Delay unit and high pass filter or DSP unit
- (1) High pass filter, 2 output delays, or DSP unit

DESIGN APPLICATION EXAMPLES

Figure 35: SPL Map of Front Loudspeakers on Main Audience Area in Conference Center

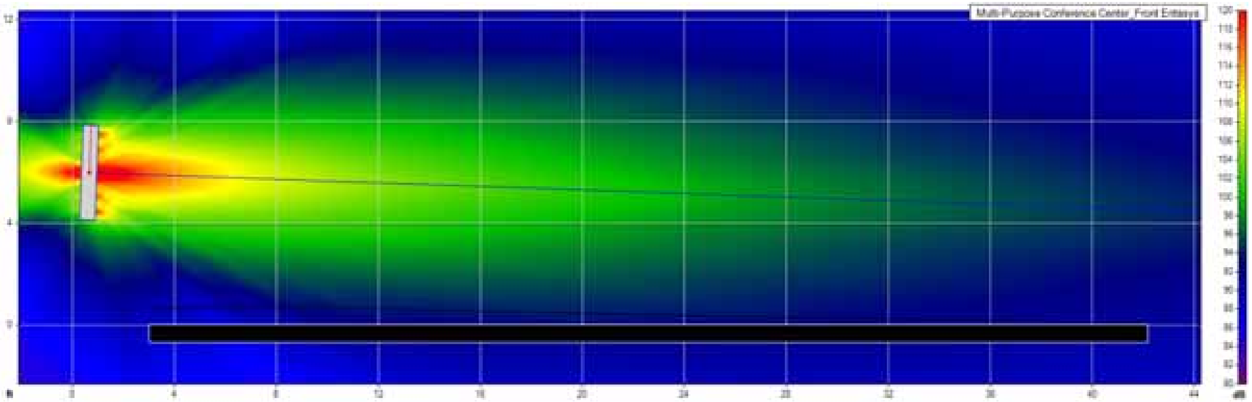


Figure 36: SPL Map of Delayed Loudspeakers on Rear Side Audience Area in Conference Center

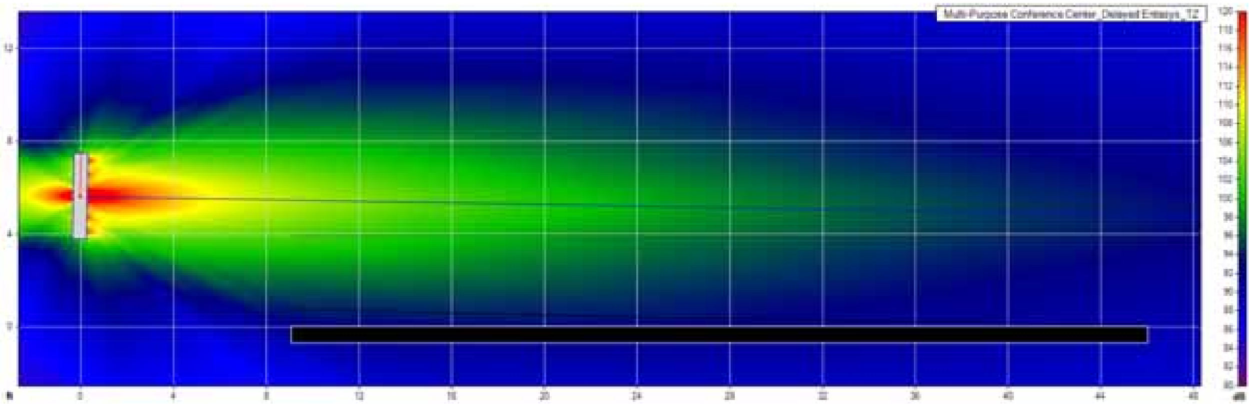
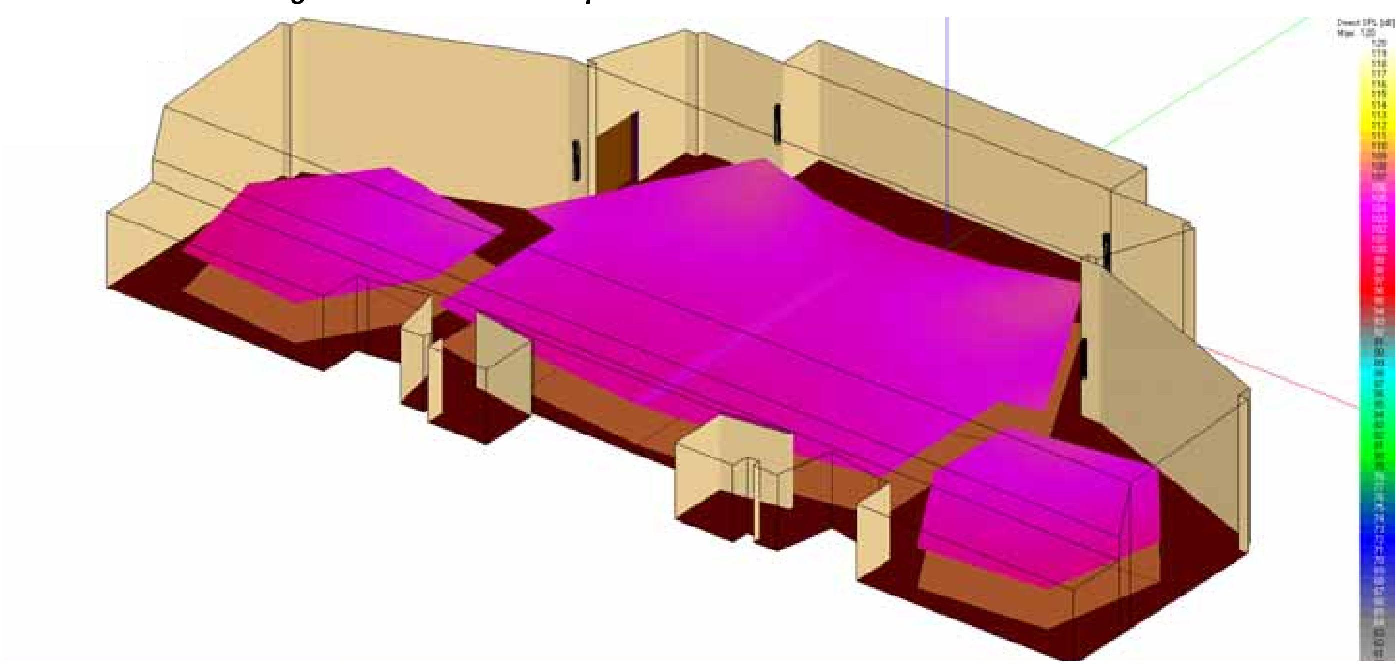


Figure 37: EASE SPL Map on Audience Areas in Conference Center



SMALL THEATER OR HOUSE OF WORSHIP

Design Approach

This example depicts a small house of worship with a relatively low ceiling. The stage area is located in a corner, rather than along one of the walls. The room has received some acoustical treatment, and exhibits a mid-band RT of 0.5 - 0.9 seconds. The primary application for this system will be spoken word and some music. Cost is again a factor, so a minimum number of loudspeakers and channels of amplification will be used.

Because of the layout of the seating area, it makes sense to place the loudspeakers along the side walls. Low frequency extension loudspeakers will be placed directly below the arrays to provide reproduction at frequencies below 200 Hz.

The main audience area is drawn in EASE Focus with the array located on the side wall (**Figure 38**). This places the audience area at approximately 4 - 49 ft (1.2 - 14.9 m) from the loudspeaker position. This is a bit closer than desirable to the loudspeaker, but only affects one seat in the corner of the audience area. The array, a single Full-Range module, is positioned 7.9 ft (2.4 m) high and aimed straight back to achieve the desired SPL and coverage.

The configuration and position of the array are transferred from EASE Focus to the EASE model. Once again, since EASE Focus only models in two dimensions the azimuth (horizontal aiming angle) of the arrays must be adjusted in the EASE 3D model to achieve the optimal coverage. Our EASE model indicates that the ideal position on the side wall places the array at the front corner of the side audience areas. The arrays are aimed 15 degrees inwards from the diagonal centerline, or 30 degrees outward from a line perpendicular to the side wall on which they are mounted.

Reference Page 54, regarding early reflections from the side walls and their effect on the quality of sound.

Results

The audience areas in **Figure 39** display uniform direct SPL ranging from 101 - 105 dB across the seating area. The system exhibits good potential intelligibility, with C50 ranging from 3.0 - 6.0 dB. The STI is approximately 0.68 and the %Alcons is about 4.2%.

What To Look Out For

The side walls should not present a significant problem in a space like this one, and their reflections can often increase both the overall SPL and the potential intelligibility if their time-of-arrival is properly correlated to the direct sound. Should those reflections present problems, diffusion can be employed to decrease their detrimental effects while maintaining a high SPL. Due to the angled side walls, reflections from behind the arrays may prove problematic on the platform area where open microphones are in use. Absorption on these side wall areas can help to address this.

Loudspeakers and Power Amplifiers Used in This Design

Two arrays, each configured as a single Full-Range module, fully curved (as shipped from Community).

- (2) ENTASYS Full-Range Modules (ENT-FR)
- (2) ENTASYS Pan Brackets (ENT-PB)
- (2) VLF208 Subwoofers
- (1) Single channel amplifier rated at 3,600 W into 4 ohms
- (1) Two channel amplifier rated at 900 W into 4 ohms
- (1) Crossover with a high pass filter or DSP unit

DESIGN APPLICATION EXAMPLES

Figure 38: SPL Map of Audience Area in Small House of Worship

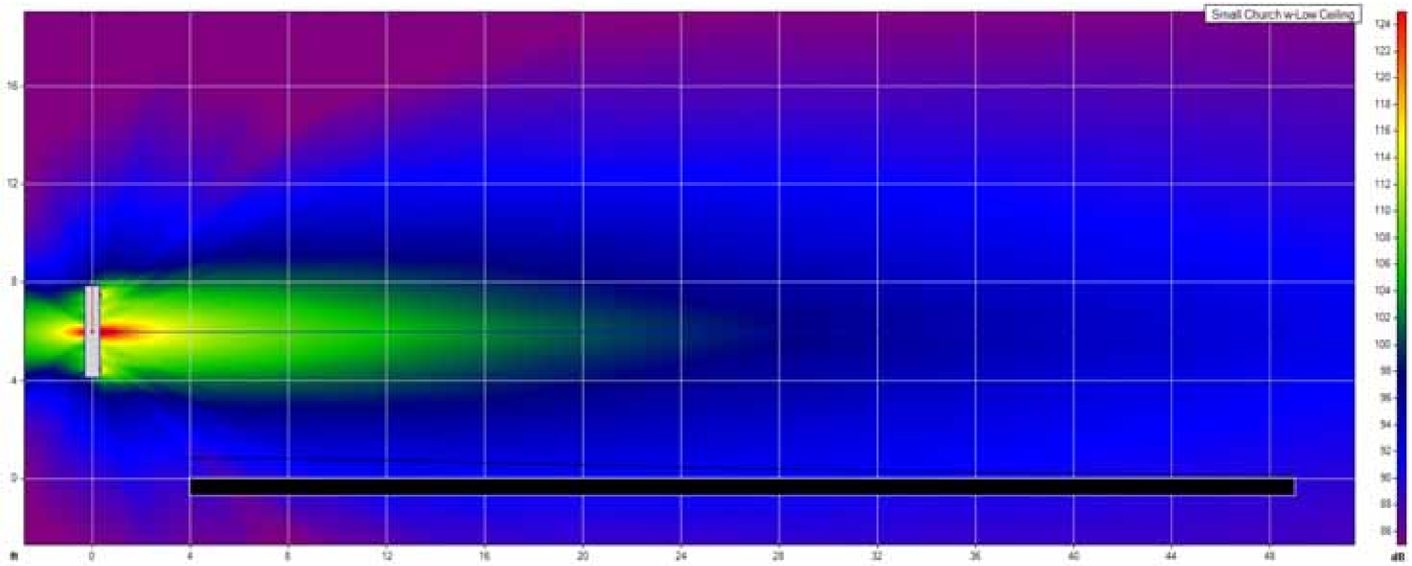
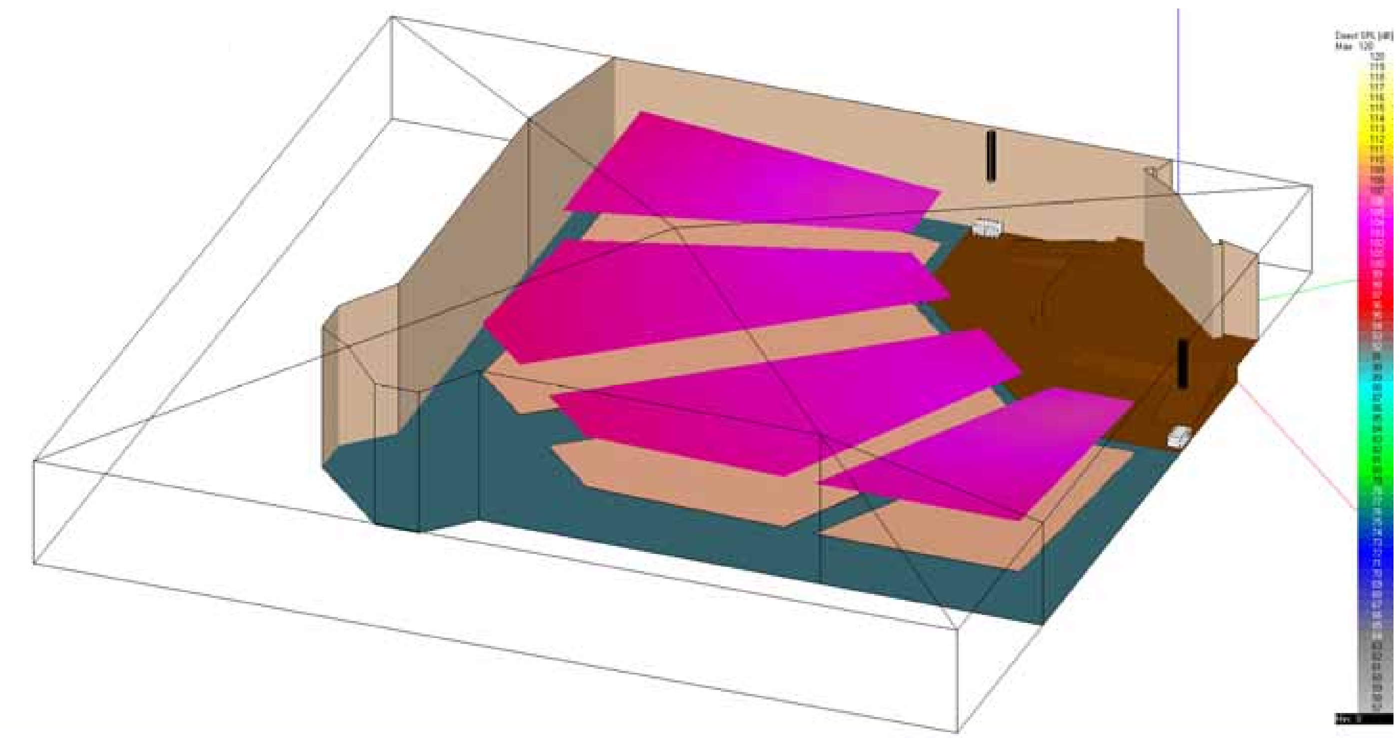


Figure 39: EASE SPL Map of Audience Areas in Small House of Worship



SPLIT-BEAM ARRAY – MAIN FLOOR AND BALCONY

Design Approach

This design example features a house of worship with a high ceiling and a balcony at the rear of the room. It exhibits a mid-band RT of 2 seconds, increasing to 3.5 - 4.0 seconds below 500 Hz. The sound system will be used for spoken word as well as musical reproduction. Because of the long reverberation time in the lower frequency region, a large array will be employed to help minimize reflections from the ceiling. Low frequency extension loudspeakers will be placed directly below the arrays for better LF directivity down to 200 Hz. These will be used judiciously to avoid excessive reflections in this frequency region, while providing more natural sounding reproduction of speech and music.

The main audience area is drawn in EASE Focus, with the array located on the front wall (**Figure 40**). This places the audience area between 11 and 76 ft (3.4 - 23.2 m) from the loudspeaker position. To provide optimal coverage to both the main floor and the rear balcony, a split-beam array is configured using two sets of two Full-Range modules, separated by a Low Frequency module in the middle of each array. The arrays are positioned very high, at 20.5 ft (6.3 m), allowing the upper portion of the array to cover the balcony while providing sufficient space below the array to locate the subwoofer.

The configuration and position of the array are transferred from EASE Focus to the EASE model. Since EASE Focus only models in two dimensions, the azimuth (horizontal aiming angle) of the arrays must be adjusted in the EASE 3D model. The arrays are aimed 15 degrees inwards to provide optimal coverage. Reference Page 54-55, regarding early reflections in the front corners and their effect on the quality of sound.

Because of the large number of ENTASYS systems used, the system design specifies two separate amplifier channels for each array. Powering the two upper-most loudspeaker modules from one channel and the three lower ones from another amplifier channel will provide for a degree of independent level control over the modules covering the main floor and the balcony. This may be useful for the final on-site adjustments during commissioning.

Results

The audience areas on the floor (**Figure 41**) exhibit fairly uniform direct SPL, ranging from 107 dB in the front corners near the arrays to 102 dB at the back of the room underneath the balcony. The SPL in the balcony area is 101 - 102 dB. The potential intelligibility of this system shows C50 at -3 dB (+/- 1 dB). The STI is approximately 0.52 and the %Alcons is about 10.5%. The intelligibility calculations are remarkably good given the reverberation time of the room.

What To Look Out For

The split-beam array should help to focus energy away from the balcony fascia. Depending on their composition and shape, the balcony fascia and/or rear walls may exhibit some reflectivity issues, in which case absorption may be employed to minimize these reflections.

Loudspeakers, Brackets, and Power Amplifiers Used in This Design

Two arrays, each configured from top-to-bottom as a Full-Range module (curved top), Full-Range module (curved bottom), Low Frequency module, Full-Range module (curved top), and Full-Range module (curved bottom).

(2) ENTASYS Low Frequency Modules (ENT-LF)

(8) ENTASYS Full-Range Modules (ENT-FR)

(2) ENTASYS Pan Brackets (ENT-PB)

(8) ENTASYS Coupler Brackets (ENT-CB)

(2) VLF212 Subwoofers

(2) Two channel amplifiers rated at 3,600 W per channel into 4 ohms

(1) Two channel amplifier rated at 900 W per channel into 4 ohms

(1) Crossover with a high pass filter or DSP unit

DESIGN APPLICATION EXAMPLES

Figure 40: SPL Map of Audience Area in a House of Worship with Balcony

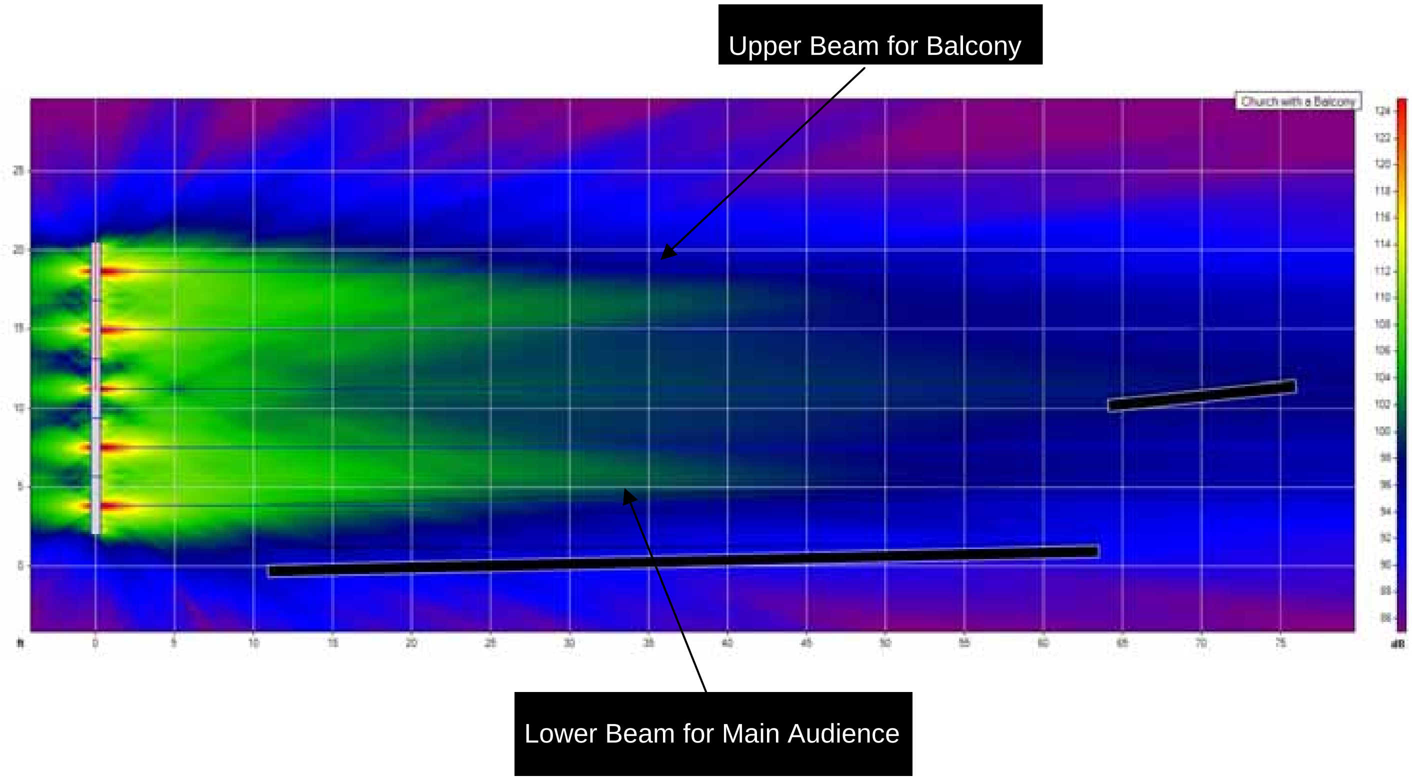
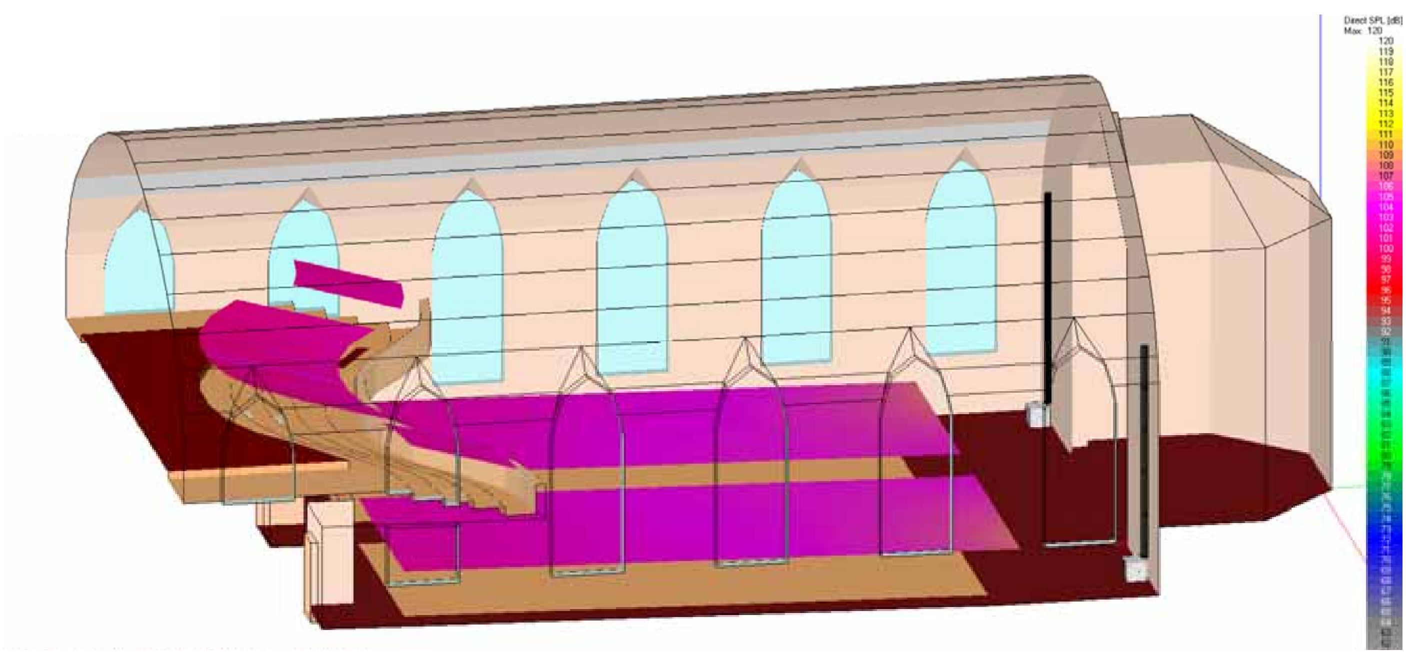


Figure 41: EASE SPL Map of Audience Areas in a House of Worship with Balcony



Multi-Purpose Room (Cafeteria/Gym/Auditorium)

Design Approach

This example shows a multi-purpose room which functions as a cafeteria, gymnasium, and auditorium (typically found in many elementary and middle schools). The room has no acoustical treatment, resulting in a mid-band RT of around 2 seconds. The sound system will be tasked with reproducing both music and speech. As a school project, budget is a consideration, thus a minimum number of loudspeakers will be employed. Intelligibility is a key requirement, as is music playback, therefore low frequency extension loudspeakers will be placed directly below the arrays to provide reproduction at frequencies below 200 Hz.

The audience area, comprising a flat floor/court area with fold-away bleachers at the rear of the room, is drawn in EASE Focus as shown in **Figure 42**. The loudspeaker array is located on the front wall, resulting in an audience area spanning approximately 5 - 62 ft (1.5 - 18.9 m) away from the speakers. The very front of the audience area is potentially a bit too close, but the flexibility of this room's usage patterns can hopefully avoid locating seats this close under most circumstances. Using an array comprising three ENTASYS Full-Range modules, mounted at a height of 15.3 ft (4.7 m) with a downward angle of 2 degrees, achieves relatively consistent SPL across the audience area.

The configuration and position of the array are transferred from EASE Focus to the EASE model. Since EASE Focus only models in two dimensions, the azimuth (horizontal aiming angle) of the arrays must be adjusted in the EASE 3D model to achieve optimal coverage. The arrays are aimed inwards at 23 degrees.
Despite the ultra-wide azimuth of the ENTASYS column line-arrays, the center of front seating will require a supplemental "front fill" loudspeaker. In this case, the i2W8 was chosen. The ENTASYs units must be signal-delayed to synchronize with the enter front-fill loudspeaker.

Since ball sports can damage an ENTASYS loudspeaker, it is recommended that the installation contractor provide a robust dent-resistant heavy gauge steel grille or cage fabricated and fastened to the wall or other sturdy mounting points in such a way so as to protect the entire loudspeaker. Make sure that any perforated grille has an open area of at least 75% to allow reasonable sound passage. The grille and mounting should be stiff to withstand high velocity strikes from basketballs, hardballs, hockey pucks, or whatever the various sports may launch at the loudspeaker.

Results

Tall full-range arrays accommodate sitting and standing audiences along the flat floor and sloped rear seats. The audience area shown in **Figure 43** indicates relatively uniform direct SPL of 102 dB (+/-2 dB) on the floor, and 101 dB (+/-2 dB) in the bleachers. In the few side seats near the array the SPL is slightly louder at about 105 dB. The system exhibits good potential intelligibility with an overall C50 of -0.5 dB (+/-2 dB). The STI is approximately 0.53 with the %Alcons being about 9.5%.

What To Look Out For

Rooms of this type with no acoustical treatment can be problematic. The ENTASYS design detailed above achieves consistent coverage and good intelligibility without exciting the reverberant field excessively. If desired, placing absorptive materials on the wall and/or hanging absorptive banners/baffles from the ceiling can decrease the room's reverberant and increase intelligibility. Note that the top full-range module can be configured straight or "tip curved" to provide very good HF propagation to the rear audience area. In this case, the straight configuration offers the advantage of not projecting a strong HF beam on the highly reflective ceiling which would have otherwise created an undesirable and obvious specular HF echo.

Loudspeakers, Brackets, and Power Amplifiers Used in This Design

Two arrays, each configured (top-to-bottom) as a Full-Range module (curved top), Full-Range module (straight), and Full-Range module (curved bottom).

- (6) ENTASYS Full-Range Modules (ENT-FR)
- (4) ENTASYS Coupler Brackets (ENT-CB)
- (2) ENTASYS Pan-Tilt Brackets (ENT-PB)
- (2) VLF212 Subwoofers
- (1) Two channel amplifier rated at 3,600 W per channel into 4 ohms
- (1) Crossover with a high pass filter or DSP unit with output delays
- (1) i2W8 and appropriate amplifier and DSP channel.

Figure 42: SPL Map of Audience Areas in a Multi-Purpose Assembly Room

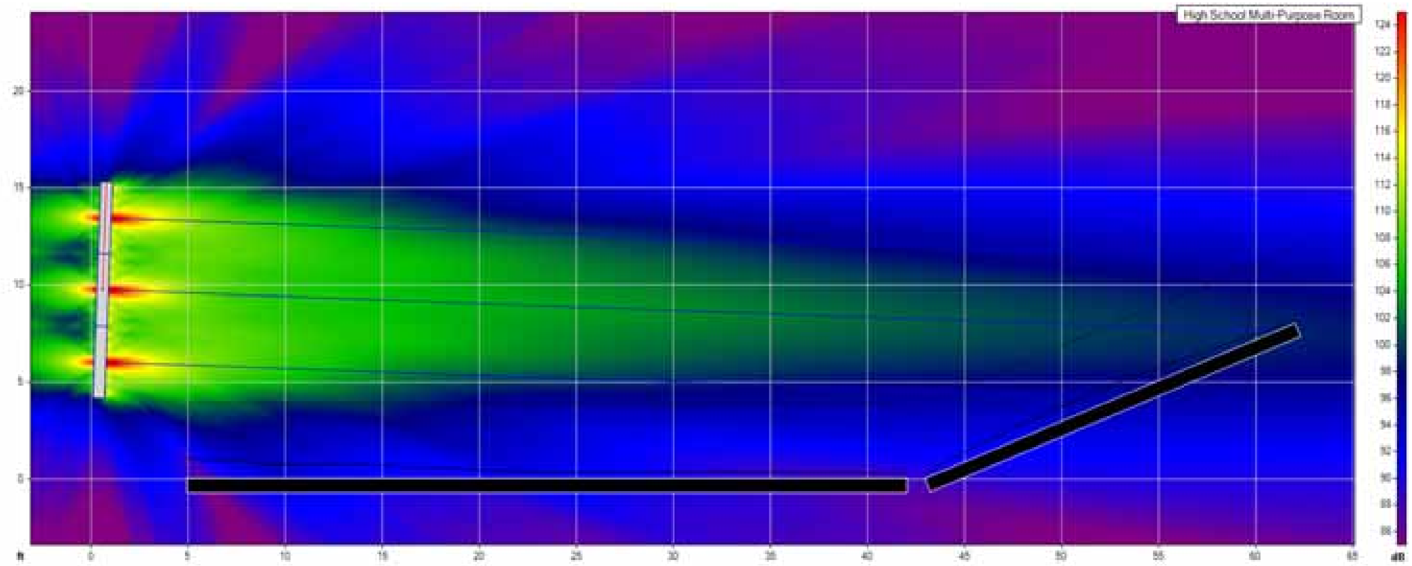
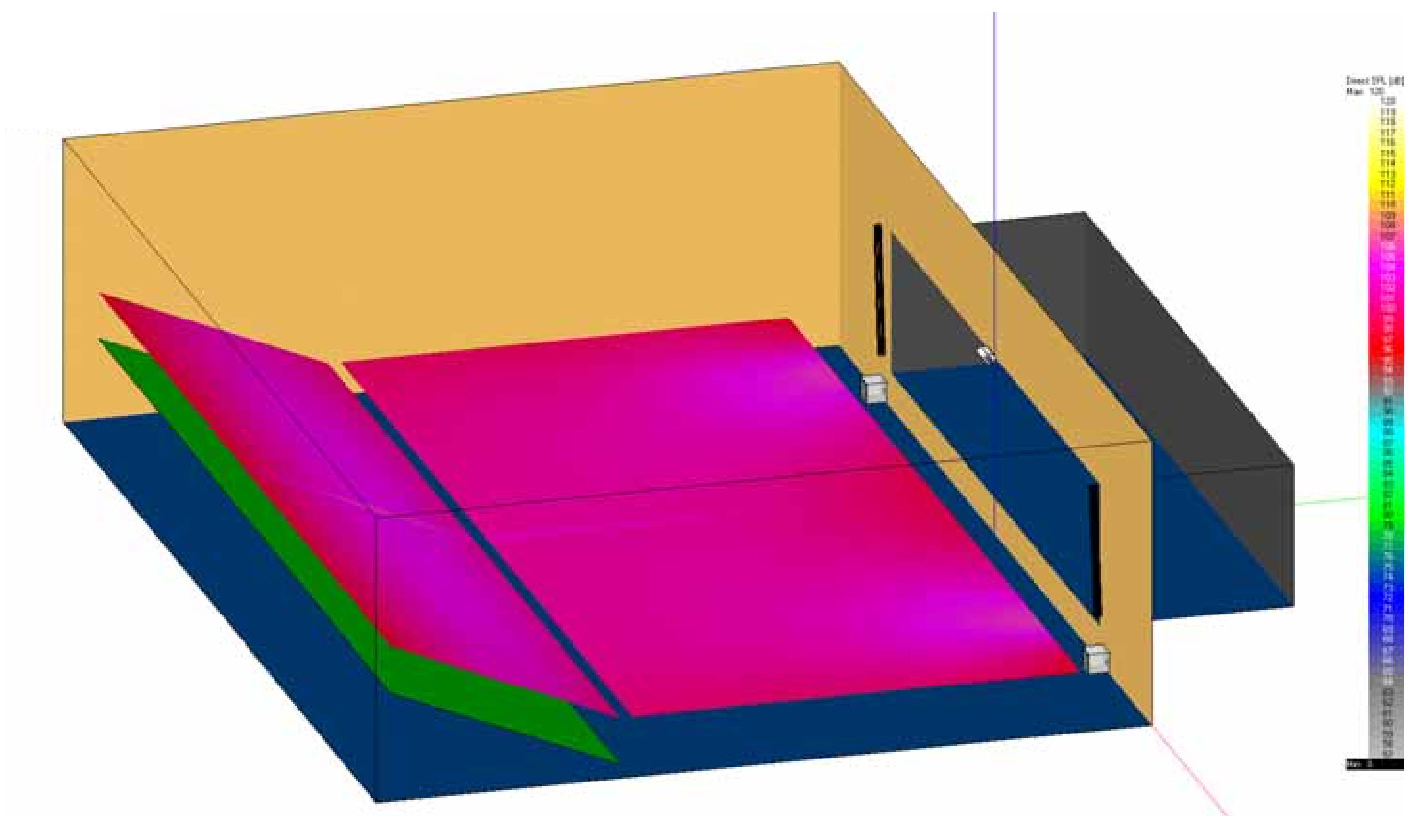


Figure 43: EASE SPL Map of Audience Areas in a Multi-Purpose Assembly Room



LARGE PUBLIC SPACE

Design Approach

The example shown in **Figure 44** illustrates a less conventional application – an announcement system installed in a large public space with an estimated mid-band RT of approximately 2 seconds. This structure's relatively high 15 ft (4.6 m) ceilings would make the cost of installing multiple ceiling speakers prohibitive.

Due to the multiple loudspeaker locations, an equivalent EASE Focus model isn't really feasible. However, as has been previously shown in this application guide, EASE Focus can be employed to get a general sense of the coverage pattern of the planned array configuration.

The potential listening area covers the entire public space at an average standing ear height. Multiple loudspeaker locations are employed, as shown in the figure, each comprising two Full-Range modules at a height of 11.9 ft (3.6 m), angled downward 2 degrees. The azimuth (horizontal aiming angle) of each array varies according to its mounting location and the required coverage area. Each of the 35 array locations are shown in the figure, along with the signal delay time for that array.

Since the potential maximum SPL will certainly exceed that required for announcements, the optional ENTASYS autoformer will be used. This will allow the input signal to be decreased using lower power taps on the autoformer, as well as allowing for the use of smaller amplifiers. Selecting the input to the autoformers at the 63 W tap for 2 columns (modules) will reduce the maximum output level by approximately 10 dB. The optional ENT-750T autoformer accessory for the ENT-FR allows higher voltage, lower current (and power) on long distance transmission cables to overcome cable losses. Higher voltage on the amplifier to autoformer cable is then stepped down to appropriate levels at each loudspeaker via selectable taps. This also allows reduced wire gauge cable which results in greater installation labor and cable cost savings. Sonically, the low-insertion loss ENT-750T autoformer diminishes overall output by 1dB with nominal impact to frequency response. (*Contact the Community Technical Applications Group (TAG Team) for more detailed information.)*

While this example utilizes a parking garage, the implementation of ENTASYS in a similar manner to many large public spaces such as shopping malls, food courts, airport or train terminals, etc. can be equally advantageous.

Results

The system exhibits good uniform coverage, with maximum values ranging from 103 - 107 dB. Our autoformer tap selection should reduce this to 93 - 97 dB, still possibly a bit louder than will be required. While there are variations in the public space, the overall potential intelligibility is good. The values for C50 range from -10 dB to +5 dB. The STI averages about 0.48 while the %Alcons is approximately 12.8%.

What To Look Out For

In this environment, there will be little opportunity to improve intelligibility by adding acoustical treatment. System performance will be maximized by careful aiming of the arrays and setting of the delay times to minimize multiple arrival times from different arrays.

Independent level adjustment of the arrays in the different delay zones may also help to optimize the overall perceived sound quality. This is easily accomplished by adjusting the input sensitivity of each amplifier channel or the DSP output feeding a particular zone.

With so many loudspeaker locations, one might be concerned about multiple sound arrivals presenting confusing artificaial echoes for the listener. A simple auralization study in EASE demonstrated that the multiple arrivals actual integrate well supportive as reflections in this particular model. Reference Pages 54-55, regarding early reflections and their effect on the quality of sound.

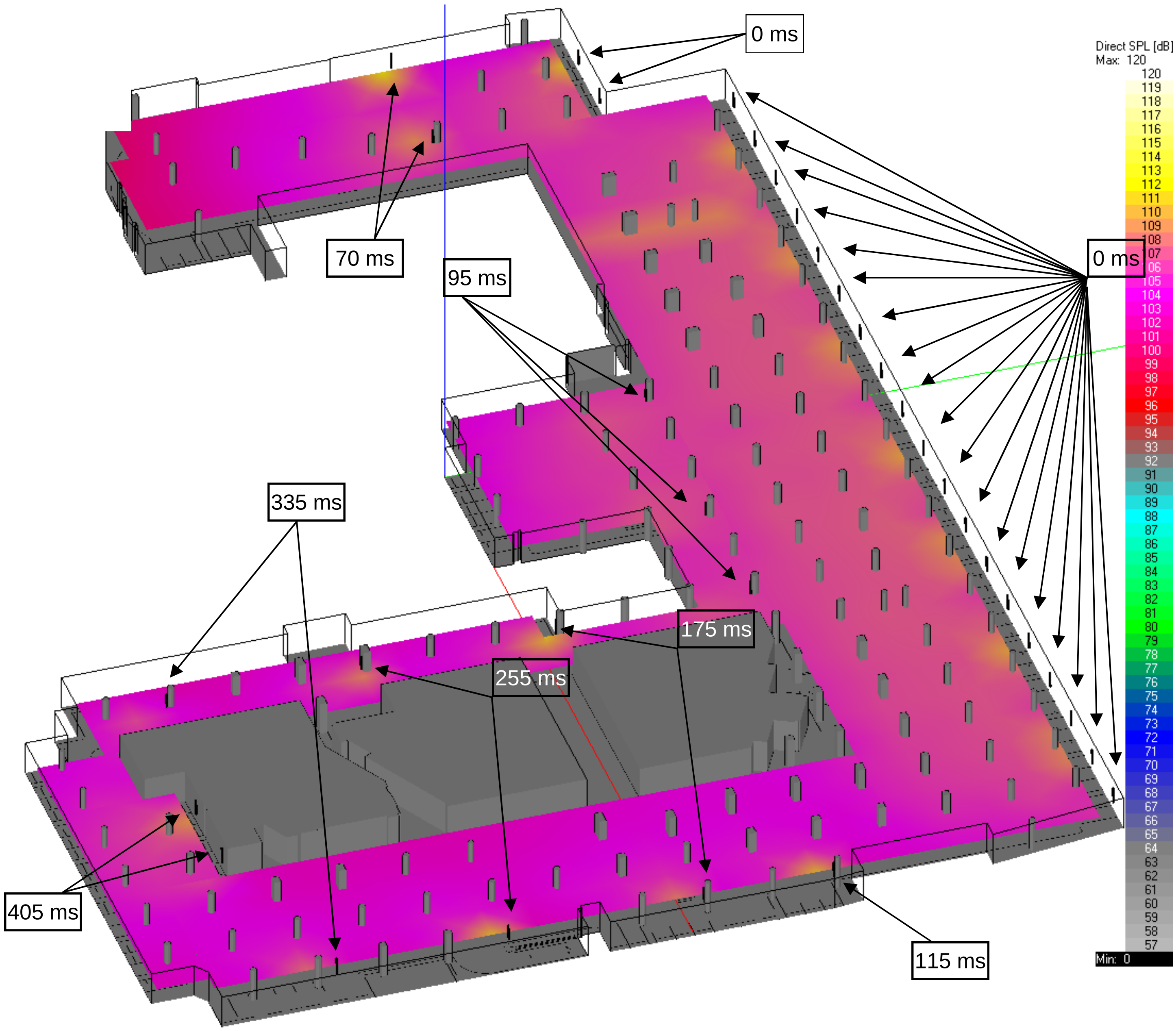
Loudspeakers, Brackets, and Power Amplifiers Used in This Design

Thirty-five arrays, each configured as two Full-Range modules (straight):

- (70) ENTASYS Full-Range Modules (ENT-FR)
- (35) Coupler Brackets (ENT-CB)
- (35) Pan-Tilt Brackets (ENT-PT)
- (35) ENTASYS Autoformers (ENT-750T)
- (5) Two channel amplifiers rated at 600 W per channel into 8 ohms (to drive 70.7V/100V distribution lines)
- (1) DSP unit with a high pass filter and eight output channels of signal delay

DESIGN APPLICATION EXAMPLES

Figure 44: EASE SPL Map of Large Public Space



COMPARISON TO A DISTRIBUTED SYSTEM

In the final design example we will compare an ENTASYS system design of a typical distributed system using overhead-mounted loudspeakers. Our example employs a moderately sized multi-purpose room with no acoustical treatment and a mid-band RT of about 1.5 seconds. The primary application of this sound system is for speech, with occasional playback of pre-recorded material or background music. Assuming a limited budget, an absolute minimum number of loudspeakers will be specified for each design to achieve the required coverage.

Community iBOX i2W8T multipurpose/under-balcony loudspeakers are used for the distributed overhead design. These loudspeakers extend a bit more than an octave below the cut-off frequency of ENTASYS. A low frequency extension loudspeaker may be added to the ENTASYS design if desired, with no detrimental effects.

ENTASYS Design Approach

For the ENTASYS design, a single array is placed along the center of the front wall, thereby ideally locating the front of the audience area about 13 ft (4.0 m) in front of the loudspeaker. The audience area extends to a distance of about 75 ft (22.9 m) away from the array.

The main audience area is drawn in EASE Focus (see **Figure 45**). An array utilizing two Full-Range modules above a single Low Frequency module is positioned 11.3 ft (3.4 m) high and aimed straight back. Since no down-tilt or panning is required the included ENTASYS T-brackets can be mounted directly to the wall. Small shims behind the upper portion of the array can provide a moderate down-tilt if slap-back echoes develop.

The configuration and position of the array are transferred from EASE Focus to the EASE model. Since the array is placed at the center of the front wall, no horizontal panning is required.

Results

The audience areas in **Figure 46** exhibit fairly uniform coverage at approximately 97 dB (+/- 2 dB). Only a few seats at the front inside corners of the two audience areas (along the center aisle) reach a higher SPL of around 101 dB. The system exhibits good potential intelligibility with a C50 averaging 1.5 dB (+/-1.5 dB). The STI is approximately 0.60 with the %Alcons being about 6.8%. Listeners will perceive the sound as coming from the front of the room where primary focus of the presentation will be.

Loudspeakers and Power Amplifiers Used in This Design

One array of a Full-Range module (curved top), above a second Full-Range module (curved bottom), with a Low Frequency module at the bottom.

- (2) ENTASYS Full-Range Modules (ENT-FR)
- (1) ENTASYS Low Frequency Module (ENT-LF)
- (1) One channel amplifier rated at 3,600 W into 4 ohms
- (1) High pass filter or DSP unit
- (1) Optional subwoofer or low frequency extension loudspeaker
- (1) Optional one channel amplifier at 900 W into 4 ohms and HPF/LPF for the subwoofer

DESIGN APPLICATION EXAMPLES

Overhead Distributed Design Approach

For the overhead design, Community iBOX i2W8T loudspeakers are mounted along the roof joists and aimed down at the audience area. The optional autoformer (ENT-750T) will be employed to maintain a high line voltage and low current (similar to the amplification scheme discussed on Page 48); thereby, allowing each row of loudspeakers to be driven by one channel of an amplifier (specifying an amp with sufficient voltage output to drive the 70.7V/100V line).

Results

Here again, the audience areas in **Figure 47** display fairly uniform coverage of approximately 100 dB (+/- 1.5 dB), except for a small area half-way back where the SPL reaches 103 dB. The potential intelligibility of this system is also good, with a C50 averaging -1.5 dB (+/-1.0 dB). The STI is approximately 0.56 with the %Alcons being about 8.2%. Since the sound sonics are above the audience, the design may have to be improved to discretely power and signal delay the loudspeakers to synchronize with presentations and natural sound from the presenter at the front of the room.

Loudspeakers and Power Amplifiers Used in This Design

- (8) Community iBOX i2W8 Loudspeakers with Autoformer (i2W8T)
- (1) Two channel amplifier rated at 1,250 W per channel into 4 ohms (70.7V /100V)
- (1) High pass filter or DSP unit

Comparison of the Different Design Approaches

The two design approaches should yield similar intelligibility in this space. The ENTASYS system offers a slight advantage in minimizing reflected energy off the ceiling area, while the rear radiation from the loudspeakers in the distributed system generates considerably more energy in the range below 800 - 1,000 Hz.

The distributed system generates approximately 3 dB more, and covers a lower frequency range, though this low frequency issue is easily remedied by adding a subwoofer, such as the VLF208.

While both systems provide adequate coverage, the major component cost of the ENTASYS system is 35% less than the i2W8 overhead distributed system, including the subwoofer and additional amplifier. When the increased labor costs for the distributed system's multiple loudspeaker locations is factored into the equation, it becomes clear that ENTASYS offers a real advantage.

Figure 45: SPL Map of Audience Area in a Multi-Purpose Room

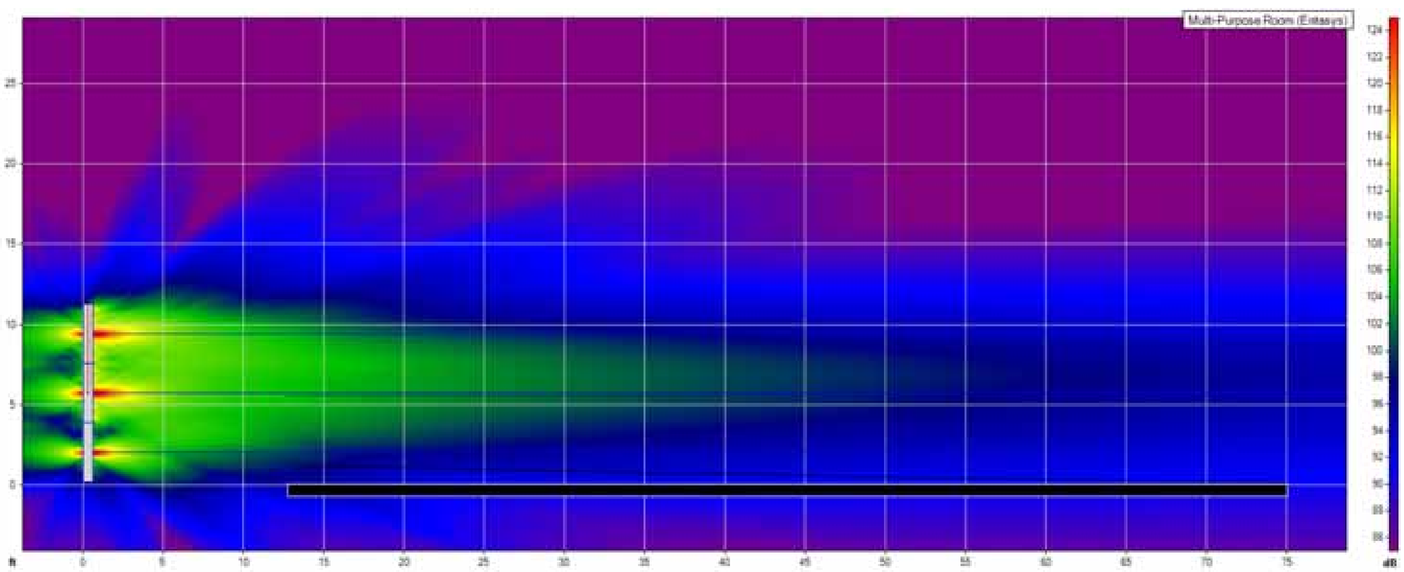


Figure 46: EASE SPL Map of Audience Areas in a Multi-Purpose Room Using ENTASYS Systems

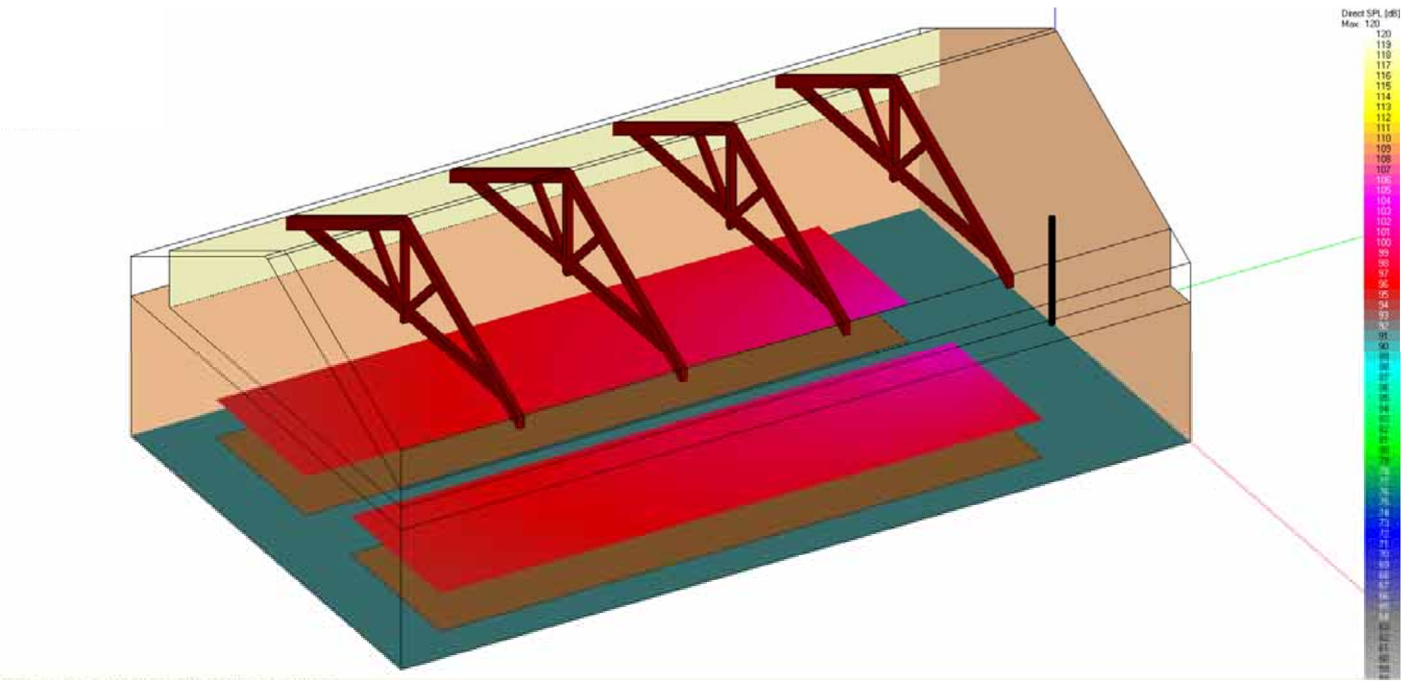
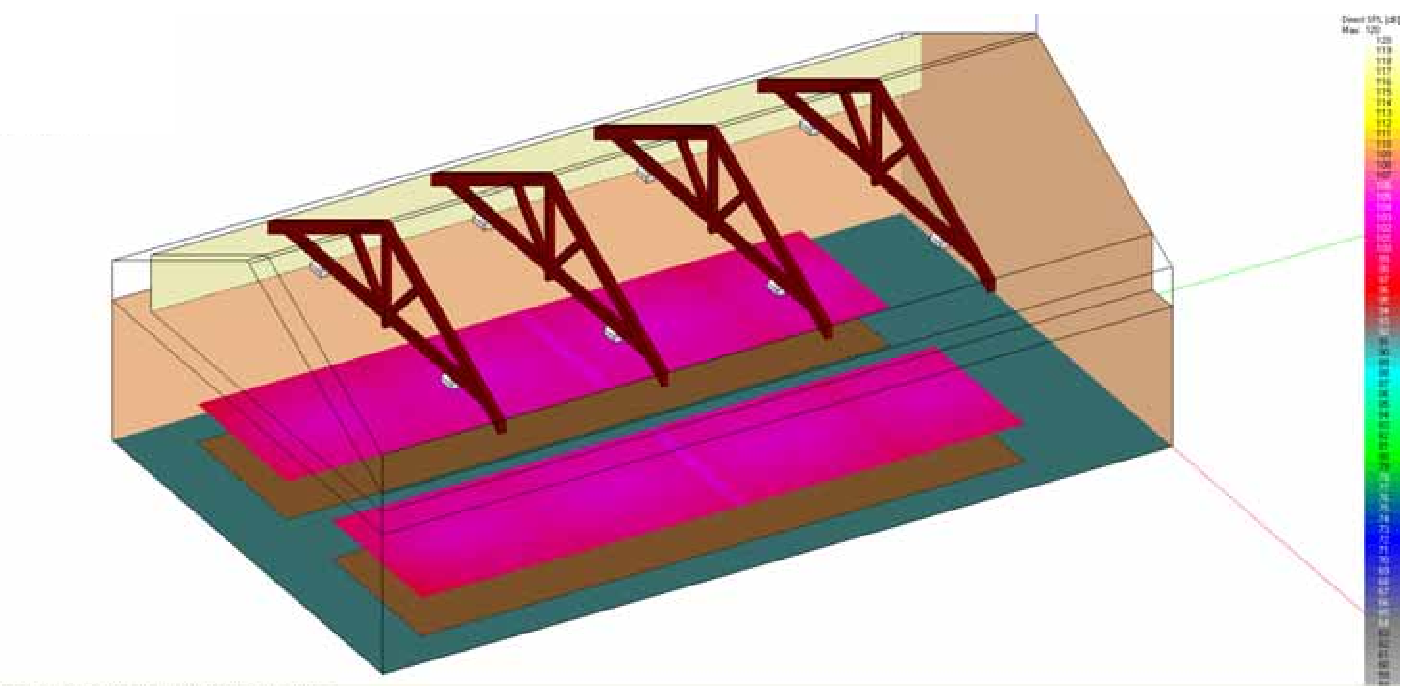


Figure 47: EASE SPL Map of Audience Areas in a Multi-Purpose Room Using a Distributed System



DESIGN APPLICATION EXAMPLES

GUIDELINES FOR COMMISSIONING THE SYSTEM

Commissioning is the process of optimizing the performance of the system after it has been installed. It includes several steps, including verifying the proper operation of each system component and adjusting system gain and levels. ENTASYS systems should be calibrated using the same rigorous methods careful installers regularly follow with particular attention to the following:

Proper Aiming

Extreme care should be exercised to verify that the aiming of each loudspeaker array is correct. This is particularly critical for devices with very vertical narrow beamwidth like ENTASYS. If the arrays are not aimed accurately, no amount of adjustment to other aspects of the system will correct for this error.

There are two very effective methods for checking the aiming of an array. The first method, which is also well suited for initial installation, involves placing a laser level perpendicular to the grille at the center of each full-range radiation beam. The projection of the laser should be compared to the intended focal point in EASE Focus or at approximately the ear height of the farthest listener. For applications requiring a split-beam array, the laser should also be repositioned at the center of each full-range radiation beam and compared to the intended focal point in EASE Focus.

The second method is employed to verify actual coverage to the audience areas. Low-level band-limited pink noise (approximately 2 - 8 kHz) should be played back while listening in the audience areas. By limiting the bandwidth of the signal to only the frequencies which will generate the smallest opening angle, it becomes easy to audibly determine the sound's directivity. In place of this pink noise signal, white noise may be used at low level.

Verify Coverage

It is also a good practice to measure the response of the sound system across the audience areas. The narrow vertical opening angle of ENTASYS systems can result in a seated person moving outside of the main energy beam by simply standing up. Placing measurement microphones at seated and standing heights of the closest and farthest listener positions can verify the direct SPL and frequency response at these extreme audience positions.

Live Acoustical Measurements

The last step in system commissioning is system equalization or "voicing." Equalization is the process of adjusting the frequency response of the system to optimize vocal intelligibility or musical sound quality (or both). It is advisable to make these adjustments with the system's microphones in proper position and open.

When applying equalization to ENTASYS systems it is important to sample several different measurement locations during the equalization process. Line array systems will exhibit varied frequency responses at different distances, as explained in the *Differences Between Line Arrays and Point Sources* section (Pages18-19). Positioning multiple measurement microphones at different distances in the audience area can provide for quick comparison of the response at these locations, as well as calculating an overall average response to help determine the appropriate equalization settings for the system.

Good results can be achieved by beginning with the recommended equalization filter settings for ENTASYS shown in **Table 3** on Page 34 - 35 (or check the Community website at www.communitypro.com for the latest recommended settings). Further modifications to these settings may be made to provide the desired voicing for each system's specific application and conditions. Use only small increments of equalization, and avoid boosting frequencies by more than about 3 dB.

Please contact Community's Technical Applications Group (TAG Team) at 610-876-3400 / 1-800-523-4934 or email TAGTEAM@communitypro.com for usage outside of these parameters.

Note that for optimal performance ENTASYS should be used with a Digital Signal Processor that offers a variety of parametric equalizer filters as well as high pass and low pass filter slopes and alignments in order to accomplish this task.

Reflections and Their Impact on Sound Quality

Introduction

A well known study by Michael Barron[1] examining the subjective effects in a listener's perception of early and late sound reflections has helped shape how this generation understands what types of sound reflections will contribute positively to the direct sound output of a sound source. For the purposes of this ENTASYS design handbook, the following chart in Figure 46 details the relationships of reflections at various levels relative to the direct sound and the amount of time in milliseconds that transpires from the initial sound impulse until the reflection travels to the listener. Regarding the effects of reflections caused by nearby boundaries near an ENTASYS loudspeaker, take particular note of the resulting acoustic behavior that occurs up to about 40ms. Reflections from such boundaries effect tonal quality of sound, psycho-acoustic imaging, and the contribution (or degradation) to intelligibility.

Very Early Reflections

When evaluating ENTASYS array locations, consider the effects of very early (up to about 10 ms), higher level reflections that contaminate the original direct sound impulse mid-flight before it even arrives at the audience. Often this can be caused by the combination of wide horizontal dispersion from an ENTASYS system and a nearby room boundary such as a wall. The term "deep comb filtering" describes the effect of these reflections on the direct sound. Also, this can cause "image shift" wherein the listener begins to perceive the original sound source as actually emanating from a phantom position between the loudspeaker and the acoustically reflective surface. The audience will be affected much like the psychoacoustic phenomenon that generates central phantom acoustic images in stereo sound systems. *These are the most destructive reflections to the audio path.* They deserve attention in the system design to consider: another mounting location, a change in horizontal aiming, acoustic absorptive treatment near the array, or some combination of these measures may improve the quality of the installation.

Supportive Early Reflections

For reflections which arrive at the audience after a greater delay and/or decreased level, the concern for modifying the system design will be less critical. In fact, as the delay exceeds 10 ms and less than 35 ms, the reflected sound will generally create a perceived tonal shift, but will also reinforce the original sound and contribute positively to intelligibility. Comb filtering will still exist, but the listener will begin to average these signals in their hearing perception. To minimize the tonal coloration in this time domain window, consider the same modifications as indicated above for very early reflections.

Reverberant Field Reflections

As reflections arrive later than 35 ms, they become part of what many call the "reverberant field". So long as these reflections arrive to the listener at lower level, they contribute positively to the listener's dimensional perception of the environment. In other words, in this region of the chart the listener will begin to perceive the various features of the venue's "acoustic signature" and appreciate its spaciousness and unique reverberation.

Harmful Reflections

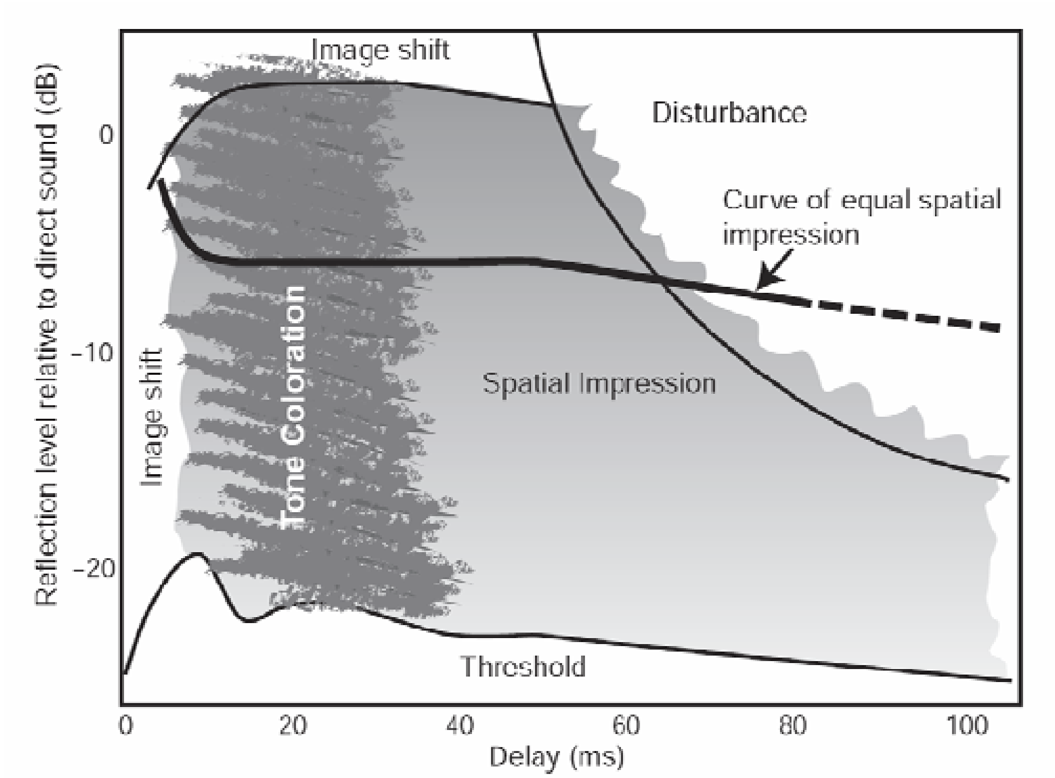
Most importantly, be aware of the very harmful effects of reflections that arrive in the zone in the chart labeled "disturbance". These sound reflections will be perceived as distinct secondary sound events commonly called "echoes" which certainly degrade intelligibility. Every effort must be made to avoid this phenomenon for the sake of preserving clarity of music and speech.

Low-Level Reflections

If there is any saving grace in dealing with reflected sound, note that reflections which arrive at the listener about 20 dB to 30 dB lower than the original sound become negligible and can largely be disregarded. In the chart, the region labeled "Threshold" represents these very low level reflections.

Reflections and Their Impact on Sound Quality

Figure 48: Subjective Effects of a single reflection arriving from 40 degrees to the side
Appears in "Sound Reproduction: The Acoustics and Psychoacoustics of Loudspeakers and Rooms", by Floyd E. Toole adapted from Barron, 1971[1]



[1] Barron, Michael[†, a] *The subjective effects of first reflections in concert halls—The need for lateral reflections*
Journal of Sound and Vibration
Volume 15, Issue 4, 22 April 1971, Pages 475-494,

[a]Institute of Sound and Vibration Research, University of Southampton
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ABSTRACT

This paper describes experiments with simulated reflections in an anechoic chamber, in an attempt to understand the importance of early reflections in a concert hall. The subjective effects of a single side reflection were investigated; and the effect of "spatial impression" was identified as the predominant subjective effect. This "spatial impression" was produced for reflection delays between 10 and 80 msec by lateral rather than ceiling reflections.

The variation in the degree of spatial impression for variations in different reflection parameters was investigated, as was the effect of two side reflections. It was concluded that the degree of spatial impression is probably related to the ratio of lateral to non-lateral sound arriving within 80 msec of the direct sound. Other authors' theories of the role of first reflections are discussed in the final sections of the paper. Results here gave support to the view that a cross-correlation process is involved in subjective spatial impression.

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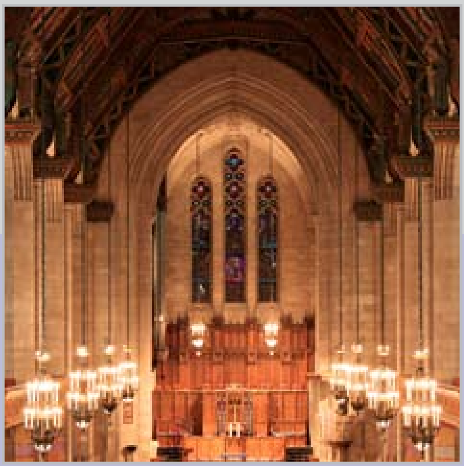
High Performance



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