Sound Reinforcement System Specification

for

(a very important client)

prepared by

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Introduction

This sound reinforcement specification was prepared at the request of ********, located in ********. Details concerning equipment needs and system configuration are included in this specification, along with recommendations for contract work. It is acknowledged at the outset that many different brands and models of equipment could be specified that effectively meet the requirements of the client, but ample justification should be provided by the installation contractor for deviating from the recommendations provided herein.

Outline of System Requirements

Included in this specification are upgrades to the sound reinforcement system in the sanctuary, the monitor system for the musicians, and a distributed system for the hallway. A new loudspeaker array, new power amplifiers, new signal processing electronics, new mixing board, new wireless body packs, new wireless handheld microphones, and new stage wiring are the primary requirements. In particular, automatic feedback elimination as well as "tamper-proof" equalization and compressor/limiter settings are a "must". The client wishes to use existing monitor loudspeakers and existing wired microphones as well as existing audio recording and playback equipment. The client also wishes to explore the addition of an effects processing unit. The inclusion of a subwoofer, however, is not deemed necessary or even desirable at this point.

The first, and perhaps most important consideration is the choice of loudspeaker components, their configuration, and their orientation. Referring to the plan view of the sanctuary provided in Figure 1, there are several challenges associated with this space. The first constraint is the availability of structural members for hanging the array. Here, the sole structural member available is a beam located about 30 feet above and slightly forward of the podium, from which the current loudspeaker cabinets are hung. Because the only suitable hanging location is fairly close to the first row of seats, the horizontal coverage angle of the loudspeaker array must be relatively wide (nearly 180°), given the splayed seating configuration. Another challenge is the relative "shallowness" of the coverage depth which, combined with the restrictions on where the array can be hung, imposes constraints on the vertical coverage angle of the array as well as the elevation angle and height at which it should be hung. A rather narrow vertical coverage pattern would be required to minimize real-wall "splash", but the relative closeness of the array to the front row calls for a relatively wide vertical coverage pattern to ensure uniformity of coverage. Fortunately, though, the space has a fairly short reverberation time and does not appear to suffer from severe "slap echo" problems. Since the "natural" reverberant sound field of the room is relatively low, a modest amount of rear-wall splash will not increase the reverberant energy in the room dramatically; thus, the use of loudspeaker array with a "normal" vertical coverage pattern (e.g., 65°) is an acceptable solution. Such an approach will not compromise the system's speech intelligibility.

An important consideration in choosing loudspeaker system components for this application is their *inherent* ability to be clustered. What some installers may not realize is how coverage patterns of independently hung loudspeakers combine, and the frequency-dependent pattern of nodes and anti-nodes that can result in the intended coverage field. This is a topic I have addressed at length in the *JAES* (*Journal of the Audio Engineering Society*) papers I have

published and AES Conference presentations I have given. Further, as is the case with the current installation, the coverage patterns of a pair of non-clustered loudspeaker cabinets aimed in different directions can fail to overlap, leaving a "hole" in the middle of the coverage zone.

My recommendation is to install a horizontal cluster consisting of three ElectroVoice Sx300WE systems (white finish, with Speakon connector), configured using two Sb300 horizontal array kits in conjunction with three Sb200 mounting brackets. The 60° mounting holes on the Sb300 array kits should be utilized to obtain the correct horizontal coverage pattern. This 3-element cluster should be hung approximately 22-23 feet above the floor at the location indicated in Figures 2 & 3 and aimed (as a unit) at an elevation angle of approximately 20° down (relative to horizontal). Since the left and right coverage zones are different in area than the middle coverage zone, the left and right array elements should be connected in parallel and driven by the same power amplifier channel; the center array element should be driven by a second power amplifier channel. Also, since the absorptive characteristics of the left and right coverage zones may be somewhat different than the central coverage zone, separate equalization should be provided for each power amplifier channel.

To drive both the main cluster and the two powered monitor channels, I recommend a pair of Crown MT-600 dual-channel (225W X 2) power amplifiers. Besides being a commercial grade product, a nice feature is that the gain controls for each channel are on the rear panel, which helps reduce the probability of tampering. Since the relative gain settings will affect the shape of the array's horizontal coverage pattern, it is best that these controls be inaccessible.

While on the subject of power amplifiers, I recommend a small, separate power amplifier specifically designed to drive a 70-volt line for the distributed ceiling speakers in the hallway, such as the TOA Model P-906MKII. There is no need to provide any signal processing for this portion of the system, as its primary purpose is for "speech monitoring" outside the Sanctuary. Generic 8" ceiling loudspeakers and baffles with integrated 70-volt transformers can be utilized (in whatever locations the client and contractor agree are necessary), with independent 70-volt wall-mount attenuators for each coverage zone. The 60 watt P-906 can drive up to a dozen speakers (each connected to the 5-watt tap on its attached 70-volt transformer). These speakers can be split up into as many different zones (each with a separate 70-volt attenuator) as desired.

The next critical component "up the chain" is the signal processing electronics, which entails equalization (EQ), gain compression/limiting (C/L), and feedback elimination (FBX). An effective, all-in-one product that provides these capabilities is the Sabine Graphi-Q (Model GRQ 3102S). A pair of these all-digital, dual-channel devices is required for this application: one for the main cluster power amplifier, and the other for the monitor power amplifier. Thus, the central and "wing" zones of the Sanctuary can be equalized separately (as well as driven at different levels), and each of the two monitor channels can be equalized separately (and also driven at different levels). Further, each channel's FBX can operate independently, and a different amount of C/L can be applied to the main cluster and the two monitor channels. The "plain panel" Graphi-Q model is very cost effective as well as tamper proof – its settings can only be modified remotely, using a computer.

The mixing board is the next consideration, although its choice is not quite as critical, as there are a number of quality 32-channel boards currently available. Based on cost-effectiveness, flexibility, and intuitive operation, I recommend the Mackie 32x4-VLZ-PRO. The four mix buses and six aux sends provided by this unit are more than adequate for this application, and the sonic performance (bandwidth, dynamic range, noise, and distortion) is excellent. Pre-fader Aux Sends 1 & 2 can be used for the two powered monitor channels, pre/post-fader Aux Sends 3 & 4 can be used to provide a "stereo" recording mix, and post-fader Aux Sends 5 & 6 can be used to provide a "stereo" effects send. A nice feature of the Mackie board is the inclusion of two line-level stereo input strips (channels 29-30 and 31-32), which the client will probably want to use for CD and tape/computer audio playback. Because the existing tape decks and CD player are consumer-grade units, I recommend interfacing them to the board via a Symetrix 303 Interface Amplifier. I also recommend the inclusion of a compressor/limiter in the output signal path for the audio recorders (specifically, a dbx 166XL). For the "wired" microphones, I recommend running a 24-channel snake cable to the stage area and connecting it directly to channels 1-24 of the board. The four new wireless microphones (specified below) should be connected to input channels 25-28, and the existing tape and CD playback units should be connected to (stereo) input channels 29-30 and 31-32, respectively. The four sub-masters available are sufficient to provide a sub-mix for "live" speakers, vocalists, musical instruments, plus a "spare" (that could be used for a drum-set). Another useful feature of the Mackie board is its mono main out, which here will be interfaced to both inputs of the Graphi-Q for the Sanctuary, the 70-v distributed system amplifier, and the existing hearing assistance transmitter via a Symetrix 305 1x4 distribution amplifier. The complete system wiring diagram is illustrated in Figure 3.

The client also wishes to add some "effects" processing, for which I recommend the Alesis Microverb 4. This programmable 18-bit digital processor should produce all the effects (primarily reverb) desired. As mentioned above, it will receive its "stereo" input from post-fader Aux Sends 5 & 6, and will return the processed signal via Stereo Aux Return 1. Note that the "Mix" control on this unit should be turned all the way to the right (fully clockwise) to ensure proper operation.

Given that the client is experiencing interference problems with the VHF wireless microphones currently in place, I recommend replacing them with frequency-agile 100-channel UHF units, specifically Audio-Technica ATW 7375 UHF bodypack systems (equipped with AT831CW clip-on cardioid microphones) and ATW7373 handheld (condenser) UHF systems.

The complete list of equipment required for this installation is summarized in Table 1. The "street price" for the equipment (not including wire, rigging cable, etc.) is approximately $10,000. A new snake cable, new microphone cables, new speaker wiring, rigging cables, etc., should add no more than an additional $1000 to the "raw" parts and equipment total (assuming use of the existing rack cabinet). The client has plans in place for "bumping out" the current mix location into the Sanctuary, so no special enclosure or cabinet for the mixing board and consumer recording/playback components is necessary.

Contract Work Requirements

The contract work required for system installation, and for which GCAC seeks competitive bids, entails the following:

1. Hanging and aiming the loudspeaker array in the sanctuary per Figures 2 & 3, and running three 14-gauge, 2-conductor cables (w/ Speakon connectors) to the equipment rack location.
2. Running a 24-channel snake cable to the stage area along with two 14-gauge, 2-conductor cables, and installing recessed connection boxes (such as Whirlwind FP-series) at six different client-specified locations (suggest each box have four female XLR microphone inputs, two ground-isolated ¼" phone jacks for monitor speaker outputs, plus one duplex A.C. power outlet).
3. Configuring the equipment specified in the existing rack cabinet per the wiring diagram provided in Figure 4 of this specification and the rack layout depicted in Figure 5.
4. Installing the hallway ceiling speakers at (up to) 12 locations, divided into (as many as) 4 different zones with a separate 70-volt wall-mount attenuator for each zone and connected using 16-gauge, 2-conductor cable (class 2 wiring).
5. Performing a 1/3-octave real-time analysis (RTA) of the Sanctuary system.
6. Adjusting the monitor EQ appropriately (may wish to perform separate RTA on each monitor channel).
7. Adjusting the compressor/limiter settings of the Sanctuary and monitor systems appropriately.

Professional sound installation contractors who wish to bid on this job should complete the form attached to this specification. Note that any deviations from the equipment specified herein should be noted and a written justification provided. Any questions concerning this specification should be directed to me at ******.

Table 1. Recommended Equipment List and Street Prices.

Manufacturer	*Model No.*	*Description*	*Unit Cost*	*Qty*	*Total Cost*
Electro-Voice	Sx300WE	2-way Speaker System	$453.00	3	$1359.00
Electro-Voice	Mb200W	Wall Bracket	40.00	3	120.00
Electro-Voice	Mb300W	Horizontal Array Kit	47.00	2	94.00
Crown	MT600	225W x 2 Power Amplifier	529.00	2	1058.00
Sabine	GRQ 3102S	Digital EQ-FBX-C/L	852.00	2	1704.00
TOA	P-906MKII	60W 70V Power Amp	358.00	1	358.00
TOA	MB25B	Rack Mount Bracket	38.00	1	38.00
TOA	B01F	Balanced Input Module	57.00	1	57.00
Mackie	32X4-VLZ-PRO	32-Channel Mixing Board	1567.00	1	1567.00
Alesis	Microverb 4	Digital Effects Processor	146.00	1	146.00
Symetrix	303	Unbal Interface Amplifier	153.00	3	459.00
Symetrix	305	1x4 Distribution Amplifier	153.00	1	153.00
dbx	166XL	Compressor/Limiter/Gate	231.00	1	231.00
Audio-Technica	ATW-7375	Bodypack UHF Wireless	448.00	2	896.00
Audio-Technica	AT831CW	Cardiod Clip Microphone	85.00	2	170.00
Audio-Technica	ATW-7373	Handheld UHF Wireless	577.00	2	1154.00
QUAM	C5/B70/W	70V Ceiling Speakers	13.00	12	156.00
QUAM	QC10CLASSIC	70V Wall-Mount Attenuator	14.00	4	56.00
Furman	PS-8R	Power Sequencer	237.00	1	237.00
					$10,013.00

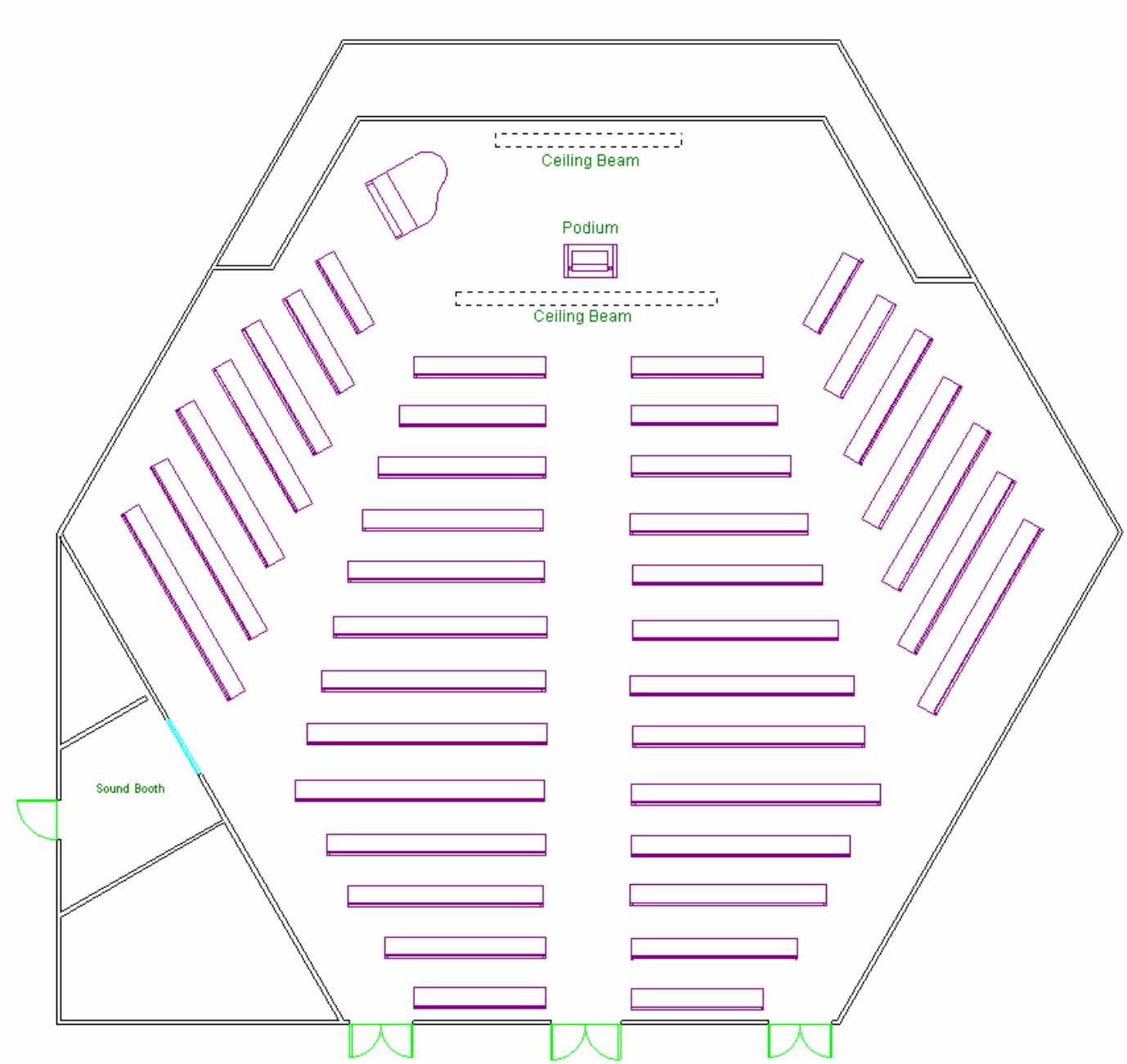


Figure 1. GCAC Sanctuary Configuration.

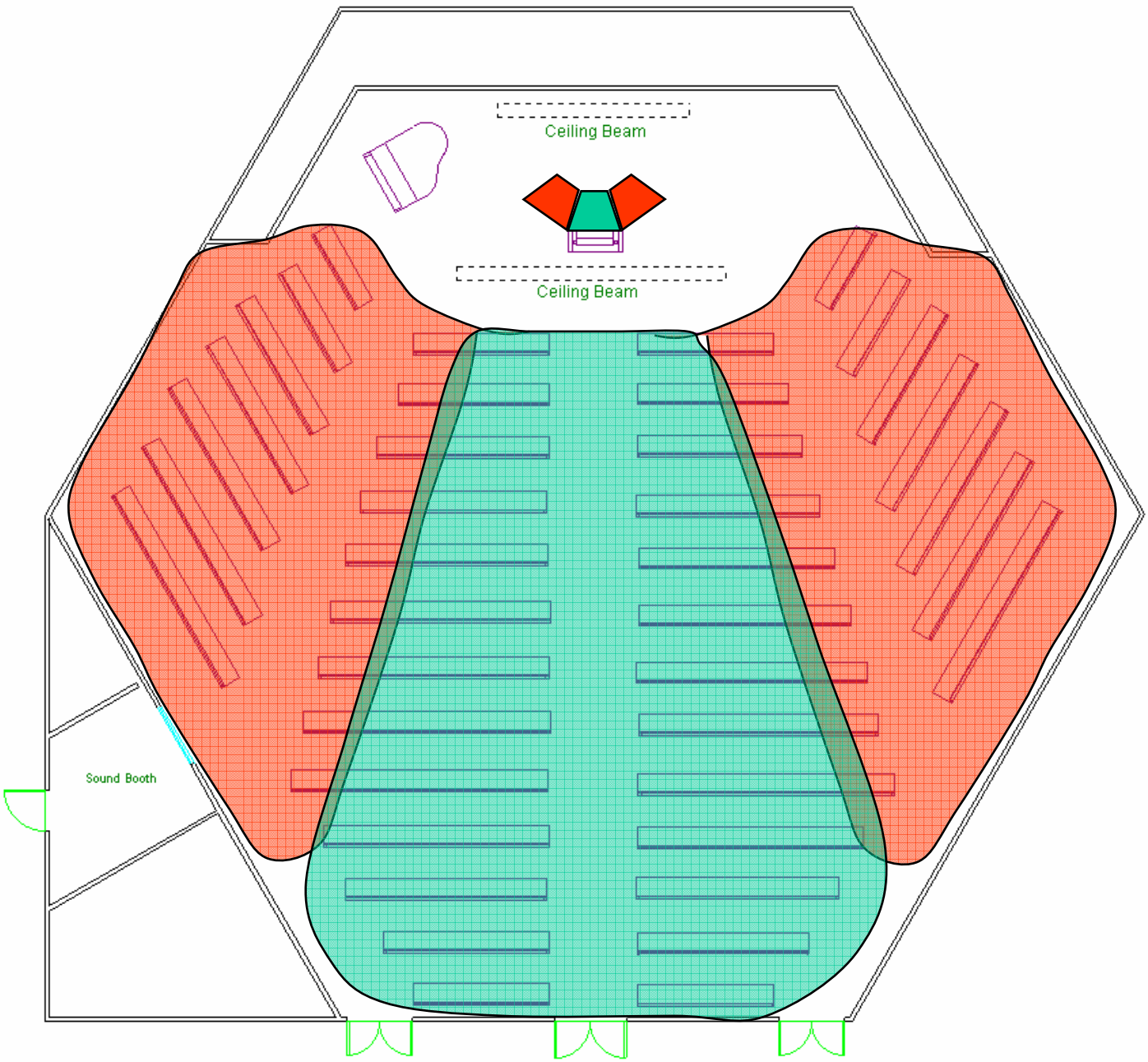


Figure 2. Array Mounting Location and Approximate Coverage Zones.

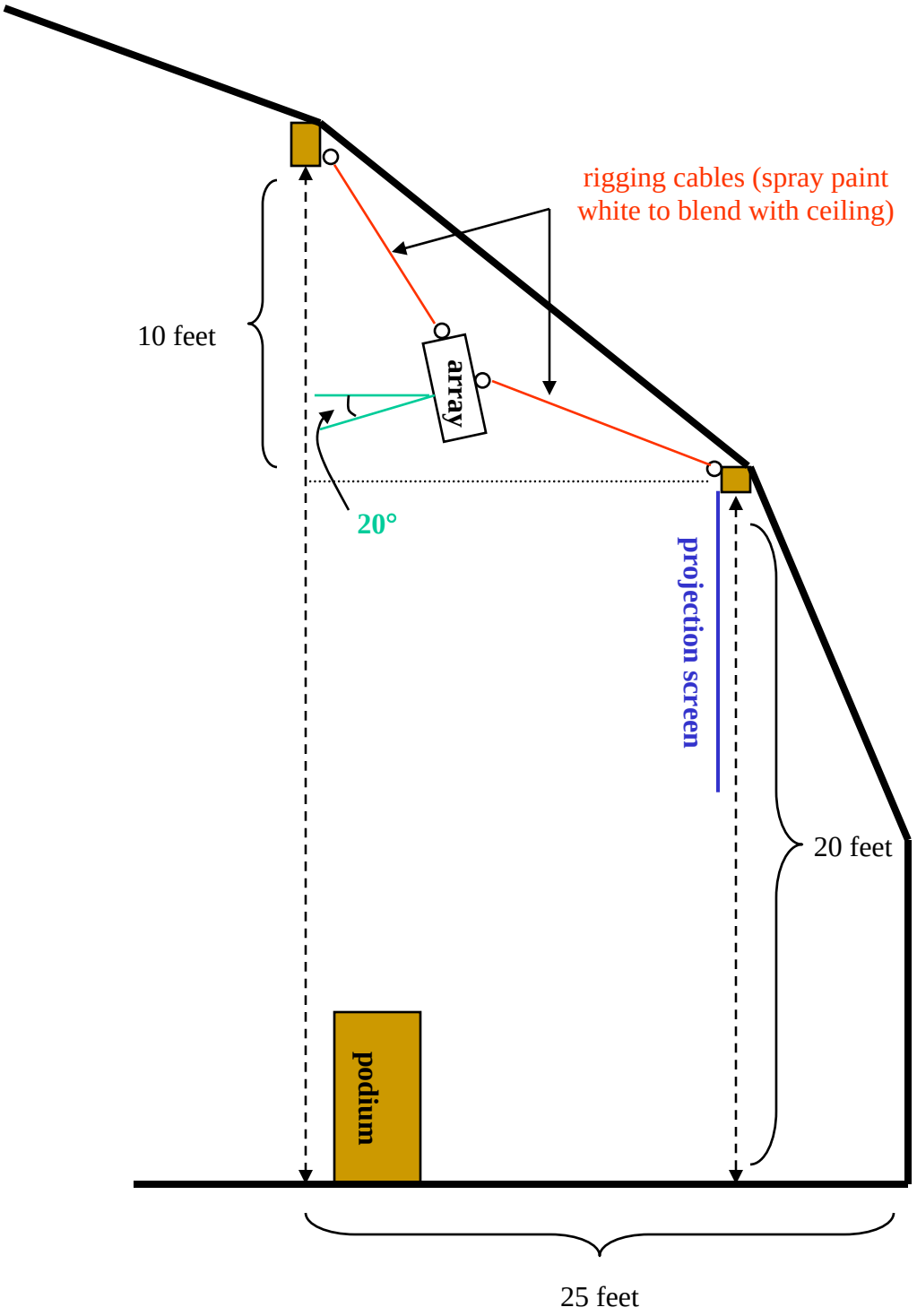
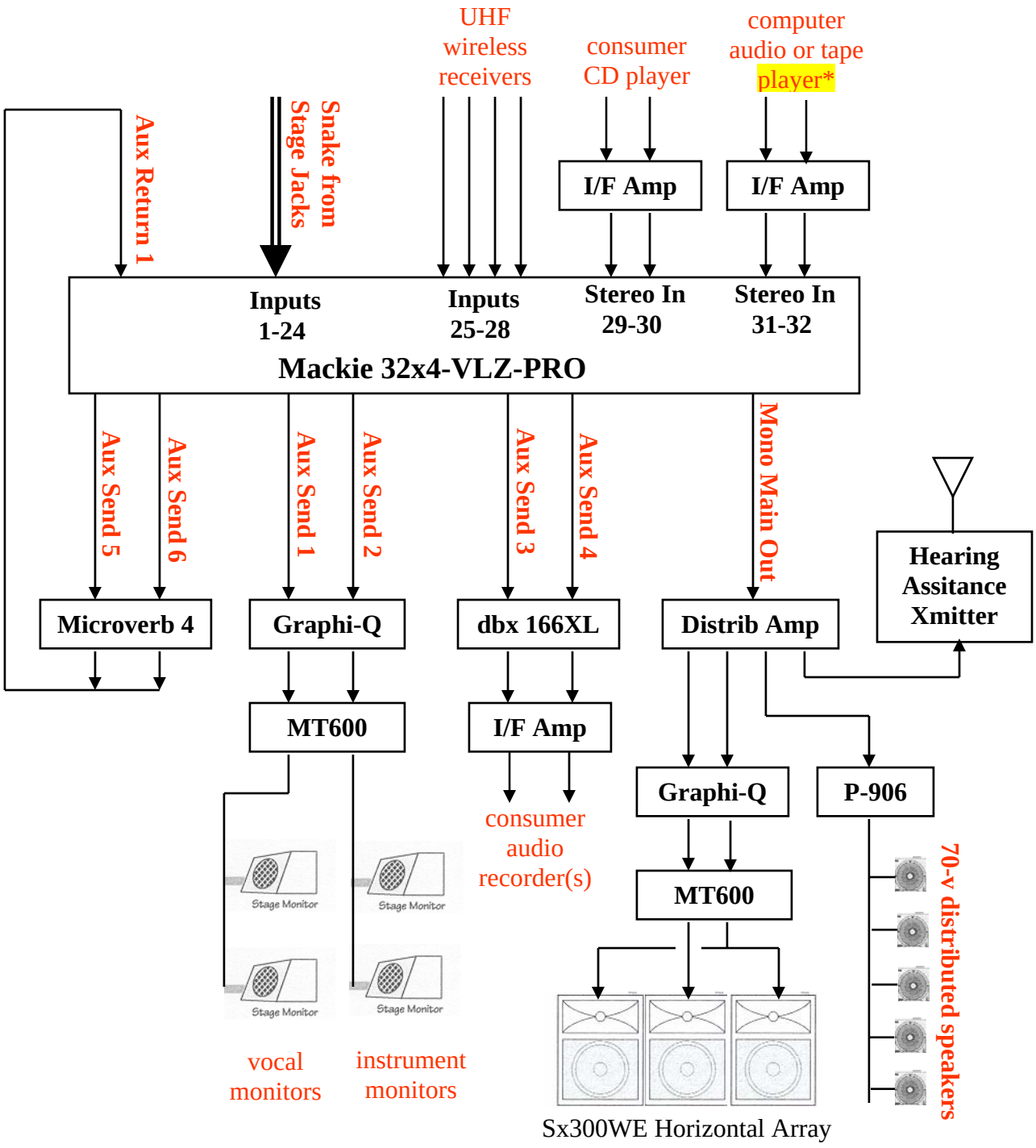


Figure 3. Side View of Array Mounting Configuration.



***IMPORTANT NOTE: This tape deck must be used for PLAYBACK ONLY – it can NOT be the same tape deck used for recording.**

Figure 4. System Wiring Diagram.

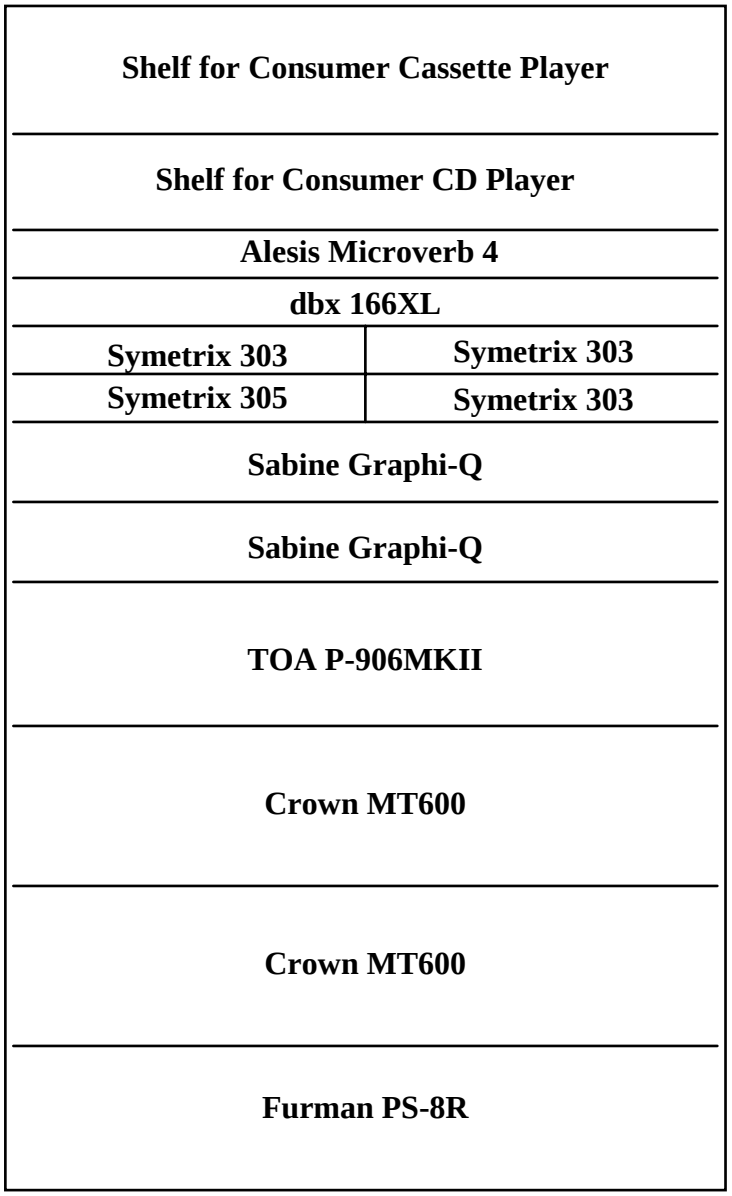


Figure 5. Rack Configuration.

Professional Audio Contractor Bid Form for GCAC Installation

Description of Work to be Performed	*Materials Cost*	*Labor Cost*	*Comments*
Assemble Sanctuary loudspeaker array, hang at specified location and orientation per Figures 2 and 3, and run three 14-gauge, 2-conductor cables w/ Speakon connectors (one for each array element) to equipment rack location.			
Run 24-channel snake cable from mixing location plus two 14-gauge, 2-conductor cables from equipment rack to "break-out" box near stage area. Install six recessed floor boxes at client-specified locations, each containing four female XLR connectors, two ground-isolated ¼" phone jacks, and one duplex A.C. power outlet.			
Deliver equipment listed in Table 1, and configure per wiring diagram in Figure 4 and rack layout in Figure 5.			
Install (up to) 12 eight-inch ceiling loudspeakers (w/ attached 70-v transformer) in client-specified locations, divided into 4 zones each with a separate wall-mount 70-v attenuator. Connect using 16-gauge, 2-conductor cable, providing a separate run from the equipment rack to the attenuator for each zone.			
Perform a 1/3-octave RTA of the Sanctuary. Note that the "central" and "wing" zones may require different EQ settings, and thus should each be individually referenced during the RTA.			
Adjust the monitor EQ appropriately (may need to RTA each monitor channel).			
Adjust the C/L settings for both the Sanctuary and the monitors appropriately.			

JOB TOTAL = MATERIALS COST OF $ _____ + LABOR COST OF $ _____ = $ _____