

# The “Big 7” of Sound System Design

*The first step of any sound system project is to qualify the designer*

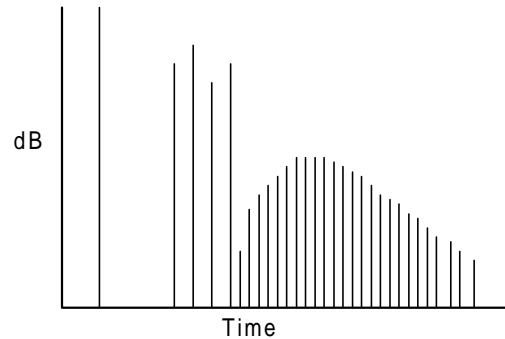
by Pat Brown

Many end-users assume that sound system design involves only selecting a list of equipment and interconnecting it. If this were true, then most sound systems would work and most venues would have excellent sound reproduction. Unfortunately, this is not the case. The sound system must be matched to a venue much in the same way that a custom suit must be fitted to an individual. Unless one has the knowledge and experience to fully evaluate the acoustic environment and to evaluate the interaction between array components, it is impossible to design an appropriate system. Perhaps part of the problem lies in the fact that the human ear/brain system is very tolerant of frequency-domain artifacts and excessive delay with regard to music reproduction. Ironically, most individuals can easily detect differences in video quality and can easily be shown why better video equipment costs more. Most listening tests are performed without a “golden standard” to use as basis for quality and accuracy. Musical quality is very subjective under these conditions. Most everyone knows what red looks like, so judgements of video quality are objective. But what should a saxophone sound like? This is why we always recommend speech as a program source for evaluating system performance, as well as making comparisons of products. Otherwise, the process is completely subjective and meaningful comparisons will be difficult if not impossible. Unfortunately, many end-users are swayed to purchase a particular system by listening to the reproduction of a music CD. Of course, music reproduction is important. But even more important are the communication properties of a system. Music is essentially useless in evaluating this critical area.

What must one know in order to design an appropriate sound system for a venue? This list (in no particular order, since all are essential) is intended to help someone pre-qualify themselves for this task. If you have a customer that considering doing their own design, then encourage them to read this first.

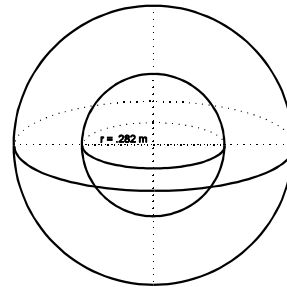
## 1. And Understanding of the Various Types of Sound Fields

This includes the direct field, early-reflected field, and the reverberant field. Since your loudspeaker system will generate all of these, and understanding of each is required to achieve the appropriate energy ratios at listener seats.



## 2. Electrical Power Required Calculations

An understanding of loudspeaker sensitivity, power handling, and the inverse-square law are required to select appropriate amplifiers for a system design. The designer must be able to manipulate these parameters and achieve the proper balance between them. Failure to do so results in systems that are underpowered (distort before reaching the desired level), or overpowered (average operating level is too high resulting in blown loudspeakers).



Since doubling the radius of a sphere quadruples the surface area, the sound intensity level will drop 6dB.

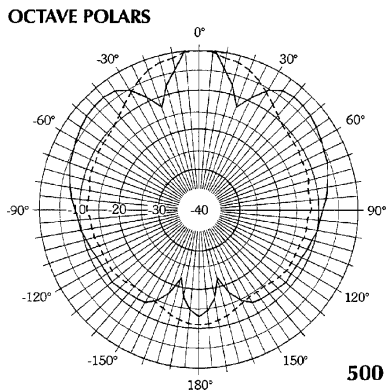
$$10 \log \frac{4}{1} = 6 \text{ dB}$$

## 3. Transducer Directivity and Interaction

Effective array design is impossible without an understanding of loudspeaker directivity. This includes not only the on-axis Q rating of the loudspeaker, but also the loudspeaker’s coverage angles as a function of frequency. Many systems fail because there is either insufficient coverage or too much. The former results in soft spots in the audience coverage, and the latter results in severe phase cancellation effects that cause “dead spots” in audience areas.

No system can improve on the signal that is presented

to it. The system designer must make certain that appropriate signal-to-noise ratios and direct-to-reflected ratios are established at each microphone, and that sufficient signal level is delivered to the mixer.



#### 4. Local Electrical Codes and Proper Rigging Practices

Even a good sounding system is not a success unless it is safe. Few end users are aware of applicable electrical codes concerning equipment and wiring. Failure to use appropriate wire gauges and insulation types can create hazards. Proper rigging is not a trivial matter, and the qualified sound system designer will make certain that flown loudspeakers remain where they are flown. This involves selecting the correct rigging hardware, as well as appropriate mounting points in the venue. Audio professionals know when they are in over their head and should call a qualified structural engineer in on a project.



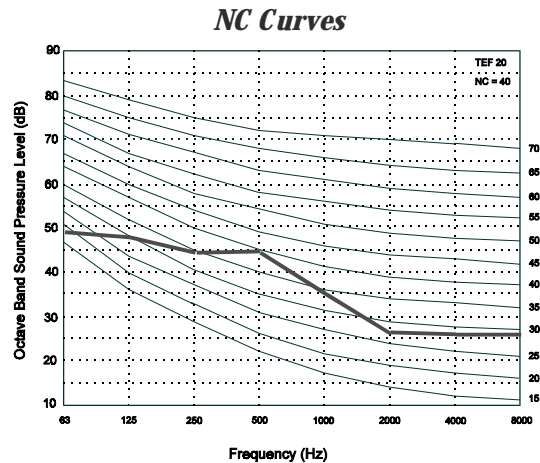
#### 5. Ohm's Law for AC and DC Circuits

Ohm's Law describes the relationship between voltage, current, and resistance in electrical circuits. A basic understanding of it is required to make judgments concerning device loading, line termination, and wire gauges. Many common sound system defects are simple violations of Ohm's Law (Y-ing of outputs, etc.)

$$W = \frac{E^2}{R}$$

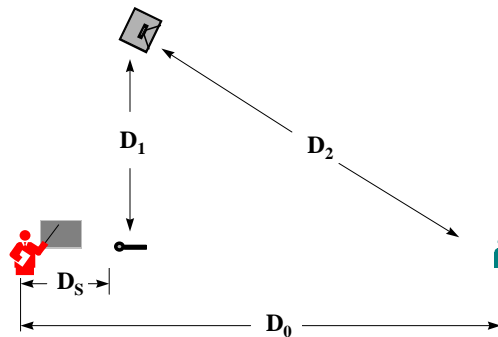
#### 6. Measurement and Evaluation of Ambient Noise Conditions

An adequate signal-to-noise ratio is an essential part of any good sound reproduction system. The competent designer can measure and specify acceptable ambient noise conditions, as well as diagnose sources of excessive noise, such as air conditioner and heating systems. It is important to understand how to use a sound level meter, as well as the differences between the weighting scales. The well-equipped audio professional possesses the instrumentation to quickly measure ambient noise parameters.



#### 7. Achieving Acoustic Gain

A sound system is useless if it goes into feedback before adequate acoustic gain is realized. A system designer should understand the trade-offs between the parameters that determine acoustic gain, and how to make the best compromises to meet the needs of the client.



Of course, there are many others, but if any of these criteria intimidate you, consider seeking the help of a qualified consultant or contractor in the design of your system. The cost of such a service is small compared to the ramifications of purchasing inappropriate equipment or poor installation practices. *pb*