TECHNICAL NOTE # 70: Acoustic Power Vs Electrical Power

Acoustic power, rather than electrical power, is the objective of a sound system. Once this determination is made, the size of power amplifier can be calculated.

For perspective, the relative acoustic power levels are shown in Table I in watts. Note that this data assumes coverage of 100 square feet with the listener located up to 8 feet from a loudspeaker – a condition typically encountered in overhead distributed sound systems.

TABLE I

RELATIVE ACOUSTIC POWER LEVELS

Desired Volume	Acoustic Power
Background Music	.000004 Watts
Normal Speech	.00004 Watts
Loud Speech	.0004 Watts
Loud Music	.004 Watts
Shout	.04 Watts
Very Loud Music	.4 Watts

It is apparent that relatively small increases in acoustic power require relatively large increases in electrical power. To raise the volume level of background music (about .000004 acoustic watts) to the level of loud speech (.0004 acoustic watts) requires electrical power to be increased 100 times!

The electrical power requirements also are effected by the efficiency of the sound source being utilized. Table II gives the safe levels of efficiency which can be assumed in most sound systems. While efficiency can vary from 0.5% for a conventional cone loudspeaker to the 5.0% attainable power from a reentrant horn, the conservative case should be taken when working with less expensive commercial grade speakers.

TABLE II

ASSUMED EFFICIENCY LEVELS

Sound Source	Percentage	Multiplier
Conventional Cone Loudspeaker	0.5%	200x
Horn System with Woofer	1.0%	100x
Sound Column	1.0%	100x
Reentrant Horn	5.0%	20x

In addition to the consideration of the loudness level and the speaker efficiency, it is necessary to build in a factor ("headroom") to allow for system peaks and power losses. Just as a well-engineered automobile has 10 times the horsepower essential to maintain the speed limit in order to permit realistic acceleration to that speed limit, good sound

system design requires a factor of 10 times the calculated electrical power to allow for peak loads and line losses.

To illustrate how electrical power requirements are determined from the desired level of acoustical power, assume an area of 2400 square feet, and a hexagonal pattern with minimum overlap spacing which dictates 26 speakers for coverage.

Since this background music system will incorporate paging, and acoustic power level equal to loud speech must be provided. Table I shows that the power of loud speech is .0004 watt per speaker. Table II shows that the efficiency of the conventional loudspeaker is 0.5%. Therefore, the .0004 watt per speaker must be multiplied by 200 (the reciprocal of 0.5%, or 1.00 divided by .005) to overcome the inefficiency of the sound source. The result is .08 watt per speaker. This value then must be multiplied by the 10x "headroom" factor to arrive at a final electrical power requirement of .8 watt per loudspeaker. To find the desired power for the total sound system, multiply the required electrical power per speaker (.8 watt) times the total number of speakers (26).

This example suggests that the transformer on each speaker should be connected on the one watt tap, and that the maximum total load on the amplifier would be 26 watts. While a 25-watt amplifier would probably suffice, a 30-watt amplifier would be preferred.