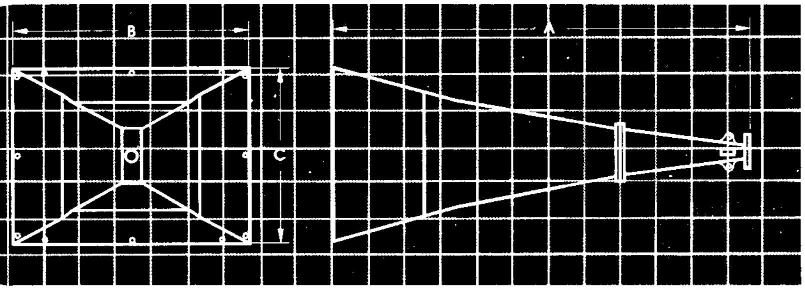

ALTEC ENGINEERING NOTES

TECHNICAL LETTER NO.113

LOSS DUE TO SPEAKER LINES

(IMPORTANT: The appendix contains information that should be understood before the table is used.)

The choice of wire size for loudspeaker lines is determined by an economic balance of the cost of copper against the cost of power lost in the line. The following table gives a considerable amount of information to help solve this problem. Examples are provided to illustrate the use of the tabulation, including the method for determination of cross-talk level when one wire is common to two circuits feeding separate zones.

LENGTH OF 2-WIRE 70vLINE DELIVERING VARIOUS VALUES OF POWER AT 0.5db (12-1/2%) LOSS

Wire Size AWG	Resistance per 1000' Wire pair	Max Safe Current	Max Safe Power	Nominal Power in the load									
				10W	15W	20W	30W	40W	60W	100W	200W	400W	1000W
#6	.8 ohms	50 Amp.	3500W	(Length of Line)				9100	6200	3640	1820	910	360 ft.
#8	1.28	35	2450				7800	5700	3900	2280	1140	570	230 ft.
#10	2.0	25	1750		9900	7300	5000	3700	2500	1450	730	370	150 ft.
#12	3.2	20	1400	9100	6200	4600	3100	2300	1600	910	460	230	90 ft.
#14	5.2	15	1000	5600	3800	2800	1900	1400	950	560	280	140	56 ft.
#16	8.0	6	420	3600	2400	1800	1200	900	600	370	180	90 ft.	
#18	13.0	3	210	2300	1500	1100	750	560	370	230 ft.			
#20	20.6	1	70	1400	960	710	480	350	240	110 ft.			
#22	32.6	.5	35	900	600	450	300 ft.						
	Load Impedance (ohms)			490	327	245	163	122	81	49	24.5	12.2	4.9

For 1 db loss, double all Lengths. For 25-volt line: divide all Lengths by 8, divide Maximum Safe Power by 2.8, and divide Load Impedance by 8.

EXAMPLES:

1. A Line composed of two #14 wires 5600 ft. long can supply 10 watts to the load at 70 v with 0.5 db loss. For a line double this length or double this resistance per 1000 ft., the loss is 1 db.
2. A line composed of two #14 wires has a resistance of 5.2 ohms per 1000 ft. of line, and it is allowed to carry up to 15 amperes (N.E.C.) or, at 70 volts, a power of 1000 watts.
3. The impedance of a load drawing 10 watts from a 70 volt line is 490 ohms.
4. A 1000 foot, 70 volt line is required for a load of 30 watts. Use #16 wire for a loss slightly less than 0.5 db or #18 for approximately 0.6 db loss.
5. 100 watts is to be supplied to a load by a 100 foot line. #22 wire would have little loss, but the Code limits the current in #22 to 0.5 ampere or 35 watts.
6. A pair of #18 wires can supply 200 watts at 70 volts (impedance 24.5 ohms) a distance of 110 feet with 0.5 db loss. The same line at 25 volts (impedance 200 ohms) may be only 14 ft. long for 0.5 db loss, but on safe power basis, the conductors would be overloaded 2.8 times.
7. A 1000 ft., 70 volt line consisting of 3 #16 wires (1 common) supplies power to two 15 watt loads in different zones. The resistance of the common is 4 ohms and each load impedance is 327 ohms. The voltage drop in the common due to one load is 4/327 (roughly .01) of the load voltage. The resulting cross-talk voltage ratio is approximately .01 or -40 db (inaudible).
8. Note that the length of line for 0.5 db loss, in a given conductor size, is inversely proportional to the power. Thus, for #14 wire pair and 100 watts, read 560 ft. from the Table; for 150 watts, dividing this by 1.5 obtain 374 ft.

LITHO IN U.S.A. 282-1M

APPENDIX

The above tabulation shows the length of cable that causes a reduction of power in the load of 0.5 db (12-1/2%). Half of this reduction is actually a line loss. The other half is power not taken from the amplifier because the load at the amplifier is not, for example, 122 ohms (40 w for 70 v), but greater by the line resistance. As an example, consider a 4000 foot pair of #10's, with a total resistance of 8 ohms, and a load intended to be 40 w at 70 v (impedance 122 ohms). The power delivered by the amplifier into its load of 122 plus 8 ohms is 37.7 w, the drop in the line is 4.3 volts, the power lost in the line is 2.3 watts, the voltage at the speaker is 65.7 and the power taken by the speaker is 35 w which is 5 w or 12-1/2% or .5 db less than intended. However, only half of this is actually lost; the rest is simply not taken from the amplifier. An additional load of 2.3 watts may therefore be connected to the amplifier. The following rules apply:

(a) The power in the final load will be 0.5 db (12-1/2%) less than the tabulated values for the lengths tabulated, 1 db or 20% less for double the lengths, 2 db or 37% less for quadruple the lengths, and 3 db or 50% less for 6 times the lengths or for conductors with 6 times the resistance.

(b) One half the above reduction is line loss; the other half is available for additional load. To recover the latter half by adding additional load to the far end of the line, proceed as follows:

No. of times tabulated length	Increase Load Watts nominally	Actual Power Delivered to Load
1	7%	94% or -.3 db
2	15	87 or - .6
3	25	81 - .9
4	35	74 -1.3
5	49	67 1.7
6	65	61 2.1
7	85	54 2.7
8	115	48 3.2

(c) For example, 4000 ft. #10 pair to supply a nominally 40-watt load: Increase the apparent load 7% to 43 watts; then 40 watts are drawn from the amplifier and 37.5 watts are delivered to the speaker. If the line is to be 4 times this length or if the wire is to be 6 sizes smaller (#16), in either case to have 4 times the resistance, increase the apparent load 35% to 54 watts. Then again 40 watts are taken from the amplifier and 30 watts (74%) actually delivered to the speaker, the remainder being lost in the line.