

material. Lagging material of similar characteristics placed on the outside of ducts serves to prevent noise originating outside the ducts being carried inside the ducts and into the air stream.

A case where outside lagging is desirable occurs when ducts originate at the fan in the equipment room and pass through this room on the way to the room being conditioned or ventilated. Unless the ducts are lined some of the mechanical noise from the equipment room air may be transmitted through the wall of the duct, thus reaching the air stream and be carried into the room. In such cases, that portion of the duct which is exposed to the sounds in the equipment room should be lagged with material such as cork, pipe covering or other sound damping material to prevent the sound from entering the duct at this point. Numerical data are not available to permit a simple and practical calculating procedure to determine thickness of covering which should be used for this purpose.

Measurements in one laboratory have shown that the loss through a sheet of No. 22 gage metal is 24 db. When a sheet of rock wool insulation 1 in. thick and weighing 1.4 lb per square foot is added to this, the insulation value is increased to 29 db. In general, however, adding a layer of insulation or pipe covering does not materially increase the sound insulation value unless the material is dense, or unless it is surfaced with another sound impervious layer such as metal or board.

Inside lining material used in the case previously mentioned would serve as an absorber of the sound transmitted through the duct walls, and thus act as a means of preventing the transfer of noise into the air stream.

Inside lining may also be used in ducts to absorb noise which reaches the air stream from equipment such as fans, sprays and coils; noise due to eddying currents set up by elbows, dampers and similar obstructions; and noise transmitted from room to room where there is a common duct system.

To use the lining effectively it must be properly located, well installed and be applied in sufficient quantity to reduce the noise level of the air stream to the level desired.

At present there are no wholly rational or generally recognized methods of calculating the amount of duct lining necessary to accomplish a given reduction of noise level in the air traveling in a duct system; consequently some empirical method has to be used.

Perhaps the commonest *rule of thumb* is that a length of duct should be lined which is equivalent to 10 to 15 diameters. If the duct is square, this may be interpreted to mean 10 times the average dimension. Tests have shown that this amount of lining will usually suffice to eliminate the majority of the high frequency noise which is prevalent. Since this is the more objectionable component of the noise, and since much of the low frequency noise is usually eliminated in passing through any extended supply system, this procedure is usually satisfactory except in severe conditions. It should be noted that the lining should be installed at or near the outlet, in order to effectively reduce all sounds which may be generated in the system up to this point. A more complete method of determining the necessary length of lining material has been described and is available for detailed reference⁴. Another empirical method uses

⁴The Nature of Noise in Ventilating Systems and Methods for its Elimination, by J. S. Parkinson (A.S.H.V.E. JOURNAL SECTION, Heating, Piping and Air Conditioning, March 1937, p. 183).

a *duct lining factor* evaluated by experience. Attention is specifically called to its empirical nature and to the necessity of exercising judgment in applying it.

Use of Duct Lining Factor

A duct lining factor (*f*) giving numerical values for use at various equipment noise levels is shown in Fig. 2. When properly used with Table 1 this chart (Fig. 2) provides a solution which may be both useful and simple. It is important to understand that the levels referred to in this chart are the *average* noise levels set up in the room by the ventilating

Duct lining factor <i>f</i>	Equipment		
	Noisy	Average	Quiet
0	75	65	55
5	65	55	45
10	55	45	35
15	45	35	25
20	35	25	15
25	25	15	5
30	15	5	-5

FIG. 2. CHART FOR DETERMINING NOISE REDUCTION IN DECIBELS FROM DUCT LINING FACTOR^a

^aValues for equipment noise are only general. Wherever possible substitute actual values as supplied by equipment manufacturer or as measured.

or air conditioning equipment. In the case of a piece of equipment which generates a noise level of 95 db, when the noise is measured immediately next to the machine, there might be a reduction of 15 db in passing through the duct, and a further difference of 15 db between the noise at the outlet supply grille and the average level in the room, leaving an effective level of 65 db in the room. Reductions of noise level ranging from 5 to 25 db through duct systems have been encountered without the use of sound absorbing linings and the drop from supply opening to average room level may vary from 5 to 20 db.

To determine whether to use column 1, 2, or 3 in Fig. 2, in forming an estimate of the relative amount of noise generated by the system, the