

confined to a channel or duct, the intensity values are averaged over the cross-section.

Transmission Loss TL is ten times the logarithm to the base ten of the sound energy incident on an obstruction in an acoustic path to the sound energy that is transmitted through the obstruction. The unit is the decibel.

Noise Reduction NR is the difference in decibels of the sound pressure levels at two points along an acoustic path in the direction away from the source; alternatively, it is the difference in decibels of the sound pressure levels existing at a single point before and after the addition of acoustic treatment to the path.

APPARATUS FOR MEASURING SOUND

The measurement of sound or noise is usually accomplished by means of (a) a sound level meter SLM consisting of a microphone, an amplifier, a variable attenuator, weighting networks, and an indicating meter which reads directly in decibels, and (b) an octave band analyzer OBA which is a set of filters for determining the sound pressure level of the sound being measured in each of eight octave-frequency bands. The approved sound level meter and octave band analyzer should comply with the specifications in the latest version of the American Standard Sound Level Meters for Measurement of Noise and Other Sounds, Z24.3-1944, and American Standard Specifications for an Octave-Band Filter Set for the Analysis of Noise and Other Sounds, Z24.10-1953, published by the *American Standards Association*.

The SLM is designed to indicate either the sound pressure level L_p or the sound level (if weighting networks are used) above the standard reference level of 0.0002 microbar. The SLM itself has three weighting networks, which are approximations to the equal loudness contours for pure tone sounds of three discrete loudness levels. The equal loudness contours give the L_p of a 1000 cps pure tone that sounds equally as loud to the average listener as the tone whose loudness level is desired.²

Unfortunately, standard sound level meters do not give an indication of the loudness of more complex noises. To serve as a basis for determining the loudness of more complex noises, measurements of complex sounds are taken on the flat scale (C scale) of the SLM using the OBA to determine the distribution of the sound pressure level as a function of frequency. Computations of loudness and loudness level are made from these data.

Allowable deviations in response and acceptable tolerances recognized in the standard for the sound level meter vary from ± 2 db in the 1000 cps range to ± 5 db, or more, below 100 cps and above 1200 cps. Calibration of the SLM and OBA should preferably be made before, during and after each use by a calibrated loudspeaker.² In turn, the loudspeaker should be calibrated at the factory at frequent intervals. Instructions and precautions in the use of sound level meters are given in Reference 2.

APPROACHES TO THE GENERAL PROBLEM OF NOISE CONTROL

It is usually necessary to think of noise control problems as composed of three parts: (1) the source, (2) the path, (3) the receiver.

It is sometimes possible to reduce the noise at any or all of these parts. However, in construction design, the engineer is usually able to do something only with the path.

The source may be any piece of equipment or person generating audible noises. The transmission path may be a path directly through air or may

be a path which includes solid structure such as walls, floors, pipes, duct walls or air within ducts in various combinations. The receiver is usually a person who might be disturbed by the noise; however, the receiver might also be a delicate machine or manufacturing process that must be isolated from vibration.

The acoustic output of a source is ideally specified by its total sound power level and the sound power level in each of a group of frequency bands, preferably octave frequency bands. Where the source is not confined to a duct or the like, it may also be necessary to specify the source directivity, i.e., the relative amount of sound radiating in each direction of interest. In general, the specification of the acoustic output of a source by a single number is not adequate for engineering design of noise control measures. The sound power outputs of fans and grilles as noise sources are discussed in later sections.

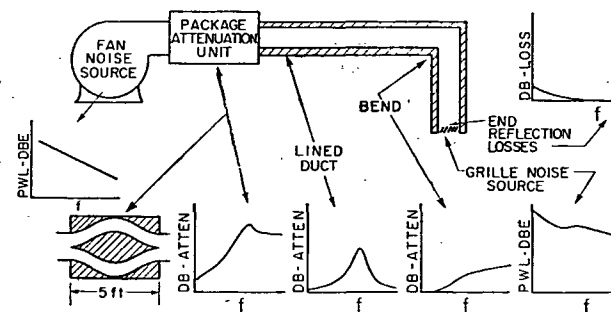


FIG. 1. TYPICAL VENTILATION SYSTEM PROBLEM.

Acoustic losses along a path from source to receiver normally exist in any building structure. These losses are a function of frequency and can be defined adequately when expressed as losses in each of eight octave bands. Losses for common structures, and for ducts of various sizes and shapes, as well as for some packaged sound attenuation devices, are published. Some values particularly applicable to ventilating problems are given in a later section.

The response of a person as a receiver has been determined under certain conditions. Noise levels which are found acceptable to the average person under specified conditions are called *noise criteria*. Several frequently used noise criteria are summarized in a later section. The noise criteria to be used must be chosen with regard to the type of activity to be carried on in the space being considered. Where delicate machines or manufacturing processes are the receiver, special noise criteria must be determined to fit the need. Noise criteria should best be specified as sound pressure levels in octave frequency bands.

A good procedure for attacking a noise control problem in a ventilating system will be illustrated by reference to Fig. 1. The sound power level of the fan is expressed in db. Sound attenuation in the duct is composed of losses in the unlined and lined portions of the duct, losses at the bend, and end reflection losses. Added attenuation of the fan noise is achieved