APPARATUS FOR MEASURING NOISE

Since the relative loudness to the ear, rather than the actual physical intensity, is the quantity in which engineers are usually interested, it has been found necessary to allow for the varying response of the ear at different frequencies in designing noise measuring equipment. It is most satisfactory to measure noise by means of a sound level meter, which usually consists of a microphone, a high gain audio-amplifier, and a rectifying milliammeter which will read directly in decibels. This meter is calibrated to give readings above the standard reference level and usually contains a weighting network to make it less sensitive at those frequencies where the ear is less sensitive. Three types of weighting networks may be provided. The "A" network is intended to provide relative frequency sensitivity corresponding to the characteristics of the ear at a loudness level of 40 decibels. The "B" network is weighted to correspond to the ear characteristic at a loudness level of 70 decibels. The meter may also be provided with a "flat" network which provides no weighting by frequency. For complete details on standards for sound level meters, refer to the information[2] published by the *American Standards Association.*

GENERAL PROBLEM OF SOUND CONTROL

As previously stated, the problem confronting the air conditioning engineer is that of designing a system which will operate without increasing the noise level in the conditioned space. To be sure that this is accomplished, it is necessary:

1. To determine the noise level existing without the equipment.
2. To ascertain the noise level which would exist if the equipment were installed without sound control.
3. To provide as a part of the installation sufficient sound control appliances to reduce the noise level substantially to that found in Item 1.

To accomplish this the engineer should have information of three kinds:

1. A knowledge of the noise levels currently considered acceptable in various rooms in order that he may have a basis on which to proceed.
2. A knowledge of the nature and intensity of the noise created by the various parts of the equipment.
3. A knowledge of how, when necessary, to vary and control the noise level between the equipment and the conditioned space.

In addition, the engineer should have sufficient information to predict the levels produced by noises which may be transmitted by the duct system from one conditioned space to another or from an outside space to the conditioned space. In either case, the designer must know the probable noise level at the point where the noise originates. From this he can compute the attenuation or transmission loss required in order to bring this level down to that required in the conditioned space. If there is likelihood of direct transmission through a duct, the attenuation required may be computed as shown on page 771. If the transmission is through dividing walls, it will be necessary to refer to published information on the transmission losses of standard building constructions[3].

Information concerning the noise levels created by ventilating and air conditioning equipment such as fans, motors, air washers, and similar items is not yet on a basis which permits tabular presentation, although certain manufacturers are prepared to offer such data and do state the noise producing properties of their products. A sound test code for fans has been developed by the *National Association of Fan Manufacturers* which uses the flat response network of the sound level meter. However, when determining the noise generated by an air distribution system, it is customary to use the noise level of the fan as determined by the weighting network most nearly approaching the noise level of the space. In most cases this will be the noise level of the fan as determined on the 40 decibel weighting network. Refer to Table 1 for typical noise levels.

KINDS OF NOISE

To solve a sound problem of this type it is desirable to consider separately the several means by which noise reaches the room. This avoids to some extent the necessity of knowing the noise level at the source, and instead, places the emphasis on ascertaining the level at the point where the sound enters the room.

The noise introduced into a room or building by ventilating or air conditioning equipment may be divided into two general kinds depending on how it reaches the room with various sub-divisions:

1. Noise transmitted through the ducts.
   a. From equipment such as sprays, fans, etc.
   b. From outside, and transmitted through duct walls into air stream.
   c. From air currents, including eddying noises.
   d. Cross talk and cross noises between rooms connected by the same duct system.
   e. Noise produced by the grilles.
2. Noise transmitted through the building construction.
   a. From machine mountings as vibration.
   b. From equipment through room wall surfaces.

The next step in the solution of this problem is to present data and discuss methods whereby solutions to the noise problem can be obtained when the allowable room noise level and the path through which the noise reaches the room are known.

NOISE TRANSMITTED THROUGH DUCTS

Operation of an air distribution system results in the generation of noise which may be transmitted through the ducts to the ventilated or conditioned room. The transmission of this noise may be controlled by the proper application of sound absorptive material within the ducts. The application of the absorptive material is a problem in balancing the room noise level requirements against the intensity of the noise generated. The four steps in the problem are:

1. Determination of acceptable room noise level resulting from the operation of the equipment.
2. Determination of noise level generated by the equipment.

The difference between items 1 and 2 in decibels is the over-all noise reduction required between the equipment and the room. In the discussion which follows reduction of noise will be referred to as *attenuation* of noise.

3. Determination of the natural attenuation of the duct system.
4. Selection of the proper sound treatment for the duct system.

The difference in decibels between the over-all attenuation required and the natural attenuation (3) is the additional sound attenuation to be provided by absorptive materials installed in the duct system or by special constructions designed to absorb sound. Experience has shown, for example, that where ventilating requirements permit, introduction of an expansion chamber or a change in area in the duct will frequently provide more reduction in low frequency noise.