this reference threshold is 10^{-10} watts. In a similar manner, when sound measurements are given in actual intensity or energy units, they can be converted to decibels by this relation.

Since the decibel is a ratio, it can only be employed when related to a reference threshold level as given. Noise levels, which vary with frequency as well as intensity, must not only be related to this reference threshold level, but also to a reference frequency, which is taken as 1000 cycles. These terms and procedures may be found in Tentative Standards[1] published by the *American Standards Association.*

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 sensitivity of the ear at different frequencies in designing noise measuring equipment. The most satisfactory method of measuring noise is 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 threshold of audibility and usually contains a weighing network to make it less sensitive at those frequencies where the ear is less sensitive. For complete specifications relative to the approved type of sound level meters refer to the information[2] published by the *American Standards Association.*

GENERAL PROBLEM OF SOUND CONTROL

As previously stated, the function of the ventilating and air conditioning engineer is to add no acoustical hazard to the conditions already present in the room or building and the problem can be stated as:

a. To determine the noise level existing without the equipment.

b. To ascertain the noise level which would exist if the equipment were installed without sound control.

c. To provide as a part of the installation sufficient sound control appliances to reduce the noise level substantially to that found in (*a*).

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 information available to deal with noises which may enter the room due to openings made into it to accommodate the equipment, such as cross talk between rooms connected with common ducts and noise transmitted to portions of duct system outside the conditioned space and through to its interior.

While the general problem may be logically outlined and the items of knowledge necessary to its solution can be listed, the available information at present is lacking in certain respects. However, attention may be directed to that information which is currently available, and to furthermore outline a solution of the noise problem based on these data.

[1]American Tentative Standards for Noise Measurement, *American Standards Association.*

[2]American Tentative Standards for Sound Level Meters for Measurement of Noise and Other Sounds, *American Standards Association.*

ACCEPTABLE NOISE LEVELS

Measurements of noise levels have been observed by several investigators in various rooms and locations. The information compiled in Table 1 is based on these data, which represent the best opinion on the subject now available. All levels are given in decibels above a reference threshold of 10^{-16} watts (corresponding to a pressure of 0.0002—dynes per square centimeter). Minimum, representative, and maximum levels are given for each application. These values are intended to indicate the variation which may be expected in different locations of the same type, but not the time variation which may be expected in each location.

TABLE 1. TYPICAL NOISE LEVELS

Rooms	Noise Level in Decibels to be Anticipated		
	Min.	Representative	Max.
Sound Film Studios	10	14	20
Radio Broadcasting Studios	10	14	20
Planetarium	15	20	25
Residence, Apartments, etc.	25	35	40
Theatres, Legitimate	25	30	35
Theatres, Motion Picture	30	35	40
Auditoriums, Concert Halls, etc.	25	30	40
Churches	25	30	35
Executive Offices, Acoustically Treated Private Offices	25	33	40
Private Offices, Acoustically Untreated	35	45	50
General Offices	45	55	60
Hospitals	25	40	55
Class Rooms	30	35	45
Libraries, Museums, Art Galleries	30	40	45
Public Buildings, Court Houses, Post Offices, etc.	45	55	60
Small Stores	40	50	60
Upper Floors Department Stores	40	50	55
Stores, General, Including Main Floor Dept. Stores	50	60	70
Hotel Dining Rooms	40	50	60
Restaurants and Cafeterias	50	60	70
Banking Rooms	50	55	60
Factories	60	70	80
Office Machine Rooms	60	70	80
Vehicles			
Railroad Coach	60[a]	70	80
Pullman Car	55[a]	65	75
Automobile	50	65	80
Vehicular Tunnel	75	85	95
Airplane	80	85	100

[a]For train standing in station a level of about 45 db is the maximum which can ordinarily be tolerated.

The values shown in Table 1 are typical of those found currently in