DESIGN ROOM NOISE LEVEL

Measurements of noise levels have been observed by several investigators in various rooms and locations and are listed in Table 1. The values given were determined with the air conditioning or ventilation equipment not in operation, and with all windows and doors closed simulating the conditions of an actual installation.

This is an important consideration, for in offices or stores adjacent to busy thoroughfares the difference between the typical noise level in the space with the windows and doors open and closed may be as high as 10 db. Minimum, representative, and maximum levels are given for each type of space. The values are intended to give the variation with respect to location and not to time, and may be roughly classified by the following:

TABLE 1. TYPICAL NOISE LEVELS[a]

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.	33	40	48
Theaters, Legitimate	25	30	35
Theaters, Motion Picture	30	35	40
Auditoriums, Concert Halls, etc.	25	30	40
Churches	25	30	35
Executive Offices, Acoustically Treated Private Offices	30	38	45
Private Offices, Acoustically Untreated	35	43	50
General Offices	50	60	70
Hospitals	25	40	55
Class Rooms	30	35	45
Libraries, Museums, Art Galleries	30	40	45
Public Buildings, Post Offices, etc.	45	55	60
Court Rooms	30	35	45
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	65	77	90
Office Machine Rooms	60	70	80
Vehicles			
Railroad Coach	60[b]	70	80
Pullman Car	55[b]	65	75
Automobile	50	65	80
Vehicular Tunnel	75	85	95
Airplane	75	80	90

[a]These values are tentative. More detailed measurements by D. F. Seacord, Bell Telephone Laboratories (*Journal Acoustical Society of America*, Vol. 12, pp. 183-187, 1940) give average values and standard deviations of room noise in residences, offices, stores, factories, etc., in large American cities.

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

Minimum loudness refers to: Spaces of expensive construction, typified by double windows, carpeted floors, heavy upholstered furniture, or acoustically treated walls and ceilings.

Representative loudness refers to: Spaces of average construction and furnishings which are exposed to external noises typical of the locality in which the space is usually found.

Maximum loudness refers to: (1) Any space of inexpensive construction, and bare furnishings where noise is not an important factor. (2) Spaces in close proximity to very intense street traffic or to intense factory noise.

In general, if the noise level in the space resulting only from the operation of the air conditioning equipment is equivalent to or less than the typical level given in Table 1, the installation will prove satisfactory. If the typical level and the equipment level are equal and heard together the resultant level will be 3 db higher than either of them alone.

In some cases it is desirable to keep the equipment noise level in the ventilated or conditioned room at such a value that it actually will not increase the noise level in the room to any measureable degree. This can be accomplished if the equipment noise at the room can be kept 10 db below the noise levels shown in Table 1.

NOISE GENERATED BY FANS

Noise generated by fan wheels may be divided into two classifications, rotational noise and vortex noise. In ventilation and air conditioning work, where the maximum ratio between the fan tip speed and the velocity of sound is not greater than 0.12, vortex noise is by far the most important. The rotational noise may be described as that due to the thrust and torque applied to the air. Vortex noise is that due to the shedding of vortices from the blade and is dependent on the angle of attack, velocity, air turbulence, and blade shape. Vortex noise is due to pressure variations on the blade as a result of variations of air circulation. Given the noise level at the outlet or inlet of one type of fan construction under specific conditions of size, tip speed, and total pressure, noise levels at other values of tip speed, total pressure, and size may be approximated by the relationships:

1. For constant size and point of rating, the noise level of a fan will increase with increasing speed.

$$db \text{ (change)} = 55 \log_{10}\left(\frac{RPM_2}{RPM_1}\right) \quad (1)$$

2. For constant pressure and tip speed, the noise level of a given type of fan will increase with increasing fan size.

$$db \text{ (change)} = 20 \log_{10}\left(\frac{\text{Size}_2}{\text{Size}_1}\right) \quad (2)$$

Fan size refers to wheel diameter, housing height or some dimension that is directly proportional to lineal units. Fan sizes based on arbitrary systems or systems of preferred numbers have no significance.

The noise of a given fan is not constant at constant speed if the air delivery changes due to change of resistance. In general, a backward curved blade fan is lowest in noise at or near the point of maximum efficiency; a forward curved blade fan at or between the point of maximum efficiency and shut-off; an axial flow fan at or between the point of maximum efficiency and free delivery. The noise level of a double width fan

TABLE 2. ATTENUATION IN STRAIGHT SHEET METAL DUCT RUNS

Duct	Size, In.	Attenuation per Ft, db
Small	6 x 6	0.10
Medium	24 x 24	0.05
Large	72 x 72	0.01