

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

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.

$$db \text{ (change)} = 20 \log_{10} \left(\frac{Size_2}{Size_1} \right) \quad (2)$$

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 3. ATTENUATION OF ELBOWS^a

ELBOW	SIZE, IN. ^b	ATTENUATION PER ELBOW, db
Very small.....	2 wide	3
Small.....	3 to 15	2
Medium.....	15 to 36	1.5
Large.....	36 plus	1

^aThe attenuation in vane elbows should be considered the same as in elbows having the same dimensions as the radius of curvature of the vanes. If the vanes are lined for the purpose of damping any vibrations in them, one third may be added to the attenuation values listed.

^bThese attenuation values are based on elbows having a center line radius 1.5 to 2 times the diameter or width of the duct. The attenuation will be greater if the ratio is less than 1.5 and less when the ratio is greater than 2.

may be taken as 3 db higher than a similar single width fan operating under the same conditions of speed and pressure.

NATURAL ATTENUATION OF DUCT SYSTEM

Straight Sheet Metal Ducts. The attenuation of sound in straight sheet metal ducts is a function of the length, shape, and size of the duct*. Attenuation values are given in Table 2. In general, this attenuation is so negligible except for long runs that it may be disregarded for all practical purposes.

Elbows and Transformations. Due to reflective interference, attenuation will take place at elbows and transformations. The magnitude of the attenuation will depend on the size and abruptness of the elbow or transformation as shown in Table 3.

When the area of a duct increases abruptly, an attenuation of noise level takes place in the duct. In duct design practice the total area of the branch ducts is greater than the supply duct. Similarly with outlets,

TABLE 4. ATTENUATION AT DUCT BRANCHES OR OUTLETS

BRANCH DUCT + OUTLET AREA SUPPLY DUCT AREA	RATIO OR SUM OF BRANCH AREAS SUPPLY DUCT AREA	ATTENUATION PER TRANSFORMATION, db
	1.00	0.0
	1.20	0.8
	1.35	1.3
	1.50	1.8
	1.75	2.5
	2.00	3.0

the area of the outlet plus the area of the duct after the outlet is greater than the duct area before the outlet. Therefore in an outlet run, attenuation occurs in the duct as it passes each outlet. Table 4 gives the db reduction for various ratios of total branch duct and outlet area to supply duct area.

Grilles to Room. The large abrupt change in area between the grilles and the surfaces within a room results in an appreciable noise attenuation. This attenuation is a function of the total grille area (supply and return) and the total sound absorption of the room in *sabines*. (The sound absorption of a room in *sabines* is the summation of the products of each surface of the room measured in square feet multiplied by its corresponding absorption coefficient). The attenuation is given in Equation 3 as:

$$db \text{ (Attenuation between grilles and room)} = 10 \log_{10} \frac{\text{Total Room Absorption in Sabines}}{\text{Total Grille Area}} \quad (3)$$

Values in Table 5 approximate the attenuation for various rates of air change, and general types of room surfaces.

DUCT SOUND ABSORBERS

The difference between the required sound attenuation and the natural attenuation is that which must be supplied by the proper sound treatment of the ducts.

*A.S.H.V.E. RESEARCH REPORT No. 1205—Determining Sound Attenuation in Air Conditioning Systems, by D. A. Wilbur and R. F. Simons (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 267).