fan is 69 db, 4 db higher than the value used in Equation 20. It is on the edge of the stated limit of approximation ± 4 db.

Approximate Octave Band Spectrum

Within about ±4 db approximation, and assuming no turbulence in the duct or the coupling between it and the fan, the octave band spectrum for a centrifugal fan, relative to the overall sound power level is given in Fig. 6.

Limited data on vaneaxial fans, indicate that the overall power level is about the same as that for centrifugal fans, but what the spectrum has a shape something like that shown in Fig. 6.

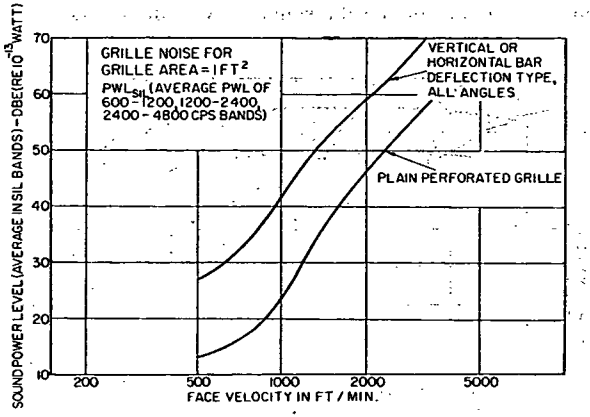

FIG. 7. GRILLE NOISE FOR A GRILLE AREA OF ONE SQUARE FOOT

The noise is expressed as the sound power level in dbe in each of the three speech interference bands (PWL_{SIL}).

NOISE GENERATED BY GRILLES

The subject of grille noise has not been covered thoroughly in the literature. The information given in this chapter has been taken from the advertising literature of several grille manufacturers and from recent experiments at the *Massachusetts Institute of Technology*.

In general, grille noise at the lower frequencies is dependent primarily on the size and shape of the grille opening, on the mass flow per minute, and on the temperature of the air. At the higher frequencies, the noise is determined primarily by the area of the grille, the velocity of air through the free (open) areas (not the core or nominal area), and the pressure drop across the grille.

For two simple types of grille, stamped and deflector vane, power levels are given in Fig. 7. These power levels are given in terms of the speech interference level, PWL_{SIL}. Conversion to the speech interference level in db in the room at a listener's position is described in the next section on Determination of Room Levels. In the absence of more complete information, it may be assumed that the power levels of the noise produced by the grilles themselves at low frequencies are inconsequential.

TABLE 2. EVALUATION OF EQUATION 21

A SQ FT	DECIBEL ADDITION	A SQ FT	DECIBEL ADDITION	A SQ FT	DECIBEL ADDITION
0.5	−3	8	9	70	18
1	0	16	12	100	20
2	3	20	13	200	23
4	6	40	16	400	26

Fig. 7 is for a grille core area of 1 sq ft. Correction to other areas of grille is made by the equation:

$$\text{Decibel addition} = 10 \log_{10} A \text{ db} \qquad (21)$$

where

A = core area, square ft.

Values of the decibel addition for various values of A are given in Table 2.

Example 2: Assume a deflector vane type of grille with a core area of 2 sq ft. Determine the sound power level in the speech interference bands for an air velocity of 2000 fpm.

Solution: From Fig. 7, the PWL_{SIL} for a 1 sq ft deflection grille is 59 dbe. From Table 2, an addition of 3 more dbe is required, so that PWL_{SIL} = 62 dbe.

NOISE GENERATED BY OTHER SOURCES

Objectionable noise may be produced by fan motors, pumps, compressors, etc. The designer must give attention to these sources of noise. It is not possible to predict the noise, because units from different manufacturers differ greatly in the noise produced.

Objectionable noise is also generated in the duct system by excessive air velocity or poor duct fittings. No systematically taken data have been published from which conclusions can be drawn. The reader is referred to Chapter 31 Air Duct Design for good design practice.

SOUND ATTENUATION IN DUCTS

Unlined Straight Sheet Metal Ducts[8]

The attenuation of sound in straight sheet metal ducts is a function of the length, shape and size of the duct. Typical attenuation values are given in Table 3.

Branches

At a junction where a duct divides or has side branches or outlets, the sound power traveling down the duct divides.

The decibel reduction in sound power from the main duct to any branch may be calculated as 10 $\log_{10}$ of the ratio of the branch area to the total

TABLE 3. APPROXIMATE ATTENUATION IN STRAIGHT SHEET METAL DUCT RUNS IN DECIBELS PER FOOT

DUCT	SIZE, INCHES	ALL FREQUENCIES
Small	6 × 6	0.1
Medium	24 × 24	0.05
Large	72 × 72	0.01