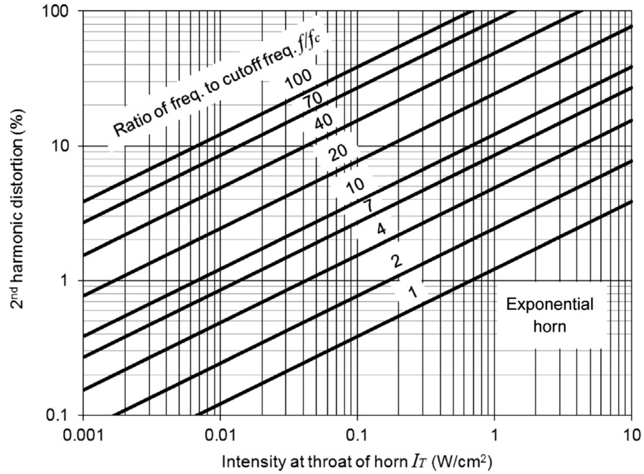

FIG. 9.13 Percentage second-harmonic distortion in an exponential born as a function of the intensity at the horn throat with the ratio of the frequency to the cutoff frequency as parameter.

For an infinitely long exponential horn, at normal atmospheric pressure and temperature, the equation for the total distortion introduced into a wave that starts off sinusoidally at the throat is

$$\text{Per cent second-harmonic distortion} = 1.22\frac{f}{f_c}\sqrt{I_T} \times 10^{-2} \tag{9.87}$$

where

f is driving frequency in Hz.
f_c is cutoff frequency in Hz.
I_T is intensity in W/m^2 at the throat of the horn

Equation (9.87) is shown plotted in Fig. 9.13. Actually, this equation is nearly correct for finite horns because most of the distortion occurs near the throat.

Equation (9.87) reveals that, for minimum distortion, the cutoff frequency f_c should be as large as possible, which in turn means as large a flare constant as possible. In other words, the horn should flare out rapidly in order to reduce the intensity rapidly as one travels along the horn toward the mouth.

Unfortunately, a high cutoff frequency is not a feasible solution for horns that are designed to operate over a wide frequency range. In this case, it is necessary to operate the horn at low power at the higher frequencies if the distortion is to be low at these frequencies. This goal is achieved automatically to some extent in reproducing speech and music, because above 1000 Hz the intensity for these sounds decreases by about a factor of 10 for each doubling of frequency.