inter-noise 96
25th Anniversary Congress – Liverpool

INCE: 23.1

COMMENTS ON ISO 9613-2

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1. INTRODUCTION

In the second half of this year the new ISO 9613-2 [1] concerning outdoor noise propagation will be published. This standard aims to predict the sound levels in octave bands under downwind propagation. This paper focuses on the discontinuities due to attenuation by screens, as the most controversial part of the ISO 9613-2.

2. ATTENUATION BY SCREENS

The screening attenuation is given by the following formulas:

$$D_z = 10\log\left(3 + \frac{20}{\lambda}.C_3.z.K_w\right) \geq 0 \quad e = 0: D_z \leq 20\text{ dB};\ e > 0: D_z \leq 25\text{ dB} \qquad 1$$

$$C_3 = \frac{1 + \left(\frac{5\lambda}{e}\right)^2}{\frac{1}{3} + \left(\frac{5\lambda}{e}\right)^2} \text{ for } e > 0 \qquad e = 0: C_3 = 1 \qquad 2$$

$$K_w = \exp\left(-\frac{1}{2000}\sqrt{\frac{d_{ss}d_{sr}d}{2z}}\right) \quad \text{for } z > 0 \qquad z \leq 0: K_w = 1 \qquad 3$$

with	e	the distance between the tops of two most effective screens	[m]
	λ	the wavelength	[m]
	z	the path length difference	[m]
	d_{ss}	distance source-screen	[m]
	d_{sr}	distance screen-receiver	[m]

K_w stands for correction of the meteorological conditions.
In the following we will only investigate the effects of one or two infinite long screens, perpendicular to the line from source to receiver. In Fig. 1 the situation is given with the names of the relevant parameters.

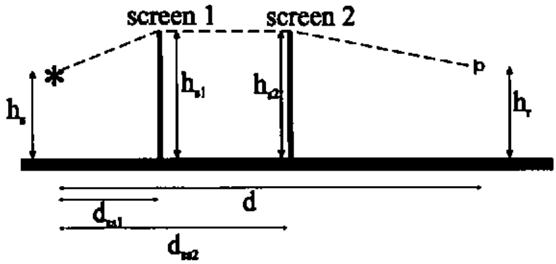

Fig. 1: All variables for screening attenuation

Single diffraction
The effect of altering the height of one screen is given in Fig. 2. Note that even when the straight line from source to receiver is not interrupted by the screen, some attenuation occurs.
According to formula 2 the effect of a screen that lies in the line of sight, will never be less than 4.8 dB [2]. This is due to the fact that the ISO standard does not take a curved radius into account for the calculation of z: if z is almost zero, K_w has hardly any influence.

Double diffraction
For investigation of the double diffraction, the following method is used:

the first screen is increased in height from 0 to 15 m, while the second screen remains at a height of 5 m.

It will be clear that at a height of 0 m the first screen will have no effect and at a height of 15 m the second screen will have no effect. For these two limits only a single screen calculation will do. Somewhere between these limits a change must be made from single to double diffraction. We have chosen for a single diffraction when the line of sight of the source - highest screen - receiver does not intersect with another screen. When this is not the case a calculation with double diffraction applies. These changes between single and double diffraction causes sharp discontinuities of about 5 dB and unwanted results, as can be seen Fig. 3: reducing the screen height of one screen increases the attenuation.
Increasing the distance between screens with the same height will give a continuous transition from single diffraction to double diffraction. When the heights of the two screens differ, again discontinuities will occur.

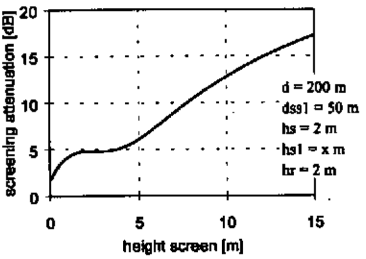

Fig. 2: Screening attenuation with one screen with differing height for 500 Hz

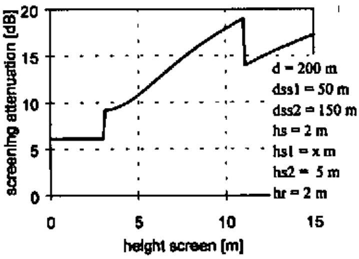

Fig. 3: Screening attenuation for two screens with differing height of first screen for 500 Hz

If we make a small detour and investigate the effect of a high screen of small horizontal dimensions and a large horizontal screen with limited height, the effect of the screening attenuation will be equal to a situation with a high and wide screen, see Fig. 4. This is not realistic.

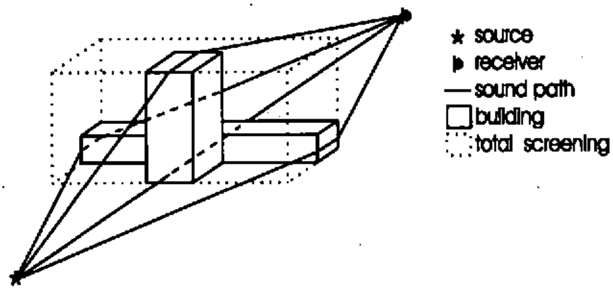

Fig. 4: The selection of a high and a wide screen

Multiple diffraction

The ISO-standard gives the following rule for calculating the effect of multiple diffraction: choose the two most effective screens and then calculate the screening effect by using formula 2. The ISO-standard does not give any means to select the two most effective screens.

First of all, in selecting the most effective screens the left and right detour should be incorporated, or else one cannot compare several screens. The option of selecting the two most effective screens by means of each single screen attenuation may result in selecting the front and backside of the same building, neglecting the effect of the other buildings. A better way is to incorporate the left and right diffraction into a reduced screen height, *R*, as done for instance in the Dutch [3] and Nordic [4] method. The following formula gives the reduction in screen height in order to make it an infinite wide screen:

$$R = h_e\left[1-\frac{1}{1+\frac{h_e}{l_l}+\frac{h_e}{l_r}}\right] \qquad 4$$

with h_e the effective screen height [m]
l the left and right screening length [m]

The effective screen height is the part of the screen above the intersection with the line from source to receiver. On basis of the reduced height (S) and sight lines the most effective screens are distinguished, selecting the screens with the highest elevation angle (Fig. 5).

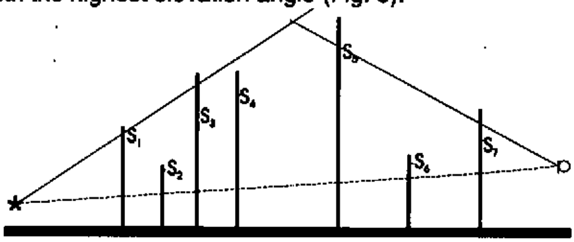

Fig. 5: Selection of the two most effective screens

3. CONCLUSIONS

We appreciate that the ISO has made a noise prediction standard. This will bring a lot of clarity and will especially be of a great help to the countries who do not have such a standard. They can take it as a basic standard and deviate from it to fit their needs. Besides this, the standard can be used independently of local authorities for projects all over the world.

The main problem with ISO 9613-2 lies in calculating the screen attenuation:

- The curved sound path is not correctly incorporated,
- Discontinuities (maximum of 5 dB) arise while changing from single to double diffraction
- The selection for more than two screens is unclear. By using the Dutch/Nordic method, the two most effective screens will be selected.

[1] Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation, ISO, ISO/DIS 9613-2.2 (1994)

[2] Comparison of noise calculation models. Ir P. van Rangelrooij, Ir J. Witte, Ing M.A. Ouwerkerk. Procedings Euronoise '95. (1995)

[3] Guide for measuring and calculating industrial noise (in Dutch), Interdepartementale commissie geluidhinder, IL-HR-13-01 (1981)

[4] Environmental noise from industrial plants. General prediction method (in English), Danish Acoustical Laboratory, Report no. 32 (1982)