The Draft International Standard Method (ISO/DIS 9613-2) for Calculating the Attenuation of Sound during Propagation Outdoors.

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INTRODUCTION - how it came about

The International Standards Organization (ISO) technical committee TC 43 on Acoustics, sub-committee SC1 on Noise, in 1983 voted to form a new working group, WG24, with the objective "to specify methods for determining the attenuation of sound propagating outdoors. This information is necessary for determining sound pressure levels at a distance from a noise source, e.g. an industrial plant, a vehicle or an aircraft." This objective placed the project squarely between two sets of existing ISO standards - those specifying methods for determining the levels of sound power emitted by various sources, such as machinery and specified equipment (the ISO 3740 series) or industrial plants (ISO 8297), and the ISO 1996 series which specifies methods for the description of noise outdoors in community environments.

The response of Working Group 24 over the last 10 years has been to produce a potential standard in two parts, which are really two separate standards, to bridge the gap between these two existing types of standard, - ISO 9613, Acoustics - Attenuation of sound during propagatioon outdoors. Part 1, Calculation of the absorption of sound by the atmosphere, was published in 1993 as an ISO Standard, and Part 2, A general method of calculation, is currently being circulated for approval as a Draft International Standard. Together they enable levels of noise in the community, as described in ISO 1996, to be predicted from a variety of sources of known sound emission.

Now specifically how did these documents come about? Working Group 24 has 14 members from 13 different countries. At the first meeting in 1984 it became clear that a great deal of scientific work in this general direction had been proceeding, relatively independently, inside several countries - usually to back their noise regulations. The work was usually sponsored by the national government, and typically published only in a contract report to that government, usually in the local language, which tends to make it relatively inaccessible and unknown. Working group 24 initially sorted through this work, found much of it was complementary, and made the initial estimate that it could be integrated into the two part ISO document. Fortunately the work of integration had already begun inside individual countries in national documents such as standards and guidelines.

The proposed International Standard is derived mainly from the national documents listed in the references. Ref. 1 is the US contribution - the American National Standard method for the calculation of attenuation of sound due to atmospheric absorption. Part 1 of ISO 9613 is essentially an updated version of ANSI Standard S1.26 of 1978, which has been widely used. Ref. 2 is the "Guidelines" developed by the Netherlands, and ref. 3 the "general prediction method" developed jointly by the Scandinavian countries through their "Nordforsk Project", both for industrial noise. Ref's 4 and 5 are the "Guidelines" developed for the control and regulation of noise in Germany by the VDI, their engineering society. ISO/DIS 9613-2 is mainly an integration of the national methods given in these references 2 to 5.

It should be recognized therefore that the methods given in DIS 9613-2 are backed not only by the scientific and engineering studies given in these references, but also by the practical experience in the prior use of the methods in the country of origin.

SCOPE

ISO/DIS 9613-2 specifies an engineering method for calculating the attenuation of sound propagating outdoors, in order to predict levels of environmental noise in the community at a distance from sources of known sound emission. This method is applicable in practice to a great variety of noise sources and environments, including either directly or indirectly, most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources.

The method aims to determine the average sound level $L_{Aeq,T}$ under meteorological conditions favorable to propagation - that is, moderately downwind propagation, or equivalently, propagation under a well-developed, but moderate, ground-based temperature inversion, such as commonly occurs at night. These conditions are chosen for stable propagation (i.e., accuracy of measurement and prediction), and also to provide an appropriate condition for a specific community noise limit - i.e., a level which is seldom exceeded.

The long-term average sound level $L_{Aeq,LT}$ may also be calculated from the above $L_{Aeq,LT,}$ using a small correction (0 to -5dB) based on elementary local weather statistics. This long-term average will normally cover a variety of weather conditions, as for example in the yearly day-night sound level YDNL.

The method in ISO/DIS 9613-2 consists specifically of octave-band algorithms (with centre frequencies from 63 to 8000 Hz) for calculating the attenuation of sound from a point source, or an assembly of point sources. Specific terms are provided in the algorithms for the following physical effects - geometrical divergence, atmospheric absorption, ground effect, reflection from surfaces, and screening by obstacles. The effect of atmospheric turbulence is included implicitly. Additional information concerning propagation through housing, foliage, and industrial sites is included.

ACCURACY

The estimated accuracy of prediction using the method of DIS 9613-2 for broad-band noise sources is shown in table 1. These figures have been obtained by comparing calculated values with an extensive data-base of measurements. The accuracy for propagation distances d less than 500m is seen to vary somewhat with distance and height of sound path h above the ground. For distances greater than 500m there is insufficient evidence to support an estimate of accuracy.

GROUND EFFECT

For downwind propagation from source S to receiver R the sound paths curve downwards, as shown in Figure 1 (a), and for distances long enough, there are several distinct paths 1,2,3 etc. as indicated. For each path there are a group of closely spaced rays from images I caused by ground reflection, as indicated at (b). Interference between these rays produces the ground effect[6]. For downwind propagation therefore the nature of the ground surface in the vicinity of the source and receiver is of prime importance, and that in between less so. The algorithms of DIS 9613-2 reflect this fact, and allow three surface conditions for each region - hard (asphalt, water, etc.), soft (any ground which will support growth), and mixed.

SCREENING

The attenuation due to screening may be calculated for diffraction over the top of a barrier (which includes a ground effect) or around its sides, as shown in Figure 2. There may be a single diffraction in each sound path when the barrier is thin, as shown in Figure 2, or the barrier may be thick, requiring a double diffraction per path. Thus the attenuation due to screening may be calculated for a variety of shapes of buildings as well as sound barriers.

REFERENCES

1) A.N.S.I.- S1.26 (1978), "American national standard method for the calculation of the absorption of sound by the atmosphere".

2) H.E.A. Brackenhoff et al. "Guidelines for the measurement and prediction of environmental noise from industry" Interdepartmental Commission on Health, Report HR-IL-13-01, Delft (April 1981). (In Dutch)

3) J. Kragh et al, "Environmental Noise from Industrial Plants : General Prediction Method", Danish Acoustical Institute Report No. 32, Lyngby (1982). (In English)

4) Verein Deutscher Ingenieure - Guidelines "Outdoor noise control by means of screening", VDI 2720 part 1 (Draft), February 1991. (In German)

5) Verein Deutscher Ingenieure - Guidelines "Sound propagation outdoors",VDI 2714, (January 1988).(In German)

6) T.F.W. Embleton, G.J. Thiessen and J.E. Piercy, JASA 59, 278 (1976)

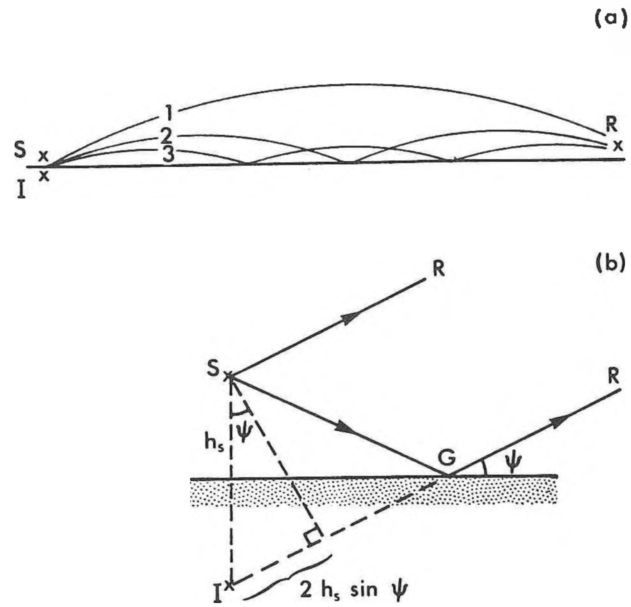

Figure 1. Sound propagation paths downwind

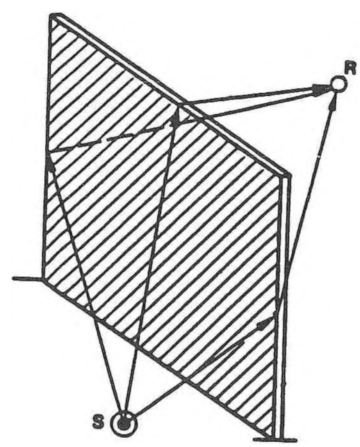

Figure 2. Different sound propagation paths at a screen

Table 1. Accuracy of $L_{Aeq,T}$(downwind)

Distance d	0 to 100m	100 to 1000m
h = 0 to 5 m	± 3 dB	± 3 dB
h = 5 to 30 m	± 1 dB	± 3 dB