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MEASURING TECHNIQUES AND CALCULATION METHODS FOR THE CONTROL OF INDUSTRIAL NOISE

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In 1981, the Dutch Ministry of Public Health and Environment issued a manual, comprising a description of measuring techniques and calculation methods to be used for the control of industrial noise. The so called manual for "measuring and calculating industrial noise" [1], also includes an analytical method for calculation of community noise levels around industrial sites.
One advantage of the manual relative to the already existing models as CONCAWE, OCMA and VDI [2], [3], [4] is, that the manual offers a set of measuring techniques and calculation methods which are completely adjusted to each other. The manual deals only with outdoor noise propagation.

The method starts from the so called immission relevant sound power level of the source, and calculates the excess noise attenuation for a set of well defined meteorological conditions in order to obtain the immission level.

Community noise levels, recorded over a long period of time, spread widely with meteorological conditions as discussed in [5]. Therefore the manual specifies that measurements at far distances from the source are only permitted under certain meteorological conditions, so that results of the calculation of the immission level can directly be compared with the measuring results.
Both levels, calculated and measured, are "down wind levels". They are the highest community noise levels that occur.
The manual also defines the so-called meteo-correction term, to be substracted from the down wind level to obtain a long-term equivalent level.

The so called immission relevant sound power level is determined from measurements. The emission measuring methods are similar to the well known methods but the immission relevant sound power level is calculated from the measured sound pressure levels measured in the direction towards the receiver. Figure 1 illustrates this point. In a large industrial plant the sound emission in vertical direction is greater than in horizontal direction.

FIG. 1

IMMISSION RELEVANT SOUND POWER LEVEL L_{WR}, MEASURED IN DIRECTION TOWARD TO THE RECEIVER.

This is due to the fact that scattering and screening within the plant causes the sound to go upwards and less sound to go towards the receiver. This quantity is in the example of figure 1 much smaller than the total sound power level obtained by measuring points on a complete hemisphere.

The manual gives three methods to obtain the so called immission relevant sound power level:

- concentrated source method,
- perimeter method of Stüber,
- enveloping surface method.

The immission relevant sound power levels, obtained with the concentrated source and perimeter method contain the inplant screening factors. Only the enveloping surface method does not include the inplant screening, since emission measurements are done at each individual source.

In this case it turns out to be almost impossible to calculate with any acceptable accuracy, all the effects of screening, scattering and absorption inside an industrial plant. To solve the problem, the following approach has been followed: an empirical inplant screening term is defined for each single noise source. This should be done for every receiver direction under concern. These terms will for instance depent on the length of the sound path through the installation. The manual gives indicative values for these factors.
Then the sum of the sound power levels including these factors of all relevant sources is compared with the immission relevant sound power level of the total plant, as determined by the concentrated source or perimeter method. Finally the inplant screening factors may be adjusted to get the best fit by repeated comparison of these two quantities.
An unwanted manipulation with this method is hardly possible. This is due to the fact that several control points are included. The sum of the sound power of all individual sources should be the same as the immission relevant sound power level obtained by the perimeter method

for each plant section and the concentrated source method for the whole site, and this should hold for several immission points around the plant and for each frequency.

Figure 2 shows a comparison between the immission relevant sound power level, obtained from hundred individual sources with inplant screening and from the concentrated source method.

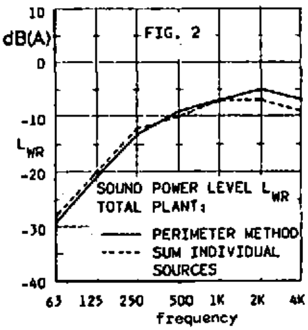


FIG. 2

From the immission relevant sound power level the immission level at a certain distance will be calculated according to the manual. A comparison with the other attenuation models, such as CONCAWE, OCMA and VDI will be made. Comparing the attenuation models, CONCAWE, OCMA and VDI, it can be seen that small differences occur in the four models as far as geometrical attenuation and air absorption are concerned. Substantial differences occur in the approaches to ground effect and to effects. The simplest approach towards ground effects is given by VDI-2714, which uses a frequency-independent, constant attenuation of 2 dB for large distances.

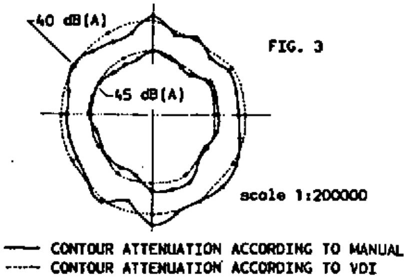
The OCMA-model distinguishes two different situations, which are designated "minimal screening" and "significant screening". The attenuation is frequency dependent.

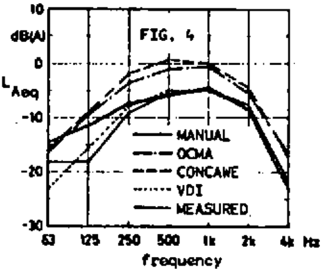
CONCAWE uses a frequency-independent approximation of the OCMA-curves and adds the possibility to adapt the attenuation to other situations. The manual gives an analytical approach to ground effects, which presumes noise propagation under down wind conditions. This indicates the main difference between OCMA and CONCAWE on the one side and VDI and manual on the other:

Inplant scattering and screening form part of the excess attenuation calculation of OCMA and CONCAWE, but not of VDI and the manual. Therefore it is not correct to apply results of the perimeter method or concentrated source method, which already include inplant screening, as an input for OCMA and CONCAWE.

To compare the results of calculated immission levels from the various methods it appears that the long-term average noise level $L_{A,eq}$ is the best basis. However the calculated levels applied to the same situation may vary up to 5 dB. The models of VDI and the Dutch Manual represent a better basis for comparison with measurement, since "neutral weather conditions" as used for CONCAWE hardly ever occur in practice. For comparison with measurements the down wind

levels should, therefore, be adhered to.
Comparison of the attenuation model of the manual with the VDI attenuation model show that both methods approximately give the same results, as can be seen in figure 3. Here a contour of 40 and 45 dB(A) is calculated for both the manual and VDI models, from the same sound power levels.





OCMA and CONCAWE calculate much higher levels, especially when elevated sources are present, as can be seen in figure 4. This is due to the fact that groundattenuation factors in these models become zero with greater hights, and thus also the inplant screening factors. Comparison of measuring results with calculations shows that the manual and VDI give the most reliable results.

References

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