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TESTING THE JOINT NORDIC SYSTEM FOR PREDICTION AND MEASUREMENT OF ENVIRONMENTAL NOISE FROM INDUSTRY

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INTRODUCTION

As a result of a joint Nordic research project a system of methods for prediction and measurement of environmental noise from industry has been established, refs [1]-[2]. One group of methods concerns the determination of noise emission from industrial sources. Another group of methods deals with the calculation of transmission effects while yet another method prescribes instrument specifications and meteorological and other conditions to be fulfilled if reproducible immission measurements are to be performed. Predicted results are useful when planning new industry or changes, or when background noise prevents reliable immission measurements.

This paper describes a project carried out at the Danish Acoustical Institute and sponsored by the Danish National Agency of Environmental Protection. Its aim was to test the applicability of the measurement methods and to check the agreement between predicted and measured immission noise levels. It was not possible to control each emission measurement method or to verify each step in the calculations of transmission effects. Only the overall system performance could be checked.

TEST SITE

As an object for the measurements an asphalt-mixing plant was chosen because of its strong noise emission and its siting in an otherwise quiet and hilly area. The major noise sources were: an oil burner (h = 2 m) and a stack (h = 23 m). Minor noise sources were a pressure blower for the burner, a rotating drying drum, and a vibration sieve.

Nine immission points were chosen in three different directions showing different topology: three near points and six far points above each other two by two. The ground was absorbing between the near and the far points, whereas it was mostly reflecting between the plant and the near points.

IMMISSION MEASUREMENTS

Immission measurements were performed between three and seven times in each point. The measurements in the three points in the same direction were done simultaneously. The mean vector wind 10 m above the ground and the vertical temperature gradient between 0.5 and 10 m above the ground were measured during each noise measurement. The decision to measure was taken on the basis of the most recent weather forecast from a nearby airport, and the wind and cloudiness were observed continuously. The exact weather conditions were unknown till after each measurement. It turned out that some measurements had been performed under conditions slightly outside the allowed meteorological frame, cf. ref. [1]. An example of results from seven repeated measurements over a period of twelve weeks is shown in Fig.1. It is a common trend in all results that the variance is small and no obvious connection exists between weather conditions being slightly "illegal" and measurement results slightly deviating. The variation of $L_{Aeq,10\,min}$ is shown in Table 1.

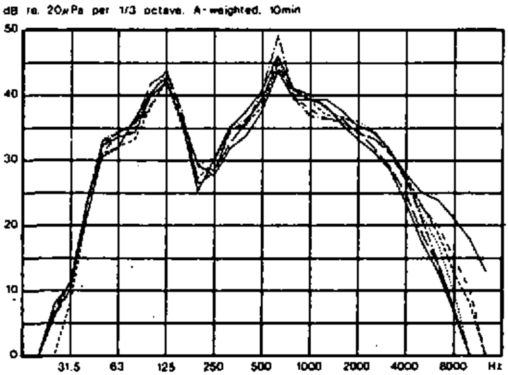

Fig.1 Measurement results in 1/3 octave bands from 7 measurements. Distance = 228 m, mic.height = 1.5 m

Distance [m]	120	238	238	120	334	334	136	228	228
Height [m]	1.5	1.5	4.3	1.5	1.5	4.3	1.5	1.5	4.3
Number of measurements	3	4	4	6	6	6	7	7	7
Conf. limits [dB]	±2.5	±2.9	±1.8	±0.6	±2.2	±1.5	±0.8	±0.6	±0.7

Table 1 90% confidence limits of repeated immission measurements

EMISSION MEASUREMENTS

The emission from the sources was determined using the "general short-distance" method (analogous to ISO 3746). The measurement distance was between 0.3 and 1.5 m depending on the source dimensions and local conditions. Furthermore the emission from the entire plant was measured using four different methods: the "general short-distance" method (22 points, distance 6 m); the method of Stüber (ref.[3], 13 points, average distance 8 m); the "general long-distance" method (8 points, radius 50 m); and the "special large source" method (3 points, radius 26 m). In Fig.2 the sum of the results from the five single-source measurements are shown together with the results from the four total-plant measurements.

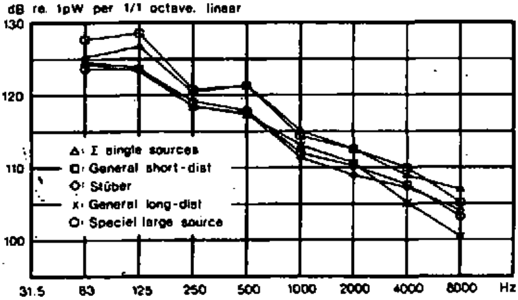

Fig.2 Results of emission measurements

PREDICTION

The noise immission was predicted using the measured emission values and the general prediction method. Prediction was made for each single source. Their contributions were summed to yield the immission level. Prediction was also done for the entire plant considered as one source using each of the four total emission levels and one "equivalent" source height. In these cases screening of the lower sources was not taken into account. Fig. 3 shows one set of predicted results together with the 90% confidence interval from the immission measurements while Table 2 summarizes the L_{Aeq} results.

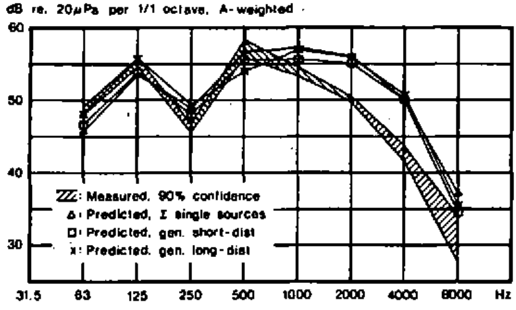

Fig.3 Comparison of prediction and measurement of noise immission (d = 228 m, h = 1.5 m)

Distance [m]	120	238	238	120	334	334	136	228	228
Height [m]	1.5	1.5	4.3	1.5	1.5	4.3	1.5	1.5	4.3
Mean of measurements	63.0	56.4	57.2	67.8	53.9	55.0	65.2	61.2	61.4
Pred. Σ single sources	70	63	65	66	57	59	71	63	65
Pred.gen.short-distance	69	63	64	67	57	59	71	62	64
Pred.gen.long-distance	64	58	59	70	60	62	71	63	64

Table 2 Immission levels, L_{Aeq} [dB re 20 μPa]; energy mean of measured results and predicted values

CONCLUSIONS

The immission measurement method is reasonably operational, and it gave reproducible results. The variance was lower than stated in the method, and hence the claimed number of repeated measurements was too high. The meteorological conditions seem unnecessarily strict for this case.

The "general short-distance" emission measurement method is applicable for small sources, but rather elaborous for large sources. For these Stüber's method seems more operational. In the present case Stüber's method gave results similar to the "general long-distance" and the "special large source" method. Both these were well applicable.

It is impossible to draw any clear conclusion as to the agreement between predicted and measured immission levels. In some points the "general long-distance" method gave predicted levels most concordant with the measured while in other points it gave deviating results. In three points the general agreement was excellent while in others deviations up to 7-8 dB occurred. The agreement was rather good at frequencies below 1 kHz while the predicted levels were about 8 dB higher in the 2 and 4 kHz octave bands. Perhaps this is due to incompleteness in the prediction of ground effect. Screening of the lowest sources occurred in four points, but the "effective screen height" was in all cases negative due to the sound ray curvature. This is believed to underestimate the screening correction and might partly explain the largest deviations between predicted and measured immission levels.

REFERENCES

[1] Kragh, J., "Joint Nordic Research Project on Environmental Noise from Industry". Proc. Inter-Noise 82, p.551-554.

[2] Complete and updated list of references to be obtained from Nordforsk, Box 5103, S-102 43, Stockholm, Sweden.

[3] Stüber, B., "Messmethode zur Ermittlung der Schalleistung ausgedehnter Schallquellen". DAGA 1972, p.241-244. This method is under consideration by ISO to be standardized.