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METHODS USED IN THE FEDERAL REPUBLIC OF GERMANY FOR THE MEASUREMENT AND DESCRIPTION OF COMMUNITY NOISE

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REGULATIONS, STANDARDS AND GUIDELINES

The measurement of community noise concentrates on industrial and construction noise. The regulations /1,2/ specify the noise limits and measuring procedures. The main purpose of the measurements is to check compliance with noise limits for the licensing of industrial installations or to provide data for expertises in court. Exposure to aircraft and traffic noise is mainly calculated from formulas given in the relevant regulations /3,4/. The standardization for which DIN (Deutsches Institut for Normung) is responsible mainly concerns sound measuring instruments and measuring procedures. To promote a uniform description of environmental noise, DIN 45645 part 1 /5/ specifies the rating levels and the reference time intervals to be used. The measurement technique is identical for the outdoor and indoor measurement of community noise and for the measurement of noise exposure at work places. Where development is still in progress and where rating procedures with limits of acceptability and technical advice for the reduction of noise are needed, the VDI (Verein Deutscher Ingenieure) issues guidelines, e.g. VDI 2058 /6/ for the rating of industrial noise.

QUANTITIES AND MEASUREMENT PROCEDURES

The rating level L_r is the main quantity and is calculated from the equivalent continuous A-weighted sound pressure level L_{Aeq} /1,5,7/ and adjustments for the impulsiveness and tone character of the noise. Attempts to determine the adjustments from measurement results were not successful for the tone adjustment, but for the impulsive adjustment the methods of the "Taktmaximalpegel" (tact maximum level), L_{AFT} /1,8/, and the time average of the A-weighted sound pressure level measured with the time weighting I, L_{AIm} /5,6,8/, proved to be useful.

The reference time intervals for L_r are 16 h for day and 8 h for night in TA Laerm but 1 h in VDI 2058 Part 1. Additionally VDI 2058 introduces a penalty of 6 dB for noises occurring at times of recreation and rest in the evening (19 to 22 hours) or early morning (6 to 7 hours). The formula for the rating level for the day L_r reads /5,6/:

$$L_{r\ day} = 10 \lg \frac{1}{16} (12 \cdot 10^{0,1 L_{r1}} + 4 \cdot 10^{0,1(L_{r2} + 6)}) \text{ dB}$$

where L_{r1} rating level for the time interval 7 to 19 hours, in decibels
L_{r2} rating level for the time intervals 6 to 7 and 19 to 22 hours in decibels.

If the characteristics of the noise vary with the time, the reference time interval is subdivided into part-time intervals T_i with approximately uniform noise characteristics L_{Aeqi} and $K_i = K_{Ii} + K_{Ti}$ in decibels. The rating level is then calculated using the formula /5/:

$$L_r = 10 \lg (\frac{1}{T_r} \sum_{i=1}^{n} T_i \cdot 10^{0,1(L_{eqi} + K_i)}) \text{ dB, where } T_r = \sum_{i=1}^{n} T_i.$$

AMENDMENTS TO L_{eq}

When the introduction of L_{eq} was discussed in the Federal Republic of Germany in the sixties, it was already pointed out that two shortcomings are inherent in L_{eq}:

- Very short events can exceed $L_{eq,T}$ with their maximum level, e.g. $L_{AF\,max}$, by 20 dB and more if T is as large as 8 or 16 hours. To limit this effect, additional limits for $L_{AF\,max}$ were specified /1,6/.
- Isolated noise events with high levels can mask the low levels of the background noise in the time intervals between the noise events so that the background noise has little or no effect on the numerical value of L_{eq}. But the low level time intervals appear to determine the judgement of the "quietness" of the environment. Finke /9/ proposed to describe the low level quality by a new quantity which he called "Pausenpegel (pause level) PP(w)". The formula for PP(w) is similar to that for L_{eq} but the levels are counted from an arbitrarily chosen reference level of 100 dB downwards to the $L_{AF\,max,i}$ measured during the ith minute. The quantity PP(w) can be combined with L_{eq}. The improvement in the correlations with subjective data collected in a study in the city of Hamburg /10/ was not convincing enough for PP(w) to be introduced for general use.

COMPLIANCE WITH NOISE LIMITS

The results of measurements performed for the characteric operation conditions of the source in the weather conditions prevailing at the location under consideration /1,5/, must comply with the noise limits. It is not always clear what weather conditions can be considered as prevailing. Downwind conditions are preferred for the measure-

ments because the results show a good reproducibility and the level of the noise from the source under consideration is the highest of all wind directions, thus reducing the adverse effects of the other noise sources on the measurement result to a minimum. A widespread practice requires that the arithmetical average of three measurements under downwind conditions minus 3 dB has to comply with the limit. The subtraction of 3 dB was originally intended to take into account the uncertainties of the measurement procedure but is nowadays sometimes interpreted as a correction to determine the long term (e.g, yearly) average over all weather conditions from downwind data.

On the assumption of a normal distribution for the n values $10^{0,1\,L_{eqi}}$ the upper limit L_u and the lower limit L_l of the confidence interval for the results of L_{eqi} from repeated uncorrelated measurements can be calculated from the formula given in the draft of the guideline VDI 3723 Part 1 /11/:

$$L_{u,l} = 10 \lg \left(10^{0,1\,L_{eqm}} \pm \frac{s \cdot t_{n-1}}{\sqrt{n}}\right) \text{ dB}$$

where $$s = \left(\frac{1}{n-1} \sum_{i=1}^{n} \left(10^{0,1\,L_{eqi}} - 10^{0,1\,L_{eqm}}\right)^2\right)^{1/2}$$

$$L_{eqm} = 10 \lg \left(\frac{1}{n} \sum_{i=1}^{n} 10^{0,1\,L_{eqi}}\right) \text{ dB}$$

t_{n-1} student factor for the two-sided 80 % confidence level.

SUMMARY AND PLANS FOR THE FUTURE

The measurement and description of community noise in the Federal Republic of Germany is based on the rating level determined for the characteristic operating conditions of the source and prevailing weather conditions. The impulse adjustment is included in the measurement by using the time average of the time weighting I or the "Taktmaximalpegel".

For the future it might be of increasing importance to take into account the different attitudes of people towards different types of noise sources e.g. industrial noise, traffic noise, railway noise, gun fire noise, noise from playgrounds and sport stadia. Additional adjustments will be required to include people's attitudes to the noise source in the rating level before comparing the data with the existing set of noise limits that was first intended for industrial noises. Any modification of the noise limits or the introduction of new limits

entails considerable political difficulties.

Before changing the quantities and methods of a national noise-rating procedure at least the following aspects should be considered:

- Applicability to all types of noises for the sake of comparability
- Reproducibility of the results within narrow limits
- Relation between the acoustical data and the effects on man
- Possibility of preciding the exposure from data of noise emission
- Conformity with national and international technical standards to enable the comparison and exchange of data and experience
- Conformity with existing laws and regulations to provide continuity
- Economical consequences including training of observers, and the equipment with measuring instruments
- Resulting benefit with respect to the reduction of noise

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