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Characteristic values for noise emission and standards for measuring them

Characteristic values that describe noise emission

To describe the noise emitted by a machine, the following characteristic values are of particular importance, as they describe the noise directly emitted independently of extraneous noise and of the room in which it is housed.

- **Emission sound pressure level at the workplace L_p**: This is a measure of the sound pressure level caused by the machine at its workplace independently of room-related effects or extraneous noise. It is thus equivalent to the sound pressure level at the workplace if the machine is set up outside in a silent environment (ideal case).

- **Sound power level L_W**: This is a measure of the total sonic energy directly emitted by the machine per unit of time.

The relationship between the sound pressure level and sound power level is relatively easy to represent for a machine under free field conditions (unhindered sound propagation) and without any appreciable extraneous noise. The sound power level L_W can then be calculated from the mean sound pressure level L_p on a measuring surface enclosing the machine and from the measuring surface area S by means of the following formula:

$$L_W = L_p + 10 \lg (S/1\ m^2) \quad dB \quad \text{or} \qquad (1)$$

$$L_W = L_p + L_S \quad dB \qquad (2)$$

Where: L_p = mean sound pressure level on measuring surface S

S = measuring surface area

$L_S = 10 \lg (S/1\ m^2)$ – measuring surface dimension (3)

Figure 1 shows an example of a measuring surface S with five measurement points for determining the sound power level. The measurement distance d from the machine surface (reference box) is usually defined as 1 m.

Under these special conditions (free field and no extraneous noise), **the sound power level therefore only differs from the mean sound pressure level L_p on the measuring surface by the so-called measuring surface dimension $L_S = 10 \lg (S/1\ m^2)$**. The measuring surface dimension L_S can be calculated with Formula 3 from the measuring surface area S or simply read off the diagram in Figure 2.

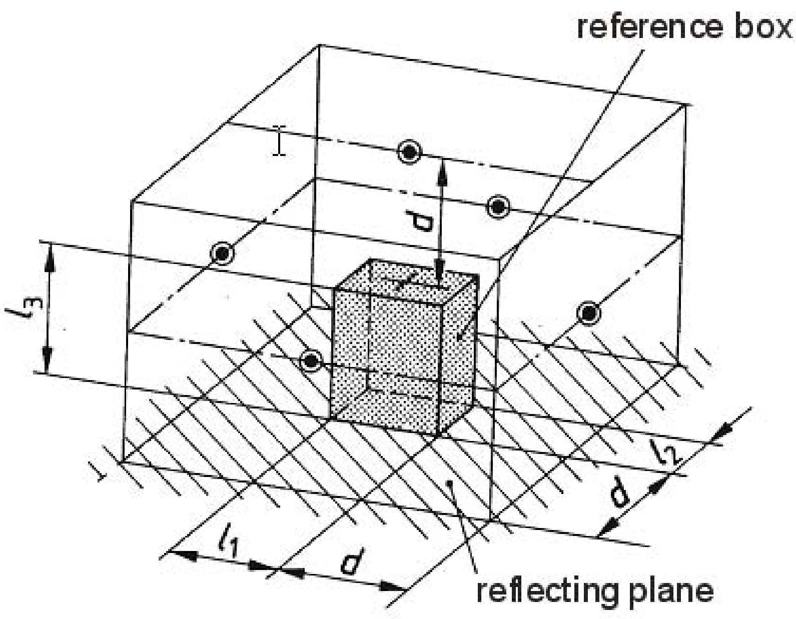

Figure 1: Example of a measuring surface with five measurement points for a small machine ($l_1 \le d$, $l_2 \le d$, $l_3 \le 2\ d$) for determining the sound power level in accordance with DIN EN ISO 3746

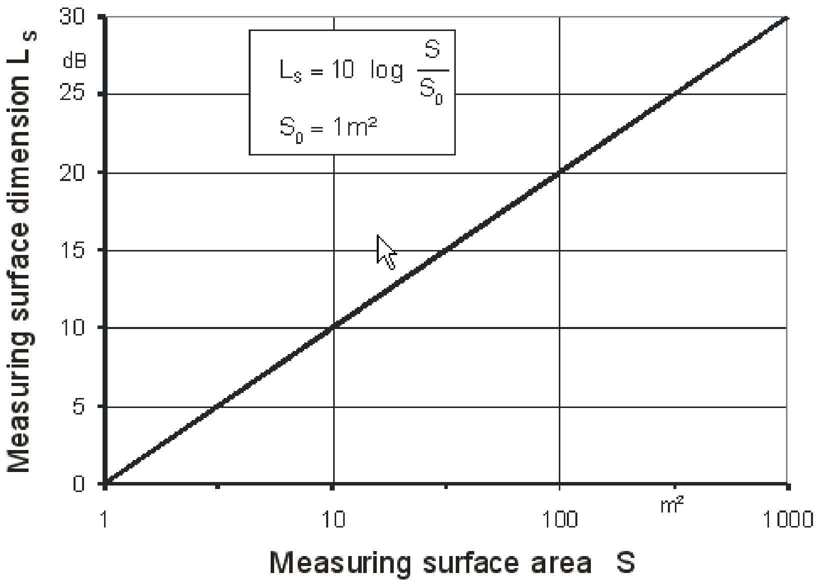

Figure 2: Measuring surface dimension L_S as a function of measuring surface area S

Since the emission sound power level at the workplace is in many cases of the same magnitude as the mean sound pressure level on the measuring surface, the difference between the emission sound pressure level and the sound power level is similar. Experience shows that the **emission sound pressure level L_p of a machine** is **roughly 8 to 25 dB below the corresponding sound power level L_W** – depending on the size of the machine, the directional characteristics of the emitted sound and the position of the workplace measurement point.

While the sound power level is usually the most important noise parameter for the purchaser of a machine, occupational safety and health professionals tend to be more interested in the emission sound pressure level at the workplace because the latter value is of the similar magnitude as the sound pressure level anticipated at the workplace. It may also make sense to choose a machine A with a slightly higher sound power level than machine B if machine A has a lower sound emission in the direction of the workplace and hence a lower emission sound pressure level.

Noise emission information

Under the EC Machinery Directive 2006/42/EC, the manufacturer or seller of a machine is obligated to state the machine's noise emission in the user's manual and sales brochures. What is firstly required as the characteristic value for noise emission is the emission sound pressure level at the workplace L_{pAd}. Only in the case of levels L_{pAd} exceeding 80 dB(A) does the sound power level L_{WAd} also have to be given, as shown in Table 1. In the case of emission sound pressure levels up to 70 dB(A), the information "70 dB(A)" is sufficient without details of the actual noise emission.

Table 1: Noise information required under the EC Machinery Directive depending on the emission sound pressure level L_{pd}

L_{pd}	Required noise information	
	Characteristic value for noise emission	Quoted value
≤ 70 dB(A)	Emission sound pressure level at the workplace	L_{pAd} = 70 dB or L_{pAd} = … dB
> 70 dB(A)	Emission sound pressure level at the workplace	L_{pAd} = … dB
> 80 dB(A)	Sound power level and emission sound pressure level at the workplace	L_{WAd} = … dB (re 1 pW) and L_{pAd} = … dB
L_{pCpeak} > 130 dB	Peak sound pressure level	$L_{pCpeakd}$ = … dB

In addition to the measured characteristic value for noise emission (L_{WA} or L_{pA}), the uncertainty K associated with this also has to be stated. This uncertainty K takes account not only of the uncertainty of the measuring method, but also of the uncertainty inherent in the statistical spread of a machine batch in production and is usually specified by the associated standard for the specific machine. Table 2 presents an example of the noise values given in accordance with the Technical Rule for the Noise and Vibration Ordinance (TRLV Lärm).

Table 2: Correct noise information with numeric values given by way of example (example from "TRLV Lärm")

Machine type, performance data, operating conditions		
Dual noise emission values in accordance with DIN EN 4871	**Idling**	**Under load**
A-weighted sound power level L_{WA} in dB re 1 pW	94	98
Uncertainty K_{WA} in dB	2	2
A-weighted emission sound pressure level L_{pA} in dB re 20 μPa at operator's workplace	80	86
Uncertainty K_{pA} in dB	2	2
The values were obtained in accordance with noise test standard DIN EN ISO xxx with the application of the basic standards DIN EN ISO 37xx and DIN EN ISO 1120x.		

Because this noise information means little to many purchasers of machines and the stated numeric value alone says nothing about the noise emission compared to other machines of the same design, the possibility of presenting this information in noise classes, e.g. A, B and C, or in colours from green via yellow to red, as familiar from the energy consumption of household appliances, is currently under discussion (see, for instance, the International "Buy Quiet" Symposium, Paris, 5th to 6th July 2011). One way of drawing attention to a particularly low-noise product and of promoting it on the market is by displaying a suitable symbol, such as the German "Blue Angel" awarded by the Federal Environment Agency.

Standards for determining emission characteristic values

Among the standards for the measurement of noise emission, a distinction can be made between the basic standards, each of which describes in general the measurement strategy for ascertaining the emission sound pressure level or sound power level, and, based on these, the standards for specific machines (noise test code). The noise test codes define the installation and operating conditions (rpm, load ...) to be achieved for the various machine categories at measurement. The measurement of the emission sound pressure level at the workplace is described in basic standards DIN EN ISO 11201 to DIN EN ISO 11205. To determine the sound power level, the main basic standards of importance are DIN EN ISO 3744 and DIN EN ISO 3746. Depending on the machine type and the usual installation conditions, other basic standards can also be meaningfully applied to ascertain the sound power level.

A complete overview of the basic standards for determining the characteristic values for noise emission is given, for instance, in the paperback "Lärmmessung im Betrieb" (in German). The publication describes the associated measurements in detail and explains them with reference to examples.

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