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Legal limits for peak levels due to industrial activities

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ABSTRACT

The present development of new environmental legislation in The Netherlands gives rise to the question what limits should be used for peak levels due to industrial activities. The approach of different countries regarding this kind of peak levels was inventoried and mutually compared. To set legal limits for peak levels could be considered for different reasons such as preventing annoyance in a general sense, startling effects by sudden sounds and/or sleep disturbance.
In this respect the character of peak levels appear to play an important role. In combination with literature about the results of dose-effect studies regarding peak levels a proposal for the possible assessment of peak levels due to industry was derived.

Keywords: Industrial noise, peak levels, legislation I-INCE Classification of Subjects Number(s): 52.5

1. INTRODUCTION

Peak levels due to industrial activities are in general different from those due to – for instance – traffic and railway noise. That might ask for a different approach in setting legal limits to assess this kind of (industrial) peak levels. That question was the back ground for the study on which this paper is based. The study aimed at a proposal for legal limits for peak levels due to industrial activities.

In this paper essentially two parameters are used:

- L_{Amax}, being the highest sound level measured in fast;
- SEL (or $L_{Aeq,1s}$), being the sound energy of the phenomena related to 1 s.

2. NOISE LIMITS FOR PEAK LEVELS DUE TO INDUSTRY IN DIFFERENT COUNTRIES

2.1 Australia (4)

2.1.1 Queensland

For dwellings the permissible indoor sound levels at night are 40 dB(A) as $L_{A01,1hr}$ for health and well-being in relation to the ability to sleep.

2.1.2 Tasmania

Permissible night-time sound levels inside dwellings are 45 dB(A) as $L_{Amax,fast}$ based on sleep disturbance.

2.2 Belgium, Flanders

Regulations are based on “Titel II van het VLAREM” (Besluit van de Vlaamse Regering van 1 juni 1995 houdende algemene en sectorale bepalingen inzake milieuhygiëne, versie juni 2015) shortly Vlarem II.

Periods are 07.00 am - 07.00 pm, 07.00 pm - 10.00 pm and 10.00 pm - 07.00 am. Only incoming sound on the façades is considered.

Distinction is made between stable, intermittent, fluctuating, impulsive and incidental sound, each having a specific definition. These quantities are characterized by $L_{Aeq,1s}$-values. Regarding noise limits sound is assessed in the same way for:

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- fluctuating and incidental sound (less pronounced variations in sound levels);
- intermittent and impulsive sound (more pronounced variations in sound levels and peak levels).

Peak levels are assessed as follows:

- the fluctuating and incidental sound may exceed the values to strive at for continuous sound with no more than 15 dB(A) during daytime and 10 dB(A) during the evening and night time;
- intermittent and impulsive sound may exceed the values to strive at for continuous sound with no more than 20 dB(A) during daytime and 15 dB(A) during the evening and night time.

Mostly the values to strive at for continuous sound levels (equivalent sound levels) relates to a value over 1 hour or a couple of hours, and depend on the type of environment such as rural areas, urban areas near industrial sites, urban areas etcetera. Furthermore these values are 5 dB more severe for new companies compared to existing companies.

The limits for peak levels for impulsive and intermittent sound concern $L_{Aeq,1s}$–values, that means SEL-values. In terms of L_{Amax}-values this means differences depending on the type of peak levels, for instance how fast the sound levels increase in time and their maximum value.

2.3 France

No valid legal limits for industrial peak levels are set.

2.4 Germany

Noise limits are described in TA-Lärm. Paragraph 6.1 gives noise limits, outside buildings, that depend on:

- the time of the day (day time from 06.00 am to 10.00 pm, night time from 10.00 pm to 06.00 am);
- the type of area according to table 1.

Table 1 – Noise limits, outside; values in dB(A)

Area type	Equivalent, day time	Equivalent night time	Peak level, day time	Peak level, night time
Industrial areas	70	70	100	90
Commercial areas	65	50	95	70
City centres, village centres, mixed zones	60	45	90	65
General residential areas, small settlement areas	55	40	85	60
Pure residential areas	50	35	80	55
Hospitals, care centres, wellness areas	45	35	75	55

The limits for peak levels in table 1 are governed by the rule that they should not exceed the limits for equivalent noise levels by 30 dB during day time and 20 dB during night time.

2.5 Italy

For industrial noise Italy has no direct limits regarding peak levels in the environment. However, a penalty can be applied on equivalent noise levels for impulsive noise. However, if the noise is impulsive there is the possibility to correct the equivalent level as described in the Decree of 16-03-1998 "Tecniche di rilevamento e di misurazione dell'inquinamento acustico" regarding acoustic measurement techniques. If the noise is considered to be impulsive, a correction factor K_I of 3 dB(A)

to L_{Aeq} can be applied. Noise is considered as impulsive if:

- L_{AImax} - L_{ASmax} > 6 dB;
- a 10 dB reduction of L_{AFmax} is reached in less than 1 second;
- the event is repeated at least 10 times/ hour during daytime and 2 times/hour during night time.

2.6 The Netherlands

Limits for peak levels that are applied in most cases are summarized in table 2, regarding standard maximum values and exemptions under certain conditions, for instance in cases where an environmental permit is required. If an environmental permit is required lower noise limits might be applicable.

Table 2 - Peak level limits (L_{Amax} in dB(A)), outside

Description	day	evening	night
Standard – maximum value	70	65	60
Exemption possibility	75	65	65

Special regulations apply to railway shunt-yards. No limits for peak levels are set but a correction on equivalent noise levels has to be applied under certain conditions relating to the character of the peak levels and the contribution of peak levels to the equivalent noise levels. If peak levels occur from sound that increases in a very short time, a “penalty” on the equivalent noise levels has to be applied.

2.7 Spain

Framework for legislation is “Ley 37/2003, de 17 de noviembre, del Ruido

Application decree: REAL DECRETO 1367/2007, de 19 de octubre en lo referente a zonificación acústica, objetivos de calidad y emisiones acústicas”. It defines five different zones for which environmental noise objectives are described; table 3 gives the noise limits for noise that only originates from industry and harbours.

Table 3 – Type of zone and limits regarding equivalent noise levels $L_{Keq,T}$ in dB(A), outside

Type of zone	Description	Day	Evening	Night
e	Prevalently healthcare, education and cultural use where specific protection against noise is needed	50	50	40
a	Prevalently residential use	55	55	45
d	Prevalently service industries use (except services described in c)	60	60	50
c	Prevalently leisure and entertainment use	63	63	53
b	Prevalently industrial	65	65	55

The $L_{Keq,T}$ criteria are calculated with the following formula: $L_{Keq,T} = L_{Aeq,T} + K_t + K_f + Ki$

K_t is the correction for tonal noise, K_f for low frequency noise and K_i for impulsive noise. The maximal value of the total K correction terms is 9 dB.

Spain does not have specific limits for peak levels generated by industrial and harbour activities. However, the peak level is somehow taken into account in the Ki correction term.

To determine the K_i value one should measure simultaneously the levels $L_{Aeq,Ti}$ and $L_{AIeq,Ti}$ (I from impulse time weighting) during the period of time Ti in which the impulsive noise appears. The difference $L_i = L_{AIeq,Ti} – L_{Aeq,Ti}$ is then calculated and compared to the values given in table 3. If 10 <

$L_i \leq 15$ then $K_i = 3$ dB, if $L_i > 15$ then $K_i = 6$ dB.

2.8 Discussion

As appears from the previous paragraphs, not all countries have specific limits for peak levels due to industrial activities. If limits are valid, the values can be related to back ground noise and / or the characterization of the area. In some cases peak levels are incorporated as a kind of penalty on the occurring equivalent noise levels.

However, if limits to peak levels are applied for the night period, it seems logical to aim at preventing sleep disturbance inside sound sensitive objects (such as dwellings, hospitals), so relating limits to the type of area might be less appropriate.

On the other hand, for dwellings in typical industrial areas it sounds reasonable to allow higher peak levels because of the special nature of living in such an area. A higher sound insulation of the façade could compensate this and still leads to an adequate prevention to sleep disturbance.

3. CONSIDERATIONS REGARDING PEAK LEVELS

A proposal for limits for peak levels for industrial noise should take into account the following considerations:

- Limits for peak levels due to industrial activities should aim at preventing:
  - annoyance in a general sense;
  - startling effects by sudden sounds;
  - sleep disturbance.
- The intensity of peak levels such as the amount of peaks and the noise levels.
- The character of the peak levels; startling effect effects are not directly related to the value but more to the unexpectedness of the noise event; sleep disturbance appear when SEL-values occur near the ear higher than 55 dB(A);
- The meaning and association of the noise: does it cause feelings of danger (explosions, nearby shunting-yard-activities with hazardous goods) or necessity for action (crying of a baby).
- The way people are familiar with the occurring sounds and are used to it.
- The way people are annoyed; this is related to many aspects such as the perceived necessity of these peak levels, the kind of concentration needed for occupational activities, the relationship with the company responsible, the way and intensity speech is interrupted, a.s.o.

However, it is not feasible for many of these, partly non-acoustical aspects to relate these to different sets of limits related to specific aspects.

Startling effects are not primarily related to the height of the sound levels but more to their unexpectedness, i.e. the sudden occurrence of sound, therefore more with the speed the sound increases in time. This aspect does not need a limit on the sound level but more on the speed at which the sound increases (in dB/s). This could lead to a “penalty” on the contribution of this kind of sound to the equivalent noise levels.

From studies it appears that effects of sleep disturbance can be expected with SEL-values above 55 dB(A). However also the frequency of these peak events is assumed to have an influence on sleep disturbance.

From an enforcement point of view the application of SEL-limits has limitations. Limits for L_{Amax} are more easy to check by means of relative simple investigative measurements. Determining SEL-values in practice means an additional calculation taking into consideration the duration of the peak event, so is less practical.

Thus, aiming at a maximum SEL-value of 55 dB(A), limits for L_{Amax}-values have to be derived, so the relation between SEL and L_{Amax} is relevant. For representative types of sound signals TNO (1) derived formulas to calculate L_{Amax} values from SEL-values:

SEL = L_{Amax} + 10 log T for square-wave signals (T the duration of specific signal);

SEL = L_{Amax} – 10 log $v_{increase}$ + 9.4 for tent shaped signals ($v_{increase}$ in dB/s);

SEL = L_{Amax} -9 for impulsive noise signals.

Square-wave signals, such as caused by trains passing by, are less important for industrial activities; the impulsive characteristics can be assessed as impulsive noise signals and the longer duration of the signal means that they might have a relevant contribution to the equivalent noise level and can be assessed by those values.

If $v_{increase}$ is assumed to be about 10 dB/s then for tent shaped signals SEL ≈ L_{Amax}. This is applicable to trucks and cars passing by and similar industrial activities.

TNO suggested to take into consideration startling effects due to impulsive noise signals by application of penalties on the contribution of the specific noise events to the equivalent noise levels, with the following values (1):

- plus 5 dB if $v_{increase}$ is above 15 dB/s;
- plus 10 dB if $v_{increase}$ is above 50 dB/s;
- plus 15 dB for impulsive signals.

The question rises whether it is necessary to apply separate limits for peak levels in addition to limits for equivalent noise levels. Based on research it was concluded that this is not necessary. However, this conclusion was based on research mainly related to traffic noise. An important characterization of traffic noise is that no “sharp” peaks occur; the sound of passing cars as a function of time is more smooth. This is an important difference from industrial noise, which in general has more sharp peaks due to specific industrial activities, for instance grinding, hammering as happens within the metal industry. In this respect the character of peak levels appear to play an important role. So, it is not immediately evident that limits to equivalent noise levels give enough protection for sleep disturbance. This is an important reason to look for specific limits to peak levels due to industrial activities.

Aiming at a maximum SEL-value of 55 dB(A) inside dwellings a.s.o., limits for L_{Amax}-values outside can be derived, taking into account the sound insulation of facades.

In combination with literature on the results of dose-effect studies regarding peak levels a proposal about possible assessment of peak levels from industry was derived. Different studies have been done regarding the use of peak levels especially by TNO and RIVM (2, 3). The results of these studies are taken into account with the proposed limits for peak levels.

4. PROPOSAL

4.1 General

Assessing peak levels due to industry should be rather simple and practical.

Although in principle a good method, it is not that practical to relate limits to the speed by which the noise increases in time ($v_{increase}$ in dB/s) because it demands a huge investigation effort, and many possibilities for discussion. On the other hand assessing peak levels without giving notice to specific characteristics, such as $v_{increase}$ and repetitiveness and intensiveness, is not adequate also. So, a compromise between different aspects should be aimed at.

Furthermore it seems reasonable to allow at least one exceeding of the limit for peak levels for each period (day, evening, night) to prevent a situation where a company is “fined” for incidental behaviour which is not “common practice”.

4.2 Day period

No limits for peak levels are proposed for the day period, taking into account the following considerations.

It is assumed that sleep disturbance is in general not an important issue in this period, and annoyance can be controlled sufficiently by limiting the equivalent noise levels. If needed, a penalty for impulsive noise with repetitive characteristics can be applied according to general accepted Standards.

Startling effects may be considered less important in the day period. Moreover, this effect cannot be prevented by a limit for peak levels but demands restrictions to behaviour or ways of operation.

4.3 Evening and night period

For the evening and night period a distinction is made between peak levels due to transport noise caused by trucks and cars passing by and all other types of peak levels. Figure 1 gives an example of an industry with mainly traffic noise.

Figure 1 – Example of industry with mainly traffic noise

The proposed noise limit for transport type of peak levels (L_{Amax}) is 70 dB(A) for both periods. This is based on the low values of $v_{increase}$ (less than 15 dB/s, so no startling effects) of this tent shaped type of noise and the way people in general are used to car and truck noise, so they will not easily be disturbed in their sleep. Taking this limit value of 70 dB(A) a SEL-value of maximal 55 dB(A) inside the sound sensitive room can be expected taking into account a sound insulation of 15 dB for a façade with a slightly opened window.

For all other types of peak levels discussion about reasonable limits for peak levels is possible. Sleep disturbance is an important aspect. But also startling aspects play a role, for which a specific "penalty" could be applied. Such a penalty could be depending on the $v_{increase}$ of the noise event. Aiming at a maximum SEL-value of 55 dB(A) inside for preventing sleep disturbance, and taking into account a sound insulation of 15 dB for a façade with a slightly opened window and the relation between SEL and L_{Amax} for impulsive noise, a L_{Amax} limit-value of at least 65 dB(A) outside the façade can be derived. However, a limit value of 65 dB(A) seems reasonable taking into account different considerations.

All this leads to a proposal regarding limits for peak levels of incoming noise due to industrial activities, outside at short distance of the façade, as summarized in table 4.

Table 4 – Proposal regarding limits for peak levels of incoming noise due to industrial activities, outside at short distance of the façade (L_{Amax} in dB(A))

Description	Day period 07.00–19.00	Evening period 19.00–23.00	Night period 23.00–07.00
L_{Amax} due to noise from transport sources such as trucks and cars passing by, or similar noise events (with low $v_{increase}$)	-	70	70
L_{Amax} due to all other noise sources	-	65	65

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