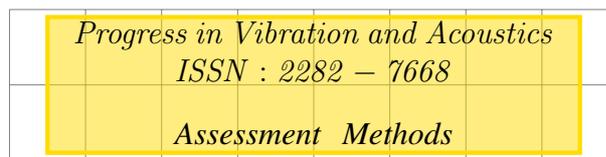


Noise assessment criteria from stationary sources in European countries



Graziella Aghilone¹ Diego Annesi² Massimo Cavacece³

¹ *Pharmacy and Medicine Faculty, University La Sapienza of Rome, Via Regina Margherita n.273, 00198 Rome (RM) Italy, e-mail: graziella.aghilone@uniroma1.it*

² *INAIL, Via Fontana Candida,1 00040 Monte Porzio Catone (Rome), e-mail: info@misurazionidelrumore.com*

³ *ASME Member, Department of Civil and Mechanical Engineering, University of Cassino and Lazio Meridionale, Via G. Di Biasio n.43, 03043 Cassino (FR) Italy, e-mail: cavacece@unicas.it*

Abstract

The main aim of Directive 2002/49/EC is to provide a common basis for tackling the noise problem across the EU. The objectives include monitoring the environmental problem; by requiring Member States to draw up *strategic noise maps* for major roads, railways, airports and agglomerations, using harmonised noise indicators. Local noise issues are addressed by requiring competent authorities to draw up action plans to reduce noise where necessary and maintain environmental noise quality where it is good. Member States shall report on noise maps. The Member States shall report on limit values in force and shall ensure that the information from strategic noise maps and summaries of the action plans are sent to the Commission. [DOI:10.12866/J.PIVAA.2014.03.002] ¹

Keywords: European Standard, Noise Assessment, Managing Noise

1 Introduction

The relationship between environmental noise and public health is perhaps the most significant reason why environmental noise has emerged as a major aspect in environmental legislation and policy in recent years. Many researches have emerged over the last two decades linking environmental noise with adverse health effects. Recently the World Health Organisation (WHO) has

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estimated that at least 1 million healthy life years are lost every year from traffic-related noise in the western European countries, including the EU Member States (WHO, 2011). In terms of strategic noise mapping, annoyance and sleep disturbance are considered to be the two most prominent adverse effects of prolonged exposure.

In this study we propose a critical point of view on some laws and assessment methods. We analyze the evaluation criteria of the disturbance from noise in order to compare current regulations adopted by the Member States of Europe. We consider the laws and articles containing the evaluation criteria, indicators, methods of calculation, limits day/night differential criterion, limits day/night of the absolute criterion, types of sources, thresholds of applicability, measurement mode, corrections to impulsivity and tonal components, corrections for the duration, indicators and methods of calculation.

The countries considered are France, UK, Germany, Switzerland, Portugal, Spain and Belgium. The sources considered are industrial noises with different spectral characteristics, low frequency noise, noise with tonal components, noise with impulsive components and events with simultaneous exposure to different types of sound sources (e.g. traffic source and fixed source).

The EU issued Directive 2002/49/EC, the Environmental Noise Directive (END) (EU, 2002) to establish a framework for environmental noise planning. This Directive, called for the production of environmental noise maps for designated areas as well as the development of appropriate noise, proposes action plans [Dir].

2 Directive 2002/49/EC

The aim of this Directive defines a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. The following actions shall be implemented progressively:

- a. the determination of exposure to environmental noise, through noise mapping, by methods of assessment common to the Member States;
- b. ensuring that information on environmental noise and its effects is made available to the public;
- c. adoption of action plans by the Member States, based upon noise-mapping results, to reduce environmental noise where exposure levels can induce harmful effects on human health;
- d. preserving environmental noise quality where it is necessary.

The Directive 2002/49/EC can be applied to environmental noise to which humans are exposed in particular in built-up areas, in public parks or other quiet areas in an agglomeration, in quiet areas in open country, near schools, hospitals and other noise-sensitive buildings and areas.

The EU issued Directive 2002/49/EC establishes a framework for environmental noise planning. This Directive requires the production of environmental noise maps for designated areas as well as the development of appropriate noise action plans and noise mitigation measures [Eur]. The Directive defines two specific indicators that must be used to describe strategic noise maps: L_{den} and L_{night} .

The day-evening-night noise indicator L_{den} represents the noise indicator for overall annoyance, expressed in dB(A); while L_{night} acts as the noise indicator for sleep disturbance. The day-evening-night level L_{den} , in decibels (dB), is defined by the following formula:

$$L_{den} = 10 \ln \frac{1}{24} \left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right), \quad (1)$$

in which:

- L_{day} is the A -weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the day periods of a year;
- $L_{evening}$ is the A -weighted long-term average sound level as defined in ISO 1996-2: 1987, determined over all the evening periods of a year;
- L_{night} is the A -weighted long-term average sound level as defined in ISO 1996 – 2 : 1987, determined over all the night periods of a year;
- the day is 12 hours, the evening 4 hours and the night 8 hours. The Member States may shorten the evening period by one or two hours and lengthen the day and/or the night period accordingly, provided that this choice is the same for all the sources.
- the start of the day (and consequently the start of the evening and the start of the night) shall be chosen by the Member State (that choice shall be the same for noise from all sources); the default values are from 7:00 to 19:00, from 19:00 to 23:00 and from 23:00 to 7:00 local time;
- a year is a relevant year as regards the emission of sound and an average year as regards the meteorological circumstances.

The height of the L_{den} assessment point depends on the application:

- in the case of computation for the purpose of strategic noise mapping in relation to noise exposure in and near buildings, the assessment points must be 4.0 ± 0.2 m (3.8 to 4.2 m) above the ground and at the most exposed faade; for this purpose, the most exposed faade will be the external wall facing onto and nearest to the specific noise source;
- in the case of measurement for the purpose of strategic noise mapping in relation to noise exposure in and near buildings, other heights may be chosen, but they must never be less than 1.5 m above the ground, and results should be corrected in accordance with an equivalent height of 4 m.

3 Noise Assessment Criteria in the standards of European countries

3.1 United Kingdom

Environmental Protection Act 1990 and Noise Act 1996 regulate the level sound of the neighborhood, from public places and temporary exhibitions in the night time. Directions under Section 5 of the Noise Act 1996: *Permitted Noise Levels and in the Approval under Section 6* of the Noise Act 1996: *The Measuring Devices* regulate the measurement techniques [Env].

The mentioned regulations propose a differential threshold criterion of applicability. Sections 4, 5 and 6 propose assessment, measurement and determination of the noise. The permitted level has been slightly reduced from the previous level. Previously the permitted level for dwellings was 35 dB(A) if the underlying level of noise was no more than 25 dB(A), or 10 dBA above the underlying level of noise where this exceeded 25 dB(A). The permitted level is now set at 34 dB(A)

if the underlying level of noise is no more than 24 dB(A), or 10 dB(A) above the underlying level of noise where this exceeds 24 dB(A).

The measures must be implemented by a device of class 1, in environments with doors and windows closed and with the microphone positioned at least 0.5 m from any reflecting surface. The noise level is determined by equivalent continuous sound level $L_{Aeq,5min}$, using the A-weighting setting on 5 minutes. The background noise is detected by a measurement of duration from 1 to 5 minutes.

The permitted level is determined by reference to the underlying level of noise. The underlying level of noise is indicative of the level of noise that would otherwise be present in the absence of the noise causing complaint. There will be cases where the level of noise complained is above the level of noise that would otherwise be present. In such cases it should be possible to assess, by judgment or measurement, that the underlying level of noise is at least 10 dB below the $L_{Aeq,5min}$ of the noise from the offending dwelling.

The measurement technique makes it possible to determine the underlying level of noise even if the dominant noise appears to be continuous. This can be done by statistical parameters, such as $L_{A99.8,5min}$, $L_{A99.5,2min}$ or $L_{A99,1min}$ for the underlying level of noise.

The measurement must be for at least 5 minutes. It could be longer if the officer consider it necessary and/or reasonable to do so. The noise emitted from the offending dwelling or offending premises and the underlying level of noise are both determined within an overall period of no more than 15 minutes. In other words, there is an *assessment window*, 15 minutes, within which both the noise from the offending dwelling or offending premises and the underlying level should be acquired.

The administrative authority may place orders to end the noise and may limit the source excessive noise.

To obtain suitable measurements for the purposes of the Noise Act 1996 in situations when underlying levels of noise are around 24 dB(A), it is recommended that the self-noise of the measuring device (including the microphone) should be below 19 dB(A). However, self-noise can exceed this level without significantly affecting the accuracy of measurement at higher sound pressure levels.

In the case of production facilities during the daytime, the normative reference is the technical standard BS 4142:1997. This standard defines the following aspects:

- a method to describe the noise level of industrial settlements;
- the procedure for evaluating the complaints of people who live nearby.

British Standard BS 4142:1997 is the standard normally used in the UK to assess whether noise from factories, machinery and industrial or commercial premises is likely to give rise to complaints from people living nearby. The standard is based on the principle that the likelihood of any complaints depends on the noise level of the factory or plant relative to the underlying level when the factory or plant is not operating.

The *specific* noise level of the industrial plant is measured at the assessment location, normally outside a nearby residence. The *background* noise level at the assessment location is measured when the specific noise source is not operating.

If there are distinguishable acoustic features present in the specific noise level (hums, whistles, bangs, clicks, clatters or thumps) or the noise is irregular enough to attract attention, then a 5 dB penalty is added to the specific noise level in order to obtain the *rating* sound level.

As general guidance, if the rating level is more than 10 dB above the background level, this is an indication that complaints are likely. If the rating level is 5 dB above the background, this

Corrective Term	ΔT
6	$\Delta T \leq 1$ minute
5	1 minute $< \Delta T \leq 5$ minutes
4	5 minutes $< \Delta T \leq 20$ minutes
3	20 minutes $< \Delta T \leq 2$ hours
2	2 hours $< \Delta T \leq 4$ hours
1	4 hours $< \Delta T \leq 8$ hours
0	$\Delta T > 8$ hours

Table 1: Corrective term values

is of *marginal significance* and complaints are possible. If the difference between the rating and background levels is low, the likelihood of complaints decreases.

3.2 France

The noises of the neighborhood are regulated by the Decree of 31 August 2006 (amending the *Code of Public Health - Book III*), updated with the Decree of 5 December 2006 *Measurements of the noise of the neighborhood*. The techniques of measurement are included in the decree technical standard AFNOR NF S 31-010 December 1996 *Acoustics - Description and measurement of environmental noise - Special Methods of measurement* [Dec, b].

The global emergency is defined by the difference between the noise level, including noise in question, and the residual noise level, generated in the external and internal environment, in correspondence of the premises and in conditions of normal operation of the equipment.

The legislation indicates a criterion of the differential type. The global emergency is the difference between ambient sound level and residual noise level. The indicator is the equivalent level in dB(A). The limits are 5 dB(A) for the daytime period (7 – 22) and 3 dB(A) for night time (22 – 7). A corrective term, depending on the total duration of the specific noise, is added to these limit values. The corrective term varies from 0 to 6 (Table 1).

If the measurement is performed within the main rooms of a house with windows open or closed, the threshold for the sound level of *quiet* is 25 dB(A). In other cases, the threshold for the sound level of *quiet* is 30 dB(A). If the measured levels are above these thresholds, the global emergency is calculated by a method defined by the AFNOR. The Art. R. 1334-34 concerns the spectral emergency. The emergency spectral is the difference between the ambient sound level in octave band normalized, and the residual noise level in the same octave band. The limits of spectral emergency are 7 dB in octave bands normalized and centered on 125 and 250 Hz and 5 dB in the octave band centered on 500, 1000, 2000 and 4000 Hz.

The overall appearance and, if necessary, the spectral emergence are searched when the ambient noise level measured, comprising the examined noise, exceeds 25 dB(A) inside of the housing and 30 dB(A) in other cases (Article R. 1334-32-CSP). The measurement can be done either inside and outside where noise level is annoying. The measurements must take at least 30 minutes.

Article R. 1334-31 states that, in a public or private place, no noise should have an impact on the tranquility of the neighborhood or on human health, for its duration, repetition or intensity. The administrative authority shall apply the administrative penalties, recommends the necessary

measures; and provides for the suspension of noisy.

3.3 Germany

Federal law *August 26, 1998 (GMBI Nr. 26/1998 S. 503)* proposes the technical instructions for the protection of the population against noise. The legislation prevents potential conflicts in urban areas in the case of multiple sound sources. The requirements apply to sources that operate with authorization and to sources that do not require administrative permissions. The regulations limit the noise from productive activities with the exception of sports facilities, recreational facilities, outdoor restaurants, agricultural production of small polygons shooting sports, mines, shipyards, port handling services and structures for social purposes. Federal law offers an absolute criterion, valid for the external environment. The evaluation will assess the level of noise disturbance generated by all sources at a specific receptor. The level of noise disturbance, L_R is obtained by the following relationship:

$$L_r = 10 \log \left[\frac{1}{T_r} \sum T_j \cdot 10^{0.1(L_{Aeq,j} - C_{met} + KT_j + KI_j + KR_j)} \right] \quad (2)$$

- $T_r = 16$ h for the daytime and 1 h or 8 h for the night time;
- T_j , time interval j in which sound levels are acquired in N time intervals;
- $L_{Aeq,j}$, equivalent continuous sound level during time interval T_j ;
- C_{met} , the meteorological correction according to ISO 9613-2;
- KT_j , the correction factor for the tonal components;
- KI_j , the correction factor for the impulsive components;
- KR_j , the correction factor for parts of the day with high sensitivity.

The sound levels are weighted in frequency domain, A-scale and with a time constant F according to DIN 60651. In the presence of tonal components, the correction factor KT_j can take value from 3 to 6 dB. The methods of identification of tonal components are described in the standard DIN 45681. The correction factor of the impulsive components is calculated using the following equation:

$$KI_j = L_{AFTeqj} - L_{Aeq,j} \quad (3)$$

where L_{AFTeqj} (Taktmaximal Mittelungspegel, defined in the standard DIN 45641) is the maximum value of the sound pressure level L_{AF} at time T corresponding to a cycle of 5 seconds.

The limits are associated with 6 classes of division of the territory. The limits are the following values:

- 35 dB in night time and 45 dB in daytime in the areas of human care;
- 35 dB in night time and 50 dB in daytime in residential areas;
- 70 dB in industrial areas.

The individual sound peaks in the short term, should not exceed 30 dB benchmarks for the immision of daytime; 20 dB at night time. Inside the buildings, the limits of the sound levels are the following values:

- 35 dB(A) for daytime;
- 25 dB(A) for night time.

In a short period of time, the individual events must not exceed the benchmark for more than 10 dB. The daytime is from 6.00 to 22.00; night time from 22.00 to 6.00. If there are local needs or relevant production activities, the night time can be up to an hour early or late. The continuous period lasts 8 hours per night.

Technical instructions for the protection against noise integrated control procedures for noise induced by low-frequency sources. If the difference ($L_{Ceq} - L_{Aeq}$) > 20 dB, noise levels, acquired with closed windows in living spaces, are harmful. Then protection is required.

3.4 Belgium, the Government of the Brussels–Capital Region

The relevant law is the decree November 21, 2002 relating to the fight against noise in the neighborhood [Arr]. The decree considers noise generated from all sources audible from the neighborhood.

In the case of indoor environments, the measurements are performed with a microphone at a height from 1.20 to 1.50 m, at 1 m from walls without windows, at 1.5 m from walls with windows. All measurements are acquired with windows closed in the absence of occupants.

The values applicable to noise and vibration are classified. The Decree of 21 November 2002 relating to noise and vibrations intend to clarify the noise level that can emit a classified facility. Values considered correspond to the noise levels from the facility and measured outside the limit of plots. Regarding the immission values measured inside (in a rest room, room or service), this law refers to the noise on the neighborhood. The limit values depend on following aspects:

- the time slot (from 7:00 a.m. to 7:00 p.m., from 7:00 p.m. to 10:00 p.m., from 10:00 p.m. to 7:00 a.m.);
- the day of the week (weekdays, saturdays, sundays, holidays);
- the possibility or not to interrupt the activity during the night or during the weekend;
- allocation of the urban area, determined by the Regional Land Use Plan.

The limits applicable to classified facilities (perceived noise outside) refer to specific noise level. The decree of 21 November 2002 sets the control method and conditions of measurement noise and provides the following definitions:

- Emergence is the temporal change in the sound pressure level or changing the spectral content that can be perceived by the human ear;
- The level of ambient noise L_f is the sound pressure level measured when the offending noise sources are stationary in dB(A);
- The total noise level L_{tot} is the sound pressure level measured when the offending sound sources are active, expressed in dB(A);
- The specific level of noise LSP is the sound pressure level of sound sources considered in dB(A). LSP considers the total noise level.

- Emergence tone is the sound level of a frequency band more important than the level of adjacent frequency bands.

Brussels legislation provides a penalty of several decibels for tonal noises, particularly troublesome for the neighborhood. The decree defines, by area and time period, the maximum level and the threshold peak specific noise (Table 2).

¹	limits applicable to stores for retail
²	limits applicable to installations whose operation can not be interrupted (ventilation, refrigeration systems, etc.)
Zone 1	residential areas, green areas, areas of high biological value, park areas, areas cemetery and forest areas
Zone 2	residential areas
Zone 3	mixed zones, sports or outdoor recreation, agricultural areas and public service interest
Zone 4	areas of regional interest
Zone 5	administrative areas
Zone 6	urban industries and areas of transport and port activity zones, railway and areas of regional interest
S_{PTE}	expressed in dB(A), is the peak sound pressure level at which the noise produced by the sources is recognized as an event
N	number of times that the system has generated a peak exceeding the threshold S_{PTE} by one hour period

Table 2: Limit values of specific external noise (LSP)

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Festivity
7–19	A	A	A	A	A	B	C	C
19–22	B	B	B	B	B	C	C	C
22–7	C	C	C	C	C	C	C	C

Table 3: Periods A, B, C for noise levels

Decree of 21 November 2002 specifies the allowable noise level in a room (rest room, service) and outside, depending on the following parameters:

- the time slot (from 7:00 a.m. to 7:00 p.m., from 7:00 p.m. to 10:00 p.m., from 10:00 p.m. to 7:00 a.m.)
- the day of the week (including Saturdays, Sundays and holidays);
- the function of the local destination (rest room, room, service);

- allocation of the urban area.

It determines the noise levels and the number of noise events tolerated depending on the area. *Arret du Gouvernement de la Rgion de Bruxelles-Capitale* du 21/11/2002, relating to classified installations noise and neighborhood noise, proposes following aspects:

Period Area	A			B			C						
	L_{sp}	N	S_{pte}	L_{sp}	N	S_{pte}	L_{sp}	N	S_{pte}				
1	42	20	72	36	42 ¹	10	66	30	5	60			
2	45	20	72	39	45 ¹	10	66	33	39 ^{1,2}	5	10 ²	60	66 ²
3	48	30	78	42	48 ¹	20	72	36	42 ^{1,2}	10	20 ²	66	72 ²
4	51	30	84	45	51 ¹	20	78	39	45 ^{1,2}	10	20 ²	72	78 ²
5	54	30	90	48	54 ¹	20	84	42	48 ^{1,2}	10	20 ²	78	84 ²
6	60	30	90	54	60 ¹	20	84	48	54 ^{1,2}	10	20 ²	78	84 ²

Table 4: Specific external noise

- periods A, B, C for noise levels in the Brussels legislation (Table 3);
- limit values applicable to specific external noise (LSP) generated by classified installations (Table 4);
- limit noise levels, inside a building, for emergencies due to noise neighbourhood (Table 5).

Building	Period	Emergence		
		Level noise [dB(A)]	Tonal [dB(A)]	Impulsive [dB(A)]
Rest	C	3	3	5
Rest	A, B	6	6	10
Residence	A, B and C	6	6	10
Service	A, B and C	12	12	15

Table 5: Limit noise levels for emergencies due to noise neighbourhood

3.5 Spain, Andalucia

In Spain, in the region of Andalucia, Articles 22 and 23 of *Decree 326/2003 of the Junta de Andalucia Regulations for protection against noise pollution* define limits for the assessment of noise disturbance within buildings [Dec, a].

Inside a building, the evaluation of the noise level, defined *NAE* and expressed in dB(A), use the equivalent noise level L_{Aeq} , with appropriate corrections. The evaluation index of the equivalent

sound level, L_{Aeq} , is measured with doors and windows closed. The limits of the noise level NAE , generated from activities, installations or installations noisy outside the perimeter of the building, are function of time, of the zoning and of the type of local. The absolute limit values, valid for the inside with the windows closed, varies as follows:

- 25 dB(A) for night time and 30 dB(A) for daytime for nursing homes;
- 30 dB(A) for night time and 35 dB(A) for daytime for accommodation in residential areas;
- 45 dB(A) for night time and 55 dB(A) for daytime per commercial buildings destined for tertiary sector.

If the background noise without noisy activity, measured by L_{Aeq} , exceeds the limits of NAE , the background noise is the permissible limit value of NAE .

Computed the equivalent level of noisy L_{AeqAR} , the value of NAE , is determined with respect to the background noise of P , the pure tones ($K1$) and impulsive tones ($K2$) by the following expression:

$$NAE = L_{AeqAR} + A, \tag{4}$$

where A is numerically equal to the larger of the following indices:

- correction for the background noise P ;
- pure tone correction $K1$;
- correction to impulsive tones $K2$.

The expression L_{90} indicates the level exceeded for the 90% of the measurement time. If the level L_{90} , measured inside the area in the absence of noisy activity, is less than 27 dB(A), the correction factor is $P = 0$. In this case, we adopt the following relationship:

$$NAE = L_{AeqAR} + P \tag{5}$$

where

- L_{AeqAR} is equivalent continuous sound level produced by the noisy activity;
- P is the correction factor according to Table 6 which can vary from 0 to 3.

L_{90}	P
$q < 24$	3
25	2
26	1
≥ 27	0

Table 6: Values of the correction factor P

In the presence of tonal components within the building, the evaluation NAE is developed by the following relation:

$$NAE = L_{AeqAR} + K1, \quad (6)$$

correction factor ($K1$) assumes the value 5 dBA.

In the presence of impulsive components within the building, the evaluation NAE is developed by following relation:

$$NAE = L_{AeqAR} + K2, \quad (7)$$

In the case of correction of impulsive tones, the value of $K2$ varies from 2 to 5 dB(A), according to the definitions contained in section 2.2 of Annex III of this Regulation.

Measurements are acquired inside the apartment with windows closed. The sound level meter must be positioned at least 1.20 m from the reflective surface and not less than 1.20 m above the ground.

3.6 Portugal

Article 13 of Decree Law 9/2007 regulates the activities noisy permanent [Dec, c]. The installation and operation of permanent noisy activity in the mixed zone must respect criteria of the disorder. This criterion considers the difference between the value of the noise level expressed by equivalent continuous sound level L_{Aeq} , in the presence of one or more noisy activity, and the value of equivalent continuous sound level L_{Aeq} of the residual noise. In accordance with Annex I of the Regulation, this difference may not exceed following values:

- 5 dB(A) in daytime;
- 4 dB(A) in the evening;
- 3 dB(A) in the night time.

If the value of L_{Aeq} of the exterior ambient noise is less than or equal to 45 dB (A), the above provisions do not apply. Similarly, if the value of L_{Aeq} of environmental noise within the receptor is less than or equal to 27 dB(A), the above provisions do not apply.

If there are any tonal or impulsive components in the noise level, Annex I to the Ordinance provides that the value of L_{Aeq} is correct. The correct level L_{Ar} is obtained by the following formula:

$$L_{Ar} = L_{Aeq} + K1 + K2 \quad (8)$$

where

- $K1 = 3$ dB(A) is the correction for tonal components;
- $K2 = 3$ dB(A) is the correction for impulsive components.

If the tonal and impulsive components are not identified, $K1 = 0$ dB(A) dB and $K2 = 0$ dB(A). If there is any tonal and impulsive components, the correction is $K1 + K2 = 6$ dB(A).

In order to identify tonal components in noise, analysis is performed for spectral bands normalized to 1/3 octave. We consider tonal components with the stationary character in the time domain and frequency. The analysis must be carried out in the frequency range from 20 Hz to 20 kHz. If the minimum level of bandwidth exceeds 5 dB minimum levels of adjacent bands, there is a tonal component.

In order to identify impulsive components in the noise, we measure the maximum values:

- $L_{AI,max}$, impulse and A-weighted sound level;
- $L_{AF,max}$, fast and A-weighted sound level.

If there are following conditions:

- the event is repetitive,
- and the difference in $(L_{AI,max} - L_{AF,max})$ is greater than 6 dB,

the noise level contains impulsive components.

The L_{Ar} is corrected with the value D (Table 7). The D value is a function of ratio q between time cumulative duration of noise level and reference period. The value of D ranges from 0 to 4. If the noise persists for more than 75% of the reference period, D is 0. If the noise persists for a time less than or equal to 12.5% of the reference period, D is 4. In order to assess the policy, the time interval, which refers to the indicator L_{Aeq} , corresponds to a month. In the case of annual seasonality, the time interval corresponds to the most critical month of the year in the noise level.

Reference period	D
$q < 12.5\%$	4
$12.5\% < q < 25\%$	3
$25\% < q < 50\%$	2
$50\% < q < 75\%$	1
$q > 75\%$	0

Table 7: Values of the correction factor D

3.7 Switzerland

In Switzerland, there are the following laws and regulations:

- the law *OIF Noise Abatement Ordinance* of 15/12/1986;
- the *Environmental Protection Act LPAmb 07.10.1983*;
- *SIA 181 12/09/2006* on the protection of buildings from outside and internal noise sources.

The National Law OIF, the main legislative reference, has the purpose of protection from harmful noise and nuisance products by road and rail infrastructure, industrial plants, civil and military airports, military and civilian shooting ranges. Annex 6 (limit values for noise exposure in industry and the arts and crafts of the Law OIF) provides the reference values, shown in Table 8.

The exposure limit values are valid for the noise:

- from the ski industry, arts and crafts and agriculture;
- transshipment facilities in the industry, arts and crafts and agriculture as well as in railway stations and airports;

Grado	Value of effective planning		Threshold limit value L_r dB(A)		Alarm limit value	
	Daytime	Night time	Daytime	Night time	Daytime	Night time
I	50	40	55	45	65	60
II	55	45	60	50	70	65
III	60	50	65	55	70	65
IV	65	55	70	60	75	70

Table 8: Reference values according to the degree of sensitivity

- c. from the traffic on the distribution areas of the plant industry, arts and crafts and on the threshing floor of farms;
- d. from buildings used for parking and the parking of a certain size out of the streets;
- e. from heating, ventilation and air-conditioning.

The systems of energy production, disposal and transport, ropeways and funicular railways, ski lifts and facilities for the practice of motor sports, which operate regularly for extended periods of time, are equivalent to the ski industry and arts and crafts. Although not stated by the law, operators detect the emission values at a distance of 1 m and the input values at the receptors. Differential criteria are not expected in OIF national law.

In accordance with Articles 14 of the Federal Act of June 22, 1979 concerning area planning, the zones have the following degrees of sensitivity:

- degree I that requires a high noise protection;
- degree II residential areas and public buildings;
- degree III mixed areas with craft settlements;
- degree IV to industrial zones.

Parts of the areas of use with a degree of sensitivity I or II may be downgraded by one degree if they are already exposed to noise.

The level of noise assessment L_R industry, arts and crafts and other similar noises is calculated for the day from 7 am to 19 and for the night from 19 pm to 7 levels by partial evaluation of $L_{r,i}$ of each phase noise:

$$L_r = 10 \log \sum_i 10^{0.1L_{r,i}}, \tag{9}$$

The level of partial evaluation $L_{r,i}$ of the average daily duration of the phase noise is obtained by the following formula:

$$L_{r,i} = L_{eq,i} + K_{1,i} + K_{2,i} + K_{3,i} + 10 \log \left(\frac{t_i}{t_0} \right), \tag{10}$$

where

- $L_{eq,i}$ is equivalent continuous sound level for the phase i of the noise;
- $K_{1,i}$ is the level correction for the phase i of the noise due to the type of source;
- $K_{2,i}$ is the level correction for the phase i of the noise because of the tonal components;
- $K_{3,i}$ is the level correction for the phase i of the noise because of the impulsive components;
- t_i is the average daily duration in minutes of the phase noise i ;
- $t_0 = 720$ minutes.

The phases are the periods of perceived sound level, of tonal and impulsive components in a uniform way on the site. Application of the formula is deduced that, for phase noise less than the time of day or night reference, the rating level $L_{r,i}$ decreases as a function of the logarithmic term time-weighting. Although not stated in the law, operators calculate the $L_{q,i}$ by subtracting the background noise to environmental noise.

The average daily duration t_i of the phase of the noise i is obtained by the following relationship:

$$t_i = \frac{T_i}{B}, \quad (11)$$

where

- (T_i) is annual duration;
- (B) is number of days of operation per year.

In the case of new or modified installations the average daily duration of the phase noise i is determined by the operating forecasts.

As indicated in the report (10), we consider the corrections K_1 , K_2 and K_3 .

The correction K_1 is equal to:

- 5 in the case of noise from domestic industry, transshipment at the facilities of industry, agriculture arts and crafts, train stations and airports;
- 0 in the case of traffic noise on the plant industry, arts and crafts and on the threshing floor of farms;
- 0 for daytime and 5 for nighttime in the case of noise from buildings to parking and the parking of a certain size out of the streets;
- 5 for daytime and 10 for nighttime in the case of noise produced by heating systems, ventilation and air-conditioning.

The correction K_3 considers impulsive noise events at placing and is equal to:

- 0, if the impulsive component is not audible;
- 2 if the impulsive component is weakly audible;
- 4 if the impulsive component is distinctly audible;
- 6 if the impulsive component is strongly audible.

Countries	Value [dB]		
	Day	Evening	Night
Francia	5	3	3
Italia	5	3	3
Belgio	12	–	3
Portogallo	5	4	3
Regno Unito	10	–	–

Table 9: Differential criteria

4 Discussion

In terms of legal criteria for the evaluation of noise, European countries are divided into two groups:

- a first group of countries apply the criteria of differential type;
- a second group of countries apply an absolute standard.

In Belgium there are two criteria. The criteria of the differential type, with the exception of the UK, measure the difference between ambient noise and residual noise, measured by equivalent continuous sound level.

The limit sound levels are following values:

- In France and Italy, the limits are, respectively, 3 dB for the night and 5 dB for the daytime. The correction is a function of the duration of the noise.
- In Belgium, the differential is evaluated with the windows closed and the limits vary from 3 to 12 dB according to the use of the dwelling and the time of day;
- in Portugal, the limits are 3, 4 and 5 dB, respectively, per night, evening and daytime;
- in UK the permitted level depends on underlying level of noise and a limit sound levels, equal to 10 dB(A) (Table 9).

The rules are in relation to the type of source. The matter is regulated by law in the case of noise in the neighborhood, to public places and temporary exhibitions. The limits sound levels are indicated in dwellings with windows closed. In the case of industrial noise limits noise levels, in the external environment, are proposed by BS 4142:1997

The absolute criteria have limitations associated with the division of the territory into areas in Italy, Germany, Switzerland and Belgium. In Spain, the limits are related to the condition of closed windows and depend on the area, the type of building and the time of day.

The tonal and impulsive components are considered. The methods of measurement are specific. The fixes for the duration of the noise are applied by various methods. In the case of Germany, the limits also depend on the time of day. Swiss law provides fixes sound levels in relation to the type of source (air conditioning, traffic, parking, industry). Belgium aims limitations associated with the area and the period of the day. Directive 2002/49/EC introduces important aspects:

- *assessment methods* by noise indicators L_{den} and L_{night} ;
- *noise mapping*, presentation of data on an existing or predicted noise situation in terms of a noise indicator, indicating breaches of any relevant limit value in force, the number of people affected in a certain area, the number of dwellings exposed to certain values of a noise indicator in a certain area;
- *strategic noise map*, designed for the global assessment of noise exposure in a given area due to different noise sources or for overall predictions for such an area;
- *action plans*, designed to manage noise issues and effects, including noise reduction if necessary;
- *acoustical planning*, controlling future noise by planned measures;
- Member States have to ensure that the strategic noise maps they have made, and where appropriate adopted, and the action plans they have drawn up are made available and disseminated to the *public* in accordance.

5 Conclusion

Outside of the broader noise reduction and method harmonisation objectives of the Environmental Noise Directive (END), four key areas of importance for the assessment and management of environmental noise under the terms of the legislation have been identified:

1. strategic noise mapping;
2. estimating population exposure;
3. noise action planning;
4. dissemination of information to the public.

With regard to (1), strategic noise mapping is defined within the Directive as a map designed for the global assessment of noise exposure in a given area due to different noise sources for overall predictions for such an area (EU, 2002, 14). Thus, strategic noise mapping is concerned with the practicalities of the noise mapping exercise as well as the assessment of exposure within designated areas.

Under (2), the assessment of population exposure is to be achieved using measurements of exposure at the most exposed building facade. These are to be used as a basis for identifying levels of population exposure within agglomerations.

In this regard the Directive requires competent authorities in each Member State to provide estimates of the number of people living in dwellings that are exposed to values of the recently established EU noise indicators L_{den} (day–evening–night–time equivalent sound pressure level) and L_{night} level) separately for road, rail, air traffic and for industrial noise (EU, 2002, 24).

The third key area (3) of concerns noise action planning. In the Directive, action plans refer to plans designed to manage noise issues and effects, including noise reduction if necessary (EU, 2002, 14). It is a requirement that competent authorities draw up action plans for the major roads, railways and agglomerations within their remit. These plans are also to be reviewed every five years once adopted and on an ongoing basis by accounting for major new developments in designated areas.

The final key area (4) relates to the dissemination of results from the strategic noise mapping process to the general public. The Directive requires that strategic noise maps and action plans are not only made available to the public but also disseminated in accordance with Directive 90/13/EEC on the freedom of access of information to the environment. The availability of the information must also conform to the minimum requirements for strategic noise mapping and action plans laid down in Annexes IV and V of the END (EU, 2002, 22–23).

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