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DAY-EVENING-NIGHT LEVELS APPRAISAL USING A "NOISE CHART"

A. Guglielmo*[1], G. Carati[1], E. Carlini[1], C. Marzi[2], D. Donati[1]

[1]Municipality of Rome - Department of Environmental and Agricultural Policies
Via Cola di Rienzo, 23, 00192, Rome, Italy
[2]Italian National Agency for New Technologies, Energy and Environment
Casaccia, Via Anguillarese, 301, 00060, Rome, Italy
a.guglielmo@comune.roma.it

Abstract

The Italian policy concerning the environmental noise measurement and management, pursuant to the Framework Law on noise pollution. No.447 of 1995 and Its concerning decrees, sets the L_{Aeq} value (A-weighted equivalent continuous sound pressure level) as indicator for environmental noise evaluation. In particular, the Italian decree DPCM (Decree of the President of the Republic) No.280 of 14.11.1997 sets daytime and night-time noise emission limits (limits set at the source of noise) and immission limits (set at the receiver), for each type of land use, in accordance with law n° 447/95. According to the Legislative Decree No.194 of 19.08.2005, the appropriated environmental descriptor for noise pollution determination and management will be in a near future the day-evening-night level (L_{den}), calculation based on noise levels measured in these three different reference periods: (day - evening - night). The present paper outlines the methodology for converting the equivalent continuous sound level into the new European indicator L_{den}, from numerous long-term sound level measurements carried out within the administrative area of Rome's municipality. The main objective of this paper is to develop a chart, which reading makes possible to identify the values of the "new" noise levels values (L_{den}, L_{day}, L_{night} and $L_{evening}$) from "old" (day and night) noise levels (L_{AeqD}, L_{AeqN}) and from statistical distribution of levels measured on such periods. Subsequently, the analysis has been extended to the determination of limit values afferent to each type of land use.

INTRODUCTION

The body of legislation connected with to the measure and management of the environmental noise, in according to the Outline Law n. 447 dated 1995 and relatives Decrees, determines the indicator for the environmental noise evaluation (excluding the evaluation noise coming from the airport), the equivalent level continuous of the

cautions sounding pressure A (L_{Aeq}); this indicator is calculated for two temporal intervals, diurnal (6.00-22.00) and nocturnal (22.00-06.00), and it is determined on the different temporal principle in according to the source quality: for example for the road noise the temporal principle is at least one week.

The Decree with the force of law dated August 19th 2005 n. 194, enacted for carrying into effect the instruction 2002/49/CE, having the purpose to harmonize the management of the environmental noise in the European context, shows new indicators of evaluation about the environmental noise such as the day-evening-night level (L_{den}) (as general indicator of trouble) and L_{night} (for the sleep trouble).

The L_{den} is calculated on the principle of the noise levels measured in three temporal intervals: diurnal (06.00–22.00), evening (20.00-22.00) and nocturnal (22.00-06.00) and it is determined on the annual temporal principle. It is indispensable very soon to calculate and/or to estimate the values about the new European describers L_{den} and L_{night} starting from the values of the noise levels determined in according to the national body of legislation. This note determines a methodology for the conversion of the daily noise on the indicators L_{den} and L_{night} through the use of a temporal succession of L_{Aeqh}, times collected continuously for 24 hours in 95 spots of measure within the municipality of Rome.

The purpose about this work is to create a paper to find out the values of the "new" noise levels changing, also, the limit values of the Italian legislation apart from the sounding source quality.

ENVIRONMENTAL LEVELS DETERMINATION

It is common knowledge that the Decree with the force of law dated August 19th 2005 n. 194, enacted for carrying into effect the instruction 2002/49/CE, establishes (having the purpose to make the acoustic describes uniform suggested from the single member States) a new acoustic describer the day – evening – night (Lden) determined as follows:

$$L_{den} = 10 \cdot \log_{10}\left[\frac{1}{24} \cdot \left(14 \cdot 10^{\frac{L_{day}}{10}} + 2 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}}\right)\right] \quad \left[L_{den} = dB(A)\right] \qquad (1)$$

where:

- L_{day} (day level) is the acoustic describer relative to the period from h 06.00 to h 20.00;
- $L_{evening}$ (evening level) is the acoustic describer relative to the period from h 20.00 to h 22.00;
- L_{night} (night level) is the acoustic describer relative to the period from h 22.00 to h 06.00.

The Italian body of legislation connected with to the measure and management of the environmental noise, in according to the Outline Law n. 447 dated 1995 and relatives Decrees, determines the indicator for the environmental noise evaluation, the equivalent level continuous of the cautious sounding pressure A (L_{Aeq}): for the diurnal period h 6.00 - 22.00 (L_{AeqD}) for the nocturnal one h 22.00 - 06.00 (L_{AeqN}).

To characterize on the whole the 24 hours period, you can relate to the global daily level (L_g) obtained composing the two continuous equivalent levels connected with to the diurnal and nocturnal period as follows:

$$L_g = 10 \cdot \log_{10}\left[\frac{1}{24}\cdot\left(16\cdot 10^{\frac{L_{eqD}}{10}} + 8\cdot 10^{\frac{L_{eqN}}{10}}\right)\right] \qquad \left\lfloor L_g = dB(A)\right\rfloor \qquad (2)$$

where:

- L_{AeqD} is the continuous equivalent cautious level A connected with the diurnal period (h 06.00 – 22.00);
- L_{AeqN} (evening level) is the acoustic describer relative to the period from h 20.00 to h 22.00.

The following schedule n. 1 shows the inlet values of the daily global level (L_g) determined using the report n. 2 for 10 about the 95 spots of measure analysed within the municipality of Rome. There are also describers values L_{den}, L_{day}, $L_{evening}$, L_{night} calculated using the equivalent hours levels of inlet (L_{Aeqh}) continuously calculated 24 hours on the above-named spots.

Schedule 1 – Environmental level of inlet for the first 10 spots of measure

N° spots of measure	**L_{AeqD}** (6:00 -22:00)	**L_{AeqN}** (22:00-6:00)	**L_g**	**L_{den}**	**L_{day}** (6:00 – 20:00)	**$L_{evening}$** (20:00 -22:00)	**L_{night}** (22:00 - 6:00)
1	63.0	58.7	62.0	63.1	60.1	59.6	55.7
2	62.6	58.1	61.5	62.6	59.7	58.8	55.1
3	62.1	58.3	61.2	62.5	59.4	56.1	55.3
4	63.1	60.2	62.4	64.6	59.0	64.3	57.2
5	76.4	73.4	75.6	77.3	73.6	71.3	70.4
6	61.5	56.4	60.3	61.2	58.5	58.6	53.4
7	61.9	56.4	60.7	61.4	58.9	58.8	53.4
8	77.1	73.6	76.2	77.6	74.4	69.8	70.6
9	58.6	55.5	57.8	59.7	55.1	57.9	52.5
10	60.2	56.4	59.3	60.7	57.2	57.1	53.4

It is clear that L_{den} values are superior then L_g because of the punishment of 5 dBA and 10 dBA by comparison with $L_{evening}$ and L_{night} (see schedule n.1). It is

indispensable to specify that the environmental noise characterizing the 95 spots is due prevalently to the vehicle traffic, because there are also deductions of industrial and handicrafts activities.

For this reason the instruction 2002/49/CE, accepted by the D.L. n. 195 in the year 2004, it has never explained whether the "future" limit values should be differentiated in according to the kind of sounding source, as well as on the Italian legislation actually happens. This allows the operation of changing of the limit values L_{den}, starting from the information not differentiated in according to the kind of source.

CURRENT LIMIT VALUES CONVERTION L_{DEN} THROUGH THE PAPER

To describe the procedure of conversion we considered the limits set up for the six use destination classes of the territory referring to the DPCM dated November 14th 1997, related on the schedule 2 creating, starting from them, the daily global level movement L_g in function of the L_{AeqD} and L_{AeqN}.

Schedule 2 – Inlet total limit values (DPCM November 14th 1997).

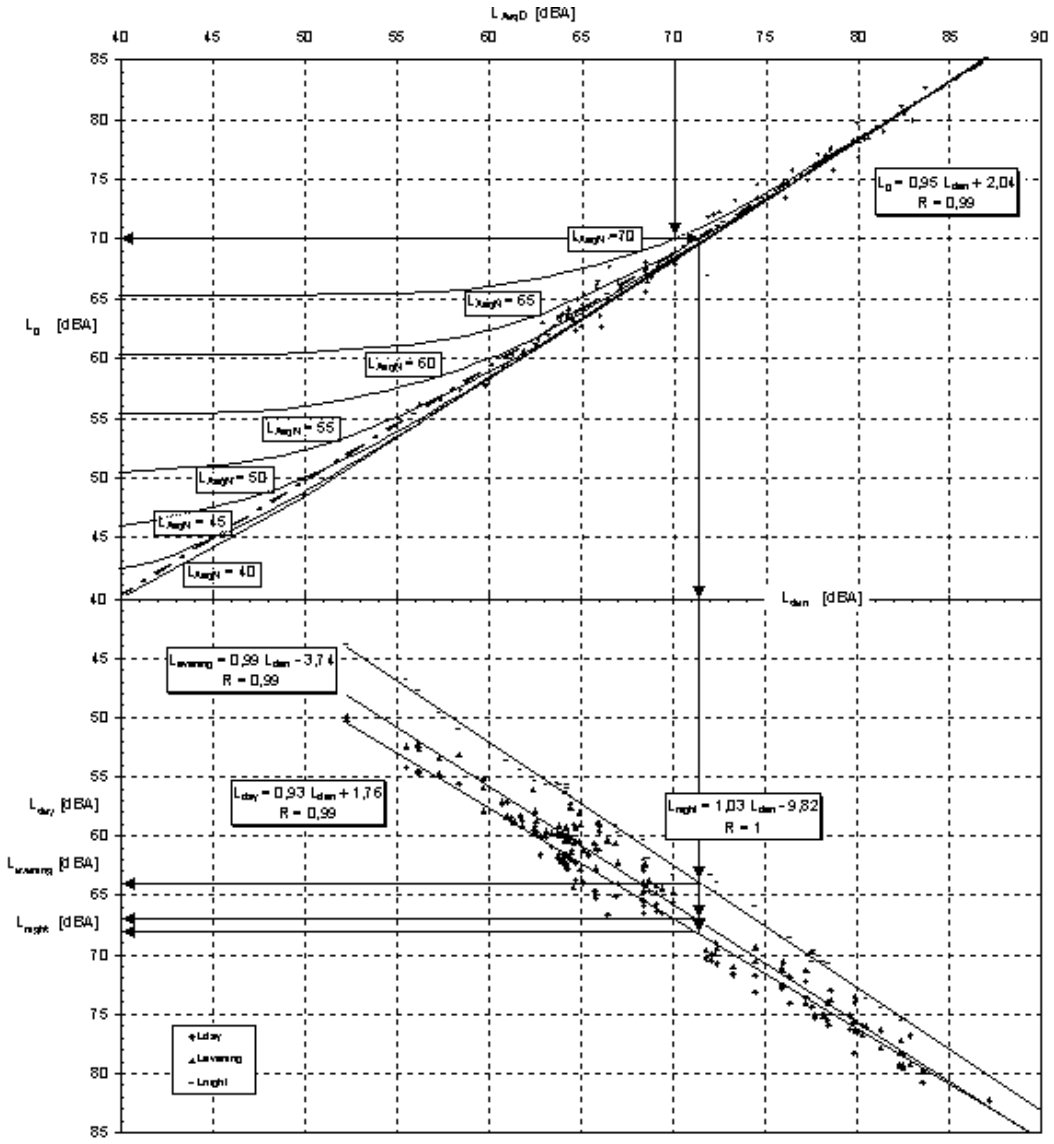
USE DETERMINATION CLASSES OF THE TERRITORY	L_{AeqD} (6:00 -22:00)	L_{AeqN} (22.00 - 6:00)
I - Zones particulary protected	50	*40*
II - Zones prevalently residential	55	*45*
III - Mixed zones	60	*50*
IV - Zones of intense human activity	65	*55*
V - Zones prevalently industrial	70	*60*
VI - Zones only industrial	*70*	*70*

Then the L_g, L_{day}, $L_{evening}$ and L_{night} values have been connected in function of L_{den} for all the 95 spots of measure, individualizing for each indicator the regression straight line to greater coefficient of correlation, related on the schedule 3.

Schedule 3 - Correlation between L_g and $L_{den,}$, L_{day} and L_{den}, $L_{evening}$ and L_{den} , L_{night} and L_{den}.

INDICATOR	REGRESSION STRAIGHT LINE EQUATION	COEFF. OF CORRELATION
L_g	$L_g = 0{,}95\ L_{den} + 2{,}04$	0,99
L_{day}	$L_{day} = 0{,}93\ L_{den} + 1{,}76$	0,99
$L_{evening}$	$L_{evening} = 0{,}99\ L_{den} - 3{,}74$	0,99
L_{night}	$L_{night} = 1{,}03\ L_{den} - 9{,}82$	1,00

The picture 1 shows the conversion paper of the noise obtained superimposing, for an easer reading, the different sections.



Picture 1 – Conversion paper of the noise.

The paper is made up of two quadrants: on the superior quadrant is related the daily global level movement (L_g) in function of the diurnal equivalent continuous levels (L_{AeqD}) to the changing of the nocturnal equivalent continuous level values (L_{AeqN}) for the different classes of use destination of the territory placed on the L_g graphic in function of the day-evening-night level (L_{den})

On the lower part of the quadrant are related the dispersion diagrams of L_{day}, $L_{evening}$ and L_{night} in function of L_{den} with the relatives straight lines.

An example can be useful to understand the use of the paper: supposing to get to know the limit values of inlet about the new describers L_{den} and L_{night} for the VI class of use destination of the territory (zone only industrial) starting from the couple of the absolute limit values of inlet L_{AeqD} = 70 dBA, , L_{AeqN} = 70 dBA (see schedule 2). On the superior quadrant of the paper you trace the equation straight line L_{AeqD} = 70 dBA which intersection with the curve at L_{AeqN} = 70 dBA determines a point which horizontal line for it, individualizes on the left side the L_g values readable on the axis of ordinates (equal to 70 dBA), and on the right side intersecting the regression straight line L_g/L_{den} a point which abscises individualizes in lower manner the L_{den} value. Then extending on the lower part of the quadrant the straight line at equation L_{den} = 71 dBA they determine 3 points through intersection with the regression straight lines L_{day} /L_{den}, $L_{evening}/L_{den}$ and L_{night}/L_{den}, which ordinates respectively provide the L_{day} = 68 dBA, $L_{evening}$ = 67 dBA and L_{night} = 64 dBA.

Therefore the "old" limit values of inlet L_{AeqD} = 70 dBA, L_{AeqN} = 70 dBA for the VI class of use destination of the territory (zone only industrial) they should change in the "new" L_{den} = 71 dBA and L_{night} = 64dBA and also L_{day} = 68 dBA, $L_{evening}$ = 67dBA.

The schedule 5 relates the "future" limit values of inlet, explained in dBA for all the classes of use destination of the territory, obtained changing the limit values, coming from the outline law, using the procedure described above.

Schedule 5 - Comparison between the "old" and "new" absolute limit values of inlet.

USE DETERMINATION CLASSES OF THE TERRITORY	**D.P.C.M. 14/11/97**		***Decree with the force of law n. 194***			
	L_{AeqD}	**L_{AeqN}**	**L_{den}**	**L_{day}**	**$L_{evening}$**	***L_{night}***
I - Zones particulary protected	50	40	46	45	42	*38*
II - Zones prevalently residential	55	45	51	50	47	*43*
III - Mixed zones	60	50	57	54	52	*49*
IV - Zones of intense human activity	65	55	62	59	58	*54*
V - Zones prevalently industrial	70	60	67	64	63	*59*
VI - Zones only industrial	*70*	*70*	*71*	*68*	*67*	*64*

On the schedule 6 are related the differences between the limit values considered for some different acoustic indicators with reference to the different classes of use destination.

It is important that:

1. The difference between L_{den} and L_{night} is equal to 8 dBA for all the classes;

2. The limit values of L_{AeqD} and L_{AeqN} are always greater than "corresponding" calculated in different periods of time, L_{day} and L_{night} with different variability for the various classes;

3. The difference between L_{AeqD} and L_{den} decrease as the acoustic classes increase.

Schedule 6 – Differences between the limit values.

USE DETERMINATION CLASSES OF THE TERRITORY	**L_{den}-L_{night}**	**L_{eqD} -L_{day}**	**L_{eqN} -L_{night}**	**L_{eqD} -L_{den}**
I - Zones particulary protected	8	5	2	4
II - Zones prevalently residential	8	5	2	4
III - Mixed zones	8	6	1	3
IV - Zones of intense human activity	8	6	1	3
V - Zones prevalently industrial	8	2	1	3
VI - Zones only industrial	8	2	6	-1

Extending the procedure of conversion used previously, to the values of quality always provided by DPCM dated November 14th 1997, you have obtained also the values of quality explained in L_{day}, $L_{evening}$, L_{night} and L_{den} (see Schedule 7).

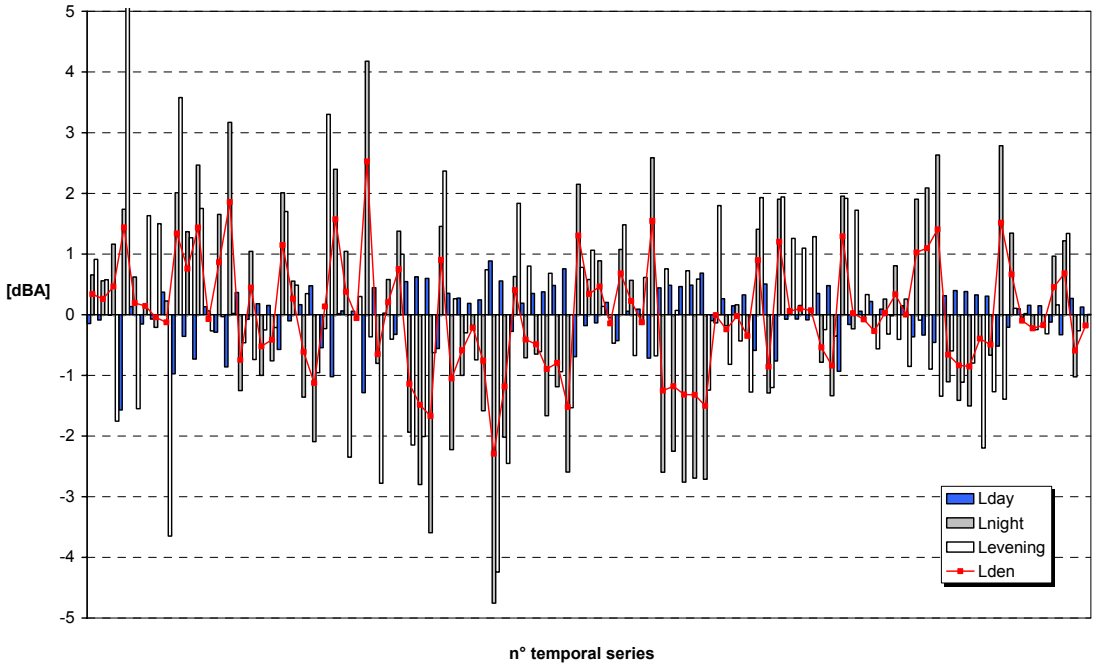
Schedule 7 – comparison between the "old" and "new" values of quality.

USE DETERMINATION CLASSES OF THE TERRITORY	**D.P.C.M. 14/11/97**		***Decree with the force of law n. 194***			
	L_{AeqD}	**L_{AeqN}**	**L_{den}**	**L_{day}**	**$L_{evening}$**	***L_{night}***
I - Zones particulary protected	47	37	43	42	39	*35*
II - Zones prevalently residential	52	42	48	47	44	*40*
III - Mixed zones	57	47	53	51	49	*45*
IV - Zones of intense human activity	62	52	59	56	55	*51*
V - Zones prevalently industrial	67	57	64	61	60	*56*
VI - Zones only industrial	*70*	*70*	*71*	*68*	*67*	*64*

Extensible to the values of quality are the differences that you can see on the schedule 6, and then also the relatives considerations, being the transfer of the function the same from the "old" and "new" acoustic indicators.

Just to be informed, on the picture 2 there are the values of the refuses between the measured values and values obtained from the regression straight lines the acoustic indicators tested (L_{day}, $L_{evening}$, L_{night} and L_{den}).

It is important to know how the differences are very variable for $L_{evening}$, L_{night}, and less variable for L_{day} and L_{den}.



Picture 2 – Refuses between the measured values and related values.

CONCLUSIONS

In this work has been shown a method of conversion for the passing of the continuous equivalent level of noise diurnal and nocturnal about the new indicator Lden recently selected with the D.L. 194 dated August 19th 2005. Waiting the promulgation of the DPCM who should fix criteria and algorithms for the conversion of the limit values, you recommend a paper of noise conversion which use can be an efficacious tool to determine the future limit values of quality and inlet.

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