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URBAN TRAFFIC NOISE MEASUREMENT OPTIMIZATION

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ABSTRACT
In this research work, a new measurement methodology is presented; the measurement techniques for urban traffic noise are based on the calculus of the minimum exposure time for the equivalent level, which is representative of a longer period of time. This method was developed from actual continuous one-minute measurements. It is very interesting to observe how the equivalent noise level stabilizes itself after a certain period of time, which is very useful to know the length of time required for urban traffic noise measurement.

1 - INTRODUCTION
The laboratory of Acoustic Engineering in the Universidad Politécnica de Valencia has a wide experience in acoustic pollution. For example, the laboratory has developed a traffic noise map of the city. Due to this large experience, a new measurement system was required in order to avoid spending too much time in measures using sonometers. This time exposure that is to be measured must be the optimal; a measurement too long means wasting resources, while a measurement too short could be a lack of representativity of the noise level.
The principle of the urban traffic noise measurement optimization is based on a new concept: *time of stabilization* t_0. A general definition is as follows:
Time of stabilization t_0 is the time of measurement necessary to obtain a difference between the accumulated "t_0 equivalent level" and a longer period of time "T equivalent level", smaller than a certain value ε dBA.
Time of stabilization is obtained when the equivalent level cannot oscillate more than a given bandwidth.

2 - EXPERIMENT DESCRIPTION
The aim of this work is to determine from several measurements what is the time of stabilization of the equivalent level on real urban traffic conditions.
According to the previous definition, a time of stabilization is going to be considered for three different grades of precision ±0.5 dBA, ±1 dBA and ±2 dBA when T reaches one hour. A formula should be written as:

$$|L_{Aeq,1h} - L_{Aeq,t_0}| < \varepsilon$$

Where t_0 is the time of stabilization and ε is the theoretical error bounds 0.5, 1 and 2 dBA.
Acoustic measurements were performed in several streets of the city of Valencia (Spain) following the ISO Standards 1996. Consequently, the source was urban traffic noise. In this study, different types of streets were examined, where the traffic flow is influenced by the position of traffic lights and the number of vehicles.
The sonometer used was Brüel & Kjaer 2260 programmed with the module BZ7202. With this set, it was possible to measure, every minute during one hour, "one minute equivalent levels" $L_{Aeq,1\text{min.}}$, and the global parameter "one hour equivalent level" $L_{Aeq,1h.}$.

Data analysis was completed by connecting the sonometer with the PC and the Evaluator Programme as link. Excel tables were very useful to work with the sixty values (one per minute during one hour) of each street.

3 - DATA ANALYSIS

In the following figures, two different shapes of urban traffic noise are shown.

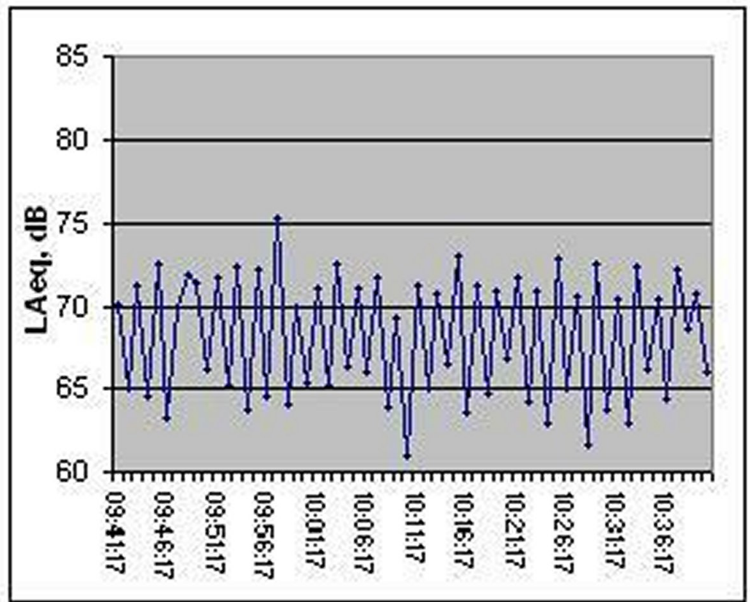

Figure 1: Urban traffic noise oscillations due to the action of traffic lights.

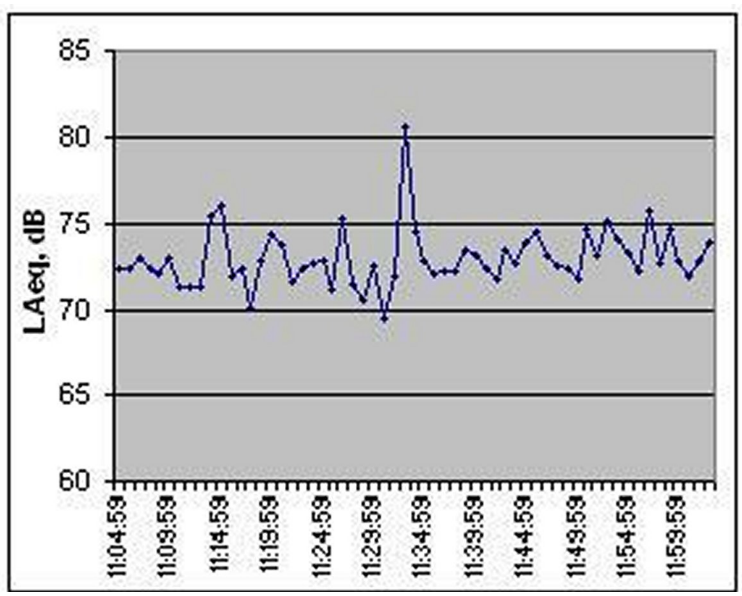

Figure 2: Constant noise where appears a peak as an anomaly.

Accumulating one minute equivalent levels was required as a next step with the formula:

$$L_{Aeq,t} = 10 \log \sum_{i=1i}^{t} \frac{1}{i} 10^{\frac{L_{Aeq,i}}{10}}$$

where $L_{Aeq,\mathrm{t}}$: *t minutes equivalent level*, $L_{Aeq,i}$ *i minute equivalent level.*

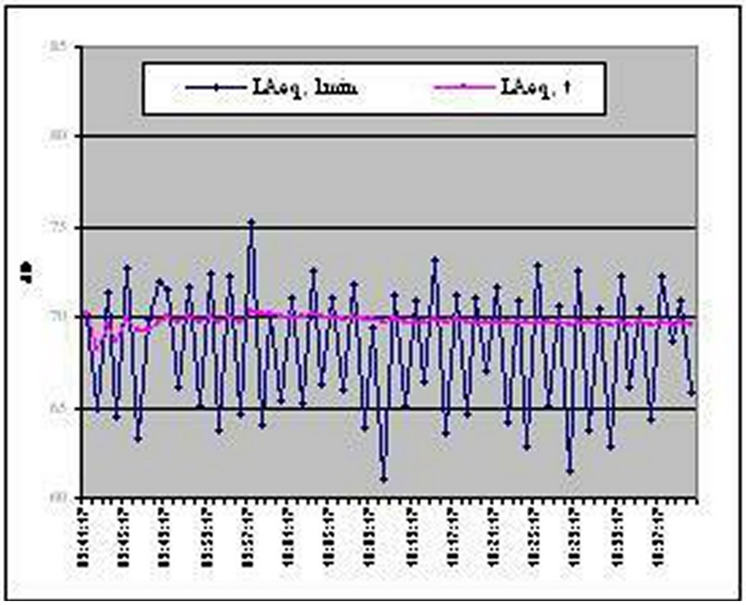

Figure 3.

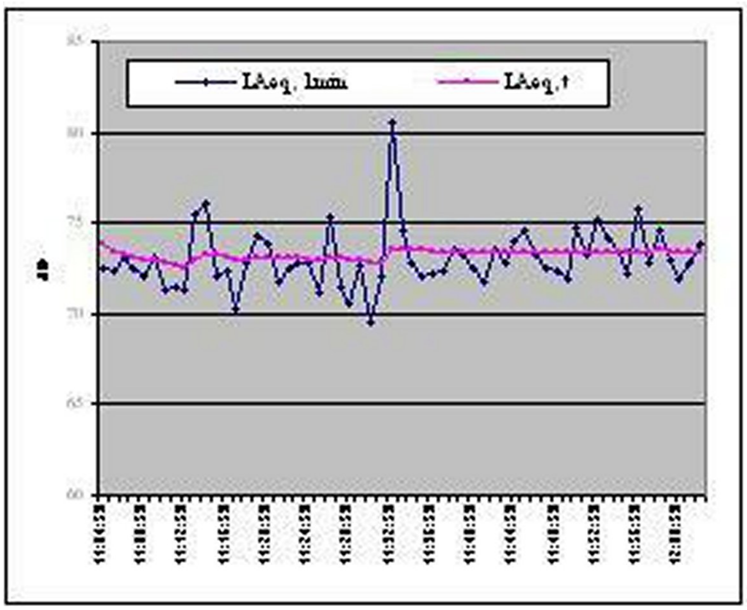

Figure 4.

Accumulation of the t minutes equivalent level $L_{Aeq,t}$ at each situation presented before can be shown in figures 3 and 4.

The main result of this study is the calculation of the time of stabilization, and the methodology is just to observe when the accumulated equivalent level is inside de bandwidth $L_{Aeq,1h} \pm \varepsilon\ dBA$ as the figure 5 shows.

4 - RESULTS

Following the above methodology, time of stabilization is calculated at the 36 measurements for each error (0.5, 1 and 2 dBA). Results are shown in table 1.

Meas.	ε=0.5	ε=1	ε=2
1	24	3	1
2	30	2	1
3	26	16	3
4	19	13	1
5	36	2	2
6	7	5	3
7	4	2	2
8	11	2	2
9	18	11	2
10	31	4	2
11	4	4	2
12	30	7	5
13	20	15	9
14	1	1	1
15	18	2	2
16	27	2	2
17	13	8	2
18	28	2	2
19	5	3	2
20	24	19	3
21	3	2	2
22	16	8	2
23	50	40	2
24	32	22	2
25	18	17	2
26	37	2	2
27	4	2	2
28	12	8	3
29	33	23	9
30	41	29	6
31	14	5	2
32	2	2	2
33	12	2	2
34	33	27	15
35	33	2	2
36	8	5	2

Table 1.

Average			***Standard Deviation***		
ε=0.5	ε=1	ε=2	ε=0.5	ε=1	ε=2
20.11	8.96	2.94	12.7	9.56	2.77

Table 2.

5 - CONCLUDING REMARKS

Considering previous calculations, and using as a reference which recommends ten minutes as a good time exposure, an error of ± 1 dBA has been selected to know about time of stabilization.
In addition, these values are scattered, due to the presence of anomalies that affect the time of stabilization.
This influence and the correlation with other parameters should be considered for future studies.

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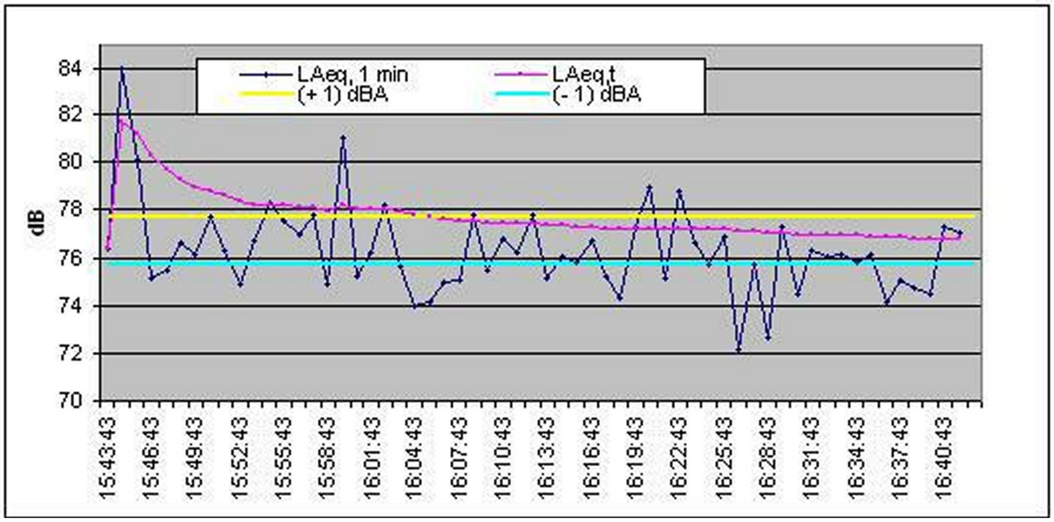

Figure 5.

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