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Comparison of Noise Emissions from in-situ measurements construction projects in Chile with those from British Standard BS 5228-1:2009

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ABSTRACT

In the current work it is presented a comparison between the Sound Power Levels (L_w) determined considering field measurements done by *Control Acústico* in construction works and the levels assessed using the British Standard BS 5228 "Noise and Vibration Control on Construction and Open Sites".

The methodology for the assessment of the Sound Power it is shown and, later, it is presented the comparison with the values determined using the British Standard.

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INTRODUCTION

A big number of Acoustic Impact studies are carried out for projects applying to the Environmental Impact Evaluation System, which is a mandatory procedure for performing any construction Project in Chile.

The Noise Consultant is in charge to evaluate these projects, and it is a hard challenge in order to perform the projects in the better way according some of the following aspects:

- **Revision of the applicable standards;**
- **Generation of the scaled cartography, being geo-referenced for each area of study;**
- **Location of the Noise Sources and the Receivers;**
- **Sound Power Level L_w of the involved noise sources.**

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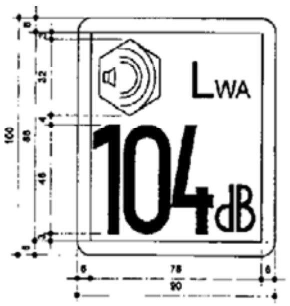
INTRODUCTION

The Sound Power is defined as the total acoustic energy emitted by unit of time.

The Sound Power Level commonly is abbreviated as L_w or *NWS* and it is 10 times the logarithm of the ratio between the assessed Power and 10^{-12} Watt (which represents 0 dB, i.e., the reference).

- **The Sound Power is depends only of the same source, being independent of the medium in which it is located;**
- **Starting from a Sound Power Level is possible to deduce the Sound Pressure Level L_p applying some corrections in function of the characteristics of the environment in which is located the sound source.**



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INTRODUCTION

For the construction stage of the projects, the noise power levels of the machinery determined by *Control Acústico* are assessed in according with the standard BS 5228-1:1997 "Noise and vibration control on construction and open sites.

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THEORETICAL INTRODUCTION

For punctual noise sources is used a simple expression for assessing the Powe Level considering field measurements:

$$Lw = Lp + 20 \cdot \log(r) + 8$$

Where:

Lw **Sound Power Level.**
Lp **Sound Pressure Level.**
r **Distance between the measurement point and the noise source.**

***** J.P.Arenas, S. Gerges . "Fundamentos y control del ruido y vibraciones", Capítulo 1.11, ecuación 1.108, página 35. NR Editora, ISBN 85-87550-04-7, Florianópolis, Brasil, 2004

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METHODOLOGY

A revision of the British Standard provides a Continuous Sound Pressure Level standardized to 10m from the machinery. The levels are given in octave bands between 63 and 8k Hz and a total in dB(A).

Considering the Leq to 10m is obtained the Sound Power Level considering the expression presented previously.

As the distance at which the values are given the Sound Pressure Levels are standardized, it is summed 28 dB for obtaining the Sound Power Level

METHODOLOGY

In the British Standard, in some cases more than 1 level is mentioned for the machinery. For representing the noise of a determined machine, the arithmetic average of the Sound Power Levels is determined

Noise Source	British Standard Lw (dBA)	Arithmetic Average (dBA)
Machine A_1	80	
Machine A_2	83	**80.3**
Machine A_3	78	

MEASUREMENT METHODOLOGY

For the field SPL measurements, it was considered the following:

- **Measurement equipment: Sound Level Meter Larson Davis Model System 824 Class 1 according to the IEC 61672-1:2002 standard.**

- **Evaluated projects: real-state projects, hydroelectrical projects, and construction of highways.**

- **Measurement conditions: the measurements were done in a point far away enough from reflective surfaces and without the presence of a second noise source that it could affect the results.**

- **The measurements were collected between June 2008 and until September 2009.**

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MEASUREMENT METHODOLOGY

Far away from reflectant surfaces

Registers without the influence
of other Noise Sources

Sound Level Meter
LARSON DAVIS
MODELO SYSTEM 824
CLASS 1 IEC 61672

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EVALUATED EQUIPMENT

It was considered the most popular machines in construction Works:

1. Dump Truck (tolva)
2. Electric saw
3. Mixer Truck
4. Mixer truck + Concrete pump
5. Wheeled loader
6. Excavator
7. Manual Compactor
8. Wheeled excavator
9. Kango
10. Concrete Vibrator
11. Mini loader
12. Crane Truck
13. Angular Emery
14. Mixer Truck + telescopic Concrete Pump
15. Overhead Crane

SOUND POWER OF THE EQUIPMENT

In the following slides are presented the Sound Power Levels for different equipment using the standard and the field measurements:

1.- DUMP TRUCK		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
108.8	107.4	-1.4
* ARITHMETIC AVERAGE CONSIDERING 4 FIELD MEASUREMENT		

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SOUND POWER OF THE EQUIPMENT

2.- ELECTRIC SAW

LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
110.6	106.1	-4.5

* ARITHMETIC AVERAGE CONSIDERING 9 FIELD MEASUREMENT

3.- MIXER TRUCK

LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
105.4	99.2	-6.2

* ARITHMETIC AVERAGE CONSIDERING 7 FIELD MEASUREMENT

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SOUND POWER OF THE EQUIPMENT

4.-MIXER TRUCK + CONCRETE PUMP		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
102.8	103.5	0.7
* ARITHMETIC AVERAGE CONSIDERING 8 FIELD MEASUREMENT		

5.- WHEELED LOADER		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
105.4	106.9	1.5
* ARITHMETIC AVERAGE CONSIDERING 4 FIELD MEASUREMENT		

SOUND POWER OF THE EQUIPMENT

6.- EXCAVATOR

LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
103.7	100.8	-2.9

* ARITHMETIC AVERAGE CONSIDERING 8 FIELD MEASUREMENT

7.- MANUAL COMPACTOR

LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
109.1	106.2	-2.9

* ARITHMETIC AVERAGE CONSIDERING 8 FIELD MEASUREMENT

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SOUND POWER OF THE EQUIPMENT

8.- WHEELED EXCAVATOR		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
110.0	103.6	-6.4
* ARITHMETIC AVERAGE CONSIDERING 8 FIELD MEASUREMENT		

9.- KANGO		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
115.8	106.7	-9.1
* ARITHMETIC AVERAGE CONSIDERING 13 FIELD MEASUREMENT		

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SOUND POWER OF THE EQUIPMENT

10.- CONCRETE VIBRATOR		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
101.6	93.3	-8.3
* IT WAS CONSIDERED ONLY 1 MEASUREMENT		

11.- MINI LOADER		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
107.2	103.2	-4.0
* ARITHMETIC AVERAGE CONSIDERING 14 FIELD MEASUREMENT		

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SOUND POWER OF THE EQUIPMENT

12.- CRANE TRUCK		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
104.9	102.2	-2.7
* ARITHMETIC AVERAGE CONSIDERING 3 FIELD MEASUREMENT		

13.- ANGULAR EMERY		
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
108.7	106.6	-2.1
* ARITHMETIC AVERAGE CONSIDERING 21 FIELD MEASUREMENT		

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SOUND POWER OF THE EQUIPMENT

14.- MIXER TRUCK + TELESCOPIC CONCRETE PUMP

LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
105.8	105.2	-0.6

* ARITHMETIC AVERAGE CONSIDERING 3 FIELD MEASUREMENT

15.- OVEARHEAR CRANE

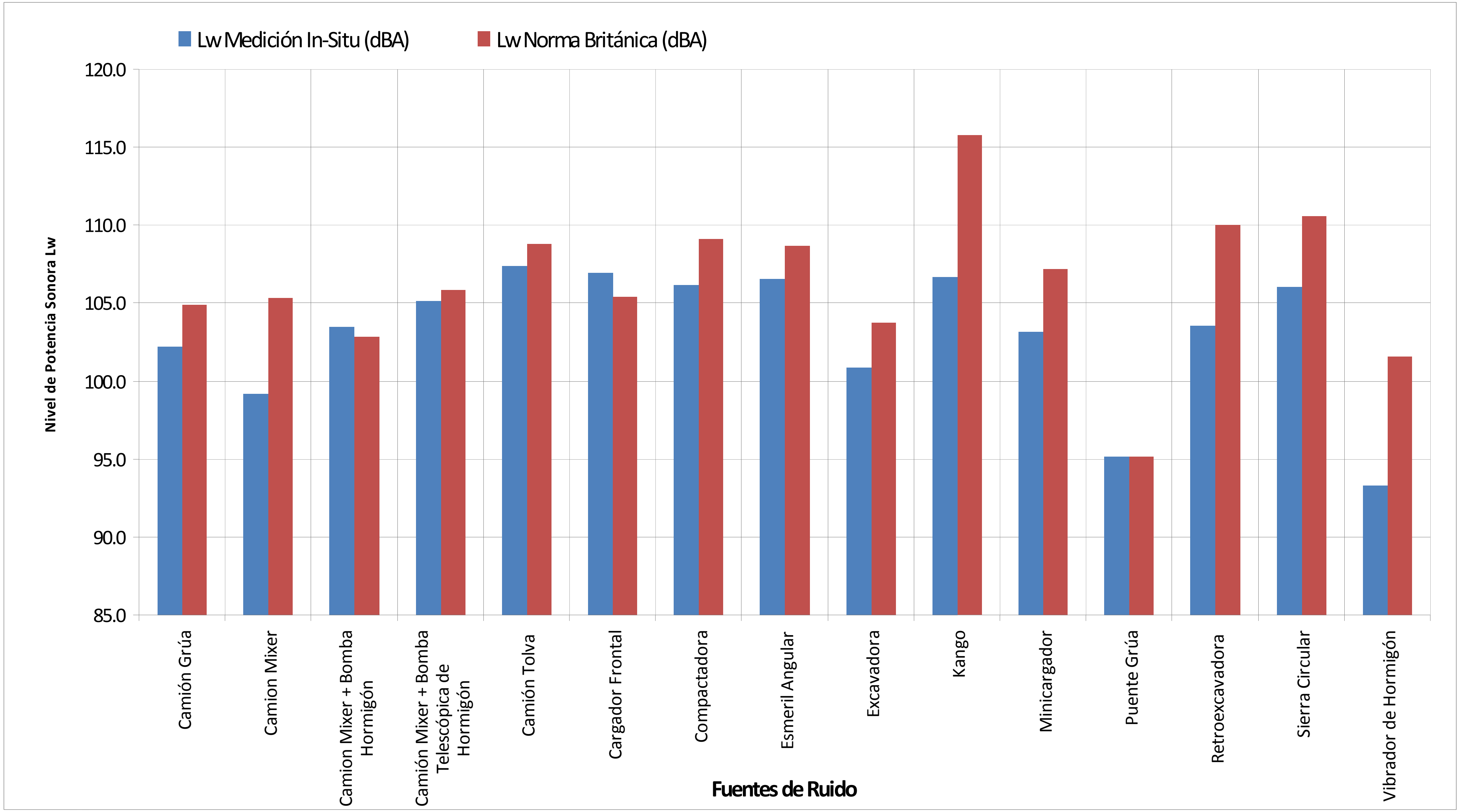
LW dB(A) BS 5228	LW dB(A) in situ*	DIFERENCIA dB
95.2	95.2	0.0

* ARITHMETIC AVERAGE CONSIDERING 4 FIELD MEASUREMENT

ANALYSIS

MAQUINARIA	Lw in situ	Lw BS 5228	DIFERENCIA
Excavadora	100.8	111.0	-10.2
Kango	106.7	115.8	-9.1
Minicargador	103.2	107.2	-4.0
Puente Grúa	95.2	95.2	0.0
Retroexcavadora	103.6	110.0	-6.4
Sierra Circular	106.1	110.6	-4.5
Vibrador de Hormigón	93.3	101.6	-8.3
Camión Grúa	102.2	104.9	-2.7
Camión Mixer	99.2	105.4	-6.1
Camión Mixer + Bomba Hormigón	103.5	102.8	0.7
Camión Mixer + Bomba Telescópica de Hormigón	105.2	105.8	-0.6
Camión Tolva	107.4	108.8	-1.4
Cargador Frontal	106.9	105.4	1.5
Compactadora	106.2	109.1	-2.9
Esmeril Angular	106.6	108.7	-2.1

ANALYSIS



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ANALYSIS AND CONCLUSIONS

- **It is observed, in general, that levels according the British Standard are greater than the measured values.**

- **Lw in situ is grater to the BS Lw values in only 2 of 15 machines with a maximum difference of de 1.5dB, which is the 13% of the cases.**

MAQUINARIA	Lw in situ	Lw BS 5228	DIFERENCIA
Camión Mixer + Bomba Hormigón	103.5	102.8	0.7
Cargador Frontal	106.9	105.4	1.5

- **BS Lw values is greter thn the measured values in the 80% of the cases, with differences between 0.6 and 10.2 dB.**

MAQUINARIA	Lw in situ	Lw BS 5228	DIFERENCIA
Camión Mixer + Bomba Telescópica de Hormigón	105.2	105.8	-0.6
Excavadora	100.8	111.0	-10.2

ANALYSIS AND CONCLUSIONS

- **In a 53% of the cases the difference between the L_w values are within 3 dB, having an average of -1 dB.**

Puente Grúa
Camión Grúa
Mixer Truck + Bomba Hormigón
Mixer Truck + Bomba Telescópica de Hormigón
Dump Truck
Frontal Loader
Compactadora
Esmeril Angular

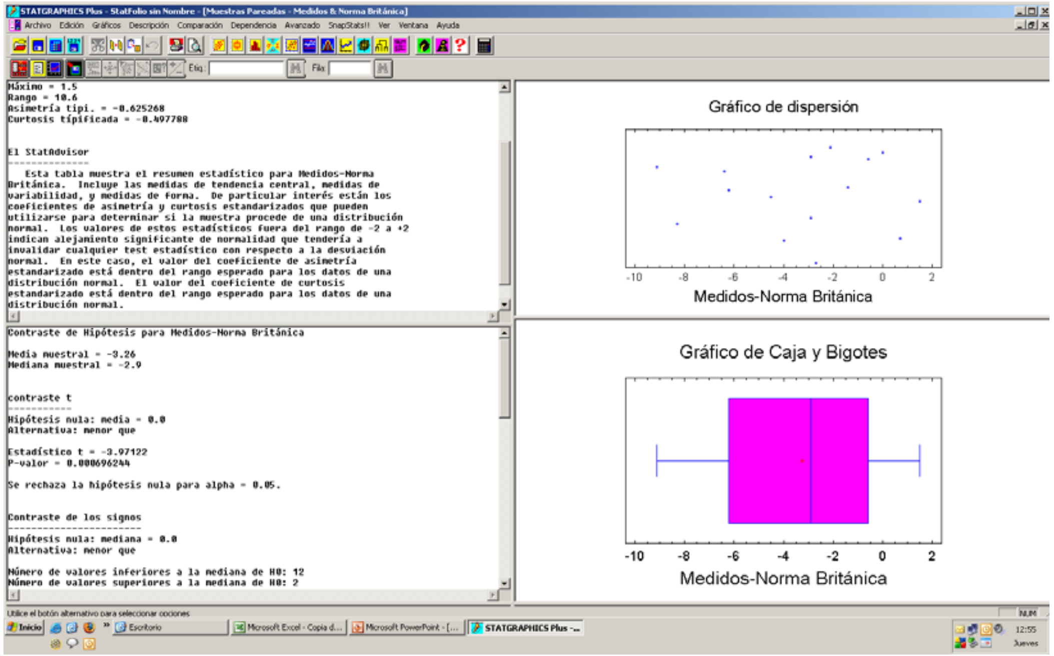
- **In a 47% the differences are greater than 3 dB, with an average of -6.9 dB**

Excavadora
Kango
Minicargador
Retroexcavadora
Sierra Circular
Vibrador de Hormigón
Mixer Truck

ANALYSIS

- **A statistical analysis based on the comparison of paired samples gives the results presented bellow.**

- **Making a t-Student test, assuming a normal distribution of the data, the in-situ L_w values are lower than the BS L_w values with a confidence of 95%.**



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CONCLUSIONS AND RECOMMENDATIONS

The values used by *Control Acústico* from the British Standard BS 5228 "Noise and vibration control on construction and open sites" considering its revisión (2004), are statistically greater than the values measured in Chilean construction projects.

The British Standard is considered appropriate for representing the Sound Power Levels considering a condition of noisy emissions (considering a considerable security factor).

CONCLUSIONS AND RECOMMENDATIONS

It is important to continue with measurements for increasing the certainty of the analysis: some cases were evaluated with a low quantity of measurements.

It was compared the assessed L_w values in Chilean construction works with an international databases for comparing their correlations.

As future work it would be desirable to perform an octave or one-third octave band analysis.

Gracias