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# Acoustical Evaluation of Machine Noise Using A and C Decibel Weighting

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**Abstract**

The study on Fast and slow mode, maximum and minimum readings using sound level, meter was conducted. Sound which is a mechanical disturbance is a wave function in the elastic medium, with a degrees of variance in terms of structural or electromagnetic wave forms, both of which obeys the Broglie theory which states that

$$MV= \frac{hv}{c}$$

Where MV represents the moment of the particle, h= planks constant= 6.625x $10^{-27,}$ 'C' velocity light = $3x10^{8}$ M/S and 'V' the radial frequency of the wave attributed to the particle which are critical in Health safety management. This study is to evaluate the acoustic A and C weighting at the science and Engineering workshop machines, of the University of Port Harcourt as index. The matrix covers the fast and slow mode, maximum and minimum noise level readings. The findings using Pearson correction are indicated in table 1, which shows some level of significant difference between the fast and slow mode and maximum and minimum readings. This finding demands that field instrument operators should understand when to use the A and C weight and when to set on minimum and maximum rating, for greater efficiency.

***Keywords:*** Acoustics; Decibel Weighting; Sound Pollution.

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## 1. Introduction

The source of noise in machine works to a large extend determines its acoustical characterization. These sources include:

- Mechanical/Shock between solids and block
- Unbalanced rotating equipment "Misalignment
- Friction between moving parts and cuttings
- Irregular fluid flow due to constriction and aerodynamic and electrical pneumatic source. The transmitted sound can be air or structure borne, it can be radially or linearly transmitted along strip The equipment in use tries to aggregate the various frequency bound into the. Leq (equivalent continuous sound level): This is constants sound level in dBA that lasting for a time 'T' would have produced the same energy in same time period 'T' as an actual 'A' weighted noise.

Thus Leq- 20 $\log_{10} = \int \frac{\dot{\mathbf{0}}}{\boldsymbol{T}} \frac{(\boldsymbol{p(t)})}{\boldsymbol{P_0}}$ 2 dt …….. D

Where P= root mean square (rms) of sound pressure in $\left(\boldsymbol{N}/_{\boldsymbol{M^2}}\right)$

P = International reference pressure of 2.0 x $10^{-15}$ $\boldsymbol{N}/_{\boldsymbol{M^2}}$

FURTHERMORE:

$$L_{pt}= L_{ps}+ 20 \text{ long } (n)\text{……………………. (2)}$$

Where $L_{pt}$= total Sound pressure level (dB), $L_{ps}$= sound pressure level from each single source (dB) and n= number of sources

### *1.1. Other major definitions useful to this study*

**$L_{Aeq}$,T:** The equivalent steady sound level in dBA containing the same acoustic energy as the actual fluctuating sound level over the given period, T.

**$L_{Amax}$:** The maximum RMS, A-Weighted sound pressure level occurring within a specified time period; the time weighting fast or slow is usually specified.

**Rating level ($L_{ArT}$)** : The specific noise level, plus any adjustment for the characteristic features of the noise.

**Residual noise:** The ambient noise remaining at a given position in a given situation when the specific source is suppressed to a degree such that it does not contribute to the ambient noise (residual noise level is measured in terms of $L_{Aeq}$,T).

**Root Mean Square (RMS):**

The RMS value of a set of numbers is the square root of the average of their squares. Please see Fig 1. Showing a typical generator fluctuating frequency band and the need for a root mean square value.

**Sound Exposure Level (SEL or LAE):** The is the measure of the A-Weighted sound energy used to describe noise events such as the passing of a train or aircraft.

**Specific noise level:** A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source.

**Time-weighting:** One of the averaging times (Fast, Slow or Impulse) used for the measurement of root mean square (RMS) sound pressure level in sound level meters.

**Sound pressure level for n number of source or machines**

Sound pressure level (SPL) or sound level is a logarithmic measure of the effective sound pressure of a sound $PRMS^2$ relative to a reference value. It is measured in decibels (dB) above a standard reference level.

Thus:

$$L_p = 10\log_{10}\left(\frac{Prms^2}{Pref^2}\right) = 20\log_{10}\left(\frac{Prms}{Pref}\right) \quad \text{dB} \ldots\ldots\ldots\ldots\ldots\ldots..$$

For n number of sources,

$$L_{\Sigma} = 10.\log_{10}\left(\frac{P1^2 + P2^{\,2} + \ldots\ldots\ldots.Pn^2}{Pref^2}\right) = 10.\log_{10}\left(\frac{P1}{Pref}\right)^2 + \left(\frac{P2}{Pref}\right)^2 + \ldots\ldots\_\left(\frac{Pn}{Pref}\right)$$

Where $L_z$ is the resultant sound. Please see table 1. Indicating resultant value of decibel addition for 2 or more sound sources.

### *1.2. Past studies on sound impact*

Few persons who carried out studies on Noise include [2–12].

### *1.3. Aim*

The aim of this study is to add into the data bank quality assurance and quality control data in field instrumentation particularly when it entails summing up sound from different sources.

**Table 1.0:** rules for combining noise levels

| When two decibel values differ by | Add the following to the higher decibel value: |
|---|---|
| 0dBA | 3.0dBA |
| 2dBA | 2.5dBA |
| 3dBA | 2.1dBA |
| 4dBA | 1.8dBA |
| 5dBA | 1.5dBA |
| 6dBA | 1.2dBA |
| 7dBA | 0.8dBA |
| 8dBA | 0.6dBA |
| 9dBA | 0.5dBA |
| 10dBA | 0.4dBA |

https://www.engineeringtoolbox.com/adding-decibel-d_63.html

## 2. Method

The methods include a generator and machine sound source, and an analytical tool to text the degree of variance between A and C weighting. CEL 231 and CEL 254 digital noise level meter with A,B,C D, weighting and impulsive noise respectively was used, with emphasis on the maximum and minimum readings. The statistical tool is descriptive statistics for correlation using [13].

## 3. Result and Discussion

The results are shown in tables 2 and 3=]' thus

Descriptive statistical, graphical method correlation and t-test statistics were employed to operational noise against the blocks in terms of significant difference.

The characterization reported by Ogoke and his colleagues (2013) which range as follows: 0.00 to 0.20 (Slight), 0.21 to .40 fair), 0.41 to 0.60 (Moderate), 0.61 to 0.80 (Substantial), 0.81 to 1.00 (Almost perfect), also called level of reliability.

(1) The intra relationship between Fast Max and Fast Mm; Slow Max and Slow Mm; Average Fast dBA and Average Fast dBC for the A and C weighing and (2) for the A and C weighing are done in Table 1.0 using Pearson Correlation.

**Table 2.0:** Correlation Analysis

| Paired Samples Statistics | Mean | Std. Deviation | Std. Error Mean | Correlation (p-values) | Level of reliability |
|---|---|---|---|---|---|
| Fast Max dBA Reading | 88.3071 | 13.16975 | 3.51976 | 0.798(0.001***) | Substantial |
| Fast Max dBC Reading | 90.0643 | 8.00554 | 2.13957 | | |
| Fast Min dBA Reading | 71.4357 | 12.88491 | 3.44364 | 0.913(0.000***) | Almost Perfect |
| Fast Min dBC Reading | 76.5214 | 11.51936 | 3.07868 | | |
| Slow Max dBA Reading | 92.0786 | 10.14018 | 2.71008 | 0.839(0.000***) | Almost Perfect |
| Slow Max dBC Reading | 89.8214 | 7.33875 | 1.96136 | | |
| Slow Min dBA Reading | 67.9429 | 14.71298 | 3.93221 | 0.893(0.000***) | Almost Perfect |
| Slow Min dBC Reading | 75.4143 | 9.74686 | 2.60496 | | |
| Average Fast dBA Reading | 79.8821 | 12.43931 | 3.32454 | 0.920(0.000***) | Almost Perfect |
| Average Fast dBC Reading | 83.3000 | 9.39167 | 2.51003 | | |
| Average slow dBA Reading | 80.0179 | 12.13515 | 3.24325 | 0.910(0.000***) | Almost Perfect |
| Average slow dBC Reading | 82.6214 | 8.08350 | 2.16041 | | |

**Footnote:** sig. at *=10%, **= 5% and ***= 1%

The result in Table 2.0 shows significance (almost' perfect) relationship between fast Min dBA Reading, Fast Min dBC Reading, Slow Max dBA Reading and Slow Max dBC Reading; Slow Min dBC Reading and Slow Mm dBC Reading; Average Fast dBA Reading and Average Fast dBC Reading; Average slow dBA Reading and Average slow dBC Reading except Fast Max dBA Reading and Fast Max dBC Reading; Fast is Substantial.

**Table 3.0:** t-Statistic Reading Fast, Slow, Average (Max and Mm) dBA and dBC

| Paired Samples Test | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | t- statistic (Sig. (2-tailed)) |
|---|---|---|---|---|---|---|
| Fast Max dBA Reading - Fast Max dBC Reading | -1.75714 | 8.31927 | 2.22342 | -6.56055 | 3.04626 | -0.790 (0.444) |
| Fast Min dBA Reading - Fast Min dBC Reading | -5.08571 | 5.26145 | 1.40618 | -8.12359 | -2.04784 | **-3.617 (0.003***)** |
| Slow Max dBA Reading - Slow Max dBC Reading | 2.25714 | 5.63720 | 1.50661 | -.99768 | 5.51197 | 1.498 (0.158) |
| Slow Min dBA Reading - Slow Min dBC Reading | -7.47143 | 7.44760 | 1.99046 | -11.77155 | -3.17131 | **-3.754 (0.002***)** |
| Average Fast dBA Reading - Average Fast dBC Reading | -3.41786 | 5.29908 | 1.41624 | -6.47745 | -.35826 | **-2.413 (0.031***)** |
| Average slow dBA Reading - Average slow dBC Reading | -2.60357 | 5.83515 | 1.55951 | -5.97269 | .76555 | -1.669 (0.119) |

**Footnote: sig. at* =10%, **=5%and *****

Table 3.0 show that there is significant difference between Fast Min dBA Reading - Fast Min dBC Reading; Slow Min dBA Reading - Slow Min dBC Reading and Average Fast dBA Reading - Average Fast dBC Reading at 1%, 5% and 10% levels. Hence, the operational noises a dBA against the operational dBA noise rating are significant for fast min, slow min and average min readings.

## 4. Conclusion and Recommendation

Acoustical evaluation of machine noise using the A and C weighting, fast and slow mode, for maximum and minimum level is to find out the validity of our selected mode of measurement. The finding is that there is a significant difference between the A and C mode of measurement, the maximum and minimum reading but correlation of the fast and slow reading which shows some degree of validity. The recommendation is that the operators of the equipment should adhere to the standards to ensure proper quality control.

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