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Evaluation of Noise Pollution Due to Electric Generators in the University of Maiduguri Campus

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Abstract: ***Noise pollution due to Electric Generators in the University of Maiduguri Campus has been evaluated using an Integrated Sound pressures Meter Model No: S-01 for twenty (20) locations within the campus. The results obtained showed that in the case of average noise levels at same distancefor the entire Campus, Aisha hostel has the highest noise level of 115 dB(A) and Student centre has the lowest noise level of 98 dB(A). On the other hand, results of noise level variations with distance for different locations within the campus revealed that the minimum safest distance at which electric Generators could be located is 260m away which will serve as a solution to the exposure of excess noise level. The implication of these exceeded limits is the health damaging effects on peoples hearing, mental and comfort. The use of sound-proof generator houses, solar and other renewable energy as an alternative source of energy and the improvement of maintenance culture of existing installed generators are recommended to alleviate and/or reduce rate of noise pollution exposure in the University of Maiduguri campus.***

Keywords: Noise, Decibel, Electric generators, Distance, Campus

1. Introduction

The use of electricity generating machines is necessary for efficient work at homes, offices, business centers, factories and industries as a result of low or lack of power supply in Nigeria. As a developing country, Nigeria is undergoing technological development and the electrical power situation is poor because of erratic power supply. As a result, there is an upsurge in the use of electric generators with its attendant noise pollution on the environment and human health [5]. Most workplaces and homes use electric generators twenty four (24) hours in alternative to power supply. The noise from electric generators in Nigeria couple with its accompanying smoke emission to the sky has greatly contributed to the depletion of the ozone layer in the sky [5].

Noise pollution and its effects on environment and life quality may be considered as very important topic in scientific research. The use of electricity generators in the University of Maiduguri campus is on increase but little attention was given to the noise generated hence, the need to evaluate the noise pollution due to these Generators. This study is aimed at evaluating the noise pollution level in the University of Maiduguri campus and analyzing its level of severity. The result of this study will be essential in the future planning and development of the campus.

2. Theory

2.1 Theoretical Basis of the Study

The measurement of environmental noise depends on the energy received, the number of noise events in a given time and the size of noise. How these are weighted depends on the scale used. A few of the common ones for the figure measurement of noise for a typical community both during the day and at night are:

1) Equivalent continuous sound level (L_{Aeq}); the steady-state sound that has the same average weighted level as the time-varying sound averaged in energy over a specified time interval.
2) Day time average sound level (L_{AdLq}); L_{Aeq} calculated using the time interval 07:00 to 19:00 similarly, the evening average sound level (L_{Ae}) takes the time interval 19:00 to 22:00 and the night average sound level (L_{Aen}) the interval 22:00 to 07:00.
3) Noise exposure level (L_{Aex}); the level of the time integral of the squared average weighted sound pressure over a stated time referenced.

These are often used to determine the compatibility of land use with the noise environment. The expression for the community noise equivalent level (CNEL) used in California has the form

$$CNEL = 10log\left(\frac{1}{24}\right)\left(\sum_{07:00-19:00} 10^{LAh+3} \sum_{19:00-22:00} 10^{LAh+10} \sum_{22:00-07:00} 10^{LAh}\right) \quad (1)$$

Where L_{Ah} is the L_{Aeq} value averaged over an hour, this then has to be linked to the question of what level of noise a community will put up with. In practice, noise levels 45dBA seen to be acceptable, anything over 65 dB(A) is certain to cause trouble [16].

2.2 Velocity of Sound

The velocity of sound through a medium differs in magnitude from one medium to another. Example, the velocity of sound through air is 332m/s, through liquid for example water is 1435m/s and through solid for example iron is 5000m/s [10].

2.3 Factors that Affect the Velocity of Sound

The factors that affect velocity of sound include: density of the medium, wind and temperature of the surrounding environment as described below.

2.3.1Density

The velocity of sound depends on the density, ℓ of the medium and partly governed by the modulus of elasticity, E (this in particular is so because the particles in a medium, for example, are subjected to varying stress with resulting strain).That is

Velocity, $V = \sqrt{\frac{E}{\rho}}$ (2)

While the velocity in a liquid medium

$$= \sqrt{\frac{k}{\rho}} \quad (3)$$

Whereas
k = bulk modulus.

For gas

$$V = \sqrt{\frac{\gamma p}{\rho}} \quad (4)$$

$$= \sqrt{\frac{\gamma RT}{m}} \quad (5)$$

Where
ρ = density
p = gas pressure
γ = ratio of principal molar heat capacity

$$\gamma = \frac{C_P}{C_V} \quad (6)$$

C_P = molar heat capacity at constant pressure
C_V = molar heat capacity at constant volume
m = mass
R = gas constant.

2.3.2 Wind

Wind affects the velocity of sound wave. Velocity of sound increases if the sound travels in the same direction as the wind. Besides the speed, the sound wave bends towards the earth. But if the wind direction is opposite that of sound, the velocity decreases while at the same time it bends upwards [10].

2.3.3 Temperature

As the air temperature increases, the speed of sound increases. This speed varies directly as the square root of the absolute temperature.

$$V = \sqrt{T} \quad (7)$$

3. Materials and Method

The instrument used for the measurement of the noise levels in the University of Maiduguri campus at twenty (20) different locations is an integrated average sound pressure level meter model number: S-01. The instrument was developed by Kweulsoft .The instrument was set at the average weighting network and the equivalent noise level (L_{eq}) which is the constant noise level that expands the same amount of energy over the same period of time. The instrument was set at automatic mode to run continuously for one minute and measurements were taken at four (4) different times of the day. That is the first, second, third and fourth measurements. The instrument faithfully follows all the fluctuations and stores them in its memory, by the end of the measurement an average energy was calculated and recorded in decibels (dBA) as similarly done in [11].In the calculation of the daytime noise level (L_D) and the night time noise level (L_N), the measured equivalent noise level was used as input data. The following equations were used!

$$L_D = 10 \log \left[\frac{1}{2}\left\{\left(10^{\frac{L_{AeqF}}{10}}\right) + \left(10^{\frac{L_{AeqS}}{10}}\right)\right\}\right] \quad (8)$$

$$L_N = 10 \log \left[\frac{1}{2}\left\{\left(10^{\frac{L_{AeqT}}{10}}\right) + \left(10^{\frac{L_{AeqFT}}{10}}\right)\right\}\right] \quad (9)$$

Where
L_{Aeq} = the average weighted equivalent sound pressure level
L_{AeqF} = the equivalent sound pressure level for the first measurement
L_{AeqS} = the equivalent sound pressure level for the second measurement
L_{AeqT} = the equivalent sound pressure level for the third measurement
L_{AeqFT} =the equivalent pressure for the fourth measurement
L_D = Day time noise level
L_N = Night noise level

The results obtained from equation (8) and (9) were used in equation (10) to determined the day-night noise level (L_{DN}) of the campus as similarly done in [4].

$$L_{DN} = 10 \log \left[\frac{1}{24}\left\{\left(15 \times 10^{\frac{L_D}{10}}\right) + \left(9 \times 10^{\left(\frac{L_N+10}{10}\right)}\right)\right\}\right] \quad (10)$$

The methods used for the measurement of noise level in the University of Maiduguri campus are the data sampling, data collection and data analysis.

4. Results and Discussion

The recorded noise level for the twenty (20) locations in the University of Maiduguri Campus is presented in table 1.

Table 1: Average Noise Levels at same distance (1.5m) for different locations in the University of Maiduguri Campus

Zones	Locations	L_D dB(A)	L_N Db(A)	L_{ND} dB(A)	Mean L_D dB(A)	Mean L_N dB(A)	Mean L_{DN} dB(A)
A	a Bursary	102			106		
	b Exam and Record	110					
	c Faculty of Engineering	107					
	d Faculty of Pharmacy	109					
	e Faculty of Science	104					

B	f Acada Commercial Area	108	99	108	100	96	103
	g M.P.H Commercial Area	96	99	105			
	h Student Center	92	92	98			
	i Central Commercial Area	101	99	105			
	j Leventis Commercial Area	101	89	100			
C	k Aisha		115			112	
	l Ali Mangono		112				
	m B.O.T		109				
	n C-Block		112				
	o D-Block		113				
D	p R-Line		110			110	
	q F-Line		110				
	r Central Housing		113				
	s NH		107				
	t SSTH		110				

Table 1 Shows the four zones in the campus and the various measuring points where measurement were taken. It also contains the day time sound level, the night time sound level and the day-night sound level calculated using equation (8), (9) and (10).

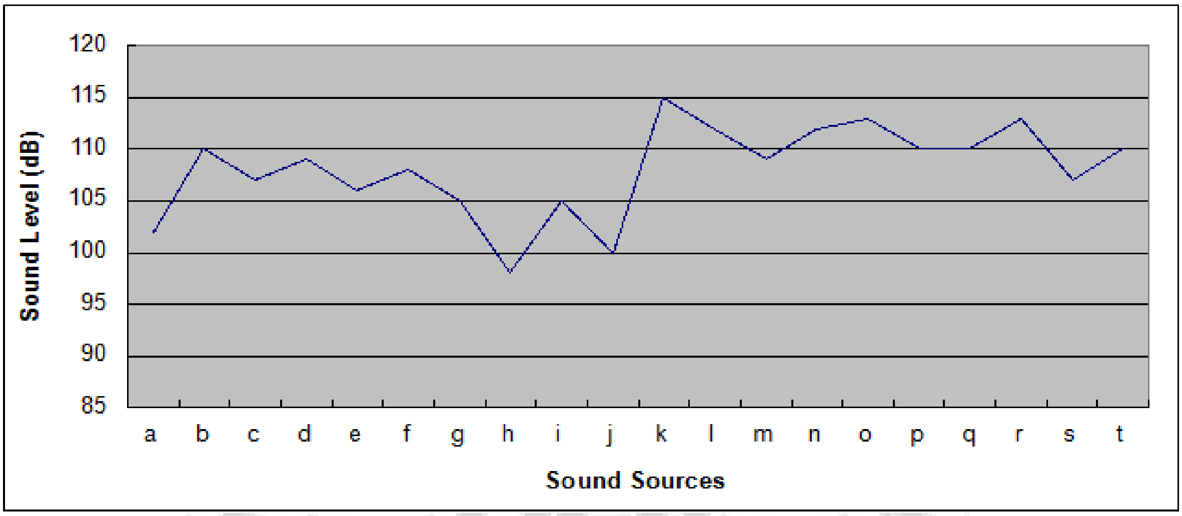

Figure 1: The Graphical Representation of Noise Level of the Entire Campus

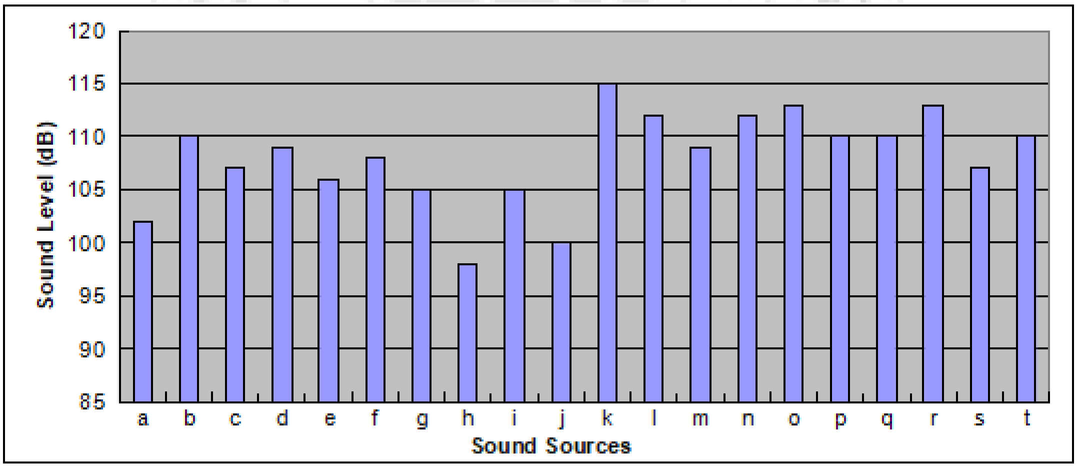

Figure 2: The Bar chart Representation of Noise Level of the Entire Campus

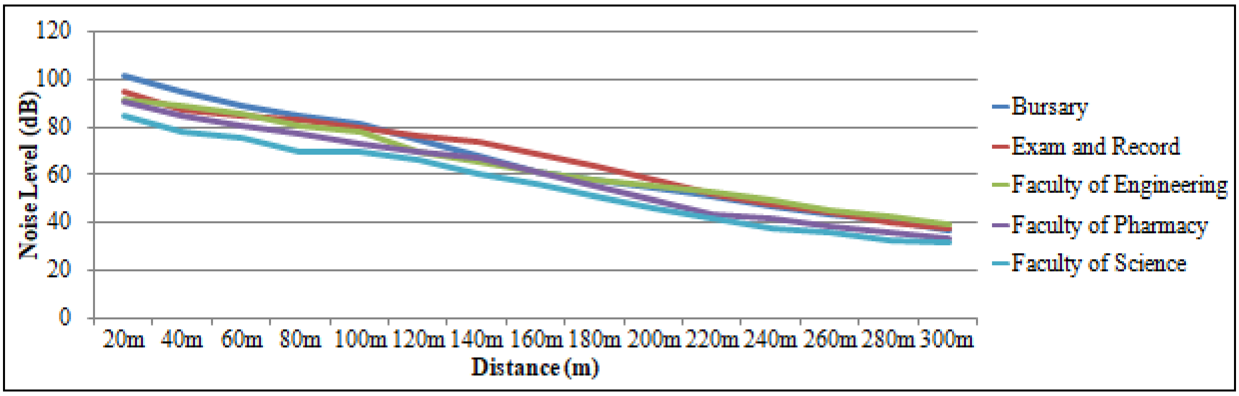

Figure 3: Noise Level Variation with Distance in Academic Areas (Zone A)

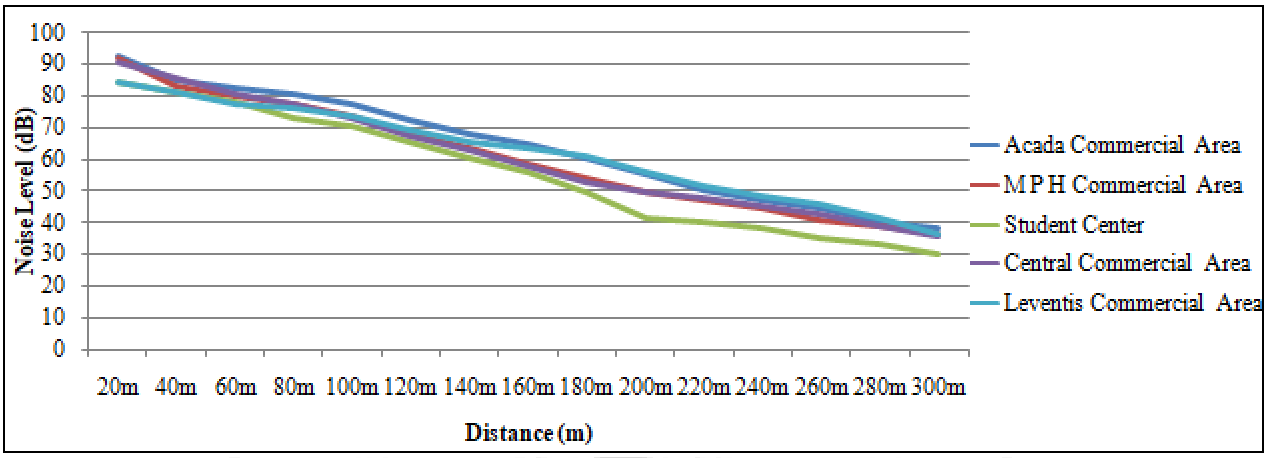

Figure 4: Noise Level Variation with Distance in Commercial Areas (Zone B)

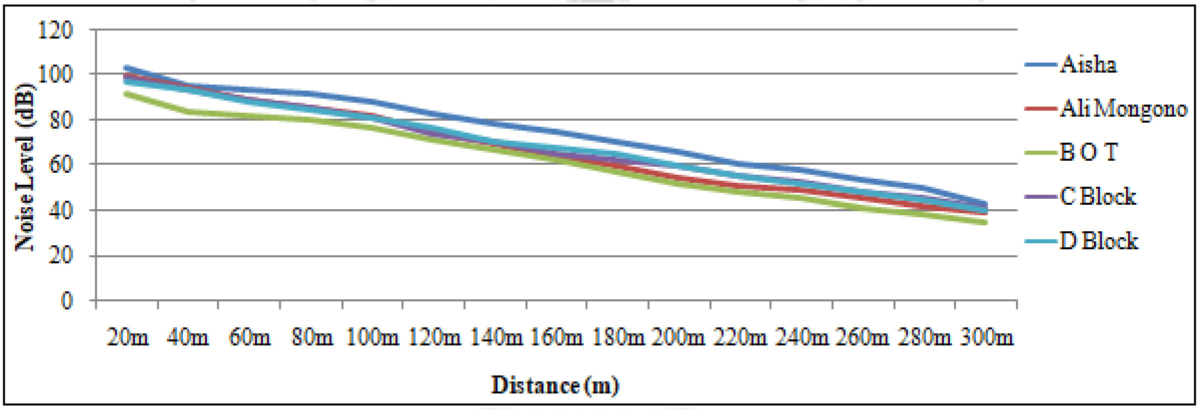

Figure 5: Noise Level Variation with Distance in Student Hostels (Zone C)

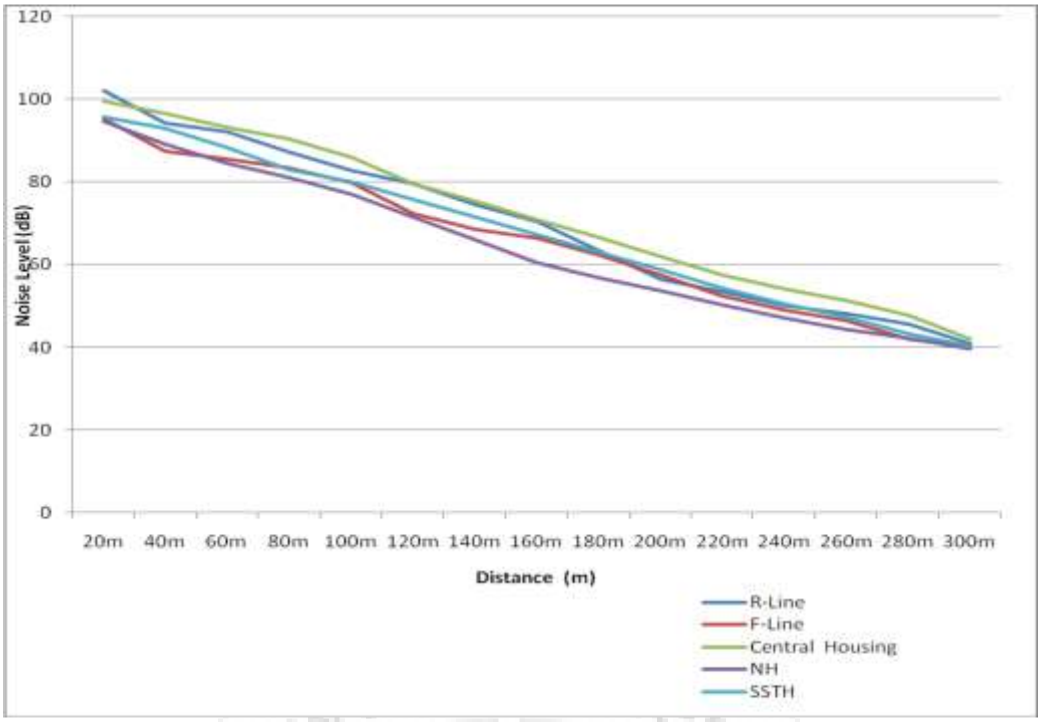

Figure 6: Noise Level Variation with Distance in Staff Quarters (Zone D)

In zone A, only the day time measurement was recorded because during the night time the Academic Area was closed and so all the electric generators were not in used during the time of the present study. The mean day time (L_D) noise level in this zone A is 106 dB(A).In zone B, the mean day-time noise level is 100 dB(A) and the mean night-time noise level is 96 dB(A), while the mean day-night time level is 103 dB(A).In zone C,the mean night-time (L_N) noise level is 112 dB(A). The day-time (L_D) noise level was not recorded because the electric generators were operated only during the night-time. In zone D, the mean night time (L_N) noise level is 110 dB(A). Electric generators were operated in the night time only during the period of this study and so day-time noise level was not recorded.Figure 4.1 and Figure 4.2 shows that in the entire Campus, Aisha hostel has the highest noise level of 115 dB(A) and Student centre has the lowest noise level of 98 dB(A). The study shows that both students and staff have been continually exposed to excess noise during the day time in Academic Areas and during the night time in their hostels and quarters respectively.Figures 3, 4, 5 and 6 shows that noise level decreases with increase in distance when noise level was varied with distance for different locations in the University of Maiduguri campus from noise sources in zone A, B, C and D respectively, this study reveals that the safest distance at which electric generators could be located is 260m away from homes, offices shops, lecture halls and hostels.Pachpande*et. al*.,[13] reported that the hearing status and audiometric analysis of school teachers and students,about 84% of the teachers and 92% of the students have reported hearing difficulty in the questionnaire. Another study was conducted by Al-Dakhlallah*et al*., [3] to quantify the levels of noise which are generated from road traffic and compared these measured levels against appropriate standards. The study established that residential areas adjacent to the sites where traffic noise was measured are subjected to noise levels of up to 78 dB. Rajaasekhar, *et. al.*, [15] also estimated either noise levels exceed or are about to cross the permissible standards. Evans, *et. al*.,[9] found that an even relatively low level of sound affects human health adversely. It may cause hypertension, disrupt sleep and hinder cognitive development in children. The effects of excessive noise could be so severe that, there can be a permanent loss of memory or a psychiatric disorder [1]. The standards guideline for the control of noise states that residential institutions and educational institutions should not be over 55dBA between 7am and 11pm and 54 dBA between 11pm to 7am, while, industrial and commercial exposure should not be over 70 dBA all time [8]. Furthermore, distracting noise reduces staff concentration and disrupts cognitive functions; staff can also suffer the increased blood pressure and heart rate [6]. Noise is known to elevate blood pressure. Causes heart attack and fatigue, disturb sleep, increases frustration and anxiety in concentration [2]. Community surveys of noise annoyance frequently noted that annoyance was common complaints to interviewers [9]. Cohen, *et. al*.,[7] indicated that unwanted noise can reduce human energy and efficiency. Loud noise is very dangerous to buildings, bridges and monuments, it creates cracks which struck the walls and put the buildings in danger condition, it weakens the foundation of buildings [12]. When students are exposed to speech interference levels of noise on a regular basis, may develop speech and reading difficulties because auditory functions are compromised [11]. Evidence has shown that when students learn in noise lecture hall, they have long time in understanding speech than those who learn in a quitter environment [14].

5. Conclusion

Unstable electricity supply or lack of it is the reason for using electric generators in the University of Maiduguri campus. Staff, students, commercial workers, business men and women are highly exposed to high noise level. The study concludes that most of the people in the campus are not wearing hearing protection equipment even with the generator operators who also stay very close to the generators for some hours on daily basis. Majority of the people are highly exposed to high noise level of 80 dB without proper ear protection. The outcomes of the study reveals that the maximum noise level is 115 dB and the minimum is 98 dB observed at Aisha Hostel and Students Centre respectively. The result of the study also shows that the level of noise in the University of Maiduguri campus far exceeds the acceptable standard set by World Health Organization (WHO). This has obvious implications on the general health of people such as irritation, loss of hearing, emotional disorder and change in behaviors.

6. Recommendations

Based on the results of the findings, the following recommendation will help in controlling noise pollution in the campus:

a) The most effective noise control measure is to promote awareness among the people on the risks of daily exposure to high noise levels
b) Proper maintenance culture of electric generators
c) The implementation of the technical measures for noise levels
d) Use of sound proof generator houses and specially designed exhaust
e) Use of alternative sources of energy such as solar energy
f) Provision of modern and quieter machinery models to be installed some distance away from the residential areas and lecture halls

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