Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 5 ~ Issue 2 (2019) pp: 38-44
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Establishment of Safe Distances for Installation of A 500 kVA Sound Proof Electric Power Generator at A Non-Work Environment

Ekott, E. E., Akankpo, A. O., Essien, I. E., Adeniran, A. O., Peter, A. J.
Department of Physics, Faculty of Science, University of Uyo, Akwa Ibom State, Nigeria
Corresponding Author: Ekott, E. E.,

ABSTRACT: *Sound produced by some sound proof electric power generators can create environmental nuisances. This is attributed to the age, power rating and poor maintenance of the generators. To this end, the safe distances for installation of a particular generator have to be acoustically established. This research work therefore presents establishment of safe distances for installation of a 500 kVA sound proof electric power generator at a non-work environment. Measurements of sound levels with distances from the generator were considered. The data obtained were analysed and environmental noise models were developed by using the relevant displayed parameters. The results obtained from the models developed in this work, $L_{G(modelled)}$ were compared with the results obtained from the physical measurements, $L_{G(measured)}$. The results of the findings indicate that the generator has a maximum noise level of (82.492 ±0.446) dBA. It was observed that the annoying sound of the generator affects people beyond a distance of 60 m. Hence, this kind of generator must be installed beyond distances of 65 m from residential areas. This is because at a distance of 65 m the noise level of the generator is 54.6 dBA which is below the WHO tolerant noise level of 55 dBA for a non-work place.*
Keywords: *Installation, 500 kVA power generator, modelling, noise levels and sound proof.*

R**eceived 25 Jan.2020; **A**ccepted 08 Feb.., 2020 © The author(s) 2020. **P**ublished with open access at* ***www.questjournals.org

I. INTRODUCTION

Usually, noise from neighbourhood originates from building and installations associated with the food preparation business like cafeterias, restaurant, and discotheques; from recorded or live music; from playgrounds and car parks; from sporting events including motor sports; and from household animals for example barking dogs. The major sources of indoor noises include aeration systems, home appliances; office machines, and neighbours. Domestic noise has increased to the point where it is presently the most important peril to the superiority of our existence. This increase in noise can be attributed to the ever increasing number of people in the globe and the growing levels of economic affluence [1]. World Health Organisation (WHO) describes environmental noise as community noise or residential noise or domestic noise [2]. The most important sources of community noise comprise air, rail and road traffic, neighbourhood, municipal work, and the construction plant, among others. In the United States of America, the Environmental Protection Agency (EPA) identified noise as a hindrance since in the 1970s [3]. Then, the agency carried out a main study of noise and has continued to bring up to date its results. This means that the study of noise is a continuous phenomenon. As with all pollutants, noise demeans the value of our environment and is known to produce various negative effects both on structures and on humans. In this context, noise is defined as unpleasant sound [4]. However, noise can be described as the unwanted sound in the unwanted location at the unwanted occasion. The degree of "unwantedness" is usually a psychological issue since the effects of noise can range from temperate irritation to everlasting hearing loss, and may be rated in a different way by special observers [5]. For this reason, it is often exigent to establish the benefits of dropping a specific noise. Noise does affect the inhabitants, humans and fauna in the natural environment. Some definite places influence noise contacts; so it is invasive that it became difficult to run away from it. The public opinion polls almost constantly rank noise in the list of the most bother some residential irritations. General noise sources are industry, neighbourhoods and traffic. The industrial noise is one of the most annoying sources of noise complaints [6]. Elevated noise levels of adequate exposure time can result in short-term or permanent hearing damage. This is generally related to those working in industrial plants or operating machinery but can also take place at discotheques or near to aircraft on the ground if the duration is long enough. However, measurable hearing loss from many industrial sounds involves daily exposure for a number of years. On the other hand, community noise intrusions like traffic noise can obstruct speech communication, interfere with sleep and relaxation and disturb the capacity to perform difficult tasks [7]. The British Columbia Work's Compensation Board (WCB) has set 85 dB as its highest tolerant level in the work place. Above this limit hearing protection should be used. It states that the threshold of pain is attained at 120 dB and it classifies 140 dB as excessive hazard level. WHO safety noise levels are similar while EPA of Nigeria tends to have even a stricter standard of 70 dB as a maximum safe level of noise in work place. They gave the safe level around home to be 50 – 55 dB [8]. Researchers have shown that constant noise above 55 dBA causes serious annoyance and above 50 dBA moderate annoyance at home [9]. In a non-work place and for health and safety purposes, 55 dBA is set as a safety noise level for outside and 45 dBA inside. Hospital and school permissible levels of noise are 35 dBA [2].

The protection of workers from the risks related to exposure to noise at work is contained in the European Union (EU) Directive (86/188/EEC). The objective of the directive is to reduce the level of noise experienced at work by taking action at the noise source. The directive specifies that when the daily exposure level exceeds 85 dBA, the worker is to be advised of the risks and trained to use ear protectors. If the daily exposure level exceeds 90 dBA, a programme to reduce levels should be put in place. Noise beyond harmless levels leads to numerous health impacts which include high blood pressure, annoyance, sleep loss, stress, hearing impairment, loss of productivity and the ability to concentrate, among others. A study by [10] shows that sleep interference by noise causes great annoyance to many people. A study by [11] shows that sleep is an important modulator of cardiovascular function. Intermittent or impulsive noises are particularly disturbing. Because of differences between locations and people, it is not easy to establish the level of noise which will not cause sleep interference [12]; [7]. When work does not involve spoken communication it is taxing to determine the impacts of levels of noise on performance. High noise levels may reduce the accuracy of the work being undertaken rather than the quantity. Steady noises appear to have little effect on work performance unless the A-weighted noise level exceeds about 90 dB [13]. The analysis [1] was carried out in six cities in Nigeria. The cities included Lagos, Ibadan, Port Harcourt, Enugu, Kaduna and Calabar and it was concluded that the major source of noise that bothers people most is the traffic.

A study carried out by Cornell University in 1993 indicated that children exposed to noise during classes experienced problem with various cognitive developmental delays in addition to words discrimination. Specifically, the writing learning mutilation called dysgraphic is usually related to stress on environment during classes [14]; [15]. Studies show that excessive noise can cause hearing impairment, that certain levels and types of noise can cause heart attack, that body tissue resonances can be adversely affected by noise and that noise generally causes discomfort and annoyance to people exposed to it [16]. In addition, the consequence of elevated levels of noise on small children has been found to be related to physical health damage [17]. According to a WHO task group, in the day levels of noise of below 50 dBA outdoors generate moderate bother in the residence [18]. Noise has been connected to vital cardiovascular health risks. In 1999, the WHO drew a conclusion that the existing evidence shown predicted a weak relationship between hypertension and long term exposure to noise beyond 67 – 70 dBA [19].

Studies have recommended that noise levels of 50 dB(A) at night may also increase the risks of myocardial infarction by constantly enhancing production of cortisol [20]. Researches on the noise impacts on children in the classroom show strong association between speech intelligibility and problems with absence of self-confidence, fatigue, irritation, uncertainty and concentration, among others [14]; [21; [15]. Fairly characteristic road levels of noise are sufficient to reduce arterial blood flow and cause elevated blood pressures; in this situation it seems that a specific part of the populace is more vulnerable to vasoconstriction. This may occur because the noise bother leads to high adrenaline intensity to activate vasoconstriction (a reduction of the blood vessels) or separately through reactions from medical stress. Additional impacts of elevated levels of sound are high rate of vertigo fatigue, stomach ulcer and headaches. Exposure to unpleasant sound is considered to be predominantly insidious when it takes place at the range of 15 - 60 days after conception, when central nervous system and the main internal organs are developed. Soon after, developmental effects take place as vasoconstriction in the mother decreases flow of blood and therefore nutrition and oxygen to the foetus. Reduced weights at birth and high sound level were also related to reduced levels of certain hormone in the mother. These hormones are assumed to be a good sign of production and to have an effect on the growth of the foetus. As birth approaches, the difference between the hormones levels of the pregnant women in boisterous against quiet areas increases. Children residing in boisterous areas have been found to possess high intensity of nervous tension induced hormones and high blood pressures. Studies also proposed that when pregnant women are exposed to 76.5 dBA noise of airplane, a little decline in birth weight takes place [20]. Also, noise has adverse effects on children's cognition and health [22]; [23]; [24]. Population studies have recommended associations between noise and mental-health indicators, such as mental-hospital admission rates, rating of wellbeing, the use of psychoactive drugs and sleeping pills, and symptom profiles. The elderly, children, and those with underlying dejection may be mostly exposed to these sound effects because they may lack sufficient surviving methods. Children in boisterous areas find noise annoying and report a reduced value of life [15]. Noise levels greater than 80 dB are connected with both increase in destructive behaviour and decrease in behaviour useful to others. High levels of noise may lead to speech interference, reduction in productivity, high blood pressure, hearing defects, health disorders, sleep interference, cardiovascular effects, loss of concentration and absenteeism, and fatigue [25].

Consequently, this work on noise pollution is essential so as to create more awareness on the impacts of noise on the environment. In this research work therefore, the establishment of safe distances for installation of a 500 kVA sound proof electric power generator at a non-work environment shall be carried out.

II. MATERIALS AND METHODS

2.1 Physical measurements

In this section, the noise level measurements were taken from a 500 kVA sound proof electric power generator. The measurements were made using a sound level meter, model TES 1350A with ½ inch Electrect condenser microphone. It has low and high measuring ranges 35 to 100 dB and 65 to 160dB respectively. Also it is equipped with a built in calibration check (94.0dB), tripod moving and analogue DC/AC conditional output of 10dB. It has a weight of 210 grammes (including a 9 V battery) and completed with hard vinyl case. It also has electronic circuit and readout display. The microphone detects the small air pressure variations associated with sound and changes them into electrical signals. These signals are then processed by electronic circuitry of the instrument. The readout displays the sound levels in decibels. The sound level meter measures the sound pressure level at one instance in a particular location. The measurements were taken by setting the sound level meter to an A-weighting network in all the sampling locations. The sound level meter was calibrated before and after each use by the manufacturer's calibration procedure given in the manual. During the noise level measurements, the sound level meter (microphone) was positioned at a distance of 5 m interval away from the generator and a height of 1.2 m above ground level were also considered (this was done to avoid reflection of sound from the ground).

Noise level measurements were taken by setting the Sound level meter response to slow since the source of noise was stationary, and low range settings was selected since the background noise levels were not above 60 dBA.

2.2 Calculating the Generator Noise Level, L_G

The Generator noise level (L_G), was calculated by using Equation (1) [5], [26].

$$L_G = 10\log10\,[10^{0.1L_T} - 10^{0.1L_B}] \qquad 1$$

Where, L_B = the background noise level in dBA and L_T = the total noise level in dBA.

2.3 Noise modeling

The data obtained were analysed by using the linear regression method. Hence, linear fitting models were developed for it by using the relevant displayed parameters.

III. RESULTS AND DISCUSSION

3.1 Results

Tables (1 – 2) and Figures (1 – 4) show the results of this research work.

Table 1: Noise levels and distance measurements from a 500 kVA sound proof electric power generator.

Distance, x (m)	Background Noise Level (dBA)	Total Noise Level (dBA)	Generator Noise Level (dBA)
5	43.06	80.2	80.19
10	42.8	77.3	77.29
15	43.6	75.7	75.69
20	47.3	73.8	73.79
25	50.7	72.9	72.87
30	48.1	70.5	70.47
35	46.2	68.2	68.17
40	43.5	67.4	67.38

45	43.3	65.6	65.57
50	49.9	63.0	62.78
55	46.4	59.3	59.07
60	45.4	56.8	56.47
65	47.6	55.4	54.61
70	47.7	53.1	51.62
75	43.5	52.7	52.14
80	44.5	49.9	48.42
85	44.1	48.9	47.15
90	43.0	47.0	44.79
95	41.6	45.8	43.72
100	40.6	44.0	41.34

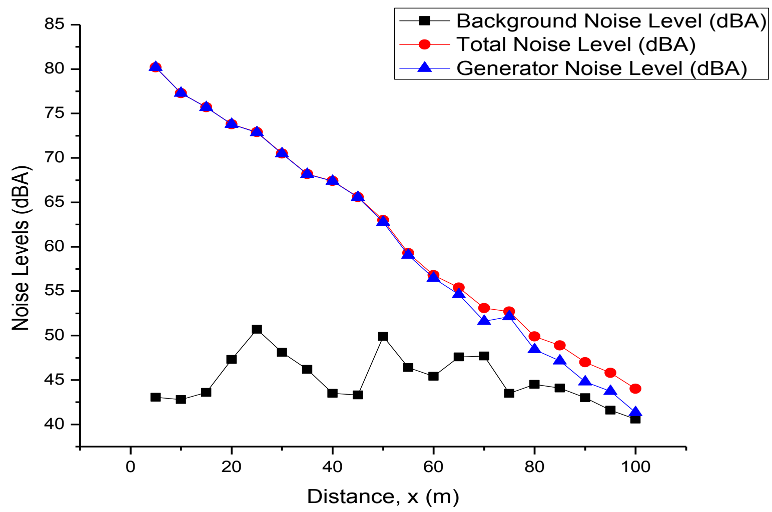

Figure 1: Plot of noise levels of the 500 kVA sound proof electric power generatoragainst distance

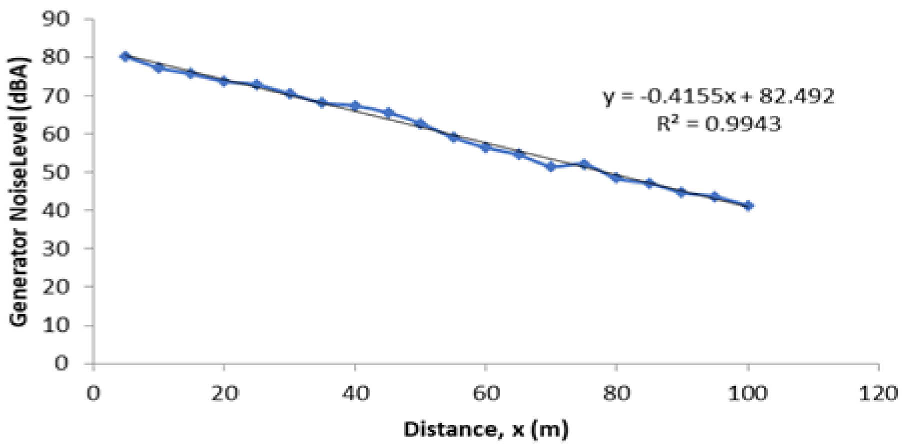

Figure 2: The characteristics of the 500 kVA sound proof electric power generator measured noise levels

Table 2: Comparison of modelled noise levels and measured noise levels of the 500 kVA sound proof electric power generator modelled noise levels

Distance, x (m)	$L_{G(modelled)}$ (dBA)	$L_{G(measured)}$ (dBA)	Difference (dBA)
5	80.41	80.19	0.22
10	78.34	77.29	1.05
15	76.25	75.69	0.56
20	74.18	73.79	0.39
25	72.1	72.87	0.77
30	70.02	70.47	0.45
35	67.95	68.17	0.22
40	65.87	67.38	1.51
45	63.79	65.57	1.78
50	61.72	62.78	1.06
55	59.64	59.07	0.57
60	57.56	56.47	1.08
65	55.48	54.61	0.87
70	53.41	51.62	1.79
75	51.33	52.14	0.81
80	49.25	48.42	0.83
85	47.17	47.15	0.02
90	45.09	44.79	0.3
95	43.02	43.72	0.7
100	40.94	41.34	0.4

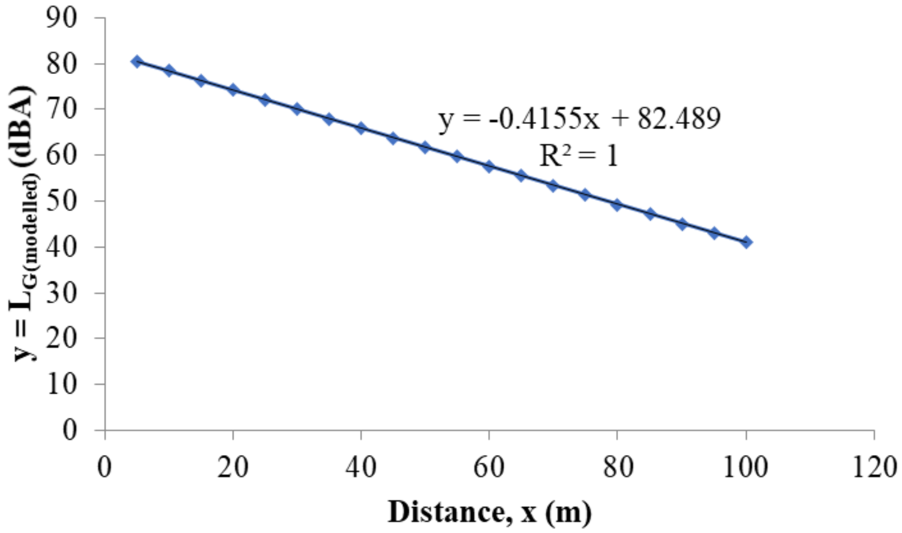

Figure 3: The characteristics of the 500 kVA sound proof electric power generator modelled noise levels.

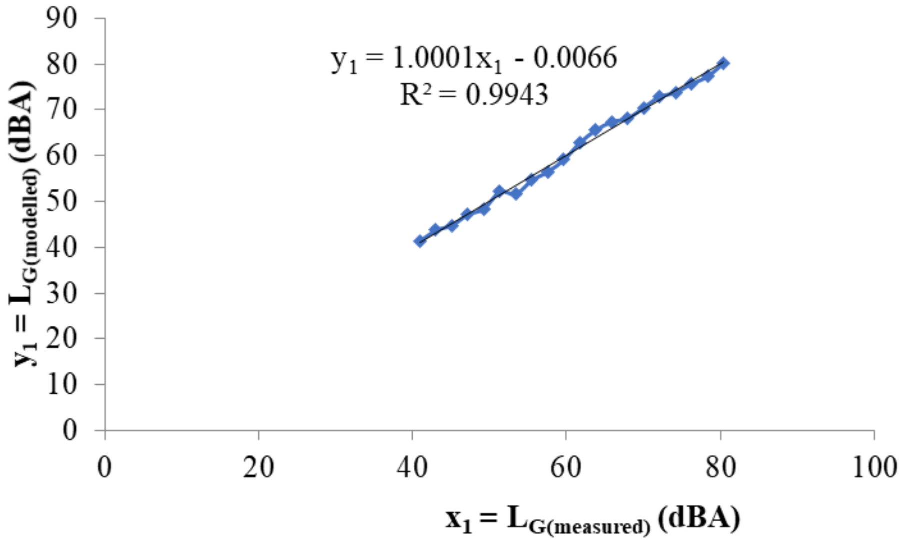

Figure 4: Comparison of modelled, $L_{G(modelled}$ noise levels and measured, $L_{G(measured)}$ noise levels of the 500 kVA sound proof electric power generator modelled noise levels.

3.2 Discussion

The results of the survey (Table 1- 2)) and Figures (1 – 4) reveal that when the generator is switched off the environment is conducive as the background noise level at any distance, x is less than the WHO safety noise standard of 55 dBA for a non-work environment. The generator noise affects the residents beyond a distance of 60 m. This is because at the distance, x = 60 m, the generator noise level, L_G = 56.47 dBA instead of the WHO safety standard of 55 dBA for a non-work place.

It is observed that the total noise levels and the generator noise levels are approximately the same up to a distance of about 50 m away from the generator. This simply means that they have almost the same frequency up to the 50 m. The generator of this kind has to be installed beyond 65 m from the people's residence. This is because at x = 65 m, L_G = 54.61dBA which is almost below the WHO tolerance level of 55 dBA for residential areas. The results of the analysis show that L_G and x are strongly correlated with the coefficient of determination, R^2 = 0.99394. The linear fitting model in dBA obtained from the analysis is presented in equation 2:

$L_G = - 0.4155x + 82.492$ 2

Considering the error term, ϵ_G, equation 2 becomes:

$LG = -0.4155x + 82.492 + \epsilon_G$ 3

At source, that is at x = 0

$L_G = 82.492$ dBA 4

Equation 4 gives the maximum noise level of the generator. It has a standard error of 0.44583 $dBAm^{-1}$. The linear model also has a slope (or attenuation coefficient) of -0.4155 dBA^{-1} with a standard error of 0.0074 dBA^{-1}. Comparing the modelled noise level of the generator ($L_{G(modelled)}$) with the measured noise level ($L_{G(measured)}$) (as presented on Table 2 and Figure 4) it was established that there is no significant difference between them. This means that Equation 2 or 3 can be used in place of equipment for this type of generator.

IV. CONCLUSION

In conclusion, the noise of the 500 kVA sound proof electric power generator is heard even at a distance of 100 m from the generator. It was observed that the generator has a maximum noise level of (82.492±0.446) dBA. The results of the findings indicated that the adverse effects of the 500 kVA sound proof electric power generator cover distances beyond 60 m. It is therefore established that this kind of generator should be installed beyond a distance of 65 m from the residential areas. Finally, the models developed in this work can be used as more reliable tools for environmental noise impact assessment.

REFERENCES

[1]. Menkiti, A. I., Analysis of noise bother by survey method. Global Journal of Pure and Applied Sciences, 7(3), 2001, 545-550.

[2]. World Health Organisation (WHO), Guidelines for community noise. Retrieved June 25, 2017 from http://www.who.int/docstore/peh/noise/index.html. 1999.

[3]. Menkiti, A. I. & Ekott, E. E., Determination of noise levels with respect to distance at selected workshops/factories in Itu Local Government Area of Akwa Ibom State, Nigeria. IOSR Journal of Applied Physics (IOSR-JAP), 6(3), 2014, 43-53.

[4]. Schmidt, C. W., Noise that annoys regulating unwanted sound. Environmental Health Perspectives, 113(1), 2005, 1–3.

[5]. Ekott, E. E., Bassey, D. E. and Obisung, E. O., Modeling the Relation Between Noise Levels and Distance from a 500 kVA Power Generator. World Journal of Applied Science and Technology, 10 (1B), 2018, 124 – 130**.**

[6]. Ekott, E. E., Impact of noise on the environment: Using Itu Local Government Area of Akwa Ibom State, Nigeria as case study. Unpublished Master of Science Dissertation, Faculty of Science, University of Uyo, Nigeria, 2011.

[7]. Kiely, G., Environmental engineering. Singapore: Irwin/McGraw-Hill, 1998.

[8]. Ekott, E. E. & Menkiti, A. I., Assessment of noise levels in parts of Akwa Ibom State, Nigeria. World Journal of Applied Science & Technology. 7(2), 2015, 170-175.

[9]. World Health Organisation (WHO), Night Noise Guidelines for Europe. Bonn: WHO, Regional Office for Europe, Retrieved June 30, 2017 from http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf, 2007.

[10]. Obisung, E. O., Onuu, M. U., Menkiti, A. I. & Akpan, A. O., Road traffic noise-induced sleep. disturbances in some cities in Eastern Nigeria. British Journal of Applied Science and Technology. 12(4), 2016, 1-15.

[11]. Halperin, D., Environmental noise and sleep disturbances: A threat to health? Journal of Sleep Science, 7(4), 2014, 209-212.

[12]. World Health Organisation (WHO), Night Noise Guidelines for Europe. WHO, Regional Office for Europe.RetrievedJune29,2017from http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf. 2009.

[13]. Davis, M. L. & Cornwell, D. A., Introduction to environmental engineering. New York: McGraw-Hill, 1991.

[14]. Clark, C., Head, J. & Stansfeld, S. A., Longitudinal effects of aircraft noise exposure on children's health and cognition: A six-year follow-up of the UK RANCH cohort. Journal of Environmental Psychology, 35(3), .2013, 1-9.

[15]. Stansfeld, B. M., Dockrell, J. E., Asker, R. & Trachmatzidis, I., The effects of noise on the attainments and cognitive development of Primary School children-final report for department of health and the department ETR. Retrieved January 14, 2014 from www.noisesolutions.com. 2005.

[16]. Environmental European Commission (E.E.C), Damage &annoyance caused by noise. Luxemburg: CEC EUR, 1978.

[17]. Goran, B., Urban road traffic noise and blood pressure and heart rate in preschool children. Environmental International, 34(2), 2008, 226– 231.

[18]. Organisation for Economic Co-operation and Development (OECD), Environmental Effects of Automotive Transport. Paris: The OECD Compass Project, OECD, 1986.

[19]. Ising, H., Babisch, W. & Kruppa, B., Noise-induced endocrine effects and cardiovascular risk. Noise Health, 1(4), 1999, 37-48.

[20]. Essiett, A. A, Akpan, R. E. & Uwak, S. O., Assessment of noise level in Ikot Ekpene Town, Nigeria. International Journal of Biotechnology and Allied Sciences, 5(1), 2010, 620 – 624.

[21]. Shield, B. M. & Dockrell, J. E. The effects of noise on children at school: A review, Building Acoustics, 10(2), 2003, 97-116.

[22]. Klatte, M., Bergström, K., & Lachmann, T., Does noise affect learning? A short review on noise effects on cognitive performance in children. Frontiers in Psychology,4: 578. Retrieved March 2, 2016 from http://dol.org/10.3389/fpsyg.2013.00578. 2013.

[23]. Seabi, J., An epidemiological perspective study of children's health and annoyance reactions to aircraft noise exposure in South Africa. International. Journal of Environmental Research and Public Health, 10(7), 2013, 2760-2777.

[24]. Clark, C., Crombie, R., Head, J., van Kamp, I., van Kempen, E., & Stansfeld, S. A., Does traffic-related air pollution explain associations of aircraft and road traffic noise exposure on children's health and cognition? A secondary analysis of the United Kingdom sample from the RANCH project. American Journal of Epidemiology, 176(4), 2012, 327-337.

[25]. WHO, Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. World Health Organization Regional Office for Europe, Denmark. 2011.

[26]. Ekott, E. & Essien, K. Evaluation and Modelling of Environmental Noise Pollution from a Palm Oil Processing Mill with a Maximum Noise Level of (110.64±0.69) dBA, International Journal of Science and Research (IJSR): 2019, 8(12), 409-413.

Ekott, E. E., et.al. "Establishment of Safe Distances for Installation of A 500 kVA Sound Proof Electric Power Generator at A Non-Work Environment" Quest Journals: Journal of Research in Environmental and Earth Science, Vol. 05, No. 02, 2019, pp. 38-44.