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# Evaluation and Analysis of Environmental Noise from Petrol Fuelled Portable Power Generators Used In Commercial Areas

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**ABSTRACT**

Infrastructure deficit gaps in Nigeria's electric power supply is prominent, affecting every sector of the nation's economy ad modum less productivity, lost and corrupt data, damaged equipment and poor power efficiency. Use of generators as alternative source of electrical power with its characteristic noise and vibration has serious health hazard and environmental impact. The intensity of noise from various generator used in small business enterprises (commercial centres) in Abeokuta metropolis was assessed using a digital sound level meter to determine the intensity of noise level from the generators. Sound emitting from each of the generators was measured from five different points. The associated noise levels at the five distances from the commercial user showed mean values of 109.86, 85.95, 83.09, 80.68 and 81.69 decibels taken at the exhaust, distances of one, two, three meters and closest distance of the generator from the commercial user respectively. Analysis of the measured generator noise loudness using the data obtained for noise level at different distances on typical noise level scale showed that 9.1, 100, 96.6 and 90.9 percents of the generators were very loud at noise at the exhaust and distances of one, two, three meters respectively. It was only at the generator exhaust that 90.9 percent there was uncomfortably loud. This high noise levels obtained necessitates acoustic muffling of the generators.

**Keywords:** Electricity, sound, generator, noise, pollution

## INTRODUCTION

The problem of environmental noise pollution is becoming a universal issue. The recognition of noise as a serious health hazard is now considered an increasingly important public health problem (Azodo and Adejuyigbe, 2013). Noise emanates from different sources such as automobiles, machines, household devices, industrial, commercial and residential generators (Azodo and Adejuyigbe, 2013). Electricity generating plants are characteristically associated with noise and vibration which are unfriendly to human health and the environment (Willis and Scott, 2000). Associated noise and vibration from electric power generator is a growing problem everywhere especially in our nation Nigeria, as electricity generating plants which are meant to serve as power alternative and almost always ready electric power supply back up source during power failure, but due to the irregular power supply in the nation, now serve as the primary source of power in homes and commercial areas (Ibitoye and Adenikinju, 2007; Yesufu et al. 2013; Azodo, 2014). The rate of importation of electric power generator has been increasing continually over the years (Okoro, 2014). Account on generator population in Nigeria showed an estimated figure of 60 million generators of varying sizes (Adeyemo, 2012) being massively used by the offices, business premises, homes, schools, churches etc. The intense cases are the commercial centre or malls where multiple units run at the same time as a necessity for businesses to function.

It is more or less not possible for any running quality generator not to produce sound at all except it is off (Dobie, 1993; Azodo and Adejuyigbe, 2013). Generator like other types of rotating machinery, reciprocating engine-powered generator sets produce noise and vibration (Aaberg, 2007). Being reciprocating engine, the process of electric power generation involves mechanical motion of piston-crank system of an internal combustion engine and as result of pressure variation created by pends on exothermic reaction of hot expanding gases (high temperature and pressure oxidized fuel) in the combustion chamber drive a rotating electric generator for electric power generation. Each movement and vibration causes a series of alternating compression and rarefaction phases, transmitted through the air and perceived by the human ear as sound. The amplitude or magnitude with which pressure wave of the sound energy reaches the ear can be measured in decibels (dB). The decibel scale is a logarithmic unit; each one-tenth of a bel indicates the relative amount of a physical quantity to a specified reference level as well as enfolds increase in noise intensity (Azodo and Adejuyigbe, 2013; Elancheliyan, 2013). The most important measurement of noise is its loudness. Loudness comprises the sound intensity, its tonal distribution and duration (Fields, 1984). This loudness depends on the human ear sensitivity to the measured physical sound pressure. Levitt (2001) stated that the sensitivity of the human ear depends on the frequency of the sound. The range of sounds that are received by the human ear is from about 0 to 140 decibel. 0 dB being the lowest sound level an unimpaired human ear can detect whereas a noise level greater than 100 decibel is extremely loud through to threshold pain value of 140 decibel. No hearing loss occurs to an average individual if the sound level is below 80 dB (Okoro, 2014). Acceptable level of noise by the Environmental Protection Agency (EPA) of Nigeria is 70-75 dB whereas noise level above 90 dB indicates the onset of hearing impairment (Okoro, 2014). Prolonged exposure to sound in excess of 85 dB is potentially hazardous. In general, the total level and length of exposure to sound are important factors in determining the impact of sound in any situation and this two interrelate (Robinson, 1987 and Dobie, 1993). This was buttressed in Omubo-Pepple et al. (2010) that the hazard noise affects increases with the intensity and exposure period. There is no positive side to sound produced from generators after all it has neither rhythm, neither sequence nor pattern. All it carries are important public health problem that manifest hearing losses, sleep disorder, cardiovascular ailment, social handicaps, reduce productivity, work absenteeism, impaired teaching and learning, increased drug use, and accidents (Azodo and Adejuyigbe, 2013). It can impair one's property and leisure time enjoyment capacity and increases the antisocial behaviour frequency (Azodo and Adejuyigbe, 2013). It is important to note that sound transmission is in waves form and when associated with solids and liquids have the capacity to travel a long distance before perceptible sound is produced in the air. This explains why it difficult to acoustically isolate generator sets and achieve all round quietness. Allowing intense noise transmission from source into the environment could be potentially hazardous and unpleasant to close by residents and/or commercial tenants. Therefore the intensity of noise from generator used in commercial centres in Abeokuta metropolis was assessed using a digital sound level meter ascertains the intensity of noise level from the generators.

## Materials and Methods

Different locations in Abeokuta metropolis were chosen for the generator sound level measurement. These include Eleweran, Odo-eran, Somorill, Alogi, Fajol, and Car-wash areas. Commercial shops (small scale businesses) whose daily business activities were dependent on electricity power supply were contacted during their operation hours for sound level measurement from their generators. Many of these generators produce enough kilowatts to power the some of the devices and equipment in their shops for power backup solutions and unplanned power outage which poses serious economic threat to the business. The owners of the shops were duly informed of the purpose of the study and were assured of non interruption of business tasks and anonymity of data obtained. Only commercial centres/shops were permission was granted was involved in the study.

Objective research technique was used in data collection as involves physical measurement of the noise produced by each generator. The data collected notes was designed to obtain information such as the business location, sizes of generators, capacity, type of business venture and sound level from the generators. The measurements of the generator sound levels were taken using a digital sound level meter of type GM 1352 at distances of 1, 2 and 3 metres away from the generator using a measuring meter rule as well as at the generator exhaust. The distance between the generators and the commercial business operators were also obtained. The noise level meter was set at maximum response mode with A-weighted decibels before the sound level was recorded. Analysis of the noise level from the various generators measured was done using typical noise levels scale by Aaberg (2007) to establish the intensity of noise emanating for the assessed generators (Figure 1).

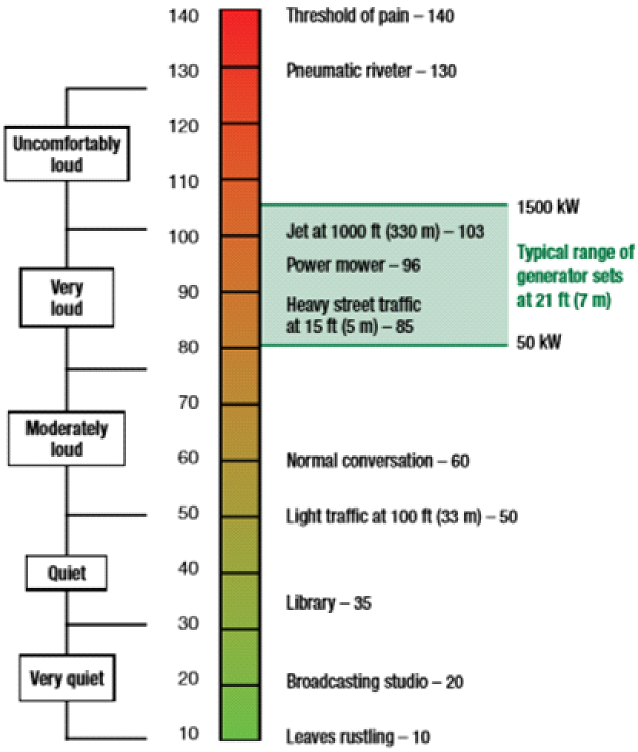


Figure 1: Typical noise levels (Aaberg, 2007)

The recorded sound levels were later transferred to Microsoft Excel and Statistical Package for Social Sciences (SPSS) 16.0 for analysis.

## Results and Discussion

Characteristics of generators used in the commercial shops varied from shop to shop and mostly depending on the capacity of the electrical devices being powered. The power rating of these generators ranges from 0.5 – 5.0 Kilo Volt Amperes (kVA). All the generators assessed were all portable petrol engine generators. There is no solid structure witnessed ır rigid support for the any of the portable ənerators observed. The ambient vibrations ere translated, this according to Jibiri et al. !015) causes noticeable vibration effect on the oor and any other thing in contact with it and ənce contribute to the noise level (Jibiri et al. )15). Without adequate vibration isolation of e sliding or skidding base on a generator and ı acoustic barrier, noise and vibrations will avel unopposed, in such a way that much of the ɔise are not damped in any way to reduce the ·oduced noise. The activities in the commercial ıops using the generators were so verse these clude hair dressing saloon (both male and male), beer parlour, business centres, phone ıarging centres, cassettes and video sale and ntal shops, electronic shops etc. Sound nitting from each of the generators was easured from five different points; the exhaust, stances of I m, 2 m, 3 m from the generator and osest distance of the generator from the ɔmmercial user. The maximum, minimum and average measured values are shown in Table 1.

**Table 1. Characteristics of noise produce by individual generators**

| Characteristics | Generator noise level at different distances (Decibels) | | | | |
|---|---|---|---|---|---|
| | At the exhaust | 1 meter | 2 meters | 3 meters | Closest distance to user |
| Maximum value | 123.60 | 96.70 | 95.20 | 95.00 | 91.10 |
| Minimum value | 90.40 | 75.70 | 73.00 | 71.00 | 65.00 |
| Mean | 109.86 | 85.95 | 83.09 | 80.68 | 81.69 |
| Variance | 42.93 | 17.19 | 18.94 | 21.17 | 29.09 |
| Standard deviation | 6.55 | 4.15 | 4.35 | 4.60 | 5.39 |

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It was observed that all the generators in this study were kept outdoors. The farthest distance measured from the commercial user was 7 meters whereas the shortest distance away from users 0.78 m. From the Table 1, the associated noise levels of the distances from the commercial user showed that maximum, minimum and average 91.10, 65.00 and 81.69 decibels respectively. Keeping the generator at short distance from the user was found in Jibiri et al. (2015) to give the users irritation, fatigue, back pain, due to the noise. The maximum values at the exhaust, distances of 1 m, 2 m, and 3 m were 123.60, 96.70, 95.20 and 95.00 decibels respectively whereas the minimum values at the exhaust, distances of 1 m, 2 m, and 3 m were 90.40, 75.70, 73.00 and 71.00 decibels. The minimum noise level of 71.0 dB obtained at a distance 3 m from the generator in this study was found to be lower than observation made in (Jibiri et al. 2015) that obtained lowest decibel of 85.33 ± 1.47 dB from the same distance (3 m). In another study (Stanley, 2011) where digital sound level meter was used to measure the noise levels from fossil fuel generators' used in Kaduna metropolis, Nigeria. The study showed that the measured noise levels were more often than not higher than the world health organization specified limits of 30 and 70 decibels for both indoor and outdoor cases respectively. In addition the high value obtained for the noise level measured at the exhaust as compared to in all other cases supports Aaberg (2007) statement that untreated generator set noise levels approach 100 dB or more, specifically without an exhaust silencer, noise produced at the exhaust ranges from 120 to 130 dB or more which can only be reduced by a minimum of 15 dB with a standard silencer. Whether the generator is continuously operated or only used occasionally in standby mode, the operating sound levels must be within ambient sound range. Across the row in Table 1 it is shown that the farther the distance away from the generator the lower the volume and intensity of noise. The same effect was recorded in Jibiri et al. (2015). In all values obtained in this study, noise at the exhaust was the highest. This does not imply that the usual sound from generators only come from the manifold exhaust gas outlet but from the working effects produced by six major sources, engine, cooling fan, alternator, induction and structural/mechanical noise. The total noise level from a generator set is the sum of all the individual sources, regardless of each unit frequency. Klinge (2000) explained that the magnetic field produces the circumferential forces needed for energy transfer in the generator and as well creates radial forces. Both the circumferential and radial forces interact with stator which is in contact with the generator frame are also energized. The vibration of the generator frame also affects the surrounding air, which is heard as noise (Klinge, 2000).

Producing sound is part of human nature however, the addition of sound to the environment beyond the natural sources and measured in terms noise intensity, the duration and frequency of occurrence is termed noise (Millers, 1979; Burtz, 1977). Analysis of the noise level from the various generators measured using typical noise levels scale by Aaberg (2007) (Figure 1) showed that at the exhaust 9.10% and 90.0% of the generator sound measured were very loud and uncomfortably loud respectively (Figure 1).

At a distance 1 m all the measurements taken were very loud (88 generators). At 2 m distance only 3 generators representing 3.4% of the measured generator sounds had moderately loud sound whereas the remaining 96.6% still read very loud. At a distance of 3 m, 8 representing 9.1% of the measured generators noise levels were moderately loud while 80 representing 90.9% where still very loud. The high level of sound recorded in this study is line with (Singh and Davar, 2004) that obtained highest generator noise level of 99 decibels. Effects of high noise levels found in earlier studies (Essandoh and Armah, 2011; Jibiri et al. 2015) causes sleep and rest disturbance which can also lead to headache, irritation, mood shifts and annoyance.

Exposure to excessive or repetitive noise over a long period of time can result in loss of hearing. Sound exposure to a level beyond the range of 70 to 75 decibels results in high blood pressure, abnormal foetal development, extreme emotions and behaviour (Osuntogun and Koku, 2007). Segerink et al. (2011) study also showed that the magnitude of the effect of vibration depends on the severity and length of exposures,

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though the impact which the noise effect manifest depends on physical, biodynamic and individual factors of the user.

**Table 2. Analysis of measured generator noise level at different distance on typical noise level scale**

| Characteristics | Very quiet (%) | Quiet (%) | Moderately loud (%) | Very loud (%) | Uncomfortably loud (%) |
|---|---|---|---|---|---|
| Noise at the exhaust | 0.0 | 0.0 | 3.4 | 9.1 | 90.9 |
| Noise at the at 1 m distance | 0.0 | 0.0 | 0.0 | 100 | 0.0 |
| Noise at the at 2 m distance | 0.0 | 0.0 | 3.4 | 96.6 | 0.0 |
| Noise at the at 3 m distance | 0.0 | 0.0 | 9.1 | 90.9 | 0.0 |

## Conclusions

The power supply challenges in the nation which seems not ameliorating encouraged more acquisition and utilization of generators in all sectors of the nation's economy. Noise emitting from these generators adversely affect both human and environment. The findings in this study showed that noise from portable generators used in the commercials centres were high. This implies that sounds from generators constitute environmental pollution. Wearing hearing protection devices in other to reduce the effect on the users may outright affect the relationship between the user and the customer as protection will block even human conversation. Consequently generator noise does not only affect human but also the natural environment also. Therefore building sound barriers in other to reduce the noise emitting from the generators will help reduce sound and hence the effect.

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