GRINDING MACHINE NOISE SPECTRA IN KADUNA METROPOLIS, NIGERIA

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ABSTRACT

When we are exposed to intense noise levels some or all of the hair cells in the organ of corti may be damaged temporarily or permanently. Exposure to excessive noise for a short period of time may produce a loss of heavy sensitivity. Continuous noise exposure over a long period of time (years) is more damaging than interrupted exposure to noise, which permits the ear to have a rest and possible recovery period. The presence of low frequency noise in the noise generated by grinding machines in Kaduna metropolis can have adverse effect on concentration and memory.Thus, this study was carried out to assess the grinding machine noice spectra in Kaduna Metropolis using sound level meter (Digital, Testo 816) and Digital Hand Data Logger (DB-525).

Keywords: *Noise level, temporary deafness, Sensitivity, A-Weight, Machinery*

INTRODUCTION

The ability of man to make and detect sound offers him the opportunity to communicate and receive valuable information such as sound alarm, music, television and many others from the environment. Noise generated from industrial use of machinery, airplanes, trucks, pumps, turbines, electricity generators, steam traps and others should be differentiated from those of the community. The major sources of community noise are highway traffic, aircraft, construction work, and distribution of transformer, railway trains, and factories from which noise escape to the surrounding areas (Onuu, 2001). On noise studies, emphasis is laid on the negative effects, that is, the pollution aspects. Noise can keep our senses on edge and thus can prevent us from relaxing. Our mental powers control this pollution to our bodies resulting into deafness over a long period of time. Also as an insidious pollutant, damage is usually long range and permanent, yet it is certainly the pollutant of least public concern and perhaps the least understood (Pickles, 1987)

With the advent of modern technologies, noise pollution from instruments and machines and other technological devices like internal combustion engines, a bus or helicopter and aircraft in general have become a major threat to the quality of human lives. These instruments and machines are used by human beings, but various studies have shown that if the noise level is far in excess of that required for the optimum arousal level for a particular task, works become irritable as well as less efficient. This irritability usually continues for sometime after the noise has stopped.

The simplest means to specify the maximum tolerable background noise is to specify maximum acceptable A-weighted level (Anderson and Halliwell, 1980). As the A-weighted level stimulates the response to the ear at low levels, and has been found to correlate well with subjective response to noise, and such specification, this is often found to be sufficient. In 1991, the Federal Environmental Protection Agency, FEPA, Nigeria rated noise sources as low, moderate, high and very high, according to the following values: less than 80dB(A), between 81 and 90dB(A), between 91 and 100dB(A) and greater than 100dB(A), respectively (FEPA, 1991). Specification such as 90dB(A) or less corresponds to 8hours exposure limits per day and is rated herein as moderate. Beyond this critical value of 90dB(A), is a threshold limit for the commencement of hearing damage.

The integration of the acoustic intensity over the encompassing spherical surface is achieved by determining time - average squared noise pressure at a discrete set of measurement points arranged uniformly. The noise power is calculated using the following equations (Agbendeh, 1999)

$$L_w = L_p + 20\log_{10} r + c\left(dBre10^{-12} w\right)$$

Where L_p is the noise pressure level in (dB), r is the mean radius of the hypothetical spherical surface encompassing the surface at the centre and c is a constant.

$$L_p = 10\log_{10}\left\{ \int_{1}^{N} 10^{\frac{L_p}{10}} \right\}$$

According to (Agbendeh, 1999), the OSHA recommended that the daily noise exposure for workers and neighborhood population should not exceed 90(dB) daily for 8 - hour working period. The recommended value for daily dose is at maximum of unity or one hundred percent. This is calculated using the equation:

$$Noise.Dose = 100\frac{C}{T}$$

Where T is the reference duration corresponding to the measured sound level and C is the total length of the working day in hours. The reference duration T is obtained using the equation:

$$T = \frac{8}{2^{\frac{L_p - 90}{5}}}$$

The noise level below which damage to hearing from habitual exposure to noise should not occur in a specified proportion of normal ears is known as the hearing damage risk criterion. To establish when the areas under investigation are in compliance with the recommended hearing deterioration index for 8-hour's exposure, the hearing deterioration index is calculated using the equation (Agbendeh, 1999).

$$HDI = 10\log_{10}\left\{\int_{t}^{t} 10^{\frac{L_p}{20}}\, dt\right\}$$

Where L_p is the noise pressure level in *dB* re pa and t is the time of exposure to habitune noise level in excess of 90(*dB*)

METHODOLOGY

In this work, measurements of noise pressure level were made using Sound Level Meter (Digital, Testo 816) and Digital Hand Data Logger (DB-525). The meter was mounted on tripod stand 1.5m high above the ground level and 3m away from the noise source in order to avoid recording the reverberant noise from other sources of noise. Measurements were performed at each measurement site by recording the noise pressure level at an interval of 10minutes. Ten readings were made at each noise source. The background noise was taken at every site when all the machines were switched off. To obtain the actual noise generated by the machines, the background noise was subtracted from the noise measured.

RESULTS AND DISCUSSION

Noise Spectra: The plots of grinding machine noise as a function of frequency are shown in figures 1 to 6. at Tudun Wada grinding machines, the noise intensity levels ranging from a minimum of 99dB at a frequency of 3,300Hz to a maximum of 109dB at a frequency of 1,800Hz for Atlas 3hp, 79dB as a frequency of 1,800Hz for Vicking 2hp and 101dB at a frequency of 200Hz to 109dB at a frequency of 2,400Hz for Mulan 3hp (fig. 1). At Kawo grinding machines, the noise intensity varies ranging from minimum of 99dB at a frequency of 3,800Hz to 112dB at a frequency of 800Hz for Yamaha 5 hp, 112dB at a frequency of 2,800Hz to 116dB at a frequency of 4,800Hz for Mulan 6hp and 100dB at a frequency of 3,300Hz and 4,800Hz to 110dB at a frequency of 1,800Hz 3,800Hz for Vicking 3hp (fig. 2)

At Ungwan Rimi grinding machines, the noise intensity varies ranging from a minimum of 96dB at a frequency of 1,300Hz to 108dB at a frequency of 3,800Hz for Honda 5dp, 105dB at a frequency of 1,800Hz to 108Hz at a frequency of 3,300Hz for Suzuki 5.3 hp and 100 dB at a frequency of 1,800Hz to 100dB at a frequency of 800Hz for Raja 6 hp (fig.3). The noise intensity varies at Malali grinding machines, ranging from a minimum of 101dB at a frequency of 500Hz to 109dB at a frequency of 800Hz for Honda 5 hp, 107db at a frequency of 4,800Hz to 110dB at a frequency of 2,400Hz for Mulan 6 hp and 102dB at a frequency of 4,800Hz to 112dB at a frequency 800Hz for Suzuki 5 hp (fig. 4).

At Kakuri grinding machines, the noise intensity varies ranging from minimum of 103dB at a frequency of 2,800Hz and 4,400Hz to 109 at a frequency of 500Hz for

Yamaha 5 hp, 101dB at a frequency of 4,800Hz to 111dB at a frequency of 500Hz and 3,300Hz for Atlas 5 hp and 105dB at a frequency of 1,800Hz and 2,800 to 112db at frequency of 3,800Hz and 4,800Hz for k Atlas 3 hp (fig. 5). At Barnawa grinding machines, the noise intensity varies ranging from a minimum of 102dB at a frequency of 800Hz to 105dB at a frequency of 3,300Hz for Atlas 3 hp, 102dB at a frequency of 3,800Hz and 4,800Hz to 114dB at a frequency of 1,300Hz for Vicking 3 hp and 100dB at a frequency of 800Hz to 103dB at a frequency of 4,400Hz for Mulan 3 hp (fig. 6)

Noise Power Level: The average noise power level radiated by grinding machines were found to be 123.98dBre10^{-12}W at Tudun Wada, 128 dBre10^{-12}W at Kawo, 124 dBre10^{-12}W at Ungwan Rimi, 125.98 dBre10^{-12}W at Malali, 125.97 dBre10^{-12}W at Nigerian Defense Academy (NDA) Mammy, 124 dBre10^{-12}W at Kakuri and 124.97 at Barnawa (fig. 7)

Noise Dose: The average noise dose in these areas were found to be 849% at Tudun Wada, 874.22% at Kawo, 803.33% at Ungwan Rimi, 874.22% at Malali, 874.22% at NDA Mammy, 874.22%, at Kakuri and 689.71% at Barnawa (fig. 8)

Hearing Deterioration Index: The hearing deterioration index computed in these areas were found to be 61.73 in Tudun Wada, 61.93 in Kawo, 61.53 in Ungwan Rimi, 61.93 in Malali, 61.93 in NDA Mammy, 61.93 in Kakuri and 61.03 in Barnawa (fig. 9). The high levels of noise associated with the grinding machines are as a result of the following:

(a) ***Poor installation of the machines:*** Some of these machines were poorly installed. Once the machine is not well balance on the floor or ground, vibration will occur which may result in the generation of noise when the machine is working.

(b) ***Poor maintenance of the machines:*** irregular servicing of the machine may result in generation of high level of noise by the machine. Some parts of this machinery prevent the shaft replaced periodically and once this is not done, rubs in rotating machinery prevents the shaft from moving or rotating in specified directions. Movement of parts of the machine in different directions level of noise.

(c) ***Ageing of the machines:*** due to the ageing of the machine, parts of its components especially the casing become the major sources of noise. Some of the machines studied in this work are old enough to be out of use. Most of the machines that have been developed for industrial purposes, for high speed transportation, to make life more enjoyable by furnishing additional comfort, reducing the drudgery of everyday living and speeding up our daily routines, and to provide additional leisure hours are usually accompanied by noise. Such noise affects humans in a number of ways, like their ability to communicate as well as their behaviours.

CONCLUSION AND RECOMMENDATIONS

When we are exposed to intense noise levels some or all of the hair cells in the organ of corti may be damaged temporarily or permanently. Exposure to excessive noise for a short period of time may produce a loss of heavy sensitivity. Temporary damage means that our hearing threshold level has shifted temporarily due to the noise exposure. Given adequate time for recovery in quieter environments, our hearing threshold returns to its original threshold level. Thus, a Noise Induced Temporary Threshold Shift (NITTS) occurs. A commonly used classification of hearing impairment is based on the average permanent threshold shift for 500, 1000 and 2000Hz measured in the lesser impaired of the ear.

A comfortable environment is one, in which there is little or no annoyance and distraction so that working or leisure tasks can be carried out unhindered either physically or mentally. Unfortunately, environmental noise has become a serious problem in Kaduna metropolis, and it is difficult to regulate by physical means alone. It is well known that environmental noise may affect sleep, conversation and cause annoyance as well as affect task performance. It is important to note that continuous noise exposure over a long period of time (years) is more damaging than interrupted exposure to noise, which permits the ear to have a rest and possibly recovery period. Powell and Forrest (1988) studied the effects of impulse noise from military weapons on long serving soldiers. They found that the continued strain led from temporary threshold shift to a permanent threshold shift. In the same manner, Admiral Rodney was reported to be deaf for a fortnight following continuous firing of eighty broadsides from the ship formidable in 1789 (Owen, 1995). At the battle of Copenhagen in 1801, an officer was also officially reported to have made permanently deaf from exposure to the discharge of cannons.

The presence of low frequency noise in figures 1 to 6 can have adverse effect on concentration and memory. Fatigue is one of the most cited effects of low frequency noise. Low frequency noise is capable to increase cortisol values, which is an indicator of stress. Other physical effect attributed to low frequency noise include, peripheral vasoconstriction, elevated blood pressure and greater risk of cardiovascular disease. The best way of reducing the noise levels of the existing noise sources is to reduce the noise level at the source - path - receiver. At the source, the noise level can be reduced by balancing the rotating masses, reducing the motion of the vibrating components, changing in the usual procedure of operation (reducing or suspending operation at night). At the transmission path, the noise level can be reduced by increasing the distance between the noise source and the receiver, use of sound absorption materials and erection of noise barriers.

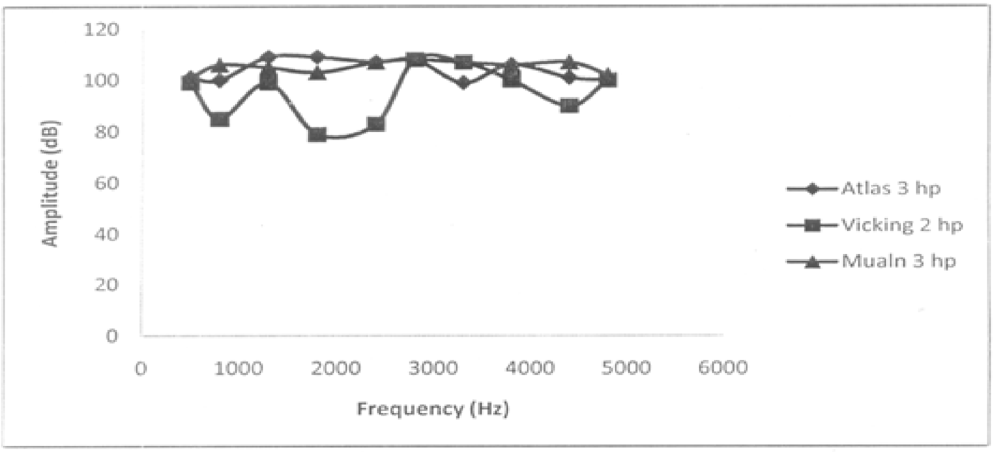

Fig. 1: Noise Spectra, Tudun Wada Grinding Machine Noise

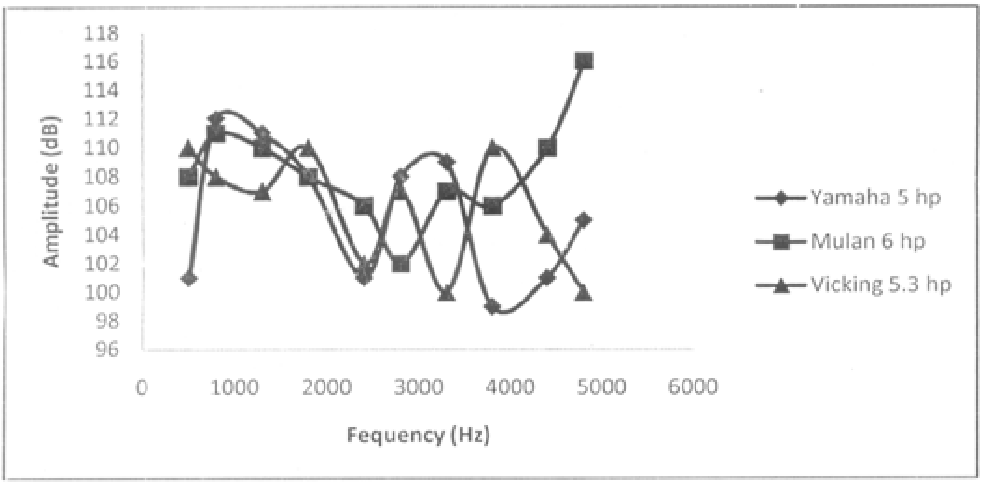

Fig. 2: Noise Spectra, Kawo Grinding Machine Noise

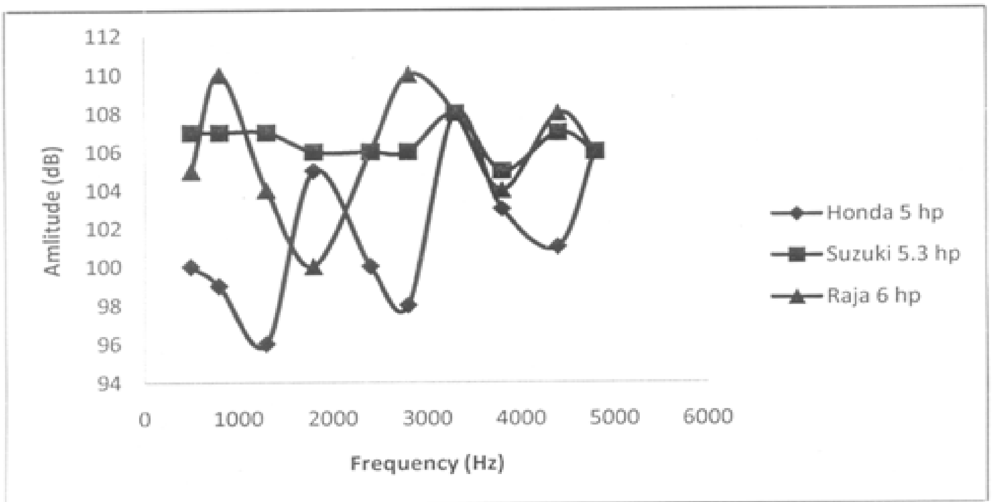

Fig. 3: Noise Spectra, Ungwan Rimi Grinding Machine Noise

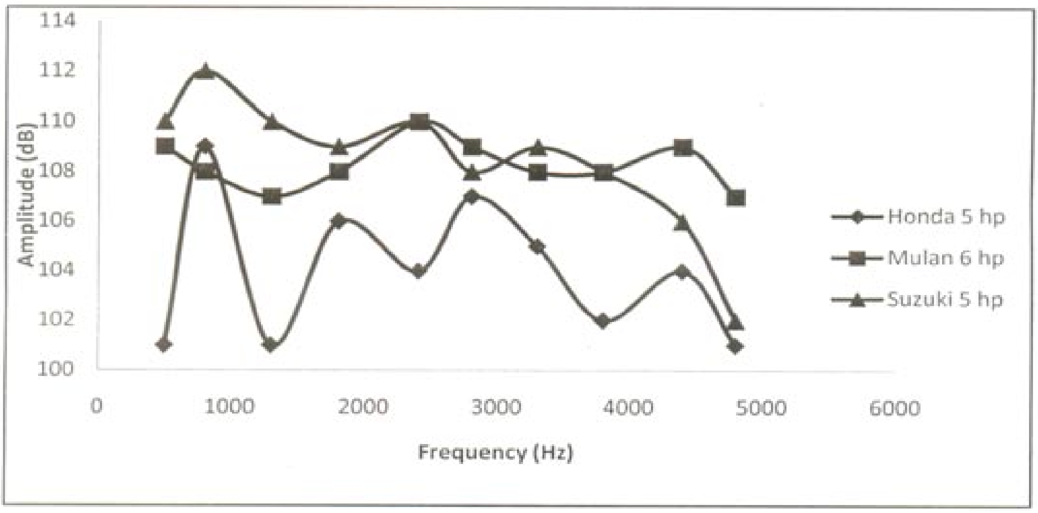

Fig. 4: Noise Spectra, Malali Grinding Machine Noise

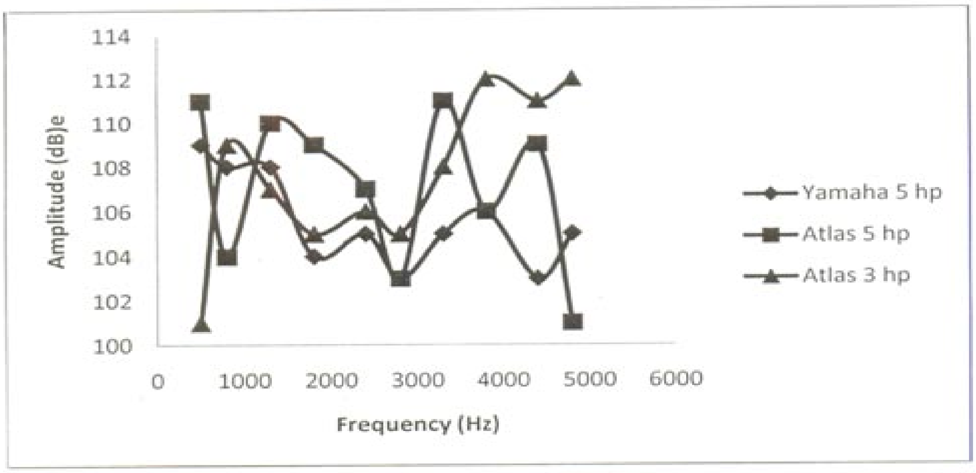

Fig. 5: Noise Spectra, Kakurii Grinding Machine Noise

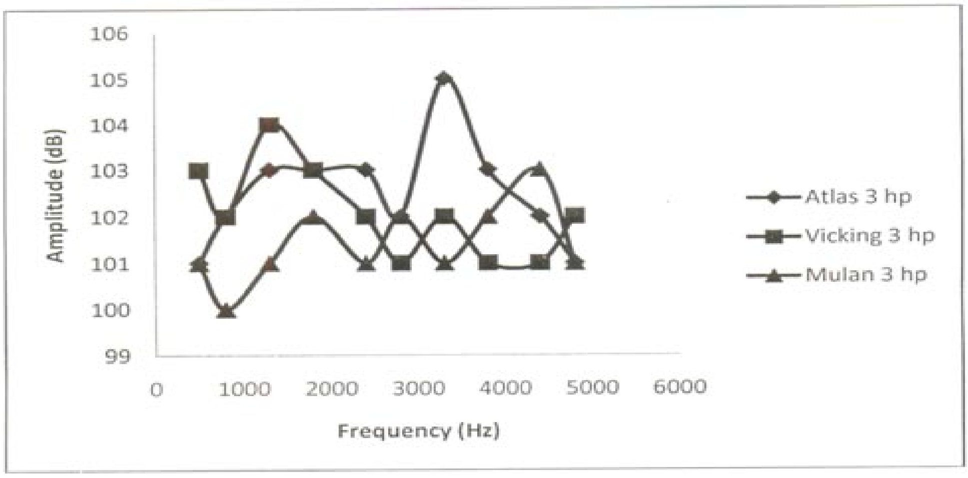

Fig. 6: Noise Spectra, Barnawa Grinding Machine Noise

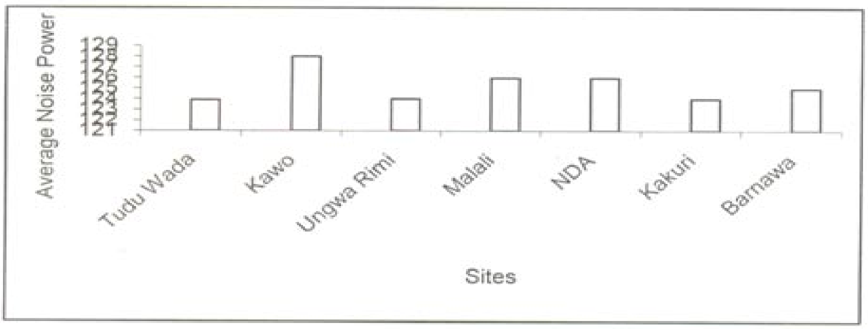

Fig. 7: Noise spectra, Average Noise Power

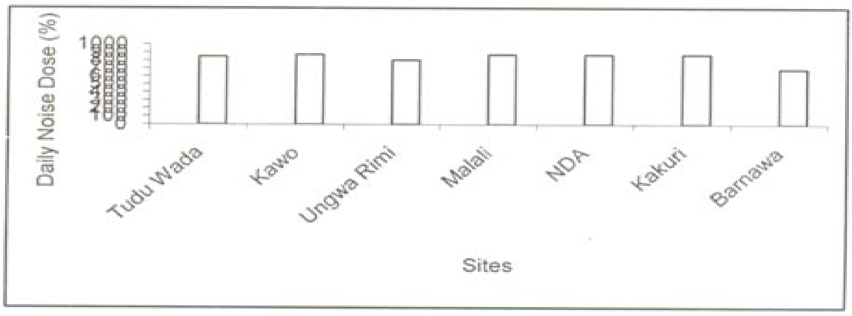

Fig. 8: Noise Spectra, Grinding Machine Noise Dose

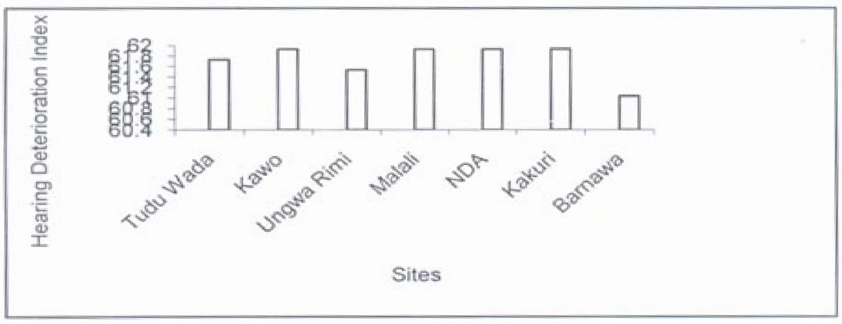

Fig. 9: Noise Spectra, Grinding Machine Hearing Deterioration Index

REFERENCES

Agbendeh, A. A. (1999). Designed, Fabrication and Testing of Digital Piezonoise Meter. Ph.D Thesis, Department of Physics, Bayero University Kano.

Anderson, D. and **Halliwell Z.** (1980). Noise from Vibration. Society of Automobile Engineers. Technical paper 800407.

International Standard Organisation ISO3745. Power Levels of Noise Sources.

Onuu, M. U. (2001). Prediction of Road Traffic Noise along Nigerian Highways: Effects of Atmospheric attenuation and Shielding. Journal of Applied Acoustics, 3, 34-45.

Owen, J. P. (1995). Noise Induced Hearing Loss in Military Aircrews. Journal of the Royal Army Medical Corps, 2 , 89-97.

Pickles J. O. (1987). An Introduction to physiology of Hearing. New York: Academic Press.

Powell, R. F. and **Forrest, M. R.** (1988). Noise in Military Environment. London: Bassey's Defense Publishers.