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Evaluation of Noise Pollution Levels in Aba Industrial Clusters of Abia State, Nigeria

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Abstract: ***A study of noise pollution levels of three Industrial Areas of Aba - : Old Aba Industrial Layout, Osisioma Industrial Layout and Ariria Leather Cluster have been carried out. The physical measurements were carried out with the use of two digital sound level meters and a handheld GPS. The noise pollution levels were obtained in three cardinal points at several distances from the major noise source in 52 locations. Results obtained showed that the mean noise pollution level for Aba old Industrial Layout ranged from 71.1±0.084 to 94.0 ±0.097dBA while those of Osisioma and Ariaria Industrial Clusters ranged from 82.2±0.091 to 89.0±0.094dBA and from 79.8±0.089 to 94.1±0.097dBA respectively. These values of noise pollution are not healthy for human hearing mechanism over long exposure. FEPA and OSHA recommended exposure limits for industries are 90dBA and 85dBA respectively for eight hours. The global recommended noise exposure limits by WHO is 75dBA. Those living and working in these environments may be at risk of noise induced health hazard due to continuous daily exposure. It is recommended that Government should review existing legislations on noise pollution and see how to improve on them so as meet up with current challenges in our environment as regards noise pollution.***

Keywords: Noise Pollution Levels, Sound Pressure Level, Industrial Clusters.

1. Introduction

Aba, as a commercial city in Abia State, Southeast Nigeria is known for rapid expansion and industrialization. The rapid industrialization of Aba has led to enormous noise pollution. Aba is a commercial town located between latitude, 5.1167°N and longitude, 7.3667°E. It has a population of 500, 183 (NPC, 2006). The production of irritating sounds with pitch higher than the human hearing capabilities is known as noise pollution (Gray, 2008). Loud continuous noise is a key characteristic of some industrial areas. The impacts of noise are everywhere and not only in industries. Noise pollution has been acknowledged as a major menace to the universal environment (Koffeman and Kerkers, 2000). Noise is the key cause of permanent hearing loss and annoyance (Koffeman and Kerkers, 2000). It is believed to be one of the key threats that besiege our environment and in future the price of alleviating noise pollution may perhaps be hard to attain (Anomohanran, 2013).

Any vibratory motion at frequencies between sixteen and twenty thousand Hertz produces audible sound and is normally transmitted to the ear through the pressure of the air waves (Liu and Roberts, 1999). Also, sound is readily transmissible through other solids, liquids, or gases. The velocity of sound is determined by the flexibility and concentration of the medium in which it is transmitted, while frictional damping largely decides the attenuation of sound (Liu and Roberts, 1999). Noise is a type of sound that is not desired or wanted (Abumere et al. , 1999). Loud sound harmful toward the ear is called noise not regarding its other properties. Hearing impairment and psychological stress are among the health hazards of noise, making it a form of pollution (Lui and Roberts, 1999). The factors influencing noise generally consist of three inter- related elements: transmission path, receiver path and the source.

A survey carried out by Srimenta and Chitralekha (2011) showed that 32 out of 52 people, experienced habitual sleeplessness and this is predominantly seen in those within the age bracket of 50 years and above especially the people that are poor with no sound proof system in their homes. They also discovered that noise aids the narrowing of the blood vessel which results in shortage of blood supply to the brain resulting in frequent headaches.

Rudolph (1990) put forward that the effect of high level noise produced by vehicles, market places, road, workplaces, etc, on pregnant women may lead to noise induced hearing loss as well as other health hazards in the fetus. He concluded that women exposed to 85dB and above of noise level during pregnancy are liable to give birth to children with hearing loss problems at the age of 4 to 10 years. Okeke and George (2015) reported that those living within Port Harcourt metropolis that experience continuous high level of noise may become deaf or suffer Noise Induced Hearing Loss (NIHL) which may be temporary or permanent after an extended duration of time. Abumere et al. (1999) investigated the environmental noise within Port Harcourt city metropolis and called for the need to employ noise control measures because the results of the measured levels of noise in the city are above the recommended FEPA limit.

Alao and Avwiri (2010) carried out a research on the noise levels associated with selected oil and gas installations in Ogba/ Egbema/ Ndoni Local Government Areas of Rivers State and reported that the combination of the sounds from machines in a factory can produce a great deal of noise. A study conducted by Omubo-Pepple (2010) in Nigeria reported that key causes of noise pollution in Port Harcourt metropolis came from loudspeakers mainly in social and religious gatherings, power generators and road traffic. The generally accepted standard to minimize hearing risk is based on an exposure of 90 dBA for a maximum limit of eight hours per day, followed by at least ten hours of

recovery time at 65 dBA or lower (Anomohanran, 2013). The recommended maximum noise level near residential area, hospitals and educational establishments is 65 dBA (Anomohanran, 2013). Noise researchers and other environmentalist need to know the noise level in an area before they can evaluate the effects of environmental noise and effective control measure to be taken in such area.

2. Materials and Method

Equipment used for this research work include two well calibrated digital sound level meter model IEC 651 TYPE II BK precision 732, model IEC 651 ANSI 51.4 TES-1350A and Global Positioning System(GPS) map reader (GPS 72H GARMIN). Prior to commencement of measurement, identification of the Industrial Clusters in Aba was carried out subsequent of which measurements of sound levels in these industrial zones at distances ranging from 10m, 50m, 100m, 200m, 250m and 300m from a majorly identified source of noise in three cardinal points: north, south and east of each cluster. Each industrial zone covers 18 locations. The fourth cardinal point could not be accessed because of physical barriers. The digital sound level meters were set on A – weighted scale because it is more suitable for industrial and environmental purposes. Measurements carried out within each zone were done by first identifying the major source of noise within the zone. Both minimum and maximum measurements for the two sound meters were also recorded with their average calculated. The sound level meter was held firmly with the microphone properly placed at a height of 1.2m above ground which is the approximate average ear to ground distance for a human being (Nwaogozie and Owate 2000). The digital sound level meter was set at slow response rate for effective measurement as this is the period of time it takes the instrument to display the average sound levels of that area. The measurements were taken between the hours of 9am to 6pm under good climatic conditions. This work was carried out in June 2017. The sound level meters was set at a range of 50 – 100 dB (A), 40 – 80dB (A) and 50 – 130dB (A) to accommodate the sound level of the area. All the readings were taken in dB (A) and the GPS reading for each location was recorded. The contour map of the area was obtained using Surfer 8 software.

The noise pollution level was obtained using the relation:

LNP = Leq + kσ (Avwiri and Nte, 2003)

Where:
- LNP = Noise Pollution Level
- k = Constant with a value of 2.565
- Leq = Equivalent energy level
- σ = Standard deviation of the acquire Leq values

The sound pressure level is obtained using

$L = 10log_{10}\left(\frac{P_1}{P_0}\right)^2 dB = 20\log\left(\frac{P_1}{P_0}\right) dB$

- L = sound pressure level
- P_1 = the given sound pressure
- P_0 = constant with value 2 x 10^{-6}Pa

3. Results and Discussions

Table 1 to Table 3below show the results of the noise level measurements as obtained for the three Industrial Clusters in Aba. The noise pollution levels in Aba old industrial layout ranged from 71.1± 0.084dBA to 94.0± 0.097dBA. Table 1. The noise pollution levels measured at Osisioma Industrial Layout ranged from 82.2± 0.091 dBA to 89.0± 0.094dBA. Table 2. The measurements of the third industrial cluster (Ariaria industrial layout) showed that the noise pollution level ranged from 79.8± 0.089 dBA to 94.1± 0.097dBA. Table 3. The computed Equivalent Energy level (Leq) showed that Aba old industrial layout had mean Leq of 65.6± 0.081dBA while Osisioma and Ariaria industrial clusters had 57.9± 0.076 dBA and 73.9± 0.086dBA respectively. These values are below the WHO and FEPA standards. The computed Sound Pressure Level (SPL) for the three clusters indicate that Aba Old Industrial Cluster had SPL ranged from 0.01 to 0.20 Pa while Osisioma and Ariaria Industrial Clusters had SPL ranged from 0.02 to 0.06 Pa and 0.03 to 0.29 Pa respectively.

Table 1: Leq, LNP, SPL and Average Noise Level of Aba Old Industrial Area

ABA OLD INDUSTRIAL AREA

	GPRS North	GPRS East	1ST METER	2ND METER				
			MEAN	MEAN	AVERAGE (Leqi)	Leq (α)	LNP	SPL
10m								
North	$05^0$06.956’	$007^0$22.304’	59.05±5.5	61.25±5.5	60.2	65.6	74.3	0.02
South	$05^0$07.318’	$007^0$22.456’	55.05±5.5	58.7±5.5	56.9	65.6	71.1	0.01
East	$05^0$07.289’	$007^0$22.550’	66.45±5.5	67.4±5.5	66.9	65.6	81.1	0.04
50m								
North	$05^0$06.965’	$007^0$22.439’	64.8±5.5	63.25±5.5	64.0	65.6	78.2	0.03
South	$05^0$07.394’	$007^0$22.443’	62.6±5.5	65.95±5.5	64.3	65.6	78.5	0.03
East	$05^0$07.294’	$007^0$22.575’	62.05±5.5	66.85±5.5	64.5	65.6	78.6	0.03
100m								
North	$05^0$07.033’	$007^0$22.424’	63.6±5.5	64.05±5.5	63.8	65.6	78.0	0.03
South	$05^0$07.437’	$007^0$22.436’	65.75±5.5	64.45±5.5	65.1	65.6	79.3	0.04
East	$05^0$07.268’	$007^0$22.587’	79.4±5.5	80.3±5.5	79.9	65.6	94.0	0.20
200m								
North	$05^0$07.092’	$007^0$22.468’	66.0±5.5	66.0±5.5	66.0	65.6	80.2	0.04
South	$05^0$07.468’	$007^0$22.443’	60.4±5.5	61.1±5.5	60.8	65.6	74.9	0.02
East	$05^0$07.232’	$007^0$22.599’	57.1±5.5	62.5±5.5	59.8	65.6	74.0	0.02
250m								

North	$05^0$07.205’	$007^0$22.395’	69.05±5.5	68.5±5.5	68.8	65.6	83.0	0.05
South	$05^0$07.479’	$007^0$22.494’	61.0±5.5	68.85±5.5	64.9	65.6	79.1	0.04
East	$05^0$07.224’	$007^0$22.642’	64.95±5.5	68.35±5.5	66.7	65.6	80.8	0.04
300m								
North	$05^0$07.283’	$007^0$22.466’	76.7±5.5	76.55±5.5	76.6	65.6	90.8	0.14
South	$05^0$07.489’	$007^0$22.542’	68.3±5.5	68.05±5.5	68.2	65.6	82.4	0.05
East	$05^0$07.203’	$007^0$22.652’	65.75±5.5	61.65±5.5	63.7	65.6	77.9	0.03
					1180.			

Table 2: Leq, LNP, SPL and Average Noise Level of Osisioma Industrial Area

	OSISIOMA INDUSTRIAL AREA							
			1ST METER	2ND METER				
	GPRS North	**GPRS East**	**Mean**	**Mean**	**AVERAGE (Leqi)**	**Leq (α)**	**LNP**	**SPL**
10m								
North	05^0 09.592’	$007^0$18.854’	68.15±7.4	69.9±7.4	69.0	57.9	88.0	0.06
South	05^0 09.515’	$007^0$18.888’	63.0±7.4	63.5±7.4	63.3	57.9	82.2	0.03
East	05^0 09.494’	$007^0$18.933’	56.3±7.4	64.05±7.4	60.2	57.9	79.2	0.02
50m								
North	05^0 09.709’	007^0 18.80’	60.05±7.4	67.6±7.4	63.8	57.9	82.8	0.03
South	05^0 09.427’	$007^0$18.925’	63.25±7.4	69.2±7.4	66.2	57.9	85.2	0.04
East	05^0 09.524’	$007^0$18.970’	65.95±7.4	65.3±7.4	65.6	57.9	84.6	0.04
100m								
North	05^0 09.816’	$007^0$18.760’	63.3±7.4	64.25±7.4	63.8	57.9	82.8	0.03
South	05^0 09.329’	$007^0$18.962’	67.2±7.4	64.75±7.4	66.0	57.9	85.0	0.04
East	05^0 09.546’	$007^0$18.991’	59.15±7.4	63.85±7.4	61.5	57.9	80.5	0.02
200m								
North	05^0 10.038’	$007^0$18.707’	66.45±7.4	66.25±7.4	66.4	57.9	85.3	0.04
South	05^0 09.198’	$007^0$19.015’	65.9±7.4	63.50±7.4	64.7	57.9	83.7	0.03
East	05^0 09.562’	$007^0$19.018’	64.9±7.4	65.40±7.4	65.2	57.9	84.1	0.04
250m								
North	05^0 10.137’	$007^0$18.774’	62.45±7.4	71.05±7.4	66.8	57.9	85.7	0.04
South	05^0 09.161’	$007^0$19.034’	65.25±7.4	64.35±7.4	64.8	57.9	83.8	0.03
East								
300m								
North	05^0 10.204’	$007^0$18.830’	64.35±7.4	70.55±7.4	67.5	57.9	86.4	0.05
South	$05^0$09.130’	$007^0$19.043’	70.70±7.4	66.30±7.4	68.5	57.9	87.5	0.05
East					1043.1			

Table 3: Leq, LNP, SPL and Average Noise Level of Ariaria Leather Cluster

ARIARA LEATHER CLUSTER			1ST METER	2ND METER				
	GPRS North	GPRS East	Mean	Mean	AVERAGE (Leqi)	Leq (α)	LNP	SPL
10m								
North	05^0 07.073’	$007^0$20.183’	77.85±4.3	79.9±4.3	78.9	73.9	89.90	0.18
South	05^0 07.065’	$007^0$20.191’	73.0±4.3	74.15±4.3	73.6	73.9	84.60	0.10
East	05^0 07.03’	$007^0$20.137’	75.5±4.3	74.3±4.3	74.9	73.9	85.92	0.11
50m								
North	05^0 07.105’	$007^0$20.161’	66.9±4.3	70.65±4.3	68.8	73.9	79.80	0.05
South	05^0 07.047’	$007^0$20.208’	74.45±4.3	75.65±4.3	75.1	73.9	86.07	0.11
East	05^0 07.015’	$007^0$20.150’	83.05±4.3	83.25±4.3	83.2	73.9	94.17	0.29
100m								
North	05^0 07.135’	$007^0$20.143’	71.8±4.3	77.55±4.3	74.7	73.9	85.70	0.11
South	05^0 07.018’	$007^0$20.237’	75.5±4.3	77.7±4.3	76.6	73.9	87.62	0.14
East	05^0 06.979’	$007^0$20.191’	72.45±4.3	70.85±4.3	71.7	73.9	82.67	0.08
200m								
North	05^0 07.164’	$007^0$20.119’	77.35±4.3	81.6±4.3	79.5	73.9	90.50	0.19
South	05^0 06.982’	$007^0$20.269’	72.25±4.3	76.45±4.3	74.4	73.9	85.37	0.10
East	05^0 06.944’	$007^0$20.228’	71.85±4.3	74.1±4.3	73.0	73.9	84.00	0.09
250m								
North	05^0 07.117’	$007^0$20.110’	74.25±4.3	75.9±4.3	75.1	73.9	86.10	0.11
South	05^0 06.971’	$007^0$20.279’	72.05±4.3	70.2±4.3	71.1	73.9	82.15	0.07
East	05^0 06.920’	$007^0$20.238’	60.54±4.3	67.1±4.3	63.9	73.9	74.90	0.03
300m								
North	05^0 07.191’	$007^0$20.102’	72.05±4.3	73.1±4.3	72.6	73.9	83.60	0.09
South	05^0 06.946’	$007^0$20.295’	73.2±4.3	74.4±4.3	73.8	73.9	84.82	0.10
East	05^0 06.892’	$007^0$20.255’	69.7±4.3	69.75±4.3	69.7	73.9	80.75	0.06
					1330.2			

Figure 1 shows the contour map of Noise Pollution Level of Aba Old Industrial Area, Figure 2 shows the contour map of Noise Pollution Level of Osiosioma Industrial Area and Figure 3 shows the contour map of Noise Pollution Level ofAriara Leather Cluster respectively. The contour maps as presented here were obtained using Sufer 8 software from the observed data.

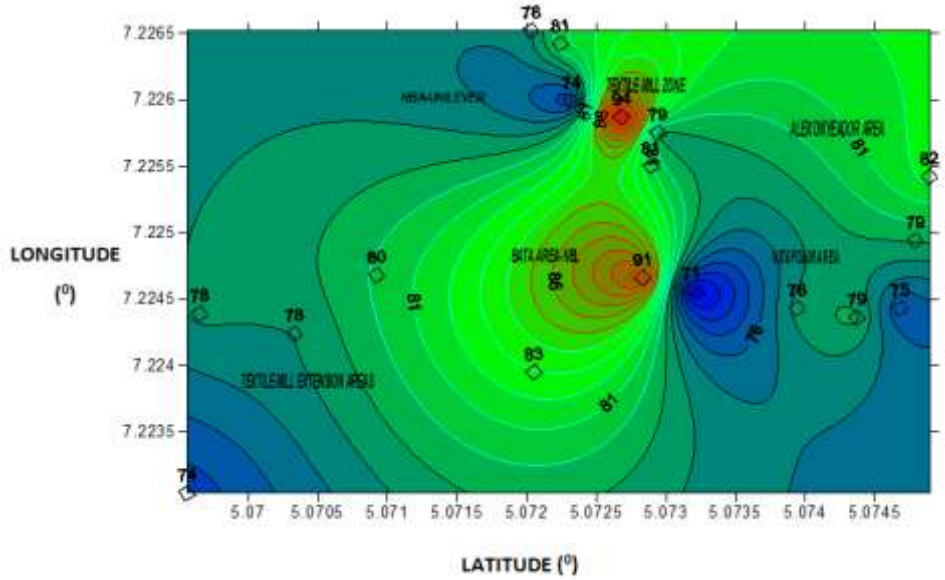

Figure 1: Contour Map of Noise Pollution Level of Aba Old Industrial Area

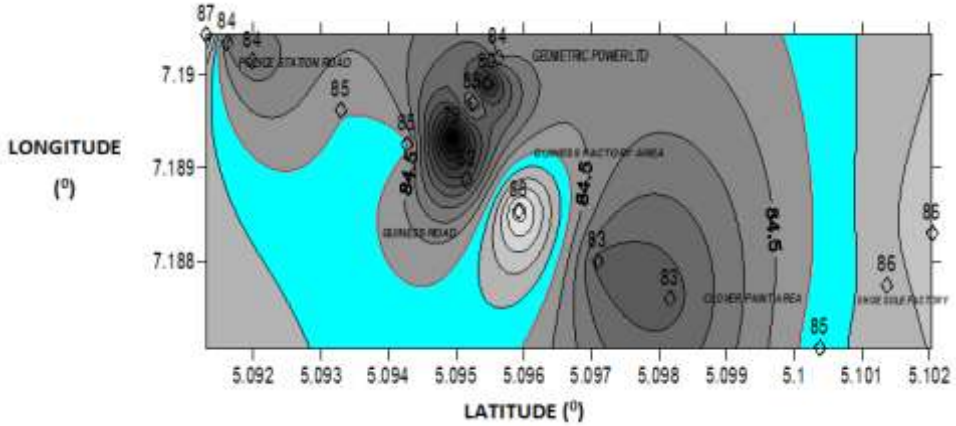

Figure 2: Contour Map of Noise Pollution Level of Osisioma Industrial Area

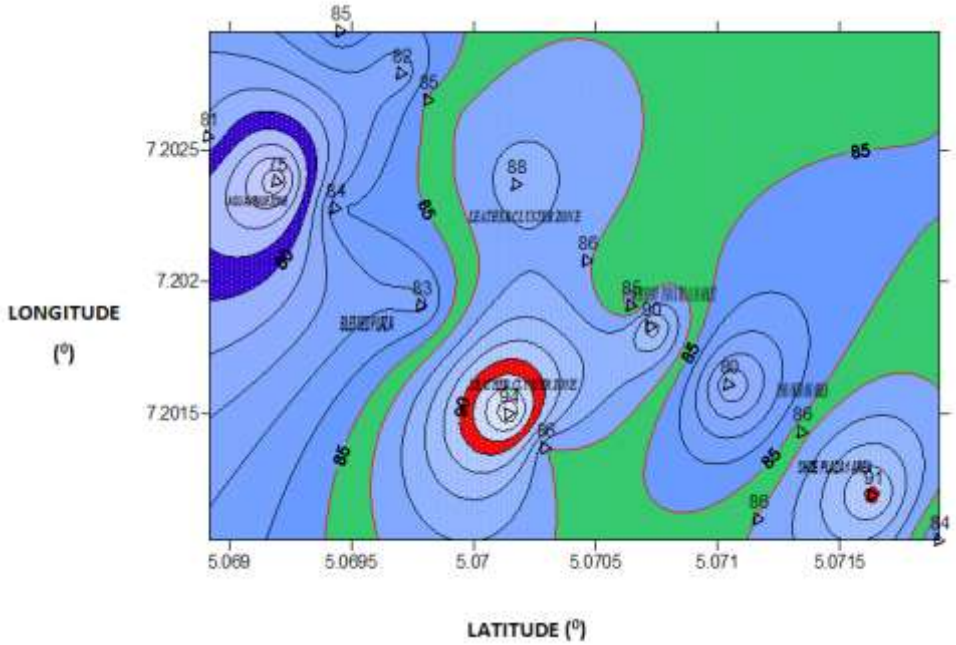

Figure 3: Contour Map of Noise Pollution Level Measurement of Ariara Leather Cluster

The respective maximum values of the noise pollution levels for the three industrial clusters (Aba old Industrial Layout, Osisioma Industrial Layout, and Ariaria Leather Cluster) were obtained at 94.0± 0.097, 89.0± 0.094 and 94.1± 0.097dBA. Aba old industrial layout and Ariaria leather cluster are above the Federal Environmental Protection Agency (FEPA) standard for industrial environment of 90 dBA while Osisioma industrial layout is slightly below the standard at 89.0 dBA. All the three industrial clusters are above the World Health Organization (WHO) standard of 75.0 dBA for industrial environment. The three industrial clusters exceeded the National Institute for Occupational Safety and Health (NIOSH) standard of 85.0dBA for industrial environment. Most of noise in these industrial clusters is generated by traffic noise and commercial activities in the area. This agrees with the findings of (Nelson, 1998) and (Oyedepo and Saadu, 2010) which states that the predominant source of noise in the environment is traffic noise. The highest level of noise pollution from the studied three clusters comes from Ariaria leather cluster with maximum LNP of 94.1 dBA due to the commercial activities carried out in this zone. This cluster is located at the center of Ariaria International Market and almost all the sources of noise are noticed from this zone. Noise from heavy traffic, generator noise, noise from different machines, noise from loudspeaker, noise from traders and buyers are all commonly seen this cluster. Continuous exposure from this level of noise can lead to permanent noise induced hearing loss and other consequences.

The maximum noise pollution level of 94.1 dBA in Ariaria leather cluster, 88.0dBA in Osisioma industrial cluster and 94.0 dBA in Old Aba industrial cluster are far higher than the values measured in Ogba/Egbema/Ndoni Local Government Area oil and gas field (Alao and Avwiri, 2010). It is in the range with the values measured in Port Harcourt metropolis (Abumere et al., 1999). It is also in the range of noise pollution measured in Abuja (Anomohanran, 2013) which also shows that the predominant source of noise is from traffic and commercial centers.

4. Conclusion and Recommendation

The evaluation of noise pollution level in Aba industrial cluster has been carried out in the three Industrial clusters of: Aba old industrial layout, Osisioma industrial layout and Ariaria leather cluster. The results showed that all the industrial clusters had noise levels that exceeded the WHO standard 50% of the time which made it dangerous to the health of individuals residing around these areas. The noise quality description of these clusters showed that the noise levels of these industrial clusters are not healthy for human health. Ariaria and Aba old industrial clusters had hazardous noise levels while Osisioma industrial cluster had unsatisfactory noise level. Continuous exposure to these noise qualities may lead to hearing impairment which may gradually lead to Noise Induced Hearing Loss (NIHL) which may be temporary or permanent. It is hereby recommended that there should be massive public campaign against noise in our cities. Those working in a noisy environment with noisy machine should wear protective devices and spend less time in such environment to allow proper recovery time for the ear. Finally, Government should review existing legislations on noise pollution and see how to improve on them so as meet up with current challenges in our environment as regards noise pollution.

Appendices

Table 4: Noise Quality Description (Day time)(Anomohanran, 2013)

Leq (dBA)	Noise quality description
0 – 30	Excellent quality
31 – 40	Very good quality
41 – 60	Good quality
61 – 75	Satisfactory quality
76 – 90	Unsatisfactory quality
91 – 110	Hazardous quality
Above 111	Not allowed

Table 5: FEPA's Exposure Guidelines of Noise for Nigeria (FEPA, 1999)

Duration per day(hours)	Permissible exposure limits(dB(A))
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Table 6: Permissible Noise Levels of Different Environments (WHO, 1998)

Types of environment	Allowable sound (dB(A))
Working environment(eight hours per day)	75
Bedroom inside at night	35
Indoor background level to ensure good speech intelligibility	45
	55
Outdoor level at daytime	45
Outdoor level at night	35
Conference room	40
Offices	50
Laboratory measurement room	75
Production area (factory)	

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