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Determination of noise levels with respect to distance at selected workshops/factories in Itu Local Government Area of Akwa Ibom state, Nigeria

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Abstract: *The measurement of noise levels with distances at selected workshops/factories in Itu Local Government Area of Akwa Ibom State, Nigeria was carried out. The noise levels measurements were made using a sound level meter, while distances were measured with a measuring tape. Firstly, the background noise levels (or noise levels without power generators and other noise makers from the workshops/factories) with distances were taken. Noise levels with power generators and other noise makers were then measured. Finally, the equivalent continuous noise levels, L_{eqs} for them were calculated. The results of the survey show that the equivalent continuous noise level, L_{eq} which is a measure of energy content of the noise decreases as the distance from the noise source increases, hence degree of bother (or annoyance) decreases with distance.*

Keywords- *Determination, distances, equivalent continuous noise levels, Itu Local Government Area, sound level meter.*

I. Introduction

As with all pollutants, noise degrades the quality of our environment and is known to produce many adverse effects both on humans and structures. Noise has escalated to the point where it is now a major threat to the quality of our life. This increase in noise can be attributed to the ever increasing population of the world and the rising levels of economic affluence [1]. Noise is defined as unwanted sound, consequently it can be considered as the wrong sound in the wrong place at the wrong time. The degree of "unwantedness" is frequently a psychological matter since the effects of noise can range from moderate annoyance to permanent hearing loss, and may be rated differently by different observers. Therefore, it is often difficult to determine the benefits of reducing a specific noise. Noise does affect the inhabitants, humans, fauna, etc, in the natural environment. Although the impact of a particular noise source is limited to a specific area, noise is so pervasive that it is almost impossible to escape from it. Community Social surveys almost always rate noise among the most annoying environmental nuisances [2]. The rate at which environmental noise pollution is increasing in Itu Local Government Area of Akwa Ibom State, Nigeria needs a critical study. Environmental Protection Agency (EPA) of the United States of America recognised noise as a problem back in the 1970s. The EU Directive (86/188/EEC) is on the protection of workers from the risks related to exposure to noise at work. The objective of the directive is to reduce the level of noise experienced at work by taking action at the noise source. The EU 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 [2]. The British Columbia Work's Compensation Board (WCB) has set 85 dB as its maximum exposure limit in the work place. Above this level hearing protection should be worn. Its state that the threshold of pain is reached at 120 dB and it classifies 140 dB as extreme danger. World Health Organisation (WHO) values are similar while Environmental Protection Agency (EPA) tends to have even a stricter standard of 70 dB as a maximum safe noise level in work place. They gave the safe level around home to be 50 – 55 dB. Studies have found that steady noise above 50 dB gives moderate annoyance and above 55 dB serious annoyance at home. For health and safety reasons in a non-work environment, 55 dB is set as a safety level for outside and 45 dB inside. Hospital and school safe levels are 35 dB. Findings also show that the noise exposure limits in decibels for industrial workers in Nigeria are the same in dBA as that of the US Department of Labour as shown on Table 1.1 [3].

Table 1.1: Noise exposure limits for industrial workers in Nigeria

Exposure Time (h/day)	Permissible Exposure Limits in dB
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

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 [4]. The hearing process consists of a number of separate processes. It should be noted that no simple and unique relationship exists between the physical measurement of sound and the human perception of the same sound [2]. The hearing damage potential of a given noise source depends not only on its level but also on its duration. It is generally accepted that a sound environment below 75 dB is not harmful (although much lower levels can cause annoyance and disturb sleep), while a single sound above 140 dB may produce permanent hearing damage. Between these two levels, the amount of hearing damage varies with the sound level, the length of exposure and the individual's susceptibility to noise. Other contributing factors are the number and length of quiet periods between exposures, the type of sound (continuous, intermittent or impulsive) and its frequency distribution. Sounds with most of their energy in the speech frequencies are more damaging. The EC Directive (86/188/EEC) on the protection of workers from the risks related to exposure to noise at work is incorporated into the laws of EC Member States [5]. It specifies that certain actions must be taken where the daily personal exposure (eight hour equivalent) of a worker to noise is likely to exceed 85 dBA or where the maximum value of the unweighted instantaneous sound pressure is likely to be greater than 200 P_a, equivalent to 140 dB. In 1999, the World Health Organisation concluded that the available evidence shown suggested a weak associated between long term noise exposure above 67 – 70 dB(A) and hypertension [6]. More recent studies have suggested that noise levels of 50 dB(A) at night may also increase the risks of myocardial infarction by chronically elevating cortisol production [7]. According to Lesser W. Sontag of the Fels Research Institute (as presented in the pamphlet authored by the U.S Environmental Protection Agency in 1978); "there is ample evidence that environment has a role in shaping the physique, behaviour and function of animals including man from conception and not merely from birth. The foetus is capable of perceiving sounds and responding to them by motor activity and cardiac rate change". Noise exposure is deemed to be particularly pernicious when it occurs between 15 and 60 days after conception, when major internal organs and the central nervous system are formed. Later developmental effects occur as vasoconstriction in the mother reduces blood flow and hence oxygen and nutrition to the foetus. Low birth weights and noise were also associated with lower levels of certain hormone in the mother, these hormones being thought to affect foetal growth and to be a good indicator of protein production. The difference between the hormone levels of the pregnant mothers in noisy versus quiet areas increased as birth approaches. Children who live in noisy environments have been shown to have elevated blood pressures and elevated levels of stress induced hormones. Studies also suggest that when women are exposed to 76.5 dB aircraft noise, a small decrease in birth weight occurs [7]. Shouted conversations at the same distance are possible up to about 85 dBA. To permit normal conversations at distances of about five metres would require a background noise level below 50 dBA. Satisfactory telephone conversations need background levels less than about 80 dBA [2]. 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 [8]. According to a WHO task group, daytime noise levels of less than 50 dBA outdoors cause little or no serious annoyance in the community[9]. Intermittent or impulsive noises are particularly disturbing. Because of differences between people and locations, it is difficult to determine the noise level below which sleep interference will not occur [2]. Noise levels above 80 dB are associated with both an increase in aggressive behaviour and a decrease in behaviour helpful to others. The news media regularly report violent behaviour arising out of disputes over noise; in many cases these disputes end in injury or death [10].

II. Materials and Methods

Some workshops/factories and companies were identified around the place. Measurements of noise levels from them as they vary with distance were carried out. All the noise measurements were made using the sound level meter (SLM), model TES 1350A with ½ inch electret condenser microphone. This model has both

A and C weightings and 0.1dB resolution with fast/slow response. It has high and low measuring ranges 35 to 100 dB and 65 to 160 dB respectively. Measurements were taken by setting the sound level meter to A-weighting network in all the sampling locations. The wind speed and direction relation to the microphone was considered. This is because at higher wind speed (i.e above 5 m/s) turbulent noise caused by the wind may mask the noise source being measured. This implies that valid measurements can be taken in wind speed up to 5 m/s. Measurement may be acceptable with wind speeds up to 10 m/s. In general the peaks of wind noise should be at least 10 dB below the noise source being measured [2]. Hence, during sound level measurements, windshield was always used (i.e. for outdoor measurements). Slow response was used for comparatively stable noise measurement. For instance, work place noise level measurements were taken on slow response. Here, the response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Fast response was used for fast varying noise. Measurements of workplace sound pressure were made in the undisturbed sound field in the workplace, with the microphone located at the position normally occupied by the ear exposed to the highest value of exposure [11]. All noise level measurements were made using the sound level meter, while distance measurements were made using a measuring tape. Finally, the equivalent continuous noise levels, L_{eqs} for them at a particular distance, d were calculated using the formula [2]:

$$L_{eq} = 10 \log_{10} \{ {}^{1}/_{T} (10^{0.1LG} \Delta T_G + 10^{0.1LB} \quad \Delta T_B) \}$$

where, T = 5 minutes; ΔT_G = 2 minutes ;ΔT_B= 3 minutes; L_G= Generator noise level in dBA
L_B=Background noise level in dBA.

III. Results and Discussion

3.1 Akwa Ibom Broadcasting Corporation Transmitting Station, Ntak Inyang

Table 3.1: Noise levels and distance measurements from a 300 kVA Perkins power generator (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	36.0	92.0	56.0	**52.1**
10	37.0	86.3	49.3	**45.7**
15	36.9	81.3	44.4	**41.4**
20	39.0	75.7	36.7	**38.2**
25	36.7	73.6	36.9	**36.8**
30	35.5	72.3	36.8	**36.1**
35	35.9	70.6	34.7	**35.5**
40	36.1	68.9	32.8	**35.1**
45	37.9	65.8	27.9	**36.0**
50	40.0	63.9	23.9	**37.9**
55	40.2	62.5	22.3	**38.0**
60	40.1	60.7	20.6	**37.9**
65	40.4	59.8	15.4	**38.2**
70	40.0	58.8	18.8	**37.8**
75	38.2	58.1	19.9	**36.0**
80	39.0	56.7	17.7	**36.8**
85	39.5	55.9	16.4	**37.3**
90	38.3	53.2	14.9	**36.1**
95	37.6	48.6	11.0	**35.4**
100	**35.2**	**50.9**	**15.7**	**33.0**

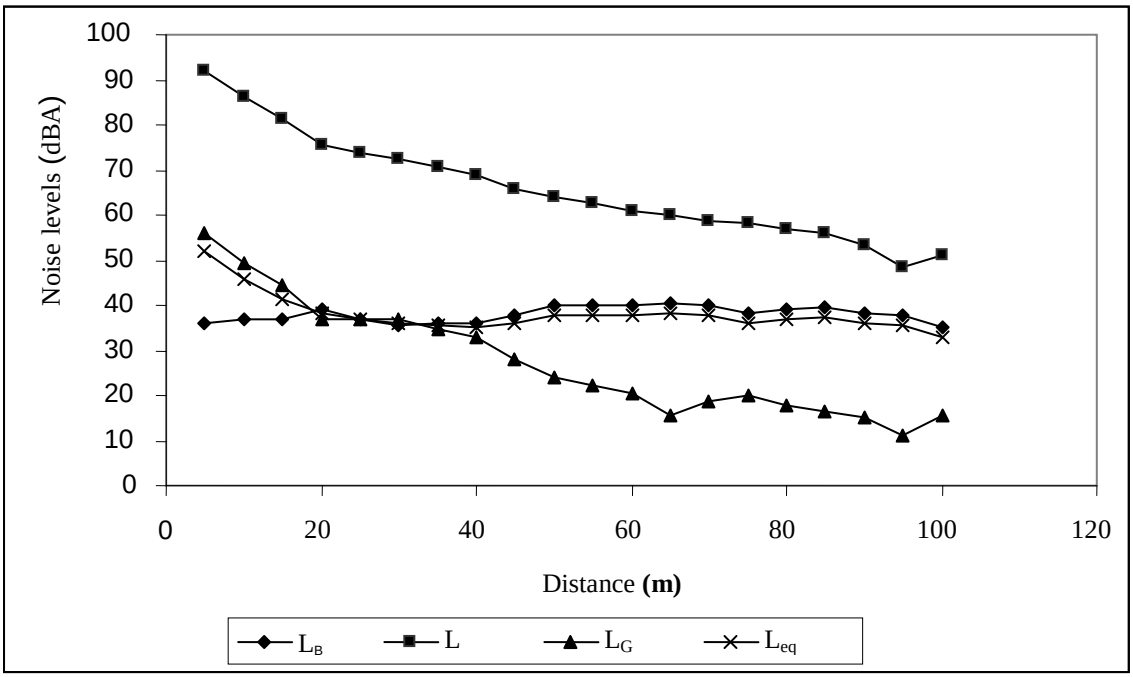

Figure 3.1: A plot of a 300 kVA Perkins power generator noise levels against distance

Table 3.2: Noise levels and distance measurements from a 375 kVA Perkins power generator (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	35.9	96.6	60.7	**56.7**
10	35.5	90.9	55.4	**51.5**
15	35.6	86.8	51.2	**47.4**
20	36.2	82.9	46.7	**39.7**
25	37.0	79.3	42.3	**39.9**
30	36.9	75.7	38.8	**37.8**
35	35.8	70.4	34.6	**35.4**
40	36.0	68.9	32.9	**35.0**
45	36.9	64.5	27.6	**35.0**
50	38.6	61.1	22.5	**36.5**
55	39.0	62.0	23.0	**36.9**
60	39.9	60.7	20.8	**37.7**
65	40.2	58.8	18.6	**38.0**
70	39.3	55.0	15.7	**37.1**
75	39.6	53.8	14.2	**37.4**
80	40.7	59.0	18.3	**38.5**
85	39.0	57.1	18.1	**36.8**
90	36.8	54.0	17.2	**34.6**
95	38.3	50.9	12.6	**36.1**
100	**39.1**	**48.8**	**9.8**	**36.9**

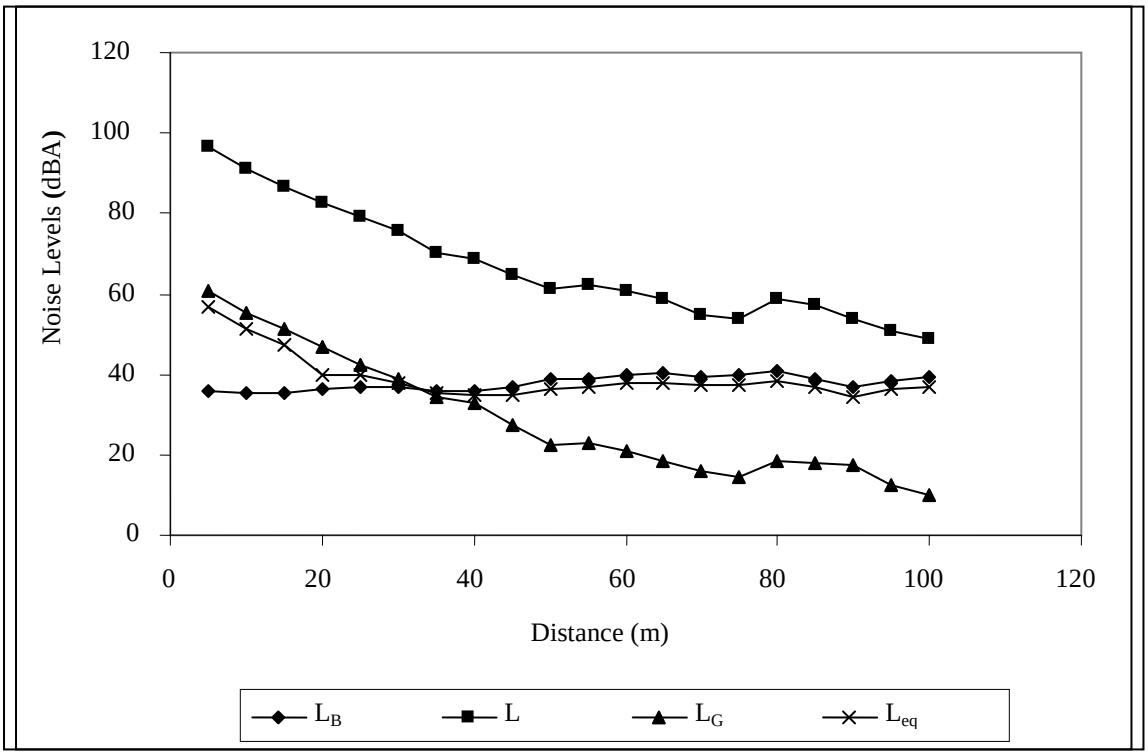

Figure 3.2: A plot of a 375 kVA Perkins power generator noise levels again distance

Table 3.3: Noise levels and distance measurements from a 500 kVA Perkins power generator (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	35.6	99.6	64.0	**60.0**
10	35.4	92.1	56.7	**52.8**
15	36.0	87.6	51.6	**47.8**
20	36.5	83.2	46.7	**43.3**
25	40.3	76.0	35.7	**39.0**
30	40.0	74.8	34.8	**38.6**
35	38.1	72.7	34.6	**37.0**
40	36.2	71.6	35.4	**35.9**
45	36.0	69.9	33.9	**35.3**
50	36.2	68.0	31.8	**34.9**
55	36.0	66.0	30.0	**34.4**
60	35.0	65.3	30.3	**33.7**
65	35.1	64.0	28.9	**35.5**
70	41.1	62.6	21.5	**38.9**
75	38.2	61.8	23.6	**36.1**
80	37.6	60.0	22.4	**35.5**
85	38.0	58.0	20.0	**35.8**
90	39.6	56.7	17.1	**37.4**
95	39.1	55.0	15.9	**37.1**
100	**40.2**	**52.2**	**12.0**	**38.0**

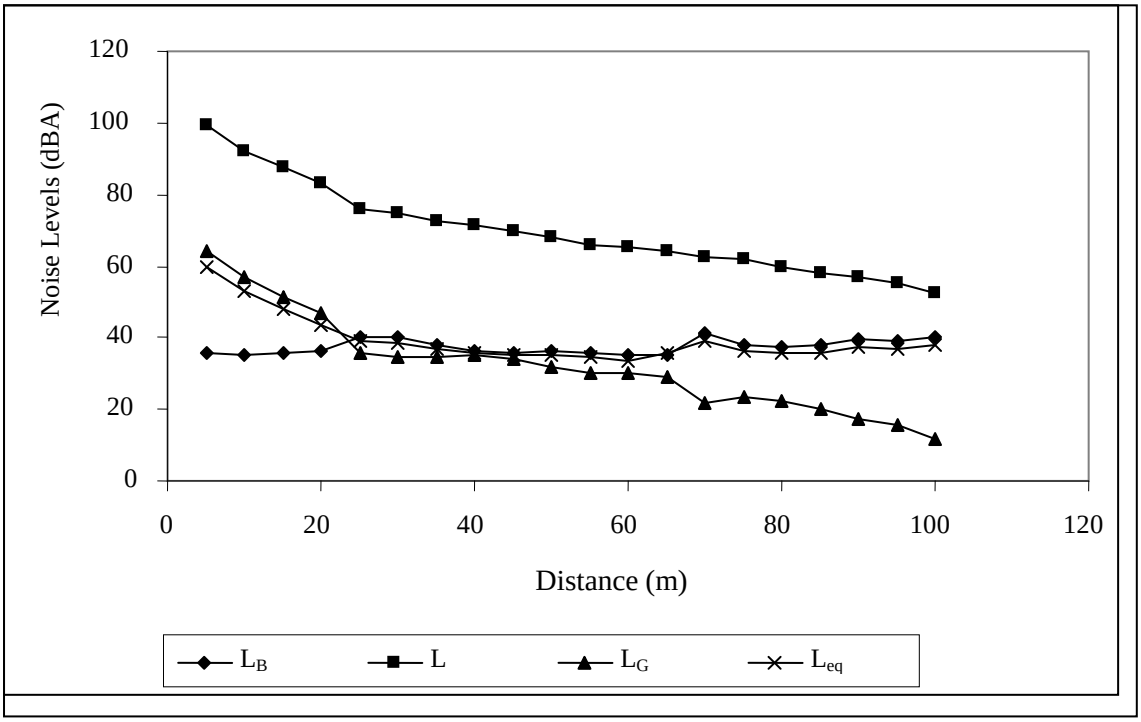

Figure 3.3: A plot of a 500 kVA Perkins power generator noise levels against distance

3.2 UPTECH Metal Construction Works, 180 Calabar-Itu Express Way

Table 3.4: Noise levels and distance measurements from a 100 kW Sifang power generator and other noise makers in UPTECH metal construction works (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	35.9	89.7	53.8	**49.9**
10	36.2	86.2	50.0	**46.3**
15	36.0	82.8	46.8	**43.3**
20	36.8	78.9	42.1	**39.7**
25	36.1	74.7	38.6	**37.3**
30	38.0	70.6	32.6	**36.5**
35	37.8	67.5	29.7	**36.0**
40	40.2	66.7	26.8	**38.1**
45	38.5	64.9	26.4	**36.5**
50	37.6	61.3	23.7	**35.5**
55	38.0	58.4	20.4	**35.8**
60	37.8	55.5	17.7	**35.6**
65	38.1	52.8	14.7	**35.9**
70	39.0	49.1	10.1	**36.8**
75	36.6	48.8	12.2	**34.4**
80	35.8	43.6	7.8	**33.6**
85	35.0	41.3	6.3	**32.8**
90	36.1	44.9	8.8	**33.9**
95	36.3	42.2	5.9	**34.1**
100	**36.0**	**39.9**	**3.9**	**33.8**

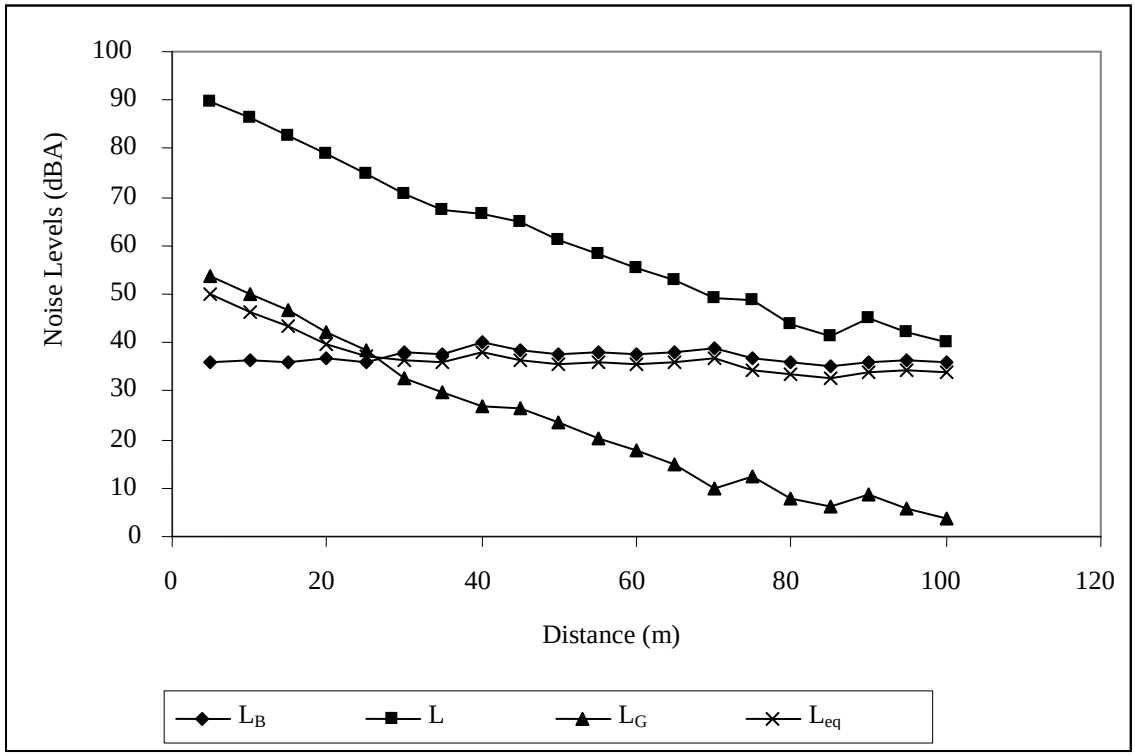

Figure 3.4: A plot of noise levels against distance for a 100 kW Sifang power generator and other noise makers in UPTECH metal construction works

Table 3.5: Noise levels and distance measurements from another Sifang power generator and other noise makers in UPTECH metal construction works (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	36.5	84.6	48.1	**44.5**
10	35.5	80.1	44.6	**41.6**
15	36.9	78.9	42.0	**39.7**
20	40.0	76.0	36.0	**38.8**
25	38.7	73.6	34.9	**37.5**
30	36.3	70.4	33.1	**35.3**
35	35.5	67.8	32.3	**34.5**
40	35.7	64.3	28.6	**34.0**
45	35.9	61.9	26.0	**34.0**
50	35.5	57.2	21.7	**33.4**
55	36.0	57.4	21.4	**33.9**
60	35.9	56.7	20.8	**33.8**
65	36.3	54.9	18.6	**34.6**
70	36.8	53.8	17.0	**34.6**
75	40.0	55.9	15.9	**37.8**
80	41.2	54.9	13.2	**39.0**
85	39.1	47.9	8.8	**36.9**
90	38.7	47.0	8.3	**36.5**
95	38.9	43.9	5.0	**36.7**
100	**42.3**	**43.6**	**1.3**	**40.1**

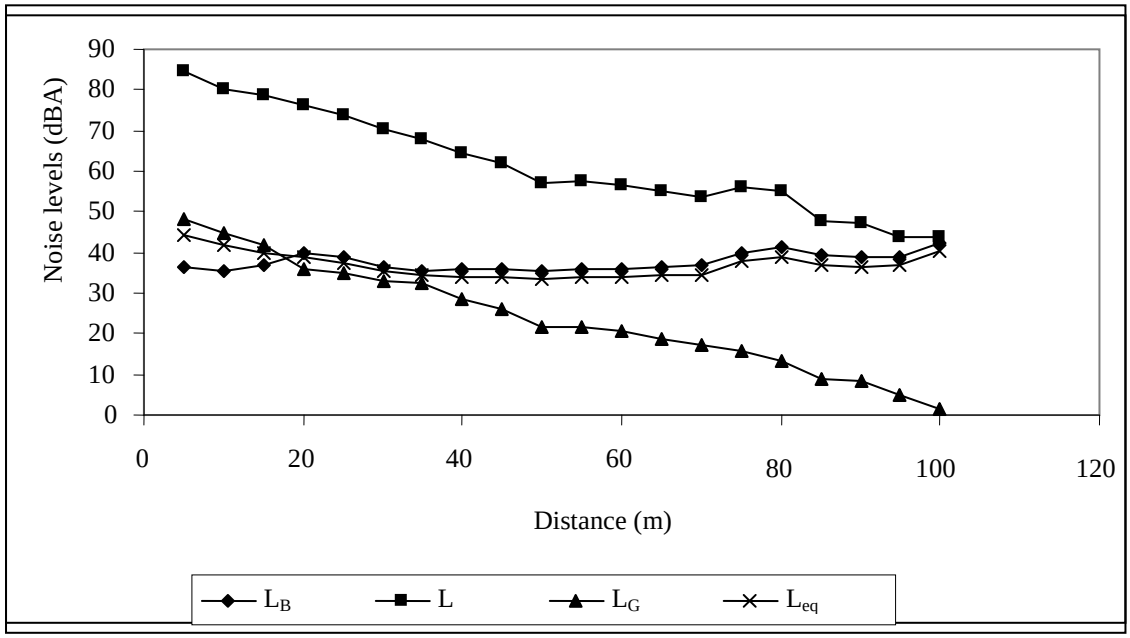

Figure 3.5: A plot of noise levels against distance for another Sifang power generator and other noise makers in UPTECH metal construction works

Table 3.6: Noise levels and distance measurements from three Sifang power generators and other noise makers in UPTECH metal construction works (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	36.8	118.0	81.2	**77.2**
10	36.9	110.6	73.7	**69.7**
15	36.0	101.9	65.9	**61.9**
20	35.7	94.3	58.6	**54.7**
25	35.5	91.5	56.0	**52.1**
30	36.3	86.7	50.4	**46.7**
35	37.4	84.7	47.3	**43.9**
40	38.5	83.0	44.5	**41.9**
45	38.0	78.9	40.9	**39.4**
50	38.8	76.8	38.0	**38.5**
55	38.5	75.0	36.5	**37.8**
60	39.2	72.8	33.6	**37.7**
65	38.9	68.1	29.2	**37.0**
70	37.0	61.9	24.9	**35.0**
75	40.0	63.4	23.4	**37.8**
80	36.9	60.8	23.9	**34.8**
85	39.6	63.3	23.7	**37.5**
90	43.5	62.8	19.3	**41.3**
95	45.3	58.1	12.8	**43.1**
100	**45.1**	**59.9**	**14.8**	**42.9**

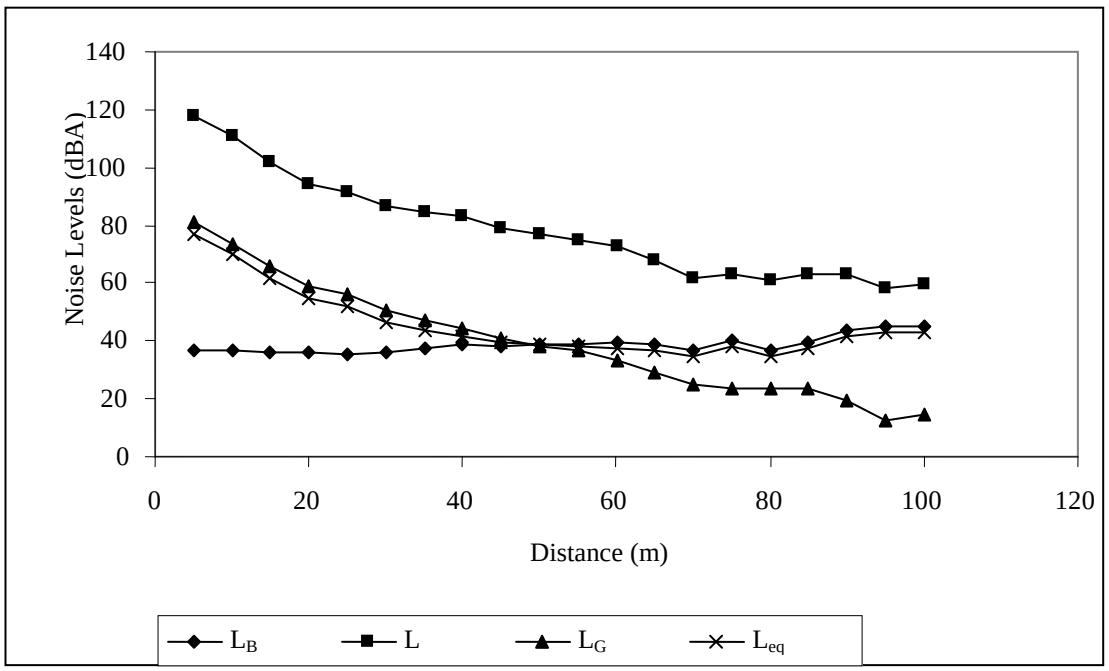

Figure 3.6: A plot of noise levels against distance for three Sifang power generators and other noise makers in UPTECH metal construction works

3.3 Holy Saviour Water Company, Ikot Ekwere Itam

Table 3.7: Noise levels with distances from Holy Saviour water company (2010)

Distance, d (m)	Background Noise, L_B (dBA)	Noise Level with Generator, L (dBA)	Generator Noise Level, L_G (dBA)	Equivalent Continuous Noise Level, Leq (dBA)
5	38.2	76.9	38.7	**38.4**
10	36.5	74.6	38.1	**37.2**
15	35.8	70.8	35.0	**35.5**
20	37.0	66.3	29.3	**35.2**
25	37.1	63.7	26.6	**30.8**
30	36.9	59.2	22.3	**34.8**
35	38.4	57.5	19.1	**36.2**
40	41.0	55.0	14.0	**38.8**
45	42.3	52.0	9.7	**40.1**
50	40.8	50.7	9.9	**38.6**
55	39.7	51.4	11.7	**37.5**
60	44.2	55.3	11.1	**42.0**
65	51.6	57.1	5.5	**49.4**
70	55.0	55.0	0.0	**52.8**
75	49.9	54.7	4.8	**47.7**
80	49.1	53.6	4.5	**46.9**
85	49.8	55.6	5.8	**47.6**
90	51.3	56.0	4.7	**49.1**
95	52.2	55.8	3.6	**50.0**
100	**53.8**	**55.6**	**1.8**	**51.6**

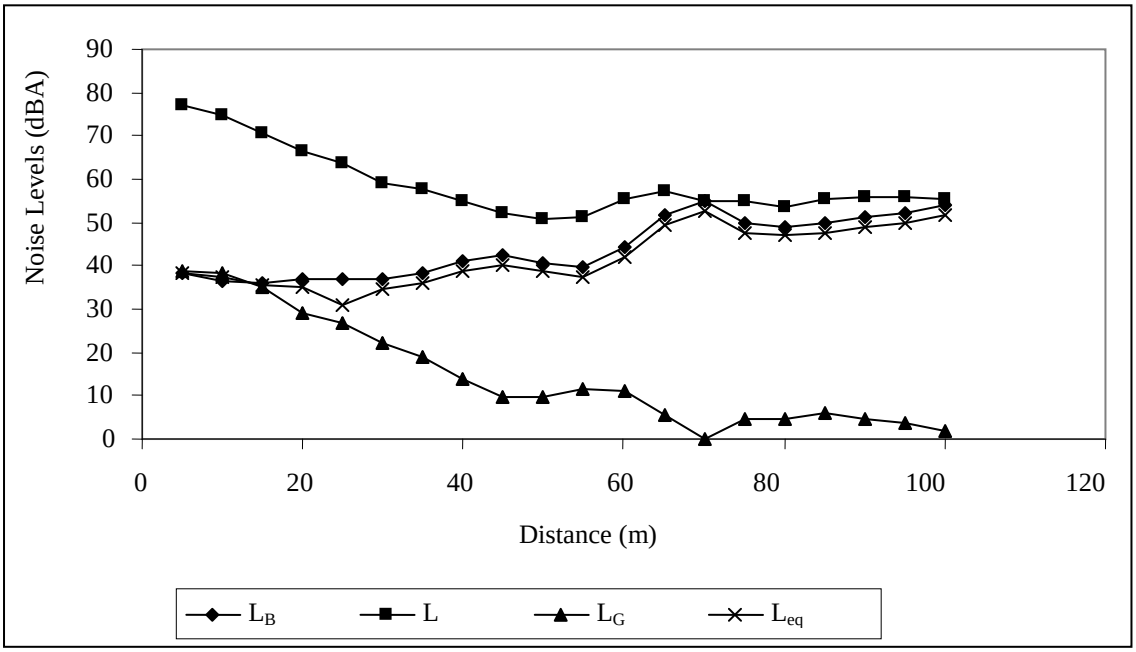

Figure 3.7: A plot of noise levels against distance in Holy Saviour water company

IV. Discussion

The results of the survey (Table 3.1 and Fig. 3.1) show that when the power generator is switched off, the area is conducive for both the workers and the residents. But when the generator is in use, noise emitted affects the people up to a distance of 80 metres away from it. At a distance of 5 metres from the generator, a total noise level of 92.0 dBA is recorded. This level (92.0 dBA) is above the World Health Organization (WHO) standard of 85 dB in a work place. Hence, the workers should be advised to use ear protector and they should not be exposed to it beyond duration of 8 hours per day as stated in Table 1.1. The adverse effects of the generator noise become more prominent at areas where it level and the equivalent continuous level are greater than the background noise level. At a distance of 85 metres away from the generator, a total noise level of 55.9 dBA is recorded. This level (55.9 dBA) is 0.9 dBA above the WHO standard level of 55 dB for a non work environment. It has a generator noise level of 16.4 dBA and an equivalent continuous level of 37.3 dBA. From about a distance of 90 metres away, the residents do not have a generator as their major source of noise. Table 3.1 and Fig. 3.1 also show that the total noise level, the generator noise level and the equivalent continuous level fall as distance increases. Table 3.2 and Fig. 3.2 show that a sound wave from a source is attenuated or decreased with distance. With this generator in use, its noise affects the residents up to a distance of 85 metres away from it. At this distance (85 metres), the total noise level is 2.1 dBA above the WHO standard of 55 dB for a non work place. At a distance of 5 metres away from the generator, the total noise level is 96.6 dBA which is above WHO standard of 85 dB in a work place. This level of noise should not be endured beyond the duration of 2 hours per day [3]. The equivalent continuous noise level of this generator at a distance of 5 metres is greater than that of 300 kVA generators at the same distance by 4.6 dBA. The results of the finding show that the noise level when the generator was in operation is 99.6 dBA at a distance of 5 metres away from it. This level is 14.6 dBA above the WHO standard level of 85 dB in a work place and 44.6 dBA above the safety level of 55 dB for a non work place. The adverse effects of the generator noise are extended to a distance of 90 metres away from it. At this distance a total noise level of 56.7 dBA instead of the WHO standard of 55 dB for a non work environment is recorded. Here, the residents from about 95 metres away from the generator, in the direction of the measurements do not have the generator as one of the major sources of noise. The results of the finding (Table 3.3 and Fig. 3.3) show that the total noise level with generator in use, the generator noise level and the equivalent continuous noise level decrease as the distance increases. The results (Table 3.4 and Fig. 3.4) of the findings show that at distances of 5 metres a total noise level of 89.7 dBA is recorded. Out of the 89.7 dBA, 53.8 dBA comes from the workshop while 35.9 dBA comes from the background. During the survey, it was observed that this workshop affects the residents seriously as its generators are located at distances of less than 5 metres away from some houses. Its adverse effects are extended to distances of about 60 metres where a total noise level of 55.5 dBA is recorded. From a distance of about 65 metres, the workshop may not necessarily be the significant noise source to the residents. The results of the study (Table 3.5 and Fig. 3.5) show that the noise

emanating from the workshop when this power generator is put to use and other noise makers adversely affect the residents up to distances of 60 metres with a total noise level of 56.7 dBA which is 1.7 dBA above the safety level of 55 dBA for a non-work environment. Also the results show that the workshop is not a major source of noise from distances of about 65 metres away. With the simultaneous operation of three generators and other noise 'makers' the results show that the noise pollution of UPTECH Metal Construction Work extends to distances beyond 100 metres. This is because at this distance, the total noise level is 59.9 dBA which is 4.4 dBA beyond the WHO standard of 55 dB for a non-work place. Fig. 3.6 also shows that noise levels of the UPTECH Metal Construction Work decrease as distance from the noise sources increases. The results of the noise survey (Table 3.7 and Fig. 3.7) have revealed that the generator noise of this company adversely affects the residents up to a distance of 35 metres which has a total noise level of 2.5 dBA higher than the WHO standard of 55 dB for a non-work environment. Here the impact of the noise is not much. From a distance of about 40 metres, the generator noise is less significant. Clearly, the results show that the generator sound level is 0 dBA at a distance of 70 metres. This implies that beyond this distance the generator sound has no adverse effects on the populace. Also, the results of the findings show that sound level decreases as distance increases.

V. Conclusion

It is concluded from the survey that the equivalent continuous noise level, L_{eq} which is a measure of energy content of the noise decreases as the distance from the noise source increases, hence degree of bother (or annoyance) decreases with distance.

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